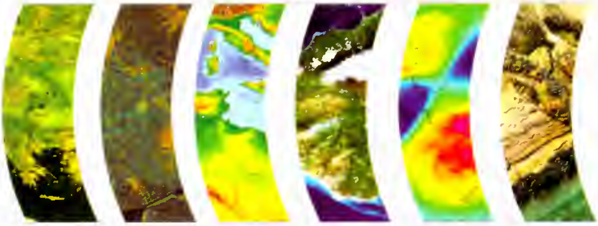
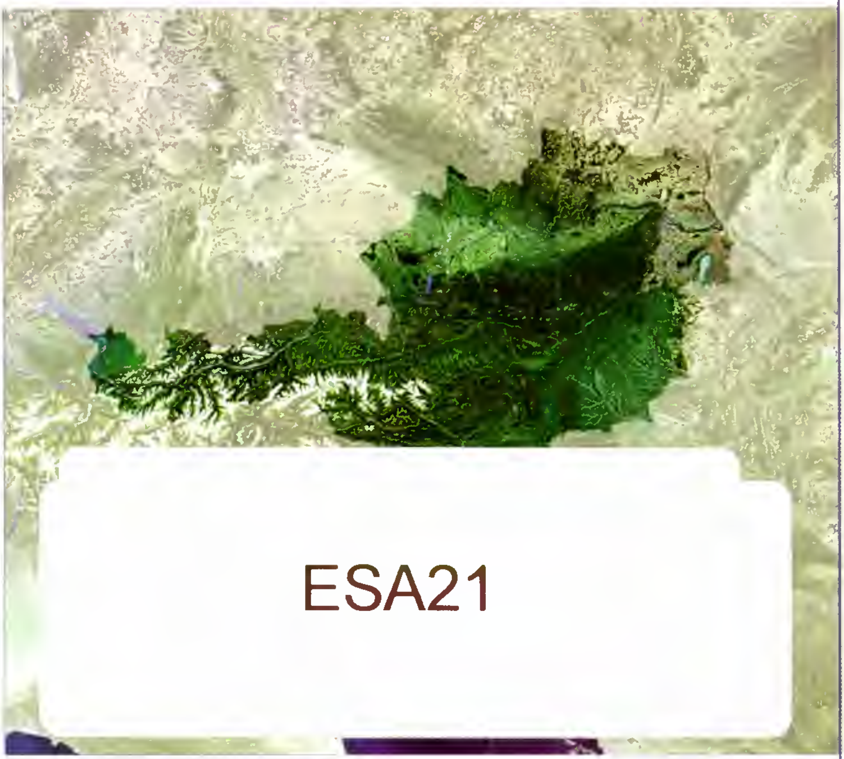
esa

ENVISAT SYMPOSIUM



ABSTRACT & PROGRAMME BOOK



ESA21

6 • 10 SEPTEMBER 2004 SALZBURG • AUSTRIA

European Space Agency
Agence spatiale européenne

the Living Planet

2004 Envisat & ERS Symposium

Programme & Abstract Book

6 – 10 September 2004
Salzburg, Austria

European Space Agency
Agence spatiale européenne

2004 Envisat & ERS Symposium
Salzburg, Austria
6 – 10 September 2004

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Symposium Objectives

Introduction

The 2004 ENVISAT Symposium follows the previous successful Symposia in Gothenburg (2000), Florence (1997), Hamburg (1993) and Cannes (1992).

Objectives

The main objectives of the ENVISAT Symposium are:

- to provide a forum for investigators to present results of on-going research project activities;
- to review and assess the development of applications and services.

The Symposium is opened to all interested parties, from scientists to operational users, working on the exploitation of the ESA Earth Observation missions. The Symposium will allow to review the scientific benefits of both the ENVISAT mission and the 13 years long ERS missions. The Symposium is the main forum for the reporting of the ESA Principal Investigators working on the Third Announcement of Opportunity for ERS Data (AO3), the ENVISAT Calibration and Validation, the ENVISAT Announcement of Opportunity and the on going Category-1 projects. The Symposium is also the main forum for the reporting of scientists and operational users of Envisat data working in the framework of European, national and international projects. The Symposium also features a number of special sessions in particular a session dealing with the transfer from research to applications and a session adressing the underlying science required for the ESA/EU initiative on Global Monitoring for Environment and Security (GMES). We wish all participants a fruitful symposium and a nice week in Salzburg.

The Envisat Symposium Organising Committee

Committees

Symposium Organising Committee

H. Laur, Chairman
G. Elfering, ESA Conference Bureau
S. Cheli, Communication
Y.-L. Desnos, Scientific Programme
H. Lacoste, Editor – Proceedings
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S. Santer - Universite' du Littoral, France
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C. Schmullius - Friedrich Schiller University Jena, Germany
M. Shimada - JAXA, Japan
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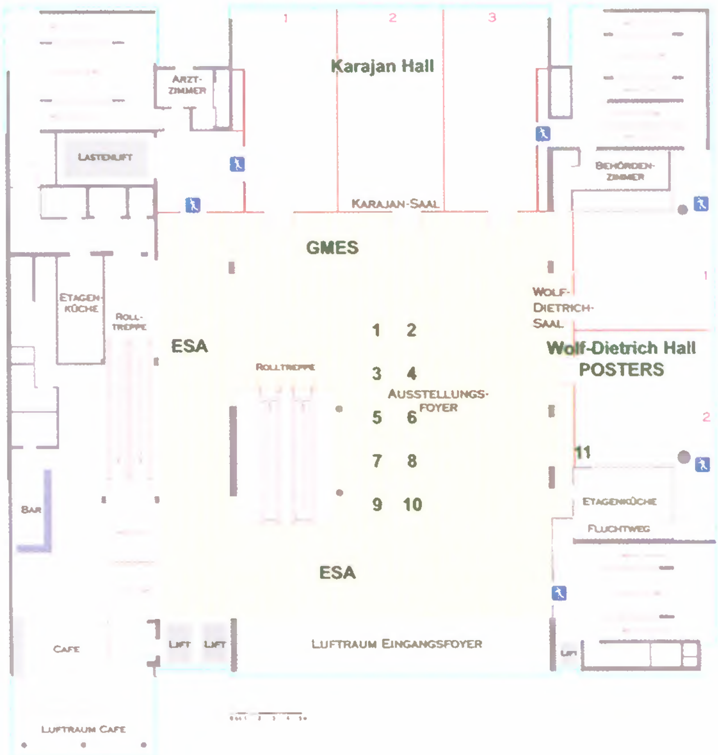
H. Skriver - Technical University of Denmark, Denmark
Y.M. Timofeyev - St. Petersburg State University, Russia
R. Touzi - Canada Centre for Remote Sensing, Canada
P. Vachon - Canada Centre for Remote Sensing, Canada
M. Verstraete - JRC
G. Wadge - ESSC, UK
W. Wagner - Vienna University of Technology, Austria
U. Wegmuller - Gamma Remote Sensing, Switzerland
H. Yesou - SERTIT, France
A. Zakharov - Institute of Radioengineering and Electronics - RAS, Russia
Zengyuan Li - MOST - Minister of Science and Technology of China, China

Exhibition, 6-9 September 2004

Exhibitors at Envisat 2004

1. Austrian Space Agency
2. ICEMON
3. Advanced Computer Systems
4. Kongsberg Spacetec
5. Gamma Remote Sensing
6. Geoville Informations
7. CREASO GmbH
8. Altamira Information
9. Brockmann Consult
10. SPOT Image
11. DLR

Floor Plan



Author Information

Paper Submission

The deadline for the submission of final papers for the Symposium Proceedings is 10 September.

Presentation Guidelines

Oral Presentations

Please note: the official language of the Symposium is English.

What shall be the duration of each presentation?

Each oral presentation has an allocation of 20 minutes, inclusive of 5 minutes discussion and change over. The program indicates lecture room and time-slot for each contribution.

How to present?

Computer files (e.g. powerpoint, interactive presentations) will be projected using the Local Desktop Computer and PC/Video Projector.
Should there be any specific presentation request (e.g. Overhead Projector), such information must be provided before the beginning of the Symposium to the ESA Conference Bureau.

How to upload presentations on the local Desktop Computer?

During the Symposium: Should you not be able to upload your presentation on the dedicated web site, presenters can still submit their final presentation up to 2 hours before the start of the relevant session **in the Speaker's Secretariat room**.

How to correct an uploaded presentation?

Presenters can edit and modify their presentation and upload the new version again on the web site; late changes can be made in the file on the PC's located in the Secretariat room.

When to check the presentation installed on the local Desktop PC?

Presenters can access the lecture room where their presentation will be held, 30 minutes before the start of the relevant session.

Please consider the following timetable for checking the presentation:

08.10-08.40	For presentations between 08.40-10.20
10.20-10.50 (coffee break)	For presentations between 10.50-12.30
13.30-14.00 (lunch break)	For presentations between 14.00-15.40
15.40-16.10 (coffee break)	For presentations between 16.10-17.50

What shall a presenter do before the start of his/her session?

Presenters are invited to contact their chairmen or their session's secretary before the start of the session.

What equipment is installed in each lecture room?

The lecture rooms are equipped with:
one PC/Video projector
a Desktop Computer (Software installed - in English- will include Windows XP, PowerPoint 2003 and Acrobat Reader)

Poster Presentations

When/where is the poster session?

Posters will be on display all day in the Poster Area, the day of the corresponding Oral Session. Coffee breaks will be served close to the Poster Area to offer an additional opportunity for poster viewing. The formal Poster Session will be held daily from 18.00 to 19.30 in the Poster Area, where a drink will be offered to all the attendees, to make the session also a social event.
Poster authors are therefore requested to be in stand-by close to their posters during the Poster session and preferably also during the coffee breaks.

What shall be the poster format?

The poster panels are 98 cm wide and 2.00 m. high.

When to mount the posters?

Please consider the following table for mounting/dismounting the posters:

08.10-08.40	For poster mounting
19.30-20.00	For poster dismounting

How to identify the poster?

Each poster has an assigned id as specified in the program to enable its identification.

What will happen after the end of the poster session?

After 20:00 the remaining posters will be discarded.

What equipment is available in the Poster area?

All the material necessary for attaching the poster to the poster board will be available in the Poster Area.

		Opera
Monday 6 (Day 1)	14 30-17 15	**1A: Plenary Opening Session**

			Mozart 4-5	Mozart 1-2	Doppler	Mozart 3	Trakl	Karajan 1-2-3
Tuesday 7 (Day 2)	08 40-10.20	Poster Session	2A1 : SAR Signal Processing Quality and Performance *Meadows - Pasquali*	2A2 : MERIS Performance and Products Quality *Fischer - Pinty*	2A3 : Atmosphere Overview (1) *Burrows - Simon*	2A4 : AATSR Performance and Products Quality *Barton - Llewellin Jones*	2A5 : Altimeter Signal Processing *Roca - Remy*	2A6 : Special Session: GMES and Science (1) *Achache - Metthey*
	10.50-12.30		2B1 : SAR Signal Processing *Monti Guarnieri - Zakharov*	2B2 : Coastal Studies (1) *Aiken - Gower*	2B3 : Atmosphere Overview (2) *Simon - Burrows*	2B4 : ENVISAT Orbit Performance *Duesmann - Otten*	2B5 : Altimeter Performance and Products Quality (1) *Laxon -Lillibridge*	2B6 : Special Session: GMES and Science (2) *Metthey - Achache*
	14 00-15.40		2C1 : SAR Signal Processing Persistent Scatterers Interferometry *Arnaud - Rocca*	2C2 : Coastal Studies (2) *Pettersson - Alpers*	2C3 : Atmosphere Overview (3) *Carli - Kelder*	2C4 : Application of Scansar Complex Product (Wide Swath SLC) *Cordey - Rosich*	2C5 : Altimeter Performance and Products Quality (2) *Scharroo - Dorandeu*	2C6 : How to move from Research to Applications? (1) *Arino - Coulson*
	16.10-17.50		2D1 : SAR Signal Processing Interferometry *Prati - Bamler*	2D2 : Coastal Studies (3) *Alpers - Pettersson*	2D3 : Trace Gases(1) *Goede - Carli*	2D4 : MERIS Signal Processing *Curran - Baret*	2D5 : Altimeter Performance and Products Quality (3) *Lillibridge - Scharroo*	2D6 : How to move from Research to Applications? (2) *Coulson - Arino*
	18.00-19.30					2E4 : Looking after Water in Africa - TIGER *Achache - Lichem*		

Poster Session and Drink

2P01; 2P02; 2P03; 2P04; 2P05; 2P06; 2P07; 2P08; 2P09; 2P10; 2P11; 2P13; 2P14; 2P15; 2P16

Wednesday 8 (Day 3)	Time		Mozart 4-5	Karajan 2-3	Mozart 1-2	Doppler	Mozart 3
	08.30-08.40	Poster Session					Introduction *Hollingsworth-Attema*
	08.40-10.20		3A1 : Landslides *Rocca - Rott*	3A2 : Vegetation *Moreno - Baret*	3A3 : Trace Gases (2) *Kyrola - Chance*	3A4 : Ocean Circulation *Challenor - Johannessen*	3A5 : Scatterometer Performance *Hollingsworth - Stoffelen*
	10.50-12.30		3B1 : Subsidence *Strozzi - Hanssen*	3B2 : Thematic Mapping *Small - Rudant*	3B3 : Trace Gases (3) *Chance - Kyrola*	3B4 : Ocean circulation and Marine Geoid *Knudsen - Lillibridge*	3B5 : Scatterometer Assimilation *Stoffelen - Hollingsworth*
	14 00-15 40		3C1 : Volcanoes and Earthquakes *Amelung - Wadge*	3C2 : Carbon and Kyoto *Quegan - Zenguyan*	3C3 : Atmosphere Retrieval (1) *Stiller - Goede*	3C4 : Wind and Wave (1) *Queffeulou - Cotton*	3C5 : Scatterometer Applications (1) *Ezraty - Ming Xia He*
	16.10-17.50		3D1 : Bam Earthquake *Fielding - Parsons*	3D2 : Forestry *Pulliainen - Schmullius*	3D3 : Atmosphere Retrieval (2) *Camy-Peyret - Stiller*	3D4 : Wind and Wave (2) *Cotton - Queffeulou*	3D5 : Scatterometer Applications (2) *Wagner - Anderson*
	18 00-19 30	Poster Session and Drink 3P01; 3P02; 3P03; 3P04; 3P05; 3P06; 3P07; 3P08; 3P09; 3P10					3E5 : 30 years C-Band Scatterometer Services *Hersbach - Atteme*

			Mozart 4-5	Karajan 2-3	Mozart 1-2	Doppler	Mozart 3	Trakl
Thursday 9 (Day 4)	08.40-10.20	Poster Session	4A1 : Agriculture (1) Pampaloni - Le Toan	4A2 : Oil Spill/Ship Detection Ming Xia He - Olsen	4A3 : Clouds and Aerosols (1) Guzzi - Murtagh	4A4 : Wetlands / Floods Yésou - Bach	4A5 : Ice (1) Young - Laxon	MeteoSat Second Generation Workshop
	10.50-12.30		4B1 : Agriculture (2) Le Toan - Pampaloni	4B2 : Water Quality Doerffer - Ruddick	4B3 : Clouds and Aerosols (2) Timofeyev - Guzzi	4B4 : Soil Moisture Wagner - Menzel	4B5 : Ice (2) Laxon - Young	
	14.00-15.40		4C1 : Fires and Land Surface Temperature Achard - Mutlow	4C2 : Ocean Color Morel - Aiken	4C3 : Ozone Profiles retrieval from GOME (1) Lambert - Meijer	4C4 : Snow Rott - Partington	4C5 : Sea-Ice (1) Dierking - Flett	
	16.10-17.50		4D1 : Hazards and Disaster Relief Wegmuller - Fellah	4D2 : Clouds and Aerosols (3) Santer - Verstraete	4D3 : Ozone Profiles retrieval from GOME (2) Zehner - Siddans	4D4 : Lake Levels Birkett - Berry	4D5 : Sea-Ice (2) Flett - Dierking	
	18.00-19.30		Poster Session and Drink 4P01; 4P02; 4P03; 4P04; 4P05; 4P06; 4P07; 4P08; 4P09; 4P10; 4P11; 4P12; 4P13; 4P14; 4P15; 4P16; 4P17					

			Mozart 4-5	Mozart 1-2	Doppler	Mozart 3	Trakl	
Friday 10 (Day 5)	08.40-10.20		5A1 : Siberia II (1) *Schmullius - Le Toan*	5A2 : Sea Surface Temperature *Robinson - Barton*	5A3 : Future Earth Observation Missions *Hoersch - Gilles*	5A4 : Wind and Wave/Sea State (1) *Horstmann - Johnsen*	MeteoSat Second Generation Workshop	
	10.50-12.30		5B1 : Siberia II (2) *Schmullius - Plummer*	5B2 : Atmosphere Assimilation *Kelder - Lahoz*	5B3 : Future Earth Observation Missions *Gilles - Hoersch*	5B4 : Wind and Wave/Sea State (2) *Chapron - Thompson*		
		Opera						
	12.30-13.30	**Plenary Session**						


SALZACH
KAPUZINERBERG
MÖNCHSBERG
AUSSERER STEIN
NONNTAL
Schwarzstraße
Rainerstraße
Franz-Josef-Straße
Schallmooser Hauptstraße
Sterneckstraße
Gabelsbergerstraße
Eberhard-Fugger-Straße
Auerspergstraße
Bürglsteinstraße
Rudolfskai
Erzabt-Klotz-Straße
Nonntaler Hauptstraße
Innsbrucker Bundesstraße
Hübnergasse
Leopoldskronstraße
Gaswerkgasse
Alpenstraße
Casino Salzburg
Autobahnausfahrt Salzburg West
Salzburger Freilichtmuseum

Day 1

Monday 6 September

11:00 **Registration**

14:30 – 18:00

Session 1: Opening Plenary Session

Chairman: K. Pseiner, *Head of Austrian Space Agency*

14:30 – 15:30 ***Welcome to Salzburg***
Local and National Authorities:

Mr Eduard Mainoni, *Secretary of State of the Federal Republic of Austria within the Federal Ministry of Transport, Innovation and Technology*

Mr. J.-J. Dordain, *Director General, European Space Agency*

Mr J. Achache, *Director of Earth Observation Programmes, European Space Agency*

15:30 – 17:15 ***Overview on Envisat Results***

Land: H. Rott (University of Innsbrück, Austria)

Oceans: J.-L. Fellous (IFREMER, France)

Polar Regions: D. Wingham (University College London, United Kingdom)

Atmosphere: H. Grassl (Max Planck Institute for Meteorology, Germany)

SAR Interferometry: F. Rocca (Politecnic University of Milan, Italy)

17:30 – 18:00 Questions & Answers with the Press
Walk to the Residenz Palace (in Salzburg City Centre)

18:00 – 20:30 ***Cocktail offered by the European Space Agency and the Austrian Space Agency***

Chamber Concert offered by the City of Salzburg and Land of Salzburg

Day 2

Tuesday 7 September - 08:40 – 10:20
MOZART 4-5

Session 2A1: SAR Signal Processing (Quality and Performance)

Chairs: P. Pasquali & P. Meadows
Secretary: B. Rosich-Tell

08:40 Envisat ASAR Instrument Performance and Product Quality Status after Two and a Half Years of Operation (608)
B. Rosich-Tell, P. Meadows, A. Monti-Guarnieri

09:00 Terrain-Dependent Geometric and Radiometric ASAR Calibration (343)
D. Small, E. Meier, D. Nüesch, D. Small

09:20 Quality Assessment of Envisat ASAR Wave Mode Products Based on Regional and Seasonal Comparisons with WAM Model Outputs (439)
V. Kerbaol, H. Johnsen, B. Chapron, B. Rosich-Tell

09:40 The ERS-2 SAR Performance: The First 9 Years (640)
P. Meadows, B. Rosich-Tell

10:00 Review of the Impact of ERS-2 Piloting Modes on the SAR Doppler Stability (265)
N. Miranda, B. Rosich-Tell, C. Santella

Poster Session 2P01: SAR Signal Processing (Quality and Performance)

2P01-1 Intercalibration of ERS AMI and Envisat ASAR with Ground-Based Parabolic Antennas (512)
A. Zakharov, P. Zherdev, A. Sokolov

Tuesday 7 September - 08:40 – 10:20
Mozart 1-2

Session 2A2: MERIS Performance and Products Quality

Chairs: J. Fisher & B. Pinty
Secretary: P. Goryl

08:40 MERIS Calibration Validation and Quality Status (639)
P. Goryl, S. Delwart, J. Huot

09:00 In-flight Spectral Calibration of MERIS (700)

R. Preusker, J. Fischer, S. Delwart, L. Bourg

09:20 Vicarious Calibration of MERIS over Ocean in the Near Infrared (106)
N. Martiny, R. Santer, I. Smolskaia

09:40 Long-term MERIS Land Product Accuracy Assessment Based on Vicarious Calibration and Regional Validation (224)
R. Zurita Milla, J. Clevers, M. Kneubuehler, S. Delwart, M. Schaepman

10:00 MERIS & Land Applications (423)
N. Gobron

Poster Session 2P02: MERIS Performance and Products Quality

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R. Preusker, R. Lindstrot, T. Ruhtz et al.

2P02-2 Cross Calibration Methods (173)
J. Nieke, M. Kneubuehler

2P02-3 Use of Envisat MERIS Data for Validating Aerosol Retrieval: the Case Study of Athens-Greece (254)
A. Retalis, N. Sifakis

2P02-5 Validation of MERIS Biophysical Products from the Valeri Project (547)
M. Weiss, F. Baret, S. Garrigues et al.

Tuesday 7 September - 08:40 – 10:20
DOPPLER

Session 2A3: Atmosphere Overview (1)

Chairs: J. Burrows & R. Koopman
Secretary: J. Langen

08:40 SCIAMACHY: Results from the First Two Years of Operation (420)
J. Burrows, H. Bovensmann, A. Richter et al.

09:00 Retrieval, Validation and Assimilation of SCIAMACHY Ozone Columns (132)
H. Eskes, R. Van der A, E. Brinksma, P. Veefkind, J. De Haan

09:20 The GOME and SCIAMACHY Water Vapor Record for Climate and Chemistry Transport Model Evaluation (183)
R. Lang, A. Maurellis, M. Lawrence

09:40 MIPAS Near Real Time Level 2 Results (91)
B. Carli

Day 2

10:00 Stratospheric Chemistry in Austral Spring 2002 as Observed by MIPAS/Envisat (328)
G. Stiller, T. Von Clarmann, H. Fischer, B. Funke et al.

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S. Rohs, M. Blaesner, K. Grunow, P. Konopka et al.

2P03-2 Validation of ClONO2 Profile Retrievals from MIPAS/Envisat Measurements (74)
M. Höpfner, C. Blom, T. Blumenstock, T. von Clarmann et al.

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T. Erbertseder, V. Eyring, M. Dameris, M. Bittner et al.

2P03-4 SCIAMACHY -Validation Using the AMAXDOAS Instrument (591)
K.-P. Heue, M. Bruns, J.P. Burrows. W-D. Lee et al.

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G. Tilstra, G. van Soest, M. de Graaf, J. Acarreta et al.

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N. Huret, M. Pirre, E. Riviere, J. Urban et al.

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T. Gulde, C.E. Blom, M. Höpfner, C. Keim et al.

2P03-8 Investigation of GOME Scan-mirror Degradation (160)
J.M. Krijger, I. Aben, J. Landgraf

2P03-9 Comparison of ERS-2 GOME Total Ozone and Nitrogen Dioxide Data with the Ground-based Spectroscopic Measurements over Russia and NIS (162)
D. Ionov, Y. Timofeyev, A. Shalamiansky, J. Lambert

2P03-10 First Confrontation between SCIAMACHY NO2 Columns and the Outputs of a Regional CTM (180)
N. Blond, K.F. Boersma, H.J. Eskes

2P03-11 SCIAMACHY NO2: Air Quality Monitoring on a Global Scale (202)
K. Folkert Boersma, I. Desmedt, R. Van der A, N. Blond et al.

2P03-12 Validation of Stratospheric Temperature Profiles Observed by MIPAS/Envisat (233)
D.-Y. Wang, T. von Clarmann, H. Fischer, B. Funke et al.

Day 2

2P03-13 Stratospheric Ozone Profiles Observed by MIPAS/Envisat and their Use for the VORTEX Split Event in Fall 2002 (236)
D.-Y. Wang, T. von Clarmann, H. Fischer, B. Funke et al

2P03-14 The GOME Near-Real-Time Service: Mission Continuity, Status and Future Plans (239)
D. Loyola, W. Lengert, M. Weber, T. Ruppert et al.

2P03-15 German Contribution to the Validation of SCIAMACHY (242)
K. Bramstedt, B. Kirchhoff

2P03-16 Validation of SCIAMACHY Level 1: UV-Vis Nadir and Limb (262)
G. van Soest, G. Tilstra, J. van Gent, P. Stammes

2P03-17 Comparison between Earth Reflectance Spectra from 300-1750 nm Measured by SCIAMACHY and Radiative Transfer Model Results (264)
P. Stammes, J. Acarreta, W. Knap, G. Tilstra

2P03-18 SCIAMACHY Long-Term Monitoring Results (294)
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2P03-19 Validation of SCIAMACHY BrO Profiles by Balloon-borne In-situ Measurements (322)
S. Hrechanyy, A. Engel, J-U. Grooß, G. Günther et al.

2P03-20 The Use of Data-quality Information for Optimal Scientific Application of MIPAS Trace-gas Data (331)
R. Mantovani, R. Koopman

2P03-21 MIPAS-Envisat Validation Measurements with the High Resolution FT-FIR Spectrometer SAFIRE-A (364)
U. Cortesi, G. Bianchini, G. Redaelli, E. Castelli et al.

2P03-22 The Use of Data-quality Information for Optimal Scientific Application of Gomos Trace-Gas Data (365)
L. Saavedra, R. Koopman

2P03-23 Long Term Monitoring of GOME/ERS-2 On-fly Calibration Parameters (371)
S. Wahl, B. Aberle, S. Slijkhuis, D. Loyola

2P03-24 The Use of Data-quality Information for Optimal Scientific Application of SCIAMACHY Trace-gas Data (375)
A. Dehn, R. Koopman

2P03-25 Re-analysis of ERS-2/GOME Diffuser Properties (424)
S. Slijkhuis, S. Wahl, B. Aberle, D. Loyola

2P03-26 Validation of MIPAS-Envisat CH4 and N2O Vertical Profiles by Airborne In Situ Observations (465)
J. Baehr, C. M. Volk, E. Ivanova, A. Werner et al.

2P03-27 The SCIAMACHY Level 1b-2 Offline Data Processor: Current Status and Recent Developments (467)
A. von Bargen, B. Aberle, A. Doicu, M. Hess et al.

2P03-28 Improvements of the SCIAMACHY Radiometric Calibration and its Validation on Solar Irradiances in the Spectral Range from 240 to 2380nm (476)
J. Skupin, K. Gerilowski, S. Noël, M. Wuttke et al.

2P03-29 Global Long Term Data Sets of the Atmospheric H2O Column Derived from GOME and SCIAMACHY (489)
T. Wagner, M. Grzegorski, S. Sanghavi, U. Platt

2P03-30 Validation of MIPAS Profiles of the Scientific Data Processor at IMK Karlsuhe with Data from the MIPAS-STR Instrument on Board the Geophysica (528)
C.E. Blom, T. von Clarmann, T. Gulde, M. Höpfner et al.

2P03-31 Advancements of the Operational Level 0 to 1 Processing of SCIAMACHY (544)
S. Slijkhuis, B. Aberle, J. Frerick, A. von Bargen et al.

2P03-32 Radiometric Characterisation of MIPAS on Envisat (576)
G. Wagner, M. Birk, A. Kleinert, F. Friedl-Vallon

2P03-33 Analysis of Water Vapour and Methane from the MIPAS Satellite Instrument (612)
V. Payne, A. Dudhia, C. Piccolo

2P03-34 SCIAMACHY on Envisat - Summary on Results from the First 2 Years in Orbit (623)
H. Bovensmann, J. Burrows, Team SCIAMACHY

2P03-35 Ozone Isotopes Retrievals (623)
C. Piccolo, A. Dudhia, V. Payne, J. Urban et al.

Tuesday 7 September - 08:40 – 10:20
MOZART 3

Session 2A4: AATSR Performance and Products Quality

Chairs: I. Barton & D. Llewellyn-Jones
Secretary: K. Cardon

08:40 Validation of the First Two Years of the AATSR Meteo Product Sea Surface Temperatures at the Met Office (78)
J. Watts, A. O'Carrol, R. Saunders

09:00 An Assessment of the Accuracy of SST Retrievals from AATSR: Comparisons with In-situ Radiometers, Buoy Data and the AVHRR and MODIS Satellite Sensors (16)

G. Corlett, I. Barton, C. Donlon et al.

09:20 Reducing Errors in Satellite-derived Sea Surface Temperature - Application to AATSR Data Analyses (210)
I. Barton

09:40 Validation of the AATSR L2 GSST Product with In-situ Measurements from the M-AERI (289)
E. Noyes, P. Minnett, J. Remedios et al.

10:00 Verification of the In-Orbit Calibration of the Visible and Near-Infrared Channels of AATSR (394)
D. Smith, C. Poulsen, B. Latter

Poster Session 2P04: AATSR Performance and Products Quality

2P04-1 Validation of AATSR SST Skin Observations Using the ISAR Radiometer (71)
C. Donlon, I. Robinson, G. Fisher, M. Reynolds

Tuesday 7 September - 08:40 – 10:20
TRAKL

Session 2A5: Altimeter Signal Processing

Chairs: M. Roca & F. Remy
Secretary: J. Benveniste

08:40 Global Waveform Shape Analysis for Envisat RA-2 (143)
M. Dowson, J. Garlick, P. Berry

09:00 Retrieval of Geophysical Parameters from RA2 Envisat Waveforms Using a Non-linear MLE Retracker (281)
J. Gomez-Enri, C. Gommenginger, P. Challenor, M. Srokosz, G. Quartly

09:20 Preliminary Results obtained using the Envisat RA-2 Individual Echoes (Full-rate Waveforms with Phase Information) (323)
M. Roca, S. Laxon, D. Martínez

09:40 Exploitation of the Envisat RA-2 Individual Echoes and S-band Data over Ocean, Coastal Region and Continental Water: Preliminary Results (593)
O. Zanifé, J. Dumont, F. Mercier, J. Benveniste

10:00 RAIES: Envisat RA2 Individual Echoes and S-band Data for New Scientific Applications for Ocean, Coastal, Land and Ice Remote Sensing (642)
P. Challenor, C. Gommenginger, G. Quartly

Poster Session 2P05: Altimeter Signal Processing

2P05-1 Non-Parametric Sea-state Bias Models and Their Relevance to Sea Level Change Studies (198)
R. Scharroo, J. Lillibridge

2P05-2 RA-2 S-Band Anomaly: Detection and Waveforms Reconstruction (301)
A. Martini, P. Femenias, M.P. Milagro Perez, G. Alberti

2P05-3 An On-line Satellite Altimetry Data Processing System: ADS CENTRAL (587)
T. Schoene, A. Helm, A. Brau, H. Wen et al.

2P05-4 Envisat Radar Altimeter Individual Echoes and S-band Applications (643)
O.-Z. Zanife, B. Soussi, M. Roca, F. Remy et al.

2P05-5 High Level Envisat Radar Altimeter & CryoSat Land/Ocean/Ice Easy-to-Use Synergy Products Development (HERACLES) (676)
J. Dorandeu, G. Dibarboure, F. Mercier, P. Sicard et al.

Tuesday 7 September - 08:40 – 10:20
KARAJAN 1-2-3

Special Session 2A6: GMES and Science (1)

Chairs: J. Achache & J. Metthey
Secretary: P. Regner

08:40 GMES Programme and Prospects: ESA GSE Activities
M. Doherty

08:55 GMES Programme and Prospects: EC FP6 GMES Activities
M. Malacarne

09:10 Research Needs for the GMES Service Element: Land
B. Su

09:25 Research Needs for the GMES Service Element: Ocean and Coastal Zones
R. Doerffer

09:40 Research Needs for the GMES Service Element: Atmosphere
J.M. Flaud

Day 2

09:55 A Model-based Approach to the Selection of In-situ Measurements
J. Mc Glade

Tuesday 7 September - 10:50 – 12:30
MOZART 4-5

Session 2B1: SAR Signal Processing

Chairs: A. Monti-Guarnieri & A. Zakharov
Secretary: B. Rosich-Tell

10:50 Unambiguous Doppler Centroid Estimation (356)
D. D'Aria, A. Monti Guarnieri, P. Mazzucchelli

11:10 Co-registration Properties of Burst-mode Data (221)
J. Holzner, R. Bamler

11:30 Ad-hoc SCANSAR Omega-k Processing (355)
A. Monti Guarnieri, D. D'Aria

11:50 Polarization Dependency in Doppler Frequency Shift and its Application to Envisat ASAR Alt-Pol Data (370)
I. Friestad Pedersen, G. Engen, H. Johnsen

12:10 Advances in Permanent Scatterer Analysis (158)
A. Ferretti, F. Rocca, C. Prati et al.

Poster Session 2P06: SAR Signal Processing

2P06-1 Evaluation of a Space Intersection Strategy for Use with Stereoscopic SAR Imagery over Developing Countries (40)
E. Edwards, A. Sowter, M. Smith

2P06-2 Development and Validation of a Sea Surface Fractal Model: Project Results and New Perspectives (201)
F. Berizzi, M. Bertacca, G. Bertini, F. Dell'Acqua et al.

2P06-3 De-speckling of SAR Imagery Based on Multi-resolution Analysis: a Comparison of Ml and Map Estimators (253)
L. Alparone, F. Argenti, N. Rovai, M. Bianchini et al.

2P06-4 Technical Aspects of Envisat ASAR Geocoding Capability at DLR (274)
M. Huber, W. Hummelbrunner, J. Raggam, D. Small et al.

2P06-5 Flashing Fields! A Preliminary Investigation (292)

U. Wegmuller, C. Werner, R. Cordey

2P06-6 Applications of Envisat-ASAR Data in Rainy and Cloudy Areas in Southern China (390)
Y. Shao, J. Chen, H. Lin

2P06-7 Sensitivity of Topographic Roughness on Interferometric SAR Data Coregistration (466)
H. Yue, R. Hanssen, J. Kianicka, P. Marinkovic et al.

2P06-8 Automatical Geocoding of Envisat ASAR Products (473)
I. Lauknes, E. Malnes

2P06-9 Construction of the Ocean Surface from SAR Images (573)
W. Koch, W. Rosenthal

2P06-10 Extraction of Weak Internal Wave Modulation from an Envisat ASAR Image by EMD with a Simple Boundary Processing Technique (598)
K. Zeng, M.-X. He, M.-Q. Fang

2P06-11 Application of Precise Correlation Techniques with SAR, ASAR for Seismic Fault Slip Detection: a Complement to Interferometry. Two Case Studies (694)
M. Pirri, F. Sarti, P. Briole, K. Feigl

Tuesday 7 September - 10:50 – 12:30,

Mozart 1-2

Session 2B2: Coastal Studies (1)

Chairs: J. Aiken & J. Gower
Secretary: M. Bouvet

10:50 Investigation of the Temporal Development of Pigment-concentration in the Baltic Sea with MERIS Data (223)
H. Krawczyk, A. Neumann, B. Gerasch

11:10 Validation of Optical Satellites Data Based on Traditional Methods and Use of Data from Ships of Opportunity (706)
K. Sorensen, J. Magnusson, J. Høkedal, E. Aas

11:30 Validation of Chlorophyll Fluorescence in Coastal Waters Derived from MERIS (211)
J. Gower, S. King

11:50 Determination of the Confidence Range of Coastal Water Products Derived from MERIS Data (629)
R. Doerffer, H. Schiller

12:10 From SeaWiFS to MERIS: Great Barrier Reef Lagoon Case Study (663)
L. Ametistova, I. Jones

Day 2

Poster Session 2P07: Coastal Studies

Day 2

Tuesday 7 September - 10:50 – 12:50

DOPPLER

Session 2B3: Atmosphere Overview (2)

Chairs: R. Koopman & J. Burrows
Secretary: J. Langen

10:50 Atmospheric Effects Due to the October-November 2003 Solar Proton Event as Observed by MIPAS/Envisat (668)
M. López-Puertas, T. Von Clarmann, H. Fischer et al.

11:10 GOMOS Results: An Overview (xxx)
J.-L. Bertaux

11:30 Validating and Improving GOMOS Inversion Algorithms (AO NORM) (502)
J. Tamminen

11:50 Temperature and Ozone Profiles from GOMOS in Comparison to CHAMP, MIPAS Operational GOMOS Ozone and ECMWF Analysis Data (510)
C. Retscher, G. Kirchengast, A. Gobiet

12:10 Ozone Distributions in the Arctic Winter/Spring 2002/2003 as Measured by GOMOS, MIPAS, and SCIAMACHY (516)
A. Bracher, K. Eichmann, C. Von Savigny, M. Weber

12:30 UPAS/GDOAS 4.0: a Major Upgrade of the ERS-2 GOME Total Ozone Operational Processor (433)
M. Van Roozendael, D. Loyola, R. Spurr et al.

Tuesday 7 September - 10:50 – 12:30

MOZART 3

Session 2B4: Envisat Orbit Performance

Chairs: B. Duesmann & M. Otten
Secretary: B. Duesmann

10:50 Envisat Precise Orbit Determination (536)
M. Otten, J. Dow

11:10 The Attitude of Envisat; the Past and Current Pointing Performance Observed by the Payload (373)
B. Duesmann, R. Koopman, L. Ventimiglia

Day 2

11:30 Envisat Orbit Control, Philosophy, Experience and Challenges (347)
A. Rudolph, P. Bargellini, M. Garcia Matatoros, L. Ventimiglia, D. Kuijper

11:50 Envisat and ERS-2 Orbit Determination (650)
P. Moore, J. Wang

12:10 Improved ERS and Envisat Precise Orbit Determination (187)
E. Doornbos, R. Scharroo

Poster Session 2P08: Envisat Orbit Performance

2P08-1 Simultaneous Orbit Error Analysis for Contemporary Altimeter Missions (574)
W. Bosch

Tuesday 7 September - 10:50 – 12:30
TRAKL

Session 2B5: Altimeter Performance and Products Quality (1)

Chairs: S. Laxon & J. Lillibridge
Secretary: P. Féménias

10:50 Envisat Altimetry Mission Status (122)
P. Féménias

11:10 Estimating Envisat Sea State Bias from Altimetric Data (440)
S. Labroue, P. Gaspar, J. Dorandeu, O. Zanifé

11:30 Envisat Radar Altimeter Calibration with High-Sea GPS Buoys (9)
T. Schueler

11:50 Envisat and ERS Validation and Cross-calibration Activities at CLS (360)
J. Dorandeu, Y. Faugere, F. Mertz

12:10 Envisat - Range Calibration Using a Transponder (104)
E. Cristea, W. Hausleitner

Day 2

Poster Session 2P09: Altimeter Performance and Products Quality

2P09-1 Analysis of Envisat Ra-2 Backscatter over Natural Land Calibration Targets (141)
S.M.S. Bramer, C.P.D. Johnson, P.A. Berry

2P09-2 Envisat RA-2 Sigma0 Absolute Calibration, Phase E Results (266)
P. Féménias, N. Pierdicca, C. Bignami, M. Roca et al.

2P09-3 Validation of Satellite Altimeter Range Measurements over Salar De Uyuni, Bolivia (484)
H.A Fricker, M. Roca, S.W. Laxon, C.C. Carabajal et al.

2P09-5 Bottom-mounted Tide Gauges for Radar Altimetry Monitoring (583)
T. Schoene, M. Forberg, S. Esselborn

2P09-6 Altimeter Calibration Using a Ruggedized GPS-buoy (586)
T. Schoene, M. Forberg, R. Galas, C. Reigber

2P09-7 Resampling and Enhancement of Altimeter Data at Tide Gauges (635)
W. Bosch, R. Savcenko

2P09-8 Lake Level Monitoring and Altimeter Calibration in the Great Lakes (653)
Y. Yi, K. Cheng, C. Shum, A. Braun, S. Calmant

Tuesday 7 September - 10:50 – 12:30

KARAJAN 1-2-3

Special Session 2B6: GMES and Science (2)

Chairs: J. Metthey & J. Achache
Secretary: P. Regner

10:50 Research Goals of the GMES FP6 Integrated Projects: MERSEA
J. Johannessen

11:05 Research Goals of the GMES FP6 Integrated Projects: GEOLAND
A. Belward

11:20 Research Goals of the GMES FP6 Integrated Projects: GEMS
T. Hollingsworth

11:35 Panel Discussion

Day 2

Tuesday 7 September – 14:00 – 15:40
MOZART 4-5

Session 2C1: SAR Signal Processing (Persistent Scatterers Interferometry)

Chairs: A. Arnaud & F. Rocca
Secretary: M. Engdahl

14:00 Validation of Point Scatterer Phase Statistics in Multi-pass InSAR (595)
G. Ketelaar, R. Hanssen, P. Marinkovic

14:20 The Development of a Scientific Persistent Scatterer System: Modifications for Mixed ERS/Envisat Time Series (315)
N. Adam, B. Kampes, M. Eineder

14:40 ERS and Envisat Long-Term Differential Interferometry with the Coherent Pixels Technique (CPT) (437)
J. Mallorqui, P. Blanco, A. Broquetas et al.

15:00 Assessment of ASAR/IMS Multi-polarization Images Phase Difference in the Framework of Persistent Scatterers Interferometry (368)
J. Inglada, C. Henry, J. Souyris

15:20 ERS-Envisat Permanent Scatterers (269)
D. Perissin, C. Prati, F. Rocca, A. Ferrett

Poster Session 2P10: SAR Signal Processing (Persistent Scatterers Interferometry)

2P10-1 SPINUA: A Flexible Processing Chain for ERS / Envisat Long Term Interferometry (409)
F. Bovenga, R. Nutricato, A. Refice. L. Guerriero et al.

2P10-2 Utilization of Parallelization Algorithms and Resources in InSAR/PS-InSAR Data Processing (588)
P. Marinkovic, R. Hanssen

Day 2

Tuesday 7 September – 14:00 – 15:40

MOZART 1-2

Session 2C2: Coastal Studies (2)

Chairs: L.H. Pettersson & W. Alpers
Secretary: A.M. Hayes

14:00 Multi-sensor Synergy for Monitoring of Algal Bloom in the North Sea (367)
B. Furevik, D. Durand, L. Pettersson

14:20 ERS SAR and Envisat ASAR Observations of Oceanic Dynamic Phenomena in the Southwestern Okhotsk Sea (83)
L. Mitnik, V. Dubina, G. Shevchenko

14:40 On Radar Imaging of Current Features: Mesoscale Eddies and Current Fronts Detection (111)
J. Johannessen, V. Kudryavtsev, D. Akimov et al.

15:00 Coastal Wave and Surface Velocities Retrieval Using ASAR-SLC(641)
F. Collard, B. Chapron, F. Ardhuin

15:20 Use of Synthetic Aperture Radar for the Analysis of Wave Fields at the Coast (533)
J. Nieto-Borge, T. Schneiderhan, A. Niedermeier, J. Schulz-Stellenfleth

Tuesday 7 September – 14:00 – 15:40

DOPPLER

Session 2C3: Atmosphere Overview (3)

Chairs: B. Carli & H. Kelder
Secretary: R. Koopman

14:00 Validation of MIPAS-Envisat Profiles for O3, HNO3 and Temperature with Data from the MIPAS-STR Instrument on Board the Geophysica (126)
C. Blom, T. Gulde, M. Höpfner et al.

14:20 Validation and Analysis of GOMOS Measurements Using Stratospheric Balloon-borne Instruments (263)
J. Renard, J. Ovarlez, C. Brogniez et al.

14:40 SCIAMACHY Validation with AMAXDOAS NO2 and O3 Measurements(190)
P. Wang, A. Richter, M. Bruns et al.

15:00 Integrated Characterisation of Envisat Ozone Profile Data Using Ground-based Network Data (521)
C. De Clercq, J. Lambert

15:20 Validation of SCIAMACHY - Current and Future Product Qualities (708)
A. Piters, H. Kelder, U. Platt et al.

Tuesday 7 September – 14:00 – 15:40
MOZART 3

Session 2C4: Application of Scansar Complex Product (Wide Swath SLC)

Chairs: R. Cordey & B. Rosich-Tell
Secretary: T. Pearson

14:00 ASAR Wide-Swath Single-Look Complex Products: Processing and Demonstration Status (52)
R. Cordey, T. Pearson, Y.-L. Desnos, B. Rosich-Tell

14:20 The ASAR Wide Swath Single Look Complex Product: Properties and Applications (195)
P. Guccione, C. Cafforio, A. Monti Guarnieri

14:40 Wave and Wind Measurements Using High Resolution Envisat ASAR Wide Swath SLC Data (610)
J. Schulz-Stellenfleth, T. Schneiderhan

15:00 SCANSAR SLC : Marine Applications (712)
F. Collard, B. Chapron

15:20 Scansar Interferometry for Atmospheric Parameter Estimation (703)
R. Hanssen, P. Marincovic

Day 2

Tuesday 7 September – 14:00 – 15:40
TRAKL

Session 2C5: Altimeter Performance and Products Quality (2)

Chairs: R. Scharroo & J. Dorandeu
Secretary: P. Féménias

14:00 Validation of Envisat Altimetry over Ice Caps (174)
B. Soussi, B. Legresy, F. Remy, F. Papa, O. Zanifé

14:20 Long Term Monitoring of the Envisat RA-2 Drift with the GLOSS/CLIVAR Fast Sea Level Data Tide Gauge Network (391)
F. Lefevre, J. Dorandeu, P. Le Traon, Cls Calval Team

14:40 Envisat Altimeter Calibration and Validation (540)
M. Otten, J. Dow

15:00 IGS Tide Gauge Benchmark Monitoring Pilot Project (579)
T. Schoene

15:20 Analysis of Envisat RA2 Altimeter Sigma-nought Bloom Events for S and Ku Bands Backscattering Intercomparison (470)
F. De Biasio, N. Pierdicca, S. Zecchetto, L. Pulvirenti

Tuesday 7 September – 14:00 – 15:40
KARAJAN 1-2-3

Special Session 2C6: How to Move from Reseach to Applications? (1)

Chairs: O. Arino & S. Coulson
Secretary: M. Paganini

14:00 BEGO: Earth Observation from Space Assisting in the Protection of the UNESCO World Heritage Sites: an Example in Central Africa (DUP/DUE) (692)
M. Hernandez, D. Fernandez, O. Arino

14:20 HUMAN: Humanitarian Mapping Service (DUP/DUE) (691)
R. Carrier, H. Hansen, A. Valvo

14:40 EPIDEMIO: EO in Epidemiology (DUP/DUE) (374)
P. Vounatsou, G. Pluschke, A. Gemperli, K. Weise

15:00 TEMIS: L'Oréal and Solar UV Radiation (DUP/DUE) (357)
F. Christiaens

15:20 The role of R&D in Developing Marketable EO Services (562)
P. Curtis, F. Knops

Tuesday 7 September – 16:10 – 17:50

MOZART 4-5

Session 2D1: SAR Signal Processing (Interferometry)

Chairs: C. Prati & R. Bamler
Secretary: M. Engdahl

16:10 On the Exploitation of the SBAS Algorithm for the Analysis of the Deformations Detected from the ERS and Envisat DIFSAR Data (499)
R. Lanari, P. Berardino, F. Casu et al.

16:30 Interferometric SAR Data Coregistration by Point-like Scatterers (46)
H. Yue, R. Hanssen, P. Marinkovic. F. Leijen, G. Ketelaar

16:50 Multipolarimetric Envisat Interferometry: Techniques and Preliminary Results (651)
P. Pasquali, A. Monti Guarnieri

17:10 Combination of ERS and Multiple Modes of Envisat SAR Data for Differential Interferometric Applications (678)
J. Closa, J. Duro, J. Inglada, A. Arnaud

17:30 Improving the Quality of ERS-Envisat Interferograms (276)
C. Prati. F. De Zan, A. Ferretti, F. Rocca

Poster Session 2P11: SAR Signal Processing (Interferometry)

2P11-2 A Re-Appraisal of the 1992 Landers Earthquake InSAR Data Using the Ambiguity Search Method (39)
M. Warren. A. Sowter, R. Bingley

2P11-3 An Assessment of the Ambiguity Search Method for DEM Generation and Land Motion Detection Using Spaceborne InSAR Data (41)
A. Sowter, M. Warren, R. Bingley

2P11-4 High Resolution Differential Interferometry using time series of ERS and Envisat SAR data
J. Closa, J. Duro, J. Inglada, N. Adam, A. Arnaud

2P11-6 A New Approach for Estimating Crustal Deformation Fields Using DInSAR and Permanent Scatterers: Preliminary Results (730)
A.O. Kohlhase, K.L. Feigl, A. Ferretti, D. Massonnet

Tuesday 7 September – 16:10 – 17:50
MOZART 1-2

Session 2D2: Coastal Studies (3)

Chairs: W. Alpers & L.H. Pettersson
Secretary: M. Bouvet

16:10 Atmospheric Fronts off the East Coast of Taiwan Studied by ERS SAR Imagery (520)
W. Alpers, J. Chen, I. Lin

16:30 Ocean Surface Polarization Signature (542)
B. Chapron, T. Elfouhaily, F. Collard, F. Ardhuin

16:50 Modelling of SAR Signatures of Bathymetric Features in the Bristol Channel Using a Coupled Wave-Current Model (11)
M. Trevor, J. Wolf, S. Wakelin, A. Elliott

17:10 Application of Spaceborne SAR for Bathymetric Monitoring (245)
J. Vogelzang, C. De Valk, H. Wensink

17:30 Mapping Surface Roughness and Sediment Texture of Intertidal Flats Using ERS SAR and Envisat ASAR Imagery (105)
D. Van der Wal, T. Ysebaert, P. Herman, A. Wielemaker-Van Den Dool

Tuesday 7 September – 16:10 – 17:50
DOPPLER

Session 2D3: Trace Gases (1)

Chairs: A. Goede & B. Carli
Secretary: R. Koopman

16:10 Equatorial Kelvin Wave Signatures in Tropical Ozone Measurements from GOME (15)
R. Timmermans, H. Kelder, R. Van Oss

16:30 Ozone in the Middle and Upper Atmosphere as Observed by MIPAS/Envisat (532)
M. Kaufmann, S. Gil-Lopez, M. López-Puertas et al.

16:50 Trace Gas Measurements from the SCIAMACHY Validation Dataset: O3, BrO, and HCHO (568)
K. Chance, C. Sioris, T. Kurosu et al.

17:10 Measurements of Water Vapor in the Lower Stratosphere and the Tropopause Region with MIPAS/Envisat (325)
M. Milz, T. Von Clarmann, H. Fischer et al.

17:30 Water Vapour and Methane Abundances under Non-LTE Conditions from MIPAS Upper Atmosphere Measurements (603)
M. Koukouli, M. LoPez-Puertas, B. Funke et al.

Tuesday 7 September – 16:10 – 17:50
MOZART 3

Session 2D4: MERIS Signal Processing

Chairs: P. Curran & F. Baret
Secretary: S. Delwart

16:10 Do MERIS, SeaWiFS and MODIS Products Measure up to the Requirements of Coastal Monitoring? (203)
C. Brockmann, K. Stelzer, R. Vaughan et al.

16:30 Retrieval of Land Surface Reflectance and Albedo from MERIS Data (313)
L. Guanter, J. Moreno

16:50 A Method for Atmospheric Correction Based on the MERIS Spectral and Spatial Variability (405)
D. Béal, F. Baret, C. Bacour et al.

17:10 MERIS LAI, fCover, fAPAR and Chlorophyll Content Products: Principles and Validation (517)
F. Baret, V. Bruniquel, C. Bacour et al.

17:30 New Features in BEAM, the Envisat MERIS & AATSR Toolbox (550)
N. Fomferra, C. Brockmann, P. Regner

Poster Session 2P13: MERIS Signal Processing

2P13-1 Development of Operational Processing Lines of the Cyclopes Project (93)
P. Bicheron, B. Miras, M. Huc, F. Niño et al.

2P13-2 Colour Display Strategies for Enhanced Representation of MERIS Data (178)
V. Tsagaris, V. Anastassopoulos, N. Giannopoulos

2P13-3 Feature Extraction of MERIS Data (179)
V. Tsagaris, V. Anastassopoulos

2P13-4 Observing the Ocean from Envisat: a New UNESCO-Bilko Teaching Module Demonstrating the Synergistic Use of Data from Envisat Sensors to Study Oceanographic Phenomena (189)
V. Byfield, C. Donlon, J.C. Da Silva, F. Shillington et al.

2P13-5 The CYCLOPES Project: Development of High Level Biophysical Products for Medium Resolution Sensors for Regional to Global Applications (477)
F. Baret, F. Nino, B. Miras, M. Leroy et al.

2P13-6 MERIS Level 3 Value Added Product Production Line for Regional Full Resolution Products of Europe (Cat1 project 1413 - GEMEL3) (545)
C. Brockmann, B. Fichtelmann, K.P. Günther, A. Neumann et al.

2P13-7 Development of Algorithms for the Exploitation of MERIS Data over Land (693)
V. Bruniquel-Pinel, C. Casillon, F. Baret, W. von Hoyningen-Huene et al.

Tuesday 7 September – 16:10 – 17:50
TRAKL

Session 2D5: Altimeter Performance and Products Quality (3)

Chairs: J. Lillibridge & R. Scharroo
Secretary: P. Féménias

16:10 Rain and Ice Flagging of Envisat Altimeter and MWR Data (205)
J. Lillibridge, R. Scharroo, G. Quartly

16:30 Radiometric and Altimetric Range Calibration (645)
P. Moore, S. Edwards, M. King

16:50 In-flight Calibration/Validation of Envisat/MWR (541)
E. Obligis, N. Tran, L. Eymard

17:10 Analysis of ERS-2 and TOPEX Microwave Radiometer In-flight Calibration and Monitoring (546)
N. Tran, E. Obligis, L. Eymard

17:30 Impact of Microwave Radiometers on Sea Level Change Studies (196)
R. Scharroo, J. Lillibridge

Day 2

Tuesday 7 September – 16:10 – 17:50
KARAJAN 1-2-3

Special Session 2D6: How to Move from Reseach to Applications? (2)

Chairs: S. Coulson & O. Arino
Secretary: F. Sarti

16:10 EO Services for Hydrocarbon Exploration (145)
M. Insley, P. Murphy, A. Laake

16:30 EO Services for Offshore and Gas (609)
S. Sandven, R. Stephens, F. Lefevre et al.

16:50 EO Services for Land Subsidence Problems in Civil Engineering (677)
C. Russell, K. Kosar, T. Conley, U. Hachethal

17:10 EO Opportunities in Fisheries and Aquaculture Sectors (634)
T. Boivin

17:30 EO Opportunities in Insurance Sectors (279)
A. Shaw, C. Eyre, A. Shaw

Poster Session 2P14: How to Move from Research to Applications?

2P14-1 Compact Active Transponders for Operational SAR Interferometry Applications (18)
M. Haynes, S. Smart, A. Smith

2P14-2 RWT Tool: Offshore Wind Energy Mapping from SAR (26)
C. Bay Hasager, M. Nielsen, M. Christiansen

2P14-3 Improvements to the Applicability of SAR Interferometric Techniques for the Monitoring of Mining Induced Surface Deformation (96)
U. Wegmuller, C. Werner, T. Strozzi, A. Wiesmann

2P14-4 Value Added Geocoded Envisat-ASAR Product Service (237)
D. Kosmann, M. Huber, A. Roth, M. Bollner et al.

2P14-5 16857 Gigabytes Later: Results from 24 Months of Envisat DDS Operations (255)
B. Collini-Nocker, S. Badessi, D. Castrovillari, D. Tomassini et al.

2P14-6 ESA/EOMD Action for Multibaseline with Permanent Scatterers ERS InSAR DEM Performance Assessment Toward Application Needs (314)
L. Rognant, C. Prati

Day 2

Day 2

Poster Session 2P15: Special Session – GMES and Science

2P15-1 The Water Quality Service of COASTWATCH (711)
A. Mangin, S. Dury, R. Doerffer, O. Fanton d'Andon et al.

2P15-2 Using ERS 1 and ASAR Imagery for Mapping Forest in French Guiana (89)
T. Häme, Y. Rauste, L. Sirro, H. Ahola et al.

2P15-3 Demonstration of MERIS Data Use for Agri-environmental Applications (100)
H. Poilvé, V. Lefevre, P. Duthil

2P15-4 Subsidence Detection in the Area of Thessaloniki (Northern Greece) Using DInSAR Techniques (384)
D. Raucoules, I. Parchiaridis, F. Novali, G. Cooksley et al.

2P15-5 ICEMON: Satellite Sea Ice Monitoring as a Component of GMES (418)
S. Sandven, H. Tangen

2P15-6 The ERS/Envisat Experience as Design Guideline for the GMES SAR Operational Mission (554)
G. Levrini, M. Zink

Tuesday 7 September – 18:00 – 19:00
MOZART 3

Session 2E4: Looking after Water in Africa – TIGER

Chairs: J. Achache & W. Lichem
Secretary: J. Aschbacher

18:00 TIGER - Status, Plans and Challenges
J. Aschbacher

18:10 Monitoring Dam Management Changes Using Envisat: Kafue River Basin, Zambia (648)
S. Hughes, C. Van der Heyden

18:20 The Impact of ARGOS and MeteoSat Transmission Systems on Integrated Water Resources Management in the River Niger Basin (658)
I.A. Olomoda

18:30 Round Table: Challenges for TIGER - How to Address Them?

Day 2

Poster Session 2P16: Looking after Water in Africa – TIGER

Day 3

Wednesday 8 September - 08:40 – 10:20
MOZART 4-5

Session 3A1: Landslides

Chairs: F. Rocca & H. Rott
Secretary: F. Palazzo

08:40 Landslides in Iceland Studied using SAR Interferometry (607)
S. Jonsson, K. Agustsson

09:00 Analysis of the Displacement along a Funicular with Large Baseline Interferograms on Point Targets (231)
T. Strozzi, U. Wegmüller, K. Graf, C. Werner, A. Wiesmann

09:20 Combined Use of Artificial and Permanent Scatterers (270)
F. Rocca, J. Allievi, C. Prati et al.

09:40 SLAM: Integration of Remote Sensing Techniques within Landslide Risk Analysis (DUP/DUE) (569)
N. Casagli, M. Brugioni, P. Canuti et al.

10:00 Monitoring Landslide Activity with SAR Interferometry (704)
C. Colesanti, J. Wasowski, A. Fumagalli

Poster Session 3P01: Landslides

3P01-1 ASAR Contribution to Landslides Inventory and Monitoring (278)
J. Fraleu, J-B. Henry, J-P. Malet, O. Maquaire et al.

3P01-2 Slope Instability and Surface Deformation in Dunedin City, New Zealand (344)
N.F. Stevens, P. Glassey, B. Smith Lyttle

3P01-3 Remote Sensing as a Tool for Supporting Landslide Risk Analysis (604)
P. Farina, D. Colombo, A. Fumagalli, E. Gontier et al.

3P01-4 Ground-surface Changes Detected by EO; their Relationships with Causative Factors of Slope Instability and Hazard Zonation (705)
P. Gostelow, J. Wasowski

Day 3

Wednesday 8 September - 08:40 – 10:20
KARAJAN 2-3

Session 3A2: Vegetation

Chairs: J. Moreno & F. Baret
Secretary: M .Rast

08:40 Evaluation of the MERIS Terrestrial Chlorophyll Index (81)
P. *Curran, J. Dash*

09:00 AVHRR Compatible Vegetation Index Derived from MERIS Data (219)
K. Guenther, S. Maier

09:20 Retrieval of Vegetation Biophysical Variables from MERIS Data: Methodology and Validation with the SPARC Dataset (471)
J. Moreno, G. Fernandez, S. Gandia

09:40 Monitoring Rangeland in the Canadian Prairie Using MERIS (599)
J. Busler, C. Nadeau, H. Wehn, A. Smith

10:00 Using MERIS on Envisat for Land Cover Mapping (240)
J. Clevers, R. Zurita Milla, M. Schaepman, H. Bartholomeus

Poster Session 3P02: Vegetation

3P02-1 Estimation of Biophysical Parameters from Surface Reflectances (53)
Y. Knyazikhin, R. Myneni, N. Shabanov, W. Yang, B. Tan

3P02-2 The Greening Earth (54)
R. Myneni, R. Nemani, C. Tucker

Day 3

Wednesday 8 September - 08:40 – 10:20
MOZART 1-2

Session 3A3: Trace Gases (2)

Chairs: E. Kyrola & K. Chance
Secretary: T. Wehr

08:40 Retrieval of CH4, CO2 CO and H2O FROM SCIAMACHY Onboard Envisat (90)
C. Frankenberg, U. Platt, T. Wagner, C. Frankenberg

09:00 Greenhouse (related) Gases CO and CH4: First Results on Global Distribution, Seasonal Variation and Pollution Events Detected by SCIAMACHY (44)
A. Straume, H. Schrijver, A. Gloudemans, et al.

09:20 Retrieval of CO, H2O, CH4, CO2, and N2O Columns from SCIAMACHY/Envisat by WFM-DOAS: Current Status (387)
M. Buchwitz

09:40 Derivation of Bry in the UT/LS Using SCIAMACHY Limb Scattering Observations (481)
C. Sioris, R. Salawitch, L. Kovalenko, K. Chance

10:00 Satellite Remote Sensing of SO2: Volcanic Eruptions and Anthropogenic Emissions (19)
M. Khokhar, U. Platt, T. Wagner

Wednesday 8 September - 08:40 – 10:20
DOPPLER

Session 3A4: Ocean Circulation

Chairs: P. Challenor & J. Johannessen
Secretary: J. Benveniste

08:40 Contribution of ERS and Envisat in Past, Present and Future Multi-mission Altimeter Systems (352)
P. Le Traon

09:00 Analysis of Near Real Time Envisat Radar Altimeter Data (457)
K. Whitmer, G. Jacobs

09:20 Validation and Applications of Near-Real Time Altimetry Data for Operational Oceanography in Coastal and Shelf Seas (120)
J. Hoeyer, T. Boevith

Day 3

09:40 Oceanographic Characterization of the Cape Verde Region Using Multisensor Data (332)
J. Fernandes, C. Lázaro, M. Santos, P. Oliveira

10:00 Tides in Coastal Areas from Altimeter Data (350)
G. Wensink

Poster Session 3P03: Ocean Circulation

3P03-1 Using SAR Images for Detection of a Surface Poleward Current off the West Coast of the Iberian Peninsula (156)
J.M. Torres Palenzuela, L. Gonzalez Vilas

3P03-2 Mean Sea Surfaces - and Inter-annual Ocean Variability (208)
O. Andersen, P. Knudsen, A.L. Vest

3P03-3 Improving Ocean Analyses and ENSO Forecasts at NOAA Using the Global Ocean Data Assimilation System and Altimetric Sea Level (297)
J. Lillibridge, D. Behringer, Y. Xue, J. Kuhn

3P03-4 SARTool: Building Marine SAR Applications (442)
F. Collard, V. Kerbaol

3P03-5 Nonlinear Internal Waves in the South China Sea (539)
M.-K. Hsu, A.K. Liu

3P03-6 Internal Waves in the East China Sea and the Yellow Sea Studied by SAR, MERIS, MODIS and ASTER Imagery (632)
W. Alpers, M-X. He, K. Zeng, X-M. Li et al.

3P03-7 Investigation of Internal Waves in the East (Japan) Sea Using Synthetic Aperture Radar (638)
D. Kim, W. Moon, S. Nam, K. Kim

3P03-8 Southern Ocean Ocean Tide Modeling (654)
C.K. Shum, Y. Yi

3P03-9 Southern Ocean Sea Level Variations (659)
C. Kuo, C.K. Shum, A. Braun

3P03-10 Absolute Local Sea Surface in the Vanuatu Archipelago from GPS, Satellite Altimetry and Pressure Gauge Data (664)
V. Ballu, K. Cheng, M.-N. Bouin, S. Calmant et al.

Day 3

Wednesday 8 September – 08:30 - 08:40
MOZART 3

Introduction to the Scatterometer Sessions

Chairs: T. Hollingsworth & E. Attema

Wednesday 8 September – 08:40 - 10:20
MOZART 3

Session 3A5: Scatterometer Performance

Chairs: A. Stoffelen & T. Hollingsworth
Secretary: E. Attema

08:40	The Advanced Scatterometer Processing System for ERS Data: Design, Products and Performances (422) *R. Crapolicchio, P. Lecomte, X. Neyt*
09:00	Calibration of the ERS-2 Scatterometer in Gyro-less Mode (563) *N. Manise, X. Neyt, M. Acheroy*
09:20	The Improved C-band Geophysical Model Function CMOD5 (537) *H. Hersbach, A. Stoffelen, S. De Haan*
09:40	On ERS Scatterometer Sea Ice and Wind Stress Determination (670) *A. Stoffelen, J. Verspeek, J. De Kloe*
10:00	Neural-network Based Stateless Ice Detection in ERS Scatterometer Data (566) *X. Neyt, P. Pettiaux, N. Manise, M. Acheroy*

Day 3

Wednesday 8 September – 10:50 - 12:30
MOZART 4-5

Session 3B1: Subsidence

Chairs: T. Strozzi & R. Hanssen
Secretary: P. Bally

10:50 Radar Interferometric Analysis of Mining Induced Surface Subsidence Using Permanent Scatterers (45)
D. Walter, J. Hoffmann, B. Kampes, A. Sroka

11:10 Monitoring Subsidence Caused by Potash Mining in a Temperate Rural Area, Using an Improved InSAR Method (452)
I. Kemeling, D. Petley

11:30 Radar Interferometry Technique for Urban Subsidence Monitoring: a Case Study in Bangkok and its Vicinity (518)
J. Worawattanamateekul, J. Hoffmann, N. Adam et al.

11:50 Urban Unstability revealed by DINSAR and PS Interferometry: Montmartre Case Example in Paris City (France) (561)
B. Deffontaines, B. Fruneau, A. Arnaud et al.

12:10 Land Subsidence Measurement with SAR Interferometric Data (443)
M. Crosetto, B. Crippa, O. Monserrat et al.

Poster Session 3P04: Subsidence

3P04-1 Evaluation of Applicability of ERS INSAR Data for Monitoring of Yamburg-Nyda Gas Pipelines State (115)
A. Zakharov, N. Khrenov

3P04-2 Detection of Urban Land Subsidence in the City of Turku in Finland Using Differential SAR Interferometry (215)
M. Karjalainen, K. Karila, J. Hyyppä

3P04-3 Monitoring Land Subsidence in Mexico City with Envisat ASAR Interferometry (234)
T. Strozzi, U. Wegmüller, C. Werner, A. Wiesmann

3P04-4 Surface Deformation at Rotorua, New Zealand Measured by InSAR, 1996-2003 (345)
J. Hole, N. Stevens, G. Wadge

3P04-5 Interferometry Techniques for Urban Subsidence Analysis over Beijing (392)
V. Prinet, J. Bai, Y.J. Zhang, P. Chen

3P04-7 Identification and Measurement of Mining Subsidence with SAR Interferometry: Experience from Upper Silesian Coal Basin in Poland (497)
Z. Perski

3P04-8 Reflexions and Insights from Urban SAR Interferometry for Monitoring Vertical Deformation Due to Water Pumping: the Haussmann-St-Lazare Case Example (Paris, France) (575)
B. Fruneau, B. Deffontaines, A-M. Prunier-Leparmentier, A. Arnaud et al.

3P04-9 Mine Subsidence Monitoring: a Comparison among Envisat, ERS, and JERS-1 (683)
G. Linlin, M. Hsing-Chung Chang, C. Rizos, M. Omura

Wednesday 8 September – 10:50 - 12:30

KARAJAN 2-3

Session 3B2: Thematic Mapping

Chairs: D. Small & J.-P. Rudant
Secretary:A. Keith

10:50 MERIS Data for Monitoring Dynamics of Vegetation Cover in Semiarid Wetlands - a Case Study of the Niger Inland Delta (Mali, West Africa) (339)
R. Seiler, E. Csaplovics

11:10 Potential of ERS and Envisat SAR Data for Environmental Monitoring of Kolkota (Calcutta) City and Coastal Region of West Bengal, India (657)
R. Chatterjee, T. Sarkar, P. Roy et al.

11:30 Continuité des Programmes SAR/ERS et ASAR/Envisat pour la Mise à Jour Cartographique en Contexte Tropical (42)
J. Rudant, J. Kouame, A. Mascret et al.

11:50 Land Cover/Land Use Classification in a Semiarid Environment in East Africa Using Multi-temporal Alternating Polarisation Envisat ASAR Data (614)
D. Klein, A. Moll, G. Menz

12:10 Erosion Assessment in the Brazilian Cerrados Using Multi-temporal SAR Imagery (222)
A. Vrieling, S. Rodrigues

Poster Session 3P05: Thematic Mapping

3P05-1 Utilisation et Contribution des Images Satellitaires dans la Caracterisation des Conditions Environnementales Liées à l'Apparition des Epidemies d'Ebola (43)
G. Moussavou, J-P. Rudant, E. Leroy, I. Jeanne et al.

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3P05-16 Analysis and Processing of ASAR and MERIS Data for Urban Areas Classification and Monitoring (625)
T. Macrì Pellizzeri, P. Gamba, P. Lombardo, F. Dell'Acqua

3P05-17 The Generation of a UK and Ireland ERS SAR Multi-temporal Mosaic (647)
P. Meadows

3P05-18 A Numerical Algorithm to Acquire the Average Height of Land Surface from Radar Altimeter Mean Return Wave (177)
X. Zhou, X. Hu, Y. Zhang

3P05-19 Recent Geological Evolution of the Lake Abhe Basin Using Multitemporal Satellite Images (199)
L. Marinangeli, A.P. Rossi, G.G. Ori

3P05-20 Reconstruction of the Paleohydrology in Desert Areas Using SAR and Digital Topography Data (200)
L. Marinangeli, G.G. Ori, A.P. Rossi, G. Di Achille

3P05-21 Applications of Envisat ASAR Data in Urban Environment, Soil Moisture and Crop Studies (214)
H. Guo, J. Liao, Z. Li, J. Chen

3P05-22 Derivation of a Multi-sensor Interferometric DEM of the Dead Sea Region (217)
U. Marschalk, M. Bauer, B. Pfeiffer, A. Roth et al.

3P05-23 DEM Resolution (220)
J. Holzner

3P05-24 Utilisation de Données Spatiales Haute Résolution pour la Cartographie des Rizières, Gîtes Larvaires Potentiels des Anophèles Vecteur de Paludisme dans la Région des Hautes Terres Centrales de Madagascar (280)
F. Rakotomanana, R.V. Randremanana, I. Jeanne, G. Moussavou et al.

3P05-25 The Use of ASAR Mosaics for Operational Global Monitoring (649)
E. Guyader

3P05-26 Canadian Envisat ASAR Applications: Preliminary Results (718)
J.J. van der Sanden, P. Budkewitsch, A. Deschamps, M. D'Iorio et al.

Day 3

Wednesday 8 September – 10:50 - 12:30

MOZART 1-2

Session 3B3: Trace Gases (3)

Chairs: K. Chance & E. Kyrola
Secretary: T. Wehr

10:50 Retrieval of Sulphur Containing Atmospheric Constituents from MIPAS/Envisat (429)
A. Burgess, A. Dudhia, R. Grainger

11:10 Polar NOx in the Middle and Upper Stratosphere Observed by MIPAS on Envisat (666)
B. Funke, T. Von Clarmann, H. Fischer et al.

11:30 Air Pollution Monitoring: Results from the TEMIS Project (419)
R. Van der A, F. Boersma, I. De Smedt et al.

11:50 Surface UV Radiation Monitoring Based on GOME and SCIAMACHY (14)
J. Van Geffen, R. Van der A, M. Van Weele, M. Allaart, H. Eskes

12:10 The Mg II Solar Activity Proxy Indicator Derived from GOME and SCIAMACHY (463)
J. Skupin, M. Weber, H. Bovensmann, J. Burrows

Poster Session 3P11: Trace Gases

3P11-1 First Results on Global Distribution and Seasonal Variation of CO2 Detected by SCIAMACHY (35)
W. Hartmann, S. Houweling, H. Schrijver, I. Aben

3P11-2 Identification of Tropospheric Emissions Sources from Satellite Observations: Synergistic Use of Trace Gas Measurements of CH2O, and NO2 (37)
T. Marbach, S. Beirle, J. Hollwedel, U. Platt et al.

3P11-3 First Results on the DOAS - Retrieval of OClO from SCIAMACHY Nadir Measurements (38)
S. Kühl, W. Wilms-Grabe, C. Frankenberg, S. Kraus et al.

3P11-4 Retrieval of SCIAMACHY Near-Infrared CH4 and CO Measurements (50)
A.M.S. Gloudemans, H. Schrijver, A.N. Maurellis, Q. Kleipool et al.

3P11-5 CAPACITY: Operational Atmospheric Chemistry Monitoring (56)
H. Kelder, H. Bovensmann, B. Kerridge, A. Goede et al.

Day 3

3P11-6 The Chlorine Deactivation Period During the Antarctic Vortex Major Warming in September/October 2002: ClONO2 Measurements by MIPAS/Envisat (72)
M. Höpfner, T. von Clarmann, H. Fischer, N. Glatthor et al.

3P11-7 Envisat Data Analyse from Democratic Congo (87)
K. Kingenge

3P11-8 Ozone and Water Vapour in the Tropical Upper Troposphere as Observed by the MIPAS Instrument (136)
H. Sembhi, A.M. Waterfall, J.J. Remedios, G. Allen

3P11-9 Intercomparison of SCIAMACHY and GOME Reflectances, Geolocation and RAL Ozone Profiles (250)
B. Latter, R. Siddans, B. Kerridge

3P11-10 Modelling the Earth's Radiation Budget within the EVERGREEN Project (268)
U. Friess

3P11-11 A Database of Spectral Surface Reflectance from 335-772 nm Derived from 5.5 Years of GOME Observations (275)
P. Stammes, R. Koelemeijer, N. Fournier, M. Eisinger et al.

3P11-12 Stratospheric N2O5 in the Austral Spring 2002 as Retrieved from Limb Emission Spectra Recorded by the Michelson Interferometer for Passi ve Atmospheric Sounding (MIPAS) (324)
G. Mengistu Tsidu, T. von Clarmann, G.P. Stiller, M. Hoepfner et al.

3P11-13 Polar and Mid-Latitude Tropospheric BrO Climatology Derived from GOME and SCIAMACHY as Part of the TEMIS Project (377)
N. Theys, I. De Smedt, M. Van Roozendael, C. Fayt et al.

3P11-14 Measurement and Validation of Hydrochlorofluorocarbon-22 from the MIPAS Instrument (441)
D. Moore, J. Remedios, A. Waterfall

3P11-15 Infrared Remote Sensing of Organic Compounds in the Upper Troposphere (479)
A. Waterfall, J. Remedios, G. Allen

3P11-16 Mapping of Tropospheric NO2 from Limb-nadir Matching (482)
C. Sioris, R. Martin

3P11-17 Observation of ClO by MIPAS/Envisat Before and During the Antarctic Major Warming in September 2002 (513)
N. Glatthor, H. Fischer

3P11-18 Monitoring Tropospheric NO2 with SCIAMACHY (526)
S. Beirle, U. Platt, T. Wagner

3P11-19 CO in the Middle Atmosphere Measured with MIPAS/Envisat (557)
B. Funke, M. López-Puertas, T. von Clarmann, H. Fischer et al.

3P11-20 Water Vapour Isotope Measurements: Comparisons between Results from MIPAS and the Odin SMR (611)
V. Payne, A. Dudhia, C. Piccolo, J. Urban et al.

Wednesday 8 September – 10:50 - 12:30
DOPPLER

Session 3B4: Ocean Circulation and Marine Geoid

Chairs: P. Knudsen & J. Lillibridge
Secretary: J. Benveniste

10:50 Long-term Sea Level Change from Multi-satellite Altimetry in the European Seas (615)
L. Fenoglio-Marc, E. Groten

11:10 Deriving 2Hz ERS-1 Geodetic Mission Altimetry for Gravity and Marine Geoid Purposes (277)
O. Andersen, P. Berry, S. Dreher, P. Knudsen, R. Trimmer

11:30 Multi-mission Mean Sea Surface and Geoid Models for Ocean Monitoring within the GOCINA Project (285)
P. Knudsen, O. Andersen, A. Vest

11:50 Geodynamics and Reconstruction of the Earth's Interior Structure by the Geoid Data in Different Region of the World Ocean (6)
R. Greku

12:10 Bathymetry from Space: Geophysics, Oceanography, and Climatology (427)
D. Sandwell, W. Smith, R. Raney

Poster Session 3P06: Ocean Circulation and Marine Geoid

3P06-1 The KMS03 Multi-mission Altimetric Mean Sea Surface (282)
O. Andersen, P. Knudsen, A. Vest

3P06-2 High Resolution Altimetric Gravity Field Mapping (KMS2002) (284)
O. Andersen, P. Knudsen

Day 3

Wednesday 8 September – 10:50 - 12:30
MOZART 3

Session 3B5: Scatterometer Assimilation

Chairs: T. Hollingsworth & A. Stoffelen
Secretary: E. Attema

10:50 Re-introduction of ERS-2 Scatterometer Data in the Operational ECMWF Assimilation System (408)
P. Janssen, L. Isaksen

11:10 *Towards an Objective Performance Measure of Spaceborne Wind Sensors: ERS Test Case (337)*
M. Portabella, A. Stoffelen, V. Wismann

11:30 Timely ERS-2 Scatterometer Winds for Weather Nowcasting (411)
A. Stoffelen

11:50 Analysis of the Remotely Sensed Winds: Sensitivity of ORCA Model to the Scatterometer Wind Forcing (701)
A. Bentamy, L. Ayiana

12:10 Investigation of the Wind Forcing of Ocean Circulation Using the Decade-long Scatterometer Measurements from ERS-1 and -2 (206)
L. Fu

Wednesday 8 September – 14:00 - 15:40
MOZART 4-5

Session 3C1: Volcanoes and Earthquakes

Chairs: S. Jonsson & G. Wadge
Secretary: F.-M. Seifert

14:00 Persistent Scatterers on Volcanoes (637)
A. Hooper, P. Segall, H. Zebker et al.

14:20 Interferometric Synthetic Aperture Radar (InSAR) Study of Okmok Volcano, Alaska, 1992-2003: Magma Supply Dynamics and Post-emplacement Lava Flow Deformation (271)
Z. Lu, T. Masterlark, D. Dzurisin

14:40 Measurements of Deformation Due to Seismic and Volcanic Sources Using ERS and Envisat Data: Examples from North and South America and Asia (486)
Y. Fialko, D. Sandwell

15:00 Mapping Interseismic Strain Accumulation Using InSAR - New Results from Western Tibet and Eastern Turkey (616)
T. Wright, B. Parsons, R. Holley et al.

15:20 Post-seismic Deformation across the Central Nevada Seismic Belt, USA, Measured by InSAR (485)
N. Gourmelen, F. Amelung

Poster Session 3P07: Volcanoes and Earthquakes

3P07-1 InSAR Survey of Alaskan Volcanoes (272)
Z. Lu, D. Dzurisin, C. Wicks

3P07-2 Contemporary Deformation in the Taupo Volcanic Zone, New Zealand, from ERS and Envisat Permanent Scatterer Processing (307)
N.F. Stevens, J. Hole, G. Wadge, J. Beavan et al.

3P07-3 Towards Near-Real-Time Envisat ASAR Interferometry at Active Volcanoes (389)
N.F. Stevens, G. Wadge, A. Celentano

3P07-4 InSAR Observations of Crustal Deformation in Iceland - an Overview (570)
R. Pedersen, F. Sigmundsson, K.L. Feigl, C. Pagli et al.

3P07-5 Estimation of Bam Earthquake Coseismic Displacement Using Envisat ASAR Interferometric Data (592)
L. Kenyi

3P07-6 Measuring Inter-seismic Deformation by InSAR in Eastern Turkey (661)
K. Feigl, S. McClusky, S. Akarvardar, S. Ergintav et al.

Wednesday 8 September – 14:00 - 15:40
KARAJAN 2-3

Session 3C2: Carbon & Kyoto

Chairs: S. Quegan & Z. Li
Secretary: E. Volden

14:00 GLOBCARBON: Multi-Sensor Estimation of Global Biophysical Products for Global Terrestrial Carbon Studies (DUP/DUE) (326)
S. Plummer, O. Arino, F. Fierens et al.

14:20 KYOTO-INV: Reporting on Land Use and Forestry under the Kyoto Protocol (DUP/DUE) (543)
J. Romero, R. Volz, M. Giamboni, W. Ruesch

14:40 Monitoring Forests as Carbon Sinks Using Remote Sensing (85)
F. González-Alonso, S. Merino-De-Miguel, A. Roldán-Zamarrón et al.

15:00 Inferring Carbon Fluxes of Forests from Tandem Coherence: Environmental and Management Controls (577)
S. Quegan, P. Drezet

15:20 Envisat-Indonesia Radar Biomass Experiment (EIRBEX) (260)
M. Raimadoya, M. Dobson, B. Trisasongko, R. van Rensburg

Wednesday 8 September – 14:00 - 15:40
MOZART 1-2

Session 3C3: Atmosphere Retrieval (1)

Chairs: G.P. Stiller & A. Goede
Secretary: R. Koopman

14:00 The GODFIT Direct Fitting Algorithm: a New Approach for Total Column Retrieval (426)
R. Spurr, M. Van Roozendael, J. Lambert, C. Fayt

14:20 An Online Version of WFDOAS Algorithm for Total Column Retrieval with GOME and SCIAMACHY (353)
L. Lamsal, M. Weber, A. Rozanov et al.

14:40 Inverse Modelling of Methane Emissions from Satellite Observations within the EVERGREEN Project (138)
J. Meirink, J. Eskes, A. Goede

15:00 SCIAMACHY Water Vapour Retrieval Using AMC-DOAS (235)
S. Noël, M. Buchwitz, H. Bovensmann, J. Burrows

15:20 GEO-MTR: a 2-Dimensional Multi-target Retrieval System for MIPAS/Envisat Observations (159)
B. Dinelli, M. Carlotti, A. Dudhia et al.

Day 3

Wednesday 8 September – 14:00 - 15:40
DOPPLER

Session 3C4: Wind and Wave (1)

Chairs: P. Queffelou & D. Cotton
Secretary: J. Benveniste

14:00 Altimeter Dual Frequency Measurements with Envisat RA-2 (564)
B. Chapron, J. Tournadre, Y. Quilfen, F. Collard

14:20 Impact of Multi Near Real-time Altimeter (Envisat and Jason) Assimilation Data on Wave Analyses and Forecast (238)
C. Skandrani, J. Lefevre, P. Queffeulou

14:40 Satellite Wave Height and Wind Speed Validation over the Mediterranean Sea (333)
P. Queffeulou, A. Bentamy

15:00 Climate Change and Extreme Wave Heights in the North Atlantic (527)
P. Challenor, W. Wimmer, I. Ashton

15:20 Extreme Wave Statistics from SAR Wavemode (445)
S. Lehner, T. König, J. Schulz-Stellenfleth, W. Rosenthal

Wednesday 8 September – 14:00 - 15:40
MOZART 3

Session 3C5: Scatterometer Applications (1)

Chairs: M.X. He & R. Ezraty
Secretary: P. Lecomte

14:00 Improving Tropical Cyclone Prediction Using Scatterometer Surface Winds in Model Initialization (669)
S. Chen, J. Tenerelli, W. Zhao, R. Foster, W. Liu

14:20 Some Evidence on the Link between Solar Activity and Climate from ERS Scatterometer Data over Land (359)
V. Wismann

14:40 Arctic Multi-year Sea Ice Monitoring: A decade of Observations Using the ERS Scatterometers (372)
R. Ezraty

15:00 Antarctic Iceberg Abundance, Size, and Drift Derived from Active Microwave Data (462)
N. Young, G. Hyland, R. Williams

15:20 Use of Soil Moisture Scatterometer Data in Hydrological Predictions (299)
G. Blöschl, W. Wagner

Wednesday 8 September – 16:10 – 17:50

MOZART 4-5

Session 3D1: Bam Earthquake

Chairs: E. Fielding & B. Parsons
Secretary: F. Sarti

16:10 Using SAR Interferometry and Teleseismic Data to Determine Source Parameters for the 2003 Bam Earthquake (475)
S. Jonsson, P. Mai, D. Small et al.

16:30 Interferometric Displacement and Damage Assessment for the 2003 Bam Earthquake (304)
J. Hoffmann, A. Roth, S. Voigt

16:50 Coseismic Deformation of the Bam Mw=6.5 Earthquake (Iran) from ASAR Interferometry and Slip Inversion by Boundary-element Method (548)
J. Sun, F. Liang, X. Xu

17:10 Earthquake Mechanisms from Envisat ASAR Imagery: the 2003 Bam (Iran) Earthquake Rupture of a "Truly Blind" Fault (559)
B. Parsons, G. Funning, T. Wright et al.

17:30 Envisat InSAR Correlation Changes Reveal Surface Ruptures and Building Damage from 2003 Earthquake at Bam, Iran (644)
E. Fielding, M. Talebian, M. Qorashi et al.

Day 3

Wednesday 8 September – 16:10 – 17:50

KARAJAN 2-3

Session 3D2: Forestry

Chairs: J. Pulliainen & C. Schmullius
Secretary: M. Engdahl

16:10 LAI Estimation of Boreal Forest with Envisat ASAR (168)
T. Manninen, P. Stenberg, M. Rautiainen et al.

16:30 Comparison of Stem Volume Retrieval Accuracy in Boreal Forest Using Multi-temporal ERS Coherence Images (508)
M. Santoro, J. Askne, L. Eriksson, C. Schmullius

16:50 Multitemporal ERS and Envisat Imagery for the Estimation of the Reforestation Process of Burned Areas (474)
F. Del Frate, F. Catalucci, F. Del Frate et al.

17:10 Forest Disturbance and Attributes Observed by Envisat ASAR (620)
G. Sun, J. Ranson, V. Kharuk, Z. Li

17:30 Burnt Area Detection by Envisat ASAR Wide Swath Backscatter in Boreal Forests of Siberia (680)
S. Huang, F. Siegert

Wednesday 8 September – 16:10 – 17:50

MOZART 1-2

Session 3D3: Atmosphere Retrieval (2)

Chairs: C. Camy-Peiret & G.P. Stiller
Secretary: T. Wehr

16:10 Retrievals of O3 and H2O in the Lower Stratosphere and Troposphere from Envisat (252)
W.J. Reburn, V.L. Jay, R. Siddans, B.J. Kerridge

16:30 Retrieval of Atmospheric Parameters from MIPAS Measurements at IMK/IAA and Application to Atmospheric Sciences (338)
T. Von Clarmann, H. Fischer, B. Funke et al

16:50 Microwindows (416)
A. Dudhia, C. Piccolo, V. Payne, A. Burgess, A. Dudhia

17:10 Iteratively Regularized Gauss-Newton Method for Atmospheric Remote Sensing Applied to MIPAS and SCIAMACHY Limb Sounding Observations (478)
A. Doicu

17:30 Bright Limb Observations by GOMOS, OSIRIS and SCIAMACHY (449)
E. Kyrölä

Poster Session 3P08: Atmosphere Retrieval

3P08-1 Simplification of SCIAMACHY's Polarisation Retrieval (127)
G. Tilstra, N. Schutgens, P. Stammes

3P08-2 Retrieval of Temperature and Pointing Information from MIPAS Limb Emission Spectra (336)
T. von Clarmann, H. Fischer, B. Funke, S. Gil-Lopez et al.

3P08-3 Tomographic Retrieval Approach and Diagnostics for MIPAS-Envisat (366)
T. Steck, M. Höffner, T. von Clarmann, U. Grabowski

3P08-4 Regridding of Remote Sounding Measurements and Application to Ozone Profile Intercomparisons (386)
Y. Calisesi, V.T. Soebijanta

3P08-5 Retrieval of Atmospheric Trace Constituents from Envisat MIPAS Observations by Means of Rapid Radiative Transfer Calculations: First Results for CFC-11 (399)
L. Hoffmann, M. Riese, P. Preusse, R. Spang et al.

3P08-6 Ozone Profile Retrieval from SCIAMACHY Nadir Measurements (401)
K. Bramstedt, V. Rozanov, S. Tellman, M. Weber et al.

3P08-7 Retrieval of Tropospheric Ozone Columns from GOME Observations (410)
R. van der A, A. Segers, H. Eskes, M. van Weele

3P08-8 A Neural Network Algorithm for the Retrieval of Temperature Profiles from GOME Radiance Measurements (451)
F. Del Frate, M. Iapaolo, S. Casadio

3P08-9 Profile Retrieval of SCIAMACHY Limb Sounding Observations (514)
S. Hilgers, A. Doicu, S. Slijkhuis, F. Schreier et al.

3P08-10 Studies in Support of an Advanced ESA Mission to Sound Atmospheric Composition after Envisat (524)
B. Kerridge, A. Baran, M. Birk, S. Buehler et al.

3P08-11 Mesospheric and Lower Thermospheric Temperature and CO2 Vmr as Measured by MIPAS/Envisat (667)
M. López-Puertas, T. von Clarmann, H. Fischer, B. Funke et al.

Day 3

Wednesday 8 September – 16:10 – 17:50
DOPPLER

Session 3D4: Wind and Wave (2)

Chairs: D. Cotton & P. Queffelou
Secretary: J. Benveniste

16:10 Assimilation of ERS and Envisat Wave Data at ECMWF (403)
S. Abdalla, J. Bidlot, S. Abdalla, P. Janssen

16:30 Comparison of Envisat ASAR Data with Met Office Global Spectral Wave Model (57)
J. Li, M. Holt

16:50 EDOWA: Envisat Data for Operational Wave Analysis (99)
H. Hajji

17:10 Assimilation of ASAR Envisat Wave Spectra in Wave Model WAM: Toward Operational Use (140)
L. Aouf, J. Lefevre, D. Hauser, B. Chapron

17:30 Rapid Nearshore Wave Climate from Earth Observation Measurements (351)
G. Wensink

Poster Session 3P09: Wind and Wave

3P09-1 Cross Calibration of Envisat, ERS-2, JASON, TOPEX-POSEIDON, and Geosat Follow-on Wind and Wave Data, Based on Comparisons with In-situ Data and Wave Model Analysis Fields (341)
D. Cotton, P. Challenor, J.-M. Lefevre

3P09-2 Global Validation of Envisat RA-2 Wind and Wave, and MWR Products (402)
S. Abdalla, P. Janssen

3P09-3 Ocean Wave Period from Space: Validation Using Envisat RA2 Data (606)
C. Gommenginger, D. Cotton, M. Srokosz, P. Challenor

3P09-4 A Comparative Study of Extreme Waves by Satellite Data (617)
M.R. Della Rocca

3P09-5 Numerical Simulation of Active Sensor Sea and Wind Response over Shallow Sea (674)
E. Pugliese Carratelli, C. Giarrusso, G. Spulsi

Day 3

Wednesday 8 September – 16:10 – 17:50

MOZART 3

Session 3D5: Scatterometer Applications (2)

Chairs: W. Wagner & C. Anderson
Secretary: P. Lecomte

16:10	Services using Soil Moisture Measured from Space (312) R. Beck, F. Groesz
16:30	Soil Moisture Products from C-band Scatterometers: from ERS-1/2 to METOP (379) K. Scipal, Z. Bartalis, V. Naeimi, W. Wagner
16:50	Effectiveness of C-band Scatterometer in Hydrological Tasks (436) C. Scheffler, W. Flügel, P. Krause
17:10	Analysis of ERS SAR and Wind Scatterometer Data Complementarity over an Agro-pastoral Sahelian Area (584) S. Zine, P. Frison, L. Jarlan et al.
17:30	The Advanced Scatterometer (Ascat) on the METOP Satellites: an Operational Follow-on to ESA ERS C-band Scatterometers (556) C. Anderson, J. Figa, J. Wilson, B. Gelsthorpe, E. Attema

Poster Session 3P10: Scatterometer

3P10-1	The ERS-2 Scatterometer Mission: Events and Long-loop Instrument and Data Performances Assessment (421) *R. Crapolicchio, P. Lecomte*
3P10-2	The Global Validation of ERS Wind and Wave Products at ECMWF (432) *H. Hersbach, S. Abdalla*

Wednesday 8 September – 17:50– 18:50

MOZART 3

Session 3E5: 30 Years C-Band Scatterometer Services

Round Table

Chairs: H. Hersbach & E. Attema
Secretary:

Day 4

Thursday 9 September - 08:40 – 10:20

MOZART 4-5

Session 4A1: Agriculture (1)

Chairs: P. Pampaloni & T. Le Toan
Secretary: A. Zmuda

08:40 Multitemporal Analysis of MERIS FR Data for Crop Monitoring in Two Agricultural Areas: Barrax and Toulouse (582)
M. Gonzalez-Sampedro, J. Moreno, T. Le Toan

09:00 Synergetic Use of Envisat-1/ASAR IMG/APG Data and Optical SPOT XS/XI Data for Land Cover and Agricultural Crops Mapping (507)
M. Mroz, A. Sobieraj, M. Ciolkowska

09:20 Multipolarized and Multitemporal Analysis of Envisat ASAR Data for Agricultural Inventories (InVeKoS) in Germany (112)
V. Hochschild, C. Weise

09:40 Sensitivity of ASAR AP Data to Crop and Soil Parameters (503)
F. Mattia, L. Dente, G. Satalino, T. Le Toan

10:00 The Internet Rice Information System - an EOMD Initiative (283)
F. Holecz, E. Van Valkengoed, M. Salopek, P. Bolton

Thursday 9 September - 08:40 – 10:20

KARAJAN 2-3

Session 4A2: Oil Spills / Ship Detection

Chairs: M.X. He & R.B. Olsen
Secretary: E. Volden

08:40 Oil Spills Automatic Detection from SAR Images (321)
F. Nirchio, P. Trivero, W. Biamino et al.

09:00 Automatic Oil Spill Detection Based on Envisat, RADARSAT and ERS Images (10)
A. Solberg

09:20 An Experience of Using ERS-1/2, Envisat and RADARSAT SAR Images for Oil Spills Mapping in the Waters of the Caspian, Yellow and East China Seas (388)
A. Ivanov, M. Fang, M. He

09:40 Polarisation-Dependent Signatures of Ships (488)
R. Olsen, T. Arnesen, P. Vachon

10:00 An Open Source Framework for Integration of Vessel Positions Detected in Spaceborne SAR Imagery in Operational Fisheries Monitoring and Control (665)
G. Lemoine, G. Schwartz-Juste, N. Kourti, I. Shepherd, C. Cesena

Poster Session 4P01: Oil Spills/Ship Detection

4P01-1 Problems in Detecting Oil Pollution in Black Sea Coastal Zone by Satellite Radar Means (113)
M. Mityagina

4P01-2 Multiscale Segmentation of Oil Slick in SAR Images Based on Morphological Pyramid (293)
T.F.N. Kanaa, G. Mercier, E. Tonye, V. De Paul Onana et al.

4P01-3 Ship Detection with Envisat's Alternating Polarisation Mode (308)
A. Smith, J. Chesworth, H. Greidanus

4P01-4 A Novel Algorithm for Ship Detection in ERS and Envisat SAR Imagery Based on the Wavelet Transform (438)
J.J. Mallorqui, M. Tello, C. Lopez-Martinez, H. Greidanus

Thursday 9 September - 08:40 – 10:20

MOZART 1-2

Session 4A3: Clouds and Aerosal (1)

Chairs: R. Guzzi & D. Murtagh
Secretary: C. Zehner

08:40 Global Observations of UV-absorbing Aerosols from ERS-2/GOME Data (241)
M. De Graaf, P. Stammes, R. Koelemeijer

09:00 Aerosol Optical Thickness Retrieval over Land and Water Using SCIAMACHY/GOME Data (67)
V. Kusmierczyk-Michulec, G. De Leeuw

09:20 Retrieval of Cloud Phase from Earth Spectra around 1.6 Microns as Measured by SCIAMACHY (119)
J. Acarreta, P. Stammes, W. Knap

09:40 Determination of Cloud Parameters from Satellite Instruments for the Correction of Tropospheric Trace Gases (13)
M. Grzegorski, C. Von Friedeburg, U. Platt, T. Wagner

10:00 Improved Cloud Detection for Upper Tropospheric Clouds Using Spectrally Resolved Infra-red Limb Sounding Instruments (51)
J. Greenhough, J. Remedios, R. Spang

Thursday 9 September - 08:40 – 10:20

DOPPLER

Session 4A4: Wetlands / Floods

Chairs: H. Yesou & H. Bach
Secretary: D. Fernandez

08:40 ASAR Multitemporal and Dual Polarization Observations of Wetland Marshes (491)
H. Karszenbaum, F. Grings, J. Jacobo et al.

09:00 InSAR-based Hydrology of South Florida (49)
S. Wdowinski, F. Amelung, T. Dixon et al.

09:20 Assimilation of Snow Properties Derived from ASAR Wide Swath Data in a Hydrological Model of the Neckar Catchment for Improved Flood Forecast (248)
H. Bach, F. Appel, A. Loew et al.

09:40 Towards Operational Flood Mapping with Satellite SAR (108)
S. Solbø, I. Solheim

10:00 Evaluation of a Remote Sensing Based Regional Flood/Waterlog and Drought Monitoring Model Utilising Multi-source Satellite Data Set Including Envisat Data (472)
G. Csornai, Z. Suba, G. Nádor, et al.

Poster Session 4P02: Wetlands/Floods

4P02-1 Usage of Satellite Information for Analysis of the Hydrological Processes (1)
V. Chub, S. Myagkov, M. Torskiy

4P02-2 InFerno+ - a Project for the Integration of Remote Sensing Information in Operational Water Balance and Flood Forecasting Models (88)
R. Ludwig, W. Schulz, U. Merkel, N. Demuth et al.

P02-3 Mapping and Monitoring of Wetlands in the Lake Chad Basin Using Envisat ASAR Wide Swath and Envisat ASAR Alternating Polarization Data (92)
T. Westra, R. De Wulf

4P02-4 ASAR Derived Flood Maps for Flood Propagation Model Calibration (229)
J.-B. Henry, P. Matgen, F. Pappenberger, L. Pfister et al.

4P02-5 Multisource SAR Data for Flood Monitoring in 2003 in China (261)
J. Liao, S. Wang

4P02-6 Hydrological Modelling in a Subtropical Catchment Area - Use of Remote Sensing Techniques for its Parametrisation (342)
T. Harum, P. Saccon, N. Calasans Rego

4P02-7 Assessment of the Synergistic Exploitation of Envisat ASAR and MERIS Data for Plain Flood Rapid Mapping: a Part of the Dragon Flood Project (381)
H. Yesou, Jiren Li, Jing Li, X. Wang et al.

Thursday 9 September - 08:40 – 10:20

MOZART 3

Session 4A5: Ice (1)

Chairs: S. Laxon & N. Young
Secretary: F.-M. Seifert

08:40 SAR and InSAR Studies on Selected Tidewater Glaciers in Spitsbergen (460)
Z. Perski, J. Jania, M. Sober

09:00 Recent Fluctuations and Damming of Glaciar Perito Moreno, Patagonia, Observed by Means of ERS and Envisat SAR Imagery (117)
H. Rott, M. Stuefer, T. Nagler, C. Riedl

09:20 Flow Evolution through the 1993-5 Surge of Bering Glacier Alaska Measured by ERS SAR Feature-tracking (244)
A. Luckman, T. Murray, A. Luckman

09:40 Using ERS and Envisat Data to Study the Glacier Changes in Tibet, the Nianqingtanggulashanmai Example (ESA Project no 2401) (378)
J. Deroin, M. Dai, L. Chuang et al.

10:00 Recent Variations of Larsen Ice Shelf, Antarctic Peninsula, Observed by Envisat (192)
C. Riedl, H. Rott, W. Rack

Day 4

Thursday 9 September - 10:50 – 12:30

MOZART 4-5

Session 4B1: Agriculture (2)

Chairs:
Secretary:

10:50 Retrieving Wheat Biomass from ASAR Data (578)
T. Le Toan, M. Gonzalez-Sampedro, J. Moreno

11:10 The Role of Envisat ASAR in Agriculture (133)
F. Holecz, P. Pasquali, M. Barbieri, S. Monaco, C. Heimo

11:30 Agricultural Monitoring in Finland Using Envisat Alternating Polarization SAR Images (95)
M. Karjalainen, H. Kaartinen, J. Hyyppä, R. Kuittinen

11:50 Estimation of Crop Parameters from Multiyear ERS - Envisat SAR Data Set (605)
C. Lucau, P. Defourny

12:10 Rice Monitoring Using Envisat ASAR Data in China (619)
P. Yong, Z. Li, G. Sun et al.

Poster Session 4P03: Agriculture

4P03-3 Crop Classification Based on Microwave Images Acquired from Envisat and ERS (165)
K. Stankiewicz

4P03-4 Ecological Agricultural Crops Classification Using Envisat-ASAR in Oases of Taklamakan Desert (227)
Q. Dong, H. Guo, Z. Li

Day 4

Thursday 9 September - 10:50 – 12:30

KARAJAN 2-3

Session 4B2: Water Quality

Chairs: R. Doerrfer & K. Ruddick
Secretary: J.-P. Huot

10:50 Suspended Matter Dynamics in Lake Constance in 2003 Derived from MERIS and MODIS Satellite Data (317)
J. Huth, P. Gege

11:10 Mapping of Photosynthetic Pigments in Spanish Inland Waters Using MERIS Imagery (186)
R. Pena-Martinez, A. Ruiz-Verdu, J. Dominguez-Gomez

11:30 Retrieval of Limnological Parameters of Perialpine Lakes by Means of MERIS Data (207)
D. Floricioiu, H. Rott, E. Rott et al.

11:50 Amazon Floodplain Water Quality Monitoring using MERIS and MODIS Data (621)
J. Martinez, L. Maurice-Bourgoin, P. Moreira-Turcq, et al.

12:10 Water Quality and Algae Bloom Mapping in the CASE 2 Waters of the Baltic Sea and Finnish Lakes Using Envisat MERIS Data (257)
J. Pulliainen, J. Vepsäläinen, S. Koponen et al.

Poster Session 4P04: Water Quality

4P04-1 Large European Lakes Vänern and Vättern in MERIS Images (225)
A. Reinart, D. Pierson, N. Strömbeck

Day 4

Thursday 9 September - 10:50 – 12:30

MOZART 1-2

Session 4B3: Clouds and Aerosols (2)

Chairs: Y.M. Timofeyev & R. Guzzi
Secretary: C. Zehner

10:50 MIPAS/Envisat Observations of PSCs in the Artic and Antarctic Winters 2002 to 2004: a Comprehensive Dataset for Polar Process Studies (309)
R. Spang, J. Remedios, L. Kramer et al.

11:10 Aerosol Optical Depth over Europe - Retrieval from ATSR-2 Data for the Year 2000 (65)
R. Schoemaker, G. De Leeuw, R. Schoemaker

11:30 Retrieving Aerosol Properties and Land Surface Reflectance from Multi-angle AATSR Measurements (246)
W. Grey, P. North, S. Los

11:50 CONTRAIL: Monitoring Aircraft Condensation Trails (DUP/DUE) (383)
F. Jelinek

12:10 Detection of Condensation Trails, Cirrus Clouds and Retrieval of their Properties with AATSR (538)
H. Mannstein, K. Dammann, W. Krebs, L. Bugliaro, B. Mayer

Thursday 9 September - 10:50 – 12:30

DOPPLER

Session 4B4: Soil Moisture

Chairs: W. Wagner & W. Mauser
Secretary: R. Cordey

10:50 Has SAR Failed in Soil Moisture Retrieval? (76)
W. Wagner, C. Pathe

11:10 Use ERS-2 SAR Data for Estimating Soil Moisture and Vegetation Water Content Variations in Boreal Forests (662)
J. Pulliainen, P. Hari, M. Hallikainen et al.

11:30 Retrieval of Soil Moisture from Envisat ASAR Images: a Comparison of Inversion Algorithms (161)
P. Pampaloni, E. Santi, S. Paloscia et al.

11:50 Multiscale Soil Moisture Retrieval to Monitor the Global Change of the Water Cycle - Perspectives from the GLOWA-Danube Project (110)
W. Mauser, A. Löw, R. Ludwig

12:10 Soil Moisture Mapping with C-band Multi-polarization SAR Imagery (102)
Z. Li, X. Ren, X. Li, L. Wang

Poster Session 4P05: Soil Moisture

4P05-1 The Retrieval of Soil Moisture Using Medium Resolution Envisat ASAR Wide Swath Data (25)
X. Kong, S. Dorling, R. Smith

4P05-2 Coupled Modelling of Microwave Landsurface Interactions Using Envisat ASAR APS Data (63)
A. Loew, W. Mauser

05-3 Soil Moisture Experiments in 2003 (SMEX03) ASAR Studies (80)
T. Jackson, R. van der Velde, R. Bindlish, J.C. Shi

4P05-4 Estimation of the Rain Moisture of Soils from Envisat ASAR (155)
I. Kalmykov, A. Boyev, V. Yefimov

4P05-5 Methodology for the Processing of ASAR Wide Swath Data for the Derivation of Land Surface Properties of the Mosel Catchment (247)
N. Demuth, F. Appel, H. Bach, A. Loew et al.

4P05-6 Retrieving of Surface Moisture and Roughness for Agricultural Soil Surfaces with ASAR-Envisat Data (273)
M. Zribi, N. Holah, N. Baghdadi

4P05-7 Subsurface Microwave Remote Sensing of Soil Water Content: Field Studies in the Negev Desert and Optical Modeling (453)
D. Blumberg, J. Daniels, J. Ben-Asher, V. Freilikher et al.

4P05-8 Analysis of ASAR Imagery for Hydrological Applications in Sardinia, Italy (487)
C. Paniconi, K. Guillotte, I. Gherboudj, M. Bernier et al.

4P05-9 Estimating the Soil Moisture from ERS-2/SAR Data in the Kurukavak Basin, Turkey (627)
Z. Akyurek, A. Unal Sorman

Day 4

Thursday 9 September - 10:50 – 12:30

MOZART 3

Session 4B5: Ice (2)

Chairs: N. Young & S. Laxon
Secretary: P. Féménias

10:50 Use of Envisat Dual-frequency Radar Altimeter Data over Continental Surfaces (194)
F. Papa, B. Legresy, F. Remy et al.

11:10 Dual-Frequency Radar Altimeter above the Antarctic Ice Sheet (94)
F. Rémy, A. Levasseur, B. Legrésy

11:30 Comparisons of Envisat and ERS Radar Altimetry and ICESat Laser Altimetry for Ice-sheet Elevation Change Studies (622)
J. Dimarzio, H. Zwally, A. Brenner

11:50 Rheological Models of European Ice Coasts from SAR Interferometry and Altimetry (17)
A. Sharov, S. Etzold

12:10 Surface Wind Field and Snow Grain Size over Antarctica Derived from ATSR Data (519)
N. Young, G. Hyland, J. Anderson, M. Fily

Poster Session 4P06: Ice

4P06-1 Melting of Seasonal Snow in Dronning Maud Land, East Antarctica Derived from Envisat ASAR Imagery (66)
O.P. Mattila

4P06-2 Envisat Radar Altimetry over the Vostok Lake Area, Antarctica (191)
B. Legresy, S. Roemer, F. Remy

4P06-3 Envisat Radar Altimetry over the Amery Ice Shelf (193)
B. Legresy, R. Coleman, F. Remy

4P06-4 Glacier Velocity Measurements Using Differential Interferometric SAR in Antarctic Grove Mountain (213)
C. Xiao, Li Zhen, Z. Yanmei

4P06-5 SAR Firn Line Detection and Glacial Climate Response; Svartisen Glacier, Northern Norway (396)
R. Storvold, K.A. Høgda, E. Malnes

4P06-6 Synergy of Active and Passive Satellite Microwave Data for Cryospheric Studies (458)
A. Kouraev

Day 4

Thursday 9 September - 14:00 – 15:40

MOZART 4-5

Session 4C1: Fires and Land Surface Temperature

Chairs: F. Achard & C. Mutlow
Secretary: M. Simon

14:00 The Watermed Field Experiment: Validation of the AATSR-LST Product with In-situ Measurements (290)
E. Noyes, G. Sòria, J. Sobrino et al.

14:20 Validation of Envisat AATSR Data Derived Land Surface Temperature - a Case Study over Indian Region (2)
K. Badarinath

14:40 Evaluation of the Envisat-AATSR Land Surface Temperature Algorithm with Ground Measurements in the Valencia Test Site (30)
C. Coll, E. Valor, V. Caselles et al.

15:00 Large-scale Forest Fires in Siberia Analysed by MODIS, MERIS and ASTER Multi-resolution Satellite Imagery (646)
F. Siegert, S. Huang

15:20 GLOBFIRE: ATSR-2 and AATSR World Fire Atlas Products, Validation, Consistency and Relationship with Climate Variables (681)
O. Arino, S. Plummer, D. Defrenne

Poster Session 4P07: Fires and Land Surface Temperature

4P07-1 Surface Temperature Estimation from AATSR Data (709)
J.A. Sobrino, J. Cuenca, G. Sòria

4P07-2 Retrieval of Surface Temperatures from ATSR Thermal Images Through a Monowindow Algorithm (144)
A. Pérez Burgos, J.L. Casanova Roque, A. Calle Montes

Day 4

Thursday 9 September - 14:00 – 15:40

KARAJAN 2-3

Session 4C2: Ocean Colour

Chairs: A. Morel & J. Aiken
Secretary: J.-P. Huot

14:00 REVAMP: the Latest North Sea Chlorophyll Atlas Results (498)
S. Peters, H. Van der Woerd, R. Pasterkamp et al.

14:20 Ocean Colour Multi-sensor Analysis During a Phytoplankton Spring Bloom in the North Sea Region (500)
A. Folkestad, L. Pettersson, D. Durand

14:40 Application of MERIS Data to Assess CO2 Upper Ocean Fluxes: Development and Validation of a Satellite-model Approach (707)
F. D'Ortenzio, D. Antoine

15:00 An Ocean Color Inversion Algorithm for Chlorophyll, Backscatter Coefficient and Coloured Dissolved Organic Matter (601)
Y. Park, K. Ruddick

15:20 Optical Observations of Marine Film Slicks (361)
I. Sergievskaya, J. Da Silva, S. Ermakov, S. Correia

Poster Session 4P08: Ocean Colour

4P08-1 A Comparative Analysis of Simple Radiative Transfer Approaches for Aquatic Environments (60)
L. Sokoletsky, Y.Z. Yacobi

4P08-2 Results of MERIS Level-2 Validation in Namibian Coastal Area and Atlantic Ocean (103)
T. Ohde, H. Siegel, M. Gerth

4P08-3 Detection of Pseudo-Nitzchia SPP Toxic Blooms Using MERIS Images on the Galician Coast (154)
J.M. Torres Palenzuela, L. Gonzalez Vilas, A. Mosquera Giménez

4P08-4 Identification of Hydrogen Sulphide Eruptions at the Namibian Coast Using MERIS Sensor (218)
T. Ohde

4P08-5 A Review of Chlorophyll Concentration in the Gulf of Eilat (Aqaba) Open Waters by In-situ Monitoring and Remote-Sensing Derived Data from the Past Two Decades (447)
A. Dadashev, D. Blumberg. D. Iluz, L. Sokoletsky et al.

4P08-6 Study of the Surface Kuroshio Bifurcations around Taiwan by MERIS Data (504)
M. Fang

Day 4

Thursday 9 September - 14:00 – 15:40

MOZART 1-2

Session 4C3: Ozone Profiles Retrieval from GOME (1)

Chairs: J.-C. Lambert & Y. Meijer
Secretary: S. Casadio

14:00 Retrieval of Ozone Profiles from GOME and SCIAMACHY (GOME O3 Profiling WG) (249)
R. Van Oss, R. Van der A

14:20 Ozone Profile Retrieval from GOME Radiance Measurements: the Inversion Problem Solved by Regularization(GOME O3 Profiling WG) (310)
J. Landgraf, O. Hasekamp

14:40 Recalibrated Ozone Profiles from GOME-UV/VIS-Nadir-Spectra (319)
S. Tellmann, M. Weber, V. Rozanov, J. Burrows

15:00 Ozone Profile Retrieval from Global Ozone Monitoring Experiment (GOME) (GOME O3 Profiling WG) (560)
K. Chance, X. Liu, R. Spurr et al.

15:20 Global Height-Resolved Ozone Distributions Spanning the Troposphere and Stratosphere from Eight Years of GOME Observations (673)
R. Siddans, B. Latter, B. Kerridge et al.

Thursday 9 September - 14:00 – 15:40

DOPPLER

Session 4C4: Snow

Chairs: H. Rott & K. Partington
Secretary: R. Cordey

14:00 Feasibility of Envisat Data for the Estimation of Snow Pack Characteristics and Areal Fraction of Snow Cover in Boreal Forests (251)
J. Pulliainen, S. Metsämäki, K. Luojus et al.

14:20 Snow Classification Algorithm for Envisat ASAR (169)
T. Nagler, H. Rott

14:40 Multi-sensor/Multi-temporal Analysis of Envisat Data for Snow Monitoring (306)
R. Solberg, J. Amlien, H. Koren et al.

15:00 Near Real Time Snow Covered Area Mapping with Envisat ASAR Wide Swath in Norwegian Mountaineous Areas (468)
E. Malnes, I. Lauknes, R. Storvold

15:20 Mapping Snow Cover in Alpine Areas with Envisat/ SAR Images (349)
P. Pampaloni, S. Pettinato, P. Poggi et al.

Poster Session 4P09: Snow

4P09-1 Snow Water Equivalent Retrieval Using Delta-K InSAR Repeat Pass Processing of Envisat ASAR Data (551)
Y. Larsen, G. Engen, E. Malnes, K. Høgda et al.

4P09-2 Comparison of ASAR Data and RADARSAT-1 Data for Cryospheric Applications in Canada (682)
Y. Gauthier, M. Bernier, S. Hardy, F. Weber et al.

Thursday 9 September - 14:00 – 15:40

MOZART 3

Session 4C5: Sea-Ice (1)

Chairs: W. Dierking & D. Flett
Secretary: O. Grabak

14:00 Demonstration of Envisat Data for Sea Ice Monitoring in the Northern Sea Route (181)
V. Alexandrov, O. Johannessen, S. Sandven et al.

14:20 Arctic Sea Ice Thickness from Envisat Altimetry Data (114)
A. Ridout, S. Laxon

14:40 Comparison of Single and Dual Polarised Envisat ASAR Data with Laser Scanner Data of Sea Ice Thickness in Fram Strait (626)
L. Toudal, K. Kloster, S. Hvidegaard, F. Rene

15:00 Lincoln Sea and Nares Strait (469)
P. Gudmandsen

15:20 Remote Sensing of Freshwater Ice Cover Using Satellite Synthetic Aperture Radar (SAR) Data (259)
G. Leshkevich, S. Nghiem

Day 4

Thursday 9 September - 16:10 – 17:50

MOZART 4-5

Session 4D1: Hazard and Disaster Relief

Chairs: U. Wegmuller & K. Fellah
Secretary: M. Paganini

16:10 How Space Can Better Support Emergency Management and Critical Infrastructure Protection (172)
I. Becking

16:30 Use of SAR Data for Natural Disaster Mitigation in the Mobile Environment (636)
M. Louhisuo, T. Häme, K. Andersson et al.

16:50 Flood Risks Management and Prevention-WARM (448)
C. King, M. Costes, J. Prof Li

17:10 Towards a European Rapid Mapping Service for Disasters Monitoring (714)
K. Fellah, B. Allenbach, S. Battiston et al.

17:30 Building Damage Detection Using Satellite SAR Intensity Images for Recent Earthquakes (327)
M. Matsuoka, F. Yamazaki

Poster Session 4P10: Hazard and Disaster Relief

4P10-1 Improving the Accessibility to Russian Satellite Data for Mitigating Natural Disaster (4)
E. Kudashev

4P10-3 Integration of Envisat-ASAR Data in a Hazard-Monitoring-GIS - Envisat Project (70)
K. Scharrer, U. Münzer, K. Weber-Diefenbach, A. Gudmundsson

4P10-4 CSTARS, a New State-of-the-Art Satellite Receiving Facility: Operational and Research Capabilities (494)
H. Graber

4P10-5 The Geohazards Integrated Global Observing Strategy (710)
M. Paganini, F. Palazzo, S. Marsh, R. Missotten

Day 4

Thursday 9 September - 16:10 – 17:50

KARAJAN 2-3

Session 4D2: Clouds and Aerosols (3)

Chairs: R. Santer & M. Verstraete
Secretary: P. Colagrande

16:10 Synergetic Aerosol Retrieval from Envisat (128)
T. Holzer-Popp, M. Schroedter-Homscheidt

16:30 A Surface Reflectance Model for MERIS Aerosol Remote Sensing over Land (188)
R. Santer

16:50 MERIS Water Vapour Retrieval and its Validation by means of Ground-Based Measurements (699)
J. Fischer, P. Albert, R. Bennartz, R. Preusker

17:10 Remote Sensing of Particle Matter Using MERIS (151)
J. Vidot, R. Santer, D. Ramon

17:30 Comparison of MERIS; MODIS and MSG Cloud Top Pressure (698)
R. Preusker, J. Fischer, S. Tjemkes, A. De Smet

Poster Session 4P11: Clouds and Aerosols

4P11-1 Development of a Full Radiative Transfer Model in the Oxygen A-band for Satellite Retrieval of Cloud Pressure (62)
N. Fournier, P. Stammes, M. Eisinger

4P11-2 MIPAS/Envisat Observations of Properties Polar Stratospheric Clouds During the Antarctic Winter 2003 in Comparison with Lidar Measurements (75)
M. Höpfner, T. von Clarmann, H. Fischer, N. Glatthor et al.

4P11-3 Coincident Cloud Observations by Altimetry and Radiometry (98)
G. Quartly, C. Poulsen

4P11-4 Validation of MERIS Atmospheric Corrections: Towards a New Aerosol Climatology (107)
N. Martiny, R. Santer, I. Smolskaia

4P11-6 Optimal Combination of Polarization and Spectral Information for the Retrieval of GOME/ERS-2 Cloud Parameters (130)
D. Loyola, Y. Livschitz, T. Ruppert

4P11-7 Coupling Oxygen Absorption at 762 NM with Scattering (185)
R. Santer, F. Zagolski

4P11-9 Validation of a Regional Model of Dust Aerosols Cycle (382)
C. Schmechtig

4P11-10 Sensitivity of the MIPAS on Envisat to the Detection of Polar Stratospheric Clouds and their Composition (425)
L. Kramer, R. Spang, J. Remedios

4P11-11 Integrated Air Quality Monitoring Service Using Ground Networks Measurements and EO Products (428)
D. Ramon, R. Santer, J. Vidot

4P11-12 Aerosol Simulation in Monte Carlo Based Radiative Transfer Modeling (490)
S. Sanghavi, C. von Friedeburg, C. Frankenberg, S. Beirle et al.

Thursday 9 September - 16:10 – 17:50

MOZART 1-2

Session 4D3: Ozone Profiles Retrieval from GOME (2)

Chairs: C. Zehner & R. Siddans
Secretary: S. Casadio

16:10 Estimating Ozone Vertical Distributions with GOME Data and Neural Network Techniques (GOME O3 Profiling WG) (455)
F. Del Frate, S. Casadio, F. Del Frate, M. Iapaolo

16:30 New 8 year NNORSY-GOME Ozone Profile Retrieval Data Set (GOME O3 Profiling WG) (590)
A. Kaifel, M. Müller, J. Kaptur

16:50 Information Aspects of Height-resolved Atmospheric Ozone Derived by Optimal Estimation from GOME Satellite Measurements (GOME O3 Profiling WG) (581)
J. Lambert, C. De Clercq, B. Kerridge et al.

17:10 Objective Evaluation of the Impact of RAL GOME Ozone Profiles on the UK Met Office 3D-VAR Analyses (GOME O3 Profiling WG) (501)
R. Dragani, S. Migliorini, A. O'Neill et al.

17:30 Characterization of Eight Different GOME Ozone Profile Algorithms (GOME O3 Profiling WG) (354)
Y. Meijer, R. Van der A, P. Bhartia et al.

Day 4

Thursday 9 September - 16:10 – 17:50

DOPPLER

Session 4D4: Lake Levels

Chairs: C. Birkett & P.A. Berry
Secretary: J. Benveniste

16:10 Monitoring of Lake and River Systems using Retracked Satellite Altimeter Data (430)
E. Mathers, P. Berry, J. Garlick

16:30 The Envisat/ERS River and Lake Retracking System (431)
J. Garlick, P. Berry, E. Mathers, J. Benveniste

16:50 Global Inland Water Monitoring with Multi-mission Satellite Altimetry: Current Status and Future Prospects (434)
P. Berry, J. Garlick, E. Mathers

17:10 Comparison of the Envisat Waveform Retrackers over Inland Waters (435)
F. Frappart, A. Cazenave, F. Seyler, S. Calmant

17:30 Floods and Droughts in Africa: Relation to Short-term Climate Variability (28)
C. Birkett

Poster Session 4P12: Lake Levels

4P12-1 River and Lake from Radar Altimetry, Sample Products for Hydrologists (303)
J. Benveniste, P. Berry, D. Defrenne, D. Di Cola et al.

4P12-2 Amazon River Stages by Envisat vs Other Satellite Altimeters (671)
S. Calmant, F. Seyler, A. Cazenave, F. Frappart

Day 4

Thursday 9 September - 16:10 – 17:50

MOZART 3

Session 4D5: Sea-Ice (2)

Chairs: D. Flett & W. Dierking
Secretary: O. Grabak

16:10 On the Use of Envisat ASAR for Remote Sensing of Sea Ice (672)
S. Nghiem

16:30 Comparison of Helicopter-borne Measurements of Sea Ice Thickness and Surface Roughness with SAR Signatures (109)
T. Busche, C. Von Saldern, C. Haas, W. Dierking

16:50 The Potential of Cross-Polarization Information for Operational Sea Ice Monitoring (493)
B. Scheuchl, R. Caves, D. Flett et al.

17:10 Operational Experience with Envisat ASAR Wide Swath Data at the Canadian Ice Service (363)
D. Flett, R. De Abreu, J. Falkingham

17:30 What do We Gain by Using an L-band SAR for Sea Ice Mapping? (84)
W. Dierking, H. Skriver, J. Dall

Poster Session 4P13: Sea-Ice

4P13-1 A First Experiment of Near Real Time (NRT) Processing of Envisat/ASAR Images to Assist Ship Routing in Antarctica (12)
F. Parmiggiani

4P13-2 Analysis of Sea Ice Roughness and Thickness Variation for Improvement of SAR Ice Type Classification (77)
C. von Saldern, T. Busche, C. Haas, W. Dierking

4P13-3 The Distribution of Sea Ice in Storfjorden (135)
R. Hall

4P13-4 Monitoring Polynya Processes and Sea Ice Production in the Laptev Sea (137)
C. Haas, W. Dierking, T. Busche, J. Hoelemann et al.

4P13-5 Envisat and the Ice Conditions in the Baltic Sea (157)
M. Similä, J. Karvonen, R. Berglund, M. Mäkynen et al.

4P13-6 Ice Cover of the Okhotsk Sea: a Study Using Envisat ASAR, ERS-2 SAR and AQUA AMSR-E Data (175)
D. Darkin, L. Mitnik, V. Dubina

4P13-7 ERS/RADARSAT/Envisat SAR Satellite Studies of the Behavior Ecology of Ice Form of Seals Affected by Differences of Winter Severity, Winter Hydrology and Climate Change (228)
V. Melentyev, V. Chernook, M. Sjoberg, S. Sandven

4P13-8 Remote Sensing of Frost Flowers and Sea Ice (256)
L. Kaleschke

4P13-9 Sea Ice Monitoring with ASAR Alternating Polarization Mode: Results from the Canadian Ice Service Gulf 2003 and 2004 Field Validation Programs (362)
D. Flett, M. Arkett, R. De Abreu, S. Prinsenberg

4P13-10 Near Real Time Use of the Envisat ASAR Images as an Aid of Winter Navigation in the Baltic Sea (509)
J. Vainio

4P13-11 Computer Based Detection and Tracking of Antarctic Icebergs in SAR Images (555)
T. Silva, G.R. Bigg

4P13-12 Use of Envisat Data in Sea Ice Modeling (572)
M. Leppäranta, K. Wang

4P13-13 Application of ASAR Coregistration between Multi-temporal WS Acquisitions for the Purpose of Polynya Monitoring (695)
R. Duca, F. Del Frate, F. Parmiggiani

Poster Session 4P14: Sea Surface Temperature

4P14-1 Using AATSR Data within the GODAE High Resolution Sea Surface Temperature Pilot Project (GHRSST-PP) (86)
C. Donlon, D. Poulter, I. Robinson

Poster Session 4P15: Atmosphere Assimilation

4P15-2 Land Surface Parameters for Atmospheric Modelling Applications (300)
K. Van de Vel, S. Adriaensen, K. De Ridder, F. Lefebre et al.

4P15-3 Assimilation of Ozone Profiles from MIPAS in the STRATAQ CTM (506)
B. Grassi, G. Redaelli, G. Visconti

Day 4

Poster Session 4P16: Future Earth Observation Missions

4P16-1 The TerraSAR-X SAR Products (243)
M. Eineder, B. Schättler, H. Breit, T. Fritz et al.

Poster Session 4P17: Wind and Wave/Sea State

4P17-1 Quantitative Remote Sensing: Horns Rev Wind Farm Case Study (23)
C. Bay Hasager, M. Nielsen, M. Christiansen

4P17-2 Ocean Surface Wave Spectrum from Envisat ASAR Observations, During the Valpareso Experiment Compared to Airborne Radar Observations, In-situ Data, and Wave Prediction Models (163)
A. Mouche, D. Hauser, V. Kerbaol, B. Chapron et al.

4P17-3 Offshore Wake Effect Study from Earth Observation SAR (123)
M.B. Christiansen, C.B. Hasager

4P17-4 Estimation of Wind Speed Frequency Distribution (291)
O.F. Omidiora

4P17-5 Mechanisms for the SAR Imaging of the Ocean (406)
M. Kanevsky, V. Karaev

4P17-6 Biological and Geophysical Parameters from Envisat over the Ocean (450)
W. Rosenthal, S. Lehner, R. Doerffer, P. Lemke et al.

4P17-7 C- and Ku-band Ocean Geophysical Model Functions under High Winds Conditions (630)
D. Esteban Fernandez, E. Kerr, S. Frasier, J. Carswell et al.

4P17-8 Investigation of Ocean Surface Streaks with Respect to SAR Wind Retrieval (729)
J. Horstmann, W. Koch

Day 5

Friday 10 September – 08:40 – 10:20

MOZART 4-5

Session 5A1: Siberia II (1)

Chairs: C. Schmullius & T. Le Toan
Secretary: S. Plummer

08:40 SIBERIA-II - Multi-sensor Concept for Greenhouse Gas Accounting in Northern Eurasia (589)
C. Schmullius

09:00 Relating Earth Observation to Dynamic Vegetation Modelling in SIBERIA-II (565)
T. Le Toan, S. Quegan, W. Lucht et al.

09:20 SIBERIA-II: Earth Observation in a Landscape-Based Greenhouse Gas Accounting Approach (600)
A. Shvidenko, S. Nilsson, I. Mccallum et al.

09:40 Processing of Envisat ASAR Wide Swath Imagery for Derivation of Biophysical Parameters of Siberian Forest - a Contribution of DLR to the Siberia II Project (286)
S. Voigt, A. Petrocchi, M. Huber, A. Roth

10:00 Identification of Wetlands in Siberia with Envisat ASAR WS Data (150)
A. Bartsch, C. Pathe, A. Shvidenko, W. Wagner

Friday 10 September – 08:20* – 10:20

MOZART 1-2

Session 5A2: Sea Surface Temperature

Chairs: I. Robinson & I. Barton
Secretary: S. Pinnock

08:20 Comparisons of AATSR-derived Sea Surface Temperature with Estimates from a Geostationary Satellite (209)
I. Barton

08:40 The ATSR/AATSR Data-Set: A Comprehensive of the Climate System (713)
D. Llewellyn-Jones, G. Corlett, C. Mutlow

09:00 Measuring Climate Change Using ATSR Sea-surface Temperatures (395)
S. Lawrence, D. Llewellyn-Jones

Day 5

09:40 Comparison of ATSR-1 and ATSR-2 Sea Surface Temperatures During 1995 and Analyses of ATSR-2 SSTs from 1995 to 2000 (27)
A. O'Carrol, R. Saunders, J. Watts

10:00 MEDSPIRATION: Delivering a New Generation of High Resolution Sea Surface Temperature Data Products (DUP/DUE) (549)
C. Donlon, I. Robinson

Friday 10 September – 08:40 – 10:20
DOPPLER

Session 5A3: Future Earth Observation Missions (1)

Chairs: B. Hoersch & P. Gilles
Secretary: B. Hoersch

08:40 ESA Third Party Missions Programme (720)
B. Hoersch

09:00 Fluctuations of the Earth's Ice Fields: the Contribution of the ERS and CryoSat Missions (728)
D. Wingham

09:20 TerraSAR-L Product Philosophy (334)
M. Zink

09:40 The Scientific Use of TerraSAR-X (721)
A. Roth

10:00 ALOS Science and Application Programme (725)
M. Shimada

Friday 10 September – 08:40 – 10:20
MOZART 3

Session 5A4: Wind and Wave / Sea State (1)

Chairs: J. Horstmann & H. Johnsen
Secretary: G. Cambell

08:40 A Simplified SAR Ocean Wave Spectrum Inversion (523)
B. Chapron, F. Collard, F. Ardhuin

Day 5

09:00 Mesoscale Flow Variability in Tropical Storms Using SAR Imagery (495)
H. Graber, S. Lehner, M. Donelan et al.

09:20 Exploiting Envisat-ERS Data for Deriving Air-Sea Fluxes of CO2 (696)
J. Aiken, N. Hardam-Mountford, S. Ufermann et al.

09:40 Impact of Envisat Alternating-polarization Mode Imagery on Rough-surface Scattering Models and the Generation of High-resolution Wind Maps (330)
D. Thompson, F. Monaldo, J. Horstmann et al.

10:00 Multi-polarisation Ocean Radar Cross-section from Envisat ASAR Observations, Airborne Polarimetric Radar Measurements and Empirical or Semi-Empirical Models (64)
A. Mouche, D. Hauser, V. Kudryavstev, J. Daloze

Friday 10 September – 10:50 – 12:30

MOZART 4-5

Session 5B1: Siberia II (2)

Chairs: C. Schmullius & S. Plummer
Secretary: S. Plummer

10:50 Development and Validation of a Diurnal Difference Indicator for Freeze-thaw Monitoring in the Siberia II Project (585)
R. Kidd, A. Bartsch, W. Wagner

11:10 SIBERIA-II: Using MERIS to Derive Land-cover Information (415)
L. Skinner, A. Luckman

11:30 SIBERIA-II: Monitoring Forest Cover Changes in Siberia by Means of Spaceborne Data (597)
M. Santoro, H. Balzter, C. George et al.

11:50 Assessment of Envisat/ASAR Data for Forest Observations in Siberia (571)
T. Le Toan, A. Wiesmann, J. L'hermitte et al.

12:10 SIBERIA-II - Multi-product and Multi-sensor Validation Strategies in the Context of GLOBCARBON, GLOBCOVER and GOFC-GOLD (602)
C. Schmullius, H. Balzter, S. Plummer

Day 5

Friday 10 September – 10:50 – 12:50

MOZART 1-2

Session 5B2: Atmosphere Assimilation

Chairs: H. Kelder & W. Lahoz
Secretary: C. Zehner

10:50 Monitoring and Assimilation of Envisat data at ECMWF (24)
A. Dethof

11:10 A New 4-Dimensional Variational Assimilation System Applied to Envisat MIPAS and SCIAMACHY Observations (58)
J. Schwinger, H. Elbern

11:30 Assimilation of Ozone and Water Vapour into the Unified Model (69)
W. Lahoz, A. Geer, R. Bannister et al.

11:50 Assimilation of Envisat Products for Continuous Monitoring of Atmospheric Trace Gases - First Results from EVIVA (305)
T. Erbertseder, F. Baier l, M. Bittner et al.

12:10 Climatology and Case Studies of Ozone for the Year 2003 as Seen by GOMOS and OSIRIS Data Assimilation (511)
S. Hassinen, E. Kyrölä, A. Seppälä et al.

12:30 Towards Assimilating Infrared Limb Radiances from MIPAS in the ECMWF System (184)
N. Bormann, S. Healy, M. Matricardi

Friday 10 September – 10:50 – 12:30

DOPPLER

Session 5B3: Future Earth Observation Missions (2)

Chairs: P. Gilles & B. Hoersch
Secretary: B. Hoersch

10:50 RADARSAT-2: Mission Overview and Applications (724)
G. Staples

11:10 COSMO-SkyMed Mission: Scientific Relevance and Application Potential (723)
G. Rum, L. Candela, S. Zoffoli

11:30 Beyond SPOT 5: Pléiades, Part of the French-Italian Program Orfeo (722)
B. Boissin

11:50 Constellations for Operational EO; Development of the DMC and Follow-on Constellations (726)
P. Stephens, P. Davies

12:10 METOP and EPS, the Next Step in Operational Polar Meteorology (727)
P. Edwards, M. Cohen

Friday 10 September – 10:50 – 12:30

MOZART 3

Session 5B4: Wave and Wind/Sea State (2)

Chairs: B. Chapron & D. Thompson
Secretary: G. Cambell

10:50 Envisat Wind Fields for Offshore Windfarming (446)
S. Lehner, T. Schneiderhan, J. Horstmann, H. Günther

11:10 An Empirical Imaging Model for SAR Ocean Wave Measurements (525)
A. Niedermeier, J. Schulz-Stellenfleth, J. Nieto-Borge

11:30 An Operational Algorithm for SAR Wind Field Retrieval (142)
J. Horstmann, W. Koch

11:50 Detailed Look at Ocean Surface Features in the Gulf of Tehuantepec through SAR and ASAR (397)
F. Ocampo-Torres

12:10 A Parametric Inversion Scheme for Envisat ASAR Ocean Wave Measurements (596)
J. Schulz-Stellenfleth, S. Lehner, M. Holt

ABSTRACT BOOK

Tuesday 7 September
08:40 – 10:20

MOZART 4-5

Session 2A1:

SAR Signal Processing (Quality and Performance)

Abstract No. 608

Envisat ASAR Instrument Performance and Product Quality Status after Two and a Half Years of Operation

B. Rosich-Tell[1], P. Meadows[2], A. Monti-Guarnieri[3]
[1] ESA, Italy
[2] BAE SYSTEMS Advanced Technology Centre, United Kingdom
[3] Politecnico di Milano, Italy

Two and a half years of successful operations have proven the performance of the Envisat Advanced Synthetic Aperture Radar. The instrument is fully operational in all modes, including Global Monitoring Mode since December 2003, and it is providing high quality data to more than 250 projects. Quality control and calibration activities are routinely performed to ensure the maximum quality and the accurate calibration of ASAR products. Furthermore, the ESA ASAR processor (PF-ASAR) has been progressively upgraded to further improve the quality of the products and a new product, the Wide Swath Mode Single Look Complex (WSS) product, has been implemented. This paper presents a detailed status of the achieved quality and calibration of ASAR products based on the above activities. In addition, the paper provides an overview of the ASAR instrument performance since the Envisat launch and it introduces the new WSS product that will be available to the user community before the end of 2004.

Abstract No. 343

Terrain-Dependent Geometric and Radiometric ASAR Calibration

D. Small, E. Meier, D. Nüesch
University of Zürich, Switzerland

We present issues and solutions concerning the calibration and validation of Envisat ASAR image products – both their geometry and radiometry are investigated. Concerning geometric calibration, the slant range products (IMS, APS) offer the best available resolution. We tabulate differences between measured (in image products) and predicted (via geodetic position and range and Doppler equations) positions of calibration targets such as transponders and corner reflectors. The differences are interpreted and used to calibrate and validate the ASAR sampling window start time (SWST) and orbit references. We extend the prediction methodology described above to ground range precision products (IMP, APP) whereby the annotated slant/ground polynomial description must be considered. For medium resolution products (IMM, APM, WSM) multiple versions of the polynomial transformation are annotated – we demonstrate geometric terrain correction of such ground range products using our chosen methodology.Concerning radiometric calibration, we review the definitions of beta nought and gamma nought, and quantify absolute radiometric errors caused by variations in local illuminated area and off-nadir angle (affecting antenna gain pattern

[AGP] distribution) caused by rolling topography. Terrain-induced local area and AGP influences are often either not modelled at all or only for nearly flat terrain. We quantify the loss of radiometric fidelity caused by the lack of adequate modelling and compensation. We describe the necessary processing steps for slant range and ground range products – during preparation of the latter, nominal AGP normalisations are included that must be undone before more robust corrections may be applied. For test sites in Switzerland, we demonstrate radiometric comparisons between imagery acquired in different modes that could not be made without the robust radiometric normalisations described above. We describe a method for creating composite radar backscatter maps formed by weighting according to the local resolution contributions from multiple acquisitions acquired at different incidence angles and look directions. For our Swiss test site, we show how such maps offer relatively high local resolution throughout, and improved interpretability.

Abstract No. 439

Quality Assessment of Envisat ASAR Wave Mode Products Based on Regional and Seasonal Comparisons with WAM Model Outputs

V. Kerbaol[1], H. Johnsen[2], B. Chapron[3], B. Rosich-Tell[4]
[1] *BOOST Technologies, France*
[2] *Norut IT, Norway*
[3] *Ifremer, France*
[4] *ESA/ESRIN, Italy*

The Envisat ASAR Wave Mode (WV) products offer the unique ability to provide continuous global directional information on wave field to wave modellers. In order to better assess general products quality, the main three outputs products (the Single Look Complex imagettes - WVI, the level 1b cross spectra - WVS and the level 2 ocean Wave spectra - WVW) have been continuously monitored and thouroughly compared and analysed with collocated parameters of the numerical wave model WAM as provided by ECMWF since January 2003. In particular, regional and seasonal comparisons are systematically performed to refine algorithms.As a result, it is stressed that calibration issue still remains unsolved as pointed out by continuous survey of mean sigma0 alonganalysis period preventing efficient retrieval of SAR derived local wind speed.Additionally, unexpected computational error arose on WVS products leading to a strong degration of azimuthal cross spectral components in the real part of the spectrum. Except for these technical processing problems, the product performs well providingambiguity free cross spectra in approximately 75% of the cases on a global basis.Furthermore, it will be shown that while level 2 products are globally in good agreement with WAM outputs in terms of significant wave height (SWH), specific limitations can be outlined due to wind dependency on SAR imaging mechanisms. As expected, SAR derived is underestimated under high sea state conditions due to well-known azimuthal low pass filtering. More interestingly, it is also noted that SAR tends to overestimate SWH under low wind conditions due to underestimation of CMOD-derived Tilt modulation transfer function. Eventually, interesting results on Doppler centroid analysis will also be presented.

Abstract No. 640

The ERS-2 SAR Performance: The First 9 Years

P. Meadows[1], B. Rosich-Tell[2]

[1] *BAE Systems Advanced Technology Centre, United Kingdom*

[2] *ESA/ESRIN, Italy*

The ERS-2 Synthetic Aperture Radar (SAR) has been in operation since April 1995 and its performance is routinely assessed via a variety of quality assessment and calibration measures. These include the various impulse response function (IRF) parameters, radiometric calibration constants for each product type, radiometric stability, image localisation and image noise estimates.The quality assessment measures and radiometric stability have been derived using the ESA SAR transponders deployed in Flevoland, The Netherlands and to a limited extent by using the IRF parameters of ERS ground stations. The transponders have also been used to derive an ERS-2 SAR calibration constant while the transponders and the ground stations have been used to assess image localisation. Internal calibration is assessed via calibration and replica pulse powers; monitoring of the calibration pulse power (the best guide to the transmitter pulse power) has shown a steady decrease of 0.66dB per year up to the end of 2000 and 0.82dB thereafter. In February 2003, the gain of the ERS-2 SAR was increased by 3dB. The main impact of the changes in transmitter pulse power has been on the noise equivalent radar cross-section of ERS-2 SAR imagery; this was -26dB at the start of the mission and -21dB just before the recent gain change. Following the change from three, one and now zero gyroscope operations, the ERS-2 attitude and SAR Doppler variations have also been monitored. The paper will give details of the ERS-2 SAR performance based on the quantities discussed above.

Abstract No. 265

Review of the Impact of ERS-2 Piloting Modes on the SAR Doppler Stability

N. Miranda[1], B. Rosich-Tell[2], C. Santella[3]

[1] *Serco, Italy*

[2] *ESA/ESRIN, Italy*

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ERS-2 was piloted in yaw-steering mode using three gyroscopes since the beginning of the mission until February 2000, when a new yaw-steering mode using only one gyroscope was implemented. The ERS-2 gyroscopes have experienced several problems during the mission and the new mono-gyro mode (1GP) was intended to ensure the mission continuity even in case of additional failures. In January 2001 a new test piloting mode using no gyroscopes, the Extra-Backup Mode (EBM), was implemented as a first stage of a gyro-less piloting mode. The aim of this challenging mode was to

maintain the remaining gyroscopes performance only for those activities absolutely requiring them, such as some orbit manoeuvres. A more accurate version of this yaw-steering zero-gyro mode (ZGM) was operationally used since June 2001 and the performance was further improved with the implementation of the Yaw Control Monitoring mode (YCM) at the beginning of 2002. The evolution from the nominal and extremely stable three-gyro piloting mode (3GP) to the YCM has allowed to successfully continuing the ERS-2 operations despite of the gyroscopes failures. Nevertheless, this evolution has significantly affected the stability of the satellite attitude and the SAR Doppler Centroid frequency. The scope of this paper is to provide an overview of the different ERS-2 piloting modes and to assess their impact on the platform attitude, the SAR Doppler stability, the product quality and the applications performance, particularly for interferometry.

Tuesday 7 September   Wolf-Dietrich 1-2

Poster Session 2P01:

SAR Signal Processing (Quality and Performance)

Abstract No. 512

Intercalibration of ERS AMI and Envisat ASAR with Ground-Based Parabolic Antennas

A. Zakharov[1], P. Zherdev[2], A. Sokolov[2]
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The goal of the report is to sum up results of ERS SAR and Envisat ASAR calibration and intercalibration in the area of Bear Lakes calibration site using under extension of AO3-343 project.The area of study is calibration site in Moscow region with parabolic antennas (4.8 meters diameter of the dish), which were used over 5 years as calibration target. The targets possess radiometric, polarimetric and interferometric calibration features because of appropriate modification in a form of insertion conducting disks and diffraction grid in antenna focal area. Of highest importance is the fact that parabolic antenna equipped with diffraction grid consisting of a set of metal wires is able to control polarization plane of backscattered electromagnetic wave with linear polarization.During fall of 2003 –spring 2004 a set of simultaneous observations of Bear lakes calibration site with ERS and Envisat was conducted. Various calibration scenarios based on parabolic antennas were provided. Among the targets there was antenna with diffraction grid oriented at the predefined angle with respect to polarization plane. The observations made are good basis for a conclusion about polarization properties of Envisat. Comparative analysis of ERS and Envisat measurements of ground based antenna RCS is a chance for intercalibration.We foresee to get results on the phase stabilities of large antennas using Envisat data as it was done before with ERS AMI data.

Tuesday 7 September
08:40 – 10:20
Mozart 1-2

Session 2A2:

MERIS Performance and Products Quality

Abstract No. 639

MERIS Calibration Validation and Quality Status

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This presentation will adress the status of the calibration and the validation of the MERIS products more than two years after the Envisat launch. A synthesis of the on board calibration and vicarious calibration program will be discussed. An overview of the validation results, for the ocean, land and atmosphere products will be showed. And finally, the overall quality and evolution of the processor since the launch will be presented.

Abstract No. 700

In-flight Spectral Calibration of MERIS

R. Preusker[1], J. Fischer[1], S. Delwart[2], L. Bourg[2]
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We present methods for and the results of the in-flight spectral calibration of MERIS, using a) the absorption within the Oxygen A-band at 760 nm and b) Fraunhofer lines of the solar spectrum. Specific spectral band settings were used during a limited number of orbits. Particular attention has been paid to the elimination of the influence of air mass by the utilization of the "spectral shape function". The spectral characterization has been achieved within 0.1 nm, in accordance with most mission objectives. This allows the investigation of the sensors spectral stability within the mission life-time. The presented methods can be adapted to other instruments.

Abstract No. 106

Vicarious Calibration of MERIS over Ocean in the Near Infrared

N. Martiny, R. Santer, I. Smolskaia
ULCO, France

For the vicarious calibration of MERIS (Medium Resolution Imaging Spectrometer) over ocean in the near infrared we have selected six sites: Venice and Lampedusa (Italy), El Arenosillo (Spain), CalCOFI/San Nicolas (United States), Helgoland (Germany) and Gotland (Sweden). The sites are

all equipped with a CIMEL station that forms part of the AERONET network. The basic idea is to associate CIMEL sky radiance measurements with MERIS level 1b data in a twin geometry which corresponds to the same scattering angle. This vicarious calibration relies on an accurate description of the atmospheric scattering based on the CIMEL measurements. We realized a similar study using data over five sites during a 5-month period. The results highligthed that there was a good agreement between the onboard calibration and our method within 2% in the near infrared, from 884 nm to 664 nm. Nevertheless, the period considered was short and only 8 days were selected for this task. This paper aims at consolidating these results using other sites and more data.

Abstract No. 224

Long-term MERIS Land Product Accuracy Assessment Based on Vicarious Calibration and Regional Validation

R. Zurita Milla[1], J. Clevers[1], M. Kneubuehler[2], S. Delwart[3], M. Schaepman[1]

[1] *Wageningen University, Netherlands*

[2] *Univ. Zurich / RSL, Switzerland*

[3] *ESA/ESTEC, Netherlands*

Since the launch of MERIS on Envisat, several vicarious calibration efforts have been taken place to estimate the TOA radiance performance of MERIS over time. Dedicated land based experiments have demonstrated good performance of the MERIS instrument and we report in the first part of this contribution about multitemporal vicarious calibration approaches performed at Railroad Valley Playa in Nevada (USA) [Kneubuehler et al. 2003]. Subsequently we will use the such derived calibration coefficients and compare the impact of uncertainty of MERIS measurements on standard product retrievals over land. We will use the standard features of the basic Envisat toolbox for (A)ATSR and MERIS (BEAM) as well as the SMAC and binning processor to compare results on a national. The validation procedure is based on existing land use maps of the Netherlands, which are aggregated to match with MERIS FR or RR pixel sizes. Vicariously derived calibration uncertainties will be interpolated based on orbit numbers to match the temporal acquisitions in Railroad Valley and the Netherlands. We will conclude on the evolution of temporal MERIS performance over land, respecting also potential reprocessing efforts of existing MERIS data. Kneubühler, M., Schaepman, M.E., Thome, K.J., & Schläpfer, D.R. (2003) MERIS/Envisat vicarious calibration over land. In Sensors, Systems, and Next-Generation Satellites VII (eds R. Meynart, S.P. Neeck, H. Shimoda, J.B. Lurie & M.L. Aten), Vol. 5234, pp. 614-623. SPIE, Barcelona.

Abstract No. 423

MERIS & Land Applications

N. Gobron
JRC, Italy

The paper reviews the evaluation and the performance of the Medium Resolution Imaging Spectrometer (MERIS) Land Surface Product, i.e MGVI.This surface product represents the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) which can be used to quantify the presence of vegetation with good reliability on a global scale. Analyses are conducted by inter-comparing similar products generated at the European Commission Joint Research Center (EC-JRC) using various optical sensors as well as in-situ measurements.time series of FAPAR over a large sample of vegetation type and maps are used to demonstrate MERIS capabilities for vegetation monitoring at both regional and global scale.

Poster Session 2P02:

MERIS Performance and Products Quality

Abstract No. 697

MERIS Cloud Top Pressure Validation using Airborne Lidar Measurements

R. Preusker[1], R. Lindstrot[1], T. Ruhtz[1], J. Fischer[1], M. Wiegener[2], B. Heese[2]
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[2] *Ludwig-Maximilian University Munich, Germany*

The MERIS cloud top pressure product has been validated by means of an aircraft. The aircraft is equipped with a LIDAR to retrieve accurate cloud top heights, as well as with an imaging spectrometer having similar characteristics as MERIS to retrieve cloud top pressure. The aircraft is operating in altitudes between 8000 and 12000 ft and has taken measurements in a time frame of 15 min before and 15 min after the overpass of Envisat. The area of the flights was around Berlin to cover different land surface types, mainly forests, lakes and fields. The spectrometer has been additionally used to determine the spectral properties of the surface. The retrieved cloud top heights have been directly used for the validation of the MERIS cloud top pressure product. The impact of the characteristics of the different cameras has been examined.

Abstract No. 173

Cross Calibration Methods

J. Nieke[1], M. Kneubuehler[2]
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Besides pre-launch and on-board calibration, the method of vicariously calibrating space sensors became a reliable tool for space sensor calibration. One possibility of cross calibration is to inter-calibrate sensors aboard different satellite platforms, directly. Another possibility is to make use of additional ground-truth data taken during the overflights of the sensors.Both methods are compared for the MERIS instrument using data sets from various space-, airborne sensors and ground-truth instrumentation. Examples for the spaceborne sensors data sets are those from GLI, MODIS, SeaWiFS, AHVRR (N16, N17) onboard the spacecrafts (ADEOS-2, Terra, Aqua, Envisat, Orbview-2/SeaStar, NOAA-16 and NOAA-17, the airborne data set was taken by the CASI instrument. Both methods have different advantages and disadvantages, however the overall goal leads to a better understanding of differences in data sets produced by MERIS.

Abstract No. 254

Use of Envisat MERIS Data for Validating Aerosol Retrieval: the Case Study of Athens-Greece

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National Observatory of Athens, Greece

Satellite sensors of high and moderate spatial resolution have started been used in the last decade to assess and map atmospheric pollution over cities, and a variety of ad hoc techniques have been developed. This paper presents preliminary results of the ESA AO 1495 project aiming at the acquisition and examination of Envisat MERIS data for monitoring air pollution in the lower troposphere of Athens-Greece. Air pollution has been assessed in terms of aerosol optical thickness (AOT).Eleven Envisat MERIS Level 2 Full Resolution images were selected in the period from June to September 2003. Most of the images were cloud-free. The corresponding ground-based air pollutant data were gathered by the EARTH national pollution-monitoring network. This network covers the area of Athens with eighteen stations. Acquired data refer to hourly concentration measurements of PM10, SO2, NO2, NO, O3 and CO. Analysis of the data was initially performed for defining the prevailing atmospheric conditions, in particular the air quality. PM10 measurements indicated high values (>50 igr/m3, which is set as the upper limit for the mean daily value) for most of the selected days. Firstly, a categorisation of the available images to high-polluted and low-polluted according to pollution levels (PM10 measurements) was performed. Thus, images were characterised with high pollution, moderate pollution and low pollution. Secondly, images were imported to the ENVI/ERDAS Imagine software and then exported to GeoTiFF format in order to be processed for AOT retrieval over land in the vicinity of Greater Athens Area based on the use of the DTA (Differential Textural Analysis) code. The extracted AOT from Envisat MERIS sensor will be further validated with the corresponding AOT extracted from the MODIS sensor and the PM10 measurements from the EARTH network of ground based air pollution monitoring stations.

Abstract No. 547

Validation of MERIS Biophysical Products from the Valeri Project

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MERIS biophysical products including LAI and fAPAR have been evaluated over few VALERI sites. Different ways of estimating LAI, fAPAR from MERIS (CYCLOPES products, MODIS products, Chen's as well as Roujean & Lacaze algorithms) were considered. Results are first inter-

compared to assess their consistency. A dedicated methodology has been applied to estimate the value of the considered biophysical variables at the spatial resolution of large swath satellites from ground measurements. Each individual site, an area of 3×3 km^2 flat and relatively homogeneous at the 1km scale, is sampled by selecting elementary sampling units (ESUs) that represent the variability observed within the whole site. Over each ESU, which spreads over 20×20 m^2, gap fraction measurements are performed using hemispherical photographs. A concurrent (±7 days) SPOT-HRV image is then used to up-scale the ground measurements performed over the ensemble of ESUs to the whole site, thanks to a transfer function. This allows therefore a comparison to the VALERI ground estimates. Conclusion is drawn on the accuracy of the biophysical products derived from large swath sensors.

Session 2A3:

Atmosphere Overview (1)

Abstract No. 420

SCIAMACHY: Results from the First Two Years of Operation

J. Burrows, H. Bovensmann, A. Richter, M. Buchwitz, A. Rozanov, V. Rozanov, C. Von Savigny, K. Eichmann, S. Noël
University of Bremen, Germany

SCIAMACHY (Scanning Imagin Absorption spectroMeter for Atmospheric CHartographY) is a national contribution by Germany, The Netherlands and Belgium to the ESA Envisat, which was proposed by an international team of scientists in 1988 from Germany in response to the call for instrumentation for the the ESA Polar Platform. SCIAMACHY was launched aboard Envisat on the 28th of February 2002. and has now provided successfully two years of measurements.SCIAMACHY measures back scattered light upwelling from the atmosphere alternately in limb and nadir viewing geometry and also measures the occultation of the sun and the moon through the atmosphere in the northern and southern hemisphere respectively. The SCIAMACHY spectrometer comprises eight specral channels and thereby measures simultaneously the spectrum between 220 and 2380 nm. Retrievals from SCIAMACHY yield important information about the composition of the mesosphere, stratosphere and the troposphere. The targeted atmospheric constituents are as follows: a) Trace gases in absorptionO3, NO2, BrO, OClO, HCHO, H2O, CO, N2O, CO2, CH4, b) Emissions from the upper atmosphere fromO2(1Δ), NO, OH, metal atomsc) Trace constituents and parameters:PMC, PSC, aerosol and tropospheric cloud parameters This contribution will bring together a series of results obtained from the first two years of operation of the instrument.

Abstract No. 132

Retrieval, Validation and Assimilation of SCIAMACHY Ozone Columns

H. Eskes, R. Van der A, E. Brinksma, P. Veefkind, J. De Haan
KNMI, Netherlands

In this contribution we will discuss a new algorithm, called TOSOMI, to retrieve total ozone from SCIAMACHY observations. It is based on the DOAS algorithm developed for GOME (TOGOMI algorithm) and OMI. Innovations include a new procedure to compute the air-mass factor (empirical approach) and a new formulation to account for rotational Raman scattering. The SCIAMACHY columns for 2003/2004 are assimilated in the ozone chemistry-transport model TM3DAM. The observation minus forecast statistics was used to verify the retrieval results, and several problems have been identified with this procedure during the development of the TOSOMI algorithm. Validation results with ground-based measurements (Brewer, Dobson) and the TOMS version 8 ozone columns will be presented. The SCIAMACHY total ozone retrieval, data assimilation

analyses and ozone forecasts are all available in near-real time on the TEMIS project web site, http://www.temis.nl/.

Abstract No. 183

The GOME and SCIAMACHY Water Vapor Record for Climate and Chemistry Transport Model Evaluation

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[2] *National Institute for Space Research, Netherlands*

Monitoring of water vapor from space is a difficult task due to the strong spatial variability of WV and its complex spectroscopic structure. Until about the turn of the century only a very limited number of instruments such as SSMI or TOVS were able to provide total column water vapor measurements on a global scale and for sufficiently long time series. Data from these instruments have therefore been operationally assimilated in ECMWF and NCEP forecasts and re-analysis data sets. However, both of the instruments have certain restrictions. The SSMI microwave sounder measures solely over ocean surfaces and TOVS, which measures emitted thermal radiation, is especially sensitive to the middle and upper troposphere. This lack of lower tropospheric sensitivity introduces some bias in the retrieved total columns. GOME on ERS-2 measures absorptions of water vapor from backscattered solar radiation in three absorption bands in the visible part of the spectrum and therefore serves not only as one of the few alternative sources to the aforementioned instruments for the period between 1995 and the beginning of the new millennium - comprising a 9-year water vapor data record - but is also capable of measuring over all surface types with a sufficient sensitivity to the lower and middle part of the troposphere for accurate column retrievals. We use the GOME water vapor record, which will be extended by the GOME instrument series on the METop satellites, for evaluations of modeled water vapor fields in Chemistry Transport Models (CTM) like MATCH-MPIC and General Circulation Models (GCM) like ECHAM. We demonstrate that monthly and yearly averages of a good part of the 9-year GOME record can be used successfully for climate and chemistry model evaluation. We further show preliminary results from SCIAMACHY, from which water vapor columns with similar accuracy and improved horizontal spatial resolution can be retrieved. SCIAMACHY is therefore expected to be able successfully to bridge the gap between the current GOME measurements and the launch of GOME-2.

Abstract No. 91

MIPAS Near Real Time Level 2 Results

B. Carli
IFAC-CNR, Italy

Starting from the end of March 2002, MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) is measuring atmospheric middle-infrared limb-emission spectra from the sun-synchronous, nearly-polar orbit of the Envisat satellite. The spectra are acquired continuously during both day and night and their Level 2 analysis provides, through an inversion process, a 3-dimensional, almost global, map of many atmospheric constituents every 24 hours.The code for the Level 2 near real-time (NRT) analysis of MIPAS spectra was developed by an international consortium of scientists (ORM Team) supported by the European Space Agency (ESA) and was implemented in the Envisat Payload Data Segment. This code is designed to provide, in an automated and continuous mode, atmospheric vertical profiles of temperature, pressure and concentration of six key species: O3, H2O, CH4, HNO3, N2O and NO2, in the range 6-68 km. Depending on data availability, the Level 2 NRT processor provided from the first day of operation continuous products and no modification was necessary in the code. Changes were limited to the tuning of auxiliary data and setting parameters. Some quality improvements, involving an extra computing time that is not feasible with the near real time processor, were adopted in a parallel off-line processor. Results are presented that assess the quality of MIPAS measurements and their innovation in terms of vertical resolution and multidimensional coverage (time, space and chemical species).

Abstract No. 328

Stratospheric Chemistry in Austral Spring 2002 as Observed by MIPAS/Envisat

G. Stiller[1], T. Von Clarmann[1], H. Fischer[1], B. Funke[2], S. Gil-Lopez[2], N. Glatthor[1], U. Grabowski[1], M. Hoepfner[1], M. Kaufmann[2], S. Kellmann[1], M. Kiefer[1], M. Koukouli[2], A. Linden[1], M. López-Puertas[2], G. Mengistu Tsidu[1], M. Milz[1], T. Steck[1], D. Wang[1]
[1] *Forschungszentrum / University of Karlsruhe, Germany*
[2] *Instituto de Astrofisica de Andalucia, Spain*

Around 25 September 2002 a Southern polar major warming occured which led to a split of the Antarctic vortex, an event which had never been observed before. MIPAS on Envisat recorded spectrally high-resolved atmospheric emission spectra in the infrared before, during, and after the vortex split. From the spectra vertical distributions of temperature and various trace species were

derived with the non-operational scientific data processing system at IMK, complementing the ESA operational data products. NOx (NO and NO2) as well as NOy species (ClONO2,HNO3, N2O5, and HNO4) give insight into heterogeneous processes on polar stratospheric clouds and denitrification. By detection of ClOx species (ClONO2 and ClO) in conjunction with the occurance of polar stratospheric clouds chlorine deactivation was observed. Water vapour in the lowermost stratosphere allows to deduce dehydration processes due to PSC formation. A survey of species derived from MIPAS measurements will be presented and analysed in terms of chemical processes during the vortex split.

Poster Session 2P03:

Atmosphere Overview

Abstract No. 32

Validation of MIPAS Level 2 Data Products of H2O by In-Situ Measurements and Trajectory Mapping

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[1] *Forschungszentrum Juelich, Germany*
[2] *FU Berlin, Germany*

Correlative measurements of H2O for validation of the MIPAS and SCIAMACHY satellite instruments were carried out in several campaigns using the Lyman-alpha fluorescence hygrometer FISH, operated onboard the Geophysica high-altitude aircraft and balloons. Up to now, data were obtained on more than 20 aircraft flights and 3 balloon flights, both at mid and high latitudes.Trajectories are calculated 10 days forward and backward of the correlative measurements to identify additional footprints of the Envisat experiments in the same air masses probed by the in-situ hygrometers. With this approach, we can match 5-10 Envisat profiles spread over the Northern hemisphere within this period to the path of a single aircraft or balloon flight. Therefore, the statistical significance of a single validation measurements will be increased, and potential mismatches between the satellite and the correlative measurement are minimised. First tests with early MIPAS retrievals show that this method can compensate erroneous results for the validation, in particular in regions with high atmospheric variability.Using our measurements and this trajectory mapping technique, we will present validation of the new level 2 data products of MIPAS to be released this spring.

Abstract No. 74

Validation of ClONO2 Profile Retrievals from MIPAS/Envisat Measurements

M. Höpfner[1], C. Blom[1], T. Blumenstock[1], T. Von Clarmann[1], H. Fischer[1], F. Friedl-Vallon[1], N. Glatthor[1], U. Grabowski[1], A. Griesfeller[1], T. Gulde[1], F. Hase[1], C. Keim[1], S. Kellmann[1], M. Kiefer[1], A. Kleinert[1], A. Lengel[1], A. Linden[1], G. Liu[1], G. Maucher[1], G. Mengistu Tsidu[1], M. Milz[1], H. Oelhaf[1], C. Piesch[1], T. Steck[1], G. Stiller[1], D. Wang[1], G. Wetzel[1], B. Funke[2], G. Toon[3]
[1] *Forschungszentrum Karlsruhe, Germany*
[2] *Instituto de Astrofisica de Andalucia, Spain*
[3] *Jet Propulsion Laboratory, United States*

Since mid-September 2002 the Michelson Interferometer forPassive Atmospheric Sounding (MIPAS) on Envisat measures continuously high-resolutionmid-infrared limb-emission spectra of the atmosphere with global coverage. In this paper we present a validation of ClONO2 profiles retrieved by use of the scientific off-line processor at the Institut für Meteorologie und Klimaforschung,Karlsruhe.Comparisons are made with thermal emission FTIR measurements by the balloon-borne MIPAS-B and the air-borne MIPAS-STR instruments, withsolar occultation observations by the balloon-borne MkIV spectrometer,and with solar absorption observations from groundbased FTIR instruments. MIPAS-B as well as MIPAS-STR were deployed during dedicated validation campaigns for the chemical payload of Envisat in September 2002 and February/March 2003. Thus, a number of close co-locations in space and time were achieved. For the two MkIV balloon flights in December 2002 and April 2003 from Kiruna, nearest MIPAS/Envisat profilelocations are used for intercomparison, and differences are discussed taking intoaccount the relative position of the polar vortex. Groundbased FTIR observations of total column amounts of ClONO2 allow, due to theircontinuous temporal coverage, a statistical assessment of integrated profiles from MIPAS/Envisat.

Abstract No. 118

Comparison of Zonal Variability in Total Ozone Derived from ERS-2 GOME and the Chemistry-Climate Model ECHAM4.L39

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DLR, Germany

8 years of ERS-2/GOME total ozone observations and corresponding ozone fields of the coupled chemistry-climate model ECHAM4.L39(DLR)/CHEM are analyzed in order to compare zonal ozone variations. Coupled chemistry-climate models (CCMs) with detailed descriptions of the stratosphere can address how climate change, stratospheric ozone and UV radiation interact, now and in the future. Long run satellite observations of total ozone as from the Global Ozone Monitoring Experiment (GOME) aboard ERS-2 are an excellent source for validating CCM results, since they cover the ozone variability with proven accuracy and high temporal and spatial resolutions.The stratosphere is strongly influenced by manifold dynamical processes that CCMs must be able to reproduce correctly. An important example is the forcing and propagation of planetary-scale waves. As a first validation step it must be shown that the amplitudes and phases of the quasi stationary planetary waves in the lower and middle stratosphere are reproduced. Here total ozone can be considered as a tracer to illuminate this dynamic variability.GOME has been successfully providing total ozone observations since July 1995. All total ozone observations (GDP Version 3.0) from July 1995 to June 2003 were assimilated by a spectral Kalman Filtering approach to gain an 8 year data set of daily global ozone distributions. This data set is now used to evaluate first results of a multi-year model simulation representing "year 2000" conditions with an updated version of ECHAM4.L39/CHEM, a CCM with a horizontal resolution of T30 and 39 layers in the vertical (surface to ~10 hPa).We present a comparison of total ozone, wave amplitudes and phases, their zonal and hemispheric means, to address the differences of the total ozone variability. The horizontal zonal amplitudes and phases are derived by means of a spectral statistical analysis.

Emphasis is on monthly and inter-annual variability of the zonal wave numbers one and two. These results are also used to derive two hemispheric Ozone Variability Indices.

Abstract No. 591

SCIAMACHY-Validation Using the AMAXDOAS Instrument

K. Heue[1], M. Bruns[2], J. Burrows[2], W. Lee[1], U. Platt[1], I. Pundt[1], A. Richter[2], T. Wagner[1], P. Wang[2]
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[2] *Univeristy of Bremen, Germany*

The AMAXDOAS-instrument is a special designed Multi Axis DOAS instrument for airborne measurements. In September 2002 and February / March 2003 it was installed on the DLR-Falcon during two SCIAMACHY-validation campaigns. Together with the AMAXDOAS an Ozone lidar (OLEX) and a microwave radiometer (AZUR) were installed on the Falcon. In about 40 flights the airplane flew from the Artic to the Tropics. All these flights were coordinated with SCIAMACHY overpasses.With four different viewing angles the AMAXDOAS measured the traces gases NO2, O3, BrO and OClO below and above the aircraft. Two spectrometers are used for the wavelength region between 300nm and 550nm.Here we want to present our results and compare these to SCIAMACHY or GOME. We want to concentrate on NO2 vertical columns measured below and above the airplane to separate tropospheric and stratospheric columns.

Abstract No. 124

Reflectance Comparison between SCIAMACHY and a Radiative Transfer Code in the UV

G. Tilstra, G. Van Soest, M. De Graaf, J. Acarreta, P. Stammes
Royal Netherlands Meteorological Institute (KNMI), Netherlands

Using an accurate radiative transfer code as a reference, we studied the reflectance measured by the SCIAMACHY instrument onboard Envisat in the ultra-violet (240-400 nm). To make the comparison possible, we selected a target site over the Sahara desert, which was completely free of clouds. After having supplied the proper ground albedo, surface pressure, and ozone profile to the radiative transfer code, a model reflectance could be calculated quite accurately (5% error at most).The conclusion resulting from the analysis is that SCIAMACHY currently underestimates the actual Earth reflectance by as much as 15 percent. The deviation is found to be wavelength dependent, but apparently does not depend significantly on the SCIAMACHY scan mirror angle. This type of comparison can also be helpful in the in-flight calibration of other UV satellite spectrometers (OMI).

Abstract No. 129

Model Results, Balloon and Satellite Data Intercomparison Using Variational Chemical Data Assimilation

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In the frame of the Envisat validation campaigns, the balloon borne instrument SPIRALE was launched from Aire sur l'Adour on October 2, 2002 and from Kiruna on January 21, 2003. SPIRALE measures in situ a large number of chemical species: O3, CO, CH4, N2O, HNO3, NO2, NO and HCl by infrared absorption spectroscopy using tunable diodes lasers (TDLAS). ODIN and Envisat satellites instruments were operating during these periods. The aim of the paper is to check the consistency between measurements (balloon and satellite instruments) and model results by using the variational assimilation technique of chemical data. To this end the variational assimilation code associated with the lagrangian model MiPLaSMO have been used to search for the best agreement between all the data and the model. Analyses of the assimilation results are presented and agreements and/or disagreements between balloon and satellite data, between satellite data, or between data and model results are pointed out.

Abstract No. 134

Validation of MIPAS-Envisat Profiles for CH4 and N2O with Data from the MIPAS-STR Instrument on Board the Geophysica

T. Gulde[1], C. Blom[1], M. Höpfner[1], C. Keim[1], G. Liu[1], C. Piesch[1], C. Sartorius[1], C. Volk[2]

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MIPAS-STR (MIPAS-STRatospheric aircraft) is a cryogenic Fourier transform emission sounder. By a combination of continuous limb sounding and upward measurements, two-dimensional distributions of the temperature and of several trace gases can be derived. The spatial resolution of the individual profiles is about 2 km vertically and 35 km horizontally in flight direction. We report the validation of MIPAS-Envisat profiles in the upper troposphere and the lowermost stratosphere with correlative data derived by MIPAS-STR onboard the high-altitude aircraft M55-Geophysica.

The validation is presented for the 22 July 2002 orbit 2051 at middle latitudes and, in the Arctic region, for several orbits of February 28th, March 2nd and March 12th, 2003. We focus on the profiles of the trace gases CH4 and N2O. The presentation includes the quality control of the MIPAS-STR measurements by inter-comparison with in-situ data from the M55-Geophysica. For the validation of MIPAS-Envisat we use two methods:(1) direct comparison with N2O and CH4 from the channel 2 of MIPAS-STR (2) measurements of CFC-11 and CFC-12 from the channel 1 of MIPAS-STR in combination with the rigid correlations, derived by HAGAR, of the CFCs with CH4 and N2O, respectively.

Abstract No. 160

Investigation of GOME Scan-mirror Degradation

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Degradation of optical components in space is a problem affecting many remote sensing instruments, due to the prolonged exposure to the conditions in orbit.Degradation has been confirmed for GOME and will likely in the future similarly affect SCIAMACHY onboard Envisat, which makes understanding the degradation of GOME important.Over the 8 year life time of GOME, the measurements of the Earth radiances and the Sun irradiances were subject to different instrument degradation in the UV (e.g., scan mirror and PMDs). To quantify this degrading effect a comparison will be made between the GOME reflectance spectra with forward simulations of GOME spectra based on adequate description of the atmosphere (ozone, temperature, and pressure profiles) obtained from co-located cloud-free independent ozone sonde measurements. For this purpose we will use the polarization-sensitive measurement of the main channels of GOME, without correction for the polarization sensitivity of the instrument. The use of the polarization sensitive measurement excludes the degradation effect of the PMDs, and will hopefully isolate the scan mirror degradation.

Abstract No. 162

Comparison of ERS-2 GOME Total Ozone and Nitrogen Dioxide Data with the Ground-based Spectroscopic Measurements over Russia and NIS

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Following the launch of GOME instrument onboard ESA ERS-2 satellite in 1995, the quality of resulting data products on total ozone and NO2 have been validated against independent well-controlled ground-based measurements, with corresponding improvements to the retrieval algorithms being introduced and data reprocessing being run, when necessary. Along with the other international ground-based network measurements (e.g. NDSC, SAOZ) the Russia and NIS (New Independent States) contributed to GOME validation with the data of national ground-based UV-visible observations in 1996-2002. The regular measurements of total ozone are carried out with a number of filter ozonometers M-124 calibrated against Dobson spectrophotometer, which is regularly compared with WMO standard. The network covers a wide range of latitude - from 38 to 78 degrees north, and the developed processing algorithm allows performing nearly all-weather observations of ozone vertical column. The twilight observations of NO2 vertical column are performed with the measurements of zenith-scattered solar radiation in the visible range at a number of locations included in the list of NDSC stations as a complementary.In this study the data of operational GOME data on total ozone and nitrogen dioxide (GDP version 2.7, 3.0) was compared to the daily averaged ground-based ozone data, collected over the 17 locations (14-141 E / 43-78 N), and twilight observations of NO2 vertical column at Zvenigorod (55.7 N, 36.8 E, Russia) and Issyk-Kul (42.6 N, 77.0 E, Kyrgyzstan) for the period of 1996-2001. Within the investigation, an agreement of both individual and monthly averaged GOME measurements with corresponding ground-based observations was examined and analyzed with respect to different conditions (season, sun elevation), temporal/spatial criteria choice (actual overpass location, correction for diurnal variation) and data processing (GDP version 2.7, 3.0). This work was supported by joint foundation of Russian Ministry of Education and St.Petersburg Administration (PD02-1.5-96) and the President of Russia grant (MK-2686.2003.05).

Abstract No. 180

First Confrontation between SCIAMACHY NO2 Columns and the Outputs of a Regional CTM

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Air pollution forecasting is a challenging scientific problem, which has recently received a high priority in many industrialized countries due to the increasing consciousness of the effect of pollutants emissions on health and environment. For the last twenty years, several Chemistry Transport Models (CTMs) have been developed at regional and continental scales. They require accurate input data (emissions, initial and boundary conditions, meteorology) which are uncertain and often difficult to collect in real time. Comparisons between ground-based observations and simulations still show discrepancies for ozone; for other species, including aerosols, a systematic model skill evaluation is not feasible because data coverage is thin and measurement sites are often not representative for model grid cells. Recently, satellite observations of the tropospheric composition have become available. The satellites provide column measurements of the boundary layer and free troposphere over averaged areas comparable to the model grid cells, which makes them potentially ideal for model evaluation. However, the retrieval of tropospheric columns from the satellite measurements is also largely un-validated due to a lack of independent measurements. Therefore, the confrontation of satellite data with chemical fields modelled by of a high-resolution CTM may bring essential information to identify errors in both CTM and retrieval systems. We will present the results of such a confrontation between SCIAMACHY NO2 columns and the outputs of the high-resolution regional-scale CTM CHIMERE.

Abstract No. 202

SCIAMACHY NO2: Air Quality Monitoring on a Global Scale

K. Boersma[1], I. Desmedt[2], R. Van der A[1], N. Blond[3], M. Van Roozendael[2], H. Eskes[1]

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Total and tropospheric NO2 column retrievals from SCIAMACHY on board Envisat will be discussed. In the framework of ESA's Tropospheric Emission Monitoring Internet Service (TEMIS, www.temis.nl) project, a scientific NO2 data product is generated in a joint cooperation between KNMI and BIRA/IASB. The method that is used is the retrieval-assimilation-modelling approach that has already been applied on GOME data as described by Eskes et al. [2003] and Boersma et al. [2004].Currently, the level-1c data poses a number of problems; theradiometric calibration of both Earthshine and Solar spectra is biased. Difficulties in the NO2 slant column density retrieval are overcome by using an Earth radiance spectrum for a fixed location on Earth as a reference spectrum. A first order correction factor resulting from a comparison between MODIS and SCIAMACHY radiances results in reasonable cloud fraction and pressure estimates based on the FRESCO cloud retrieval scheme.SCIAMACHY NO2 results will be presented for the year 2003. Various aspects of this dataset will be discussed, including interesting spatial and temporal features, a comparison with GOME retrievals, errors in the retrievals, and validation. Boersma, K.F., et al. (2004), Error Analysis for Tropospheric NO2Retrieval from Space , J. Geophys. Res., 109, doi:10.1029/2003JD003962.Eskes, H. J. et al. (2003), EU GOA project Final report (available on www.knmi.nl/goa/)

Abstract No. 233

Validation of Stratospheric Temperature Profiles Observed by MIPAS/Envisat

D. Wang[1], T. Von Clarmann[2], H. Fischer[2], B. Funke[3], S. Gil-López[3], N. Glatthor[2], U. Grabowski[2], M. Höpfner[2], S. Kellmann[2], M. Kiefer[2], A. Linden[2], M. López-Puertas[3], G. Mengistu Tsidu[2], M. Milz[2], T. Steck[2], G. Stiller[2]

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This analysis presents stratospheric temperatures observed by MIPAS on Envisat. MIPAS temperatures are retrieved by several data processors at different institutions. The MIPAS data analysis processor at Institut für Meteorologie und Klimaforschung (IMK) provides simultaneous retrieval of temperature and line-of-sight parameters, as well as, indirectly, pressure from measured spectra and the spacecraft ephemerides. This step precedes the species abundance retrievals, because an accurate knowledge of the observational geometry and the physical state of the atmosphere is an essential requirement for any space-based limb-viewing remote sensing experiment attempting to characterize the chemical composition of our environment. The MIPAS IMK stratospheric temperature data are compared with a number of other observations, including world-wide radiosonde, HALOE solar occultation, and CHAMP and SAC-C radio occultation measurements, as well as ECMWF and METO assimilation analyses. The individual profiles and zonal means measured by MIPAS and other instruments at different locations and times show reasonable agreement, though deviations may exist due to characteristics of the instruments and observation scenarios. The global mean differences between MIPAS and other observations are less than 1 K. This indicates the reliabilty of MIPAS-IMK data products and their capability for providing valuable scientific information.

Abstract No. 236

Stratospheric Ozone Profiles Observed by MIPAS/Envisat and their Use for the VORTEX Split Event in Fall 2002

D. Wang[1], T. Von Clarmann[2], H. Fischer[2], B. Funke[3], S. Gil-López[3], N. Glatthor[2], U. Grabowski[2], M. Höpfner[2], S. Kellmann[2], M. Kiefer[2], A. Linden[2], M. López-Puertas[3], G. Mengistu Tsidu[2], M. Milz[2], T. Steck[2], G. Stiller[2]

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Stratospheric ozone profiles are retrieved from limb-viewing infrared spectra observed by MIPAS/Envisat using the IMK (Institut für Meteorologie und Klimaforschung) science data processor. The MIPAS ozone volume mixing ratio (VMR) profiles are compared with those obtained by HALOE and Sub-Millimeter Radiometer (SMR) on ODIN. The three instruments show good consistency, with mean differences within $\pm$(4-8)\% (0.1-0.3 ppmv). These results indicate the reliabilty of MIPAS-IMK data products and their capability for providing valuable scientific information. The ozone data are used to investigate the characteristics of the unprecedented Antarctic major stratospheric warming of 2002. In response to the rapid poleward increase of temperatures and remarkable reversal of the latitudinal temperature gradients at 35 km or below in several days, the zonal mean ozone VMR increase poleward, and have maximum values of 7 ppmv in a wide region between 20 - 40 km at latitudes south of 40°S. The longitudinal variations are dominated by wave 1 at the onset of the warming. The wave 1 amplitudes drastically increase at 60°S - 80°S, reaching maxima of 2 - 3 ppmv in the region of 20 and 35 km. The large-amplitude wave 1 disturbances break down in one or two days, and the amplitudes of wave 1 and 2 become comparable, resulting in an apparent wave 2 pattern with the ozone VMR peaked around longitudes of 30°E and 100°W.

Abstract No. 239

The GOME Near-Real-Time Service: Mission Continuity, Status and Future Plans

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Ozone and other relevant trace gases are important constituents of the Earth atmosphere and play key roles in several important environmental issues (UV exposure, climate change). The availability of global and accurate near-real-time information on atmospheric ozone and other substances and their distribution is essential for monitoring the ozone layer.The GOME/ERS-2 near-real-time service is a valuable contribution to the ozone monitoring effort. Furthermore, it is extremely important to maintain this service in order to provide continuous long-term ozone monitoring with an overlap to the current and future missions like SCIAMACHY/Envisat, OMI/AURA and GOME-2/METOP.The GOME near-real-time service was initiated in January 1997 with the installation of the GOME Data Processor (GDP) at the Kiruna station in Schweden; it was extended in November 2001 with the GDP installation at the Gatineau station in Canada and completed in February 2002

with the GDP installation at the Maspalomas station in Spain. In July 2003 the ERS-2 tape recorder failed after eight years of continuous acquisition. Since then ESA and DLR are working in the continuation of the ERS-2 LBR (low bit rate) mission extending the GOME coverage with additional ground stations.The current GOME NRT service provides accurate ozone information for Europe, North America and, on campaign basis, in the Antarctic. The Antarctic Receiving Station of DLR in O'Higgins was operated from October to December 2003 and from January to March 2004. The Matera station in Italy has started acquiring GOME data in March 2004. The additions of other ERS-2 LBR stations in Mexico and North Brazil are currently planned.

Abstract No. 242

German Contribution to the Validation of SCIAMACHY

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An adequate validation of SCIAMACHY data products is a prerequisite for a successful completion of the SCIAMACHY mission. The German validation team, consisting of 23 different projects with more than 60 scientists, contributes with a wide range of instrument types as important part of the international validation community. A global network of ground-based stations with DOAS, FTIR, microwave instruments and ozone sondes has been build. Satellite inter-comparisons utilize the measurements of independent space-born sensors. Balloon-borne instruments participate in the Envisat Stratospheric Aircraft and Balloon validation campaigns and the German FALCON research aircraft has undertaken large flights from the Arctic to the Tropics. Here an overview of the German activities during two and half years of SCIAMACHY lifetime is given.

Abstract No. 262

Validation of SCIAMACHY Level 1: UV-Vis Nadir and Limb

G. Van Soest, G. Tilstra, J. Van Gent, P. Stammes

KNMI, Netherlands

In this contribution we compare radiances calculated by radiative transfer models (RTM) with earthshine and limb radiances measured by SCIAMACHY.For the nadir earthshine reflectance calculation we concentrated on the UV channels. The RTM (we used LIDORT or DAK) is supplied with ozone profiles retrieved from SCIAMACHY limb measurements [1]. The result is a powerful validation technique which utilizes the unique combination of co-located nadir and limb observations in one instrument. We discuss the details of the validation method and results.Secondly, we present the first validation of absolute limb radiances from SCIAMACHY by comparison with the SCIARALI RTM. We characterize the quality of the SCIAMACHY data as a

function of wavelength and a number of instrument parameters.[1] C. von Savigny, IFE/IUP Bremen; http://www.iup.physik.uni-bremen.de/scia-arc/

Abstract No. 264

Comparison between Earth Reflectance Spectra from 300-1750 nm Measured by SCIAMACHY and Radiative Transfer Model Results

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KNMI, Netherlands

SCIAMACHY, launched in March 2002 on-board the Envisat satellite,is a spectrometer covering the wavelength range 240-2380 nm with a spectral resolution between 0.2 and 1.5 nm. It measures the Earth radiance and solar irradiance at 8000 distinct wavelengths.The ground pixel size varies between 30 km x 30 km and 30 km x 240 km. Unlike many other satellite instruments which measure at selected wavelengths,SCIAMACHY offers for the first time a full spectral view of the Earth in the shortwave range. Various processes occurring in the atmosphere and on the surface can be determined from this spectrum. Absorption lines of ozone, NO2, O2, H2O, CO2, and several minor gases can be used to determine column densities and in some cases profiles of these trace gases. The spectral scattering and absorption properties of clouds and aerosols are being observed, as well as the spectral reflectances of surface types. Because the calibration of SCIAMACHY is still ongoing in 2004, only reflectance results below 1750 nm will be shown.We will present reflectance spectra of typical Earth scenes (clear and cloudy) as measured in nadir view mode for the range 300-1750 nm, and compare these to model results from the doubling-adding radiative transfer code DAK and MODTRAN 4.1.

Abstract No. 294

SCIAMACHY Long-Term Monitoring Results

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The Scanning Imaging Absorption spectroMeter for AtmosphericCHartographY (SCIAMACHY) is a contribution to the Envisat satellite, which has been launched successfully in March 2002. SCIAMACHY determines the amount and distributions of a large number of atmospheric constituents by measuring Earthshine radiance and solar irradiance spectra simultaneously from about 240 to 2380 nm in nadir, limb and occultation viewing geometry. To assure the high quality of

the SCIAMACHY data products over the mission, a continuous monitoring of the SCIAMACHY functionality and performance is essential.For this purposes, the SCIAMACHY mission planning concept includes dedicated calibration measurements on a daily, weekly and monthly time scale. These calibration measurements are regularly analysed; they comprise solar and lunar measurements as well as measurements using SCIAMACHY's internal light sources (spectral and white lamp).This presentation will give a short overview of the SCIAMACHYcalibration and monitoring concept.Furthermore, results of the monitoring activities will be presented showing for example that:* The SCIAMACHY instrument is radiometrically very stable over time.* The internal White Light Source (WLS) has proven to be stable enough for throughput monitoring.* SCIAMACHY is sensitive enough to detect variations in the solar activity on a sub-percent scale.

Abstract No. 322

Validation of SCIAMACHY BrO Profiles by Balloon-borne In-situ Measurements

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The ClO/BrO instrument of Research Center Jülich onboard the TRIPLE multi-instrument balloon payload has performed three flights for the validation of SCIAMACHY (SCanning Imaging Absorption spectroMeter for Atmospheric CartographY) onboard Envisat.While SCIAMACHY uses Differential Optical Absorption Spectroscopy (DOAS) from UV limb observations to obtain BrO profiles, the ClO/BrO instrument employs the in-situ CCRF (Chemical Conversion Resonance Fluorescence) technique providing really independent validation measurements. However, spatial and temporal mismatches as well as effects of the very different spatial resolution of the instruments need to be carefully considered due to the photochemical diurnal variation and possible atmospheric heterogeneities in BrO.Three different geophysical regimes were chosen for the flights: mid-latitude autumn (Aire-sur-l'Adour, France; 24 September 2002), high latitude spring (Kiruna, Sweden; 6 March 2003) and high latitude summer (Kiruna; 9 June 2003).Intercomparisons of the in-situ BrO profiles with SCIAMACHY profiles derived by off-line retrievals of the Universities of Bremen and Harvard do in general show good agreement. However, small scale structures in the in-situ profiles observed in the June 2003 measurement are not reproduced within the SCIAMACHY profiles and can most probably be assigned to dynamical processes. Implications for the SCIAMACHY validation as well as for BrO photochemistry as derived from dynamical and photochemical simulations employing the Research Center Jülich ClaMS (Chemical Lagrangian Model of the Stratosphere) model will be discussed.

Abstract No. 331

The Use of Data-quality Information for Optimal Scientific Application of MIPAS Trace-gas Data

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The objective of this paper is to show how the information related to the instrument status and the complex processing chain is fundamental to use in an optimal way the MIPAS trace-gas data. Instruments are designed as a compromise between scientific requirements and technical feasibility. Data processors are designed as a compromise between extraction of maximal information from the instrument and the constraints in processing and dissemination resources. This latter compromise should drive the data quality expected from an instrument. In practice, data quality is variable due to several sources of quality degradation. Optimal application of these data to scientific studies requires knowledge of the data quality. This paper explains important transient error sources that frequently affect data quality. These are related to instrument anomalies and degradations, near-real-time calibration quality variations, and data processor issues. The paper outlines the various sources of information that have been set up to provide the data user with quality information, in particular many dedicated records in the products themselves, and several documentation resources available on line. It also describes methods of applying this information, for example by filtering using specific data fields. For some parameters, error information in product files is not yet adequate, and improved information is available in separate documents. Finally the off-line consolidation of products allows corrections to near-real-time calibrations, attitude assessments and meteorological initialisation data, and have therefore a significant quality advantage over near-real-time data. This paper addresses the most important differences between the two.

Abstract No. 364

MIPAS-Envisat Validation Measurements with the High Resolution FT-FIR Spectrometer SAFIRE-A

U. Cortesi[1], G. Bianchini[1], G. Redaelli[2], E. Castelli[3], B. Dinelli[3], L. Palchetti[1]
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Results of Envisat validation measurements obtained by the high resolution Fourier transform far-infrared spectrometer SAFIRE-A during dedicated campaigns with the M-55 Geophysica aircraft carried out in the frame of the ESABC (Envisat stratospheric aircraft and balloon campaigns)

programme are presented and discussed.SAFIRE-A operated as part of the core payload of remote-sensing chemistry sensors deployed on-board the M-55 stratospheric platform at mid and high latitudes, with the aim of validating the chemistry instruments of the Envisat satellite, and mainly focussed on the validation of MIPAS level-2 products. The instrument was flown in six flights from Forlì, Italy (Lat. 44°N, Lon. 12°E) in July and October 2002 and in four flights from Kiruna, Sweden (Lat. 68°N, Lon. 20°E) in March 2003 for a total of approximately 45 flight hours and in several cases attained high quality limb sounding measurements of the volume mixing ratio vertical profiles for O3, HNO3, N2O and ClO in good spatial and temporal coincidence with MIPAS scans. The inter-comparison between vertical distribution of Ozone, HNO3 and N2O retrieved from data of the satellite and of the aircraft instruments has been supported by modelling tools specifically developed by University of L'Aquila. In this paper, we describe in some detail the analysis conducted for the inter-comparison and provide a comprehensive overview of the consolidated results obtained by SAFIRE-A Envisat validation measurements.

Abstract No. 365

The Use of Data-quality Information for Optimal Scientific Application of GOMOS Trace-Gas Data

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ESA/ESRIN, Italy

The objective of this paper is to show how the information related to the instrument status and the complex processing chain is fundamental to use in an optimal way the GOMOS trace-gas data. Instruments are designed as a compromise between scientific requirements and technical feasibility. Data processors are designed as a compromise between extraction of maximal information from the instrument and the constraints in processing and dissemination resources. This latter compromise should drive the data quality expected from an instrument. In practice, data quality is variable due to several sources of quality degradation. Optimal application of these data to scientific studies requires knowledge of the data quality. This paper explains important transient error sources that frequently affect data quality. These are related to instrument anomalies and degradations, near-real-time calibration quality variations, and data processor issues. The paper outlines the various sources of information that have been set up to provide the data user with quality information, in particular many dedicated records in the products themselves, and several documentation resources available on line. It also describes methods of applying this information, for example by filtering using specific data fields. For some parameters, error information in product files is not yet adequate, and improved information is available in separate documents. Finally the off-line consolidation of products allows corrections to near-real-time calibrations, attitude assessments and meteorological initialization data, and have therefore a significant quality advantage over near-real-time data. This paper addresses the most important differences between the two.

Abstract No. 371

Long Term Monitoring of GOME/ERS-2 On-fly Calibration Parameters

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After more than 8 years successful operation of GOME and its data processing, it is of great interest to analyse the on-fly calibration results and their parameters to get a first long term monitoring of their behaviour. The calibration parameters calculated during the Level 0 to 1 processing are a good means to analyse the stability of the instrument. In the same way the daily sun measurements are important for analysing the instrument degradation. Most of these parameters are stored in a database covering the complete GOME mission. In this study a time series of the most important parameters like the sun mean reference, the wavelength calibration, the pixel-to-pixel gain, the leakage current and polarisation correction factors will be shown.

Abstract No. 375

The Use of Data-quality Information for Optimal Scientific Application of SCIAMACHY Trace-gas Data

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The objective of this paper is to show how the information related to the instrument status and the complex processing chain is fundamental to use in an optimal way the SCIAMACHY trace-gas data. Instruments are designed as a compromise between scientific requirements and technical feasibility. Data processors are designed as a compromise between extraction of maximal information from the instrument and the constraints in processing and dissemination resources. This latter compromise should drive the data quality expected from an instrument. In practice, data quality is variable due to several sources of quality degradation. Optimal application of these data to scientific studies requires knowledge of the data quality. This paper explains important transient error sources that frequently affect data quality. These are related to instrument anomalies and degradations, near-real-time calibration quality variations, and data processor issues. The paper outlines the various sources of information that have been set up to provide the data user with quality information, in particular many dedicated records in the products themselves, and several documentation resources available on line. It also describes methods of applying this information, for example by filtering using specific data fields. For some parameters, error information in product files is not yet adequate, and improved information is available in separate documents. Finally the off-line consolidation of products allows corrections to near-real-time calibrations, attitude assessments and meteorological

initialisation data, and have therefore a significant quality advantage over near-real-time data. This paper addresses the most important differences between the two.

Abstract No. 424

Re-Analysis of ERS-2/GOME Diffuser Properties

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Trace-gas profile retrievals from the GOME instrument depend on the calibration accuracy of the on-board diffuser.We have re-analysed historical GOME solar irradiance measurements. This work shows that the optical properties in the diffuser lightpath are significantly more complex than previously thought.

Abstract No. 465

Validation of MIPAS-Envisat CH4 and N2O Vertical Profiles by Airborne In Situ Observations

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Airborne in situ measurements of N2O, CH4, CFCs 11 and 12 with the High Altitude Gas Analyzer (HAGAR) and the balloon-borne cryosampler of the University of Frankfurt are compared to vertical profiles from MIPAS-Envisat. We validate ESA Level-2 standard products (v. 4.61) and non-operational trace gas profiles of CH4, N2O, CFC-11 and CFC-12 derived with the scientific data processor run at IMK Karlsruhe.Three validation campaigns were performed by the high altitude research aircraft M-55 Geophysica comprising a total of 16 flights in July and October 2002 out of Forli in northern Italy and in February/March 2003 out of Kiruna, Sweden. Flights were planned to achieve good collocation with MIPAS-E profiles up to 20 km. HAGAR measures N2O, CH4 and the halocarbons F11 and F12 with in situ gas chromatography (GC-ECD) at a time resolution of 90 s. Calibrations are performed every 7.5 minutes during flight using two standard gases tied to the NOAA/CMDL scale yielding an absolute accuracy of 2%. The in-situ data from HAGAR are correlated with near-coincident measurements made with MIPAS-E in order to assess the quality of different MIPAS data processors.

Abstract No. 467

The SCIAMACHY Level 1b-2 Offline Data Processor: Current Status and Recent Developments

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This contribution is dedicated to demonstrate the ability of the Level 1b-2 offline data processing for SCIAMACHY nadir and limb sounding measurements. Starting with the current status of the operational version, we will present the most recent developments in algorithms and software and demonstrate the improvements for the data products. One focus will be on the discussion of the limb profile retrieval of O3 and NO2. Another emphasis wiil be on the improvement of nadir UV/VIS data products. Special care will be taken on the discussion of the impact of Level 1b data quality for the Level 2 product generation. An additional goal is to provide the user community a detailed insight what to be expected in the coming versions of the Level 2 offline data processing of SCIAMACHY measurements.

Abstract No. 476

Improvements of the SCIAMACHY Radiometric Calibration and its Validation on Solar Irradiances in the Spectral Range from 240 to 2380nm

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SCIAMACHY (SCanning Imaging Absorption Spectrometer for Atmospheric CHartographY) is part of the payload of ESA's Environmental Satellite Envisat which was launched into a sun-synchronous polar orbit on 2002-03-01. The main purpose of SCIAMACHY is to determine the amount and distribution of various trace gases and aerosol as well as cloud cover and cloud top height in Earth's atmosphere by measuring the atmospheric radiance in limb and nadir geometry. In addition several solar observations are performed on a regular daily or even orbital time grid.SCIAMACHY is the first spaceborne instrument covering a wavelength range from 240 to 2380 nm thus including ultraviolet, visible and near infrared spectral regions. A prerequisite for high quality data products is the in-flight validation and if necessary the improvement of the radiometric calibration of SCIAMACHY. First in-flight validation results already showed inconsistencies in the radiometric calibration of SCIAMACHY. Hence the on-ground calibration was thoroughly revised.

In addition beforehand disregarded on-ground calibration measurements as well as in-flight data were analysed. As a result an improved radiometric calibration for SCIAMACHY could be derived.The following topics will be presented:(a) Results of the revision of the on-ground calibration(b) Improvements for the calibration of irradiance measurements (solar measurements)(c) Improvements for the calibration of radiance measurements (Earthshine measurements)(d) As an example of the improved radiometric calibration the comparison of the solar irradiance measured by SCIAMACHY with other in-orbit instruments like SOLSTICE and SOLSPEC as well as with a spectrum derived by R. L. Kurucz will be given.

Abstract No. 489

Global Long Term Data Sets of the Atmospheric H2O Column Derived from GOME and SCIAMACHY

T. Wagner, M. Grzegorski, S. Sanghavi, U. Platt
Uni-Heidelberg, Germany

Atmospheric water vapour is the most important greenhouse gas which is responsible for about 2/3 of the natural greenhouse effect, therefore changes in atmospheric water vapour in a changing climate is subject to intense debate. H2O is also involved in many important reaction cycles of atmospheric chemistry, e.g. in the production of the OH radical. Thus, long time series of global H2O data are highly required. New UV/vis satellite sensors like GOME, SCIAMACHY or OMI are capable of measuring the total atmospheric H2O column (including also the surface near concentrations). Thus these sensors allow to investigate the global long term evolution of H2O and possibly also to identify a trend due to climate change. Such studies can in particular focus on different regions and seasons. H2O column data from GOME and SCIAMACHY might be also of great value for meteorological weather forecast.We present global long term data sets of H2O derived from GOME and first results from SCIAMACHY.

Abstract No. 528

Validation of MIPAS Profiles of the Scientific Data Processor at IMK Karlsuhe with Data from the MIPAS-STR Instrument on Board the Geophysica

C. Blom, T. Von Clarmann, T. Gulde, M. Höpfner, C. Keim, S. Kellmann, N. Glatthor, G. Liu, C. Piesch, C. Sartorius, G. Stiller, G. Tsidu
Forschungszentrum/Universität Karlsruhe, Germany

We report the validation of temperature and trace gas profiles derived from the MIPAS NRT level-1b data with the scientific data processor developed at the IMK Karsruhe in the upper troposphere and the lowermost stratosphere with correlative data derived by MIPAS-STR onboard the high-altitude aircraft M55-Geophysica. The validation is presented for the 22 July 2002 orbit 2051 at middle latitudes and, in the Arctic region, for several orbits of February 28th, March 2nd and March 12th, 2003. We focus on the profiles of the temperature and of the trace gases O3 , HNO3, ClONO2, CFC-11, CFC-12, N2O and CH4.

Abstract No. 544

Advancements of the Operational Level 0 to 1 Processing of SCIAMACHY

S. Slijkhuis[1], B. Aberle[1], J. Frerick[2], A. Von Bargen[1], S. Wahl[1]
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[2] ESA-ESTEC, Netherlands

In this paper we present an overview of the advancements which have been made to the operational Level 0 to 1 processing of SCIAMACHY, since software version 4 of December 2002. The aim is to give the users of SCIAMACHY level 1 data an impression of the improvements in Level 1 data quality since the first ACVE workshop.We further present an outlook to the changes in the prototype software, which will become operational in the near future.

Abstract No. 612

Analysis of Water Vapour and Methane from the MIPAS Satellite Instrument

V. Payne, A. Dudhia, C. Piccolo
University of Oxford, United Kingdom

Water vapour and methane are two of the target gases retrieved operationally in near real time from the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on Envisat. Water vapour and methane are chemically linked, since methane oxidation is the main source of water vapour in the stratosphere. The oxidation of methane eventually produces water vapour and molecular hydrogen such that the sum H2 + H2O + 2CH4 is approximately constant with altitude. Assuming that the mixingratio of molecular hydrogen is constant with altitude in the lower stratosphere, we would also expect the quantity H2O + 2CH4 to be reasonably constant in this region, providing a useful internal validation test.Here we assess the quality of water vapour and methane profiles from the ESAoperational retrieval, based on three years worth of MIPAS data. Monthly means of MIPAS profiles are used to examine differences from climatology, seasonal cycles and long-term trends.

Comparisons are also made with measurements from the Halogen Occultation Experiment (HALOE) on UARS.

Abstract No. 623

SCIAMACHY on Envisat - Summary on Results from the First 2 Years in Orbit

H. Bovensmann, J. Burrows, Sciamachy Team
University of Bremen, FB 1, Germany

The Scanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) is a German/Dutch/Belgium contribution to the Envisat satellite, which was launched in March 2002. The SCIAMACHY instrument measures sunlight transmitted, reflected and scattered by the Earth's atmosphere or surface simultaneously from the UV to the SWIR spectral region (240 - 2380 nm) in nadir, limb, and occultation viewing geometry. This measurement strategy allows the global characterisation of the composition of the Earth atmosphere from the boundary layer up to the mesosphere. In the troposphere SCIAMACHY delivers tropospheric column concentrations of O3, NO2, SO2, H2O, HCHO, CO, CO2, CH4 as well as cloud and aerosol information. In the stratosphere profiles of O3, NO2, BrO, H2O and other parameters can be derived. Beside this SCIAMACHY is able to contribute with solar irradiance data and upper atmospheric soundings to solar-terrestrial research relevant for the understanding of climate change. The talk will summarise on the results and findings from the first 2 years of SCIAMACHY in orbit, demonstrating SCIAMACHY's capability to characterise the composition of the Earth atmosphere from the boundary layer to the mesosphere. SCIAMACHY data has the potential to significantly contribute to applications in the area of GMES "Atmospheric Monitoring", Kyoto and Montreal Protocol verification as well as "Chemical Weather" applications.

Abstract No. 716

Ozone Isotopes Retrievals

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[3] *Chalmers University of Technology, Sweden*
[4] *Forschungszentrum Karlsruhe, Germany*

The isotopic ratios of stratospheric ozone can be used as valuable tracers for many processes in the atmosphere. Stratospheric enrichment of heavy ozone, produced by a higher photodissociation of

heavy oxygen molecules, can reveal information about sources and sinks of heavy ozone and the transport processes which influence its distribution. Here we compare stratospheric enrichments of heavy ozone obtained from three limb sounders: MIPAS (Michelson Interferometer for Passive Atmospheric Sounding), on board Envisat, SMR (Sub-Millimetre Radiometer), on board the Odin satellite, and MIPAS-B2, the balloon-borne Michelson Interferometer for Passive Atmospheric Sounding.

Tuesday 7 September
08:40 – 10:20

MOZART 3

Session 2A4:

AATSR Performance and Products Quality

Abstract No. 78

Validation of the First Two Years of the AATSR Meteo Product Sea Surface Temperatures at the Met Office

J. Watts, A. O'Carrol, R. Saunders
Met Office, United Kingdom

The Advanced Along-Track Scanning Radiometer (AATSR) Meteo product has been available in near-real time since 19 August 2002. Validation has been performed on these data at the Met Office on a daily basis, two days after the observations have been made. Skin and bulk SSTs, which have been calculated from the Meteo product, have been compared with alternative SST measurements in the form of buoy data, a 1 degree climate SST analysis field compiled from in situ measurements and AVHRR SSTs, a 5-degree 5-day averaged in situ dataset and the Tropical Rainfall Monitoring Mission (TRMM) Microwave Imager (TMI) SSTs. All of these have shown the Meteo product skin SSTs to be of high accuracy, and the AATSR instrument to be performing within specification.For the first three months, a maximum of only 10 orbits per day of AATSR Meteo product data were available in near-real time from an ESA FTP server. The introduction of a second ground receiving station and FTP server to the data chain in November 2002 allowed the full complement of Envisat orbits to be represented in the product. Since February 2003, supply of the product from ESA has been very reliable, although whole-day outages, such as those for out-gassing events, are still occasionally experienced.Analyses have shown evidence of a state dependent bias between the 2-channel and 3-channel night time dual-view SST observations in the AATSR Meteo product. Comparisons against in situ data have also suggested that warm mean global biases are present in both the 2-channel dual-view SSTs (a bias of approximately 0.05K) and the 3-channel dual-view SSTs (a bias of approximately 0.22K).

Abstract No. 16

An Assessment of the Accuracy of SST Retrievals from AATSR: Comparisons with In-situ Radiometers, Buoy Data and the AVHRR and MODIS Satellite Sensors

G. Corlett[1], I. Barton[2], C. Donlon[3], D. Llewellyn-Jones[1], P. Minnett[4], T. Nightingale[5], E. Noyes[1], A. Pearce[6], A. O'Carrol[3], J. Remedios[1], I. Robinson[7], R. Saunders[3], J. Watts[3], L. Horrocks[3]
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[2] CSIRO, Austria
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[5] RAL, United Kingdom
[6] CSIRO, Australia
[7] University of Southampton, United Kingdom

The Advanced Along-Track Scanning Radiometer (AATSR) was launched on Envisat in March 2002. The AATSR instrument is a highly stable self-calibrating radiometer designed to make precise and accurate global Sea-Surface Temperature (SST) measurements. These data, when added to the large data set collected from its predecessors ATSR and ATSR-2, will provide a long-term record of SST measurements (>15 years) that can be used for independent monitoring and detecting of climate change. The formal specifications require that retrieved AATSR SST values achieve an absolute accuracy of better than ± 0.5 K, with ± 0.3 K (one sigma) adopted by the project as the target accuracy. An intensive SST validation programme has been in operation since launch that involves validating retrieved AATSR SST values against a) SST data retrieved from other satellite sensors such as AVHRR and MODIS b) a global network of buoy derived SST measurements and c) SST values determined from in-situ data collected from high-precision radiometers. This presentation will summarise the AATSR SST validation programme and will show that AATSR is currently meeting its objective to determine accurate global SST measurements to within 0.3 K (one sigma).

Abstract No. 210

Reducing Errors in Satellite-derived Sea Surface Temperature - Application to AATSR Data Analyses

I. Barton
CSIRO, Australia

Operational multi-channel algorithms for deriving sea surface temperature (SST) from satellite data are derived using theoretical models of infrared radiation transfer through the atmosphere or by regression of satellite data with ground-based observations. In both cases the algorithm derivation implies a "first-guess" of the water vapour content along the atmospheric path between the satellite and the surface. Deviations from this first-guess water vapour profile may result in errors in the derived SST. The six channels of the AATSR (3 wavelengths x 2 views) account for much of this variation, but significant errors can still occur. These errors can be reduced by first using the AATSR data to derive some estimation of the water vapour content of the atmosphere, and then selecting SST algorithm coefficients from a pre-determined table. The derivation of water vapour content and distribution using AATSR data will be presented first followed by details of the two-step advanced approach to SST derivation.

Abstract No. 289

Validation of the AATSR L2 GSST Product with In-situ Measurements from the M-AERI

E. Noyes[1], P. Minnett[2], J. Remedios[1], B. Mannerings[1], G. Corlett[1], M. Edwards[1], D. Llewellyn-Jones[1]

[1] *University of Leicester, United Kingdom*

[2] *RSMAS/MPO, University of Miami, United States*

The Along-Track Scanning Radiometer (ATSR) is a space-borne instrument designed to accurately measure Skin Sea Surface Temperature (SSST). The instrument has a unique design in that it has both a nadir- and forward-view, allowing the Earth's surface to be viewed through two different atmospheric path lengths and enabling an improved atmospheric correction to be made when retrieving measurements of SSST. The infrared radiometer also uses an innovative and exceptionally stable on-board calibration system, which, together with actively cooled detectors, gives exceptionally high radiometric sensitivity and precision, enabling SSSTs to be retrieved to within ± 0.3 K (1-sigma limit). The most recent ATSR, the Advanced ATSR (AATSR), is the third instrument in the series and was launched onboard ESA's Envisat Satellite in March 2002. The Marine-Atmospheric Emitted Radiance Interferometer (M-AERI) is an in situ instrument which provides accurate measurements of SSST along regular cruise tracks in the Caribbean Sea (residual uncertainties in the measurements are < 0.03 K). The measurements from this instrument, which is permanently deployed onboard the Explorer of the Seas cruise ship, are therefore ideal for providing a near-continuous SSST dataset that can be used to validate the AATSR Level 2 operational dual-view Gridded Sea Surface Temperature (GSST) product over the area. The M-AERI provides an unprecedented number of measurements which enables us to validate the AATSR SST products on a scale that has not been possible with its two predecessors, ATSR-1 and ATSR-2. We present validation results obtained between September 2002 and September 2003 which indicate that, although the AATSR appears to measure slightly warm (circa + 0.14 K), the GSST product is accurate to within 0.28-0.41 K (Root Mean Square difference) in this geographical region, depending on the validation criteria used. Further investigations into a number of validation points that do not fall within the target ± 0.3 K accuracy zone have been carried out and will also be presented.

Abstract No. 394

Verification of the In-Orbit Calibration of the Visible and Near-Infrared Channels of AATSR

D. Smith, C. Poulsen, B. Latter
CCLRC Rutherford Appleton Laboratory, United Kingdom

The visible and near infrared (VNIR) channels of the Advanced Along Track Scanning Radiometer (AATSR) are calibrated by an on-board VISCAL system. The VISCAL system is based around a white Russian Opal diffuser that provides a signal corresponding to approximately 15% top of atmosphere (TOA) reflectance.The authors present the results from a range of techniques to determine the in-orbit calibration of the VISCAL system. Two basic approaches have been used here: one to compare AATSR TOA reflectances with those measured by other sensors such as ATSR-2, MERIS and GOME, and the other to compare measurements from Arctic stratus clouds with simulated reflecances using a model based on DISORT. The comparisons with other satellite sensors are made using data from complete orbits as well as specific ground targets that are known to be stable and uniform. The results from all methods show a consistent bias of the AATSR calibration, which will be discussed.In addition to the absolute calibration, time series of TOA reflectances from the test sites are used to determine the long-term stability of the calibration system. The results from the first two years of the mission are presented here.

Tuesday 7 September Wolf-Dietrich 1-2

Poster Session 2P04:

AATSR Performance and Products Quality

Abstract No. 71

Validation of AATSR SST Skin Observations Using the ISAR Radiometer

C. Donlon[1], I. Robinson[2], G. Fisher[2], M. Reynolds[3], W. Wimmer[2]
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This paper describes quasi-operational autonomous deployments of the Infrared Sea surface Temperature Autonomous Radiometer (ISAR) system to validate the Envisat AATSR. The ISAR instrument has been developed specifically for the autonomous validation of satellite SSTskin temperature data and 4 instruments are permanently deployed on ships operating in the USA and in the EU. We present ISAR SSTskin observations and associated ocean/atmosphere data collected during sustained deployments aboard the P&O Ferries ship 'Pride of Bilbao' operating in the English Channel and Bay of Biscay in collaboration with the Southampton Oceanography Centre FerryBox Experiment. Data for the Period May - September 2004 have been collocated in time and space with Envisat AATSR data and analysed to validate AATSR SST data products. These deployments provide valuable SSTskin validation data as they are obtained in cooler ocean waters compared to the vast majority of available SSTskin temperature data collected by other international groups.

Tuesday 7 September
08:40 – 10:20
TRAKL

Session 2A5:

Altimeter Signal Processing

Abstract No. 143

Global Waveform Shape Analysis for Envisat RA-2

M. Dowson, J. Garlick, P. Berry
De Montfort University, United Kingdom

Prior work with ERS RA-1 data has already shown the complex spatially-correlated occurence of different echo shapes over the earth's surface. A global analysis of ERS data from both the ERS-1 Geodetic Mission and ERS-1/2 35 day data has illustrated the geographically corrrelated temporal changes in waveform shapes, and has demonstrated the physical mechanisms underlying these variations. This paper presents a global analysis of echo shape distribution over all surfaces for the Envisat RA-2, in both Ku and S bands. Detailed results for specific regions of interest are also given, and the results are compared and contrasted with those obtained for ERS-1, ERS-2, and Topex (in both Ku and C bands). The mode switching performance of the RA-2 at Ku band is investigated globally, and an analysis is presented of echo retrieval and shape distributions for all three modes.

Abstract No. 281

Retrieval of Geophysical Parameters from RA2 Envisat Waveforms Using a Non-linear MLE Retracker

J. Gomez-Enri, C. Gommenginger, P. Challenor, M. Srokosz, G. Quartly
Southampton Oceanography Centre, United Kingdom

The Southampton Oceanography Centre ocean retracker, initially designed for ERS-1 altimeter data, has been updated for RA-2 Envisat waveform data, in order to be used to retrieve some geophysical parameters suchas, the significant wave height, the backscatter power and the range. Such algorithm, based on the Maximum Likelihood Estimation, is capableto obtain those parameters, assuming both linear and non-linearconditions for the ocean. The use of the non-linear case allows us toestimate additional parameters, such us the skewness, which relates tothe nonlinearity of the wave field (i.e. peakier crests/flattertroughs) and a cross-skewness term, with no clear physicalsignificance. In the present work, we have retrieved the significantwave height and the range from RA-2 Envisat 18 Hz waveforms using theSOC ocean retracker. First results show that the linear MLE modelretrieves parameters consistent with those in RA-2 SGDR records. Thiswork is part of an ESA study for the exploitation of the Envisat radaraltimeter individual echoes and S-band data for ocean, coastal zone,land and ice/sea-ice altimetry (RAIES).

Abstract No. 323

Preliminary Results obtained using the Envisat RA-2 Individual Echoes (Full-rate Waveforms with Phase Information)

M. Roca[1], S. Laxon[2], D. Martínez[1]
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[2] *CPOM/UCL, United Kingdom*

The RA-2 in its nominal operation provides averaged waveforms at the rate of 18 Hz (one averaged waveform over 100 individual echoes, every 0.0557 seconds). It has also the capability to provide limited bursts of individual, unaveraged echo sample data in phase (I) and quadrature (Q), at the full PRF rate. In this concept the full-rate data are stored, for a short burst, into an internal buffer memory, in parallel to the normal averaging and other functions of the instrument. The buffered data are subsequently read out at a much lower rate and appended to the normal science data. These Individual Echoes (IE) are, therefore, not processed on-board in the same way that the nominal RA-2 waveforms are. It has been demonstrated that through the full rate data it is possible to discover some behaviours than can not be seen with the averaged data. Moreover, it is the first time in altimetry that we have echoes that contain the information of the phase. This is a great potential for new science studies.This paper describes the algorithm applied on-ground to the IE of the RA-2 Burst Waveforms to reproduce the same process done by the instrument on-board. Once this algorithm is applied to the IE they will be in the same condition than the normal RA-2 telemetred average waveform. The final objective of this work is the used of the IE fully processed and instrument calibrated for calibration, validation and science exploitation purposes. We will present preliminary results of studies carried out using these IE.In particular we will present the use of these data with transponders for the Sigma_0 calibration. During the Envisat commissioning phase a Sigma-0 transponder was deployed in Holland (Hock Van Holland). Data were collected and analysed and a sigma-0 absolute bias was estimated [Roca M, et al., December 2002]. At that time only averaged waveforms were analysed due to unavailability of a procedure to analyse IE. However, the IE were always collected over the transponder passes. These IE waveforms can be used to improve the accuracy of the previously estimated Sigma-0 bias.We will also present preliminary results of the analysis of the behaviour of IE over the "Salar D'Uyuni" in Bolivia and their comparison with an independent GPS survey over the same area [Fricker et al., April 2003] to better understand biases in retracking of specular echoes. The results can be used to improve the current understanding of retracked elevations over sea ice and help to improve tuning of current sea ice retracking schemes for the Envisat RA-2 instrument.The blurring on the averaged waveforms depends on the total movement of the range window [Roca, February 2002], which in turn depends on slope of the terrain, the orbit slope and ultimately, how well the on-board tracker tracks that particular waveform shape. In early studies using ERS data, the blurring on the averaged waveforms has been estimated by simulating the ERS range window movement during tracking [Peacock, March 2002]. Using individual echoes there is no longer the need to do so, we can directly use these echoes. The IE will be averaged in the correct way and compared to the averaged waveform provided in the nominal RA-2 product. Changes on the retracked epoch and slope of the leading edge will be assessed for different type of waveforms over different surfaces.References:Roca M.,

Jackson H., Celani C., "RA-2 Sigma-0 Absolute Calibration" Envisat Validation Workshop Proceedings, Frascati, December 2002.Fricker, H.A., S.W. Laxon, M. Roca, C. Carabajal, K. Quinn, A. Borsa, J-B. Minster (2003). "Validation of satellite altimeter range measurements over salar de Uyuni, Bolivia". Presented at EGS-AGU-EUG Joint Assembly, Nice, France, 7-11 April 2003.Roca M., "The RA-2 On-Board Tracker and its Autonomous Adaptable Resolution", ESA Technical Note, POTN-ESA-RA-1316, 1.a, 13 February 2002.Peacock, N.R, and Laxon, S.W., (in press). "Sea Surface Height Determination in the Arctic Ocean from ERS Altimetry". J. Geophys. Res.

Abstract No. 593

Exploitation of the Envisat RA-2 Individual Echoes and S-band Data over Ocean, Coastal Region and Continental Water: Preliminary Results

O. Zanifé[1], J. Dumont[1], F. Mercier[1], J. Benveniste[2]
[1] *CLS, France*
[2] *ESA/ESRIN, Italy*

The radar altimeter, RA-2 on board Envisat, has an additional mode : the burst mode or individual echoes (IE) collection. A description of this mode is presented in M. Roca et al. paper (2004) in this conference. Such a source of information is a unique feature of RA-2. It is also offering a unique possibility to assess further the full potential and capabilities of altimeter measurements. First, speckle characteristics over different altimeter scenes, ocean, ice, land, but also, potential blurring effects associated with range window changes during the 100 echoes average process, shall directly help understand and evaluate better the instrument and processing limits and capabilities. Many investigations and full use of the radar altimeter measurements, including the combined use with the concurrent S-band measurements, shall indeed be triggered by the enhanced possibilities of this new and unique altimeter mode.In particular, one remaining weakness and challenging goal in current altimetric measurements is to advance and better assess uncertainties in the range resulting from the actual mean height of the sea surface being above the derived-altimeter height. The error directly comes from the interaction between the altimeter impulse response and the non-symmetric reflecting sea surface that slightly shifts the mean power towards the wave troughs. But, as found with different altimeter missions, these range correction characteristics change from instrument to instrument (Zanife et al 2003). Using individual echoes is thus certainly a key to better understand and quantify instrumental effects (waveform blurring, speckle and gate-to-gate correlation statistics, ...).Over land surfaces, the individual echoes will allow the monitoring of the behaviour of the altimeter over transition zones, i.e. at the border between surfaces exhibiting drastic differences in surface characteristics and/or topography. Changes in the phase of the radar signal will also help discriminating transition of the reflecting media. However, a large number of possible transition zones configurations may be envisaged. For some situations, the transition zone may simply be identified from the fluctuation of only one parameter whereas for other cases, a smart combination of several parameters can be necessary. The retrieved geographical extent of the transition zone has to be compared with the real value to assess the sensitivity of the technique.The main goal of S-band

estimates is to provide an estimate of the altimeter range performed with a different frequency than the one used in Ku-band in order to derive the ionospheric correction on the altimeter range. Due to the design of the instrument, S-band estimates will always be less accurate than Ku-band ones (25 IE in S band against 100 IE in Ku-band, gate resolution of 94 cm in S band against 47 cm in Ku band, 64 waveform samples in S band against 130 in Ku band, this includes the 2 DFT samples). One way of improving the S band range estimate is to couple the Ku and the S band parameters by inputting the Ku Significant Wave Height (SWH) in the retracking algorithm for the S-band waveforms.In this paper we will present preliminary results on the blurring effect coupled with investigations on the tracker bias, on the speckle theory validation (bin to bin correlation, pulse to pulse correlation, probability density of the noise affecting the individual echoes) and about transitions zones using Ku band IE. Also, preliminary results about the improvement of the S band range estimates will be presented.Reference : Zanife OZ, P. Vincent, L. Amarouche, JP. Dumont, P. Thibaut and S. Labroue, "Comparison of the Ku-band Range Noise Level and the Relative Sea State Bias of the Jason-1, TOPEX and POSEIDON-1 Radar Altimeters", Marine Geodesy, Volume 26, Number 3-4, July-December 2003, pp: 200-238

Abstract No. 642

RAIES: Envisat RA2 Individual Echoes and S-band Data for New Scientific Applications for Ocean, Coastal, Land and Ice Remote Sensing

P. Challenor[1], C. Gommenginger[1], G. Quartly[1], J. Gomez-Enri[1], M. Srokosz[1], P. Berry[2], L. Mathers[2], J. Bennett[2], D. Cotton[3], D. Carter[3], I. Leduc[4], C. Rogers[4], J. Benveniste[5]

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[2] De Montfort University, United Kingdom
[3] Satellite Observing Systems, United Kingdom
[4] SciSys Ltd, United Kingdom
[5] ESRIN, Italy

This paper presents the latest results of an ESA-funded study for the scientific exploitation of Envisat RA2 Individual Echo and S-band (RAIES) data for ocean, coastal, land and ice remote sensing. Envisat RA-2 is the first space borne altimeter to provide both Ku and S band average waveforms, as well as bursts of up to 2000 individual echoes at Ku band, in addition to the standard altimeter geophysical products. The paper will review the processing scheme required to reconstruct RA2 individual echoes and retrieve amplitude and phase of the returned signals. New scientific applications with Envisat will be presented for the ocean and the coastal zone, including improved rain, wind and wave products using Ku and/or S-band data, novel ocean wave parameter retrieval using waveform re-tracking over the ocean, and the estimation of the sea surface wave spectrum along the altimeter track using the phase of the individual echoes. The project will also present our latest findings on the range of new science applications made possible with Envisat individual

echoes or averaged waveforms for land and ice remote sensing. The paper will summarise the achievements and scientific findings of the study to date, highlight existing difficulties and provide recommendations to facilitate the exploitation of RA2 data.

Poster Session 2P05:

Altimeter Signal Processing

Abstract No. 198

Non-Parametric Sea-state Bias Models and Their Relevance to Sea Level Change Studies

R. Scharroo[1], J. Lillibridge[2]
[1] NOAA, United States
[2] NOAA / Lab for Satellite Altimetry, United States

The sea-state bias (SSB) correction to sea surface height is the dominant error source in satellite altimetry. We have developed a "hybrid" method for estimating SSB error models that blends the direct estimation approach with a smoothing and extrapolation by a best-fit parametric function. We have applied it to ERS-1, ERS-2, TOPEX, Poseidon, GFO, Jason-1, and Envisat. We observe remarkable similarities in the structure of the SSB models between the various altimeters, particularly those with a common heritage such as Jason-1 and Poseidon. Dual-frequency altimeters like those of Envisat and TOPEX are handled with additional care, as the ranges on both frequencies contribute to the sea state bias in an ionosphere-free combination. Particular emphasis is put on the comparison of the two sides of the TOPEX altimeter and the impact that changes in SSB modelling have on sea level change studies.

Abstract No. 301

RA-2 S-Band Anomaly: Detection and Waveforms Reconstruction

A. Martini[1], P. Féménias[2], M. Milagro Perez[1], G. Alberti[3]
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[3] CORISTA, Italy

As widely known the RA-2 data are affected by the so-called "S-Band anomaly" discovered in the early days of the Commissioning Phase. It consists in the accumulation of the S-Band echo waveforms that starts, apparently randomly, after an instrument Acquisition phase. Investigation is on going to try and find the instrumental cause of this behaviour but in the meantime the data affected by this anomaly are completely unusable. For this reason the need has arisen for the users to be able to detect the anomalous data and eventually reconstruct a usable signal from them.This paper describes the algorithm developed for the L1b processor that allows to set a flag identifying the data affected by the "S-Band anomaly" and reconstruct normal echo waveforms to be then ingested in the nominal re-tracking procedure at L2. It presents also the results obtained after the implementation in the L1b reference processor.

Abstract No. 587

An Online Satellite Altimetry Data Processing System: ADS CENTRAL

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Answering the emerging questions about human-driven climate changes and, more specifically, the sea level change, an interdisciplinary interpretation of various data sets is needed. Several groups on the national and international level are recently active in building up services to facilitate the access to geoscientific data to a broader community, especially the access to higher level products. GFZ Potsdam is currently developing the modular German Earth Science and Information System (GESIS). In the frame of GESIS the Altimeter Database System (ADS) has been already developed and implemented. The ADS module provides high quality altimeter data for a variety of different altimeter missions and, moreover, processing capabilities for radar altimetry data to a wide range of users. ADS is an attempt to offer easy access to the daily growing satellite altimetry database and numerous geophysical correction models and orbits. Due to the effectiveness of the underlying data structure and software system, new missions and models can be added to the system at any time. The system has undergone several tests by external and internal users successfully and has been proven to be very useful. Especially to those users not having convenient access to a satellite altimetry data processing system and database. ADS offers new possibilities for research activities.ADS can be accessed worldwide via the internet based user-interface "ADS Central" with a standard browser at http://gesis.gfz-potsdam.de/ads. After a registration process the system offers higher level standard products, calculated routinely from the harmonized and inter-calibrated satellite database. Additionally, ADS allows to generate individual user specific products. The user is able to perform several processing and analyzing steps, e.g. to generate mean sea surface height grids, to extract altimetry data time series around a given location, to analyze parameter variability, or to perform a crossover analysis. Furthermore, the user can specify general parameters like the time interval or regional subsets and may select different correction models (e.g. tidal models). It is further possible to enter several quality parameters to optimize the data for individual applications. These individual user defined products are automatically processed by ADS at GFZ Potsdam and are subsequently distributed to the user.

Abstract No. 643

Envisat Radar Altimeter Individual Echoes and S-band Applications

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A unique feature of the Envisat Radar Altimeter (RA-2) is to provide bursts of individual,unaveraged Ku band echo sample data in phase (I) and quadrature (Q), at thefull rate 1800 Hz.This data offers a unique possibility to assess the full capabilities of altimeter measurements.Both technically and scientifically, much can be expected from these bursts ofindividual echoes, e.g., speckle characteristics over different altimeter scenes, ocean,ice, land, coastal zone transitions but also blurring effects associated with range windowchanges during the 100 echoes on-board averaging. Moreover, for the first timein altimetry from space, investigations can be carried on the direct use of phase informationfrom backscatter signals. Envisat RA-2 also features a second frequency inS band. The combination between absolutely calibrated Ku and S band data can yieldinteresting improvement for wind speed, wave period, gas exchange estimates, etc.Preliminary results from the technical and scientific application of Envisat RA-2individual echoes and S band data will be shown.

Abstract No. 676

High Level Envisat Radar Altimeter & CryoSat Land/ocean/ice Easy-to-use Synergy Products Development (HERACLES)

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The Envisat radar altimeter mission will be joined soon by CryoSat. The two missions will overfly ice, land and ocean surfaces with complementary samplings, allowing improvements in observing

capabilities. The HERACLES project aims at developing algorithms and merging techniques to provide both scientists and newcomers to altimetry with easy-to-use Envisat and CryoSat synergy products, including dual-crossovers and gridded data. A great part of the project is devoted to studies to homogenize Envisat and CryoSat level 2 products and to investigate complementarities between the two missions. In particular, the CryoSat specificities in terms of orbit and geophysical corrections are taken into account to allow optimal merging of the two datasets. As part of the project, a prototype processor is designed and developed to produce Envisat/CryoSat combined datasets. High priority is given to interactions with users during the project with easy-to-to-use, homogeneous and unified products. Both usefulness and effectiveness of these merged products will be assessed after the dissemination of demonstration products and based on input and feedback from HERACLES users.

Tuesday 7 September
08:40 – 10:20
KARAJAN 1-2-3

Special Session 2A6: GMES and Science (1)

(No abstracts)

GMES Programme and Prospects: ESA GSE Activities

M. Doherty

GMES Programme and Prospects: EC FP6 GMES Activities

M. Malacarne

Research Needs for the GMES Service Element: Land

B. Su

Research Needs for the GMES Service Element: Ocean and Coastal Zones

R. Doerffer

Research Needs for the GMES Service Element: Atmosphere

J.M. Flaud

A Model-based Approach to the Selection of In-situ Measurements

J. Mc Glade

Tuesday 7 September
10:50 – 12:30

MOZART 4-5

Session 2B1:

SAR Signal Processing

Abstract No. 356

Unambiguous Doppler Centroid Estimation

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We propose technique to compute Doppler Centroid frequency (both ambiguous and unambiguous) on a SAR image, like from Envisat or RADARSAT. The Doppler Centroid is estimated, as usual, into two steps: (1) ambiguous Doppler centroid modeling and estimation, and, (2), integer ambiguity (multiple of PRF) estimation. The whole processing is performed on a range compressed Envisat ASAR image (or, in general, range compressed SAR data). The first step is accomplished by exploting blockwise one of the existing techniques to derive ambiguous estimate of the Doippler Centroid, and fitting a low order polynomial model (without explicitely unwrapping measures). The fit is perfromed by as a proper weighted average. The second step performs ambiguity estimation. Two statistical methods have been chosen to accomplish the task: multi look beat frequency (MLBF) and wavelength diversity ambiguity resolver (WDAR). The first method is suitable for high contrast images, and is used to retrieve an unbiased absolute Doppler centroid frequency. The second method is good for low contrast scenes but has an important drawback: it provides a biased DC estimation. The biasing constant is called WDAR frequency offset and it has to be estimated independently. In our approach, these algorithms are used jointly to retrieve both the integer ambiguity value and the frequency offset constant (that allows the estimation to be performed also on low contrast scenes acquired from the same orbit). MLBF and WDAR estimations reliability, strongly depends on the way the processing blocks are chosen so a very fine block search process, based on image contrast, has to be performed. In addiction to these statistical methods, a measure of DC frequency absolute mean value is derived from acquisition geometry (being known the sensor yaw-steering law). Depending on the variance of the three measures performed (WDAR, MLBF and geometrical), the most probable integer ambiguity value is chosen.

Abstract No. 221

Co-registration Properties of Burst-mode Data

J. Holzner, R. Bamler
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Burst-mode data are characterised by their flexible structure. This also provides many possibilities for interferometric burst-mode data processing. Two main options for interferogram generation are discussed. For the single burst interferogram formation option individual burst interferograms are formed and then coherently added in order to obtain a swath interferogram. The second method is called multiple coherent burst interferogram. With this option the complex burst images are

superimposed in advance to swath interferogram formation. With this two options also two options for the derivation of the co-registration parameters from the data are available. Estimation accuracy for single burst-mode depends very much on estimation window size. For a window that covers the whole azimuth extend of the burst, the auto-correlation function and, hence, the co-registration estimate have a resolution or standard deviation in the order of the auto-correlation of SAR data that was acquired in strip-map mode. In contrast to this the window sizes used for multiple coherent burst mode co-registration can be relatively small and still co-registration estimates with standard deviation corresponding to the strip-map mode resolution can be obtained. Some care, however, must be taken to remove outliers that occur due to the multimodal auto-correlation function. Since the standard deviation of the cross-correlation estimate depends on the resolution of the SAR data the obtained co-registration estimates have different qualities. For option 1 patches for each burst of the primary and secondary channel are correlated. Then the co-registration results are averaged in order to decrease the standard deviation of the shift estimates.

Abstract No. 355

Ad-hoc SCANSAR Omega-k Processing

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Omega-k focusing algorithm is known as an efficient technique to focus SAR data. Moreover, it is "exact" as long as an ideal straight and flat geometry is assumed. It can be performed by applying an analytical phase term in the omega-k domain and by resampling the resulting spectrum along the omega coordinate (i.e. applying the so called Stolt interpolation). In non ideal, non-stationary geometry, this technique needs to be implemented blockwise, to fit time-varying Doppler parameters. In ScanSAR processing, thinks may be worse due to possible variation of PRF from swath to swath, and the need of a very good radiometric and phase calibration. In these cases the mosaicking of the blocks requires some skill, in order to ensure (1) phase preservation, (2) to spectral registration and (3) time domain registration. We show in the paper the impact on the final image, the implications of these aspect in omega-k processing and Stolt Interpolation, and the way to derive the proper solution even in the case of large Doppler Centroid.

Abstract No. 370

Polarization Dependency in Doppler Frequency Shift and its Application to Envisat ASAR Alt-Pol Data

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It has recently been shown that the Doppler frequency shift (anomaly) in Synthetic Aperture Radar data is highly correlated to the wind field component along the radar line of sight. For coastal areas this anomaly may just as likely be connected to the coastal current component than to the wind, or a mixture between wind field and surface current. The goal of this paper was to investigate the capabilities of dual polarization data to resolve or improve the wind/current retrieval based on SAR Doppler measurements. The idea is that while the contribution from wind is polarization dependent, the contribution from a steady current is polarization independent. It is therefore of importance to model the expected Doppler frequency shift for different polarizations as function of wind speed and imaging geometry (incidence angle). A theoretical framework for using Doppler shift information from SAR measurements for wind/current retrieval is developed and applied to Envisat ASAR Alternating Polarization Mode data. The basis for the development has been the derivation of a general expression of the backscattering model source function, which includes a wide range of incidence angles as well as the effect of surface curvature on polarization responses. Results showing the theoretical computed C-band Doppler frequency shift between HH and VV polarization as a function of wind speed for different incidence angles are presented. At a wind speed of 10 m/s and an incidence angle of 30 deg, a Doppler shift difference (HH-VV) of the order of 10 Hz is predicted. For 25 deg incidence angle the difference is reduced to the order of 4 Hz. We conclude that the difference in Doppler frequency shift between HH and VV polarization is significant, especially at higher incidence angles. The theoretical results are supported by Doppler frequency estimation from Envisat ASAR Alt-Pol data.

Abstract No. 158

Advances in Permanent Scatterer Analysis

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The Permanent Scatterers (PS) technique allows the identification of a sparse grid of radar targets only slightly affected by temporal and geometrical decorrelation. The PS can be exploited successfully for monitoring very different deformation processes, from landslides to tectonic motion. Lately, the technique has been improved in order to cope with: (1) highly non-uniform displacements; (2) identification of radar targets exhibiting PS behaviour only on a subset of SAR scenes; (3) extraction of motion information where two or three dominant scattering centres (rather than a single one) are present.As well known, a polynomial model for the displacement time series is not suitable in areas where strong deformation phenomena occur, e.g. mining areas or water/gas/oil pumping zones. In this kind of analyses, areas affected by severe subsidence or uplift phenomena can be identified, but - usually - PS density is very low and PS time series can show phase unwrapping errors. Whenever the displacement field is spatially correlated (a reasonable hypothesis, not difficult to meet), the so-called "advanced PS analysis" can take advantage of this behaviour: for each PS candidate, phase data are unwrapped with respect to an "a priori" deformation model estimated from the nearest PS. As it will be shown, this allows one to recover much more information and increase significantly the PS density.Special attention has then been

paid to the impact of reflectivity changes (i.e. amplitude values) on PS identification. In this contribution Semi-PS (SPS) and Temporary PS (TPS) are first defined and possible solutions to their detection are proposed with examples coming from real data-sets. Finally, it will be shown how PS density can be further improved applying higher order models for scattering mechanism within each resolution cell. The price to be paid is a much higher computational burden.

Poster Session 2P06:

SAR Signal Processing

Abstract No. 40

Evaluation of a Space Intersection Strategy for use with Stereoscopic SAR Imagery over Developing Countries

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The generation of topographic data from spaceborne stereoscopic Synthetic Aperture Radar (StereoSAR) imagery, requires the use of a precise sensor model for relating image coordinates to object space and involves a process normally referred to as space intersection. The recent launch of the Envisat satellite has augmented the number of sensors available for providing StereoSAR imagery over cloud affected developing countries, such as the Caribbean, where the use of optical or even spaceborne interferometric SAR techniques would be extremely limited. Using the range-Doppler equations and the superior orbital data of the Envisat satellite, this study presents a rigorous strategy for conducting space intersection without the use of costly ground control points. The Caribbean Island of Jamaica will be used as a test case and the results would be compared with those obtained using RADARSAT imagery.

Abstract No. 201

Development and Validation of a Sea Surface Fractal Model: Project Results and New Perspectives

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In 1998, in response to the "Announcement of Opportunity for the exploitation of Envisat data", the University of Pisa together with the University of Pavia and Siena presented a project to the European Space Agency (ESA) entitled "Development and validation of a sea surface model". The aim of this project was to develop and demonstrate the validity and usefulness of a sea surface fractal model [1-3], when applied to ASAR Envisat images. The first two years of the project were funded by the Agenzia Spaziale Italiana (ASI) from 1999 to 2001. Because of the delay in Envisat launch, the project stopped for one year. Now, with the availability of the ASAR end ERS1/2 data, courtesy provided by ESA, the project is restarted.The purpose of this paper is to provide a summary of the main results obtained in the project and introduce the new objectives we are going to pursue. Sea surface is largely demonstrate to have fractal nature [4], [5]. Based on this postulate, the

researchers of the University of Pisa have developed a fractal model of the sea surface [1-3]. The model exploits the fractal properties of Weierstrass surfaces to account for the multiscale structure of the sea and the dispersion effect is also included to model the sea wave motion. The large number of parameters makes the model to be very flexible and able of generating different sea situations spanning from very calm to very rippled sea. A first validation of the model was done by comparing the directional spectrum expression derived from the sea surface model, with the common Pierson-Moskowitz and Jonswap models and with real spectral data collected by the buoy of the Italian Ondametric Network [2]Since electromagnetic sea backscattering retains the fractal properties of the surface [6].[7], it is reasonable to expect the sea SAR image to be a fractal too. According to this insight, the main objective of the project is to define methodologies and algorithms to extract the model parameters from ERS1/2 and ASAR data. The methodologies to be used for this purpose are: 1) Fractal analysis of the SAR images. 2) Sea SAR image spectral modelling and analysis 3) Model parameter estimation from ASAR wave spectra. Fractal analysis consists of estimating the fractal dimension of the sea SAR images. The fractal dimension is a parameter related to the image irregularity, which is strongly dependent on the sea roughness. Three different fractal dimension estimation techniques have been developed in the project: 1) Morphological covering algorithm; 2) Box-counting algorithm; 3) Wavelet-based algorithm. These techniques allow to estimate the fractal dimension of the sea surface SAR images. The results is compared to the sea fractal dimension estimated by analysing the omnidirectional spectrum data obtained by in situ measurements. This procedure is applied both on simulated images and on real ERS1/2 images.A new spectral model of the sea SAR image has been defined. This model is the product of a noise-like omnidirectional contribution, which is common to all the ERS or ASAR sea images, and a fractal part refelcting the fractal nature of the sea. By estimating and compensating the noise-like contribution, the fractal contribution of the sea SAR image spectrum can be used to get the sea surface fractal model parameters. A suitable fitting algorithm, able to extract the sea surface fractal parameters from the directional sea wave spectrum, have been defined. This algorithm can be applied to the ASA_WVW_2P to estimate the sea surface parameters. The ASAR_WVW_2P and the ASA_WVI_1P data are currently in order, therefore, this approach will be verified later.Results on the first two methodologies will be presented at the symposium. Currently, the project aims to extend and exploit the above techniques to extract information on sea surface anomalies (oil slick, natural film, wind fall, targets, ship wakes and other) from the sea SAR image. A few preliminary results will be presented at the workshop. References [1] F. Berizzi, E. Dalle Mese, G. Pinelli, "One-dimensional fractal model of sea surface", IEE Proceedings Radar, Sonar and Navigation, Vol. 146, No.1, pp.55-64, 1999[2] F. Berizzi, E. Dalle Mese, 'A new sea wave fractal spectrum for SAR remote sensing' to IEE Proceedings Radar, Sonar and Navigation, Vol.148, No.2, April 2001, pp. 56-66[3] F. Berizzi, E. Dalle Mese, M .Martorella "A Sea Surface Fractal Model For Ocean Remote Sensing" International Journal of Remote Sensing, Taylor & Francis Group, Vol. 25, No. 7-8, pp. 1265-1270, April.2004. [4] Morrison A.I., Srokoz M.A., 'Estimating the fractal dimension of the sea surface: first attempt', Ann. Geophysicae, 1993.11, pp.648-658[5] Lo T., Leung H., Litva J., Haykin S., "Fractal characterization of sea scattered signals and detection of sea-surface targets", IEE Proceedings-F, 1993, 140, 4, pp.243-250, [6] F. Berizzi, E. Dalle Mese, "Fractal analysis of the signal scattered from the sea surface," IEEE Trans. on Antenna and Propagation. Vol.47, No.2, February 1999, pp. 324-338[7] F. Berizzi, E. Dalle Mese, 'Scattering from a 2D-sea fractal surface: fractal analysis of the scattered signal' IEEE Trans on Antennas and propagation, Vol.50, No.7, July 2002, pp. 912-925.

Abstract No. 253

De-Speckling of SAR Imagery Based on Multi-resolution Analysis: A Comparison of Ml and Map Estimators

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De-speckling filters aim at performing an estimation of the radar reflectivity (signal), based on the speckled image (observed signal). Under Gaussian signals assumptions, the minimum mean square error (MMSE) solution becomes a linear function of the covariance matrices of the signal and of the noise; it is referred to as linear MMSE (LMMSE) filtering [1]. The underlying hypothesis of uncorrelated noise yields a spatial LMMSE filtering, by locally modelling the covariance matrix of the signal [2]. The further assumption of uncorrelated signal variations around its space-varying mean yields the local LMMSE (LLMMSE) filter [1, 3]. The forerunner Lee's filter [4] is nothing but an approximation of the LLMMSE estimator. When non-Gaussianity assumptions are made on the first-order distribution of reflectivity, e.g. a piece-wise constant RCS possibly modulated by a unity-mean piece-wise stationary texture, the LMMSE solution is no longer optimal. Consequently, the LLMMSE solution is a maximum likelihood (ML) approximation of the MMSE estimate. In the non-Gaussian case the MMSE estimator may be formulated as a maximum a posteriori (MAP) estimator [5]. Since SAR reflectivity is non-Gaussian distributed, if the number of looks is not too large, better estimators are obtained, like the Gamma-MAP filter [6], in which the underlying assumption of Gamma-distributed texture allows a closed-form MAP solution to be easily derived. Since one of the problems of SAR speckle filtering is detecting and handling local non-stationarity [7, 8], the geometrical adaptivity of both ML and MAP filters has been improved by splitting the processing window to match local heterogeneities [9, 10].An approach to de-noising that has been only recently formalized consists of taking a transformed version of the noisy image and de-noising in the transformed domain. Since their introduction in the late eighties wavelets have been universally recognized as extremely powerful tools for the analysis of non-stationary signals and images [11]. As an outcome of the wavelet theory, de-noising in the domaindefined by the discrete wavelet transform (DWT) may be stated as a thresholding of DWT detail coefficients of the noisy image, either hard, or soft [12]. The latter implies that the modulus of the thresholded coefficient is diminished by the threshold value. Thresholding, however, yields a maximally smooth estimation, i.e. is a MINMAX solution. In most of signal/image processing applications an MMSE solution is preferable. Furthermore, in wavelet thresholding the noise is assumed to be white and signal-independent.For the case of speckle filtering, homomorphic filtering, in which the DWT of the logarithm of the noisy image is either adaptively thresholded [13], or empirically shrunk in an adaptive fashion [14], has been used. The major inconvenience of such an approach is that the backscatter mean is not preserved in homogeneous areas when the logarithm is inverted after filtering [15]. That is, multi-resolution homomorphic ML filtering is biased. To overcome this drawback, multi-resolution homomorphic MAP filtering was investigated [16].Two alternative approaches are based on pixel ratioing. The former [17] relies on a normalized version of the

wavelet "a trous", i.e."with holes", which is a redundant multi-resolution transformation whose layers have all the same scale. Point-wise normalization is introduced to remove the dependency of the signal-dependent noise on the signal mean, represented by the approximation layer (baseband) containing the lowest frequency coefficients. The latter [18] is based on a Rational Laplacian Pyramid (RLP), obtained by pixel ratioing each layer of a Gaussian pyramid to its coarser version, which is expanded to match the size of its underlying layer. This work has demonstrated that multi-resolution processing is the key to adaptive filtering of signal-dependent noise. In fact, the RLP de-speckling procedure is nothing but an LLMMSE estimator operating in a transformed, yet oversampled, domain in which connected image structures are effectively represented on multiple scales. Estimation of the local statistics driving the filtering is expedited and layered processing allows adaptivity to be extended also across scale, since multi-resolution structures exhibit a signal-to-noise ratio (SNR) increasing with scale. LLMMSE spatial filtering has been recently extended to deal with multiplicative noise and applied to undecimated wavelet frames [19]. The rationale for working in the undecimated wavelet domain is that classical dyadic wavelet decompositions, characterised by iterated filtering and down-sampling, make estimation of non-stationary signal and noise variances critical, due to the missing translation-invariance. Furthermore, when coefficients are changed, e.g. thresholded or shrunk, the aliasing term between two adjacent sub-bands is no longer cancelled during the synthesis stage, thereby resulting in the onset of structured artefacts.The further step is MAP estimation in the undecimated wavelet domain. Apart from the homomorphic approach, in which MAP estimation is applied to undecimated wavelet coefficients of the logarithm of the SAR image [16], few works are found in the literature [20, 21]. The main problem is statistical modelling of wavelet coefficients obtained from SAR images. Starting from the observation that the empirical distributions of detail coefficients are heavy-tailed, such models as beta-complex (Pearson, type IV) distributions [20] and normal inverse Gaussian [21, 16] have been used. However, for a wide class of grey-scale images, detail wavelet coefficients have been shown to be Gaussian distributed with zero mean and non-stationary variance [22]. In that case ML estimation would be optimal in the MMSE sense, because for Gaussian signals MAP and ML solutions are identical [1]. When SAR images are concerned, however, the non-stationary Gaussian model may no longer hold. Hence, benefits of MAP, compared to ML filtering, are expected.In this paper, detail wavelet coefficients of reflectivity and noisy image are modelled as Generalised Gaussian (GG) distributed with zero mean. The GG function is uniquely defined by the variance and by a shape factor ruling the decay rate [23]. The shape continuously changes from impulsive to rectangular passing through Laplacian and Gaussian as the factor varies between zero and infinity. The Gaussian case is obtained with shape factor equal to two. Parametric GG models with different shape factors are tailored to wavelet detail coefficients of both reflectance and speckled images. A MAP solution is analytically derived from statistics calculated in the image domain by exploiting the fact that undecimated wavelet coefficients are given by convolving the image with a linear shift-invariant equivalent filter [19]. Unlike [16], no logarithmic transformation of the speckled image is used. Extensive experiments and comparisons on simulated SAR images demonstrate that, though theoretically and procedurally different, the proposed ML and MAP undecimated wavelet-domain estimators yield comparable SNR results on simulated data, with a computational complexity of the MAP approach several times greater than that of ML filtering. However, on true SAR images (ERS and ASAR) the proposed MAP filter visually outperforms the earlier ML filter developed by two of the authors [19], specifically concerning texture restoration and preservation of point targets. This analysis leads to the conclusion that detail wavelet coefficients of SAR images may not be accurately modelled as Gaussian.[1] S. M. Kay, Fundamentals of Statistical Processing, Volume I:

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Abstract No. 274

Technical Aspects of Envisat ASAR Geocoding Capability at DLR

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[3] Remote Sensing Laboratories, Switzerland

Based on the experience of the geocoding systems for ERS-D-PAF (GEOS), the SIR-C/X-SAR (GEOS) and SRTM missions (GeMoS) geocoding functionality was extended for Envisat ASAR data. The existing Envisat ASAR Geocoding System (EGEO) can handle all Level 1-b image products (IMS, APS, IMP, APP, IMM, APM, WSM and GM1). Complementary to geocoded products provided by ESA (IMG, APG) the geocoding procedure applied at DLR makes use of a DEM to achieve higher geolocation accuracy. The resulting geocoded image can be either an EEC (Enhanced Ellipsoid Corrected) or an ETC (Enhanced Terrain Corrected) product. These products mainly differ in the underlying DEM used for geocoding. The EEC utilizes GLOBE, while the ETC utilizes the "best" DEM available in the data base. This "best" DEM can be assembled from different DEM data sets (e.g. derived from SRTM, ERS, ...). Further differences such as the interpolative (EEC) and rigorous (ETC) geocoding approach will also be outlined. An incidence angle mask can be generated.The necessary upgrades to be able to geocode ASAR stripline products (e.g. IMM, WSM) will be presented. Stripline products cover a large area along track, as they consist of concatenated stand-alone products ("slices"). Thus the updates of relevant parameters have to be taken into account.

Abstract No. 292

Flashing Fields! A Preliminary Investigation

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The launch of Envisat in 2002 and the operation of the ASAR instrument has immediately questioned some important assumptions concerning the nature and stability of radar measurements of soils and vegetation. The key observations concern large localised discrepancies ("flashing") between measurements made by the Envisat ASAR instrument and the ERS-2 AMI, within 30 minutes of each other over Flevoland in the Netherlands. The discrepancies appear not to be related to changing environmental conditions but rather to the fine details of the observing geometries of the two instruments. Such sensitivity is not predicted by the models for microwave interaction usually applied to soils and vegetation. The presence of poorly characterised anomalies of this type may have severe implications for the confidence with which we assimilate satellite SAR data and

consequently we need to improve our understanding of the phenomenon and examine strategies for mitigating its effects.As a first step the "flashing fields" anomalies were carefully characterized. Then the data were analyzed to better understand the observations and suggest explanations for the effects seen. The observed backscatter variation depends on the difference in the imaging geometry used. The highest differences of more than 6dB are observed in the case of ERS-2 data with acquired with very high Doppler centroids resulting in aspect angle differences of more than 1 degree. One "type" of "flashing" is observed for fields with cultivation directions perpendicular to the SAR look vector. Highly directional scattering from long row structures is a possible explanation. Another "type" of "flashing" is observed for fields with cultivation directions clearly not perpendicular to the SAR look vector. The most likely explanation are resonce effects from periodic row structures.An important question addressed is if it is possible to identify such anomalies to the backscattering in a single image. For some "flashing fileds" indications are found in single image spectral characteristics as local Doppler Centroid shifts, the azimuth spectrum width, and the mean-to-sigma ratio of sub-bandwidth "looks images".Finally, the anomalies are placed in a wider context and potential strategies for reducing, eliminating, or avoiding them are discussed.

Abstract No. 390

Applications of Envisat-ASAR Data in Rainy and Cloudy Areas in Southern China

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The Advanced Synthetic Aperture Radar (ASAR) instrument on board the Envisat satellite, operating at C-band, ensures continuity with the image mode (SAR) and the wave mode of the ERS-1/2 AMI. It features enhanced capability in terms of coverage, range of incidence angles£¬polarization, and modes of operation¡£ We analyzed ASAR data application potential taking Zhao Qing of Guang Dong Province in southern china as experimental area which include many kind of ground objects such as building, bridge, forest, ship, grassland and crop. We used two ASAR dataset which are both ASAR alternating polarization precision image over the area in research. One ,acquired on 13 June of 2003, has imaging swath of IS5 and polarization of HH/HV¡£ The other, acquired on 2 July of 2003, has imaging swath of IS7 and polarization of VV/HH¡£We derived the backscattering coefficients of main ground objects in the images and classified the crops based on the combination of these images. The results show that different ground objects in experimental area have distinctive and different characteristics of backscattering coefficient in the images, and multi-temporal and multi-incidence angle of ASAR data can improve the crops and other ground targets discrimination. This means that ASAR data can find a wide application in crop growth monitoring in rainy and cloudy areas.

Abstract No. 466

Sensitivity of Topographic Roughness on Interferometric SAR Data Coregistration

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Coregistration is a crucial step in interferometric SAR data processing which influences the quality of all consecutive products. Traditionally, the (complex or amplitude) correlation of the two data sets is evaluated in a number of windows distributed over the scene, searching for maximization of the estimated correlation as a function of local offset parameters. After determining the offset parameters for every window position, a polynomial function is evaluated to determine the actual offset for every pixel needed for the resampling of the slave image. Both the windows approach and the polynomial evaluation introduce errors in the resampling. First, in the windows approach, only at the window positions the offsets are evaluated. This implies that rough terrain with a large range in altitude will be suboptimally sampled leading to suboptimal results in the coregistration. Second, the polynomial approach requires choosing the polynomial order. In general, for a smooth terrain a low order resampling polynomial might be sufficient, whereas a rough terrain might require a higher order approximation. A suboptimal choice will either lead to a description which is too smooth or which shows overshoot, both affecting coregistration quality.Moreover, in general, the terrain may even be non-stationary. In this paper we investigate these effects, their influence on interferogram quality, and suggestions for improvement. Specifically, we compare the results of the data-only methods with methods using additional sources of information such as an a-priori DEM in combination with precise satellite orbits, as suggested by Adam et al. (2003).

Abstract No. 473

Automatical Geocoding of Envisat ASAR Products

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In automatical system for geocoding and calibration of Envisat ASAR products have been developed by NORUT IT in the Envisnow EC EESD FP 5 project using data from ESA AOE 785 and near-real time data from Kongsberg Satellite station. The software is adapted to the Envisnow snow covered area processing system, and works automatically for specified modes from the Envisat ASAR modes IMP, IMS, WSM, APS and APP and the ERS modes (SLC and PRI). The tools are mainly implemented in the program languages Envi/IDL under a common framework. The output is a geocoded and calibrated SAR image on a selected projection. The system is used as a module in the Envisnow production line to provide high quality geocoded SAR imagery for snow cover area classification.Most data from ESA PAF's are geocoded automatically. The accuracy of

the geocoding is estimated to be on average to be less than 1 pixel (30 m for image modes and 100 m for wide swath) by cross correlation with simulated SAR imagery based on DEM. Due to bad quality orbit data or poor SAR processing from some PAF's, a new correction algorithm has been implemented. The algorithm is based on using the first order geocoded product based solely on orbit parameters and DEM together with the simulated SAR image. The algorithm then picks a number of control points automatically by cross-correlating sub-images of the two products. This is subsequently used to update orbit parameters before the SAR scene is geocoded again. The method will be demonstrated and the quality assessed.

Abstract No. 573

Construction of the Ocean Surface from SAR Images

W. Koch, W. Rosenthal
GKSS Research Center, Germany

For the research on extreme waves construction of the ocean surface is of great value. Such a construction is possible from SAR images, because the brightness of the radar image is influenced by the incidence angle of the radar beam. By resolving this dependency, SAR images can be transformed in images of slopes in range direction. Images of the ocean surface result after integration of the slopes and spectral filtering. The relation between normalized radar cross section, incidence angle, and wind speed and direction is taken from the empirical C-band model function CMOD4, that was developed for the ERS scatterometer and is also used for derivation of wind speed from SAR images. First results suggest that this approach could be successfully persued.

Abstract No. 598

Extraction of Weak Internal Wave Modulation from an Envisat ASAR Image by EMD with a Simple Boundary Processing Technique

K. Zeng, M. He, M. Fang
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The modulation of internal waves in an Envisat ASAR image acquired over the East China Sea in 2003 May is considered. The modulation is so weak that it is hard to do further analysis by common data processing methods such as FFT, wavelet and so on. Empirical Mode Decomposition (EMD) firstly proposed by Huang et al. in 1998 shows remarkably effective in analyzing nonlinear signals. It adaptively represents nonstationary signals as sums of zero-mean AM-FM components by iteratively conducting the sifting process. While, how to determine the boundary conditions of the cubic spline when constructing the envelopes of data is the critical issue of the sifting process. A very simple but effectual boundary processing technique is presented in this paper by which the

EMD is conducted fluently without any assumptions of the processed data. The weak modulation of internal waves is extracted successfully from the Envisat ASAR image by EMD with the simple boundary processing technique.

Abstract No. 694

Application of Precise Correlation Techniques with SAR, ASAR for Seismic Fault Slip Detection: A Complement to Interferometry - Two Case Studies

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Precise correlation techniques can be applied to SAR or ASAR co-seismic pairs for the purpose of fault mapping and fault slip measurement. Being based on speckle tracking or on coherence maximisation, speckle conservation is a prerequisite for the applicability of these techniques. Interferometric conditions and short baselines are therefore required. Compared to interferometry, precise correlation techniques represent an interesting complement, allowing for azimuth shift measurement (sensitivity to north-south slip component) and for displacement mapping where too-high phase gradient would prevent phase unwrapping or fringe observability (fault vicinity). This is shown in two case studies, representative of east-west and north-south oriented fault segments: (1) application of the speckle-tracking technique to ERS SAR co-seismic acquisitions for the Izmit earthquake of August 1999; (2) application of coherency maximisation to Envisat ASAR co-seismic acquisitions for the Bam earthquake of December 2003.

Tuesday 7 September
10:50 – 12:30

Mozart 1-2

Session 2B2:

Coastal Studies (1)

Abstract No. 223

Investigation of the Temporal Development of Pigment-concentration in the Baltic Sea with MERIS Data

H. Krawczyk, A. Neumann, B. Gerasch
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For many questions of the coastal zone management the knowledge on the biological and ecological state of coastal waters is of high importance. Due to the complexity of this water type, characterized by different classes of constituents, a sophisticated methodology needs to be applied for quantitative remote sensing.Within the MAPP-Project (MERIS Applications and Regional Products Project) a specific remote sensing interpretation algorithm was developed for the regional assessment of water constituents in the Baltic Sea. This is a part of the ESA Cat-1 proposal ID 1413 GEMEL-3 ("Generation of MERIS Level-3 products for European multidisciplinary regional applications"). The operational implementation in a MERIS-value-adding system allows a near real-time estimation of chlorophyll, sediment and gelbstoff concentrations on a regular (daily) basis. The algorithm, basing on a principal component inversion technique and the model will be briefly introduced. Examples of model validation will be demonstrated on a number of comparisons of MERIS reflectances and in-situ measurements. The potential of the model shall be demonstrated on the analysis of available MERIS data. A time series of chlorophyll concentrations of the area will be demonstrated and put a first statistical analysis.

Abstract No. 706

Validation of Optical Satellites Data Based on Traditional Methods and Use of Data from Ships of Opportunity

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This paper describes the activities and results from Norwegian waters concerning validation of optical satellite sensors, based on traditional validation campaigns and use of data from ships of opportunity (ferrybox-systems). The introduction of earth observation products in modern environmental monitoring has clearly showed its use, but also limitations. Validation of geophysical products and development of local algorithms and higher level products are of crucial importance to succeed in introduction of earth observation in environmental monitoring. In situ data from ship of opportunity to validate earth observation data, and development of new products are investigated in Norwegian and European marine water through national and EU-funded projects. The possibility of using ships in fixed routes as a platform for measuring optical quantities and collecting water

samples during satellite pass would significantly increase the number of validation data. Optical sensor data such as chlorophyll-a fluorescence, turbidity, downwelling irradiance and water leaving radiance are candidates for validation of MERIS marine products, as well as geophysical quantities derived from water samples. Results from comparisons of ferrybox data and MERIS data and the possible introduction in long term monitoring will be presented.

Abstract No. 211

Validation of Chlorophyll Fluorescence in Coastal Waters Derived from MERIS

J. Gower, S. King
Institute of Ocean Sciences, Canada

MERIS on Envisat provides images of above-atmosphere spectral radiance in bands at 665, 681 and 709 nm. These bands were included in the baseline spectral band set to allow detection of the fluorescence signal from surface chlorophyll in sea water, stimulated by ambient sun and sky light. We present images of fluorescence as derived from the level 1 MERIS data that show significant patterns in coastal waters of western Canada. We compare the signal levels of the fluorescence with measurements of extracted chlorophyll from research cruises during 2002 and 2003, with satellite estimates of chlorophyll from the blue to green ratio observed by MERIS, MODIS and Seawifs, and with fluorescence measurements made by MODIS. We show that the fluorescence signal is consistent between MERIS and MODIS, and that relation between fluorescence and chlorophyll concentration in surface waters is consistent with a simple model accounting for absorption of stimulating and emitted radiation by chlorophyll pigments. Considerable scatter is observed, suggesting variable fluorescence efficiency and effects of coloured dissolved organic matter.

Abstract No. 629

Determination of the Confidence Range of Coastal Water Products Derived from MERIS Data

R. Doerffer, H. Schiller
GKSS Research Center, Germany

The success of the retrieval of concentrations of coastal water constituents from multispectral reflectances depends on a number of factors. In particular variable compositions and optical properties of the substances may lead to concentration errors, which vary from pixel to pixel. As an extension of our neural network coastal water algorithm, we have implemented a procedure to determine at least part of this retrieval error and to provide a confidence map along with the concentration maps of phytoplankton chlorophyll, suspended matter and gelbstoff. With this

procedure we firstly determine if the reflectance spectrum is within the scope of the algorithm. In a second step, an optimization procedure is used together with the forward neural network to determine the concentration range for each water component, which produces the same or a similar reflectance spectrum. Using this method MERIS data of different water types - from turbid estuarine water to open ocean water - have been analyzed. Variable and sometimes large errors demonstrate that a confidence map is an important additional information to the user of MERIS coastal water products.

Abstract No. 663

From SeaWiFS to MERIS: Great Barrier Reef Lagoon Case Study

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An empirical-analytical bio-optical model for a coastal region in the vicinity of the Herbert River (Central Great Barrier Reef) was developed, which relates satellite-derived (SeaWiFS) optical properties to physical and biological parameters of the surface waters of the region. The model was verified using sea-truth data collected during field studies in 2002-2004. The dynamics of Herbert River plumes observed from the space helps in understanding whether sediments and pollutants coming from the river reach coral reef ecosystems. The extent of elevated surface suspended sediment concentrations, as observed from the satellite, correlates well with the peaks in Herbert river discharge.With a spatial resolution of 300 m and 15 spectral bands, the new European ocean color sensor MERIS is better designed for coastal waters. The first 6 months of MERIS coastal ocean products have been compared to corresponding SeaWiFS data for our region of interest. Three cloud-free days with corresponding in situ measurements enabled us to both compare and validate each instrument. The regional bio-optical model performed better than case 2 MERIS algorithm. This can be explained by the fact that MERIS algorithms are based on averaged coastal waters properties, which are known to vary widely. More in situ validation data is needed in order to ensure continuity of accurate ocean monitoring using remote sensing techniques.

Tuesday 7 September Wolf-Dietrich 1-2

Poster Session 2P07:

Coastal Studies

Abstract No. 8

Mapping Coastal Aquaculture and Fisheries Structures by Satellite Imaging Radar

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Inventory and monitoring of coastal aquaculture and fisheries structures provide the necessary baseline data for decision-making on aquaculture and mariculture development, including regulatory laws, environmental protection and revenue collection. Mapping these structures can be performed with good accuracy and at regular intervals by satellite remote sensing, which allows observation of vast areas, often of difficult accessibility, at a fraction of the cost of traditional surveys.Satellite imaging radar (SAR) data are unique for this task not only for their inherent all-weather capabilities, very important as aquaculture and mariculture activities mainly occur in tropical and subtropical areas, but essentially because the backscatter from the structure components allows for their identification and separation from other features.The area selected and object of the study has been Lingayen Gulf , sited in Northwestern Luzon Island, the Philippines, where all these structures of interest occur.Field verification of the methodology resulted in the following accuracy: fishponds 95 percent, fish pens 100 percent. Mapping accuracy for fish cages was estimated at 90 percent and for fish traps at 70 percent.The study is based on interpretation of SAR satellite data and a detailed image analysis procedure is described. The report aims at the necessary technology transfer for an operational use of the approach indicated in other similar environments.

Abstract No. 31

Polarimetric SAR Image Signatures of the Coastal Ocean

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Polarimetric signatures of the coastal ocean have been studied using numerical modells, Envisat ASAR and SIR-C/X-SAR images. Particular attention has been given to the polarimetric properties of radar backscatter from the coastal features associated with sea bottom topography and internal waves. The optimal SAR polarimetric parameters for coastal ocean observations are discussed.

Abstract No. 59

Radar and Optical Observations of Oceanic and Atmospheric Phenomena in the Black Sea Shore Area

O. Lavrova, M. Mityagina, T. Bocharova

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This work presents the results of analysis of the ERS-SAR and Envisat ASAR images of the Black Sea shore area which are at our disposal in frame of the AO3.224 and C1P.1027 projects.Summer/autumn concurrent experiments conducted for the past four years by Space Research Institute RAS near Gelendzhik, Black Sea shore, allowed to closely monitor sea and atmosphere dynamics in the region. Over 35 ERS-2 SAR and 3 Envisat ASAR images obtained exhibit large variety of important phenomena: atmospheric and oceanic fronts, pollution and other slicks, atmospheric convection, vortices, lee patterns, etc. Available extensive data covering all-year sea state, NOAA data and hydrometeorological condition help to adequately interpret SAR signatures. The focus is on three phenomena: a strong storm occurred in June 2001 as mirrored by SAR imagery and combined with concurrent buoy measurements; vortices which are a frequent occasion in the 100-km coastal zone where north-western current predominates; lee structures in the atmosphere downwind from the coastal ridge and their dependencies of their growth rate and spatial characteristics on wind speed and direction, medium stratification and surface wave strength.The analysis shows that slicks produced by surfactants of various origin and found in great quantities in the studied area are a good means of imprinting oceanic vortex structures in radar images. Even very small vortices, 2-10 km in size, can be detected by satellite radar in the presence of slicks while neither ship nor satellite optical instruments are capable of that. Such small-sized vortices play an important role in water circulation and mixing in the region. A complicated mountainous relief of the shore is a constant source of atmospheric vorticity above the sea surface. Under certain conditions, radar images can imprint so-called lee structures in the atmosphere. They emerge downwind rocks and from narrow canyons opening to the sea. We discuss an example of a mushroom flow detected in one of the images.

Abstract No. 148

Evidence of the West Sakhalin Current in ERS-2 and Envisat Co-located SAR images

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Collocated ERS-2 SAR and Envisat-1 ASAR images acquired on 4 October 2003 with time difference of about 28 min have trapped the West Sakhalin Current (WSC) during its maximum intensity. The current was observed as a narrow strip (width of about 15 km) which was adjacent to the northwestern Sakhalin coast. Backscatter contrasts in the convergence region between the

Tsushima Current and the WSC reached 20 dB. Such contrasts were due to the combined effect of the sea surface temperature difference and wave-current interaction in the convergence and shear zones. The surface manifestations of the several packets of internal waves were clearly visible in the southeastern part of the Tartar Strait and in La Perouse Strait. Transformation of the internal wave packets is noted near the WSC's boundary. Time delay between ERS-2 and Envisat observations allowed us to reveal the areas of the increased dynamic activity and estimate quantitatively the surface current velocity on the northern Sakhalin shelf.

Abstract No. 153

Intercomparison of Satellite Derived Products over Coastal Waters in the SISCAL Project

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The SISCAL project, funded by the European Community, aims at promoting a friendly use of the Earth Observation for end users concerned by monitoring the water quality for coastal areas and inland waters. The data processor shall be a generic tool, which may be applied to a large variety of operationally gathered satellite data. In order to ensure the compatibility of the same products derived by different ocean colour sensors (MERIS, MODIS, SeaWiFS), the same chain of algorithms has been applied to this set of satellite sensors based on the similarity of spectral bands (actually, transforming MERIS and MODIS into a SeaWiFS like sensor). We will first present the different modules of the SISCAL processor which start with level 1-b. On selected areas, we will then conduct an inter comparison exercise between sensors on the SISCAL level 2 products as well as on the regular products distributed by the Space Agencies.

Abstract No. 212

A New Way of Detecting Intense Plankton Blooms Provided by MERIS

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MERIS can be used to detect a peak in the optical spectrum of water-leaving radiance at about 705 nm which provides a signature of intense plankton blooms. Such blooms (colloquially called "red

tides") are becoming an increasingly important phenomenon in coastal waters, and can cause significant financial losses to aquaculture. The blooms can colour surface waters over large areas and can therefore be imaged from space. In many cases, however, satellite sensors confuse the blooms with other suspended material in water or signals from clouds or aerosols. We present examples of this signature in images and spectra derived from MERIS data, and demonstrate how this signature arises using model results. The MERIS band at 709 nm, which is an essential part of this detection scheme, is not present in either Seawifs or MODIS. In many cases the higher spatial resolution (300 m) provided in the FR mode of MERIS data is important for detecting small area events. The combination of wide area coverage, 300m spatial resolution, and appropriate spectral bands makes MERIS a unique and potentially important tool for global, intense plankton bloom monitoring.

Abstract No. 230

River Plume Slicks and their SAR Imagery

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It is known that surfactant materials, either of biogenic or anthropogenic origin, accumulated on the sea surface are distributed non-uniformly and form slicks due to enhanced damping of short wind waves. Slicks are characterized by different geometry, and can be considered as tracers of different oceanic and atmospheric processes and have become a very efficient tool for the ocean remote sensing specially by synthetic aperture radars (SAR). An important process that affects significantly the dynamics of coastal waters is river outflows and associated river plumes. Radar signatures of river plumes were described previously in the literature mainly as curved "horse-shoe" bright fronts. The fronts were explained as a result of wave/current interaction leading to amplification of wind waves and their possible breaking in convergent zones, where a river outflow meets the marine water. In some radar images, however, river plumes were observed as dark areas either confined or not by the bright 'horse-shoe' boundary. One may expect then that surfactant films are transported to the ocean by river outflows and are accumulated due to the current convergence in the river plumes. The transport of surfactants, therefore, can be monitored using radar observations of river plumes. Here we report on satellite and 'in situ' observations of the Douro River Plume on the Iberian Shelf carried out on November, 15, 2000. An ERS-2 SAR imagery of the plume showed the occurrence of both a "horse-shoe" bright front and a large slick inside. Quasi-simultaneously to the satellite overpass, sampling of surfactant films from the river plume slick and from outside the slick was performed using a net method. Physical characteristics of the films (the surface tension coefficient and the film elasticity) were carried out in laboratory conditions using a specially developed parametric wave method. It is obtained that the film elasticity parameter increased strongly in the plume slicks compared to the nonslick area. The damping degree (contrast) was estimated from a model of wave damping using the film elasticity values obtained from the experiment. Theoretical radar contrast values are shown to be in agreement with SAR data. Analogous results of simultaneous SAR and field studies of Teighmouth river plume are described.

Abstract No. 412

The SISCAL Service - Implementation and User Evaluation

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In principle, there exists a significant demand for Earth Observation (EO) data products on aquatic ecosystems, both with public authorities and non-governmental organisations (environmental protection, emergency management, natural resources management, regional planning, etc) as well as private companies (tourist industry, insurance companies, water suppliers, etc). However, for a number of reasons, most of the data products that can be derived in this respect have not yet left the scientific community.The goal of the EU-funded project SISCAL (Satellite-based Information System on Coastal Areas and Lakes) is to develop a service providing potential users with a simple and user-friendly access to EO-derived data products. SISCAL aims such at contributing to closing the gap between EO data providers and research institutions on one side and the actual end users on the other side. The SISCAL data products shall be tailored to individual users' needs, and, where possible, be delivered in Near-Real-Time (NRT).The project has started in September 2001. Meanwhile, an operational system has been set up providing simple and comfortable access to a number of harmonised data products (CHL, TSM, K490, SST) from five satellite instruments (AATSR, AVHRR, SeaWiFS, MERIS, MODIS). Product ordering and retrieval is user-driven ("on demand") and entirely done over the internet. SISCAL data products are either visualised on-line through a web-mapping tool or analysed off-line using a commercial off-the-shelf Geographical Information System (GIS) adapted to the needs of the target user groups. Target users have meanwhile tested the system and have come up with a number of recommendations to increase the usefulness and acceptance of the SISCAL service.The present article describes the actual state of the SISCAL service, and its perspectives for the next future.

Abstract No. 496

DISMAR: Data Integration System for Marine Pollution and Water Quality

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The main goal of DISMAR is to develop a distributed system for monitoring and forecasting of the marine environment, integrating data from various observing platforms and modeling systems. This distributed system will be used to improve the management of natural or man-made pollution crises in the coastal and ocean regions of Europe, supporting public administrations and emergency services responsible for prevention, mitigation and recovery of crisis such as oil spill pollution and harmful algal blooms. DISMAR will provide a single entry point, via a web portal, to several services delivering satellite data and other observations as well as model results, conforming to international standards for both metadata and data. A prototype decision support system (DISPRO) is being developed, for integration and distribution of multi-source data and results from numerical models. The DISPRO architecture is consistent with INSPIRE's general model of an SDI (Spatial Data Infrastructure). DISPRO is a multi-tier system with four main groups of components: user applications, geo-processing and catalogue services, catalogues and content repositories. Implementation is based on INSPIRE, OpenGIS and W3C standards, using Open Source software where available. Metadata plays a central role in DISPRO. All data products and services are described in an accompanying metadata file. The latter is a profile of the ISO 19115 geographic metadata standard restricted mainly to the core 'discovery' metadata elements. Metadata are provided in XML format, validated against an XML Schema. The metadata are stored in a native XML database and transformed to HTML for presentation using XSLT stylesheets. The DISPRO system will be demonstrated in six coastal zone and ocean areas in Europe where Web Map servers are installed: (1) North Sea / Skagerrak area, (2) German coast, (3) coast of Italy, (4) coast of France, (5) coast of UK. and (6) South-West Ireland. Users will get online access to a number of EO (Earth Observation), in situ and model data and products. Satellite ocean colour data and SAR images will be used in combination with FerryBox data, oil drift model and ecosystem models to show how algae blooms and oil spills can be monitored and forecasted. Aircraft observations using infrared and ultraviolet sensors and coastal radar will be used to observe water quality parameters on local scale. Users in each of the demonstration areas will be involved in testing and evaluation of the distributed system.

Abstract No. 552

Synergy of Numerical Modeling and Envisat MERIS for an Operational Suspended Particulate Matter Transport Model

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Monitoring and modeling of suspended particulate matter (SPM) is an important task especially in coastal environments. Several SPM models have been developed for the North Sea. However, due to waves in shallow water and strong tidal currents in the southern part of the North Sea, this is still a challenging task. In general there is a lack of measurements to determine initial distributions of SPM in the bottom sediment and essential model parameters e.g., appropriate exchange coefficients.In many satellite borne ocean color images of the North Sea a plume is visible, extending from the southeast coast of England towards the northeast into the North Sea. The intensity and length of the plume depends on the wave and current climate as well as their history. It is well known that the SPM plume is especially obvious shortly after strong storm events.In this paper an operational 3D SPM transport model of the North Sea is presented, which was improved utilizing the synergy of satellite borne ocean color data and numerical modeling. The model is so far the only model, which is able to reproduce the temporal and spatial evolution of the plume intensity. The results of the numerical model are compared to SPM surface concentrations retrieved from Envisat MERIS data under different oceanographic and meteorological conditions. The results will be discussed with respect to the tuning of model parameters as well as assimilation purposes in long-term model runs.This work was performed within the ESA data grant BIGPASO (AOE-220).

Abstract No. 631

Determination of Parameters from Envisat Data for Estimating Primary Production by Phytoplankton in Coastal Waters

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Coastal regions under fresh water influence (ROFI) belong to the most productive marine areas due to the steady input of nutrients from rivers. Here the primary production (PP) by phytoplankton is mainly determined by the light available for photosynthesis (PAR). PAR in the water column in turn depends on a number of factors, including cloud conditions, water depth, stratification and depth of the upper mixed layer, turbidity and on the attenuation by phytoplankton itself. Furthermore, the water temperature is an important physiological factor. Nearly all of these variables can be derived from Envisat data. During the project ENVOC (Envisat Oceanography) we have developed a scheme to determine the primary production for the area of the German Bight (North Sea) by using data of the chlorophyll concentration and irradiance attenuation from MERIS, PAR at the surface from time series of METEOSAT data, water temperature from AATSR and the occurrence of stratified water from wind and temperature time series. These data are combined using a primary production model together with measurements of the PAR - PP relationship. The significance of each of these variables have been analyzed. In particular the high SPM concentrations have a strong influence on the production. Maps of PP derived from Envisat data demonstrate the high variability in coastal zones, which is mainly due to the variability of the light field.

Abstract No. 633

Status of Operational Demonstration of COASTWATCH Coastal Oceanographic and Hydrologic Applications of Envisat ASAR Imagery

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The goal of this project is to develop coastal and marine applications of Envisat Advanced Synthetic Aperture Radar (ASAR) data and then demonstrate these applications in an operational environment. Applications include surface winds, automated vessel detection, oil spill detection, and river ice monitoring. This project builds upon product development accomplished with ERS-1/2 and RADARSAT-1 data and upon a successful near-real-time applications demonstration conducted in Alaska since 1999 (the Alaska SAR Demonstration or AKDEMO). High-resolution ocean surface winds derived from ASAR data using wind directions from meteorological forecast model winds and wind-aligned features in the SAR imagery itself are being developed and compared with National Oceanic and Atmospheric Administration (NOAA) meteorological buoy winds in Alaska and for the East Coast of the United States. Similar comparisons with RADARSAT-1 data yield root-mean-square errors of less than 2 m/s. Vessel positions derived from ASAR imagery using a constant false alarm rate algorithm are also being developed and evaluated against known locations of oil platforms in Cook Inlet, Alaska. This algorithm has been evaluated in the past by finding fishing fleet locations in the Bering Sea crab fisheries. With RADARSAT-1 SAR data, approximately half of the vessels participating in the crab fisheries are detected. These algorithms primarily use the ASAR Wide Swath mode; however, the Alternating Polarization mode is also being tested. In addition, Alternating Polarization data are being evaluated for: improvements in techniques for oil spill detection, mapping, identification, and tracking; improvements in techniques for analysis of ice condition and change during spring river ice breakup; and improvements in techniques for detection and mapping of current fronts and river plumes. Geographic regions under study include selected regions of the Atlantic Ocean, Gulf of Mexico, and the waters around Alaska. This paper covers primarily the applications development effort for this project. The applications demonstrations are scheduled for 2005.

Abstract No. 702

Distribution and Flux of Suspended Matter in the Wadden Sea Investigated withOptical In-situ Measurements and Remote Sensing

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The Wadden Sea is a highly dynamic tidal flat system in the south-eastern North Sea influenced by open marine and on-shore processes. Physical, biological and geochemical conditions in the water column differ with tide, day and season. One of the goals of our Wadden Sea Research project is to characterise and quantify particulate matter in the tidal flats, and to investigate the processes, which control the particulate matter flux between open sea and backbarrier tidal flats.

Besides temperature, salinity and geochemical parameters, optical methods can provide a specific information on suspended matter, but also on organic seawater constituents which are responsible for aggregation of small particles. This includes:

- multispectral transmissometry from which the amount of suspended particles, gelbstoff and phytoplankton is retrieved based on an inverse model using their optical properties,
- fluorescence of phytoplankton and gelbstoff, to and dissolved and or Its physical, biological and geochemical properties differ with tide, day and season. Our investigation is aiming at the characterization and quantification of the dissolved and particulate matter and its balancing.
- daylight reflectance measured with multispectral radiometers.

The imaging spectrometer MERIS on the satellite Envisat allows to investigate suspended matter in the Wadden Sea with an island and backbarrier basin resolving capability. MERIS data are compared with the locally measured optical in situ data to validate its results, and to apply the MERIS images for studying suspended matter budgets on larger scales.

Tuesday 7 September
10:50 – 12:50

DOPPLER

Session 2B3:

Atmosphere Overview (2)

Abstract No. 668

Atmospheric Effects Due to the October-November 2003 Solar Proton Event as Observed by MIPAS/Envisat

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The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) isa high-resolution limb sounder on board the Envisat satellite,successfully launched on March 1, 2002. MIPAS measures the atmosphericemission in the 4.15-14.6 um range with a spectral resolution of0.05 cm-1 (apodised). The instrument scans the limb operationallyfrom 6 km up to 68 km with a near-global latitude coverage both at dayand nighttime. From MIPAS spectra many atmospheric constituents areretrieved, including O3, H2O, CH4, CO, and nitrogen oxides (NOand NO2). MIPAS spectra are analyzed at different institutions, eachoperating its own data processor, including the ESA operationalretrieval model (ORM). Here we present the results obtained by using theIMK-IAA retrieval scheme, which includes non-LTE processes. We show inthis paper the significant depletions measured in O3 t highlatitudes above 40 km after the solar protons events of 28th October and4th November 2003. Depletions are also observed in water vapour and asmall reduction in methane. The temporal evolution of decreases in O3is shown, with larger reductions in the upper stratosphere during thefirst days and then moving to lower altitudes in subsequent days. Thetemporal evolution of NOx (NO+NO2) is also shown. Increases oflower mesospheric NO2 of over 50 ppbv were measured by MIPAS. Thesimultaneous measurements of such a large number of atmospheric species,with global coverage, obtained by MIPAS constitute an unprecedenteddataset to study the atmospheric effects caused by large solar protonevents.

Abstract No. xxx

GOMOS Results: An Overview

J.-L. Bertaux

Service d'Aéronomie du CNRS

(not available)

Abstract No. 502

Validating and Improving GOMOS Inversion Algorithms (AO NORM)

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The GOMOS instrument measures ozone and other trace gas profiles atabout 400 different geographical locations during one day. Before thelaunch of Envisat it was expected that GOMOS could measure profiles between18 km and 100 km. The first real measurements revealed thatGOMOS was able to perform measurements as low as 5-10 km when using the brighteststars. However, at such low altitudes the retrieved constituentprofiles were very noisy. Also, the NO2 and NO3 profiles turned out toinclude more noise than expected because of the uncorrectedscintillations. As a remedy some smoothness for the retrieved profiles is nowrequired. An additional special feature of GOMOS is that thevertical resolution of the measurements varies strongly depending onthe geometry of the occultation measurement. The smoothness prior is therefore realized by implementing amodification of the standard Tikhonov-type regularization tailored tothe changing measurement geometry of GOMOS. The amount of smoothingis altitude dependent and is chosen according to the targetresolution. The improvement of this modification compared to theoriginal processing is clear.In addition, as a separate part of AO NORM we have validated thenonlinear GOMOS inversion using the Markov chain Monte Carlo technique which allows computing the full nonlinear solution.

Abstract No. 510

Temperature and Ozone Profiles from GOMOS in Comparison to CHAMP, MIPAS Operational GOMOS Ozone and ECMWF Analysis Data

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The Envisat platform, in orbit since March 2002, carries several instruments important for monitoring Earth's atmosphere, oceans, land, and ice.Amongst those the Global Ozone Monitoring by Occultation of Stars (GOMOS) instrument is dedicated to perform high-accuracy altitude-resolved global ozone monitoring as well as measurements of other atmospheric trace gases and of temperature. Measurements are carried out within an altitude range of about 15 to 100 km.We present results of a GOMOS temperature profile retrieval compared to CHAMP, MIPAS and ECMWF analysis data. A second focus lies on the presentation of GOMOS ozone profiles, determined from GOMOS transmission data, validated against operational GOMOS ozone profiles and ECMWFanalysis data.GOMOS temperatures are gained by exploiting pointing data of the

Steering Front Assembly (SFA) and the Star Acquisition and Tracking Unit (SATU), which provide information on the refraction of the star light in the atmosphere and thus allows to derive refractive bending angle profiles. The bending angle profiles are then converted via refractivity and pressure profiles to temperature profiles.According to the SFA sampling rate and retrieval algorithm requirements we performed the retrieval at 10 Hz including down-sampled SATU data from 100 Hz. Bending angles were found with errors of $\sim$3μrad. Statistical optimization of observed bending angles with model bending angles was used to provide adequate data quality for the Abel transform from the stratopause region upwards, which led to a significant gain in temperature retrieval accuracy up to 40 km height due to suppressed downward propagation of errors induced by Abel transform and hydrostatic integral.Together with the SFA/SATU-based refractivity and temperature retrieval, we developed an optimal estimation retrieval scheme forozone using sensibly selected channels from the Spectrometer A transmission spectra within 260-340 nm and 602-634 nm. As a side product, NO$_2$, is retrieved as well, which is also a factor in the discussion of ozone depletion and stratospheric temperaturechange.A comparison to co-located sets of CHAMP GPS occultation profiles, Envisat/MIPAS temperature profiles and analysis profiles of the European Centre for Medium-range Weather Forecasts (ECMWF) will be discussed. All three comparison sets show errors below 2 K from 20 km up to 40 km.Below about 20 km the accuracy of GOMOS bending angle data is degraded, which leads to biases.Ozone profiles were found with errors < 1.5\% from about 25 km to 70 km. From 15 km to 25 km and for altitudes between 70 km and 80 km errors of < 3\% were found. A benefit of the GOMOS Spectrometer A ozone retrieval, from use of SFA/SATU-based refractivity profiles improving ray-paths and Rayleigh absorption cross sections in the forward model, will be highlighted.In a future add-on to the present analysis, SFA/SATU temperature data will also be compared to newly processed high resolution temperature profiles (HRTP) from GOMOS fast photometer data.

Abstract No. 516

Ozone Distributions in the Arctic Winter/Spring 2002/2003 as Measured by GOMOS, MIPAS, and SCIAMACHY

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The three atmospheric Envisat instruments GOMOS (Global Ozone Monitoring by Occultation of Stars), MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) and SCIAMACHY (Scanning Imaging Spectrometer for Atmospheric Chartography) are all measuring stratospheric ozone profiles while SCIAMACHY also measures total ozone columns and includes tropospheric information. The ozone measurements of the three instruments complement each other: MIPAS measures during day- and night time while SCIAMACHY is only measuring during daytime and GOMOS only during night and twilight time. MIPAS and SCIMACHY ozone profile have a coarser resolution of about 3 km, but GOMOS has a resolution of around 1 km. In this study, ozone measurements from SCIAMACHY are taken from the operational total column product provided by ESA and from the University Bremen ozone profile retrieval by C. von Savingy; GOMOS ozone profiles are from the ACRI prototype processor and MIPAS ozone profiles from the operational

ESA processor. The information on ozone distributions in the Arctic winter/spring 2002/03 is intercompared and synthesized in order to retrieve a complete picture on the ozone chemistry. In addition, first estimates on chemical ozone loss calculations within the polar vortex are presented.

Abstract No. 433

UPAS/GDOAS 4.0: a Major Upgrade of the ERS-2 GOME Total Ozone Operational Processor

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The Global Ozone Monitoring Instrument (GOME) was launched in April 1995. Since July 1995 the GOME Data Processor (GDP) retrieval algorithm has processed operational total ozone amounts. With nearly one decade of continuous high quality operation, GOME has become a key instrument for total ozone trend analyses. However this requires that the accuracy of the retrieval reaches a level that enables the detection of a change of 1% in the ozone column over a period of 10 years, a precision not reached by earlier versions of GDP including the latest version 3.0. Here we present a major upgrade of the GOME operational processing environment (UPAS/GDOAS 4.0), which implements the GDOAS retrieval algorithm. GDOAS was developed under ESA/ESRIN funding during 2003 and selected in early 2004 for implementation in the GOME Level 1-2 operational environment. It is based on an optimised approach to the classical Differential Optical Absorption Spectroscopy (DOAS) method, which involves slant column fitting followed by Air Mass Factor (AMF) conversion to vertical column. Significant gain in accuracy over previous GDP versions is obtained through improved wavelength calibration, use of optimised reference spectra, implementation of a new Ring correction scheme as well as a state-of-the-art cloud correction scheme based on the new OCRA/ROCCIN cloud product. A key component is an iterative column-driven approach to AMF calculation, in which AMFs are calculated on-the-fly for each GOME pixel using the fast and accurate multiple-scattering radiative transfer code LIDORT. Using this approach, the need for complex pre-calculated look-up tables of AMFs is avoided; hence, ozone profile climatologies of any level of complexity can be implemented in a straightforward way. For the operational UPAS/GDOAS version 4.0, the recent TOMS version 8 ozone profile climatology has been used. We describe results of a geophysical validation study involving comparisons with NDSC and WMO/GAW ground-based networks as well as with the new TOMS version 8 total ozone product. With respect to GDP 3.0, RMS values have improved by a factor of two, and seasonal dependency reduced by the same amount. On a global basis, UPAS/GDOAS 4.0 total ozone results lie between –1% and +1.5% of ground-based values for moderate solar zenith angles lower than 70°. At higher solar zenith angles in polar regions, where errors on both satellite and ground-based measurements tend to increase, larger discrepancies of up to +4% are found.

Tuesday 7 September
10:50 – 12:30

MOZART 3

Session 2B4:

Envisat Orbit Performance

Abstract No. 536

Envisat Precise Orbit Determination

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The Navigation Office at ESOC has been closely involved in all aspect of the Precise Orbit Determination (POD) of Envisat throughout the mission lifetime. These activities started shortly after launch through a membership of the Orbit Validation Team. During this time ESOC was involved in both calibration and validation of the DORIS doppler data, the SLR data and the different POD solutions provided by the OVT members. These activities were concluded in May 2003 with an orbit comparison campaign led by ESOC. After this phase routine monitoring of the overall performance of the Envisat DORIS doppler data, SLR data and the MOE and POE orbit solution from CNES has continued. The results of these activities are reported bi-weekly on our website. This presentation will give an overview of all these activities performed during the last two years.

Abstract No. 373

The Attitude of Envisat; the Past and Current Pointing Performance Observed by the Payload

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[2] ESA/ESRIN, Italy
[3] ESA/ESOC, Germany

The attitude of Envisat clearly affects the observations of the instruments onboard. During the commissioning phase review, mispointing phenomena were reported by various groups.The most dominant effect was a sudden pitch rotation in the order of 0.020 deg, apparently occurring twice per day.The effect was visible in Scia, Mipas and ASAR data.Furthermore GOMOS and MIPAS data, indicated that the pitch bias was not constant.Although the reported mispointing is within the overall attitude specification, working groups were created to understand and potentially correct or improve the attitude performance.Right from the start it was evident that the upload of new orbital parameters, was the reason for the pitch jump.However the slowly varying pitch bias was not understood, until the correlation with the Earth Precession was revealed.Meanwhile, ESOC proposed a correction to the algorithm, calculating the orbital parameters. The response of the attitude system to this change, was analysed in depth. Resulting in the decision to use the new algorithm operationally as per mid December 2003. Statistical analysis of the startracker data indicates that the mispointing is reduced significantly: error better than 0.010 deg (99.7%), with a bias in the order of 0.001 deg.Also the instruments of Envisat confirm the current stability of the

platform. The data analysed in the first quarter of 2004 indicates that both the daily trend and the yearly harmonic of the pitch are effectively removed.

Abstract No. 347

Envisat Orbit Control, Philosophy, Experience and Challenges

A. Rudolph, P. Bargellini, M. Garcia Matatoros, L. Ventimiglia, D. Kuijper
ESA/ESOC, Germany

The Envisat satellite launched on 1-Mar-2002 by an Ariane V from French Guyana is the biggest and most advanced European Earth Observation Satellite in-orbit. Since the mass of Envisat is approx. 3.2 times that of ERS2 and since both satellites were provided with approx. 300 kg of Hydrazine at launch fuel is a precious resource on-board Envisat. The paper will present the fundamentals of the Envisat orbit maneuver strategy (which is based on the strategy applied successfully to the ERS missions already), its impact at system level and the experience acquired in the frame of the mission. In particular, the baseline accuracy for ASAR interferometry achieved with the current control strategy will be presented. The special series of orbit manoeuvres performed in support of an interferometry campaign over the City of Bam, Iran, after the earthquake disaster will be described. Finally, the penalties and limitations of different control scenarios (including a tighter dead-band control) and the impact on instrument operations will be discussed.

Abstract No. 650

Envisat and ERS-2 Orbit Determination

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This presentation outlines the dynamic and reduced dynamic methodology at Newcasttle for precise orbit determination of Envisat and ERS-2. The reduced dynamic methodology is applied when global tracking data is available, either through DORIS data for Envisat or by the use of dual satellite crossovers with TOPEX/Poseidon or Jason-1 for ERS-2. Results from the dynamic and reduced dynamic procedures are compared through tracking data residuals, dual and single satellite crossover residuals and by comparison with orbits produced by other analyses centres.

Abstract No. 187

Improved ERS and Envisat Precise Orbit Determination

E. Doornbos[1], R. Scharroo[2]
[1] *Delft University of Technology, Netherlands*
[2] *NOAA, United States*

For over a decade, the Delft precise ERS-1 and ERS-2 orbits have been used in many scientific investigations based on ERS altimeter and interferometric SAR data. This orbit computation is now continued for Envisat, with an unprecedented accuracy due to better tracking data and lower force model errors. Orbit errors due to inaccuracies in the Earth's gravity model, which have been the main focus of research during the 1990s, have been reduced to the same level as those incurred by errors in measurement modelling and non-gravitational force modelling. We have investigated several competing models and methods in order to reduce each of these error sources. When reprocessing the tracking data over the solar maximum period of the past years, frequent large and unpredictable changes in thermospheric density form the dominant remaining source of orbit error, for which accurate modelling remains a difficulty. Nevertheless, the quality of our Envisat precise orbits already rivals that of TOPEX/Poseidon and Jason. The orbit quality will likely further improve as solar activity continues to drop towards solar minimum.

Tuesday 7 September Wolf-Dietrich 1-2

Poster Session 2P08:

Envisat Orbit Performance

Abstract No. 574

Simultaneous Orbit Error Analysis for Contemporary Altimeter Missions

W. Bosch
DGFI, Germany

Altimeter missions with different orbit configurations are cross-calibrated by means of dual-satellite crossover differences. Global crossover analysis has been successfully applied to harmonize the vertical component of ERS-1/2 and TOPEX/Poseidon. Altimeter satellites flying in tandem configuration (as e.g. ERS-2 and Envisat) are more precisely cross-calibrated by collinear analysis. Since some years there are up to five altimeter satellites operating simultaneously (with another tandem configuration between TOPEX/Poseidon and Jason-1). This implies a large number of nearly simultaneous dual satellite crossover events that are unaffected by any sea level variability. While single satellite crossovers with short time delay are concentrated at high latitudes simultaneous dual satellite crossovers are distributed rather regularly. In addition simultaneous dual satellite crossovers between satellites in tandem configuration and a third satellite implicitly realize a collinear analysis. Such crossover events are therefore used to estimate corrections for the vertical component of all altimeter missions operating at the same time. A discrete representation is used to model the orbit error corrections with mission specific range bias and geocenter offsets as additional solve-for parameters. Strategies to fix the range bias singularity and to include prior information of absolute calibration approaches will be investigated. Statistics of single satellite crossovers will be used to verify the orbit error corrections.

Tuesday 7 September
10:50 – 12:30
TRAKL

Session 2B5:

Altimeter Performance and Products Quality (1)

Abstract No. 122

Envisat Altimetry Mission Status

P. Féménias
ESA/ESRIN

The Envisat satellite was launched on March 1, 2002. It carries on-board a new generation Radar Altimeter (RA-2), a Microwave Radiometer (MWR) and a DORIS receiver. The RA-2 instrument provides improved measurement performances and many new capabilities, which will benefit the science and application community. With almost two decades of altimetric measurements acquired by ESA, long-term evolution of parameters playing a key role in climate change can be addressed. This requires homogeneous data sets inter-calibrated at the millimetre level, supported by an accurate and permanent monitoring of the sensor performances and product quality. Over the last two years, the Altimetry system (RA-2, MWR, DORIS) on-board Envisat has been commissioned and is now nominally operational since January 2003. The status of the Altimetry mission in terms of sensors performances, algorithms, product evolutions and services shall be addressed.

Abstract No. 440

Estimating Envisat Sea State Bias from Altimetric Data

S. Labroue, P. Gaspar, J. Dorandeu, O. Zanifé
CLS, France

A preliminary estimation of Envisat sea state bias in Ku band has been calculated with data from the verification phase. Further work based on more data is now in progress to take benefit of the different algorithms improvements and to better assess the wind and waves related variations of the sea state bias. A whole year is analysed to take into account the annual variations of the sea state bias.Based on the non parametric technique, different analyses can be performed to extract the sea state bias signal. We know that fitting crossover, collinear sea surface height differences or residuals from a mean sea surface yields sea state bias estimates with significant differences. An effort is made to better characterise the errors of each method and thus to select the one which provides the most accurate estimation. The proposed SSB models for Envisat are compared to the ones derived for other altimeters (JASON 1, TOPEX and GFO missions). Another point of interest for Envisat is the analysis of the sea state bias in S band. Estimating the sea state bias in Ku and S band allows to correct properly the dual ionospheric correction for the sea state effects. Furthermore, it also gives the chance to assess the difference between Ku and S band, since the sea state bias depends on the frequency.

Abstract No. 9

Envisat Radar Altimeter Calibration with High-Sea GPS Buoys

T. Schueler

Universitaet der Bundeswehr Muenchen, Germany

The environmental satellite Envisat was successfully launched by the European Space Agency ESA in March 2002 and carries - among other sensors - a radar altimeter which is capable of measuring the height between sea surface and satellite with a precision of a few centimetres. Unfortunately, radar altimeters exhibit a bias which cannot be determined a priori with help of laboratory measurements. Consequently, an elaborate field campaign is to be conducted in order to recover the altimeter's offset during the commissioning phase. The principle is relatively simple: Precise centimetre-level orbit determination using the French DORIS system together with accurate values of the instantaneous sea surface height allows to compute the distance between satellite and surface which can be compared with the radar altimeter measurements yielding the instrumental bias. Several methods can be thought of to accomplish this task, e.g. tide gauges are often used to measure the sea level. A different method is carrier phase GPS-positioning onboard of buoys. Such a measurement system with autonomous high-sea platforms was developed by the University FAF Munich and deployed at the north-western part off the coast of Menorca in the Mediterranean Sea.This paper will point out advantages and disadvantages of this approach in comparison to the other methods. Technical aspects as well as practical experiences gained during the measurement campaign will be mentioned. Main focus is centred on latest results for sea surface height determination including the short baseline GPS data analysis and its error budget as well as the long baseline method using already existing reference stations several hundreds of kilometres away from the buoys which could save reference station infrastructure for future applications of this kind. Finally, conclusions for future work will be drawn.All in all, it can be stated that the high-sea buoy approach is an innovative contribution to the radar altimeter calibration campaign that carries some additional potential for future applications of this and similar kind.

Abstract No. 360

Envisat and ERS Validation and Cross-calibration Activities at CLS

J. Dorandeu, Y. Faugere, F. Mertz

CLS, France, Metropolitan

ERS and Envisat altimeter measurements have represented for many years a large contribution to multi-mission altimeter combined datasets, which now supplies applications and ocean models with altimeter data in both near real time and delayed mode (SSALTO/DUACS system). To reach the goal of precise altimetry, it is mandatory to perform Validation and Cross-Calibration of altimeter systems. As part of the ERS and Envisat commissioning phases, extensive studies have been carried out at CLS to assess altimeter data quality and performances, and to compare ERS and Envisat to other missions. The Validation and Cross-Calibration processing is routinely operated in order to

provide Quality Assessment and Cross-Calibration reports, associated to Envisat GDR dissemination. This activity is also associated with a number of studies in terms of altimeter data quality, as a contribution to Envisat Quality Working Group.

Abstract No. 104

Envisat - Range Calibration Using a Transponder

E. Cristea, W. Hausleitner
Austrian Academy of Sciences, Austria

The waveforms provided by the SGDR product are used to perform an absolute range calibration for RA-2, the altimeter on board Envisat. If a dedicated transponder is operating within the footprint of the altimeter, the corresponding waveforms differ both in power and shape from the other waveforms caused by natural targets.By means of transponder signature analyses, the time of the closest approach of the satellite to the transponder is determined and the range is hence calculated. The accuracy of a single measurement of this sort is limited to about 2-3 cm by the ability to model the propagation delay in the atmosphere. It is planned to deploy the transponder beneath the ascending Envisat track on the Greek island Gavdos from June 2004. Numerical results are to be presented if relevant data are available.

Tuesday 7 September   Wolf-Dietrich 1-2

Poster Session 2P09:

Altimeter Performance and Products Quality

Abstract No. 141

Analysis of Envisat Ra-2 Backscatter over Natural Land Calibration Targets

S. Bramer, C. Johnson, P. Berry
De Montfort University, United Kingdom

Natural land targets for ERS RA-1 backscatter, including the Simpson desert, the Takla Makan, parts of the Sahara and the Arabian desert, have previously been identified and modelled using ERS Geodetic mission and tandem mission data. These have been used to perform cross-calibration of ERS-1/2 ice and ocean mode altimeter sigma0. The advent of the Envisat RA-2 provides an opportunity to study the behaviour of RA-2 backscatter over land, at both Ku and S bands.This paper presents an analysis of RA-2 backscatter performance over natural land targets, and provides a detailed comparison with ERS RA-1 data. Comparison is also made with Topex Ku and C band data over the identified calibration sites.

Abstract No. 266

Envisat RA-2 Sigma0 Absolute Calibration, Phase E Results

P. Féménias[1], N. Pierdicca[2], C. Bignami[2], M. Roca[3], A. Martini[4]
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[2] *Univ. "La Sapienza" of Rome, Italy*
[3] *PILDo Labs, Spain*
[4] *SERCo, Italy, Italy*

The nadir backscattering coefficient, sigma-0, measured by radar altimeters is being used for wind-speed retrieval over ocean using empirical methods. For this reason only relative calibration has been traditionally performed between the different missions. Recently the need has arisen to perform an absolute calibration to be used within physically based models.During the Envisat Commissioning Phase a newly-developed transponder was deployed in the Netherlands, giving promising results. This paper describes the activities, performed during the Envisat Operational phase, for the deployment of the same transponder in Italy. It describes also the activities related to the planning of the altimeter in preset mode and presents the results obtained from the processing of the 4 measurements per cycle acquired over a period of seven months.

Abstract No. 484

Validation of Satellite Altimeter Range Measurements over Salar De Uyuni, Bolivia

H. Fricker[1], M. Roca[2], S. Laxon[3], C. Carabajal[4], K. Quinn[5], A. Borsa[6], B. Minster[6]

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[3] *Department of Space and Climate Physics, UCL, United Kingdom*

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[6] *Scripps Institution of Oceanography, UCSD, United States*

The salar de Uyuni in the Bolivian altiplano covers approximately 9600 km2, and is the largest dry salt lake in the world. This vast, flat stable surface is ideal for estimation of the range bias on altimeter instruments such as GLAS on board ICESat (launched 12th January 2003), RA-2 on board Envisat (launched March 1st 2002) and ERS-2 radar altimeter (RA, launched 1995), and to compare the measurements from these altimeters. Here we describe a kinematic GPS survey of the salar de Uyuni that was carried out in August/September 2002 and was designed to calibrate GLAS and RA-2. The eastern part of the salar was surveyed with 8 grids 22.5 km x 13.5 km at 2.25 km spacing, and with 2 grids which straddled one ascending and one descending ERS-2/Envisat orbit across this part of the salar, one 44.5 x 9 km, the other 18 x 13.5 km.Comparison of GPS heights from one GPS grid to the next and crossover analysis at intersections suggests that RMS accuracy of the GPS measurement is around 2 cm. We retracked the altimeter waveforms by fitting the system point target response to retrieve the altimeter surface elevation. We fitted a gaussian-smoothed surface to the GPS heights collected around the ERS-2/ Envisat grids and interpolated these surfaces to the locations of altimeter footprints to obtain an estimate of the range bias for each instruments (GLAS and RA-2).

Abstract No. 583

Bottom-mounted Tide Gauges for Radar Altimetry Monitoring

T. Schoene[1], M. Forberg[2], S. Esselborn[2]

[1] *GeoForschungsZentrum Potsdam, Germany*

[2] *GFZ Potsdam, Germany*

With the launch of JASON-1 the successful radar altimetry (RA) mission TOPEX/Poseidon (T/P) is extended to a second decade. Various analyses have shown that any altimetry mission is subject to

performance degradation resulting in an apparent sea level change. Comparisons of RA with in situ measurements of the instantaneous sea level at Harvest Oil Platform have been used to monitor the absolute sea level measurements of T/P, but not for other missions. Island or shore based tide gauges have also been used in global analyses, mainly for the T/P mission. However, only a combination of e.g. Envisat and JASON-1 gives a sufficient coverage in time and space.For the past and current missions different strategies are used for the calibration and the drift monitoring, e.g. using altimetry crossovers or tide gauges as a height reference. The later method requires that the distance between the tide gauge and the satellite pass is small and the behavior of the partial tides is similar. Moreover, the slope in the sea surface must be known with high accuracy.GFZ is operating several bottom-mounted tide gauges in the North Sea. A triple intersection of Envisat with a T/P, a JASON-1 and a GFO sub-track was chosen. Pressure and wave tide recorders have been placed directly beneath the nominal satellite passes in order to reduce cross-track errors. With a sampling rate of 10 minutes resp. 30 minutes, the instantaneous sea surface height (iSSH) for each satellite track can be interpolated with high accuracy. Due to the sensors array distribution also the iSSH for off-track satellite passes can be estimated. The relative depth stability of each tide gauge sensor can be achieved by the intercomparison between the individual sensors. Using the air pressure from nearby meteorological stations the height of the water column can be estimated. Also first attempts have been made to measure the absolute sensor depth using GPS equipped buoys.The results of the comparison between the RA measurements and the tide gauges will be shown.

Abstract No. 586

Altimeter Calibration Using a Ruggedized GPS-buoy

M. Forberg, T. Schoene, R. Galas, C. Reigber
GFZ Potsdam, Germany

With the launch of Envisat and JASON-1 the successful series of the radar altimetry missions is extended to a second decade. Various analyses have shown that any altimetry mission is subject to performance degradation, like aging of electronic components, resulting in an apparent sea level rise. Comparisons of RA with in situ measurements of the instantaneous sea level e.g. at Harvest Oil Platform have been used to monitor the absolute sea level measurements of TOPEX/Poseidon, but not for other missions. However, only a combination of different missions gives a sufficient coverage in time and space.For the past and current missions different strategies are used for the calibration and the drift monitoring, e.g. using crossovers or tide gauges as a height reference. Thedisadvantage of all calibration methods is, that no direct measurement beneath the sub-satellite tracks are available for all missions and, therefore, models have to be used to account for e.g. the sea surface slope or time varying signals. As shown for ERS-1 and TOPEX/Poseidon, a GPS-equipped buoy, anchored beneath a sub-track, can be used as a height reference. Since GPS-derived coordinates are ITRF-referenced, an absolute calibration is possible. In the context of the Helmholtz Association's strategic project SEAL (Sea Level Change: An Integrated Approach to its Quantification) the GFZ Potsdam has developed a ruggedized offshore GPS-buoy which is able to measure the instantaneous sea level with high accuracy. In May 2002 the buoy has been deployed at an intersection point where the actual RA missions TOPEX, JASON-1, ERS-2, Envisat, and GFO-1

intersect. The position is the only point in the German Bight that allows data transmission to a land station via an HF radio link. During the first deployment period till August 2002 in total 26 satellite passes has been acquired. Each data set comprises one hour of multi-sensor measurements centered at the satellite pass time. Differential GPS data is collected at 10Hz sampling rate both on the buoy and a reference station. Tilt angles as well as 3-axis accelerations are monitored by a dynamic motion sensor. Thus, together with the dipping depth which is collected by an underwater pressure sensor, the GPS antenna height can be reduced to the instantaneous sea surface height for every single GPS measurement.Additionally several meteorological sensors provide data every 10 minutes (e.g. air and water temperature, air pressure, wind direction and speed) and three moored tide gauge sensors in the vicinity and a wave tide recorder beneath the GPS-buoy allow to account for the sea surface slope and significant wave height, respectively. The resulting series of coincident measurements is used to derive a range bias for each RA, the envisaged long-term deployment will allow the monitoring of all missions. Additional information on: http://op.gfz-potsdam.de/seal/

Abstract No. 635

Resampling and Enhancement of Altimeter Data at Tide Gauges

W. Bosch, R. Savcenko
DGFI, Germany

Tide gauge records are complementary to altimetry: they measure at individual points, but provide quasi continuous sea level records with highest precision – in general for much longer time periods as altimetry. Tide gauge data has been successfully used to control the long-term performance of altimeter systems and were used to estimate global sea level rise. Mean sea level, as observed by tide gauges were taken to define the zero point of national height systems although a unique global height system definition must be related to a common (global) geopotential surface, the geoid. There are close relationships between both, tide gauge records and altimetric sea level time series. It is however not obvious that both time series observe the same oceanographic signal. Geodetic control by global navigation systems is a fundamental requirement to avoid that undetected vertical tectonic motions at tide gauges are interpreted as sea level rise (or fall). Coastal altimeter observation on the other hand are degraded in accuracy because the radar echo is affected whenever the footprint includes non-ocean surface, global ocean tide models fail to predict extreme tidal water levels at the coast and strong changes of environmental conditions are not taken into account. The present paper suggests to resample altimeter data and to enhance the observations by orbit error corrections, analysis of long-term trends, seasonal oscillations and residual ocean tides. The approach will be applied to selected sites in the North Atlantic and at the coast of South America.

Abstract No. 653

Lake Level Monitoring and Altimeter Calibration in the Great Lakes

Y. Yi[1], K. Cheng[1], C. Shum[1], A. Braun[2], S. Calmant[3]
[1] *Ohio State University, United States*
[2] *Byrd Polar Reserach Center, OSU, United States*
[3] *CNES, France*

More than 70% of our planet is ocean. The Great Lakes in North American hold 95% of United States' and 20% of the world's fresh water supply, and its region is home to 30% of U.S. population. There are 4,500 miles of coastlines bordering the Great Lakes, which represent a precious natural resources and significantly affect the weather of northeastern part of North America. Recorded lake level changes from water level gauges have shown significant changes (several meters) over the last few decades.The availability of radar altimeters has allowed improved geocentriclake level monitoring. This paper describes the research performedin the Great Lakes using radar altimeters including Envisat. In particular, research to establish a multi-altimeter calibration and monitoring site in Lake Erie is described, with the calibration and validation results for Envisat RA-2. Results for the use of Envisat and other altimeters for the monitoring of lake level changes will be presented.

Tuesday 7 September
10:50 – 12:30
KARAJAN 1-2-3

Special Session 2B6: GMES and Science (2)

(No abstracts)

Research Goals of the GMES FP6 Integrated Projects: MERSEA

J. Johannessen

Research Goals of the GMES FP6 Integrated Projects: GEOLAND

A. Belward

Research Goals of the GMES FP6 Integrated Projects: GEMS

T. Hollingsworth

Panel Discussion

Tuesday 7 September
14:00 – 15:40
MOZART 4-5

Session 2C1:

SAR Signal Processing
(Persistent Scatterers Interferometry)

Abstract No. 595

Validation of Point Scatterer Phase Statistics in Multi-pass InSAR

G. Ketelaar, R. Hanssen, P. Marinkovic
Delft University of Technology, Netherlands

In radar images, point scatterers provide reflections that can often be attributed to a single physical object, usually smaller than the resolution cell size. Stable point scatterers with high backscatter coefficients through time (mainly 'man-made features') are potential targets for InSAR deformation analysis.To validate the estimated deformation parameters from InSAR pointscatterer measurements, knowledge about the observation statistics is necessary. One way to improve this understanding is to perform a controlled experiment using an additional independent technique. In the period from March 2003 to April 2004 the movements of five corner reflectors in the area near Delft University of Technology have been monitored using leveling and repeat-pass InSAR (ERS-2 and Envisat).To compare the InSAR phases with the leveling data, they are corrected for topography and converted to mm along the vertical. Observations are double differences between pairs of corner reflectors, to eliminate atmospheric differences between interferograms. The resulting misclosures between leveling and InSAR are analyzed.For both techniques the observation statistics have to be properly defined. In case of InSAR, the signal to clutter ratio (SCR) is used for estimating the phase variance. After the stochastic modeling of the observations, condition equations can be set up for the leveling-InSAR double differences between each pair of corner reflectors within an interferogram. Misclosures and their variance-covariance matrix are validated using test statistics such as the overall model test and data snooping to verify the observations and the functional and stochastic model.As InSAR phase observations have a wrapped character, misclosures are practically limited to half the wavelength in the line-of-sight. To indicate the significance of the misclosures, the results are compared with the statistics of repeated simulations using wrapped random distributed InSAR phases, taking the probability density function of the wrapped phases into account.

Abstract No. 315

The Development of a Scientific Persistent Scatterer System: Modifications for Mixed ERS/Envisat Time Series

N. Adam, B. Kampes, M. Eineder
DLR, Germany

The permanent scatterer technique invented at POLIMI has meanwhile developed into a remarkable operational method. It facilitates innovative data products like urban subsidence maps or atmospheric delay measurements and permits new geophysical applications. The accuracy and validity of this technique has been proven in several projects at DLR. Due to the outstanding

availability of data, time series of this technique have mainly been produced from data of the compatible sensors ERS-1 and ERS-2. These time series can even span a continuous time range of about twelve years. This long-term observation enables the monitoring of displacements with millimetre accuracy and even facilitates the detection of seasonal periodic effects.The sensor ERS-1 acquired its last scenes back in 2000. The similarly constructed successor ERS-2 still monitors the Earth's surface even after nine years of operation. But recent acquisitions are unfortunately not optimal for general interferometric applications. The reason is a heavily varying Doppler centroid frequency due to failures of gyros.The ERS-2 successor Envisat/ASAR is able to pursue the unique continuity in the monitoring of urban areas. But it operates with a slightly different radar frequency compared to the ERS sensors. Consequently the interferometric principle becomes more complicated and the processing has to be modified. We will present the required adaptations for the permanent scatterer cross interferometry on the developed scientific permanent scatterer system. Alternatively to the permanent scatterer cross interferometry two independent time series can be generated, one for ERS and one for Envisat/ASAR. The decision for one of the alternative methods influences e.g. the permanent scatterer density. We will report on our experiences with both methods and summarize their advantages and drawbacks.

Abstract No. 437

ERS and Envisat Long-Term Differential Interferometry with the Coherent Pixels Technique (CPT)

J. Mallorqui[1], P. Blanco[1], A. Broquetas[1], R. Romero[2], J. Dominguez[2], A. Martinez[2], D. Carrasco[2], D. Navarette[2]

[1] UPC, Spain

[2] INDRA, Spain

In this paper, a modification of the Coherent Pixels Technique (CPT) to work with both ERS and Envisat images will be presented. The developments have been carried out under the scope of the ESA Project "Development of Algorithms for the Exploitation of ERS-Envisat Using the Coherent Pixels Technique" (Contract No. 17584/03/I-LG). The algorithm has been tested with data from the urban area of Paris affected by subsidence.CPT is able to retrieve the linear and non-linear components of movement from a set of low resolution interferograms (multilooked), estimating at the same time the DEM error and the atmospheric artefacts. The basis for the linear estimation of movement is the adjustment of a linear model, which considers the linear velocity of displacement and the DEM error, to the available data. The pixel selection criterion is based on its coherence stability in the stack of interferograms, in consequence the final product will have lower resolution than the original images and interferograms with short baselines will be preferred to maximize the number of selected pixels, but this restriction is not compulsory. Besides this, the generation of the interferograms does not require establishing a master image, allowing free combinations of all available images depending on the restrictions of temporal and perpendicular baselines set. These two characteristics enable the algorithm to work with a small number of images, if compared with the requirements of other techniques. This flexibility allows the user to generate deformation maps

at a reduced cost and once a problematic zone is detected to plan the acquisition of more images. The method adjusts a linear model to phase increments between two neighbouring pixels linked with the Delaunay triangulation, avoiding the need of a sparse grid phase unwrapping of the interferograms. Once the linear velocity of deformation and the DEM error have been retrieved, the algorithm continues with the non-linear movement and the atmospheric artefacts estimation. In essence the algorithm takes advantage of the different behaviour of the atmospheric artefacts in time and space with respect the non-linear movement to isolate their respective contributions to the phase. A combination of temporal and spatial filters sequentially applied are able to extract the atmospheric artefacts and the low and high pass components of the non-linear movement. As the interferograms were generated freely from the available images, the SVD method is used to retrieve the temporal sequence suitable for the temporal filtering. One of the advantages of the algorithm is that there is no need to unwrap the noisy differential interferograms, which can be a difficult step and a potential source of errors. In addition the SVD method provides a minimum norm solution and allows the connection among non-connected subsets of interferograms.As the algorithm is not affected by the presence of subsets of disconnected interferograms the inclusion of Envisat data to the existing ERS datasets is quite straightforward. The modifications included in the algorithm to work with different sensors will be presented and the validation results discussed.

Abstract No. 368

Assessment of ASAR/IMS Multi-polarization Images Phase Difference in the Framework of Persistent Scatterers Interferometry

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The Envisat ASAR sensor offers two possibilities for polarizationdiversity. First of all, one can make non simultaneous acquisitions using the IMS mode. The second possibility consists in using the APS mode, which produces two alternate polarizations (HH/VV, HH/HV, VV/HV) with disjoint but interlaced spectra in the azimuth direction. The phase coherence between polarization channels (and consequently the polarimetric phase difference) is generally not preserved because of the lack of a common phase reference.However, for specific targets, the phase coherence can be recovered. Such is the case for targets behaving as corner reflectors, and presenting a very stable response in phase throughout the whole illumination time. These specific targets are subsequently said to have a high internal coherence.Standard polarimetric analysis shows that the polarimetric phasedifference between HH and VV polarizations for this kind of target is expected to be either 0 (for dihedral-like targets) or pi (for trihedral-like targets).The purpose of this paper is to assess this behavior on ASARimages using the following approach : 1. On a full polarimetric airborne image, internal coherence on VV and HH channels will be detected using recently published techniques [1]. 2. We will show that for those targets, the differential polarimetric phase is either 0 or PI radians.Once this result has been shown, one can use this property in order to combine HH IMS ASAR images together with VV IMS ASAR images and even ERS-SAR images with the PSI (Persistent Scatterers Interferometry) technique as follows : since most of the scatterers used in the PSI technique have a

high internal coherence behavior, the phase behavior presented above applies on them. Thus, only a 0-PI ambiguity on the interferometric phase will remain. This ambiguity can be solved by making the assumption of temporal correlation of the phasevalue of the scatterers. This is a very interesting possibility, because it can dramatically increase the number of available scenes on a given site, allowing for an easier application of the PSI technique. Illustrations of this approach will be shown.An extension of this research may include the assessment of the ASAR/AP mode for a similar purpose.[1] Jean-Claude Souyris, Caroline Henry, and Frédéric Adragna. On the use of complex SAR image spectral analysis for target detection. Assessment of polarimetry. IEEE Transactions on Geoscience and Remote Sensing, 41(12):2725--2734, December 2003.

Abstract No. 269

ERS-Envisat Permanent Scatterers

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In ERS-Envisat cross-interferograms a new term arises in the phase of a perfect point-wise Permanent Scatterer (PS), dependent on the 30 MHz central frequency change and on the slant range position of the scatterer. The phase term is different for each PS but constant in all the interferograms. Exploiting a dataset of ERS and Envisat images, a PS analysis has been carried out. Elevation, LOS velocity and the new phase term have been jointly estimated and removed for a spatially uniformly distributed ensemble of scatterers with high amplitude stability, allowing the identification of the atmospheric phase screen. The phase residuals obtained by removing atmospheric disturbances have been analyzed in relation to the Radar Cross-Section and to the dependence on the acquisition geometry of the amplitude of the scatterers. The behavior of each PS has been analyzed both in ERS and Envisat data, studying the probability of a natural target to be coherently observed by the two different sensors. Moreover, exploiting the dependence of the phase shift on the slant range sub-cell position, the capability to precisely locate a PS in range has been analyzed. Experimental results carried out on a data set of 80 ERS images and 7 Envisat images (ERS-like mode) on Milano over a 20 km side area will be presented.

Poster Session 2P10:

SAR Signal Processing
(Persistent Scatterers Interferometry)

Abstract No. 409

SPINUA: A Flexible Processing Chain for ERS / Envisat Long Term Interferometry

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Several approaches have been developed for extracting displacement information from multi-temporal SAR data series, following two main strategies: the Persistent Scatterers (PS) approach [1], which studies the phase information over single pixels on differential interferograms obtained from each single SAR acquisition with respect to the same reference master image; and methods based on differential interferograms obtained from image pairs with the lowest values of spatial and/or temporal baseline, which then infer, through different procedures (LMS, SVD), the connected time series of phase values due to deformation [2, 3, 4].The first method relies on the identification and monitoring of single objects that remain highly coherent through time. These stable targets (called Persistent Scatterers) have size typically smaller than that of the image pixel (around 5×20 m for ERS/Envisat sensors), so that they are not affected by spatial decorrelation effects. An important condition for a successful application of the technique is the identification of a sufficient number of PS; this is critical for an adequate correction of atmospheric effects and to obtain reliable results. In favourable settings (e.g. urban areas containing many potentially coherent targets such as buildings or other man-made structures), and using long temporal series of SAR images (generally > 30), this technique allows to detect small changes in ground surface elevations with millimetric accuracy.The second method uses the redundancy of information contained in overlapping interferograms to reduce processing errors and noise. In order to ensure low spatial decorrelation, image subsets characterized by small baselines are identified and processed following a standard differential SAR interferometry chain. Different solution are adopted to join the information contained within separate image subsets. This allows to retrieve spatially-distributed displacement information wherever this is available. However, the merging step in the processing chain can fail e.g. due to approximate solutions provided by the SVD technique, or to wrong assumptions in the interpolation of the deformation trend. The SPINUA (Stable Point INterferometry over Un-urbanised Areas) processing chain has been developed and tested in the framework of ASI-, ESA- and EU- funded projects, and represents an effort to adapt and optimise the general approach of long-term SAR interferometry for the study of un-urbanised areas such as those typical in Mediterranean sites affected by slope instabilities. In the critical conditions related to long-term interferometry applications for these kinds of environments (high temporal/spatial baselines, causing low coherence, and low density of man-made structures), even conventional pre-processing steps such as image equalisation, interpolation, co-registration, interferogram generation, etc., need further refinements. Great care is also required during the processing of the phase of the complex signals. All the processing steps in the SPINUA chain have been specifically optimised to these ends

([5],[6],[7],[8],[9]).In this work, the processing framework adopted in the SPINUA processing chain is presented organically, highlighting innovative aspects and some ad hoc solutions which render the tool, respectively, flexible and suitable for applications to areas characterized by low densities of persistent scatterers, of either spatially-extended or point-like nature. Some results obtained by applications to landslide test sites are presented.[1] A. Ferretti, C. Prati, F. Rocca, "Permanent Scatterers in SAR Interferometry", IEEE Trans. Geosci. Rem. Sens., vol.39, No.1, pp. 8-20, Jan. 2001.[2] P. Berardino, G. Fornaro, R. Lanari, E. Sansosti,"A new Algorithm for Surface Deformation Monitoring Based on Small Baseline Differential SAR Interferograms", IEEE Transactions on Geoscience and Remote Sensing, Vol. 40, No.11 , pp. 2375-2383, Nov. 2002.[3] O. Mora, J.J. Mallorqui, A. Broquetas, "Linear and nonlinear terrain deformation maps from a reduced set of interferometric sar images", IEEE Trans. Geosci. Rem. Sens., Vol. 41 No. 10, pp. 2243-2253, Oct. 2003.[4] S. USAI "A Least-Square Approach for Long-term Monitoring of Deformations with Differential SAR Iterferometry", Proc. of IGARSS 2002, June 24-28 2002, Toronto, Canada. [5] A. Refice, F. Bovenga, R. Nutricato, "Stepwise Approach to InSAR Processing of Multitemporal Datasets", Proceedings of FRINGE`03, ESA-ESRIN, Frascati, Italy, 1-5 December, 2003.[6] F. Bovenga, S. Stramaglia, R. Nutricato, A. Refice, "Discrimination of different sources of signals in Permanent Scatterers technique by means of Independent Component Analysis", IEEE IGARSS 2003, Proc. of IGARSS 2003, July 21-25 2003, Toulouse, France.[7] F. Bovenga, A. Refice, R. Nutricato, G. Pasquariello, G. De Carolis, "Automated Calibration of Multi-Temporal ERS SAR Data", IEEE IGARSS 2002, Proc. of IGARSS 2002, June 24-28 2002, Toronto, Canada. [8] R. Nutricato, F. Bovenga, A. Refice, "Optimum Interpolation and Resampling for PSC Identification", IEEE IGARSS 2002, Proc. of IGARSS 2002, June 24-28 2002, Toronto, Canada.[9] Refice, F. Bovenga, S. Stramaglia, D. Conte, "Use of scaling information for stochastic atmospheric absolute phase screen retrieval", IEEE IGARSS 2002, Proc. of IGARSS 2002, June 24-28 2002, Toronto, Canada.

Abstract No. 588

Utilization of Parallelization Algorithms and Resources in InSAR/PS-InSAR Data Processing

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The classical InSAR processing is known to be computationallylaborious. Although may aspects of the data processing chain arealready well known, there is a need for more efficient methods that provide faster results. Especially the advent of radar time-series analysis, needed for precise pin-point deformation measurements, is a driving force for improvements in processing technology, due to the very large quantities of data and intermediate products. Improvements in processing speed can be sought in a stringent initial selection of potentially useful reflections, but this will also limit potential alternative applications. A posteriori implementation of small corrections to the processing chain, as well as storage of variance-covariance information requires keeping as much information at hand as possible.This paper discusses possible improvements in the processing chain by means of combined algorithm parallelization and distribution. The detailed analysis of the processing chain is evaluated from the aspect of the computational time. Within this concept processing can be split into the available processing units by using either the multiple threads of execution on a multi-processor system, or a message passing interface (MPI) technique to coordinate multiple processes distributed across a networked cluster of computers.The Matlab or Octave development environment is used for thepreliminary evaluation of the performance of the improvedalgorithms. Subsequently these parallelization concepts areimplemented in DORIS (Delft Object-oriented Radar InterferometricSoftware) software. The first processing results are discussed in detail.

Tuesday 7 September
14:00 – 15:40

Mozart 1-2

Session 2C2:

Coastal Studies (2)

Abstract No. 367

Multi-sensor Synergy for Monitoring of Algal Bloom in the North Sea

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During the period of April and May in 1998 and 2000 significant blooms of the algae specie Chattonella sp. were reported from the west Jutland waters off the coast of Denmark. The water masses in this region of the North Sea are of particular concern to Norway as they often are transported towards the coast of south Norway, following the general circulation pattern of the region. The bloom - its specie composition and the absolute level of concentrations - were confirmed by in situ sampling, however early detection and determination of the geographical extent of the bloom area was made by use of the satellite-based information (ocean colour and SST), during cloud-free conditions. All three blooms were characterised by a very high-biomass, high-chlorophyll concentrations in the upper layer of the water column leading to biological spills at the sea surface. The latter were distinctively observed in SAR images of the area.Based on concomitant analysis of SeaWiFS, AVHRR and ERS_SAR data acquired during blooming events of Chattonella in May 1998, May 2000 and March 2001, we demonstrate how the bloom modulates the sea surface, leading to specific signatures in the SAR images. A systematic statistical characterisation of these signatures has been conducted together with texture and shape analysis of the observed features. A multi-resolution analysis based on wavelets is used to identify and to extract specific spill structures occurring at scales between 100 and 1000 m. Large-scale patterns are then compared to identify blooming features observed in the 1-km resolution SeaWiFS ocean colour and AVHRR-SST data. We show that a statistical and textural consistency is observed in the bloom-pattern signatures in the SAR images, which allows us to define criteria for specific detection of such features. We demonstrate that the use of multi-resolution analysis permits the discrimination of similar bloom features from ocean colour, SST and SAR images, which might lead to a capability for using SAR data as a substitute for optic and infrared data, in specific conditions, for the monitoring of high-biomass, near-surface algal blooms. We present a first attempt of defining a methodology for integration of SAR data as a proxy in the monitoring of such algal blooms during cloudy periods. Finally new possibilities based on Envisat data (MERIS and ASAR) are discussed with focus on data simultaneity and increased spatial resolution.

Abstract No. 83

ERS SAR and Envisat ASAR Observations of Oceanic Dynamic Phenomena in the Southwestern Okhotsk Sea

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A combined use of multi-sensor remote sensing and in-situ data for the analysis and interpretation of oceanic features observed in the area of the Okhotsk Sea between southern Sakhalin and northern Hokkaido-Kuril Islands is considered. SAR (ERS-1, ERS-2 and Envisat), thermal infrared (NOAA AVHRR), visible (NOAA AVHRR and Landsat) and microwave radiometric (Aqua AMSR-E) images as well as the results of modeling were integrated to associate the SAR backscatter patterns observed in warm and cold seasons to physical and biological forcing processes. The interpreted SAR features included the current front, internal waves, eddies and different types of sea ice and orography-induced surface wind variations. A special attention was given to consideration of the Soya Warm Current area, including synoptic-scale eddies propagating southeastward parallel to Hokkaido coast and a cold belt adjoining to the Current from the north. Cyclonic and anticyclonic spiral eddies in the Aniva Bay manifested themselves as dark filamentary bands due to increased concentration of surface film. In winter sea ice served as tracer of surface circulation under weak winds. Ice eddies the size of about 90 km consisting of 2-3 spirals each of which was formed by sequence of 5-7 smaller elliptical eddies the size of 7-10 km were detected on ASAR images. The large-scale details were also clearly visible on AMSR-E images. The use of the multi-sensor synergetic approach improves and deepens interpretation of the SAR signatures.

Abstract No. 111

On Radar Imaging of Current Features: Mesoscale Eddies and Current Fronts Detection

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[3] Ifremer, France

Manifestation of ocean surface features such as meandering fronts eddies and internal waves have been regularly observed and documented in SAR images since the SEASAT L-band SAR in 1978. Wave-current interactions, suppression of short wind wave by natural film and varying wind field resulting from the transformation of the atmospheric boundary layer across sea surface temperature

front are commonly accepted as mechanisms responsible for the surface manifestation of such ocean features. This is quantitatively explored using a new radar imaging model (Kydryavtsev et al., 2004) that solves the energy balance equation where wind forcing, viscous and wave breaking dissipation, wave-wave interactions and generation of short waves by breaking waves are taken into account. High quality in-situ data rarely exist for realistic description of the two dimensional surface conditions and for model validation. Instead, regular three dimensional fields of temperature and ocean current are derived from two distinct numerical ocean models. Based on these fields SAR image expressions of coastal current fronts and eddies are then simulated. Comparison to ERS SAR and Envisat ASAR images yields very good results. We are consequently confident that the new imaging model provides promising capabilities for advancing the quantitative interpretation of current features manifested in SAR images.

Abstract No. 641

Coastal Wave and Surface Velocities Retrieval Using ASAR-SLC

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[3] *SHOM, France*

Wave spectral inversion is allready implemented on an operational basis to produce the level 2 ASAR wave mode product from ASAR SLC data.We propose an extention of the algorithm to ASAR image mode in coastal area that takes into account the shallow water and range varying incidence angle effects on the existing modulation transfer function used in the inversion.Retrieval of sea surface velocities is also investigated and appears to be very promising. As a demonstration, integrated wave parameters and surface velocities retrieval using ASAR data during the coastal experiment EPEL 2003 organized by SHOM will be presented and compared to model output and in-situ measurements.

Abstract No. 533

Use of Synthetic Aperture Radar for the Analysis of Wave Fields at the Coast

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German Aerospace Center (DLR), Germany

The study of ocean waves approaching the coast line has been historically carried out using moored buoys at a fixed location of the sea.. These measurements can characterize the wave fields at a fixed point (e.g. the mooring position) of the sea, but it is not possible to get information about those sea

surface phenomena related to the variable bottom topography, which characterizes the wave behaviour in shallow waters close to the coast lines (e.g. wave diffraction, wave energy dissipation, etc.). These phenomena have special importance for coastal protection, as well as for supporting operation and maintenance of coastal structures, such us breakwaters, harbours, etc. As the wave fields approaching to the coast are spatially inhomogeneous, it is necessary to use wave sensors at different locations of the sea surface. In recent years spaceborne synthetic aperture radar (SAR) has been demonstrated to be a reliable remote sensing tool to analyse wave fields on the open ocean and on global scale. The wave field information extracted from SAR measurements is obtained by means of the directional wave spectrum. Recently, new algorithms have been developed to obtain additional information in the spatial domain rather than the spectral domain. These methods permit the detection of individual wave heights, wave groupiness, as well as to estimate surface wind fields. This work investigates the capabilities of spaceborne SAR to extract information on areas close to coastal locations, where the incoming wave fields show strong spatial inhomogeneities. The new developed algorithms mentioned above are applied to spaceborne SAR images of the sea surface close to different coastal locations. For this purpose, ERS-2 SAR and Envisat ASAR images of the North Sea and the Bay of Biscay are used to study the ocean waves in shallow waters under different climate and oceanographic conditions. High resolution sea surface elevation fields are computed from complex image mode data. The spatial variation of the ocean wave fields is analyzed and related to the underlying bottom topography. The potential of Envisat dual polarization data for wave measurements is discussed. The relevance of the investigations for different practical applications is explained.

Tuesday 7 September
14:00 – 15:40
DOPPLER

Session 2C3:

Atmosphere Overview (3)

Abstract No. 126

Validation of MIPAS-Envisat Profiles for O3, HNO3 and Temperature with Data from the MIPAS-STR Instrument on Board the Geophysica

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[5] *Jet Propulsion Laboratory, United States*

MIPAS-STR (MIPAS-STRatospheric aircraft) is a cryogenic Fourier transform emission sounder. By a combination of continuous limb sounding and upward measurements, two-dimensional distributions of the temperature and of several trace gases can be derived. The spatial resolution of the individual profiles is about 2 km vertically and 35 km horizontally in flight direction. We report the validation of MIPAS-Envisat profiles in the upper troposphere and the lowermost stratosphere with correlative data derived by MIPAS-STR onboard the high-altitude aircraft M55-Geophysica. The validation is presented for the 22 July 2002 orbit 2051 at middle latitudes and, in the Arctic region, for several orbits of February 28th, March 2nd and March 12th, 2003. We focus on the profiles of temperature and of the trace gases O3 and HNO3. The presentation includes the quality control of the MIPAS-STR measurements by inter-comparison with in-situ data from the M55-Geophysica, O3- and temperature sondes, remote temperature sensing from the Geophysica and O3 lidar measurements from the Falcon aircraft.

Abstract No. 263

Validation and Analysis of GOMOS Measurements Using Stratospheric Balloon-borne Instruments

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Five stratospheric balloon-borne instruments were involved in the validation of night time measurements of GOMOS onboard Envisat: AMON, SALOMON, MicroRADIBAL, ELHYSA, and LMD aerosol counters. AMON and SALOMON are UV-visible spectrometers operating during night, which use stars and Moon as light source, respectively; MicroRADIBAL is a photopolarimeter operating at sunset; ELHYSA is an hygrometer operating at night; the LMD aerosol counter is implanted in the gondola of the three other instruments since the beginning of 2004. This set of instruments allows a direct validation of the O3, NO2, NO3, OClO, H2O and aerosol profiles of GOMOS.In the frame of GOMOS validation, a flight of AMON was conducted on March 1, 2003 from Kiruna (northern Sweden), flights of SALOMON were conducted on September 19, 2002, at mid latitude from Aire sur l'Adour, France, and on March 4, 2004 from Kiruna; and flights of MicroRADIBAL and ELHYSA were conducted from Kiruna on March 8, 2004, and March 11, respectively. All flights were successful. A new flight of SALOMON is planed on June 2004 from Gap (France). For the September 2002 and March 2004 flights, the spatial coincidence between the balloon and GOMOS measurements were less than 500 km; the time coincidence were less than 2 hours for the chemical species, and less than 4 hours for the aerosols. Then, valuable comparisons between the GOMOS and balloon profiles can be performed in the 15-35 km range. The March 2003 flight was perform during the occurrence of polar stratospheric clouds also observed by GOMOS.The first part of the validation program in 2002 and 2003 has allowed giving recommendations for improvements in the GOMOS retrieval algorithms. The analysis of the previous measurements and of the new ones will be done using the new version of the GOMOS data available in Spring 2004. Then, the accuracy of the transmission measurements of GOMOS, as well as that of the vertical profiles, will be discussed. The presentation will focus on the ability of GOMOS detection for low concentration of NO2 in the polar vortex, the consequence of a PSC event on the GOMOS transmissions, and on the meaning of GOMOS aerosol extinction measurements in order to derive the real size distribution of aerosols.

Abstract No. 190

SCIAMACHY Validation with AMAXDOAS NO2 and O3 Measurements

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The AMAXDOAS instrument on board the DLR-Falcon is an airborne multi-axis UV/visible spectrometer which was designed specifically for the validation of products from the SCIAMACHY instrument on Envisat. The instrument has zenith and nadir viewing directions which match the SCIAMACHY nadir mode. It also has off-axis upward and downward view directions which are similar to the SCIAMACHY limb geometry, although only for two lines of sight. The AMXDOAS instrument was flown during two large SCIAMACHY validation campaigns in September 2002 and February and March 2003. The campaigns covered high northern latitudes, mid-latitudes and the tropics in two seasons, producing a large number of perfect matches with SCIAMACHY overpasses.In this presentation we will briefly introduce our campaign, then show the NO2 and O3 vertical columns measured by the AMAXDOAS along the flight track. We have compared the AMAXDOAS measurements with GOME data and in most cases, very good agreement was found. In the next step, the results are used to validate the SCIAMACHY nadir NO2 and O3 columns for the first time.

Abstract No. 521

Integrated Characterisation of Envisat Ozone Profile Data Using Ground-based Network Data

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The atmospheric chemistry payload of ESA's environmental satellite Envisat includes three instruments monitoring the vertical distribution of atmospheric ozone on the global scale: Global Ozone Monitoring by Occultation of Stars (GOMOS), Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), and SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY). Although operating from the same orbiting platform, the three instruments rely on substantially different observation techniques and geometries, leading to different perceptions of the vertical profile of ozone.Since the successful launch of Envisat in March 2002, the ground-based subgroup of the Atmospheric Chemistry Validation Team for Envisat (ACVT-GBMCD) has collected correlative measurements of the ozone profile at a list of ground-based stations performing network operation in the framework of the Network for the Detection of Stratospheric Change (NDSC), WMO's Global Atmospheric Watch programme (GAW) and NASA's Southern Hemisphere ADditional OZonesonde programme (SHADOZ). Correlative profile measurements have been acquired from the Arctic to the Antarctic by ozonesonde, lidar, and millimetre wave radiometer. This extensive database allows validation studies of Envisat ozone profile data from pole to pole and from the ground up to the lower mesosphere.We report an integrated validation study of ozone profile data measured by the three Envisat ozone profilers, GOMOS, MIPAS and SCIAMACHY, based on pseudo-global comparisons with correlative data collected by the ACVT-GBMCD. The study concludes to a reasonable quality and consistency of Envisat profiles when adequate data selection (e.g. dark limb GOMOS data only) and vertical ranges are envisaged. Global structures, seasonal variations and pointing errors are further investigated. We also discuss the impact of the adopted comparison method on the comparison results.

Abstract No. 708

Validation of SCIAMACHY - Current and Future Product Qualities

A. Piters[1], H. Kelder[1], U. Platt[2], P. Simon[3], R. Timmermans[1], J. Lambert[3],

K. Bramstedt[4], B. Kirchoff[2], I. Aben[5], J. Burrows[4], C. Camy-Peyret[6], E. Hilsenrath[7], B. Kerridge[8], K. Kunzi[4], D. Perner[9], M. Riese[10], H. Smit[10], J. Staehelin[11], D. Swart[12], G. Lichtenberg[5], G. Tilstra[1], A. Richter[4], M. van Roozendaal[3], T. Wagner[2], M. de Maziere[3], J. Notholt[4], B. Barret[13], W. Hoyningen-Huene[4], F. Wittrock[4], M. van Weele[1]

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SCIAMACHY on board Envisat measures globally the vertical distribution and total column amounts of several atmospheric constituents. The values retrieved from the observed spectra, both operationally and non-operationally, are subject to a continuous validation process, in which 38 European and non-European institutes participate. The SCIAMACHY validation product co-ordinators monitor the results of this process and regularly asses the accuracy of each product. The product accuracy is described in such a way that it is of direct use for algorithm improvement, instrument characterisation and atmospheric research. In this presentation we will summarise and illustrate the current quality of the SCIAMACHY products. Also we will outline our plans for the coming years to ensure a regularly updated and complete description of the accuracy of each SCIAMACHY product.

Tuesday 7 September
14:00 – 15:40

MOZART 3

Session 2C4:

Application of Scansar Complex Product (Wide Swath SLC)

Abstract No. 52

ASAR Wide-Swath Single-Look Complex Products: Processing and Demonstration Status

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The European Space Agency is in the process of implementing a wide-swath single-look complex (SLC) product from the Envisat ASAR and is acting to alert the potential user community and encourage the widespread exploitation of such a product.The Envisat ASAR currently supports interferometry and other applications of single-look complex data through the provision of single-polarised and alternating-polarisation stripmap SLC products and SLC wave-mode imagettes. Wide-swath SLC products have not been offered to users on an operational basis.A number of significant users communities are believed to exist for wide-swath SLC products. These include seismologists and those active in other surface movement applications, and oceanographers seeking contiguous large-area directional ocean wave spectra and surface current fields. A particular advantage offered to the seismology community by wide-swath data is its ability to provide rapid large-area coverage, which can potentially act as a reference dataset with which subsequent strip map images can form more localised "post-event" interferograms. Wide-area interferograms, formed from pairs of wide-swath SLC images are also likely to be attractive, both for large-scale surface deformation mapping, and for the more effective characterisation of atmospheric radio frequency delay features. However, the derivation of such products is constrained by the timing of the radar bursts from the ASAR instrument into each of its sub-swaths. A data screening process to identify suitable wide-swath INSAR pairs has been investigated by ESA and will be described.Oceanographic applications of wide-swath SLC products may offer, through local tracking of radar Doppler centroids, the potential to estimate a component of ocean surface currents over a 400km-wide swath. Directional wave-spectra estimation may also take advantage of the multi-burst structure of the ASAR wide-swath SLC data to use algorithms similar to those currently implemented within the ESA Level-2 wave-mode product. This paper is intended to serve as an introduction to more specific discussions on individual applications and processing to be presented by members of ESA's Wide-Swath SLC Working Group.

Abstract No. 195

The ASAR Wide Swath Single Look Complex Product: Properties and Applications

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In the Envisat products list, ESA is going to add a new one: the ASAR Wide Swath Complex product, containing Wide Swath Mode phase preserving data focused on a coherent grid. This product will fill the lack of level-1 "full-resolution" images in WSM mode, where only a medum resolution, detected product is currently available. The image will then cover an area of 400 x 400 km, at a resolution of approximately 30 x 120 m (range, azimtuh) where three independent looks are interleaved in azimuth. The intended applications are thus interferometry, wave-wind speed measures, and large scale monitoring (oil spills detection etc). The generation of the product, shorlty summarized in the paper, is made by accomplishing: (1) phase preserving focusing on a grid common both for range and azimuth, for all the swaths, (2) undersampling in azimuth to save space and computing time, (3) formatting the final product as a separate collection of bursts for each of the five swaths. The purpose of this paper is to describe the main features of this product and the rationale that is behind some choices. Results obtained by using this product both for the ScanSAR-ScanSAR and mixed ScanSAR-IM interferometry are also presented as a possible application.

Abstract No. 610

Wave and Wind Measurements Using High Resolution Envisat ASAR Wide Swath SLC Data

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German Aerospace Center, Germany

Envisat ASAR wide swath data have shown their big potential for oceanographic applications. With their coverage of about 500 by 500 km, they are ideally suited to study mesoscale processes like, e.g. the near ocean surface wind field. However the resolution of the standard wide swath product is significantly lower than the image mode resolution, and therefore not suitable for ocean wave measurements. Furthermore, only intensity images are provided as a standard product, i.e. the complex SAR information, which is of great value for different applications is not available.In this study reprocessed high resolution Envisat ASAR wide swath single look complex (SLC) data, which were provided in the framework of the wide swath SLC working group, are used for wave and wind measurements. The data have the same range resolution as image mode data and furthermore contain the full complex information. Multilook techniques are applied to estimate two-dimensional ocean wave spectra with resolved ambiguities of wave propagation directions. A closer analysis of a wave field observed during the Prestige oil tanker accident at the Spanish coast is performed. The potential and the limitations of the data with regard to ocean wave measurements are summarized. Wind fields are estimated from calibrated data. The benefit of the high range resolution for wind measurements is discussed in the context of concrete applications like e.g. offshore wind farming. Finally the potential of the data for current measurements based on the so called Doppler centroid estimation technique is discussed. The combined effects of waves and wind are analyzed.

Abstract No. 712

SCANSAR SLC : Marine Applications

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A prototype version of the future SCANSAR SLC product is investigated in terms of suitability for marine applications. Algorithm initially developed for single look complex narrow swath data are tentatively adapted to account for burst azimuth sampling and large incidence angle variations across range. Unambiguous swell inversion, sea surface motions based on doppler centroid anomaly, unambiguous ship detection and synoptic sea surface roughness retrieval are considered. A first estimation of derived geophysical parameters accuracy is discussed

Abstract No. 703

Scansar Interferometry for Atmospheric Parameter Estimation

R. Hanssen, P. Marincovic
Delft University of Technology, Netherlands

The most important characteristics of Envisat Scansar products are the wide swath width of 400 km and the higher revisit time between acquisitions imaging a specific area on earth, from different tracks. The availability of Wide Swath Single Look Complex (WSS) products potentially enables the formation of repeat-pass interferograms. Apart from the usual factors limiting the application of interferometry, such as the length of the perpendicular baseline and temporal decorrelation, Scansar interferometry is mainly limited by the synchronization of the Scansar bursts. Insufficient overlap of these bursts will cause decorrelation in the interferograms. Nevertheless, of the WSS data analyzed, there is a considerable amount that allows a successful interferometric combination. In this paper we will investigate the potential of these interferometric products to produce first wide swath vertically integrated water vapor maps. These products are computed by extracting the topographic, orbital, and hydrostatic delay signal from the interferogram, and mapping the residual to columnar water vapor measures [kg/m2]. If routinely available, such maps can significantly improve meteorological analyses We use time collocated images of MERIS to validate and interpret the results. Conclusions and recommendations on data selection and processing issues will be given.

Tuesday 7 September
14:00 – 15:40
TRAKL

Session 2C5:

Altimeter Performance and Products Quality (2)

Abstract No. 174

Validation of Envisat Altimetry over Ice Caps

B. Soussi[1], B. Legresy[2], F. Remy[2], F. Papa[2], O. Zanifé[1]

[1] *CLS, France*

[2] *LEGOS, France*

Envisat offers for the first time an operational geophysical data record over ice caps. ERS 1 and 2 showed the large potentiality of altimetry over the ice sheets and a dedicated processing algorithm has been developped for Envisat. We developped and applied an operational anlaysis of the data quality over the ice sheets. Using this processing chain we can infer the quality of the data for every cycle and survey the evolution of the measurement. A comparison with ERS products which we processed with the same algorithms helps to give a good picture of the Envisat altimeter behaviour in terms of height recovery, but also backscatter stability, radar echoes shape, polarization effects on crossoverpoint differences, etc..We will present the results of this survey over the beginning period of the satellite.

Abstract No. 391

Long Term Monitoring of the Envisat RA-2 Drift with the GLOSS/CLIVAR Fast Sea Level Data Tide Gauge Network

F. Lefevre, J. Dorandeu, P. Le Traon, . Cls Calval Team

CLS, France

The long term monitoring of the Envisat RA-2 bias is known as the RA-2 relative range calibration. The usefulness of tide gauge data networks for calibrating satellite altimetry systems was demonstrated by several authors (Mitchum (1994, 2000), Chambers et al. (1998), Cazenave et al. (1999)...). Their proposition was to use tide gauge data as an independent system to monitor drifts and bias of altimeter system over time.We took over their works and improved them to compare Envisat RA-2 measurements with the GLOSS/CLIVAR "fast" sea level data tide gauge network (formerly known as the WOCE network). The main interest of tide gauges for altimetry is to provide independent measurements of sea surface height variations. The basic idea of the method is that differences between tide gauges and altimetry should not have any drift or bias over long time scales. Choosing tide gauge stations where the differences between altimetry heights and the tide gauge sea levels are small is essential to get good variance estimates. To validate the method, we used ERS1/2 data from GDRs (~8 years of data). The methodology of the comparison of Envisat RA-2 data against tide gauge measurements is now operational. The method will be presented and the results for Envisat will be given with the last GDRs available.

Abstract No. 540

Envisat Altimeter Calibration and Validation

M. Otten, J. Dow
ESA/ESOC, Germany

As a principal investigator for the Envisat RA-2 Altimeter the Navigation Office at ESOC has been actively involved in the Calibration and Validation phase of the Altimeter. The activities performed during the Cal/Val phase of the Altimeter consisted of estimation of range and time bias (absolute and relative to ERS-2), validation of the geophysical corrections and the CNES precise orbit solution on the altimeter product. ESOC continued performing most of these activities after the Cal/Val phase as a member of the Quality Working Group (QWG) of the Envisat Altimeter. Results of these activities are presented at the QWG meetings held 3-4 times a year and bi-weekly on our website. This presentation will give an overview of all these activities.

Abstract No. 579

IGS Tide Gauge Benchmark Monitoring Pilot Project

T. Schoene
GoForschungsZentrum Potsdam, Germany

Sea level is a very sensitive parameter to natural and human-driven climate related changes and an important factor for the vulnerability of near coastal, densely populated areas. For more than a century tide gauges (TGs) have been the most important measuring devices for the sea level. Although new remote sensing techniques, like e.g. radar altimetry, have become available, TG measurements remain a valuable tool. The limiting factors for using TGs for sea level change studies are the globally uneven distribution of TG measurements and the stability of the TG benchmark (TGBM). Historically tide gauges had either no ties to a height reference system or the tie was maintained by first order leveling only. With the broad use of GPS since the 1990th ties are more and more established either through repeated campaigns or more recently on a continuous basis. This gives the unique possibility to reference the sea level measurements to an absolute reference frame.In 2001 the IGS established the Tide Gauge Benchmark Monitoring Pilot Project (TIGA-PP). The primary product of the service will be time series of coordinates for analyzing vertical motions of TGBMs. Different Analysis Centers are providing weekly solutions for selected GPS stations near TGs on a continuous basis. The pilot project was operated for the period 2001 to 2004, but is now continued for at least two years. See also http://op.gfz-potsdam.de/tiga.

Abstract No. 470

Analysis of Envisat RA2 Altimeter Sigma-nought Bloom Events for S and Ku Bands Backscattering Intercomparison

F. De Biasio[1], N. Pierdicca[2], S. Zecchetto[3], L. Pulvirenti[2]

1 CNR, Italy

2 Dept. Electronic Engineering, Univ. "La Sapienza", Italy

3 CNR-ISAC, Italy

Non-negligible percentages of sigma-nought measurements from Envisat-RA2 altimeter are affected by sigma-nought blooms, a phenomenon characterised by radar backscatter levels unusually high, and radar return waveform shapes very different from usual altimetric echoes. Sigma-nought blooms tend to appear during calm sea state condition and light wind: in this situation the ocean tracker is likely to lose lock, giving erroneous estimation of range, sea surface roughness and wave height. The Envisat-RA2 instrument, thanks to its double-band design, allows the analysis of this phenomenon by simultaneous KU- and S-band measurements. The objective of this work is the intercomparison of the sigma-nought blooms characteristics on the two bands, using also data from other satellites sensors, in order to identify distinctive sea state geophysical conditions. This may provide additional information on the calibration of sigma-nought of the two channels when blooms events are caused by understandable scattering mechanisms, provided the receiver is not saturated. A number of checks have been implemented on the data in order to select bloom events suitable for this scope.Further research will be devoted to relate the bloom events to the geophysical conditions inside the illuminated footprint.

Tuesday 7 September
14:00 – 15:40

KARAJAN 1-2-3

Special Session 2C6:

How to Move from Reseach to Applications? (1)

Abstract No. 692

BEGO: Earth Observation from Space Assisting in the Protection of the UNESCO World Heritage Sites: an Example in Central Africa (DUP/DUE)

M. Hernandez[1], D. Fernandez[2], O. Arino[2]
[1] *UNESCO, France*
[2] *ESA/ESRIN, Italy*

UNESCO, the specialized agency of the United Nations for Education, Science and Culture has recently initiated an international partnership with the Space Agencies. Such an important partnership is a call to all international space agencies to support UNESCO through the use of space technologies to assist developing countries in the monitoring of World Heritage sites. This paper presents an example of the use of remote sensing to monitor and to derive maps for the World Heritage sites in the Democratic Republic of Congo (DRC), Uganda and Rwanda.

These sites have in addition the particularity of hosting the last mountain gorillas, therefore monitoring from space is essential in order for the park rangers to be able to define their main priorities for conservation. Within the framework of the European Space Agency (ESA) Data User Programme (ESA-DUP) a significant financial contribution has been awarded by ESA to make use of space technologies and satellite images for the benefit of World Heritage Conservation species in Central Africa. The project has the nickname of BeGo (Build Environment for Gorilla). The habitat of the mountain gorillas is located in three different countries in the border region between the Democratic Republic of Congo (DRC), Rwanda and Uganda, countries affected by regular war conflicts and pressure from farming and refugees. In addition, some of the National Parks are extremely large in size. Among the protected areas there is the Park National de Virunga, the first protected area of Africa. The terrain is mountainous, going from the plain at sea level up to the Virunga Mountains that are among the highest peaks of Africa, some having eternal snow and getting close to the 5,000m high. Some of the parks are of extremely difficult access, the name of the World Heritage site of Uganda *Bwindi Impenetrable Forest* explains by itself the fact that only Earth Observation from Space can be used to derive maps for conservation. The project has a quite interesting partnership brought together that comprises the European Space Agency, the Canadian Space Agency, as space experts; UNESCO as main user representative jointly with the local park authorities of DRC, Uganda and Rwanda; assisted by an important group pf conservation experts: the International Gorilla Conservation Programme (IGCP), The Dian Fossey Gorilla International Fund (DFGIF), the World Wildlife Fund (WWF) and the Wildlife Conservation Society (WCS). The project uses a large variety of satellite images from the Landsat archive, ASTER, Envisat as well as RADARSAT generously provided by the Canadian Space Agency.

An interesting aspect is the use of Envisat since this project is one of the first activities that uses the extremely new Envisat data, not only for research purposes but directly in an operational application. The paper will describe the problems of the area, the main requirements of the users, the space technologies used and the results obtained.

For the whole areas selected the following 1:50,000 (medium scale) products are being developed:

- Medium scale DEM (Digital Elevation Model) of the specific sites under consideration;
- Base maps and land cover/land use maps of the sites under consideration:
- Analysis of the land-cover/land use changes (between 1990 and 2000) at medium scale of the sites under consideration (including the surrounding areas).

For the whole area more coarse scale (1:200,000) products are being developed:

- Small-scale DEM of the whole geographical area of interest;
- Analysis of the land-cover/land use changes (between 1990 and 2000) of the whole geographical area of interest.

At the end of the project a user manual describing the whole methodology followed through the whole project will be produced. This will assist the local staff working in conservation to better understand the necessary steps to make use of satellite images to detect changes in the forest, habitat of the mountain gorillas. Finally other examples of the use of space technologies to monitor World Heritage sites will also be shown.

Abstract No. 691

HUMAN: Humanitarian Mapping Service (DUP/DUE)

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[2] *Keyobs*

[3] *Intecs SpA*

The HUMAN service has been conceived and developed with Médecins Sans Frontières - Belgium (MSF-B) and an industrial consortium lead by Keyobs. MSF are engaged in medical humanitarian relief operations and are present and active in 85 countries world wide. MSF field teams often operate in places where up-to-date maps are difficult to obtain, are obsolete or are available but at an inappropriate scale. The aim has been to meet the requirement for timely and up-to-date geo-spatial information in the form of paper and digital maps to assist the emergency, management and rehabilitation phases of humanitarian relief operations. The requirement for geo-spatial information is often time critical. The HUMAN service has been configured to exploit web and space based mapping technologies in order to meet these time critical requirements. In the field, paper maps are being used by field staff to help situation analysis and set up of medical projects as well as support the delivery of food, medicines and equipment. But an important element of the project has been to ensure delivery of digital products across the web using a Web Mapping Service (WMS) at MSF headquarters. Very high resolution optical (~1m) EO data is being used to up-date detailed infra-structure information, whilst courser resolution optical and SAR data is used for the creation of vegetation, water resources and topographic information. For EO data delivery, service level agreements have been made with EO data providers that ensure emergency level programming, acquisition and fast delivery of images. All of this makes for a cost effective and efficient service.

Abstract No. 374

EPIDEMIO: EO in Epidemiology (DUP/DUE)

P. Vounatsou[1], G. Pluschke[1], A. Gemperli[1], K. Weise[2]
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[2] Jena-Optronik GmbH, Germany

The objective of the EPIDEMIO project is to provide EO-derived information on the environment to epidemiologists working to study, monitor and predict threats to human health. End user organisations directly involved in the project include the World Health Organization, European research institutes, and several organisations based in Africa. EO provides a broad range of information types: digital elevation maps, urban maps, cartography, maps of water bodies, vegetation maps, land surface temperature maps, and monitoring of wind-blown Sahelian dust. This information is used in applications such as malaria and meningococcal meningitis epidemic early warning, in planning fieldwork campaigns for research into the Ebola virus's reservoir, and in the management of development projects in public health. This paper describes the work done in the early phases of the DUE EPIDEMIO project to survey the user's needs and to understand the potential benefits that EO can bring to their work.

Abstract No. 357

TEMIS: L'Oréal and Solar UV Radiation (DUP/DUE)

F. Christiaens
L'Oréal, France

Hair and skin occupy a special place on the surface of the human body, in direct contact with the environment. This explains the diversity of their properties according to places where people live, and their alterations in terms of structure, function, appearance. This diversity and these alterations (cosmetic and pathologic) are partly linked to climate and pollution.Available data on solar UV irradiances and pollution have limitations: Spatial coverage is sparse and there are limited data over time. Moreover, consumers look for more customised products, wherever they live, which means to fine-tune laboratory experiments. So L'Oréal is involved in the ESA Data User Programme project called Tropospheric Emission Monitoring Internet Service (TEMIS), which uses space-based atmospheric instruments such as SCIAMACHY. The project will chart global concentrations of trace gases, aerosols and UV.Solar UV data are compared with data from published models. Additional climatologies and time-series are expected for the remainder of the project.

Abstract No. 562

The role of R&D in Developing Marketable EO Services

P. Curtis[1], F. Knops[2]
[1] *VEGA Group, United Kingdom*
[2] *Booz Allen Hamilton, United Kingdom*

VEGA Group and Booz Allen Hamilton have carried out a market survey into the characteristics and performace of the European and Canadian Earth Observation Value-Adding Industry. This survey is the most detailed and far reaching ever carried out in this area. It identified a population of more than 160 companies active in the industry and used a combination of research tools to gather information on the companies, their products and services, their working practices, their perceptions of the industry community and their financial health and performance. The resulting reports present an extensive review of the condition of the EO service industry, identify some strengths and weaknesses and make recommendations on possible steps to enhance the industry over the next few years. The data gathering has also looked at currently marketable services and will produce a compendium of services to act as a focal point for potential buyers of EO services.

Tuesday 7 September
16:10 – 17:50
MOZART 4-5

Session 2D1:

SAR Signal Processing (Interferometry)

Abstract No. 499

On the Exploitation of the SBAS Algorithm for the Analysis of the Deformations Detected from the ERS and Envisat DIFSAR Data

R. Lanari[1], P. Berardino[1], F. Casu[1], M. Manunta[1], M. Manzo[1], A. Pepe[2], E. Sansosti[1]

[1] IREA-CNR, Italy

[2] Università degli Studi di Napoli Federico II, Italy

Differential Synthetic Aperture Radar Interferometry (DIFSAR) is a remote sensing technique that allows us to analyze deformation phenomena affecting both extended zones and localized structures. This result is achieved by exploiting the phase difference of SAR image pairs relevant to the area under study. In this context, we consider the technique referred to as Small BAseline Subset (SBAS) approach whose capability to analyze deformations at low and high spatial resolution have been already shown [1-3].The key idea of this work is to carry out a full exploitation of the SBAS procedure by processing a large data set relevant to a specific test site. In particular, the investigated area is the Napoli Bay which includes two large volcanos (the Campi Flegrei caldera and the Somma-Vesuvius volcanic complex) a highly urbanized zone (the city of Napoli and surroundings) and several areas characterized by geo-hydrological risks. The data processing operation is focused on the time interval 1992-2004 and leads to the generation of deformation time-series produced from ascending and descending tracks of the ERS-1 and ERS-2 sensors. We show that the availability of these multi-orbit SAR data allows us to detect the ground deformations in the radar Line Of Sight (LOS) and to discriminate the vertical and east-west displacement components.Moreover, we also apply the two-scale resolution approach described in [2], which is based on the use of two different data set generated at low and high spatial resolution, respectively. The former allows us to identify and estimate large scale deformation patterns, atmospheric phase components and topography artifacts; the latter, to zoom on selected areas and to detect localized displacement contributions, like, for istance, those affecting single buildings.Finally, in order to expand the temporal coverage, we present an extension of the SBAS approach for the integration of the available ERS data with a set of Envisat acquisitions relevant to the subswath IS2. In particular, the images acquired by the ERS and Envisat radar systems are assumed to belong to independent subset; accordingly, no cross-interferograms are considered and the combination of the ERS/ERS and Envisat/Envisat interferograms is carried out via the conventional SBAS procedure. We explicitly remark that this integration is carried out by using multilook interferograms and that the impact on the basic SBAS procedure, due to the integration of the multi-sensor data, is negligible therefore its implementation is straightforward.The quantitative assessment of the performance of the proposed extended SBAS approach will be carried out by comparing the DIFSAR measurements with those available from the geodetic network located in the area which covers an area of nearly 2000 Km2 and includes more than 200 leveling benchmarks.References[1] P. Berardino, G. Fornaro, R. Lanari, E. Sansosti: "A new Algorithm for Surface Deformation Monitoring based on Small Baseline Differential SAR Interferograms", IEEE Transactions on Geoscience and Remote Sensing, Vol. 40, No. 11, pp. 2375-2383, November 2002.[2] R. Lanari, O. Mora, M. Manunta, J.J. Mallorquì, P. Berardino, E. Sansosti: "A Small Baseline Approach for Investigating Deformations on Full resolution Differential SAR Interferograms", in press on IEEE Transactions on Geoscience and Remote Sensing, 2004.[3] Berardino P., Casu F., Fornaro G., Lanari R., Manunta M., Manzo M., Pepe A., Sansosti E.: "Small Baseline DIFSAR Techniques for Earth Surface Deformation Analysis", in Fringe '03, ESRIN, Frascati (Italy), 1-5 December 2003.

Abstract No. 46

Interferometric SAR Data Coregistration by Point-like Scatterers

H. Yue, R. Hanssen, P. Marinkovic, F. Leijen, G. Ketelaar
Delft University of Technology, Netherlands

Coregistration is a key step in the interferometric SAR data processing which determines the generation of fringe map,precise coregistration decreases the noise of fringe map and increases the coherence of interferometric pair,so lead accurate InSAR results. Generally the complex coherence or amplitude cross correlation and fringe contrast optimization algorithm are used to coregister the master and slave images, and about 0.05-0.1 pixels accuracy can be achieved. But for the interferometric pairs with very long spatial baseline(about or more than the critical baseline) or very long temporal baseline, the master and slave are almost totally decorrelated, so the correlation algorithms fail in the process of coregistration. One of the latest InSAR technique is the permanent scatterers processing which uses SAR series data to monitor the earth surface deformation at long time scale.in this technique it is necessary to explore the information of long spatial baseline or long temporal baseline interferometric pairs, although the interferograms of these pairs are totally decorrelated. It has been observed that some features,especially some man-made structures maintain high coherence over long time scales and in the the case of long spatial baseline,some of these man-made features only show pointwise information on the interferograms and have the characteristics of point target scattering on SAR images,which lead strong backscattering in one or several pixels and maintain relatively stable amplitude and phase in a long time run, so these pointwise radar information can guide us to match the same point or point-like scatterers and find the correlatted pixels,eventually estimate the shift vectors of pixels and transfer the slave image to the master geometry. In this paper, a coregistration algorithm based on point-like scatterers is proposed, which includes the following steps: (1).Coarse coregistration by precise orbit data and DEM to the accuracy of several pixels. (2).Selecting top values and isolating the most likely point-like scatterers. (3).Matching these selected points and then consistency test. (4).Within pixel matching. (5).Estimating the coarse parameters of the polynomial. (6).Within-pixel correlation and remove the influence of the incorrect matched points. (7).Caculating the polynomial and interpolating the slave image. Furthermore, the effects of topography to the coregistration are studied by simulation and real SAR data of the mountainous area, a correcting method is proposed to diminish the topographic induced coregistration error. At last this algorithm is tested and evaluated by SAR interferometric data of various areas.

Abstract No. 651

Multipolarimetric Envisat Interferometry: Techniques and Preliminary Results

P. Pasquali[1], A. Monti Guarnieri[2]

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[2] *Politecnico di Milano, Italy*

In the paper we summarize the capabilities, the techniques and the possible application achieved by combining interferometrically either two Envisat Alternating Polarization (AP) acquisitions or one AP and one Image Mode (IM) surveys. The AP mode is an innovative technique that exploits ScanSAR principle to switch on polarization instead than swath. In that way, two different polarizations can be obtained in one acquisition. The combination of one AP acquisition and one IM mode allows the generation of two interferogram with different polarizations. A further interferogram can be generated by differentiating these two ones: this interferogram will carry information on the "polarimetric phase difference", i.e. the polarimetric behavior of targets. This interferogram will not be influenced by atmospheric or topographic artifacts; however a good quality can be achieved only on those targets that are long term stable. Further information will be provided by the coherence maps that can be generated by different polarizations.In the paper, we present the technique and the possible combinations of AP / AP / IM images, and we show some results achieved in processing real Envisat datasets, with comments to possible applications.

Abstract No. 678

Combination of ERS and Multiple Modes of Envisat SAR Data for Differential Interferometric Applications

J. Closa[1], J. Duro[1], J. Inglada[2], A. Arnaud[1]

[1] *Altamira Information, Spain*

[2] *CNES, France*

Multiple applications have arisen since the launch of the ERS-1 and ERS-2 satellites which use repeat pass interferometric techniques. In order to commercialize these applications and give long term information it is required that the availability of each acquisition over a certain area is ensured with a certain frequency which is specific of each application and under certain conditions. The launch of Envisat in 2002 carrying onboard the more advanced SAR (ASAR) gives continuity to this data acquisition and offers the possibility to continue providing good quality services. The instrument's capability has been enhanced with respect to the ERS SARs by extending the acquisition modes to those in different polarization combinations and/or the use of ScanSAR to

increase the swath length. However this is not always an advantage since it enters in conflict with the use of the ERS like mode (Image Mode in IS2 incidence angles and VV polarization) systematically necessary for the long-standing applications and data is not always acquired in the desired mode. The combination of ERS and ASAR data in Image Mode has already been demonstrated by the use of large baselines in classical interferometry as well as the continuity in their phase measurements. This study will show the introduction of the Alternating Polarization and the experimental Wide Swath mode complex products in order to be used in interferometric applications and their operational use to derive small subsidence displacements. Results of the introduction of phase measurements derived from such products in long time series of ERS and ASAR Image Mode data to obtain subsidence maps and the continuity with the rest of data take sequence will be shown.

Abstract No. 276

Improving the Quality of ERS-Envisat Interferograms

C. Prati[1], F. De Zan[2], A. Ferretti[3], F. Rocca[4]

[1] *POLIMI, Italy*

[2] *Polimi, Italy*

[3] *TRE - Srl, Italy*

[4] *Politecnico Milano, Italy*

The spectral shift mechanism allows distributed scatterers interferometry on ERS-Envisat pairs, provided that the normal baseline is close to the so called compensation baseline (for flat terrain). The same principle, however, shows that the common band is heavily dependent on the local terrain slope. In order to retrieve the common part of the spectrum one should a priori know the local slope, which might not be the case. Attempts to recover such information from the unfiltered interferogram itself are bound to failure when the common band is less than a certain fraction of the total band. A new technique is proposed seeking to determine the best possible common band filtering and the local slope at the same time in a Maximum-Likelihood style approach. A bank of filters is employed and the two images are filtered in many ways (one for each local slope hypothesis). Subsequently the slope that maximizes the a posteriori interferometric coherence is chosen as the most probable solution. This approach could be extended to a multi-image framework. Experiments have been carried out both on synthetic and real ERS-Envisat data The a posteriori coherence is also a good indicator of volumetric effects, since after spectral shift filtering the geometric decorrelation should not affect the interferogram. Given the short time lag (30 minutes) between the ERS and Envisat acquisitions, a small temporal decorrelation is expected.

Poster Session 2P11:

SAR Signal Processing (Interferometry)

Abstract No. 39

A Re-Appraisal of the 1992 Landers Earthquake InSAR Data Using the Ambiguity Search Method

M. Warren, A. Sowter, R. Bingley
University of Nottingham, United Kingdom

The 1992 Landers earthquake is perhaps the most famous earthquake for InSAR, having been the subject of many different scientific journal, magazine and newspaper articles. This plethora of papers means that the site is very well known and any attempt to process the data should be able to confidently predict the results. The ambiguity search method, proposed in 2003, offers a potential procedure for DINSAR that appears to have some benefits when there is no terrain model or when ground control is sparse, even over mountainous terrain. In this paper, an attempt to re-create the classic Landers results using the new process is described. The results are compared with previous results and also with GPS data freely available over the region.

Abstract No. 41

An Assessment of the Ambiguity Search Method for DEM Generation and Land Motion Detection Using Spaceborne InSAR Data

A. Sowter, M. Warren, R. Bingley
University of Nottingham, United Kingdom

In 2003 a method for the solution of the integer phase ambiguity in InSAR data was proposed and demonstrated using laboratory data. The method does not follow the usual procedure of phase flattening but rather uses the absolute phase and a rigorous radargrammetric model to derive the absolute 3-dimensional position of a target. This method appeared to show some capability for absolute, as opposed to relative, positioning and showed some benefits in applications where accurate DEMs are not available and there is little ground control. This paper explores this approach further, this time using ERS data for DEM generation and for 3-pass differential InSAR, appropriate for remote areas. The methodology is applied rigorously and compared with alternative approaches using flattening and phase ratios. The results are quantitatively compared with GPS data in each case and the benefits and drawbacks highlighted.

Abstract No. 679

High Resolution Differential Interferometry using time series of ERS and Envisat SAR data

J. Closa[1], J. Duro[1], J. Inglada[1], N. Adam[2], A. Arnaud[3]
[1] Altamira Information, Spain
[2] DLR, Germany
[3] CNES, France

During the last ten years, a long history of data has been acquired by the SAR sensors on board the ERS-1 and ERS-2 satellites offering a wide range of interferometric applications. With the launch of Envisat in 2002, the more advanced SAR (ASAR) has given continuity to the success of the remote sensing mission of the ERS satellites by ensuring and increasing the value of the archived ERS data. The subject of this study under ESA's 3rd Announcement of Opportunities is to demonstrate the continuity of the interferometric measurements obtained from the combination of long temporal series of SAR differential interferograms in order to derive small subsidence displacements. The implemented technique makes use of either ERS SAR or ASAR differential phase measurements to generate long term terrain movement maps with the same resolution as the original SAR images without spatial interpolation. The algorithm is capable to use all the available phase information even in conditions of large baselines or platform instabilities giving place to large Doppler centroid variations. Such artifacts are handled by precise location estimate of the scatter within the pixel and accurate elevation extraction. One interesting by-product of this technique is the interpretation of the DEM errors as an approximation of a DSM (Digital Surface Model) in low density urban and peri-urban environments and the use of such measurements to improve precise target positioning. Continuity on the displacements measured from both sensors after atmospheric artifacts removal will be shown in the results.

Abstract No. 730

A New Approach for Estimating Crustal Deformation Fields Using DInSAR and Permanent Scatterers: Preliminary Results

A. Kohlhase[1], K. Feigl[2], A. Ferretti[3], D. Massonnet[2]
1 DLR, Germany
2 CNES, France
3 TRE, Italy

The usefulnes of long-term Differential Interferometric SAR (DInSAR) for measuring inter-seimsic strain fields is mainly constrained by the magnitude of the overlaid Orbital (OPS) and Atmospheric Phase Sreen (APS) as well as temporal decorrelation. To encounter the problem with the orbital errors in the interferometric measurement, the standard approach is to subtract a linear phase ramp from the interferogram distorting or even removing the deformation fringes. Furthermore, topographic artifacts can be in the magnitude of the signal making the measurement ambiguous. We propose a solution how to improve the Signal-to- Noise Ratio (SNR) by modeling the orbital effects with a new Orbital Tuning Approach (OTA) and by applying the Permanent Scatterers (PS) technique. If the interferometric time interval is shorter than a critical temporal baseline, the use of high-precise or improved orbit estimates is sufficient for velocity field estimation with DInSAR assuming small and known atmospheric/topographic artifacts. In the other case, we consider the application of the PS technique combined with the new OTA. First, we use this approach to improve 6 shortarc European Remote Sensing (ERS) orbit estimates to measure a post-seismic deformation field in Landers/California after the 28 June 1992 earthquake. We recalculate an interferogram whose SAR images were acquired on 7 August 1992 and 18 June 1993 by using the corresponding and improved short-arc orbit estimates. The interferogram calculated with the post-fit orbital estimates compares favorably with that corrected with the conventional one and shows the geophysical deformation more clearly than in previous studies. Then, we process 42 ERS SAR images between August 1992 and June 1998 to identify PS. First estimation of the PS velocity field reveals a regional and inter-seismic gradient of about 0.25 mm/yr per km with a maximal Line-Of-Sight (LOS) standard deviation of about 3-4 mm/yr. Modeling the inter-seimic range change field from horizontal GPS velocity measurements calculated by the Southern California Earthquake Center (SCEC) confirms the general trend of the PS analysis. The removal of a superimposed linear phase component drops the LOS standard deviation under 0.5 mm/yr. This enables the recognition of local phenomena, such as post-seismic or anthropogenic subsidence but removes the inter-seismic contribution to the phase signal too. The new OTA can improve absolute quality of precise ERS short-arc orbit estimates. However, atmospheric phase contributions are still an uncertainty because they create high standard deviations in the estimated adjustment components. The post-fit interferograms are only useful if they are temporally and geometrically well-correlated. But it is necessary to have a new optimization approach producing reliable and high-accurate baseline estimations both from ERS and RADARSAT orbit data. PS analysis promises to be a useful tool for geophysical deformation studies in bare and non-urban areas. To minimize the noise coming from orbital and atmospheric effects, the number of SAR acquistions must be very high (n >20). As a consequence, we will apply the OTA to the whole set of ERS SAR data to adjust as much short-arcs as possible to further improve the SNR in the PS velocity field estimation. Interpreting the observed features in terms of geophysical modeling and of temporal series evolution of selected PS, however, will require further research effort.

Tuesday 7 September
16:10 – 17:50

Mozart 1-2

Session 2D2:

Coastal Studies (3)

Abstract No. 520

Atmospheric Fronts off the East Coast of Taiwan Studied by ERS SAR Imagery

W. Alpers[1], J. Chen[2], I. Lin[3]
[1] *University of Hamburg, Germany*
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Atmospheric fronts off the East coast of Taiwan studied by ERS SAR imageryWerner AlpersCenter for Marine and Climate ResearchInstitute of OceanographyUniversity of HamburgHamburg, GermanyJen-Ping ChenDepartment of Atmospheric SciencesNational Taiwan UniversityTaipei, TaiwanI-I LinNational Center for Ocean ResearchTaipei, TaiwanAbstractA large number of ERS SAR images acquired during descending paths of the ERS-1 and ERS-2 satellites along the East coast of Taiwan show very pronounced sea surface manifestations of atmospheric fronts running almost parallel to the coast at a distance between 30 and 60 km from the coast. The formation of these atmospheric fronts is linked to land-sea breeze effects resulting from differing heating of air over land and water. A unique feature encountered at the East coast of Taiwan is that there the air circulation is strongly affected by a high coastal mountain wall (up to 3952 m) and by heating of the air by the warm waters of the Kuroshio Current. We have analyzed in detail several ERS SAR images showing distinctive radar signatures of frontal features and compared them with cloud images obtained from the Japanese Geostationary Meteorological Satellite GMS-4, the NOAA satellites, and the TERRA and AQUA satellites (MODIS images) as well as with sea surface wind maps derived from Quikscat data. Also meteorological data obtained from weather maps, radio soundings, a weather station located at the island of Lutao, and from ships of opportunity have been used in the analysis. Finally, a high resolution regional atmospheric model has been applied for interpreting the sea surface manifestations of the atmospheric frontal features visible on the ERS SAR images.

Abstract No. 542

Ocean Surface Polarization Signature

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As recently proposed by Elfouhaily et al., radar polarization signatures may be associated to the shape of the surface elevation correlation function. The Envisat ASAR AP modes offer the unique ability to probe the same observed surface with both polarization states. In this presentation, we shall discuss the use of such a wealth of information in light of our proposed scattering model, to interpret ocean surface radar signatures.

Abstract No. 11

Modelling of SAR Signatures of Bathymetric Features in the Bristol Channel Using a Coupled Wave-Current Model

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Spaceborne synthetic-aperture radar (SAR) images from ERS and Envisat over the period 1995 - 2003 are analysed for two areas of sandbank in the Bristol Channel, namely the Nash and Helwick Banks. The bathymetric signatures in these images are modelled using the outputs from a current model (POLCOMS) coupled to a third-generation wave model. The results show good agreement with a simple model where the SAR image signature is proportional to the gradient of the current across the bathymetric feature. However, the imaging geometry for these Bristol Channel sites implies that wave motions have a significant effect on the SAR signatures. This effect introduces a bias in the ability to image the features on ebb and flood tides for ascending and descending passes.The POLCOMS results reveal the two-dimensional structure of the surface currents in the presence of the bathymetry. The modelling of this structure for idealised cases of current flow shows the relative importance of bottom friction and continuity of flow. The assumption of local one-dimensional flow which has been used by many authors appears to be a reasonable approximation for many cases, but more complicated behaviour is expected around the edges of bathymetric features. The effects of two-dimensional flow can therefore be incorporated as a correction to existing schemes which relate the bathymetry to the local one-dimensional flow.The sequences of SAR images from 1995 - 2003 show no evidence for significant changes in the location and shape of the bathymetric features. In situ surveys show complex changes during this period, with shifts of order 100 m in the locations of the sandbank crests. While there is some dredging in these areas, the dominant changes appear to be associated with natural processes.The implications for the planned TerraSAR mission are assessed. The lower radar frequency of this mission (L band) is expected to lead to more clearly imaged bathymetric features, as well as a better ability to detect small changes in the location and shape of bathymetric features.

Abstract No. 245

Application of Spaceborne SAR for Bathymetric Monitoring

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Under suitable conditions (moderate wind and strong tidal current) the topography of shallow seas may be visible in radar images. It is generally agreed that this is caused by wave-current interactions. The Bathymetry Assessment System (BAS) uses this phenomenon to optimize time and cost consuming bathymetric surveys.In the BAS a two-dimensional model for the imaging mechanism is inverted numerically by minimizing two penalty functions simultaneously within an efficient multi-grid scheme. The first penalty function contains three terms: one for the deviation between calculated and actual radar modulations, one for the difference between calculated and measured depths (echo soundings), and a smoothness criterion. Optionally, the directionality of the smoothness criterion can be modified by optical imagery showing tidal channels. The second penalty function determines the small-scale flow field associated with the bottom. In the minimizing process also some model parameters determining the amplification factor between current gradients and surface roughness are estimated. In this manner a semi-empirical but very flexible and powerful imaging model is obtained. The BAS finds the bottom that fits best to the echo soundings, the radar image (or images), and the smoothness criterion.The BAS needs one or more radar images as its input, but also a limited number of echo soundings. It should be stressed here that the BAS doesn't replace echo soundings. It merely acts as an intelligent interpolator that needs less support points than traditional methods because it uses physical information from satellite data. Typically, the BAS needs only one third of the echo soundings for constructing a depth map with the same quality compared to traditional methods.Operational services based upon the BAS are commercially available at ARGOSS, a value adding company. Rijkswaterstaat, being responsible for coastal monitoring of the Netherlands, and the EC show great interest in the BAS. At this moment the system is being tested by Rijkswaterstaat to determine its operational merits. If these tests are all satisfactory, the system will be considered as an operational alternative measurement tool. Within the EC fifth framework project OROMA the performance of the BAS is studied in a wider perspective.In this contribution the status of these tests will be reported. Recent results will be presented and discussed. Particular attention will be paid to accuracy and costs.

Abstract No. 105

Mapping Surface Roughness and Sediment Texture of Intertidal Flats Using ERS SAR and Envisat ASAR Imagery

D. Van der Wal[1], T. Ysebaert[2], P. Herman[2], A. Wielemaker-Van Den Dool[2]

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High resolution, synoptic information on surface characteristics of estuarine intertidal flats, such as surface roughness and sediment texture, is required as input for, for example, hydrodynamic models and for habitat mapping. This study aims to derive such information from space-borne Synthetic Aperture Radar. Estimates of the backscatter coefficient sigma-nought were extracted from a series of ERS-1 SAR and ERS-2 SAR PRI and Envisat ASAR IMP_P imagery, acquired during low tide, of two intertidal flats in the Westerschelde, an estuary in the southwest of the Netherlands. The data were related to matching field measurements of surface roughness, interstitial moisture, surface water and sediment texture. In accordance with predictions by analytical backscattering models, such as the Integral Equation Model, a significant positive relationship was found between surface roughness RMSz and the backscatter coefficient estimate. Surface roughness was also significantly correlated with sediment grain-size, with surface ripples being more pronounced in coarser (sandy) sediment. This resulted in a significant negative correlation between silt content and the backscatter coefficient estimate, and a significant positive correlation between median grain-size and the backscatter coefficient estimate. The relationships between sediment texture and backscatter were generally consistent in time, both for different seasons and years. The moisture content of the sediment was too high to significantly alter the backscatter coefficient. The presence of surface water, on the other hand, significantly affected the backscatter signal. The relationships found allowed the development of a semi-empirical relationship for the prediction of surface characteristics from SAR/ASAR imagery, which can be used for mapping both surface roughness and sediment texture.

Tuesday 7 September
16:10 – 17:50

DOPPLER

Session 2D3:

Trace Gases (1)

Abstract No. 15

Equatorial Kelvin Wave Signatures in Tropical Ozone Measurements from GOME

R. Timmermans, H. Kelder, R. Van Oss
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Kelvin waves play an important role in the dynamics of the tropical atmosphere. When propagating vertically, they carry momentum into the middle and upper atmosphere, which is believed to influence the quasi-biennial oscillation in the lower stratosphere and the semi-annual oscillation in the upper stratosphere and mesosphere.In addition to temperature fluctuations, Kelvin waves also induce fluctuations in the ozone concentrations either through motions or the temperature dependence of the photochemical reactions. Therefore ozone observations can be used to identify Kelvin waves.This study investigates tropical Kelvin wave signatures in GOME (Global Ozone Monitoring Experiment) ozone data and the correlation with corresponding Kelvin wave signals in the ECMWF ERA-40 wind and temperature fields.The study demonstrates the sensitivity of the GOME measurements to tropical Kelvin waves, showing the potential of the GOME ozone data set to contribute to a global description of equatorial Kelvin wave activity.

Abstract No. 532

Ozone in the Middle and Upper Atmosphere as Observed by MIPAS/Envisat

M. Kaufmann[1], S. Gil-Lopez[2], M. López-Puertas[2], B. Funke[2], M. Koukouli[2], H. Fischer[3], T. Von Clarmann[3], G. Stiller[3], N. Glatthor[3], U. Grabowski[3], M. Hoepfner[3], S. Kellmann[3], M. Kiefer[3], A. Linden[3], G. Mengistu Tsidu[3], M. Milz[3], T. Steck[3], D. Wang[3]
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[2] *IAA, Spain*
[3] *IMK, Germany*

The MIPAS/Envisat instrument is able to measure vertical profiles of mid-infrared ozone limb radiance from the tropopause region up to the lower thermosphere. Ozone fundamental bands at 10 and 13 micron are used to retrieve ozone densities from 20 km to 100 km by means of a non-LTE model that couples collisional, radiative, chemical and photochemical processes.Ozone hot bands in the 5 micron regime are very sensitive to non-LTE model parameters, particularly with regard to the choice of the kinetic model and the surprisal of the recombination reaction O+O2+M which forms highly excited O3 molecules.The high spectral resolution of the MIPAS instrument makes it

possible to resolve the different hot bands of ozone and in combination with a non-LTE model gives a unique opportunity to study the above physical processes.

Abstract No. 568

Trace Gas Measurements from the SCIAMACHY Validation Dataset: O3, BrO, and HCHO

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SCIAMACHY nadir spectral measurements are analyzed using a radiancefitting technique to provide slant column abundances of O3, BrO, and HCHO. Fitting includes improved wavelength calibration and slit function determination, quantitative correction for the Ring effect, and undersampling correction. Vertical column abundances are determined from the fitted slant column abundances using air mass factors that include a combination of radiative transfer modeling and chemical transport modeling. These values are then compared to Envisat validation measurements and, where possible, to column measurements from GOME.

Abstract No. 325

Measurements of Water Vapor in the Lower Stratosphere and the Tropopause Region with MIPAS/Envisat

M. Milz, T. Von Clarmann, H. Fischer, N. Glatthor, U. Grabowski, M. Höpfner, S. Kellmann, T. Steck, G. Stiller
Universitaet Karlsruhe/Forschungszentrum Karlsruhe, Germany

Water vapor is an important gas in the atmosphere. Its significance for the natural green house effect requires the knowledge of the global distribution to assess its influence on the radiative budget. Additionally water vapor in the tropopause region is a suitable tracer to observe transport processes from the troposphere to the stratosphere and vice versa.The satellite borne Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) onboard the European research satellite Envisat provides global measurements of water vapor and other atmospheric state parameters. MIPAS is a high resolution limb sounding Fourier spectrometer measuring atmospheric emission spectra in the mid infrared from which vertical profiles of numerous trace species can be retrieved. In the standard measurement mode MIPAS provides profiles covering a nominal altitude range from 6 to 68 km.Retrievals with the IMK data processor covering the upper troposphere and the lower stratosphere are presented. Examples will be emphasized where large scale indications for exchange processes in the tropopause region can be seen. In the tropics the large scale ascent of very dry

stratospheric air as a consequence of the Brewer-Dobson-Circulation is clearly visible. In the subtropics measurements of enhanced water vapor volume mixing ratios above the thermal tropopause hint towards possible troposphere to stratosphere transport processes.

Abstract No. 603

Water Vapour and Methane Abundances under Non-LTE Conditions from MIPAS Upper Atmosphere Measurements

M. Koukouli[1], M. LoPez-Puertas[2], B. Funke[2], M. Kaufmann[2], S. Gil-LoPez[2], T. Von Clarmann[3], H. Fischer[3], N. Glatthor[3], U. Grabowski[3], M. Höpfner[3], S. Kellmann[3], M. Kiefer[3], A. Linden[3], G. Mengistu Tsidu[3], M. Milz[3], T. Steck[3], D. Wang[3]

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We present a radiative transfer analysis of water vapour and methanefrom the Upper Atmospheric mode MIPAS spectra, with a spectral rangeof 685-2410 inv. cm. (4.1-14.6 micron) and retrieval altitude rangeof approximately 20-80 km. The Generic RAdiative traNsfer AnD non-LTEpopulation Algorithm (GRANADA), jointly developed by the Instituto deAstrofica de Andalucía (I.A.A.) and Institut für Meteologieund Klimaforschung (I.M.K.), has been used to analyse ten upper atmosphereorbits, from July 2002 and June 2003.The retrieved vertical profiles of both gases are compared andcalibrated against other modent water vapour experiments in the corresponding vertical and spacial co-locations. Globalthree-dimensional maps are also presented and validated againstgeneral circulation modelling results. The total hydrogencontent of the Earth's middle atmosphere will also be investigated asmeans of identifying possible sinks or sources in the water vapour andmethane day-night variability.For the first time, direct spectral evidence for non-LTE state in themethane v4 band, emitting near 7.6 micron ,in the mesosphere haebeen observed and will be discussed. The high spectral resolution of themeasurements (0.025 inv. cm.) further offers the unique opportunityto retrieve non-LTE parameters for the main collisional processes involving vibrationally excited statesof water vapour and molecular oxygen.

Tuesday 7 September
16:10 – 17:50

MOZART 3

Session 2D4:

MERIS Signal Processing

Abstract No. 203

Do MERIS, SeaWiFS and MODIS Products Measure up to the Requirements of Coastal Monitoring?

C. Brockmann[1], K. Stelzer[1], R. Vaughan[2], M. Slater[2], S. Dury[3], H. Hakvoort[3], R. Jordans[3], G. Hesselmans[4], W. Krzyminiski[5], B. Piliczewski[5]

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Optical remote sensing can be used to monitor important water quality parameters, most notably total suspended matter and Chlorophyll, which provide indications of phytoplankton concentrations. This information is required in coastal waters for a number of reasons, including the determination of eutrophication status. Under the authority of the Oslo and Paris Commissions (OSPAR), the condition of sea areas covered by the OSPAR convention is kept under continuous review. Both the Southern North Sea and Baltic Sea's coastal zones have been defined as eutrophication problem areas (OSPARCOM, 1995), and consequently under the "OSPAR Strategy to Combat Eutrophication" (OSPAR, 1998) the nations of the European Union are required to identify the eutrophication status of its maritime area. Proper monitoring of phytoplankton (through chlorophyll), is therefore essential. National monitoring agencies, such as RWS in the Netherlands or IMGW in Poland are under an increasing pressure to fulfil these requirement whereby the available budget is decreasing. This study aims at an assessment of the potential to replace in-situ measurements at least partly by remotely sensed data.A variety of optical measurements of the Marsdiep and Western Scheldt sites have been undertaken or acquired, including: 1) Ship borne measurements: spectra of subsurface reflectance R(0-); and spectra of specific inherent optical properties and 2) Acquisition of relevant satellite (MERIS, SeaWiFS, MODIS) images: spectral images of normalized water-leaving radiance and standard Level 2 algal/chlorophyll products. Two recent developments (2002) associated with global environmental monitoring sensors at medium spatial resolution have been the introduction of a second MODIS instrument (Aqua) and MERIS onboard Envisat. MERIS is a particularly promising instrument for coastal zone phytoplankton and general water quality monitoring with 15 ocean colour specific channels and 300m spatial resolution.In situ measurements of amongst others sediment and chlorophyll concentration were collected from both OROMA project specific cruisers and via fixed stations in the North Sea associated with the DONAR database at RWS. This provides the opportunity to undertake two types of time series analyses: 1) Incorporating remote sensing products with field observations to provide an enhanced time series monitoring of DONAR and field sites i.e. Marsdiep and Western Scheldt. 2) Case study comparisons between water quality parameters derived from field observations and the range of different sensors and their associated atmospheric/water IOP models.In-situ data are lacking spatial and temporal coverage, while remotely sensed data suffer from cloud coverage, sun glint and improper atmospheric correction. The results of the analysis show that the satellite data fit

statistically into the existing time series if regionally adapted algorithms are applied, and that significant additional value is gained by the complementary two different methods. This is acknowledged by the monitoring agencies who will further investigate the use of remote sensing data. Especially more MERIS data at both full and reduced resolution are required to be included in the statistical analysis.

Abstract No. 313

Retrieval of Land Surface Reflectance and Albedo from MERIS Data

L. Guanter, J. Moreno
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In order to achieve an accurate retrieval of surface reflectance and biophysical parameters from MERIS images, some previous preprocessing is needed. In particular, the removal of the atmospheric effects from the Top-of-Atmosphere (TOA) radiance measurements is a key task to obtain the maximum information from the data. In terms of atmospheric correction, the bottleneck usually appears in the characterization of the main atmospheric variables coincident in time and area with the image acquisition. Apart from specific field campaigns, where atmospheric ground measurements might be available, the atmospheric state is mostly given by default model values or by ancillary data from close meteorological stations. The first approach leads to unrealistic values in non-standard conditions, whilst the second fails in the temporal and spatial overlapping requirement very often. Thus, a challenging matter inatmospheric correction issues is to develop algorithms that can extract the needed atmospheric information from the data itself.In this way, the high-multispectral resolution of Envisat MERIS, as well as of other recently launched sensors, makes possible to characterize the atmospheric state by means of the inversion of the TOA radiances measured in the suitable bands. In this paper we want to present an aerosol and water vapor retrieval algorithm specifically designed for MERIS, even though its solid principles make it works for any hyperspectral sensor with little modifications. The final objective of the algorithm is to obtain physical knowledge on the atmospheric aerosols and water vapor content, to derive surface reflctance and spectrally integrated albedo from the image. The fundamental basis lies on a multiple parameters inversion for heterogeneous clusters of various pixels in the image, considering invariant the atmosphere in a window above them for numerical stabilization reasons. Reflectance in the surface level for each pixel is modelled as a linear combination of two typical vegetation and soil spectra. The atmospheric contribution to the TOA signal is evaluated with the 6S radiative transfer code. In this contribution the information relative to gaseous abundances, except from water vapor, and its vertical profiles are fixed, whilst four parameters are left free for aerosol characterization. These are the aerosol optical depth in 550nm and the percentage of the four aerosol species implemented in the 6S code (dust-like, water soluble, oceanic and soot types). Once the atmospheric reflectance and transmission functions are known, the surface reflectance and albedo are retrieved for the area covered by the window. Albedo retrievals are possible by modelling the spectral variability across the spectrum, in a consistent way with the method used to retrieve aerosols. The algorithm has already been applied to a wide range of images with different reflectance properties, from bright arid regions to dark forest canopies and inland waters. To validate the algorithm it has

been initially checked with MODTRAN4 MERIS simulated TOA spectra, retrieving both atmospheric and surface parameters in good agreement with forward conditions. Further validation has been made using the SPARC campaign atmospheric measurements (solar extinction and radiosoundings), finding a good agreement with the algorithm retrievals. The intercomparison with coincident CHRIS/PROBA data is also very consistent.

Abstract No. 405

A Method for Atmospheric Correction Based on the MERIS Spectral and Spatial Variability

D. Béal[1], F. Baret[1], C. Bacour[2], G. Derive[1], K. Pavageau[1], X. Gu[1]
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[2] *LSCE, France*

Atmospheric correction is necessary to estimate the surface reflectance required within biophysical algorithms usedto estimate canopy characteristics. Aerosol characterization is obviously one of the main problem in atmosphericcorrection because aerosol may vary rapidly with time and space. The objective of this study is to develop anautonomous aerosol correction method exploiting the information content in MERIS images.The spectral variation of the radiance signal, when enough sampled by the sensor, allows decoupling aerosol effectsfrom that of the surface because of the very different spectral features exhibited. We thus propose to use (i) 13over the 15 MERIS bands, (ii) the geometry of the scene and (iii) the atmospheric pressure and ozone and water vapourcontents to estimate the aerosol optical thickness (AOT) assuming only continental aerosol type in this prototypealgorithm. For this purpose, several dedicated neural networks were trained to retrieve aerosol AOT from the top ofatmosphere signal contained in MERIS level 1B products. The training database was generated with radiative transfermodel simulations, SMAC coupled to SAIL and PROSPECT.Performances demonstrate the pertinence of the method for the median of 5 neural networks, with a 0.047 Root MeanSquare Error associated to the estimation of the AOT at 550nm. This induces a RMSE on the estimated top of canopyreflectance better than 0.005. In addition, assuming that the aerosol vary typically over scales of few tenths ofkilometers, while the surface varies at shorter distances, allows to smooth out the AOT values for all pixels ofan image using a moving window. The method was applied to actual MERIS data (more than 50 scenes) over AERONETsites for its validation with a 0.07 Root Mean Square Error associated to the estimation of the AOT.Conclusions are drawn on possible improvements of the database and of the neural network's architecture like thenumber of entries and the inclusion of different aerosol types.

Abstract No. 517

MERIS LAI, fCover, fAPAR and Chlorophyll Content Products: Principles and Validation

F. Baret[1], V. Bruniquel[2], C. Bacour[1], K. Pavageau[1], M. Weiss[2], D. Béal[1], B. Ruelle[1]
[1] INRA-CSE, France
[2] Noveltis, France

Biophysical variables such as LAI, fAPAR, fCover or the chlorophyll content are canopy state variables required to constrain process models and to monitor vegetation at regional to global scales. Dedicated products have been developed from top of canopy reflectance data. The main principles of these algorithms are presented and discussed. They are based on neural networks trained over a dedicated data base that reproduces the distribution of the main variables over the Earth's surface. The inputs are 11 over the 15 MERIS bands, along with the geometry of observation. Validation elements are then presented, mainly consisting in the comparison with other products as well as to actual ground measurements collected over few VALERI sites. The performances of these products are discussed and ways for improvements drawn out. These products were incorporated within the BEAM environment to be easily applied over MERIS data.

Abstract No. 550

New Features in BEAM, the Envisat MERIS & AATSR Toolbox

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BEAM is an application suite which facilitates the utilisation, viewing and processing of the Envisat MERIS, AATSR and ASAR data products. The software is being developed by Brockmann Consult GmbH under contract to the ESA. Continued as an open source project, BEAM has become the definitive, freely available software used throughout the Envisat scientific user community. Thanks to its 100% pure Java implementation, it is available for the Windows, Linux, Max OS X, Solaris and other Java enabled operating systems. Today, BEAM is in use by many end users of MERIS and AATSR data and even the Envisat Cal/Val team makes significant use of BEAM's analysing, visualizing and processing capabilities. The success of the open BEAM software package was also made clear during the first MERIS User Workshop held at ESRIN in November 2003 in that a growing number of users are already using or are willing to use the application programming interfaces of BEAM for their own developments using the Java, C and IDL programming languages.The new version of BEAM includes many new tools and extensions most requested by

end-users. Important new features include a configurable MERIS Level 2 processor, a MERIS ortho-rectification tool and improvements to VISAT, the intuitive visualization and analyzing application of BEAM. The MERIS Level 2 processor as implemented in the Envisat Ground Segment is a very complex processing system composed of a number of processing elements each of them using extensive auxiliary data for configuring the specific processing branch. For the operational generation of standard MERIS L2 products, algorithms have been tuned and auxiliary data have been chosen such that best quality products can be achieved on a global scale, i.e. under all observation situations of MERIS and many different environmental conditions. However, in many situations higher product quality can be achieved if the processing is performed with individually adjusted processing parameters on a scene by scene basis. The BEAM implementation of the Level 2 processor allows users to adjust processing parameters according to their special needs. The first version of the BEAM processor concentrates on MERIS Level 2 ocean products, such as the concentration of chlorophyll, total suspended matter and yellow substance and photosynthetically active radiation. The interactive ortho-rectification tool allows for improved geo-coding accuracy for MERIS data using ground control points and an underlying DEM dataset. The tool has been implemented as a stand-alone tool for batch processing as well as a BEAM plug-in, so that it can be invoked from VISAT's main menu.Thanks to numerous feedback and direct consultation with BEAM users many valuable features and improvements have been implemented into VISAT, and includes image export as GeoTIFF which improves the existing TIFF support by adding geo-referencing to the stored image. The list of available projections has been expanded to include the Lambert Conformal Conic, which is a widely used map projection and is especially used for large scale maps, such as for Level 3 products. Many users will also appreciate the possibility to transfer a selected region of interest (ROI) to other bands by keeping the geographical coordinates of the geometric shapes chosen. Besides many other visualisation enhancements, the zooming and panning tools have been optimized, especially for very large images.

Tuesday 7 September   Wolf-Dietrich 1-2

Poster Session 2P13:

MERIS Signal Processing

Abstract No. 93

Development of Operational Processing Lines of the Cyclopes Project

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[5] *INRA, France*

The objective of CYCLOPES is to develop and validate biophysical variables (albedo, LAI, fAPAR, fCover) from large swath sensors (AVHRR, VEGETATION, POLDER, MERIS). The algorithm includes the fusion of concurrent sensors observations when available and will aim at providing long, continuous and consistent time series.The CYCLOPES products are global fields of these variables and the associated uncertainties over the 1997-2003 period, with a 10 days temporal resolution and a spatial resolution between 1 to 8 kilometres. The use of these products is then demonstrated for two important applications in relation to climate change : the detection and categorization of land use change detection, the estimation of carbon fluxes to improve the description and understanding of the vegetation - atmosphere interactions. The version 1 of algorithms including calibration, cloud screening, atmospheric correction, multitemporal synthesis, biophysical algorithm, and multisensor fusion has been coded in several modules and implemented at MEDIAS. These processing lines will be incremental. Once a module has been enhanced, the whole line could be rapidly updated, and the products reprocessed. CNES provided a breadboard qualification line to MEDIAS for VEGETATION and AVHRR. Meteo-France provided ATBDs concerning the directional normalisation, the biophysical products, and the multisensor fusion. Then the processing lines of the version 1 have been prototyped for the AVHRR, VEGETATION and POLDER sensors by MEDIAS. The version 2 will integrate the processing lines for MERIS. It will be done using partially BEAM modules. We will present the modular architecture of the processing lines, the definition and the format of the different output products. We will also analyse the performance of the processing lines. The first results of version 2 will be presented.

Abstract No. 178

Colour Display Strategies for Enhanced Representation of MERIS Data

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The Medium Resolution Imaging Spectrometer (MERIS) is one of ten sensors onboard Envisat. It records visible and near-infrared radiation reflecting from the earth surface across a range of up to 15 programmable wavebands, to a resolution of either 1200 or 300 metres [1]. The flexibility and the improved radiometric and spectral performance designed into the instrument means that scientists can make use of MERIS data across many different fields, variously obtaining information on Earth's oceans, coastal zones, land surfaces and atmosphere.In this work 15 bands of full resolution (FR) Level 1 data and 300m spatial resolution were used. The MERIS bands exhibit a high degree of correlation and thus complementary information is dispersed among the source bands. The main purpose of this work is to provide alternative display strategies [2,3] that will give a compact colour representation of the scene and incorporate all salient features of the original bands [4]. For this reason, measures from information theory and feature extraction techniques are employed in order to provide an image with improved interpretation capabilities. Three different approaches, aiming at different goal and revealing different spectral characteristics are described in this work along with a comparison of these alternative representations.References [1] MERIS Users Handbook[2] J. Tyo, A. Konsolakis, D. Diersen, R.C. Olsen, "Principal-components-based display strategy for spectral imagery", in IEEE Transactions on Geoscience and Remote Sensing, vol. 41, no. 3, pp. 708-718, March 2003.[3] V. Tsagaris and V. Anastassopoulos, "Multispectral image fusion for improved RGB representation based on perceptual attributes", submitted in International Journal of Remote Sensing.[4] D. Malacara, "Color vision and colorimetry: theory and applications", SPIE Press.

Abstract No. 179

Feature Extraction of MERIS data

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The Medium Resolution Imaging Spectrometer (MERIS) is one of ten sensors onboard Envisat. It records visible and near-infrared radiation reflecting from the earth surface across a range of up to 15 programmable wavebands, to a resolution of either 1200 or 300 metres. The MERIS bands exhibit a high degree of correlation and thus complementary information is dispersed among the source bands [1]. In these work different feature extraction algorithms are applied to the MERIS multispectral data. A comparative study between unsupervised learning algorithms such as principal components analysis (PCA) [2,3], independent common analysis (ICA) and non-negative matrix factorisation (NMF) is carried out for the case of MERIS data. PCA provides the best representation in terms of maximal variance or equivalently minimum square error and thus provides very good energy compaction. On the other hand, ICA [4] evaluates non-gaussian components based on the strong statistical independent property. Finally, NMF [5] yield in bases functions that are evaluated using the non-negative constraint and thus provides an additive representation of the data. The different feature extraction techniques are compared in terms of classification accuracy, computational complexity and dimensionality reduction performance and some useful conclusions are drawn. References [1] MERIS Users Handbook[2] J. Tyo, A. Konsolakis, D. Diersen, R.C. Olsen, "Principal-components-based display strategy for spectral imagery", in IEEE Transactions on

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Abstract No. 189

Observing the Ocean from Envisat: a New UNESCO-Bilko Teaching Module Demonstrating the Synergistic Use of Data from Envisat Sensors to Study Oceanographic Phenomena

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Over the past few decades satellite sensors have made it possible to observe ocean dynamics in an unprecedented way. The UNESCO-Bilko teaching module 'Observing the Ocean from Envisat' demonstrates how the MERIS, ASAR, AATSR and RA-2 sensors may be used synergistically and combined with data from other sources to study a range of oceanographic phenomena. The Envisat teaching module consists of an introductory tutorial covering the main features of the Bilko software, and seven thematic lessons on topics such as sea surface roughness, internal waves, fronts and eddies, coastal upwelling, river plumes, global sea surface temperature patterns and the measurement of rainfall at sea.The UNESCO Bilko project was initiated in 1987 under UNESCO's then Marine Sciences Training and Education Programme (TREDMAR) to develop training capability in coastal and marine remote sensing. Using specially commissioned educational image-processing software (Bilko), designed to operate on personal computers, the project has provided seven modules of computer-based lessons to over 500 marine science laboratories and educational establishments and over 600 individual users in more than 70 countries around the world. The current version, Bilko v. 3, is designed to run using Microsoft Windows 2000 and Windows XP, but will also run under Windows 95, Windows 98 and Windows NT. The project team always recognised that the value of any Bilko lesson would increase if students could use relevant data - e.g. by time, place, sensor etc. To realise this aim the latest version of Bilko has been substantially extended to include support for a range of common image formats. With ESA's support, this now also includes the N1 format used to store data from the MERIS, ASAR and AATSR sensors. The Envisat teaching module demonstrates a number of common methods for processing and analysing

image data from the ocean. The lessons provide a step by step approach to opening and studying files from the different Envisat sensors, the use of flags and ancillary data, different techniques for enhancing display such as stretches and palettes, and a variety of statistical and numerical methods for imageanalysis. To aid data interpretation, this is combined with relevant oceanographic background information, and a selection of references for further reading in each of the topics covered.

Abstract No. 477

The CYCLOPES Project: Development of High Level Biophysical Products for Medium Resolution Sensors for Regional to Global Applications

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The CYCLOPES project aims at bridging satellite data suppliers with users by developing operational biophysical products (albedo, LAI, fAPAR, fCover) from the fusion of coarse resolution sensors (VEGETATION, POLDER, MERIS, MSG, AVHRR). This should provide the consistent and long time series required by the user community. Global fields of the variables will be produced for the 1997-2003 period at a 10 days temporal sampling interval and with 1 to 8km spatial resolution. The products will be validated over independent ground measurements and uncertainties will be associated.Two important applications related to climate change will be addressed to demonstrate the pertinence of the products generated:- the detection, categorization and interpretation of land cover changes- the carbon cycle modeling.The several versions of the products envisioned are presented, with incremental improvements of the fusion strategy and enhanced modules including sensor calibration, cloud masking, atmospheric correction, BRDF normalization, biophysical algorithms and fusion.First results are illustrated, with due attention on product definition and evaluation.

Abstract No. 545

MERIS Level 3 Value Added Product Production Line for Regional Full Resolution Products of Europe (CAT1 project 1413 – GEMEL3)

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[2] DLR, Germany
[3] GKSS Research Centre, Germany
[4] Free University Berlin, Germany

Regional studies of land, oceanic and atmospheric parameters require data on a spatial scale below 1km, which are provided by MERIS in full resolution. Regional algorithms have been developed for a land use classification of Europe, an AVHRR compatible NDVI, water quality indicators in the North Sea, Baltic Sea and the Lake Constance, aerosols in coastal areas, and cloud and water vapour statistics. Bi-weekly, monthly and yearly means and associated statistics are derived with these algorithms for the European continent and adjacent waters. The algorithms are partly described in dedicated presentations at this conference.A data acquisition and processing system (MERIS-VA) has been implemented, which starts from MERIS Level2 Full Resolution products and delivers the above listed Level3 ocean and land parameters on a 300m grid, and the cloud statistics integrated to a 5x5km^2 grid as standard products. However, the temporal and spatial product grids are fully configurable. The MERIS data are acquired at the German receiving station in Neustrelitz and processed up to ESA standard Level 2 at the D-PAC in Oberpfaffenhofen. The data are transferred back to Neustrelitz, where the MERIS-VA processing up to Level 3 is performed.The MERIS-VA processor includes a Level2 and Level3 module. The software is implemented such that a processor engine is responsible for data management, ingestion of MERIS and auxiliary input data, formatting of the MERIS-VA output products and meta data, error handling and logging, and the management of the processing algorithms. These are implemented as Plug-Ins, which are independent from the processor engine, so that they can be changed and loaded during processing. This enables a very flexible configuration of the operational processing, rapid development cycles for updates and minimizes the maintenance and downtime of the processor. New products, i.e. new plug-ins, can be added to the processor without the need to recompile the engine. The MERIS-VA products are stored as HDF5, and the meta data are compatible with the DIMS system of the German Remote Sensing Data Archive (DFD). After quality control by the GEMEL3 project partnership the products will be made available to the user community through the EOWEB of the DFD.

Abstract No. 693

Development of Algorithms for the Exploitation of MERIS Data over Land

V. Bruniquel-Pinel[1], C. Castillon[1], F. Baret[2], W. Von Hoyningen-Huene[3], T. Block[4], J. Moreno[5], J. Chen[6], P. Regner[7]

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[2] *INRA CSE*

[3] *University of Bremen, Germany*

[4] *Brockmann Consult, Germany*

[5] *Universidad de Valencia, Spain*

[6] *University of Toronto, Canada*

[7] *ESA*

This paper presents the results of an ESA contract n° 16545/02/I-LG related to the definition and the validation of processing chains for the exploitation of the MERIS data over terrestrial surfaces. Two algorithms have been developed: the first one focuses on the aerosol correction scheme and the second one on the retrieval of vegetation bio-chemical and bio-physical parameters from the standard MERIS L2 products. The vegetation products are the Leaf Area Index (LAI), the fraction of Absorbed Photosynthetically Active Radiation (fAPAR), the canopy chlorophyll content (LAIxCab) and the fraction of vegetation cover (fCover). The vegetation products are retrieved from Top Of Canopy reflectances. However, the reflectances provided by the MERIS level 2 land products corresponds to Top Of Aerosol, i.e. they are only corrected of the atmospheric molecular and gaseous contributions and not of the aerosol effect. Consequently, a definition and an implementation of an aerosol correction scheme for the removal of aerosol scattering contributions over land has been developed in the frame of this study before the generation of the vegetation products. The selected algorithm for the aerosol correction scheme is based on a simultaneously estimation of the aerosol properties (Aerosol Optical Thickness and Angstrom coefficient) and the correction of the atmospheric effects. The algorithm to produce the vegetation products is based on a modelling inversion method using a Neural Network Technique. This technique needs a training database on which the network is calibrated. This database has been simulated with the help of radiative transfer models. Validation results will be presented in the frame of this paper. The two scientific modules (correction of the aerosol signal and vegetation products generation) are available in the BEAM toolbox that is a software dedicated for the processing of (A)ATSR and MERIS images.

Tuesday 7 September
16:10 – 17:50
TRAKL

Session 2D5:

Altimeter Performance and Products Quality (3)

Abstract No. 205

Rain and Ice Flagging of Envisat Altimeter and MWR Data

J. Lillibridge[1], R. Scharroo[1], G. Quartly[2]
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[2] Southampton Oceanography Centre, United Kingdom

Altimetry range, wave height, and wind speed measurements are often corrupted by two effects over the ocean: rain and floating sea-ice. Radiometer measurements, which provide the altimetric wet troposphere correction, are similarly corrupted by the presence of rain or sea-ice in the instrument's footprint. To avoid contamination of sea surface height measurements, it is imperative that data influenced by either of these effects be edited out. The waveform 'peakiness' parameter, available on the GDR data sets (but NOT on the MAR data), is effective at identifying sea-ice returns when stringent thresholds are applied. The mean relationship between backscatter (sigma-0) at the two altimeter frequencies allows us to flag data impacted by both rain and sea-ice. Anomalous radiometer brightness temperatures provide further evidence for the presence of rain, and when combined with the backscatter information yield a more robust rain detection algorithm. New methods for flagging rain or sea-ice contaminated data, based on two-dimensional histograms in sigma-0 and brightness temperature spaces, also show potential as altimetric edit criteria.

Abstract No. 645

Radiometric and Altimetric Range Calibration

P. Moore, S. Edwards, M. King
Newcastle University, United Kingdom

This presentation will address the calibration/validation of the Envisat altimetric range and the ERS-2 and Envisat radiometric wet tropospheric corrections. Altimetric range calibration has been undertaken by repeat pass measurements with ERS-2 along the common ground track, by crossovers with ERS-2 and by dual-crossovers with TOPEX/Poseidon and Jason-1. Results will also be presented of a validation of the ERS and Envisat radiometric wet tropospheric calibration against GPS derived wet tropopheric delays.

Abstract No. 541

In-flight Calibration/Validation of Envisat/MWR

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[1] *CLS, France*
[2] *LODYC, France*

In the context of the Envisat mission, we are responsible for the development of the radiometer algorithms, for the in-flight calibration of the microwave radiometer, as well as for the validation of the radiometer products (mainly the wet tropospheric correction). Retrieval algorithms for wet tropospheric correction, integrated vapor and liquid water contents, atmospheric attenuations of backscattering coefficients in Ku and S band, have been developed using a database of geophysical parameters from meteorological global analyses and corresponding simulated brightness temperatures and backscattering cross-sections by a radiative transfer model. Meteorological data correspond to 12 hours predictions from the European Center for Medium range Weather Forecasts (ECMWF) model. Relationships between satellite measurements and geophysical parameters are determined using a statistical method. The quality of the retrieval algorithms depends therefore on the representativity of the database, the accuracy of the radiative transfer model used for the simulations and finally on the quality of the inversion model. The database has been built using the latest version of the ECMWF forecast model, which has been operationally run since November 2000. The 60 levels in the model allow a complete description of the troposphere/stratosphere profiles and the horizontal resolution is now half of a degree. The radiative transfer model is the emissivity model developed at the Université Catholique de Louvain [Lemaire, 1998], coupled to an atmospheric model [Liebe et al, 1993] for gaseous absorption. For the inversion, we have replaced the classical log-linear regression with a neural networks inversion. For Envisat, the backscattering coefficient in Ku band is used in the different algorithms to take into account the surface roughness as it is done with the 18 GHz (respectively 18.7 GHz) channel for the TOPEX (respectively JASON) algorithms or an additional term in wind speed for ERS2 algorithms. The in-flight calibration/validation of the Envisat radiometer has been performed with the tuning of 3 internal parameters (the transmission coefficient of the reflector, the sky horn feed transmission coefficient and the main antenna transmission coefficient). First an adjustment of the ERS2 brightness temperatures to the simulations for the 2000 version of the ECMWF model has been applied. Then, Envisat brightness temperatures have been calibrated on these adjusted ERS2 values. The advantages of this calibration approach are that :i) such a method provides the relative discrepancy with respect to the simulation chain. The results, obtained simultaneously for several radiometers (we repeat the same analyze with TOPEX and JASON radiometers), can be used to detect significant calibration problems, more than 2–3 K). ii) the retrieval algorithms have been developed using the same meteorological model (2000 version of the ECMWF model), and the same radiative transfer model than the calibration process, insuring the consistency between calibration and retrieval processing. Retrieval parameters are then optimized. iii) the calibration of the Envisat brightness temperatures over the 2000 version of the ECMWF model, as well as the recommendation to use the same model as a reference to correct ERS2 brightness temperatures, allow the use of the same retrieval algorithms for the two missions, providing the continuity between the two. iv) by comparison with other calibration methods (such as systematic calibration of an instrument or products by using respectively the ones from previous mission), this method is more satisfactory since improvements in terms of technology, modelisation, retrieval processing are taken into account. For the validation of the brightness temperatures, we use either a direct comparison with measurements provided by other instruments in similar channel, or the monitoring over stable areas (coldest ocean points, stable continental areas). The validation of the wet tropospheric correction can be also provided by comparison with other radiometer products, but the only real validation rely on the comparison between in-situ measurements (performed by radiosonding) and retrieved products in coincidence.

Abstract No. 546

Analysis of ERS-2 and TOPEX Microwave Radiometer In-flight Calibration and Monitoring

N. Tran[1], E. Obligis[1], L. Eymard[2]
[1] CLS, France
[2] LODYC, France

The microwave radiometers on altimeter missions are specified to provide the "wet" troposphere path delay with an accuracy of 1 cm or better, at the location of the altimeter footprint. These instruments have 2 or 3 channels including one in the water vapour absorption line centred at 22.235 GHz in order to properly retrieve the path delay. The quality of the retrieval relies on an-accurate in-flight calibration, both in term of absolute values and of time stability. The calibration of the measured brightness temperatures requires the exact knowledge of all the instrument parameters but within the on-ground calibration in vacuum chamber, the reflector cannot be included, so the instrument characterization is not fully representative of the situation in space. Moreover, it is very difficult to properly estimate the radiation emitted by the various sources in space (emission/reflection of the microwaves by the satellite itself, contribution of the earth in the side lobes). The reflector transmission is also poorly known (and often not measured), and is subject to degradation in space due to aging or collisions with debris or other small object particles. For all these reasons and because the mission requirements are high, it is not possible to be confident in the pre-launch calibration adjustment. So careful analysis, development of indirect methods of calibration, and correction when needed are required after launch. We propose in this paper to do a comparison of the calibration of 2 microwave radiometers, EMWR on ERS-2 mission and TMR on TOPEX/Poseidon mission by (1) presenting the specifications of each one and their in-flight calibration results after launch; (2) the different methods to monitor the stability of the instruments along their lifetime; and (3) the different methods used to externally absolute calibrate the instruments because contrary to conically scanning instruments, the in-flight calibration does not include the complete antenna circuit and so it is therefore impossible to achieve an absolute internal calibration.

Abstract No. 196

Impact of Microwave Radiometers on Sea Level Change Studies

R. Scharroo, J. Lillibridge
NOAA, United States

The radiometers on board the satellites ERS-1, TOPEX/Poseidon, ERS-2, GFO, Jason-1 and Envisat measure brightness temperatures at two or three different frequencies. These measurements determine the total columnal water vapour content and wet tropospheric path delay, a major correction to the altimeter range measurements. In order to assess the long-term stability of the path delay, the radiometers are calibrated against vicarious cold and hot references, against each other, and against several atmospheric models. Four of these radiometers exhibit significant drifts in at least one of the channels, resulting in unmodeled errors in path delay of up to 1 mm/year, thus limiting the accuracy at which global sea level rise can be inferred from the altimeter range measurements. Because of their heritage, the radiometers of ERS and Envisat serve as an important reference, providing a potentially 16-year long continuous record of brightness temperatures and water vapour path delay estimates.

Tuesday 7 September
16:10 – 17:50

KARAJAN 1-2-3

Session 2D6:

How to Move from Reseach to Applications? (2)

Abstract No. 145

EO Services for Hydrocarbon Exploration

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[2] *WesternGeco, United Kingdom*

EO data is now routinely used in onshore and offshore hydrocarbon and mineral companies as a fundamental component of GIS hosted exploration databases. Within the hydrocarbon industry the use of EO data extends into exploration, production and development phases both onshore and offshore. This paper presents a number of case studies to show how the use of ERS data has been developed from being used only for traditional mapping of geological structure in densely vegetated, persistently cloud covered regions. In particular case studies are presented which show the increasingly important contribution of ERS SAR data for:

- Global Seep Screening - Offshore extensive archive of more than 8000 scenes has enabled evaluation of more than 25,000,000 sq. km of the world's offshore sedimentary basins extending out to water depths up to 3000m. The database provides explorationists with global distribution of natural oil seeps providing an indication of the limits of petroleum systems.
- Estimating Seismic Quality - for evaluating surface texture and relative surface moisture as part of an EO-based, GIS hosted product for predicting seismic quality.
- Geological/geotechnical mapping - to emphasise subtle structures and mapping near surface subcrop and shallow buried rock for pipeline routing and seismic planning in arid and semi-arid regions.

Of particular interest is the integrated EO data and derived information for evaluating seismic quality. This EO-based product has been developed with WesternGeco as part of the ESA Long-Term Market Development Programme to help promote and expand the utilisation of ESA Missions data. The combination of ERS SAR and multispectral optical satellite imagery provides information on the mechanical and lithological properties of the weathered layer of the geophysical earth model. The information can be calibrated with surface seismic quality information to assist logistic planning and predict seismic data quality prior to seismic acquisition. The successful development of the seismic quality product has resulted in significant savings in man-time as well as improved acquisition and data quality.

Abstract No. 609

EO Services for Offshore and Gas

S. Sandven[1], R. Stephens[2], F. Lefevre[3], L. Bertino[1], F. Counillon[1], D. Szabo[4], J. Le Bras[3], P. Gaspar[3]

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[2] *Ocean Numerics Ltd., United Kingdom*
[3] *CLS, Space Oceanography Division, France*
[4] *Fugro GEOS Inc, United States*

EMOFOR (Envisat MOnitoring and FORecasting services for offshore industry) is one of the ongoing long-term earth observation market development projects addressing offshore operator's needs for environmental information. The EMOFOR project aims to provide oceanographic monitoring and forecasting services to operators who need information about currents and other oceanographic phenomena. Ocean currents have strong impact on floating constructions, risers and other installations in deep seas, especially eddies and fronts which represent maximum currents. Information on eddies and other extreme current events, both from in situ measurements, satellite data and model simulations is therefore essential for operators in deep water areas.In EMOFOR a service chain is established where: 1) atmospheric forcing data are used to drive a nested system of ocean models to produce nowcast, forecast and hindcast 2) satellite data are assimilated into the model system and used for validation of the model output 3) in situ data from moorings, rigs, buoys and ships are used to obtain site specific depth profiles of currents in real time. The TOPAZ modeling and data assimilation system is provided by NERSC, while the satellite data products are delivered by CLS. In situ measurements are provided by Fugro GEOS in the specific areas where the service is developed.The satellite data used for assimilation are sea surface height from present operational radar altimeters, including Envisat RA-2 data. SST, ocean color and SAR images are used as supplementary data for daily monitoring of eddies and eddy features as well as for validation of the model simulations. The integrated service system is implemented and tested in the Gulf of Mexico under the name FOCUS (Forecasting Ocean Currents Service). The main focus of the service is to produce forecasts of the Loop Current and detached eddies with high current speed representing a hazard for the deep sea operations. The service system, which is planned to be implemented in other deep sea exploration areas world wide, is run operationally by Ocean Numerics Ltd. (http://www.oceannumerics.com)

Abstract No. 677

EO Services for Land Subsidence Problems in Civil Engineering

C. Russell[1], K. Kosar[1], T. Conley[2], U. Hachethal[2]
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[2] *AMEC Europe, United States*

AMEC, a an international project management and services company, was recently awarded a contract under ESA's Earth Observation Envelope Program, Market Development Element to carry out market Development Activities Geo-information Services for the Identification, Monitoring and Mitigation Of Land Subsidence Problems. AMEC is one of the world's largest engineering and construction companies that employs 50,000 people worldwide and generates revenues in excess of 8 billion euros. The primary focus of the company is to develop and maintain long-term relationships with a diverse range of local clients, government departments and industry leaders. This highly successful approach has allowed the company to build a high quality business with the majority of work arising from repeat assignments. Land subsidence is a global problem that is estimated to annually cause hundreds of million of dollars of losses in terms of structural damage and depreciation of property values. AMEC's portfolio of engineering services includes all the key business sectors where land subsidence is a chronic problem including human activities such as subsurface mining, fluid withdrawal and hydro-compaction or from natural processes including dewatering of organic soils, seismic liquefaction and melting of permafrost. AMEC views Earth Observation products and services as a "new idea" that when integrated into our company's portfolio of services has the potential in the short term to provide significant cost savings to our well established long term customers and in the long term to provide market advantage in expanding the company's global Customer base. AMEC's strategy for earth observation market development for land subsidence problems is described in this paper. It involves developing and maintains relationships with high quality, well established and well respected EO Service Providers. AMEC will encourage its Project Managers to establish preferred relationships with EO Services Providers that can support AMEC's efforts to maintain the highest level of service quality to our Customers. The short term the focus of this EOMD initiative has involved exposing and training selected AMEC Service Line Leaders and Senior Project Managers in Europe and the Americas to the applications, benefits, and limitations of EO technologies (specifically InSAR and high resolution optical imaging). These AMEC personnel are gaining hands on experience in applying these technologies through the ESA Earth Observation Market Development Program. In the long term the focus will expand to include all Project Managers, Technical Personnel and Market Development Personnel. This paper also describes internal processes within AMEC that are being implemented to assist in the adoption of these EO technologies on a worldwide basis. The company is presently establishing quality assurance programs to ensure professional liability issues associated with the application of these technologies are properly addressed. Technical and contractual issues associated with use of the technology in various market sectors are being addressed. These activities will be formally incorporated within AMEC's Risk Assessment Program prior to routine use of the technology within the organization.

Abstract No. 634

EO Opportunities in Fisheries and Aquaculture Sectors

T. Boivin
Hatfield Consultants Ltd., Canada

Abstract Text The aquaculture market is one of the most dynamic and lucrative business sectors in the world, growing at an average compound rate of 10% per year since 1990. In 2001, global fisheries production was 130 million tons, representing $56 biillion US in revenue. Despite the huge potential for Earth Observation (EO) data and services to be applied to the fisheries sector, to date there has been limited use of these technologies by the industry. The NEMA Project is designed to determine the impact of the main market drivers influencing the fisheries and aquaculture sectors, and to elaborate appropriate EO responses. Funded under the European Space Agency's Earth

Observation Envelope Program (EOEP), the NEMA project includes an in-depth analysis of the various market forces shaping the fisheries and aquaculture industry in the near- to medium-term. The market drivers are being assessed from a global perspective, with prototype EO responses being tested in Southeast Asia and Chile. Knowledge gained from assessing these emerging market forces will help to identify opportunities for development of customized services using current Envisat/ERS data, as well as archived data, and also help plan applications for upcoming sensors (e.g., RADARSAT-2). These may include site-specific surveillance of planned or ongoing aquaculture operations by means of high-resolution satellite imagery, regional observations of oceanographic conditions affecting fisheries operations, aquaculture site mapping and detection services, fishing vessel monitoring, coastal zone management, and harmful algal bloom (HAB) monitoring. Upcoming project activities include conceptualizing suitable EO responses in support of, and in alignment with, the evolution and growth of the aquaculture industry. The NEMA project is being implemented by a team led by Hatfield Consultants Ltd. (Canada, as well as Indonesia, Thailand and Chile), Apolloni Virtual Studio (Italy), Aerde Environmental Research (Canada), DHI Water and Environment (Denmark), ACRI (France), and Nefisco Foundation (Netherlands). The presentation will include an overview of NEMA Project results to date, and will also discuss potential opportunities for involvement of VACs in Phase II activities.

Abstract No. 279

EO Opportunities in Insurance Sectors

A. Shaw[1], C. Eyre[2], A. Shaw[1]

[1] ESYS plc, United Kingdom

[2] Aon Risk Consulting, United Kingdom

ESYS plc and Aon Risk Consulting have teamed up to provide a fresh examination of the business issues within the Insurance industry that are driving demand for geoinformation products and services. The study is then seeking to understand how this demand creates opportunities for solutions involving Earth observation (EO) data and what actions are necessary to overcome barriers to market entry. As one of the largest insurance companies in the world, Aon have business interests in most industrial sectors where issues such as climate change, environmental legislation and globalisation are creating new challenges and opportunities for innovative information products and services. Of particular interest to this study are the areas of:Forestry - forestry insurance and climate change sinks monitoringAgriculture - guaranteed yield productsProperty - flood and subsidence riskEnergy - revenue smoothing and climate change issuesMarine - environmental monitoring and marine riskSecurity - property and business interruptionAfter a broad assessment of all sectors, the study will focus on 2-3 key areas of opportunity. By evaluating how geoinformation is used today within key areas of the Insurance industry and assessing the current range of offerings from the EO services community, the study team will suggest actions that need to taken in order to fulfill the potential for EO. This should include some preliminary response actions from qualified value adding companies. The paper will report on study progress and the results known at the time of writing.

Tuesday 7 September Wolf-Dietrich 1-2

Poster Session 2P14:

How to Move from Research to Applications?

Abstract No. 18

Compact Active Transponders for Operational SAR Interferometry Applications

M. Haynes[1], S. Smart[2], A. Smith[3]
[1] *NPA Satellite Mapping, United Kingdom*
[2] *SEA Group, United Kingdom*
[3] *Phoenix Systems, United Kingdom*

We report on the latest developments and results demonstrating the operational uses of Compact Active Transponders with Envisat, ERS-2 and RADARSAT-1 data, in particular for in situ ground and structure motion monitoring using SAR Interferometry. The transponders have been developed in partnership by NPA Group, SEA Group and Phoenix Systems under funding by the British National Space Centre's Service Mission Support Programme.

Abstract No. 26

RWT Tool: Offshore Wind Energy Mapping from SAR

C. Hasager, M. Nielsen, M. Christiansen
Risoe National Laboratory, Denmark

Demonstration of software RWT (Risoe Wemsar Tool) developed by Risoe National Laboratory, Dept. of Wind Energy for assessment of offshore wind resource maps based on satellite SAR observations will be given. The software runs on pc in Windows and is compatible with WAsP (Wind Atlas Analysis and Applications Programme). WAsP is the de facto standard software in wind resource mapping used in more than 90 countries by more than 1000 users worldwide. Calculation on wind power production typically is based on meteorological data input to WAsP. RWT provides an alternative method for wind data input in offshore regions based on satellite SAR wind field observations. Wind statistics related to spatial variations (e.g. noise level, physical representation) and temporal variations (e.g. number of samples, cut-off range) are included. Error estimation on wind resource parameters (e.g. Weibull distribution parameters) is provided through RWT. Work in on-going to include scatterometer wind fields for wind resource estimation in RWT. RWT is part of the EO-WINDFARM service in development within the EOMD project EO-WINDFARM (17736/03/I-IW).

Abstract No. 96

Improvements to the Applicability of SAR Interferometric Techniques for the Monitoring of Mining Induced Surface Deformation

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In the mining context legal obligation, safety, and environmental reasons result in a significant demand for deformation information. Existing non-EO techniques are rather expensive. Consequently, there is a significant interest in the EO based techniques.In the past years land surface deformation monitoring with SAR data reached an operational status. In spite of the high interest and the quite advanced stage of the interferometric techniques there remain important limitations to the availability of the EO based information. Reasons for unavailability include:- Incomplete spatial coverage with information gaps for low coherence areas.- Difficulty to resolve high phase gradients.- Limitations to the EO data availability.In the mining application these limitations can be quite severe because of high deformation rates, high spatial gradients, and a dynamic temporal behavior. One part of the ESA supported EOMD - Mining project is to reduce some of these limitations. The objective of our presentation is to demonstrate that important improvements to these limitations can be achieved by:- Including point target based interferometric techniques.- Using L-band SAR.The main improvement of including techniques which explore the interferometric signatures of scatterers with a point-like scatter characteristics is the better spatial and temporal coverage achievable. There is a good potential to find some scatterers in low coherence areas and artificial point targets can be installed to fill important gaps. Pairs with long baselines can be included in the interferometric point target analysis, permitting a more complete use of the available SAR acquisitions and to improve the temporal sampling.In vegetated areas and for rapid deformations L-band INSAR (JERS, ALOS-PALSAR) has a better potential as compared to C-band SAR (ERS, Envisat-ASAR, RADARSAT). Due to its longer wavelength decorrelation in vegetation is reduced. Furthermore, the lower phase-to-deformation sensitivity reduces the problems in the case of high deformation gradients.Based on specific cases the improvements achieved are discussed. Examples confirm the good potential of the interferometric point target analysis and the possibility to measure subsidence in forested areas and that subsidence cones with high phase gradients could be resolved using L-band SAR.

Abstract No. 237

Value Added Geocoded Envisat-ASAR Product Service

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The German Remote Sensing Data Center (DFD) of the German Aerospace Center (DLR) is an element in the network of the Multimission Facilities of ESA and responsible among other tasks for SAR processing. The DLR has implemented a service for value added products over land. This service can support the user community with preceise geocoded products in addtion to the standard products of ESA.The Envisat GEOcoding system (EGEO) support the highresolution image modes, the medium resolution and the global mode from Envisat, product examples will be presented.The user service includes also the integration of national geodetic maping parameter to the products. Different datumshift parameter sets are implemeted. New parameter sets can be easily integrated, if the user can deliver the required geodetic parameters.Two major types of geocoded products are available: · Enhanced Ellipsoid Corretced (EEC) · Enhanced Geocoded Terrain Corrected (ETC) The EEC generation is a fully automated process. The process has access to a Digital Elavation Model (DEM) data base, because a GLOBE DEM (1km resolution) is used to reduce height induced errors in a global quality.The ETC uses the best available DEM to eliminate geometric mislocation. SRTM DEMs with 100m and 25m resolution and other high resolution DEMs, e.g. InSAR DEMs or from other sources can be utilized. The system was built up in co-operation with the Remote Sensing Laboratory (RSL), University Zürich (CH) and Joanneum Research, Graz (A). ESA and the German Ministry of Education and Research (BMBF) supports this project.

Abstract No. 255

16857 Gigabytes Later: Results from 24 Months of Envisat DDS Operations

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The Envisat satellite-based Data Dissemination System (DDS) for distribution of remote sensing data from the Envisat satellite to the various European users was integrated in early 2001. The system relies on DVB/MPEG-2 based transport links for carrying IP datagrams. It uses a broadcast satellite forward channel and a terrestrial return channel. The forward link operates on a geostationary, digital TV satellite whereas the return channel uses Internet. The DataCast/RRMP software by GCS (A) is the engine for the dissemination of the remote sensing data. As part of it the Restricted Reliability Multicast Protocol (RRMP) provides full-reliable multicasting and this efficiently exploits the inherent broadcast capabilities of satellites. For privacy reasons, DataCast uses dynamic encryption, allowing for dissemination of data to a dynamic group of receivers for every transmission. For efficiency, RRMP employs an error control strategy that is based on ARQ and Forward Error Correction mechanisms. Intecs (I) developed the part relevant to the interface to data sources, reporting and monitoring of the overall operations.The DDS architecture and functions are per design scalable in terms of the number of uplink sites and receivers and can also support a

further increase in bandwidth, to allow the accommodation of new data-dissemination requirements emerging during the mission's lifetime. Initially DDS operated from two uplink sites in Frascati (I) and Kiruna (S). Late 2002 a third uplink site (Svalbard) was integrated. Earlier this year the transmission rate was increased from 4 Mbps to 6 Mbps, and the Svalbard uplink was moved to a dedicated satellite carrier and Svalbard transmission rate has been increased to 4.45 Mbps.Additionally the DDS's design allows for multi-mission use, i.e. other missions can make use of DDS services in parallel with Envisat. In fact, DDS has been used to support limited ERS data distribution in parallel with the Envisat rehearsal activities. DDS is now 24 months in operations and has recently and successfully transferred the 16th TeraByte of data over the satellite channel simultaneously to more than 4 user sites on average, for a total of about 70 TeraBytes of data safely received at the user ends. A central web interface (http://dwlinkdvb.esrin.esa.it/DDS/) provides the users a means to verify the status of the system and to get information on the current activity. A local web interface eases monitoring by the user of its individual site. A jointed team of engineers from Intecs and Vitrociset (I), operating at ESA/ESRIN (Frascati), monitors and maintains the high performance of the system. The paper will present an in-depth analysis of the transmission statistics collected during these 24 months of operations. Quite surprising is the fact that more than 97 per cent of the data files (average size 50 Megabytes) were transmitted over a 7.5 MHz SCPC carrier (initially at 4 Mbps with FEC ½, now 6 Mbps with FEC ¾) without any negative acknowledgements to request forward error correction retransmission.

Abstract No. 314

ESA/EOMD Action for Multibaseline with Permanent Scatterers ERS InSAR DEM Performance Assessment Toward Application Needs

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In this paper, we present the results of the performances assessment of Multibaseline DEM InSAR toward operational application needs. This work has been conducted in the framework of the ESA/EOMD framework. We start with a brief presentation of the POLIMI multibaseline InSAR DEM production chain exploiting the ERS 1&2 archive. This algorithm combines the multibaseline SAR interferometry and the Permanent Scatterers analysis.Then, we analyse the output product performances over a CEOS test site. The DEM is compared to reference DEM and a standard tandem InSAR ERS DEM.Finally, we compare the measured performances (altimetric, planimetric accuracy) toward user needs for risk management applications. We present the applications and their needs and conclude to the qualification of the Multibaseline InSAR DEM toward the tandem InSAR DEM for the end user applications.

Abstract No. 318

Development of an Operational EO Service for Flood Monitoring within an EOMD Project

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The overall objective of this activity is to set-up an operational EO-based service for flood monitoring to meet the requirements of the Civil Protection Authorities and Re-Insurance Companies. This project is co-ordinated by SERTIT who is teaming up with the EMZ-EST, the civil protection agency in charge of the Eastern-Defence zone in France and VISTA who is taking care of market development to Re-Insurance Companies in Germany in collaboration with Swiss Re. SPOT image, the third party of the consortium, will act as an unique one-stop-shop for the provision of EO data. ESA is contributing to the project in the framework of Earth Observation Market Development (EOMD).Civil protection organisations need information on flooding and its impacts, most urgently, while a flood is happening. EO derived products have been identified and developed taking into account Envisat's new capabilities and SPOT5. The first product, showing the extent of the flood, is the rapid flood mapping product, delivered to the Civil Protection authorities within 6 hours after the service receiving the EO data. The second product, the rapid impact mapping product, based on a regularly updated landcover map, describes the landscape affected by the flood and is delivered 12 hours after the reception of the EO data.With 24 hours a day EO based on-call service, the service is integrated directly into the current operational practices of the Civil protection agency. It is prepared for any request, providing relevant information for flood risk mapping, flood forecasting, and for crisis and post-crisis management.In parallel, the Insurance sector in Germany is marketed by VISTA with flood risk zone related products and services, to estimate risk categories and to quantify the damage after a flood has happened. Through this information, the insurance companies can optimise their premium system and become more competitive.This EO service can also contribute to the International Charter "Space and Major Disasters". It has operated successfully in generating EO added value products during flooding in France (Gard September 2002, South France December 2003), Dominican Republic flood event in December 2003, and for other natural disasters, including the Salvador earthquake in February 2001, the Nyiragongo Volcano lava flow in January 2002 and more recently after the Stromboli volcanic explosion in April 2003. Earthquakes have become a major focus of activities with Turkey in May 2003, Algeria in May 2003, Iran in December 2003 and Morocco in February 2004.

Abstract No. 335

Image Information Mining for Earth Observation at ESA

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As in other domains, also in Earth Observation (EO) the key items are the data, the information that can be extracted from it, and the knowledge necessary to perform this process. EO images (data) are normally retrieved from archives using attributes like geographical location, time of acquisition, sensor, etc., which do not provide any insight in their information content. Experts then apply their knowledge, interpreting the images to extract information, through a human intensive and therefore expensive process.In recent years our ability to acquire and store large quantities (even petabytes) of data has greatly surpassed our ability to extract meaningful information in time, also leaving events totally undetected. This discrepancy between the offer (data) and the need (information) is continuously increasing since, in order to cope with the large requirements from emerging applications, like event or change detection, global monitoring, disaster management support, etc., more missions and also constellations are being conceived and deployed, with broader sensor variety and increasing data rates (higher resolutions and number of channels). As an example, Envisat alone accumulates 400 terabytes of data every year.Therefore, the need for timely access to clear, focused, concise, and reliable information will likely remain unsatisfied, despite the availability of potential answers in the EO data, unless a breakthrough is introduced. This contribution describes ESA initiatives in Image Information Mining (IIM), which has been identified as the field capable to provide this breakthrough. The activities include specific projects as well as coordination at European level.In the year 2000 ESA started the identification and the implementation of IIM techniques, which could support / ease the experts' tasks also by applying their knowledge to small and large image sets. These technologies need to include learning systems capable to discover, store and apply the necessary knowledge in order to automate IIM, and mediating interfaces capable to understand user semantic and domain of interest. The key ESA projects in the field (see: http://earth.esa.int/rtd), include:KIM Knowledge Driven Information Mining in Remote Sensing Image ArchivesKES EO domain specific Knowledge Enabled Services (two projects)SURF Survey and classification of advanced feature manipulation techniques and tools for Earth Observation applicationsKIMV KIM Validation for EO archived data exploitation supportKEO Knowledge-centric Earth ObservationCADC Image Information Mining: Content Aware Data Compression for Image Time Series HandlingSome of these projects have provided the initial results, described in this contribution. They have demonstrated, at least in particular cases, the feasibility of automating IIM and have permitted to identify areas still requiring research and analysis. In the short term the results are being applied to speed up the interactive manipulation of image sets for extracting information, or to permit enhanced search of archived images also via their content. In the longer term, these techniques should also permit to systematically extract and provide the information contained in the images as features through an OGC compliant feature server.Since the end of 2002 the IIM activities are coordinated on a voluntary basis in Europe within the Image Information Mining Coordination Group (IIMCG), chaired by ESA, with European Space Agencies

and Research Centres as funding members. The focus is on research and technological activities for automated and user centred extraction of information from EO images and image archives in support to content understanding (see: http://earth.esa.int/rtd/IIMCG for further details).

Abstract No. 340

The ESA Service Support Environment

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Despite the success in many scientific areas Earth Observation (EO) has not yet evolved into a real, self-sustaining, service industry. Ongoing efforts to broaden the European EO market highlight the need for EO services and "information products" closer to customer expectations and processes (easily understandable and ready-to-use without further manipulations). In general terms there is the need to move from a "data" or "product" centric vision of EO ground segments to a "service" oriented approach.Today the lack of an integrated, transparent and service oriented infrastructure adds a further barrier to the transformation from basic EO products (data, images) into information and services. This transformation is performed by a relatively small number of specialised companies operating independently in specific application domains. This separation increases costs and leads to a time consuming process, which prevents the optimisation of allocated resources. These problems limit the deployment of cost effective EO services, in particular when support to service orchestration is limited and companies spend their efforts in getting hold of the data or in repeating basic processes outside their own core business, which may be efficiently performed by specialised partners.In synthesis, ease and low-cost access to Earth Observation data in an environment enabling the setting up of strategic partnerships for providing synergic services are the key factors to the development of an EO service industry.ESA has addressed the challenges related to the implementation of such an environment in a large GSTP project, which has demonstrated through a prototype that an infrastructure based on today business-to-business and business-to-customer technologies provides some of the key required capabilities, including: · Easy service publication, chaining and provision· Easy service identification, activation and monitoring · Support for provision of on-line and off-line services· Service provision from local Service Providers' systems · Customised quotation before order· Interactions also in national language· ...The prototype is now being consolidated into a pre-operational environment, including a number of precursor services, which will be available by the end of 2004. Further evolution for better compliancy with the GIS world and large programmes like GMES, INSPIRE, etc. are already being prepared for possible deployment of an enhanced European Services Infrastructure in 2007.This paper describes past and future of the ESA activities in the field and shows how the identification of a set of common EO related standards and the support of a neutral "Service Support Environment" infrastructure is capable to foster the seamless integration of open operational services (from facilities or Service Providers) in Earth Observation.

Abstract No. 346

EOMD PSIGN Project: Developing Markets for EO-derived Land Motion Measurement Products

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(not available)

Abstract No. 348

Value Chains in the Tourism Segment for New Satellite Data Sales Channels

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The ESA EOMD project "EARTH OBSERVATION RESPONSES TO GEO-INFORMATION MARKET DRIVERS – TOURISM" fully sponsored by ESA, investigates the market drivers affecting demand and supply for geo-information in the tourism market.In this ongoing project, an international team investigates the current market and the opportunities for EO data and EO based services to establish new or contribute to existing value chains.The contribution establishes a value chain based scenario. The demand side identifies the current use of geo-information in the tourism segment, and potential needs in the near future. The highest potential is seen for internet based offerings and travel information systems.The EO industry part deals with the technical capabilities and the resulting possible supply side components. Non- EO based geo-information is already used in the tourism segment and thus a focus is put on the strengths and weaknesses of EO based data and also services here. A special discussion on the potential use of Envisat/ERS data is included. Besides a viable technical approach appropriate business models are crucial. Data and service pricing must be value not cost oriented. The paper derives generic business model components out of the operational experience of the project team.The outlook proposes practical implementations of the identified value chain by an application scenario. The project team propose several applications in the 3D and 2D information systems area.

Abstract No. 400

Improved Water Forecasts from Integrating EO Products - an EOMD approach

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The Water Forecast is a commercial operational marine forecasting service, delivering hindcast and forecast products to end-users. The core of the service is a set of numerical models of the marine system covering the North Sea and Baltic Sea capable of predicting a range of hydrodynamic, biological and wave phenomena up to four days ahead.The purpose of the work presented here is to add value to satellite derived Earth Observation (EO) products, by making them more accessible through integration in the Water Forecast. A great deal of satellite derived EO measurements are taken continuously, but their value is only exploited to a small degree due their generally inaccessible format. In this project GRAS and ARGOSS operate a Value Adding Company (VAC) processing the raw EO data to a format, which DHI subsequently can assimilate into the Water Forecast. DHI is a Market Player (MP) providing the Water Forecast products to the end-users, DONG and Musholm Lax. Thus, the integrated service chain from satellite to a prediction of the marine environment can be regarded as a necessary moulding of the data to gain value for end-users.Dedicated Water Forecasts will be provided to the two end-users. A benchmark for improvement will be calculated as the present model forecast performance in 2003 as compared to available satellite and in situ measurements throughout the domain and particularly for the products requested by the end-users. Subsequently, EO data will be assimilated and the increased value thereof will be assessed by the end-users.

Abstract No. 464

Earth Observation Market Development of Envisat Based Services - SAR-Based Oil Spill and Fishing Vessel Detection Services

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Kongsberg Satellite Services (KSAT), Tromsø, Norway has since 2002 been managing a project entitled "SAR based oil spill and fishing vessel detection services". The other project partners are QinetiQ (UK), Kongsberg Spacetec (Norway) and a set of European users. The aim of the project is to develop the market for SAR (Synthetic Aperture Radar) based oil and ship detection services, and to ensure that the new capabilities of Envisat ASAR are rapidly included in existing services. The core of such services is the combination of radar satellites and other surveillance methods such as dedicated aircraft equipped with radar (SLAR) and IR/UV scanner. The project is co-funded by the ESA Long Term Market Development Program (ESA/EOMD).Kongsberg Satellite Services and QinetiQ both provide SAR based marine surveillance services. The two providers cooperate in this project on developing a harmonized pan-European SAR-based oil and ship detection service. The services are primary for the European marked, but the project has also identified global

opportunities that are being followed-up. It has become evident during this project that the involvement especially from the institutional users depend on individual annual national budgets. High service costs combined with cuts in already limited national surveillance budgets is one of the main blockages for further development of the institutional market. Coordination among users within a geographical area and harmonization of their needs therefore seem to be a viable approach in order to secure a sustainable service. This will provide additional information for each user, but also a less expensive service for each user through a cost-sharing model. A multi national oil spill monitoring trial based on Envisat ASAR is currently conducted as a shared service for three key users in the North Sea. Ship detection will be performed on the same dataset, for the Fishing Monitoring Centers in the same area. Through this trial the capabilities to provide operational, near real-time detection and early warning of possible oil spills and surface ship positions for local and regional environmental monitoring will be demonstrated. A user evaluation will be conducted and the SAR-based multi-use service ability to meet the operational requirements from the various user-groups will be presented. Initiatives to expand beyond Northern Europe are also taken.

Abstract No. 480

EO-based Information Service for Windfarm Management (EO-WINDFARM) - a Project within the EOMD Activity

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An international survey conducted by the European Commission shows that renewable energy is a top priority for European citizens (Press release, www.ewea.org, 10 March 2003). It also documents that research in renewable energies such as wind and solar is significantly more popular than other energy-related research in the European Union. In two decades, Europe will be importing 70 % of its energy unless there is a change direction: renewables can help to fill the gap in the European energy supply. While Europe is not rich in oil, gas and coal, there are huge wind resources and European companies are world leaders at converting these into electricity. Wind power and other renewables provide economic growth, security of energy supply, employment, and technology development, and none of these at the expense of the environment. Exploitation of wind energy will therefore help to stagnate the release of dangerous waste (from other non-renewable energy sources) and will contribute significantly to meeting the Kyoto targets for reduction of CO2 emissions.EO-WINDFARM – a market development project sponsored by ESA - aims at providing Earth observation (EO) data to the wind farm industry. In remote areas and particularly offshore there is an urgent need for data. The EO-WINDFARM services will contribute to fill this need and will possibly increase the cost-effectiveness when siting, constructing and operating wind farms. In EO-WINDFARM, a service will be set up where relevant EO-based information products can be integrated with existing products and tools for wind farm design and management. In the first phase a limited number of products are included in the service, comprising tides and waves, which are useful for designing constructions, and wind speed and direction for siting and wind resource calculations. For land based sites, terrain roughness maps and topography are included as useful information for modelling of the airflow over land. The service will be thoroughly tested and validated for cost-effectiveness within the ESA-sponsored project.

Abstract No. 618

Ground Motion History for Stoke-on-Trent (UK) Interpreted from PS InSAR and Thematic Geological Information

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New PSInSAR results from the GMES Terrafirma project, have just become available to the British Geological Survey (BGS) for the Stoke-on-Trent region, United Kingdom. This area has a legacy of several centuries of clay, ironstone and coal mining activity, much of the coal being used to fire kilns for its famous pottery industry. This activity has resulted in many ground subsidence problems in the past, and is likely to continue into the future. Given this problematic background, it was felt that this region would make an ideal testing area for the PSInSAR technique.Sixty-seven ERS 1&2 radar scenes were processed by one of the Terrafirma partners, covering a time interval from May 1992 to December 2000. After the latter date, most of the remaining ERS scenes were found to be unprocessable.In 1992 the BGS completed a Geological Thematic Mapping Programme in Stoke-on-Trent. This information has now been assessed to give likely explanations for the patterns of ground motions displayed by the PSInSAR results. These are described in this paper. Several small, coalescing areas of high subsidence occur in the southern area, and shown to correlate with deep mining activity. Other narrow areas of lesser subsidence relate to highly compressible soils in alluvium deposits of the River Trent and Vale of Etruria. However, most surprisingly, there is one very large and two smaller sub-elliptical areas of uplift in the northern parts of Stoke-on-Trent. While these occur within areas of older underground mining, the explanation for the direction of their motions is difficult. One possible hypothesis, is that there has been an influx of groundwater within the mines due to cessation of pumping in these particular areas, causing uplift.If substantiated by other information, then this provides powerful support for the PSINSAR technique. Especially as one might have expected the opposite to have occurred.

Abstract No. 628

Experience with Near Real Time Distribution of Envisat ASAR Data to End-Users

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During the last 5 years the Danish Center for Remote Sensing has operated a near real time data distribution system for ice, weather and ocean data. The system utilizes recent advances in Internet technology to provide the user with certain GIS-like functionalities using a limited bandwidth and software tools available in standard web-browsers. The system provides a unified access to a large number of data sources primarily from satellite microwave remote sensing instruments such as AMSR, QuickSCAT SeaWinds, SSM/I, AVHRR, AMSU.Data are typically available within a few hours (3-8) after acquisition. In this paper we will discuss our experience with distributing Envisat ASAR data through this system. We tested the processing of Envisat ASAR data during the CRYOVEX experiment in April 2003, and the data were used on-board the R/V Polarstern for experiment and cruise planning. We expect also to be able to demonstrate the processing and distribution og Envisat ASAR Global Mapping Mode data before the Envisat and ERS Symposium.

Abstract No. 660

The Evolution of the Operational ESA SAR Processors

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Since the 1980's MacDonald Dettwiler has provided operational SAR processors for the Agency's major SAR missions. On this, the 25th anniversary of the Canadian association with ESA, we would like to offer a presentation which traces the history of the SAR missions and the Canadian involvement in them, and the relationship to the Canadian satellite radar program.The paper will begin with the conceptual framework for delivery of SAR products for the ERS mission, and then trace the evolution of the processors from the launch, through the emergence of VMP as the operational platform, the decision to follow ERS-1 with ERS-2, to the current work to ensure support for ERS far into the future. The paper will trace the history of the PF-ASAR processor, again from the concept to the reality of the current implementation, touching on the use of PF-ERS to validate the processor, the Cal-Val campaign, and the addition of the two new products available since launch (Wave L2 and WSS).The nature of the paper will be anecdotal rather than technical.

Abstract No. 684

Open GRID Services for Envisat and EO Applications

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Earth Observation (EO) satellites provide constant 24-hour surveillance of the Earth, regardless of atmospheric conditions. With these data, scientists are able to monitor the delicate balance between ecosystems, keep us informed about the weather and monitor environmental changes on a global scale. The Open Grid Services for Earth Observation defines a generic infrastructure where specific data handling and application services are seamlessly plugged in. Coupled with the high-performance data processing capability of the GRID it provides the necessary flexibility for building an application virtual community with quick accessibility to data, computing resources and results. This user-friendly environment aims to:

- Support science users for focused collaborations as needed for calibration and validation, development of new algorithms, generation of high level and global products
- Provide the reference environment for the generation of systematic application products coupled with archives and near real time data access

In particular, the ESA proposed Open Grid Service infrastructure allows GRID-based applications to discover and retrieve information about relevant datasets in any global coverage area of interest, transfer large amounts of EO data products to the GRID, and trigger hundreds of concurrent processes to carry out data processing and analysis on-the-fly. The access to GRID computing resources is handled transparently by the EO Grid interfaces that are based on web services technology (HTTP and using SOAP/XML), and were developed by ESA within the DATAGRID project (European Commission Grant IST-2000-25182E). This project, initiated in 2002 by ESA, has lately demonstrated the potential of GRID systems for providing a suitable infrastructure to ESA's EO scientific users to support their activities related to data and algorithm validation. As being based on a large amount of satellite earth-observation data, the validation of earth remote-sensing satellite data and associated algorithms often requires a large amount of processing resources and highly interactive access to the large amount of satellite data input to the validation or data-processing algorithms. A common shared infrastructure accessible to science users can be seen as a very valuable and cost-effective approach to support EO science and application development. Although it is recognized that the GRID middleware proposed today "off-the-shelf" is still evolving and on its way to standardization, it can also be established that it already offers a certain number of components and driving concepts of particular high-value to EO data applications, in particular:

- A virtual access to scalable processing resources, independent of their inner architecture and "delocalised"
- The concept of generic and delocalised computing resources and their management, including processing power or auxiliary resources such as data, licenses, computing software, etc.
- The reference infrastructure for supporting e-collaboration, i.e. the access to, and sharing of, data, resources and tools by a decentralized community of users (virtual organization)

- Security access management

Currently the system supports the automatic binning of MERIS images (reduced and full resolution), the processing of GOME and GOMOS ozone profiles and their data validation with external LIDAR data. All the components of the new version of BEAM (Basic ERS, Envisat (A)ATSR and MERIS Toolbox), e.g. the SMAC, Smile correction and binning processors are being integrated in the system and this service is also being extended to AATSR and ASAR imagery. Additional services are being proposed to support the new General Studies Programme activity related to e-collaboration.

Abstract No. 719

Eduspace: Preparing Future EO Users

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An increasing number of schools and education institutions are visiting the Eduspace, the multi-lingual Europen Web Portal for Secondary schools developed by ESA in cooperation with international space and education partners. The threshold of 1000 registered schools was passed in May 2004. Currently available in English, German, French, Italian and Spanish, the portal is being enriched with the Danish version, whilst others are in preparation. New modules have been or are being implemented, such as the "Envisat" and "Africa from Space" modules, and other application-oriented ones are in preparation. In particular, among those two ideas are worth mentioning: a module called "Latin America from Space", to be developed in collaboration with latin American entities to open the portal to that continent, and a "World Heritage Sites" module, to be built in close cooperation with UNESCO to stimulate users towards applying EO data for the monitoring and preservation of the protected sites. The Version 2 of the powerful Eduspace LEOworks software package has been also implemented. Finally, the Eduspace Council of Teachers was created by ESA, in order to ensure that the portal grows in line with the educators needs. The Council held its first meeting on 23-24 April at ESA HQ in Paris, where some fifteen European teachers discussed particularly on the current status and the future development of the portal.

Poster Session 2P15:

Special Session – GMES and Science

Abstract No. 89

Using ERS 1 and ASAR Imagery for Mapping Forest in French Guiana

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ERS 1 and ASAR imagery were used for mapping the forest area of French Guiana for 1992/1993 and 2003/2004, respectively. For the 1993 map 60 ERS 1 precision images were received. These images included multi-temporal acquisitions of two to five dates from the same location. The imagery was ortho-rectified using the Digital Elevation Model of the Shuttle Radar Topography Mission. Three features were computed using the SAR data: average amplitude of the overlapping images, average texture, and temporal variability of the backscattering. A classification to forest and non-forest was done using a combination of unsupervised and supervised techniques. The ASAR data were VV polarization with the IS4 (33 degrees) incidence angle. They were processed and classified in the similar way to the ERS 1 data. The reference data to validate classifications were collected using a combination of ground sample and a sample from Landsat (E)TM and Spot 5 imagery. Using SAR based estimates and sampled reference data confidence intervals for the forest area in Guiana in 1993 and 2003 were computed.This work is part of the GSE Forest Monitoring project of the GMES program.

Abstract No. 100

Demonstration of MERIS Data Use for Agri-environmental Applications

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The Cat-1 project "Demonstration of MERIS data use for Agri-Environmental applications" led by EADS Astrium is attached to the SAGE project which is part of the ESA GMES Service Elements Consolidation Studies. The SAGE project, led by Infoterra GmbH, is aiming at developing precursor services to support the implementation of the Water Framework Directive and Soil Protection Initiative.The specific objective of the MERIS-based application is to develop a precursor service for evaluating water used by irrigation, based on an evaluation of irrigated surfaces and water

heights. The goal is to make available to users these information products at regional scale (typically for a large catchment, e.g. 100 000 Km2), in a sustainable way i.e. demonstrating an operational, highly automated and low-cost approach based on medium resolution EO data.In this context the MERIS data, with the high revisit capability due to sensor wide swath, its intermediate spatial resolution of 300 m in FR mode and the rich spectral information provided by its 15 VNIR bands, provides a unique opportunity. In order to fully exploit the MERIS spectral information, the developed processing approach is based on inverting a coupled vegetation/atmospheric model. The atmospheric model uses interrogation techniques of the LOWTRAN or MODTRAN model. The vegetation model is based on the SAIL and PROSPECT models and takes care of the composite pixel nature to describe mixed vegetation covers (such as a mix of green and senescent crops, and bare fields). This overall technique of coupled inversion has proved to be highly powerful and robust in ensuring a stand-alone atmospheric correction. For vegetation, target biophysical variables are cover fractions that describe the green and the brown fraction of vegetation within the pixel. It has been shown that MERIS spectral information even allows to assess cover heterogeneity within the pixel. i.e. differentiate between two conditions having same cover fraction but resulting either from a homogenous cover or a contrasting fully developed crop / bare soil mix. The time series of green and brown cover fraction maps is then the basic information that is exploited to develop spatial analyses of the agriculture and natural lands at the regional scale. In SAGE the water abstraction mapping precursor service is being developed on the Adour Garonne catchment (South West of Farnce). Firstly it is applied on a sub-catchment of the Garonne basin, called the "Neste System", and area is about 8 000 km2. Then it is extended to the broader scale of the whole Adour-Garonne basin representing about 115 000 km2. A temporal coverage of the "Neste System" area has been acquired with MERIS during the crop vegetative period in 2003, with a typical revisit of 15 days, and in parallel data for the whole Adour-Garonne basin has been collected at a lesser frequency (every month). The corresponding vegetation fraction maps have been produced and are now exploited with the objective to derive an estimation of irrigated crops acreage, per small region unit, by de-convoluting the contribution of different crop groups : winter crops, summer crops irrigated and non-irrigated. This is a challenging goal, however this approach if demonstrated can be applied to many applications at regional scale in the Agriculture and Agri-Environmental domain, for example for monitoring the evolution to sustainable farming practices in Europe, monitoring changes in the rural landscape, or providing real-time estimates of crop areas in far foreign countries. The ability of the Envisat Ground Segment to produce and deliver pre-processed MERIS data in near-real time may then be the next limiting factor to a true development of operational applications.

Abstract No. 384

Subsidence Detection in the Area of Thessaloniki (Northern Greece) Using DInSAR Techniques

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The SAR interferometric techniques (Permanent Scatterers and stacking of conventional interferograms - ERS data) have been applied to the region of Thessalonoki (Greece) in order to detect and map subsidence. The sector is affected by several ground deformation phenomena in relation with the tectonic context and the exploitation of underground water. Subsidence bowls have been detected and assessed by SAR interferometry in four sectors of the city. Kalochori-Sindos with more than 30mm/y deformation and Mygdonian basin with 20 mm/y were previoulsy documented as subsiding. However, two areas located at the NNW and SE (airport sector) suburbs of Thessaloniki with subsidence rates between 10 and 20 mm/y present a particular interest as no bibliographic references or technical report describe those subsidence phenomena. Interpretations in relation with the a priori knowledge of the context (geology, tectonics and piezometry) are proposed.The study has been carried out with the support of the TERRAFIRMA Project (http://www.terrafirma.eu.com), funded by ESA's GMES Service Element Programme which aims to provide a Pan-European ground motion hazard information service.

Abstract No. 418

ICEMON: Satellite Sea Ice Monitoring as a Component of GMES

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ICEMON is one of the initial GMES projects with focus on development of operational sea ice monitoring by satellites. The long-term objective ICEMON is to implement a coherent European operational oceanography system for the high latitudes, consisting of sea ice, meteorological and oceanographic services. ICEMON is envisaged to be the European component of a circumpolar service system where Canadian, US, Russian and other relevant monitoring and forecasting services are included. The ICEMON products will utilize existing and new satellite sensors such passive microwave data, optical and infrared images, wideswath SAR, scatterometer and radar altimeter data. In the consolidation phase (2003 – 2004), ICEMON is focused on provision of new sea ice products based on data from recently launched satellites such as global ice types and drift maps from Quickscat, higher resolution ice concentration maps from AMSR-E and Wideswath/Global Mode ASAR from Envisat. ASAR data are used to produce high resolution ice maps and deliver geolocated images to ships operating in sea ice areas. Non-space data will have a key role as supplement to EO-data to fill gaps and for validation of the EO-based products. Use of coupled ice ocean models and data assimilation methods will be a central element in ICEMON to deliver both monitoring and forecasting products as well as hindcast data. Monitoring and forecasting services will support both operational users who need real time services and climate-related user who need

long-term data sets and statistics. This implies that various met-ice-ocean products need to be produced on daily, weekly, monthly and annual scales. Research and development work to support and upgrade the services will be conducted for building capacity to retrieve quantitative information from existing satellite data, improve modeling and forecasting skills, and for utilization of state-of-the-art information technologies, communication and end user systems.

Abstract No. 554

The ERS/Envisat Experience as Design Guideline for the GMES SAR Operational Mission

G. Levrini, M. Zink
ESA/ESTEC, Netherlands

The paper addresses the importance of taking full advantage of the lessons learned from ERS and Envisat in the design of the next, operational, SAR mission.We will show that the main mission parameters – such as: modes definition, resolution, swath width, revisit time, operational concept – can be uniquely derived by the high level requirements of providing:1) continuity to the ERS/Envisat SAR observations;2) operational support to the GMES services (interferometry being the top priority).The resulting system is characterized by:• A systematic data acquisition strategy, built around a single 'main' operative mode, a Wide Swath (WS) mode with interferometric capabilities.• A WS resolution of 20 m (3 sub-swaths) in azimuth and 5 m (100 MHz bandwidth) in range.• A WS swath width of ~ 250 km• A repeat cycle of 14 days• A high rate imaging time of ~ 20 minutes/orbit• A generated data volume in the range of 30-40 GB/orbit• An operation concept based on a large S/C autonomy and a systematic exploitation strategy.• A processing of the science data built on a data driven approach and 2-3 main receiving stations.

Abstract No. 711

The Water Quality Service of Coastwatch

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Coastwatch is a set of services using available Earth Observation data from space to the benefit of the Europe environmental monitoring within the frame of environmental policy at local, regional and global scale. The Coastwatch water quality service is oriented toward the best use of ocean color data and is developed as a strong component of the Integrated Coastal Zone Management to serve,

in particular, the very ambitious European Water Framework Directive which is currently under tuning, harmonization between EU countries and deployment. The service operated today corresponds therefore to a wide dialogue between policy needs and Earth Observation capabilities in terms of accuracy, repeatability and reliability. The service is presently based on the work of 19 partners with a large range of responsibilities covering scientific validation, operational set up and processing and iteration with environmental policy representatives at various scales. Today the service processes and delivers in NRT Sea Surface Temperature, Chlorophyll-a, Total suspended matters maps and numbers of others geophysical components including environmental indicators, derived from MERIS, SeaWiFS, MODIS, AVHRR with a main emphasis on European waters for monitoring purpose (algal blooms, eutrophication, transparency...). A large validation and qualification task making use of in situ data is run in parallel with the delivery operations. The extent of the service along with on going applications and results will be presented. This initiative is supported by the European Space Agency.

Tuesday 7 September
18:00 – 19:30

MOZART 3

Session 2E4:

Looking after Water in Africa – TIGER

Abstract No. xxx

TIGER - Status, Plans and Challenges

J. Aschbacher
ESA/HQ

Abstract No. 648

Monitoring Dam Management Changes Using Envisat: Kafue River Basin, Zambia

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The Kafue river basin, located on the Central African Plateau in Zambia, faces significant pressure from competing land use and water management practices. Most of Zambia's mining, industrial and agricultural activities and approximately half of the country's population are concentrated in the basin, making the Kafue River, in terms of the national economy, the most significant waterway in Zambia, (van der Heyden, 2003). Recent changes in dam/flood management practices designed to emulate natural conditions will drastically impact the availability of water to both natural and anthropogenic systems. This study uses multi-temporal Envisat satellite imagery to show the impacts these changes have made on land use, agriculture and natural and alien vegetation. Full benefit was made of the multi-spectral imagery to monitor both extent and duration of flooding. Image classification, change detection and GIS-based spatial analysis techniques were applied to assess proportional changes in land use, and land cover. A simple assessment of the financial benefits and impacts of the dam management changes is also made. The study illustrates the important role Earth Observation and GIS can play in monitoring Integrated Water Resource Management activities in a river basin and assessing the benefits and success of policies implemented at this scale.

Abstract No. 658

TIGER Initiative and Integrated Water Resources Management of the River Niger Basin

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Water Resources Development - Niger Basin Authority, Niger Republic

River Niger is the third longest river in Africa and 9th in the World with a total length of about 4,200 km. Its initial catchment area of about 2,100,000 sq Km covering 10 Countries namely Algeria, Benin, Burkina, Cameroon, Chad, Cote D'Ivoire, Guinea, Mali, Niger and Nigeria, has now

being reduced to an active catchment area of about 1,500,000, without Algeria, as a result of the effect of climatic change and Sahara movement southwards. In 1963, the 9 remaining Countries covered by the river's active basin, formed the River Niger Commission (RNC), with the view of fostering cooperation among its members states most especially in use and management of the basin's resources. The RNC was later changed to the Niger Basin Authority (NBA) in 1980 with additional mandates for the enhancement of an effective integrated water resources management and development of the basin, among others. Since the last 4 decades the Niger basin has been experiencing series of hydro-climatic changes that has resulted in the persistent drought that is causing the Sahara desert movement southward towards the Atlantic Ocean; erosion and river siltation that is causing floods with its attendant loss of lives and properties; continued low flow that is reducing reservoir storage capacity with consequences of acute water shortages and increasing water demands; pollution, weed encroachment and increasing water borne diseases that are now ravaging the river and its ecosystems; increasing mortality rate, famine, poverty and high rate of migration to urban areas. The lack of basic and adequate data on climate, hydrology and the environment were among the factors affecting the planning and management of the transboundary water resources in the basin that are also having direct consequences on socio-economic development in the Niger basin. The lack of hydroclimatic data collection systems has also been a major constrain towards accurate, consistent data and information gathering for the mitigation of impact of Climate, hydrology and the environment ravaging the region. Consequently, in 1984, the UNDP, OPEC, EEC and the NBA member countries funded the establishment of 65 satellites controlled hydrological Data Collection Platforms (DCPs) along the river Niger and its major tributaries under the framework of the Hydroniger project. The DCPs transmit real time hydrological data through Argos Satellite transmission with reception by the Argos Direct Satellite Receiver (ADSR) installed at the Hydroniger IFC in Niamey and at the National Forecasting Centers in some NBA member states. Real time hydrological data received through the Argos Satellite are processed, analysed and stored in the NBA data bank for its member countries, the stakeholders, Universities and Research Institutions. The data are also used for Hydrological forecasting, publication of the NBA Monthly Bulletin, Hydrological Year Book and Technical Notes. The information is also circulated globally through the NBA Websites, e-mails and the Hydrological Circle Observing System for West and Central Africa (AOC-HYCOS). Since the end of the Hydroniger Project and the handing over of the DCP stations to the NBA in early 90s, the stations have continue to develop technical problems ranging from old age of equipment and non availability of spare parts. Presently over 90% are no longer functional despite all efforts to improve them by the NBA. This therefore led to the consideration of the Meteosat DCP as an alternative to the Argos DCP by the NBA so as to enhance performance in its data collection efforts. This paper takes a critical look at the various problems facing the Argos DCPs operation in the basin and the various efforts made by the NBA to ameliorate them. It further looked into the various factors and additional parameters incorporated to the DCP Meteosat that enhances its performance in the areas of Hydroclimatic data collection for an effective water resources planning, management and development most especially in the Niger Basin.

Round Table: Challenges for TIGER - How to Address Them?

Tuesday 7 September   Wolf-Dietrich 1-2

Poster Session 2P16:

Looking after Water in Africa – TIGER

Abstract No. 687

The Use of Envisat ASAR Data and GIS in a Pilot Project for Mapping Current and Potential Rice Production in Nigeria's Fadama Wetlands

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CSIR Satellite Applications Centre, South Africa

As part of the activities packaged in the NEPAD agricultural programme, the Nigerian Government is committed to increasing food supply and reducing hunger through accelerated domestic production of rice, rather than reliance on imported rice. In support of this initiative, the Nigerian National Space Research and Development Agency (NSRDA) have contracted the CSIR Satellite Applications Centre to develop a Fadama Land Information Management System (FLIMS). The aim of FLIMS is to assist in the enhancement of fadama (or wetland) based rice cultivation in Nigeria. Fadama is the local Nigerian term for "wetland", which are usually highly cultivated for rice production. The contract includes the use of 40 Envisat ASAR images over 5 test sites, spatial modelling and relevant ancillary data for mapping the current extent of fadama-rice cultivation in Nigeria. The overall aim is to develop a long-term, sustainable programme that will provide planners with information on the current extent of fadama rice cultivation, identify potential new areas for fadama rice cultivation development, and allow long-term rice production monitoring using local expertise. The specific objectives of this proposal are:

- Identify all potential areas for fadama rice cultivation development
- Map the current extent of fadama rice production in the fadama wetlands

Five (5) test sites have been identified throughout Nigeria. Each test site covers approximately 100 x 100 kms, equivalent to a single Envisat ASAR image (Figure 1). Sample site distribution has been designed to provide, as far as possible, adequate north-south and east-west coverage of the various agro-ecological and climatological gradients occurring within Nigeria (Figure 2), within which floodplain cultivation is practiced, according to the client supplied land-cover GIS dataset. 8 ASAR images have been ordered for each of the test sites from April through to September. It is proposed that the results as at 1 September will be presented at the conference to demonstrate the use of Envisat ASAR in contributing to sustainable food security and the wider NEPAD objectives in Africa.

Abstract No. 690

Envisat Usage in Southern Africa

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Although ESA launched Envisat in March 2002, knowledge and use of data from this satellite is restricted to a few research initiatives. This is in spite of Envisat's ambitious and innovative payload with instruments to observe atmosphere, ocean, land and ice such as SCIAMACHY and MERIS. This contrasts to the regions' exposure to NASA's TERRA satellite where the ground calibration campaign carried out in southern Africa (SAFARI2000) has resulted in wide-ranging awareness, knowledge and usage of TERRA products from the ASTER, CERES, MISR, MODIS and MOPPIT payloads. An increase in capacity can be readily illustrated as a consequence of this exposure, evidenced by numerous post-graduate degrees awarded to scientists in southern Africa based on use of these data, and companies and institutes within the region who have developed applications and products based on the use of particularly MODIS and ASTER data. Most of the academic degrees were application specific, including field validation, with a few related directly to technical aspects. In contrast, Southern Africa's lack of exposure to ESA and its' products is evident in an almost total lack of use of the data, particularly if a comparison is drawn between the two environmental satellites and their payloads, TERRA and Envisat. The TIGER programme which aims to use Earth Observation (EO) remote sensing technologies based on Envisat data for improving integrated water resources management in Africa, would serve to introduce Envisat data more broadly to the region while also providing information for decision-makers. This can be illustrated in the proof of concept case study developed, using datasets from sources other than ENIVSAT, over a subset of the Olifantsrivier which drains into the cross-border Limpopo River catchment but within South Africa. This river runs through mining, industrial, agricultural, residential, communal and conservation areas, highlighting the myriad of multi-sectoral and multi-temporal user needs. Involvement in the TIGER initiative, as well as with ESA, is seen as important as this will not only provide ESA with a new market for its products and activities but also contribute to regional capacity building as well as capacity retention through the creation of sustainable opportunities in the EO field.

Wednesday 8 September
08:40 – 10:20
MOZART 4-5

Session 3A1:

Landslides

Abstract No. 607

Landslides in Iceland Studied using SAR Interferometry

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Landslides in Iceland have caused both fatalities and considerable economic loss during the past centuries. Recent discovery of creeping landslides near towns in eastern and central-north Iceland has prompted various efforts to assess the risk of a catastrophic event to occur. These efforts include geodetic observations of landslide movement using ground based GPS measurements and satellite radar interferometry. Our project has two primary objectives: The first is use InSAR to study landslides that are known to be active, to compare InSAR data to the GPS observations, and to assess the monitoring capabilities of InSAR on Icelandic landslides. The second objective is to survey large areas in eastern and central-north Iceland to search for other creeping landslides that may exist. This is an ongoing project and here we only present initial results. Two landslides are known to be active in eastern Iceland near the towns of Seydisfjordur and Neskaupsstadur. Recent GPS measurements show that these landslides are moving at rates of up to 40 cm/year. We analyzed several radar interferograms covering this area using ERS-1/2 data. Almost all existing data are from descending orbits and no usable interferograms could be formed using ascending data. This prevents observation of the Neskaupsstadur landslide, as it can only be imaged from ascending orbits due to layovers in descending data. No deformation is detected on the Seydisfjordur landslide in interferograms from the time period 1993-1998. In contrast, repeated GPS measurements after 2001 show clearly that the landslide is moving. Unfortunately, we do not have usable SAR data for this time-period; however, this indicates that the Seydisfjordur landslide displacements may be highly episodic. One active landslide has been discovered in eastern Iceland from the InSAR data. This landslide is located near the town of Vopnafjordur. The landslide is about 1 km wide and up to 10 cm line-of-sight displacement was detected during the summer of 1997, indicating relatively fast creep. To assess present landslide activity we have requested several Envisat-1 acquisitions from both ascending and descending orbits above eastern and central north Iceland during the summer of 2004, and in summer of 2005 further acquisitions will be carried out. These data will provide information about current landslide displacements and direct comparison to GPS observations will be possible.

Abstract No. 231

Analysis of the Displacement along a Funicular with Large Baseline Interferograms on Point Targets

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In spring 1999, heavy rainfall following a period of exceptionally strong snowfall in the Alps during January and February triggered as many as 350 landslides in Switzerland with a total damage of about 60 to 75 Mio CHF. Above the town of Lauterbrunnen (Canton of Bern, Switzerland) the large landslide of Gryfenbach with an estimated mass of about 25 Mio m3 was strongly accelerated due to the heavy water saturation. The first section of the Lauterbrunnen-Mürren Mountain Railway (BLM), which was built in 1891 to facilitate the access to the village of Mürren located on a plateau above Lauterbrunnen, is crosscutting the landslide on it's southern fringe. Whereas average rates of displacement measured on the railway superstructures in the last 100 years were in the order of 10 to 20 mm/year before 1999, in the spring of that particular year a displacement rate of 10 mm/day was observed over a short time period. Overall, a displacement of several decimeters was observed, threatening the existence of the funicular. At the end of the summer 1999, however, there was a sensible slowing down of the displacement and regular operation of the funicular could be assured since then. An analysis of the displacement along the funicular was performed using ERS-1/2 SAR data of the time period 1995-2000. An initial interferometric point target analysis was performed with images acquired before the spring of 1999 and excluding all winter acquisitions with snow cover. The profile of displacement rate along the funicular shows in the region mostly concerned by the landslide average rates of about 2 cm/year in the satellite line-of-sight direction, with negligible displacements near the lower and upper stations. After 1999 the analysis was continued on single interferograms because of the very large displacements of several decimeters. For conventional spatial interferograms we observed that the interferometric phase is too high for interpretation in the case of pairs with more than 300m baseline because of spatial decorellation and not accurate height correction. Therefore, we computed interferograms only on the point targets previously identified with the SAR data of the time period 1995-1998. The phase signal of these interferograms can be analyzed even for baselines larger than 300m. With a series of such interferograms we could finally analyze the displacements along parts of the funicular even during the summer of 1999 and in 2000. This work showed that interpretation of single large baseline interferograms is feasible on selected point targets.

Abstract No. 270

Combined Use of Artificial and Permanent Scatterers

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The Permanent Scatterers (PS) technique allows the identification of a sparse grid of radar targets only slightly affected by temporal and geometrical decorrelation. The PS can be exploited successfully for monitoring very different deformation processes, from landslides to tectonic motion. However, in the case of landslides or urban sites, it may well happen that new reflectors, e.g. Corner Reflectors, should be added to measure motion where no PS exists. Alternate shapes of

reflectors were studied in order to be able to optimise the Radar Cross Section for ascending and descending orbits or for combining different pointing angles with the same reflector, without recurring to the complexity of a CR.Furthermore, the rapid motion of a landslide may create alias such that the real trajectory of the artificial reflector may hardly be detectable. We report the case study of a fast landslide (moving more than a few cm/year) where several CR's were deployed. Polynomial fits were used to represent their motion in a 4 years span. The interconnection of this small network of artificial reflectors with the much wider network of PS was extremely useful to be able to unwrap the phase histories of the CR's.

Abstract No. 569

SLAM: Integration of Remote Sensing Techniques within Landslide Risk Analysis (DUP/DUE)

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The SLAM project (Service for Landslide Monitoring), was launched in 2003 by the ESA for the definition of a service based on the integration of EO-data within the current practices of landslide mapping and monitoring. For the Italian territory the Arno River Basin (Central Italy) has been selected as the principle service case, mainly for the presence of a high number of mass movements (up today about 300 areas at high landslide risk and more than 20,000 individual landslides have been mapped from the institutional authorities) and for its significance with respect to the Italian Apennine territory, in terms of landslide type and environmental conditions. By considering the technical requirements imposed by the Italian legislation three products based on EO-data have been produced for the Arno sevice case, respectively related to landslide inventory mapping, landslide hazard mapping and landslide monitoring. Several users have been involved as partners of the project, in order to validate the provided products, to assess the quality of the services and to assure scientific aspects. In particular two national organizations that have an institutional mandate in hydro-geological risk mitigation, the Italian Ministry of Environment and the Italian National Group for Hydro-geological Disaster Prevention, have agreed to participate to the project. The former has been selected by the Agency for its representativeness of a wide user community and its guidance role at national level, while the latter has been actively involved for assuring a strong scientific approach during the project, consistent with the current research topics in the hydro-geological risk field. The contributions of such organizations to the SLAM project, still in progress, regard mainly the user requirements consolidation, the product validation and qualification and the results dissemination. On the other hand, expectations are firstly connected to the possibility, by integrating EO-derived information within the current practices employed in the landslide risk management, of providing to the local users standard methodologies, especially for landslide mapping and hazard assessment. These methodologies, being based on objective and quantitative data, should guarantee a more homogenous level of the documents related to the landslide risk requested by the Italian law,

such as the Piano di Assetto Idrogeologico (PAI), performed by the Italian Basin Authorities. In addition, the future EO-derived data use could be facilitate the work of the technicians devoted to the geologic analysis, decreasing the field surveys and, as a consequence, the costs. As a local user the Arno Basin Authority has been strongly involved in the project, especially for those activities which require the knowledge of the territory, such as ancillary data collection, quantitative and widespread product validation and final integration of the products within the Italian official document related to the landslide risk management (Hydrogeological Structure Plan - Piano per l'Assetto Idrogeologico – PAI), which is produced by the Basin Authorities. The results obtained up today have been deeply validated from the local users and the qualification ranking is very high, especially because the products facilitate the user working procedures and they simplify the updating activity which the users have to perform every 4 years. This means that the final results will impact on the current instruments used by the Arno Basin Authority for the landslide risk management, representing one of the first examples in Europe of full integration of remote sensing data into land regulations concerning landslide hazard.

Abstract No. 704

Monitoring Landslide Activity with SAR Interferometry

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Satellite-borne Synthetic Aperture Radar Differential Interferometry (DInSAR) is attractive for slope instability assessment and landslide monitoring, because of the regular schedule, wide-area coverage, all-weather and day-night capability to produce digital elevation models (DEMs) and measure small ground surface deformations with centimetric to millimetric precision. We focus on the application of the recently introduced, patent-pending Permanent Scatterers (PS) DInSAR technique, which overcomes some major limitations of the conventional DInSAR (e.g. temporal decorelation in presence of vegetation). The PS technique combines the wide-area coverage typical of satellite imagery with the capability of providing deformation data relative to individual image pixels. The technique can be used to provide initial wide-area assessment of ground deformations, and then to focus on those areas where there is a potential slope hazard and where more detailed investigations may be required. To demonstrate the applicability of PS interferometry we present the results of study regarding a landslide prone area in Liechtenstein. Several tens of SAR images of ESA satellites ERS-1/2 covering 9 years have been processed to identify the PS, provide data for preliminary slope instability assessment and to monitor a large active landslide. The environmental conditions, geological features and processes related to landsliding are discussed to indicate how these can constrain the applicability of the PS technique and the interpretation of SAR data. Attention is drawn to ground truth data which may be required to distinguish the ground surface deformations produced by landslides from those related to subsidence, settlement of engineering structures, and shrink and swell of geological materials. We conclude the PS method represents a very valuable complementary source of information with respect to in-situ ground surveying.

Poster Session 3P01

Landslides

Abstract No. 278

ASAR Contribution to Landslides Inventory and Monitoring

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Landslides are a major natural threat claiming thousand of lives and millions of Euros each year over the world. Landslide hazard is relevant not just to the local inhabitants but also to all users of the environments, including tourists, owners of equipment, infrastructure and land, and users of roads and railways. Landslide mitigation necessitates extensive inventory and monitoring at large scales, often very difficult and expensive with traditional methods. Remote sensing techniques offer an alternative to this problem, allowing a regional identification of landslide prone-areas.The main objective of this paper is to evaluate the contribution of ASAR data in an operational system for landslide monitoring. This study has been undertaken with different partnership whose skills cover all the chain of ASAR data exploitation for landslides identification: remote-sensing, data production and geoscientists.The study site is located in the French South Alps in the landslide prone-catchments of Super-Sauze and Draix. These areas are well documented case studies allowing field validation of the documents derived from remote-sensed data. Several parameters useful for landslides inventory and monitoring have been derived from ASAR data such as Digital Elevation Models (by radargrammetric and interferometric methods)and landcover maps. Soil moisture maps are derived in a very prospective way. Difficulties associated to the identification of landslide areas with SAR data are presented. The main difficulty in mountainous areas stands on the visibility for DEM applications and on the computation of the local incidence angle according to the slope. Nevertheless, the numerous configurations of ASAR instrument give a lot of possibilities to acquire interesting scenes.

Abstract No. 344

Slope Instability and Surface Deformation in Dunedin City, New Zealand

N. Stevens, P. Glassey, B. Smith Lyttle
IGNS, New Zealand

The city of Dunedin, on the South Island of New Zealand, contains a number of active landslides in Dunedin that have affected residential properties, roads and infrastructure. Landslide damage in Dunedin is best illustrated by the Abbotsford landslide of 1979, a catastrophic slope failure following a period of accelerated ground motion, which destroyed 69 houses. Many of these slides have had, or currently have, surface deformation monitoring networks, with repeat surveys over various periods to measure horizontal and vertical deformation. However, repeated measurements of millimetre- and centimetre-scale slope movement are costly to obtain, and are time-consuming to

acquire at a high spatial resolution if using traditional field-based techniques for resurveying, such as levelling and differential GPS (global positioning system) measurements.In this study, we investigate the viability of ERS and Envisat differential radar interferometry as a potential solution to this problem, as the technique has already proven successful for monitoring slope instability in the French and Austrian Alps. In general, we found that the technique worked well over the urban, built-up areas of Dunedin. However, there were relatively few, or only very small, independently documented landslide movements within the intervals of the DInSAR image acquisitions in urban areas, as these are controlled by engineering works as soon as they are discovered. Several slides which were likely to be deforming actively during the study period coincided with forestry and agricultural areas, and are completely decorrelated in the ERS data. Although ERS radar interferometry did not yield the results as we had hoped for, we were able to make several interesting observations, including a deformation signal which appears to correspond to an area of reclaimed land in central Dunedin, and we hope that our results will be invaluable to other groups considering similar studies to this, in similar environments.

Abstract No. 604

Remote Sensing as a Tool for Supporting Landslide Risk Analysis

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Within the framework of the SLAM project, funded by the European Space Agency (ESA), and aimed to the definition of a service based on the integration of EO-data within the current practices of landslide mapping and monitoring both optical and radar images have been analyzed in order to extract information to be integrated with traditional methods. In particular, the Permanent Scatterers processing and the analysis of high resolution images (e.g. SPOT5 and aerial-photos) have been performed at a basin scale, on the whole territory of the Arno River basin (Central Italy). The drainage basin of the Arno River is almost entirely situated within Tuscany. The river is 241 km long, while the catchment has an area of about 8830 km2 and a mean elevation of 353 m a.s.l. The test basin, chosen for the presence of a high number of mass movements (up today about 300 areas at high landslide risk and more than 20,000 individual landslides mapped from the institutional authorities), are representative of the Italian Apennine territory, in terms of landslide type and environmental conditions. By considering the technical requirements imposed by the Italian legislation for the documents related to landslide risk management, three products based on EO-data have been defined related to landslide inventory mapping, landslide hazard mapping and landslide monitoring. To this aim, about 350 SAR images have been interferometrically processed by means of the PS technique, detecting about 600,000 PS. The processing of SPOT5 images and aerial-photos, still in progress, have been performed for the extraction of features related to the landslide presence, useful for the geomorphological analysis, in order to give a spatial meaning to the

punctual information provided by the PS. This procedure has been coupled with a intense geological interpretation phase characterized by the analysis of traditional in situ monitoring data, ancillary data and the performing of field surveys. The results obtained up today have been intensely validated in collaboration with the local users and the comparison with traditional geotechnical data and the observations coming from field checks have confirmed the effectiveness of the methodologies. Such results have obtained a very high qualification ranking also from the users. The final results will impact on the current instruments used by the Arno Basin Authority for the landslide risk management (e.g. Hydrogeological Structure Plan - Piano per l'Assetto Idrogeologico – PAI) representing one of the first examples in Europe of full integration of remote sensing data into land regulations concerning landslide hazard.

Abstract No. 705

Ground-surface Changes Detected by EO; their Relationships with Causative Factors of Slope Instability and Hazard Zonation

P. Gostelow[1], J. Wasowski[2]

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Natural and anthropogenic temporal ground-surface changes detected by EO which might individually or cumulatively lead to landslides are reviewed with respect to a physically based limit equilibrium slope instability model. Impacts are assessed qualitatively and may be positive or negative, depending on the actual position and type of surface change on a natural slope. Preliminary groupings of eleven broad change groups are identified and have been tabulated with their impacts to show potential failure and post-failure behaviour in relation to eight geotechnical material classes. Slope deformations can also be responses to limit equilibrium change but may now be detectable by EO. At present there is limited information on the magnitudes of wide-area ground movements which might be detected in different geological and geomorphological environments and a tentative grouping of just three groups are included here. The potential impacts of all the EO detected surface change to instability on slopes have been divided on the basis of whether the latter mainly consist of rocks or soils (cohesive or cohesionless) and their stress-strain behaviour or brittleness. An indication is also given on whether such wide-area surface changes are likely to give rise to individual landslides of large magnitude or to a high spatial frequency of low magnitude. A brief summary of EO techniques (with emphasis on SAR interferometry) which might detect such changes on a temporal basis follows. The paper concludes by putting forward a qualitative schematic approach for relative geotechnical hazard zonation with respect to slope instability which directly uses integrated EO data, a physically based model and the stress-strain characteristics of the ground. It is further suggested that with the new high resolution imagery (such as Ikonos and Quickbird) which is becoming available that such an approach might be used to routinely utilise EO directly as a contribution to both hazard mapping and subsequent zonation to warn of potential slope deformation, especially in other urban and peri-urban areas. Acknowledgements: This work was supported in part by the European Community (Contract EVGI 2001- 00055 - Project LEWIS).

Wednesday 8 September
08:40 – 10:20
KARAJAN 2-3

Session 3A2:

Vegetation

Abstract No. 81

Evaluation of the MERIS Terrestrial Chlorophyll Index

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The Medium Resolution Imaging Spectrometer (MERIS) has fine spectral resolution, moderate spatial resolution and a three day repeat cycle. This makes MERIS a potentially valuable sensor for the measurement and monitoring of terrestrial environments at regional to global scales. The red edge, which results from an abrupt reflectance change in red and near-infrared (NIR) wavelengths, has a wavelength location that is related positively to the chlorophyll content of vegetation. A new index, called the MERIS terrestrial chlorophyll index (MTCI) uses data in three red and NIR wavebands centred at 681.25nm, 705nm and 753.75nm (bands 8, 9 and 10 in the MERIS standard band setting) to locate the relative position of the red edge. The MTCI is easy to calculate and can be automated. Preliminary indirect evaluation using model, field and MERIS data suggested the sensitivity of MTCI to chlorophyll content, notably at high levels and its insensitivity to spatial resolution and atmospheric effects. As a result this index is now an ESA level-2 product.Three data sets were used for direct evaluation of the MTCI/chlorophyll content relationship. First, MERIS data and a surrogate of chlorophyll content for sites in southern Vietnam; second, MERIS data and actual chlorophyll content for sites in the New Forest, UK and third, field spectroradiometer data and actual chlorophyll content for plots in a greenhouse.Forests in southern Vietnam were contaminated with Agent Orange during the 1960s/70s. The level of contamination was spatially very variable with high levels of contamination associated with lowered levels of chlorophyll content, even within forests that have long since regained full canopy cover. The amount of Agent Orange sprayed onto the forest between 1965 and 1971 was used as a surrogate for contemporary chlorophyll content and was related to current MTCI at selected forest sites. The resulting relationship was, as expected, negative and significant. Further per-pixel investigation of the MTCI/Agent Orange concentration relationship is underway for larger forest areas. For the second and third data sets MTCI was related directly to chlorophyll content at two scales and the resulting relationships were, as expected, positive.Further plans involve evaluation of the MTCI in relation to the MERIS Global Vegetation Index (MGVI) at local, regional and eventually global scales.

Abstract No. 219

AVHRR Compatible Vegetation Index Derived from MERIS Data

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Within the ESA – AO project GEneration of MERIS Level 3 products for European Multidisciplinary Regional applications (GEMEL3, AO-ID 1413) a new MERIS land product is

developed. The new product, the AVHRR compatible NDVI, is dedicated as a continuity index for the AVHRR NDVI products used world wide for climate change research. In Northern Europe the NDVI is delivered as a daily, weekly and monthly product by DFD-DLR. Using MERIS full resolution data. DFD intends to continue the delivery of vegetation index products with higher spatial resolution.The AVHRR compatible NDVI is based on top of atmosphere radiances (ESA Level 1b data). The development of the continuity index is linked with simulations of the signal of the broad spectral channels of the NOAA – AVHRR by a linear combination of MERIS channels having bandwidths of typically 10nm. As an example, for the AVHRR channel 1 typically covering the spectral range from 580nm to 680nm the MERIS channels 5 and 6 will be used with suitable weighting factors. The weighting factors are determined by modelling the coupled radiative transfer for atmosphere, canopy and leaves. Leaf reflectances and transmittances are calculated using the SLOP model (Maier et al., 1999). The SLOP model is driven by typical leaf parameters as pigment content (chlorophyll, carotenoids), scattering coefficient, water status and refractive index of leaf surface. The resulting leaf reflectance and transmittance spectra are input data for the canopy radiative transfer model SAIL (Verhoef, 1984) which was modified for including a hot-spot parameterisation (Kuusk, 1991). Finally the calculated "bottom of atmosphere (boa)" spectra of the canopies are injected in a modified SMAC model, describing the radiative transfer of the atmosphere (Rahman & Dedieu, 1994). The convolution of the modelled "top of atmosphere (toa)" spectral signature of different canopies with the transmission curves of the MERIS and NOAA16 - AVHRR channels yields the virtual signals of both instruments. The mean weighting factors are calculated based on the virtual signals. When the reflectance spectra of a great number of canopy architectures illuminated by different solar geometries as well as different observation geometries are modelled, a regression has given the best weighting factors. Finally, the AVHRR compatible NDVI is calculated.The „AVHRR compatible NDVI" will be available as L2 and L3 products. The maximum value technique for weekly and monthly composites is applied. In addition, the first validation results will be presented using data from AVHRR on NOAA 16 acquired at the same day over the same area.

Abstract No. 471

Retrieval of Vegetation Biophysical Variables from MERIS Data: Methodology and Validation with the SPARC Dataset

J. Moreno, G. Fernandez, S. Gandia
University of Valencia, Spain

The spectral capabilities of MERIS data make these data specially suitable to retrieve vegetation biophysical variables such as Leaf Area Index (LAI), leaf chlorophyll, fractional vegetation cover, leaf (dry) biomass and other relevant information related to vegetation types and areal extension. Although some information is retrievable by means of traditional classification approaches, optimised spectral indices and model-inversion techniques are more suitable methods to retrieve such vegetation information. Validation of such retrievels require ground measurements at relevant scales, complemented by collateral data to compare retrievals at high spatial resolution and then validate retrievals from low resolution data.In the context of this work, MERIS images available for our study area in La Mancha, Spain, have been radiometrically, geometrically and atmospherically

corrected according to methods described in other papers in this conference. All the available ground measurements were cross-checked with GPS measurements. Then, for each available ground measurement, the corresponding point was identified in the image. A dedicated database was developed by putting together each ground measurement with the corresponding MERIS measurements, to facilitate the development and testing of different retrieval algorithms.Variability in ground measurements was evaluated by statistical techniques, according to the sampling used in the data collection. Although it was a large variability in some biophysical variables (particularly leaf chlorophyll and leaf area index) mean field values can be derived, and inter-fields variability is still larger than intra-field variability. The data was collected to make possible retrievals al the level of sampling unit, thus describing within field variability.Two different approaches have been followed in the retrieval of vegetation biophysical variables. First, a large number of spectral indices have been tested with the available spectral information. Retrievals based on spectral indices are limited in accuracy, but they allow also to check the overall consistency in database content. The second method used is based on model inversion techniques. A combination of adapted versions of PROSPECT and SAIL models have been tested in forward mode, by using all available ground measurements to reproduce the top-of-canopy reflectance, and then compare these forward simulations with atmospherically corrected MERIS data. Large discrepancies in model simulations versus MERIS data must be understood before a model inversion strategy is applied. Moreover, multi-step techniques seem to be required to decouple the different information in a consistent manner and to determine simultaneously all the biophysical variables with reasonable values for all of them. Although retrievals focus on chlorophyll and leaf area index as main variables, canopy structure and dry matter content seem to be critical factors when accounting for the coupling of leaf reflectance and leaf transmittance at the canopy level in model-inversion approaches.In order to validate such retrievals, a large amount of ground measurements were collected in the Barrax study area during the SPARC campaign, in July 2003, covering LAI, fCover, Leaf Chlorophyll a+b, Leaf water content and leaf biomass, together with other complementary data. Apart from the MERIS FR data, in the context of the SPARC campaign, a total of 10 different view angle images from CHRIS/PROBA, all of them acquired in Mode 1 (62 spectral bands), and two lines of HYMAP airborne data (126 spectral channels, app. 5 m resolution) and 4 lines with ROSIS airborne data (115 spectral channels, app. 1 m resolution) were acquired. MERIS retrievals can then be validates by using simultaneous retrievals from CHRIS and ROSIS high spatial resolution data with similar spectral capabilities.Validation of retrievals with the large dataset of ground measurements which is available in SPARC represents a unique opportunity to exploit multi-scaling issues by using MERIS data, by comparing field measurements to ROSIS (1m of spatial resolution), HyMap (5m), CHRIS (34 m) and MERIS (300 m) data.

Abstract No. 599

Monitoring Rangeland in the Canadian Prairie Using MERIS

J. Busler[1], C. Nadeau[1], H. Wehn[1], A. Smith[2]

[1] *MacDonald Dettwiler, Canada*

[2] *Agriculture and AgriFoods Canada, Canada*

Rangeland or native grass prairie is an important food source for cattle and wildlife in western Canada. The effects of changing weather patterns and historical grazing practices have a significant impact on the sustainability of this resource. Provincial rangeland management groups monitor health and biomass to establish the grazing capacity of hundreds of thousands of hectares of rangeland each year. Long term management plans and grazing policies are developed by combining these parameters with local ranching practices and the ecological needs of an area. The wide field of view, narrow band width and medium resolution of the MERIS sensor make it well suited to monitor the vast areas and multiple ecozones of grazed prairie in Alberta and Saskatchewan.A two-year collaborative study, partially funded by PRECARN, joins the technical and agricultural expertise from MacDonald Dettwiler, Agriculture and Agri-Foods Canada, York University, Radarsat International and the Canada Centre for Remote Sensing. This project uses in-situ sensors, remotely sensed image products and field visits to study and assess the health and livestock use of a 2224 ha area of rangeland near Brooks, AB. The growing season of 2004 is the first year of this study. The in-situ sensors measure a variety of meteorological and agricultural parameters such as soil moisture, air temperature, precipitation, wind speed and direction. Site visits at regular intervals throughout the season use hand-held optical sensors to measure the leaf area index (LAI) and collect samples for measuring wet and dry biomass. Data collected from the in-situ sensors and site visits is compared with green LAI and biomass estimates derived from MERIS image products acquired coincidentally. The green LAI for the rangeland sites are calculated using improved variants of the TVI and MCARI spectral indices described in Haboudane et al., 2004*. These indices are less sensitive to variations in chlorophyll concentration so they have a good linear relationship with LAI. Biomass is estimated from LAI using rangeland vegetation models. These preliminary results assess the suitability of using medium resolution space-borne imagery for Canadian rangeland management. * D. Haboudane, J.R. Miller, E. Pattey, P. J. Zarco-Tejada and I.B. Strachan. 2004, "Hyperspectral vegetation indices and novel algorithms for predicting green LAI of crop canopies: modeling and validation in the context of precision agriculture." Remote Sensing of Environment, 90:337-352.

Abstract No. 240

Using MERIS on Envisat for Land Cover Mapping

J. Clevers, R. Zurita Milla, M. Schaepman, H. Bartholomeus
Wageningen University, Netherlands

One of the benefits of MERIS on Envisat for global land studies is the provision of land cover maps over large areas. Major contribution of MERIS in this respect is the provision of (calibrated) data with a spatial resolution intermediate to that of NOAA-AVHRR or SPOT-VEGETATION and Landsat-TM or SPOT-HRV data.This paper describes the results of a study towards the use of MERIS for land cover mapping in the Netherlands, which is used as a test site. Full resolution MERIS data of February 18th 2003, June 16th 2003 and July 14th 2003 and reduced resolution data from March 22nd 2003 and July 14th 2003 were used in this study. The Dutch land use database LGN was used as a reference by aggregating the database from 25 m to 300 m and 1200 m, respectively. First, spatial, spectral and radiometric quality and information content of the used MERIS images were explored. Subsequently, the feasibility of the data for land cover classifications

was studied at both scale levels. Results were also compared to results obtained with other sensors, like MODIS, VEGETATION and AVHRR.Preliminary results already show very good geometric characteristics of the MERIS images used in this study. Major land cover classes can already be well separated based on a monotemporal image. The merit of MERIS lies primarily in the improved spatial resolution of the full resolution mode (300 m) when compared to the mentioned low-resolution sensors. The use of multitemporal data analysis will be further explored. Quantitative assessments will be made regarding spatial, spectral and radiometric quality for this type of application.

Poster Session 3P02:

Vegetation

Abstract No. 53

Estimation of Biophysical Parameters from Surface Reflectances

Y. Knyazikhin, R. Myneni, N. Shabanov, W. Yang, B. Tan
Boston University, United States

Land surface processes are important components of the terrestrial climate system. Accurate descriptions of the interaction between the surface and the atmosphere require reliable quantitative information on the fluxes, mass, and momentum, especially over terrestrial areas, where they are closely associated with the rates of evapotranspiration and photosynthesis. Many of these processes can be related to the spectral reflectance of the surface. The vegetation canopy is classified as a special type of surface not only due to its role in the energy balance but also due to its impact on the global carbon cycle. Its reflection results from bio-physiological, chemical and physical processes, and is characterized by spatial, seasonal and diurnal variations. Modern satellite-born sensors (e.g., MODIS, MERIS, MISR, POLDER, SeaWiFS) allow for rich spectral and angular sampling of the radiation field reflected by vegetation canopies. This presentation will provide an analysis of leaf area index and fraction of photosynthetically active radiation absorbed by vegetation derived from MODIS and MISR data.

Abstract No. 54

The Greening Earth

R. Myneni[1], R. Nemani[2], C. Tucker[3]
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3 NASA/GSFC, United States

Global carbon cycling studies imply an increasing terrestrial carbon sink since the 1980s, but the location and mechanisms behind such a sink remain unclear. Evidence exists for recent climatic changes enhancing plant growth over the northern latitudes, but a globally comprehensive analysis of the impact of climatic changes on net primary production (NPP), the balance between photosynthesis and respiration by plants, is lacking. Here, we present a global picture of plant growth responses to climatic changes, by analysing 18 years (1982-1999) of both climatic data and satellite observations of vegetation activity. Our analysis indicate that global changes in climate have eased many climatic constraints to plant growth, such that NPP has increased globally, with the largest increase in tropical ecosystems. Results substantiating this claim will be presented.

Wednesday 8 September
08:40 – 10:20
MOZART 1-2

Session 3A3:

Trace Gases (2)

Abstract No. 90

Retrieval of CH4, CO2 CO and H2O FROM SCIAMACHY Onboard Envisat

C. Frankenberg[1], U. Platt[2], T. Wagner[2], C. Frankenberg[2]
[1] University of Heidelberg, Germany
[2] IUP Heidelberg, Germany

The spectrometer SCIAMACHY aboard Envisat provides three near infrared channels with moderate spectral resolution. The vertical column amounts of the absorbing atmospheric constituents are retrieved through an iterative DOAS technique basing on the optimal estimation approach.Amongst the absorbers in these spectral regions are greenhouse gases such as CH_4 or CO_2, which can be retrieved with high accuracy. In this work, the first results and the further potential of the latest SCIAMACHY data products are discussed with special regard to greenhouse gases, viz. CH_4 or CO_2 and H_2O.First examinations indicate the existence of peculiar atmospheric conditions in which the measured total column can be artificially enhanced.Furthermore, the possibility of measuring CO as tracer for anthropogenic emissions is investigated.

Abstract No. 44

Greenhouse (related) Gases CO and CH4: First Results on Global Distribution, Seasonal Variation and Pollution Events Detected by SCIAMACHY

A. Straume, H. Schrijver, A. Gloudemans, A. Maurellis, J. De Laat, S. Houweling, Q. Kleipool, G. Lichtenberg, R. Van Hees, I. Aben
SRON, Netherlands

The SCanning Imaging Absorption spectroMeter for Atmospheric CartograpHY (SCIAMACHY) has been measuring earth-reflected sunlight scattered by the atmosphere in the ultraviolet, visible and near-infrared (240–1750 nm, 1940-2040 nm, 2265-2380 nm). We present here new CO and CH_4 data products derived from the near-infrared channels.The near-infrared retrievals have proven more complex due to the presence of an unexpected ice layer on the detectors. However, its effects have been reduced by applying dedicated in-flight decontamination procedures and additional in-flight calibration measurements, as well as ongoing in-house improvements to the calibration. The SRON-retrieved CO and CH_4 total columns are currently in the process of being comprehensively validated through in-house retrieval intercomparisons, and comparisons to ground-based measurements, chemical transport model calculations (TM3/5 and GeosChem), and measurements by other satellite instruments most notably MOPITT. Although most results are still very preliminary, there is clear evidence that SCIAMACHY is sensitive to the distribution of lower

tropospheric CO and CH4. Such evidence is provided by observed latitudinal gradients and seasonal variations, as well as the detection of plumes from biomass-burning events.

Abstract No. 387

Retrieval of CO, H2O, CH4, CO2, and N2O Columns from SCIAMACHY/Envisat by WFM-DOAS: Current Status

M. Buchwitz
University of Bremen, FB1, Germany

SCIAMACHY nadir measurements of scattered and reflectedsolar radiation enable the retrieval of total column amounts ofimportant atmospheric trace gases.This paper summarizes the current status of our CO, H2O, CH4, CO2, and N2Overtical column retrievals using a modified DOAS algorithm(WFM-DOAS).Although the operational Level 1 data products used for the retrievalare currently limited in quality (preliminary calibration) and quantity (not all orbits have been made available) it is shown that encouraging higher level data products can be derived.For example, plumes of CO due to biomass burning in Africa areclearly detectable and show good agreement with independentmeasurements (e.g., MOPITT/TERRA). The retrieved water vapourcolumns agree well with SSM/I satellite microwave measurements over ocean and ECMWF analysed meteorological fields over ocean and land. Retrieval of well mixed gases such as CH4, CO2, and N2Ois also possible but difficult as basically onlysmall variations of a nearly constant background concentration are of relevance, e.g., to infere information on the (surface) sources and sinks of these important Greenhouse gases.

Abstract No. 481

Derivation of Bry in the UT/LS Using SCIAMACHY Limb Scattering Observations

C. Sioris[1], R. Salawitch[2], L. Kovalenko[2], K. Chance[1]
[1] *Smithsonian Astrophysical Observatory, United States*
[2] *Jet Propulsion Laboratory, United States*

The observed global distributions of BrO (15-30 km) and NO2 (11-41 km) from SCIAMACHY are shown along with a brief description of the retrieval approach. The volume mixing ratio of inorganic bromine (Bry) is derived from SCIAMACHY measurements of the vertical distribution of BrO and NO2 by using these observations to constrain a photochemical model and give the local bromine partitioning. Comparisons are made with previous Bry profile estimates from inorganic and organic methods. Possible sources of Bry in the tropical tropopause layer are discussed.

Abstract No. 19

Satellite Remote Sensing of SO2: Volcanic Eruptions and Anthropogenic Emissions

M. Khokhar, U. Platt, T. Wagner
IUP, Germany

Sulfur Dioxide (SO2) is an important trace species in the atmosphere, both under background conditions and in polluted areas. It is released to the troposphere as a result of both anthropogenic and natural phenomena. Only one-quarter of the sulfur in the atmosphere is natural, and the rest is caused by human activitiesVolcanoes are an important natural source of various atmospheric trace gasses. Volcanic eruptions and their emissions are sporadic and intermittent and often occur in uninhabited regions. Therefore assessing the amount and size of the gaseous and particulate emission from volcanoes is difficult. Satellite remote sensing measurements provide one well suited opportunity to overcome this difficulty. Onboard ERS-2, GOME's moderate spectral resolution enables us to apply the Differential Optical Absorption Spectroscopy (DOAS) algorithm to retrieve SO2 column densities from radiance/irradiance measurements in UV spectral region. In this work we give a comprehensive overview on the retrieval of SO2 column densities from GOME data for the years 1996 – 2002, anthropogenic sources and several volcanoes. The focus is on both eruption and out gassing scenarios from different volcanic eruptions in Italy, Iceland, Congo/ Zaire, Ecuador and Mexico.In GOME data, the SO2 columns by anthropogenic emissions above China in winter are always largest, but SO2 can sometimes also be observed above the US, the Arabian Peninsula, Eastern Europe, parts of Russia and South Africa.

Wednesday 8 September
08:40 – 10:20
DOPPLER

Session 3A4:

Ocean Circulation

Abstract No. 352

Contribution of ERS and Envisat in Past, Present and Future Multi-mission Altimeter Systems

P. Le Traon
CLS, France

Since the late 90's, ERS-2 and later on Envisat have been successfully and operationally used in combination with other altimeters. The consensual need of at least two altimeters to resolve the mesoscale signals has been possible thanks to the ERS / Envisat measurements.An overview will be given on past and present instances of combination systems using Envisat data, and notably on the operational merging done in near real time (NRT) by SSALTO/DUACS (Data Unification and Altimeter Combination System). The operational applications of such a NRT merging will be presented, as well as the significance of Envisat therein.Future merging and future needs related to Envisat will be described: the experimental merging with opportunity measurements from CryoSat using the HERACLES prototype, the operational use of delayed time data from Envisat to continue the TP+ERS historical series of maps of Sea Level Anomalies from AVISO and ENACT, the reliable satellite coverage needed in 2007+ for GMES and recommended by the GAMBLE thematic network...

Abstract No. 457

Analysis of Near Real Time Envisat Radar Altimeter Data

K. Whitmer, G. Jacobs
Naval Research Laboratory, United States

The Envisat radar altimeter has proven to be a valuable contributor to the realm of near real time satellite altimetry. The quality and the value of this product to the real time oceanographic community is demonstrated both statistically and graphically. Currently the IGDR's are ingested into the US Navy's real time processing system to produce high quality sea surface height anomalies (SSHA). A brief description is made of the processing techniques and of the quality checks made. The latter is presented to explain the criteria for which data points are dropped from the final SSHA product. Analysis is presented of the major contributors to dropped data. Suggestions for improving the most significant of these are discussed. Graphic presentation of the SSHA is presented and compared to other sources for validation purposes. The SSHA values are also compared at crossover points with both itself and the GFO and Jason-1 satellite altimeter data. These comparisons are quantified by computation of RMS values. Finally, an analysis of the timeliness of the data products is presented with a discussion of its effect on the end products.

Abstract No. 120

Validation and Applications of Near-Real Time Altimetry Data for Operational Oceanography in Coastal and Shelf Seas

J. Hoeyer, T. Boevith
Danish Meteorological Institute, Denmark

The near-real time altimetry products from JASON-1and Envisat are validated against tide gauge observationsin the North Sea-Baltic Sea system. Correlations and errorstatistics are presented for the altimetry observations close tothe tide gauges. The spatial and temporal correlation scales have been calculated and the space vs. time sampling issue of the two satellites will be discussed. Based upon the covariances, the feasibility of using the data in combinationwith operational hydrodynamical models is investigated.

Abstract No. 332

Oceanographic Characterization of the Cape Verde Region Using Multisensor Data

J. Fernandes[1], C. Lázaro[2], M. Santos[3], P. Oliveira[3]
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[3] Instituto Nacional de Inv. Agrária e das Pescas, Portugal

The Cape Verde Archipelago lie under the influence of several current systems: on the north side, the southern portion of the Canaries Current and the North Equatorial Current; on the south side, the North Equatorial Counter Current (NECC). These two very different water masses meet in the vicinity of the archipelago forming a large scale frontal system. The associated frontal systems are potentially productive zones, favourable for the aggregation of large pelagic highly migratory fish species. This study focuses on the characterization of the NW Africa region (3°N - 30°N ; 40°W - 10°W) in terms of the main ocean circulation and associated phytopigment concentration patterns and their seasonal and interannual variability using multisensor data. This work has being done in the scope of the ESA A03-265 project. The data used include absolute dynamic topography (ADT) and derived surface geostrophic currents from ERS-2 and Topex/Poseidon, sea surface temperature (SST) from ATSR2 and AVHRR and chlorophyll-a from SeaWiFS. The first two data sets (altimetry and SST) cover 8 years, from June 1995 to May 2003. The chlorophyll-a data set comprises nearly 6 years, from September 1997 to May 2003.The analysis of this large data set allowed the characterization of the main current systems and their variability, the seasonal distribution of the SST and chlorophyll-a concentration and associated synergies between these data

sets. Here only some of the conclusions are highlighted.The seasonal cycle/signal along the NW Africa coast is strongly linked with coastal upwelling variability forced by the north-south migration of trade winds in the region. From December to May the band of cold and pigment-rich upwelled waters extend as far south as 10° N. This is associated with the strengthening of the Canaries current and the weakening of the NECC during this period. From June to November, the upwelling relaxation is accompanied by the northward extension of the NECC transporting warm oligotrophic waters, which reach the latitude of 20° N around August. The change in the SST distribution follows the ICTZ meridional seasonal migration. In the offshore region, the seasonal amplitude of SST is much lower than in the coastal region and achieves maximum values from September to November, when higher pigment concentrations are observed in the vicinity of Cape Verde islands.Several cyclonic/anticyclonic structures visible in the current fields can be associated with regions of high/low chlorophyll-a concentration.The results were compared with tuna catch per unit of effort (cpue) data, although their low spatial and temporal resolution makes this type of analysis difficult.Two types of fisheries were analysed: the purse-seine fishery, more industrial and oceanic and the more artisanal and coastal bait-boat fishery.The activity of the purse-seine fishery during 1995-1997 was usually associated with a cyclonic circulation off the Guinea-Senegal coast (the Guinea Dome), clearly seen in the ADT maps. The enhanced productivity in the surface waters above these domes, coupled with the shallowing of the thermocline could explain, the success of the fishing activity associated with this feature.The bait-boat fishery operates mainly in the Cape Verde-Mauritania region, associated with the upwelling season. It is interesting to note that in this case the success of the fishery seems to be associated with the warm waters adjacent to the cold pigment-rich upwelled waters. However, the limitation of the fishing data (low spatial resolution and small period of time) does not allow conclusive results.

Abstract No. 350

Tides in Coastal Areas from Altimeter Data

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ARGOSS, Netherlands

BackgroundRadar altimeter data from satellites as Topex/Poseidon (T/P) have been used successfully in the past decade to determine ocean tides. There exists great demand for tidal information closer to the continents, where human activity is more intensive and tidal effects more pronounced. This information can be obtained in a similar way, by assimilation of altimeter data in coastal tidal models. On the finer computational grids of regional tidal models altimeter data become (relatively) sparser and therefore hydrodynamic model equations more important. Furthermore, in these model equations non-linear terms become relevant. This note shows our approach to assimilate altimeter data in shallow water tidal models.Satellite altimeter measurements have a global coverage. Using these data we can set up and run regional models anywhere in the world, also in areas in which traditional tidal measurements (e.g. in harbours) are sparse. The results model runs consist of gridded tidal constants. The depth map that is used in the model determines the grid. Additionally, also the tidal constants for the currents are computed.2. Tidal modelWe use the shallow water equations to describe the hydrodynamics. As our purpose is to determine tidal

constants in the regional model area, the behaviour in time of the water level and current is represented with only eight (largest) tidal components. We use a Galerkin technique to close the hydrodynamic equations and thereby create a model that describes the interaction between tidal constants. In linear terms of the hydrodynamic equations the individual tidal components decouple. In two-field terms, such as advection, two tidal components interact with the closure component when they obey a resonance condition. The drag coefficient in the friction term, which is taken proportional to the absolute value of the speed, is non-analytic and very complex in a tidal constant representation. Fortunately, the drag coefficient is determined in good approximation by the component with the largest flow constant (usually M2).Measured tidal data are inserted in the assimilation method in the form of tidal constants. This means that a harmonic analysis is applied to the altimeter measurements. The problems involved with the long repeat period of satellites are well known. We use a straightforward least square regression method, because consistency with hydrodynamic laws and neighbouring tracks is added in the data assimilation method and should therefore not be used in the data analysis. The only restriction that we impose is that the tidal constants should vary smoothly along the tracks. For the boundary conditions we need to know the surface slopes across the boundaries. These are estimated from a harmonic analysis of altimeter data on tracks that cross the boundary. The tidal constants are parameterised as a smooth surface that is fitted in a strip around the boundary. From this surface the cross-slope is computed. Alternatively, boundary conditions can be estimated from the results of larger regional or even global model computations.3. ApplicationsThe purpose of these modelling efforts is to be able to efficiently set up regional tidal models for worldwide applications. As a case study we will consider the Arabian Gulf, an enclosed, shallow area with significant tidal variations. The depth map in the model is based on the GEBCO database, which determines the grid spacing of 1/60th degree (about 1.8 km). As input data for the model we have tidal constants along 37 satellite tracks and in 22 harbours.

Poster Session 3P03:

Ocean Circulation

Abstract No. 156

Using SAR Images for Detection of a Surface Poleward Current off the West Coast of the Iberian Peninsula

J. Torres Palenzuela, L. Gonzalez Vilas

University of Vigo, Spain

The surface circulation off the western coast of the Iberian Peninsula is strongly influenced by the atmospheric pressure distribution in the North Atlantic. As a result of the pressure gradient force winds blows northward along the Iberian coast during the winter season. So, the combination of the onshore Ekman transport and the geostrophic adjustment of the large-scale oceanic zonal flow causes the appearance of a seasonal poleward along-shore flow named Navidad current. This surface flow was investigated using hydrographic data together with satellite infrared imagery. ERS Synthetic Aperture Radar (SAR) data responds to the roughness of the sea surface, and the radar backscattering strength is dominated by the Bragg backscattering mechanism. SAR have demonstrated their capabilities for imaging ocean waves, surface currents and wind fields, and in this paper a strip of four ERS-2 SAR frames acquired over the North Atlantic ocean off the Iberian Peninsula coast on 26 November 2002 were used to try to demonstrate the capability of radar data to identify the presence of this surface current under certain hydrodynamic conditions.

Abstract No. 208

Mean Sea Surfaces - and Inter-annual Ocean Variability

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In a comparison between hydrodynamic derived mean dynamic topography (MDT) and synthetic derived MDT (derived from the difference between the MSS and the geoid), the resuls depends on the quality of the MSS and geoid, but also on the inter-annual ocean variability. In principle the MSS used to derive the synthetic MDT should be averaged over the same period in time as used to average the hydrodynamic derived MDT to avoid leakage of inter-annual ocean variability on the result. Different global mean sea surfaces (CSR98, GSFC00, CLS-SHOM98, CLS01, KMS01) are based on limited T/P time-epoch used in their derivation. Consequently, inter-annual ocean variability (like the major El-Nino event in 1997-1998) will be visible to a larger or smaller extend in these different MSS (the MSS are actually quasi-stationary MSS). In our new mean sea surface (KMS03) we have included a method to account for the inter-annual ocean variability. By investigating the inter-annual ocean variability from T/P the MSS can be made to include the inter-annual variability over a specific period in time From the 9.9 years of T/P altimetry the inter-annual ocean variability for each year have been modeled using the annual mean sea level height once the

"intra"-annual ocean variability have been removed. The "intra"-annual variability was initially removed by removing the mean monthly value of all months from the 9.9 year period. Evaluation of the available mean sea surfaces will be carried out in the GOCINA study region (www.gocina.dk) in the Northern Atlantic region. An extended comparison will also be presented in the Arctic Ocean to demonstrate the impact of improved geoid and mean sea surface modeling to derived reliable synthetic MDT. Particularly using the GRACE derived geoid models (GGM01), and the KMS03 mean sea surface.

Abstract No. 297

Improving Ocean Analyses and ENSO Forecasts at NOAA using the Global Ocean Data Assimilation System and Altimetric Sea Level

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2 NOAA/NCEP Climate Modeling Branch, United States
3 NOAA/NCEP Climate Prediction Center, United States

Operational forecasts of the El Niño / Southern Oscillation (ENSO) in the tropical Pacific have been carried out at NOAA's National Centers for Environmental Prediction (NCEP) since 1994. The Global Ocean Data Assimilation System (GODAS), introduced in September 2003, provides initial conditions for the Coupled Forecast System (CFS03) global ocean/atmosphere model that will become operational in 2004. The GODAS assimilation system is quasi-global (65S-75N), is based on the GFDL MOM-3 ocean model, is forced by momentum, heat, and fresh water surface fluxes from NCEP's Reanalysis-2, and utilizes 'synthetic salinty' profiles based on climatological temperature/salinity relationships. Evaluation of GODAS versus in situ observations reveals that using climatological T/S relationships seriously supresses sea surface salinity variability, which can cause large errors in surface current fields.Presently the model assimilates temperature data from XBTs, profiling Argo floats, and the tropical Pacific TAO moorings. GODAS is being updated to include altimetry data from JASON-1, Envisat, and possibly GFO in the coming months. We expect the inclusion of altimetry data to improve both the salinity and current fields in GODAS. Based on studies using statistical Markov models, sea level is the most important predictor for forecasting the future evolution of ENSO. The improvement in GODAS with the inclusion of altimetry and its influence on ENSO forecast skill will be investigated.

Abstract No. 442

SARTool: building marine SAR Applications

F. Collard, V. Kerbaol
BOOST Technologies, France

A software tool dedicated to marine SAR applications will be demonstrated.it includes: basic ASAR data handling for all modes: antenna pattern correction, incidence angle compensation. Display enhancement and GIS overlay. Statistical/spectral/transect analysis output in binary, NetCdf, Postscript, Raster format. Marine application specific processing: wave inversion wind inversion oil spill monitoring (including ancillary data overlay) ship detection oceanic front/eddies detection radial surface velocities estimation. multi-layer ancillary data and model outputs information

Abstract No. 539

Nonlinear Internal Waves in the South China Sea

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Synthetic Aperture Radar (SAR) images have been used to study the characteristics of internal waves in the South China Sea. Most of internal waves in the north part of South China Sea are propagating westward and are generated from the shallow topography or sills in the Luzon Strait. Based on the RADARSAT ScanSAR images collected in 1998 and Envisat ASAR images collected in 2003 and 2004, huge internal solitons were observed near DongSha Island with crest more than 200 km long. One of the most interesting processes is the detection of elevation internal waves in shallow water and depression waves on the shelf break in the same SAR imagery. The effects of water depth on the evolution of solitons and wave packets have been modeled by modified KdV-type equation and linked to the satellite image observations. For a case of depression waves in deep water, the solitons first disintegrate into dispersive wave trains and then evolve to a packet of elevation waves in the shallow water area, after they pass through a "critical depth" of approximately equal thickness of mixed layer and bottom layer as demonstrated by the numerical model. Near DongSha Island, the westward propagating huge internal solitons are often encountered and broken by the coral reefs on the shelf and re-merged after passing the island. In the shallow water area, significant sediment re-suspension due to the current induced by the elevation internal waves has also been observed.

Abstract No. 632

Internal waves in the East China Sea and the Yellow Sea studied by SAR, MERIS, MODIS and ASTER imagery

W. Alpers[1], M. He[2], . Zeng Kan[2], . Li Xiao-Ming[2], . Guo Ling-Fei[2]

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Internal waves in the East China Sea and the Yellow Sea studied by SAR, MERIS, MODIS, and ASTER imagery Werner AlpersCenter for Marine and Climate ResearchInstitute of OceanographyUniversity of HamburgHamburg, GermanyBundesstr. 53, D-20146, Hamburg, Germanyalpers@ifm.uni-hamburg.dealso Visiting Professor at the Ocean University of China, Qingdao, ChinaMing-Xia HE, Kan Zeng, Xiao-Ming Li, and Ling-Fei GuoKey Laboratory of Ocean Remote SensingOcean University of China, Ministry of EducationYushan Road 5, Qingdao, 266003, Chinazengkan@orsi.ouc.edu.cn, mxhe@orsi.ouc.edu.cnUntil now only very few oceanographic measurements have been carried out in the East China Sea and the Yellow Sea for studying internal waves. Satellite imagery can greatly help in locating generation regions of internal waves and in obtaining information about their propagation characteristics. A first systematic study of internal waves in the China Seas and the Yellow Sea using ERS SAR imagery has been carried out by Hsu et al (2000). In this paper we extend their investigation by not only analyzing more SAR images acquired by the ERS and Envisat satellites, but also by including visible and infrared images acquired by the Envisat, Terra and Aqua satellites. The MERIS sensor on Envisat, the MODIS sensor on Terra and Aqua, and the ASTER sensor on Terra also capture sea surface signatures of internal waves. These signatures are especially pronounced when the images are taken in the sunglint. We present several examples of such signatures of internal waves and discuss how they depend on the elevation angle of the sun and on the viewing angles of the sensor. By including visible and infrared images acquired by these satellites, the data base for studying the generation and propagation of internal waves in the East China Sea and the Yellow Sea is greatly enhanced.

Abstract No. 638

Investigation of Internal Waves in the East (Japan) Sea using Synthetic Aperture Radar

D. Kim, W. Moon, S. Nam, K. Kim
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Recently, several ship experiments have shown that nonlinear internal solitary waves are frequently observed in the East (Japan) Sea, mostly in the continental slopes located along the west side of the East Sea basin. It is well known that oceanic internal solitary waves can be detected in synthetic aperture radar (SAR) images with both high resolution and large coverage. Interaction between surface capillary-gravity waves and horizontally varying surface currents induced by internal solitary wave produce variations in sea surface roughness which can be detected by SAR. C-band SAR images from Envisat ASAR and RADARSAT have been used to investigate the characteristics of these internal solitary waves in the East Sea. Both SAR observations and in-situ measurements were carried out during IWXES (Internal Wave eXperiment in the East Sea) in 2003 and 2004. The in-situ measurements include currents and water temperatures, which were made using thermistor chains, recording current meters and acoustic Doppler current profilers (ADCPs) located in the shelf slope. The observed deformation of internal waves (refraction, fission, shoaling, and breaking, etc.) in the SAR image were verified from in-situ measurements and theories, which were caused by the changes in bottom topography and stratification. Furthermore, we demonstrate how the SAR images can be used to estimate sea surface patterns caused by internal solitary waves.

Abstract No. 654

Southern Ocean Ocean Tide Modeling

C. Shum, Y. Yi

Ohio State University, United States

Ocean tides play a significant role in the complex interactions between the atmosphere, ocean, sea ice and floating glacial ice shelves. Tidal currents create turbulent mixing at the bottom of the ice shelf contributing to the creation of rifts for the possible detachment of part of the ice bergs and can influence heat transport between the ice shelf and sea water. Tides near and under floating ice shelves and sea ice, and depending on surface and basal slopes, grounding line migrates with time within a grounding zone. Tides are much less well-known in coastal regions and in polar oceans, especially underneath sea ice covered covered seas and beyond +/- 66 degree latitudes. In this paper, we present results of empirical ocean tide models using Envisat, ERS, GFO and TOPEX/POSEIDON altimeter data over the ocean and over sea ice, from -50 degree latitude poleward. An analysis of improving tidal aliasing and spatial resolutions of the tide model using multiple altimeter data sets and the accuracy assessment of the model will be presented.

Abstract No. 659

Southern Ocean Sea Level Variations

C. Kuo, C. Shum, A. Braun

Ohio State University, United States

High-latitude polar ice sheets and the polar ocean are the primary heat sink in the global climate system, and play an important role in climate change and its variability. The circulation of the Southern Ocean is dominated by the zonal Antarctic Circumpolar Current, which isolates the Antarctic continent and maintains its low temperature. Satellite altimetry such as Envisat, ERS-1/-2, GFO, Geosat, because of their higher orbital inclinations, covers more polar ocean than from TOPEX/POSEIDON and JASON. Observational evidences suggest that the Southern Ocean is significantly warmer since the 1950s (Gille, 2002) and that the power of the sea level rise in the 1990's is predominately in the Southern Ocean (Cazenave et al., 2001; Shum et al., 2002). In this paper, we report studies of sea level variations in the Southern Ocean due to potential anomalistic warming using Envisat and other high-latitude altimetry, in situ data, oceanic mass variation observations such as GRACE, and ocean models.

Abstract No. 664

Absolute Local Sea Surface in the Vanuatu Archipelago from GPS, Satellite Altimetry and Pressure Gauge Data

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Water height measurements provided by seafloor tide gauges are a combination of sealevel variation and ground motion. Both of these signals are of scientific interest, but they must be separated in order to be useful. A reliable estimation of the vertical ground motion is specially important in very seismically areas such as the Pacific Ocean rim. One promising method to separate the two contributions is to use satellite altimetry data which gives absolute water height, but these data must be calibrated using "ground truth" measurements. Once different components of the signal are separated, bottom pressure gauges can be used to detect vertical movements of the seafloor.The Vanuatu archipelago is part of the Pacific « ring of fire », where plates are quickly converging. In this area, movements are very rapid and the seismic activity is intense, which gives a good opportunity to study deformation and seismic cycle. To get an integrate picture of vertical deformation over one plate and between the two plates, one needs to be able to monitor vertical movements on both underwater and emerged areas. We conducted an experiment in the Vanuatu archipelago, South West Pacific, to compare measurements from bottom pressure gauges located beneath altimetry satellite tracks with sea surface altitude measurements from GPS. A bottom pressure gauge is immerged since Nov. 1999 on Sabine Bank (15.90°S, 166.14°E), West of Santo Island, Vanuatu. In order to perform absolute calibrations of ERS/Envisat altimeters that overfly the Sabine Bank, we conducted 2 campaigns of GPS measurements of instantaneous sea surface height onboard the R/V Alis and using a GPS buoy. We present here results of GPS computations in kinematic mode for the March 2003 and March 2004 campaigns. These sea level GPS measurements are compared with ERS/Envisat sea heights, and sampling differences and high frequency variations were removed using continuous pressure gauge data. The observed discrepancies are likely to be explained by local geoid variations or dynamic topography and we conducted GPS surveys to map these differences.

Wednesday 8 September
08:30 – 08:40
MOZART 3

Introduction to the Scatterometer Sessions

Wednesday 8 September
08:40 – 10:20
MOZART 3

Session 3A5:

Scatterometer Performance

Abstract No. 422

The Advanced Scatterometer Processing System for ERS Data: Design, Products and Performances

R. Crapolicchio[1], P. Lecomte[2], X. Neyt[3]
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2 ESA, Italy
3 RMA, Belgium

Since the launch of ERS-1 in 1991 and ERS-2 in 1995, carrying a C-band Scatterometer, a data set of more than thirteen years of backscattered signal from the Earth surface is available for exploitation. With its global coverage, day or night and all-weather operation, ERS Scatterometer data offer unique opportunity for long-term studies and research. Beyond the original mission of ERS Scatterometer, intended to provide measurements of the wind vector over the Oceans, a large number of new unforeseen application have emerged during the last years. Originally developed to measure winds over the ocean from space, Scatterometer data has proved to be very useful in a variety of studies These new applications cover the wind, but also land, continental or sea ice, soil moisture, and vegetation and require high quality and long-term backscatter information.To fulfill the needs of such large scientific community, the European Space Agency (ESA) has developed the project: Advanced Scatterometer Processing System (ASPS). Main scope of the project is to provide with state of the art algorithm, high quality and homogenous Scatterometer measurements (sigma nought) of the Earth surface and high quality wind field over the Oceans by re-processing the entire ERS mission. Additional scope is to provide on experimental basis scientific products in high resolution tailored for the emerging Scatterometer application.The ASPS project is now in a pre-operational phase and the scope of the paper is to give to the scientific community an overview of the ASPS architectural design, to report on the ASPS product format and performances. Those new data, available in the next years, hopefully will help the scientific community to better understand and monitor the Earth's climate changes and to protect our environment.

Abstract No. 563

Calibration of the ERS-2 Scatterometer in Gyro-less Mode

N. Manise, X. Neyt, M. Acheroy
Royal Military Academy, Belgium

The scatterometer on-board ERS-2 is an active real aperture radar instrument designed to measure the backscatter coefficients from the earth with a high repetitivity. The main application is wind-retrieval, but other land or sea-ice application emerged. The limited bandwidth of the filter on-board of the ERS satellites limits the Doppler shift that can be tolerated. For these reasons, the ERS spacecrafts need to be yaw steered. However, due to a malfunction of several gyroscopes, precise

yaw steering cannot be guaranteed any more. This prompted for a review of the scatterometer processing chain in order to estimate the actual yaw angle and to take it into account in the derivation of the normalized backscattering coefficients.The calibration of the instrument is performed using distributed targets and transponders. The distributed targets can be used to perform a relative calibration of the instrument, assuming an isotropic behaviour of the distributed target. Transponders at known locations (on ground) can be used to perform an absolute calibration of the instrument. Since the yaw angle is unknown, the calibration algorithms need to be reviewed in order to take into account the estimation of the yaw angle in the calibration chain. In this paper, we will present the reviewed calibration chain. The transponder is represented by a peak in the echo signal energy. The first step consists in localizing the transponder in the echo data. In order to meet the accuracy requirements, this has to be performed with a sub-pixel resolution. We will also present the results of the calibration and possible differences before/after the gyro less operations.

Abstract No. 537

The Improved C-band Geophysical Model Function CMOD5

H. Hersbach[1], A. Stoffelen[2], S. De Haan[2]
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Since the launch of the ERS-1 satellite in 1991, surface wind-vectorobservations derived from space-borne scatterometer measurementshave been available over the global oceans continuously.Maximal prolongation of the currently operational ERS-2 and QuikSCATmissions and the launch of METOP-2 (late 2005), containing the ASCATinstrument, should ensure continuity over two decades.The retrieval of a surface wind vector from the radar backscatter signalrequires a geophysical model function. In practice such model functions aredetermined empirically by means of collocation with independentsurface-wind information from NWP model fields or buoy measurements.Presently, space-borne scatterometer wind products are based on the QSCAT-1model function for the ku-band radar frequency (QuikSCAT) and CMOD4for C-band (ERS-2).This presentation will describe the design and performance of an improvedC-band model function recently developed at ECMWF and KNMI.This new model function, CMOD5, was redesigned from scratch from a studyinvolving more than 22,000,000 collocations between ERS-2 scatterometerbackscatter triplets and ECMWF first-guess winds.For extreme wind conditions, results from recent aircraft campaigns weretaken into account as well.As an extra constraint the position of the 2-dimensional CMOD5 conein three-dimensional observation space was optimized.Validation shows that CMOD5 is able to largely remove known wind biasesin CMOD4 for all wind domains and incidence angles. This is especiallyevident for strong winds where CMOD4 has a saturation behavior: CMOD5winds are much more realistic and the dynamical range is extended to atleast 35 m/s. Compared to the ECMWF first-guess winds, CMOD5 providesa lower scatter index and a more uniform performance across the ERSscatterometer swath than CMOD4.In backscatter space, the fit with the cone surface is improved, resultingin about 75% skill of the first rank solution for winds above 10 m/s.These improvements aid the general usefulness of retrieved ERS and futureASCAT scatterometer winds for climate and weather applications, and theambiguity

removal in dynamical and extreme weather conditions more inparticular. Therefore, CMOD5 has now replaced CMOD4 in the operationalassimilation system at ECMWF.

Abstract No. 670

On ERS Scatterometer Sea Ice and Wind Stress Determination

A. Stoffelen, J. Verspeek, J. De Kloe
KNMI, Netherlands

ERS scatterometer wind information can be determined over water surfaces. As such, we evaluated a new method to separate water from (partial) ice sea surfaces, using the C-band radar backscatter measurements. In fact, a sea ice model has been derived, which is used in a sea ice retrieval step to retrieve the ice condition. The behaviour of the model in both Arctic and Antarctic is shown. Both the wind and ice retrieval residuals are used to determine the probability of ice. Since ice and water surfaces are ambiguous in the middle of the ERS swath, some (recent) past data is needed to obtain a reliable ice probability over the entire swath, as will be shown.The triple collocation calibration methodology applied for the development of the CMOD5 model function, relating 10m wind to C-band radar backscatter, are used to calibrate wind stress. The resulting CMOD5 wind-to-stress conversion is being applied in a 10-year reprocessing of ERS scatterometer winds at KNMI, which will also be put available as a wind stress series. At the conference the method and data are described.

Abstract No. 566

Neural-network Based Stateless Ice Detection in ERS Scatterometer Data

X. Neyt, P. Pettiaux, N. Manise, M. Acheroy
Royal Military Academy, Belgium

The data acquired by the scatterometer on-board the ERS spacecraft can be used to determine sea-surface windspeed provided the data was acquired over open water. As part of the upgrade of the ground-processing of the ERS-2scatterometer data [1], it was deemed necessary to perform areal-time ice detection in order to remove bogus wind vectors,thus avoiding disturbing the wind ambiguity removal process. While it is relatively easy to discriminate land from seatrough the use of maps, discriminating between sea-ice andopen water is more challenging. Several methods have been proposed to discriminate betweenice and open water. A threshold on the backscattering isotropywas proposed [2], however this measurement is reputed only discriminantat high incidence angles. Similarly, a threshold on the derivativeof the backscatter with respect to the incidence angle can alsobe used [3] but again, this criterion is not discriminant overthe whole swath. Moreover,

these two criterions fail forparticular wind orientations relative to the satelliteground track. A model [4] for the scatterometermeasurements over sea was also proposed, and observed sigma0triplets located far from that model are more likely to havebeen measured over ice [5]. Similarily, a model for backscatteringover ice has been proposed in [6]. Combining the distances betweenthe measurements and the ice and the wind model, a decision can bemade as to whether the considered node is over open sea, over iceor unknown (mixed sea & ice or unable to discriminate). Thislast method also explicitely acknowledges that the discriminationis not always possible since, for some configurations, the ice andthe wind model are very close to each other. Also, in this lastmethod, the threshold used is incidence-angle dependent.All the methods above are based on thresholding the parametercorresponding to the method. Moreover, some of these methodsare only relevant for particular incidence angles. We propose a new ice discrimination method that combines themetrics defined above using neural networks. For each of themetric, a neural-network is trained to output an ice/seaprobability. The neural-network is a perceptron (a feed-forwardneural network with one hidden layer) and has two inputs: themetric and the across-track node number (indicating theincidence angle). The output is trained against referencedata where sea is represented as 0 while ice is representedby 1. The output of the neural network after training thusrepresents the ice probability given the inputs. The thresholdof the original method is automatically determined, as wellas the incidence-angle region where the metric is discriminant.This allows to perform a comparison of the different metricsin a consistent framework.We thus propose to have one neural network per metric andto combine the output of each neural network in order to providethe final ice probability. The combination is performedby a modified majority voting.Finally, to further enhance the results, a spatial coherenceis imposed. The motivation for this is that the ice-determinationat mid-swath is relatively unreliable. However, if ice is presentat near- and far-swath with a high probability, it is also highlyprobable that ice will be present at mid swath. Results are very promishing, particularily if one considers thefact that no time averaging is considered. [1] X. Neyt, P. Pettiaux, and M. Acheroy. Scatterometer ground processing review for gyro-less operations. In Proceedings of SPIE: Remote Sensing of the Ocean and Sea Ice 2002, vol. 4880, Crete, Greece, Sep. 2002.[2] A. Cavanie, F. Gohin, Y. Quilfen, and P. Lecomte, Identification of sea ice zones using the AMI-WIND: Physical bases and applications to the FDP and CERSAT processing chains, in Proc. Second ERS-1 Validation Worshop, Hamburg, Germany, 11-14 Oct. 1993, pp 1009-1012[3] F. Gohin, Some active and passive microwave signatures of Antarctic sea ice from mid-winter to spring 1991, Int. J. Remote Sensing, 1995, vol. 16, no. 6, pp 2031-2045.[4] Ad Stoffelen, Error Modeling and calibration: towards the true surface wind speed, J. Geophys. Res., vol. 103, pp 7755-7766, 1998.[5] F. Gohin, C. Maroni, ERS Scatterometer Polar Sea Ice Grids User Manual, Tech. Report. no C2-MUT-W-03-IF, IFREMER, Mar. 1998.[5] A. Cavanie, An empirical C-band backscatter model over arctic sea ice from ERS-1 AMI-wind data, Proc. of a Joint ESA-Eumetsat Workshop on Emerging Scatterometer Applications -- From Research to Operations, pp 99-106, ESTEC, Noordwijk, NL, Oct. 1998.[6] S. de Haan, A. Stoffelen, Ice discrimination using ERS scatterometer, Tech Report, KNMI, Sep. 2001.

Wednesday 8 September
10:50 – 12:30

MOZART 4-5

Session 3B1:

Subsidence

Abstract No. 45

Radar Interferometric Analysis of Mining Induced Surface Subsidence Using Permanent Scatterers

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We present results of a radar interferometric study of surface subsidence. Here we apply the permanent scatterer technique to interferometric ERS SAR observations to analyze the surface subsidence induced by hard coal mining activities at the "Prosper-Haniel" mine (Ruhr region, Germany).Underground mining causes extensive subsidence at the earth's surface. Small displacements can be detected and analyzed using differential radar interferometry (DInSAR). Unfortunately, the interferometric analysis of radar data in central Europe is often hampered by extensively vegetated land surfaces. These can destroy the deterministic phases differences in temporally separated images. Longer temporal separations between two radar acquisitions typically reduce the ability to interpret the measured phase differences. The recently developed "Permanent Scatterer" technique now enables the construction of much longer time-series of displacement measurements than previously feasible. This method identifies scatterers in the radar images through statistical analysis that remain coherent over a long time and a wide range of viewing angles. Displacement measurements are then made at these points only. A condition for successful subsidence measurements is an adequate temporal motion model.We use about 80 ERS-1/2 scenes for analysis. Extensive validation data are also available to constrain the spatial and temporal displacement field and verify the interferometric results.

Abstract No. 452

Monitoring Subsidence Caused by Potash Mining in a Temperate Rural Area, Using an Improved InSAR Method

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Space borne synthetic aperture radar (SAR) and more specifically InSAR have proven to be economic and reliable techniques to monitor surface deformation at sub centimetre accuracy. Previous studies of the technique have recognised that whilst the technique shows great promise, further research is needed to determine constrains of, for example, surface vegetation, topography and rates of deformation on the feasibility of the technique (Hanssen, 2001). Stabel and Pischer (2001) noted that "the artefacts occurring in the different climate and vegetation zones have to be evaluated in detail." These effects are particularly significant in temperate agricultural areas in

which seasonal vegetation growth and farming activities such as ploughing cause significant modification to the surface of the land. In this article an InSAR method is presented developed to monitor surface deformation in a temperate rural area undermined by a very deep potash mine. Subsidence caused by deep underground potash mining forms a complex pattern in space and time, affected by factors such as faulting, failure of historic mineshafts, brine drainage and many other local and regional processes. Well spread spatial and multi-temporal subsidence data provides data from which knowledge on the behaviour of parameters affecting subsidence can be derived. Deformation was assessed using conventional three and four pass interferometry as well as using a method where 'Interest Points' (IPs) improved the accuracy. ESA have granted us 30 archive ERS-SAR images and a further 20 real-time Envisat-ASAR images, to do this research. The data concern the Boulby potash mine in North Yorkshire, which has a depth of 800 to 1300 m below the surface and is the deepest mine in Europe. The InSAR deformation estimations are evaluated based on an extensive thirty year long levelling dataset and a GIS based empirical subsidence model.

Abstract No. 518

Radar Interferometry Technique for Urban Subsidence Monitoring: a Case Study in Bangkok and its Vicinity

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Overdraft of groundwater from the Bangkok multiaquifer system has been identified as the principle cause inducing subsidence, which causes substantial damage in the area. Reliable and up-to-date subsidence information are crucial for monitoring, strategic problem solving and future urban planning. This study aims at deriving subsidence magnitudes for Bangkok from two radar interferometry techniques, classical differential interferometry (DInSAR) and point scatterer interferometry (PSInSAR) technique. Difficulties in achieving coherence in the classical method can be overcome by PSInSAR approach. Also, all available ERS-SAR data can be fully exploited. An initial test area of 10x12 km located south of Bangkok is selected to examine the subsidence estimation by PSInSAR technique using two time-series of 17 and 11 ERS-SAR acquisitions for two partly overlapping image frames. First, interferograms of the same master scene are generated, then the relative subsidence rate of each point scatterer (PS) is estimated by interpreting their interferometric phase time series assuming a linear deformation model. We investigate the feasibility and reliability of using this technique with relatively few acquisitions and in a tropical location for subsidence estimation. Verification of the PS estimate is carried out by comparing them point-wise with the available ground leveling data. Our comparison indicates good agreement between the PS subsidence estimation and the surface leveling measurements.

Abstract No. 561

Urban Unstability revealed by DINSAR and PS Interferometry: Montmartre Case Example in Paris City (France)

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Since antiquity, Montmartre Hill (Northern Paris city) was a source of good quality gypsum, Ludian in age (Eocene), due to its favourable geology. Exploitation of the Hill started in the downstream part of the hills by open air and then by underground quarries. Those quarries stopped in 1862 then collapsed or improperly backfilled a century ago, have created plenty of unstabilities and problems to the above buildings extended all over the Hill, and remain the origin of disorders at the surface.The general inspection of the quarries, a service of the City of Paris, is charged to identify and limit the hazards and risks due to old exploitations. In this context, a first study, published in 1979, had checked the stability of the Hill and prescribed a certain preventive and curative actions. 12 years of soil investigations and grouting of the underground quarries under the public domain have permitted to reduce the frequency and the intensity of the damages. A recent accident has however attracted our attention to the role of the water circulation and the open-air quarries' backfillNew INSAR and PS techniques bring major arguments to map the present displacement field and therefore give arguments to locate, characterize and quantify the topographic deformation of the Hill. This gives new major constrains to stabilize buildings and infrastructures. Furthermore a compulsory complementary study done in the fields revealed numerous deformations linked to landslides in the south and the west of the Montmartre Hill which also affects buildings. Two origins is therefore highlighted in the Montmartre Hill in Paris city.To conclude, our approach evidence the operationality of DINSAR and PS combined with field work analyses, for a better understanding of natural hazards in urban areas such Paris city in order to insure the security of the Parisians in front of the underground risk.

Abstract No. 443

Land Subsidence Measurement with SAR Interferometric Data

M. Crosetto[1], B. Crippa[2], O. Monserrat[1], M. Agudo[1], E. Biescas[1]

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Land subsidence measurement with SAR interferometric dataM. Crosetto(1), B. Crippa(2), O. Monserrat(1), M. Agudo(1), E. Biescas(1) 1 Institute of Geomatics, Campus de Castelldefels, Av. del Canal Olímpic s/n, E-08860 Castelldefels (Barcelona), Spain. 2 Department of Earth Sciences, University of Milan, Via Cicognara 7 I-20129 Milan, Italy The paper will focus on the deformation monitoring based on remotely sensed radar data and the differential interferometric SAR technique (D-InSAR). D-InSAR represents a relatively new technique for deformation monitoring, which can be used in a wide range of application fields: glacier dynamics; earthquakes; volcanoes; landslides; and the analysis of the deformations related to water resource exploitation, mining activity, and construction works. The capability of D-InSAR to measure wide area deformation fields has been extensively documented in the literature of the last decade. The major contributions have been collected in important scientific journals like the Journal of Geophysical Research, Nature, Science, etc.The paper will address two main uses of the technique for the monitoring of land subsidence:1. The detection of unknown (or only partially known) subsidence phenomena. In this context the technique is used as an "early detection tool" to monitor wide areas.2. The quantitative analysis of deformation phenomena, where major emphasis is given to the precision, accuracy and reliability of the D-InSAR observations.The first type of application fully takes advantage of the wide area coverage of the spaceborne SAR systems, such as ERS and Envisat. Since this application is mainly focus on the early detection of unknown phenomena (e.g. slow subsidence phenomena in suburban areas), it does not require a very accurate D-InSAR analysis. In fact, its preliminary (qualitative) results are usually employed to plan more detailed studies, which can then be based on a quantitative DInSAR data analysis or on geodetic surveys.The quantitative aspects of the D-InSAR deformation monitoring have been often disregarded. This is partially due to the fact that some applications rather focus on a qualitative use of the D-InSAR results, which, however, is not adequate to support all the potential D-InSAR applications. An example is represented by the subsidence monitoring in urban areas, which needs to be characterised by high quality standards (i.e. providing precise, accurate and reliable observations) like those usually achieved by the geodetic techniques. D-InSAR may potentially offer a powerful and cost-effective subsidence monitoring tool. However, different aspects of the technique have to be carefully considered. The paper will consider in particular the use of multiple observations (multiple interferograms), which represents the key factor to achieve a quantitative D-InSAR deformation monitoring.The two main uses of the technique addressed in the paper can play a fundamental in the control of the geological hazards related to land subsidence. Their discussion will be illustrated by considering the results obtained in different D-InSAR applications developed at the Institute of Geomatics and the University of Milan.

Poster Session 3P04:

Subsidence

Abstract No. 115

Evaluation of Applicability of ERS INSAR Data for Monitoring of Yamburg-Nyda Gas Pipelines State

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The goal of the report is a discussion of the results of ERS INSAR data analysis in the area of Yamburg-Nyga gas pipelines located in Siberian permafrost area on the 6 years time interval (period of 1993-1998) with a goal of detection of the vertical displacements of the pipelines.The area of interest is of high economical importance containing 192 km long gas pipelines built in 1986-1994. The northernmost territory is a very complicated because of presence of low-temperature permafrost as well as thawed/waterlogged soils which are changing their state because of seasonal variations and thermal contact with a pipe.Analysis of the interferometric pairs does show evidence of temporal displacements of portions of pipes located on the permafrost areas. Pairs with annual or more time interval between acquisitions show evidence of pipes uplift at centimeters level because of permafrost heave. Among the impressive results is a detection of surface displacements on the interferogram from ERS tandem pair obtained in June 1996, where the effect of pipes subsidence at the first millimeters scale took place because of permafrost thawing in summer time. The subsidence of the car road because of underlying permafrost thawing is evident as well as subsidence of swamps surface because of water discharge.Ground truth data from 1992, 1993 and 2000 include air/helicopter borne camera, hyperspectal scaner and high resolution X-band SAR as well as field trip measurements with georadar. The data mentioned complement ERS DINSAR results and confirm good applicability of spaceborne INSAR techniques for monitoring of pipelines dynamics.Authors express thanks to ESA for ERS SAR data obtained under AO "Exploitation Projects" project.

Abstract No. 215

Detection of Urban Land Subsidence in the City of Turku in Finland Using Differential SAR Interferometry

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The centre of the city of Turku by the river of Aurajoki in Finland has been built on clay and silt soil. The level of the ground water has been constantly lowering in the last few centuries due to the postglacial land uplift and extensive water usage leaving the old wooden pilework exposed to decaying. The decaying has led to the subsidence of some historical buildings in the old centre of

Turku at the rate of few centimetres per year, thus huge investments are needed to repair damages and to prevent any buildings from collapsing in the future. Nowadays, the subsidence monitoring is done with traditional land surveying, namely by levelling the benchmarks in the area regularly. Recent advances in the SAR interferometry, especially the permanent scatterers technique, has enabled a long-term study of vertical land movements using SAR images. In the end of 2002 our proposal for a Category 1 project 'Land subsidence and land uplift determination due to the postglacial rebound in the boreal forest zone using repeat pass satellite SAR interferometry and Permanent scatterers technique' was accepted (CAT-1 1488) and we requested altogether 40 ERS-1 and ERS-2 single look complex SAR images covering our test area in the city of Turku. The reference data of the subsidence of individual buildings has been acquired from the Real Estate Department of Turku. This paper presents the first results of the long-term differential SAR analysis.

Abstract No. 234

Monitoring Land Subsidence in Mexico City with Envisat ASAR Interferometry

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Gamma Remote Sensing, Switzerland

Mexico City is built on highly compressible clays and because of strong groundwater extraction a total subsidence of more than nine meters has been observed over the last century. Previous studies using ERS and JERS SAR differential interferometry between 1994 and 1996 showed a maximum subsidence rate larger than 40 cm/year over part of the city. Between November 2002 and January 2004 Envisat ASAR acquired 10 scenes in IS2 mode over Mexico City. These regular interferometric ASAR acquisitions were used to assess recent subsidence rates at Mexico City. The results demonstrate that Envisat ASAR interferograms are of excellent quality for land subsidence studies and that land subsidence in Mexico City is continuing at an impressive rate of several decimeters per year.

Abstract No. 345

Surface Deformation at Rotorua, New Zealand Measured by InSAR, 1996-2003

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[3] *Environmental Systems Science Centre, United Kingdom*

The Taupo Volcanic Zone (TVZ) on the North Island of New Zealand is an area of crustal extension and volcanism, dominated by large silicic magma bodies with associated geothermal systems. The Rotorua Geothermal field is one of these and has been widely exploited throughout the city of Rotorua by the drilling of private boreholes and wells to provide domestic and industrial heating and energy. Although these wells are relatively shallow (20-200m), the demand on the system was such that during the 1980s, it was discovered that the increasing water draw-off was affecting the natural geothermal features in the area. For example, there was a reduction and failure of some of the geysers at Geyser Flat, Whakawerawera. As a result of this, heat and water extraction was greatly reduced in 1987 and water levels subsequently rose. In recent years this has led to increased surface activity including a series of hydrothermal explosions. Exploitation of other geothermal fields in the TVZ and elsewhere has led to significant subsidence. We have studied the surface deformation at Rotorua for recent years since this new management regime for the geothermal system was introduced. Using ERS SAR data from 1996-2003, we have shown via radar interferometric processing (InSAR) that deformation is occurring in Rotorua city in a region located on the western edge of the known active thermal area. Subsidence in the area south of Kuirau Park of up to 13mm/year during 1996-2000 is indicated. We are currently investigating what the causes of this might be and whether the deformation is related to the geothermal field or other environmental factors.

Abstract No. 392

Interferometry Techniques for Urban Subsidence Analysis over Beijing

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This paper aims at presenting on-going work carried out in an AO1 project (ID2365, "DInSAR Technique for Beijing Subsidence and XingJiang Province Earthquake -China"). The project's objective is to study long term topographic change over Beijing city and suburb, from differential interferometry (D-Insar) and permanent scatters (PS) techniques. The acquired data include yet 15 ERS-2 SLCI images and 4 Envisat images from 1996 to 2003. An other set of Envisat images is expected to be scheduled for planning. Preliminary processing raised quite a number of practical problems : the dataset clearly does not provide favorable basis for "easy and quick" analysis. Technical issues focus on Envisat and ERS images merging --specifically for D-Insar and PS. The processing is performed simultaneously via the Doris software (provided by Delft University) and self-developed software (Windows based), which includes optimised techniques recently developed by the authors.

Abstract No. 497

Identification and Measurement of Mining Subsidence with SAR Interferometry: Experience from Upper Silesian Coal Basin in Poland

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This work presents main conclusions regarding the operational use of SAR Interferometry over one of the biggest in Europe coal-mining field of Upper Silesia in Poland. The Upper Silesian Coal Basin (USCB) covers an area of about 7250 km2. Mining activity of Carboniferous hard coal deposits has been carried out here for over 200 years. As a result, the region becomes highly urbanized, industrialized and thus environmentally degraded. At present there are 39 active coalmines in the Polish part of the basin. However, because of restructurization of Polish industry, the significant number of the coalmines is going to be liquidated. Since 1998 the 50 ERS SAR scenes over Upper Silesia have been analyzed and processed. As the result of this study the interferogams of variable baselines (between 0 to 431 m) have been successfully generated using 2-pass, 3-pass and 4-pass approaches (ESA AO3-127 project). Detailed analysis of these data demonstrates that SAR interferograms contain two types of information: quantitative, concerning the rate of subsidence during a period between repetitive ERS SAR acquisitions and qualitative, which allows to identify the shape and extent of subsided area The interferograms present various coherences depending on seasonal and weather conditions. Comparative studies shows that it is a typical situation for Central Europe and for other areas of moderate climatic zone. Low coherence strongly reducing interpretation of the fringe pattern and usually preclude the subsidence measurements. To omit this problem and derive the quantitative subsidence data the interferograms should be constructed from SAR data of as small as possible temporal baseline. However, in that case the fringe pattern presents the subsidence increment during a period of repeated SAR observations. Consequently, SAR interferograms of small temporal baseline present valuable information only about subsidence velocity pattern but with spatial quality impossible to reach using traditional terrestrial methods. The traditional InSAR techniques have been extended in last years to pixel-based approaches like e.g. Permanent Scatters method. However, the main problems related to decorrelations still remain. A potential advantage in this matter seems to be possible using alternate polarization and multifrequency SAR data. Acknowledgments: The author gratefully acknowledges the European Space Agency and European Space Research Institute for supporting and sponsoring this research and supplying the ERS SAR data from AO3-127 ? InSAR for Land Subsidence Monitoring in the Upper Silesian Coal Mining Region, Poland?

Abstract No. 575

Reflexions and Insights from Urban SAR Interferometry for Monitoring Vertical Deformation Due to Water Pumping: the Haussmann-St-Lazare Case Example (Paris, France)

B. Fruneau[1], B. Deffontaines[2], A. Prunier-Leparmentier[3], A. Arnaud[4], J. Rudant[5]
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The St Lazare area in Paris (France) has undergone important water pumping for the construction of the underground Haussmann - St Lazare station for Eole subway line (SNCF). This oral talk presents the monitoring of small surface displacements related to the pumping activity by both classical and PS SAR interferometry. Hydrogeolocial and geodetic data are examined in order to validate the phenomenon: piezometric measurements were provided on 87 piezometers by SNCF and IGC, precise levelling were processed on 626 points by SNCF. Analysis and comparisons of all available data show first their good agreement and complementarity to monitor the small surface deformation of the studied area and second the potential operationnality of the classical and PS SAR interferometric approach in such study. At least reflexions and insights are delivered by two teams (BRGM and UMLV) who worked separately on the understanding of this phenomenon (see references below). A precise study done with fields data shows the limits of the methods they used, the misfits, and of course in contrast the potentialities and the operationality for urban hazards.Fruneau B., Sarti F., 2000. Detection of ground subsidence in the city of Paris using radar interferometry : isolation of deformation from atmospheric artifacts using correlation, Geophys. Res. Lett., 27, 3981-3984.Le Mouellic S., Raucoules D., Carnec C., King C., 2002. A ground uplift in the city of Paris (France) detected by satellite radar interferometry, Geophys. Res. Lett., 29, 1853.

Abstract No. 683

Mine Subsidence Monitoring: A Comparison Among Envisat, ERS, and JERS-1

L. Ge[1], M. Hsing-Chung Chang[1], C. Rizos[1], M. Omura[2]
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This paper reports the progress of the Envisat CAL/VAL Project No 1078. Subsidence in an underground coal mining region southwest of Sydney has been monitored using Envisat, ERS, and JERS-1 satellites. Data from the ERS-1/2 tandem mission have been widely used to generate digital elevation models because of the 24 hour short time interval (temporal baseline) between the two acquisitions which delivers high coherence in the synthetic aperture radar interferometry (InSAR) data processing. ERS tandem data based differential InSAR analysis (tandem differential InSAR)

has also been used to study atmospheric effects in InSAR results. In this case, the topographic contribution is carefully removed from the interferogram and an assumption is made that there is no significant ground displacement within 24 hours. What have been left in the differential InSAR result are atmospheric disturbances. The assumption cannot be held, however, in the shallow underground mining region (mining depth about 500 m) selected for the project. Tandem differential InSAR analysis has revealed 1 cm subsidence in 24 hours with a resolution of +/- 3 mm. In contrast to tandem differential InSAR, repeat-pass differential InSAR has been widely used since 1993 to map ground surface movements due to many natural (e.g., earthquakes and volcanoes) and man-made (e.g., underground mining and oil / water / gas extractions) activities. In repeat-pass differential InSAR, the master and slave images are acquired by the same sensor aboard the same platform. Therefore, the temporal baselines are multiples of 24, 35, and 44 days for Radarsat-1, ERS-1 and -2, and JERS-1, respectively, which is significantly lager than the tandem case. These much larger temporal baselines lead to temporal de-correlation which degrades the InSAR results. For example, for the same Australian region mentioned above, the accuracy of InSAR measured subsidence is +/- 1.4 cm from the JERS-1 repeat-pass differential InSAR when compared to ground truth. Comparing the tandem to repeat-pass differential InSAR, it can be seen that due to the much shorter temporal baseline, tandem differential InSAR can measure ground displacement at a much higher resolution. In the meantime, seven Envisat images have been acquired over the same site as well during 29 March 2003 and 10 May 2003 (http://www.gmat.unsw.edu.au/snap/staff/linlin/Results/NewEVtrial/EnvisatTesting/Envisat_testing_summary.html). Apart from the challenges that they were acquired from both descending and ascending passes with four different imaging modes, the newly developed Envisat module in the software seemed also to have some bugs. More Envisat acquisitions have been requested. Differential InSAR results from these data will be reported and compared to the ERS and JERS-1 results.

Wednesday 8 September
10:50 – 12:30
KARAJAN 2-3

Session 3B2:

Thematic Mapping

Abstract No. 339

MERIS Data for Monitoring Dynamics of Vegetation Cover in Semiarid Wetlands - a Case Study of the Niger Inland Delta (Mali, West Africa)

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The Niger Inland Delta is one of the most fragile ecosystems of African Sahel. Availability of surface water as the main impetus for vegetation growth is generally low and significantly variable in its spatial and temporal distribution. Conditions during dry and rainy seasons are remarkably influenced by pre-flood, flood and post-flood periods, which are driven by the variations of the water level of the river Niger and its tributaries. Quality and quantity of vegetation cover is thus periodically changing in correlation with oscillations of the water level. While the inland delta is dominantly covered by irrigated fields or grasslands during flood and post-flood months (late July till October to January) most of the photosynthetically active vegetation vanishes during the rest of the year (March to June).Medium Resolution Imaging Spectrometer (MERIS) as a payload component of Envisat-1 operates with a 15 band setting in the visible and near infrared part of the electromagnetic spectrum. The spectrometer acquires data with a spatial resolution of 300 m (full resolution) or 1200 m (reduced resolution) over land, allowing for the analysis of land cover with special regard to vegetation at a regional to global scale. Main focus of this paper is laid upon the assessment of the dynamics of vegetation cover of the Niger Inland Delta and the Plateau de Bandiagara eastwards the delta. As the plateau is not affected by annual flooding it serves as reference for the semiarid vegetation cycle. High spectral resolution of MERIS data in the red and near infrared spectrum was used to separate vegetation signals from bare soil signals. The dynamics of increase versus decrease of vegetation-soil-patterns during one growth season were monitored by analysing 5 MERIS full resolution scenes of processing level 1B covering a time period from August 2002 till June 2003.Besides supervised pixel-based classification of imagery for the five acquisition dates an analysis of red-edge position and red-edge shift was performed. A third objective of the research work was to test the capability of MERIS Global Vegetation Index (MGVI) for monitoring sparse and mostly non-green vegetation. Preliminary results indicate that MERIS proves to serve as a powerful sensor for vegetation analysis also in semiarid regions characterized by a variety of land cover patterns dominated by sparse vegetation. The merit of MERIS mainly lies in the availability of 10 different bands within the red and infrared part of the electromagnetic spectrum. This allows for reliable studies on the quantity and quality of vegetation cover. Nevertheless it has to be concluded that the accuracy of results is strongly depending on the availability of auxiliary informations such as measurements in the field, annual as well as seasonal variations of water levels and others. Especially for data of the late dry season with a ratio of vegetation coverage less than 10% per unit area the separation of the vegetation signal from the "background" signal was rather vague.

Abstract No. 657

Potential of ERS and Envisat SAR Data for Environmental Monitoring of Kolkota (Calcutta) City and Coastal Region of West Bengal, India

R. Chatterjee[1], T. Sarkar[1], P. Roy[1], J. Rudant[2], P. Frison[2], B. Fruneau[2], H. Trebossen[2], D. Mitra[1], P. Gaurav[1], S. Banerjee[1]

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The present work is principally aimed at studying the potential of ERS SAR and Envisat ASAR data for environmental monitoring of an urban test site and a coastal test site of India. Kolkata (Calcutta) City of India, which typically represents the urban environmental set-up of the developing world, has been taken up as the urban test site in this work (Figure 1). Due to rapid urban growth and population explosion in Kolkata City during the last few decades, rapid changes in landuse-landcover pattern, infrastructural development, augmentation of transport system to subsurface (Metro Rail) and excessive ground water extraction to meet the water demand of the population and industry have occurred. All these have adverse environmental impacts to this region. Geologically, the Greater Calcutta area forms a part of Bengal Basin comprising of a thick pile of unconsolidated sediments (~150m.) of alluvial/deltaic origin in subsiding trough. Consequently, the area is undergoing regional subsidence over the years. In addition, differential local subsidence in some parts of the city area has been reported by the media and the people which might have been occurring due to over-extraction of ground water, dewatering of the underground water-bearing horizons for installation of subsurface transport system (Metro Rail) or due to slow differential movement along subsurface basement faults (seismotectonic). Illegal urban sprawling in and around the city is another aspect of environmental concern in regard to planning and management purposes. The part of Bay of Bengal in India to the south of the urban test site, characterized by rapid and diverse coastal changes in terms of coastal erosion, delta development and evolution of mangrove forests, has been taken up as the coastal test site in this work (Figure 1). The geomorphology of this region is intricate and fast-evolving due to the combined effect of fluvial action from the distributary channel network from the land and tidal action from the vast tract of Bay of Bengal. The shore line which surrounds the main land and/or numerous islands in this region is evolving rapidly with time. With the evolving geomorphological set-up, the landuse-landcover pattern of the region has been changing with time which adversely affects the environmental condition of the region. Mangrove forest, the major landcover unit of the tidal flat region, has tremendous impact over the environmental set-up of the coastal region. The following major objectives are being addressed in this work:

(i) Studying ground subsidence in different parts of Kolkata City from interferometric ERS SAR data.

(ii) Understanding the causes of ground subsidence in Kolkata City and preparation of a potential subsidence map by spatially integrating the causes of subsidence under GIS (Geographic Information System) environment.

(iii) Characterization of ERS SAR backscattered intensity and interferometric coherence information for landuse-landcover mapping and geomorphologic studies.

(iv) Characterization of Envisat ASAR multipolarization backscattered intensity of IS2 beam mode which is similar to ERS imaging geometry for landuse-landcover mapping and geomorphological studies.

(v) Characterization of ERS SAR backscattered intensity and interferometric coherence information, and Envisat ASAR multipolarization backscattered intensity of IS2 beam mode for mangrove mapping.

(vi) Characterization of ERS SAR and Envisat ASAR backscattered intensities with respect to settlement density for the purpose of identifying illegal urban sprawling in and around the city.

(vii) The changes in landuse-landcover pattern during last 25 years in general and during last 10 years in particular to understand the trend in environmental condition as a function of urban growth and time. The changes in landuse-landcover pattern in the coastal region during last 25 years in general from multi-temporal optical and radar data.

(viii) Shoreline evolution of the coastal region in terms of coastal erosion and delta development.

(ix) Geomorphological evolution of the coastal region in terms of migration of creeks and inland river channels, changes in spatial position and spatial occurrences of sand bar and beaches, estuaries, intertidal lagoons and current ridges.

(x) Finally, the suitability analysis of ERS SAR and Envisat ASAR data as complementary and/or supplementary sources of information beside optical remote sensing data and conventional surveys for environmental monitoring of urban and coastal regions.

For the purpose of studying environmental changes during last 25 years three sets of multi-date optical data (Landsat MSS and Landsat TM), two sets of ERS SAR tandem data pairs and some Envisat ASAR IS2 beam mode VV polarization data have been procured over the two test sites. Several pairs of ERS interferometric data over the urban test site have also been procured for studying ground subsidence during last 10 years. Multi-polarization Envisat ASAR IS2 beam mode data are presently being procured for studying varied backscattered response from different landuse-landcover classes and geomorphological units which may be helpful for mapping the said terrain elements. Initially, the landuse-landcover maps of the two test sites were prepared from Landsat MSS or Landsat TM multispectral optical data by unsupervised and supervised classification techniques. Geomorphological map of the coastal region has been prepared by visually interpreting the image. A settlement density map of the urban test site has been prepared by digital enhancement and segmentation of Landsat TM data acquired in 1998. Similarly, the mangrove maps of the coastal test site with respect to their density have been prepared from Landsat MSS and TM multispectral data by digital enhancement and segmentation technique. The radar backscattered intensity images of ERS SAR individual scenes and tandem data pairs and Envisat IS2 beam mode VV polarization scenes have been processed. The ERS SAR interferometric tandem data pairs of the two test sites have been processed by DIAPASON software of CNES, France and SARDA software, ISRO, India. Characterization of the backscattered intensity of ERS SAR and Envisat ASAR data and the coherence information of ERS SAR interferometric data pairs particularly that of the tandem pairs with respect to landuse-landcover classes, geomorphological units, settlement density and mangrove forests have been carried out in this work in regular grids. Similar characterization of Envisat ASAR multipolarization IS2 beam mode data will be done. Attempts are being made to understand the range of radar backscattered intensity of ERS SAR and Envisat ASAR IS2 beam mode VV polarization data and coherence values of the ERS SAR interferometric data pairs to identify and delineate a particular terrain element from radar imagery. Three differential interferograms have been processed from ERS SAR interferometric data pairs of the urban test site. Due to the presence of atmospheric artifacts over extensive areas in a regular pattern, no local subsidence could be detected from the three differential interferograms processed so far. Processing of a number of differential interferograms and suppression of atmospheric artifacts are in progress in an attempt to identify the zones of local subsidence in the urban test site.

Abstract No. 42

Continuité des Programmes SAR/ERS et ASAR/Envisat pour la Mise à Jour Cartographique en Contexte Tropical

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Cette communication, portera sur une synthèse des résultats obtenus grâce aux images ASAR de Envisat , en continuité avec les images SAR de ERS.Sont concernés les domaines d'application suivants:-occupation du sol: évolutions d'origine anthropique: pratiques culturales (brulis), orpaillage (Guyane Française), croissance urbaine (Guyane, Gabon, Cameroun), cartographie des formations végétales (Guyane, Gabon)-géomorphologie littorale: suivi des évolutions littorales avec quantification des phénomènes d'érosion et de sédimentation affectant le littoral de Guyane Française depuis 1992, cartographie géomorphologique (Sahara occidental, Sénégal)Au travers des exemples présentés, nous nous attacherons sur le plan technique:- à démontrer l'intérêt pratique de la continuité des programmes ERS et Envisat (mode IS2, polar VV)- à analyser les apports respectifs des divers modes d'acquisition ASAR-Envisat (incidence, polarisation) pour les applications thématiques évoquées ci dessus

Abstract No. 614

Land Cover/Land Use Classification in a Semiarid Environment in East Africa Using Multi-temporal Alternating Polarisation Envisat

ASAR Data

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The region west of Mount Kenya is a heterogeneous bio-ecosystem characterized by high rainfall variability and a high population density. Land use varies over short distances from rain fed agricultural areas with small scale farming close to the mountain towards semiarid tree and grass savannas further northwest. During the last decades land use and land cover changed rapidly because of immigration. To monitor these changes due to the human impact but also due to climatic changes high quality information on the current state of the land cover is required as a baseline. Only remote sensing can provide such information with sufficient spatial detail in a homogeneous and continuous way as required for operational monitoring purposes.With the Envisat ASAR sensor alternating polarization images (VV/VH, VV/HH or HH/HV) are available every 35 days with a spatial resolution of 30m. Additional the invariance of ASAR data regarding cloud conditions and the possibility to automatize the processing of the images make the data especially suitable for an operational use. Therefore the potential to obtain an optimal land use/land cover classification in this region from Envisat ASAR data is investigated.Beneath the mean, different texture measurements like variance, coefficient of variance and semivariogram were calculated to generate additional input layers for the classification procedure. A quantitative separability criterion is used to determine the contribution of each measure to the overall classification and for specific classes. Furthermore the optimal acquisition times for classification purposes are identified. Ground truth was taken during a comprehensive field campaign in the dry season in February 2004. The results show that multi-temporality provides most explanation and separability. The discrimination possibilities are highly depended on the phenological state of the vegetation and therefore the date of the analysed image is crucial. The contribution of the different texture measures is class dependent, while the polarisation seems to provide only additional information over the few large-scale farm areas. This is attributed to the predominant of volume scattering from the acacia forests over most of the study region. The small-scale farm land is to patchy and heterogeneous in order to provide sufficient proof that a polarisation influence can be really identified.

Abstract No. 222

Erosion Assessment in the Brazilian Cerrados Using Multi-temporal SAR Imagery

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Accelerated soil erosion causes severe problems to agriculture and infrastructure, especially in tropical regions where high-intensity rainstorms occur frequently. To combat erosion processes, a sound erosion mapping and monitoring system is needed, which can indicate the extent and the location of erosion-prone areas. Tropical regions generally have poor data availability and frequent cloud cover. This hampers both the application of erosion models, and the use of optical remote sensing techniques for mapping and monitoring purposes.SAR imagery potentially can assist soil erosion studies through (1) detection of erosion features, and (2) derivation of information on erosion-controlling factors. Detection of erosion is limited to large features like gullies, with the exception of SAR interferometry, which can be applied in (semi-) arid regions to detect random changes indicating soil loss (Liu et al., 2001). The most important and dynamic erosion-controlling factor is vegetation cover. SAR provides good means to study both the spatial and temporal aspects of this factor. The objective of this study is to explore the information content of multi-temporal SAR imagery for its potential use in erosion detection, mapping, and monitoring (ESA EO-1223 project).ERS SAR and Envisat ASAR data were acquired for the 10*10 km study site near the city of Uberlândia in the Brazilian Cerrados. Field data on land use, land cover, and erosion features, were collected during the 2003-2004 rainy season. The site has deep sandy soils, which are mainly covered by pastures, shrubs, and trees. Most pastures are degraded which appears from a low soil cover and a large fraction of weeds. Less soil cover means less soil protection, and thus sheet and rill erosion increasingly remove topsoil and nutrients, which in turn negatively influences pasture development. Deep gullies dominate the landscape, which were formed more than fifty years ago, and of which some are still very active. The study area has a dry season from May to September, and intense rainstorms occur mainly between December and February. Especially in the beginning of the rainy season, soils are less protected against erosion. This study presents results on the multi-temporal analysis of SAR imagery for the Brazilian study site. Gullies could be detected in individual ERS and Envisat images. The gully dynamics could not be assessed, because the annual retreat rate is generally less than a SAR resolution cell. The SAR interferometry technique was tested, but was judged inappropriate for this study site, as vegetation cover causes rapid decorrelation. Assessment of erosion-controlling factors focussed on spatial and temporal variability of vegetation characteristics. Overlays of calibrated ERS SAR and Envisat ASAR imagery allowed identifying when the area is most susceptible to erosion, and revealing the spatial patterns of land use and management. Integration of the imagery and field data resulted in a better identification of land use units, and an initial assessment of erosion risk. However, for accurate erosion risk mapping, integration with additional data sources, like a DEM is required.Reference:Liu J.G., F. Hilton, P. Mason, and H. Lee, 2000. A RS/GIS study of rapid erosion in SE Spain using ERS SAR multi-temporal interferometric coherence imagery. Proceedings of SPIE 4171:367-375

Wednesday 8 September Wolf-Dietrich 1-2

Poster Session 3P05:

Thematic Mapping

Abstract No. 43

Utilisation et Contribution des Images Satellitaires dans la Caractérisation des Conditions Environnementales Liées à l'Apparition des Epidémies d'Ebola

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Depuis 1994, le Gabon et le Congo ont connu 8 épidémies de fièvre hémorragique virale (FHV) Ebola dont la dernière est survenue en décembre 2003. Ces épidémies sont toutes survenues dans la même région "Nord-est Gabon / Cuvette-ouest Congo". On constate qu'elles apparaissent souvent durant la période de transition de la saison sèche à la saison de pluie suivante. Pendant la plupart de ces épidémies, on a relevé une grande mortalité au sein des populations de gorilles et de chimpanzés qui semblent ainsi particulièrement exposées et sensibles à la maladie.Ces observations nous amènent à penser que l'apparition des épidémies de FHV Ebola est un phénomène lié aux variations des conditions écologiques du milieu, ce qui permet d'envisager la présente étude.Il s'agit d'une approche multidisciplinaire qui fait intervenir de nombreux domaines de compétence (écologie, géographie, climatologie…) et intègre l'utilisation de nouveaux outils tels que la télédétection et les systèmes d'information géographiques (SIG).Au moyen de diverses informations issues d'images satellitaires et de données de terrain on se propose de caractériser les conditions du milieu qui précèdent ou accompagnent l'apparition des épidémies d'Ebola. Ce travail doit apporter une aide en santé publique (Fig. 1) selon 3 objectifs majeurs à atteindre :- Mettre en place une base de données géographique sous forme de SIG- Identifier et déterminer des facteurs écologiques de risque d'épidémies- Contribuer à l'élaboration d'un système de veille sanitaire pour la prévention des épidémiesII - Méthodologie1-Principe de l'étudeOn se propose de caractériser l'environnement dans lequel apparaissent les épidémies d'Ebola. Le travail consiste à effectuer une analyse spatiale (distribution géographique) et temporelle (variations saisonnières ou annuelles) des différents paramètres du milieu (végétation, hydrographie, climat, populations humaines et animales…).Pour cela on se sert, d'une part, de données de télédétection spatiale (images satellitaires optiques et radars) et, d'autre part, de données de terrain (écologiques, épidémiologiques, climatologiques…). L'ensemble de ces données est intégré dans un SIG sous formes de diverses couches d'informations fusionnées. Le SIG nous permettra par la suite d'effectuer des analyses multifactorielles.Notre étude comprend les étapes de travail suivantes :- Traitement des données : analyse et interprétation d'images spatiales, analyse et mise en forme des données écologiques, épidémiologiques, climatologiques…- Exploration du terrain : des travaux sont menés sur le site étudié pour la récolte de données écologiques et la validation de l'interprétation des images spatiales.- Développement du SIG : intégration et fusion des informations multi-sources obtenues.- Exploitation du SIG : analyses milti-factorielles, production de cartes thématiques2-Zones d'étudeL'étude porte sur deux zones de tailles différentes :- Région "Nord-Est Gabon / Cuvette-Ouest Congo" (zone globale d'étude, 13°50 E - 14°30 E / 0°20 S - 1° 60 N, 40 000 km2): l'approche d'investigation est régionale ce qui implique une petite "échelle de travail";- Aire de conservation de gorilles de Lossi (400 km2): zone

dans laquelle nous sommes opérationnels sur le terrain. Les analyses y sont menées de manière plus détaillée ("grande échelle de travail").L'utilisation des images satellitaires pour l'étude de ces zones revêt alors une importance majeure pour trois raisons :- L'étendue de l'ensemble de la zone étudiée : elle représente une vaste région forestière dont l'investigation cartographique est techniquement plus envisageable et facilitée par la télédétection.- Le caractère diachronique de l'étude : il implique une grande quantité et une haute fréquence d'acquisition des données nécessaires d'où la mise à jour régulière du SIG serait très difficile en se limitant aux classiques travaux de terrain.- Le type de climat : il est tropical, se caractérisant par un dense et presque permanent couvert nuageux qui empêche l'exploitation complète des images optiques, mais cet obstacle est aisément contourné grâce aux images radars.III - Exploitation des données préliminaires L'exploitation de quelques images satellitaires obtenues a été entamée. Leur analyse et leur interprétation ont permis d'aborder une première approche de l'étude de la dynamique spatiale du milieu.1-Les images optiques :A partir de quelques images Landsat obtenues, nous avons commencé la cartographie du couvert végétal de la zone d'épidémies. Cette zone présente ainsi 4 types principaux de paysages végétaux : forêts de terre ferme, forêts ripicoles/hydrophiles, forêts marécageuses et savanes.Nous comptons réaliser cette cartographie pour toute l'aire étudiée. Une mise à jour régulière nous permettra de suivre la dynamique du paramètre végétation dans le temps.Nous pensons pouvoir corréler le suivi de la végétation à celui de la faune en superposant sur cette cartographie des couches d'informations concernant notamment la distribution naturelle d'espèces et les cas de mortalités animales observés.2-Les images radars :Nous avons commencé l'exploitation de quelques images ERS et Envisat. Ces images nous apportent des informations pertinentes permettant de décrire la physionomie générale du milieu concernant les thèmes "relief " et "hydrographie":- La région étudiée présente globalement un relief plat d'altitude moyenne de 600 à 700 m variant ça et là de quelques dizaines de mètres. On a pu mettre en évidence un escarpement de relief Nord-Sud. Cet escarpement joue certainement un rôle de barrière géographique dans les mécanismes écologiques de l'écosystème de la région.- Les images analysées montrent que le réseau hydrographique de la région d'épidémies est dense et très ramifié. On constate ainsi que cette région se caractérise par la présence de nombreuses zones humides et marécageuses (zones de terres régulièrement ou en permanence immergées). Nous pensons pouvoir obtenir des informations très intéressantes à partir du suivi de la dynamique temporelle de ce paramètre "hydrographie".A partir de données récemment acquises, nous avons commencé l'analyse d'une série diachronique d'images Landsat, ERS et Envisat. Les résultats de cette analyse nous fourniront certainement des éléments importants pour la suite de notre travail et concernant notamment l'étude de la dynamique temporelle des différents paramètres du milieu dont une brève première description spatiale vient d'être présentée ici.

Abstract No. 79

Multitemporal and Dual-polarization SAR Data for Detection of Urban Areas

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Urbanization modifies urban environment and properties so that we need to better understand these changes. The remote sensing tools are able to explore urban environments and retrieve spatial, temporal, and environmental characteristics. Synthetic aperture radar (SAR) is used for urban

monitoring because they are independent of the weather condition and day and time. At present, most SAR satellites are single band and single polarization, which limits the information to intensity and texture. Only Envisat ASAR is dual-polarization. In the paper, the SAR data from different sensors at different bands and different temporals, including in Envisat, and JERS-1, are used to detect the changes of urban environment over Beijing area of China.Beijing, the capital of the People¡¯s Republic of China, is the center of national politics, economics, and culture. It covers an area of 16.8 thousand square kilometers, and the major buildings are centered around the Forbidden City. As the result of the Chinese economy developed quickly, the city enlarge raptly, especially rural urbanization have been becoming important issues since many projects are building for the Olympic Game in 2008. So, this paper aims at investigating the usefulness of the multiply SAR datasets for defection and discrimination of urban area by texture measure and urban land cover classification. At the same time, the method of pattern recognition is used for detection linear features, such as the main axes in road networks. We compare classification results obtained by using multitemporal or multipolarization datasets, and explore the interactions among SAR data recorded by different sensors. Finally, we want to discuss whether the use of more polarizations effectively overcomes the possibility to combine multitemporal single polarization images. This could be useful for detection of the potential for urban environmental changes using the optimal mode of ASAR sensor.

Abstract No. 82

Multi-Incidence Angle DEM Generation and Land Cover Classification using Envisat/ASAR data

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Being the ERS SARs had a fixed 23° incidence angle, the effect of radar layover in hilly terrain prevents widespread use of the data. Envisat/ASAR image mode will provide data acquisition in seven different swath (i.e. IS1 to IS7), giving incidence angle ranging from 15°to 45°. The availability of different viewing angles, especially for higher off-nadir angle, of ASAR enhances the interferometric visibility of steeper slopes, which are otherwise in layover with 23° of incidence angle of ERS-1/2. In addition, Microwave interactions with the surface are complex and different scattering mechanisms may occur in different angular regions. Thus, radar backscatter has an angular dependence, and there is potential for choosing optimum configurations to improve land cover discrimination using multiple incidence angles Envisat/ASAR data. From the technical capabilities of selectable incidence angles of Envisat/ASAR and the angular dependence of radar backscatter, In this paper, firstly, the interferoemtric SAR data processing algorithm of DEM generation using Envisat/ASAR data will be developed, such as using DELFT precision orbit data to reduce the baseline error, the methods to mitigates atmospheric effects using integrating information from multiple INSAR interferograms etc. Secondly, Three DEM of different incidence angle will be generated for the test site, the effects of incidence angle on the quality of inteferoemtric SAR DEM will be investigated, and a DEM reconstruction methods which can improve the accuracy of DEM will be developed using these DEMs according to the multi-incidence angle characteristic of ASAR.

Thirdly, the coherence and backscattering characteristic of land cover under different incidence angle will be analyzed, and combining the coherence and backscattering components under different incidence angle of Envisat/ASAR data, the capacity of land-cover discrimination under multi-incidence angle will be investigated. At last, the accuracy of these DEMs and land-cover discrimination will be analyzed and validated by comparing them to the topographic map, land use map and the field measurement data.

Abstract No. 125

Contribution of Envisat RA-2 to Global SRTM Evaluation

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Altimeter data from the ERS-1, ERS-2 and Envisat missions have been reprocessed using a rule-based expert system to yield hundreds of millions of height measurements over the earth's land surface. This unique dataset has been used in a global scale evaluation of the SRTM mission. Whilst analysis with ERS RA-1 data has given good results over relatively flat terain, the inability of the altimeter to maintain lock over mountainous terrain has severely limited independent evaluation of global and regional DEMs using altimetry. The Envisat RA-2 uses three modes of operation to maintain lock over even extreme terrain. This presents the first opportunity to examine the performance of DEMs with altimeter derived heights over a significant proportion of the earth's land surface. This paper presents results from a global scale study comparing Envisat RA-2 Ku and S band retracked heights with the NASA SRTM dataset, and evaluates the potential for Envisat RA-2 to contribute to global terrain mapping.

Abstract No. 131

Urban Dynamic with Multitemporal Envisat/ERS SAR Images and Multispectral SPOT Optical Image by Using Data Fusion Approach

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The urban area is a concentration place of human occupation, which often undergoes rapid transformations, particularlyin developing countries. These transformations appear through a great dynamic of the urban area and suburbanoccupation, which can be followed by remote sensing data.In the rain forest context, the weather conditions oblige to exploit SAR images for many applications in remote sensing; but if available, the optical images can be used locally, in order to facilitate automatic interpretation of SAR images[1], which are corrupted by the speckle noise.The urban dynamic can be appraised with the help of change detection techniques, which consist in

estimating thegradient in the temporal direction of a spatial data series.We propose in this article, a data fusion approach which allows to highlight urban transformations on a given period,by studying the urban growth and the urban decrease, particularly habitations bright pixels dynamic with the help ofEnvisat/SAR multitemporal SAR images. One SPOT optical image is exploited in the method as prior information :a urban and non-urban index is used for this purpose, such as NDVI (Normal Dierence Vegetation Index) index.The proposed approach operates in two steps :1. the urban dynamic quantification is computed on the multitemporal SAR images, with the help of the fundamentalSAR temporal change measure Du based on the constant false alarms edges detector [2]. the fusion of previous quantification measure with the urban and non-urban index coming from the optical image is performed.The fusion strategy used is based on the subsets theory, first developed by [3]. Then, according to the dynamic of Duand NDVI measures : a urban growth (Du < 0), a urban decrease (Du > 0) or no-change (Du -> 0) can be highlighted.The proposed method is illustrated on the images (Envisat'2003, ERS'1999 and SPOT'2001) of Douala urban area,which has a great pressure concerning the urban and suburban human occupation space. The results show an importanturban growth and urban decrease phenomenon. This kind of of information could be useful for the urban planers of thiscity.References[1] V.-P. Onana, E. Trouv´e, G. Mauris, J.-P. Rudant, and P.-L. Frison. Change detection in urban context with multitemporal ERS-SARimages by using data fusion approach. In Proceedings of IEEE IGARSS'2003, Toulouse, 2003.[2] R. Touzi, A. Lopes, and P. Bousquet. "A Statistical and Geometrical edge detector for SAR images". IEEE Transactions on Geoscienceand Remote Sensing, 26(6):764–773, 1988.[3] L.-A. Zadeh. Fuzzy sets. Inform. and Control, 8:338–353, 1965.

Abstract No. 171

The Role of Earth Observation in the Good Practice Guidance for Reporting Land Use, Land Use Change and Forestry Activities as Specified by the Kyoto Protocol

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The Kyoto-Protocol, which aims to combat the uncontrolled increase of atmospheric greenhouse gases (carbon dioxide, methane, nitrous oxide, etc.), allows for the accounting of biological sinks. A "sink" is defined as a process, activity or mechanism that removes a greenhouse gas from the atmosphere. An ecosystem represents a sink for carbon if its assimilation of carbon through photosynthesis exceeds its loss through respiration and disturbances (e.g., harvest). Correspondingly, a "source" is a process, activity or mechanism that releases carbon dioxide to the atmosphere. There are several articles in the Kyoto Protocol (Articles 3.3, 3.4, 6, 12 and 17) that deal with the so-called "land-use, land use change and forestry" (LULUCF) activities such as afforestation, reforestation, and deforestation (ARD) activities and management practices, including "forest management", "cropland management", "grazing land management" and "revegetation".The measurement of national carbon stocks below and above ground is a challenging task and many countries do not have the financial resources to carry out national-scale inventories of carbon stocks in forests and soils. Even for smaller countries like Austria, where national forest inventories are carried out at regular intervals (every 5–10 years), the uncertainties are comparably high as a result of using uncertain conversion factors to convert forest inventory data into carbon stocks. The concern is that the high uncertainties of the LULUCF sector veil the emission reductions to which the signatory countries of the Kyoto Protocol have committed themselves. It is therefore important to fully utilize existing technologies and methods, and/or to develop new ones that may help to decrease the uncertainty of LULUCF reports.Remote sensing has been identified as a potential technology to provide inputs (estimates of independent variables such as deforested or burnt areas, biomass, etc.) to carbon models and as such to the Kyoto Protocol. However, it is not clear which role satellite-based remote sensing will play for reporting and verifying LULUCF activities. In this paper we will analyze how the role of remote sensing is seen in the Good Practice Guidance Report for the LULUCF sector (prepared by the Intergovernmental Panel on Climate Change), which is soon to be released. Since this report gives specific recommendations on which techniques should be employed, it is important that the remote sensing community is informed. The discussion will consider earth observation data of varying spatial and thematic content: low resolution optical imagery (Envisat MERIS), high resolution optical and radar imagery (Envisat ASAR, Landsat), and very high resolution E-SAR data (simulated TerraSAR-X).

Abstract No. 302

Global Land Topography and Ocean Bathymetry from Radar Altimetry

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A new Digital Elevation Model was compiled for Envisat with a 5' * 5' grid spacing. This Global Model was achieved by integrating a Bathymetry model built by Walter Smith from NOAA and David Sandwell from Scripps Institution of Oceanography, USA, with the Altimetry Corrected Elevations (ACE) produced by Philippa Berry of De Montfort University, UK. Both models present the advantage of associating satellite global altimetry grid with field data (depth sounding for the bathymetry and local DEM for the altimetry). To take full advantage of the resolution of both input datasets, two other DEM were also produced with a respective grid spacing of 2' and 30''.To obtain a final model with a full, dense and homogeneous coverage, that includes all the information from the initial models and preserves their accuracy, a merge of the data sets was performed carefully respecting the boundary between land and ocean because both original grids had different resolutions. Then, the entire dataset was divided in small geographical tiles that were separately triangulated and interpolated. Edge effects were avoided by taking in consideration an overlap

boundary zone. Finally, three grids were obtained at different resolutions, 30 arcseconds, 2 arcminutes and 5 arcminutes (respectively, 1, 4 and 10 km approximately) to be used for applications requiring different scales. These grids are the first global models including essentially satellite radar altimeter measurements of land elevation and ocean bathymetry merged together, giving a unity and a complete, dense and homogeneous coverage of the world, with an unprecedented accuracy.This new global model at 5-arcminutes resolution will replace the previous model used in Envisat data processing and the model at 30-arcsecond resolution will be also used for MERIS and ASAR application projects.

Abstract No. 358

Synthetic Aperture Radar Studies of Desert Duricrusts

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Desert duricrusts are important for preserving palaeoenvironmental evidence in deserts. In the Libyan Fezzan they preserve lacustrine sediments from erosion. These sediments contain important palaeoenvironmental information and record highstands of Lake MegaFezzan, which covered c.117,000 sq km at 74(+23-16)ka, and c.149,000 sq km at 9.5±2.5 ka. During the latter episode the lake covered about a third of its catchment, indicating a surprisingly wet environment at this time. This giant lake is one of several that once existed in the central Sahara in adjacent closed basins and between them they submerged nearly 6% of the Sahara in the early Holocene. We explore the capabilities of Envisat ASAR to identify duricrust locations associated with palaeolake sediments and demonstrate how Ground Penetrating Radar studies can help explain the energy-matter interactions involved.

Abstract No. 385

Assessment of Wildlife Habitat Using Remotely Sensed and GIS Data in Royal Bardia National Park, Nepal

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In this study earth observation data have been used to predict potential habitat for the umbrella species; Tiger (Panthera tigris), Greater one horned rhinoceros (Rhinoceros unicornis) and Asian elephant (Elephas maximus) in Royal Bardia National Park, Nepal. Multi- temporal Satellite data (landsat ETM and ERS SAR), aerial photos, topo sheets, and field survey data were the main

sources of information to assess and classify land use/land cover types, terrain conditions, water availability, human encroachment and/or risk assessment. Ground survey data were used as an indication of animal's presence and their conflict with human. Satellite data were processed and classified into 13 land cover types at the European Space Research Institute (ESRIN), Frascati, Italy. The project has generated habitat suitability map (HSM) for umbrella species and GIS resource management database. The HSM and GIS resource management database are most fundamental for long-term monitoring of these umbrella species.

Abstract No. 393

Analysis of ASAR Polarisation Signatures from Urban Areas

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ERS-1 opened for the analysis of multi-temporal SAR images, while RADARSAT has made it possible to investigate SAR images from the same geographical area on land when viewed with several incidence angles. Envisat ASAR gives the opportunity to add another dimension to the analysis and interpretation of urban features: multi-polarisation. It is believed that Envisat Alternating Polarisation mode can be of importance if one chooses to use ASAR images to build up general knowledge of infrastructure in an area. Basic theory states that like-polarised return signals (i.e. HH or VV) are 10 % to 15 % higher than cross-polarised returns from natural surfaces, and that the like-polarised signal is more influenced by the cardinal effect than cross-polarisation. On the contrary, cross-polarisation will give a strong radar return from complex structures. By comparing the ASAR backscatter from HH, VV, and HV or VH, it may be possible to say something about the complexity of an object and the direction (horizontal/vertical) of its dominant components. By using several ASAR incidence angles, it is also possible to investigate backscatter changes as a function of incidence angle.The ESA AO 434 project is focusing on ASAR backscatter change from urban categories as a function of polarisation and incidence angle, as well as classification abilities of various urban classes. More than ten scenes were acquired over the Oslo region in Norway in ASAR Alternating Polarisation mode from summer 2003 to spring 2004, and processed to single-look-complex (APS) images at ESA and Kongsberg Satellite Services. The ASAR data sets should be absolutely calibrated when comparing backscatter from several acquisitions and modes. The ASAR backscatter is analysed with respect to incidence angle and polarisations. Contrast and structural information from man-made objects are also investigated. Results show that backscatter from natural surfaces (e.g. forest, agriculture) is typically 4-7 dB higher in the like-polarisation channel than in the cross-polarisation channel. In the Oslo region, there are more bright points from man-made objects in like-polarisation than in cross-polarisation. This is often due to the cardinal direction effect. Some building complexes gave up to 30 dB's higher backscatter in HH than in HV. Strong cross-polarisation backscatter is evaluated with respect to building types. Ongoing work is also focusing on which incidence angles (or incidence angle combinations) that will give the maximum information of man-made structures from an urban area when using Envisat ASAR data.

Abstract No. 417

Performance Evaluation of a Combined Multi-resolution Textural Classification of a Single ERS-1 Image

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Against the multispecral images, working only on one single monobande Radar image, for cost and image availability reasons, is a hard task due to nature of these images. In this work, we present an attempt for the classification of an ERS-1 Radar image for the need of thematic cartography.The drawback of monobande Radar image is surmounted by the integration of the spatial dimension of the image i.e the textural information. This precious information is obtained by using the wavelet transformation. This latter provides us the possibility to extract the maximum of textural information by introducing the changing in image resolution in the textural analysis scheme. A redundant wavelet transformation provides us a 'tower' representation instead of the pyramidal one, thus, we preserve pixels to pixel correspondence between the different towers level. A textural information fusion step is then applied in order to deal with the well known 'curse of dimensionality' problem.A supervised classification process, which combine both radiometric and textural information's, in a multi-resolution scheme is applied. The results obtained over a single ERS-1 image which cover a relatively complex area are satisfactory. This permits us to confirm that the presented classification scheme is a good approach for the purpose of cartography with only a single Radar image.

Abstract No. 461

Land Cover / Land Use Classification Using MERIS Full Resolution Data

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The German Remote Sensing Data Centre (DFD) of the German Aerospace Centre (DLR) is developing a new land product within the ESA – AO project Generation of MERIS Level 3 products for European Multidisciplinary Regional Applications (GEMEL3, AO-ID 1413). This new product, a land use /land cover map (LULC) of Germany, will be generated automatically every year on the basis of MERIS full resolution level 2 data (top of aerosol reflectance). Subsequently, it is planned to extend the LULC map to the entire area of Europe. The new product is dedicated to indicate land cover/land use changes and will be used in climate change research.The classification consists of

two steps, a multi-spectral and a multi-temporal one.The multi-spectral classification is performed by means of a data base containing the mean spectra, covariance matrices etc. of each class. Owing to the wide field-of-view of MERIS (68.5°), this data base takes into account the view zenith, sun zenith and relative azimuth angle of each pixel. The multi-spectral classification is computed using the maximum-likelihood technique and delivers two distances, one corresponding to the shortest distance, the other to the second-shortest distance. This fuzzy first classification stage makes the overall process less susceptible to noise in the input data and allows an accuracy estimate based on the ratio of the two distances. The first classification step yields intermediate classes (colour classes) and not yet land use /land cover classes.In a second step, a multi-temporal classification is performed, which takes into account the phenology of the land use /land cover classes (e.g. phenology of deciduous forests with increasing greenness from spring to summer and autumnal breakdown). For the land use /land cover of Germany, only central European phenology is regarded. For the extension of the LULC to Europe, the phenology of northern European and Mediterranean vegetation must be considered. Only after this second step, an assignment of pixels to land cover /land use classes is possible. The legend of the LULC map will be similar to the IGBP legend.

Abstract No. 530

Generating, Comparing and Exploiting DEMs for Hydrological Applications over the Galapagos Islands

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This study aims to understand the hydrology and groundwater flow of the Galapagos Islands, an insular basaltic environment with growing anthropogenic pressure and ecosystems to preserve. Lack of essential data for system modelling ie. topography, led to retrieving this information from other sources. Generation and exploitation of DEMs in this context is presented here for the island of Santa Cruz.Techniques with Radar were preferred, as images are not affected by cloud cover. The interferometric DEM was realized with ASAR images and Atlantis EarthView, taking into account temporal and baseline decorrelation constraints. Radargrammetric DEM was generated by Gamma Remote Sensing with multi-incidence angle capacity of ASAR. The two techniques are compared for this type of environment. SRTM 90 m resolution elevation data (recently available from NASA) and a digitalised topographic contour DEM (M. Souris, IRD) were used to aid phase unwrapping (interferometry) and for comparison and validation. The DEMs were used to determine theoretical drainage network and the area of watersheds. Water balance calculation can now be carried out. Field work shows that riverbeds are mostly non-perennial, indicating important temporal dependence of runoff and recharge. Also structural and geomorphological data, ie. the preferential East-West fault direction and the position of lower watershed depressions, will be used to constraint

the hydrogeological model. The integrated georeferenced database will also used for defining hydrological network setup and geophysical investigations.

Abstract No. 594

Application of Envisat ASAR Data for Alpine Land Use Classification

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The advantage of Envisat ASAR over its predecessors, namely ERS-1 and ERS-2, as a land observation tool resides in its multiple polarization and multi-look angle capabilities. As a radar sensor the ASAR backscattering coefficient is sensitive to the moisture content of the scattering media and its geometrical properties (i.e. size, shape, roughness, and orientation).In this paper, application of Envisat ASAR multiple polarization backscattering data for the discrimination of alpine land use categories, i.e. forest area and types, agricultural fields, meadows, urban areas and water bodies is presented. Envisat ASAR data acquired during the period April 2003 to May 2004 over test areas in Salzburg (Central Alps) and East Styria (Eastern Alps) in Austria are compiled and processed. The processing included geo-referencing, backscattering coefficients retrieval and topographic normalisation.The ASAR backscattering coefficients averaged over reference polygons of homogeneous forest stands were extracted and statistically analysed. The ASAR Multiple polarisation data were found to discriminate forest from non-forest with very good degree of accuracy, although some high grass are confused with forest. Generally, for forest types separation the measured ASAR backscattering coefficients were found to perform some limited discrimination of forest types. Whereas, the statistics of the various land-cover categories were found to show good class discrimination.

Abstract No. 624

Use of InSar Products for Gold Exploration in the Kedougou-Kenieba Inlier of Senegal and Mali (West Africa)

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Interferometric Synthetic Aperture radar (InSar) is a technique for extracting three-dimensional information of the Earth's surface by analysing the phase content of the radar signal. Interferograms (phase differences) can be computed from image pairs acquired with the repeat-pass ERS-1 orbits or the ERS-1/ERS-2 tandem mission. InSar derived products, digital elevation models (height information and coherent images (phase correlation), are very useful for improving SAR images for

a number of geological applications like surface geology and geomorphological studies, lithological discrimination, lineament analysis and structural mapping. The Kedougou-Kenieba test site, which is part of the West African cratoon, is constituted by Birimian (Paleoproterozoic) rocks, surrounded by discordant, late Proterozoic formations. It has been actively explored for gold and its important potential has been confirmed by the discovery of deposits, among which the Sabodala type which is associated with a major senestral NE_SW shear zone. But gold exploration in this region, based on traditional methods like geological, geochemical and geophysical surveys, shafting and drilling, has already costed millions of dollars, without having proved the existence of valuable economic concentrations, despite of good surface evidences. This is mainly due to the presence of a lateritic crust of up to 40-50 meters thickness, which extends over wide areas and impedes a direct observation of rock outcrops and mineralised structures. SAR intensity imagery and their derived InSar products are of great utility for optimising lithostructural mapping and identifying shear zones, potential for gold mineralization. InSar processing has been conducted on the 1 December 1995 (orbit 22899, frame 3339) and 5 January 1996 (orbit 23400, frame 3339) interferometric image pair, covering part of the Kedougou-Kenieba inlier (Senegal, Mali). The resulting DEM has beeen used to produce a hill-shaded relief image with colour-coded height information.The coherence and the DEM have then been combined with the amplitude to generate the intensity landuse (ILU) image. Finally the three images have been interpreted and a lineament map extracted. This map shows the N-S to NNE-SSW senestral shear zone of regional extent, evidenced by the alignment of basic volcanic rocks, cut and displaced by more recent NW-SW, NE-SW and E-W fault systems. The Sabodala gold deposit and its "satellites" appear clearly along a N-S axis. They are associated with NE-SW, NW-SE and EW structures. A similar fault setting is visible at the upper left, middle right and bottom central parts of the lineament map (areas A, B and C). Particularly, the intersection zones between the N-S and the later fault systems may be considered as potential zones for gold concentrations.Synergistic exploitation of radar amplitude images and InSar products (DEM and coherence images) can greatly improve the interpretability of radar imagery for geological applications. This approach has been tested successfully on the Kedougou-Kenieba inlier where lithostructural mapping and mineral exploration are rather difficult because of the presence of a thick and widely covering lateritic cap. The analysis of the lineament map established from the interpretation of the InSar derived images has allowed to retrieve the structural fault systems controlling the sabodala gold deposit. Other areas of the image showing similar fault settings have been identified. They may be potential gold deposit zones. These results confirm that radar remote sensing in general , InSar and derived products in particular, are a highly informative and cost-effective tool for mapping and for mineral exploration, especially in poorly outcropped terrains.

Abstract No. 625

Analysis and Processing of ASAR and MERIS Data for Urban Areas Classification and Monitoring

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The aim of this research was to investigate the potentialities of ASAR and MERIS data for applications related to urban areas. In particular, we aimed at providing a first assessment of the effectiveness of the different multiparametric characteristics (multiangle, multisensor, multispectral, polarimetric) of the sensors for the classification and the monitoring of urban areas. This goal was achieved by means of (i) the direct analysis of the statistical characteristics of the data, and (ii) through the development of techniques for the extraction of the relevant information, and the evaluation of the achieved results. For the second point, we developed techniques based either on a statistical approach or a neuro-fuzzy approach, and we considered different applications. In the following, we will illustrate the selected test site and the used data, moreover we will describe the different aspects considered, specifying for each one the field of application, the achieved and the expected results, and the conclusions. Description of the worka) Test site: almost all the results were obtained considering the town of Pavia, in Northern Italy. This site can be considered relevant for the following reasons:- it is a medium-size town with different classes of urban tissue (densely built up areas, residential areas, industrial areas, etc…);- it is located in a flat area, thus the corresponding images are not affected by layover or shadowing phenomena;- a high volume of data is available to the authors for this site, both in term of images and ground truth.b) Data set: due to the reduced amount of ASAR and MERIS data available to the authors at the time the present research was carried out, some of the results were obtained on data from other sensors, with similar characteristics. In particular, we considered ERS and SIR-C data, and Landsat TM and ETM data. c) Analysis, processing, and results.- Statistical analysis of multiangle/multitemporal SAR data: this analysis was carried out on ERS and ASAR data, considering images acquired with different incidence angle and in different dates. We analysed the characteristics of different classes of the urban tissue, with the aim of identifying a suitable statistical model among different candidates. We also investigated the effects of variations of the incidence angle on the backscattered radiation, and we studied the potential separability of the different classes present in the considered scene. Results show that the incidence angle has a great impact on backscattering characteristics, and that different classes of urban tissue are potentially distinguishable using the considered data.- classification of mono- and multitemporal SAR data: we analysed the possibility to distinguish different classes of the urban tissue applying a statistical classification scheme on ASAR data. Moreover we studied different ways to combine the multitemporal information to improve classification accuracy, using statistical, neurofuzzy, or combined approaches, and exploiting the contextual information. Finally, we studied the effectiveness of change detection techniques, with application to the detection of flooded areas. The achieved results and the conclusions will be reported in the final paper. - classification of multispectral/multisensor data: we considered different approaches to the classification of multispectral/multisensor data, in order to investigate their effectiveness for the extraction of the relevant information. In particular, we considered a statistical and a neurofuzzy approach, moreover we considered different schemes for the fusion of the different bands, and we also evaluated the impact of the contextual information on the achievable classification accuracy. Finally, we analysed the effects of the fusion of SAR and optical data. The comparison of the achieved results and the conclusions will be presented in the final version of the paper. 4. Polarimetric SAR image processing: we considered different approaches to the combination of the polarimetric channels for an efficient classification of urban areas. The use of the polarimetric information proved to be effective for SIR-C data, while its effectiveness for ASAR data is currently under investigation.ConclusionsIn this work we considered different aspects and approaches to the processing of ASAR and MERIS data. The aim of this research was to define both the potentialities of such data for urban area characterization and monitoring, and the results practically available using different approaches.

Abstract No. 647

The generation of a UK and Ireland ERS SAR Multi-temporal Mosaic

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A multi-temporal mosaic of the UK and Ireland has been generated using ERS SAR imagery. The large archive of ERS SAR imagery has been exploited to generate the mosaic as much of this data has been acquired such that large areas have been imaged over short periods of time. The mosaic enables large scale land features to be visualised and shows potential for land use monitoring on a large scale.Approximately 100 ERS SAR PRI images were used for each of the three mosaics required to generate the false colour multi-temporal mosaic. Each individual 100 km by 100 km PRI image has been converted to a common map projection and then combined with images from adjacent swaths. There is a need to remove the across-track image intensity variations due to the changing radar cross-section of land surfaces across the SAR swath and also to mask out water regions. The localisation information within the ERS SAR PRI product has been found to be adequate for registration of images within the mosaic. It is necessary to ensure that the time span between the three individual mosaics is sufficient to show changes in radar backscatter. This poster paper will show the multi-temporal mosaic of the UK and Ireland and describe how it has been generated. A CD-ROM of the mosaic is available from ESA. It is important to note that large scale mosaic generation has become much easier using the wide swath product acquired by the Envisat ASAR instrument.

Abstract No. 177

A Numerical Algorithm to Acquire the Average Height of Land Surface from Radar Altimeter Mean Return Wave

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Based the radar altimeter mean return wave, a new numerical algorithm to acquire the average height of land surface is proposed through the origin analysis about each point of return waveform. For the time relay of mean return wave reflects the corresponding information of incident scope, it can result in a practical numerical reconstruction to extract the distance between altimeter and land surface. In the difficult situation of how to decide the single characteristic point responding the average height, the technique built this numerical algorithm can be operated easily in practice. Otherwise, simulation results and practical airborne altimeter measurements validate our model in a good way.

Abstract No. 199

Recent Geological Evolution of the Lake Abhe Basin Using Multitemporal Satellite Images

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We used a multitemporal dataset (ERS1/2 and Landsat) to investigate the recent geological evolution of a tectonic basin of the East African Rift. The study area is the Lake Abhe-Goba'ad basin which is located at the border between Djibouti and Ethiopia.The Lake Abhe in particular, is currently confined to the western part of Goba'ad depression but it experienced strong climatic fluctuations during Late Quaternary reaching also the maximum extension of about 6.000 km2.We focused our study on the radar and spectral characteristics of sedimentary deposits such as alluvial fans, deltas, both active and inactive, and possible recent fan-deltas. These features are the most sensitive to climate changes. Drainage pattern has been also mapped on the different images. The area covered by Lake Abhe in the multitemporal images has been measured on the geocoded dataset and the result shows a rapid shrinking of the lake during the last tens of years.We identified a relative chronology between different fault systems on the basis of cross-cutting relationships. Also, we compared the shapes of the main sedimentary basins of Southern Afar and the trend and density of the main tectonic structures. The Lake Abhe basin in particular, seems to be linked to the oldest deformative episodes, less tectonically active in Late Quaternary if compared to younger basins such as the Asal one to the East. Moreover, the Abhe basin appears to be the most geometrically complex depression in Southern Afar.

Abstract No. 200

Reconstruction of the Paleohydrology in Desert Areas Using SAR and Digital Topography Data

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Arid zones have been affected during the quaternary by a large hydrological and climate variability. This change of processes has shaped the landscape leaving the signature of former paloedrainage and sedimentological features. Using the radar SAR images matched with the detailed topography, it is possible to reconstruct the paleodrainages and identify the paleohydrological behavior of the past rivers and standing bodies of water.Interferometric data may show morphologies and provide elevation to estimate the former paleowater budget. A direct comparison between the past and previous settings is possible by the matching of SAR and other imaging product. Examples from Western Sahara (Algeria and Tunisia) will be presented. The saharian study areas consist of ephemeral rivers and dry lakes, but shows the past evidence of large rivers and shallow water,

perennial lakes. Instead the other shows several small basins with sebkas and permanent lakes showing evidence of dramatic environmental changes due to quaternary climatic changes. A quantification of these changes is possible by the analysis of topographic data. The observation of partially buried paleovalleys is more consistent in radar data rather than other remote sensing images.

Abstract No. 214

Applications of Envisat ASAR Data in Urban Environment, Soil Moisture and Crop Studies

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The Advanced Synthetic Aperture Radar (ASAR) instrument on board the Envisat satellite, compared with ERS-1/2 SAR, has an enhanced capability in terms of coverage, range of incidence angles£¬polarization, and modes of operation. In our project, we have conducted three aspects research with Envisat ASAR data on crop analysis of Zhaoqing area in Guangdong Province of South China, urban environment analysis of 2008 Olympic Game site in Beijing, and soil moisture measurement and retrieval analysis. The followings are the results of our study.1) Crop Analysis. For rainy and cloudy areas in southern China, we utilized two ASAR dataset with alternating polarization mode. One, acquired on 13 June of 2003, had imaging swath of IS5 and polarization of HH/HV. The other, acquired on 2 July of 2003, had imaging swath of IS5 and polarization of VV/HH. At first we derived the backscattering coefficients of main ground objects in the images and used the crop microwave scattering model to build the relation between the backscattering coefficient and LAI (leaf area index) of rice and banana. Then we compared the LAI obtained from ASAR with that obtained from the ground measurements and TM acquired on 18 June of 2003. The results show that different ground objects in experimental area have distinctive and different characteristics of backscattering coefficient in ASAR images with different polarization and imaging swath, which imply that ASAR data can be used in targets detecting and classification. The LAI obtained from ASAR data can be used in crop growth monitoring with certain accuracy. The accuracy of crop microwave scattering model also can be improved if we have more ASAR data with multi-incidence angle and multi-polarization.2) Soil moisture measurement and retrieval analysis. Using Integral Equation Model (IEM), we simulated the backscattering coefficients of C band SAR backscatter at different incidence angles and the alternating polarisation mode, and analysed the sensitivity to soil moisture. The algorithm of inferring surface soil moisture from radar backscatter is developed according to semi-empirical model from the results of simulation and sensitivity analysis. Several microwave satellite images are obtained, which are ASAR APS 1P data with HH and HV polarisations on Jun. 27, Jul. 13 and Aug. 12, 2003. Additionally, field soil moisture measured on the day of acquisition at several sites including Tuotuohe, Tibet plateau (34¡ã13¡¯N, 92¡ã25¡¯E) and Hetian, Xinjinag (37¡ã15¡¯N, 79¡ã48¡¯E) area, where are the arid and semi-arid area of west China. The soil moisture ground-truth data are collected through the TDR and gravimetric methods, and are used to assess the ASAR imagery soil moisture estimations. The soil moisture map retrieving from ASAR backscatter measurements compared to the spatially distributed ground truth. Accuracy in the retrieval of the surface moisture content from the radar measurements follows the accuracy in the field measurement. The results demonstrate the effects of soil moisture monitoring using mutil-polarisation mutil-incidence ASAR data. 3) Urban environment analysis for

2008 Olympic game site. We applied pattern recognition method to Envisat ASAR data of 26 January 2004, together with JERS-1 SAR data of several years for extracting road information, and study the dynamic changes of urban development of the Beijing Olympic Game site in recent years. In this paper we will present the results of our study for the above-mentioned aspects.

Abstract No. 217

Derivation of a Multi-sensor Interferometric DEM of the Dead Sea Region

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Radar interferometry is a well established technology for the generation of digital elevation models (DEM). Several satellites with SAR-sensors on board have been launched during the last 10 years, which provide interferometric datasets for this purpose. One of them is the Envisat ASAR, a repeat pass interferometric system with a repeat cycle of 35 days. The great advantage of this sensor is the new beam steering capability that allows data takes with different incident angles. Especially for the mapping of steep mountainous regions, like the border of the Dead Sea, the combination of different incidence angles will have a favorable effect. Under ESA project 2341 we investigated the combination of several Envisat ASAR datasets with different orientation (ascending /descending) and various incidence angles. Another objective of the work has been the comparison of the Envisat ASAR DEMs with other interferometric datasets derived from ERS-1/2 tandem data, SRTM and RADARSAT data. The advantages and disadvantages of the different datasets like wavelength, incidence angle, resolution, single versus repeat pass will be discussed.The result of the study is a multi-sensor DEM, which combines the advantages of each dataset in one final product.

Abstract No. 220

DEM Resolution

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DEMs can be represented in a first approximation as fractal processes. Multi-resolution representation and analysis is a suitable method of whitening DEM signals. This means, in case of fractal processes, that neighbouring coefficients of a specific wavelet decomposition are uncorrelated. However, coefficients on the various decomposition levels representing the same area in the 2D signal show self-similarity properties. In case of DEMs that may be represented as a single

mode fractal a wavelet decomposition represents a Karhunen Loéve Transform to the signal. This paper explores the possibility to measure DEM resolution with the mentioned techniques.

Abstract No. 280

Utilisation de Données Spatiales Haute Résolution pour la Cartographie des Rizières, Gîtes Larvaires Potentiels des Anophèles Vecteur de Paludisme dans la Région des Hautes Terres Centrales de Madagascar

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Le paludisme demeure un problème de santé publique à Madagascar. Son histoire est marquée par les épisodes épidémiques sur les Hautes Terres Centrales (HTC), la population y est dépourvue de prémunition et reste vulnérable. Le paludisme représente une consultation sur cinq dans les dispensaires. La riziculture constitue la principale activité de la population rurale sur les Hautes Terres Centrales Malgaches. L'entretien des rizières entretient en même temps les gîtes larvaires d'Anopheles funestus, principal vecteur du paludisme à l'origine d'une épidémie meurtrière des années 1980 sur les HTC. Il y a plusieurs types de rizières, celles: - de grands périmètres irrigués- en digitation occupant les bas fonds- en terrasse ou gradin- en petite parcelle pluviale.A part ces différents types, les rizières sont caractérisées par le fait qu'elles ne sont pas homogènes. Au sein même des grands périmètres irrigués se trouvent des cultures vivrières. Le travail commence au mois d'octobre avec le labour. La mise en eau des rizières ne précède le repiquage que de quelques jours, principalement au cours du mois de décembre. A partir de ce moment, les rizières sont toujours inondées, le niveau de liquide doit se maintenir autour de 10 cm. La récolte se place au mois d'Avril. L'état des rizières est en perpétuel changement durant toute la période de croissance du riz et ce jusqu'à la moisson. Un projet d'étude sur le Système d'Information Géographique pour la prévention du Risque de survenue d'Epidémie de Paludisme (SIGREP) sur les Hautes Terres Centrales trouve son application et prétend optimiser la lutte antivectorielle en ciblant les foyers potentiels d'épidémie de paludisme. Les critères de choix des sites d'étude reposent sur la situation géographique, le type de rizières, la prévalence du paludisme et l'existence des pulvérisations intra domiciliaires antérieures. Notre objectif est d'étudier les informations apportées par les imageries radar dans la segmentation des rizières / non rizières en complémentarité avec celles qu'on a extrait des images Spot afin de cartographier les rizières, gîtes larvaires potentiels des anophèles responsables du paludisme sur les Hautes Terres Centrales malgaches. L'étalonnage des images de chaque bande et l'analyse en composante principale ont été effectués avant la composition colorée. Les coordonnées relevées par GPS et la reconnaissance terrain ont servi à la détermination des

parcelles d'entraînement pour la classification supervisée. La comparaison des signatures des échantillons a été effectuée sur les moyennes des réponses spectrales. Les images ont été classées en rizières, végétation et autres, puis le résultat obtenu recodé en rizières et non rizières. L'index Kappa a été accepté à partir de 0.80, pour la validation de la classification. Dans certaines régions, il est difficile de séparer les végétations des rizières. Une analyse de décorrélation maximum des bandes a été effectuée. Fautes de cartes récentes, les rizières digitalisées à partir des cartes topographiques vieilles de 40ans ne reflètent pas la réalité. Des confusions existaient entre rizières et végétation; ceci implique le recours aux images radar ou la réponse du signal est particulièrement sensible à l'humidité de la surface étant donné que les rizières sont toujours inondées. Les images radar complètent de manière efficace les informations apportées par les images optiques (Spot...). Elles permettent un suivi global et permanent de vastes régions indépendamment des conditions climatiques et météorologiques. La distribution des données radar ne suit pas la loi normale. L'utilisation pour ce type de données, d'algorithme de classification paramétrique pourrait entraîner des erreurs. La photointerprétation des images permettrait en premier lieu de distinguer les rizières qui sont la plupart du temps inondés et qui devraient apparaître en noir ou sombre. L'image de changement temporelle serait intéressante pour différencier les zones présentant une rétrodiffusion stable (végétation) par rapport à celle correspondant à une rétrodifussion qui change de façon rapide (rizières). Le calendrier cultural du riz coïncide totalement avec la saison humide, ce qui limite les conditions d'acquisition des images optiques. Les images Spot ont été acquises entre le mois d'avril et juin 2000 tandis que les images radar ont été commandées en début (janvier –février 2004) et fin de croissance du riz (avril 2004). L'index, surface des rizières par commune et des zones tampon de 1 kilomètre autour des rizières ont été pris en compte comme facteurs, parmi tant d'autres paramètres, utilisés dans l'évaluation multicritère des risques d'épidémie de paludisme sur les Hautes Terres Centrales.Note:Projet CAT 1 2320

Abstract No. 649

The Use of ASAR Mosaics for Operational Global Monitoring

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A mosaic is a geolocated product composed with several overlapping images. Whereas a single image scans an area of size A, two images mosaicked together provide an area of size 2A, and so on. One easily understands the advantages of such products, since the observed area becomes larger with the number of original images stitched together. Imaging rivers along countries and continents can only be assured with mosaics (eg, Chang Jiang river, 5990 km). Mapping continents across seasons can also provide valuable information on forestry and agriculture.This justifies an operational use of mosaic. By systematically observing predefined large areas, low-variant changes at large scale can be highlighted and analysed with mosaics. It can be a first step towards further forecasts and operational intervention.Global land monitoring is used for observing great changes occurring at large scale. Large areas can be covered up within 3 days, thus allowing an efficient monitoring of slow-variant changes. An exception is on polar areas, since they are revisited every day, fast-variant changes can be observed in a reactive context. Multi-temporal composite images

can also provide large scale studies, both at the time scale and at the geometric scale.Hydrology, topography, agriculture, forestry, can gain a lot from mosaicking. The phenomena related to these domains occur at very large scale, and the studies can thus be led in a global context. Ice monitoring can also expect great help from mosaicking. In polar regions, it is of interest to follow the movements of the sea-ice, resulting in a value-added in the field of forecasts. From ASAR Wide Swath (150 metres resolution, up to 75 metres pixel spacing) to ASAR Global Monitoring Mode (1000 metres resolution, up to 500 metres pixel spacing), global monitoring becomes easy with these images 400 km wide. The resolution is an interesting feature, but implies processing very heavy files, especially in the case of Wide Swath. The software is developed in order to not alter the resolution, and makes use of several optimization methods to reach such a level of accuracy. Accurate geolocation is provided, together with an efficient memory management. The software is conceived in order to be used in a parallel chain : high velocity can be gained thanks to several computers working in parallel, thus reducing the time of computing.

Abstract No. 718

Canadian ENVISAT ASAR Applications; Preliminary Results

J.J. van der Sanden, P. Budkewitsch, A. Deschamps, M. D'Iorio A.L. Gray, T.J. Pultz, V. Singhroy

Canada Centre for Remote Sensing, Natural Resources Canada

The paper will discuss the preliminary results of a number of Canadian-led ENVISAT AO projects that aim to develop applications in the domains of geology, glaciology and hydrology. We have a particular interest in developing applications for ENVISAT ASAR alternating-polarization data since these can be seen as a precursor of the selective dual-polarization data that will become available from the Canadian RADARSAT-2 satellite. RADARSAT-2 is currently scheduled for launch in the fall of 2005. The geological applications focus on the mapping of surface properties in the Canadian Arctic and the delineation of terrain units along a proposed pipeline corridor in Northern Canada. Effects of polarization and incidence angle on the potential of C-band SAR data for the mapping tundra barren lands on Bathurst Island, Nunavut are discussed. The identification of the surface properties of such lands in terms of rock, vegetation and soil types supports active geological exploration in the region. Fusion of C-band VV and DEM data was found to be particularly useful for the mapping of terrain units and landslides along proposed pipeline corridors in permafrost terrains in Northern Canada. Results relating to glaciology address the potential of alternating-polarization repeat-pass interferometric ASAR data for application to the monitoring of glacier motion in Antarctica and the Canadian Arctic. The information derived from ASAR standard beams is assessed and compared to results derived from other sensors, e.g. RADARSAT-1. In terms of hydrology, we will address the potential of alternating-polarization ASAR data for the extraction of information on soil moisture at the watershed scale. Multiple acquisitions collected over the Roseau River watershed, located in western Canada, were analyzed in relation to ground observations and meteorological conditions. A method was then developed to produce soil moisture maps for input to a hydrological model for flood forecasting. In addition, preliminary results of a study into the potential of alternating-polarization ASAR data for the monitoring of river ice

breakup will be presented. The area of interest for this study is Fort McMurray, Alberta.

Wednesday 8 September
10:50 – 12:30
MOZART 1-2

Session 3B3:

Trace Gases (3)

Abstract No. 429

Retrieval of Sulphur Containing Atmospheric Constituents from MIPAS/Envisat

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Operationally only pressure, temperature and six significant trace gases are retrieved by ESA from MIPAS data. However, there is information on many interesting species that is also present in the spectra. We apply a variety of techniques and our own retrieval model to retrieve concentration information on three of these other species - SO2, COS & SF6.Sulphur Dioxide (SO2) is an acidic gas with both natural and anthropogenic sources that is rapidly converted to sulphuric acid and hence sulphate aeorsols in the atmosphere. Carbonyl Sulphide (COS) is produced naturally at the ocean surface and by biomass burning and is thought to be the main contributor to non-volcanic stratospheric sulphate aerosols. Sulphur Hexafluoride (SF6) is almost entirely anthropogenic in its origins and shows steady year-on-year increases making it useful for age of air and tracer studies. After DiMethylSulphide (DMS), these species comprise the main source gases in the atmospheric sulphur budget.We anticipate the good global coverage and continuity of data will make MIPAS useful for the determination of changes and trends in the quantity and distribution of these species - both natural and anthropogenic.

Abstract No. 666

Polar NOx in the Middle and Upper Stratosphere Observed by MIPAS on Envisat

B. Funke[1], T. Von Clarmann[2], H. Fischer[2], S. Gil-López[3], N. Glatthor[2], U. Grabowski[2], M. Höpfner[4], M. Kaufmann[5], S. Kellmann[2], M. Kiefer[2], M. Koukouli[3], A. Linden[2], M. López-Puertas[5], G. Mengistu Tsidu[2], M. Milz[2], T. Steck[2], G. Stiller[2], D. Wang[2]
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The Michelson Interferometer for Passive Atmosphere Sounding (MIPAS) on board of the polar orbiter Envisat, launched on March 1st, 2002, detects non-LTE emissions of NO (5.3 um) and NO2 (6.2 um) with high spectral resolution.The simultaneous detection of both NOx species along with the pole-to-pole coverage of MIPAS data offers an unique opportunity to study the descent of mesospheric/thermosphericNOx into polar winter stratosphere. Vertical profiles of both NOx

species have been retrieved from a large set of MIPAS observations with the scientific non-LTE data processordeveloped at IMK and IAA. Derived data show a clear NOx enhancement in the upper stratosphere due to NOx descent during polar night which disappears in the sunlit spring stratosphere.

Abstract No. 419

Air Pollution Monitoring: Results from the TEMIS Project

R. Van der A[1], F. Boersma[1], I. De Smedt[2], W. Di Nicolantonio[3], H. Eskes[1], C. Fayt[2], J. Van Geffen[1], R. Guzzi[4], C. Lecerf[3], G. De Leeuw[5], I. Van der Neut[1], T. Nicolas[2], A. Petritoli[4], D. Schaub[6], R. Schoemaker[5], W. Som De Cerff[1], P. Valks[1], M. Van Roozendael[2], J. Van De Vegte[1], A. Weiss[6]

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[6] EMPA, Switzerland

The Troposheric Emission Monitoring Internet Service (TEMIS), part of the Data User Programme (DUP) of ESA, aims at the processing and delivery of tropospheric datasets for targetted user groups. These datasets consists of global concentrations of tropospheric NO2, SO2 and ozone, and aerosol and UV products derived from observations of nadir-viewing satellite instruments such as GOME, SCIAMACHY and (A)ATSR. These data sets are especially useful for monitoring of air pollution, which often travels long distances and affects areas far from the emission source. The transport and patterns in air pollution can be identified in the daily datasets. The TEMIS dataproducts are made available within 24 hours after observation. The results of TEMIS (2002-2004) will be presented and discussed.

Abstract No. 14

Surface UV Radiation Monitoring Based on GOME and SCIAMACHY

J. Van Geffen, R. Van der A, M. Van Weele, M. Allaart, H. Eskes
KNMI, Netherlands

It is important to monitor surface UV levels on a global scale and to do this over a prolonged time period. Thinning of the atmospheric ozone - due to ozone depletion and changes in the meteorology

in the stratosphere - leads to elevated levels of UV-B radiation at the Earth's surface. Exposure to enhanced UV incidence increases the risks of, e.g., sunburn (erythema) and DNA damage in living organisms.Within the TEMIS project a near-real time forecast service has been set-up for total ozone and for surface UV data. The satellite measurements of the near-real time ozone column by GOME and SCIAMACHY are assimilated in a transport model in order to produce near-real time forecast of the worldwide surface UV radiation for local solar noon and clear-sky conditions (UV Index). Further, the daily UV dose is computed for the last complete day using hourly cloud information from Meteosat (only for Europe). Additionally, worldwide UV doses are calculated using cloud climatology data from ISCCP as soon as these are made available. Time series of UV index and UV dose for the GOME measurement period are completed and are continued using SCIAMACHY measurements.The presentation will give an overview of the available TEMIS UV data products. Validation is performed by comparison with ground-based surface spectral UV measurements at sites in Europe and in Surinam. All data files and images are delivered via the TEMIS website at http://www.temis.nl/uvradiation/.

Abstract No. 463

The Mg II Solar Activity Proxy Indicator Derived from GOME and SCIAMACHY

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It has been shown that the Mg II index derived from daily direct solar observation in the near UV spectral region provides a good measure of the solar UV variability and it can be used as a reliable proxy to model extreme UV variability during solar cycle. For solar-terrestrial climate interaction an establishment of a long time series spanning serval decades is important. GOME (Global Ozone Monitoring Experiment, 1995-present) and SCIAMACHY (SCanning Imaging Absorption Spectrometer for Atmospheric CHartographY, 2002-present) provide continuous direct solar observations in the near UV since 1995.GOME and SCIAMACHY are passive remote sensing instruments operating in the ultraviolet, visible, and near infrared wavelength regions whose primary objective is the determination of the amounts and distributions of atmospheric trace constituents. In addition solar observations are performed regularly that offer the possibility to monitor solar variations.Together with the second European ozone monitoring experiment GOME2 (to be launched in 2005), GOME and SCIAMACHY complete a triple of similar instruments ensuring a continuous record of solar and atmospheric observations well into the second decade of the 21st century.The results presented will cover the following topics:(a) A continuous solar Mg II index from 1995 to 2004 based on GOME and SCIAMACHY solar measurements.(b) The comparison of the GOME/SCIAMACHY solar Mg II index with the results from the NOAA/SBUV2 instruments.

Poster Session 3P11:

Trace Gases

Abstract No. 35

First Results on Global Distribution and Seasonal Variation of CO2 Detected by SCIAMACHY

W. Hartmann[1], S. Houweling[2], H. Schrijver[1], I. Aben[1]
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The SCanning Imaging Absorption spectroMeter for Atmospheric CartograpHY (SCIAMACHY) on Envisat has been measuring Earth reflected and back-scattered light from the atmosphere in the ultraviolet, visible and near-infrared (240–1750 nm, 1940-2040 nm, 2265-2380 nm).Although SCIAMACHY's instrument design is not optimized for CO2 measurements, its wavelength range includes a number of CO2 absorption bands. We aim to explore the use of these bands to derive information on sources/sinks of CO2. Global coverage is achieved every 6 days. Thus CO2 measurements from space are a potentially interesting additional source of CO2 data complementary to the existing CO2 surface network.Our CO2 total columns are currently in the process of being comprehensively validated. Seasonal variation is already clearly observed in the CO2 data. Qualitative analysis of the CO2 data shows seasonal variations changing in tandem with large-scale trends predicted from atmospheric transport models (TM3)CO2 measurements from space are expected to be sensitive to Aerosol Optical Depth (AOD), which either decreases the photon path length through the atmosphere by blocking part of the atmosphere from view or increases it by reflections and scatterings between the Earth's surface and the aerosol layer. The retrieved CO2 column is changed accordingly. To study the above effects retrieved CO2 columns are compared with the AOD obtained from various sources like e.g. the Aerosol Robotic Network (AERONET) program.

Abstract No. 37

Identification of Tropospheric Emissions Sources from Satellite Observations: Synergistic Use of Trace Gas Measurements of CH2O, and NO2

T. Marbach, S. Beirle, J. Hollwedel, U. Platt, T. Wagner
University of Heidelberg, Germany

Satellite observations are a helpful tool for the identification of the sources for tropospheric emissions by providing global observations of the different trace gases.We present case studies for the combined observations of CH2O and NO2. The satellite CH2O observations provide information concerning the localization of biomass burning (intense source of CH2O). The principal

biomass burning areas can be observed in the amazonian forest and in central Africa. Other high CH2O emissions can be correlated with climatic events like El Nino in 1997, which induced dry conditions in Indonesia causing many forest fires. Tree isoprene emissions contribute also for high CH2O concentrations especially in southwest United States.Biomass burning are also an important tropospheric source for NO2 emissions and can be compared with the CH2O emissions to discriminate the influence of the vegetation type on the tropospheric emissions of both trace gases during biomass burning.

Abstract No. 38

First Results on the DOAS - Retrieval of OClO from SCIAMACHY Nadir Measurements

S. Kühl, W. Wilms-Grabe, C. Frankenberg, S. Kraus, U. Platt, T. Wagner
Institut für Umweltphysik, Germany

The Scanning Imaging Absorption Spectrometer for Atmospheric Chartography was launched successfully onboard Envisat on March 1, 2002. It observes the solar radiation transmitted, backscattered from the atmosphere and reflected from the ground in nadir, limb and occultation viewing modes. Chlorinedioxide (OClO), an important indicator for stratospheric chlorine activation, can be measured in the UV spectral range by Differential Optical Absorption Spectroscopy (DOAS).First results of the DOAS retrieval of OClO slant column densities (SCDs) from the SCIAMACHY measurements are presented and compared to measurements of the Global Ozone Monitoring Experiment (GOME) which has successfully measured OClO since 1995. SCIAMACHY flies in the same orbit, but measures approx. 30 minutes earlier than GOME. As OClO shows a strong diurnal variation, this leads to differences in the observed column densities, which may be useful to investigate the photochemistry of OClO and related compounds. Also, the spatial resolution of SCIAMACHY is higher (30*60 km2 compared to 40*320 km2 for GOME), which will allow a more detailed study of small scale effects like e.g. chlorine activation in mountain waves.

Abstract No. 50

Retrieval of SCIAMACHY Near-Infrared CH4 and CO Measurements

A. Gloudemans, H. Schrijver, A. Maurellis, Q. Kleipool, G. Lichtenberg, R. Van Hees, A. Straume, I. Aben
SRON, Netherlands

Measurements by the SCIAMACHY instrument on board the Envisat satellite allow to investigate the global distributions of important trace gases, such as CH4 and CO. These gases play an important role in long-term changes of the atmospheric composition and possible climate change.The near-infrared nadir spectra measured by SCIAMACHY between 2265 and 2380 nm enable the retrieval of CH4 and CO total columns. We present here two SRON-developed retrieval algorithms and the seasonal variations of their retrieved CH4 and CO columns.These retrieval algorithms use in-house information aboutthe calibration and characterization of the SRON-developed near-infrared detectors. Although the retrieval within this wavelength range is hampered by the growth of an ice layeron the detector, the SRON algorithms allow a correction for this.The retrieved CH4 and CO total columns from the SRON algorithms will be intercompared and details of the SRON retrieval methods will be discussed.

Abstract No. 56

CAPACITY: Operational Atmospheric Chemistry Monitoring

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The ESA project CAPACITY refers to future Operational Atmospheric ChemistryMonitoring Missions. Here operational is meant in the sense that a reliable serviceof specified information products can be established that satisfies user needs.Monitoring is meant in the sense that long-term continuity and consistency in thequality of the information products can be achieved. The objectives of the projectare:- To consult with user communities to develop high level informationrequirements and the form of the information products.- To identify and prioritise mission objectives.- To derive mission data requirements from the high level user informationrequirements and iterate these with the users.- To set these requirements against observation systems available orapproved for the future.- To identify missing information products or information products ofinsufficient quality.- To define a global observation system that would satisfy userrequirements.The time frame of this operational system is projected to cover the period 2010 to2020 concurrent with the operational satellites MetOp and NPOESS. In order toaddress these objectives a large European consortium has been formed consistingof approximately 30 partners from 9 ESA countries (F, D, UK, I, SW, N, DK, B,NL). The project is led by the Royal Netherlands Meteorological Institute(KNMI). Four application areas are identified:- Protocol Monitoring (Montreal and Kyoto) and Policy Support- Air Quality Monitoring and Policy Support (CLRTAP)- Long Term Science Issues and Climate Monitoring- Forecast CapacitySeveral user organisations have been consulted to establish user requirements anda dedicated workshop was held 20+21 January 2004 at ESTEC, Noordwijk, TheNetherlands. In the derivation of level 2/3 data and mission requirements from theuser requirements the consortium relies on a large group of modellers usingsatellite data, and of space research institutes with expertise in retrieval andcalibration/validation of satellite data as well as Industry with experience inbuilding space instrumentation. The project started 1 October 2003 for 18 months.At the time of the conference data requirements for future monitoring ofamtospheric composiiton will be available, together with the assessment ofcurrent and planned systems to these requirements and the missing elements.

Abstract No. 72

The Chlorine Deactivation Period During the Antarctic Vortex Major Warming in September/October 2002: ClONO2 Measurements by MIPAS/Envisat

M. Höpfner[1], T. Von Clarmann[1], H. Fischer[1], N. Glatthor[1], U. Grabowski[1], S. Kellmann[1], M. Kiefer[1], W. Kouker[1], A. Linden[1], G. Mengistu Tsidu[1], M. Milz[1], T. Reddmann[1], R. Ruhnke[1], T. Steck[1], G. Stiller[1], D. Wang[1], B. Funke[2]

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During end of September 2002 the Antarctic polar vortex was affected by an unusual major stratospheric warming.This period was covered by first continous measurementsof the mid-infrared limb emission sounder MIPAS (MichelsonInterferometer for Passive Atmospheric Sounding) on the Europeanpolar orbiting satellite Envisat.Here we report on the evolution of ClONO2 in the Antarctic polarvortex from September 18 until October 13, 2002 as measured by MIPAS. Due to persisting chlorine activation on 475K, ClONO2showed a pronounced collar structure with high mixing ratios atthe vortex edge and low values in the inner region on September18-20. During the following five days mean inner vortex ClONO2 increased by 0.7 ppbv. This indicates thatfrom September 20-25 the conversion into ClONO2 was themain pathway for chlorine deactivation on 475 K.Very likely due to conversion intoHCl, ClONO2 decreased after September 25.Chlorine deactivation had already taken placeon 625 K on September 18 and in the following ClONO2 mixingratios were decreasing. This evolution of ClONO2 is in agreement with the observation of polar stratospheric clouds by MIPAS:around the 475 K level last PSCs weredetected by MIPAS on September 18 and no PSCs on 625 K from September 8 until October 13.Still in mid-October elevated ClONO2 volume mixing ratios werefound in vortex remnants above 550 K even north of 30N.

Abstract No. 87

Envisat Data Analyse from Democratic Congo

K. Kingenge
Universität Salzburg, Austria

After analysis of the data which were provided by the service Americain d' Observation of the Ozon layer we can drawn one seen from what the evolution of Ozon in the towns of BRAZZAVILLE and KINSHASA gave us of 1996 until 2003. As we have to note in the lines which will follow. The tables of the figures which are énuméres above shows us the evolution and the change which takes place this last time within the area of BRAZZAVILLE AND KINSHASA. Referring in our table we can quote like notes important the various ones.

Abstract No. 136

Ozone and Water Vapour in the Tropical Upper Troposphere as Observed by the MIPAS Instrument

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Dynamical and in situ chemical processes influence water vapour and ozone in the tropical upper troposphere. This region of the atmosphere is poorly monitored and is dependent on aircraft and balloon campaigns such as the ongoing MOZAIC program that offers limited temporal and spatial resolution. Deep convection and stratospheric – tropospheric exchange (STE) are just some of the processes transpiring in the lower and mid atmosphere hence increased UT/LS surveillance will improve our understanding of these processes.The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) onboard the Envisat provides the opportunity to study infrared emission spectra of the Earth's limb using Fourier transform spectroscopy. The MIPAS allows global, consistent and continual retrievals of atmospheric constituents at a high resolution currently down to 12km. Operational MIPAS data shows significant cloud contamination particularly at the tropical latitudes. A cloud detection scheme, developed at the University of Leicester is used to 'clean' data for use in analysis. Calculations of cloud occurrence frequencies provide an effective measure of identifying cloud positions hence allowing recognition of 'cloud-free' data. The primary objectives of this project are to study seasonal, monthly and shorter timescale variation of tropical water vapour and ozone that can then be used in validation and verification of model and aircraft measurements of the tropical regions. Results will be shown for seasonal averages of particular regions including the Amazon, west coast of Africa and Indonesia. Understanding these trends will provide greater knowledge of the impact of biomass burning on atmospheric composition in the tropics.

Abstract No. 250

Intercomparison of SCIAMACHY and GOME Reflectances, Geolocation and RAL Ozone Profiles

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To evaluate the radiometric and geolocation accuracies of reflectances measured by SCIAMACHY, comparisons have been made with reflectances measured simultaneously by AATSR in its three visible channels (approx. 550, 670 and 870nm) and 1.6micron channel. This requires integration of SCIAMACHY spectra over the AATSR filter bands and integration of AATSR images over SCIAMACHY-nadir ground pixels. The comparatively small size of AATSR ground pixels allows the along-track and across-track geolocation of SCIAMACHY ground-pixels to be established quite accurately. The same methodology has previously been applied to GOME and ATSR-2 data. Results of a four-way intercomparison between GOME, SCIAMACHY (nadir), ATSR-2 and AATSR will be presented.Rutherford Appleton Laboratory (RAL) has developed a scheme to retrieve ozone profiles spanning the troposphere and stratosphere from GOME (ERS-2), which has been extensively validated. The scheme has now been extended to work with SCIAMACHY (nadir) level 1 data, and retrievals have been carried out for a sub-set of test orbits. Ozone profiles derived by this scheme, from both GOME and SCIAMACHY-nadir data have been intercompared and initial results will be shown.

Abstract No. 268

Modelling the Earth's Radiation Budget within the EVERGREEN Project

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The EVERGREEN project aims to improve our knowledge on emissions, sources and sinks of atmospheric greenhouse gases by satellite observations of CO2, CH4, N2O, CO, O3, NO2 and H2O from SCIAMACHY and MIPAS on Envisat. The measured global distribution of these Kyoto Protocol gases will serve as input for radiative transfer calculations with the aim of improving our knowledge of the Earth's radiation budget. The primary objective of modelling studies currently been undertaken is the investigation of the effects of changing atmospheric composition on the Earth's radiation budget. In particular, the important role that Kyoto Protocol gases play in establishing the balance between the incoming short-wave radiation and outgoing long-wave

radiation will be studied. The modelled radiative fluxes will be compared to satellite-borne broadband radiation measurements from the Global Earth Radiation Budget (GERB) instrument onboard MSG-2. GERB allows the diurnal variations in the incoming and outgoing radiation to be measured for the first time due to its geostationary orbit.We will present first sensitivity studies on global radiation budget modelling within the EVERGREEN project. This includes scenario modelling to investigate the sensitivity of the radiation budget modelling to changes in the atmospheric concentration of individual primary and secondary Kyoto Protocol gases, and the comparison of modelled short-wave and long-wave fluxes with surface radiation measurements. Furthermore, we will present an outline of the GERB radiation measurements and the forthcoming intercomparison of GERB measurements with modelled top of the atmosphere radiative fluxes.

Abstract No. 275

A Database of Spectral Surface Reflectance from 335-772 nm Derived from 5.5 Years of GOME Observations

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A global database of Lambert-equivalent reflectance (LER) of the Earth's surface has been constructed, by analyzing observations of the reflectance at the top of the atmosphere made by the Global Ozone Monitoring Experiment (GOME). Since its launch on-board the ERS-2 satellite in April 1995, the GOME instrument has been measuring spectra of the Earth between 237-794 nm, with a spectral resolution between 0.2-0.4 nm and a spatial resolution between 40x80 km2 - 40x320 km2. The LER database covers eleven 1-nm wide wavelength bins centered at 335, 380, 416, 440, 463, 494.5, 555, 610, 670, 758, and 772 nm, which were selected for various retrieval applications. The original database has a spatial resolution of 1 deg x 1 deg, is made for each month of the year, and pertains to the period June 1995 - December 2000.Typical spectra of various surface types are presented. Attention is paid to instrument degradation and residual cloud contamination. We have found satisfactory agreement between our database at 380 nm and the TOMS LER database at 340-380 nm.Recently, the spatial resolution of the database has been improved around coastlines to 0.25 deg x 0.25 deg, in order to account for the improved spatial resolution of new sensors.The database presented here can be used to support retrievals oftrace gases, clouds and aerosols from GOME, SCIAMACHY, OMI, and GOME-2.The database can be downloaded from the internet.

Abstract No. 324

Stratospheric N2O5 in the Austral Spring 2002 as Retrieved from Limb Emission Spectra Recorded by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS)

G. Mengistu Tsidu[1], T. Von Clarmann[1], G. Stiller[1], M. Hoepfner[1], H. Fischer[1], B. Funke[3], N. Glatthor[1], U. Grabowski[1], S. Kellmann[1], M. Kiefer[1], A. Linden[1], M. Milz[1], T. Steck[1], D. Wang[1]

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N2O5 was retrieved from infrared limb emission spectral radiances of the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on board the European environmental satellite (Envisat). The measurements were taken during the period covering the Antarctic polar vortex split between 20 September and 13 October, 2002. The retrieval of N2O5 is aggravated by its continuum-like emission feature covering a wide spectral region, which is hardly distinguishable from background continuum emission. The method of constraining the background continuum in the N2O5 analysis spectral region to its value in a N2O5 free spectral region was found to be appropriate to solve this problem. Retrieved volume mixing ratios (VMR) of N2O5 exhibit features consistent with the dynamics prevalent at the time in the Antarctic and known N2O5 chemistry governing diurnal variability. The observations of poor N2O5 inside vortex airmass and rich N2O5 ex-vortex airmass are strongly in support of the chemistry that governs its partitioning within the NOy family. The enhanced nighttime high geographic latitude N2O5 VMR with a peak in the altitude range of 32-37 km during last week of September 2002 is consistent with airmass transport from lower to high latitudes and temperature sensitive N2O5 formation chemistry. N2O5 enhancement upto 6 ppbv was also observed by Cryogenic Limb Array Etalon Spectrometer(CLAES) and Improved Stratospheric and Mesospheric Sounder (ISAMS) on Upper Atmospheric Research Satellite (UARS) during northern hemisphere January 1992 stratospheric warming which was a factor of 3 larger than measurements prior to the 1992 period. In contrast, a maximum of 4.1 ppbv N2O5 VMR observed by MIPAS at 32-37 km is only a factor of 2 larger than its prewarming values.

Abstract No. 377

Polar and Mid-Latitude Tropospheric BrO Climatology Derived from GOME and SCIAMACHY as Part of the TEMIS Project

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Bromine monoxide plays an important role in the chemistry of the polar atmosphere because of its high efficiency as a catalyst of the ozone destruction in both the stratosphere and the troposphere. In the polar boundary layer, large cyclic emissions are observed every year at spring (the so-called "bromine explosion" phenomenon), which are responsible for the occurrence of fast and efficient tropospheric ozone destruction events. Total columns of BrO have been monitored by the GOME instrument onboard the ESA ERS-2 satellite since 1996. Since July 2002, similar observations can be obtained with SCIAMACHY on the Envisat platform. In the present contribution, analyses for total and tropospheric BrO columns derived from both instruments are described, with a focus on the assessment of their mutual consistency. Results of a new algorithm applied to both instruments to extract quantitative estimates of the tropospheric BrO contents over polar and mid-latitude regions are presented. This algorithm, developed as part of the TEMIS project, uses a residual technique combining GOME and SCIAMACHY measurements with SLIMCAT 3D chemical transport calculations, and cloud information derived using FRESCO (Koelemeier and Stammes, 2001). Key aspect of the tropospheric BrO retrieval and efforts done to validate it using available ground-based measurements are discussed. Results from its application to 8 years of GOME measurements and one year of SCIAMACHY data are illustrated. The BIRA-IASB GOME and SCIAMACHY BrO products are available on the ESA TEMIS web-site (http://wwww.temis.nl).Koelemeijer, R. B. A., P. Stammes, J. W. Hovenier, and J. F. de Haan, "A fast method for retrieval of cloud parameters using oxygen A band measurements from the Global Ozone Monitoring Experiment," J. Geophys. Res. 106, 3475-3490, 2001

Abstract No. 441

Measurement and Validation of Hydrochlorofluorocarbon-22 from the MIPAS Instrument

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Hydrochlorofluorocarbon-22 (HCFC-22) is an important trace constituent in the atmosphere through its role as a greenhouse gas and its potential influence on stratospheric ozone chemistry. Previous estimates of its vertical distribution have been limited largely to infrequent and sparse balloon and aircraft campaigns, giving poor spatial coverage. By using a limb sounding, spectrally resolving, instrument such as the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) onboard Envisat, it is possible to measure the infrared emission from trace gases and hence obtain atmospheric concentrations by inversion of the measured spectra. This study focuses on the quality of HCFC-22 retrievals from such spectra.Extensive validation with comparable datasets is required to characterise the quality of measured atmospheric quantities from the MIPAS. A preliminary validation study of our HCFC-22 retrievals will be presented with respect to global mean behaviour. In particular, comparisons will be made with recent in-situ balloon measurements and historical data sources such as the Atmospheric Trace Molecule Spectroscopy instrument (ATMOS) measurements.Global behaviour of HCFC-22 can also be examined by correlation with other trace species. Both CH4 and N2O, like HCFC-22, are relatively long lived gases and neither has a significant stratospheric source. Where timescales of atmospheric mixing are much shorter than these photochemical lifetimes, distributions of the three gases should be homogeneous and there should be a compact relationship between them. Preliminary correlations between our retrieved HCFC-22 and MIPAS operational measurements of CH4 and N2O, over a range of altitudes, will be presented.

Abstract No. 479

Infrared Remote Sensing of Organic Compounds in the Upper Troposphere

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Organic compounds are of central importance for studies of tropospheric chemistry. They are a key component in control of tropospheric ozone, act as tracers of dynamics, and provide indicators of large scale pollution influences, e.g. biomass burning. However, current measurement systems are mostly restricted to specific, in situ, field campaigns, and only recently have the first global datasets become available for this type of compounds. The measurement of formaldehyde columns by the Global Ozone Monitoring Experiment (GOME) has been an important step forward. In recent years, it has been realised that there is the potential for measurement of key organic species in the upper troposphere using infrared remote sensing instruments, such as the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on Envisat and the Tropospheric Emission Spectrometer (TES) on EOS-AURA. Here we will discuss the detectability of a number of organic species in the upper troposphere, in particular ethane, acetone, formic acid and PAN, with reference to a high resolution limb sounding infrared spectrometer such as the MIPAS instrument.

Abstract No. 482

Mapping of Tropospheric NO2 from Limb-nadir Matching

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The stratospheric vertical column of NO2 from integration of the vertical profile from limb scattering is subtracted from the total vertical column obtained from nadir geometry. This residual technique is applied on a global scale. Transport of NO2 from urban to rural areas is shown as well as the contribution of forest fires and the importance of high spatial resolution. The focus of this work will be on determining sources in North America and Europe.

Abstract No. 513

Observation of ClO by MIPAS/Envisat Before and During the Antarctic Major Warming in September 2002

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The first ClO profiles retrieved from limb emission spectra recorded by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) Fourier transform spectrometer on board the European research satellite Envisat (ENVironmental SATellite) are presented. These measurements were taken between September 8 and October 13, 2002. They cover the Antarctic major warming around September 25, an event which had never been observed before. During the period of investigation, MIPAS measured typical ClO volume mixing ratios (vmrs) between 1 and 2 ppbv from September 8 until September 23 in contiguous parts of the dayside lower Antarctic stratosphere (400 K - 625 K), i.e. before and at the beginning of the major warming. After September 23 no significant amounts of ClO were detected any more. Daily averages of inside-vortex daytime ClO showed a slight increase until about September 17 and a subsequent rapid decrease. Further, a positive response of inside-vortex nighttime ClO to increasingtemperatures, due to enhanced Cl2O2 dissociation, was detected. Comparison with other measurements from previous years showed a similar temporal development. Thus, the warming event obviously happened too late to lead to a premature chlorine deactivation significantly different from "normal" Antarctic winters.

Abstract No. 526

Monitoring Tropospheric NO2 with SCIAMACHY

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The results of trace gas retrieval from the Global Ozone Monitoring Experiment (GOME) demonstrate the potential of satellite observations for identifying, localizing and monitoring emissions. Mean maps of the global distribution of NO2 reveal a clear fingerprint of anthropogenic sources (fossil fuel combustion). Also NOx stemming from biomass burning and lightning can be identified and estimated. A further advantage of satellite data is the temporal coverage, allowing to

track pollution plumes. Several intercontinental transport events have been reported. However, GOME data suffers from the rather coarse spatial resolution of 320 km east-west, leading to a smearing out of the retrieved maps of tropospheric vertical column densities. Furthermore, due to its extent the majority of the GOME pixels is (at least partly) clouded, leading to a shielding of tropospheric constituents.SCIAMACHY on Envisat provides an improved spatial resolution of 30*60 km^2. Here we present some pilot studies, comparing the retrieved absolute column densities of SCIAMACHY to GOME results as well as to validation measurements. We analyse the benefit of the improved spatial resolution of SCIAMACHY, i.e. a more precise knowledge of the global distribution of NO2, allowing to localize and assign enhanced NO2 levels directly to a certain source, i.e. a city, and separate different source types.

Abstract No. 557

CO in the Middle Atmosphere Measured with MIPAS/Envisat

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Due to its long chemical lifetime and variable volume mixing ratio in the middle atmosphere, carbon monoxide serves as an excellent tracer for stratospheric and mesospheric dynamics. Spectrally resolved non-LTE emssions of CO are measured by the Michelson Interferometer for Passive Atmosphere Sounding (MIPAS) on board of the polar orbiter Envisat since March 2002 with full global coverage. Vertical profiles of CO have been retrieved from a large set of MIPAS observations with the scientific non-LTE data processor developed at IMK and IAA. The usefulness of this data for the investigation of the dynamical coupling of stratosphere and mesosphere is demonstrated for the South polar vortex split in September/October 2002. Furthermore, the status of validation activities will be summarised.

Abstract No. 611

Water Vapour Isotope Measurements: Comparisons between Results from MIPAS and the Odin SMR

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The isotopic composition of stratospheric water vapour depends on the sources of water vapour and on the temperature and precipitation history of the stratospheric air. Isotopic measurements therefore have potential to aid invesigation of dehydration in the polar vortex, of stratospheric/tropospheric exchange, of upward transport in the tropics and of subsidence at polar latitudes.Here we compare water vapour isotope measurements from two satellite limb-sounding instruments: the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), an infra-red limb sounder on Envisat, and the Sub-Millimetre Radiometer (SMR) on board the Odin satellite.

Wednesday 8 September
10:50 – 12:30
DOPPLER

Session 3B4:

Ocean Circulation and Marine Geoid

Abstract No. 615

Long-term Sea Level Change from Multi-satellite Altimetry in the European Seas

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Satellite altimeter measurements of the ERS and Envisat missions are used to estimate the long-term sea change in the European Seas over the last decade. The agreement between the results obtained from the multi-mission data and those obtained from the uninterruped single-satellite mission Topex/Poseidon is investigated. The stability of the instrument and the accuracy of the corrections appear to be very important for long-term sea level change determination. The use of the Bent iono-correction introduces in the ERS-2 sea level heights a negative drift that can be interpreted as negative sea level change, that almost disappears when the GIM or IRI ionospheric corrections are applied. The accuracy in the merging of data from two missions is limited by the uncertainty in the relative-bias between the missions, that is estimated by the dual-crossover and colinear methods. The sea level heights obtained by different instruments are compared over the European seas and near to the coast, where tide gauge stations are used as reference. The comparison between near-simultaneous altimetry and tide gauge data show promising results in assessing data quality and in cross-calibrating the altimeter satellites as the results obtained are in good agreement with the results obtained by the DXO method. In the interval 1995-2002 the relative trend between the ERS -2 and Topex is of -2 mm/yr, with a strong seasonal component, while an higher relative trend is observed in the first part of the ERS-1 mission. The spatial pattern of variability detected by ERS-2 and Topex/Poseidon are in general consistent. In the Eastern North Atlantic and in the European Seas region the linear term of sea level change is mostly positive with exception of the Ionian Sea in the Mediterranean Sea with -15 mm/yr. The positive values are generally lower than 6 mm/yr, higher values are observed in the eastern Mediterranean (10 mm/yr) and in the Black Sea (14 mm/yr) and in the southern part of the Baltic Sea (10 mm/yr).

Abstract No. 277

Deriving 2Hz ERS-1 Geodetic Mission Altimetry for Gravity and Marine Geoid Purposes

O. Andersen[1], P. Berry[2], S. Dreher[3], P. Knudsen[1], R. Trimmer[4]

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[2] *De Montfort University, United Kingdom*

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All present global marine gravity fields are based on the 1Hz (6km resolution) ERS-1 Geodetic Mission (GM) altimeter data along with other altimetric data. Close to the coast (< 25 km) investigations by i.e. Trimmer (2004) have demonstrated that the altimetric gravity fields degrades because the height estimations degrades due to a combination of several factors. By starting out from the original waveform data and retracking the entire GM mission using a highly advanced expert based system of multiple retrackers the return time from both the open sea surface and from all ice-covered regions within the coverage of the ERS-1 can be derived with higher accuracy that presently available. This presentation describes the combined effort in improving the ERS-1 GM dataset through retracking and regression to 2 Hz and its effect on gravity field modeling close to the coast.The use of 2Hz data will enable a better determination of gravity field related signal both in the deep ocean but particularly in shallow water/coastal regions. In the coastal regions the expert re-tracking system will result in consider more data and at a higher resolution than present in the standard dataset. Extensive comparisons carried out at the National Geospatial-Intelligence Agency is also presented to document the improvements.

Abstract No. 285

Multi-mission Mean Sea Surface and Geoid Models for Ocean Monitoring within the GOCINA Project

P. Knudsen, O. Andersen, A. Vest

National Survey, Denmark

A major goal of the EU project GOCINA (Geoid and Ocean Circulation In the North Atlantic) is to develop tools for ocean monitoring using satellite altimetry combined with satellite gravimetry. Furthermore, the project will determine an accurate geoid in the region between Greenland and the UK and, hereby, create a platform for validation of future GOCE Level 2 data and higher order scientific products. The central quantity bridging the geoid and the ocean circulation is the mean dynamic topography, which is the difference between the mean sea surface and the geoid. The mean dynamic topography provides the absolute reference surface for the ocean circulation. The improved determination of the mean circulation will advance the understanding of the role of the ocean mass and heat transport in climate change. To calculate the best possible synthetic mean dynamic topographies a new mean sea surface (KMS03) has been derived from nine years of altimetric data (1993-2001). The regional geoid has furthermore being updated using GRACE and gravimetric data from a recent airborne survey. New synthetic mean dynamic topography models have been computed from the best available geoid models (EGM96, GRACE, GOCINA) and the present mean sea surface models (i.e. CLS01, GSFC00, KMS03). These models will be compared with state of the art hydrodynamic mean dynamic topography models in the North Atlantic GOCINA area. An extended comparison in the Artic Ocean will also be presented to demonstrate the impact of improved geoid and mean sea surface modeling. Particularly using the GRACE derived geoid models, and the KMS03 mean sea surface.

Abstract No. 6

Geodynamics and Reconstruction of the Earth's Interior Structure by the Geoid Data in Different Region of the World Ocean

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Work with the ERS altimetric data stimulated a solving of an important geotectonic problem through the geoid characteristics: reconstruction of the Earth's interior. The geoid topography is caused by the gravitational nature of the inhomogeneous geological structure of the Earth. Elevations and depressions on the ocean surface by altimeter measurements correlate with location of disturbing earth masses. We developed a technique to image the interior of the Earthand named it as a "gravimetric tomography". Owing to this the altimetric and geoid data provide now not only geodetic but geological information also. The method includes a decision of the main two tasks: determination of depths of disturbing layers of the Earth according to harmonic degrees of the geoid topography expansion and determination of density of anomalous disturbing masses. Assessments of the depths are computed with the harmonic function 1/r known in the geoid theory. Density anomalies are computed by the H. Moritz's algorithm under some conditions. The reconstruction of the Earth's geological structure show a detailed distribution of masses in lithosphere, geometry and sizes of density inhomogeneities, their displacement in depth under impact of dynamic processes, and correlation of subsurface bodies with the visible topography also. Values of disturbing gravity potential in terms of the geoid heights, values of harmonic density anomalies in units of g/cm3 and values of upper cover depths of disturbing layers of the Earth are computed. Spherical coefficients of the EGM96 geoid model were used. Many maps and vertical cross-sections of distribution of density inhomogeneities for different depths were built for different region. Region of the Scotia's Sea lithosphere was studied using the gravimetric tomography method. The distribution of density inhomogeneities for whole range of Earth's depths is displayed along the characteristic latitudinal and longitudinal cross-sections, and on lateral levels of region with the spatial resolution of 30 km also. Latitudinal vertical cross-sections through the island arc are shown a situation of root parts of the island arc and the trench on depth. The roots of the island ridge are inclined to the Scotia sea side and dived up to depths of 25-30 km on extention of 500 km. Such significant displacement of root areas on depth show intensive contrary geodynamic processes of different plate blocks. Density structure and geodynamic processes on depths more than 100 km are distinguished considerably from upper layers. The anomalous dense body like a lens is revealed in depth of 780 km. Its kernel is 200 km on thickness (depth of 680-880 km) and 1100 km on extension. Deep density structure and geodynamic features of the Tethys region along geological/geophysical transects (TRANSMED Project) as vertical cross-sections from the geoid surface up to the Earth's core depths and as a spatial location on maps in different depths are considered also. The transect (Ukraine - Black Sea - Cyprus-Sahara) with an extension of 2337 km is a significant interest. The lower mantle in depths 2800-800 km is characterized here by two density blocks: the negative one is in the north part and the positive is in the south. The vertical boundary between them are projected to the southern edge of Anatolia. The layer of 800-300 km is a transitive zone from lower to the upper mantle. Three large anomalies are allocated in the basis in depth 300 km. A differentiation of geological masses is increased in smaller depths. Significant geodynamical displacements (up to 400 km) concerning root parts of the bodies are identified in depths less than 10 km. Total density range for different anomalous bodies along the transect is changed from -0.0003 g/cm3 (lower mantle) up to 0.2 g/cm3 (mountain ridge). Contemporary problem for the Coastal States - determination of limit lines of the

continental margin under the UN Convention on the Law of the Sea (UNCLOS) – are considered using the altimeter and geoid data. UNCLOS recommends determining the boundary of the continental mass as a foot of the continental slope, which can be made "visible" by echo-sounding and seismic surveys. It is obvious that the real continental margin extends under the upper layers of the ocean floor further seaward than the visible continental slope. The gravimetric tomography method enables to "glance" through depths like seismic methods. Deep layers on the vertical sections crossing the Argentine shelf show that roots of The Andes extend to 60-70 km. The lower boundary of the continental crust in depth of about 30 km and the oceanic crust at about 15 km are coordinated with seismic surveying. Geoid data can be an important addition to study the continental margin of the coastal states. It allows to reduce laborious and expensive marine geophysical surveyes.Comparison of the global seismic tomography data and gravimetric tomography data was carried out along cross-sections through the Kurils subduction zone. These methods are based on various physical principles of measuring, the various physical properties of geological bodies and they have various resolutions at depth and lateral extension. Nevertheless singular coincidences are observed. In particular, sinking of the oceanic crust in the subduction zone is visible. Continuation of a dense body with an epicentre in depth 250 km is flattened in depth about 700 km. In both results an existence of more dense mass in depth 1300 km is confirmed. The geodynamic processes from the west (EuroAsia plate) and east (Pacific Ocean plate) change the geometry of this body essentially along depth.

Abstract No. 427

Bathymetry from Space: Geophysics, Oceanography, and Climatology

D. Sandwell[1], **W. Smith**[2], **R. Raney**[3]

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[3] *Johns Hopkins University, Applied Physics Laborato, United States*

Satellite altimeter measurements of the marine gravity field have been used with ship soundings to construct global bathymetric maps at 30-km wavelength resolution. While these maps have revolutionized several areas of geophysics, oceanography, and climatology, many applications now require higher resolution and global coverage. These include: resolving the fine-scale (~15 km wavelength) tectonic structure of the deep ocean floor in areas that have not been surveyed by ships (e.g., abyssal hills, microplates, propagating rifts, seamounts, meteorite impacts…) measuring the roughness spectra (15-50 km wavelength) of the seafloor on a global basis to better constrain models of tidal dissipation, vertical mixing, and mesoscale circulation of the oceans and; resolving the fine-scale (~15 km wavelength) gravity field of the continental margins for basic research and petroleum exploration. Here we discuss two approaches for improving the accuracy and resolution of marine gravity and bathymetry maps. The near-term approach is retracking the waveforms of ERS-1 and Geosat Geodetic Mission data using a newly-developed algorithm that is optimized for recovery of along-track sea surface slope by assuming the significant wave height varies smoothly along track. The long-term approach is to launch a new dedicated satellite altimeter mission using delay-Doppler technology to provide the smaller along-track resolution and improved height precision required for better bathymetry.

Poster Session 3P06:

Ocean Circulation and Marine Geoid

Abstract No. 282

The KMS03 Multi-mission Altimetric Mean Sea Surface

O. Andersen, P. Knudsen, A. Vest
National Survey, Denmark

In a comparison between hydrodynamic derived mean dynamic topography (MDT) and synthetic derived MDT (derived from the difference between the MSS and the geoid), the resuls depends on the quality of the MSS and geoid, but also on the inter-annual ocean variability. In principle the MSS used to derive the synthetic MDT should be averaged over the same period in time as used to average the hydrodynamic derived MDT to avoid leakage of inter-annual ocean variability on the result. Different global mean sea surfaces (CSR98, GSFC00, CLS-SHOM98, CLS01, KMS01) are based on limited T/P time-epoch used in their derivation. Consequently, inter-annual ocean variability (like the major El-Nino event in 1997-1998) will be visible to a larger or smaller extend in these different MSS (the MSS are actually quasi-stationary MSS). In our new mean sea surface (KMS03) we have included a method to account for the inter-annual ocean variability. By investigating the inter-annual ocean variability from T/P the MSS can be made to include the inter-annual variability over a specific period in time From the 9.9 years of T/P altimetry the inter-annual ocean variability for each year have been modeled using the annual mean sea level height once the "intra"-annual ocean variability have been removed. The "intra"-annual variability was initially removed by removing the mean monthly value of all months from the 9.9 year period. Evaluation of the available mean sea surfaces will be carried out in the GOCINA study region (www.gocina.dk) in the Northern Atlantic region. An extended comparison will also be presented in the Arctic Ocean to demonstrate the impact of improved geoid and mean sea surface modeling to derived reliable synthetic MDT. Particularly using the GRACE derived geoid models (GGM01), and the KMS03 mean sea surface.

Abstract No. 284

High Resolution Altimetric Gravity Field Mapping (KMS2002).

O. Andersen, P. Knudsen
National Survey, Denmark

A series of KMS high resolution near global gravity fields from altimetry has been released during the past 7 years. This presentation focuses on describing the improvements leading to the release of the new KMS2002 field.Significant improvements have been achieved through careful fine-tuning of the procedure and parameters used for the derivation of gravity from satellite altimetry. Particularly emphasis has been made in improving the gravity field determination at medium wavelengths ranging between 100-500 km, and at shorter wavelength in coastal regions. Emphasis was made in recovering the gravity field in lakes, which have normally been deleted from global marine gravity field maps. Extensive comparisons carried out at the National Geospatial-Intelligence Agency is also presented to document the improvements.

Wednesday 8 September
10:50 – 12:30

MOZART 3

Session 3B5:

Scatterometer Assimilation

Abstract No. 408

Re-introduction of ERS-2 Scatterometer Data in the Operational ECMWF Assimilation System

P. Janssen, L. Isaksen
ECMWF, United Kingdom

On 9 March 2004, ECMWF re-introduced the usage of surface-wind observationsfrom the ERS-2 scatterometer in their operational assimilation system.This wind product had been publicly re-distributed by ESA since21 August 2003, after a long suspension period from January 2001.In the meantime, research at ECMWF and KNMI had led to an improved formulationof the relation between the scatterometer observed radar backscatter andthe geophysical quantity of interest: the ocean-surface vector wind.Besides improving overall product quality, this geophysical model function, called CMOD5has shown to largely correctthe wind speed biases present in the model function CMOD4, currently used at ESA.ECMWF has a long experience with the usage of scatterometer data.Scatterometer data from ERS-2 and its predecessor ERS-1 have been successfullyassimilated from January 1996 up to the failure in January 2001.The four-dimensional variational assimilation system at ECMWF allowsfor a dynamically consistent use of observations.In this way, information of the scatterometer surface windsis propagated to the entire troposphere, and both ambiguous wind solutions canbe exploited without the need of prior de-aliasing.Scatterometer data has proven to have a positive impact on theECMWF forecast skill in general, and the analysis of tropical cyclones in specific.Off-line experiments including the assimilation of CMOD5 based winds from the newlydistributed data confirmed that a positive impact was observed,despite the loss of global coverage.Some examples, such as the correction of the position for hurricane Kate on 5 October 2003,will be shown.

Abstract No. 337

Towards an Objective Performance Measure of Spaceborne Wind Sensors: ERS Test Case

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Spaceborne wind observations have proven important for a wide variety of applications, including nowcasting, short-range forecasting and mesoscale numerical weather prediction (NWP) data assimilation. However, because of the different spatial and temporal sampling characteristics as well as the different error statistics of the various spaceborne systems, the comparison among the different wind sources is not trivial. In addition, the error analysis for wind data derived from

spaceborne sensors requires special care due to non-linearities and ambiguities in the geophysical model functions (GMF) leading to multiple solutions in the wind retrieval.Within the framework of an ESA project, we try to assess the information content of spaceborne wind observations to set an objective performance measure that will allow us to not only compare different wind sensors but also seek for a future and improved sensor.In this study, the dependence of the geophysical noise on instrument resolution, wind speed, and GMF is evaluated first for ERS scatterometer in the form of a sensitivity analysis. The latter shows substantial dependencies of the geophysical noise, notably in the wind speed and measurement geometry domains. Based on these results, an in-depth analysis of the impact of the retrieval technique is ongoing. It is known that different retrieval schemes using normalization by measurement noise (Kp), solution Kp, or no normalisation at all lead to different error distributions with respect to measurement geometry and wind speed. Inclusion of the geophysical noise term in wind retrieval has not been performed yet. Results on the impact of inclusion of the pre-determined geophysical noise in the Kp term in wind retrieval will be presented at the conference.

Abstract No. 411

Timely ERS-2 Scatterometer Winds for Weather Nowcasting

A. Stoffelen
KNMI, Netherlands

The current ERS-2 scatterometer ground processing provides excellent winds, albeit with an occasional and local drop-out due to attitude. Moreover, the failure of the on-board tape recorded provided an incentive at ESA to drastically increase the number of satellite acquisitions and ground stations. This results in an unprecedented data timeliness of about 30 minutes and good coverage over the North Atlantic and European seas. The acquisitions are combined at KNMI to increase the number of backscatter triplet measurements and to exclude duplicated data. The thus streamlined data flow is subsequently put in the KNMI wind processor to obtain a spatially coherent scatterometer wind product (See http://www.knmi.nl/scatterometer/ers-prod/)The 30 minutes timeliness makes the current ERS-2 wind product suitable for operational weather nowcasting and short-range weather forecasting. This offers advantages in analysing and forecasting extreme weather events. Examples of this benefit will be shown at the meeting.

Abstract No. 701

Analysis of the Remotely Sensed Winds: Sensitivity of ORCA Model to the Scatterometer Wind Forcing

A. Bentamy, L. Ayiana
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Numerical Weather Prediction and analysis outputs are usually used to investigate oceanic and climatic processes and to run ocean models in a forced mode. This oceanic forcing function might be validated and improved, particularly for wind stress and turbulent heat fluxes, directly by the use of scatterometer high-resolution surface wind data. Indeed, enhanced global turbulent flux fields are constructed from ERS and Seawinds on board QuikScat with a spatial resolution of 0.5° in longitude and latitude, and a temporal resolution of 12 –hour, daily, weekly, and monthly. The quality of the remotely sensed fluxes is investigated through comparisons with data from buoys moored at several areas. For instance, over the Mediterranean sea, the correlation coefficients exceed 0.85, the biases are less than 0.5 m/s and the root-mean-square (rms) are less than 1.7 m/s. For wind direction the difference standard deviation is less than 20°. For latent heat flux estimates, the bias in quit small and not significant, while the rms difference, and the correlation coefficient are about $22W/m^2$ and 0.79, respectively. The buoy data are then used to assess the quality of flux properties (spatial and temporal patterns) estimated from satellite as well as from NWP analyses (ECMWF) and re-analysis (ERA40) for the time period 1996 – 2003. For instance, the wind large-scale characteristics from satellite and models compare well. However, significant discrepancies are found in the tropical areas, and especially between satellite and ECMWF analysis. At higher latitudes, differences in the spatial structure is found in the wind stress magnitude as well as in the Northern-Hemisphere sub-polar gyres. The driven-wind response of the ocean is investigated through a simulation with the oceanic general circulation model (ORCA). The annual mean ORCA responses to the satellite winds and to surface winds from the ECMWF analyses and re-analysis are compared in terms of mean and variability of sea surface temperature (SST), salinity, surface heat flux, barotropic stream function, and current. The global and local difference results will be presented and documented.

Abstract No. 206

Investigation of the Wind Forcing of Ocean Circulation Using the Decade-long Scatterometer Measurements from ERS-1 and -2

L. Fu
Jet Propulsion Laboratory, United States

For the first time we have decade-long satellite observations of the global sea surface height and wind velocity for studying the variability of ocean circulation. The precise measurements of sea surface height made by the TOPEX/Poseidon altimeter have led to the discovery of a new class of ocean variability that has spatial scales of 1000 km and temporal scales of a few days to months. Using wind observations from the ERS scatterometers, we have demonstrated that this large-scale ocean variability is primarily forced by the curl of wind stress. A simple model of the balance of ocean vorticity is used to demonstrate the dynamics governing the oceanic motion. The entire water column of the ocean varies in unison in response to the wind forcing, resulting in the so-called barotropic mode of oceanic motion. On longer time scales, the ERS wind observations are also analyzed to study the forcing of interannual-to-decadal variability of sea surface height measured by altimetry. The relation between low-frequency wind variability and sea surface temperature variability is also analyzed. The results will be presented in terms of low-frequency change of the ocean and the interaction with surface wind field with a focus on the decadal variability of the Atlantic Ocean.

Wednesday 8 September
14:00 – 15:40

MOZART 4-5

Session 3C1:

Volcanoes and Earthquakes

Abstract No. 637

Persistent Scatterers on Volcanoes

A. Hooper[1], A. Hooper[1], P. Segall[1], H. Zebker[1], B. Kampes[2], N. Adam[2]
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The use of persistent scatterers (PS) to estimate steady (i.e. linear with time) deformation has been shown to be very effective when applied to urban areas. The use of PS for the estimation of deformation on volcanoes is generally more challenging because a) most volcanoes are not urbanised and therefore lack man-made structures, which usually make the best PS and b) deformation tends to be non-steady.We have analysed data from Long Valley Volcanic Caldera in California, and determined that there are low amplitude pixels with reasonable phase stability, although amplitude dispersion thresholding as described in Ferretti et al. [2001] does not generally do well at picking them. We have therefore developed a new method for identifying low amplitude PS candidates.We have also developed a method to process PS and estimate deformation that is spatially correlated, with no prior assumptions about the temporal nature of this deformation.

Abstract No. 271

Interferometric Synthetic Aperture Radar (InSAR) Study of Okmok Volcano, Alaska, 1992-2003: Magma Supply Dynamics and Post-emplacement Lava Flow Deformation

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[2] *USGS, Cascades Volcano Observatory, United States*

Okmok volcano, located in the central Aleutian arc, Alaska, is a dominantly basaltic complex topped with a 10-km-wide caldera that formed circa 2.05 ka. Okmok erupted several times during the 20th century, most recently in 1997; eruptions in 1945, 1958, and 1997 produced lava flows within the caldera. We used 80 interferometric synthetic aperture radar (InSAR) images (interferograms) to study transient deformation of the volcano before, during, and after the 1997 eruption. Point-source models suggest that a magma reservoir at a depth of 3.2 km below sea level, which is located beneath the center of the caldera and about 5 km northeast of the 1997 vent, is responsible for observed volcano-wide deformation. The pre-eruption uplift rate decreased from about 10 cm/year during 1992-1993 to 2-3 cm/year during 1993-1995 and then to about –2 cm/yr during 1995-1996. The post-eruption inflation rate generally decreased with time during 1997-2001, but it increased significantly during 2001-2003. By the summer of 2003, 30-60% of the magma volume lost from the reservoir and erupted in 1997 had been replenished. Interferograms for periods before the 1997

eruption indicate consistent subsidence of the surface of the 1958 lava flows, most likely due to thermal contraction. Interferograms for periods after the eruption suggest at least four distinct deformation processes: (1) volcano-wide inflation due to replenishment of the shallow magma reservoir, (2) subsidence of the 1997 lava flows, most likely due to thermal contraction, (3) deformation of the 1958 lava flows due to loading by the 1997 flows, and (4) continuing compaction of 1958 lava flows buried beneath 1997 flows. Our results provide insights into the post-emplacement behavior of lava flows and have cautionary implications for the interpretation of inflation patterns at active volcanoes.

Abstract No. 486

Measurements of Deformation Due to Seismic and Volcanic Sources Using ERS and Envisat Data: Examples from North and South America and Asia

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[2] *UCSD, United States*

We use repeat orbit Synthetic Aperture Radar data collected by the ERSand Envisat satellites to investigate surface deformation due to arange of tectonic processes. We derive full vector displacement fieldsfor the 1992 Landers and 1999 Hector Mine earthquakes in southernCalifornia by combining pixel tracking techniques with interferometricSAR data from the ascending and descending orbits. A comparison withindependent GPS data collected in the near field of the earthquakeruptures indicates that the accuracy of the 3-D vector displacementfield is of the order of 5 cm for all three components. A similaranalysis allows us to retrieve the 2.5-D displacement field for the2003 Bam (Iran) earthquake using Envisat data from two viewingdirections. We analyze the post-seismic deformation due to the Landersearthquake using a massively redundant ERS data spanning a timeinterval of about 10 years following the earthquake. The stacked InSARdata provides critical constraints on physical models of thepost-seismic relaxation. We find that the post-Landers deformation isbest explained in terms of the poro-elastic rebound of thefluid-saturated upper crust. Analysis of multiple interferogramsallows us to detect subtle crustal uplifts above the giant magmabodies in the middle crust inferred from seismic studies in New Mexico(US), Altiplano-Puna (South America), and Southern Tibet (Asia). Wedemonstrate that the available data allows us to detect theline-of-sight displacement rates of the order of millimeters per year,and strain rates of the order of 10^-7 - 10^-8 per year, i.e., on theverge of the theoretical accuracy of the C-band interferometric SAR.

Abstract No. 616

Mapping Interseismic Strain Accumulation Using InSAR - New Results from Western Tibet and Eastern Turkey

T. Wright[1], B. Parsons[2], R. Holley[2], P. England[2], E. Fielding[3]
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Tim Wright (1), Barry Parsons (1), Rachel Holley (1), Philip England (1), Eric J. Fielding (2),(1) COMET, Department of Earth Sciences, University of Oxford.(2) COMET, Department of Earth Sciences, University of Cambridge.Although InSAR has been used extensively to map the deformation thatoccurs during earthquakes, there are relatively few examples ofinterseismic deformation measured by InSAR. This is largely becausethe signals from interseismic deformation are small (a few centimetresper year at most) and are often distributed over many tens ofkilometres in length scale. It is therefore difficult to separate thesignal from noise caused by changes in the atmosphere and orbitaluncertainties. However, if multiple SAR acquisitions are used toincrease the signal to noise ratio, interseismic deformation can bedetected. We present new observations of interseismic deformation inWestern Tibet and Eastern Turkey. In Tibet, we have used several5-frame ERS interferograms to map the deformation occurring across theplateau associated with the major faults of the region -- theKarakoram and Altyn Tagh Faults, previously thought to be slipping at20-30 mm/yr. Our data show that the Karakoram Fault has a slip rate ofjust 1+/-3 mm/yr and the Altyn Tagh Fault a rate of 5+/-5 mm/yr, ratesthat are consistent with the predictions of continuous models forcontinental deformation. In eastern Turkey, we have extended ourstudy of the North Anatolian Fault to the west. New ERS data confirmour previous result that the North Anatolian Fault is slipping at ~20mm/yr under a ~18 km elastic lid. We also hope to present results forthe East Anatolian Fault. We will conclude by discussing the prospectsfor continuing this work with Envisat data.

Abstract No. 485

Post-seismic Deformation across the Central Nevada Seismic Belt, USA, Measured by InSAR

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RSMAS, United States

We investigate the surface deformation in the Central Nevada Seismic Belt (CNSB), at the south western end of the Basin and Range, USA. The CNSB was the location of major normal and strike-

slip earthquakes in 1915 (Pleasant Valley M7.5) and in 1953 (four Magnitude 6.8-7.2 in a 6 month period). GPS measurements have shown ongoing crustal deformation at rates of 5 to 10 mm/yr across the CNSB. Those geodetic estimates of deformation are by a factor of 3-4 higher than geologic fault slip rates derived by paleoseismology. A possible explanation for the discrepancy between geodetic and geologic rates of deformation is that the geodetic measurements do not reflect long-term strain accumulation but transients processes such as post-seismic relaxation following the 1915-1954 earthquakes. We measure surface deformation in the CNSB using Interferometric Synthetic Aperture Radar (InSAR). We obtained 9 independent interferograms each covering four adjacent frames (~400 km in along-track direction) spanning 4-7 years using ERS SAR imagery acquired between 1992 and 2001. A precise displacement map obtained by stacking (averaging) the interferograms shows shortening of the distance between the ground and the satellite at a rate of ~2-3mm/yr (range change). We compare the InSAR derived rate to permanent GPS station derived measurement. The maximum range changes occur in the epicentral area of the 1954 Dixie Valley and 1915 Pleasant Valley earthquakes. A visco-elastic model of post-seismic relaxation fit the InSAR measurements. This suggest that post-seismic deformation still occurs 50 to 90 years after the earthquakes.

Wednesday 8 September Wolf-Dietrich 1-2

Poster Session 3P07:

Volcanoes and Earthquakes

Abstract No. 272

InSAR Survey of Alaskan Volcanoes

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Interferometric synthetic aperture radar (InSAR) imaging is a recently developed remote sensing technique capable of measuring ground-surface deformation with centimeter to subcentimeter precision and spatial resolution of tens-of-meters over a relatively large region. The spatial distribution of surface deformation data, derived from InSAR images, enables the construction of detailed mechanical models to enhance the study of magmatic and tectonic processes. This poster summarizes our recent InSAR studies of more than a dozen of Alaskan volcanoes, associated with both eruptive and non-eruptive activity. These examples include the pre-eruption inflation, co-eruption deflation, and post-eruption inflation at Okmok volcano; magmatic intrusion and the associated tectonic stress release at Akutan volcano; progressive aseismic inflation of Westdahl volcano; magmatic intrusion at Mount Peulik volcano and its relation to an earthquake swarm 30 km away; magmatic intrusion at Makushin volcano associated with a small eruption in 1995; complex patterns of transient deformation during and after the 1992-1993 eruption at Seguam volcano; uplift from 1993 to 1995 at New Trident volcano; surface subsidence caused by decrease in pore fluid pressure in an active hydrothermal system beneath Kiska volcano; compaction of young pyroclastic flow deposits at Augustine volcano; and a lack of expected deformation associated with recent eruptions at Shishaldin, Pavlof, Cleveland and Korovin volcanoes. These studies demonstrate that InSAR can improve our understanding on how the Aleutian volcanoes work and enhance our capability to predict future eruptions and the associated hazards.

Abstract No. 307

Contemporary Deformation in the Taupo Volcanic Zone, New Zealand, from ERS and Envisat Permanent Scatterer Processing

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The Taupo Volcanic Zone (TVZ) is an area of active plate tectonic back-arc spreading in the North Island of New Zealand, and is volcanically active along its ~200 km onshore length (as recently as 1996). The TVZ is also moving apart by ~8 mm per year tectonically, and geothermal power

extraction contributes significant localised deformation in the area. Future volcanic and tectonic activity at the TVZ represents a real risk to the contemporary New Zealand population and infrastructure. Measurement of the deformation field across the TVZ is thus important for modelling and understanding the physical processes operating within the TVZ, which has obvious benefits towards risk mitigation.At present, TVZ deformation is measured via differential GPS at widely spaced continuous installations and on 3-5 yearly campaign revisits. The GPS network was designed originally for measuring tectonic deformation, and has a low spatial density. Although some continuous sites are being installed with a view to volcano monitoring, the low spatial density of measurements mean that this network could miss pre-eruptive deformation signals. In 1999-2002, differential SAR interferometry using data acquired by the ERS-2 satellite was investigated. This project was largely unsuccessful due to the low correlation between ERS SAR pairs in this highly vegetated area.A time series of ERS data has been acquired for 1996-2003. We are investigating the use of permanent scatterer processing in areas of the TVZ where there is a sufficiently dense concentration of point scatterers. The successful launch of the European Space Agency Envisat ASAR C-band instrument in 2002 provides the opportunity to extend the measurements to 2006 and beyond. Imaging modes were chosen to reflect the styles of deformation previously observed in the TVZ – on descending passes (parallel to the axis of previously observed TVZ tectonic motion) the IS5 imaging mode is chosen because it is likely to be more sensitive to horizontal crustal motion, unlike the IS2 mode, which is chosen for ascending passes to seek volcanic and geothermal extraction deformation signals.The surface deformation measured in the TVZ during this period (ERS: 1995-2003, Envisat: 2003-2006) will have direct relevance to current and future monitoring and modelling efforts, and will provide a unique data set from which future projects are sure to evolve.

Abstract No. 389

Towards Near-Real-Time Envisat ASAR Interferometry at Active Volcanoes

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The ability to measure surface deformation at active volcanoes has obvious value, because such measurements inform deductions about internal magma movement, and provide indications of flank instability. Measurement of volcanic surface movement is already an established operational technique at many volcano observatories to help understand internal processes and to aid in eruption forecasting. Differential synthetic aperture radar interferometry shows excellent promise as a near-real-time tool to supplement such measurements, with an already well-proven ability to map patterns of surface deformation on volcanoes. However, repeat-pass interferometry as a technique has not yet become operational, partly because current spaceborne radars were not designed for the task. We investigate the limitations of the ERS and Envisat SARs for this purpose in terms of: radar system

constraints, volcano surface characteristics, interpretational uncertainties and the operational context. We illustrate some of the drawbacks at volcanoes in South America and New Zealand, chosen to represent a range of conditions and volcano morphological types. Freely-available global datasets of vegetation cover and atmospheric water vapour content can be used as proxy measures of coherence and path delay effects, which are the two main determinants of data quality. We also consider the issue of whether near-real-time (NRT) measurements from an instrument such as Envisat ASAR, with a repeat-pass interval of 35 days, are valuable in an operational sense. Ultimately, we argue that any additional information that informs emergency managers in a crisis situation has value, regardless of the interval of measurements attainable, especially that of centimeter-scale volcanic deformation in the weeks or months preceding an individual SAR acquisition. Of course, with the seven imaging modes of Envisat ASAR, a new acquisition could theoretically be acquired of an area as often as every few days, if emergency data commissioning procedures allow it. However, interferometric processing is restricted by compatibility with, and availability of, existing archived data, which often requires advanced planning to ensure adequate data archives are in place. The latter can be problematic if the volcano has not shown any signs of previous unrest, and if nobody actively ordered the data in the first place.Lastly, the entire NRT observational capability then hinges on the rate of data delivery, or the turnaround time between data acquisition by the satellite and delivery of the RAW product to the end-user, and we discuss the NRT capability that is currently being offered by Eurimage, the leader of the EMMA consortium and global commercial distributor of the European Space Agency ERS and Envisat standard derived products. With concerted effort, operational volcano DInSAR should be viable in the near future. In the meantime, our experience using existing systems, such as Envisat, will inform the construction of future orbital radar systems designed specifically for this purpose.

Abstract No. 570

InSAR Observations of Crustal Deformation in Iceland - an Overview

R. Pedersen[1], F. Sigmundsson[1], K. Feigl[2], C. Pagli[1], S. Jónsson[3], E. De Zeeuw-Van Dalfsen[4], H. Vadon[5]

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Interferometric combination of radar satellite images (InSAR) is becoming an extensively used way of documenting sources of deformation within Iceland. The technique often supplements other geodetic data, such as campaign dry tilt and GPS measurements. The InSAR images most often provide a spatially highly improved illustration of the surface deformation, due to the excellent backscatter conditions prevailing in Iceland. Crustal deformation events in a variety of tectonic settings have been recognized using ERS1 and ERS2 images provided by ESA, including:1): Intrusions in the Eyjafjallajökull volcanic system. Images spanning 1993-2000 identify considerable

surface deformation in an area south of the Eyjafjallajökull icecap. The intrusive events (occurring in 1994 and 1999) have also been detected by tilt and GPS campaign measurements, as well as high seismic activity. Modeling based on InSAR data suggest a more complex source geometry than previous work based on GPS and seismic data.2): Earthquake faulting in the SISZ due to seismic activity in June 2000 has been detected in several images. On June 17, and June 21, 2000 two Mw 6.5 earthquakes ruptured N-S striking faults in the SISZ. Joint inversion of InSAR and GPS data indicates that the two events activated faults 15 km long extending to about 9 km depth. Maximum slip, reaching more than 2 meters in both events, is concentrated in the upper crust, from the surface to 5-6 km depth. 3): Deformation due to dynamically triggered earthquakes on the Reykjanes Peninsula, about 80 km to the east of the main event in the SISZ (June 17, 2000 Mw 6.5 earthquake). Inverse modeling of the InSAR data estimates the deformation to originate from a Mw 5.8 and a Mw 5.3 event, when assuming uniform slip on two simple rectangular fault patches.4): Subtle surface deformation signal in the vicinity of the main earthquake faults active in the June 2000 SISZ sequence have been documented in InSAR images. The deformation signals correlate well with water-level changes in geothermal wells and have been interpreted as poro-elastic rebound following the SISZ 2000 earthquakes. 5): An eruption at Hekla volcano began on February 26, 2000. Short-term precursory seismic activity was detected about one hour before the eruption started. Initially, a 6-7 km long eruptive fissure opened up along most of the Hekla ridge. Deformation due to the eruption is seen in a series of interferograms. The displacements appear to be the result of dike opening as well as subsidence due to deflation of a deep-seated magma chamber.6): Surface inflation due to inflow of magma in the Hengill area can be seen in images spanning 1993 to 1998. The uplift signal can be explained by an expanding Mogi-source at 7 km depth, with 2-cm/year inflation rate. Persistent seismicity during 1994 to 1998 was associated with the widespread uplift.7): Long-term subsidence in the Askja caldera has now been recognized not only by tilt and GPS, but also in InSAR images. A series of interferograms shows continuous subsidence, with the size of the deformation signal scaling well with the time span of the images. The subsidence can be related to drainage and/or cooling of a shallow magma chamber.8): Readjustment of the spreading segment at Krafla has been detected in InSAR images spanning 1992 to 1999. Subsidence occurs above an inferred shallow magma chamber, which fed events during the 1975 to 1984 rifting period. The subsidence is elongated along the spreading axis, which is interpreted to be due to cooling contraction and ductile flow of material away from the spreading axis. A wide-spread uplift signal of about 1 cm/yr has however been recognized to the north, and appears to be due to recharging of magma into a deep seated source. All these studies have benefited from images contributed by ESA PI contracts.

Abstract No. 592

Estimation of Bam Earthquake Coseismic Displacement Using Envisat ASAR Interferometric Data

L. Kenyi
Joanneum Research, Austria

On the 26th December 2003 an Earthquake, that measured 6.6 on the Richter scale, struck the town of Bam in Southern Iran. As a results, many buildings were demolished and thousands of people lost their life. The European Space Agency (ESA) through its orbiting Envisat ASAR sensor managed to acquire 3 ascending and 3 descending image sets of the Earthquake area. These image data were distributed, on request, free of charge to the research community.In this paper, the interferometric results and analysis of these Bam's Earthquake Envisat ASAR scenes are presented. The scenes were interferometric processed using the well known differential techniques. The resulting displacement maps from ascending and descending image sets were compared. Additionally, the SRTM 90m resolution DEM was used to remove the topographic phase from the interferograms that contained the coseismic displacement phase. The logic behind this is to test the suitability of the SRTM 90m resolution DEM for such an application. However, the preliminary results generated have shown that the predicted phase from the SRTM 90m resolution DEM add too much speckle to the difference interferogram. In addition to this, the phase gradient technique was applied and it was found to clearly detect the coseismic fault which is not visible in the amplitude image.

Abstract No. 661

Measuring Inter-seismic Deformation by InSAR in Eastern Turkey

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We seek to measure interseismic deformation across the fault systems intersecting at the Karlova Triple Junction using radar interferometry at C-band (~5 cm) wavelengths. We have obtained ERS interferograms with enough correlated pixels to interpret for pairs spanning up to 3 years, provided that the images are both acquired in the summer months (June-September) and the altitude of ambiguity is very favorable (over 500 m in absolute value). This result extends the work Wright et al. [GRL, 2001]. We have developed an approach that analyzes changes in range in profiles perpendicular to the strike of the fault. After unwrapping, these profiles show gradients which combine the interseismic deformation signal with the unmodeled orbital effects. Previous studies have neglected the orbital errors. To separate the former from the latter, we apply an approach called temporal adjustment that should estimate both interseismic deformation parameters and orbital corrections. We compare the INSAR results to available GPS estimates.

Wednesday 8 September
14:00 – 15:40
KARAJAN 2-3

Session 3C2:

Carbon & Kyoto

Abstract No. 326

GLOBCARBON: Multi-Sensor Estimation of Global Biophysical Products for Global Terrestrial Carbon Studies (DUP/DUE)

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'Greenhouse gases', especially carbon dioxide, are intimately connected to climate change. To predict future climate change accurately and find ways to manage the concentration of atmospheric carbon dioxide, the processes and feedbacks that drive the carbon cycle must first be understood. Understanding the spatial and temporal patterns of carbon fluxes is essential to inform the policy process. However, our current knowledge of spatial and temporal patterns is uncertain, particularly over land. The ESA GLOBCARBON project aims to generate fully calibrated estimates of at-land products quasi-independent of the original Earth Observation source for use in Dynamic Global Vegetation Models, a central component of the IGBP-IHDP-WCRP Global Carbon Cycle Joint Project. The service will feature global estimates of: burned area, fAPAR, LAI and vegetation growth cycle. The demonstrator will focus on seven complete years, from 1998 to 2003 when overlap exists between ESA Earth Observation sensors (ATSR-2, AATSR and MERIS) and VEGETATION. However, the system will be flexible and therefore can be retrospectively applied to existing archives and used with future satellite sensors. This paper examines the experience of the GLOBCARBON project as it begins to deliver products to the identified user community of atmospheric chemistry and dynamic global vegetation modellers. It features discussion of user requirements, operational algorithms, and product output and use within the Sheffield and Lund-Potsdam-Jena DGVM and the atmospheric chemistry models of LSCE and MPI. Examples of leaf area index, fAPAR, vegetation growth cycle and burned area estimation will be provided.

Abstract No. 543

KYOTO-INV: Reporting on Land Use and Forestry under the Kyoto Protocol (DUP/DUE)

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The KYOTO-INV is a project funded by ESA within the Data User Program Framework (DUP-2). Its aim is to define and to implement EO-based services in support of the reporting and the verification of Land Use, Land-Use Change and Forestry (LULULCF) activities under the Kyoto Protocol. Five European countries have been involved in the project for the definition of services and products: Italy, Switzerland, Norway, the Netherlands and Finland. Common requirements for all users are the assessment of different subclasses of forest areas and land-use, as well as afforestation, reforestation and deforestation activities. Taking 1990 as the baseline year, these activities have to be geo-referenced with a minimum unit of 0.1-0.5 ha and a thematic accuracy of 90-95%. Furthermore, each country has defined specific requirements corresponding, *inter alia*, to the characteristic of its forests, its topography and the availability of ground truth. During Phase I of the project (Prototype), one LANDSAT image per year has been used for each one of the various areas (each 50 km x 50 km) that were defined in each country as test areas. Existing EO-data based algorithms for forest, land use and cover map have been used. The results show the capabilities and the limits of this approach.

Abstract No. 85

Monitoring Forests as Carbon Sinks Using Remote Sensing

F. González-Alonso, S. Merino-De-Miguel, A. Roldán-Zamarrón, S. García-Gigorro, J. Cuevas
INIA, Spain

The Kyoto Protocol intends to limit or reduce CO2 and other greenhouse gas emissions to 1990 levels and allows carbon emissions to be balanced by carbon sinks represented by vegetation. The assimilation of atmospheric CO2 by the Earth's vegetation ecosystems, especially by forests which represent a long-term pool, is a very important component for the global balance of carbon. In order to fulfil the Kyoto Protocol commitments and for treaty verification, different control and monitoring mechanisms should be implemented on a global basis. For those aspects referred to carbon sinking by land use change (reforestation or afforestation), reliable systems will be a key

point in reducing uncertainties in inventory practices. In this context, the remote sensing community seems to be very well positioned: (i) it is best equipped to address CO2 and other greenhouse gases inventory (Rosenqvist et al., 1999; Richards, 2003) and (ii) land cover change identification using remote sensing is becoming more widely applied (Richards, 2003) among other well known advantages. AVHRR-based studies carried out during the last years have shown a clear tendency through an increase in the carbon pools of boreal and temperate forests, both at global and regional scales (Myneni et al., 1997; Myneni et al., 2001; Dong et al., 2003; González-Alonso et al., 2003a; González-Alonso et al., 2003b; González-Alonso et al., 2003c). The launch of the Envisat satellite opened new opportunities for such studies since information derived from MERIS is much more accurate in terms of radiometric, spatial and spectral characteristics. The present paper shows the first results in the application of MERIS data for forest biomass retrieval in Spain and it is based on the use of spectral indices.

Abstract No. 577

Inferring Carbon Fluxes of Forests from Tandem Coherence: Environmental and Management Controls

S. Quegan, P. Drezet

Centre for Terrestrial Carbon Dynamics, United Kingdom

Various studies have shown that ERS Tandem coherence is related to the age or biomass of forests, but that this relation can vary greatly with location and environmental conditions. In this paper, we use environmental models for plant and soil moisture, together with scattering models, to investigate the spatial and temporal behaviour of time series of coherence over forests in the UK, focusing particularly on Kielder Forest in northern England. Both soil and plant moisture are shown to be important determinants of the coherence. The 11 am local time of the data acquisitions coincide with rapid changes in leaf moisture, affecting the ratio between the coherent returns from soil and the incoherent returns from the canopy. This ratio in turn is critical in determining the value of coherence. Simple relations between coherence and the age (or biomass) of the forest only appear in forests that are cleaned of undergrowth or in which the undergrowth is otherwise suppressed. Otherwise the undergrowth contributes significantly to the incoherent canopy term, distorting or destroying the coherence/forest biomass relation.The temporal and spatial behaviour of coherence is investigated experimentally using a long time-series of coherence data from Kielder Forest, together with full UK coverage gathered during June-August 1995. Environmental conditions under which it is reasonable to invert coherence to age are identified, and the uncertainties on the inversion are quantified. These are converted into uncertainties on average annual carbon flux from the forests, taking into account the dependence of this flux on forest age. Finally, the implications of these results for exploiting the Tandem archive to produce an age/biomass map and corresponding carbon flux estimate for the boreal zone using archived data are discussed.

Abstract No. 260

Envisat-Indonesia Radar Biomass Experiment (EIRBEX)

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2 NASA, Usa
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A study for operational application of Envisat/ASAR in the sector of Land Use and Land Use Change and Forestry (LULUCF) of the Kyoto Protocol is implementing under Envisat AO (AOE-869). The concentration is in the implementation of Article 12 (Clean Development Mechanism – CDM) in the tropical environment, which requires higher tier input data compared to national greenhouse gases inventory exercise.Due to CDM/LULUCF complexity and the existing international political negotiation process within the United Nations Framework Convention on Climate Change (UNFCCC), the following strategy was applied in this study : (1) focus on the above ground biomass of the afforestation and reforestation, (2) use of commercial tropical timber plantation to get one large contiguous block of land as the test sites, (3) perform Envisat/ASAR biomass detection ability at the test site, (4) implement Envisat/ASAR application for Kyoto Protocol Article 6 (Joint Implementation – JI) requirements, as a transition, and (5) adapt the application to the CDM/LULUCF (Article 12) requirements in the tropical environment.Based on the above strategy and the implementation of the study in Riau Province, Central Sumatera, Indonesia, this presentation demonstrate the positive result of the ability of Envisat/ASAR for good practice CDM/LULUCF estimation and reporting requirements, such as : (1) representation of land area for broad land use categories, (2) stratification of the timber plantation area, (3) identification of relevant carbon pools and non-CO2 greenhouse gases, (4) the sampling framework design, (5) identification of method (field and model) for monitoring the pools, and (6) monitoring plan development, including quality assurance/quality control plan. A description of intensive field data collection and small format aerial photo coverage mission to support this study is also provided.

Wednesday 8 September
14:00 – 15:40
MOZART 1-2

Session 3C3:

Atmosphere Retrieval (1)

Abstract No. 426

The GODFIT Direct Fitting Algorithm: a New Approach for Total Column Retrieval

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The GOME total ozone record dates back to July 1995; it is now an important candidate for ozone trend analysis. This requires retrieval accuracy high enough to detect 1% changes in total ozone over a 10-year period. Several improved total ozone algorithms were developed in 2003 under ESA/ESRIN funding. The present consortium was responsible for two of them - the direct fitting GODFIT algorithm described here, and the GDOAS algorithm described in a companion presentation at this Symposium. GDOAS was selected for the GOME total ozone record reprocessing in 2004, and has been implemented in the GOME operational processing environment (UPAS/GDOAS 4.0). The GOME Direct Fitting (GODFIT) algorithm uses nonlinear least squares fitting (with optional regularization) to make direct comparisons between measured backscatter radiances and simulated forward model quantities. All radiative transfer (RT) simulations are done from scratch using the linearized LIDORT code. One call to LIDORT will return simultaneous computations of radiances and analytic Jacobians with respect to surface and atmospheric properties. The algorithm is flexible and modular; reference data (atmospheric properties, spectra) can be easily implemented and changed as needed, and the algorithm operates without the need for extensive look-up tables. For the retrieval of total ozone amounts from GOME and related instruments (SCIAMACHY, OMI and GOME-2), we consider earthshine measurements in the UV ozone Hartley-Huggins bands. RT simulations require ozone profiles (partial columns); we use the TOMS Version 8 column-classified ozone climatology to generate a unique map between the fitted total column and the input RT profile. RT simulations are done in a Rayleigh atmosphere, and the surface albedo is fitted as an internal closure polynomial (3 coefficients). GODFIT is not limited to optically thin regimes typical for DOAS-style algorithms based on Beer-Lambert absorption; separate AMF computations are not needed. Both GDOAS anad GODFIT contain improved schemes to deal with Ring effect corrections. Clouds are treated in the independent pixel approximation, with cloud-top pressure and fractional cover as model parameters. GODFIT was applied to a a set of GOME validation orbits selected for the ESA/ESRIN study in 2003. GODFIT can process one orbit (~2000 scenes) in under 15 minutes. We present validation results from comparisons with NDSC and WMO/GAW ground-based networks, and with TOMS Version 8 total ozone measurements. We compare results with GDP 3.0 and the newer UPAS/GDOAS 4.0 total ozone product. As with GDOAS, we find that GODFIT produces improved RMS values and reduced seasonalities compared with GDP 3.0 results. Again, GODFIT results lie within -1% to +1.5% of ground-based values for solar zenith angles up to 70 degrees. Further work is underway to extend GODFIT to aerosol and minor trace gas retrievals for GOME and related instruments.

Abstract No. 353

An Online Version of WFDOAS Algorithm for Total Column Retrieval with GOME and SCIAMACHY

L. Lamsal, M. Weber, A. Rozanov, V. Rozanov, M. Coldewey-Egbers
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A novel algorithm based upon WF-DOAS (Weighting Function Differential Optical Absorption Spectroscopy) has been successfully developed for ozone vertical column density retrieval from GOME. WFDOAS V1.0 uses look-up tables for most RTM quantities like reference intensities andweighting functions and it has been carefully validated with independent ground measurements and was proven to produce highly accurate ozone columns for GOME. An online version of WF-DOAS with the new radiative transfer model SCIATRAN 2.0 has been now developed that allows RTMcalculations during the fitting procedure. This algorithm isspecifically designed for use with different satellite instruments such as GOME, SCIAMACHY, and later GOME2. The new version will facilitate, to a large extent, various sensitivity studies for optimising the retrieval. Salient features of the algorithm will be illustrated by first applications to SCIAMACHY.

Abstract No. 138

Inverse Modelling of Methane Emissions from Satellite Observations within the EVERGREEN Project

J. Meirink, J. Eskes, A. Goede
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The Kyoto Protocol, which the EU has ratified, calls for a quantitative reduction in greenhouse gas emissions by the year 2010. However, global emissions, sources and sinks, are not accurately known. The EC project EVERGREEN (5th FP, Feb. 2003 - Jan. 2006) proposes to improve this situation by using Envisat measurements.In this presentation the status of the EVERGREEN project will first be reviewed. We will then focus on the inverse modelling of methane emissions, which is done using four-dimensional variational data assimilation of synthetic SCIAMACHY data. The potential added value of SCIAMACHY measurements for CH4 source attribution is assessed. Sensitivity studies give an indication of the impact of a number of aspects, e.g. measurement errors and the presence of clouds, on the retrieved CH4 sources.

Abstract No. 235

SCIAMACHY Water Vapour Retrieval Using AMC-DOAS

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Measurements of the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) on Envisat have been used to derive global water vapour total column amounts over ocean and land.For this purpose, the Air Mass Corrected Differential Optical Absorption Spectroscopy (AMC-DOAS) approach, which has already been successfully used with GOME data, has been applied to SCIAMACHY's nadir measurements.Whereas operational SCIAMACHY water vapour products are derived from measurements in the NIR, the AMC-DOAS algorithm is applied to the spectral region around 700 nm where both water vapour and molecular oxygen absorptions are present.AMC-DOAS is an extension of the standard DOAS method.To be applicable to water vapour retrieval, it considers the non-linear relation between absorber amount and absorption depth (saturation effect).Furthermore, an air mass correction factor is derived from O2 absorption features.This air mass correction factor not only compensates deviations of the modelled atmospheric conditions from reality, it also serves a an inherent quality check for the retrieval by which e.g. too cloudy scenes can be identified.First comparisons of the SCIAMACHY total water vapour columns derived with the AMC-DOAS method with corresponding SSM/I and ECMWF water vapour measurements and a Weighting Function Modified (WFM-)DOAS retrieval have been performed.Taking into account the large temporal and spatial variability of water vapour, the SCIAMACHY results agree within about 10% with these correlative data not only over ocean but also over land, thus showing the capability of SCIAMACHY to derive water vapour concentrations on the global scale.

Abstract No. 159

GEO-MTR: a 2-Dimensional Multi-target Retrieval System for MIPAS/Envisat Observations

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In this paper we present a new retrieval system for MIPAS/Envisat measurements, developed in the frame of the ESA study 'Development of algorithms for the exploitation of MIPAS special modes measurements'.The new code performs 2-Dimensional (2-D) retrievals of the altitude distributions

of pressure, temperature and Volume Mixing Ratio of selected molecules. These quantities can all be retrieved simultaneously (MTR functionality) or sequentially. For the analyses, the system makes use of selected small spectral intervals (Micro Windows). The best performances of the new system can be attained analysing simultaneously the data coming from a full orbit, but the possibility of analysing orbit segments (down to one sequence only) is implemented in the code. The new system can perform the 2-D analysis of MIPAS special observation modes that are not routinely analysed by ESA Level 2 processor. The new-system will be distributed by ESA as an open source code.The new system has been tested on real MIPAS observations, using micro windows especially selected for 2-D, MTR analyses. The 2-D retrievals of pressure, temperature and of the VMR of Ozone and Water Vapour from selected orbits have been performed on nominal and on special observation modes. These results, along with the results obtained for the retrieval of non-level 2 molecules will be presented.

Wednesday 8 September
14:00 – 15:40
DOPPLER

Session 3C4:

Wind and Wave (1)

Abstract No. 564

Altimeter Dual Frequency Measurements with Envisat RA-2

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Global S- and Ku-band nadir radar measurements have been analyzed to demonstrate the potential to jointly use both frequencies to infer improved sea surface roughness properties. This work follows investigations related to the use of C and Ku-band measurements from the TOPEX altimeter. In this presentation, we shall report on the retrieved altimeter wind, significant wave height and period. Efforts related to the use of altimeter individual echoes and absolute calibration issues will also be tentitatively discussed.

Abstract No. 238

Impact of Multi Near Real-time Altimeter (Envisat and Jason) Assimilation Data on Wave Analyses and Forecast

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Satellite altimetry has become an important discipline in the development of sea-state forecast domain or like a new challenge, that of operational oceanography. Météo-France Marine and Oceanography Division is much involved in altimetry in which it is also one of the main operational customers. Sea-state forecasts are produced every day with the help of numerical models assimilating Fast Delivery Product from ESA's ERS-2 satellite, available in real-time (3-5h). Theses forecasts are transmitted to seamen as part of safety mission of persons and properties, or specific assistances for particular operations. With the launch of Envisat (from ESA, launched on March 1, 2002, to take over the ERS mission) and Jason-1 (from CNES/NASA, launched on December 7, 2001, successor of Topex/Poseidon), we have the unprecedented opportunity of the availability in quasi-real-time of data from several altimeters, offering an improved coverage. The objective of this study is to evaluate the impact of near real-time measurements from several altimeters on wave model analyses and forecasts, at global scale. Since July 2003, Météo-France inject the wind/wave OSDR (Operational Sensor Data Record) Jason data on the WMO Global Transmitting System (GTS), which yields them available in near real-time to the international meteorological community. Previous works with the support of CNES (Lefevre et al., 2003, Skandrani et al., 2004), showed that the impact of the assimilation of altimeter data on wave model analyses and forecasts is much larger

when two sources of data (ERS and Jason) are used instead of one (ERS). The necessary adaptation of multi-satellite data assimilation has been implemented and evaluated for operational use. Also, Fast Delivery Marine altimeter data of Envisat will improve coverage and contribute to the constant progress of marine meteorology. For this purpose, Significant Wave Height time series were generated using Wave Model WAM implemented by an assimilation scheme (Lionello et al., 1992), with the two satellites, Envisat and Jason. The results were then compared to GFO (US Navy Satellite) and moored buoys waves data. The impact of assimilation was also investigated for individual storms with severe conditions.

Abstract No. 333

Satellite Wave Height and Wind Speed Validation over the Mediterranean Sea

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The altimeter and scatterometer wind and wave algorithms have been developped and tested for global open ocean conditions. Previous studies showed that altimeter significant wave height (swh) and wind speed measurements have to be corrected in order to take into account particular behaviours, such as underestimation of highest swh by altimeters, or some electronics drift, in the case of TOPEX for instance, in order to get consistent and homogeneous data sets over the various altimeter missions. Such corrections have been obtained using buoy and cross altimeter comparisons, over the whole oceans. Over the Mediterranean Sea the validity of these corrections can be questioned. Indeed because of the limited size of the Mediterranean bassins, short fetch modifies the sea state characteristics and, consequently, the radar backscatter measured by altimeters and scatterometers and used for wind speed and swh retrieval.The paper presents, first, the status of the validation, over the global ocean, of the altimeter and scatterometer missions since 1991, with particular emphasis on the recent missions QuikSCAT, JASON-1 and Envisat. Then, a particular validation study is performed over the Western Mediterranean Sea, using buoy, altimeter and scatterometer comparisons. The dependencies of wind and swh residuals on oceanographic and atmospheric parameters derived from buoys are also examined, using colocated data.The analysis shows that the satellite measurements can be affected by the limited fetch conditions over the Mediterranean Sea, and, according to the geographical location, by the local meteorological variability. Modification of satellite retrievals over the Mediterranean Sea is more significant for wind speed than for wave height.

Abstract No. 527

Climate Change and Extreme Wave Heights in the North Atlantic

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We know that the mean wave height in the North East Atlantic is very dependent on the position of the storm track as given by the North Atlantic Oscillation index. Is this true of extreme conditions as well? We altimeter data from ERS-1/2 , TOPEX/POSEIDON, Envisat and JASON to estimate extreme conditions (the 50-year return value) in each 2° by 2° square of the North Atlantic. Unlike previous estimation methods we use the statistical theory of extreme values to give us a robust estimate of the extreme values (with attached uncertainty). We assume that exceedences of a high threshold come from a point process and we use a Generalised Pareto Distribution for values exceeding this threshold. The estimation of this threshold is difficult and is normally done by hand. This is impractical for the number of series we have therfore we have developed a 'floating threshold' method to estimate this value. We look at the robustness of the method to two altimeter data products: GAPS and RADS. We present a map of 50-year return value across the North Atlantic and verify the results with buoy data. The problem of satellite sampling is discussed. Using these methods it is possible to model the effect of explanatory variables such as seasonal effects and the NAO index. We show that the extreme waves are affected by the state of the NAO and map out the extent of this influence. We also examine whether there is any evidence of a trend which could be caused by global warming.

Abstract No. 445

Extreme Wave Statistics from SAR Wavemode

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[4] *GKSS, Germany*

The central goals of the Envisat AO WaveAtlas (ID 2342) are to globally derive and examine sea state information from SAR image wavemode data for a period of at least two years. The result will be an atlas showing the climatology of extreme wave events. Special emphasis is put on areas of ship accidents due to extreme waves. The atlas will include maps of extreme wave occurrence, wave crest lengths, groupiness and related parameters. The first version of the atlas will cover a two years period, which will be extended to the whole lifetime of ERS-1/2. ERS-1/2 raw wavemode data are reformatted and archived at DLR's robot archive. From the raw wavemode data archive, single look complex imagettes are computed using the DLR BSAR processor. In the framework of the MAXWAVE project, funded by the EU, imagettes were inverted in order to estimate sea surface height at each pixel of the imaged area. Sea surface topography is analyzed to find relevant parameters such as the maximal single wave height (Hmax), wave steepness (smax) as well as the significant wave height (Hs). Several image analysis tools like wavelet edge detection are used to examine wave grouping phenomena and wave crest extension in the original SAR imagettes. Data derived from imagettes in spatial and temporal neighborhood to ship accidents, which happened due to severe weather situations are examined.

Wednesday 8 September
14:00 – 15:40
MOZART 3

Session 3C5:

Scatterometer Applications (1)

Abstract No. 669

Improving Tropical Cyclone Prediction Using Scatterometer Surface Winds in Model Initialization

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[2] University of Miami/RSMAS, United States
[3] University of Washington/APL, United States
[4] JPL, United States

Observations over the world ocean become increasingly important as tropical cyclone prediction models continue to improve in terms of model resolution and physical representation to capture the fine structure of the hurricane inner core. The spaceborne scatterometer, namely the NASA QuikSCAT, has provided the needed surface wind observations. The contribution to forecasting errors from the model initial conditions is a key issue in the current hurricane predictions. The impact of the QuikSCAT winds on hurricane forecasting using high-resolution mesoscale model has been tested model simulation of Hurricane Floyd (1999). We use multi-nested, vortex-following grids to cover a large-scale storm environment and still resolve the fine structure of the hurricane. The grid resolution for the outer domain and the three inner fine-mesh domains are 45, 15, 5, and 1.67 km respectively. The model is integrated for six days. We blend the sea-level pressure and surface wind fields from the QuikSCAT data smoothly into the corresponding MM5 initial fields. The simulation with QuikSCTA winds improves the storm intensity forecast significantly, by 10-20 hPa during the first 3 days. It is crucial to have adequate temporal and spatial coverage for monitoring and forecasting the rapid storm intensity changes within 6-12 hr windows. The lack of coverage from the single QuikSCAT is clearly evident in many intense hurricanes in the past. The recent tandem scatterometor missions? the addition of SeaWinds on ADEOS-II have increased the critical coverage of two major hurricanes in 2003. In this study we analyze both SeaWinds and QuikSCAT in Hurricanes Fabian (2003) and Isabel (2003). Both scatterometer winds are compared with the airborne surface wind analysis from the research flights other in situ data from the Hurricane Research Division at AOML/NOAA. We have developed a method of setting up high-resolution model simulations using combined SeaWind and QuikSCAT for model initial conditions. The results of this study will be presented at the conference.

Abstract No. 359

Some Evidence on the Link between Solar Activity and Climate from ERS Scatterometer Data over Land

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In the past the variability of the solar radiation caused changes in the Earth's climate. However, it is discussed controversially whether recent changes in the 20th century also may have a significant solar component. During a solar cycle of 11 years the "solar constant" varies about 0.1%, which seems to be too small to have any measurable impact on Earth's climate. However, in other wavelengths, e. g. x-ray, this variability could be several orders of magnitude. It is argued that more cloud condensation nuclei are produced with increased cosmic ray ionization, which could lead to more and smaller droplets, longer cloud life times, and thus to localy less rain.Radar backscattering from the Earth's surface depends on climatological sensitive parameters like state of vegetation cover, soil moisture, and moisture content of the vegetation. Any change in these properties should be detectable in radar data. However, local weather variability, seasonal variations, and interannual differences may hide a solar cycle signal. The current data set of global ERS scatterometer data spans the period from August 1991 until July 2003 and covers one solar cycle. At the beginning of the radar measurements Cycle 22 was still at a maximum with a sun spot number of 145. Cycle 23 started in May 1996 and peaked in April 2000 with monthly sun spot numbers of 8 and 121, respectively.The analysis of global ERS data revealed locations in Argentina, Botswana, and Australia where the time series of the normalized radar cross section (NRCS) show sinusoidal variations of about 1.5 dB with a period of approximately 11 years, which are in phase with the time series of sun spot number. This variation cannot be explained by any instrumental effects. Common to these sites is a sparse vegetation cover. Thus small changes in precipitation or air/soil moisture might be amplified by the response of the vegetation and thus lead to a considerable change in NRCS. These changes in vegetation are confirmed by corresponding variations of the normalized difference vegetation index (NDVI) derived from data of the Advanced Very High Resolution Radiometer (AVHRR) over Australia. Concomitant time series of maximum monthly air temperature show an anti-phase sinusoidal behavior, which is another evidence of a periodical change of vegetation or moisture flux.

Abstract No. 372

Arctic Multi-year Sea Ice Monitoring: A decade of Observations Using the ERS Scatterometers

R. Ezraty
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Scatterometers have become classic instruments to monitor sea ice extent and types at global Ocean basin scale. The basic physical property which enables sea ice to be discriminated from open ocean is its azimuth isotropy at the scale of the footprint. Thus, over sea ice, backscatter remains a function of the incidence angle of the electromagnetic beam and of the roughness of the surface, at the scale of the radar wavelength. Sea ice which has survived at least one summer melt, is named "Multi-year sea ice". As sea ice ages, the little roughness which form at the surface act has reflectors, it follows that Multi-year sea ice have a higher backscatter than that of first year sea ice. Because of the dependence of backscatter with respect to the beam incidence angle, a correction needs to be performed to map homogeneously sea ice backscatter. This correction is ice type dependant. ERS scatterometer backscatter map are typically normalized at forty degrees incidence angle and,

because of the limited swath, one week of data are required to map the whole Arctic basin. Such maps have been built from 1991 until 2001; then the yaw steered capability of the satellite could not be used any more to separate sea ice areas from open water. (http://www.ifremer.fr/cersat)The analysis of this ten-year long time series shows that the multi-year sea ice area decreases during each winter period by about 1.5 x 106 km². The anticipated long term decreasing trend of multi-year area (7% per decade for the period 1978-98) is blurred by the sudden increase of multi-year area during summer 1996 (middle of the time series) likely due to a reversal of the wind regime. Yet, the systematic decrease is observed on each side of this jump.A new gyro-less ERS scatterometer backscatter processor has been developed at ESA/ESRIN, this processor is now operational and used for wind vector estimations. It is planned to test this revived dataset for sea ice monitoring using the winter 2003-2004 data, to fill-in the 2002-2003 data gap when the backlog will be reprocessed and to extend the multi-year area time series until the ASCAT becomes operational. An overlap period between the two instruments would be invaluable to ensure the long term data homogeneity.

Abstract No. 462

Antarctic Iceberg Abundance, Size, and Drift Derived from Active Microwave Data

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A survey of the characteristics of the population of icebergs around a large sector of Antarctica has been carried out using data from active microwave instrumentation. The survey results provide information on the spatial distribution, abundance, and size characteristics of the iceberg population. Many of the observed icebergs occur close to the coast, typically in areas where few if any observations have been collected by ship-board observers or other means. Thus they represent new data on the iceberg population, especially for those close to their sources, the ice shelves or glaciers from where they had calved.The icebergs are detected and their dimensions extracted by analysis of the texture properties present in high resolution SAR images. The observed sizes range from a fraction of a square kilometre to many thousands of square kilometres. The number of observations exceeds 23,000 and so provides robust statistics for the size and shape characteristics of that part of the population. The total population in the Southern Ocean had been estimated to number between 200,000 and 300,000.The drift tracks of very large icebergs are extracted by analysis of a time series of coarse resolution images generated from scatterometer data. The combination of these tracks shows the overall broad pattern of drift for the iceberg population. Close to the coast the drift is typically from east to west in the "East Wind Drift". The observed drift velocities show the presence of a narrow "slope current" with higher speed than adjacent water. Several retroflections occur in the pattern where icebergs migrate northwards along preferred corridors to join the southern flank of the Antarctic Circumpolar Current which carries them from west to east. Detail information on drift velocities is derived from the displacements of uniquely identified icebergs or clusters of icebergs extracted from pairs of SAR images acquired at different times. The aggregation of many short-term

vectors provides information on the local spatial and temporal variability in the drift pattern.The presence and movement of icebergs can cause important modifications to their environment. Their drift transports freshwater away from the continent and their subsequent melt injects that water into the surface layer, reinforcing the ocean stratification. Recent calving of massive icebergs from the Ross Ice Shelf and Filchner-Ronne Ice Shelf has more than doubled the total mass of icebergs in the ocean and thus the potential freshwater flux. The presence of icebergs can also modify the movement and concentration of sea ice which in turn influences surface productivity, and habitats, as well as atmosphere-ocean-ice interaction.

Abstract No. 299

Use of Soil Moisture Scatterometer Data in Hydrological Predictions

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Soil moisture has an important influence on hydrological and meteorological processes. Soil moisture is important in processes that partition rainfall into runoff and infiltration. Extreme hydrological events (floods and droughts) often have a large socio-economical impact. Depending on the catchment soil moisture state, the runoff response to a given rain storm may be vastly different. A realistic representation of such events by hydrologic models is therefore essential. Traditionally, the soil moisture state of catchments has been estimated from rainfall and evaporation, based on soil moisture accounting schemes (SMAS). However, there are difficulties with accurately estimating the parameters for this type of model, particularly in catchments where no stream flow observations are available. In this paper we examine the potential of using ERS scatterometer data to better constrain the hydrological models. The rationale behind this combination is that even though both approaches (SMAS and scatterometer analyses) have clear limitations and are associated with significant uncertainty it is their combination that helps reduce the uncertainty of the integrated estimates. The main hypothesis of this is that the error structures of the estimates from these two methods are likely different, so one would expect a combination of the two approaches to be less biased and exhibit less random error than any of the two methods individually. The estimates come from completely different instruments, ground based instruments and spaceborne sensors, so one would also expect their errors to be different. Also, the models that estimate soil moisture in these two approaches have a different structure and they are calibrated in different ways. Based on this general idea, we will examine potential methods of estimating the space-time dynamics of soil moisture more accurately than has been possible in the past with either of the two sources of information. The focus is on ungauged catchments, i.e. catchments without stream flow measurements, where the potential of using the spaceborne data, probably, is particularly large. Specifically, we are interested in methods capable of representing the spatial and temporal distribution of hydrologically relevant soil moisture for Austrian conditions.

Wednesday 8 September
16:10 – 17:50
MOZART 4-5

Session 3D1:

Bam Earthquake

Abstract No. 475

Using SAR Interferometry and Teleseismic Data to Determine Source Parameters for the 2003 Bam Earthquake

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The 26 December 2003 Mw 6.6 Bam (Iran) earthquake is the world's deadliest earthquake to occur for more than a decade. About 80% of buildings in the city of Bam collapsed during the earthquake, including large parts of the Bam citadel, which is more than 2000 years old. No large earthquakes are known to have happened in Bam prior to the 2003 event. The earthquake occurred on a near-vertical, north-south oriented strike-slip fault with primarily right-lateral displacement. In this study we combine Envisat-1 InSAR data and broadband teleseismic data to determine the source parameters for the Bam earthquake. The Envisat-1 radar interferograms are from radar scenes acquired from both ascending and descending orbits, which is critical in reducing trade-offs between estimated parameters of the fault geometry. The far-field teleseismic data are from several broadband seismic stations of the IRIS and GEOSCOPE worldwide seismic networks. Our fault parameter estimation comprises two main steps. During the first step we estimate the fault location and geometry using the InSAR data and teleseismic data independently. In the second step we divide the fault plane into many fault patches, and solve for variable slip on the fault plane using the InSAR and the seismic observations in a joint inversion. The Envisat-1 InSAR data have proven to be vital for the understanding of the Bam earthquake as no near-field ground based geodetic data are available.

Abstract No. 304

Interferometric Displacement and Damage Assessment for the 2003 Bam Earthquake

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We use interferometric displacement maps covering the Mw 6.6 Bam (Iran) earthquake on December 26, 2003 in ascending and descending viewing geometries derived from Envisat ASAR data to quantify the coseismic displacement field. From the observed line-of-sight displacements in ascending and descending geometries we estimate the approximate three-dimensional displacement field using a simple displacement model.Interferometric displacement maps are now used routinely to investigate earthquake processes and determine fault plane geometries and coseismic slip

accurately.Interestingly near real-time interferometric SAR products might also be used for damage assessment following major earthquakes. The Bam earthquake was the deadliest earthquake in 2003. An estimated 30000 people were killed and 85% of the buildings in the area were damaged or destroyed. We observe that the interferometric coherence in the coseismic interferograms is decreased markedly in the city of Bam. Using the high-resolution optical images acquired by the IKONOS sensor immediately after the earthquake we can relate this loss of coherence to the extensive destruction. Thus, the coherence maps can help provide accurate damage maps of disaster areas and possibly complement optical data sources. This may be particularly important in cases where optical data is unavailable, e.g. due to cloud coverage.

Abstract No. 548

Coseismic Deformation of the Bam Mw=6.5 Earthquake (Iran) from ASAR Interferometry and Slip Inversion by Boundary-element Method

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On December 26, 2003, at 07:56:56 GMT (05:26:26 local time), a destructive earthquake (Mw= 6.5) struck in the early morning hours, near the ancient city of Bam, southeastern Iran (USGS, 2004). An important cultural loss was the destruction of the ancient citadel of Arg-e-Bam, located on the historic Silk Road and thought to be over 2,000 years old. About 40,000 were killed, 30,000 injured, and between 45,000 and 75,000 are homeless.In this area, the Arabian Plate and the Eurasian Plate collide against each other and several large earthquakes happened in the past 20 years. As viewed from rigid plate, the Arabian Plate moves northward against the Eurasian Plate at a rate of 30 mm/yr. The relative plate motion vector in Iran along the Zagros Mtns. suggests both compression and right-lateral strike-slip of the Eurasian Plate against the Arabian Plate margin. This event occurred on the previously mapped north-south oriented Bam fault according to the field investigation. Due to this disastrous event ESA kindly provided it¡¯s newly launched Envisat ASAR data for scientific research. There are 7 ASAR SLC products, Image Mode, Swath 2, Polarization VV, same as ERS1 and ERS2. Both ascending pass and descending pass data are available and the perpendicular baseline values are 0.6 m and 2 m long respectively for deformation pairs. We have computed the coseismic deformation using descending pass data and found that the maximum slip of this event was about 70 cm (horizontal deformation) that¡¯s less than the result from teleseismic data (about 1.2 meters). We also combined ascending pass and descending pass data and amplitude offsets of the two passes for complete surface displacement field computing because of the consistent orientation between the fault trace and the azimuth direction of the Radar. At the same time we inverted the slip distribution of the Bam earthquake by 3D boundary-element method using INSAR data and triangular element discontinuities and compared the outcome with the results from teleseismic data inversion.

Abstract No. 559

Earthquake Mechanisms from Envisat ASAR Imagery: the 2003 Bam (Iran) Earthquake Rupture of a "Truly Blind" Fault

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InSAR has been extensively used with ERS SAR data to investigate surface displacements occurring in earthquakes. Because SAR interferograms provide direct measurements of the geometry of earthquake faulting, and can detect quite small movements, InSAR with ERS data has led to results that could not have been obtained with seismology. The Mw 6.5 earthquake that devastated the town of Bam in southeast Iran on 26 December 2003 was one of the first large shallow earthquakes for which there was prior coverage of Envisat ASAR data. InSAR studies using the Envisat radar data show that the Bam earthquake had two unusual features. Immediately after the earthquake it was assumed that the earthquake had occurred on a fault the surface trace of which is clearly visible in satellite imagery. However, surface displacements and decorrelation effects from InSAR show that the earthquake occurred on a previously unknown fault. It is common for earthquakes to occur on so-called blind faults, where the slip at depth does not fully reach the surface. Despite the lack of a significant surface rupture, repeated slip on these faults in earthquakes still produces long-term surface effects by which their existence may be recognised, such as drainage that incises into growing topography or is deflected as the fault increases in length. However, in the case of the Bam earthquake, there is a complete absence of any geomorphic expression of the fault on which the main rupture occurred, such that it could not have been identified prior to the rupture. The existence of such 'truly blind' faults makes the proper estimation of seismic hazard problematic. A second unusual feature of this earthquake is that it actually involved rupture on two faults. It was possible to derive ASAR interferograms from both ascending and descending Envisat passes in this case. Together with azimuth offsets derived as part of the InSAR analysis, the full 3-dimensional surface motion occurring in the earthquake could be determined. Modelling of these displacements suggests that the main rupture was on a mainly strike-slip fault and triggered slip on a neighbouring thrust fault, repeated earthquakes on the latter probably being responsible for the surface features seen in satellite imagery. That the surface displacements due to the main and secondary events could be separated was due to the availability of both ascending and descending interferograms, underscoring the value of regular acquisitions of ASAR data on ascending tracks in addition to those on descending tracks.

Abstract No. 644

Envisat InSAR Correlation Changes Reveal Surface Ruptures and Building Damage from 2003 Earthquake at Bam, Iran

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The small city of Bam in southeast Iran was devastated by a Mw 6.5 earthquake on 26 December 2003, killing almost half of the 100,000 people living there. We were fortunate that the Envisat background mission had already acquired a number of ASAR images of the area before the earthquake, enabling interferometric analysis of the effects of the earthquake. The first field visits after the earthquake concentrated on the fault scarp about 5 km east of Bam that was first mapped from aerial photographs in the 1970s, but there was no evidence of significant slip on this fault. We used Envisat images acquired after the earthquake to form interferograms and measure the interferometric correlation for both co-seismic intervals including the earthquake and pre-seismic intervals before the earthquake. Two extended linear zones of very low correlation were discovered. One zone south of the city is about 8 km long and trends directly into the center of the city, and field checks at this location showed that it was a fresh fault rupture with surface offsets of up to 25 cm. High resolution calculation of the co-seismic correlation revealed a very narrow zone (<100 m) of fault rupture including a series of sub-segments with step- overs between them. The second low correlation line northeast of Bam has a wider zone of decorrelation (100-200 m wide). Field checks of this location showed only minor surface breaks, indicating that the deformation measured by the InSAR was distributed over a wider zone instead of a discrete rupture. Combination of the ascending and descending Envisat InSAR pairs indicates that the northern rupture zone has a small convergence component and the southern rupture zone has a small extension component in addition to the primary strike-slip motion. The correlation measurements from the Envisat InSAR also recorded damage to the buildings in and around Bam. Some low correlation in the area is due to vegetation, especially the date palms for which Bam is famous. By subtracting the correlation image for the pre-seismic interval from the correlation image for the co-seismic interval, we can largely separate the decorrelation caused by the trees from the decorrelation caused by destruction of the buildings. The difference, or correlation change, image shows the heavily damaged central zone of Bam as an area of dramatic decrease in correlation. The residents of these buildings had the extreme misfortune of living less than 1 km from the fault that ruptured beneath the city in 2003.

Wednesday 8 September
16:10 – 17:50

KARAJAN 2-3

Session 3D2:

Forestry

Abstract No. 168

LAI Estimation of Boreal Forest with Envisat ASAR

T. Manninen[1], P. Stenberg[2], M. Rautiainen[2], P. Voipio[3], H. Smolander[3], K. Andersson[4]

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[3] Finnish Forest Research Institute, Finland
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The leaf area index (LAI) is one of the key parameters for detecting changes in the status of terrestrial ecosystems due to climate change. In large areas remote sensing is the only reasonable way to estimate LAI. Typically, estimates of LAI are derived using spectral vegetation indices (SVIs) calculated based on optical satellite data. The cloud cover, however, constitutes a major problem for optical LAI estimation of large areas. Therefore a microwave data based LAI estimation method would be valuable. Envisat ASAR alternating polarization data were acquired over two boreal forest test sites in Central Finland during summer, autumn and winter 2003. The swath range from IS1 to IS6 was studied. The results supported previously reported results obtained using ERS SAR and Radarsat data (Manninen et al., Proc. IGARSS'03). The VV/HH polarization ratio correlated quite well with the ground truth LAI values. The coefficient of determination was around 0.65 for the sites when data from all stands were used without separating between species. Using the average VV/HH ratio of all summer images or all images produced about the same R2 value as the best single image VV/HH ratio. For spruce (Picea abies L.) dominated stands the coefficient of determination exceeded 0.7 and for pine (Pinus sylvestris L.) dominated stands it was even higher. According to the results of this study Envisat/ASAR has potential in LAI estimation of boreal forests.

Abstract No. 508

Comparison of Stem Volume Retrieval Accuracy in Boreal Forest Using Multi-temporal ERS Coherence Images

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Among all spaceborne SAR and interferometric SAR quantities, the C-band ERS one-day coherence has been shown to have the highest sensitivity to forest biophysical parameters. Several studies have reported on methodologies for stand-wise stem volume retrieval in boreal forest, highlighting large accuracy (Santoro et al., 2002, RSE; Wagner, 2003; Pulliainen et al., 2003, RSE), which can reach a

level comparable to in situ measurements. A further step is now needed to determine to which extent forest biophysical parameters can be determined throughout an entire biome by using one methodology.The availability of ERS one-day coherence images and extensive in situ data from test sites located in Sweden, Finland and Siberia allows us to provide the first ever assessment on the consistency of stem volume retrieval within the boreal zone at stand level. For each test site at least six image pairs are available, acquired under a large range of perpendicular baselines (0 to 300 m) and several weather conditions typical of northern latitudes. The test sites are characterised by different forest structure and ground properties. The methodology applied is based on the semi-empirical Interferometric Water Cloud Model, IWCM, (Askne et al., IEEE TGRS, 1997) and on a multi-temporal approach (Santoro et al., RSE, 2002, Askne et al., IEEE TGRS, to be published).The relationship between coherence and stem volume measurements strongly depends both on the weather conditions at the time of acquisition and on the specific features of the test site, namely the forest structure and the ground dielectric properties. These aspects affect both the modelling results and the stem volume retrieval accuracy. It is always possible to fit the measurements used for training the model; nonetheless, a few parameters can become mere regression factors under specific weather conditions and/or forest structures. The baseline length significantly affects the modelled coherence when it is longer than 100 m. Best retrieval accuracy is obtained under frozen and stable weather conditions, for which the largest difference between ground and vegetation coherence is found. Image pairs acquired under changing weather conditions are unsuitable and must be discarded beforehand. Highest accuracy is achieved at the intensively managed test site in Sweden. The multi-temporal combination of image pairs acquired under winter-stable conditions produces stem volume estimates comparable to in situ measurements. At all other test sites, the retrieval error increases, depending on the test site specific properties. This study shows the dependence of the ERS coherence on both forest structural and dielectric properties. Since a similar result has been recently reported concerning the inversion of L-Band JERS SAR backscatter for stem volume retrieval at the same test sites (Santoro et al., submitted to IJRS), it is possible to conclude that the application of SAR in forestry cannot discern from the knowledge of the type of forest being investigated.

Abstract No. 474

Multitemporal ERS and Envisat Imagery for the Estimation of the Reforestation Process of Burned Areas

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According to personnel working in environmental agencies and state institutions the rate of biomass regrowth over burned areas can be a crucial factor for the damage assessment related to a forest fire event. In some cases the reforestation process is very fast and after two years the burned areas will be completely repopulated. In other cases such a process can take even decades so that the environmental and economic impact of the fire event is much stronger. The knowledge on the repopulation capability over burned areas of different types of vegetation is so far sparse and limited

to local experiences.Satellite data can alternatively offer the possibility of a more sistematic investigation on the topic. In particular, multitemporal SAR data could be suitable for this aim, in fact, the possibility to draw relationship between the amount of regrown biomass in a burned areas and intensity and/or coherence grade of the signal received is, in principle, feasible. In this study the potentialities of ERS/Envisat-SAR multitemporal data for the analysis of the reforestation process over burned areas are investigated. The summer 2000 burned area of Castel Fusano (near Rome) is the selected test site. Optical images have been considered for the detection of the boundaries of the burned area. The intensity and coherence of the SAR returns plus textural features have been examined over several passes of the satellites before and after the event. The reforestation process has been monitored attempting to classify the stage of the regrowth cycle.

Abstract No. 620

Forest Disturbance and Attributes Observed by Envisat ASAR

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Envisat ASAR C band data were requested from ESA in Howland, Maine USA, Boguchany area, Siberia, Russia, and Daxinganling, China for investigating the capability of the C-band multi-polarization data for forest disturbance characterization, and physical parameter retrieval studies. The repeat-pass alternative polarization single look complex images (ASA_APS_1P), and alternative polarization mode precision images (ASA_APP_1P) were acquired during the growing season of 2003. This study was designed to investigate the capability of the InSAR, and multi-polarization radar data from Envisat.The mixed hardwood and softwood forest at the Northern Experimental Forest, in Howland, Maine (45o28¡¦N, -68o40¡¦) provides a ideal study site because of the rich field observation data and various forest structures due to active management. It is an Ameriflux research site and the EOS MODIS validation site. The Boguchany wild fire test site was selected because of the presence of some large fire scars and logged areas in this location. The site is located at 97o 25¡¦ E and 59o 2¡¦ N, 75 km North of the Angara River and 350 km east of the Yenisey River in Eastern Siberia. The fires that caused the burn scars in this study were ignited by lightening and extinguished by rainfall. The fire was a strong surface and crown fire and by the time it was extinguished on August 8, 1996, 32 thousand hectares of forest, old clear cuts and dense regenerating stands were burned. The study site at Daxinganling, Hailongjiang Province, China, the Mohe (53.1o N, 122.5ƒno E) and Tahe Bureau of Forestry (52.5ƒno N, 124ƒno E), is an area burnt from 6 May to 2 June 1987, with 870,000 ha of forest destroyed. After the fire, the Chinese government implemented a 10-year program to suppress forest fire and plant trees in the burnt area.The characteristics of the fire scars and the conditions of the forest recovery were studied using ASAR data. The estimates of forest parameters from ASAR and other data such as ETM+ were compared, and the results will be presented in the paper.

Abstract No. 680

Burnt Area Detection by Envisat ASAR Wide Swath Backscatter in Boreal Forests of Siberia

S. Huang, F. Siegert

Remote Sensing Solutions GmbH, Germany

Wildfire disturbance is common and an integral part of the Boreal Eurasia ecosystem. The observed trend towards the occurrence of years with large fire damages in shorter time intervals and the presumable release of huge amount of carbon prompts for accurate information on the burnt area and the damages to the vegetation. Till now fire monitoring and burnt areas assessement in Russia are based on low resolution satellite imagery as NOAA AVHRR and hence fire regime is not well understood in Central and Eastern Russia. For the detection of burn scars optical remote sensing technology is of limited use because during summer when fires frequently occure a persistant clouds cover greater than 60% of the region in Siberia and dense haze from burning fires impede optical sensors. Therefore Synthetic Aperture Radar (SAR) systems with their ability to penetrate cloud and haze are a promising alternative. Because of the enormous size of the fire affected boreal region high resolution radar systems such as ERS or Radarsat are not operational for large scale monitoring. Therefore we investigated the capability of the medium resolution Envisat wide swath ASAR (WSM) mode. To approach this objective, 1.) the backscatter dynamics change of burnt forest and unburnt forest in a time series of seven ASAR WSM images was analysed: 2.) change detection analysis was applied to pre and post fire images to detect burnt areas; 3.) the backscatter of fire scars from different years was studied in monotemporal and multitemporal images. Our results show that 1.) ASAR WSM can be used to detect fire scars; 2.) the optimal time period in boreal forest of Siberia to detect fire scars is from May to early July, 3.) fire scars are difficult to detect after more than 3 years in monotemporal images. The main disturbing factors were wheather conditions during image acquisition, wetlands areas and layerover effects in mountain regions. The results suggest that ASAR WSM on Envisat is a usefull instrument for operational burnt area mapping over large areas.

Wednesday 8 September
16:10 – 17:50
MOZART 1-2

Session 3D3:

Atmosphere Retrieval (2)

Abstract No. 252

Retrievals of O3 and H2O in the Lower Stratosphere and Troposphere from Envisat

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Rutherford Appleton Laboratory, United Kingdom

A MIPAS processing scheme is being developed at RAL, which aims to complement the ESA operational Level 2 processor through optimisation for ozone and water vapour in the upper troposphere and lower stratosphere (UT/LS). Sections of spectrum (microwindows) have been selected to target O3 and H2O specifically in the UT/LS, and a tomographic approach can be implemented.The tomographic retrieval method models radiative transfer in 2-D, taking horizontal gradients in temperature and constituents into acount, and inverts measurements from multiple limb-scans simultaneously. This method can achieve higher horizontal resolution than is possible for conventional (1-D) limb sounding retrievals.In its nominal mode, MIPAS measures spectra at 0.025 cm-1 resolution at tangent-heights from 6 to 68 km (in 3 km steps up to 42 km) with ca. 512 km horizontal along-track spacing. One of the MIPAS special modes (S6) has been defined to sound the UT/LS with improved spatial resolution, by scanning from 6 to 35 km tangent-height (in 2 km steps up to 24 km) and with ca. 112 km along-track spacing, at the expense of reducing spectral resolution to 0.1 cm-1. Measurements in the S6 mode therefore provide the first opportunity to apply the principles of tomographic limb-sounding, which have been developed previously through simulations, to real satellite measurements.The RAL MIPAS retrieval scheme dedicated to UTLS O3 and H2O will be described and initial results will be presented.

Abstract No. 338

Retrieval of Atmospheric Parameters from MIPAS Measurements at IMK/IAA and Application to Atmospheric Sciences

T. Von Clarmann[1], H. Fischer[2], B. Funke[3], S. Gil-López[3], N. Glatthor[2], U. Grabowski[2], M. Höpfner[2], M. Kaufmann[3], S. Kellmann[2], M. Kiefer[2], M. Koukouli[3], A. Linden[2], M. López-Puertas[3], G. Mengistu Tsidu[2], M. Milz[2], T. Steck[2], G. Stiller[2], D. Wang[2]

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IMK operates in co-operation with IAA a processor for retrieval of atmospheric state parameters from MIPAS limb emission spectra. The processor has been designed for retrieval of abundances of

numerous atmospheric constituents with emphasis on species beyond those of the ESA near real time data product. For this purpose, the retrieval processor supports various approaches to constrain the retrievals, includes a generic model to calculate the excitation state of molecules under non-local thermodynamic equilibrium conditions for the actual atmospheric condition, and is able to retrieve MIPAS tangent-altitude-pointing information directly from the measured spectra. The option of 2-dimensional tomographic retrievals is available.Forward modelling of radiative transfer is performed by the Karlsruhe Optimized and Precise Radiative Transfer Algorithm (KOPRA), which supports single scattering at cloud particles and thus allos the retrieval of microphysical and chemical cloud properties. The IMK/IAA data product includes temperature, line-of-sight information,pressure, H2O, O3, HNO3, CH4, N2O, NO2, ClONO2, ClO, N2O5, HNO4, CFC-11, CFC-12 (in routine-type processing mode); the above in non-standard observation modes, as well as CO, NO, and NO2 under consideraion of non-local thermodynamic equilibrium (in expert processing mode); cloud parameters, HOCl, COF2, OCS, HCFC-22, C2H6, SF6 (processing parameters are currently optimized). Sample data products are presented and their application to the investigation of atmosphric processes is discussed.

Abstract No. 416

MIPAS Microwindows

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MIPAS acquires infrared spectra from 680-2410cm-1 at 0.025cm-1 resolution every 4.6 seconds, which is several orders of magnitude more measurement information than can be handled in a retrieval scheme incorporating an explicit radiative transfer forward calculation in near real time.Microwindows are subsets of of the full spectrum, typically up to 3cm-1 wide, chosen to maximise the information on the atmospheric parameters to be retrieved (ie profiles of temperature and/or composition) while minimising the forward model computation time. ESA's operational processing of MIPAS data uses from 2-7 microwindows perspecies to generate profiles of temperature, CH4, H2O, HNO3, N2O, NO2 and O3.The selection of these microwindows is described together with microwindowsselected for alternative retrieval schemes and additional products.

Abstract No. 478

Iteratively Regularized Gauss-Newton Method for Atmospheric Remote Sensing Applied to MIPAS and SCIAMACHY Limb Sounding Observations

A. Doicu

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In this paper we present an inversion algorithm for nonlinear ill-posed problems arising in atmospheric remote sensing. The proposed method is the iteratively regularized Gauss-Newton method. The dependence of the performance and behaviour of the algorithm on the choice of the regularization matrices and sequences of regularization parameters is studied by means of simulations. A method for improving the accuracy of the solution when the identity matrix is used as regularization matrix is also discussed. Results are presented for the retrieval of trace gas profiles from MIPAS and SCIAMACHY limb sounding observations.

Abstract No. 449

Bright Limb Observations by GOMOS, OSIRIS and SCIAMACHY

E. Kyrölä

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OSIRIS on board Odin and GOMOS and SCIAMACHY on board Envisat measure scattered sunlight in the limb direction. These measurements are used to derive vertical profiles of various trace gases. In this work we compare radiances and retrieved trace gas profiles from these instruments. We also investigate how well the radiative transfer modelling can explain observed radiances. This work is part of the Envisat AO-project LIMBVAL.

Poster Session 3P08:

Atmosphere Retrieval

Abstract No. 127

Simplification of SCIAMACHY's Polarisation Retrieval

G. Tilstra, N. Schutgens, P. Stammes

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We study the relationship between the two relevant Stokes parameters Q and U that describe the (linear) polarisation of the Earth's reflected radiation, and find it to be equal to or very close to the theoretical single scattering relation. This conclusion is drawn after careful inspection of polarisation data provided by both the POLDER instrument onboard ADEOS-I and a polarised radiative transfer code.As a consequence, performing additional measurements of the ratio U/Q does not provide that much new information about the atmospheric polarisation. This is a most important conclusion for SCIAMACHY, which currently relies on a self-measured value of U/Q. Apart from being unnecessary, this measured value is currently also known to be very unreliable. Therefore the theoretical single scattering value of the ratio U/Q instead of the measured value is currently used in the polarisation-retrieval of SCIAMACHY.

Abstract No. 336

Retrieval of Temperature and Pointing Information from MIPAS Limb Emission Spectra

T. Von Clarmann[1], H. Fischer[2], B. Funke[3], S. Gil-Lopez[3], N. Glatthor[2], U. Grabowski[2], M. Hoepfner[2], S. Kellmann[2], M. Kiefer[2], A. Linden[2], M. López-Puertas[3], M. Lopez-Valverde[3], G. Mengistu Tsidu[2], M. Milz[2], T. Steck[2], G. Stiller[2], D. Wang[2]

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Accurate knowledge of instrument pointing in terms of tangent altitudes and tangent altitude increments is crucial in limb sounding. In case of MIPAS, the star-camera based pointing information provided can be improved by exploitation of the spectral measurements themselves. We present an optimal-estimation based concept for joint retrieval of temperature and line-of-sight pointing information, which has been tailored to the MIPAS instrument. After testing this algorithm on the basis of synthetic measurements, it has been used for independent pointing assessment of the MIPAS instrument during the commissioning phase of Envisat, as part of the MIPAS calibration/validation activities. Intercomparison of nominal and retrieved tangent altitudes reveals a pointing offset, oscillations, and discontinuities. In order to remove offset and oscillations, ESA has implemented a mispointing correction. The retrieval method presented here now is used to independently verify the MIPAS pointing information. Examples of retrieved versus nminal tangent altitudes are shown.

Abstract No. 366

Tomographic Retrieval Approach and Diagnostics for MIPAS-Envisat

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The Fourier transform spectrometer MIPAS (Michelson Interferometerfor Passive Atmospheric Sounding) on Envisat measures infraredemission of the Earth's atmosphere in a limb viewing mode.Due to the long ray path, limb sounders are sensitive to evenlittle abundant species. However, horizontal gradients causesystematic errors within the retrieval if a horizontallyhomogeneous atmosphere is assumed.A dedicated method of taking full 2-dimensional (2d) fields ofstate parameters into account is presented. The 2d state vectoris updated sequentially for each limb scan. The diagnosticscomprise estimated random error, vertical and horizontal degreesof freedom for retrieval, as well as vertical and horizontalresolution. Analysis of 2d Jacobians and averaging kernels giveinformation on the spatial origin of the spectral signal andatmospheric parameters.

Abstract No. 386

Regridding of Remote Sounding Measurements and Application to Ozone Profile Intercomparisons

Y. Calisesi[1], V. Soebijanta[2]
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Homogenization of the comparison data is a prerequisite to any intercomparison of atmospheric constituents profiles. In the case of remote sensing observations, the homogenization procedure is hampered by the mapping of the retrieval results on different numerical grids, depending on the involved retrieval algorithms. Among others, the question of homogenizing the retrievals vertical coordinates for comparison purposes deserves particular attention. Simple vector interpolation is mostly unsatisfactory in this case, as the vertical grid associated to each retrieval result constitutes indeed an integral part of that result, and should therefore be taken into account in subsequent profile transformations.Recently, a method of comparing remote sounders while allowing for different observational characteristics was proposed by Rodgers and Connor [2003]. At the time of publication, application of this method was, however, restricted by its authors to comparisons of identical state vectors. We propose to relax this condition, by the use of a linear transformation function to regrid the products of remote sensing observations. Thanks to the linear transformation matrix, the regridding of the retrieved profiles and associated averaging kernels becomes straightforward. We combine this method with the procedure described by Rodgers and Connor [2003] to compare independent ozone profile measurements performed during 2000 by the Global Ozone Monitoring Experiment (GOME) onboard ERS-2, and the MeteoSwiss ground-based

microwave radiometer (MW) located in Payerne, Switzerland. As a result and after removal of identified comparison artefacts according to Rodgers and Connor [2003], an overall +/- 20% (2sigma-width) agreement was observed between a total of 84 coincident MW and GOME measurements. Confirmation of the achieved comparison results was obtained by considering a control MW retrieval series, computed firsthand on the original GOME retrieval grid.References:Rodgers C.D., and B.J. Connor, Intercomparison of Remote SoundingInstruments, J. Geophys. Res., 2003, doi:10.1029/2002JD002299Note: This contribution is dedicated to Vincent.

Abstract No. 399

Retrieval of Atmospheric Trace Constituents from Envisat MIPAS Observations by Means of Rapid Radiative Transfer Calculations: First Results for CFC-11

L. Hoffmann, M. Riese, P. Preusse, R. Spang, M. Ern, M. Kaufmann
Forschungszentrum Juelich, Germany

Up to now, several retrieval processors for Envisat MIPAS observations have been developed. Almost all of them utilize forward models which compute the radiative transfer by means of line-by-line calculations. These calculations are most exact, but computationally expensive and time-consuming. In this context, it is worthwhile to consider approximative methods. The BANDPAK software library of G & A Technical Software, Inc. utilizes the Curtis-Godson approximation and the emissivity growth approximation as well as sophisticated computer techniques (e.g. emissivity look-up tables) to speed up radiative transfer calculations by three to five orders of magnitude. The library has been used successfully for the evaluation of several UARS instruments and the CRISTA satellite experiment. We developed a retrieval processor for Envisat MIPAS utilizing the BANDPAK library for forward modeling. The processor allows for global fit and optimal estimation retrievals. The retrieval system proposed to ESA will complement the results of the operational retrieval of Envisat MIPAS observations by additional comprehensive distributions of minor trace species. These are especially suited for trend-analyses of atmospheric dynamics and chemistry. We give a detailed description of the retrieval system and present first retrieval results of chlorofluorocarbon distributions derived from Envisat MIPAS measurements.

Abstract No. 401

Ozone Profile Retrieval from SCIAMACHY Nadir Measurements

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SCIAMACHY on-board Envisat measures the reflected and backscatteredradiation from the Earth in limb and nadir geometry. The FUll retrieval method FURM is an advanced optimal estimation

scheme to retrieve ozone profiles from nadir measurement in the UV and visible spectral range and it has been successfully used to retrieve ozone profile from GOME. Here, FURM is applied in a first case studies to nadir measurements of SCIAMACHY. Implications of the radiometric calibration of SCIAMACHY for deriving nadir ozone profiles will be discussed.

Abstract No. 410

Retrieval of tropospheric ozone columns from GOME observations.

R. Van der A, A. Segers, H. Eskes, M. Van Weele
KNMI, Netherlands

A retrieval method will be discussed to derive global tropospheric ozone columns from GOME observations. Ozone profiles and their averaging kernels have been retrieved from GOME. Using meteorological information from ECMWF, these profiles and kernels are assimilated in the chemical-transport model TM to derive a global 3D ozone field. The retrieved and assimilated ozone profiles are validated with ozone sondes. Total ozone columns from GOME are calculated with the TOGOMI DOAS-algorithm. By subtraction of the stratospheric ozone profile from the total ozone column a tropospheric ozone column is derived. The tropospheric ozone columns are compared to chemical-transport model results. First results for the year 2000, calculated within the TEMIS project, will be presented.

Abstract No. 451

A Neural Network Algorithm for the Retrieval of Temperature Profiles from GOME Radiance Measurements

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Monitoring the Earth's atmosphere in order to understand the chemical and physical processes therein represents one of the main objective aimed by the satellite remote sensing instruments. In particular, the atmospheric thermal structure, which has a relevant influence on the circulation mechanism of air masses and on the distribution of trace gases in the atmosphere, results from a very complex interplay between radiative and physical processes. Neural networks algorithms can be a useful tool to face with such complexities in retrieval operations. They are composed of many nonlinear computational elements (called neurons) operating in parallel and linked with each other through connections characterized by multiplying factors. This structure makes neural networks inherently suitable for addressing nonlinear problems. The derivation of particular rules or statistical a priori information on the data to be processed is not necessary. The neural networks establish the

inverse mapping and the input-output discriminant relations on the base of data presented to them during the learning phase. In this study neural networks potentialities have been exploited to design a real time algorithm for the retrieval of vertical temperature profiles from the spectral radiances measured by the Global Ozone Monitoring Experiment (GOME), the instrument boarded on the satellite ERS-2 and expressively addressed to the monitoring of the global distribution of ozone and other trace gases through the spectral analysis of the sunlight backscattered from the Earth's atmosphere in the UV-VIS range.Several algorithms have been already implemented for the retrieval of such distributions. However, their performance might be significantly improved by a priori knowledge of temperature gradients. The neural network designed for the temperature estimation has been trained having in input GOME measurements belonging to the spectral range of 321-325 nm, where the radiance signal shows a strong dependence on the temperature profile; the output is, on the contrary, represented by temperature profiles extracted from atmospheric databases. The training dataset collects measurements from two years, 1997 and 1998. Once trained, the retrieval performance of the neural algorithm has been tested on a validation dataset, which includes measurements from the same two years but not belonging to the training set. It has to be reminded that the results obtained in this study could be easily extended to the measurements provided by SCIAMACHY, the instrument successor of GOME boarded on the Envisat satellite.

Abstract No. 514

Profile Retrieval of SCIAMACHY Limb Sounding Observations

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In this contribution we like to present the results of the profile retrievals from SCIAMACHY Limb sounding observations. At DLR-IMF the development of the SCIAMACHY Level 2 Offline data processor wrt limb observations is supported by an independent study system. This study system contains different retrieval methods. Taking into account the experience gained from the study system, the SCIAMACHY Level 2 offline data processing can be optimised and advancementof the data processor can be initiated. We present a detailed discussion with a special emphasis to O3 and NO2 profile retrieval from SCIAMACHY limb sounding measurements.

Abstract No. 524

Studies in Support of an Advanced ESA Mission to Sound Atmospheric Composition after Envisat

B. Kerridge[1], A. Baran[2], M. Birk[3], S. Buehler[4], C. Camy-Peyret[5], C. Clerbaux[5], A. Dudhia[6], E. Mattias[7], C. Emde[4], P. Eriksson[7], F. Friedl-Vallon[9], D. Grainger[6], J. Greenough[10], M. Hoepfner[9], V. Jay[1],

P. Jeseck[5], F. Lama[6], B. Latter[1], A. Maurellis[11], D. Murtagh[7], Y. Reburn[1], J. Remedios[10], R. Siddans[1], R. Spang[12], T. Steck[9], G. Stiller[9], C. Teichmann[4], T. Von Clarmann[9], M. Wickett[13]

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During the last three years, two studies have been undertaken in parallel for ESA to consolidate the scientific basis for an advanced future mission to sound atmospheric composition in the period beyond Envisat. In this paper, an overview will be given of the scope and principle findings from these two ESA studies.The "Atmospheric Chemistry Observational Requirements Study - 2nd Extension" focused on refining the specifications of new instruments in polar orbit designed for: (a) limb-sounding of the upper troposphere and lower stratosphere and (b) nadir-sounding of the troposphere at near-IR wavelengths. These instruments were selected (as for the candidate Explorer Core mission ACECHEM (SP-1257(4))) to extend and complement the observational capabilities of the future operational missions MetOp and NPOESS in the most effective way. Novel aspects of simulations performed for the limb-sounders were: (a) to use 2-D radiative transfer and retrieval models to determine error sensitivities and to define instrument specifications and (b) to investigate quantitatively the potential value of a limb cloud imager to support UTLS trace gas retrievals from the limb FTIR emission sensor. The near-IR nadir-sounding part of the study focused on refining the specifications of Fourier transfrom and grating spectrometers by means of detailed retrieval simulations and comparison against(externally specified) requirements for worthwhile satellite observations of CO2, CO, CH4 and other hydrocarbons. Through the "Consideration of a Mission Studying Chemistry of the Upper Troposphere and Lower Stratosphere" the state-of-the-art for limb-sounding of the UTLS region has been advanced in three major ways: firstly, through pioneering development of tomographic (ie fully 2-D) retrieval schemes for the advanced mm-wave and IR limb-sounders MASTER and AMIPAS and performing iterative, non-linear retrieval simulations for multiple trace gases in the presence of realistic, horizontal (and vertical) structure in temperature, trace gas and cloud fields; secondly, through development of a radiative transfer model (ARTS-2) to calculate rigorously limb radiance spectra for a multiply-scattering 3-D cloud field and, thirdly, to determine penetration depth into the troposphere for limb-sounding at different wavelengths as a function of latitude and time of year, on the basis of ECMWF temperature,humidity and cloud fields. The two tomographic (2-D) retrieval schemes developed in this ESA study are now being adapted for application to observations by Envisat MIPAS in its UTLS special mode (S6), in order to perform a first practical demonstration of tomographic limb sounding of the UTLS.

Abstract No. 667

Mesospheric and Lower Thermospheric Temperature and CO2 Vmr as Measured by MIPAS/Envisat

M. López-Puertas[1], T. Von Clarmann[2], H. Fischer[2], B. Funke[3], S. Gil-López[3], N. Glatthor[4], U. Grabowski[5], M. Höpfner[5], M. Kaufmann[3], S. Kellmann[4], M. Kiefer[5], M. Koukouli[6], A. Linden[5], G. Mengistu Tsidu[5], M. Milz[5], T. Steck[4], G. Stiller[5], D. Wang[5]

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The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is ahigh-resolution limb sounder on board the Envisat satellite, successfullylaunched on March 1, 2002. MIPAS has a widespectral coverage, high spectral resolution (0.05 cm-1, apodised), and highsensitivity, which allows to measure,simultaneously, the kinetic temperature, the CO2 volume mixing ratio, andnon-LTE populations of vibrational levelsemitting at 15, 10 and 4.3 μm in the upper atmosphere. This data set is veryuseful for better understanding the non-LTEin CO2 and the composition and energetics of the upper atmosphere. MIPASscans the limb operationally from 6 km up to 68 kmand up to 120 km for special modes of observations. In this work we presentretrieved non-LTE parameters associated to theCO2 4.3 and 2.7 μm emissions, as well as temperature and CO2 vmr profilesretrieved from the spectra taken byMIPAS on 1 July 2002 and 11-14 June 2003.

Wednesday 8 September
16:10 – 17:50
DOPPLER

Session 3D4:

Wind and Wave (2)

Abstract No. 403

Assimilation of ERS and Envisat Wave Data at ECMWF

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Unlike atmospheric data assimilation which started in the 1960's, wind-wave data assimilation emerged in 1980's. Satellite wave data are assimilated to enhance the "nowcast" and to improve the forecast of the wave model. This has proved to be of great value (see, e.g. Komen et al., 1994). As an example, Bidlot et al. (2002) showed that assimilation of satellite radar altimeter wave heights reduces the model wave height errors with respect to buoy observations by about 10-20%. Operational assimilation of ERS-1 radar altimeter (RA) fast delivery wave heights at ECMWF started on 15 August 1993 (Janssen et al., 1997). This was followed by the transition to ERS-2 on 1 May 1996 and to Envisat on 22 October 2003. Furthermore, ERS-2 Synthetic Aperture Radar (SAR) wave data have been assimilated since 13 January 2003. Wave data assimilation at ECMWF is based on the optimal interpolation (OI) technique as described by Lionello et al. (1992).The impact of wave data assimilation based on the ECMWF experience will be presented. This includes the impact of assimilation on the analysis and forecast. Verifying data from wave model analysis, in-situ (wave buoy) observations, satellite observations and a combination of all of these sources (multiple-correlation) are used for this purpose.REFERENCESBidlot, J., Holmes, D.J., Wittmann, P.A., Lalbeharry, R., and Chen, H.S. 2002. Intercomparison of the Performance of the Operational Wave Forecasting Systems with Buoy Data. Weather and Forecasting, 17, 287-310.Janssen, P.A.E.M., B. Hansen, J.-R. Bidlot 1997: Verification of the ECMWF wave forecasting system against buoy and altimeter data, Weather and Forecasting, 12, 763-784.Komen, G.J., Cavaleri, L., Donelan, M., Hasselmann, K., Hasselmann, S., and Janssen, P.A.E.M. 1994. Dynamics and Modelling of Ocean Waves, Cambridge University Press, Cambridge, UK, 532 p.Lionello, P., Gunther, H. and Janssen, P.A.E.M. 1992. Assimilation of Altimeter Data in a Global Third Generation Model. Journal of Geophysical Research, C97, 14453-14474.

Abstract No. 57

Comparison of Envisat ASAR Data with Met Office Global Spectral Wave Model

J. Li, M. Holt
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The Met Office routinely runs a global spectral wave model providing analyses and forecasts of sea state on a grid spacing of approximately 60 km. The modelled two-dimensional wave energy spectra are compared with along track Envisat ASAR observations on a daily basis. Comparisons are made for selected wave period ranges. Preliminary results indicate that Envisat ASAR level 2energy

spectra are systematically higher in the long periods (>16 s) or low frequency parts than the modelled spectra. There is a better agreement in the mid-periods of about 8-16 s. Model values of significant wave heights, derived from the wave energy spectra, are compared against the Envisat RA2 altimeter data as an independent data source, providing additional judgement on performance of the Envisat ASAR and the spectral wave model. The modelled significant wave heights are in goodagreement with the along track altimeter data. Following the EU Framework Program 5 project MAXWAVE, some new spectral diagnostics are calculated from both the wave model and the ASAR data. The usefulness of these extra diagnostics is assessed.

Abstract No. 99

EDOWA: Envisat Data for Operational Wave Analysis

H. Hajji
MétéoMer, France

EDOWA co-funded by ESA aims to upgrade and improve the operational wave analysis and forecasts provided by MétéoMer. This should be performed by integrating Envisat ASAR and RA2 ocean measurements into the MétéoMer's wave model. In this paper, we will present the MétéoMer operational wave system and the new wave model which was implemented to achieve ESA wave observation assimilation. Some relevant details of the retained assimilation procedure will be given. Results of the different assimilations including the operational model as well as the new model with and without assimilation will be showed.

Abstract No. 140

Assimilation of ASAR Envisat Wave Spectra in Wave Model WAM: Toward Operational Use

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Since the launch of the Envisat satellite, directional spectral information of the sea states has became available from the on board Advanced Synthetic Aperture Radar (ASAR). Previous studies carried out at Meteo France (Aouf et al. 2003) showed that the assimilation of such observations in wave model induces a better estimate of the sea state (wave height, mean direction and period), especially when swell is dominant.We first present a validation of Envisat ASAR data provided by the European Space Agency (ESA) for a three months period, based on comparison with wave model

(WAM) outputs. Then, runs with assimilation of wave spectra for this period (January, February and March 2003) have been performed in order to set-up an operational assimilation scheme for operational use. A global scale version of the WAM model WAM at a resolution of 1x1 degrees in latitude and in longitude has been implemented and the assimilation scheme consists of using the partitioning concept and an optimal interpolation of observed and modeled mean wave parameters. The azimuthal cut-off of ASAR spectra is taken into account in the assimilation scheme and the sensitivity of the scheme to different values of azimuthal cut-off (corresponding to 0.1 and 0.08 Hz frequencies or 150 and 240 m wavelength) has been assessed. One difficulties of using ASAR data lies in their quality control. In order to eliminate erroneous data, the signal to noise ratio and the retrieved ASAR wind speeds are checked.The intercomparison between observed and modeled wave parameters shows that more than 70% of data can be used for assimilation. Results show that the assimilation procedure works properly with a reduction of the difference significant wave height and mean period from model and ASAR. Significant wave heights from the assimilation of ASAR spectra are compared to those obtained from the assimilation of ERS2 altimeter data. First we have confirmed that the use of directional spectral information induces a larger impact in the forecast period than the use of significant wave height only. Secondly, statistical analysis performed at crossover locations of JASON-1 and Envisat satellite tracks, showed the best performance in terms of mean bias and RMS errors for the assimilation of ASAR spectra in comparison with JASON-1 altimeter data. In other respects, the assimilation tests with different values of azimuthal cut-off have shown that the use of inaccurate azimuthal cut-off can deteriorate the analyzed wave parameters. In the context of future work, preliminary results on combined assimilation using altimeter and ASAR data in wave model will be also presented.

Abstract No. 351

Rapid Nearshore Wave Climate from Earth Observation Measurements

G. Wensink
ARGOSS, Netherlands

Satellites are routinely collecting metocean data since 1985. Scatterometers provide detailed information on wind speed and direction. Altimeters can measure the wind speed and significant wave height, and from SAR data, spectral wave information can be derived. At ARGOSS, methods were developed and implemented to obtain reliable offshore wind and wave climate information from these measurements. Many applications, however, require nearshore wave climate. The density and resolution of satellite data is not sufficient for that purpose. Instead, the neighbouring offshore data are transformed to the nearshore location. We present a simple but effective method to carry out this transformation, and show validation case studies. Nearshore wave transformation - In the transition from deep to shallow water profound changes in the wave climate may occur. The most relevant physical processes involved are sheltering by islands and capes, refraction, shoaling, breaking and in some situations bottom friction. These processes are implemented in a model that transforms individual wave spectra from deep water to a shallow water target point assuming locally

straight parallel depth contours. Only the seaward normal direction, the depth at the target point, the depth profile in the normal direction (for friction), and neighbouring shorelines (for sheltering) are taken into account. Calibrated offshore directional spectra are split in a sea and a swell part. From these, nearshore spectra are computed based on all processes except breaking. A significant wave height limitation due to breaking is applied to wind sea and swell spectra separately. Spectral shapes of wind-sea and swell are assumed to remain unaffected. Finally, the nearshore wave climate is obtained from a statistical analysis of the computed nearshore wave data. Tests - A number of case studies were carried out to validate this approach. One case study was located at Duck Beach at the east coast of the United States. In this study in-situ wave measurements from NOAA are available both offshore and nearshore, and satellite altimeter and SAR data are available offshore.Nearshore results for wave height and direction are compared. In another validation study at the west side of the US the effects of sheltering are more prominent, and in a study near Chile the statistics of different swell systems are important. In all case studies the simple transformation approach performed well.

Poster Session 3P09:

Wind and Wave

Abstract No. 341

Cross Calibration of Envisat, ERS-2, JASON, TOPEX-POSEIDON, and Geosat Follow-on Wind and Wave Data, Based on Comparisons with In-situ Data and Wave Model Analysis Fields

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[3] *Météo France, France*

We present a calibration of significant wave heights and wind speeds of Envisat against in situ buoy data and model analysis fields and, through this, a cross calibration and comparison against other concurrent altimeter data sets (ERS-2, JASON-1, TOPEX, Geosat Follow-On). Series of co-located data sets of altimeter data, in-situ data (wave buoys) and model wind and wave analysis fields have been generated for the years 2002-2004. For this study, data from buoys in the Atlantic and Pacific Oceans (courtesy of US NDBC, UK Met Office, and Canada Marine Environment Data Service) are used. Wind and wave model analysis fields were supplied by Méteo France. The procedure adopted aims to provide a true estimate of errors in the altimeter, buoy and model wind and wave data, and to use these errors to calculate the true regression coefficients between all data sets. In the general case, errors are to be found within the reference and altimeter data sets. A recently developed technique is applied to these multiple colocation data sets. Making the assumption that we have independent data sets we generate estimates of error in each of the data sets. Under the assumption that the errors in each of the estimates of wave height (or wind speed are uncorrelated it is possible to express the mean square errors (i.e. bias2 + variance) of each as a simple function of terms that are easily calculated from the data. Using these methods we estimate the errors in each input data source, and these errors are used to scale orthogonal regressions between the data sets to generate calibrations and residual errors for each data source. In addition, it is important to note that the results gave an indication of possible inconsistencies between data from the buoys operated by different agencies (NDBC, UKMO, CMEDS). Whilst the cause is not clear (and may be environmental or instrumental) the conclusion to draw is that it should not be assumed that all buoy data are consistent with each other.

Abstract No. 402

Global Validation of Envisat RA-2 Wind and Wave, and MWR Products

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Envisat fast delivery wind speed and significant wave height products from the RA-2 instrument and wet tropo correction and total column water vapour products from the MWR instrument have been monitored and validated against corresponding parameters from ERS-2, buoys, first-guess and analyzed ECMWF data over the period of the 18th of July 2002 until the 20th of March 2004. In general fast delivery wind speed data are of acceptable quality except for the period of 23rd of October 2002 to the 7th of April 2003. However, they do suffer at low (below 5 m/s) and high (above 20 m/s) wind speed regimes. Regarding the Ku-band significant wave heights, we note that the Ku-band RA-2 observations are of high quality. This follows from a quintuple collocation where each product is assumed to be the sum of a linear function of the truth and an error. Results suggest that the relative random errors compared to corresponding mean values are 6.6%, 7.3%, 9.7% and 5.2% for Envisat RA-2 wave heights, ERS-2 RA wave heights, buoy wave heights and analyzed wave heights, respectively. Taking the buoys as a reference it is found that the RA-2 wave heights are too high by 2.0%, while the ERS-2 and analyzed wave heights are too low by 4.5% and 5.0%, respectively. The RA-2 S-band wave height product is generally of acceptable quality except for a number of clearly wrong outliers. The global mean of S-band wave height value showed a step-wise change with respect to Ku-band and the model. This seems to be corrected in November 2003.Apart from short periods of degraded quality, the MWR products are generally of acceptable quality. However, they tend to be drier than the model for low values and converge to the model at higher values. They used not to show the saturation behaviour that one would expect based on theoretical arguments. This was corrected on the 26th of November 2003.

Abstract No. 606

Ocean Wave Period from Space: Validation Using Envisat RA2 Data

C. Gommenginger[1], D. Cotton[2], M. Srokosz[1], P. Challenor[1]

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The ability to measure ocean wave period globally, regularly and with accuracy is of great interest both operationally and for research. A novel source of ocean wave period was recently proposed with a new empirical algorithm which proposes to retrieve ocean wave period directly from satellite altimeter data (Gommenginger et al., 2003, GRL). The empirical model, developed from a large dataset of Topex altimeter data collocated with moored buoy spectra, indicates an r.m.s. error under 1 second globally, and under 0.8 s in wind sea conditions. In this paper, the same approach is applied to RA2 data collocated with buoy measurements, in order to check the validity of the concept for Envisat and produce an dedicated empirical model for the retrieval of wave period with RA2. In addition, the sensitivity of RA2 S-band data to long ocean waves is considered in order to define whether S-band measurements are better suited to ocean wave period retrieval from space.

Abstract No. 617

A Comparative Study of Extreme Waves by Satellite Data

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The extreme values of significant wave height represent fundamental data to forecast wave risk in coastal zones. The probability that significant wave height exceeds an assigned threshold, P(Hs>h), has in general obtained, by in situ data. However the utilization of such data introduces a limit: the data are punctual (limited to neighboring area the buoys) although they are continuous in the time. The measure of wave motion through satellite data, arranged with numerical models, constitutes a powerful tool to obtain informations about waves for engineering purpose. In this paper the significant wave height extracted from altimeter radar of the ERS-2 and Envisat satellite is analyzed to establish statistics of levels of wave motion to obtain assessments of the same one in limited areas of coastal zones. Moreover space-temporal window, centered on Mediterranean buoys, are considered to estimate the differences between in-situ an satellite data.

Abstract No. 674

Numerical Simulation of Active Sensor Sea and Wind Response over Shallow Sea

E. Pugliese Carratelli[1], C. Giarrusso[2], G. Spulsi[3]
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[2] *Delft Hydraulics, Netherlands*
(not available)

Wednesday 8 September
16:10 – 17:50
MOZART 3

Session 3D5:

Scatterometer Applications (2)

Abstract No. 312

Services using Soil Moisture Measured from Space

R. Beck, F. Groesz
NEO BV, Netherlands

In a series of projects since 1997 methods to exploit soil moisture information retrieved from especially the ERS-scatterometers have been prototyped, tested and validated in projects in which NEO participated. In this presentation the scope and market of services in drought and yield estimation, hydrology and climatology will be discussed, once guaranteed data will be available.

Abstract No. 379

Soil Moisture Products from C-band Scatterometers: from ERS-1/2 to METOP

K. Scipal, Z. Bartalis, V. Naeimi, W. Wagner
Vienna University of Technology, Austria

Despite scatterometer applications over land have so far received comparable little attention by the scientific community, it has resulted in the first multi-year, global remotely sensed soil moisture data set. This data set was derived from ERS-1/2 scatterometer data (1992-2000) and has been found to be of comparable quality with state-of-the-art modelled products. An exciting aspect of these developments is that the ERS scatterometer mission will find a continuation in the Advanced Scatterometer ASCAT. The Advanced Scatterometer will be part of EUMETSAT Polar System (EPS) and will be nearly identical to the ERS scatterometer. It is designated as an operational system with the intention to ensure data continuity over an initial period of at least 14 years, staring in 2005. Principally, the methods developed for the ERS scatterometer should be directly applicable to the Advanced scatterometer. Thus, it should be possible to deliver operational 25 km soil moisture products in quasi-real time (2-3 hours after reception) with an accuracy of about 0.05 m3m-3 from 2006 onwards. This would result in a dataset interesting for real time applications as well as for long-term studies in the field of climate change.Nevertheless, slight differences in the design and operation of the two sensors oblige a careful use of measurements coming from the two sensors. The ASCAT sensor will use a slightly lower frequency than the ERS scatterometer, a different calibration procedure will be applied, it will use six antennas instead of three and it will have a higher resolution. It is the intention of this paper to review the differences in the sensor design and operation and its possible impact on data characteristics. Further, the suitability of the methods developed for the ERS scatterometer for application for Advanced scatterometer data will be analysed.

Abstract No. 436

Effectiveness of C-band Scatterometer in Hydrological Tasks

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In hydrological modelling it is essential to determine soil moisture content and storage capacity in its spatial and temporal variability as precisely as possible. Several studies, for instance Nielsen et al. (1973), Vinnikov et al. (1996) and Grayson et al. (1997), showed the dependencies of soil moisture spatial variability on parameters such as vegetation, soil type, topography and meteorological patterns. Normally, soil moisture is measured using in-situ techniques, which provide accurate soil moisture calculations only at point scale. Remote Sensing techniques, especially microwave instruments offer large potential for measuring soil moisture and capturing its variability over various space and time scales. A promising microwave instrument is the Synthetic Aperature Radar (SAR). Due to its fine spatial resolution, great efforts have been done to obtain soil moisture of those data. But so far most retrieval methods are still experimental. On the other hand a tremendous progress has been made in providing soil moisture from coarse resolution systems. The C-Band Scatterometer on board the European Remote Sensing Satellite (ERS) acquires large-scale soil moisture content in the top layer (0-5 cm) with a temporal resolution of 3-4 days, and a spatial resolution of about 50 x 50 km. In a primarily study the quality of Scatterometer soil moisture product was evaluated. The Scatterometer derived soil moisture was compared to hydrometric data, such as daily runoff and water level data for one of the major rivers in Southern Africa: the Zambezi River. Between these two data sets a reasonably fit was identified. Additionally the data peaks of soil moisture and those of hydrological data showed a temporal shift amounted thirty days at the headwater of Zambezi River whereas at downriver areas it increased to about sixty days. This shift is caused by soil dependent response time to precipitation events. To quantify the shift, a regression model was used, which determined correlation coefficents above $R^2=0.8$ for all stations. This study presents the remarkable quality of Scatterometer soil moisture products. The results indicate the potential of coarse soil moisture for improvement and application of hydrological models. These data might build up an important data source in hydrological modeling and validation. For this, hydrologists requires a finer spatial resolution. The future challenge will be to develop a downscaling approach for efficiently using of C- Band Scatterometer data. References: Grayson, R.B., A.W. Western and F.H.S. Chiew (1997): Preferred states in spatial soil moisture patterns: Local and nonlocal controls, Water Resources Research, Vol. 33, pp. 2897- 2908.Nielsen, D.R., J.W. Biggar, K.T. Erh (1973): Spatial variability of field measured soil water properties, Hilgardia, Vol. 42, pp. 214-259.Vinnikov, K.Y., A.Robock, N. Speranskaya, C.A. Schlosser (1996): Scales of temporal and spatial variabilty of midlatitude soil moisture, J. Geophysical Res., 101, 7163-7174.

Abstract No. 584

Analysis of ERS SAR and Wind Scatterometer Data Complementarity over an Agro-pastoral Sahelian Area

S. Zine[1], P. Frison[1], L. Jarlan[2], E. Mougin[2], P. Hiernaux[3], J. Rudant[1]
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[2] CESBIO, France
[3] University of Hohenheim, Germany

ERS Wind Scatterometers have demonstrated their abilities for large-scale land surface monitoring. It is particularly true for arid and semi-arid areas, where the marked seasonality of key parameters (such as soil moisture and above ground biomass) combined with strong sensitivity of scatterometer data to these parameters have led to quantitative studies. These have been conducted over rangeland areas along a north-south gradient in Sahel to estimate those key parameters and retrieve surface characteristics using inversion algorithms. This paper presents an extension of that work to different agroclimatic conditions throughout the Sahel, with a study conducted over an agro-pastoral site in the Fakara region (southwestern Niger), characterized by a very heterogeneous land use. To evaluate heterogeneity effects, a temporal profile of ERS WSC backscattering coefficient at 23° of incidence angle is analyzed over year 1995 using ERS SAR data. In particular, one-day spaced SAR tandem data show spatial pattern related to dramatic changes in soil surface conditions, in total agreement with WSC profiles. The contributions of the different landscape units (i.e. millet crops, herbaceous vegetation, bush and bare soil) within a WSC resolution cell are evaluated. This study is then extended over the 1994-2000 period at 23° and 45° of incidence angle, using biomass and soil moisture ground measurements to calibrate a regional Sahelian grassland model that simulates the evolution of surface parameters, and a radiative transfer model. Good simulation results led to surface parameters inversion after a simplification of the model.

Abstract No. 556

The Advanced Scatterometer (Ascat) on the METOP Satellites: an Operational Follow-on to ESA ERS C-band Scatterometers

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2 ESA/ESTEC, Netherlands

The Advanced Scatterometer (ASCAT) on METOP is a follow-on to the wind mode of the Active Microwave Instruments on ERS-1&2. The prime objective of the instrument is to measure the wind field at the ocean surface. Other objectives supported by ASCAT include measurement of sea ice boundaries, ice concentrations and type, as well as the retrieval of several land surface parameters

such as snow cover and soil moisture. ASCAT is a real aperture C-band radar with high radiometric resolution and stability. The beam geometry, radar frequency and vertical polarisation are the same as for the ERS scatterometer. Data will be provided at a nominal horizontal resolution of 50 km, as well as at a high-resolution mode of 25 km. ASCAT has a dedicated microwave source and a double swath of 550 km wide on each side of the satellite track, improving significantly the coverage with respect to the ERS scatterometers. Also important is the shifting of the swath to higher incidence angles, to improve the directional skill of the wind measurements.ASCAT will fly on board the platforms METOP-1, -2 and -3, on a low earth 29-day repeat cycle orbit and is the first operational European scatterometer mission, planned to cover 14 years of operations as of 2006, within the EUMETSAT Polar System (EPS) mission. It is expected that the high area coverage of ASCAT data will lead to a larger positive impact of scatterometer data on short and medium range weather forecasts. The high resolution mode will allow studying mesoscale wind structures, and in particular improving the tracking of tropical cyclones and polar lows. In combination with other scatterometer instruments and altimeters, it will give the forecaster a wealth of information on the ocean surface and contribute significantly to climate monitoring. ASCAT will continue and enhance the already long time series of C-band radar measurements provided by the ERS scatterometers.

Wednesday 8 September
18:00 – 19:00
MOZART 3

Session 3E5:

Round Table
30 Years C-Band Scatterometer Services

Poster Session 3P10:

Scatterometer

Abstract No. 421

The ERS-2 Scatterometer Mission: Events and Long-loop Instrument and Data Performances Assessment

R. Crapolicchio[1], P. Lecomte[2]

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The ERS project by the European Space Agency (ESA), initially designed as an experimental and pre-operational space based system to acquire geophysical information with worldwide geographical and repetitive coverage, has reached thirteen years of continuous operations. The first satellite (ERS-1) was launched in July 1991; the second one (ERS-2) was launched in April 1995, both from Kourou in French Guyana. The Scatterometer mission is part of the ERS project and its primary scope is to measure, with global coverage, the backscattered energy from the Earth surface. The core mission's element is the Active Microwave Instrument (AMI), a radar working at 5.3 GHz. That instrument operated in Scatt mode is able to acquire the backscattered signal from the Earth surface with three different look angles: sideways, 45° forward and 45° backwards with reference to the satellite's flight direction. Those measurements allow the retrieving of important geophysical parameters as: the wind speed and direction over the Oceans, the sea ice concentration and ice age, the soil moisture, the land crop classification. For meteorological centers it becomes an operative system and data are routinely assimilated into forecast and nowcast weather model prediction. On June 2004 after the failure of both on-board tape recorders, the ERS-2 Scatterometer mission is managed on regional basis. In that new scenario, the data coverage is only within the visibility of the ground stations and includes the Arctic, the North Atlantic, the Mediterranean, the Gulf of Mexico and a small part of the North West Pacific. To ensure the quality of the Scatterometer data during the mission lifetime, the Product Control Service (PCS) at ESRIN is responsible for the long loop instrument and data performance monitoring. This activity is routinely performed on the instrument telemetry data and on the user's products with the main scope to detect and face out instrument or satellite degradation due to aging and ground segment anomalies. The aim of the paper is to report to the users community the results of that monitoring activity in term of: events that have impacted the ERS-2 Scatterometer mission since the satellite launch (Flight and Ground segments), corrective actions put in place to maintain the nominal data quality and presentation of time-series to assess the instrument and products performances. The quality of the products delivered is also analyzed and discussed. The conclusion summarizes the lesson learned during these thirteen years of ERS Scatterometer operations; that experience can provide some reference for the next generation of Scatterometer mission as ASCAT on Metop.

Abstract No. 432

The Global Validation of ERS Wind and Wave Products at ECMWF

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Since the beginning of the ERS-1 mission, ECMWF is involved inthe global validation and long-term performance monitoringof the wind and wave products on-board ERS spacecrafts.These products are retrieved from three instruments, defining threeFast Delivery (FD) products that are received at ECMWF in BUFR format.Significant wave height and surface wind speed (URA product) data areobtained from the radar altimeter (RA).Ocean-wave spectrum (UWA product) data are received from the SyntheticAperture Radar (SAR). Surface wind speed and direction (UWI product) dataare retrieved from the Active Microwave Instrument (AMI) scatterometer.In-house developed monitoring tools are used to compare these productswith corresponding parameters from the ECMWF atmospheric and wave model.Whenever possible, these tools include a comparison with in-situobservations like wave buoys. In addition, tests are performed on theinternal consistency of the underlying observed quantities measuredby the three instruments.An overview for the last four years of monitoring validation willbe presented. This period is dominated by the on-board failure on17 January 2001, after which none of the six gyroscopes has been availablefor the platform's attitude control. It had a negative, though acceptable,effect on the quality of the altimeter and SAR data. However, it had adetrimental effect on retrieved scatterometer winds, which led to thesuspension of the dissemination of UWI data.Since that event, considerable effort on correcting data processingwas invested by ESRIN, culminating in the introduction of a completelyrevised on-ground processor (ESACA).Monitoring at ECMWF of a pre-released version during spring and summer2003 confirmed a more than complete quality recovery of the new UWI product.Performance in wind speed is as least as high as before, and especiallyESACA's improved de-aliasing algorithm was found to give by far the bestresults obtained during the entire ERS mission.The UWI product was publicly re-distributed by ESA on 21 August 2003,and was re-introduced in the operational assimilation system at ECMWFon 9 March 2004.

Thursday 9 September
08:40 – 10:20
MOZART 4-5

Session 4A1:

Agriculture (1)

Abstract No. 582

Multitemporal Analysis of MERIS FR Data for Crop Monitoring in Two Agricultural Areas: Barrax and Toulouse

M. Gonzalez-Sampedro[1], J. Moreno[2], T. Le Toan[3]

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One key advantage of MERIS data over previously available system is the relatively high spatial and temporal resolutions, but mainly the spectral information. Such narrow bands and the radiometric quality of the data allow retrievals of vegetation properties never available before in systems with global coverage. The objective of this paper is to test such innovative capabilities in agricultural areas, by using Full Resolution mode and exploiting the spectral and multitemporal information in the retrieval procedures.We analyse multitemporal Full Resolution MERIS data to monitor the seasonal variations of two agricultural regions with different climatic conditions: Toulouse (France) and Barrax (Spain). The temporal series has been acquired in the frame of the EO-662 and EO-726 projects. Time series of MERIS data were acquired along 2003, following crop evolution from March to October by means of routine ground measurements, complemented with specific campaigns to collect more detailed ground information.MERIS images are processed by using available tools. Given the extension of the geographical areas of interest, geometric correction is performed with the help of ground control points. Atmospheric correction of the images has been performed by using an algorithm explicitly developed to process MERIS data (Guanter et al. in this conference). Retrieval algorithms are based on optimised spectral indices for each biophysical variable.Crop phenology evolution is monitored in both sites through the following biophysical parameters: LAI, chloropyll and fractional vegetation cover obtained from MERIS. The retrieval of biophysical parameters is tested at Barrax with the ground data collected during the SPARC field campaigns. Consistence with the retrievals from high resolution spatial data (SPOT and LANDSAT) is also addressed. After the algorithms have been validated by means of field measurements and high spatial resolution imagery, the algorithm is applied to the full temporal series of MERIS data. Autoconsistence in the retrieved values for the different vegetation biophysical variables is then addressed.Spatial and temporal changes of phenology indicators along the season are reported and discussed. In the area of Barrax in Spain, agricultural fields are so large that many of them can be individually identified in MERIS data, so that crop phenology can be monitored. Due to agricultural practices of combining different crops in management units, monitoring is only possible when all crops follow similar phenology, still enough for applications that do not require single field identification, such as total water balance at local/regional level for irrigation management purposes.The final goal of this work is to use the biophysical information derived from MERIS data in crop-growth models, together with radiative transfer models describing soil-leaf-canopy reflectance, so that in future years data assimilation can be exploited in almost real time applications such as irrigation advisory services (e.g. in Barrax). To that aims, future research will intercompare retrievals derived from different systems such as ASAR, CHRIS/PROBA, Landsat and SPOT, already available for the same test sites, and to address the relating scaling issues.

Abstract No. 507

Synergetic Use of Envisat-1/ASAR IMG/APG Data and Optical SPOT XS/XI Data for Land Cover and Agricultural Crops Mapping

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University of Warmia and Mazury in Olsztyn, Poland

The progress, current status and results achieved of the Envisat-AO ID:783 Project will be presented. The project concerns the use of Envisat/ASAR data acquired in Image Mode and Alternating Polarization Mode with different viewing angles and polarization configurations for land cover mapping and agricultural crops identification. The 27 different ASAR images taken during ¡§Summer 2003¡¨ campaign over a very flat, typically agricultural ¡§Malbork¡¨ test area in the northern Poland have been geometrically corrected, speckle filtered and calibrated using available external calibration constants. Many field visits (14) for collecting ground truth data like: land cover / crop check, identification of developing stage of vegetation, soil moisture and plant water content for some of crops / parcels measurements, taking photographs of parcel and plants, have been carried out. This ancillary non-RS data have been used for better ASAR image understanding and facilitating its interpretation during data reduction and preparation of subset for automatic classification procedure.In the context of sensors¡¦ fusion synergism and their complementarity a time series of five SPOT XS/XI registrations were programmed. Using near and middle infrared channels some ¡§optical¡¨ indices like: vegetation indices, ¡§water content index¡¨, Tasseled Cap ¡V BGW have been calculated and included as supporting information in ASAR time series analysis.The catalogue of signatures (spectral features expressed in the form of color compositions) for many parcels representing main land cover types and the major types of crops found in the AOI has been established for each optical registration. Similar catalogue has been also done for ASAR images and their compositions, completed with the values of Sigma Nought as an objective quantitative parameter. The coefficient ƒ× = ƒã„a / cos ƒÑ incid has been also studied.The main aim of the data processing was to produce the detailed thematic map of land cover and crops, as expected by national and European operational activities in the field of remote sensing applications in agriculture, using ASAR data, reducing as much as possible the redundancy occurred in inter-correlated multitemporal ASAR ¡§channels¡¨. Optical data served as a support in the identification of parcel limits strongly degraded during speckle filtering. Additionally the efficacy of ASAR data processing and its usefulness for mapping have been controlled by the set of optical compositions. The quality and usefulness of Alternating Polarizations images versus Image Mode images have been also partially verified and estimated. The results show that in the context of detailed and early-season mapping of land cover and crop types the fusion of two mentioned sensors can give some advances comparing with ¡§traditional optical approaches¡¨. Coarser mapping with ASAR but faster and rather unaffected by weather conditions, independent of expensive optical programming, can be refined by sparse optical images.

Abstract No. 112

Multipolarized and Multitemporal Analysis of Envisat ASAR Data for Agricultural Inventories (InVeKoS) in Germany

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On the base of the Integrated Agricultural Administration and Controlling System (InVeKoS), the Federal State of Thuringia (Germany) has a strong interest in actual, area covering land use types and borders. Until now the inventory is based on optical orthophotos. Goal of this study is to analyze, whether these orthophotos might be replaced by spaceborne remote sensing data, especially by multitemporal, multipolarized Envisat A-SAR data, to develop cost and time efficient operational evaluation procedures. Further objectives include change detection methods to optimize the in-situ controlling. According to the phenological development ERS-2, Envisat A-SAR "image mode" and Envisat A-SAR "alternating polarization" data were evaluated over selected testsites within the agicultural intensively used Thuringian Basin in the center of Germany. The satellite data covered the whole vegetation period from March till October 2003 and were compared with GIS land use data of several farmlands. Theprocesing chain consists of sophisticated preprocessing methods like sigma nought calculation and speckle filtering. The data analysis itself includes the selection and spectral analysis of training sites, pixel based and object oriented superviesed classification methods an finally verification of classification results.The multitemporal and multipolarized evaluations enabled the distinction between arable land and grassland (pastures). Further separations of different land use classes within the arable land were possible, although some were overlapping quite a lot. Envisat A-SAR data therefore improves the possibilities of classifying land use classes immense compared to conventional single polarization ERS classifications. But although its multipolarized sensor capabilities, it is still a single frequency system. Operational monitoring systems will have to wait until future multisensoral investigations with combined X-, C- and L-Band systems.

Abstract No. 503

Sensitivity of ASAR AP Data to Crop and Soil Parameters

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With the launch of the European Space Agency (ESA) Environmental Satellite (Envisat) in March 2002, C-band Advanced Synthetic Aperture Radar (ASAR) data, available at horizontal–horizontal

(HH), vertical-vertical (VV), and horizontal–vertical (HV) polarizations and at different incidence angles, are expected to increase the possibility to retrieve biophysical parameters. Previous simulation studies conducted in Europe with ground based C-band scatterometer systems have shown a good potential of ASAR data to retrieve biophysical parameters over vegetated and bare fields. In particular, over wheat fields, the HH/VV backscatter ratio at 40° was found strongly related to above-ground biomass during the crop growing season and the HH backscatter at 23° showed good sensitivity to soil moisture changes. However, these studies were carried out on a limited number of fields and need to be confirmed by ASAR data at larger scale.In this context, an experimental study on the Matera (Italy) site has been initiated in 2003. Over this area multi-temporal ASAR data have been acquired since February 2003. The acquisitions have been carried out in alternating polarization mode at different polarization and incidence angles. Coincidentally, ground data such as soil moisture content, soil roughness, wheat biomass, LAI etc., have been collected.In this paper results of this experimental campaign are reported and implications for development of retrieval algorithms based on ASAR data will be discussed.

Abstract No. 283

The Internet Rice Information System - an EOMD Initiative

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Rice is the most important food crop in developing countries, which still produce 1.6 times as much rice as wheat, the second most important staple. Rice now provides 29 percent of the total calorie intake of developing countries, down from 31 percent in the 1970s. Ninety-one percent of the world's rice is produced in Asia and Pacific. Recent projections made by the International Food Policy Research Institute show that the demand for rice will increase by about 1.8% per year over the 1990-2020 period. This means that over the next 30 years, rice consumption will increase by nearly 70%, and Asian rice production must increase to about 840 million tons by the year 2025, from the present level of about 490 million tons, if rice prices are to be maintained at current levels.The goal behind IRIS is to contribute to the transparency of the production, management and distribution of rice in the world, with emphasis on Asia as a first step, in order to help the rationalization of the agricultural and insurance-related policies. This rationalization leads to a better flow of information, enabling nations to better manage the main staple food of the planet – and transfer the risks associated with price volatility from the farmers to the traders and financial institutions.The Internet Rice Information Service (IRIS), developed with financial support from the European Space Agency (Earth Observation Marketing Development Program), provides an operational rice information service suitable for government and non-government users requiring timely and reliable information on i) acreage, ii) transplanting/emergence moment, iii) growth status, iv) damages, v) yield, production and harvest time in the rice growing regions of Asia. While

rice transplanting/emergence moment, acreage, growth status and damages are determined by using Synthetic Aperture Radar data such as Envisat ASAR and Radarsat-1, rice yield, production and harvest time are estimated in a predictive way using an Agro-Meteorological Model. Clients can access the IRIS information service through the Internet. An easy-to-use web-application provides them with predictive statistics in the form of tables, graphs and/or maps for any sub-district and any rice season in Asia.

Thursday 9 September
08:40 – 10:20
KARAJAN 2-3

Session 4A2:

Oil Spills / Ship Detection

Abstract No. 321

Oil Spills Automatic Detection from SAR Images

F. Nirchio[1], P. Trivero[2], W. Biamino[2], M. Sorgente[3], A. Giancaspro[4], E. Parisato[2], R. Ravera[2]

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A probabilistic method has been developed that distinguishes oil spills from other similar sea surface features in Synthetic Aperture Radar (SAR) images. It considers both the radiometric and the geometric characteristics of the areas under test. In order to minimize the operator intervention, it adopts automatic selection criteria to extract the potentially polluted areas from the images.The method has an a priori percentage of correct classification higher than 90% on the training dataset; the performance is confirmed on a different dataset of verified slicks. The system and its ability to detect and classify oil and non-oil surface features are described. The ERS probability to detect a oil pollution event is estimated using a set of verified oil spills and analysing the wind intensity, deduced from the image itself. The present performances of a off line processing data centre are also analysed, in term of throughput and response time, in order to verify them against the user requirements.

Abstract No. 10

Automatic Oil Spill Detection Based on Envisat, RADARSAT and ERS Images

A. Solberg
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Many studies have attempted to do automatic detection of oil spills in SAR images, but most studies have involved a small number of images and no comparison with aircraft verifications. In this study, we evaluate the performance of our advanced automatic oil spill detection system on more than 100 Radarsat and Envisat SAR images. We also compare the results for our automatic detection algorithms to manual inspection with benchmark data sets established in the EU project Oceanides.The potential for oil spill detection in SAR images was demonstrated on ERS images in the early 90-ies. We started to work with automatic oil spill detection in ERS image in 1993, and developed an advanced algorithm for oil spill detection, which performed well on a large-scale study. The algorithm consists of three main parts – dark spot detection, spot feature extraction, and spot classification. Detection of dark spots is done by adaptive thresholding. For each detected spot

a number of features are computed in order to classify the slick as either an oil slick or a `lookalike' (other oceanographic phenomena which resemble oil slicks). A supervised classification scheme is then utilized based on statistical modeling with a rule-based approach. The approach embraces knowledge about the probability of oil presence (e.g. occurrences in vicinity of ships, oil platforms, etc). Incorporated in the model is also knowledge about external atmospheric, oceanographic and geographic conditions (e.g. wind speed, etc), and sensor-specific image mode parameters. The framework can be applied to Radarsat, Envisat, and ERS images. Sensor-specific modules have been built by training the system on about 100 images from each sensor. The dark spot detection step is tailored to each sensor, and for Radarsat and Envisat a pyramid approach is used to detect dark spots on multiple scales. The three modules use very similar features, but the classification step has a sensor-specific set of rules. By training on 100 images from each sensor, we are able to build a system that finds all suspect dark spots in an image, and classifies them as oil or look-alike with very high accuracy.In some cases, a manual operator can not be sure if a slick is oil or algae or some other kind of look-alike. Operational oil spill monitoring is therefore based on using both satellite and aircraft sensors, and let the aircraft inspect and verify all slicks reported from satellite. In two benchmark studies (Radarsat and Envisat) in the North Sea and the Baltic sea, we have compared the automatic algorithm to manual inspection and semi-manual inspection. These studies are done without the operators or algorithms knowing the aircraft verifications, so we get an objective comparison of the detection capabilities of different human operators and the automatic algorithm. Results on the Radarsat data set showed that the automatic algorithm performs close to manual inspection both in terms of detection verified oil spills and in terms of the number of false alarms. The Envisat benchmark are delayed due to very late delivery of Envisat AO data. Envisat results will be available in May 2004.

Abstract No. 388

An Experience of Using ERS-1/2, Envisat and RADARSAT SAR Images for Oil Spills Mapping in the Waters of the Caspian, Yellow and East China Seas

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This paper summarizes our experience in application of different swath and resolution synthetic aperture radar (SAR) images to regional oil spill monitoring. The main objective of this study is to work out an optimal approach to the problem. On the 1st step the method of mapping of oil spills using a set of wide-swath ScanSAR images acquired by Radarsat over the Yellow and East China Sea in the end of 2000 has been developed. The finding of this study is that a SAR, in its wide-swath mode, is a very valuable tool for oil spill detection/localization, and an oil spill distribution map can be easily created on that basis. On the 2nd step this approach has been further developed on the basis of collection, processing and analysis of all available SAR images and applied to mapping of oil slicks in the Caspian Sea. Low-resolution ERS-1/ERS-2 SAR images, so-called quick-looks,

available at the ESA web-based catalogue, have been used. The oil slicks/spills distribution map has been prepared for May 1996 and then integrated into the GIS. In the Caspian Sea they were mainly associated with crude oil production/transportation, river runoff and oil seeps. It's shown that analysis of GIS-integrated oil spill distribution map allows doing a number of important conclusions concerning intensity of oil pollution, risk areas and their link with possible land and sea sources.On the 3rd step, a routine oil spill monitoring in the Yellow and East China Sea using different swath and resolution ERS-2 and Envisat SAR imagery, started from October 2003, has been performed (in the frameworks of the Envisat AO project #226). Results of this study indicate that the marine areas in the China Seas are most polluted along the main ship routes and river mouths. A sequence of SAR images allowed retrieving oil spill drift characteristics. Detection and classification of oil spills among other look-alikes is still one of unsolved problems in spite of development of a number of automatic/semiautomatic detection methods.Moreover, acquired experience shows that:- regional oil spill monitoring does require a large amount of wide-swath SAR images,- this imagery shouldn't have a very high resolution, 200 m is quite enough,- and, finally ESA should consider a making of a special (low-cost and middle resolution) Oil Spill SAR Product for this purpose.

Abstract No. 488

Polarisation-Dependent Signatures of Ships

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Vessel detection with spaceborne SAR has been an interesting research topic and operational application for several years. Considerable research and development has been carried out to develop algorithms and establish the actual capabilities of single channel SAR on ERS-1 & 2 and RADARSAT-1. The Envisat ASAR AP mode presents a new capability for spaceborne SAR, and has the potential to provide increased detection capabilities in high sea states and for a larger range of incidence angles, compared to previous SAR systems. It is therefore of particular interest to explore the performance of the ASAR in AP mode in imaging ships, and where possible, also their wakes.For both VV and HH polarisation, ship to sea contrast improves with increasing incidence angle, and decreases with increasing wind speed and sea state. The cross-pol contrast and its dependence on imaging geometry, sea state and vessel characteristics, however, is much less well documented. We have therefore initiated a study to assess the AP mode imaging capabilities for ship detection. Some of the issues we aim to address are:· What are the polarisation ratios (VV/VH, HH/HV abd VV/HH) for ships of known design, and how do these ratios depend on imaging geometry?· What are the ship to sea contrast ratios for different polarisations, imaging geometries and sea states?In this paper we present results from analyses of AP mode data acquired in Canadian and Norwegian waters. Images have been collected over areas where known vessels have been present, and polarisation ratios have been determined. Part of the data set was acquired over a moored ship at the Norne oil field off central Norway, using different beams and polarisations to determine which combinations of these parameters and sea state provide the best ship to sea contrast.

Abstract No. 665

An Open Source Framework for Integration of Vessel Positions Detected in Spaceborne SAR Imagery in Operational Fisheries Monitoring and Control

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European Commission, Italy

The European IMPAST project has implemented a vessel detection system (VDS) based on the near real time use of synthetic aperture radar (SAR) imagery from operational orbiting satellites. Both RADARSAR and Envisat ASAR data use is implemented. The modular system consists of a number of distinct processing steps that are combined in an automated work flow capable of providing detected target positions within 45 minutes after at-sensor image acquisition.The main purpose of the VDS is to support verification actions of timely position reports which are collected as part of the regulatory vessel monitoring system (VMS) in place at the European fisheries monitoring centres (FMCs). VMS systems on-board Community fishing vessels report positions at hourly, or two-hourly, intervals in real time. The overall goal of the combined use of VMS and VDS, together with other fisheries information collections, is to enable the European Commission to better manage and control fish stocks in European and international waters where the European fishing fleet is active. The specific objective of the VDS system is to support the analysis of possible anomalies in VMS position reports and estimate presence of non-VMS carrying fishing vessels in international waters. The VDS implementation at the European Commission's Joint Research Centre (EU-JRC) will be discussed in detail. In particular, the system components set up to integrate the VDS positions directly into the FMC's analysis environment are detailed. This environment is based around a set of web services that combine various mapping outputs as transformable XML streams. Apart from basic map layers, dynamically generated higher order analysis results, such as positional correlation results, can be assessed in this way. Graphical output is presented as a merged set of XML streams transformed to Scalable Vector Graphics (SVG) that are "wrapped" in an elaborate GIS interface.The EU-JRC VDS is implemented with Open Source components and extended with Java-based APIs. Organisational and operational considerations will be highlighted and demonstrated with extensive experimental data obtained during monitoring pilot campaigns in 2003 and planned experiments in 2004.

Poster Session 4P01:

Oil Spills / Ship Detection

Abstract No. 113

Problems in Detecting Oil Pollution in Black Sea Coastal Zone by Satellite Radar Means

M. Mityagina

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The shore zone of the northeastern Black Sea is a unique environmental complex and the only Russia's recreation area on the Black Sea. At the same time, the region with its large ports, vast cultivated terrains and growing residential construction is subject to an appalling anthropogenic pressure. Monitoring of oil pollution in the region of Novorossiisk Bay is of prime importance, because satellite observations during the last four years have revealed frequent discharges of oil products into the sea in the immediate vicinity of residential and tourist sites. The basis of our study is a series of ERS-2 SAR images of the eastern part of the Black Sea obtained over the period from October 1999 to October 2003 in different seasons and under various weather conditions. Available extensive all-year sea state monitoring data, including NOAA data and hydrometeorological contact measurements, help to adequately interpret SAR signatures. Possibilities to explain some backscattering features due to oil slicks are discussed. Automatic detection of oil signatures in radar images is not a simple task because they are hardly distinguishable, especially at low wind, from signatures of other phenomena and objects called "oil-likenesses". The paper discusses possibilities to detect radar signatures of oil pollution and separate them from areas of decreased scattering due to various phenomena, such as so-called "wind shadows", rain cells or upwelling.Determination of the time when oil was spilt is also an important task. A method to solve this problem is presented based on data on three consequent oil spill events.

Abstract No. 293

Multiscale Segmentation of Oil Slick in SAR Images Based on Morphological Pyramid

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ERS images had proved their interest in a large scale detection and monitoring of pollution on ocean surface. The improvement of the technology leads to the arrival of Envisat sensors for which the exploitation of such images offers new possibilities. Up until now, several methods based on intensity images have been used to measure signatures of oil slick by a spaceborne mono-frequency

Synthetic Aperture Radar (SAR) [1] [2]. Among these methods, the Multiscale Oil Slick Segmentation (MOSS) with Markov Chain Model (MCM) [3] is based on the Marangoni theory [4] which proposes models to explain the effects of slick on sea surface, particularly a dampening of the energy of the wave spectra .We propose an approach in this paper to detect oil slick in oceanographic SAR intensity images by taking the same properties into account. Then, to improve the detection of local variations of the wave spectrum, the image is first decomposed into multiscale analysis based on the morphological pyramid [5]. In this step, the morphological gradient as a high-pass filtering, and the residue (calculation of the information lost) as a low-pass filtering, with an varying structuring element, are performed. In this way, the multiscale analysis considers together, the structural characteristics, and the local frequential description of the oceanic waves on sea surface. High-pass images and the final low-pass image are extracted during the decomposition as complementaries information. These new channels are then merged with the help of information fusion [6], to achieve the segmentation process.The method is tested on Envisat ASAR Precision Images. The obtained results are promising and improve performance of oil slick detection in oceanographic SAR images. References[1] Kanaa T. F. N., E. Tonye, G. Mercier, V. P. Onana, J. Mvogo Ngono, P. L. Frison, J. P. Rudant, R. Garello, (2003) – "Detection of Oil Slick Signatures in SAR Images by Fusion of Hysteresis Thresholding Responses", IEEE International Geoscience and Remote Sensing Symposium, IGARSS '03 Proceedings.[2] Kanaa T. F. N. , E. Tonye, G. Mercier, V. P. Onana, A. Akono et J. P. Rudant, (2004) – "Télédétection RSO pour la Détection des Signatures de Pollution par Hydrocarbures au large du Littoral Camerounais", accepté aux Journées Scientifiques du Réseau de Télédétection, Agence Universitaire de la Francophonie, mai 2004.[3] Mercier G., S. Derrode, W. Pieczynski, J. M. Le Caillec, and R. Garello, (2003) – "Multiscale Oil Slick Segmentation with Markov Chain Model", IEEE International Geoscience and Remote Sensing Symposium, IGARSS '03 Proceedings.[4] Franceschetti G., A. Iodice, D. Riccio, G. Ruello, and R. Siviero, (2002) – "SAR raw signal simulation of oil slicks in ocean environments," IEEE transactions on geoscience and remote sensing, vol. 40, no. 9, pp. 1935 – 1949.[5] Laporterie Florence, (2002) – "Représentations Hiérarchiques d'Images avec des Pyramides Morphologiques. Application à l'Analyse et à la Fusion Spatio-temporelle de Données en Observation de la Terre", Thèse de Doctorat, ENSAE, mai 2002.[6] Bloch I., (1996) – "Information combination operators for data fusion : A comparative review with classification", IEEE Transactions on Systems, Man and Cybernetics, 26(1):52–67.

Abstract No. 308

Ship Detection with Envisat's Alternating Polarisation Mode

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Maritime traffic and fisheries have to abide by international conventions and agreements. In coastal waters, information on maritime traffic and fisheries is gathered by various means: AIS (Automatic Identification System) for traffic control, VMS (Vessel Monitoring System) for fisheries control, port and coastal radar stations, from inspection ships, and by sensors on airborne and spaceborne

platforms. Although these surveillance systems are in many ways complementary, their data are mostly still treated separately, leading to partial views as opposed to a more complete picture.The DECLIMS project (DEtection, CLassification and Identification of Marine traffic from Space) aims to establish the state of the art in vessel detection from space, and further to stimulate developments by exchanging information between parties active in this field. Over twenty companies, institutes and businesses participate in this multinational research project led by the European Commission's Joint Research Centre (JRC).Within DECLIMS, TNO Physics and Electronics Laboratory are investigating the possibilities for an integrated network of AIS, coastal radar stations and spaceborne Synthetic Aperture Radar (SAR) for monitoring the North Sea off the Dutch coast. A key element is the development of an algorithm for the detection of vessels in SAR images. Of special interest is the Envisat imagery recorded in Alternating Polarisation (AP) mode. Because of the different interaction of the HH and HV polarisation channels with the sea clutter on the one hand and with the target on the other, it is anticipated that dual polarisation HH/HV images will give a better detection result than can be obtained from HH imagery alone. From a few AP images taken in 2003 over the Channel and the North Atlantic, it is found that although many targets are detected both in HH and HV, quite a few are detected only in HH, and very few only in HV. On the other hand, HV seems to produce less false alarms than HH. So it would seem there is a complementarity between the two channels, with HH giving most information on the targets, and HV providing a check for false alarms. To prepare for a measurement campaign to be held in late 2004 in which data of AIS, a coastal radar station and Envisat imagery are simultaneously collected, acquisition and analysis of HH/HV images with concurrent ground truth data from VMS is presently continuing. Detection statistics obtained with features developed from HH/HV images are compared with those obtained from HH imagery. Based on these statistics, a strategy is developed to optimise the use of the HH and HV polarisations for ship detection.

Abstract No. 438

A Novel Algorithm for Ship Detection in ERS and Envisat SAR Imagery Based on the Wavelet Transform

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Carrying out an effective control of fishing activities is essential to guarantee a sustainable exploitation of sea resources. While traditional reconnaissance methods, such as planes and patrol vessels are indispensable, their operation is quite time consuming and costly over the extended regulated areas. On the contrary, satellite-based Synthetic Aperture Radar (SAR) provides a powerful surveillance capability already confirmed by a large amount of investigations and experiments all over the world. In particular, in Europe, the project IMPAST (Improving Fisheries Monitoring by Integrating Passive and Active Satellite Technologies) aims at developing a fully automated process combining information for satellite imagery and VMS (Vessel Monitoring

Systems), while the DECLIMS project compares the performance of existing tools of ship detection and classification from space.Nevertheless, algorithms conceived for automated ship detection in SAR imagery, usually based on the application of thresholds, often encounter difficulties, not yet solved. More specifically, the adjustment of thresholds is complicated and it relies on the existence of a considerable contrast between vessels to be detected and the sea clutter, which is not always reached. This contrast is affected by speckle and clutter, both directly associated with the intrinsic nature of SAR oceanic imagery and thus unavoidable. Firstly, the coherent processing produces speckle which is undoubtedly the major disturbance in the exploitation of SAR images. Then, ocean surface processes such as waves, current gradients and wind fields produce random clutter and texture. All those heterogeneity sources can yield to the failure of ship detection algorithms, hiding some of the vessels or generating false alarms. In some awkward situations, the detection success is far lower than expected even if, surprisingly, undetected vessels are sometimes visible by eye. Attending to these particular circumstances, a novel approach for ship detection purposes is proposed based on the analysis of SAR images by means of the wavelet transform. In fact, in a similar way as the human visual system, multi-resolution analysis with wavelets performs simultaneously over the observed scene a selective filtering in both frequency and orientation and it is also able to focus on different elements at different scales. On the one hand, this zooming potential will allow an intelligent management of different kind of heterogeneities. On the other hand, the exposed procedure takes advantage of the difference of statistical behaviour of the ships on the sea and of its interpretation through the wavelet coefficients in order to provide a more reliable detection. The performance of the algorithm based on the correlation of the sub-bands at each wavelet scale has been tested over a set of simulated and real ERS and Envisat data. The results from the new algorithm are compared to the outcomes of a conventional ship detection algorithm based on local background estimation and thresholding and to available ground-truth based on VMS transponder ship positions. This correlation confirms its robustness: some targets, undetectable with other conventional techniques are noticeably enhanced, whereas background noise is drastically reduced.

Thursday 9 September
08:40 – 10:20

MOZART 1-2

Session 4A3:

Clouds and Aerosal (1)

Abstract No. 241

Global Observations of UV-absorbing Aerosols from ERS-2/GOME Data

M. De Graaf[1], P. Stammes[1], R. Koelemeijer[2]
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GOME Absorbing Aerosol Index (AAI) from July 1995 - December 2000 is presented. The AAI indicates the presence of UV absorbing aerosols in theatmosphere, using the difference between the reflectances at two UV wavelengths, 335 nm and 380 nm, compared to that in a pure Rayleigh atmosphere. In the UV the contribution of the surface to the reflectances is minimal over most surface types allowing retrieval of aerosol information over both land and ocean. The AAI separates scattering from absorbing effects in the atmosphere, and is therefore capable of distinguishing between absorbing aerosols and clouds, which is a huge advantage for space-borne instruments with large footprints, like GOME and TOMS. The AAI from NASA's TOMS instruments is the longest global aerosol record available, from 1978 to present. It is used extensively for investigation of long-term global aerosol trends and variations, and to study heavy dust, biomass burning and vulcanic eruption events.However, from 1993 to 1996 no TOMS observations were available. The GOME AAI can be used to supplement a part of the missing data. There is a very strong correlation between the GOME AAI and the TOMS AAI. The GOME AAI corresponds very well to known desert dust events and biomass burning events. It is a very useful independent data source for aerosol validation and detection of aerosol events. As a side-effect it can be used as an independent calibration tool, as the AAI is very sensitive to calibration errors.

Abstract No. 67

Aerosol Optical Thickness Retrieval over Land and Water Using SCIAMACHY/GOME Data

V. Kusmierczyk-Michulec, G. De Leeuw
TNO Physics and Electronics Laboratory, Netherlands

An algorithm for the retrieval of the aerosol optical thickness over land and over water from SCIAMACHY (SCanning Imaging Absorption SpectroMeter for Atmospheric ChartographY) is presented. Because calibrated data are not yet available for the SCIAMACHY channels used by the algorithm, the concepts were tested with GOME (Global Ozone Monitoring Experiment) data. The cloud fraction in the GOME pixels has been determined using the FRESCO (Fast Retrieval Scheme for Clouds from the Oxygen A Band) algorithm. Surface contributions to the TOA reflectance are determined from the GOME surface reflectance database. The aerosol retrieval algorithm uses Look Up Tables (LUT) that were created using the radiative transfer model 6S. The algorithm allows for

the retrieval of aerosol types characterized by Ångstrom coefficients in the range from -0.1 to 2.8. Comparison of the results with AERONET sun photometer data for 12 sites in Europe and Africa shows very good agreement.

Abstract No. 119

Retrieval of Cloud Phase from Earth Spectra around 1.6 Microns as Measured by SCIAMACHY

J. Acarreta, P. Stammes, W. Knap
Royal Netherlands Meteorological Institute, Netherlands

The SCIAMACHY instrument is a space-based spectrometer on boardthe Envisat platform. It has a spectral range of 240-2380 nm with a spectral resolution between 0.24 nm in the UV and 1.56 nm in the NIR. The pixel size for the SCIAMACHY wavelengths used in this workis 60x30 km2.An index for fast thermodynamic cloud phase (water or ice clouds)retrievals (or CPI) is presented. The CPI is calculated fittingthe spectral slope around 1.6 microns (wavelength cluster 43). Itis normalized with the reflectance at 1.64 microns to avoidcalibration offsets. A comparison with MODIS is performed. We alsopresent a preliminary new calculation of the CPI combining thespectral information of the wavelength clusters 43 and 45.

Abstract No. 13

Determination of Cloud Parameters from Satellite Instruments for the Correction of Tropospheric Trace Gases

M. Grzegorski, C. Von Friedeburg, U. Platt, T. Wagner
University of Heidelberg, Germany

The SCanning Imaging Absorption spectrometer for Atmospheric ChartographY (SCIAMACHY) on Envisat-1 allows measurement of different tropospheric trace gases (e.g. NO$_2$, SO$_2$, CH$_4$) using the DOAS technique. Cloud detection algorithms are essential for calculating the vertical column density.A widely used method determines cloud fraction using broad band spectrometers, the Polarization Monitoring Devices (PMDs). A precise calculation of thresholds representing cloud free and completely cloudy scenarios is essential for the computation of cloud fractions. Image sequence analysis is suited to determine the lower threshold, which depends on region and time. The upper threshold is independent from earth albedo, but have to be calculated with depend to different physical, geometrical and instrumental properties. The new algorithm developed for SCIAMACHY is based on the experience with the Heidelberg Iterative Cloud Retrieval Utilities (HICRU) designed for GOME, which is already well validated. The algorithm can also apply new instruments on SCIAMACHY, especially spectrometer in IR-wavelength-bands.

Abstract No. 51

Improved Cloud Detection for Upper Tropospheric Clouds Using Spectrally Resolved Infra-red Limb Sounding Instruments

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[2] *ICG I Research Centre, Germany*

Over the past decade, limb sounding instruments have increasingly been able to sound the upper troposphere where clouds become an important issue both for retrievalsensitivity and for investigations of atmospheric composition. The Michelson Interferometer for Passive Atmosphere Sounding (MIPAS) is providing unprecedented, high spectral resolution measurements of clouds in the upper troposphere. These measurements will be presented and discussed in terms of the sensitivity of infra-red spectra to cloud extinction, and the frequency of occurrence of clouds which are expected to be mainly sub-visible cirrus. It will also be shown that the concentration of water vapour is critical to the detection of clouds in the MIPAS data. Combination of a water index with the currently operational cloud index method is shown to deliver improved results below 10 km in the tropical atmosphere where water vapour mixing ratios exceed 2000 ppmv. This strengthens the possibility to retrieve water vapour at low altitudes and has implications for the design of new infra-red instruments which aim to measure profiles of clouds with high vertical resolution.

Thursday 9 September
08:40 – 10:20
DOPPLER

Session 4A4:

Wetlands / Floods

Abstract No. 491

ASAR Multitemporal and Dual Polarization Observations of Wetland Marshes

H. Karszenbaum[1], F. Grings[1], J. Jacobo[3], J. Tiffenberg[4], P. Kandus[3], P. Pratolongo[3], G. Parmuchi[4], P. Ferrazzoli[5]

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[4] *Univ. de Roma "Tor Vergata", Italy*

The Delta of the Paraná river is one of the most important wetland systems of South America, covering 17000 km2. Natural habitats coexist with large forest plantations and recreational areas. It is subject to a complex flooding regime due mainly to the Parana, Uruguay and De la Plata rivers. In addition, Buenos Aires city expands along one of its sides. The principal aim of the Envisat AO-667 project currently in progress is to use the alternating polarisation modes of ASAR to develop procedures for: a) mapping the regular flooded area, and its fluctuations (baseline map), b) identifying which land-cover/land-use units are completely covered and/or partially covered by water, c) determining the extent of unusual flooding events, d) identifying, and quantifying the affected land-use/land-cover units. The development effort is concentrated in maximising the capabilities of ASAR data. The product is thought as an assessment tool for identifying land cover elements under different degrees of flooding and for evaluating risk and damage.Within this frame, the current research efforts are directed toward: a) to demonstrate the capabilities of Envisat SAR alternative polarization mode for monitoring weland ecosystem characteristics, b) to use this mode to map spatial patterns of wetland communities and to determine spatial and temporal patterns of inundation, c) to explain the beahviour of SAR response for different polarizations HH, VV and HV using radar data and EM modeling, d) to assess the sensitivity of polarization and incidence angles to ecosystem characteristics such as density, height, and environmental conditions, e) to show the increase in information content in the case of dual polarization radars in comparison with single polarization systems.This paper presents: 1) a summary of the previous work done using multitemporal ERS 2 (AO-232) and Radarsat data (GlobeSAR II program) and the questions that this data arose regarding the cause of the strong differences observed in the SAR response for HH and VV from marshes (junco and cortadera), 2) an explanation of these differences using electromagnetic models, 3) a set of S1 Envisat ASAR images collected under different hydrologic conditions showing: a) the strong changes that the soil condition produces in the SAR response of wetland vegetation, b) how differently HH and VV are being affected by changes in environmetal conditions, c) the information gain due to dual polarization.The Envisat ASAR data confirm the observations acquired by two different systems such as ERS 2 and Radarsat in this area with the great advantage, for a consistent interpretation, of obtaining simultaneous HH-VV data (same environmental conditions). Also, this set, consisting of several dual polarization images, shows how the soil conditions (due to hydrologic conditions) modify the dominant soil-vegetation-radar interactions and how the magnitude of this change depends on vegetation structure and polarization. Interpretation of observations is supported by electromagnetic modeling.

Abstract No. 49

InSAR-based Hydrology of South Florida

S. Wdowinski[1], F. Amelung[1], T. Dixon[1], F. Miralles-Wilhelm[1], R. Carande[2]

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New space-based observations of South Florida involving interferometric SAR (InSAR) reveal spatially detailed, quantitative images of water levels in the Everglades. The new data capture dynamic water level topography, providing the first detailed picture of wetland sheet flow. We observe localized radial sheet flow in addition to well-known southward unidirectional sheet flow, modelled as a linear diffusive flow. We obtain quantitative estimates of transmissivity (40-180 m2/s) and Manning's friction (0.3-1.0), the first space-based estimates of such hydrologic parameters. Space-based hydrologic observations can provide critical information for monitoring, understanding and managing wetland sheet flow, and thus contribute significantly to wetland restoration.

Abstract No. 248

Assimilation of Snow Properties Derived from ASAR Wide Swath Data in a Hydrological Model of the Neckar Catchment for Improved Flood Forecast

H. Bach[1], F. Appel[2], A. Loew[3], R. Ludwig[3], W. Mauser[3], B. Waske[3], U. Merkel[4], W. Schulz[4]

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Methods to accurately assess and forecast flood discharge are mandatory to reduce the impact of hydrological hazards. However, existing rainfall-runoff models rarely consider the spatial characteristics of the watershed accurately, which is essential for a suitable and physics-based description of processes relevant for runoff formation. Land surface parameters of high temporal variability, like soil moisture and snow properties are as yet hardly available and used in operational forecasts.Remote sensing methods can improve flood forecast by providing information on the actual water retention capacities in the watershed and facilitate the regionalisation of hydrological models due to synoptic coverage and homogeneous data provision. To prove and demonstrate this, the project "InFerno" (Integration of remote sensing data in operational water balance and flood forecast modelling) was started in 2001. Within InFerno (funded by the German Aerospace Center

DLR), optical and microwave remote sensing data are thoroughly processed to deliver spatially distributed parameters of snow properties and soil moisture. For the generation of products, previous algorithms for calibration, geocoding and analysis were adapted to the new data sets. These tools make it possible to derive radiometric and geometric high-precision products from ERS and Envisat ASAR scenes. Melting snow (wet snow) is detected using an algorithm based on the image ratio technique. For the assimilation of remote sensing data in hydrologic models the methods of wet snow classification and snow line delineation were adapted for large areas. First products of wet snow distribution during the snow melt season in spring 2003 were delivered. Products from ASAR together with daily snow cover maps (presently from NOAA AVHRR) are to be integrated in the hydrological model LARSIM, which enables continuous spatially distributed simulations of (all) water balance terms in meso-scale catchments. Currently LARSIM is operationally applied for the flood forecast and the water balance simulation for the Neckar and (soon) the Mosel catchment (Southwest Germany). It is intended to use the information from the satellite imagery for an optimisation of substantial parameters of LARSIM. Within our work, the Envisat ASAR sensor proved its high potential. The WSM datasets allow (for) the acquisition of surface parameters covering the entire area of the investigated Neckar catchment with sufficient spatial and fair temporal resolution.

Abstract No. 108

Towards Operational Flood Mapping with Satellite SAR

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Norut Information Technology, Norway

The ability to map flood extent is important in applications like flood management, area planning, insurance risk assessment andhydrological modelling. Remotely sensed data are a well-suitedinformation source for large-scale flood mapping, especially forregions where hydrological information is difficult to obtain due to inaccessibility, sparse distribution of gauge stations or slowassimilation of data. Satellite-borne synthetic aperture radars(SARs) are sensors of special interest, since they can acquire images independently of daylight and practically in all weather conditions.One of the main objectives of the FloodMan (AOE C1P.2364) projet is to develop and demonstrate an operational flood monitoring service based on EO data. Thus, within the framework of the FloodMan project is the development methods for unsupervised near-real time detection of flooded areas in all types of terrain and land-cover.Different strategies has to be applied for detecting floods with SAR in non-forested/open, forested/vegetated and urban areas. In this work we present the principles of detecting flood with SAR in the different land cover classes, and we review algorithms, both classical and newly developed, suitable for an operational flood mapping service. We demonstrate these on data from various SAR sensors covering recent flood incidents in different land-cover types. We also discuss the limitations of flood mapping with SAR and how to remedy these. ERS has limited performance for mapping flood in non-forested areas, due to its low incidence angle and VV polarisation. We show some examples where water bodies are invisible with VV polarisation, and discuss the gain we get by using the two polarisations in Envisat alternating polarisation data.Further, we present our considerations for an operational processing chain, and discuss the auxiliary data needed for a well performing operational service.

Abstract No. 472

Evaluation of a Remote Sensing Based Regional Flood/Waterlog and Drought Monitoring Model Utilising Multi-source Satellite Data Set Including Envisat Data

G. Csornai[1], Z. Suba[2], G. Nádor[2], I. László[2], A. Csekõ[2], C. Wirnhardt[2], L. Tikász[2], L. Martinovich[2]

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Series of severe flood, waterlog and drought events hit Hungary recently, thus the provision of quick, objective and homogenous information about the development and impact of these disasters is very imperative. FÖMI Remote Sensing Centre started to develop a cost-effective satellite based model to monitor these natural disasters at regional level. In the frame of the ESA Scientific Experiment Development Programme (Prodex), the FÖMI-ESA Prodex-Envisat R&D project (ESA Contract no. 14525/00/NL/SFe(IC), ESA EO CAT-1 1139) was launched in 2000. The main objectives of the project were to extend the already developed methodologies to rapid, regional monitoring of flood/waterlog and drought affected areas by increasing the quality (temporal, spatial and spectral) of the applied satellite data set and with the possible involvement of the new generation ESA Envisat data. The effectiveness of remote sensing based techniques has been proved by the implementation of the operational Crop Monitoring and Production Forecast Program (CROPMON 1997-) at FÖMI RSC. CROPMON provides country and county (19) level crop production forecast to Ministry of Agriculture and Rural Development (MARD) by a strict calendar across the season based entirely on remote sensing, measuring the areas and expected yields of the 8 main crops in Hungary. This program also gives technology and knowledge basis for other additional applications such as satellite based waterlog assessment and impact monitoring (1998-), flood and drought monitoring (2000-).The further extension of the applied methodologies was based on the comparative analysis of different low- and medium resolution operational satellite data (NOAA AVHRR, SPOT VEGETATION, IRS-1C/1D WiFS). The activities included the monitoring and mapping of the development, area extension and "intensity" of flood/waterlog or drought events at regional scale on agricultural cultivated areas using large satellite data set (from 1998 and from 2000-2003).The first stage of the project focused on the setup, extension and testing of the model (data from 1998 and 2000) utilising archive data of various satellite sources for the regional monitoring. The second stage contained further testing procedures with semi-operational phase using additional optical and radar data (from 2001). The third stage of the project included real-time monitoring phase and the experimental utilisation of integrated radar (ERS)/optical (Landsat, IRS WiFS) and Envisat data (from 2002-2003). Time series of Envisat MERIS full and reduced resolution data obtained in 2003 were also processed and evaluated taking into account its utilization for regional drought monitoring. According to the Envisat MERIS sensor's enhanced capabilities the first experiences showed very promising result in applying MERIS data for land surface observation in the field of regional vegetation and crop monitoring.

Thursday 9 September Wolf-Dietrich 1-2

Poster Session 4P02:

Wetlands / Floods

Abstract No. 1

Usage of Satellite Information for Analysis of the Hydrological Processes

V. Chub, S. Myagkov, M. Torskiy
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The Amudarya river is one of the largest in the world. The mean volume of the annual run-off is 73.5 km^3. The length of the river is 2600 km; the area of catchment is 465000 km^2. The river flows through the territory of Tadjikistan, Turkmenistan, Afganistan, and Uzbekistan into the Aral Sea. The unexplainable discrepancies of the channel balance are observed in the middle part of the Amudarya river. The satellite image analysis of the middle part of the Amudarya river has been carried out. For this analysis, the representation of an image as a three-dimensional surface of brightness approach was used. The depression stretched out to the north of the riverbed having an extension of more than 200 km and a width of more than 10 km has been found in the narrow range of brightness. When analyzing the image series for different periods, it was revealed that the depression width alters in the course of time. The preliminary comparison of the difference in water discharge between hydraulic sections and the depression width has shown that there is an inverse dependence in the form of $Y=-0.0014X+5.7645$, with a reliability of value $R^2= 0.587$, where: Y-the width of brightness zones, X- the difference in water discharge between upper and lower hydraulic sections. The distance between hydraulic sections is 434 km and the time of flood wave passing alters from 3 to 5 days depending on water discharge. The more water discharge in the upper hydraulic section the faster flood wave approach. That is why, the modeling of the 6 days flood wave passing process was carried out before the time when the image was obtained and the water balance value was used for comparison with the depression width. In this case, the reliability of value has increased up to $R^2= 0.8273$ having dependence of $Y=-0.0018X+5.5927$. **Conclusions**: Based on the conducted analysis of the satellite images has been revealed, that there is a flow of ground waters directed towards the Kyzylkum desert. Most likely, this anomaly is not large in comparison with the neighboring parts and therefore, it was not detected by ground-based observation facilities, since the difference in brightness of the image is not more than three units which is not noticeable on the tonal image, although the area of the depression is quite large. Such distribution of brightness in the image is caused by the difference in reflectance of the earth surface, which can be subject to both the thickness of vegetation and the depth of ground waters occurrence. The more river water loss the closer ground water to the surface and the wider "depression" zone of brightness in the satellite images.

Abstract No. 88

InFerno+ - a Project for the Integration of Remote Sensing Information in Operational Water Balance and Flood Forecasting Models

R. Ludwig[1], W. Schulz[2], U. Merkel[2], N. Demuth[3], H. Bach[4], F. Appel[4], A. Löw[1], B. Waske[1], W. Mauser[1]

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Methods to accurately assess and forecast flood discharge are a fundamental requirement in practical hydrology. However, existing rainfall-runoff models, seldom consider the spatial characterisation of the land surface, which is essential for an accurate description of processes relevant for runoff formation. Especially land surface conditions of high temporal variability, like soil moisture and snow properties, influence the extent of a flood event and are hence prerequisite boundary conditions and state variables prior to and during a storm. The DLR-funded project InFerno (Integration of remote sensing data in operational water balance and flood prediction modelling) has been established in 2001 to demonstrate the potential and applicability of remote sensing data from Envisat imagery for improving operational flood forecasting by retrieving information for model parameterization and data assimilation. The Envisat sensors firstly provide the opportunity to synergetically use multisensoral imagery at a sufficient spatial and temporal resolution for mesoscale catchment applications. Existing algorithms, based on former satellite data are currently adapted and extended. The focus has been given to the quantitative retrieval of near surface soil moisture, spatial snow distribution and snow properties, all being major flood supporting factors in the test areas of the Neckar (~14.000km^2) and the Mosel (~28.000km^2) river basins. The project consortio comprises a collaboration between end user (1,2), science (4) and a value-adding company (3) to provide sustainable and transferable techniques settled close to the actual needs of flood warning services. The common effort of the project partners is to investigate, how these products can be suitably assimilated in the Large Area Runoff Simulation Model (LARSIM), which operates on a 1km^2 resolution. Algorithms and methods for a multiscale retrieval of snow covered area and its liquid water content from combined optical (NOAA, MERIS) and microwave (ERS, RADARSAT, ASAR) image interpretation and advanced rationing techniques are shown. Besides the retrieval of snow covered area, Envisat imagery is synergetically employed to assess the spatial distribution of phase transition temperatures during the accumulation of a snowpack as well as for the estimation of critical snow densities initializing melting periods. The water content of the top-soil layer, being a crucial indicator for flood risk, is determined from a semi-empirical model, which compensates topographical and vegetation effects (biomass, incidence angle) from the radar backscatter signal. The model is applied on ASAR-WSM imagery. The derived soil moisture products are validated against field measurements with an RMSE well below 6 Vol.%. Results of the concept realization, the imagery processing chain, the parameter retrieval and the scaling techniques are demonstrated for the Neckar river basin in Baden-Wuerttemberg.

Abstract No. 92

Mapping and Monitoring of Wetlands in the Lake Chad Basin Using Envisat ASAR Wide Swath and Envisat ASAR Alternating Polarization Data

T. Westra, R. De Wulf
Ghent University, Belgium

The wetlands in the Lake Chad Basin are both economically and ecologically of exceptional importance. Their extent and inaccessibility render remote sensing the only feasible method for monitoring flooding and vegetation cover. For large scale monitoring, a fusion method based on the wavelet transform is used to combine Envisat ASAR Wide Swath data and SPOT-VEGETATION optical data. The proposed method outperforms classical fusion methods, such as those based on intensity hue saturation (IHS) transformation and principal component (PC) transformation, in terms of feature enhancement and classification accuracy. For more detailed mapping, Envisat ASAR Alternating Polarization images are used. It is examined which combination of polarization modes is best suited to separate wetland from dry land and to differentiate between wetland classes. Performance of a neural network (NN) classifier is compared to a simple maximum likelihood (ML) classifier. Furthermore, it is investigated how different texture measures can improve classification accuracy.

Abstract No. 229

SAR Derived Flood Maps for Flood Propagation Model Calibration

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During flood events Earth observation (EO) synthetic aperture radar (SAR) is able to provide valuable information on the spatial extent of an inundation. The use of different polarisations and polarisation combinations enable a quite accurate mapping of the overall flood extent. With its multi-polarisation capacity, the Envisat ASAR instrument is now able to propose reliable data for maximum flood extent retrieval. These extents can be useful in calibrating and/or evaluating flood propagation models and their uncertainties.Hydraulic models allow the anticipation of hazardous situations and thus potentially constitute a key application of remotely sensed information. Models are currently calibrated with in situ measurements such as high water marks and flow velocities. Since these measures are punctual, it may sometimes be difficult to relate this information to a highly spatial dependent phenomenon: flooding. Earth observation derived information, such as

flood extent maps, provides a highly valuable calibration data source. Systems like ASAR provide a synoptic and synchronic view (thousands of square kilometres observed in a few seconds). Thus, the proposed method compares the EO-derived instantaneous observation of the flood extent with the results from flood simulation models. A fuzzy rule based calibration approach allows evaluating uncertainties and inconsistencies in both model parameterization and flood extent extraction. The results show that EO derived information can greatly benefit flood propagation model calibration. Moreover, these data can be usefully combined with ground surveys to improve flood extent modelling.

Abstract No. 261

Multisource SAR Data for Flood Monitoring in 2003 in China

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IRSA, China

Flood is a major natural hazard in China, and it is the costliest natural hazard in the world and accounts for 31% of the economic losses resulting from natural catastrophes. Synthetic aperture radar (SAR) play a very important role in monitoring hazards, especially flood. In fact, because of the presence of clouds and bad weather conditions in almost all flood events, SAR is often the only available tool to monitor such events when they occur and also to contribute in post-event damage assessment analyses. Since SAR can acquire images independently daylight and in all weather conditions, SAR data are often thought to be optimal for mapping flood inundation. The accurate delineation of inundation extend provides important information that can help guide management decisions and provide necessary data for application in hazards, hydrology, geomorphology and landscape ecology research.In the summer of 2003, the most serious flood since 1991 occurred in the catchments of Huai River in central of China. Many of areas were inundated. The Chinese Ku-band airborne radar system, developed by the Institute of Electronics, Chinese Academy of Sciences, was used for flood monitoring and damage assessment. At the same time, RADARSAT data was also acquired for providing the extent and development of flood inundation in middle reaches of Huai River. The Ku-band system acquired more than 20000 km2 real-time, high resolutions of 1m data for these areas, including Wangjiaba, Hongze Lake and Lixia River areas. Firstly, The raw airborne SAR signal data of each flight line were converted to image data through imaging processing. Image data of all flight lines registered together to make the final mosaic image. Then the airborne radar mosaic image and RADARSAT images were registered to existing National Environment and Resources Database or Landsat TM image collected in dry season to identify the normal water bodies. Finally, delineate the inundated areas in the radar image with the information of normal water bodies from database or Landsat TM image to produce the flood distribution map.Based on the analysis of the SAR data and related database, the area of flood inundation is more than 3800 km2. The land types of flood inundation includes in farmland, residential site and industrial area. Further, the extent, distribution and development of flood and damage assessment were indicated, and the suggestions on flood prevention and control were provided.

Abstract No. 342

Hydrological Modelling in a Subtropical Catchment Area - Use of Remote Sensing Techniques for its Parametrisation

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The catchment area of Rio Cachoeira is located in Bahia (Brazil) and covers an area of 4500 km2. It is one of the pilot areas in the ongoing project ECOMAN (Decision Support System for Sustainable Ecosystem Management in Atlantic Rain Forest Rural Areas), which is financed by the European Union (INCO-DEV, ICA4-CT-2001-10096). The main objective of the project is the simulation of scenarios concerning the impact of land use changes on water resources as input for an integrated decision support system (DSS). For the calibration and validation a physically based, dynamic, fully distributed hydrological model has been used, which simulates all major hydrological processes occurring in the land phase of the hydrological cycle. Remotely sensed data has been processed to support the parametrisation of the hydrological model regarding land use, land use changes and the estimation of the aerial distribution of the leaf area index (LAI). This index has been calibrated using data measured in the field. It has been combined with meteorological data for the estimation of the actual evapotranspiration and its distribution in space and time. The results have been validated by the model calibration and simulation of the water balance. The results show that the combination of remote sensing techniques with field data and hydrological methods represents an important input for decision support systems especially as tool for an improved management of land use and water resources and on the other side to reduce flood risks.

Abstract No. 381

Assessment of the Synergistic Exploitation of Envisat ASAR and MERIS Data for Plain Flood Rapid Mapping: a Part of the Dragon Flood Project

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Within, the framework of the MOST-ESA Dragon project, a proposal on the "Assessment of the synergistic exploitation of Envisat ASAR and MERIS data for Plain Flood Rapid Mapping and for Flood Support Risk Management", has been accepted and started in May 2004 after the Xiamen kick off meeting.This Flood Dragon project will enhance the Envisat objective to monitor natural disaster such as flooding. An other aspect of the proposal deals with the exploitation of Envisat data as input for monitoring tools at catchment's scale are necessary for improving flood prediction and water resources management.The rapid mapping part of the project is focussed on the assessment of the Envisat ASAR and MERIS, spatial and temporal resolution potential for flood mapping; ie ASAR spatial resolution ranging from Precision to Global modes in order to maximize the revisit and coverage, as well as polarization mode for thematic accuracy will be assessed. One of the major final goals is give the guidelines/recommendations for a Real Near Time exploitation of ASAR data for flood monitoring.Two major test sites, known as highly risky area have being selected in China. The first one, the Dongting-Poyang lakes sector, covering 300*600 km2 and located in Central China, is a major part of the Yangtze watershed. The Dragon test second test site, the Songhua Jiang flood prone, a 200*450 Km2 area located in the Heilongjiang province (North Eastern part of China, ex_Manchouria) consists in a very flat zone where very huge marshlands, internationally renowned for their biodiversity interest, coexist with wide agricultural plain, plus a very sensitive area from an economic point of view, as the oil field of Daqing or the industrial city of Harbin. Over these test sites, reference data such as ERS, Landsat SPOT data are already collected and integrated in database. Plus over, three small sensitive areas, sensitive in term of economy/human impact as well as in term of sensitive ecosystem, Cris Proba data, and equivalent to a four images mosaic, have been required. The Envisat data collection has began in spring 2004 and will continue durng the flooding period in 2005 and 2006. The first proceed images wand derived results will be presented

Thursday 9 September
08:40 – 10:20

MOZART 3

Session 4A5:

Ice (1)

Abstract No. 460

SAR and InSAR Studies on Selected Tidewater Glaciers in Spitsbergen

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This study is part of the international GECALVEX project and interferometric analysis have been performed thanhs to ESA project CP1-1076. This paper presents some results of flow velocity studies of two large tidewater glaciers in NW Svalbard, Aavatsmarkbreen and Comfortlessbreen and some preliminary results from Hornsund area (S Svalbard). During the field campaigns of July 2000 and April 2001 the GPS data of flow velocities and elevation have been registered, using static and kinematic methods. Also the flow velocity for the glaciers have been calculated from SAR interferometric satellite measurements using both ascending and descending satellite passes. Assuming that the glacier flow is superficial, the flow velocity was calculated using satellite passes (both ascending and descending). Three ERS SAR data sets have been used in this study: (a) scenes acquired during 2nd ice mission of ERS-1 (ascending) (b) scenes acquireduring a tandem mission by ERS-1 and ERS-2 (descending)and (c) new ERS-2 scenes acquired simultaneously during field campaign. To calculate flow velocity field from from ascending and descending observations, a precise topographic information is required. As input data, the glacier slope and flow direction (this only in a case of calculations with single pass) must be known to a high level of accuracy. To prepare such data the 20-m DEM provided by Cartographic Branch of the Norwegian Polar Institute (NP) have been applied. Additional problem have been identified in as much as the DEM presents very detailed and accurate height information for the ground but its accuracy for the glacier surfaces leaves much to be desired. Elevation data for glaciers was collected mostly in 1936 from photogrammetric surveys. Additionally, owning the interpolation errors of up to 50 m in respect of the sparse data elevation points, the quality of DEM on glaciers has been degraded. To try to avoid this problem, the NP DEM have been updated for Aavatsmarkbreen and Comfortlessbreen areas using field GPS elevation data acquired in 2001. The front position was also updated using optical satellite ASTER image acquired in 2001.

Abstract No. 117

Recent Fluctuations and Damming of Glaciar Perito Moreno, Patagonia, Observed by Means of ERS and Envisat SAR Imagery

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Glaciar Perito Moreno, one of the main outlet glaciers of the Southern Patagonian Icefield, has been remarkably stable during the last 80 years, with typical fluctuations of the frontal position by a few hundred metres only. The front terminates with a calving cliff in the southern arm (Brazo Sur) and Canal de los Témpanos of Lago Argentino. Since 1917 the glacier dammed up Brazo Sur about 20 times by reaching the opposite bank of the lake. The most recent damming event started in mid-October 2003 after a minor frontal advance, and ended with a collapse of the ice dam in March 2004. Due to the rise of the water level by more than 8 metres, about 20 km2 of pasture land were flooded, as observed in an ASAR image of 29 February 2004. We studied frontal fluctuations preceding this damming event, based on ERS SAR data since 1992, made available by ESA for the project AO2.A101, and on Envisat ASAR data (project AO308). The SAR data were terrain-corrected and geocoded using precise orbit data (as far as available) and a digital elevation model (DEM) acquired by the Shuttle Radar Topography Mission (SRTM) of NASA and DLR. Comparison with geodetic points and lines measured in the field by means of GPS confirms good quality of the SRTM elevation model. In addition, we studied fluctuations of the snowline on the glacier with the SAR data, revealing little interannual variations of the snowline position at the end of summer and a comparatively high accumulation to ablation area ratio. This agrees with field studies of mass fluxes which suggest that Moreno glacier is approximately in equilibrium. Among the reasons for this behaviour, which is in contrast to the pronounced retreat of the majority of Patagonian glaciers, are the comparatively high elevation of the accumulation area, the particular orographic constraints at the terminus and the topography of lake bottom at the calving front.

Abstract No. 244

Flow Evolution through the 1993-5 Surge of Bering Glacier Alaska Measured by ERS SAR Feature-tracking

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The 1993-5 surge of Bering Glacier, Alaska, is as well-documented as any such event. Yet attempts to understand the evolution of surface flow have been hampered by velocities up to two orders of magnitude greater than can be resolved by ERS interferometry. Manual feature-tracking has provided some analysis of flow patterns, but the spatial and temporal extent of these measurements so far is very limited.In this paper, feature-tracking based on optimising correlation between patches of 35-day-repeat intensity-detected ERS SAR images is used to measure the flow evolution through the 1993-5 Bering surge. This technique is entirely automatic and is able to match features not readily visible to the naked eye. This has allowed more extensive measurements of velocity fields over Bering and the ability to efficiently quantify the patterns of velocity over many more time

periods than has been attempted before.Analysis of 40 ERS1 and ERS2 images has provided 32 maps of surface velocity in 1993 as the surge was starting, and 1995 as it was ending. Once the surge had started and features began to appear, surface velocities could be mapped over large areas of the glacier. The evolution of flow velocities has been revealed and will lead to a better understanding of the little-understood mechanisms behind glacier surging.

Abstract No. 378

Using ERS and Envisat Data to Study the Glacier Changes in Tibet, the Nianqingtanggulashanmai Example (ESA Project no 2401)

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The sensitivity of mountain areas to global change has gradually emerged over the past few decades. Mountain areas are the source of water for more than half the word's population. Moreover, mountain ecosystems are particularly vulnerable to a number of natural hazards, such as avalanches, floods, volcanic eruptions, and earthquakes. In the Himalayas, more than 40 glacier lakes have been filling so rapidly that they could bring about famous 'glacial lake outburst floods' (GLOFs) in the next years.Scientific teams from France and China have launched a joined project entitled 'Survey of the snow and ice seasonal changes. Application to the Tibetan plateau using Envisat and MODIS data'. Whereas optical methods and InSAR data have been frequently used for monitoring glaciers, the use of radar SAR amplitude data is poorly illustrated. The difficulty to link the backscattering and surface parameters is probably the main encountered problem. Nevertheless, the different states of water from snow and firn to ice could be recognised using radar data. Our study is based on a multitemporal approach using ERS-EMI and Envisat-ASAR data. A Landsat TM scene from 1991 has been also used to calibrate the image interpretation. A field trip is scheduled for the next summer. Nianqingtanggulashanmai is a 600km-long belt (shanmai in Chinese) culminating at the Nyenchentangiha (7088m), about 100km as the crow flies from Lhasa in Tibet (Xizang Zizhiqu). These mountains have been chosen as preliminary test-site, on the one hand because this place corresponds to the largest glacier area of the Tibetan plateau in front of the Himalayas and, on the other hand, because the glaciers are accessible using the main track linking Xining to Lhasa.First results have shown the potential for using radar data, in particular for the detection of seasonal changes. Yearly variations have been studied owing to four Envisat-ASAR scenes from April, May, July, and September 2003 respectively. ERS data from 1998 and 1999 have been also processed to detect changes in a multiyear basis. Geomorphologic features of the Tibetan glaciers have been emphasised. Further studies would be carried out when detailed field data will be obtained.

Abstract No. 192

Recent Variations of Larsen Ice Shelf, Antarctic Peninsula, Observed by Envisat

C. Riedl, H. Rott, W. Rack
University of Innsbruck, Austria

The Larsen Ice Shelf on the eastern side of the Antarctic Peninsula has been subject to rapid retreat due to climate warming during the last decades, which culminated in the collapse of Larsen-A Ice Shelf in January 1995 and of northern Larsen-B in March 2002. These events were documented in detail by means of ERS SAR images. The sensor ASAR on board of Envisat, complemented by MERIS, enabled us to study the most recent developments at Larsen Ice Shelf, starting with the first ASAR image acquired in March 2002. Time sequences of ASAR and MERIS images were made available by ESA for the Envisat project AO308. Further retreat of the remnant section of Larsen-B started soon after the collapse, whereas the adjoining ice shelf section Larsen-C so far has been rather stable, though major changes can be expected if the climate signal spreads further south. ASAR data are also used to study the surface melt on the ice shelf and the sea ice extent in front. The time sequence of ERS and Envisat data shows remarkable interannual variability of surface melt and sea ice concentration in summer, with the major calving events taking place in summers with long melt periods. Of particular interest for understanding the role of ice shelves on stability of grounded ice is the observation of outlet glaciers from the peninsula after disintegration of Larsen-A and B which now calve directly into the sea. On these glaciers the retreat proceeded rapidly to grounded ice and the glacier flow accelerated, confirming the importance of ice shelves for the stability of glaciers up-streams.

Thursday 9 September
10:50 – 12:30

MOZART 4-5

Session 4B1:

Agriculture (2)

Abstract No. 578

Retrieving Wheat Biomass from ASAR Data

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[2] University of Valencia, Spain

Previous studies using C-Band ground-based scatterometer data and theoretical modelling demonstrated the possibilities to monitor wheat biomass during the growth season, in particular by using the polarisation ratio between HH and VV [Le Toan et al., 1984, Mattia et al., 2003, Picard et al., 2003]. However demonstrations with satellite SAR data have not been possible until Envisat ASAR data become available. To assess the capabilities of ASAR data to monitor wheat biomass, experiments have been conducted in the region of Toulouse (France) and in the Barrax area (Spain).Temporal series from March to June, 2003 of ASAR multiangular data in HH and VV polarisations have been acquired in Toulouse (AO 662). Biomass and soil moisture were measured on a wheat field simultaneously to the image acquisitions.ASAR data have been acquired in the Barrax area (Spain) during April, 2003 (EO 726), where plant biomass and soil moisture were measured for different agricultural fields (including wheat and barley).ASAR data (HH, VV, HH/VV at different incidence angles) have been analysed as a function of biomass and soil moisture. In order to make use of all the ASAR data available at different incidence angles during the 2003 season, angular variations of backscatter from wheat fields at different phenological stages observed in past experiments and in theoretical modelling have been used to account for the angular effects. The analysis results confirm that the temporal change of HH/VV at high incidence angle over wheat fields follows their biomass variations ; this leads to an algorithm using ASAR APP data to map wheat fields and to estimate wheat biomass.The experiments are extended in 2004 in order to assess the generality and robustness of the methods. References: Le Toan, T., Lopes, A. and Huet, M., "On the relationships between radar backscattering coefficient and vegetation canopy characteristics", Proc. IGARSS, Strasbourg, France, pp 155-160, August 1984.F. Mattia , T. Le Toan , G. Picard , F. Posa , A. D'alessio , C. Notarnicola, A.M. Gatti , M. Rinaldi , G. Satalino , G. Pasquariello, "Multitemporal C-band radar measurements on wheat fields", Transactions on Geoscience and Remote Sensing, Vol. 41, No 7, pp.1551-1560, July 2003Picard G., T. Le Toan and F. Mattia, "Understanding C-band radar backscatter from wheat canopy using a multiple coherent model" Transactions on Geoscience and Remote Sensing, Vol 41, No. 7, pp 1583-1591, July 2003.

AbstrAbstract No. 133

The Role of Envisat ASAR in Agriculture

F. Holecz, P. Pasquali, M. Barbieri, S. Monaco, C. Heimo
sarmap, Switzerland

In agriculture, cropped areas figures (or acreage) – i.e. the actual cultivated area during the crop season – are often unknown or roughly estimated, thus making questionable the reliability of production figures. Consequently, without reliable data, the productivity growth and the welfare of the agricultural sector is hindered due to the lack of insurance products and/or to unbalanced governmental subsidies, while, in the food security sector, actions – in terms of time and donations – taken by international / transnational or non-governmental organisations often do not correspond to the actual food crisis needs.While for the assessment of crop parameters in some services high spatial resolution multi-spectral data are fragmentally used (whenever images are available), the utilisation of Synthetic Aperture Radar (SAR) data, which offer a valid alternative, is still unknown or very marginal. The primary – but not exclusively – reason is the lack of tools, which support the generation of tailored made products/services. The purpose of this paper is to illustrate a range of applications and products for different crop types and conditions in South-East Asia, Africa and Europe. These tailored made products have been generated using SARscape®, an operational SAR processing chain embedded in the Geographic Information System environments ArcView® and GeoMania@ and in the image processing tool ENVI®. The proposed strategy is based on the use of times-series – driven by the specific crop calendars and land practices – and multi-sensor data (Envisat ASAR Alternating Polarization and Radarsat-1), enabling in this way to take advantage at the best of the synergy between the two SAR systems. The implications, in terms of products and spatial/temporal resolution, with the event of the forthcoming SAR sensors TerraSAR-X-1 (planned for late 2005) and Radarsat-2 (planned for early 2006) will be finally discussed.

Abstract No. 95

Agricultural Monitoring in Finland Using Envisat Alternating Polarization SAR Images

M. Karjalainen, H. Kaartinen, J. Hyyppä, R. Kuittinen
Finnish Geodetic Institute, Finland

An agricultural monitoring project has been carried out in Finland in the framework of ESA's Envisat Announcement of Opportunity (EAO-488). The project started in spring 2003 when we selected a test area near the city of Seinäjoki in South Ostrobothnia, which is located in the western Finland at the latitude of 63° North. South Ostrobothnia is one of the northernmost consistent agricultural areas in the world. The main crops, approximately 50% of all parcels, are barley and oats, which are sown in springtime, but there are also small areas of wheat and rye in cultivation. Altogether 16 alternating polarization SAR images (VV/VH) were requested from the growing season in 2003, from which 12 images were acquired. Simultaneously with image acquisition, we collected field measurements of growing stage, crop height and soil surface moisture. Soil surface roughness was measured in the beginning of the growing season before the emerging of the crops. The topography of the area is flat, thus, the effect of land slope is negligible. Information about test parcels, such as crop species and parcel boundaries, were acquired from the Ministry of Agriculture and Forestry maintaining the Land parcel identification system in Finland. A Finnish company Kemira Agro Oy provided us test parcels for more detailed research from their Kemira LORIS precision farming system. All SAR images were orthorectified into the Finnish uniform coordinate

system and time series of average backscattering were calculated for each of the test parcels. The results of the multiple linear regression modeling for estimating the crop growth from backscattering are presented in this paper.

Abstract No. 605

Estimation of Crop Parameters from Multiyear ERS - Envisat SAR Data Set

C. Lucau, P. Defourny
UCL, Belgium

In this paper the SAR time series for crop parameters estimation is evaluated. The study is based on six ERS time series acquired in 1995 (14 images from April to October), 1996 (11 images from March to August), 1997 (9 images from May to August), 1998 (13 images from May to August), 2000 (15 images from February to August) and 2003 (17 ERS2 and 4 Envisat ASAR images from February to September) complemented by extensive field campaigns. Since 1995 six field measurement campaigns has been carried out during the crop growth season. The test sites are situated in Belgium (Loamy region) and the monitored crops are: maize, winter wheat, winter barley and sugar beet. Soil moisture, row orientation, plant density, plant height, canopy cover, LAI and biomass were measured several times during each crop growth season, simultaneously with SAR data acquisition.The semi-empirical Water Cloud model was used for the parameters retrieval. Its advantages are the simplicity and manageability. Only few variables and some coefficients are included to a simple function. The model coefficients were first fitted against backscattering signatures collected over several fields. The model inversion allowed than to estimate the parameters such as the LAI and the plant height. The detailed results of model inversion are discussed and compared to the field measurement.For the 2003 campaign, the 4 Envisat ASAR NS images have been acquired in VV polarisation S2 mode to be compatible with the multiyear ERS data set. Three of them were acquired on the same dates than the ERS images. Therefore ASAR and SAR backscattered signals were compared for the different crops in order to asses the impact of the frequency shift between the sensors. These results are discussed in the perspective of combining Envisat and ERS data in the same time series in order to take advantage of the already multiyear dataset for the Envisat data processing.The obtained accuracy is analysed in the framework of the information requirement for different applications.

Abstract No. 619

Rice Monitoring Using Envisat ASAR Data in China

P. Yong[1], Z. Li[1], G. Sun[2], Y. Pang[1], M. Wooding[3], E. Chen[1], B. Tan[1]
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[2] 2. *Department of Geography, University of Marylan, United States*
[3] *Remote Sensing Applications Consultants, United Kingdom*

Rice is one of the major crops in China. To control and maintain a close balance between rice production and food need, there is a requirement for effective rice mapping and yield estimation. During previous studies, two ERS SAR images acquired at the transplanting stage and the ripening stage were used to generate accurate rice maps in Guangdong Province. Envisat ASAR with multiple incidence angles and multiple polarisations provides more imaging configurations for rice mapping and rice biomass monitoring during the rice growing cycle.Based on field measured rice biophysical parameters, rice paddy backscatter has been simulated by a continuous canopy microwave backscatter model. The model shows that it is possible to use several different ASAR data combinations to map rice: 1)one image before field flooding, with another at the flooding/ transplanting stage; 2) one image at the flooding/transplanting stage, together with another image at the ripening stage; 3) one image at the booting stage, with another at the ripening stage; 4) one dual-polarisation image on a single date; 5) two dual polarisation images obtained within one week (one with hh/hv, the other with vv/vh). Of these alternative approaches, the last two use the polarisation capability of ASAR data, while the first three methods can benefit from more timely data acquisition using the multi-angular imaging capability. All of these selections have been evaluated in the North and South of China. Rice biomass has been estimated by inversion of the multi-temporal backscatter coefficient from ASAR data. According to the relationship between rice biomass and yield of certain rice varieties, the rice yield can be estimated.

Poster Session 4P03:

Agriculture

Abstract No. 165

Crop Classification Based on Microwave Images Acquired from Envisat and ERS

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Institute of Geodesy and Cartography, Poland

The aim of the presented project was to assess the efficiency of crop classification which was based mainly on microwave images from Envisat-1 satellite. Seven Envisat images acquired with alternating polarization at the consecutive crop growths stages constituted the main set of data in the project. Three images from ERS-2 satellite were included in the analysis in order to supplement Envisat data with additional polarization configuration. As a result of preliminary processing pixels of images were represented by ã values. The field observations made in Wielkopolska region in Poland during the growing season of 2003 supplied ground truth data which were needed for both: training the classifier and assessment of classification accuracy. Data were collected for 700 plots covered by homogeneous crops. The following crops are dominant in the test site: wheat, rye, triticale, barley, sugar beet, rape, maize and grass.Ancillary data referring to the selected test site were also taken into account. Land use maps, digital elevation model and soil maps contain important information which were used in the classification process. The following set of attributes was specified for each plot: land use type, slope, slope direction, soil type, average ã coefficient for each image of the analyzed set. Other group of plot attributes originated from ground observations. That group contained type of crop and various plant characteristics referring to different stages of crop growth. Analysis of variance proved that differences among mean values of ã coefficient calculated for various crops are statistically meaningful. Neural network classifier was applied to segmented microwave images in order to create map of crops in the test area. It was possible to differentiate the following crops: rape, sugar beets, maize, alfalfa and cereals. Rape was distinguished from the other crops as early as at the end of April or at the beginning of May by investigation of at least two Envisat images with differing polarization. Differentiation of cereals on microwave images was possible but signatures of cereals reveal close similarity. Cereals recognition depends strongly on the date of image acquisition and also on the soil moisture level and water content in plants at the moment of image acquisition.

Abstract No. 227

Ecological Agricultural Crops Classification Using Envisat-ASAR in Oases of Taklamakan Desert

Q. Dong, H. Guo, Z. Li
Institute of Remote Sensing Applications, China

The present paper gives a method using Envisat-ASAR imagery to survey the agricultural planting texture in Hetian area, Xinjiang Vygur Autonomous Region, China, where the agriculture in oases Agriculture is a mainstay of the social economy. The ecological balance is very weak ecotypically in Hetian area because of the fact that Hetian locates southern skirt of Taklamakan Desert. The glacial melt-water from Kunlun Moutain feeds a string of oases in the area. We take utility of ASAR imagery of 2003 to analyze the agrotype, economic forestry, water system and agricultural drainage. Also, the Global Positioning System (GPS), and Geographical Information System (GIS) were used as an aid for understanding the change of the natural oases and development of man-made oases while many towns and villages around the oases are developed at the cost of ecological balance and natural oases areas, which are the main source of food and the unique pocketbook of local people. The research concludes that the ecological agriculture planning and dvelopment should be based on conservation of natural oases and reclamation of the desert edges where the glacial melt-water from Kunlun Moutain is very limited.

Thursday 9 September
10:50 – 12:30
KARAJAN 2-3

Session 4B2:

Water Quality

Abstract No. 317

Suspended Matter Dynamics in Lake Constance in 2003 Derived from MERIS and MODIS Satellite Data

J. Huth, P. Gege
DLR, Germany

Lake Constance is the second largest freshwater lake in Central Europe. The river Rhine, which passes the lake, imports significant amount of mineralic particles. Their transport and sedimentation within the lake is of importance for a number of applications, for example ship traffic, pumping stations for extraction of drinking water, hydraulic engineering, fishery, and ecology. Only satellites offer a cost-effective way for obtaining time series of the spatial distribution of suspended matter in such a large lake. The potential of satellite-based monitoring of suspended matter is investigated using MERIS and MODIS time series from 2003, addressing two specific questions: (1) Are these sensors suited to derive useful time series of medium- and large-scale patterns of suspended matter in Lake Constance? (2) Are the quantitative results from the two sensors comparable?

Abstract No. 186

Mapping of Photosynthetic Pigments in Spanish Inland Waters Using MERIS Imagery

R. Pena-Martinez, A. Ruiz-Verdu, J. Dominguez-Gomez
CEDEX, Spain

The first stage of the project AO-594 comprised the development of algorithms for photosynthetic pigment mapping with MERIS, obtained from an extensive field campaign carried on 36 inland water bodies throughout the years 2001-2002. The ratio of simulated bands 9 and 7 showed a good correlation ($R2 = 0.919$) with HPLC-measured chlorophyll-a concentration, whilst the ratio of 9 and 6 showed an R2 of 0.723 with phycocyanin in-situ fluorescence.The objectives of the second stage of our project are the calibration and validation of the developed models using MERIS imagery and field data, and the set up of a web-based operational system for pigment mapping and water quality monitoring of the main Spanish reservoirs. For that purpose, an accurate atmospheric correction of L1b imagery is needed, since the reflectance values of L2 are not yet useful for inland waters. The available MERIS tools show also some problems of underestimation of atmospheric transmittance, which leads to negative values of reflectance in red and infrared bands. To overcome those difficulties, several band indexes have been tested, instead of simple band ratios, in order to estimate the pigment concentrations. Based in this approach, thematic maps of photosynthetic pigments are already in process, calculated from the reflectance-corrected L1b imagery. The models calibration and validation field campaigns are also under way this year.

Abstract No. 207

Retrieval of Limnological Parameters of Perialpine Lakes by Means of MERIS Data

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The capabilities of MERIS for monitoring limnological parameters of perialpine lakes are investigated in the Envisat project AO-164. The data base includes about 15 full resolution images of MERIS acquired over the Eastern Alps from March to September 2003. Further investigations are planned for spring and summer 2004. Study sites are several lakes located within the northern slopes of the Austrian Alps and the Italian Lake Garda. Field data, acquired parallel to several satellite overflights, include reflectivity spectra above the water surface measured with a spectroradiometer and limnological parameters extracted from water samples. Aerosol properties were derived from atmospheric transmittance measurements at four wavelengths with a Precision Filter Radiometer deployed at the shore of the lakes.The derivation of the surface reflectance from the measured spectral radiance by means of radiative transfer calculations is a critical issue in the development of algorithms for water quality. The field measurements revealed high variability of aerosol optical thickness. Because the aerosol load and properties are usually unknown it is necessary to derive them directly from MERIS data if the data shall be used for monitoring purposes. A viable solution for this problem is the Dark Dense Vegetation (DDV) approach.The surface reflectance data derived from MERIS were analysed in relation to the limnological field data in order to study possibilities for retrieval of limnological parameters. This analysis, as well as previous investigations with MERIS data simulated from an hyperspectral airborne survey and field spectroradiometry on the Austrian oligotrophic lakes revealed the Chl-a concentration as the water quality parameter which is best correlated with the spectral reflectance. For other optically active substances (e.g. gelbstoff, suspended sediments) the algorithms are based on spectral bands in the blue region which is critical in respect to sensor radiometry and aerosol modelling within the atmospheric correction. The investigations confirm the feasibility of MERIS to estimate the Chl-a concentration also for perialpine lakes, which are characterized by comparatively low concentrations of optically active substances.

Abstract No. 621

Amazon Floodplain Water Quality Monitoring using MERIS and MODIS Data

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Until now, few works dealt with the use of satellite data to monitor water quality in the Amazon basin, in particular because of the unavailability of appropriated remote sensing sensors and of the dramatic lack of in situ measurements to validate the analysis. The Amazonian floodplain constitutes one of the major freshwater wetland system. It is compounded of several thousands lakes, showing strong spatial and temporal heterogeneities caused by the large water level fluctuations, reaching up to 20 meters. These lakes act like natural reservoirs during high water stage, stocking large amount of water and sediments. In such heterogeneous and fast-changing environment, the challenge is to retrieve the parameters of interest when the water optical properties are affected at the same time by the presence of phytoplancton, dissolved organic components and the suspended matter. Sensors such as MODIS and MERIS, by joining fine spectral resolution (15 bands for MERIS between 400 and 900 nm), high temporal resolution (2 images a day for MODIS) and medium spatial resolution (250 to 500 meters), appear promising. In this study, we assess the use of MODIS and MERIS data for the monitoring of the Amazonian floodplain lakes. MERIS data were acquired trough a ESA Category-1 user project. The floodplain studied is the "Lago Grande de Curuai", located on the right bank of the Amazon R., across from the city of Óbidos. This floodplain is a complex system of more than 30 interconnected lakes, with a maximum inundated area of 2,300 km². A very high temporal variability of the monitored TSS in various lakes and channels has been observed. The TSS concentrations at the surface of white water lakes are ranging from 4 mg/l during the flood peak to extreme values, of about 1600 mg/l, during the low water stage, when annual TSS concentrations in the Amazon mainstream range from 1 to 256 mg/l in the same period. Making use of a large dataset of water quality measurements we analyzed the spatial and temporal variations of the water signatures. Measurements come from several field campaigns during which a large number of points are visited and from a long-term monitoring network on a limited set of stations. Measurements include : TSS, DOC, POC, chlorophyll, granulometry of sediments and heavy metals concentrations. The fine spectral resolution of MERIS allows to identidy finely main water constituents and to understand the biophysical processes taking place in the lakes. MERIS makes it possible to monitor the extension and duration of phytoplanctonic blooms and to retrieve the chlorophyll-a and TSS concentrations during the main lake stages. Comparisons of MODIS data with TSS measurements collected every 10 days proves that such sensor allows to finely monitor the surface sediment fluxes. Accuracy of the TSS retrieval using semi-analytical techniques ranges between 5 and 17 mg/l. Complementarity of both MERIS and MODIS sensors is discussed.

Abstract No. 257

Water Quality and Algae Bloom Mapping in the CASE 2 Waters of the Baltic Sea and Finnish Lakes Using Envisat MERIS Data

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Water quality and algae bloom mapping in the CASE 2 waters of the Baltic Seaand Finnish lakes using Envisat MERIS dataJouni Pulliainen, Jenni Vepsäläinen*, Sampsa Koponen, Seppo Kaitala**, Kari Kallio* and Timo Pyhälahti* Helsinki University of Technology, Laboratory of Space Technology, P.O. Box 3000, FIN-02015 HUT, Finlande-mail: jouni.pulliainen@hut.fi* Finnish Environment Institute (SYKE)** Finnish Institute of Marine ResearchWater quality and algae/cyanobacteria bloom mapping in the Baltic Sea and lake regions of Finland is an important national and international environmental assessment issue. For example, the Gulf Finland in the Baltic Sea is considered to have serious human impacts. In Finland, the total number of lakes to be monitored according to EC regulations is 56,000 (surface area > 0.01 km2). Their monitoring is a difficult task in practice through conventional monitoring programmes. The use of Earth observation data may solve part of these problems.In the Baltic Sea, unattended flow-through fluorometers are currently operatively employed to provide information on chlorophyll a (chl-a) concentration and distribution. The information is collected on a daily basis at merchant and passenger vessels operating in the region (automated Alg@line sampling system). These ship-of-opportunity observations are used for the general assessment of the status of the Baltic Sea. Since chl-a is a measure of phytoplankton biomass, spatially distributed information on eutrophication is obtained. However, the spatial coverage of data is restricted to transects cruised by vessels. In lakes, the classification system based on water sample collection has several limitations. In Finland, monitoring stations only cover a small portion of the lakes. Furthermore, in many lakes there is only one monitoring station. Hence, the variability of water quality within those lakes is not known. Also, some monitoring stations are visited only once during the open water season so the temporal coverage of the monitoring is not very good.Space-borne optical spectroradiometers, such as MERIS and MODIS, provide daily remote sensing reflectance observations correlated to chl-a concentration of surface water layer. These data are available whenever cloud conditions permit for a moderate spatial resolution of 250 to 300 metres. Spectroradiometers can be used for the mapping of chl-a using empirical or semi-empirical algorithms. However, their accuracy is limited in the CASE 2 waters due to the relatively high yellow substance (CDOM) and total suspended particle concentrations. Due to the high concentrations, the atmospheric correction of satellite observed radiance data to water leaving reflectance values is also a cumbersome task. As an outcome, if satellite data retrieval algorithms do not apply nearly concurrent in situ reference information for the algorithm calibration, these factors result to systematic errors in estimated water quality characteristics. In practice, the chl-a concentration is occasionally seriously under- or overestimated even though the correlation of observed reflectances with the chl-a values may be high. This handicap seriously reduces the feasibility of satellite observations for the operational monitoring of the Baltic Sea and Finnish lakes, unless satellite data are used together with in situ observations.In this investigation, MERIS data and Alg@line-ship of opportunity data were used to derive empirical chl-a maps for the Baltic Sea. Additionally, the obtained results showed that during highly dynamic cyanobacteria blooms, the combined use of Alg@line and MERIS observations provides good results. The comparison of MODIS and MERIS data also yielded information on optimal wavelength bands and channel indices for the assessment of the Baltic Sea. The results indicate that both instruments can be used for the water quality mapping with about the same accuracy. However, MERIS has the advantage of better spatial resolution. Spatial resolution was found to be crucial performance characteristic during surface floating cyanobacteria blooms.The quality of water in Finnish lakes is monitored at about 5,000 monitoring stations. The monitoring is based on traditional ground truth measurements. From time to time, the collected data are used for classifying lakes into five quality classes ranging from excellent to poor. The latest classification was completed in 1999 and it used data collected during 1994-1997. The analysis for the classification took about two years to complete and it included over 2.5 million measurement results. The only cost efficient way to improve the spatial and temporal coverage of lake monitoring is remote sensing. With remote sensing techniques it is possible to first retrieve the values of some water quality parameters (e.g. chl-a, turbidity, suspended solids) and then use those values to classify lakes. In this paper a more direct approach is used: The quality class of a lake is assumed to be directly proportional to the radiance values detected over the lake with MERIS and MODIS sensors. The results indicate that these sensors can be used for operational water quality mapping in Finnish lakes, together with in situ observations. For example, the results obtained using MODIS data show an overall classification accuracy is 80 % (of 19,208 data points).

Poster Session 4P04:
Water Quality

Abstract No. 225

Large European Lakes Vänern and Vättern in MERIS Images

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In order to complement present water quality monitoring of large lakes, we have attempted to make use of satellite imagery. In addition to ocean color sensors SeaWiFS and MODIS, lately also MERIS images became available. By bio-optical simulations we have shown that MERIS bands are more suitable to estimate chlorophyll concentrations than SeaWiFS and MODIS in these lakes, which contain also significant amount of dissolved organic matter. We have also shown that SeaWiFS and MODIS standard atmospheric correction often fails over these lakes. Here we compare 20 almost cloud free full resolution atmospherically corrected MERIS images with SeaWiFS and MODIS images from the same day. Water leaving reflectance spectra are compared with results of bio-optical model simulations, in situ chlorophyll and absorption by dissolved organic matter.

Thursday 9 September
10:50 – 12:30
MOZART 1-2

Session 4B3:

Clouds and Aerosols (2)

Abstract No. 309

MIPAS/Envisat Observations of PSCs in the Artic and Antarctic Winters 2002 to 2004: a Comprehensive Dataset for Polar Process Studies

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Monitoring of Polar Stratospheric Cloud (PSC) coverage and type differentiation by remote sensors on a vortex-wide basis are essential for better understanding and quantification of the denitrification in both polar vortices and effects on ozone recovery. The spectrally highly resolved limb emission spectra measured by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) are providing an excellent opportunity for this detection and differentiation of PSC cloud types. Furthermore, the MIPAS is currently the only instrument in space delivering observations close to the pole (-90,+90 deg latitude) of PSC distributions over complete winters. These types of measurements, i.e. vortex-wide and spectrally resolved data, are becoming more and more important for the validation of PSC formation mechanisms of microphysical model on a statistical basis.In this study MIPAS level 1b spectra have been analysed. Derived PSC quantities (e.g. cloud top heights and PSC occurrence frequencies) for the Arctic winter 2002/3 and 2003/4 as well as Antarctic winter 2002 and 2003 will be presented in comparison with meteorological analyses, coincident trace gas measurements (Level 2) from MIPAS and results by the Chemical Lagrangian Model of the Stratosphere (CLaMS). Characteristics of specific winters will be highlighted.

Abstract No. 65

Aerosol Optical Depth over Europe - Retrieval from ATSR-2 Data for the Year 2000

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At TNO Physics and Electronics Laboratory aerosol properties are retrieved from ATSR-2 data (ERS-2 satellite) by means of scientific algorithms. The dual view algorithm for application over land and the single view algorithm for application over ocean have been merged into a fast and efficient algorithm that allows for near real-time processing and which is suitable for operational use. It includes all necessary corrections for surface and atmospheric effects including fully automated cloud screening procedures. The algorithm can be applied to retrieve aerosol optical depth (AOD), Ångström parameter and aerosol types. An analysis with newly obtained data for the

year 2000 over Europe is presented here. It is shown that the retrieved AOD compares favorably with collocated sun-photometer data from the Aerosol Robotic Network (AERONET).

Abstract No. 246

Retrieving Aerosol Properties and Land Surface Reflectance from Multi-angle AATSR Measurements

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Atmospheric aerosol particles significantly affect the Earth's radiation budget, yet aerosols are one of the largest uncertainties within climate modelling and the lack of measurements on a global scale is one reason for this. However, satellite remote sensing offers a viable means of monitoring aerosols over large areas and on a timely-basis. Aerosol measurements can also be used for atmospheric correction of remotely-sensed data allowing land surface reflectance to be compared over time so that vegetation state can be monitored.In this paper, dual-angle AATSR measurements are used for retrieving both atmospheric aerosol properties and bi-directional reflectance over land. Previous research has shown that it is possible to separate the atmospheric and surface components from multi-angle measurements. To achieve this, angular variation due to both atmospheric effects and surface scattering need to be taken into account. This paper demonstrates how the inversion of a physical model of light scattering can be used for quantitative mapping of aerosols over different land surfaces types. Testing is performed over a representative set of land cover types and aerosol sources, and at a range of latitudes. Nearly four-hundred AATSR scenes for more than 20 sites around the world have been acquired. These test sites have been selected to correspond with the sites of permanent AERONET sun-photometer instruments. In addition to the ground-based sun-photometer datasets, MISR, MODIS and TOMS aerosol data products were acquired from NASA for a few of these sites for inter-sensor validation. MODIS ground reflectance products were also acquired so that comparison with AATSR derived ground reflectance could be made. For nearly all of the sites there is a good correlation between sun-photometer measurements of aerosol optical depth and the AATSR derived measurements. In addition, there is a high correlation between the AATSR aerosol measurements of aerosol opacity and the other satellite aerosol products, demonstrating that the AATSR method of aerosol opacity retrieval works effectively. Over all sites the RMSE is approximately 10 percent of the aerosol optical depth. The method is also developed to examine the potential determination of aerosol type based on best fit over a range of aerosol scattering models in the inversion procedure. Validation is performed qualitatively by a priori knowledge of the aerosol sources over spatially extensive land covers. For many of the sites realistic parameters are obtained for a given land surface and likely aerosol source. Furthermore, the retrieved AATSR ground reflectance is compared with the MODIS BRDF product and initial results indicate close correlation between the two instruments' estimate of surface reflectance.

Abstract No. 383

CONTRAIL: Monitoring Aircraft Condensation Trails (DUP/DUE)

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Exhaust emissions from jet aeroplanes contain large amounts of water vapour which, under certain atmospheric states, will condense to form elongated cloud-like condensation trails in the sky. The ice particles so formed then act as cloud condensation nuclei, and provoke the condensation of yet more moisture from the surrounding atmosphere. The "contrails" formed in this way could have a significant environmental impact by modifying the radiative balance of the Earth-atmosphere system. This perturbation is caused both by the contrails themselves, and possibly also by the formation of persistent cirrus clouds which might not otherwise have existed. The focus of this DUE project is to develop and demonstrate an EO-based service in support to the continuous assessment of the environmental effects of increasing volumes of air traffic, by monitoring the daily contrail and cirrus cloud coverage over Europe and the North Atlantic. EUROCONTROL is interested for two reasons: (i) in order to reduce the uncertainties on the assessment of the greenhouse impact of contrails, and (ii) in order to validate a contrail formation model. The model will be used to explore scenarios for mitigation strategies, if the environmental impact is found to be severe. This paper examines EUROCONTROL's requirements, the current status of the project, and the services to be delivered.

Abstract No. 538

Detection of Condensation Trails, Cirrus Clouds and Retrieval of their Properties with AATSR

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To investigate a possible impact of air traffic and its emissions on cirrus clouds, differences in the properties of cirrus clouds will be compared between areas of high air traffic density in the Northern and areas of low air traffic density in the Southern Hemisphere.Within the Envisat-AO project "NOSOKO" (North-south contrast near the midlatitude tropopause as an indicator for the impact of aircraft emissions) these differences are investigated by retrieving the optical thickness and effective ice particle size of cirrus clouds from AATSR/Envisat over these areas.Additionally maps of cirrus cloudiness and aircraft producedcondensation trails will be derived from AATSR over Europe and the North Atlantic within the ESA Project "CONTRAILS". These maps are used to investigate the occurence of condensation trails compared to natural cirrus clouds for the year 2004 and to identify areas with high air traffic density in the Northern Hemisphere for NOSOKO.First results will be presented.

Session 4B4:

Soil Moisture

Abstract No. 76

Has SAR Failed in Soil Moisture Retrieval?

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Soil moisture plays an important role in a variety of environmental processes. It controls the partitioning of precipitation into runoff and infiltration, determines the separation of incoming available energy into sensible and latent heat fluxes to the atmosphere and limits evaporation and transpiration.In-situ measurements of soil moisture yield precise values, admittedly representing only point measurements. Remote sensing methods provide indirect areal estimates of soil moisture. Microwaves show a unique sensitivity to dielectric properties of natural media, thus radar remote sensing is in principle regarded a well suited tool for retrieving soil moisture information. Although numerous studies and experiments have been conducted in the last three decades, there still exists no operational method for easily extracting soil moisture information from Synthetic Aperture Radar (SAR) imagery. The problem is that radar backscatter also strongly depends on the geometrical properties of the imaged terrain. The influence of soil surface roughness on the backscattered signals is as distinct or even greater than the soil moisture information itself, making surface roughness a major limiting factor in radar remote sensing of soil moisture. Surface roughness found in the field often do not fall in the validity range of existing theoretical bare soil backscatter models, nor give current roughness measurement methods satisfying and representative descriptions of natural roughness conditions. This makes soil moisture retrieval from SAR data still a problematic task, often leading to poor modeling results and making most of the soil moisture retrieval algorithms proposed in the literature simply not applicable.This study reviews the experiences made in various experiments that aimed at extracting soil moisture from SAR data, trying to answer the question why they failed. One of our observations is that new techniques for measuring surface roughness are urgently needed, since most campaigns failed to collect representative surface roughness data. Another observation is that change detection approaches using long SAR time series and scatterometer data have in general been very successful. With change detection only the changes in the backscatter signals in comparison to a known reference are interpreted, which allows to circumvent the problem of surface roughness characterization.As an outlook to the future, this study proposes an new approach to extract soil moisture from ScanSAR data at a scale of 1 km. Unfortunately, Envisat ASAR has many competing modes and power supply restrictions, which limits the availability of ASAR ScanSAR data. However, even with currently available technology it would be feasible to build an advances ScanSAR system which could be operated continuously, thus providing measurements every 3-4 days with a high spatial resolution. The major challenge using ScanSAR data is that the local incidence angle changes from acquisition to acquisition, thus requiring a retrieval model that is applicable over a wide range of incidence angles (20° - 60°). On the other hand, the information obtained about the incidence angle dependency of the backscattering coefficient may turn out to be very useful for characterizing surface roughness and vegetation.

Abstract No. 662

Use ERS-2 SAR Data for Estimating Soil Moisture and Vegetation Water Content Variations in Boreal Forests

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The response of C-band SAR data to variations in soil and vegetation water content is investigated by applying a one-year time-series of 18 ERS-2 SAR observations from the Hyytiälä forest research station, Finland. The reference data include daily average soil moisture observations from a TDR-measurement network as well as daily maximum and minimum pine trunk diameter observations. Additionally, high-resolution soil type and forest cover (species and stem volume levels) information were available for a large surrounding forest region. The actual derivation of SAR-based moisture/water content estimates was carried out for different land and forest types of this region. The in situ soil moisture values were separately measured for the top humus layer and for the top mineral soil layer. The available trunk diameter data are directly related to the total water content of tree canopy. Hence, the data set enabled the investigation of the influence of soil moisture and vegetation water content to backscatter from boreal forest. Additionally, the data set was used for studying the quantitative performance of soil moisture estimation. This was carried out by inverting a semi-empirical boreal forest backscattering model.The results indicate that during the snow-free period the C-band SAR observations detect well the extreme volumetric water contents of forest canopy and those of underlying mineral soil. The minimum backscattering coefficient was observed for dry summer conditions with minimum water content levels. During autumn, in situ water contents for soil and trees lay in their maximum saturated values, and thereby, the backscattering coefficient also shows the highest level. The employed inversion approach estimates forest canopy water content as well as soil moisture from the SAR data when a priori forest biomass (stem volume) information is available. The inversion method provides an estimate for the soil moisture of forested terrain, which is here directly compared with in situ values. The other SAR-based quantities used for comparisons include the observed mean backscattering coefficient for the densest forest and the estimated water content of forest canopy.The results obtained for pine dominated boreal forests show a moderate correlation coefficient r of 0.66 and a RMSE of 5.7%-unit between the SAR-derived soil moisture values and in situ data. The total variation in the TDR-observed reference soil moisture of mineral soil was from 13% to 33%. Generally, the seasonal behavior pattern of soil moisture was well observed in SAR-based estimates. The results also indicate that the in situ daily minimum pine trunk diameter correlates well with (a) the level of backscatter observed for dense forests and (b) the estimated water content of tree canopy. The obtained correlation coefficients (r) exhibit values of 0.78 and 0.73, respectively. This suggests that tree water content variations can be detected by using C-band SAR data in case of pine-dominated boreal forests. The observed seasonal behavior of C-band backscatter for spruce-dominated forests appears to be more complicated than that of pine-dominated forests. This may be a consequence from the fact that spruce forests represent more wettish land types (typically mires) than pine forests.

Abstract No. 161

Retrieval of Soil Moisture from Envisat ASAR Images: a Comparison of Inversion Algorithms

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Soil moisture (SMC) plays a critical role in the surface energy balance at the soil-atmosphere interface and can be considered a key state variable that influences the redistribution of the radiant energy and the runoff generation and percolation of water in soil. We know that local SMC measurements are strongly affected by spatial variability, besides being time-consuming and expensive. Moreover, the use of hydrological models for extending the forecast of soil moisture over larger areas is not easy, and depends on the homogeneity of the selected areas and on the information available on them (soil properties, i.e. hydraulic characteristics, and permeability, together with meteorological and climatological data, etc.). The possibility of measuring soil moisture on a large scale from satellites, with complete and frequent coverage of the Earth's surface, is, therefore, extremely attractive. The sensitivity to soil moisture of the backscattering coefficient measured at low microwave frequencies is a well-known phenomenon already investigated by many scientists. Indeed, research activities carried out worldwide in the past have demonstrated that sensors operating in the low frequency portion of the microwave spectrum (P- to L-band) are able to measure the moisture of a soil layer, the depth of which depends on soil characteristics and moisture profile. The most significant information was obtained by combining different frequencies, polarizations, and incidence angles. Unfortunately, L-band is not available from current satellite sensors, which moreover operate in a single-frequency band. Thus, research for the retrieval of soil moisture has been focused on the potential of existing sensor frequency, i.e. the C-band, which is operational on ERS-2, RADARSAT, and Envisat. C-band backscattering is still sensitive to SMC, but it is significantly influenced by vegetation and surface roughness too, so that the estimation of spatial variations of moisture with the accuracy requested in many applications is rather still problematic, and needs the use of correcting procedures.In this paper we present a comparison of algorithms for retrieving SMC from Envisat ASAR images collected on two agricultural areas in Italy: Alessandria, in the Northern part, and Montespertoli, in Central Italy. SAR images were collected in summer and fall 2003 and in springtime 2004 together with ground data. The algorithms taken into consideration were: a FF Neural Network with two hidden layers, a statistical approach based on Bayes theorem, and an iterative algorithm based on Nelder direct search method. The training of the NN and the generation of reference values for both the Bayes and Nelder approaches were performed by simulating radar backscattering through the Integral Equation Model. Per pixel maps of soil moisture were generated from SAR images on the basis of these algorithms, and the obtained values were compared with ground data. The comparison showed that all the tested algorithms produced satisfactory results, but the predictions of the NN were slightly more accurate than the other approaches.

Abstract No. 110

Multiscale Soil Moisture Retrieval to Monitor the Global Change of the Water Cycle - Perspectives from the GLOWA-Danube Project

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The GLOWA-initiative, funded by the German Ministry of Research and Education (BMBF), has been established to address the consequences of Global Change on regional water resources. The GLOWA-Danube project is dealing with the Upper Danube watershed as a representative mesoscale test site (~ 75.000 km²) for mountain-foreland regions in the temperate mid-latitudes. The principle objective is to identify, examine and develop new techniques of coupled distributed modelling for the integration of natural and socio-economic sciences. The transdisciplinary research in GLOWA-Danube has developed an integrated Decision Support System, called DANUBIA, to investigate the sustainability of future water use. In order to synthesize a common understanding between the project partners, a standardized notation of parameters and functions and a platform-independent structure of computational methods and interfaces has been established, by making use of the Unified Modeling Language (UML). DANUBIA is object-oriented, spatially distributed and raster-based on a 1 km² grid spacing. The study outlines the GLOWA-Danube approach of network-based, object-oriented model coupling to communicate data and model parameters across the typical discipline borders. Encouraging results of the DANUBIA prototype are shown, for both simulated physical and socio-economic processes in the Upper Danube watershed. Remote Sensing is the key to an integrative monitoring-concept for GLOWA-Danube. Multitemporal and multisensoral (and hence multiscale) remote sensing information is used as a source of input- and validation data for various modeling approaches. Hydrologic processes, such as runoff production or evapotranspiration, largely depend on the variation of soil moisture and its spatial pattern. While standard image products usually lack sufficient spatial extent and frequent availability, Envisat's ASAR-WideSwathMode imagery synoptically covers mesoscale areas in medium spatial resolution and high temporal repetition. This study presents a semi-empirical model for the retrieval of near-surface soil moisture from ASAR-WSM imagery. The procedure compensates for the different topographic and vegetation effects on the backscatter signal. Small scale variations in vegetation, especially in agricultural areas, are crucial for the accuracy of soil moisture retrieval. Since GLOWA-Danube operates on a 1km² grid, a scaling procedure was developed which takes into account subscale land cover datasets derived from AVHRR and MERIS imagery. Quantitative comparisons of derived near-surface soil moisture products to field measurements and mesoscale hydrologic model results show a remarkable improvement and overall good agreement, when the vegetation effect on the radar backscatter signal is accounted for on a subscale basis. Based on the mesoscale results of the soil moisture retrieval for the Upper Danube watershed, an attempt was made to utilize this information for developing a bi-directional scaling procedure for global scale applications. The lack of global soil moisture observations is a major obstacle for various research activities ranging from climate monitoring to the quantification of biogeophysical fluxes, and hence for a reliable estimation of processes related to Global Change. In order to potentially bridge the gap between mesoscale and global scale applications and vice-versa, the validated soil moisture data derived from ASAR is aggregated to create virtual footprints of the highly anticipated SMOS (Soil Moisture and Ocean Salinity) sensor, which is to be launched by ESA in 2006. The payload of SMOS is a L-band radiometer (1.4 GHz) based on a two-dimensional aperture synthesis concept,

with new and significant capabilities, especially in terms of it's multi-angular viewing configuration. SMOS will provide soil moisture products for the root-zone with a spatial resolution in the range of 20 km and in high temporal frequency, and must therefore be considered a valuable monitoring system for large scale applications in hydrology and related sciences. Simulated SMOS footprints for the Upper Danube watershed are shown and discussed. Upon availability of SMOS imagery, the developed scaling procedure will in return be utilized to disaggregate soil moisture information for the mesoscale.

Abstract No. 102

Soil Moisture Mapping with C-band Multi-polarization SAR Imagery

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Soil moisture is a variable that plays a leading role in surface water and energy balances, especially in arid continent of western China. Periodic and distributed observations of this key variable allow to improve surface water and energy balances. High resolution data of C band ASAR (Advanced Synthetic Aperture Radar) sensor aboard ESA's satellite offers the opportunity for monitoring surface soil moisture at high spatial resolution with mutil-polarization and multi-incidence capabilities, which is suitable for distributed mapping at the small scales area.This paper reports results of research into C band SAR from ERS-1/2 and Envisat for soil moisture mapping. Using Integral Equation Model (IEM), we simulated the backscattering coefficients of C band SAR backscatter at different incidence angles and the alternating polarisation mode, and analysed the sensitivity to soil moisture. The algorithm of infering surface soil moisture from radar backscatter is developed according to semi-empirical model from the results of simulation and sensitivity analysis. Using ERS-1/2 SAR imagery on May 27, May 28, Jun. 26, Jun. 31, Sep.04, 2001, and ASAR APS 1P data with HH and HV polarisations on Jun. 27, Jul. 13 and Aug. 12, 2003, the soil moisture map of temporal period are retrieved in Tuotuohe, Tibet plateau(34°13¢N, 92°25¢E). Additionally, field soil moisture measured on the day of acquisition at several sites through the TDR and gravimetric methods, and are used to assess the SAR imagery soil moisture estimations. The soil moisture map retrieving from SAR backscatter measurements compared to the spatially distributed ground truth. Accuracy in the retrieval of the surface moisture content from the radar measurements follows the accuracy in the field measurement. The results demonstrate the effects of soil moisture monitoring using temporal and mutil-polarisation SAR data.

Poster Session 4P05:

Soil Moisture

Abstract No. 25

The Retrieval of Soil Moisture Using Medium Resolution Envisat ASAR Wide Swath Data

X. Kong[1], S. Dorling[1], R. Smith[2]
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[2] *Met Office, UK, United Kingdom*

The aim of this study is to estimate soil moisture using Envisat Advanced Synthetic Aperture Radar (ASAR) medium resolution data and to compare with field measurements and with a hydrological model, MOSES 2.2, developed by the UK Met Office and the UK Centre for Ecology and Hydrology. Envisat ASAR Wide Swath Mode offers a reasonable compromise for soil moisture monitoring due to the increased temporal resolution (3-5 days) and area coverage (400km) with medium resolution (150m), thus providing data for larger scale soil moisture monitoring with an appropriate temporal repetition. During 2004, fieldwork is being carried out in Norfolk, UK on the days of image acquisition. The soil moisture and vegetation data are collected at three sites with different vegetation types: winter wheat, sugar beet and grass. Empirical regression and neural network approaches are used to retrieve soil moisture from the ASAR images. The retrieval is validated against ground truth soil moisture and also compared with MOSES model estimates. Results from this analysis will be presented at the symposium.

Abstract No. 63

Coupled Modelling of Microwave Landsurface Interactions Using Envisat ASAR APS Data

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Spatially distributed information about the current state of the land surface can be obtained from remote sensing measurements. These may be used with great benefit for the understanding of hydrological processes on the landscape level, where in situ measurements must fail due to lacking spatial coverage.The potential to quantify soil moisture conditions of the top soil layer by means of active microwave imagery has been successfully demonstrated in numerous studies. Contrasting earlier and rather experimental research efforts, the Alternating Polarization (AP) data acquired from the Envisat ASAR sensor firstly enables to continuously monitor areas with high temporal frequency, high spatial resolution and different polarizations.The paper presents a semi empirical modelling approach for multipolarized microwave data and strategies for the derivation of soil moisture and vegetation parameters from AP datasets.Due to the changing imaging geometry between different ASAR swathes, a rigorous correction of the local terrain effects has to be applied

to eliminate the terrain induced geometric and radiometric distortions. This is crucial for the retrieval of landsurface parameters. Based upon the experience gained from ERS data an algorithm was developed for ASAR to correct the backscattering coefficient in that way. Based on a time series of Envisat AP datasets a semi empirical backscattering model was calibrated for all ASAR swathes. Therefore extensive field campaigns were carried out to measure soil and plant parameters. The bare soil backscatter contributions are obtained using a two parameter theoretical model based on the Integral Equation model (IEM). This is crucial to overcome the problem of accurate surface roughness parameterisation for bare soils.Using the measured ground truth database, significant relationships between plant parameters and the polarization signatures could be observed. This can be used for the estimation of the vegetation contributions to the signal and thus to its compensation. Different compensation strategies are presented in this context.The obtained results are promising. The backscattering coefficient can be modelled with an RMSE less than 1 dB and the inverted soil moisture of the upper soil layer is reproduced with an accuracy comparable to the variance of the parameter on the ground.

Abstract No. 80

Soil Moisture Experiments in 2003 (SMEX03) ASAR Studies

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Soil moisture retrieval and mapping using satellite synthetic aperture radar (SAR) has had limited success. A reason for this is that roughness and vegetation scattering are also important components of the radar measurement. Using a single channel SAR it has been difficult to develop robust algorithms. Success has been achieved in specific studies by limiting the impact of roughness and vegetation. The Envisat ASAR offers a dual polarization mode. With two radar measurements it may be possible to make the retrieval algorithms more robust. The use of dual polarization ASAR data in soil moisture retrieval was explored using data collected by in situ stations and field experiments conducted in Oklahoma during 2003. Ground observations consisted of thirteen permanent surface soil moisture points in the Little Washita Watershed, OK and 15 fields that were intensively sampled during the Soil Moisture Experiments 2003 (SMEX03). Each field was approximately 800m by 800m and 14 points were sampled. Each of the permanent stations provided a single point on an hourly basis and was typically located on the edge of a pasture field. A total of seven ASAR alternating polarized geocoded (APG-VV/VH) images were obtained. These included acquisitions made during SMEX03 and acquisitions made outside the field campaign. The longer-term acquisitions were collected at the same incidence angle range (IS2) and included a range of soil moisture conditions. The radar images obtained during the intensive field campaign were acquired at different incidence angles; however, the observed soil moisture range was small. These soil moisture data sets were used to evaluate the backscatter coefficient sensitivity to soil moisture. The correlation between backscatter coefficient and soil moisture was poor ($R2 < 0.22$). Somewhat better results were obtained for the VH backscatter coefficient values than for the VV backscatter coefficient measurements. With a limited range of soil moisture during SMEX03 it was difficult to demonstrate soil moisture retrieval. We used the Dubois model with ground observations to reproduce the measured backscatter coefficient values. The observed soil moisture and backscatter coefficient for one date were used with the model to estimate the surface roughness parameter (root mean square, rms, height) for individual fields. The ASAR observations and Dubois modeled backscatter coefficient values were well correlated for the validation data sets (R2 ~ 0.80). However there are systematic errors between the modeled and observed backscatter observations, resulting in root mean square errors of approximately 2.3 dB.

Abstract No. 155

Estimation of the Rain Moisture of Soils from Envisat ASAR

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The present paper demonstrates the possibility of using the Envisat ASAR data to obtain the freshly precipitated rains on the test sites in the southern region of Europe. The terrain areas in which the above test sites are located is basically a plain surface. In most, cases the soils are loamy. The analysis is performed using the radar surveying data acquired in 2003 year. By utilizing the dependencies of complex dielectric permittivity upon the moisture, a relationship has been obtained between the relative moisture and the magnitude of radar contrast. For the contrast of 5 to 7 dB the value of relative moisture is 10 to 14 %, which corresponds to the rainfall of average intensity. The obtained results are consistent with the data of field measurements.

Abstract No. 247

Methodology for the Processing of ASAR Wide Swath Data for the Derivation of Land Surface Properties of the Mosel Catchment

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An operational application of remote sensing data for hydrologic tasks in meso- to large scale watersheds requires frequent observations with wide swath imagery. Thus, in order to allow for a sufficient temporal and spatial coverage of the area of interest, datasets from ascending and descending paths and various orbits need to be allocated and processed. The challenge for the derivation of operational products from the heterogeneous image geometries is founded in the large spatial extent of WideSwath data and the related diversity of incidence angles. The derivation of

land surface properties from ASAR imagery for large scale areas, firstly necessitates practicable and automated methods for data homogenisation.The study describes the geometric and radiometric methods and techniques that were developed and applied to process the Envisat-Wide swath data for the Mosel watershed (28.000km2). For an intended operational application of Envisat data in hydrological modelling, instant and accurate processing of the data is essential. Relevant parts of the developed and adapted methodology are the geocoding of the WSM_1P datasets using orbit information, automatic fine correction based on ground control areas and the correction of incidence angle influences. Details of the advanced procedure comprise the application of a synthetic ASAR wide swath scene used as reference for the co-registration and the development of an empirical based model to correct the land use dependant influence on the backscatter signal in consequence of variable incidence angles. Geometric processing consists of parametric geometric and detailed radiometric correction of the WSM data based on orbit and DEM information. All parts of the process are enhanced for operational processing with regard to the announced near-real-time availability of the Envisat data. A software for automatic product generation is currently under development.The processed ASAR-WSM data will be used to derive information on snow properties and soil moisture. First results of derived products from the Mosel catchment will be presented. This information will be assimilated in the water balance model LARSIM in order to improve flood forecast.The developments presented in this paper were achieved in the context of the Inferno project, funded by the German Aerospace Center DLR.

Abstract No. 273

Retrieving of Surface Moisture and Roughness for Agricultural Soil Surfaces with ASAR-Envisat Data

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In the last years, the importance of soil surface conditions, particularly characterized by moisture and roughness in hydrology and climatic studies, has been shown. In fact, soil moisture plays a critical role in the surface energy balance at the soil-atmosphere interface and can be considered as a key state variable that influence the distribution of the radiant energy and the runoff generation and percolation of water in the soil, whereas the surface roughness is involved in the separation of the water flow into infiltration and runoff.Many studies and methods have been developed in radar remote sensing research in order to understand the backscattering response from natural surfaces and to retrieve surface parameters. Nevertheless. In spite of the improvement in backscattering simulation by means of analytic and empirical models, a discrepancy with many experimental radar measurements in agricultural watersheds still remains. In this study, our objective is to understand the behavior of different ASAR-Envisat radar configurations (incidence angles, polarization, phase, ...) function of moisture and roughness parameters.A large experimental radar measurements have been made in the Beauce agricultural region in France at 15 dates. For each date, ASAR data are taken in complex configuration in the alternating polarization mode (HH and VV or HH and HV) with one incidence angle. Simultaneously to radar measurements, soil surface moisture and roughness have been measured for more than 15 bare soil test fields. Therefore, a large data base

with different radar configurations, different roughness and moisture parameters is developed. The statistical study of radar data has shown the behavior of different configurations (polarization, incidence angle, phase, ...) function of surface parameters. The relationship between backscattering signal and surface moisture and roughness has been investigated as a function of incidence angle and polarization. Radar data have been compared with different backscattering models (theoretical models like IEM or empirical models). The potential of ASAR data has been studied for all swaths (incidence angles) in the alternating polarization mode.

Abstract No. 453

Subsurface Microwave Remote Sensing of Soil Water Content: Field Studies in the Negev Desert and Optical Modeling

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The population's increase in the Middle East and respective decrease of water resources requires innovative methods for utilization and monitoring of water resources. The development of remote sensing tools can pave the way for remote, rapid mapping of soil-water content, control of excessive irrigation, and prevention of water waste.This paper describes a series of experiments conducted in the Negev Desert that were aimed at developing such tools for monitoring soil water content. The use of visible near infrared and microwave techniques seems plausible. All provide good correlation with soil water content measured on the ground. However, the microwave techniques presented here using a P-band scatterometer and ERS-2 SAR seems the most promising. Finally the possibility of optical simulation of the microwave processes is presented in an effort to improve the physical basis for empirical studies. A method of fabrication of optical samples that model soils with different water content and different surface roughness is developed, and a system for measuring backscattered signals is designed. It is shown that the reflectivity of a layered medium is a non-monotonic function of the water content. The effect of the surface roughness on the reflection from a strong buried reflector was and is being studied

Abstract No. 487

Analysis of ASAR Imagery for Hydrological Applications in Sardinia, Italy

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[4] *Politecnico di Milano, Italy*
[5] *Ente Autonomo del Flumendosa, Italy*

The AO project is concerned with assessing the potential of ASAR imagery for hydrological applications in Sardinia, Italy. This island faces acute water management problems due to its semi-arid climate exacerbated by possible global warming impacts and to losses (from theft, leakage, etc) along the water distribution and irrigation networks. There is thus a strong interest in assessing the potential of space-based monitoring, mapping, and modeling techniques for hydrological and agricultural applications. Results from analyses of a first set of images acquired in 2003 and early 2004 will be presented for two regions, a small (65 km^2) hilly catchment and a larger agriculturally important flatter region. Various image configurations (polarization and incidence angle) are being explored via multi-temporal and other mapping methods, and the limitations and potential of current retrieval algorithms for near-surface soil moisture retrieval are also being examined. The mapping efforts are being evaluated with field data collected at both sites (meteorological, soil moisture, and irrigation and other agricultural data). The retrieval efforts tie in with ongoing research on adapting data assimilation techniques for various hydrological models so as to make possible the joint and optimal use of simulation and observation data. Periodic observations of surface soil moisture can be used to update model boundary conditions that drive surface and subsurface partitioning of water and energy fluxes. These efforts will also be briefly described.

Abstract No. 627

Estimating the Soil Moisture from ERS-2/SAR Data in the Kurukavak Basin, Turkey

Z. Akyurek, A. Sorman
Middle East Technical University, Turkey

Practical applications in recent years have shown that remotely sensed model variables are an important source of information for hydrologic models in order to make them operational. Estimating the runoff exactly as an output from the hydrological models depend on the physical parameter description of the hydrological models. In order to develop and run phsically based hydrological models and management scenarios, detailed spatial and temporal information on a wide range of land surface parameters is required. Moisture content, vegetation and roughness are the main parameters in defining the soil properties. The field study is limited to point representation. Therefore satellite images are used to obtain soil properties. The SAR signal is a fraction of the geometric and dielectric surface properties over bare soil. The problem to estimate soil moisture is to free from the effects of the space and time fluctuations of soil rougness and from the vegetation cover attenuation and scattering. This paper describes the first findings of how synthetic aperture

radar (SAR) data from the ERS-2 satellite series were used to derive the estimates of near-surface soil moisture for non-irrigated aggricultural area and bare soil surfaces in Kurukavak Basin, Turkey. This basin is located in the north-west part of Turkey, near Eskisehir province and it was chosen as an experimental and representative basin for hydrological research. Data were acquired between August 2001 and February 2002, covering both wet and dry seasons. Landsat TM image was also used as optical data source to obtain vegetation density distribution in the area. The volumetric soil moisture values were obtained from the gravimetric soil moisture values measured at 44 locations in the basin during the field measurements. The methodology presented in this paper is based on the selection of land cover and soil types for which the SAR signal is mainly sensitive to soil water content variations, and for which the vegetation and the rougness effects can be estimated and removed if needed. The difference between dry- and wet-season SAR backscatter was used to normalize roughness effects, and surface reflectance in optical wavelengths to account for differences in vegetation density were utilized. For a data set of three dates for three soil types, we confirmed that the relation between ERS-2 C-band SAR backscatter and volumetric soil moisture was weak($r2=0.023$); for the same data set the relation between the difference of dry backscatter values from the backscatter values and volumetric soil moisture for soil type SCL was comparatively strong ($r2 = 0.57$). The positive results from this study encourage the use of a multi-temporal SAR for estimating soil moisture in a semiarid region.

Thursday 9 September
10:50 – 12:30

MOZART 3

Session 4B5:

Ice (2)

Abstract No. 194

Use of Envisat Dual-frequency Radar Altimeter Data over Continental Surfaces

F. Papa[1], B. Legresy[1], F. Remy[1], O. Zanifé[2], J. Benveniste[3]
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Initially developed to operate over ocean surfaces and make precise measurements of the sea surfaces topography, the satellite-altimeter radars, which are nadir-pointing active microwave sensors, rapidly exhibited on strong capabilities to provide information over continental surfaces.At this time, radar altimetry mainly shows its capabilities over ice caps with the construction of precise topography or the characterisation of the snow surface roughness and snowpack structure. In parallel, the development of altimetry to monitor continental water surfaces and measure their stage elevation makes this sensor a powerful tool to study regional hydrological systems. However, many other particularities of radar altimeter over continents are still not exploited, like the opportunities to use all retracked waveform parameters, to use the dual-frequency measurements or to develop a synergy with passive microwave data obtained by the radiometer that operated simultaneously on the altimeter platform.The aim of this paper is so to show the new potentials of radar altimetry data for hydrology and cryosphère studies.Recently, the capabilities of Topex-Poseidon (Ku and C band) radar altimeter data for land surface studies have been investigated at global and regional scales. It first shows, at a global scale, the capabilities of dual-frequency altimeter to monitor forests, deserts, boreal regions… and their seasonal variations. At the regional scale, radar altimeter backscatters was successfully used to recover snow depth evolution through winter over the snow covered areas of the Northern Hemisphere. It also enables to determine the duration of the snow period, within the beginning and the end of the winter snow pack. Topex-Poseidon data are also used to develop a synergetic method using active and passive microwave measurements to study the sea ice variability of the Caspian and Aral Sea. These works were also used for the calibration/validation phase of the new dual-frequency radar altimeter on board Envisat (Ku and S bands) over land surfaces and ice sheets. First Envisat dual frequency radar altimeter data over continents will be so presented and new opportunities to retrieve parameters, such as soil moisture over continents or accumulation rates over ice sheets will be discuss.

Abstract No. 94

Dual-Frequency Radar Altimeter above the Antarctic Ice Sheet

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[2] *Legos, France*

For the first time, the Envisat RA-2 altimeter provides dual-frequency observation of the ice sheets. Moreover, the Envisat ground segment provides waveform parameters related to these observations to users. This double information strongly enhances the capacities of radar altimeter to fulfil its goal. First, the major interest of radar altimetry above ice sheet, the restitution of a precise topography, is limited by the penetration of the radar wave within the snowpack, leading to error that can be prohibitive for ice sheet mass balance study. The difference of penetration measured from the comparison between both bands is a tool to estimate the ku penetration and the induced error. Second, the backscattering and waveform shape deduced from radar altimetry is also a powerful tool to observe the surface and snowpack characteristics. It is a mean to derive surface roughness, ice grain size, internal stratification, and others parameters related to geophysical ice sheet characteristics. The dual-frequency observation allows to better constraint the inversion of such parameters.We built maps of each parameter using the level 2 data and waveform parameter deduced from the ice2 retracker. We describe these maps and comment on the reliability and usage of each parameter. We present a statistical analysis of this dataset for the first cycles of Envisat data and discuss on the possibilities to invert snowpack related parameters. We developed and applied an inversion with a devoted waveform model and give unprecedented figure of the altimetric capabilities over ice sheets.

Abstract No. 622

Comparisons of Envisat and ERS Radar Altimetry and ICESat Laser Altimetry for Ice-sheet Elevation Change Studies

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[3] *SSAI, United States*

Envisat continues the long timeline of satellite radar altimetry over the continental ice sheets that commenced with the Seasat mission. This span of data is invaluable for studying more than 25 years of ice sheet elevation and mass balance changes. The coincidence of Envisat and ERS-2 allows a unique opportunity to examine differences in the measurement characteristics of the two altimeters. The measurement differences can then be removed from the time series to emphasize the signal that comes from real changes in the surface properties. The more accurate Laser altimetry measurements from the Ice Cloud and land Elevation Satellite (ICESat)/Geoscience Laser Altimeter System (GLAS) mission, which are time-coincident with Envisat, offer a unique opportunity to validate the less accurate radar altimetry. Cross-mission crossover analysis between ERS-2, Envisat, and ICESat is used to quantify the differences between ERS-2 and Envisat, the differences between the laser and radar measurements, and to quantify the error budget of the radar measurements as a function of slope and surface characteristics. The laser precision as a function of slope varies from less than 20 cm in the low slope regions up to 50cm over 2 deg slopes. Two sets of Envisat/ICESat crossovers will be calculated; one with the Envisat nadir position applying the NASA slope correction that alters the elevations, and the other one using the slope-corrected geolocation from the ESA Envisat

data records. These will be used to quantitatively validate the different slope-induced error corrections. The crossover data set with the "best" slope correction will then be used to characterize the backscatter dependent error in the radar altimetry.

Abstract No. 17

Rheological Models of European Ice Coasts from SAR Interferometry and Altimetry

A. Sharov, S. Etzold
Joanneum Research, Austria

In the European Arctic sector, ice coasts formed by glaciers extending into the sea stretch for approx. 3600 km and are among the most varied elements of the coastline. Studying the dynamics of ice coasts presents a special problem since their changes are controlled to a very great extent by variable glacier motion, marine abrasion and calving of icebergs. Seaward ice cliffs rising 5 to 80 m above sea level advance and retreat in their own cycle, and the mechanism of their reaction to environmental forcing is still poorly understood. Daily, seasonal and interannual variability of ice flow at the largest European tidewater glaciers has scarcely been studied, and the total ice discharge through maritime glacier fronts on a continental scale remains largely uncertain. The detailed and equivalent rheological models derived from remote sensing data that reliably describe frontal glacier velocities and ice deformation are thus essential for better understanding the evolution of ice coasts, estimating the main causes of ice flux instability, measuring ice-mass balance and monitoring glacio-marine interactions.The present paper discusses the use of spaceborne ERS-1/2-SAR interferograms and ICESat laser altimetry data for dependable topokinetic reconstruction, change detection and precise rheological modelling over frontal parts of the largest European tidewater glaciers belonging to:· the central part of Franz Josef Land representing the largest (> 1100 km) cluster of European ice coasts;· Main Ice Sheet (23,800 km²) at North Island of Novaya Zemlya, the largest mass of land ice in Eurasia; · Austfonna Ice Dome (8,120 km²) in the Svalbard archipelago, the 2nd largest ice cap in the "Old World".An original transferential (from Lat. trans – change + ferre – carry) approach based on the analysis of fast sea-ice displacement away from the shore as a result of glacier flow was successfully applied to measuring frontal velocities of tidewater glaciers and interpreting glacio-marine interactions along "active" ice coasts from single SAR interferograms taken during the cold seasons (February - March) 1994/95/96. In winter interferograms, the effect of a small lateral displacement of fast ice manifests itself as a zone of concentric hemi-elliptical fringes converging at the tips of the glacier front. The orientation of such interferential features called "outflows" mostly coincides with the cross-track direction, and their origin is believed to be related primarily to the horizontal displacement of coastal ice. In the tide-coordinated INSAR data without significant tidal effects, the frontal (horizontal) glacier velocity was simply determined by counting the number of interferential fringes within corresponding outflows. The ICESat-GLAS L1B & L2 data taken over the study areas in March 2003 were used for measuring the heights of precipitous ice coasts above the current sea level, mitigating local problems related to the operation of interferometric phase unwrapping, compensating "radar penetration" effects, and enhanced geocoding of glacier interferometric models. Careful analysis of the tide-coordinated GLA06 and GLA12 through GLA15 altimetry products showed that, within outflows, the sea ice surface was usually 0.5 – 0.7 m lower than the mean level outside. The ice surface roughness in outflow areas

was mostly greater than in the surroundings. A simplified analytical expression for the combined impact of glacier motion, wind and tidal effects on fast ice compression was represented in the form of a differential equation relating the sea ice strain rate with the quantities observed in INSAR (extent and shape of outflows, total number and rate of interferometric fringes within the outflow, coherence) and GLA (surface roughness and freeboard) products using the quasi-static approximation and the ancillary equations known from solid mechanics.The numerical model proved to be useful for the proxy evaluation of the specific throughput of ice at glacier fronts. The involvement of the concurrent NOAA and ATSR-2 infrared images improved the nephanalysis and coastal hydrographic interpretation of INSAR and GLAS data. Several technical questions concerning the co-registration of ICESAT-GLAS profiles with ERS-INSAR products were analysed and briefly discussed. The impact of different survey dates and seasonal / diurnal changes in glacier activity on the modelling results was appraised, and an integral estimation of the ice-coast regime and glacier changes in the Barents Sea region was performed. The results were verified during several field campaigns and represented in the form of satellite image maps showing the rheology and structural morphology of the test glaciers at medium scales.

Abstract No. 519

Surface Wind Field and Snow Grain Size over Antarctica Derived from ATSR Data

N. Young[1], G. Hyland[2], J. Anderson[1], M. Fily[3]

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[3] *LGGE-CNRS, France*

The physical properties of the snow cover of Antarctica are influenced by prevailing meteorological conditions. The surface snow layer accumulates with fresh fine-grained snow precipitated from clouds as well as by clear-sky precipitation (diamond dust). This upper-most snow layer is redistributed under the action of the surface wind. Material may be added or eroded from the surface, generating a certain roughness. This roughness can occur on a range of scales from centimetres to kilometres. Air temperature and solar radiation also influence the development of the snow structure. Once precipitated, snow undergoes metamorphism, with snow grain size growing with time. The rate of grain growth is strongly influenced by temperature, and vapour diffusion in the snow pack. ATSR data are analysed to extract information on the spatial pattern of the snow grain size and the surface wind-field and their temporal variability.Scattering from a snow surface in the short wave infrared part of the spectrum (0.9 to 3.5 micron) is strongly dependent on grain size and to a lesser extent on grain shape. This dependence together with measurements of the snow surface reflectance obtained with the ATSR-2 instrument is used to map the spatial distribution of grain size over the Antarctic snow cover. The ratio of reflectance measurements at two different wavelengths, 0.87 and 1.6 micron, is used to account for local slope effects on the reflectance of the snow surface. A relation between grain size, solar incidence angle, and this ratio of reflectance was established from theoretical work, and model calculations, as well as laboratory observations of reflectance from snow surfaces. The derived grain size exhibits a large and systematic variation across Antarctica. In addition, there is considerable temporal variation by as much as a factor of 2 or

3 as a result of grain growth over time and accumulation of fresh snow.In images generated from the thermal infrared channels of the ATSR data, a subtle filament like structure can be detected over the snow surface under clear sky conditions. The filament structure is related to the thermal structure observed in the atmospheric boundary layer and is aligned in the direction of the surface wind field. Thus it gives the ATSR data give an instantaneous view of the surface wind field at the time of satellite overpass. These derived wind directions compare well with wind directions observed at the few automatic weather stations [AWS] that operated within the area. The variation in direction with season also compares well with changes in wind direction observed at the AWS. Data are accumulated from many images to build a mean surface wind field over the Antarctic ice sheet where there are no direct observations.

Poster Session 4P06:

Ice

Abstract No. 66

Melting of Seasonal Snow in Dronning Maud Land, East Antarctica Derived from Envisat ASAR Imagery

O. Mattila
-, Finland

European Space Agency's Envisat ASAR, C-band synthetic aperture radar, data is used to follow the development of the melting front in a coastal area in western Dronning Maud Land during austral summer 03/04. Measurements of physical properties, subsurface structure and surface roughness observations from two field seasons 00/01 and 03/04 are used as reference and ground truth. Backscatter values together with the in situ data display the changes in the seasonal snowpack. This information is used to evaluate melting in larger scale.

Abstract No. 191

Envisat Radar Altimetry over the Vostok Lake Area, Antarctica

B. Legresy[1], S. Roemer[2], F. Remy[1]
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[2] *IPG, Germany*

The Envisat radar altimeter allows for the first time to observe high latitude glacial surfaces with a dual S and Ku band. We observed the surface and snow pack in the vostok area using this opportunity. This area has the advantage of being relatively homogeneous, with a very smooth topography and a very weak slope over a scale large enough to establish very reliable analysis of the data. We built a reference topography as well as maps of the various altimetric parameters as output of the Ice2 retracking using the ERS1 and ERS2 12 years of data. We used these reference maps to compare the observations of Envisat as to height recovery bias, and all altimetric parameters both following a statistic analysis. We also used an altimeter simulator to compare the actual measurement to what it would be from the topography and snow characteristics we know. Differences between S and Ku band observations and the simulations were then be interpreted in terms of snowpack charcteristics. The snowpack is dry, stratified and homogeneous in this area and the interpretation allowed us to infer dielectric characteristics.

Abstract No. 193

Envisat Radar Altimetry over the Amery Ice Shelf

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The Envisat radar altimeter allows us for the first time to observe high latitude glacial surfaces at both S and Ku band. We have validated the altimeter observations over a region of the Amery ice shelf and also observed the in-situ surface and snow pack conditions in the area during our field season. In December 2004 we measured the surface topography at small scale over the Amery ice shelf in a 35km diameter area around an Envisat crossover point using differential roving GPS. The vertical time variable component (mostly from tides and atmospheric pressure) is mostly controlled by using a nearby reference GPS station established in the same period. The resulting high resolution topography allows us to simulate the radar altimeter echoes, and compare them to and validate with the actual Envisat measurements in both S and Ku band. An analysis has also been made by comparing the observations to the ERS-1/2 time series and a simulator to control the effect of the summer melting. We are then able to determine the impact of radar penetration in snow and discuss the impact on the temporal ice thickness variations survey.

Abstract No. 213

Glacier Velocity Measurements Using Differential Interferometric SAR in Antarctic Grove Mountain

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SAR interferometry proves to be the most effective method to measure the glacier velocity. However till now, most of the D-INSAR ice flow research activities are in Arctic and Antarctic costal ice shelf, where the ice flow concentrate between ridges and the pattern of fringe is simple and transparent. Grove Mountain is a newly-found meteorites trap where more than 4,000 meteorites were found. Large area of blue ice fields and many nunataks and outcrops spread the kernel region of Grove Mountain. Ice flow in Grove Mountain is quite complicated for the presence of outcrops and subglacial peaks. According to the data availability and D-INSAR methodology, five ERS and two JERS-1 synthetic aperture radar (SAR) interferometric data from two adjacent orbits acquired in 1996 are used. For one orbit, an ERS-1/2 tandem image pair and a subsequent ERS-1 image with 35-day interval are processed using 3-pass differential INSAR to get the ice flow fringe. In the other orbit, an ERS-1/2 tandem image pair is used to generate the DEM, while a JERS-1 pair with 44 days apart were combined for ¡°4-pass differential INSAR¡± to get the ice flow information.The overall visibility and continuity of the fringe from the JERS-1 pair is much better than that from ERS pair for L-band SAR interferometry allows longer temporal baseline and greater displacement in glacier velocity measurements. The research gives the ice flow result in Grove Mountain.

Abstract No. 396

SAR Firn Line Detection and Glacial Climate Response; Svartisen Glacier, Northern Norway

R. Storvold, K. Høgda, E. Malnes
Norut IT, Norway

The glacial firn line of the Svartisen Glacier has been detected using ERS II SAR and Envisat ASAR data from 1995 and up to today. The firn line is detected by first correcting the image backscatter intensity for topographic and geometric contributions using the Muhlmann backscattering model. Then we discriminate between firn and ice facies based on the backscatter intensity since frozen firn has a much higher backscatter than ice. Transects across different areas of the glacier were chosen based on requirements of smoothness of topography, precipitation zones, as well as the availability of field data for validation and comparison.From having quite stable conditions during the nineties we have observed a substantial retreat of the firn line over the last few years. The equilibrium line derived from field measurements show a similar trend as the firn line changes but has a much larger year to year variability. This indicates that the firnline may be a better indicator of climate change than the equilibrium line due to the smaller variance. We have also found correlation between the shape of the backscatter intensity distribution along the transect and positive or negative mass balance years. This is due to the slight Increase in backscatter by a relatively thin layer of last year snow covering the glacial ice in years of positive mass balance. However it is difficult to determine the snowline accurately using SAR images as the snow layer tapers off relatively smoothly. The retreat of the firn line altitude is more rapid on Austbreen than on Storglombreen which is located further to the west. A large change is observed on Engabreen which is located furthest to the west of the Svartisen Glacier system, though this change may have been amplified by the local topography. These findings indicate that SAR is a well suited tool for monitoring glacial response to climate change.

Abstract No. 458

Synergy of Active and Passive Satellite Microwave Data for Cryospheric Studies

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Studies of continental snow cover, sea, lake and river ice, require continuous weather-independent observations, covering large and often remote areas. Satellite microwave observations very well suit

these requirements. Additional improvement lies in the complementing passive microwave observations by active ones, thus enhancing the radiometric resolution of studies and providing new insights for cryospheric studies.Our main source of information is data from the TOPEX/Poseidon satellite, operating since 1992 and followed by Jason-1 in 2002. These platforms have two nadir-looking instruments – a dual-frequency radar altimeter and a passive microwave radiometer. This information is further complemented by long series of passive microwave data from the SMMR (Scanning Multichannel Microwave Radiometer) instrument onboard the satellite NIMBUS-7 (since 1979) and the SSMI (Special Sensor Microwave Imager) instrument on board the DMSP (Defense Meteorological Satellite Program) series (since 1987).We demonstrate benefits, drawbacks and potential for application of use of the TOPEX/Poseidon simultaneous active (backscatter coefficient at 13 GHz) and passive (brightness temperature at 18 and 37 GHz) microwave measurements together with SMMR and SSM/I data to estimate sea, lake and river ice extent and roughness, as well as extent and depth of snow cover. Various factors, such as differences in the footprint size for various sensors and changes in radiometric properties of sea ice and snow at different stages of their temporal evolution are considered. This approach for combination of active (radar altimeter) and passive (radiometers) microwave data may be successfully used for new satellite missions, such as Jason-1 and Envisat.We present results of studies of sea ice conditions in the Caspian and Aral seas, Baikal lake and Ob' river. The Caspian and Aral seas, located on the far southern boundary of sea ice cover development in the Northern Hemisphere, are characterised by significant variability of ice extent and duration of ice season, with strong warming signal in recent time (1998-2002). We discuss the reasons for these changes and their impact on industrial activity, navigation and marine environment. For Ob' river, for which hydrological regime is closely related with ice and snow cover conditions, radar altimetry permit to estimate river discharge and microwave signatures - to clearly determine the dates of river freezing and opening, as well as duration of ice-free period. The time series of these parameters for various sub-regions of Ob' river are established and analysis of their variability is performed. We discuss their relation with various meteorological parameters, such as temperature and precipitation regime, as well as large-scale climatic indexes. Baikal lake, a UNESCO World Heritage site, also has significant variability of ice cover in relation with large-scale climate changes. We show the potential of satellite data for studies of ice cover extent and phenology, as well as snow extent and depth.

Thursday 9 September MOZART 4-5
14:00 – 15:40

Session 4C1:

Fires and Land Surface Temperature

Abstract No. 290

The Watermed Field Experiment: Validation of the AATSR-LST Product with In-situ Measurements

E. Noyes[1], G. Sòria[2], J. Sobrino[2], J. Remedios[1], D. Llewellyn-Jones[1], G. Corlett[1]

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The Advanced Along-Track Scanning Radiometer (AATSR) onboard ESA's Envisat Satellite, is the third in a series of a precision radiometers designed to measure Sea Surface Temperature (SST) with accuracies of better than ± 0.3 K (1-sigma). The (A)ATSR instrument design is unique in that it has both a nadir- and a forward-view, allowing the Earth's surface to be viewed through two different atmospheric path lengths, thus enabling an improved atmospheric correction to be made when retrieving surface parameters such as temperature. It also uses an innovative and exceptionally stable on-board calibration system for its infrared channels, which, together with actively cooled detectors, gives extremely high radiometric sensitivity and precision. For the first time since the ATSR project began in 1991, an operational Land Surface Temperature (LST) product, which uses nadir-only data from the AATSR, will be available from mid-2004. The prototype version of this product has been distributed for validation purposes only, since the AATSR instrument was launched in March 2002. In this presentation, results from a comparison of the prototype LST product with in situ measurements obtained at the WATERMED (WATer use Efficiency in natural vegetation and agricultural areas by Remote sensing in the MEDiterranean basin) field site near Marrakech, Morocco, are presented. The comparison indicates that the product is performing to within the target specification (± 2.5 K) over the WATERMED field site, although the AATSR is measuring slightly warm with a bias of + 1.5 K (standard deviation 0.7 K). We also present the results of investigations into several anomalous validation points that have been observed during the analysis.

Abstract No. 2

Validation of Envisat AATSR Data Derived Land Surface Temperature - a Case Study over Indian Region

K. Badarinath

National Remote Sensing Agency, India

In the studies related to surface energy balance, satellite data provides important inputs for estimating regional surface albedo and evapotranspiration. The paper describes the analysis of AATSR satellite data in determining the surface emissivity over heterogeneous areas by taking

Normalized Difference Vegetation Index (NDVI) as modulating parameter at pixel resolution. The estimated emissivity values have been used to estimate the surface temperature at the pixel scale. Field campaigns have been conducted in synchronous with the satellite data over pass. Satellite derived surface temperature values are within ±1 0 C from ground measured values.

Abstract No. 30

Evaluation of the Envisat-AATSR Land Surface Temperature Algorithm with Ground Measurements in the Valencia Test Site

C. Coll, E. Valor, V. Caselles, R. Niclos, R. Rivas, J. Sanchez
University of Valencia, Spain

The Advanced Along-Track Scanning Radiometer (AATSR) on board Envisat was primarily designed to obtain accurate measurements of sea surface temperature (SST) on a global basis. Additionally, one of the proposed products from AATSR is the land surface temperature (LST) prototype product, which is based on the split-window technique using channels at 11 and 12 micron with land cover classification, fractional vegetation and precipitable water data (Prata, 2000). In this work we describe the activities carried out for the validation of the LST product in a test site close to Valencia, Spain. The experimental area is a large (4 km x 4 km), flat and homogeneous area of rice crops. Coincidentally to the Envisat morning overpasses, radiometric temperatures were measured along transects covering the area of an AATSR pixel (1 km x 1 km) in a field campaign during the summer of 2002 and 2003. Three thermal radiometers were used, which were calibrated and inter-compared through the campaign. Radiometric temperatures were corrected for emissivity effects using field emissivity and downwelling sky radiance measurements. Coincident AATSR data (L1b and LST product) were acquired for five days in 2002. For these scenes, a comparison was made between the ground measurements and the collocated LST data retrieved by the prototype and other split-window algorithms as well. Results show a good agreement between ground-measured and satellite derived LSTs, with maximum differences of ±1.5 K, and a standard deviation of ±1 K.

Abstract No. 646

Large-scale Forest Fires in Siberia Analysed by MODIS, MERIS and ASTER Multi-resolution Satellite Imagery

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Exceptionally large fires were observed in Southern Siberia in 2003. We investigated the spatial extent and impact within area of 1,300,000 km2 Persistent cloud cover and orbit parameters did not allow observation of large areas with high resolution imagery shortly after the fires. Therefore we

used a combination of high, medium and low resolution satellite imagery in which MODIS was used to record fire occurrence each day over large areas, while multispectral MERIS and ASTER imagery were used to determine the burnt area in cloud-free subsets of our study site. We then extrapolated the detailed results on burnt areas obtained from ASTER and MERIS to the full range covered by MODIS HTEs data. A regression analysis showed that there were linear correlations between burnt areas derived from ASTER and MERIS imagery as well as between MERIS imagery and MODIS hotspot data. The analysis showed that the burnt area derived from MODIS hotspots resulted in an underestimate of approximately 40%. In total 202,000 km2 burnt in 2003, which is more than the total area burnt between 1996-2002 in this region. To determine the land cover types affected by fire we intersected the burnt area with the GLC2000 land cover map. 71.4% of the burnt area was forest, 10% was humid grasslands and 4% were affected a second time by fire. Recurrent large scale wildfires like the one observed in 2003 amplified by climate extremes will diminish the carbon sequestration potential of this largest resource of boreal forest worldwide and thus to a net carbon release to the atmosphere.

Abstract No. 681

GLOBFIRE: ATSR-2 and AATSR World Fire Atlas Products, Validation, Consistency and Relationship with Climate Variables

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'Greenhouse gases', especially carbon dioxide, are intimately connected to climate change. To predict future climate change accurately and find ways to manage the concentration of atmospheric carbon dioxide, the processes and feedbacks that drive the carbon cycle must first be understood. Understanding the spatial and temporal patterns of carbon fluxes and other trace gases is essential to inform the policy process. However, our current knowledge of spatial and temporal patterns is uncertain, particularly over land and particularly for what regard disturbance phenomena such as fire. The European Space Agency GLOBFIRE project has been established to extend the unique eight-year World Fire Atlas (WFA) fire archive, already generated with the second Along-Track Scanning Radiometer (ATSR-2) using the advanced ATSR (AATSR) sensor on board Envisat. It is anticipated that this will continue the archive at least the next 7 years. This paper presents the current status of the GLOBFIRE project. It underlines the type of products and their limitation. It recaps the validation of these products. It shows the consistency of data collected from ATSR-2 on board ERS-2 with the one of AATSR on board Envisat. It provides a first analysis of a significant time series of quasi 10 years of data and makes the first attempt to link these global and regional trends with climate variables such as precipitation and temperature. Finally the paper presents upcoming efforts to inter-compare and harmonise ATSR World Fire Atlas with other observations of active fire from satellites and a non-exhaustive synopsis of ATSR World Fire Atlas uses in the world.

Poster Session 4P07:

Fires and Land Surface Temperature

Abstract No. 709

Surface Temperature Estimation from AATSR Data

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In this paper we present a series of dual angle- and split-window algorithms for estimating ses (SST) and land surface temperature (LST) from the Advances Along-Track Scanning Rediometer (AATSR) on board ESA's Envisat Satellite. The numerical values of the coefficients have been obtained from statistical regression method using synthetic data. The new SST and LST algorithms have been tested with simulated and real AATSR data in wide range of atmospheric and surface conditions. Comprehensive sensitivity and error analysis has been made to evaluate the performance of the proposed algorithsm and its dependence on surface properties, the range of atmospheric conditions and surface temperatures and on noise equivalent temperature difference. The results shown in general that the dual-angle algorithms provide smaller errors in the estimation of surface temperature than the split-widow algorithms and that the algorithms with water vapour dependence give an improvement of the accuracy of the results. However one of the conditions from precise dual-angle algorithms is an accurate knowledge of the angular variation of surface emissivity in the thermal infrared region. Today, there are very few measurements of this variation. In the present work we provide angular emissivity measurements for representative samples (water, bare soil, wheat, sugar, beet, green grass and alfalfa). The measurements have been made in one thermal infrared broad band (8-13 μm) and three narrower bands (8.2-9.2 μm, 10.3-11.3 μm and 11.5-12.5 μm) at angles of 0°-60° (at 5° increments) to the surface normal. The results show a general decrease of the emissivity with increasing viewing angles.

Abstract No. 144

Retrieval of Surface Temperatures from ATSR Thermal Images Through a Monowindow Algorithm

A. Pérez Burgos, J. Casanova Roque, A. Calle Montes
University of Valladolid, Spain

ATSR images are used to derive surface temperatures through a monowindow algorithm applied to channels 11 and 12 μm separately. Simple equations relating brigthness temperature and surface temperature, including several aproximations, are shown; between these aproximations, the definition of an effective transmitance to be applied to the whole infrared band (11 or 12 μm) will lead to a simple inversion of the radiative transfer equation. In order to obtain this parameter, a previous calculation of the spectral transmittances from an atmospheric radiation model is carried out. The spectral response function of the channel is also considered. Standard atmospheric profiles are used in order to calculate numerical values for the algorithm coefficients; resultant equations are finally applied to ATSR images to obtain the corresponding surface temperature maps.

Thursday 9 September
14:00 – 15:40

KARAJAN 2-3

Session 4C2:

Ocean Colour

Abstract No. 498

REVAMP: the Latest North Sea Chlorophyll Atlas Results

S. Peters[1], H. Van der Woerd[1], R. Pasterkamp[1], M. Eleveld[1], K. Ruddick[2], Y. Park[2], M. Devolder[2], C. Brockmann[3], T. Block[3], R. Doerffer[4], H. Krasemann[4], P. Jorgenson[5], G. Tilstone[6], G. Moore[6], V. Martinez[6], K. Soerensen[7], J. Hokedal[7], E. Aas[8]

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The objective of the EC-funded project REVAMP is to produce an atlas of validated Chlorophyll-a maps of the North Sea in 2003, based on MERIS high-resolution observations. The project has produced a new robust algorithm for CHL retrieval (based on a fitting of MERIS observed spectra to Hydrolight simulations at all possible viewing geometries) that is now being validated and applied to approximately 300 MERIS images. From an inventory of user requirements a specification was made of desired Value Added Products such as multi-temporal aggregates, full resolution time series and derived products such as a trophic-state index. During a workshop with an end-user panel a series of prototype products was demonstrated and evaluated and the requirements for the final atlas were formulated. This presentation will show the prototype atlas products, some results of the validation and will discuss the applicability of this type of information for North Sea management authorities.

Abstract No. 500

Ocean Colour Multi-sensor Analysis During a Phytoplankton Spring Bloom in the North Sea Region

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[3] *Norwegian Institute for Water Research, Norway*

Several satellite-borne ocean colour Earth Observation (EO) sensors are presently collecting data on an operational basis, including the Envisat MERIS sensor. By merging information from these sensors, improved temporal resolution and spatial coverage can be obtained, while an extensive time series of ocean colour EO data is gathered. This study aims at detecting differences in ocean colour EO sensor performances for ocean monitoring and in particular the study of algal bloom situations. The paper identifies the differences in future applications where data from three sensors (MERIS, SeaWiFS, MODIS) are merged or compared. A crucial step for merging data from different sensors is to analyse, quality check and compare output products available in order to ensure consistency of data products. In this respect coinciding images taken by the ocean colour sensors MERIS, SeaWiFS and MODIS have been collected, processed to level 2, and analysed for the North Sea region. An inter-comparison of output ocean products (Water-leaving radiance, concentrations of chlorophyll, sediments, and dissolved organic matter) from the three sensors with in situ measurements of relevant parameters has been performed for data acquired during the development of an early spring algal bloom in 2004 along the Southern Norwegian coasts. Images from non-bloom situations have also been analysed for comparison purpose. The study assesses the different capabilities of these OC sensors in the cases of bloom and non-bloom situations with respect to both quality and availability of data.

Abstract No. 707

Application of MERIS Data to Assess CO2 Upper Ocean Fluxes: Development and Validation of a Satellite-model Approach

F. D'Ortenzio, D. Antoine

Laboratoire d'Oceanographie de Villefranche, France

The recent requirements of an assessment of the carbon fluxes at global and local scales need an accurate estimate of the contribution of the marine compartment to the total carbon budget and to the regulation of atmospheric CO_2 concentration [*Falkowski et al.*, 1998]. *In situ* estimates of carbon fluxes are generally sparse and irregularly sampled, and are then ineffective when global and basin scales are considered. MERIS data offer now the opportunity to exploit high quality and increased resolution observations to investigate the role of the upper ocean dynamics in the general carbon cycle. A 1-d model, developed and tested by Antoine and Morel [1995a; 1995b] and specifically realized to operate with satellite data, is used to evaluate the upper ocean CO_2 fluxes on the DYFAMED station (Mediterranean Sea). Long time series of biological and physical *in situ* observations are available at this station, which represents an ideal site for the implementation and tuning of the simulations. MERIS chlorophyll-*a* data coupled with the 1-d model are then used to reproduce the observed dynamics of the DYFAMED station. Future developments will consider an application of the approach to the whole Mediterranean basin, fully exploiting the MERIS capability in the ocean observation.

Abstract No. 601

An Ocean Color Inversion Algorithm for Chlorophyll, Backscatter Coefficient and Coloured Dissolved Organic Matter

Y. Park, K. Ruddick
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An algorithm for simultaneous retrieval of chlorophyll a (Chl), backscatter coefficient (bb) and coloured dissolved organic matter (CDOM) from water-leaving reflectance spectra is described. While this algorithm, in principal, can account for the effect of each other, it may be sensitive to the errors from atmospheric correction or modeling of inherent optical properties. This sensitivity is studied using water-leaving reflectance spectra simulated in case 1 and case 2 waters. The algorithm is applied to both of seaborne measurements and the MERIS images to see the quality of the retrieved Chl, bb and CDOM.

Abstract No. 361

Optical Observations of Marine Film Slicks

I. Sergievskaya[1], J. Da Silva[2], S. Ermakov[1], S. Correia[2]
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Optical small-scale signatures - slick patterns and periodic bands due to internal waves were identified on a series of MERIS Full Resolution images off the Iberian Peninsula. It is well known that organic slicks and internal wave trains are frequently observed in high-resolution Synthetic Aperture Radar (SAR), but until now satellite sensors with high temporal resolution (wide field-of-view and near-daily global coverage) such as SeaWiFS, were unable to observe small scale ocean processes such as these. Remote sensing of organic films on the sea surface, in particular, is a high priority field in modern oceanography because of pollution monitoring and detection of biologically productive zones in the ocean.Mechanisms of optical imaging of internal waves and film slicks are discussed. The sensor measures optical radiance formed by light reflected from the surface and from underwater layers. The two components give different contributions depending on optical characteristics of sea water, optical wavelength, geometry of observation and the spectrum of wind waves. Relations between the light reflected from underwater layers and the wind wave spectrum are analysed. Possibilities of slick/internal wave detection and film characterization at different geometry of observation is examined.It is shown that for typical optical characteristics of the studied area and for a given geometry of observation internal waves are mostly seen due to variations of the depth of a thermocline in the blue band and due to variations of the wind wave spectrum cased by internal waves in the red/infrared band. The film slicks are easily seen mostly due to damping of wind waves in film slicks in red band. These results are used for the interpretation of MERIS image signatures of slicks and internal waves at visible and near infrared wavelengths.

Tuesday 7 September Wolf-Dietrich 1-2

Poster Session 4P08:

Ocean Colour

Abstract No. 60

A Comparative Analysis of Simple Radiative Transfer Approaches for Aquatic Environments

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Upwelling water-leaving radiance transmitted through the atmosphere and received by satellite sensors carries information on color-imparting water components, either naturally occurring or man-induced. Therefore, our understanding of optical processes operating on the air-water surface and within the water column has an utmost importance. However, rigorous theory of underwater light field based on solution of radiative transfer equation (RTE) is very complicated and cannot be used in routine remote sensing practice. On the other hand, it appears that simple approaches for radiative transfer in plane-parallel layers, such as the self-consistent Haltrin¡¦s RTE solution, Chandrasekhar-Klier exact solution for isotropic scatters, an extended version of two-flux radiative Kubelka-Munk theory, neutron diffuse Gate-Brinkworth theory and different versions of ƒÔ-Eddington radiative transfer model, may be the key to a practical solution of various optical and bio-optical problems. We made a comparison of several of those approaches and evaluated their usefulness, and conclude that Haltrin¡¦s theory is the most expedient for the goal of characterization of the natural underwater light field using reflectance data recorded by remotely operated sensors, and other variables measured in the field. In addition, we consider the surface effects, using the assumption of plane-parallel flat surface, and discuss the benefits and limitations of such an assumption.

Abstract No. 103

Results of MERIS Level-2 Validation in Namibian Coastal Area and Atlantic Ocean

T. Ohde, H. Siegel, M. Gerth
Baltic Sea Research Institute, Germany

The application of MERIS geophysical data requires the validation of Level-2 products using in-situ data. In-situ measurements of optically active water constituents and their inherent optical properties were collected during a four-week field cruise with RV Meteor from 13 March to 15 April 2003 in Namibian coastal waters and Atlantic Ocean. The Namibian coastal waters are of special interest due to its high biological productivity caused by upwelling processes. The recommended validation method is based on comparison of in-situ measurements with MERIS Level-2 products of simultaneous Envisat overpasses. Ten cloud-free in-situ stations are usable for such match-up analysis. Unfortunately no MERIS Level-2 data are available from the ESA EOLI-SA archive during the time period of in-situ field campaign. Therefore, another validation method based on comparison of derived variation ranges and mean values of in-situ data and MERIS Level-2 products was used. The best available MERIS scenes were evaluated for this purpose.The in-situ data set covered a wide range of different water masses from very productive coastal upwelling waters to clear open ocean waters whereas the water color varied from green-yellow to blue. Very high productive water with HPLC chlorophyll-a concentration up to 18 mg m-3, yellow substance absorption up to 0.17 m-1 and total suspended matter concentration up to 4.4 g m-3 were found near the Namibian coast due to upwelling processes caused by south-easterly winds. The measured water-leaving reflectance curves in the open Atlantic Ocean show the typical optical behaviour of blue ocean water. The concentrations of water constituents are very low. The HPLC chlorophyll-a concentration is lower than 0.07 mg m-3, yellow substance absorption is up to 0.05 m-1 and total suspended matter concentration is lower than 0.8 g m-3. The comparison showed that the MERIS Algal_1 and Algal_2 indices are underestimated in Case 2 water of Namibian coastal waters and are overestimated in Case 1 water of open Atlantic Ocean. The MERIS TSM concentration is to low in Case 2 and Case 1 waters and the MERIS YSBPA product is only in Case 1 water in the range of in-situ values. These preliminary results have to be validated by additionally investigations in the future.

Abstract No. 154

Detection of Pseudo-Nitzchia SPP Toxic Blooms Using MERIS Images on the Galician Coast

J. Torres Palenzuela, L. Gonzalez Vilas, A. Mosquera Giménez
University of Vigo, Spain

Pseudo-nitzschia spp. is a diatom that may produce domoic acid, the toxin responsible for amnesic shellfish poisoning (ASP). Periodic blooms in Galician coastal areas have caused virtual collapse of ecosystems with accompanying serious economic impacts. Harmful Algal Blooms (HABs) result in mass ecosystem dysfunction, risks to public health, and enormous economic losses. Ocean color measurements from space has been proved to be very useful to obtain information about the abundance of phytoplankton, including some toxic species. This paper presents results of a study of detection of Pseudo-nitzschia spp. toxic blooms in Galicia using MERIS images and field data obtained from the monitoring program of the Galician Centre for Quality Control of Marine Environment (CCMM) in May 2003. Since MERIS has a high spectral and radiometric resolution, the utilization of supervised classification techniques allow to monitor the toxic blooms in spite of using reduced resolution (RR) products. This work has been done in the framework of ESA Envisat-AO 623 project.

Abstract No. 218

Identification of Hydrogen Sulphide Eruptions at the Namibian Coast Using MERIS Sensor

T. Ohde
Baltic Sea Research Institute, Germany

The research activities in relation to the toxic hydrogen sulphide eruptions at the Namibian coast are increased in the scientific community because of their major influence on the marine ecosystem. The registration of the eruptions is the basis for the investigation but is not always possible by in-situ measurements during field campaigns because of the uninhabited desert landscape and the limited number of ship research cruises. The eruptions discolour the water surface whitely turquoise and therefore the method of remote sensing by ocean colour sensors is a powerful tool for registration. MERIS Level-2 data are used to identify hydrogen sulphide eruptions in the Namibian coastal area. The spectral characteristic of the milky eruptions is investigated and different water masses are distinguished using the wavelengths dependent water-leaving reflectance. The dates, the spatial expansions and the influenced areas are determined for the eruptions of year 2004. There are blooms of coccolithophores in the Namibian upwelling system discoloured the water also milky turquoise by their calcite production. The spectral curves are studied and it is tried to differentiate the blooms from the eruptions in MERIS scenes.

Abstract No. 447

A Review of Chlorophyll Concentration in the Gulf of Eilat (Aqaba) Open Waters by In-situ Monitoring and Remote-Sensing Derived Data from the Past Two Decades

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The Gulf of Eilat is an environmentally unique area, with highly oligotrophic warm clear waters and a complex reef ecosystem. This unique entity is impacted by natural and anthropogenic effects. The long-term monthly means of hydro-meteorological parameters and Chl concentration provide valid tools for environmental monitoring of such effects. Using satellite-carried optical sensors, one can estimate phytoplankton spatial distribution, synoptically, rapidly and on a large scale, and thus provide a useful tool for monitoring aquatic environments. This paper presents a review of the measurements of Chl concentration, temperature profiles and bio-optical parameters collected during the period 1979-2002 in the Gulf of Eilat (Aqaba). We are using images acquired by a variety of sensors that span this time frame including CZCS, Landsat, SeaWiFS, etc. Our aim is to compare historical archival imagery with ground truth data and study the seasonal geographical variability of Chl and sea surface temperature in the context of the spatial and temporal characteristics of anthropogenic and natural eutrophication of the northern part of Gulf.

Abstract No. 504

Study of the Surface Kuroshio Bifurcations around Taiwan by MERIS Data

M. Fang

ORSI,Ocean University of China, China

Although how the Kuroshio branches around Taiwan and where these branches are heading has been studied by many reseachers using various data sets,these problems still remain unclear. Our recent study shows that Meris data might bear significant information that may help better understanding the mechanisms of the Kuroshio bifurcations. Our study show that:1) there exists a branch in the Taiwan Strait and this branch can arrive at north of Taiwan and sometimes will join the main branch to east to Taiwan and 2) the surface main branch east to Taiwan can extend as far as near to the mouth of Changjiang River instead of being locked in the Okinawa Trough as previous studies indicated.

Thursday 9 September
14:00 – 15:40

MOZART 1-2

Session 4C3:

Ozone Profiles Retrieval from GOME (1)

Abstract No. 249

Retrieval of Ozone Profiles from GOME and SCIAMACHY (GOME O3 Profiling WG)

R. Van Oss, R. Van der A
KNMI, Netherlands

We present algorithm details and results from GOME and SCIAMACHY nadir ozone profile retrieval. The algorithm (Opera) is based on the efficient LIDORT radiative transfer model for the reflectance simulation and uses optimal estimation for the inversion. LIDORT is used with minimal number of streams and vertical layers to achieve the largest possible computational speed, still meeting the required accuracy. Intercomparisons with ground based ozone profiles will be shown to assess the accuracy. Opera is one of the algorithms that has joined the GOME Ozone Profiling Working Group. An operational and open-source version of Opera for GOME is being developed in the framework of the ESA CHEOPS project. Opera has also been selected for operational ozone profile retrieval for OMI on EOS-AURA and GOME-2 on the METOP series.

Abstract No. 310

Ozone Profile Retrieval from GOME Radiance Measurements: the Inversion Problem Solved by Regularization (GOME O3 Profiling WG)

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The Global Ozone Monitoring Experiment (GOME) on board of ESA's ERS-2 satellite measures the backscattered solar radiation from the Earth atmosphere in the ultraviolet and visible of the solarspectrum. Because of the strong wavelength dependence of the ozone absorption in the ultraviolet the measurements contain information about the vertical distribution of ozone in the probed atmosphere. For the retrieval of ozone profiles a new algorithm is presented, which consists of two major modules: (i) A vector radiative transfer model, which simulates the polarization sensitive measurements of GOME. Due to this approach problems are avoided concerning the polarization correction of GOME measurements, which uses broadband PMD measurements. (ii) An inversion model employing the Phillips-Tikhonov regularization. Because the retrieval of ozone profiles from GOME measurements is an under-determined problem, that means within the bounds of the measurement error the measured spectrum is insensitive to fine structures in the unknown ozone distribution, the inversionhas to be regularized. Phillips-Tikhonov regularization, in itsstandard form, minimizes next to the Least squares condition the norm of of the profile, where a regularization parameter determines the balance between the Least Squares norm and the additional side constraint. The regularization parameter allows to choose the balance such that the solution contains all components of the profile about which information is present in the measurement.

Profile components about which no information is present are not retrieved. Thus, for the first time the presented algorithm allows to retrieve ozone profiles from GOME measurements without any use of climatological ozone information. The algorithm is extensively validated with ozonesonde measurements at 38 geo-locations.

Abstract No. 319

Recalibrated Ozone Profiles from GOME-UV/VIS-Nadir-Spectra

S. Tellmann, M. Weber, S. Tellmann, V. Rozanov, J. Burrows
Institute of Environmental Physics, Germany

Ozone profiles from GOME (Global Ozone Monitoring Experiment) from 1995-2003 are a valuable dataset for investigating longterm ozone trends and also allow us to make comparisons with subsequent satellite instruments like SCIAMACHY.An accurate analysis of these data requires an adequate calibration correction with regard to the increasing degradation of the instrument in time. Especially the stratospheric ozone profile retrieval was complicated up to now by calibration deficiencies in the short wavelength range below 300 nm. A modification of the retrieval algorithm FURM (FUll Retrieval Method) is presented which uses the advanced optimal estimation scheme including the eigenvector method from Kozlov. Our new approach enables us to extend the wavelength range to shorter wavelengths below 290 nm after a calibration correction scheme was developed by long term comparisons between GOME sunnormalized spectra and SCIATRAN model spectra calculated using HALOE (HALogen Occultation Experiment) ozone profiles included in the fittings. A longterm comparison between GOME and SAGE II (Stratospheric Aerosol and Gas Experiment II) data will be presented to demonstrate the workings of the new calibration scheme.

Abstract No. 560

Ozone Profile Retrieval from Global Ozone Monitoring Experiment (GOME) (GOME O3 Profiling WG)

K. Chance[1], X. Liu[1], R. Spurr[1], T. Kurosu[1], C. Sioris[1], R. Martin[2], M. Newchurch[3], P. Bhartia[4]
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[2] *Dalhousie University, United States*
[3] *University of Alabama in Huntsville, United States*
[4] *NASA Goddard Space and Flight Center, United States*

Ozone profiles are derived from backscattered radiances in the ultraviolet/visible spectra (i.e., 290-340 nm, 530-650 nm) measured by the nadir-viewing Global Ozone Monitoring Experiment, with particular emphasis on improving tropospheric ozone retrieval using optimal estimation. To improve

the fitting precision needed for tropospheric ozone retrieval, we improve wavelength and radiometric calibration by performing detailed treatments of (a) variable slit width in the instrument transfer function, (b) variable wavelength shift between radiances and irradiances, (c) real-time first-order Ring effect correction, (d) undersampling correction, (e) wavelength shift between measurements and spectroscopic data, (f) polarization correction, and (e) wavelength-dependent degradation correction. We also improve the characterization of the atmosphere by using (a) monthly mean stratospheric aerosol data from SAGE and tropospheric aerosol model fields from Goddard Earth Observing System CHEM model (GEOS-CHEM), (b) cloud data from GOME Cloud Retrieval Algorithm (GOMECAT), (c) Daily ECMWF temperature profiles and NCAR-NCEP surface and tropopause pressure, and (4) NCAR-NCEP monthly mean water vapor profiles for modeling the pressure- and temperature-dependence of water vapor absorption in the Chappuis band. The TOMS Verison-8 ozone climatology with Earth-Probe TOMS monthly mean total ozone is used to initialize a priori ozone profiles. Retrieved height-resolved ozone profiles compare very well with coincident ozonesonde measurements at Hohenpeisenberg, Lauder, Java, and Samoa. Comparisons with retrievals using Phillips-Tikhonov regularization are also presented.

Abstract No. 673

Global Height-Resolved Ozone Distributions Spanning the Troposphere and Stratosphere from Eight Years of GOME Observations

R. Siddans, B. Latter, B. Kerridge, Y. Reburn, V. Jay
Rutherford Appleton Laboratory, United Kingdom

The first scheme to retrieve from a single satellite observation the vertical distribution of ozone in the troposphere as well as the stratosphere has been developed, implemented and extensively validated at RAL. Sub-sets of data have already been produced from this scheme for a variety of applications at the request of (>30) individual users. The GOME mission (1995-2003) is now being processed in full in order to produce a unique, global data set with which to examine seasonal and interannual variability in both the troposphere and stratosphere. In parallel, cloud and surface parameters associated with each GOME ground pixel are being generated from co-located ATSR-2 images at much higher spatial resolution (1km x 1km). The processed GOME and ATSR-2 data sets are available to the wider community via the British Atmospheric Data Centre (BADC). In this paper, key features of the RAL processing scheme and the extensive validation of the 8 year data-set against ozone-sondes will be reported.

Thursday 9 September
14:00 – 15:40

DOPPLER

Session 4C4:

Snow

Abstract No. 251

Feasibility of Envisat Data for the Estimation of Snow Pack Characteristics and Areal Fraction of Snow Cover in Boreal Forests

j. Pulliainen[1], S. Metsämäki[2], K. Luojus[1], M. Hallikainen[1], S. Anttila[2], J. Kärnä[1], M. Huttunen[2]

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Feasibility of Envisat data for the estimation of snow pack characteristicsand areal fraction of snow cover in boreal forestsJouni Pulliainen, Sari Metsämäki*, Kari Luojus, Martti Hallikainen, Saku Anttila*, Juha-Petri Kärnä and Markus Huttunen* Helsinki University of Technology, Laboratory of Space Technology, P.O. Box 3000, FIN-02015 HUT, Finlande-mail: jouni.pulliainen@hut.fi* Finnish Environment Institute (SYKE)Hydrological processes in boreal forest zone are highly affected by the seasonal snow cover. Thus, hydrological models operationally used for run-off and river discharge forecasting employ spatially distributed information on physical snow pack characteristics, and on the extent of snow. In Finland, the most important period is the spring melt season and the snow parameters essential for forecasts include the fraction of snow-covered area (SCA) and snow liquid water content (snow wetness). This information is required in a spatial scale from a few to several kilometers corresponding to sizes of sub-basins. The Finnish forecasting system applies snow information interpolated from weather stations and snow gauging network. However, its spatial accuracy is relatively poor. Moreover, measurements on some important parameters, such as snow liquid water content, are not carried out operationally. Space-borne observations can be used to overcome these problems.The areal fraction of snow cover during the melting season is already operatively monitored in Finland by the Finnish Environment Institute (SYKE). This is carried out for all drainage basins of Finland using NOAA AVHRR data. In this investigation, a reflectance model-based method will be now demonstrated for MERIS full resolution data. A comparison between MERIS-derived and AVHRR-derived SCA is performed.The operational hydrological forecasting system already applies SCA-estimates derived from optical satellite images during the spring melt period, but they are only available under non-cloudy conditions. Space-borne SAR provides information that can be used for the mapping of SCA regardless of cloud cover. SAR measurements can be also used to retrieve information on snow wetness. These aspects are investigated here using both ERS-2 and Envisat ASAR data.The performance of SAR-based SCA estimation in forested areas is analyzed by comparing the obtained estimates with independent SCA reference data sources: (a) hydrological model predictions, (b) observations at weather stations and (c) high-resolution aerial photography and (d) optical satellite images. An inversion method for deriving snow liquid water content information from C-band radar images is also introduced. The performance of this approach is assessed here by comparing the SAR-derived estimates with hydrological model predictions. The applied estimation methods for SCA and snow wetness are based on the semi-empirical modeling of C-band backscattering coefficient as a function of forest cover (biomass level), soil properties and snow pack characteristics. All investigations are carried out using time-series of ERS-2 SAR images from years 1997, 1998, 2000, 2001, 2002, and a time-series of Envisat ASAR images from the year 2003.The liquid water content of snow pack (snow wetness) was estimated for SAR images acquired for conditions with a full snow cover. The comparison of results with hydrological model predictions

indicates that the liquid water content of snow pack can be mapped in a regional scale both for open and forested areas even using a single channel system (for forested areas reference information on biomass is required). The C-band SAR-based snow liquid water content estimates coincided well with the six-year hydrological model predictions in case of all nine applied test areas, each sized 15 km by 15 km. The obtained results also indicate that the SCA mapping accuracy of C-band SAR is poorer than that of optical satellite images. However, as optical images are not always available due to cloud cover, SAR data can be applied for those cases. Moreover, the semi-empirical backscattering model-based compensation of forest canopy backscatter can effectively reduce the disturbances caused by the forest cover.

Abstract No. 169

Snow Classification Algorithm for Envisat ASAR

T. Nagler[1], H. Rott[2]
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An algorithm for snow mapping has been developed, using images of the Advanced Synthetic Aperture Radar (ASAR) on board of Envisat. For algorithm development the backscattering signatures of snow covered and snow free surfaces in Alpine valleys and on mountain slopes were studied with ASAR data of different look angles and polarizations in connection with field measurements of snow properties and meteorological data. The procedure for automatic generation of snow maps during the melting period with ASAR data is based on the same principle as the method developed for ERS SAR. The algorithm for wet snow mapping applies change detection of the backscattering coefficient between repeat pass images of snow covered scenes and reference images, which are acquired during snow-free or dry snow conditions. Of particular importance for the use of ASAR time series is the impact of various look angles (swathes) and polarizations for snow classification. Whereas the combination of VV and HH polarized repeat pass data is well suitable for snow classification, cross-polarized data show different incidence angle behaviour and need to be combined with the same products. Effects of the imaging geometry for snow mapping in steep terrain have been evaluated by comparing various ASAR swathes and modes. At the high look angles of ASAR (IS6, IS7) the loss of information due to layover and foreshortening is strongly reduced compared to ERS SAR, making these swathes particular attractive for applications in mountain areas. The ASAR based snow maps have been verified in various test sites by means of optical satellite imagery and field observations, conforming the good quality of the snow cover product.

Abstract No. 306

Multi-sensor/Multi-temporal Analysis of Envisat Data for Snow Monitoring

R. Solberg[1], J. Amlien[1], H. Koren[1], E. Malnes[2], R. Storvold[2]
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The Envisat satellite with its many sensors opens for new interesting approaches of combined multi-sensor, multi-temporal monitoring. In this study, we have focused on monitoring of snow parameters in the snowmelt seasons of 2003 and 2004 (April-June) in South Norway. The sensors used in this study are Envisat MERIS, ASAR and AATSR and Terra MODIS. The study is motivated by operational prospects for snow hydrology, meteorology and climate monitoring.We have developed a generic multi-sensor/multi-temporal approach for monitoring of snow cover area (SCA), snow surface wetness (SSW) and snowmelt onset time (SOT). The objective is to analyse on a daily basis a time series of optical and SAR data together producing sensor-independent products. We have defined raster products for each variable and developed a prototype production line. The production line automatically performs data retrieval, pre-processing, parameter retrieval, data aggregation and product generation. A few algorithms for multi-sensor/time-series processing have been developed and are compared. A typical approach is to analyse each image individually and combine them into a day product. How each image contributes to the day products is controlled by a pixel-by-pixel confidence value that is computed for each image analysed. The confidence algorithm is able to take into account information about the local observation angle/IFOV size, probability of clouds, prior information about snow state, etc. The time series of day products are then combined into a multi-sensor/multi-temporal product. The combination of products is done on a pixel-by-pixel basis and controlled by each individual pixel's confidence and a decay function of time for the product. The "multi product" should then represent the most likely status of the monitored variable.

Abstract No. 468

Near Real Time Snow Covered Area Mapping with Envisat ASAR Wide Swath in Norwegian Mountaineous Areas

E. Malnes, I. Lauknes, R. Storvold
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A near-real time GMES-relevant monitoring system for semi-operational retrieval of snow covered area for hydrological and climatological applications have been developed in the Envisnow EC EESD FP 5 project. The system, using Envisat ASAR wide swath data from ESA AOE 785 and from the Kongsberg satellite station, geocodes and classifies Envisat ASAR data automatically, and produces SCA maps with confidence flags. The snow covered area maps are used in hydrological models in Norway to improve run-off forecasting and flood warnings.We show that Envisat ASAR wide swath data can be used to produce snow cover maps with 100 m resolution and 500 km by 500 km coverage. This allows semi-operational use of SAR data for regional snow mapping. The applied wet snow detection algorithm (Nagler and Rott, 2000) has been complimented with a dry snow algorithm, predicting dry snow above medium wet snow line. Results from campaigns in southern Norway in 2003 and 2004 will be shown. Results from a near-real time demonstration of the system in 2004 will also be shown.A multisensor and multitemporal algorithm for combining SAR and optical SCA data has been developed. The method is based on re-sampling of all single sensor data

to the same geographical grid. In addition to the SCA map each single-sensor algorithm also produces a confidence map, which is subsequently used in the multisensor algorithm. Confidences are degraded over time to facilitate multitemporal accumulation. Results from 2003 will be shown. The results demonstrate that integration of snow parameter data from several sensors (both radar and optical) may be used to improve temporal resolution and coverage, avoid problems with clouds and improves the overall classification accuracy.

Abstract No. 349

Mapping Snow Cover in Alpine Areas with Envisat/ SAR Images

P. Pampaloni[1], S. Pettinato[1], P. Poggi[1], G. Macelloni[1], S. Paloscia[1], P. Pampaloni[1], A. Crepaz[2]

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The possibility of obtaining information about the seasonal variations of snow cover in alpine areas is very important for hydrology, water management and climatology. It has been well established that optical and near-infrared sensors can monitor snow cover in cloud free conditions and several systems have been developed for operational monitoring of snow parameters from remote sensing data. However, microwave sensors only are able to acquire data independently of day light and in adverse weather conditions. The effects of dry snow on C- band backscattering are rather small and difficult to detect. On the contrary, several experiments have documented the ability of SAR instruments for mapping the extent of wet snow using both ERS and RADARSAT data. Compared to the ERS SAR, the Envisat ASAR (Advanced Synthetic Aperture Radar) provides enhanced capabilities in terms of the imaging geometry, swath width, polarization and revisit time. In 2002-2004 a series of ERS SAR and Envisat ASAR images were collected in the Italian Alps in the framework of the EC ENVISNOW Project. The experiments, which also included ground measurements and a flight with the DLR E-SAR system at C and X band aimed at further evaluate the potential of C-band SAR data in remote sensing of snow and, in particular, in detecting temporal evolution of the snow cover. All the SAR images acquired at different dates over the Cordevole test site in Italy were geocoded by using a DEM of the area and the orbital parameters. The calibration, carried out in accordance with the ESA backscattering calibration documents, took into account the local topography. A change detection approach was used to monitor the extent of wet snow and showed the possibility of separating wet snow from bare soils. Moreover, the temporal sequence of SAR images was analysed by comparing the backscattering of specific sub-areas of interest with in-situ snow and meteo data, and with simulations performed with a model based on the Strong Fluctuation Theory. A very good agreement was found between ASAR and E-SAR backscattering data at C-band. Both experimental data and model simulations showed a clear decrease of backscattering as snow melted.

Poster Session 4P09:

Snow

Abstract No. 551

Snow Water Equivalent Retrieval Using Delta-K InSAR Repeat Pass Processing of Envisat ASAR Data

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Snow Water Equivalent (SWE) is the key snow parameter of interest forhydro power production, flood management, and climate studies.Recently, a novel methology for SWE retreival from SAR data wasproposed. The method is based on measuring the interferometric phaseof two SAR images taken approximately from the same position atdifferent times, i.e., repeat pass interferometry. The images arerecorded in periods with no snow and dry snow cover, respectively.The interferometric phase is caused by different optical path lengthdue to refraction of the radar signal at the air-snow interface,assuming that the dominant backscattering to occur at the snow-groundinterface, and it contains information on the SWE. However,conventional interferometric SAR (InSAR) processing is difficult;phase wrapping occurs when the snow layer variation exceeds some tensof cm due to the high InSAR phase sensitivity to snow depth. Byperforming a delta-K processing of the two SAR scenes, followed byaveraging, an SWE estimate can be achieved for the averaged area withgood accuracy.The delta-K processing is performed by splitting the radar band of each ofthe summer and winter images into two subbands in the spatial Fourierdomain. The effect of this is to give the two subband images two newcenter wavenumbers separated by small difference wavenumber (delta-K).The two subband images are multiplied to obtain the delta-K images,one for summer and one for winter. Finally the delta-K interferometricSAR image is generated multiplying the two resulting delta-K imagesfrom summer and winter together.The contribution from topography to the interferometric phase is takeninto account by using a high-precision digital elevation model andperforming a backward solution of the range-doppler equations. By usingboth summer/winter and winter/winter pair combinations, as well asauxiliary data such as vegetation maps, we may be able to separate outnoise contributors, such that the SWE estimate is further improved.Preliminary results using ERS-1 data show promising potential for themethod. SWE estimates were obtained with an accuracy of about 100 mm.In this paper we will demonstrate the technique on Envisat data from amountainous area in northern Norway. To validate the technique, acontrolled experiment is being conducted. Corner reflectors(trihedrals of side length 1.8 m) are deployed in the test area forcalibration purposes, and in-situ measurements of SWE has been collected.

Abstract No. 682

Comparison of ASAR Data and RADARSAT-1 Data for Cryospheric Applications in Canada

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For Canadian SAR data users, the availability of Envisat-ASAR data represents both continuity and opportunity. It provides us with another reliable source of C-Band single polarization data and it opens the door to new or enhanced applications through dual polarization data. In that sense, we have decided to explore Envisat-ASAR data within two cryosphereric application development projects that primarily relied on RADARSAT-1 data. The first one tests the feasibility of integrating ASAR images into the *EQeau* model for improvement of snow water equivalent estimations over the La Grande River basin (hydroelectric complex, taiga environment, northern Quebec, Canada). From November 2003 to March 2004, we have acquired a series of RADARSAT ScanSAR Narrow (HH), ASAR Wide Swath Mode (HH) and ASAR Alternate Polarization Mode (HH-HV) images, simultaneously to field measurements of the snow profile. The image processing procedure has been harmonized for the three sets of data, in order to compare backscattering coefficients on an optimal 375m by 375m unit. The accuracy of the estimated snow water equivalents from each set of data is discussed. The second project concerns the monitoring of river ice from SAR data for flood prevention and dam management in winter. In this case, an increased availability of SAR data is essential to eventually design an operational and near real time river ice monitoring system. RADARSAT Fine mode images (HH, 8m resolution) and ASAR Alternate Polarization Mode images (HH-HV, 30m resolution) are used to validate a relationship between backscattering coefficients and the ice cover thickness of the Peace River (Northern Alberta, Canada). Using a contextual approach, a compared classification of the ice types in February 2004 is also presented.

Thursday 9 September
14:00 – 15:40
MOZART 3

Session 4C5:

Sea-Ice (1)

Abstract No. 181

Demonstration of Envisat Data for Sea Ice Monitoring in the Northern Sea Route

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Several previous demonstration campaigns have proved the usefulness of SAR images from ERS-1/2 and RADARSAT satellites for sea ice monitoring and support of navigation in the Northern Sea Route. Based on this experience, a first demonstration of Envisat ASAR Wide Swath images for navigation support was started in summer 2003. In June – July several ASAR images were transmitted in near real time to the Murmansk Shipping Company and onboard the icebreaker "Sovetskiy Soyuz", which operated in the Barents and Kara seas. After data readdown at KSAT in Tromso and image post-processing at NERSC, the ASAR images were sent to Murmansk as 300m/pixel jpg and tiff files in a pre-defined projection. In cases of good weather AVHRR NOAA images, acquired at AARI for the southern part of the Kara Sea, were also transmitted to the icebreaker. Sub-satellite sea ice observations were made onboard, aimed at improving the current image interpretation techniques. The ASAR images proved to be quite useful for estimating sea ice parameters in summer and selecting the icebreaker route in sea ice. However, ordering of ASAR images two weeks in advance, as it is required by ESA, limits their use because detailed icebreaker operations are planned for the nearest two-three days. The NOAA images were successfully used for navigation purpose in good weather conditions. It was found that both the satellite images and the ice charts composed from them were very useful for the ship navigation. The satellite images provided the details of the sea ice, which were necessary for operational route selection. The ice maps were useful when the onboard navigator met difficulties in image interpretation. This experiment demonstrated that availability of both satellite images and ice maps in near-real-time on the icebreaker bridge significantly simplified its navigation in the sea ice.The second demonstration was started in February 2004, when ASAR Wide Swath images were transmitted to the Marine Operations Headquarters of Murmansk Shipping Company. This winter convoys between Murmansk and Dikson navigated mainly through the Kara Gate Strait, and south of 74o30'N – 75oN between Belyi Island and Dixon. It was decided to alternate the image coverage between the southwestern and central parts of the Kara Sea. ASAR imagery were transmitted to Murmansk in near-real time and used by several nuclear icebreakers for convoy routing. E.g. from an analysis of the ASAR image for February 18 it was found that strongly deformed first-year ice almost blocked the southern route through the Kara Gate Strait, whereas much easier ice conditions were found for the northern part of Novaya Zemlya. Therefore the route to the north of the island was selected for the icebreaker convoys. Here also Envisat ASAR images proved to be very useful for supporting the

navigation in winter ice conditions. The easily navigable polynyas and leads can be well detected in the images, and also the difficult areas with heavy ice deformation.

Abstract No. 114

Arctic Sea Ice Thickness from Envisat Altimetry Data

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Radar altimeter data from the ERS-1 and ERS-2 satellites has been used to obtain a continuous time series of Arctic sea ice thickness to 81.5 degrees North going back to 1993. With only sparse in-situ measurements of sea ice thicknesses available, such large scale observations provide important knowledge about the natural variability of sea ice thickness for its representation in global climate models and for understanding the role of sea ice in climate.Since its launch in March 2002, the radar altimeter on board the Envisat satellite has continued the observation of Arctic sea ice from space. Here we show how the ERS method of extracting ice thicknesses from altimetry data has been extended to Envisat. We will show some initial comparisons of Arctic sea surface height anomalies and freeboard from ERS-2 and Envisat for the winter of 2002/2003. Although there are some differences between the two satellites, the general pattern of freeboard and sea surface height anomaly is similar.

Abstract No. 626

Comparison of Single and Dual Polarised Envisat ASAR Data with Laser Scanner Data of Sea Ice Thickness in Fram Strait

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[3] *KMS, Denmark*

The CRYOSAT CAL/VAL activities include a series of pre-launch field experiments. One of these was the CRYOVEX experiment conducted in Fram Strait between Svalbard and Greenland during 2 weeks in April 2003. As part of the CRYOVEX experiment a set of wide swath Envisat ASAR data were acquired in order to asses the ability of the SAR data for monitoring near real time ice drift within the experiment region. The wide swath data were supplemented by a set of high resolution Alternate Polarization data from the expected study area. The main activity of the experiment was testing various in-situ and airborne instruments for measuring ice thickness. Amongst these were the KMS laser scanner operated from a Twin Otter aircraft.In this project we have produced co-registered datasets of laser scanner and Envisat ASAR data (AP and WS). A comparison of Envisat

ASAR ice pixel values and polarization differences with ice freeboard height measured with the KMS laser scanner is made. The CRYOVEX-2003 dataset of 15.April 2003 was found to contain too few lead features to adjust the SAR image coordinates for a matching with the lidar. Therefore, the dataset of 11 April is used here. The laser scanner data and the ASAR AP data were collected with a time difference of less than 1 hour whereas the time difference between the laser and the WS flights is as long as 8 hours. This dataset contains many wide and clear ice leads between large ice floes.The main result of the comparison is that a rough relation between the ASAR signal and the laser freeboard measurements is found. The accuracy in pixel location is also addressed.

Abstract No. 469

Lincoln Sea and Nares Strait

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In Lincoln Sea, north of Ellesmere Island, the almost perennial sea-ice cover breaks up every winter with ice being advected into Nares Strait between Ellesemere Island and northwest Greenland. The break-up was first described by Kozo (1991) who classified the phenomenon as a hybrid polynya with the characteristics of a latent as well as a sensible heat polynya (Smith et al., 1990). His studies were based on occasional observations with the NOAA AVHRR. Later studies of the winter 1992-1993 based on ERS-1 SAR data were presented at the ERS/Envisat Symposium in Gothenburg (Gudmandsen, 2000). They demonstrated that the break-up begins by the end of September/early October and terminates by the end of April/beginning of May and that the drift is controlled by wind in addition to the ocean current. This paper presents additional studies of the area that exploit ERS SAR and RADARSAT data of Lincoln Sea and Nares Strait. Three buoys of the International Arctic Ocean Buoy Program that happened to drift through Lincoln Sea and Nares Strait in 1990, 1991 and 2000 give detailed information about the drift conditions at different times of the year. It is found that the phenomenon varies a great deal from year to year although following a general scheme. There are strong indications that the phenomenon is associated with the formation of an ice bridge in the southern part of Kane Basin that generally forms in early spring. It causes a stop of the ice drift southwards and with the collapse of the bridge by the end of the summer the ice drift is resumed and the break-up of ice in Lincoln Sea – about 500 km to the north - begins. The link between ice in the Arctic Ocean and Lincoln Sea appears to be controlled by winds with a slight effect on the drift that takes place along the north coast of Greenland towards Fram Strait.Part of this work is carried out in connection within the GreenICE project, an integrated study of ice drift and sediment sampling funded by the EC Framework Programme.Gudmandsen, P., 2000. A remote sensing study of Lincoln Sea.Proc. the ERS-Envisat Symposium, Gothenburg, October 2000, Paper 409, (CD-ROM). ESA Publication Division, SP-461, 8 pp.Kozo, T.L., 1991. The hybrid polynya at the northern end of Nares Strait. Geophys. Res. Letters, Vol. 18, pp. 2059-2062.Smith, S.D., R.D. Munch and C.H. Pease, 1990. Polynyas and leads. An overview of physical processes and environment.J. Geophys. Res. Vol. 95, pp. 9461-9479.

Abstract No. 259

Remote Sensing of Freshwater Ice Cover Using Satellite Synthetic Aperture Radar (SAR) Data

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This paper presents remote sensing of Great Lakes and Great Bear Lake (freshwater) ice cover using Synthetic Aperture Radar (SAR) data from ERS-2, RADARSAT, and Envisat. Applications of radar mapping of Great Lakes ice cover includes marine resource management, lake fisheries and ecosystem studies, natural hazards such as ice jams and flooding, shipping and hydropower industries, and Great Lakes climatology. The approach is to use in-situ backscatter measurements and ground truth measurements from our 1997 Great Lakes winter experiment (GLAWEX 1997) in conjunction with concurrent satellite SAR data from ERS-2 and RADARSAT-1, and more recently acquired SAR data from Envisat. The polarimetric C-band backscatter signatures are used as a library to develop an ice classification and mapping algorithm. Verification of the ice mapping results are carried out with in-situ observations from US Coast Guard (USCG) icebreaker vessels operating on the Great Lakes under the jurisdiction of the Ninth Coast Guard District. In addition, we installed a web camera to monitor the seasonal ice cover over an area in Lake Superior. The polarimetric radar backscatter measurements made from a USCG icebreaker during GLAWEX 1997 reveal that multi-polarization backscatter data for the typical snow-covered snow ice on lake ice in the Great Lakes can be used to map ice and open water without the ambiguity encountered in single polarization data due to variations in wind speed over water. Polarimetric C-band SAR data collected by JPL AIRSAR over the Great Lakes during GLAWEX 2002 together with field observations and measurements will be useful for understanding and interpretation of multi-polarization SAR data such as Envisat ASAR data for lake ice applications. During our 2003 winter experiment (GLAWEX 2003) Envisat ASAR wide swath and alternating polarization data were collected over Lake Superior and Great Bear Lake (Canada) together with in-situ field observations. Polarimetric C-band SAR signatures obtained from GLAWEX 1997 (shipborne radar) and Envisat SAR data collected during GLAWEX 2003 will be used to develop multi-polarization algorithms.

Thursday 9 September
16:10 – 17:50

MOZART 4-5

Session 4D1:

Hazard and Disaster Relief

Abstract No. 172

How Space Can Better Support Emergency Management and Critical Infrastructure Protection

I. Becking

Operations, Canada

The paper will outline the current use of Space, in Canada by the disaster management community at the national level as represented by Public Safety and Emergency Preparedness Canada. The paper is based primarily on the author's experience as an Operations Officer and Geomatics Manager for the former Emergency Preparedness Canada (EPC), the former Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) and as the Authorized User for Canada under the International Charter: Space and Major Disasters. The disaster management community has a variety of general and specific information requirements which will be discussed in the paper which change depending on a number of factors. The paper will argue that, while space is meeting some of the needs of the community at the national level, it clearly can do more and must be available at all times for disaster management officials; not just during responses to disasters. Some recent examples of the use of space in Canada will be discussed and some observations made regarding its use. The paper will also contain a discussion regarding the barriers to the effective use of space and make some recommendations on how to correct, and improve the use of space. These are made purely from a disaster management point of view and from the perspective of an end-user. The paper will then discuss the area of critical infrastructure (CI) protection and how space can support this area. Canada's critical infrastructure consists of those physical and information technology facilities, networks and assets, which if disrupted or destroyed would have a serious impact on the health, safety, security or economic well-being of Canadians or the effective functioning of governments in Canada. The paper will illustrate how disaster management and critical infrastructure protection are linked and are complimentary. This area of study is becoming increasing more important for world governments and citizens are depending more and more on information technology as part of their daily lives. The paper will argue that this area requires continuous access to space as part of a coordinated planning and threat monitoring effort. As well, with continuous access to space, the response to critical infrastructure failures from physical threats will be improved. Finally, the paper will highlight some of the efforts on going to try to coordinate the world's satellite operators and create a global system to support disaster management. The paper will conclude with a reminder that the information requirements of the disaster management community must be included in any such effort.

Abstract No. 636

Use of SAR Data for Natural Disaster Mitigation in the Mobile Environment

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Natural disasters have no border. Every country suffers from all types of natural disasters such as earthquakes, volcanic eruptions, floods, and landslides, claiming many human lives and damaging a great deal of property. Especially, the developing regions are hard-hit by such disasters due to their lack of infrastructure and emergency services. In order to develop infrastructure for natural disaster management, the joint research project was initiated, leaded by VTT Technical Research Centre of Finland as the principal investigator, and the National Research Institute for Earth Science and Disaster Prevention of Japan (NIED) NIED and other organizations and universities from China and Malaysia as well as Japan as co-investigators.The objective of the project is to make use of Remote Sensing data in the early warning, mitigation, and management of natural disasters. More concretely, the goal is to construct a pilot system and use it to demonstrate the value of the RS data (especially space-borne radar) as a source of relevant and up-to-date information for the rescue and early mitigation/rehabilitation phases of natural disasters. The most appropriate sensor systems for this purpose are the satellite SAR systems such as the Envisat of ESA and the ALOS of JAXA (in future).The work consists of two parts: Demonstration of the SAR data usage in the disasters using a pilot system, and specifying requirements for and designing the prospective environmental management system. The purpose of the piloting and demonstration part of the project is to construct a SAR-based pilot system for disaster applications and , verify its feasibility in real disaster cases. The flooding in China and landslides in Japan and Philippine have been analyzed using Envisat ASAR data within this project.The main issues to be considered are the time-critical requirements, data acquisition, processing, analysis, and distribution. The level 0 SAR data are processed to SLC images using the SAR processor running on the NIED computer facilities (including a Fujitsu VPP5000 supercomputer). The resulting multi-temporal data sets are registered into a geometrically consistent data set, which is rectified to map co-ordinates. The largest scale cartographic material is used in the rectification. Fast interactive image analysis techniques are then utilised to derive a map of areas affected by the disaster. The resulting maps are prepared into standard RGB images suitable for WWW-publication. Finally, the image products are distributed on the Internet, i.e., published on the project web site, where they can be viewed using any standard browser running on both mobile and fixed devices.The data acquisition is organized in an efficient way, so for disaster cases taking place in Europe, VTT orders and inputs SAR data provided by ESA (ERS-1/2 AMI SAR, Envisat ASAR) to the project database. Similarly, concerning the cases in South-East Asia, NIED supplies the database with the corresponding data provided by JAXA (JERS-1 SAR, ALOS PALSAR). Fast Internet connection, using APAN (Asian-Pacific Advanced Network), is used for transferring the data between VTT and NIED. A distributed data processing scheme is used for producing the output images. Finally, the Inter/intranet distribution enables a wide access through diverse fixed and mobile devices, to the image products.

Abstract No. 448

Flood Risks Management and Prevention-WARM

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Within, the framework of the MOST-ESA Dragon project, a proposal on the "Assessment of the synergistic exploitation of Envisat ASAR and MERIS data for Plain Flood Rapid Mapping and for Flood Support Risk Management", has been accepted and started in May 2004 after the Xiamen kick off meeting.This Flood Dragon project will enhance the Envisat objective to monitor natural disaster such as flooding. An aspect of the proposal is supported by the France-China network of research called WARM. It deals with the exploitation of Envisat data as input for monitoring tools at catchment's scale are necessary for improving flood prediction and water resources management.The potential of runoff and flooding is focussed on the assessment of the Envisat ASAR, spatial and temporal resolution potential for flood risk assessment and prevention; ie urban land use monitoring and potential assessment of roughness through ASAR data are examined in order to optimise the parameters describing the state of surface of catchment basin and depending on incidence and polarization mode for thematic accuracy will be assessed. One of the major final goals is give input for describing the geophysic and physiographic parameters of the catchment basins and propose environmental effect simulation. ASAR Envisat data will be used to map and monitor both the wide floods affecting China and Mediterranean watershed representative of the flash flood, "CEVENOL" phenomenon The tests sites well representative of Asian major flood plains and French fast floodOver these test sites, reference data such as ERS, Landsat SPOT data are already collected and integrated in database. The Envisat data collection has began in spring 2004 and will continue during the period 2005 and 2006. The tools of simulation able to use input data and the first proceed images wand derived results will be presented.

Abstract No. 714

Towards a European Rapid Mapping Service for Disasters Monitoring

K. Fellah, B. Allenbach, S. Battiston, C. Bestault, S. Clandillon, J. Henry, C. Meyer, H. Scius, N. Tholey, H. Yésou, P. De Fraipont
SERTIT, France

Space techniques such as positioning, telecommunications, and especially earth observation can contribute to improving natural disaster management. Space-derived information can be a valuable source of up-to-date geo-information for risk mapping (prevention), forecasting (preparedness phase) and for the crisis and post-crisis phases dealing with damage assessment. Current EO missions have demonstrated their benefits in risk management. This is especially the case for the all-weather and spaceborne SAR missions and highly reactive optical satellite which allow the provision of timely information on regions affected by natural disasters. A new generation of high resolution space borne radar and optical sensors (RADARSAT 2, Terra-Sar, ALOS, Pleaides, Comos-Skymed, ..) are being developed which will ensure quality enhancement of the derived information as well as the continuity of EO data provision. The overall objective of this activity is to set-up an operational EO rapid mapping service providing assistance worldwide in the management of natural disasters. With a 24 hours a day EO based on-call service, the service is prepared for any request, providing relevant information for disaster mapping during the crucial phases of crises and

post-crisis management. This EO rapid mapping service can also contribute to the International Charter "Space and Major Disasters". It has operated successfully in generating EO added value products during flooding in France (Gard September 2002, South France December 2003), Dominican Republic flood event in December 2003, Namibia in April 2004. Haiti in May 2004 and for other natural disasters, including the Salvador earthquake in February 2001, the Nyiragongo Volcano lava flow in January 2002 and more recently the Stromboli volcanic explosion in April 2003, earthquakes in Turkey, May 2003, in Algeria, May 2003, in Iran, December 2003, and Morocco. February 2004. This EO rapid mapping service is used by the French Space Agency (CNES) when the International Charter "Space and Major Disasters" is triggered. The development of such a service could also serve the initiative for the provision and use of operational information for Global Monitoring of Environment and Security (GMES).

Abstract No. 327

Building Damage Detection Using Satellite SAR Intensity Images for Recent Earthquakes

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The recent earthquakes such as the 1994 Northridge and the 1995 Kobe earthquakes, realized us the importance of grasping damage information of built-up areas at an early stage for recovery activities and restoration planning. Synthetic aperture radar (SAR) is remarkable for its capability to record the backscattering coefficient, the physical value of the earth's surface, regardless of weather condition or sun illumination. Therefore, SAR is a powerful tool which can be utilized to develop a universal method to comprehend damaged areas in disasters such as earthquakes, forest fires and floods. Detailed ground truth data for building damage due to the 1995 Kobe earthquake provided us the opportunity to investigate the relationship between the backscattering property from SAR images and the degree of damage. From the above analysis we have already developed a method to detect areas of building damage. In this paper, we applied this method to the satellite SAR, including ERS and Envisat, images taken over the area hit by the 1999 Kocaeli, Turkey, the 2001 Gujarat, India, the 2003 Boumerdes, Algeria, and the 2003 Bam, Iran earthquakes, and then the accuracy of the proposed method was examined by comparing the results of the analyses with those from the damage surveys.

Poster Session 4P10:

Hazard and Disaster Relief

Abstract No. 4

Improving the Accessibility to Russian Satellite Data for Mitigating Natural Disaster

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For many years Russia has been carrying out an intensive program of Earth observation using a range of satellite remote sensing instruments. Relevant missions include PRIRODA-MIR, RESURS and METEOR. Each one of these systems generated a large amount of data that were not exploited as much as they could be especially outside Russia. However, it is important to utilize fully the information provided by these data sets in order to achieve maximum cost effectiveness from these investments in the space program to justify future expenditures on new and continuing programs. In order to be fully exploited, Russian data and information systems need to be easily accessible and linked to and interoperable with other national and international information systems. An example of an important and complementary Earth Observation Information system is EOSDIS Project. To encourage the wider use of information generated by remote sensing/Earth observation satellites and to allow U.S. industrial users and academic researchers to locate more easily data and information services, NASA funded the development of the EOS Data and Information System (EODSDIS). Users interact with EOSDIS through the Internet using their WWW browsers. The EOSDIS Search Server is based on Catalogue Interoperability Protocol (CIP) standard and will allow simultaneous searching many remote data catalogues. In addition, EOSDIS includes an Advert and Announcement Server, a Data Dictionary service and a Metadata User Guide. Improving the accessibility to Russian satellite data could make substantial contribution to mitigate natural disaster. Integration of distributed data archives use satellite data flows to deal with various problems of Remote Sensing posed by joint programs for forecasting and mitigating natural disaster. Our paper is directed on complex development of distributed information system of satellite data for the Earth Observation as an estimation of environmental condition, resource studies and damage from natural and technogeneous disasters. Our project units a ground network of reception of satellite data on the territory of Russia. It is supposed to modernize and to integrate into the ramified infrastructure the regional databases of satellite data, receiving from the polar-orbital satellites during the ecological monitoring. The basic segment of developed information system is the Web-Server of the satellite data, which is developed in the Space Research Institute. As a basis of the ramified infrastructure the ground stations of reception in Krasnoyarsk and Salekhard and in Vladivostok are used, and they will be incorporated through Internet with the data archive. This distributed information system integrates in uniform system regional databases, that opens an opportunity of realization operative monitoring of environmental condition and estimation of danger of natural disasters on the whole territory of Russia. It is essential to work out its adequate structure necessary for efficient data retrieval from the archive. The archive structure is elaborated based on the understanding of typical requests of potential archive users. The experience of functioning space archives shows that user requests primarily focus on data representation levels, the name of the project under which the data is obtained and the name of the sensor that provided the data. The archive should be divided into segments corresponding to different data representation (process) levels with each segment subdivided into data sets related to a certain project and instrument (sensor). Efficient organization of information resources and open access to spatially distributed experiment data are founded on the Web technology (access to data including data search and request).The development of satellite natural-resource information software targets the following problems: real time Earth Observation, thematic processing of Remote Sensing Data and filling in of the Digital Archive, geoecological monitoring of the environment, ecosystem condition evaluation through space techniques, access to hydro meteorological information from around the globe. Appropriate metadata management systems are built to provide for the collection and distribution of experiment data and thematic processing results; while the archive is linked to the regional centers of geoecological monitoring via Internet. An important element is the elaboration of interface, archiving and network data exchange structures. This calls for the development of search engines and a remote interactive access regime for external users via Internet to catalogues of experiment data and processing results and the realization of the on-line access mode. Our Digital archive was devised and is functioning in on-line mode as fully interoperable system. INFEO users have no problems in the access to data archive as well as the latter easily exchanges data with the INFEO system. The principle of distributed data processing gains an ever-growing importance for satellite monitoring. Stage-by-stage development of data archive making possible efficient functioning of a system with only a few units assembled proves to be promising. Thus, the building of an access system to satellite data received and processed at different ground stations begins by setting up of a main server at a network location having developed telecommunications. The information of the main server is updated by the regional centers even via low-speed switching channels. The tasks are included the development of MySQL-PHP bundle for support of the electronic catalogues, the application of the Oracle DBMS for central depositarium, the creation of ecological Databases of satellite monitoring, interfaces to separate databases and remote creation of resources. It is planned to ensure the coordination of the standards and interfaces, integrating regional databases and ecological information resources. In comparison with the developed systems this system of opened access to the regional ecological information has the following advantages and features: - System allows to carry out the collection and distribution of experimental monitoring data on regions of territory of Russia in the most complete form, to increase volume of the processed information, to ensure with the information a significant circle of the users. - System provides high-speed input and decommutation of the monitoring data, and also long-term archiving of data sets (not less than 15-20 years); the standardization of formats and carriers of the satellite data.- In view of large speeds and volumes of the information, transmitted from a board of the satellite, System provides information support to ground structure of ecological monitoring and early detection of natural disasters. - System provides opened access to the regional ecological information and to metadata structures on-line, transfer of the data, ordered by the users, under the coordinated order of transfer with the help of telecommunication means or in a mode off-line on magnetic carriers

Abstract No. 70

Integration of Envisat ASAR Data in a Hazard Monitoring -GIS - Envisat Project [ID g]

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A substantial collection of achieved multi-sensor SAR data sets produced in the course of research on disaster monitoring in Iceland, carried out under the auspices of ESA, NASDA and CSA since

1992, is now at the disposal of the ongoing ESA project "Hazard Assessment and Prediction – Long-term Observation of Icelandic Volcanoes and Glaciers Using Envisat-ASAR and Other Radar Data" (ID 142). This valuable material allows the long-term assessment and analysis of the surface changes observed in the highly active Neovolcanic Zone of Southern Iceland. Combined with other geoscientific information (air-based, space-based or ground-truth data) it plays an important role in devising early–warning methods.Recent efforts have been directed towards the Mýrdalsjökull testsite (596 km²) and the central volcano Katla in particular. In view of the eruption cycle of this subglacial volcano (dormant phase maxima 80 years, minima 13 years) and the marked increase in seismic activity since 2000, a fresh outbreak releasing huge glacial torrents is expected to happen in the near future. At the peak of the last major event in 1918 the glacier's discharge reached a volume of 300,000 m³/s. To fully use all the space-related information at hand, the Department of Earth and Environmental Sciences, Section Geology at Ludwig-Maximilians-University Munich has developed a multi-source GIS. Various layers supply data on the geology, the hydrology and the ice morphology of the volcanic zone. Lineaments and a precision DEM are provided, facts and figures of past seismic and volcanic events are given, such as locations of epicentres and eruption sites or details of meltwater discharges. Processed Envisat-ASAR data are continuously fed into the GIS.The present investigations revealed, 20 possibly latent eruption sites so far. The potential runoff paths of meltwater floods triggered in these high-risk areas were derived by GIS based estimation. With the knowledge gained from roughly 12 years of research and the GIS, specially developed to meet the conditions of the southern regions of Iceland, surface changes now should be detected very quickly and dynamic processes monitored almost in real time. Risk assessment and prediction models will be made available when ever needed.

Abstract No. 494

CSTARS, a New State-of-the-Art Satellite Receiving Facility: Operational and Research Capabilities

H. Graber

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CSTARS (Center for Southeastern Tropical Advanced Remote Sensing) is the University of Miami's newest facility conducting research with remotely sensed data received from earth-orbiting satellite systems. CSTARS is a new state-of-the-art real-time satellite tracking facility located at the former U.S. Naval Observatory/Alternate Time Tracking Station site at Richmond, in southern Miami-Dade County, Florida. CSTARS was designed and developed as a highly automated, near real-time, multi satellite reception and processing facility that provides data for environmental monitoring of the Equatorial Atlantic region; northern South America, Central America, the Caribbean Basin, Gulf of Mexico and the Southeastern US. The facility is based on two antennas for redundancy and conflict resolution and includes dual units of all key components of capture and processing systems for redundancy and backup. This approach permits highly automated operation and seamless transition to backup units in case of sudden component failure. Satellite data reception and tracking is accomplished with two ViaSat 11.28m X-band antennas with characteristics: G/T = 37dB @ 5 deg elevation; half-power beamwidth = 0.24 deg. TheCSTARS coverage map or visibility for a typical low-Earth orbiting satellite in an 800 km orbit is about 2° minimum elevation and covers all of

Florida and the eastern half of the USA even into northern part of Canada, all of the Caribbean Basin including the Lesser Antilles, Central America, Mexico, and the northern part of South America. The expanded coverage of satellite tracking permits to provide rapid data access for many time sensitive applications such as environmental monitoring (e.g. the Everglades), storm prediction (e.g. hurricanes and tropical storms), volcanic eruptions (e.g. numerous volcanoes are active in Mexico and Central America), pollution (e.g., oil spills), natural hazards (e.g., flooding and mud slides), change detection (e.g. beach erosion, agricultural land uses, vegetation monitoring).The present satellite operation schedules and capabilities include: RADARSAT-1, SPOT-2/4, Envisat ASAR, ERS-2 SAR and WindScat and MODIS on Terra and Aqua for reception, telemetry, processing and analysis. This paper will provide an overview of the operational capabilities and the on-going research applications of CSTARS which include extraction of marine parameters from synthetic aperture radar (SAR) and optical SPOT data. Special emphasis will be placed on:• Marine parameters from SAR for the derivation of wind fields and sea state under tropical storm and hurricane conditions for studying and quantifying mesoscale flow patterns in synoptic and tropical lows.• The use of SAR interferometry to monitor water level changes in the Everglades for improved estimates of flow properties and tracing of pollution.• Detection of subsidence in urban areas due to excessive ground water withdrawal.• Monitoring of hazardous volcanoes in México, Central America and the Caribbean to determine pre-cursor activities leading to eruption.• Monitoring of changes in spatial coverage of coral reefs and water properties impacting coral reefs as well as environmental conditions that may stress coral reefs.• Development of algorithms of water constituents and ocean color with applications in the Gulf of Mexico.• Establishment of long term validation sites (tropical to extra-tropical latitudes) using in-situ measurements to validate continuously model functions for missions and sensors (e.g. Envisat, QUICKSCAT, WindSat, etc).

Abstract No. 710

The Geohazards Integrated Global Observing Strategy

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Worldwide, the impact of earthquakes, volcanic eruptions, landslides and subsidence on the population and property is enormous. Population increase in hazardous areas makes the effects of these natural hazards from year to year even more dramatic. All such hazards, driven directly by geological processes, involve ground deformation and, to be better understood, may require similar observations even if at different scales. The ambitious objective to better exploit existing knowledge and information so as to identify gaps e.g. in organisation, observations or systems that need to be filled (in a decade) in order to reach a better understanding of the hazard -enabling hence its management (e.g. prevention and prediction)- has led to the creation of the **Geohazards IGOS theme**, chaired by BGS, ESA and UNESCO. Such theme has been adopted by the Integrated Global Observing Strategy (IGOS), a partnership of international organisations concerned with global environmental change issues. The goal of the Geohazards IGOS theme is to integrate disparate, multidisciplinary, applied research into global, operational systems by filling gaps in organisation,

observation and knowledge. Four strategic objectives have been set: building global capacity to mitigate geohazards; improving mapping, monitoring and forecasting, based on satellite and ground-based observations; increasing preparedness, using integrated geohazards information products and improved geohazards models; and promoting global take-up of local best practice in geohazards management. Common observational requirements have been identified for the geohazards concerning with baseline topographic and geoscience mapping and for crustal deformation and seismic monitoring. Systems that meet these requirements include stereo optical and radar interferometry satellites plus ground-based GPS and seismic networks. Specific hazards like volcanoes require additional observations like temperature and gas emissions. Observations must be stored in well-managed and accessible databases. Tools to produce information products through integration, modelling and assimilation must be well documented. Networking, education, training and skills transfer must be undertaken to build the capacity to use them. Critical gaps still exist in: provision of detailed, global topographic data, hazard inventories and geoscience maps; continuity of the C- and especially L-Band radar interferometry that is needed to observe crustal deformation below vegetation; density of local GPS and seismic networks; accessibility of relevant databases; adequacy of models and data integration; and the integration of the geohazards community. The **Geohazards theme report** has been approved for implementation in November 2003 by the IGOS Partners and includes an action plan with objectives set on the 3, 6 and 9 years period. The report identifies priority actions such as: begin networking within the geohazards community; improve topographic data provision using existing observations and secure continuity of C and L-Band radar interferometry with the space agencies; assess the potential for existing data to be integrated into geohazard products and services; evaluate ways to improve databases with their managing agencies; and initiate research that increases geohazards knowledge. The implementation of the Geohazards IGOS, supported by an ESA-funded Executive Bureau and the UNESCO-IUGS's Geological Applications of Remote Sensing (GARS) Programme, is being set-up; links with relevant sub-groups under the new Group for Earth Observation have been already established.

Thursday 9 September
16:10 – 17:50
KARAJAN 2-3

Session 4D2:

Clouds and Aerosols (3)

Abstract No. 128

Synergetic Aerosol Retrieval from Envisat

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Within ERS-AO projects PAGODA and PAGODA-2 a new synergeticaerosol retrieval method to exploit ATSR-2 and GOME wasdeveloped, valdiated, and published. This method SYNAERretrieves aerosol optical thickness and type over land andocean by combining the complementary high spatial (radiometer)and high spectral (spectrometer) simultaneous observations.Within the Envisat-AO project SENECA this method is transferredto the similar sensor pair AATSR+SCIAMACHY. Furthermore afirst 14 month ATSR-2 + GOME dataset over Europe and Africa was processed (3 days each month with GOME small swath width)to retrieve a first climatological aerosol component dataset.This presentation will show first Envisat SYNAER results anddiscuss relevant issues encountered during the ERS-2 toEnvisat transfer. Furthermore, the ERS-2 1-year aerosolcomponent climatology will be presented.SYNAER deliveres relevant information which is required foraerosol data assimilation (national DFG project AERO-SAM) inair quality forecasting and for monitoring the differentcomponents of the atmospheric aerosol loading (ESA DUE projectGlobAER).

Abstract No. 188

A Surface Reflectance Model for MERIS Aerosol Remote Sensing over Land

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Aerosol remote sensing over land is based on the use of pixels covered by vegetation. Because of the absorption of the photosynthesis pigments, these pixels are quite dark in the blue and in the red. This consideration led to introduce the concept of DDV pixels. Initially, 11 DDV models have been selected from the POLDER 1 imagery. ARVI, atmospheric resistant vegetation index, has been used to detect these pixels. A clear limitation to the initial process was the limited spatial coverage of DDV pixels. That the reason why, the DDV concept has been extended to include less dark pixels for the aerosol remote sensing. First, an extensive archive of MERIS images has been fully corrected from the atmosphere, including the aerosols. Second, a simple linear regression can be applied to the surface reflectance versus the ARVI in the MERIS band used for aerosol remote sensing. We answer to the question: how far we can go using less dense vegetation? A validation of this concept is reported. This work is the fundamental basis for the last MERIS reprocessing on the aerosol product over land.The pixel identification is based on the use of the ARVI. Alternative vegetation indices are used to identify the best way to select pixels over which the surface reflectance is the better known in the blue and in the red.

Abstract No. 699

MERIS Water Vapour Retrieval and its Validation by means of Ground-Based Measurements

J. Fischer, P. Albert, R. Bennartz, R. Preusker
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The MERIS water vapour algorithm has been applied to MERIS data above different targets and has been validated using measurements of the microwave water radiometer at the ARM-SGP site in Oklahoma, USA, ground-based GPS stations in Germany and radio soundings in central Europe. All three were used for the validation of derived total columnar integrated water vapour above cloud free land pixels, however, the radio soundings were also used for the validation of MERIS retrievals of the integrated water vapour above cloud tops. The root mean square deviation between the satellite retrievals and the validation measurements is in the order of 0.2 g/cm^2. The quality of the MERIS water vapour retrieval with respect to applications will be discussed.

Abstract No. 151

Remote Sensing of Particle Matter Using MERIS

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[3] *HYGEOS, France*

Over land, the Dense Dark Vegetation is used to derive in a first stage the aerosol path radiance and in a second stage to propose an aerosol product which consists of the aerosol optical thickness at 865 nm and the Angstroem coefficient. Air quality monitoring of the particles is based on measurements of PM10 and PM2.5 which are respectively the density of particles of diameter lesser than 10 µm, lesser than 2.5 µm, at the surface. The satellite aerosol product can be converted into PM10 and PM2.5, based on different assumptions: particle density and vertical distribution mainly. This first attempt to monitor PM from space can be validated with in-situ data. Another approach will simply consist in using the in-situ PM measurements to calibrate the satellite imagery. With the frame of a European project, we generated, over an area centered on Lille (50°36° N, 3°08 E, North of France), a data base with MERIS, and the PM data collected by the regional air quality network. The above technique will be applied and validate using this data base. Applications in air quality monitoring will be presented.

Abstract No. 698

Comparison of MERIS; MODIS and MSG Cloud Top Pressure

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We present results of comparisons of cloud top pressure products, derived from MERIS, MSG and MODIS. The individual satellite algorithms are impaired by ambiguities especially due to multi-layer cloud systems with thin top layers. The CO2 slicing method used in MODIS algorithm is working day and night and is accurate for single layer high and mid-level clouds. The MERIS algorithm based on a differential absorption technique using the O2A band at 0.76 μm is accurate for single layer clouds in all heights, but there are weaknesses in the detection of very thin clouds. The individual characteristics of the retrieval algorithms allow a breakdown of the cloud top pressure comparisons with respect to cloud types (low, middle and high level clouds, thin and thick clouds, multilayer clouds, water and ice clouds), to day and night, to surface types, to the viewing geometry. The MSG-SEVIRI cloud top pressure products are finally compared with MERIS and MODIS cloud top pressures.

Thursday 9 September Wolf-Dietrich 1-2

Poster Session 4P11:

Clouds and Aerosols

Abstract No. 62

Development of a Full Radiative Transfer Model in the Oxygen A-band for Satellite Retrieval of Cloud Pressure

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As clouds strongly influence retrievals of tropospheric gases and aerosols from GOME, SCIAMACHY and GOME-2, accurate co-located cloud information is required. The O2 A-band is well suited to provide this information. Since oxygen is a well-mixed gas, the measured column amount of oxygen yields the cloud pressure.The Doubling-Adding KNMI (DAK) radiative transfer model is designed for line-by-line calculations of radiance, polarisation, and irradiance inside and at the top of the atmosphere. It consists of an atmospheric shell around a monochromatic multiple scattering kernel, based on the polarised doubling-adding method. The atmosphere consists of an arbitrary number of plane-parallel layers, each of which can have Rayleigh scattering, gas absorption, aerosol and cloud particle scattering and absorption. The atmospheric shell describes the optical parameters of each layer: optical thickness, single scattering albedo and scattering matrix. For aerosols and cloud particles the entire 4x4 scattering matrix can be included, as coefficients of generalised spherical functions. DAK was currently used in the UV-visible spectrum with trace gases absorption.This paper describes the extension of the DAK model with oxygen absorption in the O2 A-band. To achieve this, the latest HITRAN database is used to evaluate the oxygen absorption cross-sections. DAK is applied in the 755-775 nm window for several cloud types and geometries. The results are then, firstly, compared with in-flight observed reflectance at scenes from the GOME and SCIAMACHY instruments. Secondly, the calculated radiances are used as input of the FRESCO algorithm (Fast Retrieval Scheme for Clouds from the Oxygen A-band) to assess instrumental polarisation sensitivity in retrieving cloud fraction and cloud pressure.

Abstract No. 75

MIPAS/Envisat Observations of Polar Stratospheric Clouds during the Antarctic Winter 2003 in Comparison with Lidar Measurements

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The mid-IR limb emission sounder MIPAS/Envisat has the capability to detect polar stratosphericclouds (PSCs) even during polar night. Thus, compared toother satellite instruments which measure only during sunlight,MIPAS delivers a continuous temporal and spatial coverageof the existence of PSCs. In addition to the altitude region of cloud occurance, it ispossible to identify different PSC types fromthe infrared spectral signatures. Different types of PSC spectra can be distinguishedin MIPAS measurements. In this paperwe will show how well these spectra canbe simulated by use of radiative transfermodelling under application ofsets of refractive index data for different chemical composition and from severallaboratory measurements.Further, we will show retrievals of altitude profiles ofmicrophysical parameters describing thePSC size distribution. Comparisons with Lidar measurements from McMurdo will be used to validate MIPAS PSC observations.

Abstract No. 98

Coincident Cloud Observations by Altimetry and Radiometry

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Over the preceding decades, a number of different satellite techniques have been developed to allow the observations of clouds and rain. However, it is only with Envisat that a dual-frequency altimeter has been co-manifested with microwave and infra-red radiometers to allow simultaneous observations of rain systems across a wide range of electromagnetic frequencies, and using both active and passive techniques. The simultaneous nature of these observations is important because rain systems can evolve markedly in a short span of time.The RA-2 is a dual-frequency altimeter, recording nadir reflections of radio pulses from the Earth's surface. Over the ocean, there is a well-established relationship between the surface scattering measurement at the instruments Ku-band and S-band. Deviation from this behaviour tends to be associated with attenuation by raindrops in the atmospheric column traversed by the electromagnetic pulses. The Microwave Radiometer (MWR) measures the emissions at 23.8 & 36.5 GHz. It is a nadir-pointing instrument with a ground footprint of ~20km, which gives a broad indication of the location of rain-bearing systems, but is unable to resolve the finer scales associated with cloud dynamics.The AATSR is a high-resolution infra-red radiometer operating at 0.55, 0.67, 0.87, 3.7, 11 and 12 microns. Each of these channels responds to a greater or lesser extant to changes in cloud properties, such as cloud optical depth, cloud effective radius and cloud top pressure. An optimal estimation technique has been developed to derive these cloud properties, taking advantage of any prior knowledge of the system, such as surface reflectance and information on the atmosphere using ECMWF profiles. The optimal estimation method also allows us to characterise the error in each parameter for each observation under the assumption that the cloud observed is consistent with the modelled cloud (i.e. reasonably plane-parallel in nature).In this paper we bring together the multi-frequency data from these three instruments (RA-2, MWR and AATSR) to show how these simultaneous measurements give us complementary information on clouds and their associated rainfall.

Abstract No. 107

Validation of MERIS Atmospheric Corrections: Towards a New Aerosol Climatology

N. Martiny, R. Santer, I. Smolskaia
ULCO, France

We propose to validate the MERIS atmospheric correction scheme by evaluating both the aerosol models presently used and the consistency of the water leaving reflectance product. We selected six sites: Venice and Lampedusa (Italy), El Arenosillo (Spain), CalCOFI/San Nicolas (United States), Helgoland (Germany) and Gotland (Sweden), all equipped with a CIMEL station that forms part of the AERONET network. Firstly, the idea is to associate CIMEL extinction data to an aerosol model from the MERIS list. This model is used as an input into a radiative transfer code to simulate downward radiances. The comparison between these radiances and the CIMEL measurements gives an estimate of the MERIS aerosol models. Secondly, we aim at retrieving the water leaving reflectance provided by MERIS. For this purpose, we derive the aerosol phase function using CIMEL radiance measurements as an input into a radiative transfer code from which we obtain the atmospheric path radiance and transmission in the visible part of the spectrum. Using a linearization of the top of the atmosphere signal we obtain the water leaving reflectance that we directly compare to the MERIS product. The evaluation of the MERIS aerosol models as well as the water leaving reflectance allows the validation of the MERIS atmospheric corrections in diverse coastal situations. Depending on the results of validation we will provide an improved list of aerosol models by developing a new climatology based on optical properties of aerosols rather than on their microphysical characteristics.

Abstract No. 130

Optimal Combination of Polarization and Spectral Information for the Retrieval of GOME/ERS-2 Cloud Parameters

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Accurate cloud information is required for the trace gases retrieval, especially for the determination of tropospheric contents and aerosols.This paper presents the retrieval of cloud information combining two algorithms that fully exploit the polarization and spectral measurements of GOME/ERS-2. The first algorithm OCRA is a well established cloud recognition algorithm that uses the PMD information for computing the cloud-fraction. The second algorithm ROCINN uses the spectral information in the Oxygen A-band around 760nm to determine cloud-top-height and cloud-top-albedo.The combination of the two algorithms provides a unique set of very accurate GOME cloud parameters: cloud-fraction, cloud-top-height and cloud-top-albedo.The GOME cloud

parameters obtained with this novel combined algorithm compare very well with cloud parameters provided by other sensors like ATSR-2/ERS-2, MODIS and MSG.

Abstract No. 185

Coupling Oxygen Absorption at 762 NM with Scattering

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The MERIS O2 absorption is used to determine the barometric pressure. A two bands ratio between 761.875 and 753.75 nm is used to derive the oxygen transmittance. Over medium bright targets, this transmittance has to be corrected from the coupling between absorption and scattering. This coupling correction is derived from radiation transfer codes which appear to be time consuming.The atmospheric scattering in the near-infrared is enough reduced to use the primary scattering assumption. Based on that, a simple formulation is proposed in the oxygen band, to express the signal. This formulation is developed both for land and ocean observations.This simple formulation first allows to conduct sensitivity study of the two bands ratio to various atmospheric conditions over ocean, including with the presence of sunglint. The objective is to use the two bands ratio in the pixel identification in order to identify cirrus clouds and or high transportation of dust.

Abstract No. 382

Validation of a Regional Model of Dust Aerosols Cycle

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Desert dust represent 40% of the annual emissions of aerosols in the troposphere,the half of this amount being commonly attributed to the Sahara desert (Coudé-Gaussen, 1991).During their transport in the atmosphere, these particles strongly affect the radiative budget,(by way of consequence the climate evolution) mainly by back scattering the incoming solarradiations and the longwave radiations reemitted by the Earth surfaces (Jankoviak and Tanré,1992; Zhou et al, 1994). Then, a good understanding of main processes governing their emission,transport and deposition is required.We lead a climatological study over an area including the Sahara and the Sahel as sources regionsand the North Tropical Atlantic Ocean and the Mediterranean sea as transports areas.i.e, SW corner 50°W-12°N NE Corner 40°E-44°N. For this purpose, we developa modelisation tool which is used to simulate the emission and the transport of deserticAerosol from the Sahara-Sahel area, towards the Atlantic Ocean and the mediterranean sea.Concretely, this tool is based on the Chemistry Transport Model (CTM) CHIMERE.This CTM is used as a transport model of passive tracers. The granulometric distribution ofthe aerosols is discretized in several classes of size. Each class of size is considered asan independant tracer. The transport model is constraint with

Meteorological Data (ECMWF)and the spatial resolution (horizontal and vertical) is adapted to the transport of desert dust.Specific parametrizations of the different parts of the cycle of desertic aerosols: emissions,transports, dry and wet depositions) are included in CHIMERE. The desertic aerosol emission is basedon a physical dust emission scheme, representing the influence of both the wind velocity and thesurface features on the dust emissions (Marticorena and Bergametti, 1995). Including the emissionmodel allows to directly simulate the emission fluxes and the aerosol granulometry.The developed tool provides us with maps of both "an atmospheric content" and asimulated size distribution. In order to validate our model,we propose to compare our mapswith Envisat data: over land, we focus on SCHIAMACHY Level2 products and particularlyon the aerosol absorption indicator and over ocean, on the MERIS level2 product,corresponding to the aerosol optical depth* Epsilon factor.As several methods using satellite brightness temperature in thermal infrared were developpedfor detecting desertic aerosols (Legrand et al, 2001), we also foresee to use AATSR level1bbrightness temperature as validation data.

Abstract No. 425

Sensitivity of the MIPAS on Envisat to the Detection of Polar Stratospheric Clouds and their Composition

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Polar stratospheric clouds (PSCs) play an important role in the process of denitrification and associated ozone loss in the polar regions. Remote sensing from satellite instruments provide a means of monitoring PSCs in these areas which are not suitable for numerous ground-based instruments. One such instrument, providing pole to pole coverage, is the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS). This spectrometer measures limb emission spectra in the mid-infrared. The high spectral resolution of the MIPAS has allowed analysis methods to be developed to detect and differentiate PSCs based on their spectral features. A cloud detection method developed at the University of Leicester enables the approximation of the cloud top height (CTH) of the PSC. In addition a spectral feature centred at 820 cm-1, most likely related to particles of solid nitric acid trihydrate (NAT), has allowed us to distinguish between PSC types. This study involves the comparison of our own analyses of MIPAS data for the Arctic winter/spring 2002/03, with other satellite and ground based measurements (e.g. POAM III, SAGE III and Lidars) to determine the sensitivity of MIPAS to the detection of PSCs and to PSC composition.

Abstract No. 428

Integrated Air Quality Monitoring Service Using Ground Networks Measurements and EO Products

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The project EXPER-PF provides a Web based tool for a better management of air pollution by particulate matter at the regional scale (North of France including Belgium and South-East England). It combines air quality networks regular measurements and EO derived PM maps from MERIS and SeaWiFS in a GIS environment. such a tool should be useful to: Validation of air quality model ouputs Long-term pollution-health correlation studies Air quality network management and planning

Abstract No. 490

Aerosol Simulation in Monte Carlo Based Radiative Transfer Modeling

S. Sanghavi, C. Von Friedeburg, C. Frankenberg, S. Beirle, M. Grzegorski, S. Kuehl, U. Platt, T. Wagner
University of Heidelberg, Germany

Aerosols, through their different direct and indirect effects, play an important role in atmospheric radiative transfer. They display a marked degree of inhomogeneity in their occurence and properties, making it important to classify them in detail for modelling purposes. The different scenarios chosen to represent various aerosol species occurring in the atmosphere within the framework of a three dimensional Monte Carlo radiative transfer model are presented. The sensitivity of the modelled retrievals on thesize distribution and vertical profile of the aerosols and on their single scattering properties is discussed. The single scattering properties of a given species are calculated using the Mie theory whose approximation to nonspherical particles is discussed. Futurepossibilies of expanding the existing model to include nonspherical particles, to simulate 3D clouds, etc. are investigated.

Thursday 9 September
16:10 – 17:50

MOZART 1-2

Session 4D3:

Ozone Profiles Retrieval from GOME (2)

Abstract No. 455

Estimating Ozone Vertical Distributions with GOME Data and Neural Network Techniques (GOME O3 Profiling WG)

F. Del Frate[1], S. Casadio[2], F. Del Frate[1], M. Iapaolo[1]

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Neural networks are already proven to be a useful tool to solve non-linear inversion problems. An artificial neural network can be viewed as a mathematical model composed of many computational elements, named neurons, operating in parallel and massively connected by links characterized by different weights. A single neuron computes the sum of its inputs, adds a bias term, and drives the result through a generally non-linear activation function to produce a single output. Such a structure is able to establish the inverse mapping on the base of examples presented to it during a training phase, which consists in finding the weights and biases minimizing the cost function that characterize the training process. Once trained, the net is able to give real time estimations, without any particular rule or statistical a priori information on the data to be processed. Depending on the choice of the spectral interval used for the inversion, two neural algorithms have been designed for the retrieval of vertical ozone profiles from GOME data. In the first one, GOME_UTV1, a narrow continuous spectral range (321-325 nm) has been selected on the base of physical considerations; in the second one, GOME_UTV2, wavelengths belong to a wider spectral range (290-335 nm) and have been selected by means of an extended pruning procedure. The two neural networks have been trained having in input the selected radiance values measured by the sensor during 22 orbits of ERS-2 from March 1998 to March 1999, and in output the corresponding ozone profiles provided by the Rutherford Appleton Laboratory (RAL). Once trained, the retrieval performance of the two neural schemes has been tested on a validation dataset which either includes GOME measurements from the same period but not belonging to the training set or measurements taken by means of other instruments such as ILAS, boarded on the Japanese satellite ADEOS. The profiles estimation is generally satisfactory, with GOME_UTV2 algorithm showing in several cases better properties of robustness. The results of the neural inversion of the algorithm GOME_UTV1 have been also validated using lidar profiles in the framework of the GOME Ozone Profiles Retrieval Working Group. Also in this case a good performance has been observed, especially in the stratosphere, where the ozone peak is situated.It has to be reminded that the results obtained in this study can be easily extended to the measurements provided by SCIAMACHY, the instrument successor of GOME boarded on Envisat.

Abstract No. 590

New 8 year NNORSY-GOME Ozone Profile Retrieval Data Set ("GOME O3 Profiling WG")

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The Neural Network Ozone Retrieval System (NNORSY) for GOME was developed during the last years for total ozone and ozone profile retrieval from GOME UV/VIS spectra. NNORSY-GOME ozone profile retrieval was implemented for real-time processing of GOME data at the DLR-DFD (http://auc.dfd.dlr.de/ngong/profile.html). With an extended and improved collocation data set based on ozonesondes, HALOE, SAGE II and POAM III measurements neural networks were trained and the whole GOME Level 1 data was reprocessed with full spatial resolution. These yields to a consistent 8 year ozone profile data base. Validation with independent ozonesondes profile measurements are shown as well as comparisons with other satellite data. Time series analyses have shown that the NNORSY profile retrieval scheme is capable to implicitly correct for instrument degradation effects of the GOME instrument and is able to deal with cloudiness pixels and scan angle effects. Furthermore, retrieval error statistics on global scale and for different latitude regions are shown.

Abstract No. 581

Information Aspects of Height-resolved Atmospheric Ozone Derived by Optimal Estimation from GOME Satellite Measurements (GOME O3 Profiling WG)

J. Lambert[1], C. De Clercq[1], B. Kerridge[2], R. Siddans[2], S. Tellmann[3], R. Van der A[4], R. Van Oss[4], M. Weber[3]
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[2] *Rutherford Appleton Laboratory, United Kingdom*
[3] *Institute of Environmental Physics, Germany*
[4] *Koninklijk Nederlands Meteorologisch Instituut, Netherlands*

Global Ozone Monitoring Experiment (GOME) was launched in April 1995 on board of ESA's ERS-2 polar satellite. Since, the nadir-looking UV-visible spectrometers of the instrument have acquired nearly one decade of atmospheric spectra from which height-resolved information can be inferred. GOME has become a key instrument for ozone profile monitoring, bridging the data records acquired by the US SBUV-1/2 series since the 1970s and by Envisat SCIAMACHY since summer 2002, with the data records to be acquired in a near future by OMI on board of NASA's EOS-Aura and by the three GOME-2 planned for the EUMETSAT series of operational satellites METOP.Several retrieval techniques have been applied successfully to derive the ozone vertical distribution from the GOME spectra, among them the classical Optimal Estimation Method (OEM) formalised by C.D. Rodgers for the remote sounding of atmospheric temperature. Height-resolved ozone information derived by OEM from a nadir radiance measurement is a filtered (smoothed) perception of the actual ozone vertical profile. Vertical smoothing is inherent to the measurement technique, the instrument performance and the retrieval method. The retrieved profile is furthermore a mixture of information coming from the measurement itself and from a priori constraints used in

the retrieval. If ignored, smoothing and a priori contribution can alter significantly the interpretation of the retrieved profile. Their knowledge is of prime importance for validation and geophysical studies. Therefore, we have investigated major information aspects of GOME ozone profile data generated by different OEM algorithms. Starting from the averaging kernel and error covariance matrixes associated to the retrieval, we address the physical resolution of the retrieved profile, the number of independent quantities that can be retrieved, the altitude where the information is coming from, and the sensitivity to the measurement as a function of the altitude, latitude and season.

Abstract No. 501

Objective Evaluation of the Impact of RAL GOME Ozone Profiles on the UK Met Office 3D-VAR Analyses (GOME O3 Profiling WG)

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A new retrieval scheme has been developed to produce height-resolved ozone profiles spanning the troposphere and stratosphere from measurements made by the Global Ozone Monitoring Experiment (GOME).Comparison of those profiles with ozone sonde data reveals goodagreement throughout the troposphere and stratosphere, with significant improvement over climatological information in the lower stratosphere.The present paper determines whether the new information contained in the GOME ozone profiles can improve global analyses of ozone produced by a data assimilation system when they are used in combination with ozone profiles derived from the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) measurements. The data assimilation system is the 3D-VAR system used by the UK Met Office.Two classes of experiment were run for the period September 2002, when there was an exceptional split of the ozone hole over Antarctica. A control experiment included ozone data from MIPAS only; the second experiment included, in addition, GOME ozone profiles. A statistical analyses is used to determine the impact of adding the GOME data. An objective comparision of the results of these experiments is also made with independent (unassimilated) data from ozonesondes.

Abstract No. 354

Characterization of Eight Different GOME Ozone Profile Algorithms (GOME O3 Profiling WG)

Y. Meijer[1], R. Van der A[2], P. Bhartia[3], G. Bodeker[4], T. Erbertseder[5], F. Del Frate[6], O. Hasekamp[7], A. Kaifel[8], H. Kelder[2], B. Kerridge[9], J. Lambert[10], J. Landgraf[7], M. Müller[3], R. Van Oss[2], R. Siddans[9], D. Swart[1], M. Weber[11], C. Zehner[12]

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[10] *BIRA, Belgium*
[11] *Uni Bremen, Germany*
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In this paper we characterize ozone profiles retrieved from measurements of the Global Ozone Monitoring Experiment (GOME) instrument. For the characterization we use tools that interpret data that include averaging kernel and possibly a priori information, and we use lidar measurements for comparison. Currently four different approaches are used to retrieve ozone profile information from GOME data, and they mainly differ in the allowance and extent of using external information and prior constraints. In total eight different algorithms will be characterized, exploiting the Philips-Tikhonov Regularization (Space Research Organization Netherlands), Optimal Estimation (Royal Netherlands Meteorological Institute, Rutherford Appleton Laboratory, University of Bremen, National Oceanic and Atmospheric Adminstration), Neural Network (Center for Solar Energy and Hydrogen Research, University of Torvergata), or Data Assimilation (German Aerospace Center) approach. In the interpretation we focus on the aspects of vertical resolution, the altitude of the retrieved value, and the contribution of a priori information. For the comparison we use lidar data from the NDSC (Network for Detection of Stratospheric Change) stations in Lauder (New Zealand), Mauna Loa (USA), Observatoire Haute Provence (France) and Andoya (Norway) for the years 1997-1999. In total the comparison involves over 1000 ozone profiles, and allows the analysis of GOME data measured in different global regions.

Session 4D4:

Lake Levels

Abstract No. 430

Monitoring of Lake and River Systems using Retracked Satellite Altimeter Data

E. Mathers, P. Berry, J. Garlick
De Montfort University, United Kingdom

Prior work has recently shown that a huge amount of data over river and lake targets can be successfully acquired using radar altimetry. The key to retrieving these data is to retrack the individual echoes. By combining data from several missions, and utilising the ability of ERS and Envisat to maintain lock, even in complex terrain, it is now possible to combine measurements made over entire lake and river systems in order to derive information on the spatial distribution and temporal change of inland water.This paper presents results obtained over selected lake and river systems, and shows how the greatly increased availability of satellite derived heights, especially from targets within complex terrain, enables modelling and monitoring of entire large-scale hydrological systems.

Abstract No. 431

The Envisat/ERS River and Lake Retracking System

J. Garlick[1], P. Berry[1], E. Mathers[1], J. Benveniste[2]
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A system has been designed and implemented for automated retrieval of river and lake heights from ERS and Envisat altimeter echoes. This system is now being used to retrieve hydrological data on a global scale. This paper presents an overview of the river and lake system, discusses instrument-specific issues, and illustrates the system operation with a range of examples addressing different hydrological applications. The exciting new opportunity for near-real-time acquisition of hydrological data from Envisat is illustrated, and the possibility of retrieval of addition parameters such as lake volume change and river width is discussed.

Abstract No. 434

Global Inland Water Monitoring with Multi-mission Satellite Altimetry: Current Status and Future Prospects

P. Berry, J. Garlick, E. Mathers
De Montfort University, United Kingdom

Satellite altimetry provides the capability for a unique measurement of the Earth's inland water resources. Results obtained using pre-processed data are severely constrained by the ocean-oriented processing used; this has historically caused the potential of this technique to be severely under-estimated, with data retrieved over a relatively limited number of inland water targets. However, the ability to retrieve meaningful information over rivers and lakes can be greatly enhanced by retracking the individual echoes to obtain precise range to surface information. This paper presents a quantitative analysis of current capabilities with retracked data are given, including global estimates of lake volume change. The contribution of Envisat multi-mode altimetry, with the ability to retrieve inland water heights over mountainous terrain, is illustrated and the future potential of radar altimetry for global inland water monitoring is discussed.

Abstract No. 435

Comparison of the Envisat Waveform Retrackers over Inland Waters

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Since its launch in 2001, the Envisat Radar Altimetry Mission provides systematic altimetric observations of the Earth surface. The Envisat Geophysical Data Records products contain, over all type of surfaces, altimetric ranges derived from four specialized retrackers: Ocean, Ice-1, Ice-2 and Sea-Ice retracker. Among the different goals of the Envisat Mission, one directly concerns land hydrology : the monitoring of lakes, wetlands and river levels. In the present study, we compare the performances of these retracking algorithms for hydrology, in particular the ability to provide reliable water levels during high-water as well as low-water season. Four test-zones have been chosen over the Amazon basin: the Rio Negro basin, the confluence between Rio Negro and Rio Solimões, the Tabatinga region and the confluence between Rio Tapajos and Amazon river. Envisat water levels are further validated with in-situ gauge measurements.

Abstract No. 28

Floods and Droughts in Africa: Relation to Short-term Climate Variability

C. Birkett
University of Maryland, United States

The overall goal of this project is to utilize predicted sea surface temperature (SST) together with near-real time remote sensing tools, to aid in the forecast of regional drought and flood. The focus of the study is centered on the African continent for the time period ~1900-2002. There are several objectives, i)To utilize the surface status of water as a proxy indicator of precipitation and as a direct measure of hydrological drought and flood, ii) To derive this surface water status, using historical records and recent remote sensing data, for a selection of geographically distributed target sites, and to seek correlations between the data and known drought/flood episodes, iii) To examine the relationships between drought/flood episodes and short-term climate events, and iv) To deduce the vulnerability of these regions to short-term climatic events and to determine the future role of combined satellite data and predictive SST forecasts. Surface water is that defined by the level or areal status of lakes, rivers and wetlands. Here, we present results from a remote sensing survey of the continent, revealing time series of water-level variations over the 1990's decade. This has been undertaken by the application of satellite radar altimetry using the TOPEX/POSEIDON and ERS mission data. This survey contains validation results for ERS-derived elevations and a study of ERS instrument performance. Inter-comparison of these ERS and T/P results with preliminary elevation data from the Envisat mission is also shown. In addition, a survey of the decade's outbreaks of floods and droughts is reported and correlations between these conditions and the remote sensing observations are presented as the second stage of this multi-year project.

Poster Session 4P12:

Lake Levels

Abstract No. 303

River and Lake from Radar Altimetry, Sample Products for Hydrologists

J. Benveniste[1], P. Berry[2], D. Defrenne[3], D. Di Cola[3], L. Mathers[2], J. Garlick[2]

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Recent research in the application of altimetry for monitoring river and lake level showed the advantage of using data derived from satellite with a global coverage and repeated sampling in addition to ground data. The European Space Agency has initiated a "River and Lake" project to provide the scientific community with easy-to-use effective and accurate river and Lake height from both ERS and Envisat data. De Montfort University (DMU, UK) has developed a system to obtain an estimation of the River and the Lake height from both ERS and Envisat data. The ambition is to obtain 10 years of data of worldwide coverage of large rivers and lakes and to make available to Hydrologists River and Lake height products in near real time, i.e., in less than 3 hours after the measurement. Sample data will be distributed on CD-ROM at the conference as well as tools to visualize them.

Abstract No. 671

Amazon River Stages by Envisat vs Other Satellite Altimeters

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[1] *IRD, France*

[2] *CNES, France*

The ability to measure river stages by satellite is a major goal in hydrology for the coming decades given the dramatic decrease in in-situ gauges observed in the recent years. As previous satellites with a radar altimeter on-board, Envisat is able to provide altimetric measurements of the height of continental waters. In addition, 4 height values are provided resulting to 4 tracking algorithms. We present a comparative study of the Envisat results for the different tracking algorithms. Comparisons are made with: - ERS data retracked with the ICE-2 algorithm, - Topex/Poseidon and GFO for the nominal tracker - ICEsat measurements.The study is conducted over the Amazon basin.

Thursday 9 September
16:10 – 17:50
MOZART 3

Session 4D5:

Sea-Ice (2)

Abstract No. 672

On the Use of Envisat ASAR for Remote Sensing of Sea Ice

S. Nghiem
Jet Propulsion Laboratory, United States

To investigate the use of Envisat ASAR for sea ice remote sensing, we carry out a study of multiple polarization C-band SAR signatures of various sea ice types. We present polarimetric SAR data acquired over sea ice acquired by the Jet Propulsion Laboratory (JPL) polarimetric AIRSAR system on the NASA DC-8 aircraft over sea ice regions in the Beaufort Sea and the Bering Sea. We use a physical sea ice model to obtain and study polarimetric scattering signatures of sea ice under various conditions. We also compare sea ice signatures with backscatter of ocean surface at different wind speeds using an empirical C-band ocean wind geophysical model function. We present backscatter signatures for Envisat ASAR single polarization modes and alternating polarization modes over all swaths. We find that different polarization combinations in various Envisat ASAR image modes at different incidence angle ranges need to be selected to obtain more accurate or more robust results for sea ice mapping. In the wide swath mode, Envisat ASAR polarization can be chosen to measure either horizontal or vertical backscatter exclusively. For light wind conditions near a sea ice edge, horizontal backscatter is better to distinguish between first-year ice (excluding young ice) and open ocean surface at large incidence angles. For high winds, vertical backscatter is better in identifying most sea ice types (except multi-year ice at large incidence angles) from open water over a large range of incidence angles. We also investigate diurnal effects to determine the impact on sea ice backscatter acquired at different times of the day. Results show that diurnal effects on first-year ice are significant so that SAR data collected over sun-synchronous ascending orbits and descending orbits in daytimes and nighttimes need to be analyzed separately to obtain consistent sea ice mapping results. This study also provides useful information for the application of the future RADARSAT-2 multi-polarization SAR to sea ice mapping.

Abstract No. 109

Comparison of Helicopter-borne Measurements of Sea Ice Thickness and Surface Roughness with SAR Signatures

T. Busche[1], C. Von Saldern[2], C. Haas[2], W. Dierking[2]
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Although sea ice thickness is not directly measured by means of radar sensors, its magnitude and variations are to a certain degree reflected by the sea ice surface characteristics. Establishing simple but robust empirical relationships between sea ice properties and SAR signatures is an alternative to a much more complex theoretical microwave modelling approach for sea ice mapping. In this study correlations between helicopter-borne sea ice thickness and roughness measurements and SAR

signatures are investigated. Sea ice thickness profiling with an electromagnetic induction sounding device mounted on a helicopter has been carried out during different field campaigns coincident with satellite overpasses in the Artic and Baltic Sea. In addition surface roughness profiles were taken simultaneously by means of a laser altimeter. The SAR dataset includes C-band SAR imagery from Envisat ASAR and Radarsat-1, giving the opportunity of an intercomparison between both sensors with their different spatial resolutions and polarisation. Image postprocessing options which might improve the correlation between the ice surface properties and ice thickness variations, on the one hand, and SAR signatures, on the other hand, are also discussed.

Abstract No. 493

The Potential of Cross-Polarization Information for Operational Sea Ice Monitoring

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Between April and November 2003 Envisat ASAR was used to collect alternating polarization (co-pol + cross-pol) data over Resolute Bay in Arctic Canada. Never before have cross-polarization signatures of sea ice been collected over an entire ice season. As part of their operations, the Canadian Ice Service provided regular ice analysis charts based on RADARSAT-1 acquisitions and other remote sensing information. Environmental records (temperature, wind, and snow) for the area of interest are also available.This paper investigates the information content of alternating polarization data for sea ice monitoring. Cross polarization signatures of various sea ice types are evaluated and challenges for data analysis are discussed. System noise level, polarization combination, incidence angle range as well as environmental conditions are taken into consideration.Current practices at the Canadian Ice Service include the visual interpretation of single channel spaceborne SAR data by expert analysts. Alternating polarization provides enhanced visualization options, recommendations will are and potential problems are outlined. A modified version of the Wishart classifier is evaluated for its potential to separate sea ice and open water. Applications and limitations for automated classification are discussed. Cross-polarization data are a valuable additional resource for operational sea ice monitoring. Data visualization and classification largely benefit from the availability of the additional information provided by the second channel. Coverage provided by dual pol modes and system noise levels pose challenges for the use of cross-pol data.

Abstract No. 363

Operational Experience with Envisat ASAR Wide Swath Data at the Canadian Ice Service

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The Canadian Ice Service (CIS), a branch of the Meteorological Service of Canada, is one of the largest single organisation users of SAR data in the world, and relies critically on satellite SAR data to carry out its mandate. In mid-2003, the CIS began to receive Envisat ASAR data received in Canada in near real-time via the Canada Centre for Remote Sensing Niche agreement. ASAR Wide Swath Mode images have been and are being used as a complementary data source to RADARSAT-1 data for the routine daily production of ice charts, bulletins, and forecasts in support of ship operations and navigation in ice. Envisat ASAR is also considered as a "hot backup" data source in the event of a RADARSAT-1 outage. In this paper, we describe the infrastructure and procedures developed to receive ASAR data through the Canadian ground segment in near real-time including, data ordering, reception, processing, delivery, and post-processing of imagery products. We also discuss our experience using ASAR data in an operational environment, including issues related to choice of polarization, timeliness, image quality, and use of ASAR data in the CIS daily operational analysis and production work flow. The CIS infrastructure has also been used to acquire Envisat ASAR data in support of both the Floe Edge and the Iceberg Detection services offered under the ESA-sponsored GMES project, The Northern View. CIS involvement in these two services with also be touched upon briefly.

Abstract No. 84

What do We Gain by Using an L-band SAR for Sea Ice Mapping?

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Until the beginning of the 90s, C-band and X-band SAR imagery was regarded as the optimum choice for sea ice type classification. In a number of studies that have been published since the early 90s it was found, however, that the classification performance is better at L-band than at C-band. This discrepancy is caused by the use of different radar-specific definitions of the ice types. L-band is superior compared to C-band when the ice surface topography is used as one criterion for the separation of different ice classes. Since the ice surface topography reflects deformationen processes as a result of ice dynamics, it is an important parameter in studies of the sea ice mass balance and the momentum transfer between the atmopshere and the ice-covered ocean. The utilization of L-band SAR imagery from PALSAR and from a potential TERRASAR-L mission is hence an interesting complement to C-band imagery. Because in operational sea ice mapping the SAR images predominantly in use are from C-band sensors, the full potential of L-band imagery has not been assessed in detail yet. In the presentation, examples from the literature and from measurement campaigns of the Danish EMISAR system over the Baltic Sea and around Svalbard will be used to demonstrate the pros and cons of L- and C-band SAR systems in sea ice mapping, respectively.

Poster Session 4P13:

Sea-Ice

Abstract No. 12

A First Experiment of Near Real Time (NRT) Processing of Envisat/ASAR Images to Assist Ship Routing in Antarctica

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The italian Base at Terra Nova Bay, Antarctica (74S 165E) is a summer Base: it opens for scientific activities when the ship of the Antarctic Project, having left New Zealand at the beginning of December, arrives there.Usually, at the onset of the melting season, the ship encounters icefields around 68S. Depending on ice condition, the duration of the trip from New Zealand can last from 12 to 25 days. After the arrival at the Base, the ship becomes an oceanographic research vessel which operates for more than one month in the Ross Sea. In order to assist ship routing in ice, a proposal was submitted to ESA to use NRT ASAR Wide Swath (WS) images. The set-up procedure consisted of the following steps:1. acquisition planning over the area of interest by DESCW, with 2 weeks of advance notice (compulsory request by ESA);2. ASAR WS data acquisition over Antarctica and download at Kiruna Station (Sweden);3. six hours after acquisition, data are available for ftp on Kiruna server and transferred to ISAC;4. data are processed as geo-coded jpeg images at ISAC;5. processed images are delivered by e-mail to the ship within 6.5 hours from acquisition.Some examples of NRT processed ASAR images will be presented.

Abstract No. 77

Analysis of Sea Ice Roughness and Thickness Variation for Improvement of SAR Ice Type Classification

C. Von Saldern, T. Busche, C. Haas, W. Dierking
Alfred Wegener Institute, Germany

Sea ice thickness and surface morphology have been investigated in order to improve ice type classification by means of SAR imagery. Since ice thickness measurements are considerably more difficult to accomplish than surface measurements, it is important to improve techniques for estimating thickness classes from surface charcteristics. The data were acquired during field campaigns in the Arctic and Baltic Sea. The thickness measurements were carried out by means of helicopter-borne electromagnetic induction sounding, the surface roughness measurements by means of a laser altimeter mounted on the same sensor platform. Simultaneously acquired SAR images are available for many of the tracks flown during the field campaigns. Ice thickness measurements contain information about the typical level ice thickness as well as the stage of deformation. Surface topography profiles contain similar information, since growth and deformation processes such as ridging, rafting etc. manifest themselves in the surface roughness. Radar signatures are dependent on ice surface topography, but ice thickness cannot be measured directly by means of radar. To describe surface roughness, the stochastic properties of the measured

roughness and thickness profiles have been analyzed using parameters such as mean elevation, rms height, skewness and fractal dimension. A cluster analysis has been applied to the parameters thus obtained in order to extract criteria for separating different ice types. Implications on ice type classification by means of SAR imagery are discussed.

Abstract No. 135

The Distribution of Sea Ice in Storfjorden

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Storfjorden, lying between the islands of Spitsbergen and Edgeoya in the Svalbard archipelago is of scientific interest to various inter-related disciplines. The formation and evolution of the Storfjorden polynya, which forms regularly during the winter months is of particular interest. The polynya leads to the formation of new ice and brine enriched shelf water.12 Envisat wide swath scenes over Storfjorden were obtained during April 2004 in conjunction with co-incident ground truth observations collected using the IceCam system. The scenes were analysed and classified to show the spatial distribution of the various ice classes over time.

Abstract No. 137

Monitoring Polynya Processes and Sea Ice Production in the Laptev Sea

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The Laptev Sea is a Siberian Shelf sea and one of the main source regions of ice in the Arctic Transpolar Drift. Most ice forms in a prominent flaw lead or polynya which extends north of and along the fast ice edge, and is then advected northward and incorporated into the Transpolar Drift. In the region of the polynya major modifications of different water masses take place with consequences for the Arctic Ocean's oceanography. Convection in the polynya on the shallow shelves also leads to redistribution and modification of seafloor and riverine sediments. In order to investigate these processes during the complete winter season 2003/2004 in more detail, two seafloor observatories were moored in the region of the polynya in September 2003. These are equipped to measure vertical profiles of salinity, temperature, turbidity and currents in the water column, as well as ice thickness and ice drift speed and direction. In parallel, the region of the polynya was monitored continuously by means of wide and narrow swath VV and AP Envisat-SAR imagery one to two times per week. While comparison of processes in the water column with ice formation and ice types at the surface will only be possible after recovery of the observatories in September 2004, we will demonstrate the observation of polynya processes with Envisat SAR, and will relate typical surface conditions and processes visible in the SAR data to the driving meteorological boundary conditions.

Abstract No. 157

Envisat and the Ice Conditions in the Baltic Sea

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In this paper an overview about the Finnish Envisat CAL/VAL-project as well as some detailed results obtained in the project will be presented. The project has three major objectives. One objective is to implement an operational data processing chain,the other is to analyse the effect of different ice properties on the SAR signature and its statistics through theoretical and empirical backscatter studies, and the third is to develop an automatic, hierarchical image interpretation system, which utilizes the backscatter modelling results.The operative data processing chain consists of the rectificationof a SAR image, its use at the Finnish Ice Service, and its transmission to users at sea. This transmission system facilitates the use of Envisat near-real time products as supporting information for planning of the icebreaker fleet operations in the Bay of Bothnia. Due to the dynamic nature of ice fields the value of the image product is highly dependent on the time gap between image acquisition and the delivery dateto an end-user on board. The end-users are well trained to evaluate the usefulness of the Envisat ASAR products, as they have used RADARSAT products operationally. To enable the validation of ASAR data a field campaign was organized in February 2003. Backscatter measurements of level ice and deformed ice were conducted with a helicopter-borne C- and X-band scatterometer. Additionally, ASAR IMP and APP images were acquired during the field campaign. Some ground truth measurements were also conducted. The ice field was photographed using a helicopter-mounted digital camera. The position and direction of the images were recorded using GPS and position sensors. For higher contrast the images were taken using a forward looking camera. These digital images are rectified and assembled into larger mosaics for further statistical processing like ice roughness, density and direction of ridges etc. to be used in backscatter modelling and image analysis studies.Theoretical modeling of backscattering signatures are conducted to: (1) estimate dominant scattering mechanism in different ice types, (2) dependence of backscattering coefficient on various sea ice and snow cover parameters. Empirical modeling study is concentrated on studying the dependence between spatial statistics (e.g. correlation length, standard deviation) and distance. The results show clearly that the variation of backscattering coefficient is fractal-like. These studies are aimed to develop a semi-empirical model for estimating the degree of ice deformation in SAR images.The work in the automatic image interpretation has addressed so far several different problems. As well-known, these kind of algorithms are sensitive to speckle. A contourlet based translation-invariant denoising scheme has been developed. The algorithm utilizes multiscale representation of a SAR image as well as a

directional filter bank. It is also designed to deal with correlated speckle. This case arises, e.g., when ASAR IMP and APP images are sampled to resolution of 12.5 m. Results for sea ice ASAR images as well as comparisons to some other despeckling methods will be given. During the project the applicability of the Independent Component Analys (ICA) to retrieve and quantify the textural variation has also been analysed. ICA produces a set of basis vectors, with a maximum statistical independence (as measured by negentropy). The set is extended by also including rotations of the basis vectors. We then group the extended set of ICA basis vectors to sets consisting of in some sense similar basis vectors (e.g. rotated and/or translated versions of each other), and use the projection coefficients of SAR data to these sets as feature vectors in classification. Classification results and their usefulness for sea ice type classification is discussed.One of the main tasks in the sea ice mapping is the discrimination between open water and sea ice. This discrimination procedure is refined by using an extensive set of SAR images and digitized ice charts. We have also began to study the possibilities offered by the dual polarized ASAR images. Preliminary results indicate that to extract highly deformed ice areas from a SAR scene, one can use these two polarizations in a hierachical manner (HH image first, then HV image).

Abstract No. 175

Ice Cover of the Okhotsk Sea: a Study Using Envisat ASAR, ERS-2 SAR and AQUA AMSR-E Data

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During 2002–2003 and 2003–2004, over 50 wide swath Envisat ASAR and ERS-2 SAR precision and quick-look images, as well as large quantity of AQUA AMSR-E and ADEOS-II AMSR microwave radiometric measurements in frequency ranges from 6.7 to 89 GHz were obtained over the Okhotsk Sea. These datasets allowed us to trace ice cover evolution, delineate open water from ice formations, and reveal fast changes in the marginal ice zone. Variations in radar backscatter and in brightness temperatures at different frequencies are evaluated and used for classification of sea ice types. Presented results are compared against NOAA AVHRR images, surface analysis maps and ice condition maps prepared by the Japan Meteorological Agency.SAR and corrected passive microwave images are analyzed using wavelet decomposition. Correction is carried out to decrease the influence of variable atmospheric emission. Wavelet domain features of different scales are used for creation of texture metrics. Feature vector composed of metric values is computed for every block in the decomposition of the images. Feature vectors are used in classification process resulting in discrimination of sea ice types and delineation of open water.

Abstract No. 228

ERS/RADARSAT/Envisat SAR Satellite Studies of the Behavior Ecology of Ice Form of Seals Affected by Differences of Winter Severity, Winter Hydrology and Climate Change

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Seals in the European Arctic include the different phocid species. Inhabit of harp and grey seal is ranged from the North Atlantic till the Western Arctic, from Canada and UK till Kola Peninsula and White Sea. Grey seals in the Baltic Sea are represented the separate population. Archeological digs disclosed the extinct species of harp seals in the Baltic: dying out was resulted by post-glacial isolation and climate change. Ringed seals are stretched very wide in the Arctic as in the Baltic and contiguous inland fresh-water bodies (Ladoga and Saimaa lakes). Ringed seals are selected water areas where is the ice is existed although at the wintertime. But unfortunately our knowledge about distribution and ecological features of the most ice forms of focid are uncompleted and fragmented. Even a few behavioral studies have been carried out. Until recently a little was known about a present-day status, movements and migration features.Introduction of satellite telemetry, as well the development of technologies of SAR satellite sub-surface sounding of the fresh-water and sea ice made it possible to study ice as non-biotic factor of marine mammals with lifestyles in difficult environmental. These successful ERS SAR satellite investigations were organized initially in frame of the ESA AO3 430 Project "ERS SAR data application use for studying sea ice parameters and retrieving of Greenland seals migration". It allows establish the connection of the migration features of harp seals with the specific type of ice that has the specific differences of SAR signatures. Further development of SAR satellite studies of behavior ecology of different representatives of ice forms seals in marginal Arctic, Baltic and inland water bodies was provided in frame of the ARCDEV, ICEWATCH, ICEMON and other national and international projects. The results of following research activities will be presented: study of regularities of breeding, whelping, molting and feeding relating to different winter severity; searching of ice features most convenient for different stages of living cycle of phocids; using ERS/Radarsat/Envisat satellite sub-surface sounding for revealing ice features non-convenient and absolutely non-convenient for different form of seals; revealing a SAR signatures of different water masses and different types of pack and fast ice most suitable for seals, processing their in contrast with surrounding water and ice areas; sub-satellite-airborne studies of the different ice processes and their tracers and SAR signatures: stable currents and quasi-stationary spiraling eddies, hummocks and ridged ice zones, different kinds of openings, fractures, polynyas; assessing of the influence of type of winter severity and climate change on the migration features of seals; field inspections of the zones of mass accumulation of ice-associated sea mammals; gathering of the water samples and ice cores with following studies in laboratory.

Abstract No. 256

Remote Sensing of Frost Flowers and Sea Ice

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Frost flowers are a common phenomenon in the Arctic and the Antarctic and can be found on almost any newly frozen lead. Frost flowers have a strong impact in the microwave as well as in the optical region of the electromagnetic spectrum. Therefore, they can cause severe errors in geophysical data products derived from remote sensing data. Frost flowers affect the ability to distinguish between different ice type in SAR images. We use a model driven by air temperature and sea ice concentration from spaceborne passive microwave sensors to estimate a theoretical upper limit of the frost flower coverage. The model results are compared to ERS and Envisat SAR images of sea ice.

Abstract No. 362

Sea Ice Monitoring with ASAR Alternating Polarization Mode: Results from the Canadian Ice Service Gulf 2003 and 2004 Field Validation Programs

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The Canadian Ice Service (CIS), a branch of the Meteorological Service of Canada, in conjunction with the Bedford Institute of Oceanography (BIO) of the Department of Fisheries and Oceans, carried out field validation programs in the Gulf of St. Lawrence in March, 2003 and February, 2004. Envisat ASAR Alternating Polarization data was collected as well as RADARSAT-1, SAR-580 airborne polarimetric data (2003), and numerous other remote sensing data sets (e.g. QuikScat, SSMI, AVHRR, MODIS). CIS and BIO personnel field validated various ice conditions via helicopter targeting specific features selected from analysis of near real-time processed ASAR and SAR-580 data. Surface sampling, photography, and helicopter-borne EM thickness measurements were collected near-coincident with the SAR data sets. Funding support for these programs was provided by the Canadian Space Agency (CSA) and ASAR data access was via the CIS AO project approved by the European Space Agency (ESA).In this paper, we provide an overview of the two Gulf field validation programs and the data collected, including self-contained HTML-based CDs/DVDs encompassing all data collected for each program, intended to be distributed to interested researchers to facilitate exploratory data analysis. In addition, we report on our own assessment, evaluation, and analysis focusing on the ASAR Alternating Polarization data and what potential there is for its use in operational sea ice monitoring. Issues related to incidence angle, polarization choices, cross-polarization sea ice backscatter levels, and noise floor limitations are highlighted.

Abstract No. 509

Near Real Time Use of the Envisat ASAR Images as an Aid of Winter Navigation in the Baltic Sea

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Ice Service of the Finnish Institute of Marine Research (Finnish Ice Service, FIS) has used satellite images to ice charting since late 1960's. Since the middle 1980's images are forwarded to the Finnish operating icebreaker fleet.The first ERS-1 SAR-images received in the early 1990's and since that Finnish Ice Service has used SAR-images in daily ice charting work and forwarded them to icebreakers.During the spring 2004 Finnish Ice Service received the first ten Envisat ASAR-images as a part of the ICEMON-project in near-real-time and forwarded also them to the Finnish and Swedish icebreakers.The very first comments from icebreaker's officer indicate that Envisat ASAR scenes are somehow "sharper" than RadarSat WideScan SAR scenes. On the other hand the ordering procedure and passing times are more unsuitable for ice charting work than RadarSat ones.

Abstract No. 555

Computer Based Detection and Tracking of Antarctic Icebergs in SAR Images

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Icebergs play an important role in climate through the transfer of fresh water and energy between ice sheets and the ocean. Synthetic aperture radar images offer a rare way to observe icebergs in the often dark and cloud-covered polar areas. Furthermore, there is now 13 years worth of comparable ERS and Envisat images of the Antarctic coast, making it possible to study the temporal and spatial variation of iceberg calving and melting. Nevertheless this large dataset is of limited use unless a time efficient and systematic way exists to analyse the images. Here, a computer based technique is proposed to detect icebergs at higher resolution than previous efforts, allowing for the shape of small to medium icebergs to be retained and used for tracking between images acquired at different moments. The detection consists of i) automatic segmentation followed by ii) classification of these objects between icebergs and non-icebergs. The icebergs are then matched between images using geometric and shape distances. The system performance was assessed by applying the technique to three wintertime ERS-1 PRI images of the East coast of Antarctica, around Kaap Norvegia (10°W). The results show both the segmentation and tracking to be effective. However the classification stage requires user intervention as the icebergs are not always a separable class from other objects, most notably from sea ice.

Abstract No. 572

Use of Envisat Data in Sea Ice Modeling

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Satellite remote sensing data have been crucial in the initialization, calibration and validation of sea ice models. These models simulate or predict the evolution of the velocity, compactness and thickness distribution of sea ice. The Envisat multi-channel, high resolution data opens new opportunities in fine grid (1-10 km) modelling. The initial fields can be properly constructed, and the influence of the basin morphology on becomes well mapped. The present study concerns the basins of the Baltic Sea, principally the Gulf of Finland, Gulf of Riga and the Pärnu Bay. The size of the basins is 10-100 km, and the ice thickness is 5-50 cm. Cases are shown of using the Envisat data with model simulations to examine the role of the coastline form and islands in sea ice drift and deformation. The results can be used to improve existing models and to examine the problem of scaling of sea ice dynamics.

Abstract No. 695

Application of ASAR Coregistration between Multi-temporal WS Acquisitions for the Purpose of Polynya Monitoring

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The new Wide Swath acquisition mode of ESA Envisat satellite is being assessed for the purpose of monitoring sea-ice evolution and coastal changes for ocean biological activities. BEST (Basic Envisat Sar toolbox) provides a useful co-registration tool to elaborate a temporal set of images. It has been demonstrated that this tool can achieve good results using images from the Western Ross Sea region (Antarctic) in the presence of a heterogeneous environment and under different geometric and temporal conditions.

Poster Session 4P14:

Sea Surface Temperature

Abstract No. 86

Using AATSR Data within the GODAE High Resolution Sea Surface Temperature Pilot Project (GHRSST-PP)

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The primary aim of the Global Ocean Data Assimilation Experiment (GODAE) High Resolution Sea Surface Temperature Pilot Project (GHRSST-PP) is to develop and operate an operational demonstration system that will deliver high-resolution (better than 10 km and ~6 hours) global coverage SST data products for use in operational ocean/atmosphere modelling systems and the wider scientific community. A new generation of SST data products will be derived and served to the user community by combining complementary satellite and in situ SST observations in near real time. A full description of the GHRSST-PP project can be obtained from the ESA sponsored GHRSST-PP International Project Office web server located at http://www.ghrsst-pp.org.The GHRSST-PP framework is based on an internationally distributed system in which the data processing operations are shared by Regional Data Assembly Centres (RDAC). RDAC ingest, quality control and merge existing satellite and in situ SST data sources that are then delivered in real-time as regional coverage quality controlled SST data products (called L2P products and are targeted to operational data assimilation systems and analysis systems). In this way, GHRSST-PP harmonises the data format of diverse SST data products greatly facilitating their application. RDAC data products are then assembled together at Global Data Analysis Centres (GDAC) where they are integrated and analysed together to provide L4 global coverage data products. Envisat AATSR data are currently available to the GHRSST-PP Science team and associated RDAC/GDAC projects via a dedicated Category-1 agreement. These data are fundamental to the GHRSST-PP as they provide extremely well calibrated SST data products that effectively provide a 'reference' data set. The AATSR has unique sensing-geometry and on-board calibration that ensure true independence from other satellite SST data sets. Within GHRSST-PP, AATSR data will also be extracted for 100+ carefully defined locations throughout the world oceans as input into the GHRSST-PP High Resolution Diagnostic Data set (HR-DDS) system. The HR-DDS provides a powerful means to operationally compare complementary satellite data sets and identify bias differences between data sets and for specific regions. In addition, because the HR-DDS is an operational system, sensor problems or significant events (such as the impact of large volcanic eruptions) may be identified quickly and appropriate responses implemented rapidly.

Poster Session 4P15:

Atmosphere Assimilation

Abstract No. 300

Land Surface Parameters for Atmospheric Modelling Applications

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Urban air pollution is one of the most stringent environmental problems in Europe today. Urban to regional scale air quality modelling systems (AQMS) are considered as the appropriate tools for the evaluation and prediction of air pollution. The AQMS developed at VITO has a numerical grid structure and contains sub-models that treat meteorological processes, tropospheric chemistry, and transport of pollutants. The meteorological model used in the AQMS contains a rather sophisticated representation of the land surface, including vegetation effects. An efficient way of obtaining information on the state of the land surface with sufficient temporal and spatial sampling for large enough regions resides in measurements from space. The possibilities offered by using MERIS imagery in conjunction with ancillary data for the specification of lower boundary conditions in regional atmospheric models will be discussed.

Abstract No. 506

Assimilation of Ozone Profiles from MIPAS in the STRATAQ CTM

B. Grassi, G. Redaelli, G. Visconti
University of L'Aquila, Italy

We use a sequential assimilation approach to assimilate ozone MIPAS profiles into the STRATAQ chemical transport model of the stratosphere. The numerical code uses parameterizations and simplifications allowing assimilation of sparse observations and the simultaneous evaluation of analysis errors. The CTM used is a high resolution three dimensional model which includes a detailed chemical package and is driven by UKMO analysis.Two weeks of MIPAS ozone measurements are assimilated duringOctober 2002, and results validated using data from APE-Envisat airborne campaign.

Poster Session 4P16:

Future Earth Observation Missions

Abstract No. 243

The TerraSAR-X SAR Products

M. Eineder, B. Schättler, H. Breit, T. Fritz, E. Boerner, J. Holzner, A. Roth, J. Mittermayer
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TerraSAR-X is a German X-Band SAR satellite to be launched in 2006. Its antenna is electronically steerable in azimuth and range and offers different polarizations and imaging modes like ScanSAR, spotlight and stripmap.The paper presents the SAR products offered by the TerraSAR-X payload ground segment at DLR. Due to the different sensor modes and the optional geocoding the product palette is quite large compared to current systems. The processing approach and the standard products derived from each imaging mode are described. Furthermore, an outlook to products from experimental sensor modes is given.

Thursday 9 September Wolf-Dietrich 1-2

Poster Session 4P17:

Wind and Wave/Sea State

Abstract No. 23

Quantitative Remote Sensing: Horns Rev Wind Farm Case Study

C. Hasager, M. Nielsen, M. Christiansen
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Observations from ERS-2 SAR, Envisat ASAR and scatterometer are used to quantify wind resources near the Horns Rev wind farm located in the North Sea, Denmark. At this site a large offshore wind farm (80 2MW-turbines) is in operation. The study includes spatial analysis of wind climatology maps derived from satellite observations, as well as time series statistics from offshore meteorological observations collected within the wind farm. Focus of the case study is on the spatial variations in wind fields within the region. The overall aim is to provide quantitative estimates on offshore wind resources, and to demonstrate possibilities and limitations on the use of quantitative remote sensing for wind resource estimation. CMOD4 is used to derive wind speed from SAR. A footprint methodology for averaging wind speeds in SAR imagery for wind resource estimation is used (Hasager et al. 2004). The current study is based on 90 ERS-2 SAR scenes, 5 Envisat ASAR scenes and several years of Quikscat and ERS scatterometer daily observations. Acknowledgements: ESA EO-1356 Cat. 1 project (Offshore wind resources from ERS SAR wind speed maps) satellite scenes, STVF SAT-WIND project funding and Elsam Engineering for wind farm meteorological data. Reference: Hasager, C. B., Dellwik, E., Nielsen, M. & Furevik, B. 2004. Validation of ERS-2 SAR offshore wind-speed maps in the North Sea. International Journal of Remote Sensing accepted.

Abstract No. 123

Offshore Wake Effect Study from Earth Observation SAR

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Winds are derived from EO SAR scenes in order to determine the wake effect of a large offshore wind farm (80 2MW wind turbines) located at Horns Rev in the North Sea. Wind wakes are regions of reduced wind speed and high turbulence intensity found downstream of obstacles (e.g. offshore wind farms). The aim of the present study is to characterize wind wakes spatially thereby supporting wake models in the prediction of environmental impacts of large offshore wind farms. The study is based on 29 ERS-2 SAR scenes, 12 Envisat ASAR scenes and additionally on high resolution airborne ESAR data. Scenes have been collected continuously since the Horns Rev wind farm became operative in December 2002. Maps of wind speed are derived from the SAR data through geophysical model functions (CMOD-4/5 and CMOD-IFR2); a priori knowledge of the wind direction is required. The wind direction is obtained from streaks in the SAR images (FFT analysis) or from a meteorological mast at 60 m. The wind speed obtained within a region upstream of the wind farm is considered the free stream velocity. Wake effects are spatially identified through

comparison of the mean wind speed downstream of the wind farm to free stream conditions. Further, turbulence intensities are mapped through the relation of standard deviation to mean wind speed. Acknowledgements: ESA EO-1356 Cat. 1 project (Offshore wind resources from ERS SAR wind speed maps) satellite scenes. STVF SAR-WAKE project funding and Elsam Engineering for wind farm meteorological data.

Abstract No. 163

Ocean Surface Wave Spectrum from Envisat ASAR Observations, During the Valpareso Experiment Compared to Airborne Radar Observations, In-situ Data, and Wave Prediction Models

A. Mouche[1], D. Hauser[2], V. Kerbaol[3], B. Chapron[4], J. Lefevre[5]

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The ASAR on board the Envisat satellite has new specificity -multiple configurations of polarization and incidences, variable horizontal resolution and swath, flexible processed products - which offers new potentiality to extract geophysical products. Over the ocean this concerns in particular the estimate of the ocean wave spectrum and surface wind speed. Concerning the estimate of ocean wave properties, recent progresses have been done in the last years to formulate the direct problem and its inversion (the retrieval of the wave spectrum from the image spectrum). Indeed, a new method has been developed by NORUT and IFREMER and implemented by ESA to process the data of the ASAR Wave mode to Level2 products. This method is derived from the one proposed by Mastenbroek and De Valk, (JGR, 2000) and consists in separating the quasi-linear and the non-linear part of the transfer function., which are associated respectively to the long ocean waves (swell) and wind-wave parts of the sea spectrum. This requires to estimate the wind vector from the data or to fix it from external information, in order to estimate the non-linear part of the transfer function. By using cross-spectral estimates between successive SAR looks, this method also allows to solve the ambiguity in the propagation direction of the waves, and to eliminate the speckle noise In order to contribute to the validation of this new algorithm, CETP has carried out a validation experiment (called VALPARESO) by performing airborne radar measurements in coordination with acquisition of Envisat ASAR data in Image Mode. In addition to the validation of the algorithm developed for the Level2 products of ASAR Wave Mode (imagetts to be acquired in the default mode in VV and incidence 19°), the objective of VALPARESO for the ocean wave part, was to develop and assess the method in other configurations of incidence angles and polarization. During VALPARESO (19 October-21 November 2002), the airborne C-Band polarimetric radar STORM, recently developed at CETP, was embarked on-board an aircraft to carry out observations of the sea surface, off the coasts of France and UK (near-Atlantic and English Channel). The geometry of observations of STORM- range of incidence angles from 5 to 35°, antenna scanning in azimuth over 360°-, and the fact that STORM uses the real-aperture technique, allows to estimate the ocean wave spectrum without the limitation of the SAR (limitation due to azimuth smearing associated with the

motion of the surface scatters). The analysis of the radar cross-section with incidence and azimuth angles is also used to estimate the wind vector (see the companion paper by Mouche et al). In this presentation we will present comparison of the wave spectrum retrieved in different configurations of incidence angles and polarization from the ASAR Images, and from the STORM radar. We will also present comparisons with in situ data (wave measurements from buoys) and wave prediction model outputs. From this study we will discuss the performance of the Level2 algorithm of ESA for the wave mode of Envisat (in VV polarisation, IS2 incidence mode), and discuss its applicability in other modes of observations (HH polarization, larger or smaller incidence angle).

Abstract No. 291

Estimation of Wind Speed Frequency Distribution

O. Omidiora

Emmaus Christian School Maenza Italy, Italy

Wind erosion is a particular serious problem on many lands, and human impact on the global environmental is an issue of International concern. To adequately predict the consequences of various land management strategies on wind erosion, new technology is needed. Wind transport moisture and heat in the atmosphere and therefore has some effect on the crop production. It also influences rates of evapo-transpiration and directly exacts pressure on crops along its path. Wind may encourage soil erosion when the speed exceeds some critical threshold value for a given soil environment. Crops may be buried by wind blow or dust while the stems and leaves of the tall crops surface abrasion by sand particles. This was part of the surface energy balance project over a bare soil at a humid tropical site at Ile- Ife, Nigeria.

Abstract No. 406

Mechanisms for the SAR Imaging of the Ocean

M. Kanevsky, V. Karaev

Institute of Applied Physics, Russian Federation

The comparative analysis ow two velocity bunching mechanisms of the SAR imaging of the ocean was performed. It is shown analytically and confirmed by means of numerical modeling that the mechanism of fluctuations of the effective dencity of scatterers, which is commonly accepted at present as the physical basis for the SAR diagnostics of ocean roughness, actually works only in the case of sifficiently flat swell. In the presence of large scale wind waves, the dominant role is played by another mechanism, namely, fluctuations of the number of surface elements whose images are randomly shifted and superimposed in the image plane due to orbital velocities. In the case of developed wind waves propagated in the azimuthal direction, the power contribution of two above mentioned mechanisms for the SAR imaging of the ocean differ by about two orders of magnitude.On the basis of numerical modeling, the set of SAR image spectra as a function of the near surface wind speed was calculated.

Abstract No. 450

Biological and Geophysical Parameters from Envisat over the Ocean

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The paper presents an overview of the Envisat AO BIGPASO (ID220). In the project new Envisat algorithms for the measurement of oceanographic variables, like wind fields, ocean waves, suspended matter, primary production and sea ice parameters were derived. Models, for oceanographic parameters like sea ice and suspended matter, were improved, and data collected in measurement ship and in situ campaigns were used for validation. The main research tasks performed and described are:· Global measurements of ocean wave propagation and measurement of individual ocean wave parameters from radar data;· High resolution measurements of mesoscale wind fields especially for extreme cases like hurricanes and polar lows;· Development of a five day sea ice model for the Arctic and assimilation of satellite data to the model;· Development of a transport model that explains the banded structure of suspended matter in the North Sea· Numerical model explaining primary production in coastal waters by remote sensing data· For validation of the sensor algorithms and models described above: evaluation of continuous time series of wind and sea state parameters from tower based radar data in the German Bight, interferometric airborne radar data acquisitions using along track antennas for currents and across track for digital elevation of mud flats at the same time and ship validation campaigns in the North Sea and the ArcticIn the investigations parameters derived from these instrument were used in synergy to:· Improve the analysis of measured wind and ocean wave fields, and thereby improve weather forecasting at European weather centres;· Determine the extent and variables of sea ice and develop a five-day sea ice prediction model, to support maritime shipping and offshore activities;· Monitor and map sediment and suspended matter transport in coastal regions, especially in areas with large river estuaries, which greatly affects shipping lanes, harbour and dredging activities;· Monitor hydro-biological and bio-geochemical variables related to water quality in coastal regions and large inland waters, which affects ecology, coastal development, aquaculture, drinking water supplies, and tourism;· Use the synergy of the derived hydro physical and hydro biological variables for new models of ocean biomass production, which is a key element in the global carbon cycle and, thus, an essential factor in climate dynamics studies, and the starting point of the marine food web.The work was performed in the framework of the ENVOC (Envisat Oceanography) Project funded by the BMBF .

Abstract No. 630

C- and Ku-band Ocean Geophysical Model Functions under High Winds Conditions

D. Esteban Fernandez[1], E. Kerr[1], S. Frasier[1], J. Carswell[2], P. Chang[3], Z. Jelenak[4], L. Connor[4], P. Black[5], F. Marks[5], X. Zhang[6]

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The University of Massachusetts (UMass), working with the National Oceanic and Atmosphere Administration (NOAA) Hurricane Research Division (NOAA/HRD), the Oceanic Research and Applications Division (NOAA/OA), and the Aircraft Operations Center (NOAA/AOC), participated in the 2002 and 2003 Office Of Naval Research (ONR) CBLAST Hurricane Field Program and the NOAA Hurricane Ocean Winds and Rain Experiment. UMass installed its Imaging Wind and Rain Airborne Profiler (IWRAP) and its Simultaneous Frequency Microwave Radiometer (SFMR) on the NOAA WP-3D hurricane research aircraft. IWRAP is a C- and Ku-band Doppler radar that acquired high-resolution dual-polarized reflectivity and Doppler velocity profiles of precipitation and ocean surface backscatter simultaneously at four incidence angles (approximately 30, 35, 40 and 50 degrees), while conically scanning at 60 RPM. SFMR is a C-band nadir viewing radiometer that measures the emission from the ocean surface and atmosphere simultaneously at six separate frequencies between 4 Ghz and 7 Ghz. It is used operationally by NOAA to provide continuous estimates of the surface wind speed and the column average rain rate. From the missions flown through hurricanes Gustav, Isadore and Lili (2002) and Fabian and Isabel (2003), C- and Ku-band measurements at both HH and VV polarizations of the NRCS of the ocean surface at wind speeds up to 72 m/s were observed. The Geophysical Model Functions (GMFs) in high winds regime at both frequencies and polarizations will be presented for rain-free conditions covering incidence angles from 25 to 55 degrees. These will be compared against the presently used CMOD5 and SeaWinds GMFs. Concrete saturation effects in the NRCS at vertical and horizontal polarization will be shown, and the sensitivity in the wind direction at high wind speed will be discussed through the analysis of the first and second harmonics of the NRCS.

Abstract No. 729

Investigaion of Ocean Surface Streaks with Respect to SAR Wind Retrieval

J. Horstmann, W. Koch

GKSS Research Center, Germany

(not available)

Friday 10 September
08:40 – 10:20
MOZART 4-5

Session 5A1:

Siberia II (1)

Abstract No. 589

SIBERIA-II - Multi-sensor Concept for Greenhouse Gas Accounting in Northern Eurasia

C. Schmullius
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Objectives The main objectives of the EC-project SIBERIA-II are the integration and combination of multi-sensor remotely sensed data and ecological regional models in order to assess the impact of terrestrial biota on the budget of major greenhouse gases (GHGs) in Northern Eurasia and the demonstration of the viability of full carbon accounting (including CO2, CO, CH4, N2O, NOx) using Dynamic Vegetation Models (DVMs) and multi-sensor Earth Observation (EO) instruments. The tools and systems to be employed include a spectrally and temporally diverse set of multi-sensor Earth Observation instruments and detailed existing databases of field information and vegetation models to account for fluxes between land and atmosphere. The prime use for the EO products within this project is to drive and to validate models for C and GHG assessment in the SIBERIA-II test area. Two biosphere process models (Lund-Potsdam-Jena, i.e. LPJ-DVM and Sheffield-DVM) and one landscape-based regional model are used in the project. Scientific achievements Thematic, spatial and temporal requirements for Earth Observation retrieved greenhouse gas accounting parameters have been determined. Operational processing chains using individual Earth Observation sensors have been established to allow assimilation of EO data into the DVMs and the landscape GIS. The SIBERIA-II EO database is installed and is under operational use. The production of surface parameters from EO data is successfully concluded: the development of a Siberian post processing chain for products formerly available from MODIS (land cover, LAI, fAPAR); development/adaptation of retrieval methods to the SIBERIA-II region (MODIS land cover, snow, freeze/thaw, phenology); implementation of new processing chains (fire scar, snow, freeze/thaw, ARD), tests of products and first validation; research for new Envisat products (biomass, wetlands). ConclusionsA tremendous amount of experience has been gained in what surface parameters are crucial for greenhouse gas accounting models and how they can be achieved be Earth Observation. Consensus was found how SIBERIA-II's results already improve greenhouse gas accounting.

Abstract No. 565

Relating Earth Observation to Dynamic Vegetation Modelling in SIBERIA-II

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This paper deals with the use of Earth Observation (EO) data in biosphere process models (the LPJ and Sheffield Dynamic Global Vegetation Models) for Carbon assessment in the SIBERIA-II project. The Dynamic Global Vegetation Models are designed to model the response of terrestrial ecosystems to long-term atmospheric changes in temperature, precipitation and CO2 concentration. A core set of coupled modules represents the interactions of ecosystem carbon and water exchanges with vegetation dynamics, under given soil and atmospheric conditions.The requirements of the Dynamic Vegetation models were examined in terms of compatibility with the thematic, spatial and temporal characteristics of products which can be derived from existing EO data. The EO data sources were selected, taking into account the data availability and continuity, the constraint in spatial and temporal resolution and in the amount of data to be integrated. A large range of EO data provided by visible, infrared, passive and active microwave sensors at various spatial and temporal resolutions are being used. This paper will deal with vegetation phenology, biomass, and snow depth derived from EO data. Emphasis will be put on the contribution of ERS-1/2 and Envisat ASAR data (including InSAR) in providing biomass information.The results show that model calculations attempting to quantify the role of forests as carbon sources or sinks could potentially be improved by exploiting EO products. By making use of the radar-retrieved biomass data, significant deviations between model calculations and ground conditions can be identified. This provides an indication of uncertainty in the calculations, and in the longer term, could be exploited to modify the calculations and reduce this uncertainty.

Abstract No. 600

SIBERIA-II: Earth Observation in a Landscape-Based Greenhouse Gas Accounting Approach

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The regional landscape-ecosystem based Siberian biogeochemical modeling scheme aims at a certified terrestrial biota full greenhouse gas account (FGGA), in order to bridge the gaps in temporal and spatial scales of current modeling of terrestrial ecosystems' biogeochemistry,

incorporate process knowledge into a common framework and allow for future projections. The scheme is based on a relevant combination of in situ measurements (production process, major fluxes, composition and concentration of the atmospheric gases, etc.), parametrization of properties of individual landscapes and ecosystems in the form of a multi-layer GIS, a multi-sensor remote-sensing concept and regional ecological models. The remotely sensed information is a crucial component of the scheme due to (1) the continental scale of the region, (2) large, remote and sparsely populated areas lacking any completeness of data in spatial, temporal and process aspects, (3) the availability of significant areas of rapid changes, and (4) trends and variability of important indicators. However, there are mutual inconsistencies in the capabilities and accuracy of RS sensors, and the needs of biogeochemical modeling, incompatibility of definitions and classifications used by different stakeholders, as well as different requirements for information. Based on experiences from SIBERIA-II, the paper presents a system analysis of requirements to the information used; discusses possibilities of harmonizing definitions and classification schemes taking into account both the specifics and capacity of RS data and interests of different stakeholders; availability of existing RS sensors for parametrising the FGGA; specifics of auxiliary models destined to connect remotely sensed indicators and "hidden" ecosystem parameters; and discusses the possibility to implement a multi-sensor RS concept as part of an operational monitoring system.

Abstract No. 286

Processing of Envisat ASAR Wide Swath Imagery for Derivation of Biophysical Parameters of Siberian Forest - a Contribution of DLR to the Siberia II Project

S. Voigt, A. Petrocchi, M. Huber, A. Roth
German Aerospace Center, Germany

Wide swath imagery of the Envisat Advanced Synthetic Aperture Radar (ASAR) can effectively used to study and map biophysical parameters of the Siberian forest. Using the wide swath (WS) mode of Envisat ASAR large areas, such as the boreal forest regions in Siberia can be mapped easily and repeatedly in comparatively short time. Within this study multi-temporal and multi incidence-angle capacities of the ASAR WS system for deriving forest types and phonological parameters are assessed. For this purpose a processing chain was set up to manage, orthorectify, calibrate and analyse large numbers of WS-imagery in an automated way. The geocoding is based on DLRs EGEO system, deriving highly consistent geometrically corrected imagery as well as incidence angle matrices. The quality of the geocoding results for the WS imagery is compared to imagery of the Shuttle Radar Topographic Mission (SRTM) and compared with other geometric correction schemes. Calibration to backscatter values is implemented according to ESAs standard calibration procedures published for Envisat and is validated against ESAs – BEST Envisat post-processing system. After the applying all the required processing and correction procedures the data is analysed using effects of backscatter changes during multi-temporal observations. These changes result from seasonal environmental changes such as freezing and thawing or more subtle cyclic phenological changes within the forest stands. Above the mutli-temporal studies the capacity of the ASAR system

for multi-incidence angle studies of the backscatter signal over the boreal forest are assessed. First, very promising results could be achieved.

Abstract No. 150

Identification of Wetlands in Siberia with Envisat ASAR WS Data

A. Bartsch[1], C. Pathe[2], A. Shvidenko[3], W. Wagner[2]
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Wetlands present an important land cover class and have multiple functions for greenhouse gas (GHG) accounting. They are an important source for methane and some type of wetlands (peatlands) feature a considerable CO2 sink. Waterlogged conditions and/or seasonal flooding are prepositions for their development, maintenance and determine their regional importance for GHG accounting. The delineation of wetland areas in boreal and subarctic regions is important for the understanding of CO2 and CH4 fluxes. They account for nearly half of global wetland area. Most of these wetlands are related to permafrost conditions not only causing considerable seasonal changes in methane emission but material might become available for decomposition after permafrost melt. Radar remote sensing has been identified as a potential technique for delineation of wetlands due to its capability to monitor changes in water surface area, sensitivity to soil moisture and weather/daytime independency. The Siberia II project area encompasses 3 Mio km2, what shows the need for satellite data in order to cover such a huge area. Multi-temporal Envisat ASAR wide swath data are available for most of the region. Inundation is a key indicator for anaerobic conditions, which are necessary for methane production. Within the study area, snow melt is important for seasonal flooding. Therefore, data from spring (2003 and 2004) are investigated additional to one full annual cycle. In a first step permanent open water bodies are delineated. Further on inundation patterns are analysed. This serves as input for a classification scheme for wetlands under the viewpoint of seasonal water coverage changes. The aim is to provide database input for GHG accounting in the Siberia II area.The results from the RS data were compared with extent and distribution of wetlands derived from the soil and landscape components of the multi-layer GIS available for the region (at scale 1:1 million). Different classifications of wetlands used by different stakeholders were discussed. We attempted to harmonise different definitions/ classification schemes of wetlands aiming at an approach, which would be relevant to both RS sensors capabilities and studying processes of biogeochemistry of high latitude wetlands.

Friday 10 September
08:20* – 10:20
MOZART 1-2

Session 5A2:

Sea Surface Temperature

Abstract No. 209

Comparisons of AATSR-derived Sea Surface Temperature with Estimates from a Geostationary Satellite

I. Barton
CSIRO, Australia

During May and June 2003 the Australian RV Southern Surveyor was operating in the Gulf of Carpentaria, Northern Australia. Measurements of sea surface temperature (SST) were made using the ship's thermosalinograph and a single-channel infrared radiometer. During this period the data from several space-borne instruments were obtained including those from AATSR, ATSR-2, MODIS, AVHRR, AMSR-E, and GLI. Data from a geostationary satellite were also obtained through the Australian Bureau of Meteorology and these have been used to study the diurnal variation of the SST in the uppermost layers of the Gulf. This study gives a valuable insight into the development of techniques for blending satellite-derived SSTs obtained at different times of the day. Low wind conditions are shown to be the most difficult and much care will be needed in future programs (such as GHRSST-PP) in blending satellite and ground-based data into a single SST product. Although the AATSR provides measurements with a narrower swath and less frequently than the other satellite instruments it appears that use of AATSR data may be vital in providing the best near-real-time estimates of global SST fields.

Abstract No. 713

The ATSR/AATSR Data-Set: A Comprehensive of the Climate System

D. Llewellyn-Jones[1], G. Corlett[1], C. Mutlow[2]
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Since the launch of ERS-1 in 1991 the ATSR instruments have been producing high-quality data on a near-continuous basis. The current sensor, AATSR on Envisat is performing as well, and better in many ways, than its predecessors on ERS-1 and ERS-2. The resulting data-set comprises near-continuous well-calibrated and stable measurements of Infrared and visible-wavelength radiances, from which the ATSR SST data-set, already in use to detect global change, is derived. In addition, a wealth of further information can be obtained from (A)ATSR data, concerning climate-related processes in the oceans, our land-surfaces, the atmosphere and ice-cover. Examples of some potential level 3 AATSR products will be shown and their possible application to climate change studies will be discussed. Examples include the spatial and temporal behaviour of the Gulf Stream in observations and in models, which is of particular climatic importance to Europe. Some recent highlights of the scientific achievements which result from the use of (A)ATSR data are briefly

reviewed, together with the potential of the (A)ATSR data-set for future investigations. The plan for its future archiving\and distribution in 'seamless' form will be described. The prospects for continuity beyond Envisat, together with some associated issues, will also be discussed.

Abstract No. 395

Measuring Climate Change Using ATSR Sea-surface Temperatures

S. Lawrence, D. Llewellyn-Jones
University of Leicester, United Kingdom

Global sea-surface temperature is an important indicator of climate change, with the ability to reflect warming/cooling climate trends. The detection of such trends requires rigorous measurements that are global, accurate and consistent. Sea-surface temperature data from the ATSR series of space instruments provide these required attributes. Analysis of ATSR data during the period 1991 to 2000 reveal trends of increasing global temperature with magnitudes of 0.13°C per decade, closely matching that derived from in situ measurements. The methodology By comparing results usin g ATSR data with those from teh AVHRR series, we are able to conclude that satellite sea-surface temperature provides an important means to quantify and explore the processes of climate change.

Abstract No. 27

Comparison of ATSR-1 and ATSR-2 Sea Surface Temperatures During 1995 and Analyses of ATSR-2 SSTs from 1995 to 2000

A. O'Carrol, R. Saunders, J. Watts
Met Office, United Kingdom

Reprocessing of the ATSR-2 Clear-Sea Consolidated Averaged Brightness Temperature (CSCABT) dataset to high quality, high spatial resolution Sea Surface Temperatures (SSTs) from the 2nd ATSR upon the ERS-2 satellite have been completed for the period June 1995 to December 2000. Validation results of these ATSR-2 SSTs against in-situ SST observations and climate SST analyses are presented with additional results from acomparison of ATSR-1 and ATSR-2 SSTs from June - November 1995.

Abstract No. 549

MEDSPIRATION: Delivering a New Generation of High Resolution Sea Surface Temperature Data Products (DUP/DUE)

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The purpose of the Medspiration sea surface temperature (SST) processing system is to fulfil the role of the European regional data assembly centre (RDAC) for the Global Ocean Data Assimilation Experiment (GODAE) High Resolution Sea Surface Temperature Pilot Project (GHRSST-PP). The primary aim of GHRSST-PP is to develop and operate an operational demonstration system that will deliver global coverage SST data products for the diverse needs of GODAE and the wider scientific community, at high resolution (better than 10 km and resolving the diurnal cycle) and within a short interval (~24 hours) from real-time acquisition. In parallel with RDACs serving other parts of the world, Medspiration will produce in near real time a new generation of SST data products for Europe, based on the combination of existing SST products from both infrared and microwave radiometers (nominally level 2 although some are level 3) already being generated and served by several different agencies. The ingested SST data are referred to generically as L2 SST inputsThe function of the Medspiration processing system is threefold: 1. To generate specific combined SST products in near-real time and to serve them to the GDAC and to European operational ocean models.2. To populate an off-line archive in which to curate them.3. To provide a data product dissemination service for all types of users.This presentation reviews the progress of the Medspiration project over the last year.

Friday 10 September
08:40 – 10:20

DOPPLER

Session 5A3:

Future Earth Observation Mission (1)

Abstract No. 720

ESA Third Party Missions Programme

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ESA/ESRIN, Italy

Most EO data users rely on several EO missions, both to increase sustainability of their service and to widen the range of observation parameters. In addition to its own missions such as ERS, Envisat and the Earth Explorers, ESA therefore offers access to the scientific and applications community to so-called 'Third Party Missions'. Third Party (TP) missions are complementing the observations of ESA missions, are used to prepare for future ESA missions including cross-calibration and create synergy to favor a wider use of EO data within ESA Member States. As part of the EARTHNET Programme ESA regularly investigates the benefits of individual Third Party Missions as part of the EO data portfolio offered to European Users through the Multi-Mission User Services. The EARTHNET service offers a single point of access for the European User community and establishes the international agreements with external Agencies/ Operators. Furthermore ESA aims to co-ordinate and standardize the generation of products from ESA and TP missions for European use, this becoming even more important in the context of the Oxygen process on ground segment harmonization and the GEO initiative. The current selection/de-selection mechanism for TP missions was established some years ago. Meanwhile, newly evolved user requirements through programs such as GMES and operational EO based services, together with technological development and altered data accessibility via ground links, demand for a revision of this selection procedure. A new selection procedure, new international agreements and the evolution in the European Ground Segment Infrastructure offer the possibility to widen the data access to new missions. The paper gives an overview of current and potential future ESA TP Missions and the new selection procedure and criteria to be applied.

Abstract No. 728

Fluctuations of the Earth's Ice Fields: the Contribution of the ERS and CryoSat Missions

D. Wingham
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Fluctuations in the ice mass of the Northern and Southern Hemispheres may have profound effects on Earth's climate and on global sea level. The North Atlantic overturning circulation is thought to be sensitive to the freshwater forcing of the Greenland-Iceland-Norwegian (GIN) seas, and half of this forcing is provided by the wind-driven transport of fresh sea ice from the Arctic Ocean. Numerical models predict that warming of the Arctic, amplified by a change in albedo, may lead to the almost complete destruction of the perennial Arctic ice, with uncertain implications for the North

Atlantic overturning circulation and relatively warm, European winters. In the Southern Hemisphere, the Antarctic ice sheet contains some 90% of the Earth's freshwater. Fluctuations of only 1% in its mass would alter global sea level by 70 cm. As recently as 1995, detailed knowledge of the fluctuations in the Earth's ice mass was lacking. It was possible to argue that the Antarctic ice sheet was anything from a 600 Gt/yr sink to 600 Gt/yr source of ocean mass (+/- 1.6 mm/yr eustatic sea level). A picture of secular Arctic ice decline could be constructed from sparse submarine records, but these could be equally explained by advective redistribution of ice within the Arctic. Almost nothing was known of inter-annual Arctic ice variability at the basin scale. In this context, it is no exaggeration to state that the ERS missions have in one decade advanced our knowledge of the present-day large-scale fluctuations of Earth's ice mass further than the accumulated ground observations of the previous 50 years. It is now established, on the one hand, that the East Antarctic ice sheet is extremely stable. On the other hand, the Pine-Island and Thwaites drainage basins of West Antarctica are losing mass to the oceans. A combination of the satellite measurements, *in-situ* ocean measurements and ice dynamic modelling is making clear that the trigger for this mass loss is thinning of the ice shelves due to melting at their base. These results have important implications: to date, the IPCC has not considered the implications for Antarctic ice mass of heat from low latitudes arriving at depth in the ocean. In the Arctic, ERS altimeter observations have revealed that basin-wide, inter-annual fluctuations of sea ice mass may reach 25% of the total mass. Further, they have shown the dominance of thermodynamics over dynamics in controlling the fluctuation, with the important conclusion that global, coupled models of ice evolution must capture the details of the summer melt-season. Important as these advances are, there remain significant gaps. Fluctuations at latitudes higher than 82 degrees are unknown today, which includes the dynamically important Ross Sea Ice Shelf ice streams and 17% of the Antarctic ice sheet margins. The region of sea ice divergence around the North Pole is also unsurveyed, and the present measurements of sea ice fluctuations are too coarse for detailed studies of interactions between the ice and, for example, the wind forcing. Filling these gaps is the purpose of the CryoSat mission, which has two advantages over its predecessors: it has a 92 degree inclination, providing almost complete coverage of the ice sheets, and it has a high resolution (1 km) altimeter that will provide coverage of the Antarctic ice sheet margins, and provide a high density of sea ice thickness measurements. In this paper, we will describe the objectives of the CryoSat mission in the context of the achievements of the ERS missions.

Abstract No. 334

TerraSAR-L Product Philosophy

M. Zink
ESA/ESTEC, Netherlands

The TerraSAR-L system, currently being designed in a Phase B definition study, will provide ESA with its most powerful radar-imaging programme to date. Specification of the L-SAR has been guided by careful analysis of the product requirements resulting in a robust baseline design with considerable margins. L-band SAR provides key contributions to global seismology research and terrestrial carbon cycle research. Major application areas are: Kyoto inventory and wetland

monitoring, solid earth science including seismic and volcanic activity as well as land slides and subsidence, land cover classification in different levels of detail and marine applications like shallow water bathymetry and retrieval of wave spectra. The TerraSAR-L operations strategy is based on a long-term systematic and repetitive acquisition scenario to ensure consistent data archives and to maximise the institutional and scientific exploitation. This operations strategy is complemented by a systematic processing of all acquired data to calibrated Single-look Slant-range Complex (SSC) products to facilitate higher-level product generation and services based on these products. A flat basic product tree, containing SSC products only in all modes, enables a modular SAR processor design using for most processing steps the same complex product generation algorithms independent of the instrument's operational mode. Such a design simplifies and reduces the effort for SAR processor development and maintenance. If required for higher-level processing, detected and/or ground range projected images can be generated from the SSC products using stand-alone tools.This paper describes the TerraSAR-L basic product tree and explains the rationale behind. The nominal TerraSAR-L imaging modes are introduced and their major performance characteristics – as far as they influence the complex product performance – are described. The generation concept for multi-look detected products in various projections based consistently on complex products – generated either at an intermediate stage during ground segment processing or serving as input product in a stand-alone tool – is presented.

Abstract No. 721

The Scientific Use of TerraSAR-X

A. Roth

German Aerospace Centre DLR, Germany

TerraSAR-X is a new German radar satellite that shall be launched in April 2006. It carries a high frequency X-band SAR sensor that can be operated in three different modes and polarization. The Spotlight-, Stripmap- and ScanSAR-modes provide high resolution images for detailed analysis as well as wide swath data whenever a larger coverage is required. Imaging will be possible in single, dual and quad-polarization. TerraSAR-X will be an operational SAR-system for scientific and commercial applications. The German Aerospace Center (DLR) will implement a satellite control system and a payload ground segment for receiving, processing, archiving and distribution of the X-band SAR data. DLR will also be responsible for the scientific use of the TerraSAR-X data, the instrument calibration and the 5 years of operation. The commercial exploitation will be task of the Infoterra GmbH. TerraSAR-X will allow multi-temporal, seasonal and long term observations. Additionally it has a high synergy potential with the frequency bands of other spaceborne systems like TerraSAR-L and ALOS-PALSAR (L-band) as well as Envisat-ASAR and Radarsat-1/2 (C-band). Innovative and unique features with respect to spaceborne systems are the high geometric (1m-25m) and radiometric resolution together with the single, dual and quad-polarization capability. Beam steering enables observation in different incidence angles and double side access can be realized by satellite roll maneuvers. The satellite will be positioned in a 11 days repeat orbit. Scientists will get access to TerraSAR-X data through an Announcement of Opportunity procedure. The call will be opened approximately one year before the launch. After the launch further proposals

can be placed at any time via a web interface. A priority scheme will be implemented to reduce conflicts and to ensure the equal share between the commercial and scientific users of the satellite tasking time. Focus of the proposed presentation will be the scientific potential of TerraSAR-X and the procedure on how scientists will get access to the data.

Abstract No. 725

ALOS Science and Application Programme

M. Shimada
EORC, Japan

Advanced Land Observing Satellite (ALOS) is the JAXA's next high-resolution earth observation satellite which carries PRISM, 2.5 meter three triplet panchromatic optical sensor, AVNIR-2, 10 meter cross track pointing Multispectral sensors, and PALSAR, L band synthetic aperture radar. ALOS will be launched near future and be injected into 695 km-altitude sun-synchronous 46 day-recurrent cycle orbits. Supported by the data storage of High Storage of Solid State Memory (HSSM), power allocation by the satellite, and availability of the data relay satellite, the PALSAR can observe the Earth surfaces globally and regionally with higher resolution, higher revisit cycle, longer observation capability, and multiple polarization, than its mother sensor, the JERS-1 SAR. These enhanced functions may powerfully assist the Earth science and the Earth monitoring. Calibration of the three sensors is essential to ensure the sensor characteristics and the qualities of products and the research products that will be generated at the EORC. NASDA/EORC will generate the research products (including high level products) to demonstrate the ALOS data utilization activity. They are the digital elevation model, Orthographically rectified SAR data, the global surface deformation map, and global sigma-zero maps for the global forest monitoring, disaster monitoring, sea-ice distribution, soil moisture map, and so on. Validation of these products is important for assuring the accuracies. As a scientific demonstration program, JAXA issued the research announcement worldwide, 1999, and we have selected 167 PIs. In order to strengthen the scientific activity in each continent scale, we will issue the NODE oriented AO. This paper introduces the ALOS science and application program, which will be conducted by JAXA and collaborative agencies.

Friday 10 September
08:40 – 10:20
MOZART 3

Session 5A4:

Wind and Wave / Sea State (1)

Abstract No. 523

A Simplified SAR Ocean Wave Spectrum Inversion

B. Chapron[1], F. Collard[2], F. Ardhuin[3]
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[2] *BOOST Technologies, France*
[3] *SHOM, France*

In this presentation, we shall discuss a simplified ocean wave spectrum inversion from Envisat ASAR data. The goal is to extend the present ESA retrieval algorithm developed for Wave Mode products to others modes, i.e. narrow as well as wide swath ASAR images, as well as to possibly improve the current scheme. As already demonstrated, the use of single look complex products enables to retrieve the Doppler information. This helps to partition the along-track coherent slow-time integration to resolve the same spatial ocean scene at different time. This provides an elegant means to reduce incoherent noise effects and to determine the imaged wavy pattern propagation direction. However, this does not help to reduce the ocean surface motion impact on the SAR image formation. Consequently, typical SAR ocean scenes under moderate to high wind conditions systematically exhibit very large azimuthal correlation lengths. This effect is known and strongly reduces the SAR imaging mechanism to provide direct valuable spectral information in the along-track direction. In this presentation, we will propose a new approach to minimize such a negative effect. Tests will be shown using both global Wave Mode products and local SAR image products over coastal areas.

Abstract No. 495

Mesoscale Flow Variability in Tropical Storms Using SAR Imagery

H. Graber[1], S. Lehner[1], M. Donelan[2], F. Monaldo[3], D. Thompson[3]
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[2] *JHU/Applied Physics Laboratory, United States*

CSTARS is capable of receiving and processing radar data from three different space-borne SAR systems: RadarSat-1, ERS-2 and Envisat ASAR. All three SARs operate in C-band, but have different imaging modes and spatial resolution as well as polarization options. For the last several years, there has been increasing interest in obtaining high-resolution (sub-kilometer) marine wind speed measurements from SAR imagery. The need for higher resolution wind fields in frontal systems and tropical storms cannot be obtained with wind fields measured onboard conventional space-borne satellites such as scatterometers (e.g., QuikSCAT, WindScat) or passive microwave radiometers (e.g., SSM/I, WindSat). These sensors are best suited for global measurements, because with 25-km spatial resolution many important high-resolution spatial phenomena are missed.A better understanding of hurricane intensities and wind speed variability in the inner core and eye

wall regions are of great interest to scientists, the weather forecasting agencies and ultimately the general public. Presently most detailed information about hurricane dynamics and characteristics are obtained from dedicated flights by hurricane hunter airplanes. These flight missions cannot always take place and when multiple tropical cyclones are present, limited resources prevent the acquisition of adequate measurements to characterize the cyclonic structure. Satellite remote sensing provides a critical alternative approach to acquire data for improved and timely characterization and forecasting of surface winds associated with tropical cyclones and hurricanes. Critical for weather forecasters is to obtain reliable characterization of the eye wall dimension and the radii of gale, tropical storm and hurricane force winds. This information will allow better understanding of the evolution and intensification of hurricanes.This study will use high resolution wind fields from SAR to study mesoscale and small-scale features in tropical and extra-tropical cyclonic systems. The spatial variability and asymmetry of wind distribution in tropical cyclones will be quantified using recently acquired and historical data of tropical storms and hurricanes.

Abstract No. 696

Exploiting Envisat-ERS Data for Deriving Air-Sea Fluxes of CO2

J. Aiken[1], N. Hardam-Mountford[2], S. Ufermann[3], D. Woolf[3], P. Challenor[3], I. Robinson[3]

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EO sensors on Envisat and ERS are targeted at the air-sea interface, providing measurements of sea surface properties that are precisely the data needed to derive air-sea interactions and the fluxes of CO_2, which is the major currency in determining the ocean component of the global carbon cycle. Despite volumes of data obtained over recent decades, EO sensors have not yet fulfilled the needs of Earth system science, in the context of the carbon cycle and climate change. Air-sea fluxes of CO_2 are driven by physical, chemical and biological processes often separated in time and space; the solubility and ecological conversion of CO_2 into the ocean is a rapid process (time scale of a few days) but the re-equilibration (time scale of ~100 days) may be displaced several hundred kilometres from the sink, because of ocean circulation. High resolution, 3-D circulation models with coupled biological processes (carbon cycle) are needed to compute CO_2 fluxes over ocean basins and shelf seas. The shelf seas are extremely heterogeneous spatially and seasonally; though only 10% of the ocean surface may account for about 30% of ocean productivity. They are the recipient of many Gt of terrestrial carbon, through riverine sources, yet it is unknown which areas are sources or sinks or the net flux. With a severe paucity of pCO_2 data and no seasonal studies, modelling is currently the best method to derive air-sea fluxes. A main goal of CASIX is to derive CO_2 fluxes by assimilating EO data into coupled circulation-ecosystem models: Sea Surface Temperature (SST, from AATSR) and Sea Surface Height (SSH from altimetry) as a measurement of sea surface physical structure and circulation, ocean colour (from MERIS) as a measurement of ocean biology (phytoplankton biomass and productivity) and sea surface roughness (ASAR, RA2) as a parameterisation of air-sea gas exchange. The modelling provides simulated fields of phytoplankton biomass and productivity from which CO_2 concentrations, pCO_2 and air-sea fluxes of CO_2 are derived. Examples and progress are

shown. In the short term we can produce an improved CO_2 flux climatology by incorporating EO data and in situ measurements. Optimal interpolation techniques are used to effectively combine the various parameters influencing air-sea gas exchange, including wind speed and wind speed variability, sea surface temperature, sea surface salinity, sea surface roughness and the gradient of CO_2 partial pressure across the air-sea interface. We explore how global and regional CO_2 flux calculations respond to the use of data from different sources and to different parameterisations of the gas transfer velocity. We use traditional parameterisations relying solely on wind speed and then investigate new approaches based on parameters more directly available through remote sensing such as sea surface roughness. Time series over the last 20 years are used to study inter-annual variability on global and basin scales.

Abstract No. 330

Impact of Envisat Alternating-polarization Mode Imagery on Rough-surface Scattering Models and the Generation of High-resolution Wind Maps

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[4] *CNRS, France*

During the summer of 2003, we have obtained synthetic aperture (SAR) imagery over the Mid-Atlantic Bight area off the US east coast to complement in situ and airborne measurements collected as part of an ONR-sponsored directed research initiative known as Coupled Boundary Layer Air-Sea Transfer (CBLAST). Between 26 July and 31 August, we have obtained more than 20 Envisat alternating-polarization (AP) mode SAR images as part of an ESA data grant. These AP images along with the in situ measurements from CBLAST are extremely useful for examining the polarization dependence of C-band scattering from the ocean. For the last several years, there has been increasing interest in obtaining high-resolution wind estimates from SAR imagery. A crucial element of these SAR wind-mapping techniques is accurate knowledge of the relationship between normalized radar cross section and wind velocity. In particular, stringent testing of the geophysical model function (GFD) used for producing wind maps from RadarSat-1, which operates at Cband HH-pol, has until now not been possible. Using Envisat AP mode imagery and the extensive availability of ground-truth measurements available from CBLAST, we are presently assessing the wind-mapping potential of the AP-mode imagery at both HH- and VV-polarization. As part of this assessment, we hope to determine whether a more robust retrieval technique that utilizes a combination of polarizations may be possible.In recent years, it has become apparent that as the incident angle increases from nadir, the ratio of the backscattered power for microwave scattering from the ocean surface athorizontal to that at vertical polarization (HH/VV) becomes larger than that predicted by standard rough-surface scattering models. Although predictions by models that include the effects of long-wave tilt and hydrodynamic modulation yield some improvement, they still under-predict significantly the polarization ratio. Besides its practical application for high-resolution wind mapping, we believe that the Envisat AP-mode imagery offers a unique opportunity to

examine in detail the C-band polarization ratio as a function of look geometry and environmental conditions, and ultimately to improve our understanding of C-band backscatter from the ocean surface. Current progress in understanding the polarization ratio for C-band scattering from the ocean as well as the more practical application of high-resolution wind mapping, both made possible through the use of Envisat AP-mode data, will be reported in this presentation.

Abstract No. 64

Multi-polarisation Ocean Radar Cross-section from Envisat ASAR Observations, Airborne Polarimetric Radar Measurements and Empirical or Semi-Empirical Models

A. Mouche[1], D. Hauser[2], V. Kudryavstev[3], J. Daloze[2]

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[2] *CNRS-CETP/IPSL, France*

[3] *NIERSC, Russian Federation*

Wind estimates from SAR observations of the ocean are presently based on empirical relationships between the Normalized Radar Cross-Section (NRCS) and wind. The well-known empirical C-MOD type models have been originally established for the ERS scatterometer data analysis, in VV polarization and for incidence angle range from 18 to 55°. C-Mod models are now applied for SAR analysis of ERS, Envisat and RADARSAT, but when used in HH they need to be corrected for the ratio between HH and VV backscattering. This ratio is still poorly known and this may induce important errors in the wind estimate. Moreover, the accuracy of these models at moderate incidence angles (15-20°) has to be assessed.Models based on physical background also exist and rely on the description of the ocean surface (wind wave spectrum) combined with a model of backscattering. Different levels of complexity exist in such models and empirical constants in these models have usually to be fitted trough comparison with radar observations.. One of the most recent models of this kind has been developed by Kudryastev et al (JGR, 2003). Its originality is that it takes into account the effect of breaking waves in the backscattered signal and has been shown to be in agreement with the observed behavior of the NRCS polarization ratio (VV/HH) as a function of radar frequency, incidence angles, wind speed and wind direction. The validation has been done however on a limited data set.New data have been collected in 2002 in the context of the Envisat ASAR geophysical validation exercise supported by ESA. During the experiment, called VALPARESO, data have been acquired by the French airborne polarimetric C-Band radar STORM, in coordination with Envisat data acquisition over the near Atlantic off the coasts of Brittany (France). In situ measurements of wind and waves are also available for comparison. By analyzing the STORM data set (16 different situations) we have obtained new information on the behavior of the polarization ratio between 10 and 50° incidence as a function of wind speed, wave conditions, incidence and azimuth angles. During this conference, we will present these results, as well as comparisons with polarization ratio from 2 ASAR images, with results existing in the literature, and with the results of the model of Kudryavstev et al (2003). An improved version of this model will also be proposed to better represent the radar cross-section at small and moderate incidence angles and to take into account the impact of wave conditions (wave age, swell).

Friday 10 September
10:50 – 12:30
MOZART 4-5

Session 5B1:

Siberia II (2)

Abstract No. 585

Development and Validation of a Diurnal Difference Indicator for Freeze-thaw Monitoring in the Siberia II Project

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Vienna University of Technology, Austria

At high latitudes the length of the growing season is relatively short and is greatly impacted by the interannual variability of the onset of thawing. This seasonal transition from frozen to non-frozen conditions is a major factor that coincides with the Siberian regions seasonal switch from a net source to a net sink of atmospheric carbon.The high temporal dynamics of freeze-thaw events require that any sensor used to monitor them must operationally provide data with a high temporal coverage and a reasonable spatial resolution. Research with the ERS-1/2 Scatterometer (C-band) and the NSCAT (Ku-band) has shown that scatterometers are well suited to monitor freeze-thaw events. Their measurements are sensitive to changes in the state of freezing and the associated changes in the backscattering mechanisms. Sudden observed changes in backscatter intensity during the spring thaw period are related to a change of the scattering mechanism from volume to surface scattering (wet snow, surface water).In the scope of the SIBERIA II project a processing chain has been developed and is operationally used for the extraction and re-gridding of backscattered measurements acquired from SeaWinds Ku band scatterometer. The extracted data is reformed into time series that are allocated to unique, regular, grid points across the project area. In the development of the diurnal difference indicator it is important to study and understand the physical processes involved in the dynamics of backscatter time series. In order to achieve this accurate information relating to the earth surface and its condition is required.In this paper we present the diurnal difference indicator derived from QuikSCAT time series and show the role of Envisat and MODIS data within its development and validation.

Abstract No. 415

SIBERIA-II: Using MERIS to Derive Land-cover Information

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The IGBP, UMD and GLC2000 products demonstrate the potential land-cover information which may be derived from medium-resolution optical sensors. These results have allowed an unprecedented view of the global system and have found use in a variety of applications. However, the spatial heterogeneity of land-cover types in some regions is significantly smaller than the kilometer resolution data used by these products. This may lead to a reduction in the thematic accuracy of the final classification since individual pixels will contain a variety of land-cover types. Furthermore, interpretation of the 'hard' classification result is complicated in these areas.

Consequently, the spatial resolution of the data used to derive land-cover may limit the results which are obtained. The MERIS sensor provides the opportunity to derive global land-cover information at a spatial resolution of 300m. The main focus of this paper is upon presenting the methods used to derive such results over the Siberia region (as part of the SIBERIA-II project). The results presented indicate the significant role that spatial resolution plays in the overall classification process. However, the MERIS spectral bands (15 bands in the visible and near-IR spectrum) are not optimal for land-cover mapping applications. In particular, the lack of a short-wave IR band may reduce the ability to discriminate between various vegetation and forest classes. Therefore, any assessment concerning the advantages in using the higher resolution data must also account for the possible disadvantages of the spectral bands available.

Abstract No. 597

SIBERIA-II: Monitoring Forest Cover Changes in Siberia by Means of Spaceborne Data

M. Santoro[1], H. Balzter[2], C. George[3], F. Gerard[3], S. Hese[1], M. Roscher[4], C. Rowland[3], C. Schmullius[1]

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The boreal forest contains almost half the total carbon pool of world forest ecosystems, and so has a very significant role in global biogeochemical cycles. The flux of greenhouse gases in and out of these forests is influenced strongly by changes in forest cover due to disturbances (e.g. insect outbreaks, diseases, logging, pollution and fire) and reforestation. In this paper we report on the monitoring of forest fire disturbances, pollution effects and Af-Re- Deforestation (ARD) activities by means of spaceborne optical and SAR data. These activities are part of the SIBERIA-II project. Main objective of the fire disturbance and the ARD activities is to obtain input layers in biosphere models for greenhouse gas accounting. The burnt area study quantifies the areal extent and temporal distribution of forest fire disturbances from 1992 to 2003 for different forest types in Central Siberia over an area of about 3 million km2. The time period investigated is of a particular interest because of the observed acceleration of fire in boreal Russia from 1996 through 2003. Fire scars were mapped using satellite imagery from SPOT-VEGETATION and MODIS acquired in 1999, 2002 and 2003, utilising various vegetation indices. The fire scars were then dated with thermal anomaly 'hotspot' data to provide yearly burnt area statistics. The results of some preliminary cross-comparisons of the fire scar map with ASAR data are also presented.The effects of pollution have been investigated in the area of Noril`sk where vegetation is mainly influenced by severe climate conditions and enormous emissions from copper and nickel plants. A temporal sequence of ASAR images from 2003 were used to map pollution damage, and the results compared to previous studies which used Landsat TM images from 1995 and 2002. It was shown that ASAR can detect pollution damage, and that the extent of the damage had not changed significantly since 1995.ARD monitoring intends to analyse forest cover changes and create ARD classes for the biosphere models. Multi-temporal classifications are performed comparing the 1989 Kyoto baseline with the status in 2000 for test territories with extensive ground truth information from forest inventory. This

is achievable by means of optical data only, as spaceborne SAR data over the project area cover a shorter temporal interval. ARD monitoring is based on high resolution Landsat TM 5 and ETM data at four test territories. Pixel based neural network classification strategies are able to detect forest cover changes but not to differentiate human induced clear cuts from old fire scars. With an object oriented change detection approach based on a primary segmentation this problem is solved. ERS SAR data from 2000 is currently being considered as additional layer to the classification scheme. Further investigations concern classification algorithms based on simple thresholding of multi-temporal ERS and ASAR data.

Abstract No. 571

Assessment of Envisat/ASAR Data for Forest Observations in Siberia

T. Le Toan[1], A. Wiesmann[2], J. L'hermitte[1], L. Eriksson[3], M. Grippa[1], U. Wegmüller[2], C. Schmullius[3]

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[2] *Gamma Remote Sensing Research and Consulting AG, Switzerland*

[3] *Friedrich Schiller University, Germany*

This paper investigates the use of Envisat/ASAR data for deriving forest information over the Central Siberia region located from 50° to 70°N and 85° to 105°E. The whole coverage of the region in Image mode for repeat pass interferometry is available in December, January and February 2003-2004. Longer temporal series of narrow swath alternating polarisation data (HH and HV) at low and high incidence angles have been acquired in 2003-2004 at a number of test sites in the region. The multitemporal backscatter intensity at different polarisations and incidences and the 35-day repeat pass interferometric coherence are analysed using Landsat quicklook and the GIS database available in the Siberia-II project.The temporal, polarisation and angular behaviours of the backscattering coefficient of different land cover and forest types suggest that (a) HV is more adapted to forest/non forest mapping, (b) the temporal variation is indicative of different surface types, (c) the seasonal effect is significant in this region where winter temperature is very low.Recently published results show that repeat-pass coherence from the L-band SAR can give forest information if the acquisitions are made during stable winter conditions. In this project, we investigate the information content of the C-band repeat pass interferometric coherence in Siberia. The coherence estimation was done with an adaptive window size taking into account phase slope, texture of the averaged backscattering coefficient and the local coherence level. The initially processed repeat-pass coherence shows relatively high values. Work is underway to analyse the coherence with respect to land cover types and forest biomass level. The results using ASAR intensity and coherence data are evaluated to determine the best ASAR measurement for mapping of the broad surface types (water, bogs, grasslands, agriculture, forests) and for mapping of low/high forest biomass.

Abstract No. 602

SIBERIA-II - Multi-product and Multi-sensor Validation Strategies in the Context of GLOBCARBON, GLOBCOVER and GOFC-GOLD

C. Schmullius[1], H. Balzter[2], S. Plummer[3]
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[3] IGBP, Italy

A major task of SIBERIA-II is the accuracy assessment and validation of all algorithms and the products used for greenhouse gas accounting. The term accuracy assessment is widely used with varying definitions. A rigorous definition is that accuracy quantifies the systematic error (bias) between a measurement or estimate and the true value. Precision is defined as a measure that quantifies the random error of a measurement or estimate, i.e. the random deviation of the measurement from the true mean. Both error types have effects on the full greenhouse gas accounting (FGA). The SIBERIA-II project agreed on an overall accuracy assessment policy, a set of statistical techniques to be employed, and the setting up of an extensive test area network. This presentation describes the spatial, temporal and spectral characteristics of all EO products, and identifies the main error sources. SIBERIA-II's results are being validated with one of the largest and up-to-date ground truth data bases existing, a GIS which contains 70 test areas distributed over 7 bio-climatic zones for a region with over 3 Mio sqkm. Each test area ranges from 40,000 to 150,000 ha and includes 700 to 7,000 primary land cover polygons. Therefore, SIBERIA-II's validation is of high relevance to other large-scale projects and programmes.GLOBCARBON will develop a service to generate fully calibrated estimates of at land products quasi-independent of the original Earth Observation source where that source is the data provided by ESA Earth Observation satellites plus a number of other sensors that are synergistic with those systems. The service will focus on development of a system to generate global estimates of the following: Fire - location, timing, area affected fAPAR and LAI Vegetation growth cycle - timing, duration, spatial and temporal variability The system will focus initially on six complete years, from 1998 to 2003, when overlap exists between the VEGETATION and ERS-2 (ATSR-2) systems (from 1998) and VEGETATION and Envisat (AATSR, MERIS). However because the objective is to develop a flexible service that is not dependent on any single satellite system, other sensor systems can be introduced e.g. MODIS, AVHRR, MSG and therefore the processing system can be retrospectively applied to existing archives and used with future satellite systems. The objective of the GLOBCOVER initiative is develop a service that in first instance will produce a global land-cover map for the year 2005, using as main source of data the fine resolution (300m) mode data from MERIS sensor on-board Envisat satellite to be acquired over the full year 2005. The service will be developed in a way that any further update of the global land cover map will be at recurrent cost to run the developed system. This new product is intended to update and to complement the other existing comparable global products, such as the global land cover map at 1 km resolution for the year 2000 (GLC- 2000) produced by the JRC. It is also expected to improve such previous global products, in particular through a finer resolution (300m). The thematic legend of the final product is intended to be compatible with the FAO Land Cover Classification System (LCCS). The initiative includes a validation phase similar to the GLC-2000 validation exercise.Global Observation for Forest and Land Cover Dynamics (GOFC/GOLD, www.fao.org/gots/gofc-gold/networks.html) is a coordinated

international effort working to provide ongoing space-based and in-situ observations of forests and other land vegetation cover types, for the sustainable management of terrestrial resources and to obtain an accurate, reliable, quantitative understanding of the terrestrial carbon budget. GOFC/GOLD is being implemented through a suite of well-considered pilot projects. Each project must provide useful information to identified user communities with clearly stated requirements, and must be achievable using proven technology, even though a fully integrated system may not yet exist. Through these projects, data providers and users benefit from increased communication, and the expansion of technological capabilities. GOFC/GOLD has involved the users in the design of these activities in order to ensure adoption by the operational agencies at the completion of the pilot phase. Since February 2004, ESA has established a Landcover Project Office at the Friedrich Schiller University (FSU) Jena.

Friday 10 September
10:50 – 12:50
MOZART 1-2

Session 5B2:

Atmosphere Assimilation

Abstract No. 24

Monitoring and Assimilation of Envisat data at ECMWF

A. Dethof
ECMWF, United Kingdom

ECMWF takes part in the Envisat cal/val activities by routinely monitoring near-real retrievals from MIPAS and SCIAMACHY. While SCIAMACHY total column ozone data, and MIPAS temperature and water vapour profiles are monitored passively, ozone profiles from MIPAS have been actively assimilated in the operational ECMWF assimilation system since October 2003.This talk presents results from the monitoring and assimilation activities of MIPAS and SCIAMACHY data at ECMWF. We will show that the assimilation of MIPAS ozone profiles has a positive impact on the ECMWF ozone field, and how the monitoring of MIPAS temperature profiles helped to improve the assimilation of AIRS radiances.

Abstract No. 58

A New 4-Dimensional Variational Assimilation System Applied to Envisat MIPAS and SCIAMACHY Observations

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Satellite data from space borne platforms such as Envisat and others provide unique possibilities of global measurements of stratospheric trace gases. To make optimal use of this data, that is scattered in time and space and that originate from different sensors, a data assimiation system with the ability to produce chemical consistent synoptic charts of stratospheric constituents is needed. Advanced spatio-temporal data assimilation methods provide a powerful technique to combine observations, statistical information, and three-dimensional chemistry circulation models delivering a "Best Linear Unbiased Estimate" (BLUE) of the stratosphere's chemical state.A four-dimensional variational (4D-var) data assimilation system intended for operational application is being developed by the AFO-2000 project consortium SACADA. Kernel of this new system is a novel stratospheric global chemistry circulation model (GCCM) and its adjoint version, using the icosahedral discretisation scheme of the German Weather Service global forcast model (GME). While the GME serves as an online meteorological driver for the GCCM, the icosahedral grid structure, the horizontal transport and the parallelisation strategy are adopted from GME. The stratospheric chemistry module accounts for 148 gas phase and 7 heterogenous reactions between 43 stratospheric constituents. As a first application of the new system, Envisat MIPAS and SCIAMACHY data have been assimilated for selected periods. It can be demonstrated that the assimilation procedure gains a considerable improvement over legacy model runs, as the discrepancies between observations and the model are significantly reduced, while chemical consistency is maintained by the computationally costly, but

efficient 4D var technique. At the same time it is possible to improve the knowledge of species which are not directly observed, as can be shown by means of experiments with artificially generated data sets or by excluding some observational data from the assimilation procedure for later validation of the analysis. As will be demonstrated the numerical concept of the system - namely the icosahedral grid and the parallelisation that are adopted from GME- results in considerable efficency gain compared to systems of conventional design.

Abstract No. 69

Assimilation of Ozone and Water Vapour into the Unified Model

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DARC, United Kingdom

The Data Assimilation Research Centre (DARC) is creating assimilated datasets of ozone and water vapour in the stratosphere as part of the EU project ASSET (ASSimilation of Envisat daTa). The assimilation system is a variant of that used to produce operational Met Office stratospheric analyses, which uses 3d variational assimilation (3d-var) to assimilate data into the Unified Model. We assimilate temperature, ozone and water vapour from the MIPAS instrument, alongside the operational datasets. Bringing together observations and models reveals the strengths and weaknesses of both.This talk will focus on two aspects: (1) the inclusion of photochemistry in the Unified Model to assimilate ozone, and (2) the challenges in assimilating water vapour in the upper troposphere and lower stratosphere region. To illustrate these aspects, examples of how the ozone and water vapour analyses and observations are evaluated will be presented.

Abstract No. 305

Assimilation of Envisat Products for Continuous Monitoring of Atmospheric Trace Gases - First Results from EVIVA

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EVIVA contributes to the main objectives of the Envisat program, since it focuses on exploiting new capabilities for an enhanced continuous synoptic monitoring system for atmospheric trace gases and aerosols. EVIVA aims at providing operational and coherent global data sets and analyses of conservative and reactive species that are requested by the scientific community and governmental authorities. Such data is a valuable source for studying atmospheric dynamics, chemistry and trends as well as validating results of coupled chemistry-climate-models to name a few. Furthermore, analyses of the stratospheric column are crucial when deriving tropospheric levels and emissions from nadir observations by the residual technique.To derive global chemical analyses data

assimilation methods and chemical-transport- modelling are systematically applied to ESA Level 2 products from MIPAS, SCIAMACHY and GOMOS in near-real time and offline. Here two approaches are pursued: Sequential data assimilation and a 4D-Var system.For all operational applications currently a sequential assimilation scheme based on the 3D-CTM DLR-ROSE is used. This results in global 3D analyses of heterogeneously distributed SCIAMACHY and MIPAS observations with focus on stratospheric ozone and ozone related species (chlorine, bromine, hydrogenic and nitrogenic components). All relevant dynamical and chemical processes and retrieval errors are included. In order to gain chemical consistent analyses observations of conservative species only are considered. For the assessment of the different chemical dynamical contributions, in addition, analyses of the reactive species like ClO and the main reservoir gasses linked to ozone are made. We present results and comparisons with ground based and other satellite borne data.Currently a 4D-Var data assimilation scheme is developed within the German AFO 2000 project SACADA. The objective of SACADA is the development of a comprehensive and efficient chemical data assimilation system for the synoptic analysis of chemical constituents for routine operation at DLR. All available SCIAMACHY, MIPAS and GOMOS observations of reactive and conservative trace gases will be synergistically assimilated into the 4D-Var system SACADA.All data is processed and archived within the Data Information and Management System DIMS at DLR-DFD with direct access to D-PAC. All products are provided to the scientific community and public users via the World Data Center for Remote Sensing of the Atmosphere (http://wdc.dlr.de). A toolbox is provided for exploiting the EVIVA data products.

Abstract No. 511

Climatology and Case Studies of Ozone for the Year 2003 as Seen by GOMOS and OSIRIS Data Assimilation

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The new profiling instruments like GOMOS onboard Envisat and OSIRIS onboard Odin produce novel datasets for chemical data assimilation. GOMOS is an stellar occultation instrument, whereas OSIRIS uses scattered solar light. Both work in limb geometry and therefore both of these instruments have a very good vertical resolution (GOMOS better than 1.7 km and OSIRIS 1-3 km). GOMOS measures mainly over the night side of the Earth and OSIRIS over the day side. Together, these two instruments provide good spatial and time coverage. FASP is an assimilation system developed for OSIRIS and GOMOS data. FASP consists of global chemistry-transport model FinRose-CTM, assimilation code based on suboptimal Kalman filter and interfaces to OSIRIS and GOMOS data. The ECMWF analysis fields are used as external dynamics. The aim of FASP is to obtain the full benefit from the new kind of profiling instruments GOMOS and OSIRIS. The stratospheric ozone development for the year 2003 based on GOMOS and OSIRIS chemical data assimilation will be presented. Furthermore, selected dynamical and chemical cases will be studied more closely to describe the full potential of profile assimilation.

Abstract No. 184

Towards Assimilating Infrared Limb Radiances from MIPAS in the ECMWF System

N. Bormann, S. Healy, M. Matricardi
ECMWF

ECMWF is developing the capability to directly assimilate limb radiances from the Michelson Interferometer for Passive Infrared Sounding (MIPAS). The direct assimilation of limb radiances has been prompted by the success of the direct assimilation of nadir radiances, which today has replaced the assimilation of retrieved atmospheric profiles from nadir sounders at almost all major numerical weather prediction centres. The assimilation of MIPAS limb radiances covers a number of aspects, for instance: 1) Development of an observation operator: A new fast radiative transfer model has been developed for MIPAS limb radiances. It is based on regression models for the effective layer optical depths, and follows similar methods currently employed in the assimilation of nadir radiances. The model has been extensively validated against a line-by-line model. The validation shows that the fast model can reproduce line-by-line radiances to a level of accuracy comparable or below the MIPAS instrument noise for most spectral points. 2) Microwindow selection and characterisation of MIPAS information content: Subsets of MIPAS data need to be selected for the assimilation to optimise the information that can be extracted within the ECMWF system given computing resource restrictions. Such selection is necessary due to the prohibitive number of observations provided by MIPAS. A strategy is employed which takes into account the error characteristics of the observations, the forward model, and the ECMWF background. 3) Development of variational data assimilation algorithms: Before the direct assimilation of MIPAS radiances within ECMWF's 4-dimensional variational assimilation (4-DVAR) system, MIPAS radiances can be evaluated using various approximations to the limb geometry. For instance, stand-alone 1-DVAR methods can be used, which neglect horizontal gradients in the atmosphere, or 2-DVAR methods can be employed for a MIPAS plane-of-sight. The presentation will give an overview of the status in these three areas. Future work and particularly challenging aspects of limb radiance assimilation will also be discussed.

Friday 10 September
10:50 – 12:30
DOPPLER

Session 5B3:

Future Earth Observation Mission (2)

Abstract No. 724

RADARSAT-2: Mission Overview and Applications

G. Staples
RADARSAT International, Canada

RADARSAT-2, planned for a 2005 launch, incorporates a suite of advanced features including polarimetric modes, a high resolution 3 m mode, and an enhanced ground system providing rapid satellite tasking and near-real time data processing. RADARSAT-2 offers three polarimetric modes: (1) selective polarization (dual pol) providing one co-pol channel (HH or VV) and the corresponding cross-pol channel (HV); (2) high resolution (3 m) single pol channel (HH or VV or HV); and (3) a fully polarimetric mode (quad pol) providing both amplitude and phase. The fully polarimetric mode is significant since RADARSAT-2 is the first commercial satellite to offer this mode. In conjunction with the Canada Centre for Remote Sensing and MacDonald Dettwiler, RADARSAT International initiated application development projects to understand the potential and limitations of the RADARSAT-2 polarimetric modes. An overview of this development work is presented, including applications for maritime surveillance, defence, agriculture, ice, and mapping. Results based on CV-580 airborne SAR data and SIR-C are used. Polarimetry, while intrinsically challenging from a scientific perspective, is daunting to the end user. The commercial focus of the RADARSAT-2 mission dictates the development of operational applications, and ultimately the extraction of information from the SAR data. An assessment of operational practicality of the RADARSAT-2 polarimetric modes is outlined.

Abstract No. 723

COSMO-SkyMed Mission: Scientific Relevance and Application Potential

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The paper will start with a brief description of the key features of the COSMO-SkyMed mission, of the main performances of the Constellation and of the characteristics of the standard products under development.The achievements and advancements on the definition of potential areas of application and the associated scientific research will be highlighted, together with short and medium term plans for further development. Preliminary results from the on going activities on applications definition in the domain of risk management (due to be completed by September 2004) will be presented.

Abstract No. 722

Beyond SPOT 5: Pléiades, Part of the French-Italian Program Orfeo

B. Boissin
CNES, France

In 2000, two years before the launch of SPOT 5, CNES had identified the user's needs for the 2005-2015 period and from this survey of the user's needs the highest priority was given to the development of high resolution systems, either with optical sensors or SAR instruments. In 2001 a cooperative program was settled with Italy as main partner, in order to develop ORFEO a Dual Use Earth Observation System, intended to be used by civilian users and by Defense ones. It will provide an Optical High resolution component developed by France and a SAR X components developed by Italy. First the French component Pléiades HR is described in this paper. With its two satellites, to be launched in 2008-2009, Pléiades HR will provide high quality images (0,7 m resolution with a 20km field of view) well suitable to be used as standard products for integration in Geographical Information Systems (GIS). The high agility of the platform and sensor will optimize acquisition of images either in stereoscopic or monoscopic mode on areas of very diversified sizes and shapes. Then a brief overview of the main applications (cartography, agriculture, forestry, hydrology, geology, risk management, littoral survey) it will permit to satisfy is given. At last the preparatory program we are conducting with ASI in order to optimize the product's definition and to favor the emergence of new methods and applications is presented.

Abstract No. 726

Constellations for Operational EO; Development of the DMC and Follow-on Constellations

P. Stephens, P. Davies
Surrey Space Centre, United Kingdom

The Disaster Monitoring Constellation was designed as a proof of concept constellation designed to be capable of multispectral imaging of any part of the world every day. Although its headline objective is to support the logistics of disaster relief, its main function is to provide independent daily imaging capability to the partner nations; Algeria, Nigeria, Turkey, UK and China. The first 4 satellites are now in orbit and the 5th is in construction at Surrey Satellite Technology Ltd., UK. The availability of medium resolution multispectral imagery at a GSD of 32 metres with the unique capabilities of 600km wide swath and daily revisit has generated considerable interest in sections of the remote sensing community. Although the low cost DMC satellites were not designed to deliver highly calibrated images, evaluation of data for appropriate applications has elicited a positive

feedback from end-users. SSTL is now implementing systems to service the commercial demand, and planning for data continuity. With SSTL's DMC satellites now providing data, the next constellation is already under construction for RapidEye. The 5 satellites are designed to provide 8metre 6-band multispectral coverage for precision agriculture applications. A high resolution constellation is also on the horizon to provide daily 2.5metre imaging. This paper will review the current status of these EO constellations and discuss the opportunities for applications of high temporal resolution data.

Abstract No. 727

METOP and EPS, the Next Step in Operational Polar Meteorology

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Meteorologists, and Earth scientists generally, have become used to the long-term availability of visible/IR imagery from AVHRR, and atmospheric soundings from other instruments, provided by the US NOAA series of meteorological satellites in polar Earth orbit. Such data have been freely available for several decades. In order to contribute to the US effort, an international system has been set up, the Initial Joint Polar System. The European contribution to this joint effort with NOAA is the Eumetsat Polar System (EPS), within which ESA leads the development of the Metop satellite series. Three such MetOp satellites are currently in the final stages of production and the corresponding ground segment infrastructure is under development by Eumetsat. The first MetOp satellite is scheduled to be launched in 2005. This paper first identifies the EPS mission to support operational meteorology with polar orbit satellite data. It summarises the instrument payload of the three Metop satellites and the commonality with the NOAA satellites to establish a coherent observation system, and the programmatic aspects leading to launch of the first satellite. Then, the functions and services provided by the EPS and its role within the Initial Joint Polar System are presented. The general architecture of the system, identifying the main components is described, together with key performance figures and dimensioning parameters. Buid-in redundancy and growth potential capabilities are identified and their effect on the mission availability presented. The dynamic aspects of the system are addressed, identifying the timeliness for the main services offered to the users. The paper then examines the payload instruments, in particular those representing advances with respect to the state of the art NOAA POES sensors. In the atmospheric sounding area, of primary interest to meteorologists, the IASI (Infrared Atmospheric Sounding Interferometer) is a Fourier transform interferometer that offers a significant step forward in vertical resolution of temperature and humidity, while GRAS (GNSS Receiver for Atmospheric Sounding)uses the principle of occultation of GPS satellites at the Earth's limb to measure atmospheric profiles. Trace gases, especially ozone, in the atmosphere will be measured by GOME-2 (Global Ozone Monitoring Experiment), which is a significantly enhanced successor to the GOME-1 instrument flying on ERS-2. For sea-surface wind speed and direction, ASCAT (the Advanced Scatterometer) is able to provide twice the spatial coverage of its predecessors on-board ERS together with improved on-board calibration measures.

Friday 10 September
10:50 – 12:30
MOZART 3

Session 5B4:

Wave and Wind/Sea State (2)

Abstract No. 446

Envisat Wind Fields for Offshore Windfarming

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The paper presents an overview of the Envisat AO WINDFARM (ID 2343).In this project historic ERS SAR and current Envisat ASAR data acquired over areas of existing or planned wind parks are analyzed. Main parameters considered are: mean wind field distribution, wind gustiness and wind turbulence. Wind wakes behind the turbines, one of the major reasons for fatigue of material and therefore expenses is analyzed using ERS SAR and Envisat ASAR data and newly developed algorithms based on the CMOD algorithms.From the ERS SAR and Envisat ASAR data high resolution wind fields are derived using a newly developed Envisat wind field algorithm. Potential effects of wind parks on the local wind field are investigated. Turbulence in time and space is investigated using the SAR-derived wind fields as well as in situ data. Historic ERS SAR and new Envisat data are analyzed for mean and maximum wind speed to produce maps of the observed region, thus relating different in situ measurements to each other. Statistics of wind fields and sea state from the Danish wind farm at Horns Rev and the German wind farms Butendiek and FINO are given.Envisat MERIS data are used to analyze the change of the distribution of suspended matter as well as biological parameters in and around offshore wind parks, which will also be supported by numerical modeling of particular suspended matter. In addition co-located Envisat ASAR and MERIS data will be analyzed concerning features appearing in both data sets. Data from GKSS ship cruises will be used to validate the optical results.

Abstract No. 525

An Empirical Imaging Model for SAR Ocean Wave Measurements

A. Niedermeier, J. Schulz-Stellenfleth, J. Nieto-Borge

German Aerospace Center (DLR), Germany

Continuous ocean wave measurements on a global basis are still only possible using spaceborne synthetic aperture radar. For more than a decade the European satellites ERS-1 and ERS-2 have acquired about 1500 globally distributed SAR images daily. Envisat is capable of recording some 3000 imagettes. However strong uncertainties in the SAR ocean wave imaging models used so far are well known. These models are either purely theoretical or semi-empirical. A new empirical model for the SAR ocean wave imaging process is proposed within this study. It is derived based on a global data set of ERS-2 wave mode spectra and collocated two-dimensional ocean wave spectra from the numerical ocean wave model WAM. A least-square minimisation approach is used to fit a quasi-linear model function calculated as an optimal estimate of the ocean to SAR transfer function. The empirical transfer function is compared to the theoretical expression used in the literature.

Comparing simulated and observed SAR spectra the quality of the empirical model is tested. Furthermore the model is used to evaluate significant wave heights based on a quasi-linear inversion approach. Both statistics and global maps of wave parameters are presented. The study is a contribution to the optimization of the operational use of global SAR data for the assimilation of numerical wave forecast models, especially using Envisat data.

Abstract No. 142

An Operational Algorithm for SAR Wind Field Retrieval

J. Horstmann, W. Koch
GKSS Research Center, Germany

A fully operational algorithm is introduced, which enables to retrieve high-resolution ocean surface wind fields from satellite borne synthetic aperture radars (SARs). The algorithm is designed for well calibrated SAR data, which are acquired in C-band at either vertical (VV) or horizontal (HH) polarization and has been successfully applied to SAR imagery from the European satellites ERS-1/2 and Envisat as well as the Canadian satellite RADARSAT-1.SAR wind field retrieval is a two step process. In the first step wind directions are extracted from wind induced streaks that are visible in the SAR images at scales above 200 m and that are assumed to be approximately in line with the mean surface wind direction. The orientations of these streaks are derived by a method based on investigation of local gradients of the SAR intensity image. The SAR retrieved wind directions are used in the second step, where wind speeds are derived from the NRCSs of the SAR data under consideration of the wind direction and local SAR imaging geometry. Therefore, the empirical models CMOD4, CMOD5 and CMOD-IFR2 are used, which were developed for the C-band VV polarized scatterometer aboard ERS-1/2. These models have been extended to HH polarization considering the polarization and its dependency on the incidence angle.For validation, the algorithm is applied to a large set of Envisat ASAR data from the southern North Sea. The resulting wind fields are compared to the results of the operational numerical model of the German Weather Service. This enables to give recommendations considering the best choice of C-band model function as well as to investigate the dependencies of the polarization ratio on incidence angle and wind. Last but not least the performance of the algorithm with respect to Envisat ASAR data is investigated and the pros and cons of the system and algorithm are presented.

Abstract No. 397

Detailed Look at Ocean Surface Features in the Gulf of Tehuantepec through SAR and ASAR

F. Ocampo-Torres
CICESE, Mexico

Historic synthetic aperture radar (SAR) images of the ocean surface over the Gulf of Tehuantepec, México, have revealed dynamic features that can be related to the influence of strong and persistent offshore winds (tehuano events) ocurring more frequently during the winter season. Eddies and fronts are commonly present in those SAR images. Recent observations of the wave filed by means of in situ sensors nearshore have been analyzed to determine the evolution of the directional wave spectrum. During measurements carried out in February 2004, we detected a few ´tehuano events´ which induced an effect on the wave behaviour. A combination of directional wave spectrum simulated numerically and wave information from advanced synthetic aperture radar (ASAR) images from Envisat is being performed to describe the influence of the tehuano wind events onto the incoming swell. The possible influence of non-linear interactions between wind-sea and opposing swell on the evolution of the swell itself as seen by the radar is also addressed.

Abstract No. 596

A Parametric Inversion Scheme for Envisat ASAR Ocean Wave Measurements

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A parametric inversion scheme for the retrieval of two-dimensional ocean wave spectra from look cross spectra (SLCS) acquired by spaceborne synthetic aperture radar (SAR) is presented. The scheme uses prior information from numerical wave models to deal with the information loss caused by the nonlinear SAR ocean wave imaging mechanism. The Partition Rescaling and Shift Algorithm (PARSA) is based on a maximum a posteriori approach in which an optimal estimate of a wave spectrum for a given measured SLCS and additional prior knowledge is calculated. The method is based on explicit models for measurement errors, as well as uncertainties in the SAR imaging model and the model wave spectra used as prior information. The correction parameters for the SAR imaging model are estimated as part of the retrieval process. The rigorous stochastic approach enables the estimation of the error covariance matrix of the retrieved parameters. Uncertainties in the prior wave spectrum are expressed in terms of transformation variables, which are defined for each wave system in the spectrum, describing rotations, rescaling of wavenumbers and energy, as well as changes of directional spreading. A new partitioning method is used which allows overlapping partitions and thus avoids discontinuities occurring in algorithms used so far.The PARSA wave spectra retrieval is equivalent to a minimization problem with regard to the transformation variables and parameters of the imaging model. A Levenberg Marquard method is used to find a numerical solution. The inversion is performed on a polar grid with a dimension, which is an order of magnitude smaller than the typical cartesian grids used so far. The reduced dimension enables the use of an extended quasi-linear approximation of the imaging model with non-diagonal Jacobian matrix, leading to a high stability of the algorithm. The scheme is tested using both ERS-2 SAR and Envisat ASAR data. It is shown that the method is able to extract information from cross spectra even if there are strong errors in the SAR imaging model. It is demonstrated that the algorithm makes use of the new phase information contained in cross spectra, which is of particular importance for multi-modal sea states. Global statistics are presented for a global data set of reprocessed ERS-2 SAR wave mode SLCS acquired in southern winter 1996.