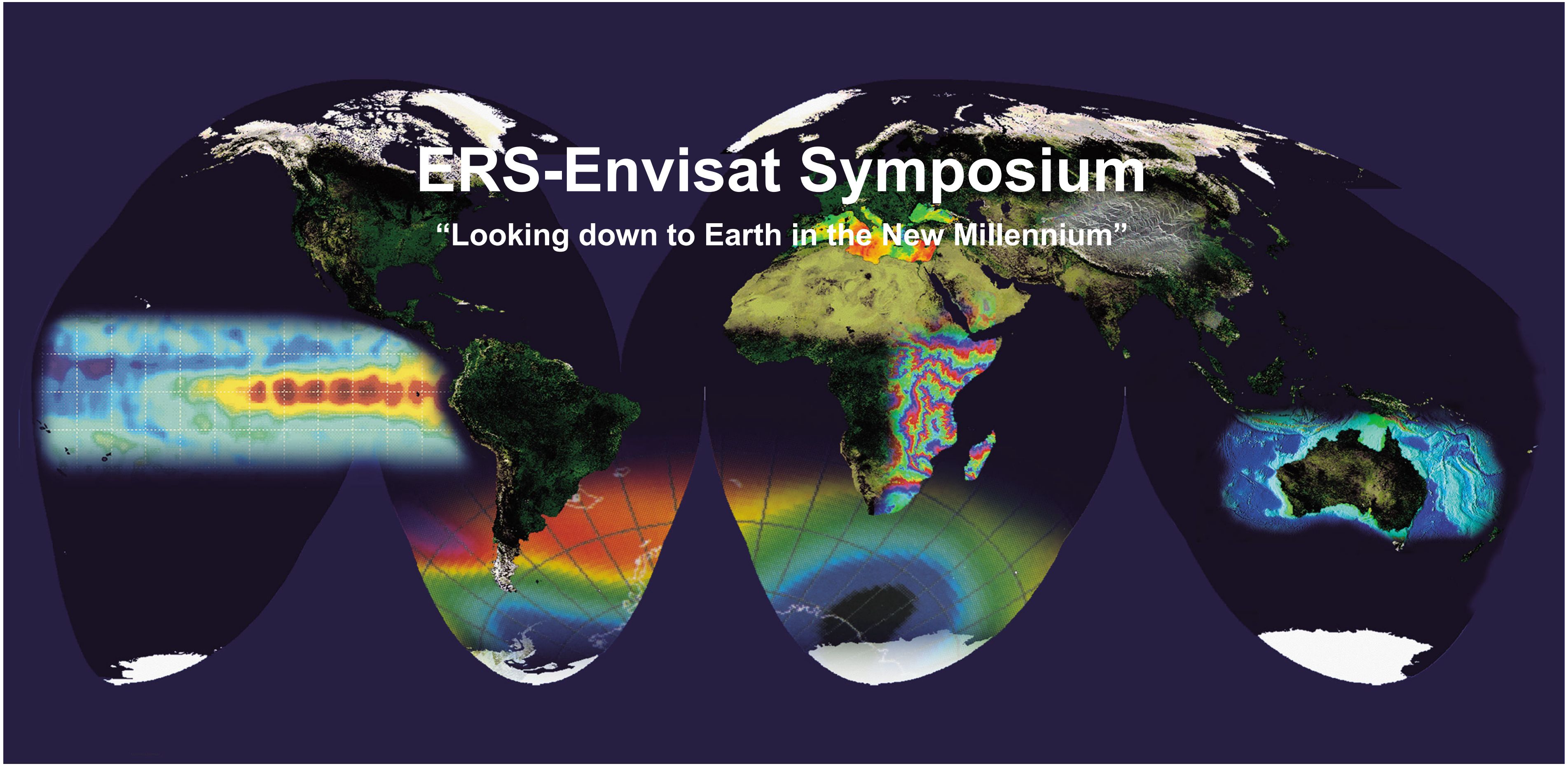

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CHALMERS

Chalmers University of Technology, Sweden

FOREWORD

The ESA ERS-ENVISAT Symposium entitled "Looking down to Earth in the New Millennium" was organized jointly by ESA and Chalmers University of Technology and was held at Svenska Mässan, the Swedish Exhibition & Congress Centre, in Gothenburg, Sweden from 16th to 20th October 2000. This was the fourth **ERS** Earth Observation symposium, following those in Cannes (1992), Hamburg (1993) and Florence (1997) and was the first **ENVISAT** symposium. This symposium was open to all interested parties, from scientists to operational commercial users and service providers and was attended by 540 participants from 34 different countries. Some 451 abstracts were submitted to the symposium and a Scientific Committee of 70 members composed of scientists and ESA experts supported the programme preparation.

Following the themes of the ENVISAT Announcement of Opportunity the 296 oral presentations were grouped into 42 sessions. Each session was chaired by leading scientists and co-chaired by an ESA expert. In the conference exhibit area some 150 posters were displayed and 5 demonstrations were organized. The conference stands allowed some 25 companies involved in earth observation to present their work.

The symposium gave participants the opportunity to review the current status of ERS science and application developments after nearly ten years of ERS data exploitation and to present the launch preparations for ENVISAT, as well as the plans for calibration and validation of the different data products that will be supplied. The ERS-ENVISAT symposium demonstrated the ERS-1 and 2 missions' contribution to the monitoring of our environment, and the continuous development of Earth Observation (E.O.) applications. The presentations given ranged from pure research, to demonstration of applications and development of services and markets. Several new applications of E.O. data were presented and an increased emphasis on atmospheric disciplines was apparent. In addition, ESA distributed to all participants two questionnaires aimed at collecting their feedback on data exploitation and user services.

The enclosed proceedings contain the results presented at the symposium in the form of full-length papers, summary reports of the 42 sessions and recommendations brought up at the symposium. A web site was also prepared for the conference and submitted papers are now available on-line at URL: http://www.esa.int/sympo2000/

We would like to acknowledge Chalmers University of Technology and the City of Gothenburg for hosting the symposium .We also thank the symposium Scientific Committee, the appointed chairs and co-chairs for their work in supporting the programme and running the symposium sessions. Special thanks to the Organizing Committee for setting up a unique infrastructure which facilitated information exchange as well as to all those who contributed daily to the successful running of the symposium. We also acknowledge all attendees and exhibitors of the symposium for their presentations and feedback.

We look forward to seeing all of you at the next ESA ERS-ENVISAT Symposium.

Dr. Stephen BRIGGS
Head Earth Observation Applications Department
ESA-ESRIN

Prof. Jan ASKNE
Chalmers University of Technology,
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A welcome to Sweden and Chalmers University of Technology
by J. Askne

It is an honour to have this symposium arranged in Gothenburg, particularly because space technology is important for Gothenburg and Chalmers University of Technology. Recently we have created a Centre for Astrophysics and Space Techniques to strengthen the activities related to Onsala Space Observatory and ongoing research related to radio waves (microwaves and sub millimetre waves). The historic roots were in ionospheric research and wave propagation, moving later to include radio astronomy and, more recently, remote sensing.

The Odin satellite, a collaborative project between Canada, Finland, France, and Sweden, is due to be launched early next year. Odin will be used both for radio astronomy and, in a limb-sounding mode, for studies related to the ozone chemistry in the upper atmosphere. The development work for Odin's sub-millimetre receiver has been performed at Chalmers, and both radio astronomical and aeronomy observations will be very important for future work as well as work related to other satellites. In Gothenburg we also have one of the major Swedish space related industries, Saab Ericsson Space.

Remote sensing at Chalmers using microwaves goes back to the 70s. The first remote sensing conference in Gothenburg was in 1987, when the URSI "Microwave Signatures in Remote Sensing" was arranged. In 1994, the EARSeL General Assembly "Sensors and Environmental Applications of Remote Sensing" and the workshop on "Topography from Space", were arranged here. Now the ESA ERS-Envisat conference "Looking Down to Earth in the New Millennium" means a further step in the development towards the usefulness of remote sensing.

The Swedish remote sensing program has always been focused on applications. A preparatory program for ERS was initiated by the Swedish National Space Board in the mid 80s. The Swedish Meteorological and Hydrological Institute (SMHI) together with key remote sensing and technical groups such as Chalmers, the National Defence Research Institute, and the Swedish Space Corporation set the goals. The goal was to support the icebreaker operations in the Baltic with near real-time SAR imagery. An important part of the project was collaboration with similar interests in Finland, and this was quickly established enabling joint airborne campaigns and in-situ observations to be carried out in 1986 and 1987. The 3-day orbit of ERS-1 in 1992 and 1994 was related to the needs of the sea ice community as represented by the ESA initiated PIPOR group. The final choice of the orbit was very much influenced by the needs to cover the Baltic. Today support by means of synthetic aperture radar images is established as an operational service in the sense that each winter season a large number of SAR images is used (and paid for…).

Sea ice remote sensing is of great interest for the northern countries, and the cloud independence of radar is rather important. In 1991, the first Swedish Arctic expedition was arranged. With the strong support of ESA, some of the very first ERS-1 images (from August 1991) were delivered for covering part of the expedition area. A group onboard the icebreaker Oden made observations of ice properties and used measurements with scatterometers to establish our understanding of scattering processes. In 1996, a second expedition to the central Arctic was carried out with Oden, again carrying a group studying ice properties and comparing with simultaneous ERS and Radarsat SAR images. Arctic sea ice is a sensitive indicator to global change and properties such as ice extent, concentration, polynyas, etc. are important to follow up over long periods of time. From SSM/I we have long term and global data sets, but with low resolution and accuracy problems. SAR is an important complement for accurate information on ice properties, concentration, polynyas etc.

Although sea ice has been an important area for microwave remote sensing, the land applications have always been of interest. 52% of Sweden is covered by forests, and play a key role in the country's economy and environment. Remote sensing for change detection and stem volume retrieval is very important. Radar backscatter from forests is highly variable, but interferometry offers the extra information necessary to estimate stem volume and biomass. The 3-day ice orbit suddenly offered the short repeat period, which is necessary for forest applications, and the "tandem" mission offered still shorter repeat times. The "experimental" aspects of ERS-1/2 (different orbits), together with the very high stability of the satellite, provided the basis for developing the interferometric applications. The Kyoto Protocol allows carbon emission to be balanced by carbon sinks represented by vegetation. For this purpose, aboveground vegetation biomass needs to be quantified. For boreal forests, InSAR seems to be an extremely interesting possibility for observations during wintertime with stable ground conditions.

ERS-1/2 have offered opportunities for major remote sensing applications for a country like Sweden, with large coverage of sea ice and forest. Envisat is a major step ahead, offering important developments for e.g. sea ice, where the SAR wide swath, the global mode and the alternating polarisation mode will be very important. The forestry applications of interferometry for forestry were based on the short repeat period available during periods of the ERS-1/2 missions and are not expected to be possible with Envisat. Instead the SAR alternating polarisation and the use of MERIS are expected to give interesting information.

With each ERS symposium, the focus moves a step further from the technical issues, and more towards the applications — in particular environmental applications. The need for global data sets with high accuracy, and stability over long time periods, is crucial to answer many questions concerning global change. For those of us doing research in the field of microwave remote sensing the ESA satellites have been a fascinating and interesting development. Let me hope this symposium will be useful and effective, and lay the ground for observations in the new Millennium.

COMMITTEES

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Session Title	Chair	Co-Chairs
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ATMOSPHERE: Clouds / Aerosols	Chance, Kelly	Callies, Jorg
ATMOSPHERE: Calibration, Radiative Transfer, Assimilation	Goede, Albert	Nett, Herbert
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Landslides	Carnec, Claudie	Palazzo, Francesco
Earthquakes	Peltzer, Gilles	Desnos, Yves-Louis
Forestry (SIBERIA)	Schmullius, Christiane	Laur, Henri
Forestry	Hallikainen, M	Laur, Henri
Rice	Le Toan, Thuy	Remondiere, Sylvie
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Wind / Waves 2	Alpers, Werner	Bellini, Andrea
ENVISAT RA 2	Benveniste, Jerome	Roca, Monica
ENVISAT AATSR	Mutlow, Christopher	Regner, Peter
ENVISAT ASAR	Zink, Manfred	Buck, Christopher
ENVISAT Atmospheric Instruments	Fischer, Herbert	Frerick, Johannes
Land Cover / Land Use	Wooding, Mike	Arino, Olivier
Vegetation / Agriculture	Skriver, Henning	Lichtenegger, Juerg
Hydrology 1	Rott, Helmut	Borgeaud, Maurice
Hydrology 2	Rott, Helmut	Borgeaud, Maurice
Sea Ice 1	Holt, Benjamin	Grabak, Ola
Sea Ice 2	Gudmansen, Preben	Grabak, Ola
Services / Market	Coulson, Steve	Bally, Philippe
ENVISAT ESA 1	Desnos, Yves-Louis	Levrini, Guido
ENVISAT ESA 2	Levrini, Guido	Desnos, Yves-Louis
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Floods / Stroms	Yesou, Herve	Paganini, Marc
Earth Motion	Rocca, Fabio	Seifert, Frank Martin
Ice 1	Doake, Christopher	Volden, Espen
Ice 2	Mohr, Johan Jacob	Volden, Espen
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SESSIONS SUMMARIES

SESSIONS SUMMARIES

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ATMOSPHERE: CALIBRATION, RADIATIVE TRANSFER, AND ASSIMILATION

Chairman: Albert Goede
Co-Chairman: Herbert Nett

This session covered a large number of papers concerned with instrument calibration and the production of good quality level 1 data from the atmospheric chemistry instrument GOME on board the ERS-2 satellite. Some papers concerned data assimilation techniques applied to space borne atmospheric measurements and one paper was devoted to the development of a new radiative transfer model for use in data retrieval of instruments like GOME and SCIAMACHY.

Calibration is at the basis of the generation of good quality geophysical data products and is an essential step in establishing GOME as a reliable ozone-monitoring instrument for the decades to come. This refers to GOME-2 on the EUMETSAT Metop 1, 2 and 3 satellite series scheduled for operation in the 2006 to 2020 time frame. Several papers addressed the issue of instrument degradation in the UV and the influence of polarisation on the accuracy of the measured radiances. Notably, the GOME scan mirror was identified as a source of degradation in the UV (240 nm to 400 nm) and it was found that this degradation is different for the various calibration modes, employing the sun, the moon and the Earth as light sources. After five years of operation, the UV (260 nm) sensitivity of the GOME instrument has dropped by more than a factor of two. The visible (400 – 600 nm) and infrared (600 – 800 nm) channels are not affected. The UV polarisation measurement device (300 – 400 nm) was found to degrade by approximately 6 % per year. This will affect the accuracy of the radiance measurements by more than 5 % after five years of operation.

Corrections can and have been defined in the GOME data processor (GDP) version 1.06, to account for instrument degradation. However, at around the end of the year 1998 a new UV degradation phenomenon seems to have arisen causing different degradation rates for the solar irradiance and Earth reflectivity measurements to occur. At present, this phenomenon is subject to further investigation. One recommendation is to analyse diffuser degradation at 260 nm rather than taking the averaged value over the channel 1 wavelength range as it is presently done.

A better correction for polarisation of the incident radiance in the spectral range 300 to 350 nm was proposed, for the benefit of obtaining better quality ozone profile retrievals. Several other features in the GOME measured radiances were identified, including the etalon effect (thin ice layer formation on cooled detector surface), the spectral features caused by the dichroic mirror outgassing, and the spectral structure in the diffuser measurements of channels 3 and 4. Improvements in the GDP to cover the varying etalon effect have been proposed and further work is needed to correct for the other known artifacts in GOME spectral radiances.

An important source of error directly propagating into the data retrieval is the error contained in the molecular absorption cross-sections. New measurements are presented using the SCIAMACHY spectrometer in on-ground White cell configuration covering most of the SCIAMACHY (and GOME) target species. At the same time these measurements have been used to obtain better instrument characterisation of stray-light, slit function and wavelength calibration. Temperature parameterisation precision of the cross-sections is expected to be better than 2 %.

A new radiative transfer model based on the discrete ordinate method, named LIDORT, has been developed for use in GOME, SCIAMACHY, OMI and other UV – visible – near infrared instruments for atmospheric spectroscopy. It aims at providing a faster algorithm that is still accurate enough to describe nadir (and limb) measurements over the entire wavelength range. This has been achieved by using a novel linearisation scheme, capable of generating both intensities and weighting functions. The model is generic in nature and requires user specific input such as BSDF, albedo and extinction coefficients. It includes a multiple scattering and pseudo-spherical approximation. The model has been validated against existing models of known accuracy. Future developments may include polarised light.

Data assimilation is a powerful technique to bring satellite measurements into a consistent time / space synoptic form. This will be valuable, in particular, for future ENVISAT atmospheric chemistry data taken sequentially in limb and nadir view from different instruments. The potential of data assimilation techniques was demonstrated using data from the GOME and CRISTA space instruments. The Kalman filter approach quantifies the effect of model errors and instrument noise, in addition to calculation of new state parameters. The feasibility of assimilating Near Real Time ozone profiles from GOME in the atmospheric chemistry transport model TM3 was studied. Accuracy was demonstrated to be satisfactory in the stratosphere.

For the future, continuous monitoring of GOME instrument degradation is necessary, making use of all available calibration sources including sun, moon, Earth reflectivity and spectral lamp information. These data need to feed theoretical instrument models, in order to extend parameter space and to understand instrument behaviour. To improve the correction of polarisation effects, radiative transfer calculations will be needed to supplement the polarisation measurements. This should be an ongoing activity, necessary in order to maintain and to improve level 1 data accuracy of the GOME instrument, which is at the basis of the subsequent geophysical data production. The knowledge gained on GOME level 1 data accuracy will also benefit the development of (in-flight) calibration schemes for GOME-2 on the Metop satellite series and will provide valuable input for the specification of calibration of proposed future atmospheric chemistry satellite instruments, such as GeoSCIA.

ATMOSPHERE: CLOUDS AND AEROSOLS

Chairman: Kelly Chance
Co-Chairman: Jorg Callies

This session and the associated posters were characterised by the increasing use of synergy among measurements from different instruments to retrieve the various cloud and aerosol products. The presentations also emphasised the effort that is going into the development of advanced algorithms in preparation for Envisat. These algorithms sometimes use multiple instruments from Envisat, for example, AATSR together with SCIAMACHY and MERIS.

New cloud algorithms were presented for the retrieval of cloud parameters including cloud fraction and cloud-top height for GOME, SCIAMACHY, and ATSR. In the case of GOME, the information from the spatial variance of the PMD detectors and the reflectance inside and outside of the oxygen *A* band is exploited. First validation results from the retrievals and comparisons among instruments were reported, showing encouraging results. A method for discriminating between water and ice clouds was tested using AVIRIS aircraft-based measurements, and proposed for SCIAMACHY. The possibility to assess the GOME radiometric calibration using reflectivity statistics was discussed. Improvements on the use of stereo photogrammetry with ATSR-2 data were reported. Example products have been evaluated by meteorological institutes. Future cloud investigations and comparisons among various instruments and techniques will require refinement of the definitions of cloud parameters and how their apparent measurement varies with technique and with wavelength, so that better consistency in the comparisons is achieved.

Ocean aerosols were determined by combining ATSR-2 visible and infrared measurements with AERONET measurements, which were advected in the retrieval scenes using Kalman filtering. Retrieved aerosol classes and amounts were satisfactorily validated against AERONET observations. The GOME multispectral capability was exploited to determine aerosol size distribution, refractive index, and optical thickness. Synergy of GOME and METEOSAT provides improvements, which will be exploited by combining SCIAMACHY, MERIS, and AATSR measurements from Envisat. Techniques have been developed to use GOME and ATSR-2 together, taking advantage of the GOME spectral coverage, the PMD spatial resolution and the ATSR-2 dual-view capability, to determine aerosol optical thickness, type, and the Angstrom parameter. This will provide the basis for algorithms used on OMI and SCIAMACHY/AATSR. Aerosol measurements have been validated against a number of satellite and ground-based measurements, with generally satisfactory results. There are currently a number of libraries of aerosol classes, with associated optical properties. This complicates comparisons among instrument and techniques. The libraries may need to be consolidated or otherwise rationalised for future use.

ATMOSPHERE: OZONE, TOTAL COLUMN, AND PROFILES

Chairman: Piet Stammes
Co-Chairman: Rob Koopman

In this session new results of GOME including new algorithm developments for ozone column and profile retrieval were presented. The conclusions and highlights are discussed in this session summary.

An overview of 5 years of operational GOME column data product generation for ozone and NO2 has been presented by DLR. The evolution of the GOME Data Processor and its auxiliary information was discussed, but also exemplary applications of GOME data were presented. In particular the observations over Antarctica in the third quarter of 2000, where historic record values have been reached for the depletion of ozone, leaving the deepest ever ozone hole. Another example is the experimental retrievals of SO2 down to the troposphere, which allowed detection of pollution and monitoring of emissions due to volcanic events.

In successive presentations, a number of alternative algorithms for retrieval of the total ozone column were presented. In addition to the GDP there is the fast-delivery service at KNMI (GOFAP) which produces ozone data within three hours, the TIDAS algorithm for Quality Assurance at ESRIN, and finally a Neural Network technique developed at ZSW in Stuttgart.

Another focal point of the presentations was the retrieval of vertical profiles of ozone concentration. Teams from RAL, KNMI and ZSW presented different profile retrieval schemes. This work on ozone profile retrieval has shown the need for improvement of GOME Level 1b data quality, as presented by KNMI, NASA and RAL. This is supported by findings in the GDAQI project (SRON, DLR, IFE, University of Heidelberg).

It has been shown that data assimilation of ozone is a powerful tool to overcome limitations in geographical sampling imposed by the satellite viewing geometry. Its use has been demonstrated in the study of the ozone mini hole above North-Western Europe in November 1999.

Neural Network techniques have been presented, which have the advantage of extremely shortened processing times. However these techniques have some limitations in retrieval of data from unique events since their results are dependent on recognition of patterns that are similar to those detected in historic observations during a learning phase.

Most authors have presented results of validation of their algorithms with independent observations, notably Brewer and TOMS observations for ozone columns, and ozone soundings and lidars for ozone concentration profiles. The typical error of the operational total ozone column retrievals at DLR and KNMI is about 3% at low and mid latitudes, degrading at higher latitudes. Ozone profile retrievals have larger inaccuracies that strongly vary as a function of altitude.

Based on the presentations of this session, improvements in both speed and accuracy of total column retrievals can be expected for the near future. This holds also true for ozone profile retrieval, but improvement of the quality of GOME level 1 data is the most important requirement for achieving better accuracy values for ozone concentration profiles. This recommendation was independently formulated by each of the teams performing profile retrieval algorithm development.

The detailed concept and designs of two future satellite instruments for ozone monitoring were presented namely GOME-2 on METOP and OMI on EOS-Aura. These instruments will be launched after Envisat. The three instruments on Envisat that are capable of retrieving total columns and/or vertical concentrations of ozone were subject of dedicated presentations during other sessions of the symposium.

ATMOSPHERE: UV RADIATION, TRACE GASES OTHER THAN OZONE

Chairman: **John P. Burrows**
Co-Chairman: Stefano Casadio

This session was dedicated to the retrieval of information about atmospheric constituents and parameters from space based atmospheric remote sensing instrumentation. The focus of the meeting was the use of data from the GOME (Global Ozone Monitoring Experiment) instrument aboard ERS-2 and in the future from the instruments aboard ENVISAT mainly SCIAMACHY. In addition some studies used data from ATSR (Along Track Scanning Radiometer) and the MW (Microwave) instruments aboard ERS-2 and two presentations were relevant for ENVISAT.

Three presentations were concerned with the determination of water vapour, H_2O, column amounts from GOME. It was demonstrated by Stefan Noel (IUP-UB) that global maps of H_2O column above the ocean, land or cloud could be retrieved. This necessitated the development of an appropriate forward radiative transport model SCIATRAN. In the future a tropospheric profile having limited spatial resolution will be available. The additional H_2O bands available from SCIAMACHY would improve such nadir profiling capability. Stefano Casadio (ESRIN) presented a simpler fast H_2O retrieval algorithm appropriate for quality assurance of GOME data. Paola Colagrande (ESRIN) presented investigations of H_2O retrieval from GOME, ATSR and MW data.

The presentation of Albert Goede (SRON) discussed the work of the GODIVAERS consortium (SRON, IUP-UB, IUP-UH, UL, BIRA, NILU, KNMI, and FMI) on GOME data. This European consortium of data users have worked on the improvement of GOME Level 1 and Level 2 data products. Systematic problems with the GOME calibration were identified and characterised using the solar and lunar observation modes of GOME and a thermal vacuum study of the GOME Breadboard Model. The expected in-flight degradation of the GOME performance could be well characterised. This work facilitates the generation of an accurate long term GOME data record, when its conclusions are implemented in the GOME data processor, GDP. Validation of the GDP level 2 data products, the ozone, O_3, and Nitrogen Dioxide, NO_2, total column amounts was supported within this project. Several new scientific Level 2 data products were developed by the participants from GODIVAERS. For example data products for minor but very significant atmospheric trace gases Bromine Monoxide, BrO, Sulphur Dioxide SO2, Formaldehyde, HCHO and chlorine dioxide, OClO were developed. BrO and OClO are important free radicals involved in the catalytic destruction of stratospheric ozone. Enhanced HCHO and SO2 tropospheric mixing ratios result from pollution and volcanic eruptions.

The ozone vertical profiles obtained using the FURM (FUll Retrieval Method) Algorithm (IUP-UB) were validated within GODIVAERS. This group had established with the assistance of ESA and the DLR, a Near Real Time GOME service, which has been used extensively by the large European Union Research Campaigns to investigate stratospheric Ozone at mid and high latitudes in the Northern hemisphere in spring, THESEO and THESEO 2000, the NASA SOLVE and the ALERT2000/TOPSE campaigns. In addition data assimilation techniques combining GOME data and atmospheric models have been developed for a variety of applications.

Michel van Roozandael (BIRA) summarised both the work of the BIRA group and other participants from an EU supported study of the atmospheric significance of BrO. GOME BrO measurements have revealed large clouds of tropospheric BrO at high latitudes in spring. In addition they indicate that BrO is present at low levels in significance amounts throughout the troposphere.

Two presentations were focussed on tropospheric HCHO from GOME. K. Chance (SAO) presented a study of HCHO observed from GOME primarily above the USA. F.Wittrock et al (IUP-UB) have retrieved global maps of HCHO indicating the importance of biogenic emissions, biomass and biofuel burning, convection of pollution and possibly snow chemistry as sources of HCHO or its precursors.

Andreas Richter (IUP-UB) described the methods for retrieving the tropospheric amount of NO_2 from GOME data. He presented a new method utilising the multispectral advantage of GOME measurements. This exploits the simultaneous measurements of absorption features at different wavelengths in the ultraviolet and visible spectral regions. This important new algorithm yields good agreement with the so-called residual techniques. Provided the performance of GOME is adequate, this approach may yield some limited but significant profile information about tropospheric NO_2, which is a precursor of tropospheric O_3.

Giorgio Giovanelli (ISAO-CNR) discussed the use of GOME data and ground based measurements during a period of volcanic eruptions from Mount Etna. Lars Hild (IUP-UB) presented a synergistic study combing GOME and TRRM data and quantifying lightning as a source of tropospheric NO_2. Renata De Winter-Sorkina (IMAU) used GOME observations and related data to estimate the tropospheric fields of OH. Melanie Coldewey (IUP-UB) provided improved surface UV fluxes from GOME data taking both clouds and the spectral dependence of the surface spectral reflectivity into account.

The Swiss Network within the framework of the WMO GAW (Global Atmospheric Watch) was discussed by Dominique Jeker (EMPA), which will be used for ENVISAT data product validation and related studies. Finally Peter Borrel presented the EUREKA-EUROTRAC-2 project called TROPOSAT. This new project aims to use satellite data for tropospheric research and promote the development of satellite instrumentation aimed at exploiting satellite data. It will focus initially on GOME and ENVISAT (SCIAMACHY and MIPAS) data but has the broader objective of using all relevant data.

In summary this session demonstrated that

- great progress has been made by the scientific groups in developing scientific data products to exploit the inherently large information content of the GOME data,
- important scientific results, concerned with both stratospheric ozone depletion and tropospheric ozone and its precursors were presented,
- Atmospheric research and the assessment of global atmospheric change for policymakers require the highest quality data products from the satellite data. Further studies are being and need to be initiated to meet this need.

COASTAL ZONES

Chairmen: Hans Wensink, Johnny Johannesson
Co-Chairman: Gordon Campbell

The presentation covered current status of development in the retrieval of ocean current features, progress in the use of ocean colour data for water quality measurements and current business development initiatives relating to operational systems based on SAR.

Present status:

- Spatial resolution of models is at present a limitation – some physics is not included which means phenomena are not fully captured. This mainly impacts on understanding second order effects in SAR-ocean surface interactions (eg the impact of wave-wave and wave-current interactions on RCS) and on the capability to follow the occurrence of new algal bloom events or to predict the intensity of a bloom.
- There has been extensive analysis to improve the understanding of SAR Ocean current signatures. Work has been undertaken in the Norwegian Sea, the Californian Bight and the Sea of Japan. The motivation for this is the expected availability of 3 SAR systems in the near future, representing the possibility for operational data assimilation into coastal ocean models.
- In SHOM there is strong support for the use of ERS SAR data to update coastal maps for areas where SHOM have mapping responsibility. As an example, a 1:50000 map of the coastal region around the area of Cayenne has already been issued by SHOM and further work is ongoing, including an analysis of the legal implications inherent in the use of EO data for chart and map updating.
- ARGOSS have undertaken an extensive validation activity of the bathymetry assessment system for use in Indonesia. Average measurement error was found to be around 10-11cm. Discussions with business partners are underway and it is expected to start full operations in 2001.
- TSS have an operational oil spill detection service for customers from both government and offshore oil companies. This was developed using ERS and is based on joint use of Radarsat and ERS SAR. The availability of Envisat is expected to make a significant contribution to the service capability in terms of both update times and service area covered. A change in legislation, which requires oil companies to undertake environmental monitoring activity, is expected to add to demand for this service.
- NOAA is presently demonstrating near real time services to a range of government users in Alaska, including the Department of Fisheries and the National Weather Service. Present services are coastal wind field data and fishing vessel surveillance based on Radarsat. It is planned to use ASAR Data once Envisat is launched and to expand the service provision to include sea/river ice monitoring and oil spill surveillance. About one year will be required to investigate the capabilities of ASAR before joint exploitation of ASAR and Radarsat is possible.
- Extensive cross validation of multiple satellites has been undertaken within the EU Clean Seas project using ocean colour, multi-spectral, IR and SAR data to analyse algal blooms and water quality signatures in 3 test sites in Europe. In some cases it has been possible to acquire more than 80 scenes from 10 different instruments over an area of interest covering a period of 7 days. Cross validation of the surface signatures over such a range of instruments represents an important step forward in improving the possibility to use satellite sensors to monitor such phenomena.
- Nansen Centre has shown that ocean colour data can be used to extend the effectiveness of conventional measurement techniques in the monitoring of algal bloom events. This is an important issue for Norway given the risk such phenomena pose to the aquaculture industry and the importance of this industry to the Norwegian economy.

Fundamental issues to be addressed

- Work is presently underway to further improve the understanding of SAR-ocean surface interactions. However, more and better quality in-situ data are required. It is hoped that the Envisat Cal-Val effort can represent a major contribution to this issue. In addition, an EU fifth framework project has just started to investigate complex signatures (wave-wave/wave-current).

- Better models are required to support an improved understanding of the SAR Ocean surface signatures.
- Better models are also required for algal bloom applications to ensure all relevant physics is captured.

Conclusions

- Further systematic analysis will require more data, both archived and new acquisitions
- Envisat Cal-Val should be used to acquire a greater amount of high quality in-situ data to support validation of fine scale models and SAR/ocean color imaging models.
- EO data definitely have a contribution to make to the areas discussed and in some cases represents the only viable source of data. Systematic progress in understanding the issues is being made.

EARTH MOTION

Chairman: Fabio Rocca
Co-Chairman: Frank Martin Seifert

The Earth motion session consisted of seven contributions and two posters. Six out of seven were successful obtaining high quality results whereas the seventh will try again with a new data set. Most of the contributors presented more than one case and validated the achieved results by optical levelling, GPS network, and thermal dilation, or applied some complex mathematical models, which were supporting the results. The discretion of DInSAR technique was underlined by clients. Overall, different subsidence rates were analysed which ranged from millimetres to more than 1 meter per year.

Highlights

Richard Stow talked about moraine bursting by lake pressure in Bhutan.

Claudie Carnec presented DInSAR application in mining areas (active and dismissed inflating for water filling of tunnels), geothermal and water pumping and compaction in urban and periurban areas.

Chao Wang showed urban subsidence due to water pumping and achieved 0.943 correlation with optical levelling.

Urs Wegmueller presented four cases: mining area (subsidence correlated to mining activity), urban subsidence due to water pumping and geothermal effects, interferogram stacking to improve the quality.

Fabio Rocca presented four applications of permanent scatters technique (PS): an histogram of stable and non stable RCSs and PS density in urban areas, building collapse, tectonic motion and geological effects. All applications showed good correlation with temperature, optical inspection or GPS network.

Mario Costantini discussed punctual coherence in areas of sparse coherence and applied the technique to monitor tectonic motion, water pumping, metro construction and geothermal effects.

Julie Boyle indicated the use of rain radar for atmospheric phase screen removal. Shrink and swell of clay area and DEM creation from multiple tandem pairs were discussed.

Recommendations

The ASAR instrument on Envisat should be operated as often as possible in one mode to allow differential SAR interferometry.

Conclusions

The high interest and expectations by the audience resulted in lively discussions. A general consensus was reached on the quality and consistency of the results revealing that differential InSAR has reached a mature status with a high potential for the market. The permanent scatterers' technique has a good potential to bridge from ERS archives to Envisat.

EARTHQUAKES

Chairman: Gilles Peltzer
Co-Chairman: Yves Louis Desnos

Nine papers on the study of earthquakes and two papers describing new studies of interseismic deformations were presented.

Earthquake studies:

- The papers dedicated to earthquakes showed that spatially continuous surface displacement maps obtained by SAR interferometry InSAR allow scientists to construct complex fault models that could not be constrained by seismological data and conventional geodetic techniques only. The example of the Shadad thrust that experienced triggered slip after a magnitude 6.6 earthquake on a nearby fault illustrates the importance of InSAR maps to observe the effects of fault interaction and of aseismic deformation.
- InSAR maps are particularly important for earthquakes occurring in remote places with little or no in situ information such as Western China, Iran and Tibet.
- One of the main limitations of InSAR in the study of earthquakes is the loss of coherence in the vicinity of the surface rupture. Two papers presented results obtained with a technique using the geometric distortion between the images (SAR or optical) acquired before and after the event, providing surface displacement deformation in the near field of the fault. The example of the Landers surface break obtained with airborne high-resolution optical images (1m) illustrates the potential of this approach.

Interseimsic studies:

- Two papers presented results of InSAR applications to the study of interseismic surface deformation. These studies showed that errors in the radar data due to tropospheric phase propagation delay could significantly be reduced by averaging several interferograms allowing a level of detection of better than 1 mm/yr in line of sight change rate. This improvement opens the range of applications of InSAR to the measurement of surface movement occurring at slow rates, characteristics of interseismic deformations.

Issues and recommendations:

- The examples presented in the session showed that C-band data performed very well over desertic regions such as Southern California and Tibet, but that interferometric coherence was low in areas covered with vegetation. This point was illustrated by the comparison of vegetation index images (AVHRR) and coherence images of a study area along the North Anatolian fault. A longer wavelength (L-band) would be preferable for a dedicated mission to improve the coherence over vegetated areas.
- Single (line of sight) component of measurement of ERS InSAR data is a limiting factor for model development. Multiple incidence angles available on ENVISAT combined with ascending and descending path acquisitions will improve InSAR measurement three-dimensional resolution.
- One of the limiting factors of InSAR application using the ERS archived data is the scatter in perpendicular baselines that covers a range of ~ +/- 1000 m. A better orbit control of ERS and of future satellites orbits would increase the opportunities of matching interferometric pairs.
- Redundant acquisitions of SAR data are important to average interferograms in order to reduce the errors due to phase propagation delays through the troposphere.
- Given the number of different operating modes of the SAR on board of ENVISAT, it is recommended that a default mode, optimised for InSAR applications, should be defined for a background data

acquisition mission. This is particularly important at the beginning of the ENVISAT mission, until the completion of a first coverage of "active" regions in InSAR default mode.

- As for any geodetic data set, the continuity in time is of prime importance. It has been recommended that the ERS mission overlap with the ENVISAT mission for approximately ten cycles of successful acquisitions (at least one year).

ENVISAT AATSR

Chairman: Christopher Mutlow
Co-Chairman: Peter Regner

The presentations addressed important aspects related to the pre-launch calibration of the instrument, the development of an accurate algorithm for providing global LSTs, and the need for high accuracy shipboard devices for the proper validation of AATSR sea surface temperatures.

The results from the laboratory calibration of the AATSR were presented including the characterisation of the absolute radiometric response, the radiometric noise, the polarisation sensitivity, and the instrument's optical alignment. It was demonstrated that the instrument meets the strict performance criteria required to meet its scientific goals: the global measurement of sea-surface temperatures to an accuracy of 0.3 K, the monitoring of global vegetation coverage, and the retrieval of cloud properties. The results of the pre-launch calibration were compared against those obtained from the calibration of the previous ATSR instruments. The traceability of the measurements to standards was emphasised.

The scientific basis for a computationally fast and accurate algorithm for deriving global LSTs with a (simulated) accuracy of around 2 K from the AATSR was presented and the important process of validating the product was discussed.

Finally, the problem of the conventional approach to validating satellite-derived skin temperatures of the ocean with buoy measurements of the temperature in the bulk of the ocean was presented. It was demonstrated that, with instruments capable of radiometric measurements of the skin temperature of the ocean from ships, a partition of the error sources into those from unresolved atmospherically variability and near-surface oceanic gradients, could be achieved. The results of a comparison with AVHRR sea-surface temperatures has shown that the residual uncertainties are less than half of those derived by conventional comparisons within situ data from buoys. The use of such high precision shipboard instrumentation is indispensable for the proper validation of Envisat SST products.

ENVISAT ASAR

Chairman: Manfred Zink
Co-Chairman: Christopher Buck

- ScanSAR Interferometric Monitoring using the Permanent Scatterers (PS) Technique, Andrea Monti-Guarnieri. The paper proposed first of all the possibility of performing interferometry using Wide Swath mode data which is made feasible by means of the permanent scatterer (PS) technique. Thanks to the heritage of ERS SAR data at least for VV polarisation many permanent scatterers all over the world have already been located in the SS1 sub-swath.
- Alternative Large-Scale Distributed Targets for SAR Elevation Beam Pattern Characterisation, Christopher Buck. The desire to find a suitable distributed target at latitudes other than the tropics was described and using ERS scatterometer data possible sites were identified in northern Greenland and central Antarctica. The results for Greenland look promising although some differences need still to be explained. One of the Antarctica sites was less suitable. The discussion concentrated on the technique for eliminating unwanted pixels, the stability of the ERS SAR and arrays of calibration targets to determine the antenna pattern.
- PHARUS ASAR Demonstrator: Simulation and Application of ASAR Data, Arthur Smith. The fully polarimetric C-band PHARUS instrument was briefly presented and selected datasets over the Black Forest (D) and Olst (NL) were analysed. By means of land-use classification over these areas, it was shown that one co-polar and one cross-polar channel are sufficient in most cases. There was some discussion on the difference between medium and low vegetation and it was pointed out that there is no useful phase information between polarisations in AP mode.
- ERS-ENVISAT Combination for Interferometry and Super-resolution, Andrea Monti-Guarnieri. It was shown how it will be possible to perform interferometry between ASAR and ERS. Depending on the baseline and the ground slope one could either derive highly accurate DEMs or generate super resolution images due to the effective increased spatial bandwidth. The question of differential interferometry between the two instruments was raised although this is problematic due to the very high fringe rate that can be expected. Provided the permanent scatterers found by ERS are still coherent in ASAR images they could improve cross instrument interferometry.
- External Radiometric Calibration Activity on Italian Test Sites for the ENVISAT Mission, Francesco Posa. The Italian calibration site in southern Italy was presented showing the use of trihedral corner-reflectors and active radar calibrators placed in desalination pools and agricultural fields. The discussion concentrated on the accuracy and stability of these calibration devices.

Three posters were also presented on:

- The Geometric Properties of ENVISAT ASAR Products, Achim Roth. DLR/DFD plans to use its geocoding system and the recently developed interferometric processing chain for analysis of the geometric properties of the ENVISAT products. This activity will be performed within the ENVISAT Cal/Val-Team.
- The Development of an Advanced Calibration Transponder for Quad-Pol SAR and ScanSAR, Peter Cooper. The design of an advanced calibration transponder including pulse encoding and digital pulse replication has been presented. This features are of particular benefit for calibrating quad-pol and low-resolution SARs. A prototype transponder is being developed and will be used for ASAR calibration.
- Passive Calibration Targets with a Large, Stable and Controllable RCS for Spaceborne SAR, Alexander Zakharov. Large parabolic reflector antennas are interesting calibration targets because of their high RCS and stability. Results from measurements with ERS-1/2 have been presented. Such targets could be useful for calibrating ASAR's Global Monitoring Mode.

ENVISAT ATMOSPHERIC INSTRUMENTS

Chairman: Herbert Fischer
Co-Chairman: Johannes Frerick

The session was opened by Bojan Bojkov, giving an overview about the COSE project, which stands for Compilation of atmospheric Observations in support of Satellite measurements of Europe. More detailed activities along the NADIR/NILU project was outlined, being the core database for the validation of ENVISAT atmospheric chemistry sensors.

Thomas Wagner then gave a summary of the German SCIAMACHY validation program. To be pointed out is a concept to validate SCIAMACHY's tropospheric column product, which is from a scientific point of view, highly desirable (see also talk of S. Noel). Asked for the first products to be validated, the UV-VIS near real time (NRT) products are expected to be validated first explained by the heritage from GOME validation. This will be followed by the IR NRT products as well as so called off-line products, which comprise profiles from nadir, limb and occultation measurements as well as tropospheric columns.

The talk given by Sander Slijkhuis described in detail the current knowledge of SCIAMACHY's polarisation sensitivity, which is based on an extended mathematical analysis of on-ground calibration data. Asked for the impact on radiometric accuracy, this is still under investigation. The same holds for potential impact on trace gas retrieval, as it was suggested by the abstract title. Due to the rather high complexity of correctly characterising an instrument for its polarisation sensitivity and – even more – to correctly compensate for this in the radiometric calibration, discussion went in a direction whether polarisation insensitive instruments should be the future baseline. No conclusion could be drawn within the rather limited time reserved for discussion. But the question should seriously be considered when planning for new mission instrumentation.

Stefan Noel then gave an overview over the concept of SCIAMACHY nominal operations. Emphasis was laid on two aspects, the limb nadir matching as well as the so-called clustering concept, both being rather unique features of the SCIAMACHY instrument. The limb nadir matching will probably allow to determine tropospheric column information of various trace gases, although the analysis of corresponding measurements would have to assume horizontal homogeneity in the stratosphere, as brought forward during the discussion. The clustering concept allows to optimise signal to noise, geometrical resolution as well as overall data rate aspects against each other. Depending on pixel respectively spectral interval (which is in fact the cluster) geometrical resolution will vary from 30 by 60 km in tropical regions to 30 by 240 km in polar regions.

Next Herman Oelhof presented validation activities with large balloon payloads, which are necessary for getting vertical profiles of atmospheric parameter for inter-comparison. Well-characterised in situ and remote sensing instruments are available for that purpose. They have already been used to validate other satellite experiments like ILAS. Finally accuracy estimates were given for profiles of different trace constituents. These are taking into account the measurement accuracy of the instruments and the difference between satellite and correlative measurement as caused by mismatch and different measurement techniques. It was also mentioned that the funding situation for the commissioning phase has to be clarified soon.

Complementing the previous talk, Cornelis Blom showed up the possibilities of validating ENVISAT atmospheric chemistry sensors by means of the high altitude aircraft "Geophysica". Scientific payload has been expanded by additional but also well-known instruments, in order to enlarge the number and quality of validation products, which are in case of remote sensing instruments highly informative atmospheric cross sections of various trace gases. Latest results of the APE/GAIA campaign have been presented, showing e.g. subsidence, denitrification and ozone depletion in the Antarctic vortex. Associated accuracy analysis is still on going.

The session was completed by a talk of Marco Ridolfi, who presented an optimised forward model as well as a retrieval scheme for MIPAS real time data processing. This is based on a global fit approach, yielding sufficient accuracy and computational performance. A new method called "Geofit" was mentioned. By simultaneous analysis of full orbit data horizontal inhomogeneity of the atmosphere could then be taken into account. Data as recorded with the different MIPAS observation modes may be processed in NRT retrieval code.

ENVISAT ESA

Chairmen: Yves Louis Desnos, Guido Levrini

The presentations in these two sessions have been devoted to the Calibration and Validation Approach of the Envisat Instruments and Products.

The number of instruments to be calibrated and the wide range of geophysical products to be validated make this task an unprecedented challenge.

The Agency is committed to deliver products to the Users starting from 6 months after the launch, which is scheduled for June 2001. Within the first 6 months in orbit ('Commissioning Phase') and after a first few weeks dedicated to the Switch-On and Data Acquisition (so called 'SODAP' Phase), a number of teams of experts, PI's, etc will carry out the core Calibration and Validation program, under ESA responsibility and overall coordination. The target is to achieve release of good quality products starting from the end of the Commissioning Phase.

A Validation Workshop will follow – 9 months after the launch- the Commissioning Phase Workshop. The Validation Workshop is focused on the reporting of the status of Validation of the level 2 geophysical products.

The Envisat Calibration and Validation Plan is available and can be downloaded from the Envisat Web site: http://envisat.estec.esa.nl/.

The detailed plan of action and the techniques and strategies that will be used to implement it have been presented in detailed by the various speakers, one per Cal/Val team. The all presentations were given by ESA staff with the exception of the three presentations devoted to the AO instruments (SCIAMACHY, DORIS, and AATSR) which have been given by representatives of the AO providers. In all cases, a sound approach has been shown, which has been received positively by the audience. The sessions have been characterised by an extremely large participation, which clearly demonstrates the interest of the user community in the Envisat products, to their quality and to the ESA product release strategy.

The ASAR calibration approach is based on the successful ERS approach, where the further challenge lies in the increased amount of instrument modes and products that the instrument will deliver.

RA-2 will be inter-calibrated with respect to several other altimeter systems, in particular ERS-2 and Jason-1.In addition, the absolute calibration of the range will be carried out to the level of 1 cm residual inaccuracies, using the north-west Mediterranean basin as a reference surface. For the first time, the sigma zero absolute calibration will be attempted.

The MERIS and AATSR Cal/Val effort are coordinated respecting the different responsibilities of ESA and the AO Providers.

SCIAMACHY: each geophysical product will be validated by a combination of at least 2 instrument types and 2 techniques (pointlike versus global methodology). A similar approach also applies to GOMOS and MIPAS validation, carried out through a combination of balloon campaigns, high-altitude aircraft campaigns, model assimilation (both Numerical Weather Prediction model and Chemical Transport Models), satellite inter-comparison and ground-based measurements. The Validation of the GOMOS, MIPAS and SCIAMACHY products is coordinated within a single group, the Atmospheric Chemistry Validation Team.

ENVISAT RA2

Chairman: Jérome Benveniste
Co-Chairman: Monica Roca

The ENVISAT RA-2 Session focused mainly on the calibration and validation aspects of the ENVISAT Altimetry mission. Many results shown in this session are derived from work initiated during ERS Calibration campaigns, which has been continued all throughout the missions to support long term calibration and drift monitoring. In fact, in this ENVISAT pre-Launch period, the ERS-2 data are used to enhance the methodology and to get prepared for the ENVISAT Cal/Val activities. Other results presented stem from novel activities. There was a unique talk on added value services to users, enhancing the ESA products with a variety of geophysical correction selectable by users, but there was another session hosting others talks on this topic.

The first talk reported a new application of Altimetry, exploring the potential of the ENVISAT RA-2 S band nadir sounding for studying forest canopy, providing a vertical profile of the vegetation. In situ data will be collected from helicopter-based S band radar over an homogenous pine forest and compared with RA-2 to validate the inverse method to extract the vegetation structural parameters.

A proposal for absolute calibration of the altimeter range was reported using a transponder, as it was done for ERS. Ideas for several improvements in both the transponder hardware and the data processing were given. A tentative to use the transponder for Sigma-0 absolute calibration was also reported.

For Radar backscatter drift monitoring, stable and homogenous natural targets on land world-wide were searched for, using the high-resolution geodetic phase data. A few regions have been found and one in particular has been demonstrated to be stable enough to monitor short (daily) and long term (yearly) stability of RA-2 sigma nought with an accuracy of 0.3 dB (in Ku band). The radar echoes backscattered from land targets are very complex compared to the well modeled oceanic or ice sheet echoes. This has hindered the development of land Altimetry applications. It was underlined that with the novel features of the ENVISAT altimeter the applications in this field are bound to develop including climatic change in soil characteristics.

Theoretical work on ocean backscatter modeling, in support to the validation of the backscatter absolute calibration campaign, was reported. Since the beginning of Altimetry the backscatter has never been calibrated; it will be attempted for the first time for the ENVISAT altimeter. The notable lack of microwave nadir backscatter in-situ data does not yet permit to estimate the parameters of the theory.

Furthermore altimeter range was calibrated against tide gauges. The experiment has been maintained all throughout ERS-2 mission, precisely estimating any drift of the altimeter system. Tide gauge networks were shown to be an essential source of in-situ data in support to altimetric missions. The ESA plans for ENVISAT RA-2 absolute range calibration are in fact based on the methodology presented here, well validated during the ERS-2 calibration phase and beyond.

A complete set of methods and tools to cross-calibrate all geophysical parameters retrieved from altimeter data were presented, as well a results from cross-calibrating ERS-2 and Topex-Poseidon. Another group involved in the absolute calibration campaign presented an indirect approach using tide gauges together with a direct approach using GPS buoys. GPS buoys are also used for altimeter drift monitoring. Taking advantage of the two frequencies on RA-2, a new parameter is estimated: the Ku band backscatter attenuation. Its definition and validation were presented.

All these effort are federated into Calibration and Validation Teams co-ordinated by ESA in support of the commissioning of ENVISAT Altimetry.

ESA presented the significant improvement of the Envisat RA-2 capabilities over previous altimetric mission and the major conceptual evolution of the ground processing strategy. This evolution leads to highly enhanced data product, particularly in the quality of the near real time data, in support to international climate study programmes such as GODAE and GOOS.

FLOODS AND STORMS

Chairman: Hervé Yésou
Co-Chairman: Marc Paganini

FLOODS

All presentations addressed plain floods. Flash Flooding has not been considered by any of the speakers.

Flood presentations have demonstrated the maturity of EO derived products and the contribution they can bring to the development of an operational flood management information system. The synergy of SAR-based flood extend maps with Very High Resolution (VHR) optical data (e.g. IKONOS), including derived Land Use Maps, brings a significant improvement to the damage assessment and provides valuable information for the visualisation of the flood damage by the Civil Protection Authorities. The only limitations highlighted by the presenters are the wind condition, which affects the backscattering of water areas and the layover in presence of high topography.

Historical archived data provides a Memory of the Flood Risk, essential for Flood prevention and constitutes the reference data for the elaboration of Flood Prevention Plans.

Within the poster session, the use of SAR data to assess the efficiency of dams to isolate radioactive polluted areas has been presented. This is of first importance to protect local population from dam overflow and radioactivity carried over.

The importance to map the flood dynamics with the vegetation types in wetlands (e.g. nature parks) has also been put in evidence.

SAR derived products, as for example Digital Elevation Models (DEM) and Soil Moisture Maps, are now integrated within Flood Forecast models but further research analysis to overcome their current limitations (e.g. lack of high accuracy DEM) are required before their utilisation in an operational environment.

Furthermore it has been highlighted the necessity to have precise Land Cover Maps as a mean to assess Flood Damage but also as input to the hydrological structure of Runoff models to better characterise the watershed. In particular SAR PRI data reveals to be a valuable way to estimate the Soil Moisture. The integration of SAR-based soil moisture within hydrological models has shown promising results and will be further improved by the synergistic use of MERIS and AATSR data.

For the Flood Monitoring and Soil Moisture assessment, a higher revisiting time, compared to the 35-days ERS repeat cycle, is needed. It is expected, by all presenters, that the wide-swath mode of the ENVISAT ASAR will provide the necessary temporal resolution.

STORMS

Multi-temporal Tandem Coherence products have demonstrated to be the optimum EO derived products to map forest damage after a storm. Different experiences following the two storms which devastated French and Swiss forests have shown reliable results of high quality, in a short time response, and have been fully appreciated by local authorities.

The coherence technique reveals to be efficient for short-term actions in the crisis phase but is also to be taken into consideration for long-term activities of re-forestation.

The interruption of the ERS-1 mission, and the related ERS tandem data, does not allow Value Adding Companies (e.g. SERTIT and GAMMA) to ensure the continuity of this service.

FORESTRY

Chairman: Martti Hallikainen
Co-Chairman: Henri Laur

The Forestry session was essentially dedicated to the boreal forests (Scandinavia, Russia, China, Canada) and confirmed most of the SIBERIA project results.

ERS SAR intensity, even used on a multi-temporal basis, does not provide suitable results for boreal forest classification. Instead, ERS coherence (tandem 1-day) is of primary use for forest/non-forest delineation. It was found that the ERS coherence is also correlated to the boreal forest stem volume, although scientists seem to disagree on the level of saturation (100 m^3/ha or 300 m^3/ha?).

Multi-temporal study indicates that the ERS coherence (1-day) is affected by meteorological factors, dry snow on ground providing the most stable results. The coherence is also affected by the forest fill factor (i.e. level of forest coverage) and the vegetation cycle.

ERS coherence revealed to be an excellent tool to map burned areas (Canada), not only in boreal areas, but also in tropical areas (Madagascar). Furthermore an attempt to use 35-day coherence gave interesting results in terms of forest delineation (70% versus 95% for 1-day coherence).

Finally, the use of ATSR to map burned forests at a global scale was presented and is in phase of pre-operationalization to provide services to civil protections. The mapping of forest fires and burned areas is also of primary importance for providing biomass burning estimates to the scientists studying the global change effects.

FORESTRY: SIBERIA

Chairman: Christiane Schmullius
Co-Chairman: Henri Laur

The SIBERIA project (SAR Imaging for Boreal Ecology and Radar Interferometry Applications) aims to image an area of global ecological importance, the central-Siberian forest, using three Earth Observation radar satellites. It was an unprecedented fast and joint effort of the German Aerospace Centre (DLR), the European Space Agency (ESA), and the Japanese Space Agency (NASDA) to collect ERS-1 and -2 and JERS-1 data via a transportable station located in Mongolia.

These data (550 ERS-scenes plus 890 JERS-1 scenes) were used in one of the most area-extensive remote sensing projects (1.2 Mio sqkm), to prove the operational use of radar remote sensing for very large-area forest mapping.

The main source of information came from the ERS tandem coherence. It was clearly confirmed that the coherence channel (1-day tandem) was the primary parameter for forest/non-forest delineation. The ERS intensity, even multitemporal, did not provide suitable results for the classification. The final results, derived from ERS coherence and JERS intensity, include classified maps with 3 forest classes of different timber volume. The areas of high relief could not be classified.

The Siberia forest map will help the Russian forest institutions to update obsolete forest inventory data and to monitor reforestation e.g. after fire events.

The session was organised in a logical way, from the data processing description to the presentation of the final classified maps, including the rationale for the applied classification methods. The posters allowed to see various steps of the SIBERIA project and to appreciate some of the final forest maps.

The SIBERIA project was funded by the European Commission within the 4th European Framework Programme.

GEODESY

Chairman: Remko Scharroo
Co-Chairman: Pierre Femenias

ERS altimeter data, especially from the geodetic mission, are used to compute highly detailed gravity anomaly maps. Recent developments have shown improvements in coastal regions and extension towards the pole. A near global gravity anomaly field is now available at 2'x2' resolution. Cross-validation against in-situ data indicates that the accuracy of the field is around 6 mgal even in shallow oceans and around topographic features. Work is ongoing to improve resolution and accuracy, especially in areas with strong meandering currents.

At the same time mean sea surface models are produced and compared.

Also on regional scales, ERS altimetry has shown to be beneficial in geodetic research. A new geoid model from the Black Sea was derived, demonstrating the correlation between sea surface topography and sea bottom topography. This correlation is clearly less in areas where the sea floor is covered by a thick layer of lighter sedimentation.

Time tag bias is a key element in the radar altimeter equation. Through the analyses of altimeter crossovers a mean and seasonally varying time tag bias was discovered a while ago. Attempts have been made to identify the sources of the timing errors. Although no conclusive causes were identified, progress has been made in the sense that new features in the temporal behaviour of this timing error are discovered. This may ultimately lead to the modeling of a correction if not the explanation of the cause of the timing error.

In the same line of auxiliary information for the enhancement of the ERS radar altimeter data products lies the SPTR correction. Although this correction removes some of the observed jumps in the altimeter range, it was not yet sufficiently accurate for specific applications, such as monitoring of sea level rise. New techniques have been employed to characterise the jumps out of an engineering perspective. A combination of clock asymmetry, shape of the PTR and the chirp slope was found to be responsible for the jumps. These parameters are now all being considered in the computation of a new SPTR correction table to be used by the user community. Further validation is on going.

ERS-1 OPR altimeter data are produced in two different formats applying different retracking algorithms and different geophysical corrections. An extensive recipe is presented to attempt to upgrade the older version 3 OPR data to the level of OPR version 6. Nevertheless, full advantage of ERS-1 altimeter data can only be taken when all the altimeter data of Phases A through F are retracked with the current retracker.

GEOLOGY AND VOLCANOES

Chairman: Geoff Wadge
Co-Chairman: Maurizio Fea

The first presentation was a general study of the geology northeast of Ankara, Turkey using SAR backscatter data together with a variety of other data sources. Tamer Ozalp showed how the combined effect of topography and roughness differences in four separate rock types could be used to distinguish between them, particularly when merged with optical data. The analysis allowed the author to identify for the first time a geological feature not known yet, the Ankara Cankiri tecto-morphological zone.

The other three presentations concerned the use of InSAR for monitoring processes at volcanoes. Zhong Lu displayed a remarkable series of differential interferograms showing deformation on the surface of four volcanoes in Alaska as measured over several multi-year intervals in the 1990s. Each case study required a different interpretation and illustrated the great variety of styles and processes related to the dynamics of volcanoes that InSAR is revealing.

People are now starting to consider InSAR as an “operational” technique for volcano observatories. Daniel Carrasco described the Spanish programme to monitor the volcanoes of the Canary Islands. This industry-academic partnership is now well developed and processing of the ERS archive has revealed areas of good long-term coherence on the islands. Tenerife is of particular interest because of the explosive Teide volcano. Although the volcano as a whole is not deforming, new areas of anomalous movement have been identified, which has resulted in a change of the strategy of ground geodesy using GPS.

When a volcano is erupting, the operational requirements become more stringent. In particular, timely access to data is needed. In an experiment in local reception at just such a volcano observatory on Montserrat, Goeff Wadge showed that InSAR products could be derived at the observatory within a few hours of the ERS overpass. During a 3-month period 5 scenes were captured including 3 descending pass images that could not be acquired by the regional receiving station.

HYDROLOGY

Chairman: Helmut Rott
Co-Chairman: Maurice Borgeaud

The papers dealt with several applications of ERS SAR data to retrieve either soil moisture or soil roughness, to extract plant variables, to generate pedologic maps, to monitor floods, to estimate snow wetness, and to predict snow melt runoff.

The retrieval of topsoil moisture with ERS SAR data has been studied by several authors. The limitations of using only a single-frequency, single-polarisation system have been addressed. In addition the fact that soil roughness and vegetation effects have a major impact on the backscattering coefficient hinders the development of a general algorithm to retrieve soil moisture. The use of spatial models of soil-vegetation-atmosphere (SVAT) processes, based on realistic vegetation growth models, has been successfully applied to retrieve soil moisture under vegetation. ATSR-2 data have been used to map and monitor wetlands in the lake Chad-basin in Africa using a sub-pixel technique.

The need for detailed in-situ data for algorithm development has been emphasised due to the fact that very often a good description of the area or the process to be studied is still missing. Precise soil roughness and soil moisture measurements have been collected to help the understanding of the electromagnetic scattering from bare soil surfaces. For soil roughness, the use of multi-polarisation SAR data has been presented and a promising technique has been introduced to retrieve roughness from ASAR data. An algorithm based on maximum a-posteriori probability (MAP) inversion approach has been introduced to retrieve soil roughness from SAR data.

The authors are more and more favouring a model-based approach to interpret their data rather than using simple empirical relationships. In addition, the need of ancillary data (e.g. meteorological, soil properties) has been stressed in order to retrieve quantitative information from remote sensing data. Furthermore the need for multi-temporal well-calibrated SAR data, as introduced by the ERS-1/2 satellites, has been emphasised by several authors.

Time sequences of ERS SAR data have been incorporated in an automatic classification algorithm to generate precise snow maps. These maps have then been applied successfully for accurate real-time forecasting of snowmelt runoff in mountainous areas, confirming the high operational potential of this technique. An algorithm to retrieve the liquid water content of snow from multi-polarisation SAR data has been described. However, a problem for applying this algorithm to ASAR data is the low level of the backscattering coefficient of wet snow at cross-polarisation.

ICE

Chairmen: Christopher Doake, Johan Jacob Mohr
Co-Chairman: Espen Volden

Parameters

The majority of the presented studies aimed at estimating the position of the grounding line of glaciers and mapping the ice topography and ice velocity. Many of them have also investigated the changes over time of these parameters. Furthermore, some of them have estimated the ice flux and the derived contribution to the increase of the sea level. A few projects have investigated other subjects, like the possibility of estimating mean wind by measuring its effect on the snow cover by SAR coherence, estimating the equilibrium and firn line with multipolarisation SAR in preparation for ENVISAT, or studying the height bias between ERS-1 and -2 radar altimeters. An assessment of the Arctic sea ice cover by using passive microwave data and model studies has also been performed. The VECTRA project was presented and promoted.

One area receiving a lot of attention was West Antarctica. Three presentations confirmed the ongoing changes there detected with SAR interferometry and altimetry. These results demonstrate the advances made in our ability to monitor remote regions since ERS-1 was launched.

A sequence of interferograms over a glacier in Svalbard covering a period from 1992 to 1998 showed the complete cycle of a glacier surge, from initiation through fast flow to quiescence. This should be an invaluable data set for helping understand the physical mechanisms of surging glaciers. An analysis of SAR interferometry and altimetry data around Dome C in Antarctica, a site for a deep ice core being drilled by the European EPICA project, suggested an area of basal sliding close to the summit, possibly over a subglacial lake. This has implications for the interpretation and dating of the ice core.

Methodology

The methodology used for deriving topography is mixed between ERS-1/2 SAR interferometry and ERS altimetry; some presentations compared the two methodologies. Differential SAR interferometry is also the most used technique for deriving ice velocity, although some have additionally used feature matching. A new strip processing technique has been applied with the aim of mapping Greenland from coast to coast.

Conclusions

As a conclusion, the sessions demonstrated the strength and success of SAR interferometry in this domain. There is need for accurate and updated information and this can be provided by SAR interferometry. Some very interesting results are now coming after several years of work on glaciers in West Antarctica. The benefit of reliable time series of parameters for monitoring the subtle changes occurring in the polar ice sheets has been amply demonstrated.

Recommendations

It was recommended to have as much interferometric coverage as possible to be able to study seasonal variations and annual changes. The massive increase in our understanding of the flow and changes in ice sheets that has come from SAR interferometry implies that every effort should be made to continue the ability to collect suitable SAR data from ENVISAT.

LAND COVER / LAND USE

Chairman: Mike Wooding
Co-Chairman: Olivier Arino

The majority of the papers presented in this session were concerned with urban applications of ERS SAR data. Urban applications have been relatively slow to develop, but the large number of papers directed towards this topic suggests that it has now become an important research topic.

The techniques presented for urban mapping included those based on the use of multi-temporal backscatter intensity data, as well as interferometric coherence data. Some success was demonstrated using ERS data for baseline mapping of urban areas in developing countries, but overall ERS data seem to be more suited to identify urban change using a baseline map generated from a higher resolution data source, or just simply by identifying new bright targets from temporal sequences of images. Examples of descending and ascending images were presented, which showed major differences, related to the orientation of streets. The simultaneous use of backscatter intensity, tandem coherence and long term coherence were found to provide information at different levels. The fusion with medium resolution optical data proved useful to discriminate vegetation from other build up areas. Examples of fusion with Landsat, SPOT and IRS were shown. One paper based on the use of airborne AIRSAR data showed how the higher resolution greatly improved the discrimination of streets and urban structures. Techniques for extracting street patterns were presented.

The possibility to retrieve building height was subject to critical discussion. Information on building height is important for planning, telecom, aerosol turbulence and land use classification. However, while the paper presented on this topic showed that it was possible to identify urban areas of different building size and density using ERS data, there were no results presented directly on the derivation of building heights.

The use of recognised nomenclature for classifying urban areas, such as those used in CORINE and MURBANDY projects was brought to the attention of the audience. The IEEE International workshop on RS and data fusion over urban areas to be held in Rome in 2001 was announced.

Other papers in the session addressed a number of different land uses mapping topics. A study in Iceland described how a DEM generated from ERS Tandem data was being used for hydrological modeling purposes. The use of ERS data for mapping and environmental monitoring in French Guiana was presented, and later followed-up by a CD demonstration on the ESA stand: themes such as deforestation, urbanism, topography and marine map update were highlighted, and the use of SAR data in cartography was shown to be very cost effective. A paper describing the results of a study in the Karakum Desert/Aral Sea area, Central Asia, showed how SAR data were being used to identify elements of the hydrological network and ancient settlements which were unable to be seen on optical satellite imagery. Next, a system developed for mapping surface water pollution was presented by Alcatel, and the end-to-end application used SAR data to produce land cover and a DEM integrated into their decision support system build around the ADAGE EU concept. Finally, the use of SAR in humanitarian relief operation was discussed, with a number of different types of remote sensing imagery being compared for identifying refugee camps and counting the number of tents present within these camps. The use of ERS data for identifying these camps compared quite favourably with the use of medium resolution optical data from Landsat, but very high resolution optical data, such as IKONOS data, were shown to be necessary for mapping individual tents within the camps.

LAND SURFACE TEMPERATURE

Chairman: Marianne Edwards
Co-Chairman: Alessandra Buongiorno

Li Jia opened the session with a paper describing the synergistic use of ATSR-2 multispectral and dual-angle for modeling 3 dimensional land surfaces. An atmospheric correction was performed on the visible and near infrared channels, which were then used to determine fractional vegetation cover. An inversion model allowed the comparison of soil to vegetation temperature. Conclusions of the paper indicated good agreement of the retrieval for homogenous surfaces.

Fred Prata presented the work of Jose Sobrino comparing different retrieval techniques based on split-window and dual view multispectral methods. Several different atmospheric conditions and emissivities were simulated to provide the user with the most appropriate method for their input data. The errors associated with the various retrievals were also quantified. The conclusions of the paper were that dual angle methods give a better accuracy than split-window ones, and split-window for nadir only view gives better results than for the forward view. The use of the 3.7 micron channel at night improves the accuracy of the estimation of surface temperature. These results were confirmed by validation campaigns performed in Australia.

In the final paper of the session, Guangjian Yan described work on a non-linear model that retrieves the thermal component of the vegetation canopy. The analysis was performed on a single ATSR-2 image, but future work hopes to provide a more extensive validation of this preliminary result.

Recommendations and conclusions from the session:

- The ATSR instrument provides great potential for improving land surface temperature retrieval from space.
- The capability of the ATSR dual view and multi-spectral characteristics for modeling the effects of the atmosphere and for the retrieval of the various land surface components has been highlighted.
- There is a need for more extensive validation including dedicated field campaigns to assess the accuracy of land surface temperature retrieval.
- The future AATSR instrument will provide the opportunity to continue and improve the exploitation of this technique.

LANDSLIDES

Chairman: Claudie Carnec
Co-Chairman: Francesco Palazzo

Highlights

- Application of distributed neural networks to landslide hazard. Features extracted from SAR Tandem data (intensity, coherence, texture, and backscatter change) were used as input to compare different classification techniques and the creation of thematic maps for landslide hazard assessment. Distributed classifiers trained on different features showed an improvement in overall accuracy by using the product combination; an increase of overall accuracy was noticed also when using Radial Basis functions.
- Use of InSAR data to derive maps for civil protection applications (natural hazard susceptibility maps).
- Operational uses of InSAR techniques were demonstrated to monitor slow mass movements in alpine areas.
- Main limitation in landslide mapping with interferometric techniques is due to land cover and atmospheric artifacts: combinations of ascending and descending orbits have been used in the Austrian Alps to increment the detectable area above the tree-line and below perennial ice from 30 to 70% prevented from obtaining sensible results.
- The use of the Permanent Scatterers (PS) technique over built-up areas has been pinpointed as a possible solution to overcome decorrelation problems.
- DInSAR techniques applied to yearly data (snow-free season) permitted to quantify average in-range deformation rate (-0.77 cm/35 days) of a creeping rock glacier. Available geodetic measurements of the vertical flow guaranteed result validation.
- Interferometry based on Tandem data, together with ice-models was used to monitor ice movements and was demonstrated as a useful, low-cost complementary information to ground surveys.

Recommendations

Yearly detection and monitoring of in-range slope movements is feasible in alpine areas above the tree-line (coherence is preserved over long time intervals) for slow and large mass movements; unsuitable orientation of slopes relatively to the radar illumination can be partially solved by combining ascending and descending orbits. Steep foreslopes are not suitable for SAR-based landslide monitoring, data should be acquired during snow-free periods. At lower elevations severe constraints result from decorrelation due to dense vegetation therefore application of interferometry over long time spans appears feasible only in built-up areas by means of the PS technique.

Applications related to ice movements need tandem data (1-day interval) and must be coupled with ice models and flow directions.

Conclusions

The symposium illustrated the state of art of SAR applications for landslide mapping and monitoring, focussing particularly on surface characterisation (2 presentations) and measurement of slow slope movements by means of SAR interferometry (3 presentations).

Encouraging results were shown to identify landslides through the integration of SAR features in neural networks.

Known interferometric limitations related to temporal decorrelation, ground resolution, topographic effects and atmospheric artifacts were stressed, but several techniques (application of PS to built-up areas and use of ascending/descending passes to map areas above the tree line) were presented as a potential solution to some of these problems. Further testing and standardisation of these techniques should give an essential contribution to the development of operational landslide mapping and monitoring.

Further works should include systematic validation and error estimation of identified movements.

SAR interferometry was demonstrated to be a highly complementary tool with field observation.

METHODS 1

Chairman: Sylvie Pouliquen
Co-Chairman: Pascal Gilles

Presentations:

- Sylvie Pouliquen: A new collocation system for satellite data
- Valerie Harscoat: CERSAT value added products
- Detlev Kosmann: Value added Geocoded SAR products from the German Envisat PAC
- Andrew Birks: Development in AATSR and ATSR Product Algorithms and Data Products

These four presentations were all different in nature. They however all focused on data manipulation methods set-up and used within the frame of the ERS mission, and indicated, whenever applicable, the way forward to apply similar method for other missions and in particular the Envisat one.

The first presentation addressed a service put in place at the CERSAT, allowing cross-sensor data querying and retrieval. The presentation started by illustrating the need for such a tool for both geophysical and cross-calibration applications. It followed by presenting the system today implemented at CERSAT and handling ERS AMI-WIND, ADEOS NSCATT and QuikSCATdata, and is foreseen to host SeaWinds and ASCAT data whenever available.

This has led to the definition of new products and services, allowing the user to retrieve a set of individual measurements from different sensors to analyse the attached parameters, or to extract all the available data from a specified collocation zone.

The presentation concluded by illustrating monitoring application for cross calibration of scatterometer sensors from different platforms.

All those products and services are available to users and accessible through a WWW server at CERSAT.

The second presentation complemented the first one by presenting specific products generated at CERSAT and derived from ERS AMI-WIND instrument, complemented by data of similar sensors on non-ESA platforms. In particular a global wind atlas and a sea-ice atlas have been produced and distributed world wide as a major contribution to climatology studies. In particular, the wind atlas, distributed to 1500 users, has been included in the WOCE dataset as a reference for wind measurement.

The third presentation focused on the SAR products generated and distributed by the German Aerospace Center, both for ESA products and genuine higher level value added products implemented under national responsibility. In particular, the presentation concentrated on those geolocated SAR products generated and the future Envisat GEOcoding system (EGEO) that will produce geocoded and geolocated products based on ASAR data.

Foreseen characteristics of this system and related products were described, with help of numerous examples generated with ERS SAR data, illustrating the targeted applications.

This system is foreseen to be ready at Envisat launch and fully operational at the end of the commissioning phase.

The fourth presentation provided a short but comprehensive description of the major differences between the ERS ATSR and Envisat AATSR instruments, and the impact on subsequent data processing on ground.

After having listed the changes in the instrument itself and on the data transmission capacity, the presentation focused on the implications for the setting up of the ground segment architecture, and the induced impacts on the data processing algorithms were outlined.

The presentation concluded by presenting the AATSR products and highlighting the heritage carried over from its ATSR predecessors.

METHODS 2

Chairman: Shaun Quegan
Co-Chairman: Josep Closa

ScanSAR data processing and radiometric calibration, by Andy Smith: Presentation based on Radarsat but also relevant to Envisat ASAR ScanSAR modes. Processing algorithms based on Specan modified to accomplish full range migration correction and its radiometric normalisation were developed which worked well on Radarsat data. A complete processing chain was presented. The calibration results obtained were 'reasonable' showing an error of ~1 dB on the IRF targets from transponders and corner reflectors deployed in the UK and a variation of the calibration constant of ~0.5 dB along time. Some problems were experienced with the AGC for Radarsat data. This should not be a problem for ASAR. Overall outlook is good for the ScanSAR modes of ASAR.

Speckle filtering and classification of ERS SAR images using GAMMA distribution, by Youcef Smara: First part based on qualitative assessment of single image filter techniques for speckle reduction, inferring Gamma Map gave the best results but there was no rigorous testing. Second part of the presentation showed assessment of Frost based maximum likelihood classifier (on a single image) applied over urban areas (Algiers) using 3x3 windows on ERS data. Performance seemed reasonable but with misclassification errors at edges due to mixed classes. After the presentation the suitability of gamma filtering for ERS data was discussed as data models were not really appropriate for the properties of ERS data, either in terms of data distributions or correlation properties.

Isolation of atmospheric artifacts in differential interferometry for ground displacement detection: different methods comparison, by Francesco Sarti: Assessment of various methods to the damaging effects of atmospheric structures on extraction of ground subsidence and displacement information using differential interferometry was presented. The most promising approach appeared to be the correlation of interferograms which main advantage is that only four acquisitions are needed. The technique was compared with the use of permanent scatters, which seems to be especially suitable in urban areas. Good results were shown over Paris with localisation of deformations and a quite detailed temporal tracking of displacements. Another study using the correlation approach was presented on the south of Portugal area, although results were not yet validated. Limitations of the correlation method are found if the atmospheric effects are themselves correlated. This appeared to be the case in the earthquake example located in California.

An efficient low-memory implementation of 2-D phase unwrapping based on minimum cost flow algorithm, by Luca Galli: A new efficient algorithm for phase unwrapping was presented. Its main advantage is the significant saving in time and memory, with performances effectively equivalent to the RELAX-4 using an optimal network topology.

Multitemporal InSAR coherence from urban type objects by Dan Johan Weydahl: Essentially the presentation was just a statement of the work to be done over Oslo area on deformation using the existing 60 ERS scenes and the existence of earthquake information (but no current ground deformation data was yet available). A full processing chain from raw data was presented using the 'Extended Exact Transfer Function' algorithm. Only multitemporal coherence preliminary results were shown the presenter experienced some problems with the Doppler centroid estimation from February 2000, which later were confirmed to be due to the monogyro operation of ERS-2. Also the importance of the baseline information availability was stressed.

Iterated multitemporal filtering and its use in land applications by Shaun Quegan: A generic approach to reduce speckle for multi-channel intensity data and particularly relevant to multitemporal data was introduced. The efficient, resolution preserving, recursive algorithm with known theoretical limits was presented. The filter is also sensor independent, being able to process ERS tandem and JERS data as inputs. It can also recursively be updated with the introduction of new data arrival. It is an essential component of applications based on multitemporal data analysis such as for agriculture, forestry, land use or hydrology; specially recommended as the archive required does not need to be too large. Results were shown from the Siberia project

METHODS 3

Chairman: Laurence Gray
Co-Chairman: Evert Attema

Highlights

Modeling

Incoherent and coherent radar backscattering models were presented for leafy vegetation. The model predictions were verified with ERS data. A fundamental theoretical problem was highlighted during the discussion related to properly accounting for vegetation attenuation in radiative transfer models. For this currently only semi-empirical solutions are available

Image Processing

Filtered principal component analysis using wavelet transforms was shown to be very successful in revealing hydrological patterns in ERS SAR images based on the sensitivity of SAR image intensity to soil moisture variations. Multi-temporal SAR classification of land targets and coastal zones were presented with special application to rice mapping, and oil slick detection on the ocean. Wavelet transform methods were shown to be efficient for cloud masking of ATSR imagery.

Atmospheric Effects

Unexpected azimuth shifts in C-band SAR imagery was shown to originate from path length variations in the ionosphere in Polar Regions. As expected the effects are worse at L-band. An algorithm for correcting the corresponding phase shifts in interferometric applications was developed.

The ATSR cloud-clearing algorithm was demonstrated. Plans for AATSR were presented. Closer collaboration with the GOME/SCIAMACHY scientists working on cloud parameter retrieval was recommended.

Conclusions

During the session a number of achievements were presented spanning a broad range of methodological topics including signature modeling, image processing and atmospheric effects on earth observation.

METHODS 4

Chairman: Laurence Gray
Co-Chairman: Evert Attema

Highlights

Oceanographic and Atmospheric Features in SAR Imagery

It is anticipated that dual polarisation radar observations of the ocean surface will facilitate discriminating surface expressions of oceanographic and atmospheric phenomena. This was demonstrated with ERS and SIR-C data. Collaboration of scientists to analyse data and develop theoretical interaction models in the framework of an approved Envisat AO project was solicited.

Multi-sensor Synergy

The benefits of multi-sensor near-coincident observation of ocean study sites for identifying a range of oceanic features was clearly demonstrated with ERS SAR, ATSR, Scatterometer and Altimeter data. The need for ocean colour data was stressed and plans for coincident observations with ASAR/MERIS were presented.

SAR Interferometry made Easy

A new methodology was proposed for non-radar expert use of interferometric data based on resampled complex imagery, and the necessary software tools have been developed.

ASAR Data Quality

The conclusions and recommendations of a study of the optimisation of the ASAR instrument parameter setting and the ASAR processing parameters were presented. The study was carried by one of the ENVISAT Expert Support Laboratories and the study results will be implemented.

Conclusions

During the session a number of plans were presented for ENVISAT data exploitation. These included the investigation of oceanographic and atmospheric features in SAR imagery using the ASAR alternating polarisation mode, the utilisation of multi-sensor synergy opportunities with ENVISAT, a new tool for SAR interferometry work and the optimisation of ASAR data quality.

OCEAN DYNAMICS

Chairman: John Lillibridge
Co-Chairman: Jérome Benveniste

More than in previous ERS Symposia, the layout of sessions at the Gothenburg meeting was less divided along instrument lines, and more truly thematic in nature. This was clearly evidenced in the Ocean Dynamics session, where results were presented from a variety of missions (ERS, T/P, GFO) as well as instruments on-board ERS-2 (RA, ATSR, SAR), dealing with oceanographic phenomena at different spatial and temporal scales.

One of the overall highlights of the oral session was the demonstration of continuing improvement in the ERS altimetry data, both in terms of operational timeliness and ability to identify processes that would not have been possible in the recent past. A novel usage of processing the Doppler returns from the SAR system showed the potential for estimating ocean surface currents with high reliability from SAR scenes. Two other presentations utilising SAR data illustrated the myriad phenomena that can be observed, and advances in quantifying them.

Many of the posters exhibited high quality both in terms of their scientific results as well as their visual graphical appeal. Two companion posters on Rossby wave propagation showed novel uses of altimetry, SST, and ocean colour in their identification and means of automated phase speed calculation.

PERFORMANCE

Chairman: Pascal Lecomte
Co-Chairman: Betlem Rosich Tell

Many activities are carried out by ESA and scientists to continuously assess and measure the quality of the ERS mission, not only in relation to the products but also in terms of instrument performance and orbit accuracy.

This activity does not stop with the assessment but aims at putting in place everything required to maintain the best possible quality both for the mission and for the products and to exploit at the best the system capabilities. A good example of exploiting the system capabilities is the high precision orbit control carried out after the Izmit earthquake by ESOC in order to provide users with a 35-days InSAR pair (including one pre and one post-seismic image) with a very small baseline.

The most recent example of the activities carried out in order to maintain the best mission quality is the development, installation and validation of the ERS-2 mono-gyro configuration which, after an important effort from all partners within and outside ESA, succeed in maintaining the good quality of the ERS-2 mission.

The concerns of users, both scientists and market oriented companies, is linked to the continuity of the products. The ESA answer to these concerns is that the maximum effort is put in place to ensure this quality continuity even under non-nominal mission conditions, taking advantage of very good spacecraft design, of the overall system flexibility and of the experience gathered during 10 years of ERS mission.

RICE

Chairman: Thuy Le Toan
Co-Chairman: Sylvie Rémondière

Potential of SAR data for rice mapping and monitoring has already been demonstrated in the past. The projects presented in the rice session reported results obtained applying already known methods to new sites and focused particularly on the development of analysis techniques and the development of user tools.

Retrieval of essential parameters for rice mapping is based on temporal backscatter behaviour analysis (ratio image method, multi-temporal combination of SAR images). Examples were presented for both temperate area (Camargue, France) and tropical areas (Indonesia, China, Sri Lanka and Vietnam). All presentations concluded that a good agreement is found for rice acreage extracted from ERS SAR data versus conventional agricultural statistics. The choice of optimum image acquisition dates versus rice growth is a condition for a successful mapping. Discrepancies are due to:

- Small field size
- Errors in field boundaries determination

The extraction of the crop sowing date and the biomass has been experimented from the ERS SAR backscatter analysis. Both parameters are introduced in a rice growth model for yield estimation. Experimentation is on going.

A major step toward operational monitoring has been the development of user tools and the transfer of knowledge to users. Algorithms and processing chains has been set up and validated for rice mapping and yield prediction. It is possible to achieve a fast mapping within few days of satellite acquisition.

Future developments will focus on methodology refinement for large-scale mapping and refinement of crop growth model.

SEA SURFACE TEMPERATURE

Chairman: Ian Barton
Co-Chairman: Philippe Goryl

The first objective of ATSR-1/ 2 and AATSR is to provide Sea Surface Temperature with a high precision (0.3 K). SST is a key parameter for numerous applications such as climate and oceanographic studies, global warming, tourism, fisheries applications, etc.

The SST session clearly shows that ATSR/SST can provide useful data for diverse applications.

The coral bleaching on Australian's Great Barrier Reef is an important phenomenon, which occur when the SST is above a certain threshold (around 29.5 deg). For the detection of coral bleaching very high precise SST measurements are needed. ATSR appears to be much more appropriate than AVHRR for such application. ATSR gives a much better result than AVHRR, especially in areas of upwelling. This application seems quite mature enough to provide an operational service and the use of NRT data would enhance this application.

Responding to the primary objective of the ATSR mission, ATSR/SST is used with success to evaluate the change in the long term (1991-2000) Sea Surface Temperature at global scale. Results show a good agreement with AVHRR analyses. Moreover a good correlation is found with Radar Altimeter providing the Sea Surface Level. A clear warming is observed in the West Pacific when a cooling down is observed in the East Pacific. The Atlantic is warming up a little bit. According to the results, we observe a global SST warming of about 0.1 degrees per year and a sea level rise of about 0.1 cm per year.

The satellite data are a very important contribution for the EO programme. The CAL/VAL is a key issue for such application. There is a clear for a long-term series of data, processed with similar algorithms in order to ensure good continuity.

Another issue addressed in the session was the skin/bulk temperature conversion. Bulk Sea Surface Temperature measurements are widely available from buoys and ships. For validation purpose it is easier to compare satellite bulk SST with buoys and ships SST. ATSR products provide a skin SST. A method has been developed to convert the ATSR skin SST to bulk SST. So far, the results show a cool bias with respect to in situ measurements. The bias is higher in the daytime. UK-Meteo Office is now improving the quality of the skin/bulk conversion coefficient. These studies could lead to the definition of an 'operational' ATSR bulk SST.

Another application presented showed the correlation between AVHRR SST and SeaWiFS ocean colour data in an area of upwelling off the coast of Spain. This application, which has potential application for fisheries, may be further developed using ENVISAT AATSR SST and MERIS ocean colour products.

SEA FEATURES

Chairman: Richard Olsen
Co-Chairman: Andrea Petrocchi

Highlights

Authors presenting their work in this session have used mostly SAR in combination with other sensors and data sources (as SeaWiFS, AVHRR, NOAA, ECMWF), as well as in-situ measurements. In some cases comparison with models were made.

- The first paper describes internal solitary waves in the Central Bay of Biscay and demonstrate that they are generated locally where the beam of internal tidal energy reaches the ocean surface. These phenomena are in strong correlation with other effects as surface cooling, water mixing, phytoplankton blooms. This is the reason why in this kind of studies the SAR observations are matched and compared with data from other sensors. In the case of this work SeaWiFS and AVHRR image data were used in addition to SAR images.

-The second presentation is a study of the Russian Foundation for Basic Research about ocean processes occurring in the Bering Strait. Phenomena like meandering fronts, eddy activity, vortexes, strong jet-like currents and intrusions of cold water are investigated using SAR images.

- The School of Ocean and Earth Science, University of Southampton UK, performed experiments over the South Andaman Sea. Also in this case several data sources are used in order to investigate the local oceanic phenomena in strong relation with atmospheric ones. In-situ observations are analysed in addition to ECMWF winds, Topex-Poseidon SSH and ATSR SST data. This work highlights the special role that SAR image data have for synoptic understanding of the environment of internal wave generation and evolution through different depth and stratification regimes.

- The Norwegian Defence research Establishment has acquired images along the coast of Northern Norway since the early part of the ERS-1 mission. The continuous and long term SAR image analysis of the continental shelf gives now the possibility to synthetise observations, and comment on signatures and observability of various features throughout the various seasons of the year.

- SAR Imagery has been studied to estimate the depth of internal waves in South China Sea. Observation and measurements of internal wave dynamics from SAR images are used as input for model. Results show reasonably good agreement with in situ measurements.

Recommendations

Most of the work presented in this session shows that SAR observations can provide qualitative information about significant ocean circulation features. To progress further in retrieving quantitative geophysical data from SAR observations, more work is required in developing and combining imaging models and appropriate hydrodynamic ocean models. Some innovative multi-sensor approaches were also presented. This work should continue to be emphasised. Ocean circulation features are highly dynamic. Their signatures in SAR imagery are strongly influenced by changing meteorological conditions. Frequent coverage of selected sites should be pursued to learn more about the variability of the features and their signatures in SAR images.

Conclusions

SAR images have been used successfully to gain more insight into local and meso-scale ocean dynamics. Significant progress has been made in the ERS era to classify different types of features commonly observed in SAR images. Quantitative information extraction is often dependent on multi-sensor approaches and/or combinations of SAR data with ocean models. Beyond spatial extent and geographic location, SAR observations alone provide limited quantitative information. Significant progress has been made with ERS data, however, with observations of internal waves. Internal waves have been observed in many different ocean regimes, and can be used to estimate important parameters of internal wave fields and conditions in the mixed upper layer of the ocean.

SEA ICE

Chairmen: Preben Gudmandsen, Benjamin Holt
Co-Chairman: Ola Grabak

The presentations were covering techniques and applications such as sea ice characterisation, sea ice thickness, navigation through sea ice, sea ice motion and polynyas.

The major findings and results are presented below:

- Arctic sea ice thickness can be derived with an accuracy of 0.5 meters from ERS altimeter measurements. Overall trend shows that average sea ice thickness for the area is decreasing by 0-1 cm per year (1993-1999). It is important to note that there are strong regional variations, which means that sea ice thickness is increasing in some areas, but decreasing in others.
- Sea ice thickness has also been derived using deformation of Lagrangian cells. The time dependent deformation of these cells is computed from the motion of the vertices obtained by tracking these points in SAR imagery. The technique is suitable for polar investigation as well as operational applications.
- The ERS wave mode imagettes data set is ideal for the observation of the sea ice cover south of 84 degrees
- Changes in SAR image tone and texture can provide the spatial extent of areas having similar ice thickness. This has been shown comparing SAR and video images acquired by helicopter.
- Polynyas can be detected and characterised using a numerical model, ERS SAR and SSM/I images
- ERS and Radarsat SAR images have been used to provide navigation support through the Kara Sea for an icebreaker. The provision of this service increased the speed of the icebreaker by a factor of 2.
- The Canadian Sea Ice Service using ERS and Radarsat has demonstrated the importance of an end to end fully operational ice information system. ASAR from Envisat will provide a complementary source of data and bridge the gap to Radarsat 2.
- Using ERS SAR and ATSR in combination has shown successful in detecting sea ice freeze-up, melting, evolution, kinematics.

Most presenters report that the techniques and applications exploiting SAR data are expected to show improved results when Envisat ASAR data is available.

SERVICES AND MARKET

Chairman: Steve Coulson
Co-Chairman: Philippe Bally

Highlights

- Both newly appointed ERS & Envisat Distributing entities (EMMA – led by Eurimage, & SARCOM led by SpotImage) presented their consortia & activities to increase commercial use of EO missions data.
- A number of commercial AO projects were presented, covering the thematic areas of Topographic Mapping Agriculture, Forestry, Oil spill detection & Marine information services.
- Good short-term prospects exist for commercial services in the Marine sector. The cost of service provision has decreased, the customer interest is increasing, and global wave information services are being sold on-line today.
- ERS Tandem data has been used to successfully produce a wide-area DEM for the Telecoms sector in Switzerland. The customer has validated the product provided.
- In addition to continuing the focused activities of the first phase of the ESA Data User Program, it is planned to start new sizeable projects in the areas of Disaster Management, Environmental Services & Natural Resources Management in the next phase (DUP-2).
- A new ESA activity of Support to the Development of Markets for EO products & services is starting now, and will initially last for 3 years. This is defined in close consultation with Industry & includes 10 – 30 short-term activities geared to specific opportunities, together with a few consolidated longer-term actions to bring key EO product & services to full market maturity.

Conclusions

- Activity geared to operational & commercial exploitation of EO data is increasing. New Value-Adding companies are being set-up and a few EO services are being provided today on a commercial basis. The newly appointed Distributing Entities will provide easier commercial access to ERS & Envisat data.
- The timescales associated with the development of EO services require that sustained support is available for a number of years. The ESA DUP program is providing this type of support & will further enable collaborative projects to be started at a European level, which demonstrate EO services to both Institutional & Industrial users.
- Value Adding Industry has expressed a very high interest in the ESA support to market development program. This industry cannot handle the financial risks associated with this type of activity alone.

TOPOGRAPHY

Chairman: Philippa Berry
Co-Chairman: Steve Coulson

Highlights

ERS RA Ice Mode data over land provides accurate information on terrain height (70% of cross-over measurements agree to < 5m). In addition, it provides valuable information on the type of land cover.

A DEM has been generated for the total area of the British Isles, using ERS Tandem interferometry. The DEM generation process is fully automatic. This DEM has been validated with a typical accuracy of 8-14 m rms. It can be used to derive fully connected hydrographic networks and catchment areas.

Recommendations

Further work should be done on the optimum methods for deriving DEM's from a variety of Earth Observation data sources (i.e. optical stereo, SAR radargrammetry, SAR interferometry). The initial results for fused DEM's are encouraging and demonstrate increased coverage and quality of the final DEM.

ENVISAT RA2 should provide better measurements of height over land, but further testing of resolution mode switching algorithm is required.

Conclusions

The generation of accurate height measurements from both the RA and SAR continues to be demonstrated for large areas. The resulting DEM's are being used successfully in hydrological and geological applications.

VEGETATION AND AGRICULTURE

Chairman: Henning Skriver
Co-Chairman: Juerg Lichtenegger

Highlights

There have been 8 papers in this session, 3 dealing with SSM/I and ERS Scatterometer land application, 3 with multitemporal SAR crop mapping, one with detailed backscatter modelling and finally there was a paper calling for help to assist in the protection of a still untouched region in the Amazon. The relevant Poster Session included a proposal for a P-band low-cost satellite and the demonstration of a crop-monitoring system in Spain.

As already reported in previous papers, the ERS Scatterometer data has been very useful for regional to global vegetation and soil moisture monitoring. The combination of using simultaneously SSM/I and SCATT adds a further promising piece of information, especially to differentiate more surface types. The comparison of typical soil land cover such as desert, deciduous and coniferous forest as well as large agricultural ground (Po-Valley) vegetation cover show characteristic behaviour when analysing for SSM/I indexes of frequency, polarisation and slope against time.

For SCATT at 45 degrees incidence angle a high correlation with heavy rainfalls could be detected and the combined frequency/polarisation index allowed an estimation of the snow depth. While SCATT is much more sensible to rainfall, the NDVI would not indicate small vegetation coverage subsequently. Modelling and inversion of backscatter for grassland has been undertaken using a new approach. Global sets of SCATT data, monthly averaged were produced and compared with world coverage of 5x5 km of LAI (Leaf Area Index). Typical seasonal pattern could be derived for a variety of land covers, but interpretation has to be cautiously performed, because change could also be related to the azimuth angle (e.g. over deserted area). When plotted on a yearly base the SCATT backscatter values have a good agreement with the LAI.

The studies also confirm the sharp drop during freeze/thaw, which is linked either to wet snow or water logged soil.

The session included also a paper on a very detailed tree shape description for backscatter modelling, which allowed deriving parameters to distinguish between spruce and pines. The modelling using several millions of 3D-points turned out to be very computing-intensive. The first few orders of parameters show just a cone-like model and only from the 10th order onwards the shape of the tree can be recognised.

A new approach for crop classification of optical/radar data has been proposed, using logic decision trees. It is based simply on logical inclusion or exclusion in a temporal series of data. Despite the results in earlier studies, it was reported that the EU project MARS will not use RS data in the near future. The reason is manifold but also includes the data availability and especially the data cost. Good success in crop type recognition was demonstrated with the polarimetric C-band airborne EMISAR. The dual-polarisation was studied in preparation for ENVISAT.

Recommendations

The good success of SCATT applications on land calls for a continuation of the mission and for a more insisting promotion of its practical application for regional monitoring of soil moisture (e.g. Sahel) and for determination of the thawing moment in spring (start of vegetation period).

Conclusions

The ERS Scatterometer has been further exploited and its use for regional monitoring was confirmed.The EU MARS programme will phase-out the use of remote sensing data, mainly also because of the cost-effectiveness.

Airborne C-Band, dual-polarisation adds to the information content in crop type classification, paving the way for a potentially successful application for ENVISAT.

WIND AND WAVES

Chairmen: Susanne Lehner, Werner Alpers
Co-Chairman: Andrea Bellini

Highlights

Presentations show significant scientific progress and focussed on the use of the three main sensors for wind and wave field retrieval: altimeter, scatterometer and SAR both in image and wave mode. In view of the ENVISAT mission, an increasing interest has been shown by the ocean community for high-resolution SAR data.

- **Altimeter**

Altimeters provide estimates of the wind speed and the significant wave height that need to be calibrated properly for possible operational services. ERS and the other altimeter missions are compared with either in-situ data or models simulations. Wind speed retrieval techniques show insufficient accuracy when applied to coastal regions. For the wave fields, comparisons with ERS data performed in the North Sea indicate 10% underestimation for values larger than 1m and a slight overestimation for values below. For wind speed, it was shown that numerical models (i.e. ARPEGE or ECMWF) are in better agreement with the measurements for high wind speeds (examples in the Black Sea and in the Mediterranean).

- **Scatterometer**

The Ocean and Sea Ice Satellite Application Facility (OSI SAF supported by EUMETSAT and hosted by Meteo-France) is preparing a pre-operational wind product based on ERS-2 scatterometer data. Preparatory work is in progress for the wind product of the ASCAT scatterometer to be flown on METOP. ECMWF has presented an analysis on the impact of scatterometer wind data on cyclones tracking. Problems are related to rain contamination of the Ku band data (QuikScat) and cross-comparisons with ERS data allows to discuss quality control aspects. Difficulties of ECMWF wave model to model Mistral conditions at short fetch in Gulf of Lions were reported. The Product Control Service (PCS) at ESRIN has developed a post processing procedure for ERS fast delivery products aimed at detecting tropical cyclones (74% of cyclones retrieved with an average of two alarms per day). A report and the corresponding reprocessed SCATT products are available in near real time on a web site. Interest in this product was shown by ECMWF, which pointed out that this product is very helpful for them.

- **SAR**

Different methodologies are applied in extracting wind and wave fields either from image and wave mode data. Amplitude images are used (local gradient of wind induced features) or spectra (with 180 degrees ambiguity removable in coastal areas if shadowing effects are present). Possibilities for successful extraction of wind fields are shown for a grid of about 1x1 km for wind direction and 0.1 km for wind speed. Operational use of ScanSAR RADARSAT wind maps is in place at the Danish meteorological institute. Some results are shown for the marginal ice zone, where SAR (CMOD4) estimated wind fields are usually too low, probably due to sea ice on the water surface. It is however still a valuable information for model validation. Furthermore, preliminary results show that open water areas must be relatively large (about 5x5 km^2) in order to retrieve wind speed comparable with numerical models.

A lot of work is done in preparation to ENVISAT, preliminary validation of ASAR wave mode level 1b and level 2 products has been presented using ERS wave and image mode SLC data collocated with in-situ measurements. It has been demonstrated that the cross spectra product of the ENVISAT wave mode is superior to the corresponding ERS product in terms of signal to noise ratio (20 dB) and retrieval of the wave direction. For the level 1 product, main results show that when ocean swell systems are detected, the propagation ambiguity is resolved in the majority of the cases. Statistical figures are also provided as a result of a good number of data processed: spectral peak wavelength and propagation direction RMS were 50m and 40 degrees respectively; mean peak wavelength is approx. 250m, the average azimuth cutoff value of the order of 250m. For wind fields retrieval, the level 2 product gives wind speed with rms error below 2 m/s and wind direction with rms error from below 20 degrees to 35 degrees.

An interesting field experiment using new airborne polarimetric radar will take place during the ENVISAT commissioning phase. The measurements foreseen will help to validate current inversion methods and appear very promising to further progress in the inversion of radar data in wind and wave products. In addition, the analysis of full polarimetric data is still to be exploited and may bring new insight in the analysis of the ocean surface.

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Chair: Piet Stammes
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Chair: Fabio Rocca
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Chair: Manfred Zink
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Chair: Christopher Mutlow
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17.20 – 17.40	439	SCIAMACHY Nominal Operations and Special Features	Stefan Noel
17.40 – 18.00	472	Validation of trace gas measurements of the ENVISAT instruments MIPAS, GOMOS and SCIAMACHY using in-situ and remote sensing balloon borne techniques	Hermann Oelhaf
18.00 – 18.20	497	Geophysical validation of level-2 products of MIPAS, GOMOS, and SCIAMACHY by dedicated campaigns of the high-altitude aircraft M-55 Geophysica	Cornelis Blom
18.20 – 18.40	446	An optimized forward model and retrieval scheme for MIPAS near real time data processing	Marco Ridolfi

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	87	Advanced MIPAS-Level-2 Data Analysis (AMIL2DA)	Thomas v. Clarmann
	286	Operational Long Term Monitoring of the SCIAMACHY Instrument on ENVISAT	Manfred Wuttke
	330	German Contribution to SCIAMACHY Validation with Ground-based FTIR Observations from the NDSC Network: Preparation Phase	Ralf Sussmann
	11	Calibration and evaluation of Envisat temperature and ozone data using statistics from the UK Met Office NWP system	William Lahoz
	413	Comparison of Ground Based FTIR measurements at Harestua to spaceborne measurements	Johan Mellqvist
	470	SAFIRE-A measurements during the APE-GAIA campaign	Giovanni Bianchini
	285	Tools for the Analysis of Residual Spectra Affecting MIPAS Level 2 Products	Siegfried Hilgers
	339	Ground Based High Resolution FTIR Measurements of Stratospheric Molecules above Harestua, Norway, during 1995 to 2000.	Bo Galle
	2	Upper atmospheric NO from SCIAMACHY : simulations and instrument capabilities.	Christian Muller
	505	NDSC Support to the Development of ERS-2 GOME Geophysical Data	J.C. Lambert

ENVISAT ESA 1

Chair: Yves Louis Desnos
Co-Chair: Guido Levrini

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
14.00 – 14.10	449	The ENVISAT System	Guido Levrini
14.10 – 14.20	1414	Earth Observation in the Fifth Framework Programme	Michel Schouppe
14.20 – 14.40	450	The ENVISAT Cal / Val Approach	Guido Levrini
14.40 – 15.00	477	ASAR Instrument Calibration	Christopher Buck
15.00 – 15.20	504	ASAR ground Processor verification and Wave validation	Yves-Louis Desnos
15.20 – 15.40	447	MERIS instrument calibration	Steven Delwart
15.40 – 16.00	444	MERIS validation Plan	Jean-Paul Huot
16.00 – 16.20		*Coffee Break*	

ENVISAT ESA 2

Chair: Guido Levrini
Co-Chair: Yves Louis desnos

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
16.20 – 16.40	475	MIPAS Calibration and Processor Verification	Herbert Nett
16.40 – 17.00	466	GOMOS Calibration and Processor Verification	Torgeir Paulsen
17.00 – 17.20	488	The validation of the products derived from the Atmospheric Chemistry Instruments	E. Attema
17.20 – 17.40	411	The SCIAMACHY Validation program	H. Kelder
17.40 – 18.00	454	The RA-2 Calibration Program	Monica Roca
18.00 – 18.20	256	The RA-2 and MWR Validation and Cross-Calibration	Jerome Benveniste
18.20 – 18.40	502	The validation of the ENVISAT orbits	Patrick Vincent
18.40 – 19.00	29	The AATSR Cal/Val plan	Marianne Edwards

ENVISAT RA2

Chair: Jérôme Benveniste
Co-Chair: Monica Roca

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	34	An ENVISAT S-Band altimeter CAL / VAL experiment in the framework of the OSCAR project	Monique Dechambre
9.20 – 9.40	171	Radar Altimeter Calibration using Ground Based Transponders	Andrew Birks
9.40 – 10.00	276	The ENVISAT RA-2 Value-Added Ocean/Ice Processor at GFZ Potsdam	Alexander Braun
10.00 – 10.20	257	The ENVISAT Altimetry Mission Data Products	Jerome Benveniste
10.20 – 10.40	106	CLS contribution to Envisat CALVAL	Joël Dorandeu
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	135	Absolute and Relative Calibration of ERS-2 RA with Applications to ENVISAT	Philip Moore
11.20 – 11.40	142	Land Calibration and Monitoring of ENVISAT RA-2 Sigma0	Philippa Berry
11.40 – 12.00	337	Measurements and modeling of ocean surface slopes and calibration of the radar altimeter	Bertrand Chapron
12.00 – 12.20	427	The CATALA campaigns: Indirect calibration technique for ENVISAT altimeter calibration	J. J. Martínez-Benjamin

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	26	Analysis of the effect rain on Envisat altimeter: definition of a rain flag	Jean Tournadre
	114	Concept for using GPS-buoys for RA drift monitoring	Tilo Schoene

FLOODS AND STORMS

Chair: Herve Yesou
Co-Chair: Marc Paganini

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
11.20 – 11.40	104	China Remote Sensing Satellite Ground Station and its Flood Monitoring with ERS in China.	An Li
11.40 – 12.00	453	Flood monitoring in Bangladesh. An application of SAR imagery for impact assessments of flood extent, flood depth and duration.	Joris de Vente
12.00 – 12.20	327	Evaluation of multitemporal radar data for the mapping of inundation dynamics in the Save-flood plain (Croatia)	Roland De Kook
12.20 – 12.40	122	Contribution of ERS SAR images and ERS coherence data to a flood information system on the Meuse basin -France	Hervé Yesou
12.40 – 13.00	123	Application of SAR-data for flood modelling in Southern Germany	Heike Bach
13.00 – 14.00		*Lunch Time*	
14.00 – 14.20	203	Validating soil moisture estimation with ERS PRI data: operational use in DeciDe, a decision support system for floods	Alberto Ortolani
14.20 – 14.40	118	Mapping Storm Forest Damage using SAR Coherence Data. The case of the Haguenau Forset - France	Hervé Yesou
14.40 – 15.00	165	Forest storm damage assessment with ERS tandem data	Andreas Wiesmann
15.00 – 15.20	210	The Devastation of Venezuela by Heavy Rains in December 1999: Assessment of the Situation using ERS InSAR Tandem Data and SPOT Images	Edmond Nezry

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	27	Flood monitoring in the Senegal River valley: First results based on SAR PRI data	Rasmus Fensholt
	217	Mapping and Evaluation of "Mitch" hurricane damages in Central America using ERS SAR and SPOT images	Edmond Nezry
	329	A rapid Mapping System for Hurricane Damage Assessment	Kader Fellah
	250	Watching for the Hazardous Spring 99 Flooding in the Chernobyl Zone in Ukraine with the ERS SAR Images	Rudolf Greku

FORESTRY

Chair: Martti Hallikainen
Co-Chair: Henri laur

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
11.40 – 12.00	235	ERS and JERS-1 SAR data application for Russian boreal forests mapping and monitoring	L.P. Bobylev
12.00 – 12.20	81	Boreal Forest Monitoring with ERS Coherence	Maurizio Santoro
12.20 – 12.40	196	An Analysis of InSAR Coherence of Boreal Forests Based on Electromagnetic Scattering Modeling	Xianyun Luo
12.40 – 14.00	251	Mapping Siberian Landscapes: natural and Anthropogenic Factors affecting Carbon Balance	Jon Ranson
13.00 – 13.40		*Lunch Time*	
14.00 – 14.20	469	Characterizing transpiration and biomass in a Siberian landscape by combining JERS / ERS-1/2 InSAR image classification, InSAR DEM analysis and field measurements	Reiner Zimmermann
14.20 – 14.40	308	Calculation of Microwave Backscatter from a Scots Pine Forest	Terhikki Manninen
14.40 – 15.00	492	Combined use of soil and vegetation data, a digital elevation model and SAR classification for C and N Pool Assessment in a Central Alaskan landscape	Jan Dempewolf
15.00 – 15.20	369	An Operational Forest Mapping Tool using Spaceborne SAR Data	Eduard Dwyer
15.20 – 15.40	1053	Global burned Area mapping using the ERS-ATSR2	Jose Miguel Pereira

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	97	Pine forest understorey sensing with ERS-2 SAR imagery	Leonor Cadete
	398	Processing and Integration of Multisensor and Multidate Satellite Data for Forest Management Mapping in Gabon (application to the first forest zone)	Marcellin Nziengui
	513	Usefulness of ERS coherence time series for monitoring the vegetation cycle of a mixed temperate forest.	Christophe Proisy
	489	Mapping China Forest with ERS SAR Tandem Data	Ranera Franck
	521	Fire damage assessment using ERS-SAR and NOAA-AVHRR data in East Kalimantan, Indonesia	Ruandha Agung Sugardiman
	85	ERS coherence and SLC images in forest characterisation	Terhikki Manninen
	271	Fire impact assessment in Indonesian rainforests with ERS and JERS SAR data	Florian Siegert

GEODESY

Chair: Remko Scharroo
Co-Chair: Pierre Femenias

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
15.20 – 15.40	92	The KMS99 Global Marine Gravity Field from ERS and GEOSAT Altimetry	Ole Andersen
15.40 – 16.00	350	Improved Modelling of Earth Gravity and Impact on ERS POD	Christoph Reigber
16.00 – 16.20		*Coffee Break*	
16.20 – 16.40	248	Black Sea Geoid and Sea Surface Topography with the ERS-1 Altimeter Data	Rudolf Greku
16.40 – 17.00	226	The time tag bias of ERS altimeter data	Remko Scharroo
17.00 – 17.20	198	Identification and Correction of Clock Asymmetry in the ERS-1 and ERS-2 Radar Altimeters	Richard Francis
17.20 – 17.40	227	Analysis of geophysical corrections applied to ERS altimeter data	Remko Scharroo

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	148	Non-Parametric Estimation of the Wet Tropospheric Correction, Cloud Liquid Water Content and Sea Surface Wind Speed in ERS Configuration.	Estelle Obligis
	346	The PRARE System onboard ERS-2: Status and Results	F.H. Massmann
	136	ERS Orbit Determination and Gravity Field Model Tailoring: Recent Developments	Remko Scharroo
	228	A recipe for upgrading ERS altimeter data	Remko Scharroo
	168	Operational Altimetry at GFZ - From ERS-2 to Envisat	Matthias Rentsch
		New mean sea surface and gravity anomaly determination for ocean circulation studies	Fabrice Hernandez

GEOLOGY AND VOLCANOES

Chair: Geoff Wadge
Co-Chair: Maurizio Fea

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	32	Comparing spaceborne ERS-SAR and airborne geophysical data : Application to geology in the French Guiana rainforest landscapes	Jean-Paul Deroin
9.20 – 9.40	194	Reconstruction of the paleodrainage and geologic evolution of Lake Abhe, East Africa	Lucia Marinangeli
9.40 – 10.00	224	ERS SAR Data and DEM Analysis to complement the Geological Interpretation of the Kalecýk-Hasayaz basin, Ankara, Türkýye	Tamer Özalp
10.00 – 10.20	30	Studies of volcanoes of Alaska by satellite radar interferometry	Zhong Lu
10.20 – 10.40	1055	First results from operational volcano monitoring in the Canary Islands	Daniel Carrasco
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	441	Operational use of InSAR for volcano observatories: experience in local reception at Montserrat	Geoff Wadge

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	407	Synergism of optic and radar data to optimize lithostructural mapping and mineral exploration in South-East Senegal and Mali (West Africa)	Souleye Wade

HYDROLOGY 1

Chair: Helmut Rott
Co-Chair: Maurice Borgeaud

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	53	Comparison ERS SAR Data derived Soil Moisture Distributions with SVAT-Model Results	Wolfram Mauser
9.20 – 9.40	338	Comparisons of detailed in-situ soil moisture and rain measurements with ERS radar backscattering data	Maurice Borgeaud
9.40 – 10.00	455	Applying surface roughness discriminator based on partially polarised SAR data to soil moisture inversion	Francesco Mattia
10.00 – 10.20	458	Generalised inversion algorithm for bare soil moisture mapping using ERS SAR data	Malcolm Davidson
10.20 – 10.40	417	Inferring the Effect of Plant and Soil Variables of C and L Backscatter over Agriculture Fields Based on Modeling Analysis	Katarzyna Dabrowska-Zielinska
10.40 – 11.00		*Coffee Break*	

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	93	Soil moisture estimation with SAR.PRI ERS images	Hector Salgado
	4	Soil Moisture Mapping Using ENVISAT ASAR and ERS-2 Data in the Southern Great Plains Region of the U. S	Thomas Jackson
	269	Appraisal of SAR Data Application in Assessment of Soil Salinity and Waterlogging Problems in Bahawalnagar and Bahawalpur Districts, Pakistan	Iftikhar Ahmed
	117	Feasibility of using SAR derived soil moisture to enhance the robustness of vegetation index based crop yield models.	Sushma Panigrahy
	331	Assessment of the ERS Times Series Fusion and Coherence Analysis for the Monitoring of Environmental Sensitive Areas in Alsace	Kader Fellah
	259	ERS-2, RADARSAT SAR backscattering characteristics of the Parana River Delta Wetland, Argentina	Haydee Karszenbaum
	491	Observation of the wetland hydrology in the Unstrut catchement in Thuringia (Germany) by multitemporal ERS-1 and ERS-2 SAR data	Volker Hochschild
	493	Monitoring of water hyacinth abundance and its occasional factors in Lake Victoria Area (East Africa) using ERS-1 and ERS-2 SAR data	Volker Hochschild
	48	The Contribution of ERS Satellite Altimetry to Hydrological Applications	Charon Birkett
	125	Retrieval of Geo- and Biophysical Information from Remote Sensing data - Overview of the GeoBIRD study	Heike Bach
	418	Application of ERS-2.SAR data for soil moisture estimates over flooded areas.	K. Dabrowska-Zielinska

HYDROLOGY 2

Chair: Helmut Rott
Co-Chair: Maurice Borgeaud

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
11.00 – 11.20	62	An approach for radar backscatter and pedologic soil characteristic investigation	Piero Boccardo
11.20 – 11.40	205	Soil moisture mapping from ASAR imagery for the Flumendosa (Italy) and Meuse (Belgium-Netherlands) river basins	Claudio Paniconi
11.40 – 12.00	96	Combining the microwave model CLOUD and the growth model PROMET-V for soil moisture retrieval	Roswitha Stolz
12.00 – 12.20	193	Mapping and Monitoring of Wetlands in the Lake Chad-basin using ATSR-2 Data (Project AO3-151)	Jan Verhoeye
12.20 – 12.40	112	SAR-based monitoring of flood-induced landcover and landuse change in the region of the inland delta of the river Niger (Mali)	Elmar Csaplovics
12.40 – 13.00	67	On Estimating Snow Wetness Using ASAR Measurements	Jiancheng Shi
13.00 – 14.00		*Lunch Time*	
14.00 – 14.20	247	Real Time Snowmelt Runoff Forecasting using ERS SAR PRI data	Thomas Nagler

ICE 1

Chair: Christopher Doake
Co-Chair: Espen volden

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	86	Processing interferometric ERS-1/2 Tandem data coast to coast in Greenland	Johan Jacob Mohr
9.20 – 9.40	3	Unsteady flow in the Antarctic ice sheet revealed by SAR interferometry and radar altimetry	Andrew Shepherd
9.40 – 10.00	36	ERS Altimetry in Antarctica	Frederique Remy
10.00 – 10.20	37	Interferometry and altimetry above Dome C, Antarctica	Benoit Legresy
10.20 – 10.40	134	SAR Interferometric Analysis of David Drygalski Glacial System and Nansen Ice Sheet (Antarctica)	Franco Coren
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	154	The evolution of a glacier surge observed with the ERS satellites	Tazio Strozzi
11.20 – 11.40	253	Investigation of Correlations Between Temporal Variations of Radar Backscatter and Altimeter-derived Ice Sheet Elevation Changes	Anita Brenner
11.40 – 12.00	284	Glaciological information derived from combining interferometric SAR with other remote sensing measurements	Niels Reeh
12.00 – 12.20	396	Eight years of ERS1/2 observations of the evolution of West AntarcticGlaciers: What have we learned ?	Eric Rignot
12.20 – 12.40	471	Surface motion and grounding line detection, measured by differential ERS-SAR Interferometry, Thwaites Glacier, West Antarctica	Bernhard Rabus

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	397	Validation of ice flow models with ERS SAR observations of Antarcticglaciers and ice shelves.	Eric Rignot
	476	Measurement of windspeed and snow-humidity on the Antarctic Peninsula using ERS-SAR-tandem interferometry	Bernhard Rabus
	1407	Differential Interferometric SAR for global change monitoring at Dronning Maud Land, Antarctica	Elaine Rowan

ICE 2

Chair: Johan Jacob Mohr
Co-Chair: Espen Volden

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
14.00 – 14.20	500	Glaciological Investigation of Mertz Glacier, East Antarctica, usingSAR Interferometry and field observations	Anja Poetzsch
14.20 – 14.40	65	Equilibrium and firn line detection with multipolarisation SAR	Max Koenig
14.40 – 15.00	324	Features of Topography and Dynamics of Glaciers of the Western Antarctic Peninsular by the ERS SAR Interferometry	Rudolf Greku
15.00 – 15.20	320	Shrinking of the Arctic ice Cover over the last two decades	Ola M. Johannessen

LAND COVER / LAND USE

Chair: Mike Wooding
Co-Chair: Olivier Arino

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	357	Monitoring Rapid Urbanisation with Imaging Radars	David Archer
9.20 – 9.40	229	Synergy Study of Multisource Data for Characterisation and Monitoring of Soil Surfaces. Application to Algiers and Laghouat Regions (Algeria).	Youcef Smara
9.40 – 10.00	495	Application of ERS-SAR and scatterometer to the study of backscatter anisotropy in urban areas	Benedicte Dousset
10.00 – 10.20	445	Understanding ERS Coherence over Urban Areas	Attilio Fanelli
10.20 – 10.40	57	Urban Remote Sensing through Multispectral and Radar Data	Paolo Gamba
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	1405	Application of EO data for urban planning in Mega Cities	Christopher Boehm
11.20 – 11.40	309	Inferring building height from SAR interferometric phase coherence images	William Grey
11.40 – 12.00	288	Evaluation of Multisensor Spaceborne SAR for CORINE Land Cover Mapping in Sweden	Yifang Ban
12.00 – 12.20	39	Interferometric SAR DEM construction for landscape process analyses in north-eastern Iceland	Jukka Käyhkö
12.20 – 12.40	332	Optimal use of multi-temporal SAR data for land use information extraction	Hugues Sassier
12.40 – 13.00	293	Use of ERS SAR Imagery in Refugee Relief	Øyvind Dalen
13.00 – 14.00		*Lunch Time*	
14.00 – 14.20	401	Exemples d'utilisation des images radar ERS pour les etudes d'amenagement et la mise a jour cartographique en region amazonienne, Projets ERS AO3-160 Guyane et ENVISAT ID 539	Jean Paul Rudant
14.20 – 14.40	219	Evolution of the Hydrographical Network of the Karakum Desert and Environmental Implications for the Aral Sea	Nikos Lyberis

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	159	Utilization of radar remote sensing and texture analysis for urban cartography in Cameroon : application to Yaoundé city.	Akono Alain
	190	Quantitative Analysis of Temporal ESR InSAR Data over the City of Graz	Lado-Wani Kenyi
	272	Statistical Analysis and Neuro-fuzzy Classification of Polarimetric SAR Images of Urban Areas	Paolo Gamba
	241	Use of multitemporal ERS data for monitoring of landcover change in Sahelian regions. The exemple of the Delta of the Niger river (Mali)	Catherine Mering
	518	Historical land transformation analysis for geographic hazard evaluation in the Italian country.	Mario Aversa
	263	On the use of ERS INSAR and multitemporal data for ecological monitoring of the Chernobyl area.	Alexander Zakharov

LANDSLIDES

Chair: Claudie Carnec
Co-Chair: Francesco Palazzo

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
14.00 – 14.20	395	Regional scale thematic maps for landslide hazard assessment using neural networks techniques.	Palma Blonda
14.20 – 14.40	207	Monitoring landslide activity in a peri-urban area by SAR Interferometry	Alberto Refice
14.40 – 15.00	234	The application of ERS SAR interferometry for the assessment of hazards related to slope motion and subglacial volcanism	Helmut Rott
15.00 – 15.20	181	Detection and Quantification of Rock Glacier Movements using ERS D-InSAR Data	Lado-Wani Kenyi
15.20 – 15.40	147	Civil Protection use of ERS1-2 SAR Data - the TS-SAR Project	Roberto Vidmar

LAND SURFACE TEMPERATURE

Chair: Mariane Edwards
Co-Chair: Alessandra Buongiorno

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	314	Synergistic use of ATSR-2 multispectral and dual-angle data for land surface studies	Zhao-Liang Li
9.20 – 9.40	204	Component temperature retrieval from ATSR-2	Claire Jacobs
9.40 – 10.00	101	Surface Temperature from ATSR-2 Data: Algorithms and Validation	José A. Sobrino
10.00 – 10.20	274	A Model-based Land Surface Temperature Retrieval Algorithm	Guangjian Yan
10.20 – 10.40			
10.40 – 11.00		*Coffee Break*	

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	242	Development of practical algorithm for inferring component temperatures from multi-directional measurements	Li Jia

METHODS 1

Chair: Sylvie Pouliquen
Co-Chair: Pascal Gilles

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	60	A new collocation system for satellite data	Sylvie Pouliquen
9.20 – 9.40	61	CERSAT Value Added Products	Valerie Harscoat
9.40 – 10.00	63	Value Added Geocoded SAR Products from the German ENVISAT PAC	Detlev Kosmann
10.00 – 10.20	174	Developments in AATSR and ATSR Product Algorithms and Data Products	Andrew Birks

METHODS 2

Chair: Shaun Quegan
Co-Chair: Josep Closa

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
10.40 – 11.00	260	SCANSAR data processing and radiometric calibration.	Andy Smith
11.00 – 11.20	18	INSAR Activities in Central Asia	Xia Ye
11.20 – 11.40	218	Speckle Filtering and Classification of ERS SAR Images using GAMMA Distribution	Youcef Smara
11.40 – 12.00	1357	Isolation of atmospheric artifacts in differential interferometry for ground displacement detection: different methods comparison	Francesco Sarti
12.00 – 12.20	1358	An efficient low-memory implementation of 2-D phase unwrapping based on minimum cost flow algorithm	Luca Galli
12.20 – 12.40	94	Multitemporal InSAR coherence from urban type objects.	Dan Johan Weydahl
12.40 – 13.00	1408	Iterated multitemporal filtering and its use in land applications	Shaun Quegan

METHODS 3 / METHODS 4

Chair: Laurence Gray
Co-Chair: Evert Attema

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
14.00 – 14.20	108	Modeling backscattering from leafy vegetation: the incoherent and coherent approaches	Paolo Pampaloni
14.20 – 14.40	182	The application of wavelet-based filtering techniques for retrieving bio-physical parameters from multi-temporal ERS-images	Niko Verhoest
14.40 – 15.00	145	Classification of Multi-temporal SAR Images and INSAR Coherence Images using adaptive neighborhood model and simulated annealing approach	Mingquan Bao
15.00 – 15.20	387	Influence of Auroral Zone Ionospheric Disturbances on Synthetic Aperture Radar and Interferometric SAR Data.	Laurence Gray
15.20 – 15.40	197	Cloud detection from satellite imagery by wavelets	Carmine Serio
15.40 – 16.00	268	Advances in Operational Cloud Clearing for ATSR-1,ATSR-2, and AATSR	Christopher Mutlow
16.00 – 16.20		*Coffee Break*	
16.20 – 16.40	281	Classification of Oceanic and Atmospheric Signatures in ASAR Dual Polarization Mode Imagery	Roland Romeiser
16.40 – 17.00	140	A Multi-Sensor Approach to Monitor Oceanography in the Gulf of Oman	Neil Stapleton
17.00 – 17.20	415	Phasemap, a simple software intended to give an efficient access to interferometry	Michel Rouze
17.20 – 17.40	383	ASAR ScanSAR modes: quality enhancement	A. Monti Guarnieri

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	68	Geolocation of InSAR interferograms	Giovanni Nico
	180	Mosaic generation using ERS SAR imagery	Peter Meadows
	416	Fuzzy Sets for Cloud Detection in ATSR-2 Images Over Land	Richard Smith
	89	A baseline estimation method for SAR interferometry	Giovanni Nico
	360	SAR images Data bank for land use monitoring in Central Africa, an efficient data storage and processing scheme .	Joseph Mvogo
	254	Estimation of biophysical parameters from Terra surface reflectances	Yuri Knyazikhin
	311	SAR Product Control Software (SARCON)	Thomas Boerner
	137	3-D reconstruction of soil surfaces by stereovision in relation with radar backscattered signal over them	Riadh Tebourbi
	384	Interferometric SAR quality enhancing by space-varying spectral shift pre-filtering	Andrea Monti Guarnieri
	1413	Analysis of Candidate Missions for Remote Sensing from geostationary Orbit	Mick Johnson

OCEAN DYNAMICS

Chair: John Lillibridge
Co-Chair: Jérôme Benveniste

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	58	Small-scale processes in the South Atlantic observed in synergy of ATSR and SAR data during the Tandem Mission.	Ian Robinson
9.20 – 9.40	105	Feasibility of ERS altimeter data to study subsurface processes in the North Atlantic	Jacob Hoeyer
9.40 – 10.00	206	ERS-2 Altimetry in Operational NOAA Forecast Models	John Lillibridge
10.00 – 10.20	252	Analysis of the Atlantic Ocean response to Pressure Variations using the Altimeters of ERS-1 and ERS-2 Satellites during his Tandem Mission	Jesus Gomez-Enri
10.20 – 10.40	1411	Satellite Observation of sharp frontal shear instabilities	Ettore Sallustio
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	287	Indian Ocean Circulation: an Integrated Model and Remote Sensing Study	Vibeke E. J. Haugen
11.20 – 11.40	348	Thermal plumes and internal solitary waves generated in the Lombok Strait studied by ERS SAR	Leonid Mitnik
11.40 – 12.00	496	Determination and Characterization of Global Mean Sea Level Change	C. K. Shum
12.00 – 12.20	534	Use of SAR derived Doppler data for obtaining quantitative current velocity information in the Gulf of Mexico	Marco van der Kooij
12.20 – 12.40	189	Internal solitary waves in the Sulu Sea studied by ERS SAR imagery	Werner Alpers
12.40 – 13.00	232	Local mean sea level slope from multi-satellite altimeter data: data analysis and unification in the Western Mediterranean Sea	Luciana Fenoglio-Marc

OCEAN DYNAMICS

Chair: John Lillibridge
Co-Chair: Jérôme Benveniste

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	78	Satellite Altimeter Sea Level Variation Analysis of the Southern Ocean	Jesus Gomez-Enri
	126	Global ocean tides - revisited The impact of ERS and ENVISAT	Ole Andersen
	266	Spiral Eddies in the Japan Sea	Alexander Ostrovskii
	431	Retrieval of Ocean Current Velocity Field using ERS SAR Raw Data	Sergey Pereslegin
	82	SAR and AVHRR Imagery Using for Investigations of Big Lakes Physics and Ecology - Lake Baikal	Sergei V. Semovski
	414	Monitoring the Eastern Alboran using Combined Altimetry, In Situ and Temperature Data	Helen Snaith
	230	Sea surface topography due to density gradients in the Baltic Sea and Kattegat	Lars Stenseng
	73	Synergistic Observations of Rossby Waves	Graham Quartly
	509	The signature of Rossby waves in the ATSR dataset	Paolo Cipollini
	77	A Study of the Mediterranean Water Outflow using the ERS and TOPEX-POSEIDON joint Altimetry	Jesus Gomez-Enri
	88	Development of a Near Real Time system for remote sensing data for the Mediterranean Forecasting System Pilot Project	Gilles Larnicol
	391	Reprocessed ERS-1 and ERS-2 Altimeter Measurements for Ocean Circulation and Climate Research	Brian Beckley

PERFORMANCE

Chair: Pascal Lecomte
Co-Chair: Betlem Rosich Tell

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	459	Five Years of ERS-2 Low Bit Rate Mission: routine Cal/Val and Long Loop Sensor Performance Monitoring.	Pascal Lecomte
9.20 – 9.40	313	ERS and Envisat orbit determination and prediction at ESOC	Rene Zandbergen
9.40 – 10.00	208	Assessment of the new ERS-2 mono-gyro piloting mode on the quality of ERS SAR data and ERS SAR applications performance	Betlem Rosich
10.00 – 10.20	178	The performance of the ERS-2 Synthetic Aperture Radar	Peter Meadows
10.20 – 10.40	42	Orbit Control of ERS-1, ERS-2 and ENVISAT to support SAR interferometry	Mats Rosengren
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	128	Spatial and Temporal Errors in ERS-2 Radial Positioning	Philip Moore
11.20 – 11.40	1410	Implementation of a single gyroscope attitude and orbit control system on ERS-2	Miguel Canela Marques

RICE

Chair: Thuy Le Toan
Co-Chair: Sylvie Rémondière

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
16.00 – 16.20	430	Towards operational use of ERS SAR data for rice monitoring	Thuy Le Toan
16.20 – 16.40	116	Analysis of multi-temporal and multi-incidence angle data for rice crop using C band RADARSAT and ERS SAR data.	Manab Chakraborty
16.40 – 17.00	365	Rice Mapping using ERS SAR Data in Guangdong Province, China	Mike Wooding
17.00 – 17.20	372	An Operational Rice Field Mapping Tool using Spaceborne SAR Data	Eduard Dwyer
17.20 – 17.40	231	Rice Yield Estimation Using SAR Images, Meteorological Data and GIS	Mika Karjalainen

SEA FEATURES

Chair: Richard Olsen
Co-Chair: Andrea Petrocchi

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	221	Multisensor Observations of Internal Waves and their effects in the Bay of Biscay.	Jose da Silva
9.20 – 9.40	270	Identification and classification of mesoscale ocean features on ERS SAR imagery	Konstantin Litovchenko
9.40 – 10.00	245	Manifestations of Sea Currents and Eddies in ERS-SAR Images of the Bering Strait	Olga Lavrova
10.00 – 10.20	246	Internal waves in the Andaman Sea, new results from ERS SAR and other sensors	robert Potter
10.20 – 10.40	364	Multi-year ERS observations of ocean circulation features along the coast of Northern Norway	Richard Olsen
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	1412	Nonlinear Internal Waves in the South of China Sea	Ming-K. Hsu

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	389	The use of ERS-1/2 SAR to the study of ocean surface features in the Gulf of California Mexico	A. Martínez-Díaz-de-León
	292	Detection and Interpretation of Oceanic and Atmospheric Signatures in Spaceborne Radar Imagery of the North-Western Pacific	Olga Lavrova
	222	On the variety of IW radar observations in the Ocean. 1. Slick-like signatures.	Jose da Silva
	223	On the variety of IW radar observations in the Ocean. 2. Rip-like signatures.	Jose da Silva

SEA ICE 1

Chair: Benjamin Holt
Co-Chair: Ola Grabak

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
14.20 – 14.40	40	Arctic Ice Thickness from ERS1/2 Radar Altimetry	Seymour Laxon
14.40 – 15.00	19	SAR, SSMI and numerical model characterisation of Arctic Ocean coastal polynyas	Sverre Thune Dokken
15.00 – 15.20	239	Sea and lake ice studies in the Northwestern Russia using ERS SAR and other satellite data	Vitali Alexandrov
15.20 – 15.40	243	ERS SAR Data Application Use for Studying Sea Ice Parameters and Retrieving of Greenland Seals Migration	Vladimir Melentyev
15.40 – 16.00	317	Mapping Sea Ice Thickness with RADARSAT and a Helicopter-borne Electromagnetic-Induction System	Ingrid Peterson
16.00 – 16.20		*Coffee Break*	

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	119	Seasonal ERS SAR studies of sea ice in the Pechora and Kara Sea region	Maria Lundhaug
	172	Sea Ice Algorithm Validation and Improvement by Multi-Sensor Analysis.	Lars Kaleschke
	305	Seasonal Characteristics of Antarctic Sea Ice Backscatter	Stefan Voss
	319	Analysis of multi-polarmetric SAR imagery from the Kara Sea	Richard Hall
	300	Sea Ice Interpretation Manual for SAR images	Stein Sandven
	249	Extension and Types of Sea Ice with the ERS-1 Scatterometry in Surroundings of the Antarctic Peninsula	Rudolf Greku

SEA ICE 2

Chair: Preben Gudmansen
Co-Chair: Ola Grabak

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
16.20 – 16.40	409	Lincoln Sea and Nares Strait - a remote sensing study	Preben Gudmandsen
16.40 – 17.00	303	Satellite Ice Monitoring for Navigation of an ice-going tanker in the Kara Sea	Stein Sandven
17.00 – 17.20	506	Operational Use of Satellite SAR for Sea Ice Monitoring in Canada - Past Experience and Future Possibilities	Dean Flett
17.20 – 17.40	516	Sea Ice Thickness from SAR-derived Kinematics	Benjamin Holt
17.40 – 18.00	160	Extraction of Sea Ice Parameters from Imagette Data	Thomas Koenig
18.00 – 18.20	74	SImA - A Software System for Motion Analysis in Satellite Image Sequences	Roland Neumann / Rene Bartholomae
18.20 – 18.40	436	SAR Sea Ice Concentration in Baltic Sea Verified by Albedo Measurements	Maria Lundin
18.40 – 19.00	302	Satellite studies of ocean fronts and eddies for deepwater development in the Norwegian Sea	Stein Sandven

SERVICES AND MARKET

Chair: Steve Coulson
Co-Chair: Philippe Bally

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20		ESA E.O. Data User Programme	Olivier Arino
9.20 – 9.40	158	The ERS oil-spill research project in New Zealand: demonstrations to the commercial market	Stella Belliss
9.40 – 10.00	1106	waveclimate.com the online offshore-climate assessment tool	Han Wensink
10.00 – 10.20	370	National-scale DEM Generation using ERS Tandem Data in Alpine Regions	Carla Poidomani
10.20 – 10.40	28	SAGA - Satellite data and Geoinformation for Agrologistics	Bernd Schieche
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	382	Support to the evaluation of the short-term exploitation opportunities for ERS data within the agribusiness market	Judith Johnston
11.20 – 11.40	428	Fast damages assessment from EO data for assistance to relief operations after major natural disasters	Richard Guillande
11.40 – 12.00	412	Advanced SAR/Optical Remote Sensing Techniques for Forestry Applications: A Case Study in Sarawak (Malaysia)	Edmond Nezry
12.00 – 12.20	482	ESA Mission Marketing Activities. The E.M.M.A. offer for the development of the ERS and ENVISAT market.	Andrea Celentano
12.20 – 12.40	486	Commercial distribution of ERS and ENVISAT products and services	Alain Hirschfeld
12.40 – 13.00		ESA E.O. Market Development	Steve Coulson

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	51	GAMMA SAR and Interferometric Processing Software	Charles Werner
	1406	SAR products for all: Rent-a-RAPIDS	Niek Schaap

FORESTRY: SIBERIA

Chair: Christiane Schmullius
Co-Chair: Henri laur

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	473	ERS Interferometric Processing for Boreal Forest Applications	Achim Roth
9.20 – 9.40	410	JERS-1 INSAR coherence over Siberian boreal forest	Andreas Wiesmann
9.40 – 10.00	429	Assessing ERS and JERS SAR information content for large scale forestmapping in Siberia	Thuy Le Toan
10.00 – 10.20	70	The classification procedure in SIBERIA: rationale and methodology	Shaun Quegan
10.20 – 10.40	334	Global forest classification using JERS and tandem ERS data	Adrian Luckman
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	328	Accuracy assessment issues in the SIBERIA project	Shaun Quegan
11.20 – 11.40	461	Russian Forest Inventory Requirements and Remote Sensing Parameters-Operational Aspects evolving from the SIBERIA Project	Christiane Schmullius

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	463	Generating a universal forest ground- truth catalogue for Remote Sensing applications to Forest Observation	Christine Schmullius
	464	Automated Training-Site Selection based on a Coherence Model for Forest Classification in the SIBERIA Project	Christine Schmullius
	465	A Comparision of SAR-Interferomety- and cartographically generated Digital Elevation Models by errors, accuracies and extracted hydrographic features	Christine Schmullius

SEA SURFACE TEMPERATURE

Chair: Ian Barton
Co-Chair: Philippe Goryl

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
11.00 – 11.20	129	The relationship between in situ and Satellite Sea Surface Temperatures in the South-western Atlantic Ocean.	Ronald Souza
11.20 – 11.40	115	ATSR maps coral bleaching on Australia's Great Barrier Reef	Ian Barton
11.40 – 12.00	127	Changes in Sea level, sea surface temperature and sea surface pressure from Satellites - The impact of ERS and ENVISAT	Ole Andersen

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	31	Conversion of ATSR-2 skin sea surface temperatures to bulk temperature for use in climate studies.	Anne O'Carroll
	278	ATSR-SST in enclosed basins - a case study in the Baltic sea	Bertil Hakansson
	80	Sea Surface Temperature and chlorophyll-a Correlation Index: Seasonal variability on Iberian Margin.	J. M. Torres Palenzuela

TOPOGRAPHY

Chair: Philippa Berry
Co-Chair: Steve Coulson

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	173	ENVISAT RA-2: Potential For Land Topographic Mapping	Philippa Berry
9.20 – 9.40	341	The LANDMAP project for the Automated Creation and Validation of multi-resolution orthorectified satellite image products and a 1" DEM of the British Isles from ERS tandem SAR interferometry.	Jan-Peter Muller
9.40 – 10.00	91	Evaluation of Methods used in Assessing the Accuracy of InSAR derived DEMs	Premalatha Balan
10.00 – 10.20	343	Using the LANDMAP British Isles 1" IfSAR DEM for Hydrological Network Derivation.	Alec Walker
10.20 – 10.40	380	DTM production by fusion of mixed sar and optical image data	Thierry Laurencot
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	507	Geomorphological and Geological Validation of Digital Terrain Models processed from spatial imagery. Applications in the Pyrennees (S France) and E Sénégal (W Africa)	Benoit Deffontaines
11.20 – 11.40	130	Automated tiepoint retrieval through heteromorphic image simulation for spaceborne SAR sensors	David Small
11.40 – 12.00	258	ERS Georeferencing Precision	Andy Smith

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	141	ACE: A new 30" GDEM incorporating satellite altimeter derived heights	Philippa Berry

VEGETATION AND AGRICULTURE

Chair: Henning Skriver
Co-Chair: Juerg Lichtenegger

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
14.40 – 15.00	107	Global scale monitoring of soil and vegetation with ERS Wind Scatterometer and SSM/I	Paolo Pampaloni
15.00 – 15.20	183	Interpretation of ERS WSC time series over Sahel during the period 1991-1999	Lionel Jarlan
15.20 – 15.40	393	Relating ERS Scatterometer Data to Global Vegetation Models	Maged Abdel-Messeh
15.40 – 16.00	304	Tree shape description for backscattering modelling of LAI	Terhikki Manninen
16.00 – 16.20		*Coffee Break*	
16.20 – 16.40	79	ERS Data use for wide-area sampling of agricultural areas: Image Logic for Cereal Monitoring.	Guido Lemoine
16.40 – 17.00	176	Crops classification in southern Sweden with multitemporal ERS-2 SAR data	Xuetang Xie
17.00 – 17.20	323	Land-use mapping using airborne polarimetric SAR	Henning Skriver
17.20 – 17.40	408	Amazonia Bio-diversity Estimation using remote sensing and indigenous taxonomy	Luigi Fabbro

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	138	An inversion model of ERS2 Radar data to retrieve wild vegetation cover in semi-arid regions	Mehrez Zribi
	435	Biomass Monitoring with SAR	Paul Snoeij
	515	CAESAR: Crop area estimation using SAR images	F Mediavilla de Diego

WIND AND WAVES 1

Chair: Susanne Lehner
Co-Chair: Andrea Bellini

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
9.00 – 9.20	113	Wind Speed and SWH Calibration for Radar Altimetry in the North Sea	Tilo Schoene
9.20 – 9.40	342	Use of ERS-2 Altimeter Wind/Wave Data for the Validation of Sea State Models	Jean Michel Lefevre
9.40 – 10.00	157	Mesoscale Wind Fields Retrieved from RADARSAT-1 ScanSAR in View of ENVISAT ASAR	Jochen Horstmann
10.00 – 10.20	301	ERS SAR wind retrieval in the marginal ice zone	Birgitte Furevik
10.20 – 10.40	315	Near Real-time Sea-surface Winds from ERS Synthetic Aperture Radar (SAR) Data	Tony Bauna
10.40 – 11.00		*Coffee Break*	
11.00 – 11.20	163	High Resolution Wind Fields and their Variation Extracted from ERS SAR	Jochen Horstmann
11.20 – 11.40	480	The Ocean and Sea Ice Satellite Application Facility Wind Product	Tilly Driesenaar
11.40 – 12.00	102	A Physically-based Model of Ocean Backscatter for Wind Speed retrieval from SAR, Scatterometer and Altimeter.	Graham Quartly
12.00 – 12.20	275	Tracking of Tropical Cyclones with the ERS Scatterometer: Algorithm Performances and post-processed data examples.	Raffaele Crapolicchio
12.20 – 12.40	359	Use of scatterometer wind data in ECMWF's assimilation system	Lars Isaksen

Posters

	Abst. ID	*Title of the Poster*	*Presenter*
	64	Quality of long term satellite wind and wave measurements	Pierre Queffeulou
	5	Internal Solitons Near Gibraltar: A Multi-Year Study Using ERS-1 & 2 SAR Imagery	John R. Apel
	139	Validation of Wind Retrieval Algorithms from Spaceborne SAR.	Flavio Parmiggiani
	1404	A model for wind speed and wave height retrieval from radar altimeter measurements	Rosaria Della Rocca
	1409	Operational use of ERS scatterometerdata at the Norwegian Meteorological Institute	Lars-Anders Breivik
	1054	On the ERS scatterometer wind measurements accuracy: evidence of seasonal and regional biasses	Yves Quilfen

WIND AND WAVES 2

Chair: Werner Alpers
Co-Chair: Andrea Bellini

From - To	*Abst. ID*	*Title of the Presentation*	*Speaker*
14.00 – 14.20	166	Global Observations of Wind Speed and Sea Surface Features using SAR Wave Mode	Susanne Lehner
14.20 – 14.40	169	SAR Ocean Wave Inversion - A Hierarchic Approach	J. Schulz-Stellenfleth
14.40 – 15.00	16	A new composite model, including non-Bragg scattering effects for the estimate of radar cross-section and Modulation Transfer Function, in wind-scatterometer and SAR conditions	Daniele Hauser
15.00 – 15.20	440	Improvement of the high resolution mesoscale atmospheric model RAMS with ERS-SAR, for detailed sea surface wind reconstruction of small scalephenomena	Alberto Ortolani
15.20 – 15.40	279	ENVISAR ASAR wave mode data simulated by ERS SAR	Birgit Schaetller
15.40 – 16.00	6	Airborne polarimetric radar measurements in the context of the geophysical validation of the ENVISAT ASAR products over the ocean	Daniele Hauser
16.00 – 16.20		*Coffee Break*	
16.20 – 16.40	508	Validation of Envisat ASAR Wave Mode Level 1 and Level 2 Product Using ERS SAR Data	Harald Johnsen
16.40 – 17.00	23	Validation of ENVISAT SAR Wind Fields: Lessons from ERS and RADARSAT	Frank Monaldo
17.00 – 17.20	394	Comparisons of observed and modelled wave energy spectra using ERS-2 SAR observations and the Met.Office wave model.	James Gunson
17.20 – 17.40	333	Waves and mixing in the coastal zone	F. Ocampo-Torres

An operational service is provided by the Tromso Satellite Station (TSS) for high-resolution wind field observation based on cross-spectral analysis. Current numerical models provide wind information at a resolution of 25 km while the new SAR wind service can give information at 12-km resolution. Preliminary validations show that wind speed and direction can be provided with the following accuracy: wind speed range 1-20 m/s: <2 m/s, wind direction <20 degrees. Other stations and customers should follow this example. There is a lot of potential interest in the European user community, only limited by the scarce availability of the SAR scenes.

Results were presented for backscattering modeling of sea surface at various polarisation states. Although empirical models are commonly used to retrieve wind information the research progressed in developing physically-based models to understand and to predict the behaviour of the radar cross-section in various imaging configurations. In this context, a new model (semi-physical) which presents several new characteristics with respect to the classical 2-scales models has been presented. The model takes into account non-Bragg scattering associated to the specular reflection of breaking waves.

Conclusions and Recommendations

The impact of sea features (oil slicks, sea ice) in the imagette has been analysed and the development of a scheme which needs minimum a priori information deserves further investigations. This will require a large dataset allowing statistics for specific regions and seasons as well as collocated buoy measurements for validation.

From the TSS operational service, recommendations are given to combine the use of the cross-spectral properties (decorrelation and phase) and backscatter measurements (CMOD).

Due to the overlapping swaths of ERS scatterometer and SAR wave mode data, a recommendation is given to collocate the imagettes with scatterometer data. This would allow to flag scatterometer data contaminated with disturbing sea features like ice, oil slicks or low wind areas.

An algorithm to derive wind fields from RADARSAT data was presented. A similar ENVISAT ASAR 500km x 500km wind product is required. Plans to have this as an official ESA product should be considered. Recommendations are given to assure continuity to ERS SAR wave mode observations. ASAR wave mode data can be processed starting by ERS wave mode acquisitions. A message has been given to reprocess the ERS archive to ENVISAT-like data and to release the data for the scientific community.

Analyses of sources of errors in wind fields estimates were featured; calibration of SAR data is a major issue. The propagation of the calibration error in the retrieval algorithm might lead to consistent wind speed errors. For the incidence angle it was shown that the best range for wind speed retrieval is above 30 degrees.

For SAR high-resolution data, discussions were triggered by the analysis of the improvements in the wind retrieval algorithms by using the polarisation-ratio and by some discrepancies observed. It is common opinion that the availability of ENVISAT simultaneous dual-polarisation images will offer a unique opportunity to improve the general understanding and will give the opportunity to improve high-resolution wind inversion techniques.

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List of Participants - ERS-Envisat Symposium

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EXPECTATIONS FOR GOME-2 ON THE METOP SATELLITES

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ABSTRACT

The first Global Ozone Monitoring Experiment (GOME) was launched in April 1995 on ERS-2. The objective was to measure the global distribution of ozone and other trace gases; an objective which has been achieved.

GOME has demonstrated its capability to measure total column ozone, ozone profile, nitrogen dioxide, sulphur dioxide, formaldehyde and halogen oxides. Furthermore, cloud parameters and aerosol properties have also been successfully retrieved. Both KNMI and DLR provide total column ozone data in near real time.

Building on the success of GOME, GOME-2 has been selected to fly as part of the payload of the first three METOP satellites, thereby ensuring operational monitoring of Ozone for a fifteen-year period.

GOME-2 has a number of improvements over GOME, including improved calibration capabilities by addition of a new on-board white light source, and better characterisation of the Polarisation State of incoming radiation from new polarisation measuring devices.

The expectations for GOME-2, its role as an operational instrument will be discussed.

ON THE VARIABILITY OF TOTAL COLUMN OZONE DERIVED FROM ERS-2 GOME AND TOMS

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ABSTRACT

ERS-2-GOME has been successfully operating in space since April 1995 in a near polar orbit. Total column ozone has been derived since then on an operational basis almost continuously.

Temporal and spatial variability of the total column ozone is analysed over a wide range of scales covering smaller scale structures such as streamers, medium scale structures such as planetary waves and interannual variations. For the long-term studies also TOMS total ozone data is taken into account.

In recent years it became evident that the distribution of ozone is also characterised by small-scale structures. Examples are the so-called streamers, finger-like structures of ozone-low air masses reaching out from tropical latitudes towards northern latitudes. They turned out to be highly variable on time scales of a few days. For the longer-term studies the total ozone column is used as a dynamical tracer, supplying information on the dynamical activity of the atmosphere and its development.

Different spectral schemes such as Kalman Filter, Harmonic and Wavelet analysis based methods are used as well as sequential data assimilation techniques such as advection and wind driven 3D chemical transport modeling. Aimed is to get the maximum information content by a combination of measurement and model at best.

Results, model result intercomparisons and comparisons to climatologies will be presented. The benefit of the utilization of ENVISAT data will be addressed.

VALIDATION OF OZONE PROFILE RETRIEVAL AT KNMI

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ABSTRACT

At the KNMI ozone profiles are retrieved from GOME observations using the optimal estimation method. A-priori ozone profiles and temperature profiles are taken from climatologies. The radiative transfer is modelled using the MODTRAN code which includes the multiple scattering based on DISORT. Prior to the retrieval a correction is applied to the level 1 product to account for the wavelength calibration and the degradation of the sun-normalized radiance.

Ozone profiles have been retrieved from GOME overpass observations at De Bilt (Netherlands) and Paramaribo (Surinam). These sites represent urban mid-latitude and rural tropical situations. These overpass data are compiled for the period 1996 up to 2000. These results are compared with local ground measurements of ozone profiles and with total ozone measurements at these locations.

SCIENCE OBJECTIVES OF EOS-CHEM'S OZONE MONITORING INSTRUMENT (OMI)

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ABSTRACT

The Ozone Monitoring Instrument (OMI) will fly on NASA's satellite EOS-CHEM, which will be launched in December 2002. The EOS-CHEM satellite is focussed on atmospheric chemistry and climate issues. The main science objectives of the EOS-CHEM mission are: (1) Is the ozone layer recovering as expected? (2) What are the sources of tropospheric pollutants, their chemical transformation and their transport? (3) What are the roles of upper-tropospheric water vapor, aerosols and ozone in climate change? The EOS-CHEM satellite consists of 4 instruments, which are the Microwave Limb Sounder (MLS), the High Resolution Dynamics Limb Sounder (HIRDLS), the Tropospheric Emission Spectrometer (TES), which is a nadir and limb sounder, and OMI.

OMI is a UV/VIS nadir solar backscatter spectrograph, which reaches global coverage in one day with a 13 x 24km^2 footprint. OMI is derived from the European satellite instruments GOME and SCIAMACHY. OMI is capable of measuring (ir) radiances of the sun and earth in the wavelength range of 270 to 500 nm, from which ozone column and profile, NO2, SO2 and BrO as well as aerosols, cloud coverage and cloud top pressure can be derived. OClO and HCHO are in principle also possible data products of OMI.

OMI's unique capability in measuring column amounts of ozone, NO2 etc. with a small footprint and daily global coverage will enable EOS-CHEM to monitor tropospheric pollution on a regional scale. The design and capability of OMI will be explained. The contribution of OMI to answer the above mentioned science questions and the resulting science requirements of the instrument will be discussed.

GOME SATELLITE DETECTION OF OZONE VERTICAL COLUMN OVER A SNOW/ICE COVERED SURFACE IN THE PRESENCE OF BROKEN CLOUDS

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ABSTRACT

In the presence of broken clouds over snow or ice covered surfaces it is quite difficult to distinguish between clouds and surfaces.

A new approach has been developed, which treats the cloud as a Lambertian surface and characterizes the inhomogeneous pixel area (with broken clouds) by deriving an effective albedo and cloud-top-height. These parameters are determined by minimizing the difference between GOME measured sun-normalized radiances and corresponding model spectra in the spectral range of O_4 absorption near 370 nm. Extrapolation of the effective albedo to short wavelengths enables to improve the ozone vertical column retrieval in the 315-335 nm range.

It will be shown that this method can clearly distinguish between clouds and snow-covered (bright) surfaces, which improves the accuracy of the retrieved ozone column.

FAST AND ACCURATE OZONE PROFILE RETRIEVAL FOR GOME-2 USING 4-STREAM LIDORT

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ABSTRACT

The retrieval of vertical profile information of ozone from nadir viewing UV/VIS sensors, such as GOME and GOME-2, requires the calculation of radiances for any given ozone profile as well as the derivatives of the radiance to the ozone at specific atmospheric layers (weighting functions). The LIDORT scheme solves for both quantities by utilizing the well-known discrete-ordinates method expanded by a scheme to calculate the derivatives in a computationally economical manner. In view of the requirements on the speed of the ozone profile retrieval algorithm resulting from the high data rate of the instruments, a fast version of LIDORT has been developed: LIDIRT4A. The number of streams has been limited to four thereby allowing analytic solutions to replace certain numerical steps in the LIDORT scheme. Only the sparse linear system that has to be solved to fix the boundary conditions still requires a numerical module. The low number of streams results in a small degradation in accuracy (about 0.5). However, this is still acceptable in view of the uncertainties inherent to the calibration of the instruments. This will be shown by comparing profile retrievals using LIDORT4A and LIDORT with sufficient streams for different atmospheric and viewing conditions. Apart from its use for the NRT retrieval for GOME, the algorithm development is part of the preparations for the NRT GOME-2 processing within the EUMETSAT Ozone SAF project.

INTERCOMPARISON OF GOME OZONE PROFILES

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ABSTRACT

A number of groups have started producing ozone profiles from the ERS-2 GOME radiance data. At the request of the GOME Science Advisory Group, this group was formed to compare the results from the different ozone profile algorithms. The intercomparison will be done in three phases:

1) Level 1 Radiance adjustment

The first area will be GOME calibration and how each group adjusts (or not) the GOME radiances. There are known wavelength dependent errors in the Band 1a calibration, there is a calibration offset between Band 1 and Band 2, there are probably other errors as well. The details how each group adjusts the level 1 radiances, all bands, before running their ozone profile algorithm will be presented.

2) Synthetic Data Retrieval

Synthetic spectra willl be generated over the GOME wavelength interval. The spectra with the appropriate meta-data will be distributed to the participating groups. The retrieved profiles will be compared will be compared with the input ozone profiles.

3) Validation with NDSC ozone profile data

The ozone profiles over NDSC sites will be compared with NDSC ozone lidar and ozonesonde profiles.

GOME FAST DELIVERY AND VALUE-ADDED PRODUCTS (GOFAP)

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ABSTRACT

In the framework of the ESA Data User Porgram a Fast Delivery processor has been developed to provide GOME ozone products within 3 hours after observation. This service meets the growing demand for ozone products for purposes like assimilation in numerical weather prediction models, radiation forecasts, and planning of experiments related to atmospheric chemistry research.

By making maximum use of the existing ERS ground segment and European Internet links the retrieval of ozone products can be performed within 3 hours after observation from the Extracted GOME Instrument Header (EGOI) Data. This data contains parts of the ultra violet spectrum applicable for the retrieval of ozone columns and stratospheric ozone profiles. The EGOI data is calibrated and processed to a level 1b product.

For the total ozone column retrieval a very fast processor has been developed. The retrieval technique is based on the Differential Optical Absorption Spectroscopy (DOAS).

Data assimilation software has been incorporated in the automatic GOME fast-delivery processing to provide global maps of ozone. In the data assimilation a transport model (TM3) and wind fields provided by ECMWF describe the atmospheric flow of ozone.

An existing off-line profile retrieval algorithm has been adapted to produce reliable stratospheric ozone profiles within the strict time constraint with a spatial resolution sufficient for numerical weather predictions.

The processed level 1 data is also used for the computation of additional NRT products like cloud and aerosol information. The cloud fraction and cloud top pressure are calculated with the FRESCO algorithm. The aerosol absorption index is computed to have an indication for areas with heavy aerosol pollution.

The near-real time processor and the presently delivered ozone products will be presented. Details of the work can be found in dedicated poster presentations.

SOFTWARE FOR EXTRACTION OF GOME DATA FROM LEVEL-2 TO -3 FOR TOTAL COLUMN OZONE AND OTHER PARAMETERS

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ABSTRACT

The Global Ozone Monitoring Experiment (GOME) has been launched on board the second European Remote Sensing Satellite (ERS-2) designed to measure a range of atmospheric trace constituents with particular emphasis on global ozone distribution. GOME is a spectrometer which measures the solar radiation scattered from the Earth's atmosphere and reflected by the Earth's surface in nadir viewing geometry in the wavelength range of 240 - 790 nm with a spectral resolution of 0.2 - 0.4 nm. For a 960 km swath width GOME achieves global coverage in three days. Global Total Column Ozone maps are provided in near real time shows actual situation of Stratospheric Ozone layer. It is difficult to ascertain the actual total column ozone values for different locations from these maps as they are based on color code. GOME level 1 to 2 software is provided for extraction of GOME Level-2 data in ASCII readable format from Level-2 binary data .In this paper, Level 2-to-3 Processing software is developed for obtaining actual concentration of total column ozone and other trace gases in numerical format. This software has different module for extraction of information and for each forward scan pixel, latitude, longitude and corresponding total column of ozone, vertical column density, DOAS slant column of ozone and other trace gases and also cloud top pressure and surface pressure, etc.

RETRIEVAL OF CLOUD PROPERTIES FROM OXYGEN A-BAND SPECTRA MEASURED BY THE GLOBAL OZONE MONITORING EXPERIMENT

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ABSTRACT

With the launch of the Global Ozone Monitoring Experiment (GOME), a UV-VIS spectrometer operating on board the ERS-2 satellite since April1995, the first global space-based measurements of the oxygen A-band (758-775 nm) have become available at a moderately high spectral resolution of 0.35 nm. These spectra offer a unique possibility to derive cloud properties, because the depth of the oxygen A-band is sensitive to cloud top pressure, whereas the reflectivity at continuum wavelengths is sensitive to cloud fraction and cloud optical thickness. Therefore, we developed a fast retrieval method, called FRESCO (Fast Retrieval Scheme for Clouds using the Oxygen A-band), to derive simultaneously cloud fraction and cloud top pressure. The FRESCO algorithm makes use of radiances measured in three narrow wavelength intervals inside and outside the oxygen A-band, namely at 758 nm (no absorption), 761 nm (strong absorption), and 765 nm (moderate absorption). The cloud properties derived using FRESCO are used as input for near-real-time ozone column retrievals from GOME, but are also important to study cloud properties on the global scale. Global monthly average FRESCO cloud fractions and cloud top pressures have been compared to ISCCP-D2 data, showing good overall agreement both for cloud fraction (0.01 average difference, 0.10 standard deviation) and cloud top pressure (35 hPa average difference, 105 hPa standard deviation). In addition, a detailed validation of FRESCO using collocated ATSR-2 data has been performed. To this end, a cloud detection algorithm is used to separate clear and cloudy pixels inATSR-2 images. The brightness temperatures of the cloudy pixels as measured by ATSR-2 are related to cloud top pressures using ECMWF profiles. Generally, the results from GOME and ATSR-2 agree well. The average difference in cloud fraction is 0.05, with a standard deviation of 0.09. The average difference in cloud top pressure is 65 hPa, with a standard deviation of 91 hPa. The comparison of FRESCO cloud properties to those of ISCCP-D2 and ATSR-2 indicates that problems with FRESCO occur mainly due to absorption within the cloud and uncertainties in the surface albedo. We will make suggestions about possible improvements to our FRESCO retrieval algorithm.

DISCRIMINATION BETWEEN WATER AND ICE CLOUDS USING NEAR-IR AVIRIS MEASUREMENTS

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ABSTRACT

Around 1.6 micron, the spectral shape of the absorption bands of water and ice is different: the water absorption spectrum exhibits a local minimum whereas for ice there is a negative gradient. This difference is exploited to develop a water/ice-cloud discrimination algorithm for top-of-atmosphere reflectivities. The algorithm is based on radiative transfer modelling using the doubling-adding method to describe multiple scattering. The single scattering properties of cloud particles are calculated by means of Mie theory for water droplets and ray-tracing techniques for imperfect hexagonal ice crystals. The central theme of this paper is the testing of the algorithm using airborne spectral radiance measurements made over clouds. The algorithm has been developed for the analysis of measurements to be made by SCIAMACHY (SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY). This spectrometer has been designed to measure radiances in the ultraviolet, visible and near-infrared wavelength regions (240-2380 nm) at moderate spectral resolution (0.2-1.5 nm). It will be flown on ENVISAT, which is planned to be launched in 2001. In order to test the concept described above, measurements made by NASA's Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) are used. The relatively low spectral resolution of AVIRIS (10 nm) is still sufficient for detecting spectral structures related to differences in water/ice absorption around 1.6 micron. Three cloudy AVIRIS flight lines are used for the analysis of the algorithm. The flight lines contain measurements made over different types of water and ice clouds over ocean. Several clusters of AVIRIS spectra acquired over these clouds are analysed with respect to their 1.6 ?m spectral gradient. On the basis of this analysis the water/ice-cloud discrimination algorithm is examined in detail and conclusions are drawn with respect to the applicability of the algorithm to future SCIAMACHY measurements.

PMD CLOUD DETECTION SCHEMES FOR GOME: COMPARISON WITH ATSR-2 DATA AND ICFA DATA REGARDING THE IMPACT ON GOME OZONE VCD

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ABSTRACT

In order to determine the ozone and other trace gase amounts more accurately, it is clear that column densities achieved by DOAS fitting have to be corrected for cloudy and partially cloudy scenes. Therefore, cloud parameters are needed. At present, the fractional cloud coverage is only retrieved in GDP (GOME Data Processor) by ICFA (Initial Cloud Fitting Algorithm). ICFA extracts information about clouds from GOME measurements both outside and within the O2 A-band. In the project CRAG (Cloud Retrieval Algorithm for GOME) a two-step procedure based on the PMDs and the GOME measurements of the O2 A-band, has been introduced. Since there have been two PMD algorithm available, we present a comparison of both in this paper.

Both PMD algorithm retrieve the fractional cloud coverage. One of these schemes is based on a threshold technique, the other on "cloud-free composite" technique. Since both algorithms work on a heuristic base, their results have to be verified with respect to the existing cloud retrieval algorithm for GOME, ICFA (Initial Cloud Fitting Algorithm), and to the cloud recognition results of other sensors. Therefore, a comparison of ICFA results will be presented. Furthermore, the impact on GOME ozone vertical column densities (VCD) by all cloud detection schemes, ICFA and both PMD algorithms, will be compared. Therefore, a computation of a broad set of orbits covering data from 1995 until 1997 has been performed.

In addition, a comparison with results of several ATSR-2 (Along Track Scattering Radiometer) swathes for the computation of the fractional cloud coverage will be shown. Finally, a discussion of both PMD algorithm will be presented including also operational aspects.

DETECTION OF CLOUD COVER FRACTIONS BY GOME POLARISATION MEASUREMENT DEVICES AND VALIDATION BY SURFACE OBSERVATIONS AND METEOSAT DATA

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ABSTRACT

Photodissociation rates of species in the atmosphere are strongly influenced by the presence of clouds. In order to determine the actinic flux and photodissociation rates from GOME measurements, the knowledge of cloud characteristics is of crucial importance. GOME Level-2 data contain cloud fractions from the Initial Cloud Fitting Algorithm (ICFA). The ICFA gives effective cloud fractions for cloud optical thickness of 20. Additionally, errors are introduced by using monthly mean cloud top heights from the ISCCP climatology. It is shown that the errors on surface photodissociation rates calculated using the ICFA cloud fraction of up to 20 are introduced due to unknown cloud optical thickness. Other methods for determining the cloud fraction have been developed using data from the broadband Polarisation Measurement Detectors (PMDs). This allows the estimation of cloud optical thickness and top height from the oxygen A-band (CRAG algorithm), which are important for actinic flux profile estimation. The aim of this work is to validate a method that produces cloud cover fractions from GOME PMD data. By using the PMDs of GOME we divide the wide swath (320x40 km) seen by the spectral detectors into smaller parts (20x40 km) at the cost of a lower spectral resolution. The PMD detected albedo of the earth can be used to distinguish between cloud and surface if the reflectance of the surface remains constant. A lookup table for each 0.5x0.5 degree grid box was generated by processing all PMD data for one month and storing the minimum and maximum value of each of the three PMD devices which represent a cloud free and a completely clouded situation respectively. All values in between are interpolated linearly to a fractional cloud cover. All GOME pixels over the Netherlands are selected for the test month and the cloud fraction per PMD sub-pixel is calculated. Observations from surface weather stations, collocated within the PMD sub-pixel, are compared with the calculated cloud fractions. Results of the comparison show that the PMD cloud algorithm has difficulty representing small cloud fractions correctly and has a wide range of solutions for higher cloud fractional covers.

CLOUD PROPERTIES DERIVED FROM ATSR-2 AND AEROSOL OPTICAL THICKNESSES DERIVED FROM GOME IN CO-LOCATED CLOUD-FREE SCENES

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ABSTRACT

A scheme to derive cloud-top height, reflectance and coverage has been developed at the Rutherford Appleton Laboratory. The scheme was developed specifically to characterise cloud in pixels used for height-resolved ozone retrieval from the ERS-2 GOME instrument and to identify cloud-free GOME pixels unambiguously for retrieval of aerosol. The scheme operates by (a) co-locating the GOME and ATSR-2 fields-of-view (FOV); (b) classifying (from visible channel reflectance ratios) all ATSR-2 pixels within each GOME pixel according to surface/cloud type; and (c) generating histograms of occurrence of each ATSR-2 pixel type vs infra-red brightness tempertature, visible-channel reflectance and parallax-height (derived by stereo-matching forward and nadir ATSR-2 views). Infra-red brightness temperature is related to cloud height by reference to the nearest temperature profile from the appropriate UKMO analysis. Cloud and surface parameters representative of the GOME pixel are derived from the histograms: e.g. total, "thick" and "thin" cloud fractions; mean and standard deviation of cloud reflectance, mean and standard deviation cloud height (from both temperature and parallax approaches). The scheme has been applied in parallel with the GOME ozone profile algorithm (see parallel paper) to a significant sub-set of the GOME/ATSR-2 data-set and the derived information is available via the British Atmospheric Data Centre (http://www.badc.rl.ac.uk)

A scheme to retrieve tropospheric aerosol from GOME measurements in the O2 A-band (near 760nm) has also been developed and applied to pixels identified as "cloud-free" by the above ATSR-2 scheme. Aerosol optical thicknesses retrieved from the A-band have been compared systematically with those obtained for the same pixels by a completely independent method developed by IMGA which uses GOME measurements in the visible and near-IR. Potential for further development of the A-band scheme will be discussed.

SCIAMACHY OPTICAL PERFORMANCE CHARACTERISTICS

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ABSTRACT

The Scanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) is a contribution to the ENVISAT-1 satellite, which will be launched in mid 2001. The SCIAMACHY instrument is designed to measure sunlight transmitted, reflected and scattered by the Earth's atmosphere or surface simultaneously from the UV to the NIR spectral region (240 - 2380 nm) in various viewing geometries, namely nadir, limb, and both solar and lunar occulation.

From these measurements atmospheric concentration distributions of O3, NO, NO2, NO3, BrO, OClO, SO2, H2CO, H2O, CO, CO2, N2O, and CH4 will be deduced globally. SCIAMACHY is the only instrument on ENVISAT, which is able to detect the concentrations of O3, NO2, BrO, SO2, H2CO, H2O, CO, CO2, N2O, and CH4 down the boundary layer or the cloud top.

The accuracy of the envisaged data products depends on a) the instrument performance and characterisation, b) the algorithms used for inversion of the data (data processing), c) the validation of the data products. Instrument performance is now well characterised and the calibrated instrument was delivered to ESA-ENVISAT in early 2000. The development of scientific and operational algorithms is progressing. The SCIAMACHY validation campaign embedded in the ENVISAT validation campaign is also under preparation.

In this contribution the as-build status of the optical performance of SCIAMACHY is presented and compared with the required performance.

Special emphasis will be placed on performance aspects relevant for data processing and validation.

A PARAMETRISATION OF THE EARTHSHINE POLARISATION IN THE UV

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ABSTRACT

Since many satellite remote sensing instruments (e.g. GOME, SCIAMACHY, OSIRIS) are sensitive to polarisation, we may expect to improve the quality of calibrated earthshine radiances through theoretical knowledge of the behaviour of the Stokes vector of atmospheric radiation. In particular, earthshine spectra show strong variation of their polarisation characteristics in the wavelength range of 290-340 nm, which is used for both ozone column and profile retrieval (ozone Huggins band).

We have constructed a database of calculated earthshine spectra for a variety of viewing angles, solar angles and surface albedos. The first three Stokes parameters I, Q and U for part of the UV (290-350 nm, at 0.2 nm intervals) were calculated using a plane-parallel polarised radiative transfer code developed at the KNMI (DAK, using the doubling-adding algorithm of de Haan et al. 1987). Only ozone absorption and molecular Rayleigh scattering for a set of standard atmospheres were considered. Surface reflectance was assumed Lambertian in nature. This database allows us to construct spectra for large ground pixels (40 x 320 km2) as observed by e.g. GOME, by interpolation to and addition of subpixel spectra.

We show applications of this database, in particular the improvement of the polarisation correction for GOME radiances. For example, the largest wavelength for which the polarisation may be determined from single Rayleigh scattering theory (around 300 nm) can be parametrised in solar zenith angle. A combination of similar parametrisations of the polarisation in the Huggins absorption band leads to significant improvement of the calibrated GOME radiances.

QUALITY ASSESSMENT FOR GOME/ERS-2 LEVEL 1 AND LEVEL 2 PRODUCTS

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ABSTRACT

The ERS-2 Satellite Payload includes the Global Ozone Monitoring Experiment (GOME) designed to measure a range of atmospheric trace constituents with particular emphasis on global ozone distribution. Good data quality assessment (QA) is essential for the scientific acceptance of the GOME data products. This paper presents the QA system used during the operational processing of GOME data. A set of QA indicators of key GOME Level 1 and Level 2 parameters has been carefully selected. The Level 1 indicators are based on instrument performance and physical constraints like mean values of science data, ratios of PMD and science channel readouts, start and end wavelength of each channel and ratios of GOME sun spectra compared to a reference spectrum. The Level 2 indicators show climatological constraints in the form of ozone and NO2 vertical columns histograms for each orbit with their corresponding errors and monthly climatologies for ozone and NO2. The QA indicators as well as statistics on the viewing mode of GOME and quicklooks showing the ground-track for each orbit are stored in a QA database. The QA database is accessed through a QA tool implemented as a Java applet that runs on standard browsers. The QA tool can plot time series of QA indicators, showing possible limit violations, and it has several additional features like for example the possibility to select a specific product using orbit number, acquisition time or geographical coordinates. The routinely GOME QA processing runs automatically. Human intervention is limited to checking of the QA indicators and flagging of the products with low quality. Such an automatic QA system is especially important during the reprocessing period where up to 200 orbits can be processed per day. The GOME QA system demonstrated to be very useful for finding and for the detailed investigation of "anomalies" not only with the data products, but also with the GOME sensor itself.

DEGRADATION OF UV EARTH RADIANCE OBSERVATIONS BY GOME

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ABSTRACT

Degradation of optical components in space is a problem affecting many remote sensing intruments. The degradation of the Global Ozone Monitoring Experiment (GOME) is monitored in-flight by observing either the sun or, occasionally, the moon. The solar measurements are acquired daily and therefore best allow to monitor the degradation of GOME. The light backscattered by the Earth's atmosphere follows however a different optical path through the spectrometer than solar irradiance. Because of the absence of a reference source for Earth radiances, the effect of the instrument degradation on the accuracy of Earth albedo is difficult to determine. In this paper we will show how the accuracy of Earth albedo measurements can be determined by identifying a range of Earth radiance targets suitable for monitoring degradation in the UV. The choice criteria, and their uncertainties, will be determined by means of a doubly adding radiative transfer code. These targets, with identical solar illumination and similar ozone columns, will yield information year after year on the degradation of the instrument along the Earth radiance path. Moreover, this information can be directly compared with the degradation observed for Moon radiance measurements, which are acquired with a different angle of the scan mirror but otherwise follow the same optical path in the instrument. In addition, the GOME instrument is polarization sensitive: the measurement of the degree of polarization of the incoming light is necessary for the radiometric calibration of earth radiance, but not for solar irradiances, which are not polarized. It follows that the sun is not a viable calibration target for degradation phenomena which might affect polarization measurements.Zonal averages of the Earth radiances measures by the Polarization Measuring Devices will also yield additional information on the way that Earth albeod measurements are affected.

RING EFFECT STUDIES FOR A CLOUDY ATMOSPHERE USING GOME DATA

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ABSTRACT

Filling-in of spectral features observed in scattered sunlight lead to what is known as the "Ring Effect". The Ring Effect can have significant consequences for the retrieval of atmospheric constituents if not adequately corrected. As clouds also have strong impacts on the radiative transfer in the UV/visible spectral range, possible changes of the Ring Effect due to clouds have to be considered. Such investigations require radiative transfer modelling including both cloud and Ring features. This is provided by the radiative transfer model SCIATRAN, developed at the Institute of Environmental Physics/Remote Sensing (IUP/IFE), University of Bremen. UV/visible measurements from GOME and also ground-based measurements, both taken under cloudy conditions, have been used to validate model spectra, adequately calculated with SCIATRAN by including Ring and cloud modelling. A number of different cloud scenarios have been taken to simulate measured radiances in both ground and satellite geometry. Retrievals of NO2 from these spectra have been investigated using the differential optical absorption spectroscopy technique. Resulting errors using different Ring spectra in the retrieval have been derived. Results of the validation and the model study will be presented, which are used to clearly explain the sources of variable filling-in of Fraunhofer and absorption structures in the presence of clouds.

RETRIEVING SPECTRAL REFLECTIVITIES FROM EXTRACTED GOME INSTRUMENT HEADER DATA

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ABSTRACT

The Extracted GOME Instrument header (EGOI) data, which are available near-real time and contain parts of the UV-Vis spectra, are used in the retrieval of ozone columns and profiles. This work is done in the framework of the ESA-DUP project GOFAP.

The level 0-1 algorithms used are based on the GOME Data Processor (GDP) algorithms of DLR, but there are several differences. The corrections for straylight and polarisation sensitivity differ from the GDP algorithms in order to account for the limited spectral information in the EGOI data (only nine small spectral windows are available).

Detailed validation studies have resulted in several improvements in the level 0 to 1 algorithms. These comprise the wavelength calibration, correction of Peltier cooler interference, correction for polarisation sensitivity and correction of the effective reflectivity degradation. This paper gives an overview of the level 0-1 processor.

PRECISION ESTIMATES FOR TRACE GAS PROFILE RETRIEVALS FROM SCIAMACHY LIMB MEASUREMENTS

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ABSTRACT

The limb measurements of SCIAMACHY provide a unique opportunity to retrieve stratospheric concentration profiles for atmospheric trace constituents. For a strong absorber like O3 profile information can be derived for the free troposphere and the lower mesosphere.

The precisions of the anticipated profile retrievals are studied using a fully spherical radiative transfer model, which computes weighting functions for the trace gas profiles quasi-analytically. This model is combined with an instrument model incorporating realistic signal/noise and field-of-view integration of SCIAMACHY to produce retrieval variances according to the optimal estimation formalism by Rodgers.

Thus the precisions of retrieved profiles of O3, NO2, ClO, BrO, SO2 and OClO in several measurement scenarios, i.e., mid-latitude, polar and ozone-hole polar, are estimated. These estimates describe the theoretical limits for the SCIAMACHY limb data products. The influences of other potential error sources like data processing uncertainties have to be investigated after launch.

By comparison of SCIAMACHY's retrieval precisions to those of other instruments aboard Envisat overlaps can be identified which enable a validation of both instruments by a cross-comparison of their retrieval results.

A NEW RADIATIVE TRANSFER MODEL FOR A SPHERICAL PLANETARY ATMOSPHERE

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ABSTRACT

A new radiative transfer model suitable to calculate the radiation field in a spherical planetary atmosphere has been developed. The developed approach involves the Picard iterative approximation to solve the radiative transfer equation in its integral form. The radiation field calculated by solving of the differential radiative transfer equation in a pseudo-spherical atmosphere is used as initial guess for the iterative scheme. This approach has on the one hand the same advantages and is on the other hand much more computationally efficient as compared to the Monte-Carlo method. The developed radiative transfer model has been verified using a Monte-Carlo radiative transfer model. The relative difference between the radiance at top of atmosphere calculated by both models has a typical value of less than 1.

MEASUREMENTS OF LIGHTNING-PRODUCED NO2 BY GOME AND LIS

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ABSTRACT

The budget of the nitrogen oxide (NOX) production by lightning is difficult to establish because the dynamics of a thunderstorm disturb NOX-measurements from both in-situ and remote-sensing techniques. Also, the interpretation of the measurements is complicated by the in homogeneity of clouds and transport effects. Therefore, only a rough estimate of 2-20 TgN/a of global NOX-production by lightning is possible up to know. In this study, some examples of NO2-production in thunderstorms are analysed using NO2-measurements from the European satellite spectrometer Global Ozone Monitoring Experiment (GOME). Lightning data measured by the NASA-satellite project Lightning Imaging Sensor (LIS) are used to identify lightning events coinciding with GOME measurements.

GOME DATA ANALYSIS AND GROUND-BASED IN THE MEDITERRANEAN AREA DURING ETNAVOLCANO ACTIVITY

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ABSTRACT

The ozone decline at mid-latitude can be explained by three different and concomitant mechanisms: - loss inside the arctic vortex and subsequent transport of low-level ozone air masses to mid latitude - local process - chlorine activation on extra-vortices PSCs

A collaborative study is started with the aim to address the first two questions by means of analysis of satellite (GOME) data, integrated by ground-based (DOAS) and balloon measurements. Furthermore we are verifying the use of GOME data for measuring volcanic (and possibly anthropogenic) emission of SO2 in the Mediterranean area, in order to estimate climatic impact of volcanic emission and monitor potentially dangerous eruptive activity. The preliminary results are presented.

TROPOSPHERIC OH PRIMARY PRODUCTION FROM ERS-2 DATA

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ABSTRACT

In order to calculate the OH production rate from satellite measurements, one has to estimate the following quantities:o Profile of the photodissociation rate of ozoneo Tropospheric ozone profileo Tropospheric water vapour profile. The estimation of tropospheric OH primary production rate from ERS-2 data is demonstrated. The tropospheric ozone profiles retrieved by RAL from GOME narrow-swath mode (40 km by 80 km) available via BADC were used. The tropospheric actinic flux profile and photodissociation rates of ozone are calculated from GOME and ATSR-2 measurements using the TUV radiation model with the DISORT radiative transfer code. For partially cloudy GOME ground pixels the photodissociation rates are approximated as a linear combination from the clear-sky and the fully cloudy cases according to an independent pixel approximation. Total ozone, ozone profile, NO2 column, spectral albedo at the top of the atmosphere (TOA), UTC date and time of pixel at the end of integration time, and ground pixel location coordinates are used in the TUV model from the GOME measurements. Thick cloud, thin cloud and cloud free fractions for GOME FOV and the thick and thin cloud top height are used from the ATSR-2 measurements processed by RAL and available via BADC. Additionally, the mean reflectance of ATSR-2 555 nm and 659 nm channels for thick cloud, thin cloud and cloud free are used to determine the cloud optical thickness using the radiative transfer model. Next, the fitting of simulated GOME albedo spectra at the TOA with the measured ones is performed. The effective wavelength dependent surface albedo for GOME pixel is determined, cloud optical thickness within the error bars is optimised and for cloud free GOME pixels the aerosol extinction is changed if needed to fit with the albedo at TOA measured by GOME. The water vapour content from the ATSR Microwave Sounder is used to estimate the tropospheric OH primary production rate. The estimates are made as well using the NOAA-14 RTOVS layer precipitable water for 3 layers between 1000 and 300 mb, and DMSP F14 SSM/T-2 water vapour mixing ratios at 15 levels from 1000 mb to 300 mb.

SURFACE UV FLUX ESTIMATION FROM GOME: IMPACT OF CLOUDS AND WAVELENGTH DEPENDENT EFFECTIVE ALBEDO

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ABSTRACT

GOME satellite measurements deliver global top of the atmosphere sun normalized radiances in the spectral range of 240-790 nm with a spectral resolution of 0.2-0.4 nm. Using ozone and cloud information from spectral inversion, surface UV flux and actinic flux can be determined. Current UV satellite methods (e.g. TOMS derived UV-B irradiances) usually employ only one discrete wavelength assuming a constant effective albedo for the entire spectral UV range. The reflectivity at 360 or 380 nm is considered to be representative.

In this study an attempt is made to take into account the wavelength dependent UV surface albedo to derive the surface flux. For various surface properties as vegetation, soil or ocean, preliminary results of estimating a typical wavelength dependence are given. Relating the cloud effective albedo to cloud optical depth makes it possible to obtain an improved cloud transmission estimate as a function of wavelength. Preliminary results from the comparison with ground-based UV surface flux measurements will be presented.

TROPOSAT: THE USE AND USABILITY OF SATELLITE DATA FOR TROPOSPHERIC RESEARCH

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ABSTRACT

While the measurement of stratospheric gases was the primary goal of the current satellite instruments, the newly-gained capability of observing tropospheric trace gas distributions (such as NO2, O3, SO2, HCHO, BrO, or water vapour) with space-borne sensors can truly be regarded as a revolutionary step in the technical development and will lead to a significant enhancement of our capability of investigating the chemistry and physics of the troposphere. To explore and encourage the use of satellite data for tropospheric research a new subproject, TROPOSAT, has been formed within EUROTRAC-2, the EUREKA project studying the transport and transformation of pollutants in the troposphere. The aim of TROPOSAT is to determine two- and three- dimensional distributions and time series of trace gases and other parameters in the troposphere and so facilitate future research and environmental monitoring on regional and global scales, in particular through:* the development of algorithms for the retrieval of tropospheric species and parameters; * the use of satellite data for understanding atmospheric processes; * the synergistic use of different instrumentation and platforms for tropospheric measurements; * the development of validation strategies for tropospheric satellite data products. In addition TROPOSAT will undertake other underpinning and derived activities such as the development of appropriate data assimilation techniques combining satellite measurements with modelling, and the specification of the requirements for future satellite instruments for tropospheric work. The poster describes the organisation and scientific work of the project and will present recent results on regional tropospheric distributions of NO2, BrO and SO2.

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GOME OBSERVATIONS OF FORMALDEHYDE

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ABSTRACT

Formaldehyde indicates and supports photochemical activity in the atmosphere. Large amounts are expected to found in industrial areas and during biomass burning. HCHO is a major intermediate in the degradation of methane (and many other hydrocarbons). In the absence of heterogenous losses, essentially every methane is molecule is converted to HCHO. Therefore it is found throughout the troposphere. It is destroyed via photolysis and reaction with OH.

GOME is the first instrument that allows measurements of Formaldehyde on a global scale. This study presents the seasonal and regional variation since launch of ERS-2 in 1995.

During large biomass burning events in Indonesia, South Africa and South America vertical columns of up to 2*10exp16 molec/cm2 are found. Other regions with high excess of HCHO are the Southeast of the United States, Eastern Europe, Southeast Asia and India depending on the season. Possible sources and the influence on the tropospheric photochemistry and in particular on the ozone production will be discussed in this study.

ERS SAR IMAGING OVER THE BRAZIL-MALVINAS CONFLUENCE AND ARGENTINE COASTAL WATERS; ITS USEFULNESS FOR DIFFERENT OCEAN ACTIVITIES

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ABSTRACT

Argentina is one of the South American countries with a very long coastline, of approximately 4725-km, extending from the southern coast of the La Plata estuary down to Cape Horn. This coastline includes one peninsula and a considerable number of bays, gulfs, and straits. The dynamics of the water masses bordering these coasts consist of different littoral drift currents influenced by the flow of the La Plata River, other secondary river affluents and the Magallan strait. Further offshore, the Western South Atlantic Ocean is dominated by the encounter of the poleward-flowing Brazil Currents and the ecuatorward Malvinas (Falkland) Current. This encounter occurs near the entrance of the La Plata River estuary, roughly between 35º and 40º S and is referred to as the Brazil-Malvinas Confluence. Multiple meanders, eddies and filaments may appear in this area, resulting in an extensive mixing zone with SST gradients that can exceed 10º C over a distance of only a few kilometers. The argentine Comisión Nacional de Actividades Espaciales inaugurated its satellite receiving station in Falda del Carmen, Cordoba, in 1997. From then on, a large volume of data of the coast and the Western South Atlantic Ocean is being acquired. In this paper, a selection of ERS SAR images from this source and from two ESA Pilot Projects, are presented and discussed. They provide a variety of radar backscatter patterns over the Brazil-Malvinas confluence and argentine coastal waters. The sensibility of microwaves to a number of atmospherics and ocean phenomena are shown, among them: wind fronts, atmospheric gravity waves, rain cells, current boundaries, eddies and internal waves. Also, the capability of this type of information to reveal natural films, oil spills, ships and ship wakes and bathymetric features is shown. This set of images is a good example of the usefulness of this type of information for different activities in the region, such us: fishery, transport, petroleum and gas extraction, recreation, scientific, etc.

OBSERVATION OF SEASONAL VARIATIONS OF THE NORTH CASPIAN COAST VEGETATION COVERS BASED ON ERS-2 SAR MULTITEMPORAL DATA RECEIVED IN 1999 YEAR

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ABSTRACT

This work has been carried out as a part of AO-3 project "Observation of Caspian coastal evolution caused by rise of the sea level" because the study of the evolution of this nature complex from year to year is not possible without a consideration of seasonal variations of the coastal vegetation covers. Analysis of the multitemporal (May, June, July) ERS-2 data on the area of interest has been carried out and dynamics maps of vegetation covers have been generated. Three coastal areas were researched - Kalmykia coast and Damchiksky and Obgeorovsky regions of Astrakhansky Biosphere Reserve. Seasonal dynamic differences allowed us to classify three zones on the maps of estuary parts, there are marine part of estuary covered by water vegetation, reed growth drainage zone and dry land that is an alluvial plain, cut by rivers arms and covered by meadows and fields. One more zone is detected in the Kalmykia coast, it is a zone of semi-desert vegetation. Dark spots in the images received in June pointed places of underwater vegetation which will appear only in July in the north of estuary, but in the south of one such vegetation (lotus etc.) appears in June on the water surface (sigma-naught is increased). The reed growth drainage zone has close values of sigma-naught on all these images because backscattering properties of reed growth are stable from May to July. The meadows vegetation on alluvial plain appeared in the May, and the sigma-naught increased in June and in July along the rivers arms but in the distance of the rivers sigma-naught of meadows and semi-desert vegetation decreased in July. Numerous agricultural lands have their original seasonal dynamics.Use of ERS SAR multitemporal data allowed to differ seasonal dynamics of the coastal vegetation covers.

ON THE USE OF ERS INSAR DATA FOR CLASSIFICATION OF COASTAL COVER TYPES AND DETECTION OF FAST VARIATIONS OF WATER LEVEL

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ABSTRACT

The AO-3 project "Observation of Caspian coastal evolution caused by rise of the sea level" included the use of ERS INSAR data for classification cover types. Single-look complex data obtained in tandem mission on 2 May and 3 May 1996 were used to study a possibility of classification of coastal cover types and the detection of the coast modifications between the sessions. Combined pseudo-color images consisted of multitemporal images plus coherence maps have been generated and used to classify the coverage types and to study fast modifications of their state. Numerous types of surface coverage have been classified. Among them are open water surfaces of sea and internal reservoirs, water surfaces covered by vegetation, reed growth, meadows, fields, plowed lands, forests, flooded lands, urban zones, salt-marshes etc. A series of the fast variations such as appearance new plowed lands, modifications of soil moisture and modifications in reed growth drainage zone were detected.. The interferogram, representing the surface topography and surface dynamics have been generated. Analysis of combined pseudo-color images and interferogram results in new information. The level of islands borders and some shore borders covered by reed growth was displaced up to 15 cm within one day between observarions. We suppose that a reason is a drop of the scattering surfaces level followed by a fast drop of sea level. This may be results of siccus, occurred in Caspian sea at that time. We suppose that interferometry may be used to classify a density of coastal covers and detection of fast variations of water level.

COASTAL CHANGES AND THE ROLE OF MANGROVE AND MORPHOLOGICAL FEATURES ON THE DYNAMICS AND PRODUCTIVITY OF THE NE-BRAZILIAN OCEANIC WATERS

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ABSTRACT

The coast of Pernambuco in Brazil is drained by several small rivers, all surrounded by mangroves. Due to the small load of continental sediments and characteristics of the area (wave regime, climate, topography, etc) this coast is vulnerable to erosional process. At the last few decades, erosional problem has largely increased, in part due to the lack of planning of coastal occupation and in part due to the construction of pier, sea walls, etc, by private initiative. This construction while aimed to resolve point-problem has caused disturbances in much larger areas. Analysis of SAR images have been proved useful for monitoring coastal dynamics and studies of sedimentation and erosion zones. ERS images, C-Band, VV Polarization in ascending orbits have been used. The SAR scenes correspond to ERS-1 (orbit 25240, 13 May 1996 and orbit 25469, 29 May 1996) and ERS-2 (orbit 05295, 25 April 1996 and orbit 05796, 30 May 1996). Also one RADARSAT image, C-Band, HH Polarization, of the NE-Brazilian coast has been used. It was taken on 8 September 1997 on a descending orbit. The beam mode was ScanSar Wide. The goals and results of the study have been related to the use of SAR ERS images to position morphological features, to trace coastline evolution and detect changes in mangrove coverage. Particular attention has been applied to: 1) Identify and map coastal features such as reefs in Recife and Olinda, sandbars, banks and marine structures as Suape Harbour, 2) Characterize mangrove vegetation as in the Itamaraca island. Finally the results have been compared with RADARSAT image.The work has been made in the framework of ERS AO3-137 project(C. Medeiros, PI, J. M.Benjamin,Co-I).

CLEAN SEAS: A NORTH SEA TEST SITE

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ABSTRACT

Over three years, the Clean Seas project team focused on the problem of monitoring marine pollution and the role that existing earth observing satellites might play. Here we present some results from the North Sea test site, examined in detail during a two-year acquisition campaign. We have examined synergy within the data from radar, optical and infrared sensors, in conjunction with hydrodynamic models. The North Sea test site is a region where river discharges can be seen from satellite imagery to have an influence on the local sea conditions. The Rhine discharge into the continental coastal waters can be clearly seen in satellite imagery. These waters remain as a distinct water mass around the west and north coasts of the Netherlands, continuing east to Denmark. We chose to look at sediment dispersal patterns from the Rhine discharge, as an indicator of the types of pollution that the Clean Seas approach of combined remote sensing and modelling might tackle well. We present results from two test periods, August 1997 and May 1998, during which several interesting hydrodynamic and turbidity patterns were observed in SST, colour and SAR images. AVHRR data were used for model boundary conditions, whilst the higher accuracy ATSR data were used for validation of the model results. Sediment distribution patterns from the model were verified using "chlorophyll concentration" data from MOS and SeaWiFS. In turbid coastal waters such as those along the Dutch coast, the chlorophyll algorithms are corrupted by high sediment loads and become indicators of suspended sediment. In conjunction with the visible channels of AVHRR and ATSR, they give an uncalibrated measure of the sediment load. During the test periods studied, there was good correlation between the data sources, e.g. between SST and ERS-2 SAR images for August 97. Both data sets showed the development of fine plume structures close to the Rhine outflow, apparently associated with the outflow, and possibly caused by tidal pulsing of the Rhine Plume. Although the model reproduced the general temperature and sediment distributions well, these fine structures were not reproduced. In the North Sea test site, we see the importance of using a model to alleviate the problems of remote sensed data in temperate coastal climates, where both cloud cover and wind speed act to restrict the amount of useful data. Future missions with coincident infrared, visible and active microwave data will improve the options for combining data. However, using the model we will still be able to see a more complete picture of the way the Rhine plume disperses over time than will be evident from the remote sensed data alone.

TOPOGRAPHIC MAPPING OF THE GERMAN TIDAL FLAT AREAS USING ERS-SAR IMAGES

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ABSTRACT

The tidal flats of the Wadden Sea along the coast of northwest Germany are highly dynamic areas whose topography changes on timescales from a few hours (storm events) up to several months (sediment ablations and disposal). Conventionally generated maps based on echo sounding and geodetic leveling techniques often do not represent the actual situation because it takes several years to map the complete Wadden Sea. With the help of remote sensing data, especially ERS-SAR images, it is possible to achieve a more frequent updating of the topographic maps of tidal areas between high and low water level using the 'waterline method'. For this purpose waterlines in ERS-SAR images acquired at different tidal levels are extracted. After geocoding the SAR images, each point of the extracted waterlines is assigned to a water level provided by a water level model to represent the height of the sea bottom. The operational model of the German Maritime and Hydrographic Agency (BSH) calculates currents and water levels based on forecasts of wind and air pressure above the North Sea. The heights of the points along each waterline form a random grid of topographic points with a wide spacing when the gradient of the sea bottom is flat and a narrow spacing when the gradient is steep. A digital elevation model is derived from this irregular grid by triangulation and interpolation using the software package TASH (Topographisches Auswertesystem der Universitaet Hanover) which is based on the Delaunay triangulation method. The results of the 'waterline method' are evaluated by comparing the interpolated topography to data aquired by echo sounding and geodetic data and can be included in conventionally derived maps.

MONITORING BLUEFIN TUNA HABITS WITH THE HELP OF SATELLITE ENVIRONMENTAL DATA: ERS EXPERIENCE WAITING FOR ENVISAT

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ABSTRACT

Many studies have provided evidence of a deep correlation between several parameters (notably climate, physical and chemical conditions of the marine environment and food-chain processes) and tuna fishes spatial distribution and displacements.

Some theories suggest that tunas follow the warm water fluxes in search of food. Actually, even though the upwelling (deep water rich in minerals and nutrients rising to the surface) takes place in cold waters, secondary production organisms (zooplankton and micronekton) which feed tunas are pushed from the cold waters where they are generated to the warm pools.

Objective of European Community project "Study of Eastern Atlantic and Mediterranean bluefin tuna migrations using Pop-off satellite tags" (Fair CT97-3975) is to get more precise information about bluefin tunas migration patterns and spawning areas, in order to supply ICCAT (International Commission for the Conservation of Atlantic Tunas) with detailed stock assessment information and EC with tools for a better management of resources.

On one side, tunas are tagged and their route is followed thanks to tags transmitted signals received from the ARGOS satellite system. On the other side, the analysis of oceanographic data (Ocean Colour and Sea Surface Temperature) in the tunas crossed areas gives some hints at correlation between environmental parameters and fish behaviour.

In order to monitor environmental parameters ATSR, AVHRR data (SST) and SeaWiFS level-2 geophysical data (in particular chlorophyll concentration) have been chosen. The criteria for data acquisition have been changed during the project together with those for working out other planned activities. Many unforeseen problems have troubled the first project phase, giving hints at new research procedures.

NUMERICAL MODEL OF WAVE SPECTRA REFRACTION BY TOPSAR POLARISED DATA

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ABSTRACT

This paper presents work done utilizing TOPSAR data to detect wave refraction patterns along Terengganu coastline. TOPSAR data was used to extract information on wave spectra. This wave spectra wave used to model the wave refraction patterns. For this purpose, 2-DFFT was applied with a selective window size of 100 x 100 pixels and lines to present wave spectra refraction pattern. The quasi-linear model was used to model the real wave spectra into TOPSAR wave spectra. A composite image of wave spectra summation was used to detect the wave refraction pattern. The gamma filter was then applied to detect the area of wave convergence and wave divergences. The density spectra for the convergence and divergence waves were used to model the energy spectra along the wave orthogonal.

The results show that L-band is more suitable for detecting wave spectra refraction pattern compare to C-band. The maximum convergence spectra energy is found near to the Sultan Mohamed Airport. The wave spectra model had a good correlation with L-HH polarised band compare to L-HV band and C-VV band. This means that the L-HH polarised band are suitable to detect the wave refraction pattern.

It can be concluded that wave refraction pattern could be detected by polarised data. The polarised data of L-band has a more potentials for monitoring wave spectra refraction pattern.

WAVE REFRACTION PATTERN AND COASTAL EROSION

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ABSTRACT

Waves play an important role for shoreline configuration. Wave pattern could induce erosion and sedimentation. The main objective of this study to model the wave refraction effects on shoreline change. Polarised TOPSAR data and ERS-1 data are used for this purpose ERS-1 data are taken in 8 th August 1993 and polarised TOPSAR data was taken in 6 th December 1996. For this purpose, 2-DFFT was applied with selective window size of 100 x 100 pixels and lines to present wave spectra refraction patterns. The simulation of quasi-linear model was used to model the rate of shoreline change. The vectors of shoreline were used to compare with wave spectra model in order to exam the accuracy of coastal erosion model. The results show that the wave refraction pattern modeled from TOPSAR data have a good correlation with the quasi-linear model compare to one extracted from ERS-1 data. The dominated feature from TOPSAR data and ERS-1 is the wave spectra tend to converge along the Sultan Mahmud Airport, which means erosion event. The shoreline rate modeled from vectors data of TOPSAR data and ERS-1 have a good correlation with a quasi-linear model. In addition, L-band polarised data were more sensitive to detect shoreline change compare to C-band. In conclusion, wave refraction patterns are good index for shoreline erosion. The integration between polarised SAR data consider as a good tools for investigation of wave effects on shoreline change.

RESIDUAL CURRENTS MOVEMENTS AND OIL SPILLS TRANSPORT

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ABSTRACT

Oil Spill trajectory could be detected from radar data. Radar data such as Radarsat are good tools for oil spills movements. In this study the finite element model was applied with Doppler frequency shift to model surface water currents on the coastal water of Malacca Straits, Malaysia. This study was used the probability density function and time series analysis to predict oil spill movements due to the effects of residual currents componets.

The results show that the water current on Malacca Straits moved in elliptical shape. The Major axis are parrallal to the coastline of Malaysia. The minor axis have a right angle with the coastline of Malaysia. It is clear that the oil spills moved towards the coastline with constant current velocity of o.23 m/s and spread in small parcales along the coastal water of Malaysia. The time was required for oil spills spreading was 12 hours.

In conclusion, the average current velocity of the time period play significant role for oil spills spreading. The extraction of oil spills with current speed make Radarsat as good tools for modelling oil spills movements in coastal zone.

PRELIMINARY STUDIES FOR ENVISAT PROPOSAL (AO-ID-542): DETERMINING OFFISHERIES AND COASTAL MANAGEMENT PLAN BY USING REMOTE SENSING TECHNIQUES IN LAKE VAN, EASTERN TURKEY

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ABSTRACT

Lake Van is largest Soda Lake on earth. The lake covers a surface area 3574km2 and its volume 607 km3, its elevation is 1650 m and average depth 171 mand the deepest point 451 m and its pH is 9.8. It is very suitable both in the feeding and living habitat for Chalcalburnus tarichi (local name Vanfish) that only one species lives into Lake Van and taken second row with a portion 31after carp in the inland water fish production of Turkey. This project have been intended to investigate of following elements: Fisheries monitoring, understanding of lake coast process, sea surface temperature (SST), detection of pollution and coastal processes, identification of area for Van fish distribution, chlorophyll concentration and coastal dynamics, creating of new lake batyhmetric map. In this project will be used ENVISAT data from AATSR, ASAR, MERIS and RA-2 sensors. Its also investigates a methodology by using a multi-stage approach and state of the art of the space technologies especially for SAR. This will increase the level of understanding and by applying the ENVISAT data used in Turkish research and academic institutions.

ENVIRONMENTAL REMOTE SENSING SYSTEM FOR COASTAL WATER MONITORING (ENVISAT AO 560)

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ABSTRACT

Human activities that take place in the coastal zones (industry, tourism, fishing, aquaculture, etc) are affecting the environment. Also, human activities effects on the coastal environment can have a remote origin, and the observed effects are often difficult to relate to the causes, as they may do not appear immediately. The strong seasonal variations in tourist activity and in the associated environmental pressures makes complicate the management of the coastal zones.

Finally, as a result of taking these interactions into account insufficiently or too late in the planning processes, human activities handicap each other and damage the environment.

The main objectives of the system are: - Integrate and assemble all environmental researches in the Black Sea zone on the purpose of achieving a superior understanding of physical, chemical and biological phenomena;- Create the structure of an operational system, partially independent of budget funds, having as inputs local measurements and researches and as output, specialized reports for different users (industrial, tourist industry, government);- Ensure the use of edge technologies in environmental monitoring, shortening the way innovative technologies have to travel to the commercial applications.- Create an environmental monitoring system that would comply and support the European and international environmental legislation;- Provide an operational system as decisional support for disaster and environmental monitoring.

An operational system, near real time effective can solve a great deal of these problems, especially when related to early response. A structure of such a system is presented, adapted to the social-economic realities of Romania, together with some methodological aspects of the use data provided by ERS-1&2 and Envisat on-board sensors.

CHINESE PROGRESS TOWARD COASTAL AND MARINE APPLICATIONS OF SPACEBORNE SAR

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ABSTRACT

Images from the synthetic aperture radars (SARs) aboard the European Remote Sensing Satellites ERS-1/2, the Canadian Radarsat and the first Japanese Remote Sensing Satelllite JERS-1 have been used by Chinese marine community since 1991. This paper presents the recent progress toward coastal and marine applications of the SAR images in China. Particular attention has been paid to mapping of coastal zone, observations of internal waves, and measurements of ocean surface winds.

OIL SPILL MONITORING IN THE MEDITERRANEAN SEA USING ERS SAR DATA

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ABSTRACT

Although SAR imagery is widely accepted as a valuable method in detecting oil spills, its operational use largely adopts subjective criteria to discriminate between slicks and other similar natural features. In the present paper a set of image features are tested in order to select those useful in detecting the oil spills.

Two different statistical approaches have also been developed in order to evaluate the probability for a dark area to be a slick on a SAR image. A comparison of the results of the two methods is provided. The advantages and the drawbacks of both are presented and discussed. Based on the previous algorithms a SAR post processing imagery system has been developed. It can analyse both in automatic or manual modality the ERS SAR PRI images in order to identify the slicks and to produce a detection report. The system functionalities, its performances and the operational framework are described. The system validation activity has been carried out on two data sets, the one used to statistically characterise the slicks and on a new one. The results obtained are very encouraging, showing about 85101153650 of correct classification in both the situations.

Last but not least, a comparison on the detection capabilities is performed, using as input to the system images with different spatial and radiometric resolutions. This analysis is devoted to identify possible system parameters to reduce the time gap between the image acquisition and the detection report availability.

WATER DYNAMICS IN THE KURIL STRAITS AREA: STUDY WITH ERS SAR

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ABSTRACT

Synthetic aperture radar (SAR) images obtained from the ERS-1 and ERS-2 satellites are analyzed together with NOAA AVHRR imagery, weather maps and hydrographic CTD data to study peculiarities of water dynamics in the southern Okhotsk Sea. The mesoscale features such as eddies of 100-150 km in diameter and fronts associated with the main currents were detected on the AVHRR, while the SAR data provided evidences on the smaller scales of ocean structure.

Characteristic outlines of anticyclonic rings were clearly defined at wind speed of 3-10 m/s and were likely associated with a modulation of the surface capillary-gravity waves by the current shear. Some small-scale features of circulation were also found due to the presence of surface films. Spatially organized compact vortex structures of 7-15 km in diameter were especially well visible in spring and fall periods, which correlates with a biological activity in the area. Among them cyclonic eddies are dominant outside of strong flows.

Rough bottom topography and strong tidal currents in the area of Kuril Islands are responsible for formation of rips, wakes and headland vortices, and packets of internal waves. Pattern of the shear fronts on the SAR images varies with a tidal phase. However the main areas of tidal energy dissipation are tightly related to the bottom topography and are likely stable. Typical spatial patterns of water dynamics and new fine details of the surface water structure are discussed.

GAMMA SAR AND INTERFEROMETRIC PROCESSING SOFTWARE

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ABSTRACT

The Gamma Modular SAR Processor (MSP), Interferometric SAR Processor (ISP), Differential Interferometry and Geocoding Software (DIFF&GEO), and Land Application Tools (LAT) are modular software packages useful to process synthetic aperture radar (SAR) images. Data of both spaceborne and airborne sensors including ERS-1/2, JERS-1, SIR-C, SEASAT, RADARSAT StripMap mode, and the single-pass Dornier DOSAR interferometer have been successfully processed interferometrically. Up-to-date algorithms were implemented to achieve accurate processing of the data while permitting timely processing of large data sets. Recent projects completed with the software were the SAR and interferometric processing of more than 700 JERS scenes in the frame of the SIBERIA project and the generation of subsidence maps for Bologna, Abano, and Mexico City. User-friendly display tools and full documentation in HTML language complement the software. Both binary and source code licenses are provided.

Recent development included the adaptation of the software to PC operated under LINUX or NT operating systems and the improvement of the functionality for differential SAR interferometry. Furthermore, as part of our ERS AO3 project (ERS AO3-175), software demonstration, training, and testing examples which can be distributed to the users were generated. Development in the near future will include the adaptation of the software to the processing of ENVISAT ASAR (with data provided through ENV AO-210) and ALOS PALSAR (ALOS AO proposal submitted) data.

SAR PRODUCTS FOR ALL: RENT-A-RAPIDS

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ABSTRACT

Through the new SARCOM consortium, a mobile receiving station can be rented. This unique service enables users to get access to timely, low cost ERS-SAR data products world-wide. SAR products for all: **anybody** (low cost), **anytime** (up to near real-time), and **anywhere** (station can be deployed worldwide).

For this service, NLR's mobile receiving station RAPIDS is used. RAPIDS is a cost-effective PC-based ground receiving station, capable of local acquisition and processing of satellite data from ERS and also Spot. Further, the station will be upgraded to receive ASAR data from the future ENVISAT. Due to the low complexity and small size of RAPIDS, the station can rapidly be deployed anywhere in the world. The turn-around time (break-down plus build-up) of RAPIDS is less than 24 hours. RAPIDS is transportable by car, ship and wide-body aircraft. The station can be operated by NLR staff or by the customer (the customer will then be trained by NLR staff). More information about RAPIDS is on the Internet: www.rapids.nl

The SARCOM consortium has been selected by the European Space Agency to distribute data products worldwide from the ERS and ENVISAT satellites. Because of this worldwide license, the Rent-a-RAPIDS service is inclusive the license for data reception. The SARCOM consortium is a group of major players in the satellite imagery market: Spot Image (France), Geoserve (the Netherlands), Nigel Press Associates (UK), NLR (the Netherlands), RADARSAT International (Canada), Satellus (Sweden) and Tromsø Satellite Station (Norway).

The Rent-a-RAPIDS service can be a solution for applications for which currently no (timely) ERS-SAR data is available. Examples applications include flood monitoring in Bangladesh, forestry and bathymetry in Indonesia and volcano monitoring on Montserrat.

KEYWORDS: worldwide, mobile receiving station, low cost, rapid deployment, commercial service.

ANALYSIS OF THE EFFECT RAIN ON ENVISAT ALTIMETER: DEFINITION OF A RAIN FLAG

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ABSTRACT

Attenuation of the signal and distortion of the waveforms by oceanic rain can significantly degrade the quality of altimeter measurements. Several studies have analysed in details the effect of rain on the dual-frequency (Ku and C bands) Topex altimeter (NRA) data. They showed that the frequency dependence of the electromagnetic signal attenuation by rain can be used to define a rain flag based on the detection of departure from a rain free relationship between the two frequency backscatter coefficients. This kind of rain flag proved to perform better than the operational one based on coincident passive microwave data. The future Envisat altimeter will also have a dual-frequency capability and will operate in Ku and S bands. The aim of the present study is to analyse in detail the distortion of the altimeter waveforms to define a rain flag. For this purpose, an analytical model has been developed to compute Ku and S band waveforms in presence of a rain cell. It has been used to quantify the deformation of waveforms for a wide range of rain rate and rain cell diameter. The results of the modelling are used to define a rain detection criterion based on the attenuation of the Ku band signal compared to the S band one. The results are also used jointly with a cloud liquid water estimate based on Marshall-Palmer drop size distributions within rain cell to propose an inversion technique to retrieve rain rate and rain cell diameter from attenuation and passive microwave cloud liquid water estimates.

ADVANCED MIPAS-LEVEL-2 DATA ANALYSIS (AMIL2DA)

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ABSTRACT

Changes in atmospheric composition are important in the context of stratospheric ozone depletion, global change and related environmental problems. The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), which is a core instrument of the Envisat polar platform to be launched in 2001 by the European Space Agency (ESA), is a powerful tool to measure vertical profiles of trace species on a global scale. While operational data processing by ESA covers only analysis of pressure, temperature, and the mixing ratios of the species O3, H2O, HNO3, CH4, N2O, and NO2, MIPAS infrared spectral limb emission measurements contain information on a bulk of further important species. The goal of AMIL2DA is to generate data analysis tools for these supplemental species along with thorough validation of these algorithms. Instead of merging the contributions of all participants to one data analysis algorithm which fits all purposes, the AMIL2DA strategy is to maintain the diversity of different computer codes by each group which are custom-tailored to their specific scientific needs. First, forward radiative transfer algorithms and retrieval processors are adapted to the physical and computational needs of the MIPAS experiment. These codes then are cross-validated by intercomparison to reveal potential weaknesses of the assessed computer models. Spectroscopic line data not included in the current databases but important to MIPAS applications are generated. After cross-validation of forward radiative transfer models and subsequent upgrading, these are operated in the context of an inversion computer code, which infers atmospheric constituent abundances from measured spectra. The different inversion algorithms are applied to a common set of synthetic measurement data in a

blind-test validation mode. After upgrading the inversion models and fine-tuning of processing parameters, a common agreed set of real MIPAS measurements is used for further testing. Residuals between measured and best-fitting modeled spectra are analyzed for systematic patterns. Emphasis is put on candidate explanations such as inappropriate predictions on instrument characteristics; different use of initial guess and a priori data; over-or under-regularization of the retrieval, and possible deficiencies in spectroscopic data. Furthermore, GOMOS, SCIAMACHY, and other data are used for validation.

CONCEPT FOR USING GPS-BUOYS FOR RA DRIFT MONITORING

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ABSTRACT

Radar altimetry is a valuable tool for measuring instantaneous sea levels or mean sea surface heights. Until today a long series of measurements from different altimeter missions exist. A main problem in using these data for determination of sea level changes are the biases between the missions and a only weakly determined drift of the different sensors. For the past and current missions different strategies are used for calibration and drift monitoring, e.g. using crossovers or tide gauges as a height reference. The disadvantage of all calibration methods is, that no direct measurement beneath the sub-satellite tracks are available and, therefore, models have to be used to account for e.g. the sea surface slope or time varying signals. A more reliable method exists, when using oil platforms equipped with GPS and tide gauges beneath the sub-tracks. Unfortunately, only a few of them are probable located. With the availability of GPS a different strategy can be applied. As shown for ERS 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. Until today only lightweight buoys were deployed. Therefore, no long-term sensor for the calibration and drift monitoring exists. A ruggedized GPS-buoy will be deployed in the North Sea in the context of a large German sea level monitoring project. An ENVISAT crossover, which intersects with a Topex/Poseidon and GFO sub-track, will be chosen. The lifetime of the buoy is expected to be several years, therefore, a long-term calibration, drift monitoring and inter-calibration of different missions will be possible. A second buoy will be deployed in the Gulf of Mexico. In addition, the buoy will be equipped with supplementary sensors, like wind speed, gyros and air pressure sensors, allowing a broader use for calibration, e.g. of wind speed or significant wave heights.

THE ENVISAT EXPLOITATION PROGRAMME

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ABSTRACT

The UK EnviSat Exploitation Programme (EEP) has aimed to encourage the EO communities concerned with policy, research, applications development and operations to work closely together on common objectives. This has been to stimulate the use of data and products that will be available from the EnviSat mission not only in the large public and science sectors but also in the wider commercial base. The programme has concentrated on the applications and potential products of the land, ocean and atmospheric instruments. This includes: - ASAR (Advanced Synthetic Aperture Radar) - MERIS (MEdium Resolution Imaging Spectrometer) - AATSR (Advanced Along Track Scanning Radiometer) - RA-2 (Radar Altimeter) - MWR (Microwave Radiometer) - GOMOS (Global Ozone Monitoring by Occultation of Stars) - MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) - SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography)

The following areas have been addressed that include information provision and gathering, data handling development, technical meetings and the provision of reports and publicity material. The results of these activities can be viewed from a Web site, address: www.eoboard.co.uk. The potential of EnviSat instruments for sea state and marine monitoring through the use of demonstrators has been included on this site. To stimulate land applications and geocoding of ASAR and MERIS data, a world wide DEM catalogue has also been produced, address: www.demcat.co.uk. For the Advanced Along Track Scanning Radiometer and the Medium Resolution Imaging Spectrometer, application studies were undertaken that produced either sample data or demonstrated higher level products. These are available on CD-ROM. There is now a comprehensive set of information leaflets that cover the EnviSat satellite, atmosphere, land, marine, global, agriculture and forestry as well geological applications.

OPERATIONAL LONG TERM MONITORING OF THE SCIAMACHY INSTRUMENT ON ENVISAT

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ABSTRACT

We outline the concept, including functions and responsibilities, for the operational instrument monitoring for SCIAMACHY. According to agreements between ESA and the Announcement of Opportunity Provider (AOP), the operational long term monitoring (OLTM) is a function which has to be provided by AOP. Its technical and scientific implementation will be realised as part of the tasks of the SCIAMACHY Operations Support Team (SOST). Monitoring the behaviour of SCIAMACHY in-orbit is an essential function during the Commissioning and Routine Operations Phase. OLTM ensures that the actual instrument status is known, that countermeasures preventing instrument malfunctions can be initiated, and that data processing can incorporate the most up-to-date instrument characterization. Thus for the full complement of OLTM tasks, both housekeeping (HK) and science data have to be evaluated. Modifications to instrument characterization will be provided by OLTM in order to account for degradation of optical components of the instrument over the mission lifetime. These are achieved by the so-called "m-factors", which ratio the actual radiance at a specific time during the mission, obtained under well defined measurement conditions, and a reference radiance determined at a phase when the instrument status could be described by the original calibration parameters. In a complementary sense also the behaviour of single optical components is monitored. OLTM based on HK data will mainly deal with long term trend analysis of parameters: extrapolation of the temporal behaviour to estimate the occurence of specific events (e.g. heater power to learn when de-contamination has to be scheduled), extrapolation of the temporal behaviour to avoid occurences of out-of-limit events, correlation of specific events with measurement parameters, investigation of out-of-limit events (e.g. frequency, triggering events, etc.) orbital dependencies. According to the presently identified orbit scenarios and their planned execution pattern in-flight calibration & monitoring data will be generated on a regular basis. Among the numerous analysis methods and purposes for these data a well-defined subset will be used to achieve the monitoring goals as described above, based on the current knowledge of the instrument and on lessons learned from GOME on ERS-2.

GERMAN CONTRIBUTION TO SCIAMACHY VALIDATION WITH GROUND-BASED FTIR OBSERVATIONS FROM THE NDSC NETWORK: PREPARATION PHASE

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ABSTRACT

Within this German SCIAMACHY CAL/VAL project columns of O3, NO2, N2O, CO, CO2, CH4, H2CO, and profiles of O3, N2O, and CH4 shall be validated with ground-based FTIR measurements. The German NDSC-FTIR-Validation Network includes sites covering 28 - 68 °N: Zugspitze (NDSC Primary Site, run by IFU-Garmisch), and Kiruna and Izana (NDSC Complementary Sites, run by IMK-Karlsruhe). In the ongoing preparation phase, existing expert know how will be exploited to guarantee an optimum consistency and quality control of the ground-based FTIR measurements and retrieval techniques. Examples of the current work will be discussed.

STUDY OF THE GEOMETRIC PROPERTIES OF ENVISAT ASAR PRODUCTS

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ABSTRACT

The base for the interpretation of remote sensing data is the calibration of the data to be analyzed. ESA is taking into account this fundamental needs by including also the ENVISAT sensors into its long tradition of high precision calibration and validation. DLR-DFD participated in those activities as one of the Processing and Archiving Centers of the ERS ground segment and consequently intends to contribute to the calibration of ENVISAT-ASAR data, too. Additionally the institute has long experience in the definition, exemplary implementation and operation of processing chains for the generation of higher level SAR products. This service shall be extended to support ENVISAT-ASAR data as well. A basic requirement is the suitability of the input standard products.

Therefore the geometric properties of the precision image, the single look complex and medium resolution products shall be checked and reported regarding product annotation, timing parameters, orbit precision, parameter stability by considering repeat acquisitions and processing artifacts. The products shall be terrain corrected and interferometrically processed. During the orthorectification procedure the ASAR data set is combined with ground control points as well as digital elevation models serving as external references. Possible processing artifacts as well as geodetic inconsistencies would be identified. Interferometric processing is a sensitive tool for the identification of several error sources like timing and orbit precision and phase behavior. The analysis of the coherence allows a fine scale investigation.

The proposed presentation will describe the intended procedures. It will be complemented with results achieved during the calibration and validation of ERS-SAR-data.

IN-SITU VALIDATION OF THE AATSR SKIN SST PRODUCTS WITH THE SISTER RADIOMETER

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ABSTRACT

The ENVISAT AATSR (Advanced Along Track Scanning Radiometer) is a filter radiometer capable of measuring infrared brightness temperatures (BTs) to very high accuracy. The principal derived AATSR product is a skin sea surface temperature (SSST), calculated from the BTs with a physically based retrieval algorithm.

Convection within the sea is inhibited at the air-sea boundary, so the transport of heat through the surface layer is relatively inefficient and the SSST is often decoupled significantly from the bulk sea surface temperature (BSST) immediately below. As a result, it is not adequate to validate the AATSR SSST product against buoy measurements of BSST alone.

The authors plan to collect in-situ measurements of SSST with the SISTeR (Scanning Infrared Sea surface Temperature Radiometer), a compact and flexible chopped, self-calibrating infrared filter radiometer specially designed for research in a maritime environment. All external radiance measurements are referred to two internal black bodies, operated at ambient temperature and at a programmable increment (typically 10K) above ambient temperature.

Measurements of the upwelling sea surface radiance are made at an angle as near as practicable to nadir, where the emissivity of the sea surface is highest. A second interlaced set of downwelling sky radiance measurements are made at the complementary angle so that a deficit due to the reflected sky signal can be corrected and the true SSST calculated.

The SISTeR will be deployed on research ships and other ships of opportunity to collect sea-level radiometric data co-incident with ENVISAT/AATSR overpasses. The SISTeR has previously been deployed in support of ATSR-2 both in coastal waters and over the open ocean. Illustrative results from some of these campaigns are discussed.

ALTIMETRIC MEASUREMENTS AT L, S, C AND KU BANDS FROM AN OPEN SEA PLATFORM

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ABSTRACT

Altimetric measurements have been carried out using coherent and impulsive radars at L (1.25 GHz), S (2.5 GHz), C (5.4 GHz) and Ku (15.4 GHz) bands, from the Italian Oil Company (AGIP) platform "Barbara C", in a deep-water site in the Central Adriatic Sea. One of the aims of the experiment is to study the properties of the sea surface obtainable from the specular reflection of the e.m. waves. This is possible due to the coherency of the radars, which allows to measure the sea surface displacement along with the radar backscatter. The instantaneous properties of the radar backscatter, as a function of the wave isplacement and of the wind, are studied using the continuous wavelet analysis, a technique which allows to distinguish between the different roles of wind and waves in the determination of the radar backscatter. Besides this, the measures allow the determination of the electromagnetic bias, which is one of the most important parameters in altimetry. The implications of these measurements, hopefully continued in the future, with the satellite altimetry, concern the e.m. bias as well as the dependence of the radar backscatter on wave age and turbulent properties of the atmospheric boundary layer.

THE DEVELOPMENT OF AN ADVANCED CALIBRATION TRANSPONDER FOR QUAD-POL SAR AND SCANSAR

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ABSTRACT

For future SAR systems with increased complexity, number of modes and number of beams the calibration requirement is significantly greater than that for ERS. For example, calibration of SAR instruments with multiple polarisations is difficult with conventional transponders and corner reflectors because of the problems in controlling the channel responses and separating them in the final image. Similarly, it is no longer possible to rely on a single well prepared and characterised calibration site and transponder to conduct a cost-effective calibration campaign. The advanced SAR transponder design described in this paper addresses both of these issues - additional functionality and multiple deployment. The transponder features separate pulse coding for each of the polarisation channels. This has two main benefits. The images from the different channels no longer interfere since the decoding processing only focuses one channel at a time. Also the background level variance in the image is reduced allowing more accurate measurements to be made. The technique has the added benefit of allowing operation without the use of specially prepared sites. The transponder also features digital pulse replication, which allows improved calibration statistics without saturating the radar receiver. This will be of particular benefit for calibrating low-resolution modes such as SCANSAR. This transponder builds on the original ESA design used for ERS but cost-effectiveness is improved by using smaller Potter horn antennas and a simplified internal calibration system. The technique has been successfully demonstrated previously using experimental C band equipment. A prototype transponder is now being developed under GSTP funding. This implements a single channel of the full quad-pol system and is being used to demonstrate the technology.

CALIBRATION AND EVALUATION OF ENVISAT TEMPERATURE AND OZONE DATA USING STATISTICS FROM THE UK MET OFFICE NWP SYSTEM

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ABSTRACT

Temperature and ozone data from the GOMOS, MIPAS and SCIAMACHY instruments aboard Envisat will be assimilated into the UK Met Office Numerical Weather Prediction (NWP) system. The operational data routinely used by the weather agencies will be assimilated together with the Envisat data. This assimilation system seeks to combine in an optimal manner atmospheric observations with data from a general circulation model of the atmosphere. The statistics generated by the assimilation procedure on the difference between the Envisat observations and the data assimilation analyses, and between the Envisat observations and forecasts using the analyses as initial data, will be used to calibrate and evaluate the Envisat data. The approach will follow that applied to temperature and ozone data from instruments aboard NASA's Upper Atmosphere Research Satellite (UARS) and from ESA's GOME instrument. Observation processing datasets generated by the statistics will be used to identify potential biases in the data. In collaboration with the Envisat instrument teams, biases in the observations will be estimated. The impact of the Envisat datasets will be tested using Observation System Experiments (OSEs) in which different sets of data are systematically removed from the assimilation. Wherever possible, the meteorological analyses incorporating Envisat data and operational data will be evaluated against independent observations (i.e. observations not used in the assimilation). The error characteristics provided by the instrument teams will be assessed. An attempt will also be made to identify shortcomings in the UK Met Office assimilation system.

PASSIVE CALIBRATION TARGETS WITH A LARGE, STABLE AND CONTROLLABLE RCS FOR SPACEBORNE SAR

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ABSTRACT

The series of calibration experiments with ERS-1/2 SAR was conducted in 1995 and 1999 at the Bear Lakes calibration site near Moscow. Since a very beginning in the number of calibartion scenarios along with standard targets (corner reflectors) new passive calibration targets based on parabolic antennas were investigated. Main tasks - study of the scatterers stability and a way to broaden scatterer pattern were made and reported earlier.

Experiments of the year 1999 were conducted under AO3-343 project and devoted to the continuation of the study of the parabolic antennas scattering stability and a way to control their radar cross section. Three parabolic antennas, used in the experiment, were located at the corners of the rectangular triangle with 50 m legs. Two antennas were used as a reference, and another one was a calibration target with polarisation grid in focal area. The use of the polarization grid allowed us to modify scattering matrix of the antenna. Final scattering properties of the structure become similar to that of the dipole. As a result, setting the angle q between the SAR polarization plane and the grid polarization plane, we were able to change the targets RCS for a single polarization system, like as ERS SAR.

The SLCI data obtained under AO3-343 project were used for the measurements of the antennas RCS. The measurements show, that reference antennas have very stable and very large, with ~ 52 dBm2 radar cross-section. The cross-section of the last one was controlled by the orientation of the polarization grid with respect to ERS-2 polarization plane. The results are in good agreement with theoretical predictions except for orthogonal orientation, where observe 4 dB higher scatter than it was predicted.

The study conducted with a use of ERS SAR data confirms high stability of the parabolic antennas and the possibility to control the polarization plane (radar cross section) of the backscattered signal, what is of special value for multipolarization SAR systems like as Envisat ASAR.

COMPARISON OF GROUND BASED FTIR MEASUREMENTS AT HARESTUA TO SPACEBORNE MEASUREMENTS

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ABSTRACT

Ground based high resolution Solar FTIR measurements conducted at the complementary NDSC (Network for Detection of Stratospheric Change) site Harestua in (60oN, 11oE, altitude 590 m) are here compared to spaceborne measurements from various instruments, such as HALOE, CRISTA (on the space shuttle) and MOPITT.

The two first above-mentioned instruments are focused on detecting stratospheric species of large relevance for the ozone depletion chemistry, such as HCl, HNO3 and O3. The Moppitt instrument also covers the troposphere measuring CO and methane. These species are of high importance for tropospheric as well as stratospheric atmospheric chemistry. Both gases have a strong anthropogenic component and especially CO with its relatively short lifetime (3 months) is likely to show a considerable variation in time and space.

In the present paper partial and total columns retrieved from spectra at the Harestua site in southern Norway (60oN, 11oE, altitude 590 m) during 1994 - 2000 will be compared to coincident measurements in time and space with the above-mentioned space borne instruments. The results will be discussed and related to the uncertainties of the FTIR measurements.

SAFIRE-A **MEASUREMENTS** DURING THE APE-GAIA CAMPAIGN

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ABSTRACT

Results of measurements obtained by SAFIRE-A (Spectroscopy of the Atmosphere by using Far InfraRed Emission - Airborne) during the APE-GAIA (Airborne Polar Experiment Geophysica Aircraft In Antarctica, Ushuaia, Argentina, 15th September 15th October 1999) campaign are presented, providing an assessment of instrument performances in view of its participation to the planned M55-Geophsyica activities for ENVISAT validation. The SAFIRE-A Far Infrared FT spectrometer was operated onboard the Geophysica stratospheric platform during the five scientific flight which the aircraft performed over the Antarctic Peninsula, aiming at investigating the chemistry and dynamics across the boundary of the southern polar vortex. The instrument provided limb sounding observations of atmospheric emission spectra over two frequency intervals: [22-23.5 cm-1], and [123-125 cm-1] where spectral features respectively of O3, ClO, N2O, HNO3 and HCl, H2O are displayed. Volume mixing ratio vertical profiles of the observed species are retrieved from limb-scanning sequences by data analysis and inversion. Variability of O3, ClO, N2O and HNO3, along the flight track, has been studied as a function of altitude and latitude and results of measurements obtained in some of the APE-GAIA Antarctic flights are displayed.

TOOLS FOR THE ANALYSIS OF RESIDUAL SPECTRA AFFECTING MIPAS LEVEL 2 PRODUCTS

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ABSTRACT

One of the atmospheric payload instruments of ENVISAT is MIPAS, an infrared Fourier spectrometer operated as a limb sounder. MIPAS level 1 products consist of sequences of calibrated emission spectra covering the range from 4.15 to 14.6 micrometer; level 2 products are vertical profiles of pressure, temperature and selected trace gas VMRs derived from sequential level 1 scans. The retrieval of the level 2 products is based on the use of initial guess data, forward modelling and iterative improvements of the assumed parameters until convergence to a stable solution has been reached.

The attainable profile quality will be affected by random as well as by systematic effects that result in differences between measured and simulated spectra remaining after the level 2 retrieval iterations. Time averaged residual spectra should average out random noise and be close to zero. Deviations from zero can be due to imprecise spectroscopic data or instrument parameters, shortcomings of radiative transfer modelling, or inappropriate retrieval techniques and parameters.

The level 2 data will be generated as near real time as well as off-line products. For both types of data our work aims at the identification and subsequent minimisation of level 2 residual spectra. To this end, a number of analysis techniques and tools have been designed and implemented allowing the detailed analysis of spectra, profiles, Jacobians and quality metrics. Some of these tools can be operated automatically, while others require interactive investigation and parameter modification.

Concepts and typical examples will be presented, where the manipulation of simulated instrumental parameters, of spectral measurements and of retrieval parameters leads to degraded profile quality. The application of the proposed tools allows the identification and quantification of separate error terms and hints to their origin.

During the mission, when we cannot rely on simulated data with known degradations, data of increasing atmospheric complexity shall be used. Thus, our first analysis steps will be the identification of instrumental features, followed by the determination of general spectral characteristics and special meso-scale effects. This rationale and the available tools will help to verify the selected approaches during the level 2 processing including the choice of the proposed emission line windows, the retrieval approaches and parameters, and the knowledge of the attainable level 2 data quality. Special emphasis has to be given to the sequential application of the various tools.

GROUND BASED HIGH RESOLUTION FTIR MEASUREMENTS OF STRATOSPHERIC MOLECULES ABOVE HARESTUA, NORWAY, DURING 1995 TO 2000.

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ABSTRACT

Groundbased high-resolution Solar FTIR measurements have been conducted at the complementary NDSC (Network for Detection of Stratospheric Change) site Harestua in southern Norway (60oN, 11oE, altitude 590 m) since 1994. Measurements has primarily been focused on molecules of interest for stratospheric ozone depletion research, HCl, HF, HNO3, ClO, ClONO2, N2O, COF2, and O3 as part of the field campaigns SESAME and THESEO. A primary goal of NDSC is satellite validation and the site is part of three accepted ENVISAT AO-proposals:

Validation of ENVISAT-1 level-2 products related to lower atmosphere O3 and NOy chemistry by an FTIR quasi-global network. Global study of inorganic chlorine and flourine loading in the earths atmosphere, based on correlative measurements by ENVISAT-1 and 12 NDSC sites. Isotopic ratios of water and methane for the study of stratospheric oxidation processes.

In order to increase the capabilities of the technique in the above mentioned applications substantial work has been devoted to development, application and validation of algorithms for retreival of vertical concentration profiles from the pressure-broadening of the absorption lines.

The FTIR measurements are performed using a Bruker 120 M high-resolution (0.0035 cm-1) FT spectrometer connected to a coeliostat. Total columns are retrieved using the softwares SFIT and MALT. In addition vertical concentration profiles of some species are derived from the pressure broadened absorption lines. Two methods for the profile retrieval have been employed: i.e. the Chahine Twomey technique which is an iterative search method and the optimal estimation technique (SFIT2) which uses a statistical approach. The retrieved profiles have been compared with other measurement data. In general the comparisons show good agreement when comparing total columns, while differences of up to 20 13620336s seen when comparing partial columns.

Results from 5 years of measurements will be presented and discussed in relation to other observations and modelling data.

UPPER ATMOSPHERIC NO FROM SCIAMACHY: SIMULATIONS AND INSTRUMENT CAPABILITIES

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ABSTRACT

The SCanning Imaging Absorption spectroMeter for Atmospheric ChartograpHY (SCIAMACHY) operates in eight channels covering the UV, the visible and two infrared regions. Recent developments in the testing of the instrument now enable not only the full use of channel 1 (240 nm-314 nm) at a required high level of performance but in some special cases its extension to 220 nm. This instrumental improvement allows new objectives to be addressed in the upper stratosphere, on top of the already proposed mesospheric and thermospheric investigations of nitric oxide. Simulations will show the instrument capabilities for these studies and will be compared with the latest instrument test data obtained before instrument delivery. The operation modes corresponding to these NO observations will also be described. The capabilities of SCIAMACHY for mapping the total column of upper atmospheric NO will be investigated as well as possibilities to infer NO vertical distribution and transfer properties between the different atmospheric regions. Nitric oxide signal will also be discussed in the present ERS-2 GOME observation.

NDSC SUPPORT TO THE DEVELOPMENT OF ERS-2 GOME GEOPHYSICAL DATA

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ABSTRACT

Operating aboard the ESAs ERS-2 heliosynchronous polar satellite since 1995, the Global Ozone Monitoring Experiment (GOME) measures the solar irradiance and the Earth radiance from 240 nm through 790 nm, at 0.2-0.4 nm spectral resolution. The atmospheric abundance of several trace species - such as O3, NO2, BrO, OClO, CH2O and SO2 - is derived from GOME spectra using differential absorption spectroscopy techniques. GOME has proven to be a major component of the global observing system and is the successful prototype of a series of new-generation spaceborne sensors.

The ground-based Network for the Detection of Stratospheric Change (NDSC) is another major contributor to the global observing system for atmospheric composition. Started in 1991, at the present time the NDSC includes five primary and two dozen complementary stations distributed from the Arctic to the Antarctic. The column abundance and vertical distribution of key atmospheric constituents are monitored at NDSC stations by a variety of complementary techniques and instruments such as UV-visible spectrometers, Fourier transform infrared spectrometers, lidars, millimeter wave radiometers, and ozone sondes. A main goal of the NDSC is to provide an independent calibration and validation of satellite measurements on the global scale as well as in the long term.

Through the geophysical validation of GOME data products and retrieval algorithms, ground-based observations associated with the NDSC have played a unique role in the further development of GOME. The NDSC provided an extensive, high-quality database to the GOME validation campaign conducted during the ERS-2 commissioning phase. It has generated well-controlled correlative data records needed for the quality assessment and the long-term verification of operational GOME data products. It has provided experimental support to advanced studies focusing on specific aspects of data retrieval. Furthermore, the synergistic use of GOME, NDSC and other correlative data has enhanced their geophysical exploitation.

The present paper highlights several contributions of the NDSC to the further development of GOME data products. Focusing on the integrated exploitation of multi-technique network data records, it also illustrates NDSC capabilities for the pseudo-global and long-term validation of future GOME-like spaceborne sensors.

NON-PARAMETRIC ESTIMATION OF THE WET TROPOSPHERIC CORRECTION, CLOUD LIQUID WATER CONTENT AND SEA SURFACE WIND SPEED IN ERS CONFIGURATION.

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ABSTRACT

Traditionally, geophysical parameters are estimated using parametric regression on an appropriate database. This estimation method is accurate in the densest region but often fails for less dense data region. In this work, we have compared performances of parametric and non parametric regression. For the wet tropospheric correction (dh in cm), the cloud liquid water content (clw in kg/m2), the atmospheric attenuation of the backscattering coefficient in Ku band (att in dB) and the sea surface wind speed (us in ms-1), estimations are made using the 2 brightness temperatures (TB24 at 23.8 GHz and TB36 at 36.5 GHz) and the backscattering coefficient in Ku band (s0Ku). This last term is used instead of a term in us_altimeter-7 m/s like in ERS2 standard products. It appears that this modification improves the atmospheric parameters retrieval since the sea surface roughness is taken into account more directly than using the sea surface wind speed calculated from s0Ku by the Witter and Chelton algorithm. Nonparametric regression (NPR) is a method to statistically smooth a data set such that a valid estimate of a variable (geophysical parameter) can be found in measurements space (TB and s0). The database consists of 12 global meteorological fields, containing both analyses and guesses of surface and atmospheric parameters. These parameters are given in 1.125x1.125 degree meshes (Bourras et al, 99). In each mesh, geophysical parameters are associated to brightness temperatures and backscattering coefficients simulated by a radiative transfer model. For a given set of ERS2 measurements the estimation of a geophysical parameter at this point is a combination of this geophysical parameter at each point of the database with the associate weight. This last is a function of the distance between the set of measurements and each set of simulations. For our non parametric regression, we take a spherical Epanechnikov kernel associated to the appropriate bandwidth in each direction, and we prefer a local linear regression estimator to the classical Nadaray-Watson regression estimator which induces bias where data density varies a lot. This retrieval method is tested first over the database itself to conclude on the regression quality and then is validated using radiosounding measurements.

THE PRARE SYSTEM ON BOARD ERS-2: STATUS AND RESULTS

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ABSTRACT

The PRARE system onboard ERS-2 is the primary tracking system of the satellite. Throughout the past 5 years this system has proven to be a reliable and highly precise range and range rate measuring instrument operating under all weather conditions in even rough climatic regions. Through various revisions the quality of the data has steadily been improved. Since 1996 the PRARE data are used by GFZ in the operational ERS-2 POD, replacing the radar altimeter crossovers. Additionally normal equations for Earth gravity coefficients and station coordinates recovery were created. The gravity and PRARE station solution of the joint GFZ/GRGS model GRIM5-S1 has been compared with external solutions, which confirm the high quality of the solution.

The poster will present the system status and the achieved scientific results.

ERS ORBIT DETERMINATION AND GRAVITY FIELD MODEL TAILORING: RECENT DEVELOPMENTS

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ABSTRACT

In the last ten years significant advances have been made in gravity field modelling, culminating in general purpose-models like JGM-3, TEG-3 and EGM96. Significant defects remain in the quality of the models when applied to orbit determination of some altimeter satellites, leading to large orbit errors, characterised by the geographically correlated nature of the altimeter crossover height differences. However, we have used these data effectively in the adjustment of JGM-3 and EGM96 to models tailored to ERS-1 and ERS-2. Many gravity field coefficients are "invisible" to altimetry, but still cause radial orbit errors through misfits with the basic tracking data: SLR and PRARE. We have now incorporated these observations in the tailoring process, and the adjustment is carried up to degree and order 70. This led to significant improvements to the EGM96 model, reducing the radial orbit error from 7 to 4.5 cm and cutting the tracking data residuals by 3 cm in RSS sense. With the availability of altimeter crossovers over the ice-covered Arctic (courtesy of UCL/MSSL) we now have valuable new information on the behaviour of the gravity field induced orbit error over this remote area. This independent source of information is used to validate several gravity field models and orbit products.

A RECIPE FOR UPGRADING ERS ALTIMETER DATA

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ABSTRACT

ERS-1 altimeter data have a history of product and algorithm definitions dating back to 1990, and not surprisingly these were soon surpassed by TOPEX-aided knowledge and models. In addition no measurements re-calibrations have been applied since, to safeguard the homogeneity of the data sets. It was only in 1995, after the launch of ERS-2, that the altimeter product generation was upgraded. Still, older ERS-1 data were never reprocessed, and more precise orbits were never incorporated. But also the ERS-2 altimeter data require upgrading by applying some instrument corrections and replacing a number of geophysical corrections by more recent models. The combination of a long list of re-calibration algorithms, updated geophysical corrections and precise orbits has led to a harmonised and accurate ERS-1/2 altimeter data set that allows the reconstruction of many ocean parameters with equal efficiency as other modern altimeters, but with denser spatial (35-day) coverage. In this poster we provide this upgrade recipe and present some new data analyses that demonstrate the quality of the new data set that is now part of the DEOS' Radar Altimeter Database System (RADS). Despite the suggested recipe, it is recommended that ESA reprocesses all ERS waveforms with the latest insights.

OPERATIONAL ALTIMETRY AT GFZ - FROM ERS-2 TO ENVISAT

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ABSTRACT

As part of the German Processing - and Archiving Facility for ERS (D-PAF), the Altimeter Data Processing System (ADP) at GFZ is responsible for the systematic acquisition and processing of ERS-2 altimeter data, the quality control, the generation of upgraded geophysical data products and its distribution.

The quick-look products are based on standard ERS-2 fast-delivery data, which are upgraded by merging the GFZ preliminary orbit, by recomputing corrections for atmospheric path delay, by applying the tides and additional altimeter range corrections, e.g. USO drift and SPTR correction. Three product types are provided and are available within 6 to 12 days, the along-track Quick-Look Ocean Product (QLOPR), the Quick-Look Ocean Crossovers (QLOPC) and the Quick-Look Sea Surface Height Model (SSHQL).

The precise products are derived from upgraded Level-2 altimeter data. Herein, the precise orbit, generated at GFZ, is merged and the altimeter ranges are corrected similar as for the quick-look products. Two gridded data sets are provided, the Short Period Sea Surface Height Model which is based on the complete altimeter data sequence of one ERS-2 cycle (35 days) and the Long Period Sea Surface Height Model which is produced each half year by accumulation of all data since launch.

The experience in operational altimetry with ERS-1/2 will be continued for the Envisat era. Based on Envisat level 1b and level 2 data products, ADP will generate various value-added ocean and ice data products. Standard geophysical data products will be provided as well as user-specific data products which will fulfill the requirements resulting from two user inquires which were initiated by GFZ in 1994 and 1995.

NUMERICAL AND ANALOGUE MODELLING OF LARGE FLANK COLLAPSE AT MOUNT ETNA

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ABSTRACT

Previous works have proposed that the dynamic of Mount Etna is dominated by large scale collapses. A recent study, based on INSAR data, has shown an active spreading of the flanks of the volcano. Two main sectors of instability, which have different spreading process, have been identified. An eastern sector bounded by the Pernicana faults system to the north, by the North and the South Rift Zones to the west and by the Mascalucia-Tremestieri-Trecastagni faults to the South East, slides to the east. A southern sector, limited to the south by an active anticlinal ridge, is driven by southward gravity spreading over a basal decollement. The onset of the sliding coincide with a new cycle of volcanic activity in summer 1996. We have used both numerical and analogue modelling in order to better constrain the geometry and the kinematic of the collapse processes of Mount Etna. The scaled analogue experiments take into account the E-W extension and also the weak Plio-Quaternary basement. The analogue models emphasises that both the E-W extension and the southward gravity spreading drive the evolution of the volcanic edifice. Numerical modelling with a boundary element method was used to explain the displacement field, observed by radar interferometry, and to estimate the stress field. It shows that stability of Mount Etna is subcritical and a perturbation like dyke's injection may be enough to destabilise the whole edifice. This work points out the interest of coupling analogic and numerical study to the understand the evolution of a volcanic edifice.

SYNERGISM OF OPTIC AND RADAR DATA TO OPTIMIZE LITHOSTRUCTURAL MAPPING AND MINERAL EXPLORATION IN SOUTH-EAST SENEGAL AND MALI (WEST AFRICA)

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ABSTRACT

Satellite remote sensing data, thanks to their synoptic view and their visible, infrared and microwave information content, are valuable geological information sources, particularly for lithostructural mapping and mineral exploration in remote regions and in terrains characterized by important vegetation, alluvial and laterite covers. We developped our research activities in two directions: (1) merging of optic and radar data, and (2) assessment of the potential of interferometric data. A composite image where spectral and textural information are combined, has been computed from Landsat-TM and radar SAR ERS-1 data covering the area of the Boboti granitic massif (South-East Senegal), by applying Principal Component Analysis and Intensity-Hue-Saturation image merging techniques. The IHS technique appeared as the most impressive, giving the possibility to weight the radar contribution in the resultant image. We interpreted this ERS-1/TM merged image and got a more accurate cartography of the Bambadji granitic massif and its fracture pattern. This is of major interest as far as the unexplored contacts of the batholite with the intruded rocks may be proposed as exploration targets for additional iron reserves and the fracture nods, as potential gold metallotects. A field trip has been conducted from 18 to 24 February 2000 in the areas of Kedougou (Senegal) and Kenieba (Mali), with a set of ERS and RADARSAT amplitude and coherence images. It demonstrated the usefulness of coherence images in understanding surface characteristics and changes, and also their capacity to enhance the expression of lithologic differences, when merged with amplitude images. In fact, thanks to their great sensitivity to vegetation types, coherence images allow to follow easily the talweg network outlined by forest galleries, and to discriminate subtle differences among vegetation covers on major river beds and plateaus zones, which may be related to the nature of underlying rocks. These results clearly indicate the possibility to optimize lithostructural mapping and mineral exploration in poorly outcropped terrains, by adding merged optic/radar images and interferometry derived products to the package of geological information sources.

EXPLORATION FOR IMPROVED QUALITY GROUNDWATER IN SEMI-DESERT NAMAQUALAND, SOUTH AFRICA

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ABSTRACT

Synthetic aperture radar (SAR) data from European Space Agency satellites ERS1 and ERS2 is used to help test a hypothesis that may improve ground water quality in Namaqualand, South Africa. Precipitation in this semi-desert is mainly from sea mist, which condenses on exposed granite domes, feeding the extremely limited aquifers. It is hypothesised that finely fissured granite domes feed the aquifers more effectively than smooth granite domes. Fissured and smooth domes are being classified by SAR speckle analysis. Results are presented.

ANALYSIS OF THE PALEODRAINAGES OF THE NORTHWESTERN SIMPSON DESERT, AUSTRALIA FROM ERS1-2 IMAGES

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ABSTRACT

The Simpson Desert is located in the arid center of the Australian continent and is part of the largest internally draining basin, Lake Eyre, in the Southern Hemisphere. To date paleoclimatic, geomorphic and sedimentologic investigations in the basin have been concentrated in the eastern river catchments and the Lake Eyre Playa itself. By contrast, the equally ancient northwestern alluvial systems, which are hypothesized to have once drained into Lake Eyre, have not been mapped or adequately studied as they are now buried by the Simpson Desert. Relative to the ancient drainage systems, the modern rivers in the basins northwest are smaller and tend to disappear in the dune swales, a short distance from the mountain ranges. Recent fieldwork in the region has revealed that this ancient channel pattern may be a strong control on the location of catastrophically avulsed channels during the late Pleistocene and Holocene. Little is known or understood about this surface which is believed to have been formed by large drainage systems during more pluvial climate regimes. Sediments in the region are variable but depositional environments are distinguishable by texture variations. The Pleistocene dune fields overlie older fluvial gravel deposits, which are often exposed in the dune swales or lie at shallow depth. Aeolian sediments tend to be fine grained, well-sorted, quartz sand with red hematite coats yielding a reddish-orange color. Fluvial sediments are coarser (medium sand to coarse gravel) and are arranged in channel fills and bar forms, and tend not to be red. The analysis of radar data for this region reveals important information on the channel location, channel scale and channel patterns which form this ancient alluvial surface. The channel patterns are essentially single thread, straight or gently winding with localized anabranching and changes to distributary patterns in the intermediate and terminal floodouts. A combination of multispectral and ERS 1-2 radar images has been used to reconstruct the past hydrological and climatic variations of the study area. This is part of the ESA project AO3-348.

FLOOD MONITORING IN THE SENEGAL RIVER VALLEY: FIRST RESULTS BASED ON SAR PRI DATA

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ABSTRACT

The traditional flood recession agriculture in the Senegal River valley in West Africa relies on adequate inundation of the valley, adequate with respect to areal extent and duration of the flood. In the recent decades, the river flow has been regulated through operations of dams in the river basin in order to provide a steady water flow in the river for use in irrigated farming. This in combination with a general decline in precipitation in the 70's and 80's in the Sahel, has resulted in a lower potential for flood recession agriculture. In 1999, the western part of Sahel, has experienced higher precipitation rates, and thus larger inundations than during the last 30 years.

Remote sensing is currently the only means for mapping the extent of the flooding in the very complex landscape, and SAR data is in particular useful. This study focuses on a small test area in the middle part of the river valley around Podor in Senegal. Four ERS2 PRI SAR scenes have been used in the analysis for delineation of flooded areas. Transects of the inundated areas measured by differential GPS, have resulted in profiles of the surface elevation across the area of flood recession agriculture. The combined use of surface elevation measurements and satellite data enabled a contour mapping of the flooded cuvette, and a rough estimation of the amount of flooding. The duration and extend of the flood could be estimated, and the result may thus serve useful to local decision-makers in crop yield estimation etc.

MAPPING AND EVALUATION OF "MITCH" HURRICANE DAMAGES IN CENTRAL AMERICA USING ERS SAR AND SPOT IMAGES

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ABSTRACT

In November 1998, Central America was devastated by the hurricane "Mitch". Never before, had this area suffered such total devastation combining wide flooding, huge forest destruction, landslides, and large-scale destruction of housing and infrastructures. A project was immediately put up to carry out a wide area / high spatial resolution evaluation of these damages, using SPOT and ERS satellite imagery. The aim was to deliver as quickly as possible accurate high spatial resolution maps of the damages that could be used by local photo-interpreters. To reach this goal, the following data processing procedure was applied: - The ERS SAR data were used to detect the damages. In the change detection process, the ERS SAR archive data acquired before "Mitch" were compared to the ERS SAR data acquired just after "Mitch". - Combined speckle filtering and super-resolution techniques have been applied to the ERS SAR data, to detect and map existing targets at a spatial resolution of 10 meters (SPOT-P resolution) before and after "Mitch", with particular emphasis to housing and infrastructures. - Change detection techniques appropriate to SAR images have been applied to detect and map the damages. - SPOT-P archive data were used as mapping background. The final product is the result of a common-sense data fusion process integrating ERS SAR change detection and SPOT-P archive data, to facilitate photo-interpretation of the final product. - Finally, two sets of cartographic UTM maps of "Mitch" damages have been produced, on 10 and 20 meters grids.

The SPOT and ERS satellite images were made available respectively during November and December 1998. Altogether, these data allowed to study about 120.000 km2 in the most devastated areas of Honduras, Nicaragua and El Salvador. All the cartographic high spatial resolution products were delivered in the first days of 1999.

This efficiency in operating the project enabled rapid validation of the results (El-Salvador in January/February 1999, Nicaragua in February 1999 and Honduras in March 1999), with satisfactory results. Validation results in Honduras are presented.

A RAPID MAPPING SYSTEM FOR HURRICANE DAMAGE ASSESSMENT

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ABSTRACT

After the catastrophic damage caused by the hurricane Mitch in Central America, the subsequent intervention of the French Civil Defence Agency DDSC, and the work carried out by ESA and the CNES, ESA and the DDSC had agreed to co-operate during the following, end of 1999, cyclone season. The objective was to assess the contribution of space techniques to perform disaster management in an operational context. Within this framework, ESA granted a contract to a consortium between SPOT IMAGE, SERTIT, PRIVATEERS and IGN Espace. The experiment was focusing on risk management in relation to hurricane threats in inter-tropical regions, the French West Indies and La Réunion Island. The main objective is to design a rapid response mapping system in order to quickly provide the DDSC with adequate cartographic and damage assessment map products. On the 16th of November 1999, the hurricane Lenny was brewing in the Antilles and therefore started the procedure. During this event, archive data from ERS, Radarsat, SPOT were processed and new acquisitions planned. Then, on the 18th of November the hurricane reached and damaged Guadeloupe. At first, a basic cartographic product was produced in less than 24hrs after a Radarsat data acquisition, the 22nd of November. This information overlaid on IGN maps and SPOT data shows the main areas affected by the hurricane. Then, high level cartographic products called damage assessment products were produced by applying radar change detection techniques. These high resolution thematic products detailed the areas affected by the hurricane and indicates potential damage levels. All the cartographic products were up-loaded to an interactive Web Intranet server which enables the partners and the DDSC to visualise and request advanced geographical and thematic mapping from the online database. The experiment demonstrates the ability to rapidly delimit potentially damaged areas using EO satellites complemented with cartographic maps. It provides feedback for assessing the contribution of EO based products and services to risk management in an operational context. The different constraints imposed by operational EO systems, the required level of processing plus thematic analyses and time aspects of the data and information provision chain are exposed. Acknowledgements: The experiment was performed with support of ESA, CNES and CSA which provided respectively ERS, SPOT and RADARSAT data.

WATCHING FOR THE HAZARDOUS SPRING 99 FLOODING IN THE CHERNOBYL ZONE IN UKRAINE WITH THE ERS SAR IMAGES

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ABSTRACT

The basin of the Pripyat River is located within a high radioactiveness zone what was occurred after the Chernobyl catastrophe. There are radioactive marshes and many burial-places of the radioactive waste materials near by the Chernobyl Nuclear Power Station (building rubbish, trees subjected by radiation, machines and equipment used for clearing and disactivation). These dangerous objects are fenced in polder dams. But overflow the dams can be happen in case of a high flood. A following return of radioactive water to the Pripyat and Dnieper Rivers bears a hazard to the densely populated areas located along the rivers. Such situation has been warned at the spring 99. To obtain a real situation the ERS-2 SAR data was required within the framework of the ESA AO3.358 Project. Forecasting by means of the domestic hydrological model on the critical high water time has been compared and defined more precisely with the ERS SAR image. Comparison with the normal situation during the previous dry autumn was carried out with another SAR image.

MINING INDUCED SEISMIC EVENTS - IMAGING SURFACE DEFORMATION OF DEEP MINE ROCK BURSTS AND FAULT MOVEMENTS

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ABSTRACT

Seismic events, some exceeding Richter magnitude 6, caused by rock bursts and fault movement induced by deep mining (around 2.5 km), are being studied with data from European Space Agency satellites ERS1 and ERS 2. The satellite synthetic aperture radar (SAR) data is applied by interferometry (InSAR) and used to image surface deformation caused by such events, with the objective of aiding mine seismology and safety. Results are presented.

SURVEY OF LARGE DEFORMATION IN THE CHILE-PERU SEISMIC GAP (SOUTH AMERICA) USING SAR INTERFEROMETRY: THE LOADING AND TRIGGERING OF GIANT EARTHQUAKE

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ABSTRACT:

The 1995 M=8.1 Antofagasta earthquake ruptured the southern segment of Chile-Peru seismic gap located on one of the fastest plate boundary, the subduction of the oceanic Nasca plate beneath South America (nearly 80 mm/yr of relative convergence). Studies of this earthquake corroborate that the conditions of applying SAR technique are exceptionally good in this region due to the extreme aridity of the Atacama desert. Combined with GPS and seismic modelling, SAR interferometry has proved to be essential to constrain the surface deformation, and to characterize the mechanics and kinematics of the earthquake: the area of co-seismic deformation is very large (200km x 300 km) and reach 60 cm of range increase; the variation of slip distribution on the fault plane indicates non homogeneous strain release; blocked in the north, by the presence of the geometrical asperity of Mejillones penninsula, the rupture propagates toward the south. The 1995 may be a foreshock of a huge earthquake that pending in the Northern Chile Gap (20°S). This region offers the unique opportunity to tackle the understanding of the mechanical processes that take place during the elasting loading (inter-seismic phase) and the triggering of earthquake (pre-seismic phase). We processed ERS scenes centred o the North Chile gap (20°S), on an area of 250km x 200km, that consist of 8 scenes on 3 parallel orbits over a period of 2 to 4 years. The map of inter-seismic deformation reveals 10 to 14 mm/yr of range decrease, consistent with uplift and eastward displacements measured by GPS. The maximum of gradient is located on the first 100 km from the coast. Modelling the inter-seismic displacement using back-arc dislocation model indicates high value of coupling (70-100), and a depth of locking of 40-50 km. To study post-seismic deformation in Antofagasta area we processed an interferogram that include 3.5 years of displacement after the event. The image of post-seismic deformation reveals a superposition of inter-seismic loading along the coast and post-seismic signal in the area of the 1995 earthquake. This can be modelled as after-slip on a fault larger and deeper than the fault, which was activated during the earthquake.

FLOOD MONITORING IN THE SENEGAL RIVER VALLEY: FIRST RESULTS BASED ON SAR PRI DATA

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ABSTRACT

The traditional flood recession agriculture in the Senegal River valley in West Africa relies on adequate inundation of the valley, adequate with respect to areal extent and duration of the flood. In the recent decades, the river flow has been regulated through operations of dams in the river basin in order to provide a steady water flow in the river for use in irrigated farming. This in combination with a general decline in precipitation in the 70's and 80's in the Sahel, has resulted in a lower potential for flood recession agriculture. In 1999, the western part of Sahel, has experienced higher precipitation rates, and thus larger inundations than during the last 30 years.

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MAPPING AND EVALUATION OF "MITCH" HURRICANE DAMAGES IN CENTRAL AMERICA USING ERS SAR AND SPOT IMAGES

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A RAPID MAPPING SYSTEM FOR HURRICANE DAMAGE ASSESSMENT

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ABSTRACT

After the catastrophic damage caused by the hurricane Mitch in Central America, the subsequent intervention of the French Civil Defence Agency DDSC, and the work carried out by ESA and the CNES, ESA and the DDSC had agreed to co-operate during the following, end of 1999, cyclone season. The objective was to assess the contribution of space techniques to perform disaster management in an operational context. Within this framework, ESA granted a contract to a consortium between SPOT IMAGE, SERTIT, PRIVATEERS and IGN Espace. The experiment was focusing on risk management in relation to hurricane threats in inter-tropical regions, the French West Indies and La Réunion Island. The main objective is to design a rapid response mapping system in order to quickly provide the DDSC with adequate cartographic and damage assessment map products. On the 16th of November 1999, the hurricane Lenny was brewing in the Antilles and therefore started the procedure. During this event, archive data from ERS, Radarsat, SPOT were processed and new acquisitions planned. Then, on the 18th of November the hurricane reached and damaged Guadeloupe. At first, a basic cartographic product was produced in less than 24hrs after a Radarsat data acquisition, the 22nd of November. This information overlaid on IGN maps and SPOT data shows the main areas affected by the hurricane. Then, high level cartographic products called damage assessment products were produced by applying radar change detection techniques. These high resolution thematic products detailed the areas affected by the hurricane and indicates potential damage levels. All the cartographic products were up-loaded to an interactive Web Intranet server which enables the partners and the DDSC to visualise and request advanced geographical and thematic mapping from the online database. The experiment demonstrates the ability to rapidly delimit potentially damaged areas using EO satellites complemented with cartographic maps. It provides feedback for assessing the contribution of EO based products and services to risk management in an operational context. The different constraints imposed by operational EO systems, the required level of processing plus thematic analyses and time aspects of the data and information provision chain are exposed. Acknowledgements: The experiment was performed with support of ESA, CNES and CSA which provided respectively ERS, SPOT and RADARSAT data.

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ABSTRACT

The basin of the Pripyat River is located within a high radioactiveness zone what was occurred after the Chernobyl catastrophe. There are radioactive marshes and many burial-places of the radioactive waste materials near by the Chernobyl Nuclear Power Station (building rubbish, trees subjected by radiation, machines and equipment used for clearing and disactivation). These dangerous objects are fenced in polder dams. But overflow the dams can be happen in case of a high flood. A following return of radioactive water to the Pripyat and Dnieper Rivers bears a hazard to the densely populated areas located along the rivers. Such situation has been warned at the spring 99. To obtain a real situation the ERS-2 SAR data was required within the framework of the ESA AO3.358 Project. Forecasting by means of the domestic hydrological model on the critical high water time has been compared and defined more precisely with the ERS SAR image. Comparison with the normal situation during the previous dry autumn was carried out with another SAR image.

MINING INDUCED SEISMIC EVENTS - IMAGING SURFACE DEFORMATION OF DEEP MINE ROCK BURSTS AND FAULT MOVEMENTS

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ABSTRACT

Seismic events, some exceeding Richter magnitude 6, caused by rock bursts and fault movement induced by deep mining (around 2.5 km), are being studied with data from European Space Agency satellites ERS1 and ERS 2. The satellite synthetic aperture radar (SAR) data is applied by interferometry (InSAR) and used to image surface deformation caused by such events, with the objective of aiding mine seismology and safety. Results are presented.

SURVEY OF LARGE DEFORMATION IN THE CHILE-PERU SEISMIC GAP (SOUTH AMERICA) USING SAR INTERFEROMETRY: THE LOADING AND TRIGGERING OF GIANT EARTHQUAKE

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ABSTRACT:

The 1995 M=8.1 Antofagasta earthquake ruptured the southern segment of Chile-Peru seismic gap located on one of the fastest plate boundary, the subduction of the oceanic Nasca plate beneath South America (nearly 80 mm/yr of relative convergence). Studies of this earthquake corroborate that the conditions of applying SAR technique are exceptionally good in this region due to the extreme aridity of the Atacama desert. Combined with GPS and seismic modelling, SAR interferometry has proved to be essential to constrain the surface deformation, and to characterize the mechanics and kinematics of the earthquake: the area of co-seismic deformation is very large (200km x 300 km) and reach 60 cm of range increase; the variation of slip distribution on the fault plane indicates non homogeneous strain release; blocked in the north, by the presence of the geometrical asperity of Mejillones penninsula, the rupture propagates toward the south. The 1995 may be a foreshock of a huge earthquake that pending in the Northern Chile Gap (20°S). This region offers the unique opportunity to tackle the understanding of the mechanical processes that take place during the elasting loading (inter-seismic phase) and the triggering of earthquake (pre-seismic phase). We processed ERS scenes centred o the North Chile gap (20°S), on an area of 250km x 200km, that consist of 8 scenes on 3 parallel orbits over a period of 2 to 4 years. The map of inter-seismic deformation reveals 10 to 14 mm/yr of range decrease, consistent with uplift and eastward displacements measured by GPS. The maximum of gradient is located on the first 100 km from the coast. Modelling the inter-seismic displacement using back-arc dislocation model indicates high value of coupling (70-100), and a depth of locking of 40-50 km. To study post-seismic deformation in Antofagasta area we processed an interferogram that include 3.5 years of displacement after the event. The image of post-seismic deformation reveals a superposition of inter-seismic loading along the coast and post-seismic signal in the area of the 1995 earthquake. This can be modelled as after-slip on a fault larger and deeper than the fault, which was activated during the earthquake.

STUDY OF SURFACE DISPLACEMENTS IN URBAN CONTEXT WITH SAR INTERFEROMETRY: APPLICATION TO THE CITIES OF PARIS (FRANCE), AND TAINAN (TAIWAN)

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ABSTRACT

Differential SAR interferometry allows detection and mapping of slow deformations, especially in urban areas, where coherence remains high over long time scales. One limiting factor is then the variation of atmospheric conditions between the acquisition of images, which can introduce large artifacts on interferograms. On Paris city (France), atmospheric heterogeneities were clearly detected on all differential interferograms we have generated. A method for automatic characterization of displacement fringes, free of atmospheric artifacts, based on complex correlation of interferograms was used, and allowed us to reveal two subsiding zones. These centimetric subsidences are associated with the construction of an underground station (Haussmann-St.Lazare) for the Eole subway, beginning in 1995 and ending in 1997. They result from the lowering of the piezometric level, due to phreatic water pumping. The spatial subsiding extent may be mapped, and the temporal evolution of the subsidences is carefully examined. We also studied Tainan city (1.2 millions of inhabitants), located in the southwestern part of Taiwan. Tainan is built on a small elongated hill, 35 m high, towering above the surrounding coastal plain. The ten processed differential interferograms show deformation of this relief on the range of 3 cm during the period 1996-1998. This validates a recent geological model (Deffontaines et al., 1997) which interpret this area as an uplift resulting from the westward propagation of the Taiwanese orogene deformation front, linked to the active collision of the Eurasian and Philippine plates. Such study leads to revalue the natural hazard mitigation in Tainan. These studies highlight the potentiality of SAR interferometry for detection, in urban context, of slow deformation (few centimeters per year) of small or larger extent (e.g. 2 km and 50 km² for Paris and Tainan respectively), related to human or natural causes. This project is supported by ESA (ERS AO3-350 / Envisat AO-441).

SUBSIDENCE MONITORING USING SPARSE SAR DIFFERENTIAL INTERFEROMETRIC MEASUREMENTS: THE BOLOGNA CASE STUDY

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ABSTRACT

From differential interferometric synthetic aperture radar (SAR) data it is possible to measure small deformations of the terrain occurred between different acquisitions. In this paper, we use ERS 1 and ERS 2 data, covering a time interval spanning from March 1993 to June 1999, to study terrain displacements occurring in the area of Bologna, Italy, and its surroundings.

According to previous studies, based on both in-situ and SAR differential interferometry measurements, the considered area has been affected by subsidence phenomena, probably caused by extraction of water from subsoil. The interferometric measurements performed up to now have been limited to Bologna's urban area, due to the limitations of traditional phase unwrapping techniques. As a matter of fact, temporal decorrelation causes a nearly complete loss of coherence over most part of the imaged scene, and good quality data are available only on sparse areas (urban areas and/or isolated buildings, other stable objects, arid terrain). This prevents unwrapping the good quality phase by means of algorithms requiring that input data are on a regular rectangular grid. Here, we make use of a new generalized technique, presented in [1] that is able to deal with sparse data. Therefore, we are able to extend the analysis to the Bologna's surrounding area.

The displacement maps corresponding to the obtained unwrapped phases are then properly combined to perform a temporal analysis of the subsidence phenomena occurring in the considered area, thus obtaining a complete space-time description of the terrain movements. Temporal analysis of data is also useful to minimize the impact of atmospheric artifacts and inaccurate satellite orbit knowledge. Finally, in order to test the effectiveness of the method, the obtained results are compared with in situ measurements.

References

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SOIL MOISTURE ESTIMATION WITH SAR.PRI ERS IMAGES

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ABSTRACT

The estimation of the water content in the root soil zone is of fundamental importance for crop management and yield forecast. This subject requires a periodic and extended monitoring along wide surfaces, which can only be achieved by means of remote sensing.

The active microwaves sensors operating in C band, such as the Synthetic Aperture Radar (SAR) of ERS, have demonstrated to be a useful tool for monitoring the level of surface soil moisture, ensuring also the systematic availability of information under any meteorological or light condition. SAR backscattering depends on the surface roughness, slope and its physical-chemical characteristics. Indeed, the backscatterered energy is a function of the dielectric constant of the soil, which depends on the water content.

This paper presents the first results of humidity estimation on soils dedicated to agriculture, with fallow cover, located in the Llanura Pampeana (in the Centre-South of the County of Buenos Aires, Argentina). Campaigns of soil sampling simultaneously with the satellite acquisition were carried out in 12 places. Samples were extracted with drill between 0 and 10 cm of depth and were processed following the gravimetric method, obtaining the corresponding values of volumetric moisture. In the first stage of the project, three images ERS-2 SAR PRI were used. The images were georeferenced and radiometrically calibrated in order to retrieve the values of sigma nought over the sampling places, using the software SAR Toolbox (ESA) and PCI (RSI Inc.). The correlation between sigma nought s0 (expressed in dB) and the measured volumetric humidity HV (expressed in) is presented. It shows an acceptable coefficient of lineal correlation (r2 = 0,65) for a linear adjustment HV = a + b . s0.

The images were classified applying this correlation function, obtaining maps of humidity for the parcels of interest. These results are compared with the values obtained estimating the humidity by hydric balance. These first experiences, limitations and the future plans for the project are presented in this paper.

SOIL MOISTURE MAPPING USING ENVISAT ASAR AND ERS-2 DATA IN THE SOUTHERN GREAT PLAINS REGION OF THE U. S

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ABSTRACT

ENVISAT data will be used to develop a regional soil moisture algorithm for the Southern Great Plains of the United States. This region is characterized by low levels of vegetation for most of the year and variable soil moisture conditions. Data from the ASAR (alternating polarization mode) will be the primary information used. A time series of ERS-2 data is currently being acquired in conjunction with ground observations of soil moisture. The time series is based upon all acquisitions for a specific track and three frames. This data set will be used to establish baseline conditions and to better understand the annual temporal backscatter coefficient signatures of grasslands and winter wheat. The time series would be continued for one year after the beginning of data collection by ENVISAT and will include the ASAR data. Alternative modeling approaches are being evaluated using this data set as well as other data already available within this region (AIRSAR, SIR-C and Radarsat). There are significant limitations in using a single channel synthetic aperture radar for soil moisture estimation. It is expected that the multipolarization data of ASAR will greatly improve these techniques. The results of the first year of ERS-2 observations will be presented. Backscattering coefficients will be compared with ground based soil moisture and land cover information for twelve sites. Land cover information is based upon interpretation of Landsat Thematic Mapper images acquired close to the date of each ERS-2 acquisition. Since the inception of the series in June of 1999, two acquisitions have not been useable due to ongoing rainfall at the time of the overpass.

APPRAISAL OF SAR DATA APPLICATION IN ASSESSMENT OF SOIL SALINITY AND WATERLOGGING PROBLEMS IN BAHAWALNAGAR AND BAHAWALPUR DISTRICTS, PAKISTAN

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ABSTRACT

Salinity and waterlogging are highly detrimental to both fertility of the soil and the environment. An accurate assessment of these problems and their physical factors in timely and cost effective manner is one of the prime requirements for reclamation of degraded soil. This study, aimed on appraisal of ERS-SAR data in assessment of soil salinity and waterlogging problems, has been conducted at SUPARCOs Satellite Ground Station, Islamabad, Pakistan in collaboration with European Space Agency (ESA) under AO3 framework. Both optical and microwave data, in separate as well as complemented modes, have been used to demonstrate the potential of satellite remote sensing technology in assessment of soil salinity and associated problems in agricultural areas. SPOT XS and ERS-SAR multi-temporal data (between 1993 and 1999) have been analyzed using digital image processing and GIS techniques to study the areal extent and intensity of the salt affected and waterlogged areas of a small test site. Independent as well as complemented applications of both sensors data have been found useful in mapping of highly saline areas (mostly in crust form). However, both types of data could not provide encouraging results in discrimination between moderately saline and other eroded material like sand silt, etc. Conjunctive use of SAR and optical data provided satisfactory results in salinity mapping during the wet season, as microwave is sensitive to the geometrical characteristics (surface roughness, dielectric properties and penetration through surface layers to some extent) of the ground surface. The authors wish to thank the European Space Agency (ESA) for providing ERS-SAR data and guidance to complete this study.

FEASIBILITY OF USING SAR DERIVED SOIL MOISTURE TO ENHANCE THE ROBUSTNESS OF VEGETATION INDEX BASED CROP YIELD MODELS.

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ABSTRACT

Realising the importance of soil moisture for crop survey, soil moisture estimation models using SAR data from ERS and RADARSAT have been used to develop site specific operational models in India.

In the present study, attempts have been made to derive soil moisture status using ERS SAR data of February 8, 1998 and NDVI from IRS data of February 9, 1998 for a mustard and wheat growing area covering parts of Agra, Mathura and Bharatpur district of Uttar Pradesh and Rajasthan states in India. Wheat and mustard fields were categorised as dry, medium moist and moist based on the derived moisture value. Corresponding average NDVI of the same fields were generated. Correlation between NDVI and the field moisture status was carried out. In case of mustard, it was observed that very low NDVI were associated with low soil moisture. However, high NDVI values of mustard crop was found to have a large variation in the underlying soil moisture. Further analysis using taluk (an administrative unit with in the district) showed that average soil moisture status was low for low yielding taluks and high for high yielding ones. There was no significant difference in the corresponding NDVI. Similar analysis for wheat fields showed a very low NDVI status for all the fields due to the early crop stage.

This indicates the possibility of deriving a soil moisture index to improve the crop yield forecasting models. This is particularly significant for indeterminant crops like mustard, where NDVI alone was not very effective indicator of crop vigour.

ASSESSMENT OF THE ERS TIMES SERIES FUSION AND COHERENCE ANALYSIS FOR THE MONITORING OF ENVIRONMENTAL SENSITIVE AREAS IN ALSACE

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ABSTRACT

At present, due to the advantages multi-temporal capability, the high stability of the ERS satellites and the historical data-set archived over many years, it is possible to envisage the monitoring of environmental changes on a medium term basis. This AO3-340 project exploits these advantages and is designed to develop the use of SAR data from both an application and applied research point of view.- the applied research aspects are focused on the assessment SAR time series processing and coherence for hydrological modelling. This is englobed within the framework of the European Project ARSGISIP, Applied Remote Sensing and GIS Integration for Model Parameterization.- the application is developed for wetland monitoring and the control of these sensitive area. It is designed to meet the needs of customers with an obligation to conserve humid area habitats. This falls within the framework of the European Project MANHUMA, Management and Conservation of Humid Areas. The application study zone, a very flat area and an environmentally sensitive biotope which is strongly influenced by hydrological processes is therefore affected by new EU environmental and CAP directives. In this context, the use of new or complementary geo-information products derived from multi-annual EO data is investigated. Multi-temporal ERS SAR fusion techniques and coherence image analyses are used to achieve these objectives. These SAR specific image processing techniques take advantage of the availability of multi-temporal ERS data sets in order to consider both the gain in the quantification of bio-geophysical parameters to be derived, the temporal change detection of these features and the delineation and characterisation of humid areas.

ERS-2, RADARSAT SAR BACKSCATTERING CHARACTERISTICS OF THE PARANA RIVER DELTA WETLAND, ARGENTINA

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ABSTRACT

The Lower Delta Islands of the Paraná River in Argentina constitute a major coastal tidal freshwater wetland located at the De La Plata River estuary. It is a complex region where the landscape pattern is characterized by mosaics of natural and man made ecosystems. Since the last few years an increased number of SAR images has been available for monitoring coastal wetlands and deltas, but the complexity of the microwave-vegetation-water-interaction mechanisms taken place needs further investigation. Difficulties arise due to scene factors such as environmental conditions, vegetation phenology, and management practices. Also, differences in the observation geometry (ascending and descending paths) add complexity to the overall interpretation of the radar response. This study was conducted to assess the potential of combined imagery from RADARSAT (C-band, HH polarization) and ERS 2 (C-band, VV polarization) SAR systems for monitoring wetland ecosystems and assess flood condition. This paper discusses the microwave-vegetation-water interaction mechanisms identified in RADARSAT, and ERS 2 SAR images, for three distinct vegetation structures forest, marshes, and rushes, and different flood conditions. TM images of close dates, an existing vegetation map and field data were used as background information. SAR images were carefully calibrated and geolocated. To establish hypothesis about the links between land cover structure, flood condition, sensor characteristics (HH, VV) and resulting scattering process the information extraction procedure consisted on the multitemporal analysis of the backscattering characteristics of well identified samples. Results show significant differences in the way SAR modes interact with woody and herbaceous vegetation, and flood condition. In addition, ascending and descending ERS 2 imagery (day and night) show interesting differences in the radar response due to the vegetation moisture conditions. Current SAR operational satellites are single frequency and single polarization, but the new generation of SAR systems will provide multi polarization measurements. Therefore it is expected that the analysis of combined ERS-2 and Radarsat data, that this paper addresses, may contribute to the understanding of the future ASAR Envisat data.

OBSERVATION OF THE WETLAND HYDROLOGY IN THE UNSTRUT CATCHEMENT IN THURINGIA (GERMANY) BY MULTITEMPORAL ERS-1 AND ERS-2 SAR DATA

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ABSTRACT

The objective of the ENVISAT ASAR preparational work in Thuringia is the observation of the development of wetlands (i.e. Esperstädter Ried) which could be balanced area covering over the last 10 years using ERS-1 and ERS-2 data. After the reunification of Germany all the pumps were destroyed and the wetlands were flooded. Now there is a continuous dehydration every springtime to use the area as pasture for cattle disturbing the natural water balance. This results in a short term and a long term variation of the water balance which will be observed using the multipolarimetric possibilities of ENVISAT ASAR.

Some of the wetlands in Thuringia play an important role as permanent used grassland areas for cattle farming. These areas would be large water covered lakesides without pumping of water. Since the subsidised market in Europe allows the closing down of large scale agricultural areas, the Federal State of Thuringia has an interest in revitalising these areas in terms of breeding places for water birds or protected areas for salt adapted plants. The multitemporal ERS remote sensing data is used to analyse the seasonal differences between the pumping of water in spring and the rising water table over summer time until autumn. Apart from the seasonal development also the long term alterations after the reunification of Germany are analysed since 1992, when the whole wetlands were full of water up to a fully developed agricultural site today.

The Thuringia Environmental Agency has a strong interest and supports the remote sensing study, since they intend to extend it to further wetland areas within Thuringia. With the multipolarimetric possibilities of the ENVISAT ASAR there are even more detailed informations about the wetland water balances are expected.

MONITORING OF WATER HYACINTH ABUNDANCE AND ITS OCCASIONAL FACTORS IN LAKE VICTORIA AREA (EAST AFRICA) USING ERS-1 AND ERS-2 SAR DATA

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ABSTRACT

This poster shows results of as proposal for the Third Announcement of Opportunity for the Exploitation of ERS Data, section '2.4 New or better Coverage by ERS Receiving Stations', especially for the evaluation of data from the new receiving station in Malindi (Kenya). The overall objective is the detection of water hyacinth in Lake Victoria with the evaluation of ERS backscatter and the phase information of interferometric ERS-1/ERS-2 pairs. Water hyacinth is a weed with enormous growth rates causing serious problems for shipping traffic, fishing, freshwater fish fauna, plant diversity, etc. The aim is now not only the detection of the weed during bad weather conditions, but also to observe the intensive agricultural land use in the surroundings of the lake and to model the solute transport from point and non point sources. The specific objective and focus of the proposal is therefore threefold:

1. Detection of the water hyacinth weed within the beaches of Lake Victoria during bad weather conditions (three rainy seasons) by the use of ERS SAR data. Control mechanisms need to have an areal and actual basis for appropriate management of the problem, therefore long term observations with the 35-day-orbit are necessary to monitor the development of the water hyacinth mats throughout the seasons. The water hyacinth grows on top of the water surface up to several cm heigh affecting the radar backscattering due to an altered surface roughness.

2. Observation of land use in marginal test catchments as an input base for distributed hydrological modelling of water balance and water quality. Around the Lake Victoria intensive agricultural land use (irrigation - plantations of sugar cane, tea, cotton, maize, etc.) is widespread. Each of these different land use types has its specific contribution to erosion and solute transport due to land cultivation techniques and fertilizer input. Areal extent and changes in time are important information sources for hydrological modelling. In particular the Nyando subcatchment, prone to flooding, near the lake could be contributing to high pollution and solute transport rates into the lake.

3. Modelling of solute transport within the test catchments. Remote sensing data serves as input for object oriented hydrological models (OMS) of freshwater pollution by agricultural non point source areas. Results are so called 'what if? - scenarios' of nutrient inputs into the lake and possible extensions of water hyacinth mats, considering growth rates, irrigation amounts, fertilizer inputs, runoff measurements, etc.

THE CONTRIBUTION OF ERS SATELLITE ALTIMETRY TO HYDROLOGICAL APPLICATIONS

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ABSTRACT

A number of satellite radar altimeters have been launched over the last few decades. Although their primary priorities are aimed at ocean and ice studies, they have had considerable success over inland water bodies. In particular, the ability to monitor level changes in lakes and inland seas has been demonstrated. Unhindered by vegetation or canopy cover, the techniques have additionally been applied to a number of rivers, wetlands and flood plains in several test-case studies. The results demonstrate how sub-monthly, seasonal, and interannual variations in surface water height can be monitored. The instruments are also unhindered by time of day or clouds, sample the surface at pre-defined geographical and temporal resolutions, and the retrieved heights are determined with respect to one common reference datum. These are keen advantages at a time when there is much descoping of traditional gauging stations, and often little or slow dissemination of data.

This study looks at the contribution of the ERS RA data to inland water studies. In particular, results from the ERS-1 phase G will be presented for a selection of lakes in North America and the Florida wetlands. The performance of the instrument over a wide range of target sizes will be discussed paying particular attention to the acquisition time, tracker stability and overall height accuracy for both ocean-like and narrow-peaked echoes. The merits of ocean mode versus ice-mode tracking will also be debated, as well as an assessment of the overall contribution of ERS and ENVISAT altimeric data to several ongoing NASA projects (e.g., the Large-Scale Biosphere-Atmosphere Experiment in Amazonia, Natural Hazards: Flood and Drought in Africa).

RETRIEVAL OF GEO- AND BIOPHYSICAL INFORMATION FROM REMOTE SENSING DATA - OVERVIEW OF THE GEOBIRD STUDY

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ABSTRACT

An overview of the results of the GeoBIRD study, a project under ESA contract number 12950/98/NL/GD, will be presented. The goal of GeoBIRD is the improved retrieval of bio-geophysical parameters crop yield, vegetation height, and tree species from multisensoral remote sensing data using ERS and optical sensors (TM, SPOT). This will be achieved through a combined application of the vegetation growth model PROMET-V, which simulates plant growth from environmental information, and remote sensing models (CLOUD and empirical models for SAR data; GeoSAIL and FLIM for optical data), which simulate sensor response from surface properties. For a variety of agricultural and forest test sites in Europe the applicability of the methodology was investigated. ERS-1 SAR images were calibrated and corrected for local incidence angle by means of orbital and digital terrain elevation data. Parameters of the CLOUD model for several agricultural crops and meadows were derived by statistical fitting of gamma values to ground observed parameters. Using information on the spatial distribution of plant parameters (biomass, vegetation water) from PROMET-V the CLOUD model was applied in the inverse mode to determine spatially distributed fields of surface soil moisture. The results were compared to field measurements and water balance calculations. For forests, also texture and

coherence information was used. It could be demonstrated that forest stand parameters can be derived from coherence information under certain environmental conditions.

By means of model inversion of GeoSAIL, Landsat TM ground reflectance images in the six optical bands were processed into maps of LAI, fraction brown leaves and surface moisture. Here, initial ranges of parameters computed with PROMET-V were used to constrain the model inversion. Updating of PROMET-V local initial plant densities from a retrieved LAI map of one date resulted into highly consistent dynamic and spatial behaviour for most crops, and may therefore result into much more detailed and realistic yield maps than a raster based growth model without updating from remote sensing data can provide.

APPLICATION OF ERS-2.SAR DATA FOR SOIL MOISTURE ESTIMATES OVER FLOODED AREAS.

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ABSTRACT

The flood in 1997 has been one of the biggest disasters in Poland in the last two centuries. European Space Agency has provided full set of satellite images ERS-2 over the flooded part of Poland. Some agriculture areas were flooded and in some others soil moisture content was very high exceeding the soil capacity. The information about soil moisture has been important not only for agricultural prognosis, but also could be the essential information for the flood forecast in order to determine the extent of saturation of the watershed and for partitioning of rainfall into surface runoff and infiltration. In July 1998 and 1999 the ground observations have been carried out in order to develop the method of soil moisture estimates. The measurements of soil moisture and vegetation parameters have been done for the area of 100x100 km2 covering the whole ERS-2.SAR scene. On radar images, it is generally difficult to separate the backscattered components related to surface roughness, vegetation cover and soil moisture. To calculate soil moisture the crop type and the crop status must be similar in order to avoid vegetation surface roughness variations. These variations can be expressed by LAI (Leaf Area Index) values, which reflect geometrical properties of an object. It has been assumed that the same type of crop covered agricultural fields in 1997 as in 1999 (crop rotation). It has been also assumed that the vegetation in the same periods of observation has been in the same stage of development. On the basis of these assumptions the developed soil moisture models have been applied for different type of crops using backscattering coefficient calculated from ERS-2 SAR. As the result, soil moisture has been obtained for each of agriculture fields. The research has proved that SAR images (C-VV) could deliver important information about the flooded area and soil moisture for its excessive amount. Extensive cloud cover, usually prevailing during flood periods seriously limits the usefulness of satellite images obtained in optical spectrum. In such cases the evaluation of flood event can only be based on images taken in microwave portion of electromagnetic spectrum.

VALIDATION OF ICE FLOW MODELS WITH ERS SAR OBSERVATIONS OF ANTARCTICGLACIERS AND ICE SHELVES

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ABSTRACT

We compared predictions from a coupled ice stream / ice shelf finite element flow model to ERS interferometric observations of glacier andice stream flow in various sectors of West Antarctica. The model requires input information on the ice shelf / stream geometry, which we take from the ERS imagery, ice thickness, which we obtain from ERS radaraltimetry or prior ice sounding radar or gravimetry data, and icerheology which we obtain from the literature. Free parameters include the coefficient of basal friction at the bed and ice softening along the margins of fast-moving ice. Forward modelling shows that it is possible to match with a high degree of precision (less than 10 percent difference in velocity) the results of the ERS interferometric analysis. The comparison in turn provides clues about the physical controls onglacier flow, such as bed processes and ice softening at the margins. Following this validation process, the flow models are then used top redict the future evolution of these glaciers with a changing climate, for instance once the ice shelves that buttress them from flowing fast into the ocean are removed by enhance basal melting.

MEASUREMENT OF WINDSPEED AND SNOW-HUMIDITY ON THE ANTARCTIC PENINSULA USING ERS-SAR-TANDEM INTERFEROMETRY

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ABSTRACT

The relation between interferometric coherence and meteorological parameters at the snow surface is investigated for three areas on the Antarctic Peninsula. For each area ERS tandem pairs have been processed to provide image sets of ERS-1/2 backscatter amplitudes and coherence. Coherence and backscatter differences are compared to meteorological ground data. As meteorological parameters, appropriate for comparison, we calculate snow humidity at the times of acquisition and mean windspeed during the 24-h periods between tandem acquisitions. For the coastal portions of the ice sheet, backscatter shows large seasonal variations. While smaller, backscatter variations within the 24-h periods of the tandem pairs are also significant. For the vicinity of the weather stations there is reasonable correlation between measured changes in surface humidity and these short-term variations. On the contrary, backscatter variations of dry snow at the high plateau are negligible both over 24 hour periods and seasonally. This demonstrates the absence of significant humidity and surface roughness changes at the plateau over time. Differences in coherence between tandem pairs are therefore expected to stem from one main source only: winddrift. We find a good linear fit between coherence and mean windspeed. For the coastal areas we evaluate the possibility of measuring windspeed and humidity separately with ERS-SAR by combining the observed backscatter changes with the coherence results.

DEVELOPMENT OF PRACTICAL ALGORITHM FOR INFERRING COMPONENT TEMPERATURES FROM MULTI-DIRECTIONAL MEASUREMENTS

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ABSTRACT

A mixture of soil and vegetation is an important category of land surfaces on which significant angular variations in thermal infrared radiance exhibits. The variation of thermal structure of the surface with view angles leads to directional effects in observed surface temperature. The directional observations from satellites imply the information of thermodynamic of mixture elements mentioned above. Especially for partial canopies, mixture targets are often characterized by large temperature differences between vegetation and the soil. Studies based on model simulations and field measurements show the angular variations of the brightness surface temperatures, which may be usable to determine vegetation and soil temperatures. The Along-Track Scanning Radiometer (ATSR) on board the First European Remote Sensing Satellite(ERS-1) is the only sensor to be able to capture the directional signatures simultaneously. Thought there is limitation in separating directional signals due to the lower spatial resolution and the heterogeneity of the surface, ATSR provides a possibility to derive components temperatures which is usually applied to dual-source heat fluxes models and improves quantifying of land surface processes. In this paper, the suitable algorithm is proposed to retrieve vegetation and soil temperature over mixture land surface based on the analysis of multi-angle and multi-channel observation made by ATSR-2. Limitation of the algorithm is also discussed when it is applied to various surfaces in range of fractional cover of surface and in conditions of homogeneity/in-homogeneity. Uncertainties in retrieving component temperatures using current algorithm and satellite data are studied further.

GEOLOCATION OF INSAR INTERFEROGRAMS

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ABSTRACT

The development of Interferometric Synthetic Aperture Radar (InSAR) systems for the measurement of highly accurate Digital Elevation Models (DEM's) has already been well documented in the literature. Three measurements are required to reconstruct the topographic information: range, azimuth, and elevation. The first is obtained by timing the return of the radar pulse, the second by observing its Doppler frequency shift, and the last by measuring the phase difference between the signals recovered at the spatially displaced antennae. The phase infromation is taken from the interferogram. Geolocation can introduce significant errors depending upon the choice of method and earth model. Methods to reduce the processing time and provide more accurate results are extremely desirable.

In this paper a new general scheme for the geolocation of InSAR information is presented. It avoids the use of an earth model and exploits the full information of a SAR interferometer: orbit data, range and Doppler frequency shift relative to each SAR image, interferometric phase. Two geolocation algorithms are obtained from this scheme.

The former studies the geolocation as the intersection of three surface defined by the three measurements: range, Doppler frequency shift and interferometric phase. In particular, the three surfaces are: the range sphere centered at the SAR antenna which is also where the Doppler frequency shift cone is located. The cone axis of symmetry is the velocity vector. The interferometric phase adds another surface - a phase cone - whose axis of symmetry is the interferometer baseline and whose apex is the center of baseline. These three surfaces intersect at two locations in space. One of them is the geolocation of image pixel. The last algorithm is based on the solution of a set of four equation: the range sphere and the Doppler frequency shift cone relative to the two SAR images. An exact closed-form solution is obtained. This solution does not use approximations and avoids iterative algorithms. This results in a reduction of the computational load.

ELIMINATION OF TROPOSPHERIC ARTEFACTS IN DINSAR IMAGES USING NUMERICAL WEATHER MODELS

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ABSTRACT

Numerical weather models assimilate continuously meteorological measurments and provide a complete state of the atmosphere typically every 6 hours. With these data sets it is possible to calculate the tropospheric delay for each pixel of a differential interferometric SAR image using a ray-tracing procedure. The delay is substracted from the SAR image reducing atmospheric artefacts in the interferogram.

For this investigation we use a global weather model from the European Centre of Medium-Range Weather Forecasts and a mesoscale model from the German Weather Service to test this approach on SAR images in Austria. We discuss the practical and theoretical limitations and compare the results to a similiar project with GPS observations.

MOSAIC GENERATION USING ERS SAR IMAGERY

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ABSRACT

The large archive of ERS SAR imagery can be exploited to generate extensive mosaics. Much of this data has been acquired such that large areas have been imaged over short periods of time. To date three mosaics have been generated - these being of the British Isles, Iceland and northern Europe. For the latter two regions, sufficient data is available that multi-temporal mosaics have been created. These mosaics enable large-scale land features to be visualised and show potential for land use monitoring on a Europe wide scale. The generation of SAR mosaics serves to convert the location of individual 100km by 100-km ERS SAR PRI images to a common map projection and to combine 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. For the multi-temporal mosaics, it is necessary to ensure that the time span between the individual mosaics is sufficient to show changes in radar backscatter. This paper will show the three mosaics and describe how they have been generated. It is important to note that large scale mosaic generation should become much easier when wide swath products from the forthcoming ESA ENVISAT ASAR instrument become available.

FUZZY SETS FOR CLOUD DETECTION IN ATSR-2 IMAGES OVER LAND

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ABSTRACT

The field of land use studies includes examples of both commercial and scientific uses of low-resolution satellite data. For the effective application of processing techniques used to derive information from satellite data, it is first necessary to determine if the image data contain atmospheric artifacts.

Algorithms used to derive land surface products from satellite data require the pixel in question to be completely cloud. Most current detection methods use crude threshold based algorithms, resulting in the removal of many useful pixels from the available data set.

This paper presents a cloud detection scheme for ATSR-2 data that has been developed using a fuzzy set methodology. Fuzzy sets allow pixel classes to be defined with soft, real-world, decision boundaries, rather than the traditional "yes/no" characterization. Described by a membership function, the grade of membership of a given fuzzy set is assigned for all image pixels.

For this scheme the cloud and surface data sets produced by the International Satellite Cloud Climatology Program (ISCCP) are used as a knowledge base of a priori data. A simple atmospheric model allows the ISCCP data to be reduced to an "as seen by ATSR-2" form, from which bi-variate fuzzy sets for a variety of Earth surfaces and cloud types are calculated, based on their probability distributions. Applied to cloud detection in ATSR-2 images, this varying degree of membership for an image pixel in the cloudy/clear fuzzy sets results in a superior image classification.

The result of cloud detection performed for fifty ATSR-2 images over a variety of land surfaces is presented. The performance of the scheme has been evaluated against the SADIST cloud detection results packaged with the ATSR-2 gridded data products, and against a visual, analyst-based cloud clearance.

A BASELINE ESTIMATION METHOD FOR SAR INTERFEROMETRY

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ABSTRACT

Synthetic Aperture Radar Interferometry (InSAR) makes use of the phase difference between two SAR images to generate topographic height information. The height map generation always includes a transformation of the unwrapped phase to the terrain height. To accomplish this operation the baseline, or space difference between the two radar positions, should be estimated. Various methods for carrying out this step have been developed. Among them, we cite the fringe frequency estimation in flat regions, the use of tiepoints, or of an existing Digital Elevation Model (DEM). However, in many cases it is not possible to satisfy the conditions these methods require. For example, when flat regions or tiepoints are not present within the scene, or an accurate DEM is not available. In this paper, we describe a method for the baseline estimation which do not require any of the previously cited conditions. The proposed approach relies on a closed-form geocoding algorithm, which allows to estimate the topographic height corresponding to each interferogram pixel by using only the orbit data and the range/Doppler frequency shift information. These data, joined to that of sensor altitude above the geoid, results in a linear system having as unknowns the two baseline components. A solution can be obtained without the need of tiepoints. Moreover, this algorithm can be applied in rough and hilly regions where the flat terrain approach is useless.

SAR IMAGES DATA BANK FOR LAND USE MONITORING IN CENTRAL AFRICA, AN EFFICIENT DATA STORAGE AND PROCESSING SCHEME

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ABSTRACT

Due to persistent cloud cover over Central Africa, Sar images are preferred to optical data for remote sensing applications. However, land use monitoring with SAR images, which is often based on multitemporal or spatial mosaic data critically, increase, the amount of data requirements. As an illustration, the ERS-SAR mosaic of Central Africa merely consumes more than 50 gigabytes (GB). Managing Data in a long-term cycle is a difficult problem, Land use monitoring require interdisciplinary collaboration and therefore the scientific community and final users expectation is to share and access to online data and metadata. Our objective is to implement a data bank for land use monitoring applications in Central Africa. It is obvious that images have to be stored and handled in a compressed form, which is strongly dependent of the application. Many data compression schemes exists for natural scenes, these, methods are not efficient for SAR images because of the presence of speckle noise, futhermore the quality assessment of the compression techniques goes beyond the commonly use psychovisual quality. In fact bounded errors on edges and textures are needed in order to preserve sufficient quality for land use monitoring. In this paper we propose an efficient transform scheme. A frequency adaptative decomposition of the SAR image based on wavelets and multiwavelets packets functions and a suitable quantization scheme on the obtained wavelets coefficients. Our method out-performs better PSNR ratios, with poor loss of information compared to JPEG or the baseline wavelet coder. A segmentation method in the wavelet domain is developed, so there is no need to use a reconstruction scheme in the spatial domain for land use monitoring applications. Some results are presented with ERS images of Central Africa. Those images are compressed up to a ratio of 30: 1 while still remaining of sufficient quality for visual interpretation, segmentation and land use monitoring. Our future work concerns the indexation of the data bank for queries management.

ESTIMATION OF BIOPHYSICAL PARAMETERS FROM TERRA SURFACE REFLECTANCES

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ABSTRACT

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) allow for rich spectral and angular sampling of the radiation field reflected by vegetation canopies. While much work on forward modeling of vegetation reflectance has been done, it is only recently, in the context of new satellite sensors such as MODIS, MISR, MERIS, POLDER, etc., that attention has focused on the inverse problem; that is, estimating biophysical parameters from remote reflectance measurements. This presentation will provide an overview of retrieval techniques, which allow us to realize the full potential of the multi-angle and multi-channel satellite-born sensors. An emphasis will be given to the operational algorithm of global leaf area index and fraction of photosynthetically active radiation absorbed by vegetation developed for the MODIS and MISR instruments of the EOS Terra mission as well as an analysis of global leaf area index and fraction of photosynthetically active radiation absorbed by vegetation derived from MODIS and MISR data.

SAR PRODUCT CONTROL SOFTWARE (SARCON)

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ABSTRACT

As SAR instruments and their operating modes become more complex, as new applications place more and more demands on image quality and as our understanding of their imperfections becomes more sophisticated, there is increasing recognition that SAR data quality has to be controlled more comprehensively to keep pace. SARCON is a comprehensive SAR product control software tailored to the new generations of SAR sensors. SARCON profits from the most up-to-date thinking on SAR image performance derived from other spaceborne and airborne SAR projects and is based on the newest applications. This paper gives an overview of the structure and the features of this new software tool, which is a product of a co-operation between teams at Marconi Research Centre and DLR. The basic features of the SARCON software include raw data analysis, antenna pattern estimation, point target analysis, distributed target analysis, polarimetric analysis, noise estimation, analysis of wave mode products, target detection, InSAR and analysis of propagation effects. The SARCON software will be initiated under operator control, i.e. the operator will select datasets for analysis, the required quality parameters, type of visualisation of results etc. SARCON contains an internal database to store the derived quality parameters in order to facilitate retrospective analyses and predictions of performance. Visualisation of the results is performed by accessing the database. The database contains the two types of quality measures, applications quality parameters and system quality parameters as well as calibration and characterisation data. Another important function of SARCON is to screen data to identify imperfections such as missing or duplicated lines. With the improvements provided by the SARCON software, it will enable problems in SAR instruments or in the processing chain to be quickly detected and, hence, remedied. It will enable data quality to be monitored over time to warn of problematic trends. Looking at historical data, SARCON can help to trace changes in performance and help to identify the cause. It will enable data sets to be specified more accurately and more meaningfully for the user. And it will help to advance the knowledge on SAR performance and to specify future sensors more effectively and efficiently.

3-D RECONSTRUCTION OF SOIL SURFACES BY STEREOVISION IN RELATION WITH RADAR BACKSCATTERED SIGNAL OVER THEM

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ABSTRACT

Potential of radar imagery to measure soil roughness is being demonstrated. To overcome limitations in soil geometry descriptions by pin (laser) profilers, three-dimensional (3-D) reconstruction of soil surface by stereovision has been powerful to improve simulation of soil backscattered signal.

In the frame of the European project Flaubert, three campaigns combining satellite and in-situ data have been made in 1999 (April, June, July) to follow the soil degradation under Mediterranean climatic conditions on agricultural sites of North Tunisia. A large number of stereoscopic images have been taken with CCD cameras near Bizerte over a large range of soil roughness. A purpose is to qualifiy 3-D reconstruction and make it of easy use. The algorithm establishes a model, which relates pixel, coordinates to 3-D soil coordinates. It is done by camera calibration which computes the camera projection matrices and by performing disparity map from the 2-D images. Disparity with sub-pixel resolution is calculated by parabola method. To validate our reconstruction method of soil surface we have simulated stereoscopic images of different random simulated soil surfaces with gaussian correlation function and obtained reconstructed 3-D maps. Their comparisons allow us to evaluate the accuracy. We evaluate the filtering of the small-scale fractal soil structure, which is of determining influence on the radar-backscattered signal. We study its relation with the radar signal using the Moment Method to simulate backscattered signal over these reconstructed surfaces. Recent work has also shown that it is possible to recover the projective structure of a scene from point correspondences only, without the need of camera calibration. This approach leads to the calculation of the fundamental matrix from the geometric information contains in the different viewpoints. The two methods (calibrated and uncalibrated) are compared on natural and synthetic targets. Impacts on the radar backscattered signal over soils is also studied using the Moment Method.

INTERFEROMETRIC SAR QUALITY ENHANCING BY SPACE-VARYING SPECTRAL SHIFT PRE-FILTERING

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ABSTRACT

Interferometric SAR data should be pre-filtered in order to remove the geometrical decorrelation by applying the proper spectral shift. This filtering cancels the amplitude components relative to the wave numbers not illuminated in both passes.

Up to now this filtering has been carried out by assuming planar topography and therefore spatial stationarity of the wave number spectra. This approximation is now superseded and two optimum space-varying linear filters are identified. They allow to estimate, from the two takes, the interferogram with the least square error. Obviously, the filter is dependent on the Digital Elevation Model. Therefore, the problem becomes non-linear when the DEM has to be estimated from the data. The optimality is dependent on the computational complexity; simple approximations corresponding to low order kernels are also analyzed.

SATELLITE ALTIMETER SEA LEVEL VARIATION ANALYSIS OF THE SOUTHERN OCEAN

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ABSTRACT

The spatial and time variations of the Southern Ocean sea level and its possible relationship with the Antarctic sea ice changes and surface geostrophic currents in the area are investigated using altimeter data sets from ERS-1, ERS-2 and Topex-Poseidon between 1992 and 1999. Altimeter data are analysed following an Empirical Orthogonal Function Decomposition (EOFD) suggesting the following results: 1-The sea level variability is complex and bathymetrically controlled. 2-Most of the energy is accounted by the two first modes of the EOFD, that separates the sea level time variability into annual and semiannual cycles. The third mode could be locally related to annual-semiannual interaction processes. 3- The Antarctic Circumpolar Current is dominated by the annual component. In the Brasilian-Malvinas Confluence region the energies in the semiannual and annual components are equally important with a clear spatial variation. 4- The stational sea level variation in the Brasilian-Malvinas and Agulhas current areas are in opposition of phase with the variation in the seasonal sea ice area. 5- An important part of the complex sea level variation in the Southern Ocean seems to be explained by the heat interchange due to ice-ocean water interaction including ice-induced salinity changes and Ocean-Atmosphere processes that affects the dynamic circulation of the Southern Ocean that may have a significant impact both in the regional weather and global climate. 6- Some transference functions that regionally relates bathymetry with altimeter measurements, can be found.

GLOBAL OCEAN TIDES - REVISITED THE IMPACT OF ERS AND ENVISAT

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ABSTRACT

Global ocean tides from TOPEX/POSEIDON and ERS-1 has previously been presented by Andersen, (1995), Andersen and Knudsen (1997) and Smith, (1999). It was concluded that more than 3 years of ERS data available at that time was required if ERS should be able to possible improve the global ocean tide models derived from TOPEX/POSEIDON alone. The possibility of improving the global ocean tide models using ERS data is revisited now that 8 years of observations are available. Especially the issue on improved ocean tide modelling in near coastal regions are investigated as the increased ground track spacing of the ERS and ENVISAT satellites is very important form ocean tide modelling in shallow waters.

SPIRAL EDDIES IN THE JAPAN SEA

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ABSTRACT

This note concerns with spiral eddies, which were overlooked by earlier studies of the Japan Sea. Previous analyses focused mostly on the mesoscale anticyclonic eddies that could be easily identified in the satellite infrared imagery of the Japan Sea (Toba et al. 1984, Isoda and Tameishi 1992, Ostrovskii 1995, Ginzburg et al. 1998, and Takematsu et al. 1999). Two types of cyclonic eddies were also observed: the streets of small cyclonic vortices of the size of about 10 km, associated with the baroclinic instabilities (Takematsu et al. 1999), and cyclonic eddies as the counterparts of anticyclones in the vortex dipoles (Bunimovich et al. 1993). New analysis of the Japan Sea upper layer dynamics is based on the ERS SAR remote sensing during CREAMS-I (1993-1997). This analysis allowed a visualization of various spiral eddies for the first time in the Japan Sea. Eddies appeared in the SAR imagery as a result of wave/current interaction, which outlines the shape of the eddy, or were revealed indirectly by presence of surfactant film trapped within spiralling lines associated with eddy orbital motion that led to backscatter contrasts of up to 10 dB. Spectacular images of the spiral eddies were obtained at the end of October 1992 and in November1993, i.e. in the season when the phytoplankton pigment concentration is high in the Japan Sea (Ishizaka et al. 1997). The eddies were also seen at the end of April 1993. The streaks of the surfactant films always spiralled counter clockwise. The eddy dimension varied from 1-3 km in the Japan Basin interior to 20-40 km south of the subtropical front. Although some of the observed spiral eddies can be explained within framework of recent theory, which dealt with frontogenesis (Munk et al. 2000 and Eldevik and Dysthe 2000), certain features remain unaccounted for by existing models. In particular small eddies of the size of the order of 1 km, located far away from the known strong currents, inside the northern gyre of the Japan Sea, seem unlikely to be related to the frontal dynamics. It is suggested that if such an eddy is cyclonic, its spiral is formed from the eddy centre towards the eddy periphery, so the eddy core serves as a source of a surfactant film that is upwelled to the sea surface from the interior below.

RETRIEVAL OF OCEAN CURRENT VELOCITY FIELD USING ERS SAR RAW DATA

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ABSTRACT

It is known that to measure spatial and temporal variability of ocean currents by using contact measurements from ships is very difficult. Principal possibility of ocean current measurements by using spaceborne SARs has been realized only several years ago. In order to study possibilities of spaceborne radars to retrieve mesoscale ocean current fields ERS Synthetic Aperture Radar (SAR) images and raw data has been collected in the framework of the ESA AO3 Project #219 titled "Experimental verification of the method for restoration mesoscale ocean velocity fields using ERS SAR data". The objective of the work was to understand ERS SAR potential for monitoring ocean current fields. The paper reports the results obtained from processing and analysis of the ERS SAR raw data as a step in the investigation the ocean with use a spaceborne SAR. Due to stability of satellite orbit there is a possibility to measure ocean current velocity by using frequency shift of Doppler spectra. Theoretical studies conducted in Institute of Oceanology showed that the Doppler radar method allows to restore only radial component of surface current velocity vector. Radar signals scattered by short surface waves have also parasite Doppler shifts due to phase velocities of short waves and orbital velocities of large waves. Conducted studies showed that shift errors due to those effects are about 3-7 cm/s. The method of processing raw data includes formation of partial Doppler spectra in non-focusing aperture regime, non-coherent accumulation of these spectra for every range element in real aperture, accumulation in respective number of range elements and measurements of averaged spectrum median. Firstly developed method has been applied to Almaz-1 raw data taken over the Gulf Stream when a possibility of ocean velocity field restoration has been shown. For method validation the test site in the Florida Strait between USA and Cuba has been selected. By applying developed method to ERS SAR raw data covering the strait the current velocity field has been retrieved. Obtained results show that current velocity field has been restored and acceptable accuracy achieved. Possibilities and limitations of the methods are also discussed.

REGIONAL LONG TERM SEA LEVEL VARIABILITY FROM MULTI-SATELLITE ALTIMETRY

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ABSTRACT

The monitoring of the long-term sea level variability requires the use of multi-satellite altimetry data. Geosat, ERS and Topex/Poseidon altimeter data are combined to analyse the sea level variability in the Mediterranean Sea over more than ten years. In a first step, the multi-mission data are analysed and unified by a multi-crossover adjustment. The analysis shows a change in the relative bias between the satellites, which is partly due to different corrections used in the pre-processing. In a further step, the main components of the variability are extracted from the unified data using statistical and spectral methods.

SAR AND AVHRR IMAGERY USING FOR INVESTIGATIONS OF BIG LAKES PHYSICS AND ECOLOGY - LAKE BAIKAL

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ABSTRACT

Lake Baikal, situated in the centre of Asian continent, is the deepest, the most voluminous, and the oldest freshwater basin on the Earth. These factors are responsible for the formation of its peculiar hydrophysics and ecology. The lake has been the subject of intensive investigations for more then century, however, using of satellite remote sensing for studies of temperature regime, circulation and ecology is on initial stage nowadays. The first opportunity to use SAR imagery for intensive Baikal studies were carried out after European Space Agency mobile receiving station set up in Ulan-Bator, Mongolia during Autumn 1997 and Summer 1998. Courtesy to ESA announcement of opportunity about 80 images proceeding by ERS satellite-born SAR instrument, have been given in our disposal. Simultaneous AVHRR HRPT imagery has been received from NOAA satellites in Irkutsk Centre of Space Monitoring. This information was used intensively for data fusion and better understanding of physical and biological features. When possible, contact data of research cruises was incorporated into analysis. Manifestations of short internal waves in water (with period of 400-800 m) on 1997-98 SAR images of Baikal demonstrate great diversity of direction and transformation in interaction with bottom topography. Some of these wave trains can present high-frequency modulation on the front of coastal-trapped Kelvin wave. Atmospheric internal waves can be also detected on SAR images as well as lee waves, thermal fronts and some other hydrophysical features. Independence of SAR images quality of atmospheric conditions supports their usage for detailed tracing of ice structure. We apply multispectral AVHRR imagery for classification on Baikal ice cover types. Database of AVHRR imagery is used intensively for studies of spatial variability of ice cover and its interannual changes. We apply SAR imagery as well as high resolution "Resurs" satellite images in visual band for calibration and verification of AVHRR-based classification. SAR imagery can be used for novel knowledge on Baikal ecosystem variability. For the late Summer autumn 1998 ERS SAR images show slicks of biological origin on the North Baikal. Probably, intensive bloom of green-blue Anabaena lemmermanii was detected. In situ observations made in the same time in research cruise of r/v "Vereshchagin" show high concentration of this algae in surface layer. This Cyanophita is capable to form patterns of high concentration (5-10 g/m3) in the thin surface layer during low wind conditions. AVHRR-derived surface temperature demonstrate similar structures of circulation field, that determines transport of cianobacteria from warm coastal area into pelagic waters.

MONITORING THE EASTERN ALBORAN USING COMBINED ALTIMETRY, IN SITU AND TEMPERATURE DATA

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ABSTRACT

As part of the EU funded OMEGA project a cruise to the Eastern Alboran (Western Mediterranean) was carried out on board RRS Discovery during December 1996 and January 1997. During the cruise, a fine scale survey, designed to be oriented along ERS ground tracks, was repeated several times. Several additional survey legs were carried out, part of which lay along additional ERS or TOPEX/POSEIDON altimeter ground tracks. Hydrographic and current profile data were collected continuously along these survey tracks using an undulating, towed CTD and an Acoustic Doppler Current Profiler referenced to a Global Positioning System,. The in situ data have been merged with the along track altimeter data to give profiles of the absolute surface current at several locations across the Almeria-Oran front, which limits the easternmost gyre in the Alboran gyre system. Where a track was repeated, several estimates of the absolute current profile have been made in order to try and understand some of the possible sources of error in the estimates. After the "one-time" calculation of the absolute profiles, several years of repeated altimeter data have been used to monitor the flow across the Almeria-Oran front. At times, the front appears to move to the south, apparently when the eastern Alboran gyre collapses, as observed in previous in situ and remote sensed studies. It is also possible to see times when the front moves northward and intensifies. The coincident altimeter and in situ tracks have high along-track resolution but much coarser track spacing and they also have limited spatial extent. This makes it difficult to gain a complete picture of the state of the Almeria-Oran front from the altimetry alone. In order to try and gain a wider spatial context, and improve the dimensionality of the data, the altimetry data have been further combined with remote sensed Sea Surface Temperature (SST) data, in particular from ATSR. Coincident data obtained during the cruise have been used to determine a relationship between the temperature field and the current structure. This relationship has been used to infer two-dimensional current fields from combined altimeter and SST data.

SEA SURFACE TOPOGRAPHY DUE TO DENSITY GRADIENTS IN THE BALTIC SEA AND KATTEGAT

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ABSTRACT

Data from ERS1/2 and TOPEX/POSEIDON have been used to calculate the sea surface topography in the Baltic Sea and Kattegat. By using data from two different satellites the results can be compared. The difference between the mean sea surface topography and the geoid is obtained by subtracting the NKG96 geoid from the mean sea surface topography. The difference is increasing with approx. 50 cm from Kattegat to the north end of the Botnic Bay. The variation is due to the density differences between the brackish Baltic water and the salty North Sea water. The phenomena have also been observed by oceanographic observations by Ekman and these are used as a check. Fourier transformation of data has been applied to see temporal variations of the sea surface topography.

SYNERGISTIC OBSERVATIONS OF ROSSBY WAVES

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ABSTRACT

Baroclinic Rossby waves are large-scale propagating features that transmit information from the eastern side of an ocean basin to the west, where they maintain and may displace the Western Boundary Currents. Satellite altimetry has led to significant advances in the mapping of Rossby wave activity, providing results to challenge the understanding of the theoreticians. Here we look at Rossby waves evidenced in sea surface height, sea surface temperature and ocean colour, using data from ERS-1, ERS-2 and other satellites.

There is good agreement in the Rossby waves recorded by the altimeters on both the TOPEX/Poseidon and ERS platforms, with signals present in all ocean basins and at most latitudes. Westward propagating features are also seen in SST derived from both infrared (ATSR) and passive microwave instruments (TMI). The signature of Rossby waves in ocean colour data is harder to detect and tends to be masked by the strong annual phytoplankton bloom, but evidence has been found in data from both OCTS and SeaWiFS. The interpretation of such a signal is even more challenging. Possibly this is due to thermocline displacement and its effect on biology.

The Rossby waves at any given latitude do not all propagate at a uniform constant speed. In many cases they speed up as they move from eastern basins to the west, in response to changing vertical density structure. Also there may exist several different modes (corresponding to different vertical structures) each of which travels at a different speed. In this paper we will compare the information on Rossby waves derived from these many diverse sensors and look at the added information acquired from synergistic observations, which suggest that whilst altimeters primarily detect the first baroclinic mode, SST and ocean colour are often more sensitive to higher modes.

THE SIGNATURE OF ROSSBY WAVES IN THE ATSR DATASET

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ABSTRACT

The purpose of this paper is to examine the surface thermal signatures of extratropical baroclinic Rossby waves (a special class of planetary waves) in the ocean and measure their propagation speed. We show that longitude-time plots of the global sea surface temperature (SST) record produced by the Along Track Scanning Radiometer (ATSR) on board ERS-1 between August 1991 and April 1996 contain clear evidence of wave propagation in all parts of the world oceans and at many latitudes. The propagation is studied with the help of a 2D Radon transform method in order to analyse more objectively the wave speed and its variation with location and time. The resultant spatial distribution of velocity estimates broadly matches the Rossby wave speeds predicted by the most recent theory and those measured by TOPEX altimetry, but there are some discrepancies, for instance at lower latitudes the waves in the SST field appear to propagate slower than in the altimeter data. We describe in details how the signals vary in both space and time in the data record. Wave signatures are found to be strongest between 25 and 40 S, where the meridional temperature gradient is strongest. Here the observed speeds are 20-30 9.50753e-305reater than theoretical predictions. Planetary wave speed is also found to vary considerably with longitude. In general there is an increase towards the west of ocean basins, consistent with the theoretical findings. Another feature of particular interest is the presence of eastward propagating signatures in the Southern Ocean. We conclude that the ATSR ASST data are a valuable source of information for studying basin scale wave processes as a complement to the use of altimetry. By observing the thermal signature of Rossby waves the method has the potential to clarify their influence on air-sea interaction processes, and contribute to climate modelling studies.

A STUDY OF THE MEDITERRANEAN WATER OUTFLOW USING THE ERS AND TOPEX-POSEIDON JOINT ALTIMETRY

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ABSTRACT

After leaving the Strait of Gibraltar the Mediterranean water outflow descends close to the bottom of the slopping topography towards the Gulf of Cadiz, being deflected to the right as a consequence of earth rotation effects, starting its mixes with its surrounding Atlantic waters. Consequently, the termohaline characteristics of the Mediterranean outflow are gradually modified, its salinity decreases and becomes less and less dense reaching, at a certain stage the density values corresponding to the mid-depth layers of the Atlantic Ocean. In the Gulf of Cadiz the Mediterranean water can be described as a gravity current flowing along the Iberian continental slope. Due to a bifurcation, its densest part proceeds westward along deeper isobaths several tens of kilometers offshore from the lighter part. The two cores may become locked together. The presence of these anticyclonic eddies, detached from the main body of Mediterranean undercurrent water, can be detected in the termohaline field, since they form lens-like structures of anomalously high temperatures and salinity, as compared with the surrounding Atlantic waters, and in the velocity field by its vortex rotating structure. This communication presents the results we have obtained in the detection of meddies using jointly the altimetry of Topex-Poseidon and ERS, analysing its sea surface dynamic signals and comparing it with the tracks recorded of several possible meddies off the Portuguese coasts, primarily detected by rafos given us for the Portuguese group of Ioceano. As meddies dynamic signals were in subdecimetric order of magnitude we have to improve both, the accuracy of the satellite orbit and the geophysical corrections applied to the satellite altimeter data.

REPROCESSED ERS-1 AND ERS-2 ALTIMETER MEASUREMENTS FOR OCEAN CIRCULATION AND CLIMATE RESEARCH

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ABSTRACT

The estimated accuracy of sea surface height measurements from the NASA/CNES TOPEX/POSEIDON (T/P) altimeter satellite is 2-3 cm. (Fu et al., 1994). As a result of this unprecedented level of accuracy, the measurements from all satellite altimeters have been significantly upgraded by successfully exploiting the results from T/P during the initial phase of the NASA Ocean Altimeter Pathfinder Project (Koblinsky et al., 1998, 1999). This presentation provides an overview of the significant improvements made to the ERS-1 and ERS-2 altimeter data sets and details current research activities and results from the NASA Ocean Altimeter Pathfinder project and collaborative work with other investigations including: Height anomalies from merged ERS -1/2, T/P, and Geosat-Follow-On (GFO)·Mean Sea Level estimates from ERS and T/P·Geostrophic velocity computations from altimetry and in-situ validation techniques·Barotropic de-aliasing: model and removal of the fast response of the ocean to wind and pressure·Global tide model improvements through embedding regional models in shallow and enclosed seas within the T/P based tide model Ionosphere modeling with IRI-2000 for Single Frequency Altimeters GFO improved orbit information·Next generation mean sea surface. Evaluation of NVAP model in Indonesian Archipelago The NOAA/NASA Pathfinder program was created by the Earth Observing System (EOS) Program Office to determine how existing satellite-based data sets can be processed and used to study global change. The data sets are designed to be long time-series data processed with stable calibration and community consensus algorithms to better assist the research community. The Ocean Altimeter Pathfinder Project involves the reprocessing of all altimeter observations with a consistent set of improved algorithms, based on the results from TOPEX/POSEIDON (T/P), into easy-to-use data sets for the oceanographic community for climate research.

SEASONAL ERS SAR STUDIES OF SEA ICE IN THE PECHORA AND KARA SEA REGION

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ABSTRACT

There is a strong seasonal and regional variability in the sea ice distribution in the Kara and Pechora Seas. It is an important sea ice production region because of very low air temperatures and repeated opening of polynya areas driven mainly by strong winds. With SAR data it is possible to map areas of open water and thin ice for estimation of heat exchange from water to air, which is essential for modelling of the climate system at high latitudes.

This study will focus on characterisation of the different types of first-year sea ice in the Pechora and Kara Sea. Regional and seasonal signatures, during the whole ice season from the early formation of thin ice to the melt period will be investigated. ERS SAR data will be used, as these are especially valuable in the Arctic due to the independence of fog, cloud cover and lack of sunlight. Image data will be examined and parameters for characterising the sea ice will be extracted. Environmental information will be used to get a better understanding of the development of the ice during the year under different weather conditions.

Monitoring of sea ice in the Pechora and Kara Sea region is very important both for economic and environmental reasons. Extensive oil and gas resources are found here, and exploitation of these as well as cargo transport along the Northern Sea Route may cause environmental problems. Also, transport of pollutants from the land areas by the huge rivers that flow into the seas, may contribute to the contamination of the Arctic environment. Sea ice information is important for planning of oil and gas installations, and safe exploitation and transport of these resources.

SEA ICE ALGORITHM VALIDATION AND IMPROVEMENT BY MULTI SENSOR ANALYSIS

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ABSTRACT

In order to validate and improve sea ice algorithms a hierarchically structured analysis of remote sensing methods was carried out ranging from large scale coverage of satellite passive microwave over intermediate scale of satellite active microwave to small scale aircraft based measurements.

The used dataset was acquired during ARTIST (Arctic Radiation and Interaction Study) which took place around Svalbard in March/April 1998. Airborne measurements were carried out with two research aircrafts of the Alfred Wegener Institute. The aircraft was equipped with well proven devices (e.g. line scanners, radiation thermometer) and new systems (19.35 GHz and 37 GHz radiometers) which were operated for the first time during ARTIST. Several coordinated satellite under flights (SSM/I and ERS SAR) were performed in the vicinity of the marginal sea ice zone.

The dissimilar resolutions and swath widths of different remote sensing systems is a common problem for multi-sensor applications. The newly developed ARTIST Sea Ice algorithm (ASI) combines the NASA team and Svendsens 85GHz methods bringing together the nearly weather independence of the lower frequency SSM/I channels with the high spatial resolution of the 85GHz channels. The goal of the ASI algorithm is to reduce the gap of resolution between ERS SAR and SSM/I. The resolution of the ASI sea ice maps (ASI:about 14km, NASA team:60km) is suitable for mesoscale applications: e.g. the accurate position of the sea ice edge meets the requirements of the mesoscale atmospheric modeling part of ARTIST, the state of the ice edge (diffuse or compact) can easily be identified, and it allows for a higher resolved interpretation of ERS SAR images in terms of sea ice concentrations. Furthermore a texture based classification algorithm for ERS SAR images was developed using co-occurrence texture features and learning vector quantization for supervised learning of the training data. The selection of training samples from the ERS SAR images can thereby aided either by the ASI sea ice maps or the aircraft measurements and observations.

SEASONAL CHARACTERISTICS OF ANTARCTIC SEA ICE BACKSCATTER

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ABSTRACT

Sea ice is an important component of the global climate system and is considered as a sensitive indicator of climate changes because it responds sensitively to them as model runs have shown. Besides microwave sensors like SSM/I only scatterometers like the wind scatterometer on board the ERS-1/2 satellites allows for a frequent and complete observation of sea ice in both Polar Regions. In view of a synergetic use of both sensor types a more thorough understanding of the scatterometer signal of sea ice is desirable. As recently reported, the backscatter of sea ice in the Weddell and Ross Sea behaves opposite to the Arctic, where there is a sudden decrease in multi-year ice backscatter once air temperatures approach or exceed zero centigrade. In the Antarctic, there is a pronounced seasonal cycle, with higher backscatter in summer than in winter. In the late austral summer, backscatter decreases again and slowly approaches winter values. The seasonal cycle is interpreted in terms of processes at the ice surface. The spring backscatter rise may be associated with the formation of superimposed ice. In fall, when formation of superimposed ice ceases due to surface cooling, gradual surface flooding with seawater becomes the dominating process and causes the observed decrease of backscatter. In this study, the seasonal cycle of about ten selected Antarctic Sea ice regions are observed with the ERS-1/2 wind scatterometer. The examination will be supplemented with data of the Sea Winds 13.4 GHz microwave radar instrument on board the NASA QUICK SCATterometer satellite (Quickscat), launched in June 1999. Combined with the ERS-1/2 wind scatterometer, the Sea Winds Ku band instrument may provide complimentary information.

ANALYSIS OF MULTI-POLARMETRIC SAR IMAGERY FROM THE KARA SEA

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ABSTRACT

Sea ice plays an important role within the global climate system. Knowledge of the Polar Regions is limited due to their size and the hostile environment in which they lie. Satellite imagery can provide synoptic coverage that overcomes these limitations. While single SAR images provide excellent data for monitoring the ice cover in all weather conditions, it is limited due to the ambiguous appearance of the surfaces of ice and water under certain conditions. To address this problem calibrated ERS-2 (C-band, VV polarisation) and RADARSAT (C-band, HH polarization) SAR images were acquired over the Kara Sea on 24th March 1997 to form a composite multi-polarmetric image. Analysis of the synergistic composite can improve the classification of sea ice in satellite imagery, and provide an indication as to how the ASAR sensor on board ENVISAT will respond to sea ice.

SEA ICE INTERPRETATION MANUAL FOR SAR IMAGES

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ABSTRACT

The overall objective of producing a SAR ice interpretation manual is to 1. Support the use of Synthetic Aperture Radar (SAR) images from ERS, RADARSAT and ENVISAT in national Ice Services and other operational users of SAR-derived ice information; 2. Promote and facilitate use of SAR images among end users such as shipping companies, oil companies and other important operators in Arctic regions; and 3. Education and training. There is a demand for a SAR ice interpretation manual which can be used in education at marine colleges and universities and in special training courses for captains, ice pilots, oil companies, oceanographers, meteorologists and other personnel working with sea ice. The manual contains an introduction to SAR imaging of different sea ice types and forms as observed by ERS and RADARSAT images from the European sector of the Arctic Ocean and adjacent seas. The main part of the manual consists of about 50 examples of typical ice types and phenomena as observed by SAR together with interpretation and analysis of the ice features, which are apparent in the images. The manual will be made available for public use both in hardcopy and on Internet.

EXTENSION AND TYPES OF SEA ICE WITH THE ERS-1 SCATTEROMETRY IN SURROUNDINGS OF THE ANTARCTIC PENINSULA

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ABSTRACT

Sea ice is a most changeable component of the Antarctic ice cover. The ice characteristics are under affect of climatic and weather factors, hydrodynamic, wind and wave variation. Traps of the coast and shallows catch and concentrate broken and drifting sea ice forming multi-year ice. Dynamics and transformation of the sea ice by the scatterometer data were considered for the Antarctic Peninsula region and for the Ukrainian Vernadsky Station area in particular. These data are an importance to the climatic analysis and active ice navigation of the research and tourist vessels in the western Antarctic. The Polar Sea Ice Grids of the ERS-1 AMI provided by IFREMER were used for our research.

SEASONAL ERS SAR STUDIES OF SEA ICE IN THE PECHORA AND KARA SEA REGION

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ABSTRACT

There is a strong seasonal and regional variability in the sea ice distribution in the Kara and Pechora Seas. It is an important sea ice production region because of very low air temperatures and repeated opening of polynya areas driven mainly by strong winds. With SAR data it is possible to map areas of open water and thin ice for estimation of heat exchange from water to air, which is essential for modelling of the climate system at high latitudes.

This study will focus on characterisation of the different types of first-year sea ice in the Pechora and Kara Sea. Regional and seasonal signatures, during the whole ice season from the early formation of thin ice to the melt period will be investigated. ERS SAR data will be used, as these are especially valuable in the Arctic due to the independence of fog, cloud cover and lack of sunlight. Image data will be examined and parameters for characterising the sea ice will be extracted. Environmental information will be used to get a better understanding of the development of the ice during the year under different weather conditions.

Monitoring of sea ice in the Pechora and Kara Sea region is very important both for economic and environmental reasons. Extensive oil and gas resources are found here, and exploitation of these as well as cargo transport along the Northern Sea Route may cause environmental problems. Also, transport of pollutants from the land areas by the huge rivers that flow into the seas, may contribute to the contamination of the Arctic environment. Sea ice information is important for planning of oil and gas installations, and safe exploitation and transport of these resources.

SEA ICE ALGORITHM VALIDATION AND IMPROVEMENT BY MULTI SENSOR ANALYSIS

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ABSTRACT

In order to validate and improve sea ice algorithms a hierarchically structured analysis of remote sensing methods was carried out ranging from large scale coverage of satellite passive microwave over intermediate scale of satellite active microwave to small scale aircraft based measurements.

The used dataset was acquired during ARTIST (Arctic Radiation and Interaction Study) which took place around Svalbard in March/April 1998. Airborne measurements were carried out with two research aircrafts of the Alfred Wegener Institute. The aircraft was equipped with well proven devices (e.g. line scanners, radiation thermometer) and new systems (19.35 GHz and 37 GHz radiometers) which were operated for the first time during ARTIST. Several coordinated satellite under flights (SSM/I and ERS SAR) were performed in the vicinity of the marginal sea ice zone.

The dissimilar resolutions and swath widths of different remote sensing systems is a common problem for multi-sensor applications. The newly developed ARTIST Sea Ice algorithm (ASI) combines the NASA team and Svendsens 85GHz methods bringing together the nearly weather independence of the lower frequency SSM/I channels with the high spatial resolution of the 85GHz channels. The goal of the ASI algorithm is to reduce the gap of resolution between ERS SAR and SSM/I. The resolution of the ASI sea ice maps (ASI:about 14km, NASA team:60km) is suitable for mesoscale applications: e.g. the accurate position of the sea ice edge meets the requirements of the mesoscale atmospheric modeling part of ARTIST, the state of the ice edge (diffuse or compact) can easily be identified, and it allows for a higher resolved interpretation of ERS SAR images in terms of sea ice concentrations. Furthermore a texture based classification algorithm for ERS SAR images was developed using co-occurrence texture features and learning vector quantization for supervised learning of the training data. The selection of training samples from the ERS SAR images can thereby aided either by the ASI sea ice maps or the aircraft measurements and observations.

SEASONAL CHARACTERISTICS OF ANTARCTIC SEA ICE BACKSCATTER

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ABSTRACT

Sea ice is an important component of the global climate system and is considered as a sensitive indicator of climate changes because it responds sensitively to them as model runs have shown. Besides microwave sensors like SSM/I only scatterometers like the wind scatterometer on board the ERS-1/2 satellites allows for a frequent and complete observation of sea ice in both Polar Regions. In view of a synergetic use of both sensor types a more thorough understanding of the scatterometer signal of sea ice is desirable. As recently reported, the backscatter of sea ice in the Weddell and Ross Sea behaves opposite to the Arctic, where there is a sudden decrease in multi-year ice backscatter once air temperatures approach or exceed zero centigrade. In the Antarctic, there is a pronounced seasonal cycle, with higher backscatter in summer than in winter. In the late austral summer, backscatter decreases again and slowly approaches winter values. The seasonal cycle is interpreted in terms of processes at the ice surface. The spring backscatter rise may be associated with the formation of superimposed ice. In fall, when formation of superimposed ice ceases due to surface cooling, gradual surface flooding with seawater becomes the dominating process and causes the observed decrease of backscatter. In this study, the seasonal cycle of about ten selected Antarctic Sea ice regions are observed with the ERS-1/2 wind scatterometer. The examination will be supplemented with data of the Sea Winds 13.4 GHz microwave radar instrument on board the NASA QUICK SCATterometer satellite (Quickscat), launched in June 1999. Combined with the ERS-1/2 wind scatterometer, the Sea Winds Ku band instrument may provide complimentary information.

ANALYSIS OF MULTI-POLARMETRIC SAR IMAGERY FROM THE KARA SEA

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ABSTRACT

Sea ice plays an important role within the global climate system. Knowledge of the Polar Regions is limited due to their size and the hostile environment in which they lie. Satellite imagery can provide synoptic coverage that overcomes these limitations. While single SAR images provide excellent data for monitoring the ice cover in all weather conditions, it is limited due to the ambiguous appearance of the surfaces of ice and water under certain conditions. To address this problem calibrated ERS-2 (C-band, VV polarisation) and RADARSAT (C-band, HH polarization) SAR images were acquired over the Kara Sea on 24th March 1997 to form a composite multi-polarmetric image. Analysis of the synergistic composite can improve the classification of sea ice in satellite imagery, and provide an indication as to how the ASAR sensor on board ENVISAT will respond to sea ice.

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QUALITY OF LONG TERM SATELLITE WIND AND WAVE MEASUREMENTS

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ABSTRACT

Since the time of the first data from ERS-1, in 1991, the french PAF CERSAT of IFREMER Département d'Océanographie Spatiale has processed and distributed data from ERS-1 and ERS-2. Concurrently the Département was involved in algorithm development and geophysical validation of the products of ERS altimeters and AMI's, and then of other satellites, like TOPEX, NSCAT and, more recently, QuikSCAT. For this purpose, procedures of cross validation of sensors were developed with the aim of building long time series from various sensors and satellites, with homogeneous quality. Here we present long term validation of significant wave height (SWH) and wind speed measurements from altimeters and scatterometers. Two methods are used: global statistical analysis and cross validation at same time and location. The first one is applied to ERS-1, ERS-2 and TOPEX SWH, and shows significant differences, up to more than half a meter for SWH, between the satellite products, over the time period from 1991 to 2000. Furthermore these differences are not constant with time but depend on changes for processing improvement, or on electronics drifts, for instance. The second method, completed by in situ data comparisons, allows to propose corrections for the data, in order to improve their global quality. Results from same technics applied to sea surface wind speed measurements from ERS-1, ERS-2 and TOPEX altimeters are shown and completed with comparisons from scatterometers of ERS, NSCAT and QuikSCAT. Beyond the scope of validation, this work is a step for merging data from various sensors to infer more accurate wind and wave fields.

INTERNAL SOLITONS NEAR GIBRALTAR: A MULTI-YEAR STUDY USING ERS-1 & 2 SAR IMAGERY

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ABSTRACT

Synthetic aperture radar (SAR) images are especially useful for observing surface signatures of coherent internal waves in the ocean. A study has been conducted of the dynamics of internal soliton packets in and near the Strait of Gibraltar, using several years' worth of imagery from the European Remote Sensing Satellites, ERS-1 & 2. The study reveals new features of the wave field as well as reaffirming behavior previously reported. It shows the waves may have two modes of propagation out into the Alboran Sea, termed Northeast and Southeast; that they penetrate eastward well beyond 200 km from their source; that they appear to be dependent on fortnightly tides as well as on semi-diurnal and diurnal forcing; and that smaller packets are generated at the Camarinal Sill that propagate into the Atlantic. The data are interpreted in terms of (1) the little-known "dnoidal" solution to the Korteweg De Vries equation for the amplitude and (2) the Taylor-Goldstein equation for the vertical internal modes, using continuously distributed profiles of density and mean flow velocity. Both historical and contemporaneous in-situ data are used. These two equations together capture many quantitative features of the soliton packets. Comparisons between observations and theory will be presented. The study has been supported by the European Space Agency and the U.S. Office of Naval Research.

VALIDATION OF WIND RETRIEVAL ALGORITHMS FROM SPACEBORNE SAR

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ABSTRACT

The exploitation of Synthetic Aperture Radar (SAR) imagery as a tool to obtain geophysical information of the marine environment has been object of intense studies by the scientific community in the recent years. Several methods have been proposed in the last few years to retrieve quantitative estimates of ocean wave spectra and of wind speed and direction at a given reference height from SAR imagery. These tools appear very interesting in view of the future dual-polarised ASAR instrument onboard the European ENVISAT satellite, whose launch is planned for June 2001.

In preparation of the availability of ENVISAT/ASAR data, we have planned a validation campaign for wind retrieval algorithms from ERS-2/SAR. The main source of reference data is the buoy ODAS Italia 1, located in the North Tyrrhenian Sea at 43.8 N and 9.1 E. ODAS Italia 1 is indeed a real open sea laboratory, equipped with a large set of meteo-marine instrumentation [1], like anemometer, pyranometer, thermometers, current meter, etc.

As a case study, an ERS-2/SAR scene of March 30 (orbit: 25842, frame: 2727) over the North Tyrrhenian Sea was selected and both PRI and SLCI products were acquired. The image shows relevant features due to the the action of the wind on the sea surface. In particular, the presence of wind streaks, which are surface evidence of the wind direction, is clearly visible. However, the ``true" wind direction cannot be immediately recognized because of the 180 degrees ambiguity. We propose to exploit the SAR backscatter spatial structure as a mean to remove the directional ambiguity. The SAR image was analyzed: i) using the empirical backscatter model CMOD4 [2] to retrieve the wind stress; and ii) by means of the VISA method [3] to retrieve the wind direction without ambiguity. Indeed, the VISA procedure allows to discriminate the ``true" wind direction when unstable thermal conditions are fulfilled. All the relevant meteorological parameters (wind intensity, wind direction, air/sea temperature) had been collected by ODAS Italia 1 during a total of 1 hour of acquisition, centered around the time of satellite pass. The comparison of measured wind intensity and direction with SAR retrieved values confirms the soundness of the employed algorithms.

Future plans of validation activities, in connection with the availability of ENVISAT/ASAR data, regard the installation of an ondametric buoy [4] in the vicinity of ODAS Italia 1, in order to jointly validate wind and wave spectra retrieval methods from SAR.

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CASE STUDIES OF COASTAL OCEAN WIND FIELD RETRIEVALS FROM RADARSAT SYNTHETIC APERTURE RADAR IMAGES NEAR THE ISLAND OF HAINAN, CHINA

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ABSTRACT

High resolution coastal zone wind field estimates may be retrieved from radiometrically calibrated synthetic aperture radar (SAR) images of the coastal zone; the wind field modulates that surface roughness, which in turn modulates the observed radar cross section. Higher wind speeds produce larger cross sections. We consider two calibrated RADARSAT SAR images of the coastal zone near the Island of Hainan, China and used a spectral analysis of the long wavelength structure in the SAR image to estimate the wind direction. The estimated direction and the radar cross section, along with a scatterometer wind retrieval model, were used to estimate the wind speed. SAR images can provide the wind vector with a high spatial resolution; our retrieved estimates are shown to be in reasonable agreement with conventional synoptic weather analyses from the observation times closest to the SAR passes. The images also provide visual evidence of the spatial development and evolution of the marine atmospheric boundary layer. Secondary atmospheric flow phenomena, such as boundary layer rolls and atmospheric internal waves, modulate the ocean surface roughness and may be imaged by SAR.

A MODEL FOR WIND SPEED AND WAVE HEIGHT RETRIEVAL FROM RADAR ALTIMETER MEASUREMENTS

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ABSTRACT

A new algorithm for simulation of the measurement of ocean wave height and wind speed by radar altimeter is proposed. This algorithm considers ocean wave spectrum and employs a parametric model for the simulation of the electromagnetic waves diffusion from surface; it offers greater flexibility and realism as to analytical models currently used.

Numerical results give assurance of independence of the measured significant wave height from wave period. They are consistent even if different backscatter models are employed. On the contrary, the numerical results show that wind speed measurements are significantly affected by wave period.

The aim of this work is two-fold: on the one hand to allow a more accurate calibration of altimeter data and on the other hand to develop a model which can be used for simulation of the sea state response as seen by other microwave instruments working at other incidence angles.

QUALITY OF LONG TERM SATELLITE WIND AND WAVE MEASUREMENTS

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ABSTRACT

High resolution coastal zone wind field estimates may be retrieved from radiometrically calibrated synthetic aperture radar (SAR) images of the coastal zone; the wind field modulates that surface roughness, which in turn modulates the observed radar cross section. Higher wind speeds produce larger cross sections. We consider two calibrated RADARSAT SAR images of the coastal zone near the Island of Hainan, China and used a spectral analysis of the long wavelength structure in the SAR image to estimate the wind direction. The estimated direction and the radar cross section, along with a scatterometer wind retrieval model, were used to estimate the wind speed. SAR images can provide the wind vector with a high spatial resolution; our retrieved estimates are shown to be in reasonable agreement with conventional synoptic weather analyses from the observation times closest to the SAR passes. The images also provide visual evidence of the spatial development and evolution of the marine atmospheric boundary layer. Secondary atmospheric flow phenomena, such as boundary layer rolls and atmospheric internal waves, modulate the ocean surface roughness and may be imaged by SAR.

A MODEL FOR WIND SPEED AND WAVE HEIGHT RETRIEVAL FROM RADAR ALTIMETER MEASUREMENTS

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ABSTRACT

A new algorithm for simulation of the measurement of ocean wave height and wind speed by radar altimeter is proposed. This algorithm considers ocean wave spectrum and employs a parametric model for the simulation of the electromagnetic waves diffusion from surface; it offers greater flexibility and realism as to analytical models currently used.

Numerical results give assurance of independence of the measured significant wave height from wave period. They are consistent even if different backscatter models are employed. On the contrary, the numerical results show that wind speed measurements are significantly affected by wave period.

The aim of this work is two-fold: on the one hand to allow a more accurate calibration of altimeter data and on the other hand to develop a model which can be used for simulation of the sea state response as seen by other microwave instruments working at other incidence angles.

THE USE OF ERS-1/2 SAR TO THE STUDY OF OCEAN SURFACE FEATURES IN THEGULF OF CALIFORNIA MEXICO

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ABSTRACT

The Gulf of California, a large semi-enclosed sea located in the north-western Mexico between the Baja California Peninsula and the Mexican main land, is a very interesting and complex region, with considerable oceanographic and meteorological interest due to its similarity to other marginal seas, such as the Red Sea, the Adriatic Sea, and the East China Sea (Roden, 1958; Badan-Dangon et al., 1991). Among the outstanding oceanographic features of the Gulf of California are the large annual range of sea surface temperature, its impressive tidal range, that increase gradually from the Gulf entrance up to Tiburon Island and than rapidly toward its head, exceeding 10m during spring tides. There is a seasonally reversing gyre, cyclonic in the summer and anticyclonic in the winter, located in the northern Gulf with speeds reaching 0.7 ms-1. The high tidal range and the complicated bottom topography produce strong currents along the Gulf, especially in the vicinity of Tiburon Island where strong tidal mixing fronts and high internal wave activity are observed. Until now the complex oceanographic processes occurring in the Gulf of California have been investigated mainly by sampling from insitu instruments aided in some occasions by nearly-coincident infra-red derived sea surface temperature images. Unfortunately, in most cases, insitu measurements do not provide adequate spatial and temporal cover of the intrinsic scales of variability associated with these oceanographic features, and due to cloud cover, a common situation to many coastal areas, infra-red imagery is not always a success. In this paper we show evidence that ERS-1/2 SAR can play a useful role in observing the complicated upper-ocean circulation features occurring in the Gulf of California.

DETECTION AND INTERPRETATION OF OCEANIC AND ATMOSPHERIC SIGNATURES IN SPACEBORNE RADAR IMAGERY OF THE NORTH-WESTERN PACIFIC

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ABSTRACT

This work presents the results of analysis of the ERS-SAR images of the Othotsk and Japan seas, which are at our disposal in the frame of ESA, grant AO3-224. The obtained images were used to study three problems.

1) Investigation of internal waves. A detailed analysis of accumulated data has shown that in the Northwestern Pacific there were regions of regular manifestations of internal waves propagating in different directions. The wave surface signatures exhibit clear nonlinear features typical for trains of internal solitons: higher-than-linear group velocities, decreases in wavelength, crest length and amplitude toward the rear of the packet. Interaction of wave structures is a very sensitive detector of both the effectiveness of nonlinear processes and principal physical mechanisms responsible for this interaction. The focus was on specific manifestations of non-linear interaction of internal waves at sea surface. The obtained results were compared with those received by the Space Research Institute in the same region in the 80s using an airborne Ku-band radar.

2) The study of ocean and atmosphere interaction in regions of intensive energy exchange such as the Kuril straits, including the Friza strait, featuring intensive convergent currents and sharp temperature contrasts. First of all, the Friza strait serves as an exchange of waters between the Okhotsk Sea and the Pacific. The strait accommodates a two-directional current system built by tidal flows and characterised by high stability in time and in space. SAR images taken by the ERS-2 on September 25, 1998, at a 12-hour difference permitted to observe the development of vortex structures on the sea surface. Here comparisons were also made with data obtained in the early 80s by means of a set of airborne and spaceborne instruments, which included a satellite-borne SAR of 5cm "Almaz-1", an aircraft-laboratory and a research vessel. The comparisons confirmed the stable character of the observed phenomena, which could add valuable information to the understanding of the long-term oceanic variability in that region.

3) The analysis of the available data made it possible to accurately identify and investigate surface manifestations of gravitational waves in lower troposphere, convective motions in atmosphere, wind fronts, etc.

ON THE VARIETY OF IW RADAR OBSERVATIONS IN THE OCEAN - SLICK-LIKE SIGNATURES

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ABSTRACT

It was shown recently that three different types of short-period Internal Wave SAR signatures occur on the Iberian Shelf depending on parameters of surface-active films. Large scale modulation of film characteristics by currents associated with internal tidal waves can also produce a signature in ERS SAR images. On the Western Iberian shelf short-period IWs typically propagate in groups of packets that are believed to be generated by the evolution of internal tidal waves over the shelf. Here it is shown that onshore propagating short-period IWs can exhibit different SAR signatures within the same wave packet according to their position relative to the phase of the internal tidal wave. These transitions of signature mode can be explained by large scale variations of film parameters produced by the internal tidal waves. At low-to- moderate winds leading waves in the IW packets usually exhibit double sign signatures, which evolve to negative sign signatures for the subsequent waves in the packets. At very low, near-threshold, winds the IW signatures can be in the form of the double sign type undergoing transition to positive sign signatures when compared to the background behind the IW packet. This is a consequence of different threshold wind speeds for excitation of Bragg waves at different film pressures. It is demonstrated that there is an increase of unperturbed film pressure in the direction of the ranking order of solitons in a packet of short-period IWs, which is predicted by a theoretical model and in agreement with measurements of film elasticity. It is concluded that observations of SAR signature mode transitions are consistent with previous model results, and a diagram describing mode transitions of the IW signatures in relation to film pressure and wind speed is presented. Examples of such transitions in different regions of the global ocean are presented, illustrating where slick-dominated SAR signatures are expected to occur.

ON THE VARIETY OF IW RADAR OBSERVATIONS IN THE OCEAN

2. Rip-like signatures

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ABSTRACT

In the accompanying paper (part 1. Slick-like signatures) we describe and present results of a recent classification scheme for synthetic aperture radar (SAR) signatures of internal waves (IWs) that has been proposed based on the analysis of ERS SAR images of the Iberian shelf zone. According to this classification IWs display three different signatures depending on the parameters of surface-active films and wind speed. In particular, it was found that at very low wind speeds IWs display single positive backscatter signatures as a result of the image background falling to the noise floor at such low wind conditions. Here, we present results of observations of predominant single positive signatures even when the background backscatter is well above the noise floor. A variety of observations from different oceanic regions, such as the Strait of Gibraltar, Andaman Sea, Sea of Bali, Gulf of California, central Bay of Biscay, etc., are presented as evidence of the phenomena. One common factor associated with these SAR observations seems to be that they correspond to comparatively long IWs (their wavelength can be up to several kilometres) which are known to propagate with high phase velocities ($C_p > 1$ m/s). However, analysis of a data set of the West Iberian shelf also shows that predominant positive signatures can occur in this region, where typical values of IW phase speed is $C_p \sim 0.5$ m/s. This has been made clear from analysis of the mode of signature, which is defined by a parameter that evaluates the IW intensity profiles in relation to the mean backscatter of the image background. The signature mode parameter is found to be correlated with the angle between the IW propagation direction and the wind velocity. A simple model which takes into account modulation of short-scale surface waves by the relative wind velocity to the surface current generated by the IWs is considered and was found to be in good qualitative agreement with the experimental results. While in the accompanying paper (part 1) we found the signature mode parameter to be sensitive to the local concentration of films, in this paper we demonstrate that it can also be sensitive to the relative wind direction to the IW propagation. In addition, we investigate also the signature dependence for moderate wind speed, which was not predicted in the accompanying paper.

GENERATING A UNIVERSAL FOREST GROUND-TRUTH CATALOGUE FOR REMOTE SENSING APPLICATIONS TO FOREST OBSERVATION

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ABSTRACT

For cost, time and accessibility reasons, the on-ground truth data collection is the usual problem for both research and practical implementation of new remote sensing sensors and technologies. In the framework of the SIBERIA, an attempt to generate a permanent universal system of on-ground truth data for all possible (current and future) remote sensing observations of Northern Eurasia terrestrial ecosystems with a special emphases to forests has been realized. In its current form, the system comprises three levels: 1) federal, 2) (sub) regional and 3) local, which are presented in a form of attributive data bases and connected GIS components. The federal level includes the comprehensive description of entire Russian land by ecological regions (totally 141 for Russia) and administrative units of the federal level. GIS components of this level are presented by a number of digitized maps at scale from 1:1 Mio to 1:4 Mio (including landscape, vegetation, soil, forest, land-use/land-cover maps, relevant layers of the DCW, others). Units of the (sub) regional level called test territories have the average area from 1 to 3 million ha and are designated to describe zonal and altitudinal diversity of landscapes & terrestrial ecosystems. GIS components are at scale 1:200000-1:300000. The local level is presented by test areas of typical landscapes (of the average area from 30000 to 150000 ha) with attributive DBs describing each land-use/land-cover unit (e.g., primary forest inventory & management units are used for forests). Corresponding GIS components have the scale at 1:50000. Two lower levels have been developed for the territory investigated by SIBERIA (of total area at about 100 million ha), and includes 8 test territories and 51 test areas. The system presents possibilities 1) to examine RS images of different types with the resolution from 5-7 m to 150-200 m; 2) to plan an appropriate design of multi-layer observations and 3) to develop appropriate classifications. Problems of spatial accuracy and up dating of the system are discussed.

AUTOMATED TRAINING-SITE SELECTION BASED ON A COHERENCE MODEL FOR FOREST CLASSIFICATION IN THE SIBERIA PROJECT

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ABSTRACT

In recent years SAR Interferometry has proven its value for deriving terrain height information and for detecting movements of the Earth's surface. Quasi as a by-product, SAR Interferometry can be used as an input to classification. In this paper the possibility of using coherence information derived from ERS Tandem Paris for estimating growing stock volume of boreal forest is investigated.

To study the relationship between forest parameters and radar parameters an extensive data set was built up within the framework of the SIBERIA project. Forestry data from 36 testsites, each covering from 20,000 to 100,000 hectares of forested land, were made available. This extensive database provides a good basis for understanding the potential and limitations for using ERS Tandem coherence for forestry applications. A visual analysis of scatter plots of ERS coherence versus growing stock volume showed that the scatter is generally relatively large. However, for test sites with a small degree of scattering, an exponential relationship is evident. To study the behaviour of the coherence model, it was fitted to the scatter plots from all testsites. With some exceptions, the estimated model parameters lay within the expected range.

The exponential coherence model was then used to select automatically training sites (or regions of interest, ROIs) as input for the maximum likelihood classification. The general idea is to determine coherence thresholds for each growing stock volume class using the coherence model, select training sites using this thresholds, and run the classifier using the signatures from the training sites. Growing stock classes for the forested areas are: < 20 qm/ha, 20-50 qm/ha, 50-80 qm/ha, >80 qm/ha. The method works quite stable for different ERS frames of the SIBERIA project area and also different image product (GTC or GEC). This method proved the capabilities of the coherence model described above.

A COMPARISION OF SAR-INTERFEROMETRY- AND CARTOGRAPHICALLY GENERATED DIGITAL ELEVATION MODELS BY ERRORS, ACCURACIES AND EXTRACTED HYDROGRAPHIC FEATURES

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ABSTRACT

Topographic data are critical to the accuracy of a variety of environmental computer models. With rapidly changing technologies in the mapping industries, the quality of Digital Elevation Models (DEM) improved significant. Data from satellite altimetry (SAR Interferometry) as well as data from cartographic sources are compared. This study focuses on errors, accuracies and the extraction of hydrographic features from DEMs.

The SAR Interferometry- models are derived from JERS and ERS with fixed-length 50-meter pixels as well as from SRTM with resampled fixed-length 25-meter pixels. All three models represent different wavelengths and system geometries. The models from cartographic sources base on maps at 1:200,000 (fixed-length 50-meter pixels) and 1:1,000,000 (GTOPO30, fixed-angle 30 arcseconds pixels) scale. The testsites are situated on Lake Baikal, Russia, within the framework of the SIBERIA project. The DEM data contain errors of three types: blunders, which are removed prior to entry in the data set; systematic errors, which follow some fixed system-specific pattern; and random errors, which are of random nature and are completely unpredictable. The horizontal and vertical discretization process generates artifical dams, pits and flats. These local differences among DEM grid cells are analyzed to compute accurate slopes, flow directions and other hydrographic parameters. The relative vertical accuracy, rather than the absolute accuracy, determines the quality of such parameters derived from local differencing computations.

The first phase of analysis focuses on the absolute and relative accuracy in horizontal and vertical dimensions of the DEM data. System-specific errors are described. The next step of calculating flow grids, includes depression filling, indication of flow direction for each cell and computation of flow accumulation, a value equal to the total number of cells that drain to it. Strahler stream orders are used to measure structural complexity of the river networks and classifying the major and minor tributaries for the different DEM's. The higher resoluted SRTM data also provides better identification of the heads of Strahler-first-order channels known as sources.

PINE FOREST UNDERSTOREY SENSING WITH ERS-2 SAR IMAGERY

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ABSTRACT

Remote sensing forest studies have mainly concentrated on the overstorey component, continuing to provide innovative approaches, particularly for the quantitative estimation of forest parameters. However, the understorey stratum has not yet received a deserved attention within this technological domain.

On one hand, the understorey has a relevant role both in the structure and functioning of forests, e.g. by being an important layer for wildlife habitats, limiting erosion hazards or providing fuel for fires. On the other hand, the inherent advantages of remote sensing tools can provide new inputs for its monitoring and characterisation, and should be further explored.

Though few, some recent contributions in the optical field have already selected this subject as study object and provided interesting results. However, SAR imagery has remained outside the satellite data choices. A priori, limitation and risks can be highlighted when approaching the use of spaceborne SAR data to understorey studies, but this type of imagery can be sensitive to this forest component, under certain circumstances. The known advantages presented by radar images when compared to optical data - independent of solar light, cloud cover or hazy atmospheric conditions, and increased penetration capabilities - have justified the start of a pathfinder project dedicated to this issue.

The objective of the present document is to explain the strategy followed to dig in the analysis of the understorey forest stratum based on ERS-2 SAR imagery and present the results achieved so far. Maritime pine (Pinus pinaster, Aiton) stands located in central Portugal were used as test areas and ground truth data was obtained through other research projects (Institutional collaboration and synergy).

USING L-BAND POLARIMETRIC INTERFEROMETRIC DATA TO RETRIEVE ESTIMATES OF FOREST BIOMASS DENSITY

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ABSTRACT

Previous use of SAR to retrieve specific forest characteristics has been limited by saturation of the backscatter over densely forested areas. The backscatter is also affected by the structure of the forest canopy making mixed forests especially difficult to characterize. A number of current airborne, as well as the next generation spaceborne sensors, hope to extend these limits using fully polarimetric L-band sensors. This will allow retrievals of forest parameters up to greater densities and additionally permit an interpretation of the scattering mechanisms through polarimetric analysis. Another source of information will be provided by interfering different polarimetric combinations, where repeat pass systems acquire suitable data, and generating coherence images over the forested areas.

This paper presents a preliminary analysis of two L-band polarimetric data sets from forest sites. The first consists of data from the SIR-C mission (Oct 1994) over Duke Forest, N. Carolina, USA and the second of L-Band polarimetric interferometric (PolInSAR) data from the BNSC SHAC (SAR and Hyper-spectral) airborne mission over Thetford Forest, East Anglia, UK. A Landsat TM image covering Duke Forest, ground DEM and forest database of Thetford Forest were acquired for ground truth. Each PolInSAR image was co-registered and geocoded to the ground database. Specific scattering combinations (HH, HV and VV) were derived from the full scattering matrix and used to derive coherence images between each polarization pair (HH+HH, HV+HV and VV+VV).

Polarimetric decomposition using the Freeman - Durden model shows volume scatter to be the dominant form of scattering over dense forest (typically > 50 t/ha). Single bounce interactions appear to become less significant as biomass density increases. Coherence over the forested areas remains relatively high even over high biomass density stands and the greatest dynamic range was observed in the HV+HV case where the majority of the scattering events occur as volume scatter within the forest canopy. Classification results were increased in both the number of classes and accuracy of class determination using the combined polarimetric and interferometric data. Therefore, by using all the information available from a typical SAR image, that is the backscatter, at different polarizations and phase coherence, we can greatly increase the accuracy of the classification results over higher biomass density forests.

PROCESSING AND INTEGRATION OF MULTISENSOR AND MULTIDATE SATELLITE DATA FOR FOREST MANAGEMENT MAPPING IN GABON (APPLICATION TO THE FIRST FOREST ZONE)

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ABSTRACT

The Central African region hosts the world's second largest tropical forest, which constitute a source of wealth: biological, ecological, as well as economic, for the different countries of the region. Given that it is almost impossible to obtain a recent and cloud-free coverage of the region with optical images, and that it is difficult to perform an aerial survey with reasonable delay and cost, radar satellites with their all-weather capabilities has appeared as an interesting source of data to be explored when carrying out thematic mapping. Mapping for forest management has long been carried out using aerial photographs. Satellite images have been used mainly as a complement, like to give an overall view of the study area or to solve some of the geometric problems of map projections. The limits of these data, however, have not been thoroughly explored. The subject of our work is therefore the assessment of the potential of optical and radar satellite images for forest mapping and management, with the objective of evaluating the contribution of multisensor and multidate images in the context of tropical forest mapping. The study is based on data provided by operational satellites (ERS 1 and 2, RADARSAT, SPOT, Landsat) which will be used in preparation of future satellite data such as those of ENVISAT. The methodology used is based on the comparison of manual and automatic approaches. On three test sites, computer-aided photointerpretation, as well as supervised and unsupervised numerical classification have been carried out in order to extract thematic information. GIS tools were then used to perform integration of results with existing vegetation maps so as to assess the processing made. The results show that both approaches give good results when the data include optical images. Also, the manual approach seems well suited in presence of radar images whose speckle noise, even when kept to a minimum is still a handicap. The work will then be focused on the segmentation and classification methods applied to multisource data and on the contribution of radar interferometry data for the caracterization of foret cover. Images provided by:Projet OIBT PD 8/95 Rev.1 (F). Stratification, cartographie et inventaire multi-sourcesen vue de l'aménagement de la première zone forestière du Gabon, phase 1 ;Projet Forêts et Environnement au Gabon (sur financement banque mondiale)Projet ENVISAT ID 539 (demande d'images ERS interférométriques en cours).

USEFULNESS OF ERS COHERENCE TIME SERIES FOR MONITORING THE VEGETATION CYCLE OF A MIXED TEMPERATE FOREST

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ABSTRACT

Within the frame of the EMAC campaign, numerous spaceborne remote sensing data including ERS-1/2 intensity images and ERS Tandem couples have been collected over the Fontainebleau forest during the period 1994-1997. The seasonal dynamics of this mixed deciduous forest has been studied using backscattering coefficients time series but no indication on the leafy period was retrieved. This study aims to investigate the capability of INSAR time series for detecting the vegetation cycle of a deciduous forest.

Prior to the analysis, a normalization process has to be implemented in order to compare absolute values of degrees of coherence computed in different acquisition conditions. Using the interferometric software Diapason developed at CNES, we processed 11 ERS tandem couples, acquired over the period of August 95 to July 1996.

The temporal variation of the degree of coherence versus foliage biomass is analyzed for a beech stand during the 1996 vegetation cycle. The interferometric profile is also compared to the s° profile. With the assistance of a coherent model, the seasonal variations of the degree of coherence are simulated and finally interpreted.

MAPPING CHINA FOREST WITH ERS SAR TANDEM DATA

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ABSTRACT

The need to monitor forest is dramatically increasing in china, particularly after the introduction of new laws against deforestation. The well known potential of ERS SAR to distinguish forest from non forest areas and the interest of the Chinese authorities to perform forest monitoring based on remote sensing data have motivated the co-operation between ESA and the China Ministry of Science and Technology (MOST) in this area. This interest found its expression in the MACFERST project, where the Chinese Institute of Forestry and ESRIN work jointly to generate a forest cover map over China. To generate this forest cover map of the whole Chinese territory, ERS SAR Interferometric Land Use images (ILU) at a quick look level are used. The project is split in four phases, each one covering a quarter of China, starting with the North-Eastern provinces. Considering the size of the area to be covered, the use of medium resolution images becomes mandatory to achieve the result in a reasonable time. The generation of a global large scale forest map requires solving problems such as the mosaicking of coherence from different InSAR pairs in overlapping areas and the adaptation of the classification algorithm as a function of the climatic zones. This paper presents the work carried out from the identification of the most adequate ERS SAR images to the selection of appropriated classification algorithms, including the strategy adopted to resolve problems related to seasonal and geographical differences affecting the radar backscattering.

FIRE DAMAGE ASSESSMENT USING ERS-SAR AND NOAA-AVHRR DATA IN EASTKALIMANTAN, INDONESIA

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ABSTRACT

This study is to examine the application of remote sensing (using ERS.SAR.PRI images and NOAA-AVHRR data) and geographic information system for fire damage assessment and to evaluate the accuracy for this study. Eleven ERS.SAR.PRI images and a set of NOAA-AVHRR data, dated just before, during and just after the fire event of 1997/1998 have been used. The study area was located in East Kalimantan, Indonesia near to Tropenbos research station, the Wanariset - Samboja. Extensive fieldcheck was also conducted to collect field information about landcover, landuse, fire damage and when the fire was happening

Adaptive filtering by Gamma Filter and multi-temporal Segmentation were the main technique applied dealing with the reduction of speckle. The maximum likelihood algorithm was used for supervised classification in ENVI (The Environment for Visualising Images). Error matrices, KAPPA analyses were the method applied in accuracy assessment. ERS-Segmentation gave better result than ERS-Filtered, with an overall accuracy of around 82 0.000000 or Error Matrix and around 79 - 8614672221018231831766519901757397219953651233680090158744268556034160937902702961623596653397107735769834952080867831384650556713927811960334366125763585583258053415457500171737201695761589337872230549536029096935150010614415360.000000 or Kappa analysis. Fire damage map was the final result of this study, which visualises the distribution of burnt areas and their extents/ areas.

Further research is needed to improve the methodology to obtain more accurate results as a practical and applicable methodology for fire damage monitoring.

ERS COHERENCE AND SLC IMAGES IN FOREST CHARACTERISATION

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ABSTRACT

The coherence of an ERS-1/ERS-2 tandem pair of winter conditions in Finland was studied. Relationships between the coherence and various boreal forest parameters were derived on the basis of standwise (partly pointwise) ground measurements of roughly 1000 stands. The results were compared with a similar study carried out in Sweden (Fransson et al., 1999) using a coherence pair of the same days. Although the stand structure in the Finnish test site is more heterogeneous the results support clearly the results obtained in Sweden: many forest parameters (diameter, height, stem volume, age) are correlated with the coherence. The shape of the dependence does not markedly change if only the 159 stands larger than 5 ha or the 417 stands larger than 2 ha are taken into account. Small stands were excluded because of possible geolocation errors and the large percentage of border areas, where the forest is systematically different from the bulk forest. The detection of clear cuttings was studied both using coherence images and multitemporal ERS SLC images. The ground truth for the clear cuttings was an optical mosaic with a pixel size of 1 m. Clear cuttings of various ages were easily identified in the coherence image. In the ERS SLC-images it was not trivial to distinguish all the clear cuttings, although some of them could be found. One reason is that many of the clear cuttings are in areas of quite rough topography with rocks and cobble deposit. Another reason is that after the tree removal many of the clear cuttings have been tilled with quite a wide spacing. In the optical mosaic, stripes with a spacing of about 5 m are visible in some clear cuttings. So in many cases there was a natural cause to cancel out the decrease of backscattering due to the clearance of trees.

FIRE IMPACT ASSESSMENT IN INDONESIAN RAINFORESTS WITH ERS AND JERS SAR DATA

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ABSTRACT

During the large El-Nino petiod in 1997 to 1998, Indonesia has experienced one of the greatest fire disaster ever observed in a tropical rainforest environment. Following this event ESA and NASDA decided to set up a cooperation project to compare and combine the capabilities of the two SAR satellite sensors systems ERS-1/2 and JERS-1 aiming at an in depth analysis of this disaster.

It was investigated whether these SAR systems can provide high resolution data on the pre-fire vegetation cover, the extent of the fire affected area and the damage to the vegetation. Different processing techniques were applied: 1.) Monotemporal approach deploying texture analysis to identify different vegetation types. 2.) Multitemporal ERS and JERS SAR images were produced from images acquired before and after the fire event. 3.) ERS SAR coherence images were produced from ERS-1 and ERS-2 tandem data. The results of the evaluation were quantitatively compared to a Landsat TM scene acquired during the fires, NOAA-AVHRR hotspot data and extensive field and aerial surveys.

Similar vegetation types were identified in ERS and JERS pre-fire images based on the structure of the forest canopy and moisture content of the leaves. Six classes could be discriminated, there was no synergy between ERS and JERS in this area. Burnt scar detection was based on changes in SAR backscatter when fire had affected vegetation. Burnt scars could be identified with high accuracy in multitemporal SAR images acquired during dry weather, a condition which prevailed during the fires. Furthermore it was possible to estimate the amount of dead, uncombusted biomass thus providing important information on greenhouse gas emission and future fire risk.

Meteorological conditions strongly influenced radar backscatter. An evaluation of orbits acquired during rainy conditions showed that it was difficult to discriminate burnt from unburnt areas in both ERS and JERS images. Similar problems occurred with Interferometric Land Use (ILU) images produced from ERS-1/2 tandem orbits. Forest/non-forest discrimination became unreliable in ILU images acquired during rainy conditions.

UTILIZATION OF RADAR REMOTE SENSING AND TEXTURE ANALYSIS FOR URBAN CARTOGRAPHY IN CAMEROON: APPLICATION TO YAOUNDÉ CITY

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ABSTRACT

The goal of this study is to produce a recent cartography of the city of Yaounde in Cameroon, by using a SAR ERS-2 image acquired in 1999. The Yaounde City is growing fast and the urban community is interested in acquiring recent maps. The actual maps are too old and the means to get new ones are very expensive. Radar remote sensing is a very useful technique allowing to produce recent maps with little time delay. Another advantage granted by radar imagery is that, in this particular area clouds are frequently planning above the sky, making acquisition of images very difficult with the optical sensors. Some studies have already been done with radar remote sensing images in Cameroon, particularly in the area of coastal zones mapping. We are now interested in producing maps in some particular urban areas. We started with the area of Kribi, and the study was presented at the last ESA symposium in Liege. We now focus our attention to the city of Yaounde. Many parameters and methods of texture analysis are used here to reach our goal. Texture features issued from the gray level co-occurrence matrix are used, as well as those issued from the run length gray level method. A rigorous selection of the parameters has been done by the sequential progressive and regressive selection method, in order to determine the parameters granting the best rate of textural classification. The norms of Chernoff and Battacharya, and the transformed divergence are conjointly used to evaluate the classes distinction. The multiplicity of texture features and parameters selection methods allow a best choice, and results to a cartography very close to the ground truth.

QUANTITATIVE ANALYSIS OF TEMPORAL ESR INSAR DATA OVER THE CITY OF GRAZ

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ABSTRACT

Results of a quantitative analysis of temporal SAR interferometric (InSAR) derived products, namely digital terrain models (DTM), correlation, and amplitude images for cartographic and thematic mapping of the area around the city of Graz in Austria are presented.

ERS-1/2 single look complex (SLC) image data sets acquired over the period August 1995 to May 1999 were compiled and interferometrically processed. The InSAR generated DTMs and the contour lines digitised reference DTM were converted to interferograms in the ERS slant range geometry and compared to the original interferograms. Differences between the original and simulated interferograms were observed, which were attributed to erroneous phase unwrapping and forest heights.

The fusion of the temporal DTMs and the error maps resulted in a detailed high quality DTM with rms. of about 8 m. The comparison of the high quality DTM with the reference one enabled the estimation of heights of some spatially large urban features such as the Graz Airport and some factory buildings.

In addition, the temporal correlation and amplitude images were fused in the RGB colour coding and the seasonal changes were observed. Forested area, urban targets, water bodies, agricultural, and stable fields were clearly detectable between the images acquired in May and August. It was also observed that some shadow areas were of high coherency and classify as stable fields; whereas, overlay regions classify as forest. The results of the RGB image composite agrees with a reference thematic map of the area generated from Landsat TM data.

STATISTICAL ANALYSIS AND NEURO-FUZZY CLASSIFICATION OF POLARIMETRIC SAR IMAGES OF URBAN AREAS

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ABSTRACT

The use of radar sensors to analyze urban environments has been already widely established in technical literature, even if it is somehow limited by the coarse ground resolution and the limited information contained in single channel images with a fixed off-nadir angle available from commercial satellite sensors. For instance, ERS data have been considered to individuate built-up areas or to describe urbanized texture patterns, but no attempt has been made to provide information about more precise environments, without considering at the same time data coming from multispetral/hyperspectral sen-sors. This paper describes first a detailed statistical analysis of SAR images of urban areas, which aims at investigating the impact of the different polarimetric channels and the different incidence angles on the probability density function (PDF) of the back-scattered intensity. This analysis is be the basis for optimised segmentation and classification of ENVISAT SAR images that fully exploits the statistic of the data. In preparation for the ENVISAT data, a set of SIR-C/X-SAR images of Pavia (Italy) is considered. A number of different areas are identified inside Pavia, which are of potential interest for automatic classification and monitoring. Their PDF and the charts of their moments are separately characterised as functions of polarimetric channels and angles of incidence, and compared. Moreover, the correlation between the different images of each area is studied. This allows us to devise few optimised discriminants to classify the considered areas with statistical methods. Preliminary results of this classification are shown and compared to the classifications obtained with a neural and/or fuzzy approach of the same data set. To this aim, a Fuzzy C-Means approach or a fuzzy ARTMAP spectral/spatial classification tools have been developed and used. Since these algorithms are suitable to jointly consider data coming from different sensors, we compare the results also with classifications obtained considering aerial photographs (suitably spatially degraded) of the same area.

USE OF MULTITEMPORAL ERS DATA FOR MONITORING OF LANDCOVER CHANGE IN SAHELIAN REGIONS. THE EXEMPLE OF THE DELTA OF THE NIGER RIVER (MALI)

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ABSTRACT

In the Sahelian zone, changes of land cover may not be considered only as a consequence of inter seasonal change. Global climatic changes and mainly the decrease of pluviometry between the 70 and the 90 must also be taken into account to explain annual changes. In the inland delta of the Niger, changes in the land cover is due to pre-flood and post flood hydrological conditions of the Niger and its tributaries. In order to observe with accuracy annual changes as well as seasonal one, we have selected a set of ERS images in the region of Mopti, taken in the pre-flood and post flood periods between 1995 and 1996. We first have reduced the speckle on ERS images by means of appropriate connected filters in order to use edge and region detection for change mapping. Actually, we had two kind of objectives, that is, on one hand to map some invariant patterns and on the other hand to detect changes in the landscape. For a given season, we may consider that land patters such as ridges or plateaus are invariant structures. These structures are detected by means of edge detection methods, applied to multidate data for a given season. Change detection between dry and wet season are then analysed by combining region extraction, obtained with a flat zone approach, with colour making images by RGB techniques from both dates. On the resulting images, major variations in the back scattering of landscape units will appear as coloured flat zones: major decrease of backscatter appears in magenta as major increasing appears in green. With the help of ground truth and aerial photographs of some well-known areas, the coloured zones are interpreted whether as flood, whether as change in the vegetation cover. The same proceeding is then used to detect annual changes from images of different years and of the same season. The results are then superimposed on corresponding maps of the hydrographical network obtained by edge extraction.

HISTORICAL LAND TRANSFORMATION ANALYSIS FOR GEOGRAPHIC HAZARD EVALUATION IN THE ITALIAN COUNTRY

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ABSTRACT

Examples of historical analyses referred to the Italian country are presented. Satellite imagines (ERS 1-2) are correlated with significant morphologic features. Archeological areas, historical land use, hydrological and geological (sismic and volcanic) evidences are analysed. Particular cases of ancient latium (Roman area) are reported: Aniene valley and Ardea coast. In the Aniene valley the verify historical information are demonstration in the evidence.

ON THE USE OF ERS INSAR AND MULTITEMPORAL DATA FOR ECOLOGICAL MONITORING OF THE CHERNOBYL AREA

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ABSTRACT

Study of the ecological situation in the area of prohibited access around the Chernobyl nuclear power plant with a use of ERS SAR in our AO3-246 project is concentrated on the monitoring of the coniferous Forests State - the most sensitive component of the vegetation covers to the radioactive pollution. For our analysis we have selected a series of ERS SAR archival data for the time interval of 1992-1996, obtained at different meteorological conditions and in different seasons of the year. Among the data used in the study are set of 16 ERS PRI scenes and ERS INSAR SLCI pair from a tandem mission. The combination of ERS resulted in multitemporal maps, coherence and DEM for the area of study - the 30 km area around the nuclear power station. The multitemporal maps mentioned above allowed us to classify the next types of the surfaces - deciduous and coniferous forests located on the regular and over moistened soils, open areas with various extent of small-scale roughness and moisture, the area of dry forest on the western trace of nuclear fallout happened in the year 1986 and vast areas of forest fires on the border of the area of prohibited access occured during the period 1986-1992. The ERS INSAR coherence and DEM data allowed to improve classification based on the level of coherence and the altitude of the scattering layers. The use of ERS data in a form of mulritemporal images and INSAR coherence demonstrated applicability of C-band SAR data for forest studies.

AN INVERSION MODEL OF ERS2 RADAR DATA TO RETRIEVE WILD VEGETATION COVER IN SEMI-ARID REGIONS

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ABSTRACT

During the last years, a large number of studies have been achieved to protect water resources and to study erosion in semi-arid regions in particular in the North of Africa. The new physically based models incorporate Geophysical Information System. This incorporation facilitates applications in large catchments and allows remotely sensed to be used. A considerable effort has been devoted to study the sensitivity of radar response over natural surfaces in agricultural sites. For hydrology applications, studies have been focused in particular to retrieve soil moisture and roughness indispensable to describe the hydrological cycle of water. Many other works have been interested in the characterisation of vegetation cover. These models have been often used for agricultural wet watersheds. Our objective, in this study, is to go more in the description of the radar potential to characterise this type of regions and particularly wild vegetation cover. During 1998-1999, a large number of ERS2 images has been taken over Kairouan site in the center of Tunisia. The climate is semi-arid with a run fall between 150 and 350 mm per year. In plain, there is a vegetation type adapted to weak precipitation with a dispersed wild and short vegetation over a very smooth surface. A model is proposed in this paper to retrieve the vegetation cover over soil surface from radar signal for this semi-arid region. Vegetation in these regions is characterised by the presence of clumps, which cover a part of soil surface. Our model described the relation between this covered percentage of surface and radar signal. Soil surface is taken from numerical vertical photos of test fields in the studied site. From these photos, a classification is done to retrieve vegetation percentage for each one. A high correlation is observed between backscattering measure and vegetation percentage. This behaviour is studied for three dates for which moisture is the same in all the site. They correspond to the end of summer and also to April. A model is then developed to characterise theoretically the relation between vegetation cover and radar signal. The comparison between simulated radar signal and real radar data over different test fields shows a very good agreement. A classification is then done over the site to map the vegetation percentage.

BIOMASS MONITORING WITH SAR

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ABSTRACT

By mapping the aboveground woody biomass in northern boreal forests and the distribution and accumulation of secondary regenerating forests in the tropics, along with the vegetation in the savannah, biomass measurements will provide insight into the size of the carbon sink. The carbon fluxes however are related to changes in the carbon sink and to green biomass activity and therefore monitoring of vegetation changes and activity are needed. By monitoring the changes in above ground woody biomass and estimation of total biomass and its temporal variability, such a mission will contribute significantly to the understanding of the carbon cycle. Furthermore biomass information is also very important to the economies of various countries both in the tropics and in boreal climates. Airborne measurements and in-situ ground campaigns cannot provide a homogeneous and frequently updated data set on a global scale, which is collected independent of national interests. Radar backscatter measurements have proven to be positively correlated with aboveground biomass and this correlation increases with the wavelength. Biomass retrieval algorithms have been developed for airborne P-band data collected over both boreal and tropical forests. Radar measurements are insensitive to cloud cover and can be operated during day and night. Hence a spaceborne radar system, operating at low frequency, will permit the measurement, mapping, and understanding of these parameters with a spatial and temporal resolution suitable for modelling ecosystem processes at regional, continental, and global scales. BioSAR will be a stand-alone mission such that its objective can be met without any additional data, but synergy is expected with using other radar and optical sensors. The main geophysical parameters, which are estimated from the polarimetric radar backscatter measurements performed by this mission, are biomass, flooding condition, and land cover class. Based on experience with airborne campaigns, a polarimetric low frequency SAR has been shown to be the most appropriate instrument to this purpose. The design philosophy behind a P-band spaceborne SAR is based on small size and low-cost, which should be achieved by using available space qualified hardware components. Also a (relative) small antenna is foreseen, for which an adequate performance will be shown. By merging user and scientific requirements with technical constrains the scenario of a SAR instrument has been investigated. It operates as a normal side-looking synthetic aperture radar and images a 50-km swath positioned such that the incidence angle at mid swath is 23 degrees, which also coincide with the ERS AMI SAR swath and the ASAR IS2 swath. This paper will concentrate on the concept of the instrument, the SAR (antenna) design and the potential applications.

CONVERSION OF ATSR-2 SKIN SEA SURFACE TEMPERATURES TO BULK TEMPERATURE FOR USE IN CLIMATE STUDIES.

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ABSTRACT

The high accuracy and almost ten year time period of skin Sea Surface Temperatures retrieved from the Along Track Scanning Radiometer (ATSR) series of instruments make them useful observations for climate studies. However, the retrieved satellite skin observations need to be converted to an observation of Bulk Sea Surface Temperature (SST) at a depth of around one metre in order to be consistent with other SST observations used for climate studies such as from ships and buoys. The conversion of skin SST to bulk SST were processed using 3.5 years worth of ATSR-2 cloud-cleared skin SSTs (averaged at a resolution of 0.5 degrees), using a skin to bulk temperature algorithm developed at The Met. Office (UK). The algorithm is based on the physical Fairall model and covers all wind speed ranges. The near surface diurnal thermocline is also modelled with the aim of rejecting those observations thought to have a strong surface thermocline. This poster presents the results from comparisons of bulk SST with climate datasets containing SSTs at 1 and 5 degrees resolution. The datasets are maintained by the Hadley Centre at The Met. Office, and contain SST observations gathered from a combination of data including in-situ and Advanced Very High-Resolution Radiometer (AVHRR) observations. Additionally, we investigate the effect of the skin to bulk conversion and the final bulk product when different SST retrieval schemes are used.

ATSR-SST IN ENCLOSED BASINS - A CASE STUDY IN THE BALTIC SEA

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ABSTRACT

High resolution SST data from the ERS-1,2 ATSR instrument has been used to derive composit images at weekly to monthly time-scales. The technique and results are presented from this AO-3 project. Presently the data covers one year - 1997. The product is developed to meet the needs of SST-users and in particular for prognostic models in oceanography and meteorology.

SEA SURFACE TEMPERATURE AND CHLOROPHYLL-A CORRELATION INDEX: SEASONAL VARIABILITY ON IBERIAN MARGIN

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ABSTRACT

The research objective is to find a correlation index between sea surface temperature and chlorophyll-a on the north-west of the Iberian Margin. The self-edge is characterised by climatology driven intense seasonal upwelling between April and August along the entire coastline, revealing also frequent alternations between upwelling events and relaxation periods. Surface water in upwelling regions reflects a chronological display, with newer water nearer the upwelling source becoming progressively modified with age as it moves away from the source. This modification occurs as a result of its exposure to light and the ensuing biological production.

Satellite-derived chlorophyll-a from SeaWiFS data, which will be provided by the Remote Sensing Group at Plymouth Marine Laboratory and will be compared with sea surface temperature from AVHRR data processed by the Remote Sensing Laboratory at the University of Vigo, in function to implement "the state of the art of upwelling understanding". There will be a strong positive correlation between sea surface temperature and satellite-derived chlorophyll-a. The studied data will allow us to describe and quantify the key factors regulating primary production and the short-time-scale variability of this ecosystem during this important event and to develop present algorithms for red tides prediction. Tracking an upwelling event may prove possible with the higher resolution of MERIS and development of algorithms that may be especially useful for harmful bloom species. ENVISAT technology involving new sensors is especially attractive as a sampling tool and must be conducted to a better understood.

KEYWORDS: Iberian Margin, satellite-derived data (chlorophyll-a, SST), upwelling, primary production.

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ACE: A NEW 30" GDEM INCORPORATING SATELLITE ALTIMETER DERIVED HEIGHTS

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ABSTRACT

A new Global Digital Elevation Model has been generated at 30" resolution by combining the best available ground truth with a unique global database of satellite altimeter derived heights. This model, ACE (Altimeter Corrected Elevations) demonstrates radically improved spatial accuracy and resolution over large parts of the globe, in particular over Africa and South America. The independent altimeter based dataset, which contains over 100 million individual height estimates, has enabled the identification and correction of gross errors in individual ground truth datasets. Source data of low spatial resolution have been replaced with greatly improved altimeter generated surfaces. Additionally, the use of this satellite derived near-global dataset of very high vertical accuracy, referenced to a single datum, has allowed the identification, measurement and correction of the vertical offsets between adjacent tiles of DTED data, widely reported by users of previous models. The result is a model in which a significant proportion of the earth's land surface is represented by a completely new dataset: this is especially true of areas for which previous models have drawn on Digital Chart of the World. Adjoining ground based datasets of good quality have also been adjusted for vertical and horizontal misplacement. The detailed assessment of dataset quality undertaken as part of the programme to create the ACE GDEM has allowed the inclusion of a unique additional information matrix: a data quality indicator is being constructed for every land pixel of ACE, together with detailed source information. This will allow the user, for the first time, to make an informed judgement on expected performance of the ACE GDEM for the desired application. The ACE GDEM is now in beta release, undergoing validation with selected end users prior to full release at the end of this year.

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ABSTRACT

Since 1991 CERSAT has been the French processing and archiving facility for the low bit rate processing of ERS1 and ERS2 radar altimeter and scatterometer. Since 1996 CERSAT has extended its activities to other scatterometers (NSCAT, QUIKSCAT launched by NASA), and also started providing the users with value added products such as the Mean WIND FIELD Atlas and the SEA-ICE atlas derived from ERS and NSCAT scatterometers. These atlases are respectively distributed to 1800 and 200 laboratories.

In 1996 we also started collocation activities providing the users with collocated database between all the sensors archived at IFREMER (ERS 1 and ERS2 radar altimeter and scatterometers, NSCAT and Quikscat scatterometers, SSM/I Radiometer for F10/F11/F13/F14 and Topex). The news sensors should be rapidly integrated in the system after their launch On the stand CERSAT will present all these data, its WWW server, its collocation database, and the future developments for the new sensors such as Envisat, SeaWinds, METOP.

A VISUAL ARCHIVE SYSTEM OF SEA ICE PARAMETERS DERIVED FROM SYNERGISTIC ATSR, AVHRR, SSMI AND ERS-1 SAR DATA

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ABSTRACT

Layers of information derived from coincident and co-located data of Arctic sea ice, acquired from different sensors, are presented within a display and browsing system that has unique users interactive features. Sea ice surface parameters are calculated from the following sensors: (1) surface temperature from the IR channels of AVHRR and ATSR independently; (2) surface albedo from the AVHRR visible channels, (3) thickness of thin ice (recently growing) from integration of SSM/I and AVHRR, and (4) major ice types (thin, first-year, and multi-year) from ERS-2 SAR. All parameters along with the original observation parameters from each sensor are combined in a visual display system in which each parameter (or a group of observation parameters) is presented as a layer of information. The entire information hierarchy can be displayed, browsed and animated in a very fast manner. The data from all sensors are co-located using a technique that defines the contours of the footprint from a coarse-resolution sensor (such as SSMI or AVHRR or ATSR) and overlays it on an image from a finer resolution sensor. These contours can also be displayed to examine the heterogeneity of ground cover within a footprint of a coarse-resolution cell using the coincident samples from the corresponding fine-resolution cell. The thermal history of Arctic sea ice in the study region will be presented. This approach allows the user to absorb huge amount of imagery data in an intuitive way.

DESIGN OF THE NETHERLANDS SCIAMACHY DATA CENTER

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ABSTRACT

The primary goal of the Netherlands SCIAMACHY Data Center (NL-SCIA-DC) is to provide data services and processing facilities to Dutch users of SCIAMACHY data beyond those offered by the ENVISAT ground segment and German D-PAC. The NL-SCIA-DC will offer data services for GOME and SCIAMACHY data. In the future more instrument data may be added to the data center. As the NL-SCIA-DC is a joint effort of KNMI and SRON, the data center will be distributed over these two institutes.

The need for a NL-SCIA-DC came from the atmospheric researchers in the Netherlands who needed faster access and more flexibility in accessing and processing GOME data. From experience in previous projects the need for close cooperation with the future users was recognized. Therefore the users do not only define the User Requirements, but also need to be actively involved in the development of the NL-SCIA-DC. The users got access to development versions of the data center, thus allowing them to evaluate their requirements and allowing new requirements to be incorporated in the design. For these reasons it has been decided to apply an evolutionary life cycle approach for the development of the NL-SCIA-DC. The evolutionary approach consists of multiple waterfall cycles with an overlap in development. All documents and project plans are made according the ESA PSS-05-lite standard.

While the described development was based on GOME data and data processing, it is intended to operate these facilities from 2001 onward and continue the development with new data from SCIAMACHY on ENVISAT.

Features: * Access the NL-SCIA-DC through the Internet at any place on any computer.
* Interactive access to satellite data located at the NL-SCIA-DC. * Generic, dynamic and platform independent GUI. * Three data selecting mechanisms:1. Catalogue search enables file level search for data. 2. Query search enables data selection on meta data parameters. 3. Browse search enables a graphical entry to select data. * Downloading of selected data. * (Re) processing of selected data. * User settings are saved and used in the next session. * Distributed architecture not visible for the user. * Facilities to test new data processors.

ERS SAR VIEWS THE TROPICAL AND SUBTROPICAL OCEAN: A NEW WEBSITE

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ABSTRACT

ERS SAR images acquired over mid-latitude ocean areas have been used quite extensively to study mesoscale phenomena in the ocean and in the marine atmospheric boundary layer, but not so in tropical and subtropical ocean areas. In order to improve this situation the European Space Agency (ESA) has funded a project to set up a website aimed at informing a broad readership about the potential of ERS SAR imagery for studying these phenomena also in low latitude ocean areas. We have searched the archives at ESA as well as at the Singapore and the Taiwan ERS ground stations for ERS SAR images showing pronounced radar signatures of mesoscale oceanic and atmospheric phenomena like, e.g., oceanic internal waves, ocean current fronts, underwater bottom topography, river plumes, oil pollution, atmospheric internal waves, coastal wind fields, atmospheric boundary layer rolls, and tropical rain cells. From these images we have selected more than 200 ERS SAR images and put them on the website. For most of them we have added supporting data like NOAA AVHRR images, SPOT images, bathymetric maps, or weather maps and have added comments on how geophysical parameters can be extracted from them. In the presentation, which requires an LCD projector, the most spectacular ERS SAR images together with supporting data will be presented and their usefulness in scientific investigations will be pointed out.

ENVIVIEW: AN ENVISAT PRODUCT TOOL

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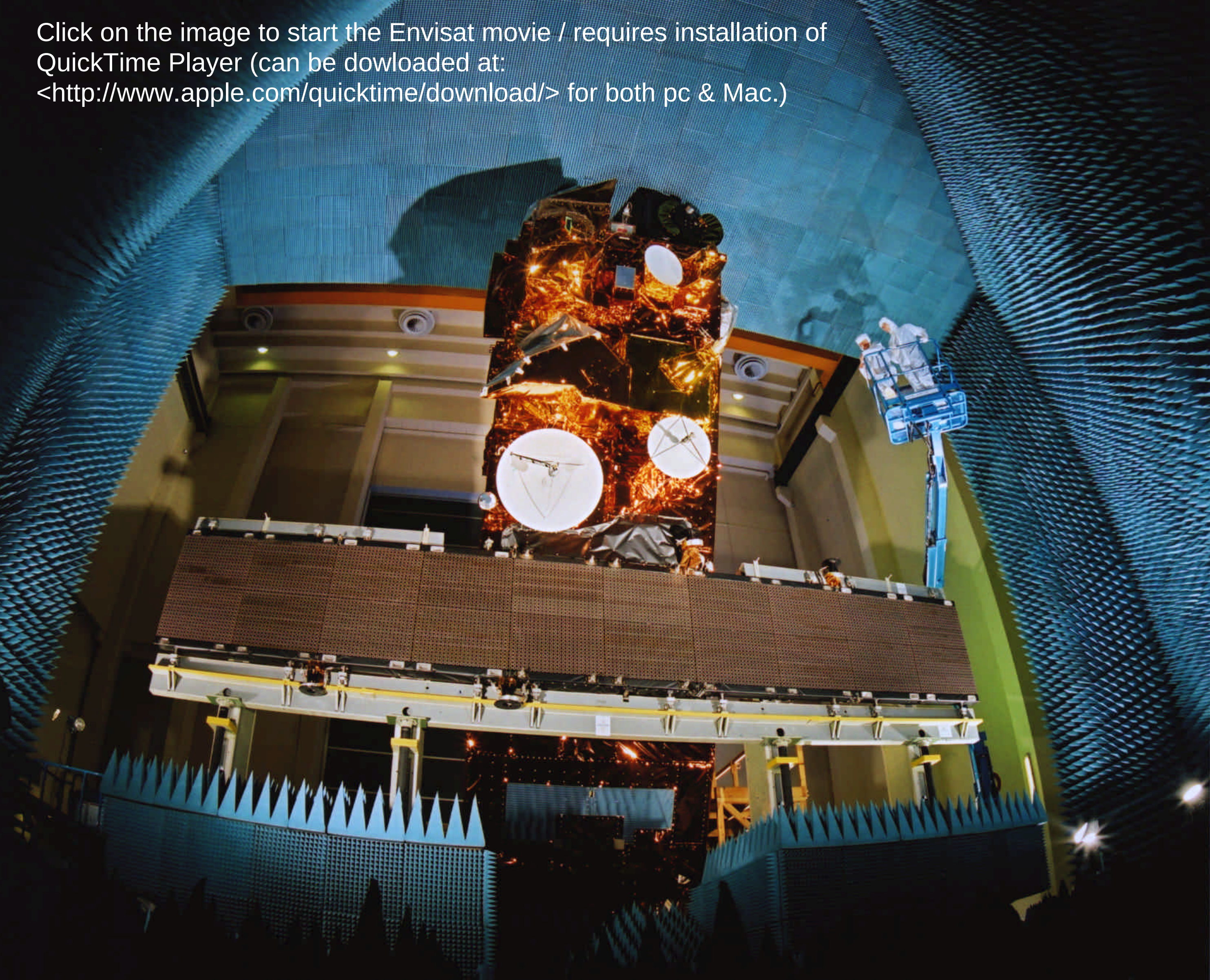
ABSTRACT

The Envisat mission, to be launched next year, is the largest European remote-sensing mission ever flown. It will deliver a very large number of data products from its 10 instruments. The Envisat products will use a specific data format, where each product is orbit based, binary encoded and contains several geophysical quantities in the same product file. With the aim of improving and widening the access to the Envisat products, the European Space Agency is developing a product tool (called EnviView) which is characterised by the following main properties: it is platform independent (developed in Java); it can access any Envisat product; it can display the content of any field in the product (image or graphs); it can be run in manual or batch mode; it can display the value of any field in any product along with its format definition and with its scientific definition; it includes the product handbook of all Envisat products. In addition, EnviView can convert part or all of an Envisat product into a number of different formats, such as HDF. Users who are already familiar with HDF products or that have already developed application software for HDF products can use EnviView to bring the Envisat products directly into their working environment. EnviView can also be used to allow immediate access to the Envisat products by all those commercial software packages, which are able to read and manipulate HDF files.

Click on the image to start the Envisat movie / requires installation of QuickTime Player (can be dowloaded at: <http://www.apple.com/quicktime/download/> for both pc & Mac.)



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