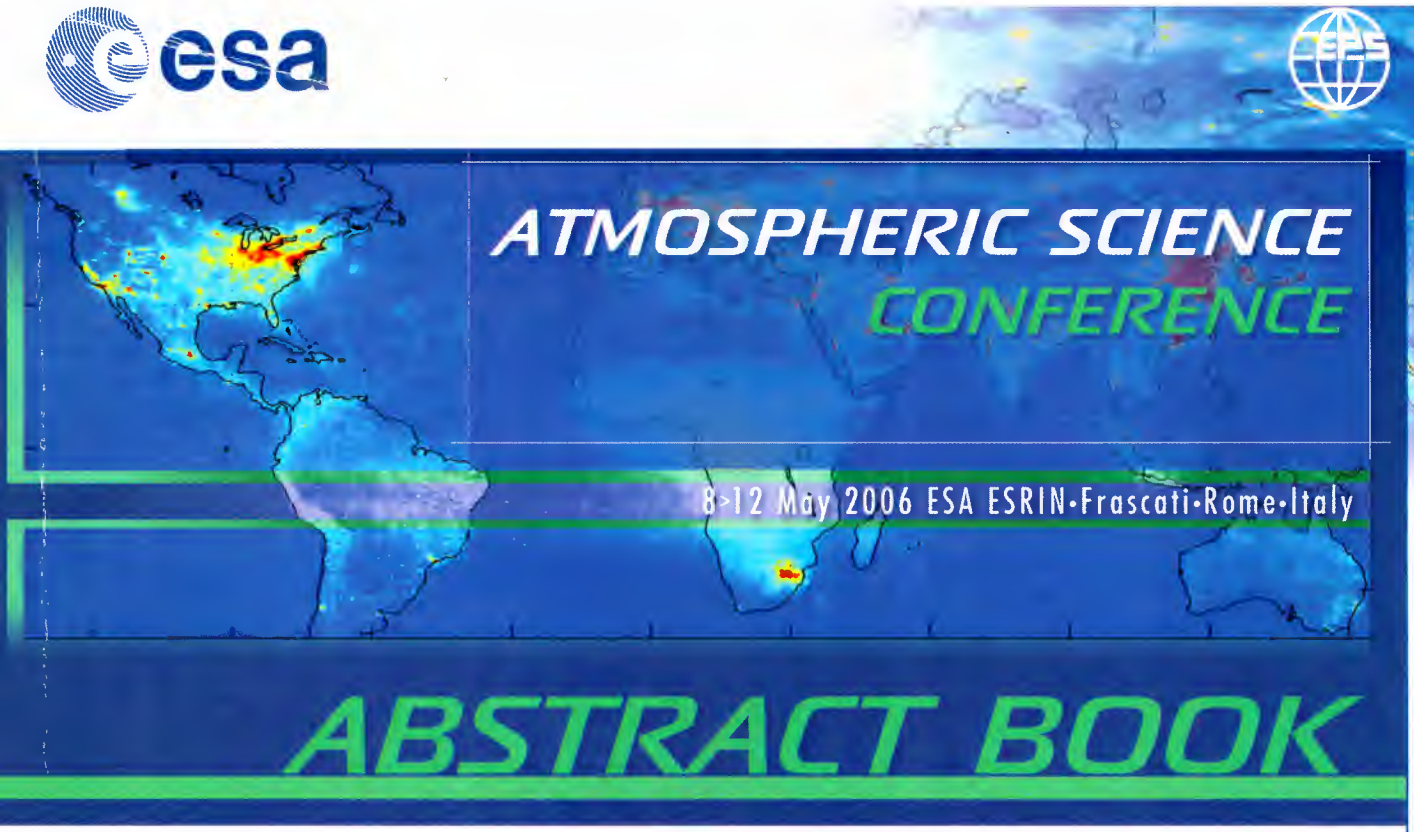

ATMOSPHERIC SCIENCE CONFERENCE

8-12 May 2006 ESA ESRIN•Frascati•Rome•Italy

ABSTRACT BOOK

GEN130

European Space Agency
Agence spatiale européenne

the Living Planet

Abstract Book and Workshop Programme

Atmospheric Science Conference

8 - 12 May 2006
ESA-ESRIN
Frascati
Italy

Organised by:

The European Space Agency

Last Update: 07 April 2006

Conference Programme

Keynote talks are in bold

Day 1, Monday 8 May 2006

09.00-10.00	*Registration/Poster Mounting/Coffee*	
10.00-10.20	*Welcome/Workshop Objectives and Organization*	
Session 1: Missions Overview/Instrument and Product Status		**Chair: Y.-L. Desnos**
10:20-10:40	The Envisat Mission	Henri Laur (Envisat Mission Manager-ESA)
10:40-11:00	The ENVISAT Atmospheric Chemistry Mission: status and performance	Thorsten Fehr (ESA)
11:00-11:20	The ERS Mission/GOME Product Quality Status	Wolfgang Lengert (ERS Mission Manager-ESA)
11:20-11:40	ESA Third Party Missions	Bianca Hoersch (Third Party Mission Manager, ESA)
11:40-12:00	The Atmospheric Chemistry Experiment (ACE): Mission Overview	Peter Bernath (University of Waterloo)
12:00-12:20	Recent Validation Results for the Atmospheric Chemistry Experiment (ACE)	Kaley A. Walker (University of Waterloo)
12:20-12:40	The AURA Mission	Ernest Hilsenrath (University of Maryland)
12:40-13:00	Overview of First Year's Results of the Ozone Monitoring Instrument	Pieternel Levelt (KNMI)
13:00-13:20	More Than One Year of Data from the Ozone Monitoring Instrument - Validation	Mark Kroon (KNMI)
13:20-13:40	SCIAMACHY Four Years in Orbit: Instrument Operations and In-flight Performance Status	Manfred Gottwald (DLR)
13.40-14.40	*Lunch Break*	
Session 2: Data Quality		**Chair: E. Kyrola and P. Bernath**
14:40-15:00	SAUNA - Sodankylä Total Ozone Intercomparison and Validation Campaign	B.R. Bojkov (NASA Goddard Space Flight Center)
15:00-15:20	A Validation of Solar Backscatter Radiances using Antarctic Ice	Glen Jaross (Science Systems and Applications, Inc.)
15:20-15:40	Evaluation of ozonesondes, HALOE, SAGE II, SAGE III, ODIN-OSIRIS and SMR, and ENVISAT-GOMOS, -SCIAMACHY and MIPAS Ozone profiles in the tropics from SAOZ long duration balloon measurements	Jean-Pierre Pommereau (CNRS)
15:40-16:00	Evaluation of GOMOS limb scattering measurements	Ghassan Taha (Science Systems and Applications, Inc.)
16.00-16.30	*Coffee Break*	
Data Quality		**Chair: E. Kyrola and P. Bernath**
16:30-16:50	10-Years Operational GOME/ERS-2 Total Column Products: The GDP 4.0 Validation	Dimitris Balis (Aristotle University of Thessaloniki)
16:50-17:10	Long-term validation of GOMOS, MIPAS and Sciamachy ozone and temperature profiles by the Envisat Quality Assessment with Lidar (EQUAL) project	Yasjka Meijer (RIVM)
17:10-17:30	Co-ordinated validation activity and quality assessment of MIPAS-ENVISAT Ozone data	Ugo Cortesi (IFAC-CNR)
17:30-17:50	EnviSat / SCIAMACHY validation with the LPMA / DOAS balloon gondola: Comparison of a) O3, NO2 and BrO profiles, b) the solar irradiance spectrum and c) limb radiances.	Marcel Dorf (University of Heidelberg)
17:50-18:10	Cross-validation of recent satellite and ground-based measurements of ozone and water vapor in the middle atmosphere	Klemens Hocke (University Bern)
18.10-18.30	*Discussion on existing Instruments and Data Processing/Quality*	
18.30-20.00	*Icebreaker at ESRIN*	

Day 2, Tuesday 9 May 2006

Session 3: Retrieval Algorithms		**Chair: R. Munro and G. Kirchengast**
08:30-09:00	**10-Years Operational GOME/ERS-2 Total Column Products: The GDP 4.0 Algorithm**	**Diego Loyola (DLR)**
09:00-09:20	High-resolution density and temperature profiling in the stratosphere using bi-chromatic scintillation measurements by GOMOS	Francis Dalaudier (Service d'Aéronomie)
09:20-09:40	MIPAS new measurement scenario: enhanced vertical resolution and regularization	Simone Ceccherini (IFAC - CNR)
09:40-10:00	Direct-fitting: a new approach for trace gases retrieval in the UV-visible spectral range	Michel Van Roozendael (BIRA-IASB)

10:00-10:20	Retrieval of BrO vertical distributions from SCIAMACHY limb measurements: Data quality assessment and algorithm improvements	Alexei Rozanov (University of Bremen)
10.30-11.00	*Coffee Break*	
Session 4: Trace Gases in the Stratosphere		**Chair: R. Munro and G. Kirchengast**
11:00-11:30	**SCIAMACHY, an update and highlights of the scientific results 2002-2006**	**John Burrows (University of Bremen)**
11:30-11:50	Retrieval of Stratospheric Trace Gases from SCIAMACHY Limb Measurements	Jānis Puķīte (University of Heidelberg)
11:50-12:10	Odin/SMR Limb Observations of Stratospheric Trace Gases during 2001-2005	Joachim Urban (Chalmers University of Technology)
12:10-12:30	New NNORSY-GOME-1 Global Ozone Profile Data Set	Anton Kalfel (Center for Solar Energy & Hydrogen Research (ZSW))
12:30-13:00	**GOMOS/ENVISAT overview**	**Erkki Kyrölä (Finnish Meteorological Institute)**
13:00-13:20	Dynamical origin of strong NO2 enhancement in the polar stratosphere and mesosphere observed by GOMOS ion ENVISAT	Alain Hauchecorne (CNRS)
13:20-13:40	Non-operational products from the GOMOS instrument : mesospheric sodium, OClO and polar stratospheric clouds.	Didier Fussen (BIRA-IASB)
13.40-14.50	*Lunch Break*	
Trace Gases in the Stratosphere		**Chair: B. Carli and J.-M. Flaud**
14:50-15:20	**MIPAS: Scientific Results**	**Herbert Fischer (Universität Karlsruhe)**
15:20-15:40	MIPAS observations of CFC trends	Alastair Burgess (University of Oxford)
15:40-16:00	A Compendium of the Non-LTE Atmospheric Emissions Measured by MIPAS	Manuel Lopez-Puertas (Instituto de Astrofisica de Andalucia, CSIC)
16.00-16.30	*Coffee Break*	
Trace Gases in the Stratosphere		**Chair: B. Carli and J.-M. Flaud**
16:30-16:50	Infrared Remote Sensing of Organic Compounds in the Upper Troposphere	John Remedios (University of Leicester)
16:50-17:10	Retrieval of tropospheric Carbon Monoxide from MIPAS measurements	Claudio Belotti (IFAC CNR)
17:10-17:30	Spatial and temporal distributions of water vapour in the UTLS as observed with MIPAS/Envisat	Mathias Milz (Universität Karlsruhe/Forschungszentrum Karlsruhe)
17:30-17:50	Upper Tropospheric Measurements of Biomass Burning Emissions with the Atmospheric Chemistry Experiment (ACE) Fourier Transform Spectrometer	Curtis Rinsland (NASA Langley Research Center)
17:50-18:10	Envisat MIPAS measurements of CFC-11 and CFC-12: an add-on to ESA operational data	Lars Hoffmann (Forschungszentrum Juelich)
18.10-18.35	Discussion on Trace Gases in the Stratosphere	

Day 3, Wednesday 10 May 2006

Trace Gases in the Troposphere/Air Quality		**Chair: J. Burrows and H. Fischer**
08:30-09:00	**Synergistic use of different atmospheric instruments: What about the spectral parameters?**	**Jean-Marie Flaud (LISA-CNRS-Uni.Paris 12 and Uni.Paris 7)**
09:00-09:20	Atmospheric processes in the upper troposphere and lowermost stratosphere as seen by MIPAS	Gabriele P. Stiller (Forschungszentrum / University Karlsruhe)
09:20-09:40	Ten Years of SO2 measurements from GOME and SCIAMACHY	Andreas Richter (University of Bremen)
09:40-10:00	Trends and seasonal variability in tropospheric NO2	Ronald van der A (KNMI)
10:00-10:20	Measurements of Tropospheric BrO, HCHO, and Glyoxal from the Ozone Monitoring Instrument on EOS Aura	Thomas P. Kurosu (Harvard-Smithsonian Center for Astrophysics)
10.20-10.50	*Coffee Break*	
10:50-11:10	Satellite Chartography of Atmospheric Methane and carbon monoxide from SCIAMACHY onboard ENVISAT	Christian Frankenberg (IUP Heidelberg)
11:10-11:30	Quantitative analysis of SCIAMACHY CO variability and its implication for chemistry transport models	Annemieke Gloudemans (SRON Netherlands Institute for Space Research)
11:30-11:50	Measuring atmospheric CO2 from space using Full Spectral Initiation (FSI) WFM-DOAS	Michael Barkley (University of Leicester)
11:50-12:10	Remote sensing of Asian pollution from space: tracking the long range transport from China using ACE measurements.	Solène Turquety (Service d'Aéronomie, IPSL)
12:10-12:30	Estimation of NO2 amounts emitted from the Portuguese wildfires in 2005: A synergistic use of observations by imaging and atmospheric instruments and chemistry-transport models	Julian Meyer-Arnek (DLR - German Aerospace Center)
12:30-12:50	Tropospheric Observations with the Ozone Monitoring Instrument (OMI)	Pepijn Veefkind (KNMI)
12:50-13:10	New Developments in the Retrieval of Tropospheric Ozone from GOME, SCIAMACHY and SEVIRI	Richard Siddans (Rutherford Appleton Laboratory)
13.10-13.45	Discussion on Trace Gases in the Troposphere/Air Quality	
13.45-14.45	*Lunch*	

14.45-18:00	Poster Session (covering all themes)
Session 2.1: Posters: Instrument Performance/Data Quality/Intercomparison	
Validation of ozone profiles retrieved from SCIAMACHY lunar occultation measurements	Leonard K. Amekudzi (University of Bremen)
Validation of OMI total ozone using ground-based Brewer observations	Dimitris Balis (Aristotle University of Thessaloniki)
Global comparisons of total O3 columns from SCIAMACHY retrieved with Weighting Function DOAS (WFDOAS) Algorithm to OMI, GOME WFDOAS and ground-based measurements	Astrid Bracher (University of Bremen)
The evaluation of SCIAMACHY CO and CH4 scientific data products, using ground-based FTIR measurements	Bart Dils (Belgian Institute for Space Aeronomy)
The DCFI-ISAC MIPAS database: 2-D routine analysis of MIPAS observations	Bianca Maria Dinelli (ISAC - CNR)
Laser methods for the accurate calibration of satellite-derived aerosol and water vapor	Luca Fiorani (ENEA)
Validation of UV and Ozone EO based data used in PROMOTE/MEDSUN service, by means of on-ground measurements	Fabrizio Flore (Flyby srl)
Ten years of NO2 comparisons between ground-based SAOZ and satellite instruments (Gome, Sciamachy, OMI)	Florence Goutail (CNRS)
BrO Profiling from Ground-based DOAS Observations: New Tool for the ENVISAT/SCIAMACHY Validation	Francois Hendrick (Belgian Institute for Space Aeronomy (IASB-BIRA))
Validation of the ENVISAT synergetic aerosol retrieval	Thomas Holzer-Popp (DLR)
Comparisons of MIPAS V4.61 and Odin SMR V1.2 ozone data	Ashley Jones (Chalmers Tekniska Högskola)
Results from the Canadian Arctic Validation of ACE Campaigns from 2004 to 2006	Tobias Kerzenmacher (University of Toronto)
MIPAS Pointing assessment	Michael Kiefer (IMK Karlsruhe)
A comparison of CMAX-DOAS measurements and satellite retrievals of NO2 in an urban environment.	Louisa Kramer (EOS)
GOME: scan-mirror degradation correction	J.M. Krijger (SRON)
Comparison of the Ozone Vertical Profiles from the Dobson Umkehr Measurements and the ECC Soundings in Poland with the EOS-MLS (on the Aura Spacecraft) Overpasses, 2004-2005.	Janusz Krzyścin (Institute of Geophysics,Polish Academy of Sciences)
Intercomparisons of SCIAMACHY and GOME reflectances and geolocation	Barry Latter (Rutherford Appleton Laboratory)
Intercomparison of Global Total Ozone Measurements Retrieved from ENVISAT/SCIAMACHY Using Different State-of-the-art Algorithms	Christophe Lerot (Belgian Institute for Space Aeronomy (BIRA-IASB))
Validation of the chemistry-transport model MOCAGE using satellite observations	Maud Martet (CNRM Météo France)
SCIAMACHY Light Path Monitoring Results	Stefan Noël (IFE/IUP, University of Bremen)
Overview of SCIAMACHY level 2 data quality	Ankie Piters (KNMI)
Validation of OMI Ground UV-Products	Erich Putz (University of Graz)
Multi-technique comparison of MIPAS O3 measurements with correlative data obtained by FIR-FTS measurements during the ENVISAT stratospheric aircraft and balloon campaigns (ESABC)	Gianluca Redaelli (University of L'Aquila)
Geophysical validation of temperature retrieved by the ESA Level 2 processor from MIPAS/ENVISAT measurements	Marco Ridolfi (Università di Bologna)
Two years of SCIAMACHY measurements: intercomparison of methane total columns from the 1.65 and 2.3-micrometer windows	Hans Schrijver (SRON Netherlands Institute for Space Research)
Inter-comparison on the influence of different cloud parameter algorithms for the derivation of O3 and NO2 vertical column densities from SCIAMACHY nadir back-scattered observations	Thomas Schroeder (German Aerospace Center)
MIPAS Data Quality - Lessons Learned	Gottfried Schwarz (DLR)
Validation of 'cloud-free' tropical UTLS MIPAS ozone and water vapour.	Harjinder Sembhi (University of Leicester)
Long Term Monitoring of GOME/ERS-2 Calibration Parameters	Sander Slijkhuis (German Aerospace Centre)
A new Tool for SCIAMACHY level 1b to 1c processing	Sander Slijkhuis (German Aerospace Centre)
Improvements of GDP Level 0-1 Processing software in the framework of CHEOPS-GOME	Sander Slijkhuis (German Aerospace Centre)
Preliminary validation results of the OMI O2-O2 cloud product	Maarten Sneep (KNMI)
Validation of the GOMOS high-resolution temperature product (HRTP) using lidar	Kerstin Stebel (Norwegian Institute for Air Research)
Validation of IMK Ozone Profiles from MIPAS-Envisat	Tilman Steck (Forschungszentrum Karlsruhe)
Comparison of three simplified algorithms for atmospheric corrections of MERIS data over land	Juergen Telaar (University of Stuttgart)
SCIAMACHY radiometric calibration	Lieuwe Tilstra (Royal Netherlands Meteorological Institute (KNMI))
OMI in-flight wavelength calibration and the solar reference spectrum	Robert Voors (KNMI)
Session 3.1: Posters: Retrieval Algorithms	
Retrieving the Velocities of Motion of Air Masses from Digital Images of Clouds	Dimitar Bakalov (Institute for Nuclear Research and Nuclear Energy)
Evidence for Solar Signals in the Mesopause Temperature Variability above a Midlatitude Station in Europe	Michael Bittner (DLR)
Regridding of remote sensing retrievals: formalism and application to GOME vs Microwave ozone profile comparison	Yasmine Calisesi (International Space Science Institute)
A proposed algorithm for line-of-sight wind retrieval from MIPAS level 1 spectra	Claude Camy-Peyret (LPMA)

The Retrieval Algorithm of the SCIAMACHY Limb Processor Version 3.0	Adrian Doicu (German Aerospace Center)
Uncertain Model Parameters for SCIAMACHY Limb Retrieval	Adrian Doicu (German Aerospace Center)
Odin-SMR observations of the tropical upper troposphere	Patrick Eriksson (Chalmers University of Technology)
Temperature Measurements in the Mesopause Region (~87 km) on board of RV Polarstern from 54°N to 34°S (ANT XXIII/1)	Kathrin Hoeppner (German Aerospace Center (DLR-DFD))
ACE retrievals using Atmosphit, a user friendly fitting software based on the optimal estimation method.	Daniel Hurtmans (Universite Libre de Bruxelles)
On The Selection Of Input Measurements For Neural Network Based Retrieval Algorithms	Michele Federico Iapaolo (Tor Vergata University)
New Global Static and Dynamic Ozone Profile Climatology - Validation, Comparison -	Jasmine Kaptur (Center for Solar Energy & Hydrogen Research (ZSW))
Tropospheric and stratospheric BrO and NO2 columns derived by use of satellite observations and 3D CTM FinROSE	Piia Post (Univesity of Tartu)
MIPAS Reference Atmospheres	John Remedios (University of Leicester)
Bending Angle and Temperature Profiles from GOMOS in Comparison to Champ and Ecmwf Analysis Data	Christian Retscher (ESA/ESRIN)
Retrieval of ozone concentration profiles from SCIAMACHY limb scatter measurements in the Hartley bands: Technique and applications	Guenter Rohen (University of Bremen)
Recent Advances in SCIAMACHY Near Infrared Nadir Level 2 Algorithm Development	Franz Schreier (DLR German Aerospace Center)
Parameterization of internal gravity waves and turbulence in the stratosphere using scintillation measurements by GOMOS on Envisat	Viktoria Sofieva (Finnish Meteorological Istitute)
Self-consistency analysis of MIPAS data using the trajectory hunting technique (THT)	Antonella Taddei (University of L'Aquila)
Providing convenient data services to the Atmospheric Science community	Richard van Hees (SRON)
The Major Revision of the SCIAMACHY Operational L1b-2 Off-line Data Processor	Albrecht von Bargen (German Aerospace Center)
Characterization of vegetation type using DOAS satellite retrievals	Thomas Wagner (Uni-Heidelberg)
Nonlinear Resonant Wave-Wave Interaction (Triad): Case Studies Based on Rocket and Satellite Data	Sabine Wuest (German Aerospace Center (DLR-DFD))
Nighttime NOx from SCIAMACHY lunar occultation measurements	Leonard K. Amekudzi (University of Bremen)
SCIAMACHY solar occultation: Ozone and NO2 profiles 2003-2005	Klaus Bramstedt (University Bremen)
DOAS Retrieval of Glyoxal from space	Steffen Beirle (Universität Heidelberg)
Carbon monoxide, methane and carbon dioxide retrieved from SCIAMACHY near-infrared nadir observations using WFM-DOAS	Michael Buchwitz (University of Bremen FB1)
A simplified forward model of limb infrared emission spectra in a two-dimensional atmosphere	Coralie De Clercq (Belgian Institute for Space Aeronomy (IASB-BIRA))
Retrieval of Formaldehyde Columns from GOME as Part of the GSE Promote and Comparison with 3d-CTM Calculations	Isabelle De Smedt (BIRA-IASB)
Observational evidence of the middle atmospheric response to perturbation	Bianca Maria Dinelli (ISAC-CNR)
Carbon Monoxide Measurements from MIPAS on Envisat	Bernd Funke (Instituto de Astrofisica de Andalucia, CSIC)
Downward Transport of Upper Atmospheric NOx in the Polar Winters During 2002 and 2003	Bernd Funke (Instituto de Astrofisica de Andalucia, CSIC)
Retrieval of peroxyacetylnitrate (PAN) in the upper troposphere from MIPAS level-1B spectra	Norbert Glatthor (Forschungszentrum Karlsruhe)
NO2 Total and Tropospheric Vertical Column Densities from OMI on EOS Aura	James Gleason (NASA Goddard Space Flight Center)
Determining Tropospheric Composition from Satellite Measurements	Lara Gunn (University of Leeds)
Spatial analysis of Anthropogenic SO2 emissions monitored by GOME on board ERS-2	Muhammad fahim Khokhar (IUP)
Effect of Forest Fires on the air quality in Seoul from MOPITT measurements	Jhoon Kim (Yonsei University)
SCIAMACHY Limb Measurements of NO2, BrO and OClO	Sven Kuehl (Heidelberg University)
Composition Changes Caused by the 2003 Solar Storm: MIPAS Measurements and Model Simulations	Manuel Lopez-Puertas (Instituto de Astrofisica de Andalucia, CSIC)
Teleconnections between El Niño event and Tropospheric Trace Gases over Indonesia	Diego Loyola (DLR)
Isoprene and Biomass Burning Emissions from Satellite Observations: Synergistic Use of HCHO and NO2 Trace Gas Measurements	Thierry Marbach (Environmental Physics Heidelberg)
GOME and SCIAMACHY Global Water Vapour Columns	Stefan Noël (IFE/IUP, University of Bremen)
Transport studies in the stratosphere using MIPAS observations	Yvan Orsolini (NILU)
Monitoring of sulphur dioxide emissions from satellite as part of GSE PROMOTE	Jos van Geffen (BIRA-IASB)
Tropospheric NO2 Column and Aerosol Optical Properties from SCIAMACHY in the Northern Italy	Andrea Petritoli (CNR)
Carbon tetrafluoride (CF4) from MIPAS measurements	Chiara Piccolo (University of Oxford)
Vector spherical radiative transfer model MCC++: linearization with respect to BRDF surface properties	Oleg Postylyakov (A.M. Obukhov Institute of Atmospheric Physics)
Ozone loss in the Arctic stratosphere over Kiruna, Sweden, during winter/spring 2005/06	Uwe Raffalski (Swedish Institute of Space Physics)
Observations of Energetic Particle Effects on the Stratosphere	Annika Seppälä (Finnish Meteorological Institute)
FTIR ozone observations in Kiev	Angelina Shavrina (Main Astronomical Observatory of NASU)

Measurement of mesospheric constituents from SCIAMACHY limb measurements	Miriam Sinnhuber (University of Bremen)
Towards a climatology of stratospheric bromine monoxide from SCIAMACHY limb observations	Bjoern-Martin Sinnhuber (University of Bremen)
Tomographic Retrieval of MIPAS Measurements in the UTLS Region	Tilman Steck (Forschungszentrum Karlsruhe)
Enhanced upper stratospheric HNO3 during Antarctic winter 2003 and Arctic winter 2003/2004	Gabriele P. Stiller (Forschungszentrum / University Karlsruhe)
Global distributions of HO2NO2 as observed by MIPAS	Gabriele P. Stiller (Forschungszentrum / University Karlsruhe)
Mean age of stratospheric air as derived from MIPAS SF6 distributions	Gabriele P. Stiller (Forschungszentrum / University Karlsruhe)
Retrieval of BrO Columns from SCIAMACHY and their Validation Using Ground-based DOAS Measurements	Nicolas Theys (BIRA-IASB)
Monitoring volcanic activity from space: Retrieval of sulphur dioxide plumes from ERS-2/GOME backscatter data	Werner Thomas (Deutscher Wetterdienst (DWD))
Simulation and retrieval of atmospheric spectra using ASIMUT	Ann C Vandaele (Belgian Inst for Space Aeronomy)
MIPAS HOCl measurements	Thomas von Clarmann (Forschungszentrum Karlsruhe / Universitaet Karlsruhe)
Southern hemispheric biomass burning as seen by MIPAS	Thomas von Clarmann (Forschungszentrum Karlsruhe / Universitaet Karlsru)
Monitoring of the Stratosphere with SCIAMACHY Measurements of Limb-Scattered Solar Radiation	Christian von Savigny (University of Bremen)
Measurement of NOx gases using MIPAS-ENVISAT	Joanne Walker (University of Oxford)
Impact of effective cloud fraction on tropospheric NO2 retrieval	Ping Wang (Royal Netherlands Meteorological Institute (KNMI))
Retrievals of O3 and H2O in the lower stratosphere and troposphere from Envisat	Alison Waterfall (Rutherford Appleton Laboratory)
Satellite Observations of Trace Gas Enhancements in January 2005	Claire Waymark (University of Oxford)
Weighting function DOAS total ozone from GOME and SCIAMACHY during the last decade	Mark Weber (University of Bremen FB1)
Distributions of nitric acid in the troposphere and the stratosphere	Catherine Wespes (Universite Libre de Bruxelles)
The retrieval of oxygenated volatile organic compounds by remote sensing techniques	Folkard Wittrock (University of Bremen)
Session 6.1: Posters: Aerosols/Clouds/UV	
Optical Thickness of Winter Clouds from Ground-based Visible Images	Kalinka Bakalova (Solar-Terrestrial Influences Laboratory, BAS)
GOME-MERIS cloud products inter-comparison on global scale	Stefano Casadio (SERCO)
Satellite on-board temperatures: proxy measurements of Earth's climate change?	Stefano Casadio (SERCO)
Spectral analyses of desert dust and biomass burning aerosol scenes	Martin de Graaf (Royal Netherlands Meteorological Institute (KNMI))
Systematic conversion of satellite AOD into near-surface mass concentrations	Thomas Holzer-Popp (DLR)
Cloud Parameter Retrieval from MIPAS Level 1B Data	Jane Hurley (University of Oxford)
Ecological study of the aerosol optical characteristics and ozone concentration using lidar, radiometer and ozonemeter	Iliko Iliev (Bulgarian Academy of Sciences)
Antarctic clouds from below and above	Amelie Kirchgaessner (British Antarctic Survey)
The SCIAMACHY cloud products derived using the semi-analytical cloud retrieval algorithm	Alexander Kokhanovsky (University of Bremen)
Aerosol characterization over Northern Greece; aerosol loading derived from satellite observations and ground-based measurements	MariLiza Koukouli (Laboratory of Atmospheric Physics)
A cloud climatology based on GOME	Diego Loyola (DLR)
Aerosol Optical Depth Retrieval over Land using Meteosat-8 SEVIRI Data	Christoph Popp (University of Berne)
Improvement of the FRESCO cloud algorithm for GOME and SCIAMACHY	Ping Wang (Royal Netherlands Meteorological Institute (KNMI))
Session 7.1: Posters: Data Assimilation	
On the assimilation of the full information content of satellite observations	Rossana Dragani (Data Assimilation Research Centre)
Multi-year stratospheric and tropospheric ozone record by assimilating ERS2-GOME observations	Thilo Erbertseder (DLR)
Towards Operational Data Assimilation of Satellite-based Aerosol Optical Depth and Type Observations in a Chemical Transport Model	Marion Schroedter-Homscheidt (Deutsches Zentrum für Luft-und Raumfahrt (DLR))
Four dimensional variational assimilation of MIPAS stratospheric trace gas observations into the SACADA global chemistry circulation model	Jörg Schwinger (University of Cologne)
Session 8.1: Posters: Applications	
SCIAMACHY 4 years in space: Achievements, Data Usage and Outlook for the next 4 years	Heinrich Bovensmann (University of Bremen, FB 1)
Application Research and Development for Atmospheric Chemistry Products	Lawrence Flynn (USDOC)
DUE GlobAEROSOL: Building components for air pollution and health monitoring services	Celestino Gomez Cid (GMV, SA)
The NorSEN network: Use of ENVISAT derived and ground-based aerosol information	Georg Hansen (Norwegian Institute for Air Research)

Radiometer-based Estimation of the Atmospheric Optical Thickness	Vassilia Karathanassi (National Technical University of Athens)
IGACO-O3: The First Step in Implementing IGACO	Anssi Mälkki (Finnish Meteorological Institute)
Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring	Tarja Riihisaari (Finnish Meteorological Institute)
Using GRID services for Sciamachy data sharing and processing in NL-SCIA-DC	Wim Som de Cerff (KNMI)
Modeling CO2 sinks and sources of European land vegetation using remote sensing data	Klaus Wisskirchen (DLR)

Day 4, Thursday 11 May 2006

Session 6: Aerosols/Clouds/UV		Chair: K. Chance and J. Staehelin
08:30-08:50	GlobAEROSOL from Earth Observation - aerosol maps from (A)ATSR and SEVIRI.	Elisa Carboni (University of Oxford)
08:50-09:10	SCIAMACHY TOA reflectance correction effects on Aerosol Optical Depth retrieval	Walter Di Nicolantonio (Carlo Gavazzi Space c/o ISAC-CNR)
09:10-09:30	Aerosol Products from the Aura-OMI Sensor	Omar Torres (University of Maryland, Baltimore County)
09:30-09:50	Variability and trends in global cloud parameters from Oxygen A-band measurements by GOME and SCIAMACHY	Piet Stammes (KNMI)
09:50-10:10	MIPAS discovers Antarctic nitric acid trihydrate (NAT) polar stratospheric cloud (PSC) belt	Michael Hoepfner (Forschungszentrum Karlsruhe)
10:10-10:30	Cloud retrieval from SCIAMACHY using broad band spectrometers and absorptions of O2 and O4	Michael Grzegorski (University of Heidelberg)
10.30-11.00	*Coffee Break*	
11:00-11:30	**Three years of ENVISAT synergetic aerosol retrieval**	**Thomas Holzer-Popp (DLR)**
11:30-11:50	Stratospheric aerosols and PSCs as observed by GOMOS on Envisat: results for the period 2002-2005.	Filip Vanhellemont (Belgian Institute for Space Aeronomy)
11:50-12:10	Retrieval of Cloud Fraction and Pressure from the Ozone Monitoring Instrument (OMI)	Johan de Haan (KNMI)
12:10-12:30	Retrieval of cloud fraction, optical thickness and top-height from GOME and SCIAMACHY	Bastiaan van Diedenhoven (SRON Netherlands Institute for Space Research)
12:30-12:50	Probing internal cloud properties from space	Thomas Wagner (Uni-Heidelberg)
12:50-13:10	Surface UV irradiance from OMI on EOS-Aura	Aapo Tanskanen (Finnish Meteorological Institute)
13:10-13:30	Solar variability measured by GOME and SCIAMACHY in the UV/visible/NIR spectral range (1995-present)	Mark Weber (University of Bremen FB1)
13.30-13.45	Discussion on Aerosol/Clouds/UV	
13.45-14.40	*Lunch Break*	
Session 7: Data Assimilation		**Chair: B. Kerridge and H. Kelder**
14:40-15:10	**The ASSET intercomparison project**	**William Lahoz (DARC)**
15:10-15:30	Ozone data assimilation of GOME, SCIAMACHY and OMI measurements	Henk Eskes (KNMI)
15:30-15:50	Simultaneous assimilation of ENVISAT/MIPAS and ODIN/SMR ozone profile into a chemistry transport model	Sebastien Massart (CERFACS)
15:50-16:10	Variational assimilation of combined satellite retrieved and in situ aerosol data in an advanced chemistry transport model	Lars Peter Nieradzik (RIU - University of Cologne)
16.10-16.30	*Coffee Break*	
Session 8: Applications		**Chair: B. Kerridge and H. Kelder**
16:30-16:50	Towards a robust estimate of the global lightning nitrogen oxides source using in situ and remote sensing data and model results	Ulrich Schumann (DLR)
16:50-17:10	Regional air quality forecasting over Greece within PROMOTE	Dimitrios Melas (Aristotle University of Thessaloniki)
17:10-17:30	Gaseous and Particle Emissions of International Shipping as seen by Satellites	Heinrich Bovensmann (University of Bremen, FB 1)
17:30-17:50	Atmospheric applications on GRID with a focus on GOMOS and MIPAS	Christian Retscher (ESA/ESRIN)
17:50-18:10	Use of atmospheric remote sensing for solar energy purposes: Experiences made in the ENVISOLAR project	Marion Schroedter-Homscheidt (Deutsches Zentrum für Luft-und Raumfahrt (DLR))
18.10-18.30	*Discussion on Data Assimilation/Applications*	

Day 5, Friday 12 May 2006

Session 9: Future Missions		Chair: P. Levelt and M. Bittner
8:30-8:50	Possible Future Atmospheric Earth Explorer Missions	Joerg Langen (ESA-ESTEC)

8:50-9:10	Definition of Future Operational Atmospheric Composition Monitoring Satellite Missions: Final Results of the CAPACITY study	Hennie Kelder (KNMI)
9:10-9:30	GOME-2 on MetOp	Rosemary Munro (EUMETSAT)
9:30-9:50	IASI instrument performances just before the launch of MetOp	Claude Camy-Peyret (CNRS and UPMC)
9:50-10:10	Future NASA Atmospheric Missions	James Gleason (NASA Goddard Space Flight Center)
10.10-10.30	Discussion on Future Missions	
10.30-11.00	*Coffee*	
Closing Session		**Chair: Y.-L. Desnos**
11.00-11.20	Report on existing Instruments and Data Processing/Quality	E. Kyrola and P. Bernath
11.20-11.40	Report on Trace Gases in the Stratosphere	B. Carli and J.-M. Flaud
11.40-12.00	Report on Trace Gases in the Troposphere/Air Quality	J. Burrows and H. Fischer
12.00-12.20	Report on Aerosol/Clouds/UV	K. Chance and J. Staehelin
12.20-12.40	Report on Data Assimilation/Applications	B. Kerridge and H. Kelder
12.40-13.00	Report on Future Missions	P. Levelt and M. Bittner
13.00-13.20	Discussion	
13:20-13:30	Conclusion	C. Zehner

Session 1:Missions Overview/ Instrument and Product Status

The Envisat Mission

Henri Laur[1]

(1) Envisat Mission Manager, ESA-ESRIN, Via Galileo Galilei, 00044 Frascati, Italy

Abstract

One of the first objectives of the Envisat mission is to provide data for atmospheric scientists. The status of Envisat's instruments used for measuring the atmosphere are described, as well as the status of the satellite and its data distribution schemes in the context of atmospheric research and applications. The expected lifetime of the Envisat mission as well as the current plan for ensuring data for the atmospheric scientific community will be also addressed.
The unique contributions Envisat has made to atmospheric science since launch will also be presented.

The ENVISAT Atmospheric Chemistry Mission: status and performance

Thorsten Fehr[1]

[1] *ESA-ESRIN, Via Galileo Galilei, 00044 Frascati, Italy*

Abstract

The ENVISAT Atmospheric Chemistry Mission: status and performance

Thorsten Fehr (presenter), E. Attema, A. Dehn, J. Frerick, R.M. Koopman, H.Laur, M. De Laurentis, P. Lecomte, Fabrizio Niro, L. Saavedra de Miguel, P. Snoeij

Three atmospheric-chemistry sensors form part of the ENVISAT payload that has been placed into orbit in March 2002.This contribution presents the ENVISAT mission status and data policy, and reviews the end-to-end performance of the GOMOS, MIPAS and SCIAMACHY observation systems. In particular, for each instrument, the review addresses mission planning, in-orbit performance, calibration, data processor algorithms and configuration, reprocessing strategy, and product quality control assessment. The evolution of each of the observation systems has been distinct during the mission history: the GOMOS instrument operation has undergone an important change, and its processing chain is subject of two upgrades. For MIPAS intervention on one of the on-board subsystems has proven necessary, and an important data processing improvement cycle has been completed through reconfiguration of the processing chain. SCIAMACHY operations have required only minor interventions, and the presentation will focus on the processing chain evolution.

The ERS Mission/GOME Product Quality Status

Wolfgang Lengert[1]

[1] *ERS Mission Manager, ESA-ESRIN, Via Galileo Galilei, 00044 Frascati, Italy*

Abstract

The ERS missions constitute a landmark in atmospheric scientific research with the introduction of satellite-borne sensors such as GOME.

The status and history of the two ERS missions with background on their use as supports for atmospheric science will be presented. The continued expected lifetimes of the missions is also outlined.

Finally, the GOME instrument will be largely focussed on, with presentation of its different products and the quality status of each.

ESA Third Party Missions

Bianca Hoersch[1]

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Abstract

ESA has a long history of cooperation with other space agencies for the use of ESA multi-mission ground systems to acquire, process, archive and distribute data from other satellites, known as Third Party Missions.

A brief history and update on Third Party missions will be given, along with some indications for future third party missions. The third party data products oriented to atmospheric science will be outlined along with their status.

The Atmospheric Chemistry Experiment (ACE): Mission Overview

Peter Bernath[1]

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Abstract

The ACE mission goals are: (1) to measure and to understand the chemical and dynamical processes that control the distribution of ozone in the upper troposphere and stratosphere, with a particular emphasis on the Arctic region; (2) to explore the relationship between atmospheric chemistry and climate change; (3) to study the effects of biomass burning in the free troposphere; (4) to measure aerosol number density, size distribution and composition in order to reduce the uncertainties in their effects on the global energy balance.

ACE is making a comprehensive set of simultaneous measurements of trace gases, thin clouds, aerosols, and temperature by solar occultation from a satellite in low earth orbit. A high inclination (74 degrees) low earth orbit (650 km) gives ACE coverage of tropical, mid-latitudes and polar regions.

A high-resolution (0.02 cm-1) infrared Fourier Transform Spectrometer (FTS) operating from 2 to 13 microns (750-4400 cm-1) is measuring the vertical distribution of trace gases, and the meteorological variables of temperature and pressure. The ACE concept is derived from the now-retired ATMOS FTS instrument, which flew on the Space Shuttle in 1985, 1992, 1993, 1994.

Aerosols and clouds are being monitored using the extinction of solar radiation at 0.525 and 1.02 microns as measured by two filtered imagers as well as by their infrared spectra. A dual spectrophotometer called MAESTRO was added to the mission to extend the wavelength coverage to the 280-1000 nm spectral region. The principal investigator for MAESTRO is T. McElroy of the Meteorological Service of Canada.

The FTS and imagers have been built by ABB-Bomem in Quebec City, while the satellite bus has been made by Bristol Aerospace in Winnipeg. ACE was selected in the Canadian Space Agency's SCISAT-1 program, and was successfully launched by NASA on August 12, 2003 for a nominal 2 year mission. Selected results for ACE will be presented.

Recent Validation Results for the Atmospheric Chemistry Experiment (ACE)

Kaley A. Walker[1], Chris Boone[1], Randall Skelton[1], Sean D. McLeod[1], Peter F. Bernath[1], Kimberly Strong[2], and C. Thomas McElroy[3]

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Abstract

The Atmospheric Chemistry Experiment (ACE), also known as SCISAT-1, is a Canadian scientific satellite to perform remote sensing measurements of the Earth's atmosphere. It was launched on August 12, 2003 and has been making measurements since February 2004. The primary ACE instrument is a high-resolution (0.02 cm-1) Fourier Transform Spectrometer (ACE-FTS) operating between 750 and 4400 cm-1. It also houses two filtered imagers to measure atmospheric extinction due to clouds and aerosols at 0.525 and 1.02 microns. The secondary instrument on-board SCISAT-1 is a dual UV-visible-NIR spectrophotometer called ACE-MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) which extends the wavelength coverage to the 280-1030 nm spectral region.

The primary measurement technique for both instruments is solar occultation. Altitude profiles of atmospheric trace gas species, temperature and pressure are obtained from these measurements. The 650 km altitude, 74 degree circular orbit provides the mission with global coverage though the focus is on the Arctic and Antarctic regions. The primary goal of the ACE mission is to measure and to understand the chemical and dynamical processes that control the distribution of ozone in the upper troposphere and stratosphere, with a particular emphasis on the Arctic region. Current validation comparisons for both instruments will be presented in this paper.

The AURA Mission

Ernest Hilsenrath[1], M.S Schoeberl[2], A.R. Douglass[2], P.K Phartia[2], R. Beer[3], Waters J.[3], L. Froidevaux[3], M. Gunson[3], J. Barnett[4], P. Levlet[5], and J. Gille[6]

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[6] *University of Colorado, Dept of Atmosphere and Ocean Sciences, Boulder, CO, United States*

Abstract

Aura, the last of the large EOS observatories, was launched on July 15, 2004. Aura is designed to make comprehensive stratospheric and tropospheric composition measurements from its four instruments, HIRDLS, MLS, OMI and TES. These four instruments work in synergy to provide data on ozone trends, air quality and climate change. The instruments observe in the nadir and limb and provide the best horizontal and vertical resolution ever achieved from space. After nearly two years in orbit the instruments are nearly operational and are undergoing a comprehensive validation program. Aura data products are now appearing in the Aura validation archive with many data available to the public. We summarize the mission, instruments, and initial results and give examples of how Aura is providing continuity to earlier stratospheric chemistry missions and new data on the connections between climate and air quality

Overview of First Year's Results of the Ozone Monitoring Instrument

Pieternel Levelt[1], Ernest Hilsenrath[2], Johanna Taminnen[3], Aapo Tanskanen[3], Bert van den Oord[4], and P.K. Bhartia[5]

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[5] *NASA-GSFC, Code 916, Greenbelt, MD 20771, United States*

Abstract

The Ozone Monitoring Instrument (OMI) is the Dutch-Finnish contribution to the NASA EOS-Aura platform, which was launched in July 2004. OMI is the first of a new generation of UV-Visible space borne spectrometers that use two-dimensional detectors. These detectors enable OMI to daily observe the entire Earth with small ground pixel size (13x24 km2 at nadir), which makes this instrument extremely suitable for tropospheric research. The scientific objectives of OMI concern the recovery of the ozone layer, tropospheric pollution, the contribution of tropospheric ozone and aerosols to climate change and changes in surface UV-B. In this presentation an overview will be presented of several results obtained in the first one-and-a-half year of the OMI instrument on Aura.

More Than One Year of Data from the Ozone Monitoring Instrument - Validation

Mark Kroon[(1)], Ellen Brinksma[(1)], Pepijn Veefkind[(1)], and Pieternel Levelt[(1)]

[(1)] *KNMI, PO-Box 310, 3730 AE De Bilt, Netherlands*

Abstract

The Ozone Monitoring Instrument (OMI) is one of four instruments on the NASA EOS-Aura satellite that was successfully launched on July 15th, 2004. OMI is a compact nadir viewing, wide swath, ultraviolet-visible (UV/Vis) imaging spectrometer that was contributed to the Aura mission by the Netherlands and Finland. Starting from September 26th of 2004, OMI is producing science data on a nominal basis.

In this contribution we present an overview of the validation results as achieved during the first 1.5 years of OMI operation. Validation results comprise of OMI comparisons with ground based Brewer, Dobson, FTIR and SAOZ observations, the results of a series of NASA Aura Validation Experiment (AVE) campaigns, and results achieved within the framework of the OMI Announcement of Opportunity. Furthermore we will introduce and discuss the role of the Aura Validation Data Center (AVDC) and provide an update on current and planned validation activities.

Please visit the OMI Home Page [http://www.knmi.nl/omi] for more information on OMI.

SCIAMACHY Four Years in Orbit: Instrument Operations and In-flight Performance Status

Manfred Gottwald[1], Eckhart Krieg[1], Stefan Noel[2], Manfred Wuttke[2], and Heinrich Bovensmann[2]

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Abstract

SCIAMACHY on ENVISAT has now successfully operated 4 years in space. The ambitious scientific objectives required an operations concept which fully exploits the instrument flexibility but keeps the operational effort to an acceptable minimum. The concept, which had been developed in phase C/D, proved its capabilities in-flight and ensures that SCIAMACHY generates a continuous stream of high-quality scientific measurement data.

In this presentation we give an overview of how the instrument is operated on a routine basis with particular emphasis on the needs of the user community. This includes viewing geometries, e.g. limb-nadir matching, spectrometer settings but also calibration & monitoring requirements. The current in-flight performance of the instrument on system-level is presented showing the excellent status with a few minor in-flight non-conformances being described. An outlook on what can be expected from an extended mission finishes the presentation.

NOTES

Session 2: Data Quality

SAUNA - Sodankylä Total Ozone Intercomparison and Validation Campaign

B.R. Bojkov[1], R.D. McPeters[1], P.K. Bhartia[1], E. Kyrö[2], C. Zehner[3], E. Brinksma[4], E. Cuevas[5], R.D. Evans[6], F. Goutail[7], D.V. Ionov[7], R. Kivi[2], U. Koehler[8], C.T. McElroy[9], T.J. McGee[1], A. Redondas[5], M. Van Roozendael[10], and B. Walsh[6]

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Abstract

After nearly thirty years of experience in comparing space-borne total ozone column measurements with ground based measurements, large differences remain at high-latitudes under conditions of low sun. These persistent ozone column differences are likely due in part to the problems with the absolute accuracy of the groundbased measurements, in part to observational differences between satellite and groundbased techniques, and in part to problems with the accuracy of the various satellite algorithms. Improved accuracy in the groundbased high-latitude/high solar zenith angle measurements of ozone, which is the goal of the SAUNA campaign. Will lead to improved satellite ozone measurements, and also to better understanding of the processes that contribute to the eventual recovery of the ozone layer.

The primary objective off the Sodankylä total ozone intercomparison and validation campaign (SAUNA) is to establish a groundbased instrument and algorithm baseline using standard network instrumentation to retrieve the total column ozone to within one percent under these difficult measurement conditions. The other objective of SAUNA is to support the ongoing validation of the EOS-Aura OMI, the ERS-GOME, the Envisat-Sciamachy and SCISAT MAESTRO and FTS instruments, by performing satellite coincident measurements.

SAUNA will take place at Sodankylä, Finland (67.4° N, 26.6° E) from March 20 through April 13, 2006. A wide variety of groundbased instruments from nine institutes in eight countries will participate. Instruments will include three Brewer spectrophotometers, two Dobson instruments, two DOAS, a SAOZ, and the NDSC traveling standard stratospheric ozone LIDAR. There will also be daily ozonesonde launches. An overview of the campaign and preliminary results will be presented.

A Validation of Solar Backscatter Radiances using Antarctic Ice

Glen Jaross[1], Jeremy Warner[1], and Marcel Dobber[2]

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Abstract

In this presentation we discuss our approach to validation of sun-normalized radiance measurements from polar-orbiting, UV/VIS spectrometers. In particular, we have evaluated the OMI and TOMS sun-normalized radiances at wavelengths greater than 330 nm, and the four shortest MODIS/Aqua bands. Our analysis should be equally applicable to SCIAMACHY up to 800 nm. The technique involves comparing normalized radiances measured over the Antarctic continent with top-of-the-atmosphere (TOA) values computed with a radiative transfer model. In our model we assume a pure Rayleigh-scattering, aerosol-free, cloud-free atmosphere, and a mean surface reflectance derived from measurements on the ground. TOA radiances are sensitive to the bi-directional distribution of surface reflectance, especially at high solar zenith angles. We have developed a surface reflectance model to help correct these effects, but it still remains the largest source of uncertainty. We estimate the residual uncertainty at all wavelengths to be 2/%.

Evaluation of ozonesondes, HALOE, SAGE II, SAGE III, ODIN-OSIRIS and SMR, and ENVISAT-GOMOS, -SCIAMACHY and MIPAS Ozone profiles in the tropics from SAOZ long duration balloon measurements

Jean-Pierre Pommereau[(1)], and François Borchi[(1)]

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Abstract

Within the HIBISCUS project, long series of ozone profiles between 10 and 25 km have been obtained at almost constant latitude (20°S) in the tropics by remote sensing from circumnavigating IR Montgolfier (MIR) long duration balloons in February–March 2003 and 2004. The performances of practically all satellite instruments available in the tropics and also ozonesondes have been investigated by comparison with this data set. Thus, systematic positive or negative altitude shifts could be observed in satellite profiles, varying from <50 m for the GOMOS stellar occultation instrument, followed by +100/200 m for solar occultation systems (SAGE II, HALOE above 22 km), but as large as –900 m or +2000 m for limb viewing systems (OSIRIS, SCIAMACHY). The ozone relative biases are generally limited, between –4 % and +4 %, for measurements in the visible Chappuis bands (SAGE II and III, GOMOS above 22 km and OSIRIS), the near IR (HALOE above 22 km) and the ozonesondes, but increase to –7 % in the UV (SCIAMACHY), and +7 % in the mid-IR (MIPAS) and the submillimetric range (ODIN-SMR). Regarding precision, evaluated statistically from the zonal variability of ozone concentration, the best measurements are found to be those of SAGE II (2 %), followed by HALOE above 22 km (3-4 %), then the ozonesondes, SAGE III moon and OSIRIS (~5%), GOMOS above 22 km and SCIAMACHY (~6 %), MIPAS (8.5 %) and finally SMR (16 %). Overall, all satellite ozone measurements appear little reliable in the tropical troposphere except those of SAGE II (and eventually SAGE III), though low biased by 50 % and of limited (50 %) precision.

Evaluation of GOMOS limb scattering measurements

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Abstract

As part of its routine measurements, GOMOS measures the solar limb scattering above and below the star to correct for background radiation. If corrected for gain and offset, and calibrated, GOMOS spectral radiances, in theory, could be used to retrieve various gaseous species as well as aerosol extinction. The information content is similar to that obtained by other limb scatter sensors, such as SCIAMACHY and ODIN/OSIRIS, with one important difference; each GOMOS image contains a stellar signal, sensor pointing and hence the vertical profile registration of atmospheric species should be superior to other limb sensors. In this work, we are analyzing a subset of GOMOS bright limb measurements with solar zenith angle less than 80o, and within 150 km of SAGE II. A radiative transfer model, with input from SAGE measurements of ozone and aerosol, as well as NCEP temperature and pressure, is used to model and investigate the quality of GOMOS limb radiances, as well as studying the accuracy and sensitivity of various altitude registration techniques, such as maximum correlation, RSAS, or ozone knee methods. Inaccuracies in altitude registration are often a major uncertainty component for trace gas profile retrievals, and hence hinder the scientific value of such measurements. Pointing errors have been identified as the largest contributor to Ozone Mapping and Profiler Suite (OMPS) limb precision errors between the tropopause and the ozone peak. Thus, it's one of OMPS main priorities to test and validate altitude registration techniques, and adopt the most accurate one.

10-Years Operational GOME/ERS-2 Total Column Products: The GDP 4.0 Validation

Dimitris Balis[1], Jean-Christopher Lambert[2], Michel Van Roozendael[2], Robert Spurr[3], Diego Loyola[4], Yakov Livschitz[4], Pieter Valks[4], V. Amiridis[1], P. Gerard[2], J. Granville[2], and Claus Zehner[5]

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Abstract

Results of a geophysical validation exercise regarding the new operational GOME data processor (GDP4.0) are presented. This exercise involves comparisons with NDSC and WMO/GAW ground-based networks as well as with the TOMS version 8 total ozone products. For GOME, RMS values have improved by a factor of two compared with GDP 3.0; seasonal dependency is reduced by the same amount. On a global basis, GDP 4.0 total ozone results lie between -1% and +1.5% of ground-based values for solar zenith angles less than 70°; accuracy is now comparable to that obtainable from ground based stations. At higher solar zenith angles in Polar Regions, larger discrepancies of up to +4% are found; in these regimes, errors on both satellite and ground-based measurements are higher. Up to 2003, total column products have not suffered from any long-term drift of quality, even with expected instrument degradation. The validation results demonstrate that the re-processed GOME total ozone record is now sufficiently accurate for trend analysis (detection of 1% change in total ozone over 10 years).

Long-term validation of GOMOS, MIPAS and Sciamachy ozone and temperature profiles by the Envisat Quality Assessment with Lidar (EQUAL) project

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Abstract

The Envisat Quality Assessment with Lidar (EQUAL) project supports the long-term validation of ENVISAT's three atmospheric chemistry instruments. This ESA funded project started in 2004 and involves eleven, and later possibly thirteen, lidar stations around the world measuring ozone and temperature profiles. The participating stations are (from north to south) located in Eureka, Ny Alesund, Alomar, Esrange, Hohenpeissenberg, OHP, Tsukuba, Table Mountain, Mauna Loa, La Reunion, and Lauder. In 2006 two additional lidar stations, located in Dumont d'Urville (Antacrtic) and Rio Gallegos (Southerrn Argentina), are likely to join the consortium. Over the period 2002-2005 in total over 3500 lidar data files have been submitted (in HDF) and are available in the correlative database at NILU (Norway). Besides the required coordination of the data acquisition, this project involves dedicated validation activities to assess the data quality. The data under investigation are the ozone and temperature profiles of the Global Ozone Monitoring by Occultation of Stars (GOMOS), Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) and Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY) instruments. The main focus will be on the quality of the operational ESA products, but the focus might sometimes be changed toward products of scientific institutes exploring retrieval algorithms of (potential) future operational products. The vast amount of lidar data covering several latitudinal regions allows the analysis for possible dependencies of these data on several geophysical (e.g., latitude) and observational (e.g., star characteristics) parameters. In this presentation the main analysis results will be presented for each of the six ENVISAT data products under inverstigation.

Co-ordinated validation activity and quality assessment of MIPAS-ENVISAT Ozone data

Ugo Cortesi[1], Cornelis Blom[2], Thomas Blumenstock[2], Ian Boyd[3], Astrid Bracher[4], Claude Camy-Peyret[5], Jayanarayanan Kuttippurath[6], Coralie De Clercq[7], Marco Iarlori[8], Jean-Christopher Lambert[7], Yasjka Meijer[9], Hermann Oelhaf[2], Gianluca Redaelli[10], Ivan Kostadinov[11], Fabrizio Ravegnani[11], Chiara Piccolo[12], Michel Pirre[13], Gottfried Schwarz[14], Harjinder Sembhi[15], Tilman Steck[16], Kimberly Strong[17], Corinne Vigouroux[7], Konstantinos Varotsos[18], Alison Waterfall[19], Francesco Mencaraglia[1], and Kelly Chance[20]

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Abstract

Launched on March 1st, 2002 on-board the polar orbiting ENVISAT satellite, the MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) mid-infrared FT spectrometer performed limb emission measurements at high spectral resolution (0.025 cm-1) for about two years. Due to too frequent anomalies observed in the Interferometer Drive Unit, operations were suspended in March 2004 and finally resumed, in January 2005, in a new reduced resolution (0.01 cm-1) mode. Operational level 2 products for the complete set of target species (i.e. geo-located vertical profiles of Temperature and volume mixing ratio of H2O, O3, HNO3, CH4, N2O and NO2) were obtained during MIPAS full resolution mission, from July 6th, 2002 to March 26th, 2004. In this timeframe, several research groups involved in the ESA programme for geophysical validation of the ENVISAT Atmospheric Chemistry Instruments and in related national activities, carried out a variety of ground-based observations (ozone soundings, FT-IR, microwave radiometers, lidars) of the ozone vertical distribution and of in situ and remote sensing measurements from high altitude platforms, in close spatial and temporal coincidence with MIPAS overpasses. As a result, a comprehensive database of correlative measurements became available for a first inter-comparison of MIPAS O3 profiles with various datasets from coincident observations. A co-ordinated effort was finally conducted to bring together the individual outcomes of the different validation activities and to better exploit their redundant and complementary information. In the latter phase, special attention was paid to rigorous selection and use of correlative data, by adopting stringent coincidence criteria and by giving top priority to homogeneous and reliable validation data sources. Here we report a brief overview of the validation of MIPAS O3 data versions 4.61 and 4.62 (fully equivalent for validation purposes) by ground-based, balloon/aircraft and satellite measurements and discuss in details the resulting quality assessment of MIPAS O3 retrieved profiles.

EnviSat / SCIAMACHY validation with the LPMA / DOAS balloon gondola: Comparison of a) O3, NO2 and BrO profiles, b) the solar irradiance spectrum and c) limb radiances.

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Abstract

To date, 4 stratospheric measurements have been performed on the LPMA / DOAS (Limb Profile Monitor of the Atmosphere / Differential Optical Absorption Spectroscopy) balloon gondola for the validation EnviSat / SCIAMACHY Level 1 and 2 products at mid- and high-latitudes during different seasons and in the tropics. From the LPMA / DOAS UV/vis/near IR solar occultation measurements, vertical profiles of O3, NO, NO2, HNO3, BrO, ClONO2, OClO, HCl, IO, OIO and of some source gases (N2O and CH4) can simultaneously be inferred. Photochemical change was calculated along air mass trajectories to match the balloon with the satellite observations. LPMA / DOAS profiles were used to validate O3, NO2 and BrO SCIAMACHY limb profiles. Furthermore, absolutely calibrated irradiance spectra, recorded at medium spectral resolution with the DOAS instrument, were compared with SCIAMACHY irradiance spectra. Additionally a new UV/vis mini-DOAS spectrometer was applied during all validation fights, which measures skylight radiances and trace gases in fixed limb and scanning limb geometry. It provides a stringent test for RT modelling and allows the cross validation of trace gas profiles. The present paper reports on a) the involved methods b) validation results and c) scientific implications.

Cross-validation of recent satellite and ground-based measurements of ozone and water vapor in the middle atmosphere

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Abstract

With ACE-FTS, ENVISAT-MIPAS, and Aura-MLS there are three different measurement techniques currently in space, observing ozone and water vapor in the middle atmosphere. More clarity about the quality of these measurements is expected when we compare the satellite observations to coincident profiles continuously recorded by ground-based microwave radiometry in Bern and Payerne (Switzerland). Finally, diurnal and seasonal changes of ozone and water vapor are analyzed by combining the various data sources.

NOTES

Session 3: Retrieval Algorithms

10-Years Operational GOME/ERS-2 Total Column Products: The GDP 4.0 Algorithm

Diego Loyola[1], Michel Van Roozendael[2], Robert Spurr[3], Dimitris Balis[4], Jean-Christopher Lambert[2], Yakov Livschitz[1], Pieter Valks[1], Thomas Ruppert[1], Pepijn Kenter[5], Caroline Fayt[2], and Claus Zehner[6]

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Abstract

GOME has become an important instrument for trace gases trend analysis, with a data record now exceeding ten years duration. The GOME Data Processor (GDP) operational retrieval algorithm has generated total ozone and NO2 columns since July 1995. This paper presents the GDP version 4.0 algorithm, a major upgrade to the operational system. The GDP 4.0 retrieval algorithm uses an optimized DOAS (Differential Optical Absorption Spectroscopy) algorithm; least-squares slant column fitting is followed by Air Mass Factor (AMF) conversions to generate vertical columns. GDP 4.0 has improved wavelength calibration and reference spectra, and includes a new molecular Ring correction scheme to deal with the distortion of ozone absorption features due to inelastic Raman scattering effects. The AMFs are calculated on-line using the pseudo-spherical multiple-scattering radiative transfer code LIDORT and adjusted iteratively to reflect the fitted slant column result. GDP 4.0 includes accurate cloud parameter estimation using the cutting-edge cloud correction algorithms OCRA and ROCINN. The geophysical validation demonstrated the long-term stability of the GDP 4.0 total column ozone, reaching an accuracy comparable to that obtainable from ground-based sensors.

High-resolution density and temperature profiling in the stratosphere using bi-chromatic scintillation measurements by GOMOS

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Abstract

The GOMOS instrument on board the Envisat satellite is equipped with two photometers sampling simultaneously the star flux at two wavelengths in low-absorption regions (~499 and ~675nm) with a frequency of 1 kHz. The intensity of light measured by the GOMOS photometers exhibit fluctuations that may exceed its regular value by several hundred percent. These fluctuations are called scintillation. They are caused by air density irregularities. The bi-chromatic scintillations allow the determination of refractive angle, which is proportional to the time delay between the photometer signals. We present the measurement principle and inversion algorithms for reconstruction of high resolution density and temperature profiles (HRTP) in the stratosphere from scintillation measurements. This new approach allows temperature and density profiling with very good vertical resolution ~200 m and high accuracy ~1-3 K at altitudes 15-40 km. The best accuracy is achieved in vertical (in orbital plane) occultations. Validation results are also shown. HRTP can be assimilated into atmospheric models, used in studies of stratospheric clouds and in analysis of internal gravity waves activity.

MIPAS new measurement scenario: enhanced vertical resolution and regularization

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Abstract

MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) is operating on ENVISAT since March 2002. After two years of nearly continuous limb-scanning measurements (from July 2002 to March 2004) at the end of March 2004 the instrument was stopped due to problems with the mirror drive of the interferometer. Operations with reduced maximum path difference, corresponding to both a lower spectral resolution (0.0625 cm-1 instead of 0.025 cm-1) and a shorter measurement time (1.8 sec instead of 4.5 sec), were resumed on January 2005.

In order to exploit the reduction in measurement time, a change in the measurement scenario was implemented. Compared with the original measurement scenario, the new scenario adopts a finer vertical limb scanning step in the region of the troposphere and lower stratosphere. If the retrieval is done at the tangent altitudes, the use of a limb scanning step smaller than the width of the instrument Field-of-View introduces instabilities in the retrieval and requires a regularization to avoid oscillations in the retrieved profiles.

A Tikhonov regularization with a novel automated procedure to determine the value of the regularization parameter will be implemented in the MIPAS Level 2 code for the analysis of spectra acquired in the new measurement scenario. The procedure is based on the criterion that the differences between the regularized and the nonregularized profiles should be, on average, equal to the errors of the regularized profile. This criterion leads to an analytical formula for the calculation of the regularization parameter. In this paper we present the results of this method in terms of both vertical resolution and errors of retrieved profiles.

Direct-fitting: a new approach for trace gases retrieval in the UV-visible spectral range

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Abstract

We present a new direct fitting algorithm developed for the retrieval of trace gas column amounts from remote sensing UV/visible spectrometers. In contrast to the commonly used Differential Optical Absorption Spectroscopy (DOAS) method, which relies on a two-step approach involving a slant column fitting followed by an air mass factor calculation, the algorithm makes a direct fit for the vertical column obtained through a direct comparison between simulated and measured spectral radiances. The inversion is based on a non-linear least-squares minimization where simulated radiances and weighting functions are calculated "on-the-fly" using, as forward model, the linearized radiative transfer (RT) model LIDORT. Ring effect resulting from rotational Raman scattering by molecular nitrogen and oxygen is treated using a parameterization of the Raman scattering source term that accounts for atmospheric absorption or using look-up-tables of correction spectra pre-calculated using LIDORT-RRS, an off-line version of the RT code where Raman scattering is included. In the retrieval process, ozone profiles are iteratively adjusted to the retrieved columns according to the TOMS version 8 ozone profile climatology. The code also includes handles to alternative atmospheric input data sets such as the Bremen DOC or the recently developed CHEOPS climatology. Temperature profiles are taken from the TOMS climatology and further adjusted as part of the retrieval.

The direct-fitting code is primarily designed for accurate total ozone retrieval from space nadir-looking sensors like GOME, SCIAMACHY, OMI and GOME-2. However it can also be applied to the retrieval of minor absorbers in the UV and visible range, like SO2, BrO, HCHO and NO2. Unlike DOAS, direct-fitting is not restricted to optically thin conditions and can handle strong non-linear absorption features such as those of ozone below 325 nm. In the present work, we concentrate on total ozone retrieval from GOME and SCIAMACHY nadir observations. First a characterization of the global error budget is presented according to Rodgers formulation. Sources of uncertainties at low sun in polar regions are highlighted. The study also includes comparisons with alternative retrievals using DOAS approaches. A particular attention is paid to the sensitivity of the inversion to the wavelengths selected for retrieval. Intervals in the range from 317 to 335 nm are investigated with the aim to establish the link between DOAS-like and TOMS-like algorithms and therefore contribute to a better assessment of the consistency of the long-term multi-platform total ozone data record.

Retrieval of BrO vertical distributions from SCIAMACHY limb measurements: Data quality assessment and algorithm improvements

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Abstract

In the recent years the efforts of several scientific groups were dedicated to an investigation of the BrO amount in the stratosphere aimed to answer a question whether the bromine loading is consistent with the current understanding of the stratospheric bromine chemistry. A special attention is payed to the lower stratosphere and upper troposphere regions were indications of significant disagreement between predicted and measured BrO amounts were found. To solve important problems arising with respect to the short lived bromine compounds in the lower stratosphere reliable observations of the BrO vertical distribution on the global scale are required.

At present, vertically resolved global measurements of stratospheric bromine can only be performed by the SCIAMACHY instrument which was launched on board the European Environment Satellite (ENVISAT-1) in March 2002 in a sun-synchronous orbit with an equator crossing local time of about 10 AM and 10 PM. The SCIAMACHY instrument measures the scattered and reflected solar radiation in limb and nadir geometry in the spectral range from 240 to 2380 nm and achieve the global coverage in 6 days.

Due to a complexity of the radiative transfer when measuring in the limb viewing geometry, sophisticated models and retrieval algorithms are required which could be sensitive to various input parameters. Additionally, the retrieval problem is complicated by a weak absorption of BrO. As recent comparisons show, this leads to a considerable disagreement between BrO profiles retrieved by different groups with respect to each other as well as with respect to balloon-born measurements. Furthermore, a strong scattering in the retrieved profiles is observed which is probably caused by the measurement noise.

This contribution is aimed to present first results of the joint project on the investigation of the retrieval quality of BrO vertical distributions from the SCIAMACHY limb measurements. The objectives of the project include an extended intercomparison of the retrieval results of different groups and a detailed discussion of the technical details with an aim to find origins of the disagreement and improve the existing algorithms.

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Session 4: Trace Gases in the Stratosphere

SCIAMACHY, an update and highlights of the scientific results 2002-2006

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Abstract

The Scanning Imaging Absorption spectroMeter for Atmospheric CHartographY, SCIAMACHY, was proposed in 1988 and was launched in 2002 aboard ENVISAT. It makes measurements of back scattered, reflected, transmitted and emitted electromagnetic radiation in the spectral range between 220 and 2380 nm.

Inversion of the measurements of SCIAMACHY yields three-dimensional information about trace gases, aerosol and clouds. Observations of atmospheric pollution in the troposphere, key constituents in the stratosphere and mesosphere are obtained. For example the following species and parameters are observed - troposphere: trace gases (O3, NO2 HCHO, (CHO)2, CO, SO2, H2O, CH4 and CO2), cloud and aerosol parameters - stratosphere trace gases (O3, H2O, BrO, OClO, NO2), PSC and aerosol - mesosphere: O3, NO emission, OH emission, OH, metal and non metal atomic emissions. In this presentation results and scientific highlights from the first four years of observations of SCIAMACHY will be presented and reviewed.

Retrieval of Stratospheric Trace Gases from SCIAMACHY Limb Measurements

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Abstract

Stratospheric profiles of various trace gases can be retrieved from limb measurements preformed by SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) instrument on ENVISAT satellite. A two-step method is used to retrieve stratospheric distribution of NO2, BrO and OClO. In the first step, slant column densities (SCDs) for the trace gases are derived from the SCIAMACHY limb spectra by Differential Optical Absorption Spectroscopy (DOAS) method. Second, the trace gases SCDs are converted into vertical concentration profiles applying radiative transfer modeling. The inversion is performed by an optimal estimation method. The retrieval algorithm includes radiative transfer modeling performed by full spherical radiative transfer model "Tracy". The Monte Carlo RTM method implements completely statistical approach of light paths and light scattering and absorption in the atmosphere, however it is time consuming and therefore it cannot be repeated for every iteration that requires reasonable linearisation to an a-priori atmosphere. We demonstrate the current status of the retrieval: the results agree well with climatological expectations and results acquired from other instruments.

Odin/SMR Limb Observations of Stratospheric Trace Gases during 2001-2005

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Abstract

Profile measurements of key constituents relevant to stratospheric chemistry and dynamics such as ozone (O3), nitrous oxide (N2O), chlorine monoxide (ClO), and nitric acid (HNO3), taken by the Odin Sub-Millimetre Radiometer (SMR), are presented.

The Odin/SMR instrument, launched in February 2001 into a polar sun synchronous orbit, employs 4 tunable single-sideband Schottky-diode heterodyne receivers in the 486-581GHz spectral range and a 1.1m telescope for passive observations of thermal emissions originating from the Earth's limb. Spectra are recorded using two high resolution auto-correlator spectrometers. Atmospheric measurements are performed in a time sharing mode with astronomical observations. Profile information is retrieved from the spectral measurements of a limb scan by inverting the radiative transfer equation for a non-scattering atmosphere. Stratospheric mode observations are performed approximately on two observation days per week. The characteristics of the recently reprocessed Odin/SMR stratospheric mode level-2 data (version 2.0) are discussed and the data quality is evaluated by comparison with correlative measurements of other spaceborne instruments such as for example MIPAS on Envisat. Scientific results are presented with emphasis on measurements taken in the polar winter stratosphere of both hemispheres during the period 2001-2005. The Odin/SMR measurements of nitrous oxide, chlorine monoxide, nitric acid, and ozone allow to study the chemical and dynamical evolution of the Arctic and Antarctic vortices by providing information on chlorine activation, denitrification, subsidence of vortex air, and on ozone loss.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (TEKES) and France (CNES).

New NNORSY-GOME-1 Global Ozone Profile Data Set

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Abstract

The Neural Network Ozone Retrieval System (NNORSY) was developed during the last years for total ozone and ozone profile retrieval from UV/VIS spectra (GOME-1) and total ozone column retrieval from IR satellite data (NOAA-TOVS). Version 1 of NNORSY-GOME-1 ozone profile retrieval was implemented for real-time processing of GOME-1 data at the DLR-DFD up to the failure of the tape recorder of ERS-2 on June 25, 2003 (http://wdc.dlr.de/data_products/SERVICES/GOMENRT/index.html). Latest developments for NNORSY-GOME-1 Version 2 yielded further improvements of retrieval accuracy and was applied to the whole GOME-1 data time range in order to generate a more than 9 year ozone profile data set with high vertical resolution at full GOME-1 spatial resolution. Comparison with other satellite ozone profile data products (SAGE, HALOE, POAM) as well as extensive geophysical validation against ozone sonde and lidar data as well as derived residual tropospheric ozone column will be presented. NNORSY processing is very fast and the ozone profile product has about the same or better accuracy as classical optimal estimation based retrieval schemes which makes NNORSY a candidate for further real-time processing on current or upcoming satellite sensors like SCIAMACHY on ENVISAT, OMI on EOS-AURA or GOME-2 on METOP.

GOMOS/ENVISAT overview

Johanna Tamminen[1], Erkki Kyrölä[1], Viktoria Sofieva[1], Jean-Loup Bertaux[2], Alain Hauchecorne[2], Francis Dalaudier[2], Didier Fussen[3], Odile Fanton d'Andon[4], Gilbert Barrot[4], Marielle Guirlet[4], Thorsten Fehr[5], and The GOMOS Team[6]

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Abstract

GOMOS (Global Ozone Monitoring by Occultation of Stars) on ESA's Envisat-satellite measures transmission of light through the Earth's atmosphere in the limb direction using the stellar occultation method. From transmissions it is possible to retrieve vertical density profiles of ozone, NO2, NO3, H2O, O2, aerosols, and neutral air in the stratosphere and mesosphere. High-resolution temperature profiles can be retrieved using data from the two fast photometers. Since the launch in 2002 GOMOS has measured more than 300 000 occultations. In this presentation we will show main highlights from GOMOS.

Dynamical origin of strong NO2 enhancement in the polar stratosphere and mesosphere observed by GOMOS ion ENVISAT

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Abstract

A strong enhancement of NO2 has been observed by GOMOS/ENVISAT instrument in winter 2004 at high north latitude. A layer with high NO2 concentration is detected at 65 km in Mid-January and goes down to the stratosphere in February. Such NO2 enhancement has been already observed after a strong solar proton event. In the present case there is no particular particle precipitation event at the time of the NO2 increase. We propose another explanation based on the dynamics of the middle atmosphere. If a strong air descent occurs in the polar mesosphere, for instance due to a wave breaking event, it will transport NOx from the upper mesosphere/lower thermosphere at 65 km. The further descent of NOx to the upper stratosphere is explained by the radiative diabatic descent into thewinter polar vortex. This hypothesis is supported by temperature observations of SABER/TIMED showing a strong temperature increase around 70 km at high latitudes at the time of NO2 increase. This increase is an indication of a strong adiabatic warming related to the air descent.

Non-operational products from the GOMOS instrument : mesospheric sodium, OClO and polar stratospheric clouds.

Didier Fussen[(1)] and the GOMOS team

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Abstract

Abstract: The ENVISAT satellite has been launched by ESA on March 1st 2002. On board, GOMOS measures the slant path atmospheric transmittance at tangent altitudes between 120 km and the ground. Apart from the major target species, the GOMOS transmittances contain small spectral details that could be exploited by averaging a large number of occultations in time-latitude bins. In particular, we will present results about the mesospheric sodium layer and the identification of polar stratospheric clouds. Also, the discovery of an OClO layer in the upper stratosphere in non-vortex conditions will be discussed. The evolution of the OClO polar activation over the period 2002-2005 will be analyzed.

MIPAS: Scientific Results

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Abstract

MIPAS measurements in the spectral range between 4.1 and 14.6 μm are processed in order to derive global distributions of temperature and more than 25 trace constitutents in the atmosphere. In addition, the broadband spectra allow to determine properties of Polar Stratospheric Clouds (PSCs) and aerosol amount after volcanic eruptions.

The strength of the MIPAS experiment is demonstrated by the simultaneous detection of the compounds of whole trace gas families (e.g. NOy) or of chemically coupled trace constitutents (e.g. ClONO2 and ClO). In addition, it will be shown that essential properties of PSCs (like particle radius and composition) can be derived from corresponding spectra including the spatial distribution and temporal development of PSCs. All this information can be used for studying chemistry, dynamics and microphysics in the stratosphere.

MIPAS data can also be used to study the tropospheric-stratospheric exchange (H2O distributions), the mesospheric-stratospheric exchange (NO/NO2 distributions), the influence of the varying solar radiation and non-LTE effects in the upper atmosphere. Further investigations deal with the analysis of highly resolved spectra in order to determine the concentration profiles of isotopes (e.g. of water vapour). These results yield complementary information on dynamics and transport in the atmosphere.

The talk will be concluded with future expectations on MIPAS results.

MIPAS observations of CFC trends

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Abstract

MIPAS is a Fourier transform interferometer on Envisat, observing the infra-red thermal self-emission of the atmosphere.

We investigate the trend in the observed concentrations of CFC-11 (CCl3F) and CFC-12 (CCl2F2) throughout the life of the instrument. From September 2002 to March 2004, the nominal 'high resolution' (0.025cm-1) reprocessed L1B data is used. New work was performed to enable the use of the 'reduced resolution' (0.0625cm-1) data now being taken so the trend calculation could be extended to early 2006.

CFCs are implicated in the catalytic destruction of ozone and the polar 'ozone holes'. They are controlled by the Montreal protocol, and this work provides some means of quantifying its effect.

The long time series from a single satellite instrument is useful for tracking the evolution of the CFC stratospheric loading, and checking the accuracy of simulations.

The profiles of these species were determined using 'MORSE', developed at Oxford. It uses optimal estimation. Resulting profiles were combined a posteriori and three-day means calculated on a monthly basis. These means were used to determine the trends in various zonal latitude bands and the stratospheric chlorine loading.

A Compendium of the Non-LTE Atmospheric Emissions Measured by MIPAS

Manuel Lopez-Puertas[1], Bernd Funke[1], Sergio Gil-Lopez[1], M. E. Koukouli[2], Thomas von Clarmann[3], Herbert Fischer[3], N. Glatthor[3], Udo Grabowski[3], M. Höpfner[3], S. Kellmann[3], M. Kiefer[3], A. Linden[3], M. Milz[3], T. Steck[3], G. Stiller[3], and Martin Kaufmann[4]

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Abstract

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is a high resolution limb sounder on board ENVISAT which scans the atmosphere at tangent heights from 6 up to 170 km with global coverage. Operational data processing by ESA is limited to the assumption of local thermodynamic equilibrium (LTE) which holds only for a limited number of atmospheric emitters in a restricted altitude range. A dedicated non-LTE data processor has been developed at the Instituto de Astrofysica de Andalucia (IAA) and Institut fur Meteorologie und Klimaforschung (IMK) in order to derive a manifold of additional quantities beyond the operational data products relevant to the chemistry, dynamics and energetics of the middle and upper atmosphere. The list of atmospheric parameters inferred under consideration of non-LTE includes (i) NO, NO2, and CO measured routinely from 6 to 70 km, (ii) pressure, temperature, CO2, O3, H2O, and CH4 measured in special mode observations up to 100 km, and (iii) various kinetic constants relevant to non-LTE populations of NO2, CO2, and H2O. The MIPAS data obtained during the first 2 years of the mission allowed to study (i) the O3, NOy, HOx composition changes due to the October/November 2003 solar proton event, and (ii) the implications of the downward transport of upper atmospheric NOx to the stratospheric NOy chemistry in the 2003 Antarctic winter. In this paper an overview of these scientific results will be presented.

Infrared Remote Sensing of Organic Compounds in the Upper Troposphere

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Abstract

Organic compounds are of central importance for studies of tropospheric chemistry. They are a key component in control of tropospheric ozone, act as tracers of dynamics, and provide indicators of large scale pollution influences, e.g. biomass burning. However, current measurement systems are mostly restricted to specific, in situ , field campaigns, and only recently have the first global datasets become available for this type of compounds. The measurement of formaldehyde columns by the Global Ozone Monitoring Experiment (GOME) has been an important step forward.

In recent years, it has been realised that there is the potential for measurement of key organic species in the upper troposphere using infrared remote sensing instruments, such as the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on ENVISAT. Here we will discuss the detectability of a number of organic species in the upper troposphere, in particular ethane, acetone, formic acid and PAN, with reference to a high resolution limb sounding infrared spectrometer such as the MIPAS instrument. In particular we will show evidence for the signatures of all four molecules in MIPAS-ENVISAT spectral data for the atmosphere and indicate likely concentrations in the light of current spectroscopic knowledge.

Retrieval of tropospheric Carbon Monoxide from MIPAS measurements

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Abstract

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), is operating on Envisat since March 2002, measuring high-resolution atmospheric limb emission spectra in the interval from 685 to 2410 cm^-1 with a resolution of 0.025 cm^-1. For each orbit MIPAS performs 75 limb scans, each made of 17 spectra, 14 orbits per day.

In order to manage this amount of data MIPAS/Envisat Payload Data Segment Level-2 analysis is focused on the retrieval of profiles of pressure, temperature and volume mixing ratio of six target species (H2O, O3, HNO3, CH4, N2O and NO2). Nevertheless, spectra contain signatures of various other species. In particular at IFAC the Optimised Retrieval Model code (ORM) has been used to perform the retrieval of profiles of CFC-11, CFC-12, ClONO2 , N2O5 and CO.

In this paper we present the results of CO profile retrieval and on CO monthly concentration mean maps.

Carbon monoxide is particularly interesting in the troposphere, where it is a signature of biomass burning and industrial activities. MIPAS CO measurements in the troposphere are made difficult by the overburden due to the high concentration in the stratosphere. Moreover CO spectral signatures lay in MIPAS Band D where the lowest SNR is observed. In order to reduce the uncertainties due to these causes, a dedicated retrieval framework has been developed around ORM to exploit the huge amount of MIPAS data and produce time and space averages of this species.

Spatial and temporal distributions of water vapour in the UTLS as observed with MIPAS/Envisat

Mathias Milz[(1)], Thomas von Clarmann[(1)], Herbert Fischer[(1)], Sylvia Kellmann[(1)], Andrea Linden[(1)], Tilman Steck[(1)], and Gabriele P. Stiller[(1)]

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Abstract

Water vapour is one of the most important greenhouse gases. Its distribution is highly variable in space and time. Measurements of the satellite-borne MIPAS onboard the European research satellite Envisat provide global coverage of water vapour profiles and other atmospheric state parameters. From July 2002 until March 2004 MIPAS was operated with the initial standard measurement mode which provided profiles covering a nominal altitude range from 6 to 68 km.

Retrieved distributions of water vapour, based on reprocessed ESA Level-1b spectra, covering the upper troposphere and the lower stratosphere are presented for different time periods. The distributions show latitudinal, longitudinal, and seasonal differences.

Time series for tropical measurements show an annual cycle for the lower stratospheric water vapour abundances and demonstrate upward transport of tropical airmasses entering the tropical stratosphere (tape recorder). For polar regions the subsidence of airmasses inside the vortex is visible.

Upper Tropospheric Measurements of Biomass Burning Emissions with the Atmospheric Chemistry Experiment (ACE) Fourier Transform Spectrometer

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Abstract

The ACE (Atmospheric Chemistry Experiment), also known as SCISAT-1, was launched on 12 August 2003 into a 74° inclined orbit by a U.S.-supplied Pegasus XL at 650 km altitude. The small Canadian-designed and built satellite contains three instruments with a shared field of view with the primary goal of recording high resolution atmospheric spectra taking advantage of the high precision of the solar occultation technique. The primary instrument is an infrared Fourier transform spectrometer (FTS) that records solar spectra below an altitude of 150 km at a spectral resolution of 0.02 cm-1 (maximum optical path difference of ±25 cm) from 750 to 4400 cm-1. The instrument is self-calibrating as low Sun solar occultation spectra are divided by exoatmospheric solar spectra from the same occultation. The ACE orbit yields tropical to high latitude occultations in both hemispheres with a vertical resolution of 3-4 km. We summarize studies of upper tropospheric CO, C2H6, HCN, CH3Cl, and CH4 from northern hemisphere high latitudes (50°N-70°N) recorded between June 29 and July 24, 2004, most likely resulting from increased fire emissions in Alaska and western Canada during that time. Elevated upper tropospheric CO, C2H6, HCN, and C2H2 were also measured at 15°S-45°S latitude between 30 September and 3 November 2004. We use other satellite measurements (MODIS fire counts and MOPITT CO and back trajectory calculations) to verify our interpreation of the ACE measurements. ACE measurements provide mixing ratios of constituents with a range of lifetimes with results of interest to modelers to study outflow and transport of source emissions and transport to the upper troposphere.

Envisat MIPAS measurements of CFC-11 and CFC-12: an add-on to ESA operational data

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Abstract

Envisat MIPAS measurements cover nearly continuously the period July 2002 to March 2004. ESA offline Level 1 and Level 2 reprocessing of MIPAS measurements during this period is completed by now. Calibrated infrared radiance spectra (4-15 micron) and atmospheric data (vertical profiles of pressure, temperature, and six trace gases) are available for further analysis. A general fast forward model and an optimal estimation retrieval processor suited to derive additional trace species from MIPAS measurements as well as other mid-infrared limb-sounding experiments have been developed in Juelich. The retrieval system was applied to derive the global distributions of CFC-11 and CFC-12 abundance and aerosol extinction coefficients near 10.7 and 12.0 micron from the MIPAS radiance measurements. Error studies indicate good quality of the retrieved CFC-11 and CFC-12 data (total error 4-7%). Further studies show that the influence of a priori on the obtained results is rather minimal (below 5-10% at most heights). Comparisons against MIPAS retrievals carried out by other working groups and first successful validations with in situ measurements show that the retrieved data are suited for further scientific analysis. Climatological mean values and standard deviations compare well against results of other satellite experiments. Being long-lived trace gases, CFC-11 and CFC-12 are rather useful to study transport processes in the lower stratosphere and upper troposphere or to evaluate transport in atmospheric models. A Kalman filter approach was applied to compare the MIPAS measurements of CFC-11 and CFC-12 against simulations obtained by the Chemical Lagrangian Model of the Stratosphere (CLaMS). The diagnostics of the Kalman filter give further information on the self-consistency of the derived data and help to check the error budgets. The comparison also shows in which atmospheric regions transport modelling in CLaMS is satisfactory or might be improved.

NOTES

Session 5: Trace Gases in the Troposphere/Air Quality

Synergistic use of different atmospheric instruments: What about the spectral parameters?

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Abstract

Optical measurements of atmospheric minor constituents are performed using spectrometers working in the UV-visible, infrared and microwave spectral ranges. In particular recently the satellite ENVISAT has been launched with three spectrometers on board, SCIAMACHY and GOMOS working in the UV-visible spectral region and MIPAS working in the thermal infrared. In the future, the combined use of Nadir-viewing UV-visible and thermal infrared spectrometers (onboard remote-sensing satellites such as OMI and TES onboard EOS-AURA, or GOME-2 and IASI onboard MetOp) will provide an important improvement of vertical trace gas concentration profiles. The analysis and interpretation of the atmospheric spectra require good knowledge of the molecular parameters of the species of interest as well as of the interfering species. This is true not only in the spectral domain used to retrieve the species (thermal infrared for MIPAS for example) but also in the other spectral domains used by other instruments: Meaningful comparisons of profiles retrieved by various instruments using different spectral domains require indeed that the spectral parameters are consistent in these spectral domains. To illustrate these points we will concentrate on two molecules namely ozone and formaldehyde.

In the mid-infrared range, the 10 μm ozone band is very strong and is the most widely used to derive concentration profiles. In the UV region, the Huggins and/or Hartley bands are currently used for spectroscopic remote-sensing of ozone. In this talk we will present two sets of results: - First a careful comparison of four sets of ozone line intensities measured independently in the 10 μm region has been achieved. From them new and more accurate transition moment constants for the v1 and v3 bands of 16O3 were derived and used to generate new line positions and intensities. These new spectroscopic parameters allowed one to simulate atmospheric spectra better than the previous spectroscopic parameters showing that on a relative basis the new spectral parameters are of better quality [1]. - Second, there have been rather few intercomparisons of ozone absorption cross sections in the UV and mid-infrared regions. We will present the results of such comparisons either between the 10 μm region and the absorption of ozone at 254 nm or between the 10 μm and the Huggins band showing that still some inconsistencies at the level of 4-5% exist.

For the measurement of atmospheric formaldehyde concentrations, mid-infrared and ultraviolet absorptions are both used by ground, air or satellite instruments. It is then of the utmost importance to have consistent spectral parameters in these various spectral domains. Consequently the aim of the study performed at LISA was to intercalibrate formaldehyde spectra in the infrared and ultraviolet regions. The experiments were performed by acquiring simultaneously UV and IR spectra at room temperature and atmospheric pressure using a common optical cell. The reactor contains two multiple reflection optical systems interfaced to a Fourier transform infrared spectrometer and to a UV-visible absorption spectrometer. The results of the work will be presented allowing one to point out a much better agreement with one of the various UV absorption cross sections available in the literature.

Atmospheric processes in the upper troposphere and lowermost stratosphere as seen by MIPAS

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Abstract

Although designed primarily for observation of the stratosphere, MIPAS provides a wealth of valuable data on the upper troposphere and lowermost stratosphere (UTLS). Processes in the UTLS relevant to chemistry-climate coupling and observed by MIPAS include the distribution of greenhouse gases in the troposphere, transport of water vapour through the (tropical) tropopause, stratosphere/troposphere exchange in the extra-tropics, biomass burning and long-range transport of pollutants in the upper troposphere, and chemical processes in the TTL. Examples for episodes representing such processes have been analysed on basis of distributions of trace gases retrieved from MIPAS spectral data with the scientific processor at IMK/IAA. In particular these are UTLS water vapour, HDO, ozone, HNO3, CFCs, SF6, CH4, N2O, CO, PAN, C2H6, clouds, and temperature. In this contribution, an overview will be given on the scientific MIPAS results related to UTLS.

The IMK/IAA MIPAS-ENVISAT TEAM is: T. von Clarmann (1), H. Fischer (1), B. Funke (2), Gizaw Mengistu Tsidu (1,3), N. Glatthor (1), U. Grabowski (1), M. Höpfner (1), S. Kellmann (1), M. Kiefer (1), A. Linden (1), M. López-Puertas (2), M. Milz (1), T. Steck (1), J. Steinwagner (4), G.P. Stiller (1), D.-Y. Wang (1,5)

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Ten Years of SO2 measurements from GOME and SCIAMACHY

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Abstract

Sulphur dioxide (SO2) is an important atmospheric pollutant. It is emitted from volcanoes, both during degassing and through eruptions, and also from anthropogenic activities such as coal burning, from refineries of oil and gas and nonferrous smelting. In the atmosphere, high concentrations of SO2 not only adversely affect human health but also contribute to acid rain and the resulting damage to the ecosystem. In addition, SO2 is closely linked to aerosol formation via sulphuric acid (H2SO4) with links to CCN formation, cloud droplet size and feedback mechanisms in climate forcing as well as heterogeneous chemistry.

In this study, one decade of SO2 measurements from the two satellite instruments GOME (Global Ozone Monitoring Experiment) and SCIAMACHY (SCanning Imaging Absorption spectroMeter of Atmospheric CHartographY) is presented. The data is analysed for volcanic and anthropogenic emissions, and the spatial, seasonal and inter-annual variability is studied. One particular focus is on the accuracy of the products and the potential to use different retrieval windows to obtain vertically resolved information.

Trends and seasonal variability in tropospheric NO2

Ronald van der A[(1)], Henk Eskes[(2)], Folkert Boersma[(3)], Twan van Noije[(2)], Michel Van Roozendael[(4)], Isabelle De Smedt[(4)], Jeroen Kuenen[(2)], and Ernst Meijer[(2)]

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Abstract

A 10-year data set of tropospheric NO2 (1996-2005) has been processed from GOME and SCIAMACHY observations using a combined retrieval/assimilation approach. This approach allows the retrieval of global, accurate tropospheric concentrations and detailed error estimates. The resulting dataset has been analysed with statistical methods to derive trends in NO2 and the seasonal variability on a grid of 1x1 degree worldwide. The seasonal variability allows us to distinguish the dominant sources of NOx emissions: anthropogenic (fossil fuel), biomass burning and soil emissions. By comparing the data with the cloud information derived from the same satellite observations the contribution of lightning to the total column of NO2 is estimated. The world-wide trends, seasonal variability, dominant source and anthropogenic emission estimates will be discussed.

Measurements of Tropospheric BrO, HCHO, and Glyoxal from the Ozone Monitoring Instrument on EOS Aura

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Abstract

Little more than one year after First Light, data products of minor trace species from the Ozone Monitoring Instrument are showing great potential for atmospheric chemistry studies: BrO, an important compound in stratospheric ozone depletion due to its high efficiency in destroying ozone molecules, has been observed by OMI in the troposphere over shelf ice, and recently over salt lakes and in volcanic plumes. Recent improvements in the retrieval of HCHO, the major proxy for volatile organic compound (VOC) emissions, produced from methane oxidation and isoprene emissions, and an indicator for urban air quality, has significantly enhanced the quality of this data product and has brought into reach its utilization in air quality studies. Finally, the observation of CHO-CHO (glyoxal), a VOC recently detected in ground-based measurements over Mexico City, constitutes the first-ever measurement of this elusive indicator of air quality from a satellite instrument. With ground pixel sizes of 13x24 km^2 at nadir and daily global coverage, OMI provides a unique data set for global tropospheric chemistry monitoring.

We present recent advances on the detection of tropospheric BrO released from Salt Lakes and in volcanic plumes, will give first satellite-based estimates of BrO-to-SO2, and will present updates on the retrievals of HCHO and CHO-CHO. The retrieval algorithm will be introduced briefly, and an overview of the status and availability of OMI data products both, operational (BrO, HCHO, OClO) and scientific (CHO-CHO), derived at the SAO will be given. Where available, results from OMI will be compared against to SCIAMACHY.

Satellite Chartography of Atmospheric Methane and carbon monoxide from SCIAMACHY onboard ENVISAT

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Abstract

The UV/Vis/near infrared spectrometer SCIAMACHY onboard the European ENVISAT satellite enables total column retrieval of atmospheric methane with high sensitivity to the lower troposphere. We apply an Iterative Maximum A Posteriori DOAS approach to derive vertical column densities of methane and carbon dioxide. Due to the low variability of CO2, its total column retrievals are used as proxy for the probed atmospheric column and thereby allow us to convert methane column densities to column averaged mixing ratios. In addition, CO2 abundances are modeled to account for possibly large seasonal variations in its total column. We discuss the retrieval algorithm and quantify possible impact factors on precision and accuracy (such as clouds and aerosols). The retrievals have been compared with methane abundances derived from the atmospheric transport models TM4 and TM5. High correlations between observed and simulated global CH4 column averaged mixing ratios are calculated for the entire 2-year period from 2003 through 2004. The theoretical retrieval precision of about 1.8% corresponds well with the observed average standard deviation between observations and simulations, which is on the order of 30 ppb. On the global scale, the most pronounced CH4 signal arises from source regions over India and South East Asia, broadly consistent with model simulations. SCIAMACHY retrievals, however, indicate higher CH4 abundances over tropical Africa and tropical America, pointing to hitherto underestimated CH4 emissions from tropical landmasses. First inverse modeling results using the methane retrievals will be shown to underline the enormous potential of SCIAMACHY with respect to global methane source inversions. Further, latest results of carbon monoxide retrievals revealing strongly enhanced abundances over the industrial regions in China and the seasonal patterns in biomass burning regions are shown.

Quantitative analysis of SCIAMACHY CO variability and its implication for chemistry transport models

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Abstract

Carbon Monoxide is an important atmospheric trace gas. It plays a key role in the global OH budget and thus in the cleansing capacity of the atmosphere and often is also used as a tracer for pollutant transport. The satellite instrument SCIAMACHY has been measuring CO total columns for several years now, allowing to study its inter and intra-annual variability. We present a quantitative and systematic analysis of SCIAMACHY CO total column measurements for the years 2003 and 2004. SCIAMACHY CO retrievals are hampered by the presence of an ice layer on the detector. However, a detailed correction scheme has been included in the retrieval algorithm, resulting in CO total columns with a precision of 1% for monthly means under ideal circumstances (cloud free pixels, high surface albedo, spatial averaging). For lower surface albedos a precision of less than 10% is obtained. Thus, SCIAMACHY CO total column measurements are of sufficient quality to provide useful new information. Comparisons with a chemistry-transport model simulation show similar spatial patterns for the global distribution of modeled and measured CO. Quantitative comparisons of modeled and measured seasonal variations show a good agreement for very different types of seasonal cycles. Differences do occur but can be attributed to an inaccurate representation of model emissions as is e.g. confirmed by recent updates of biomass burning emission data bases.

Measuring atmospheric CO2 from space using Full Spectral Initiation (FSI) WFM-DOAS

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Abstract

Satellite measurements of the atmospheric CO2 concentration is a rapidly evolving area of scientific research which can help reduce the uncertainties in the global carbon cycle fluxes and provide insight into surface sources and sinks. One of the emerging CO2 measurement techniques is a relatively new retrieval algorithm called Weighting Function Modified Differential Optical Absorption Spectroscopy (WFM-DOAS) developed by Buchwitz et al., (2000). This algorithm is designed to measure the total columns of CO2 (and other greenhouse gases) through the application to spectral measurements in the near–infrared (NIR), made by the SCIAMACHY instrument on-board ENVISAT. The algorithm itself is based on fitting the logarithm of a model reference spectrum and its derivatives to the logarithm of the ratio of a measured nadir radiance and solar irradiance spectrum. A detailed error assessment of this technique has been conducted and it has been found necessary to include suitable a priori information within the retrieval in order to minimize the errors on the retrieved CO2 columns. Hence, we introduce a new CO2 retrieval algorithm called Full Spectral Initiation (FSI) WFM-DOAS which generates a reference spectrum for each individual SCIAMACHY observation using the known properties of the atmosphere and surface the time of the measurement. Initial retrievals over Siberia and North America, for the year 2003, show that the measured CO2 columns are not biased from the input a priori data and that whilst the monthly averaged CO2 distributions contain a high degree of variability, they also contain significant spatial features. Comparisons to ground based FTIR data and the TM3 chemical transport model (Heimann and Körner, 2003) are also presented.

Remote sensing of Asian pollution from space: tracking the long range transport from China using ACE measurements.

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Abstract

With more than half of the world's population in its urban areas, Asia represents one of the most important pollution source regions. The cumulative effects of population growth, industrialization and increasing transportation could result in a significant enhancement of the emissions over this region. Furthermore, recent studies have shown that long range transport of pollution from Asia has significant influence on the chemical composition of the troposphere over the Pacific and downwind continents. The impact of this region on air quality, the global oxidizing capacity of the troposphere and climate therefore need to be analyzed and monitored on a local, regional and global scale. In this study, we explore the information provided by the available satellite observations on the transport and production of pollutants in the troposphere above Asia and downwind. We use the observations collected in 2004 and 2005 by the Atmospheric Chemistry Experiment (ACE) on the Canadian Scisat satellite. The ACE Fourier transform infrared spectrometer operates in solar occultation and allows the measurement of a series of trace gases with high vertical resolution (~3km) from the middle troposphere to the thermosphere. Self-consistent measurements of ozone and its main precursors CO, VOCs (C2H6, HCN, CH3Cl, CH4) and NOx (NO, NO2), as well as HNO3 and possibly PAN, allow the analysis of the transport and photochemistry within Asian pollution plumes during long range transport. However, the ACE measurement technique implies a limited coverage and does not allow for measurements below ~8km. Information from ACE are complemented with observation from the other satellite missions operating during the same time period: O3 from the TES/Aura instrument, CO measurements from the MOPITT/Terra and the TES/Aura instruments and NO2 from SCIAMACHY/Envisat. Their nadir viewing geometry allows a better spatial and temporal coverage and a good sensitivity to the free troposphere, but also implies a much lower vertical resolution. We examine the consistency and complementarities of the available observations.

Estimation of NO2 amounts emitted from the Portuguese wildfires in 2005: A synergistic use of observations by imaging and atmospheric instruments and chemistry-transport models

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Abstract

During August and September 2005, severe wildfires took place on the Iberian Peninsula. Wildfires are generally associated with large/strong emissions of NO2 and other ozone precursors. In this study, tropospheric vertical NO2 columns derived from SCIAMACHY observations are used to quantify NO2 emissions from wildfires and soils on the Iberian Peninsula. At DLR-DFD tropospheric vertical NO2 columns are operationally derived using a synergistic approach combining SCIAMACHY measurements and results from stratospheric and tropospheric chemistry models. First, the SCIAMACHY total slant NO2 column is separated into a stratospheric and a tropospheric part. The stratospheric slant NO2 column is derived from the chemistry and transport model (CTM) ROSE/DLR. This CTM is routinely applied for the assimilation of ozone derived from SCIAMACHY measurements. Secondly, the tropospheric vertical NO2 column is computed from the tropospheric slant column by applying a tropospheric air mass factor (AMF) depending on the NO2 profile, the surface albedo and the cloudiness. The AMF are calculated using the LIDORT radiative transfer model (v2.2+) and tropospheric NO2 profile shape information derived from the EURAD/RIU air quality model. The EURAD model system simulates the physical, chemical and dynamical processes which control emission, production, transport and deposition of atmospheric trace species. At DLR-DFD this model is operationally used to forecast the air quality over Europe. NO2 emissions from wildfires and soils are derived from the retrieved tropospheric vertical columns by steady state chemistry calculations. The emitted NO2 is assumed to balance the NO2 loss, which is due to transport and chemical conversion in the regarded domain.

Tropospheric Observations with the Ozone Monitoring Instrument (OMI)

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Abstract

The Ozone Monitoring Instrument (OMI) is the Dutch-Finnish contribution to the NASA EOS-Aura platform, which was launched in July 2004. OMI is the first of a new generation of UV-Visible spaceborne spectrometers that use two dimensional detectors. These detectors enable OMI to measure atmospheric trace gases and aerosols over the entire Earth within a single day and with high spatial resolution (13 km by 24 km at nadir), which makes this instrument extremely suitable for tropospheric research. Several of the OMI products contain information on the troposphere: the ozone total column and ozone profile, columns of NO2, SO2, HCHO, and aerosol optical thickness and aerosol absorption.

In this contribution case studies on tropospheric events will be discussed that show the capabilities of the OMI data. Using more than one year of OMI data, analyses on air quality in Europe will be presented that make use of the unique spatial resolution and daily global coverage of this dataset.

New Developments in the Retrieval of Tropospheric Ozone from GOME, SCIAMACHY and SEVIRI

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Abstract

Uv-vis nadir spectrometers, such as GOME and SCIAMACHY, provide height-resolved information on ozone spanning the troposphere and stratosphere. A well established scheme to extract this information from GOME data has been developed at RAL and has been applied to process the complete ERS-2 mission up to the tape-recorder failure in mid 2003. A new version of the processing scheme is currently being developed which will provide more accurate tropospheric information by modelling the effects of cloud and aerosol using results from ATSR-2 generated by the NERC GRAPE project. While this technique is providing valuable new insights into the distribution of tropospheric and lower stratospheric ozone, the quality of the tropospheric information in particular is limited. Retrieval simulations indicate that better resolution and precision in the troposphere could be obtained if the uv-vis observations are combined with measurements in the mid-infrared ozone band at 9.7 microns. In principal mid/upper tropospheric ozone should be clearly distinguishable from ozone in the lower troposphere / boundary layer. This additional information originates from differences in the sensitivities of the uv-vis and mid-ir to perturbations in ozone in the lower troposphere (the ir being relatively insensitive due to lack of thermal contrast with the surface, whereas uv-vis sensitivity extends to the ground). Several current and planned satellites include measurements in the 9.7 micron band including spectrometers such as METOP-IASI and imaging instruments such as MSG-SEVIRI.

This paper will (a) present an overview of the current state-of-the-art GOME/SCIAMACHY ozone profile retrieval scheme developed at RAL (b) report new results from a Eumetsat study which demonstrate for the first time the potential of a synergistic retrieval scheme to deliver enhanced information on tropospheric ozone by combining uv-vis measurements from GOME/SCIAMACHY with 9.7 micron observations from SEVIRI.

NOTES

Session 2.1: Posters: Instrument Performance/Data Quality/Intercomparison

Validation of ozone profiles retrieved from SCIAMACHY lunar occultation measurements

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Abstract

Stratospheric number density profiles of ozone were retrieved from lunar transmission spectra measured by Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY), over the high Southern latitude (60°S--90°S). The ozone profiles were retrieved for 2003 and 2004 data using the spectral window of 510-560nm. In order to assess the accuracy of the retrieved profiles, a comparison of the retrieved ozone profiles with ozone profiles inferred from HALOE, POAM-III and SAGE-II were carried out. The validation results show that the quality of SCIAMACHY ozone is within the accuracy of 10-25% in the altitude range of 20-40km.

Validation of OMI total ozone using ground-based Brewer observations

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Abstract

Near-to-real time as well as "archive quality" Brewer total ozone observations, which are performed with well maintained and calibrated instruments over the Northern Hemisphere have been used for the validation of the total ozone column product of the Ozone Monitoring Instrument (OMI) aboard the NASA EOS-Aura satellite. During the commissioning phase of OMI, the near-to-real time ground-based data, which are submitted to the WMO Northern Hemisphere Ozone Mapping Centre within few hours after observation, have been employed to check the behaviour of the OMI instrument as a function of measuring geometry. In addition the near-to-real time ground based data are also used as an early warning tool for the detection of possible problems during the operation of OMI. Archived ground-based data have been used to validate more than one year of OMI-TOMS and OMI-DOAS total ozone measurements. The comparisons show an agreement of better than 1% for the OMI-TOMS measurements and better than 2% for OMI-DOAS. Finally the validation results are compared with the respective GOME 4.0 and TOMS v8.

Global comparisons of total O3 columns from SCIAMACHY retrieved with Weighting Function DOAS (WFDOAS) Algorithm to OMI, GOME WFDOAS and ground-based measurements

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Abstract

The new satellite instruments SCIAMACHY (SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY) on ENVISAT launched in March 2002 and OMI (Ozone Monitoring Instrument) on AURA, launched in July 2004 deliver global data sets of total ozone columns. Global stratospheric ozone columns from 2004-2005 derived from these satellite instruments are compared to data of their predecessor GOME (Global Ozone Monitoring Experiment) on ERS-2 and to ground-based data from the Brewer-Dobson network in order to detect biases between these data sets. The comparisons are also analysed for dependencies to total ozone, solar zenith angle, seasons and latitudes. Data sets for SCIAMACHY and GOME are retrieved using the weighting function DOAS algorithm (WFDOAS; Version 1.0 for both instruments). For OMI the operational product is used. Results help to understand how these different global total ozone data sets can be linked together for ozone trend studies.

The evaluation of SCIAMACHY CO and CH4 scientific data products, using ground-based FTIR measurements

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Abstract

In the framework of the EVERGREEN project, three scientific algorithms, namely WFM-DOAS, IMAP-DOAS and IMLM, have been developed to retrieve the total column amounts of key atmospheric trace gases including CO and CH4 from SCIAMACHY nadir observations in its near-infrared channels. These channels offer the capability to detect trace gases in the planetary boundary layer, potentially making the associated retrieval products suited for regional source-sink studies. The retrieval products of these three algorithms, in their present status of development, have been compared to independent data from a ground-based quasi-global network of Fourier-transform infrared (FTIR)spectrometers. Comparisons have been made for individual data, as well as for monthly averages. To maximize the number of coincidences that satisfy the temporal and spatial collocation criteria, the individual SCIAMACHY data points have been compared with a 3rd order polynomial interpolation of the ground-based data with time. Particular attention has been paid to the question whether the products reproduce correctly the seasonal and latitudinal variabilities of the target species. We present an overall assessment of the data quality of the currently available latest versions of the CO and CH4 total column products from the three scientific retrieval algorithms.

The DCFI-ISAC MIPAS database: 2-D routine analysis of MIPAS observations

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Abstract

The measurements performed by MIPAS/ENVISAT at the original nominal spatial and spectral resolution have been analysed with the 2-D analysis system GMTR [Carlotti et Al., Appl. Opt. Feb. (2006)] in order to obtain the 2-D fields of pressure, temperature and VMR of H2O, O3, HNO3, CH4, N2O and NO2. The GMTR algorithm has been developed in the frame of an ESA supported study and is distributed as part of the BEAT tools (http://envisat.esa.int/services/beat/). The obtained results and a comparison with the ESA Level 2 MIPAS products will be presented and discussed.

Laser methods for the accurate calibration of satellite-derived aerosol and water vapor

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Abstract

Aerosol and water vapor have a twofold importance: from one hand, they are among the critical factor of our climate, from the other hand, they heavily affect satellite imagery. For this reasons, space-borne sensors are devoted to their monitoring or must take them into account for the measurement of other geo-physical parameters: e.g. in ocean color remote sensing marine radiance must be separated from the atmospheric contributions, which typically represent about 80% of the total. In this paper we suggest the development of calibrations/validations of the aerosol and water vapor satellite retrieval relying on the optical radar or lidar. In fact, a differential absorption lidar based on a carbon dioxide laser could accurately profile aerosol and water vapor in the planetary boundary layer, the optically thicker zone of the atmosphere.

Validation of UV and Ozone EO based data used in PROMOTE/MEDSUN service, by means of on-ground measurements

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Abstract

During Summer 2005 Flyby srl has delivered the MEDSUN public service with the supervision of the Regional Agency for Environmental Protection of Tuscany (ARPAT). The MEDSUN service, funded by the GSE-PROMOTE ESA program, provided a personalized safe sun exposure time by correlating the EO based UV Index with the customized personal phototype. The UV Index was a function of both EO based columnar Ozone and EO based cloud coverage. The Ozone was derived from SCIAMACHY/ENVISAT by KNMI. The cloud coverage was derived from SEVIRI/MSG by Flyby. The article presents the features of MEDSUN service and the results of two validations based on on-ground measurements. The first validation regards the EO based UV Index and was done using a UV broadband radiometer. The second validation regards the EO based total columnar Ozone and was done using Flyby's spectroradiometer SpectrAIR.

Ten years of NO2 comparisons between ground-based SAOZ and satellite instruments (Gome, Sciamachy, OMI)

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Abstract

SAOZ (Systeme d'Analyse par Observations Zenithales) is a ground-based UV-Visible zenith-sky spectrometer installed between 1988 and 1995 at a number of NDSC stations at various latitudes on the globe. The instrument is providing ozone and NO2 vertical column using the Differential Optical Absorption Spectroscopy in the visible range, during each twilight – at sunrise and sunset.

The ERS-2 Global Ozone Monitoring Experiment (GOME) in 1995 was the first satellite mission to provide a global picture of atmospheric NO2 with reasonable spatial and temporal resolution. It was then followed by SCanning ImAging spectroMeter for Atmospheric CHartographY (SCIAMACHY) onboard ENVISAT in 2002, and Ozone Monitoring Instrument (OMI) onboard EOS-AURA in 2004, with a similar capacity to monitor total NO2. All these instruments are nadir viewing mapping spectrometers, applying DOAS technique to derive NO2 vertical column in UV-Visible range from space.

Here we present the results of NO2 long term comparison between GOME satellite data and SAOZ ground-based measurements, for the whole period of GOME operation since 1995, and at various latitudes – tropics, mid-latitudes and polar regions of both hemispheres. More recently, comparisons are also presented with SCIAMACHY and OMI in 2004-2006. In general, the daytime satellite measurements (around noon) are found in agreement with sunrise ground-based data, with an average smaller difference in southern hemisphere, than in the north. A photochemical box model is used to explain and improve this agreement. However, some seasonal dependence of the difference between ground-based and satellite total NO2 remains, which can be related to the choice of NO2 air mass factor within DOAS processing of both systems.

BrO Profiling from Ground-based DOAS Observations: New Tool for the ENVISAT/SCIAMACHY Validation

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Abstract

A profiling algorithm has been developed at IASB-BIRA in order to provide low vertical resolution BrO profile in the 0-37 km altitude range from ground-based zenith-sky DOAS observations. This algorithm is based on the Rodgers Optimal Estimation Method (OEM) and includes a validated forward model accounting for the transfer of the multiply scattered radiation in a pseudo-spherical atmosphere and the diurnal variation of the stratospheric BrO. It has been applied to the ground-based zenith-sky UV-visible observations continuously performed at the NDSC station of Harestua (60°N, Southern Norway) since 1998. The reliability of our BrO retrievals has been also verified through correlative comparisons with SAOZ and LPMA/DOAS balloon measurements.

Here, the time-series of stratospheric and tropospheric BrO profiles and columns retrieved at the Harestua station are used to validate limb and nadir ENVISAT/SCIAMACHY scientific products for the 2002-2004 period. Retrieval algorithms from the following groups are involved in the validation exercise: IUP/IFE Bremen, IUP/IFE Heidelberg, and Harvard Smithsonian for limb BrO profiles and, IASB-BIRA, IUP/IFE Bremen, and IUP/IFE Heidelberg for nadir BrO total columns. Comparisons between ground-based UV-visible and SCIAMACHY data are also performed in the same photochemical conditions since the profiling algorithm includes a stacked box photochemical model, enabling the retrieval of BrO profiles at any solar zenith angle.

Validation of the ENVISAT synergetic aerosol retrieval

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Abstract

At DLR-DFD a synergetic aerosol retrieval method SYNAER was developed, which exploits the complementary information content of the radiometer AATSR and the spectrometer SCIAMCHY, both onboard ENVISAT. This combination of two instruments allows to retrieve several parameters of the atmospheric aerosol loading: - aerosol optical depth at 550 nm - aerosol speciation from a choice of pre-defined aerosol types - near-surface aerosol mass concentration (PM10, PM2.5, PM0.5) assuming a fixed boundary layer height

Application of the SYNAER algorithm faces limitations, which need to be quantified: - the accuracy of the results decreases significantly for bright surfaces - the retrieved speciation is ambiguous for low aerosol optical depth - the accuracy of the results decreases for high cloud fraction - the accuracy of the PM values depends on the assumed vertical profile

Within the ESA GSE project PROMOTE, SYNAER contributes to the air quality monitoring service with daily near-real time aerosol products and an archive of aerosol observations over the MSG field of view (Europe, Africa, Atlantic) and parts of Asia. As in all GSE services quality control through thorough and continuous validation is a key requirement by the users. SYNAER provides accuracy and quality information for each pixel with retrieval results.

It is the goal of this paper to summarize the validation results by inter-comparison to ground-based observations (AERONET, EMEP) achieved by these two core users of the PROMOTE consortium: NILU and UBA Austria. The pixel-wise SYNAER quality information will be assessed using PM data from the national ground-based in situ monitoring networks of Norway and Austria. Based on these validation results, a contribution to the quantification of the SYNAER limitations will be extracte

Comparisons of MIPAS V4.61 and Odin SMR V1.2 ozone data

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Abstract

We have compared level 2 MIPAS V4.61 and Odin SMR V1.2 ozone data using three methods, including Individual Profile Comparisons, zonal averages and balloon sonde matches for the period of July to November 2003. Direct comparisons showed both MIPAS and Odin SMR to generally agree within +/-10% between 19-52 km. However, on average, large differences (20%) were observed at the tropics below 25 km as well as a large difference (in excess of -30%) at the winter pole above 45 km. Between 30-45 km at all latitudes mean differences showed MIPAS to exceed Odin by 5-10%. Balloon profile comparisons used from seven different stations around the globe showed that below 30 km, both Odin SMR and MIPAS on average underestimated ozone by a maximum 12% and 5% respectively. Balloon matches also suggest that the differences seen at the tropics were possibly due to Odin underestimation, while the observed 10-15% difference seen between 30-45 km seen in the first two methods, could be due to MIPAS overestimation

Results from the Canadian Arctic Validation of ACE Campaigns from 2004 to 2006

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Abstract

Three Arctic measurement campaigns have been conducted in Eureka (Canada) in spring 2004, 2005 and 2006 to validate measurements from the Atmospheric Chemistry Experiment (ACE) satellite mission. Launched on 12 August 2003, the ACE satellite (SCISAT-1) is in an 74° orbit at 650 km altitude. ACE science operation began in February 2004. Two instruments on board the satellite provide measurements of chemical species: a high-resolution infrared Fourier Transform Spectrometer (ACE-FTS) and a dual UV-visible-NIR spectrophotometer called ACE-MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation). The main goal of the ACE mission is to provide measurements to increase our understanding of the ozone distribution in the upper troposphere and stratosphere, especially over the Arctic.

The validation campaigns were conducted at Environment Canada's Arctic Stratospheric Ozone (AStrO) Observatory (now PEARL - the Polar Environment Atmospheric Research Laboratory) in Eureka, Nunavut (80°N, 86°W) between February and April in 2004 to 2006. This period coincides with the most chemically active time of year in the Arctic and with a significant number of satellite overpasses. Seven ground-based instruments were operated during the 2004 campaign: a ground-based version of the ACE-FTS (PARIS-IR - Portable Atmospheric Research Interferometric Spectrometer for the Infrared), a clone of the ACE-MAESTRO, a SunPhotoSpectrometer (SPS), a zenith-viewing UV-visible grating spectrometer, a Bomem DA8 Fourier transform spectrometer, a Differential Absorption Lidar (DIAL) and a Brewer spectrophotometer. For the 2005 and 2006 campaigns, a Système d'Analyse par Observation Zénithale (SAOZ) instrument and a second Brewer spectrophotometer were added to the instrument complement. In addition to the ground-based instruments, balloon-borne ozonesonde and radiosonde sensors were flown frequently during both campaigns.

We focus here on comparisons of ozone, nitrogen dioxide and temperature measurements made by the ground-based, balloon-borne and satellite-borne instruments during the three ACE Arctic Validation campaigns. Comparisons of both retrieved columns and profiles will be presented. Also, the results from the three campaigns will be compared to highlight the differences between the years.

MIPAS Pointing assessment

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Abstract

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Abstract Text: The scientific L2 retrieval processor for MIPAS operated at IMK allows to retrieve pointing information, in terms of tangent altitudes, along with temperature. The retrieved tangent altitudes are independent of engineering line-of-sight information. The difference of pointing retrieved from the reprocessed high resolution MIPAS spectra and the engineering pointing information was examined wrt spatial/temporal behaviour. Among others the following characteristics of MIPAS pointing could be identified: Prior to December of 2003 there is a drift of about 50-100 m/h, which is due to a slow change in the satellite attitude. A correction of this attitude is done twice a day, which leads to discontinuities in the order of up to 2 km in the pointing. Further there is a systematic difference of mispointing between the poles which amounts to 1.5-2 km, i.e. there is a conspicuous orbit-periodic feature. The analysis of the correlation between the instrument's viewing angle azimuth and differential mispointing supports the hypotheses that part of this latter phenomenon can be attributed to an uncorrected roll angle of the satellite/instrument system of approx. 30-50 mdeg.

A comparison of CMAX-DOAS measurements and satellite retrievals of NO2 in an urban environment.

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Abstract

The Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) technique has been advanced by several groups over the last few years, primarily using a motorised telescope or mirror assembly to take sequential images along different viewing geometries. The Leicester based UV/visible Concurrent MAX-DOAS (CMAX-DOAS) system is based on the concept of observing several viewing geometries simultaneously, utilising an instrument that images from multiple viewing angles using a single CCD with an imaging spectrometer and a multi-track fibre-optic cable, giving an instrument that offers temporal resolution of a minute or less.

The Leicester CMAX-DOAS instrument has previously been tested during the NAMBLEX (North Atlantic Marine Boundary Layer Experiment) in Ireland in 2002 and more recently formed part of the NDSC inter-comparison campaign in Andøya, Norway in 2003. The system is now installed on the Space Research Centre roof at the University of Leicester performing measurements of nitrogen dioxide, ozone and other trace gas species.

Global NO2 data have been retrieved from measurements performed by SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY) operating on the European satellite ENVISAT and the Ozone Monitoring Instrument (OMI), launched onboard the NASA satellite Aura in July 2004. Both SCIAMACHY and OMI have good spatial resolutions making the instruments suitable for comparisons with measurements on an urban scale.

In this presentation, an overview of the instrumental setup will be given and the current performance and potential of the instrument discussed. Finally, a comparison of CMAX-DOAS retrievals and data from the SCIAMACHY and OMI instruments will be presented, examining the full range of spatial scales available for urban air quality monitoring.

GOME: scan-mirror degradation correction

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Abstract

Degradation of optical components in space is a problem affecting many remote sensing instruments, due to the prolonged exposure to the conditions in orbit. Degradation has been confirmed for GOME and will likely in the future similarly affect SCIAMACHY onboard ENVISAT, which makes understanding the degradation of GOME important. Over the 8 year life time of GOME, the measurements of the Earth radiances and the Sun irradiances were subject to different instrument degradation in the UV (e.g., scan mirror and PMDs). To quantify this degrading effect a comparison was made between the GOME reflectance spectra with forward simulations of GOME spectra based on adequate description of the atmosphere (ozone, temperature, and pressure profiles) obtained from co-located cloud-free independent ozone sonde measurements. For this purpose we used the polarization-sensitive measurement of the main channels of GOME, without correction for the polarization sensitivity of the instrument. The use of the polarization sensitive measurement excludes the degradation effect of the PMDs, and will isolate the scan mirror degradation.

Comparison of the Ozone Vertical Profiles from the Dobson Umkehr Measurements and the ECC Soundings in Poland with the EOS-MLS (on the Aura Spacecraft) Overpasses, 2004-2005.

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Abstract

The ozone vertical profiles derived from the Umkehr observations by the Dobson spectrophotometer at Belsk (51.50N, 20.47E) and from the ozonesoundings carried out at the nearest aerological station Legionowo (52.24N, 20.58E) have been compared with those measured by the MLS instrument on board of the Aura spacecraft during the sites overpasses for the period 2004-2005. It is assumed that the satellite-station distance should be less than 2 degree and 4 degree for the latitudinal and longitudinal difference, respectively. The bias, RMS error, and the correlation coefficients between the ozone content in the Umkehr layers (from the second Umkehr layer, 250-125 hPa, up to the ninth layer, 1.95-0.98 hPa) have been calculated using Dobson/sonde/MLS data. Ozone mixing ratio at selected levels in the lower and mid stratosphere (from 215 hPa up to 6.8 hPa) have been compared using the sonde/MLS data. The number of analyzed daily values was ~ 40 (Dobson/MLS), 60 (sonde/MLS) and 60 (Dobson/sonde) since August 13, 2004. The comparisons shows a good correspondence (bias ~ +/- 5% , RMS < 10%, correlation coefficient >0.5) between the ozone content in the Umkehr layers 4-8 and ozone mixing ratio at pressure < 50 hPa. At lower stratosphere (Umkehr layer 3) and upper stratosphere (Umkehr Layer 9) there is also statistically significant relationship between the data but the biases and RMS are ~ 2 times larger.

Intercomparisons of SCIAMACHY and GOME reflectances and geolocation

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Abstract

Cross-calibration of satellite sensors is essential for understanding multi-sensor data records. The ERS-2 and ENVISAT satellites carry a number of sensors which observe reflected UV/visible and emitted IR radiation. The GOME and SCIAMACHY instruments are low spatial/moderate spectral resolution grating spectrometers; ATSR-2 and AATSR are imaging radiometers. The overlap of measurements in time, space, wavelength and observation technique provides an opportunity to examine the cross-calibration and degradation of these instruments.

To evaluate the radiometric and geolocation accuracies of reflectances measured by SCIAMACHY, comparisons have been made with those measured simultaneously by AATSR in its three visible channels (approx. 550, 670 and 870nm) and its 1.6micron channel. This requires integration of SCIAMACHY spectra over the AATSR filter bands and integration of AATSR images over SCIAMACHY-nadir ground pixels. The comparatively small size of AATSR ground pixels allows the along-track and across-track geolocation of SCIAMACHY ground-pixels to be established quite accurately. The same methodology has previously been applied to GOME and ATSR-2 data. Results of both two- and four-way intercomparison between GOME, ATSR-2, SCIAMACHY (nadir), and AATSR will be presented examining the current data versions and spanning the respective mission durations.

Intercomparison of Global Total Ozone Measurements Retrieved from ENVISAT/SCIAMACHY Using Different State-of-the-art Algorithms

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Abstract

The SCaning Imaging Absorption spectroMeter for Atmospheric CartograpHY (SCIAMACHY) is an imaging spectrometer launched in March 2002 on the ESA ENVISAT platform. Its primary objective is to achieve global measurements of a number of important atmospheric trace gases, among which ozone. Combined with measurements from ESA's Global Ozone Monitoring Experiment (GOME), which was launched in 1995 but lost is capability for global coverage in June 2003, SCIAMACHY provides an opportunity to accurately monitor the state of the ozone layer over a period of more than a decade. However, this requires that the accuracy of the SCIAMACHY total ozone retrieval matches the one recently achieved for GOME as a result of algorithmic developments carried out at BIRA-IASB, KNMI and IFE-Bremen during 2003 under ESA/ESRIN funding.

In this work, we compare the results from three established state-of-the-art total ozone algorithms developed for GOME and applied to nadir backscattered light observations from SCIAMACHY, namely: SDOAS, the SCIAMACHY version of the GDOAS algorithm developed at BIRA-IASB for GOME and currently implemented at DLR in the ESA operational system of both GOME and SCIAMACHY; TOSOMI, an adaptation of the total ozone algorithm developed at KNMI for the Aura/OMI instrument; and WF-DOAS, an advanced modified-DOAS algorithm developed at IFE-Bremen. Although in principle trivial, the transfer of algorithms designed for GOME to the SCIAMACHY instrument comprises some difficulties mainly related to spectral calibration and reference data issues. In order to reach a target accuracy of 1% on total ozone retrievals, these issues must be carefully addressed. We focus on assessing the consistency between the aforementioned algorithms including the ESA SCIAMACHY off-line operational processor (SGP L12) after optimization to both GOME and SCIAMACHY observations. The latitude, solar zenith angle, cloud fraction and temporal dependences of the retrieved ozone columns are characterized. We concentrate on conditions where largest and/or systematic discrepancies are observed (e.g. Polar Regions and high solar zenith angle conditions). The aim is to improve the understanding of these discrepancies and thereby consolidate the data products. It is expected that the study will lead to a better understanding of the limits of the physical models and help to increase the quality of future algorithms.

Validation of the chemistry-transport model MOCAGE using satellite observations

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Abstract

Due to their scattering and absorbing properties, aerosols affect solar and terrestrial radiations, modifying Earth's radiative balance. Therefore, they may have an important role in climate change. In order to quantify the impact of aerosols on this change, it is important to consider aerosols in climatic simulations. The Chemistry-Transport Model of Météo-France MOCAGE reproduces the composition of atmosphere (three-dimensional gazes and aerosols concentrations). A validation of MOCAGE results is necessary if we want to couple it with a climatic model. Thanks to satellites, global data are at our disposal: satellites measure backscattered radiation and calculate the aerosol optical thickness. Considering that the particles are spherical and determining the complex refractive index according to aerosol type (black carbon, desert dust...) and wavelength [Torres, 2002], this parameter is linked to aerosol concentrations. Using a Mie code, aerosol optical thickness is calculated by this model. Comparing measured and computed data, we can globally validate MOCAGE results. This study shows that three-dimensional aerosols fields calculated by MOCAGE are reliable and can be used by a climatic model.

SCIAMACHY Light Path Monitoring Results

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Abstract

The spectrometer SCIAMACHY (SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY) on-board ENVISAT is measuring solar irradiances and Earthshine radiances from the UV to the NIR spectral region in nadir, limb and lunar/solar occultation geometry. From these measurements the amount and distribution of various atmospheric constituents are derived (O3, BrO, OClO, SO2, H2CO, NO2, CO, CO2, CH4, H2O, clouds, and aerosols).

To assure the quality of these data products at any time during the whole mission a detailed knowledge of the instrument status and behaviour is mandatory.

To achieve this a comprehensive monitoring concept has been developed and implemented, involving various dedicated calibration and monitoring measurements.

In this presentation, selected results from the analysis of these monitoring data are shown. Special emphasis is placed on the performance monitoring for the various light paths.

Overview of SCIAMACHY level 2 data quality

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Abstract

SCIAMACHY onboard Envisat observes the Earth reflectance in a wide spectral range (240-2380 nm), allowing the retrieval of a variety of species. Currently available products are: vertical columns of O3, NO2, BrO, SO2, H2O, HCHO, CO, CH4, CO2, slant columns of OClO, tropospheric columns of NO2, vertical profiles of O3, NO2, OClO, and BrO, absorbing aerosol index (AAI), cloud fraction, cloud top height, and other cloud properties, PSC, UV index and UV dose.

These products are generated at different scientific institutes (IFE/IUP Bremen, IUP Heidelberg, KNMI, SAO, BIRA-IASB, SRON, Dalhousie), in some cases as joint products. The matureness, availability, validation status, and quality vary considerably among these products. In order to facilitate the use of these products for research applications the involved institutes have agreed on common quality criteria regarding documentation, availability, and validation of their products. The quality assessment is performed by the SCIAMACHY validation product coordinators, under the responsibility of the SCIAMACHY VALidation and Interpretation Group, subgroup of the SCIAMACHY Science Advisory Group. All these products, their documentation, and their quality status are presented on a central web site, from where they can also be ordered.

Most of the UV-visible data products - O3, NO2, SO2, H2O, BrO total columns; OClO slant columns; O3, NO2, BrO profiles - already have acceptable, if not excellent, quality. Provisional near-infrared column products - CO, CH4, and CO2 - have already demonstrated their potential for a variety of applications. Cloud and aerosol parameters are retrieved, suffering from known calibration errors with the exception of cloud cover.

The operational SCIAMACHY processors established by DLR on behalf of ESA are currently undergoing a major upgrade which is expected to affect the quality of the operationally available total columns of O3 and NO2, slant columns of BrO, SO2, OClO, and HCHO, cloud cover and height, AAI, and profiles of O3 and NO2. The first operational data from the upgraded processors are expected to become available in the second quarter of 2006. The quality of some of the currently (January 2006) operational level 2 data products - total columns of O3 and NO2, slant columns of BrO and cloud cover - is acceptable for limited periods and geographical domains.

Validation of OMI Ground UV-Products

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Abstract

At the moment there is much work going on in the quantification of aerosols and its role in climate. Aerosols are strongly dependent on time and space and their exact specification is still an unsolved problem. Typically aerosols are accounted for in climate and atmospheric chemistry models by some kind of off-line aerosol data bases. The OPAC (Optical Properties of Aerosols and Clouds) plays a prime role in such off-line considerations. The OPAC is the result of aerosol science studies conducted in the last 20 years. However, the static OPAC tries its best to gather a lot of aerosol optical properties information but there has been no exact validation taken place which compares OPAC results with in-situ measurements on a global scale. The AERONET (AERosol RObotic NETwork) is a very successful worldwide network with the aiming of measuring and retrieving aerosol optical properties all over the world. We show in this poster a method for linking the OPAC data base with AERONET retrievals. We developed a Monte Carlo search algorithm which is capable of searching for solutions in the OPAC data base which best match AERONET retrievals (over Greece). The AERONET delivers only column integrated retrievals whereas OPAC delivers aerosol optical properties based on a combination of aerosol models of different nature. Eventually the results will be used for validation of satellite ground UV-products e.g. OMI data.

Multi-technique comparison of MIPAS O3 measurements with correlative data obtained by FIR-FTS measurements during the ENVISAT stratospheric aircraft and balloon campaigns (ESABC)

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Abstract

In the frame of ESA ESABC (ENVISAT Stratospheric Aircraft and Balloon Campaigns) activities in 2002-2003, two Fourier transform Far-Infrared limb sounders - namely, IBEX (Infrared Balloon Experiment) and SAFIRE-A (Spectroscopy of the Atmosphere by using Far Infrared Emission - Airborne) - were deployed in mid and high latitude flights, aiming at the validation of MIPAS L2 products for Ozone and other target species. For Ozone, in particular, a thorough comparison was performed by using traditional correlative analyses (comparing O3 mixing ratio profiles collocated within a chosen spatial-temporal vicinity), trajectory matching technique, quasiconservative coordinate analyses and chemical assimilation in a Chemical Transport Model.We report details of the adopted validation strategy and show how complementary information derived from different validation techniques and tools contributed to the quality assessment of MIPAS O3 data retrieved from observations during the instrument full spectral resolution mission.

Geophysical validation of temperature retrieved by the ESA Level 2 processor from MIPAS/ENVISAT measurements

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Abstract

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is operating on the ESA ENVIronmental SATellite since March 2002. The high resolution (0.025 cm-1) measurements acquired by MIPAS in the first two years of operations constitute a self-consistent set of data with very good geographical and time coverage. These measurements have been re-processed by ESA up to Level 2, with the most recent versions of both Level 1b and Level 2 algorithms. The products of the ESA Level 2 algorithm are geolocated profiles of temperature and of volume mixing ratio of six key atmospheric constituents: H2O, O3, HNO3, CH4, N2O and NO2. As for all the measurements made with innovative instruments and techniques, this data set requires a thorough validation. During the last year, a large team of European scientists spent great efforts in the validation of this data set (technically labelled with versions 4.61 and 4.62). In particular, the authors of this paper have focused their activities on the validation of temperature. The validation was carried-out by comparing MIPAS retrieved temperature with correlative measurements made by radiosondes, lidars, in-situ and remote sensors operated either from stratospheric balloons or satellites. Preliminary results show that MIPAS profiles are affected by a bias generally smaller than 1K. This bias is usually localized at the edges of the altitude range covered by the MIPAS scan (6 – 68 km). As already pointed-out by several authors [see e.g. Rodgers C. D. and Connor B. J., J. Geophys. Res. 108, 4116 – 4130 (2003)] the intercomparison of measurements acquired by instruments that have different characteristics is not a trivial task and requires specific techniques to be used. Therefore in this paper we illustrate both the techniques adopted for the intercomparison of measurements relating to instruments with different spatial response functions and the results of such an extensive validation work.

Two years of SCIAMACHY measurements: intercomparison of methane total columns from the 1.65 and 2.3-micrometer windows

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Abstract

Total columns of methane can be retrieved from two wavelength windows covered by SCIAMACHY: one at 1.65 micron in channel 6, the other around 2.3 micron in channel 8. Depending on the window, specific complications are involved in the interpretation of the results.

In channel 6 the retrieved columns are considerably affected by spatial variations in optical path length and must therefore be corrected, for example using carbon dioxide columns obtained from the nearby 1.58-micron window. Errors may be introduced in cases where the surface albedo varies rapidly with the wavelength, so that the optical path length becomes wavelength dependent.

In channel 8 these variations are much smaller, although not entirely absent. But in this case there is the need to correct for the effects (absorption and scattering) of the varying ice layer on the detector window, leaving some uncertainty about the adequacy of the correction.

Retrievals from two years of SCIAMACHY measurements in both windows have been performed using SRON instrument calibrations and temperature and moisture profiles from ECMWF data; these results will be presented and compared, and the respective merits of both windows analyzed, also with consideration to model results.

Inter-comparison on the influence of different cloud parameter algorithms for the derivation of O3 and NO2 vertical column densities from SCIAMACHY nadir back-scattered observations

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Abstract

The operational data processors for the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) onboard ESA's ENVISAT were recently subject to a major upgrade in its retrieval to several products. One focus was dedicated to the integration of the SCIAMACHY DOAS (SDOAS) algorithm from BIRA-IASB for the derivation of Ozone and NO2 vertical column densities from nadir back-scattered light observations. In deviation to the original approach, cloud parameter are provided by the newly integrated SACURA algorithm of IFE Bremen for cloud-top height and cloud optical thickness and the OCRA algorithm of DLR-IMF for cloud coverage. This is also in alternative to the operational implementation (GDP 4.0) selected for processing of GOME back-scattered light observations where the column densities are derived with the GOME DOAS (GDOAS) algorithm of BIRA-IASB in combination with the cloud algorithms OCRA and ROCINN of DLR-IMF. SACURA was selected because it provides additional cloud parameters. Thus, this presentation is dedicated to the effect of different cloud algorithms on the trace gas retrievals. For this, the operational SDOAS implementation at DLR-IMF in combination with SACURA and OCRA will be compared with the original SDOAS implementation based on the combination with the FRESCO algorithm developed at KNMI. Additionally FRESCO data are fed into the operational processor for cross-check. The study is completed by results of Weighting-function DOAS (WF-DOAS) of IFE-Bremen that use both OCRA/SACURA and FRESCO.

MIPAS Data Quality - Lessons Learned

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Abstract

The MIPAS instrument flown on Envisat has delivered an enormous amount of binary data. From these instrument data higher level products have been derived routinely.

While the scientific community hopes for geophysical products of highest quality, a number of technical constraints, atmospheric conditions and calibration uncertainties can limit the usefulness of some data products. Typical limitations range from data availability to geometric and radiometric accuracy.

After some years in orbit, a number of potential pitfalls is known today. We will outline how the data quality of MIPAS products can be monitored and how to circumvent the use of questionable products.

Our results will be presented mostly in tabular form allowing a direct comparison with other instruments and their products and we will conclude with an outlook on the potential gain of product re-processing.

Validation of 'cloud-free' tropical UTLS MIPAS ozone and water vapour

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Abstract

Understanding the dynamical, chemical and radiative processes that control the variation and distribution of trace gases in the tropical upper troposphere and lower stratosphere (UTLS), 12 to 21 km, is vital to characterise how this sparsely monitored region influences and connects to the global atmosphere. Satellite instruments overcome the temporal and spatial coverage restrictions of ground- and air-based instruments, potentially allowing continuous global atmospheric information to be obtained. This can enable investigation of large-scale transport, in addition to UTLS processes such deep convection, stratospheric dehydration and tropospheric ozone production.

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is a high resolution Infrared Fourier Transform Spectrometer that observes the Earth's limb from 68 km to the lower atmosphere at 6 km. Measuring tropical UTLS trace gas concentrations with remote sensing instruments like MIPAS is problematic as scattering due to cloud and aerosol particles at these altitudes can lead to distortion of the retrieved trace gas concentrations. A cloud detection algorithm incorporated into the operational MIPAS processor is used to remove cloud contaminated data from Level 2 vertical profiles. However, analysis of water vapour and ozone profiles display 'false' data values that may still be affected by contaminant cloud and aerosol particles. This suggests the operational cloud detector is not removing corrupt level 2 data effectively.

This paper will describe how a Leicester cloud detection methodology produces potentially cloud-free profiles and how this method can be used observe cloud distribution and occurrence in the tropical UTLS. To validate and assess the accuracy and precision of these cloud-free MIPAS water vapour and ozone data comparisons are made to 1) the solar occultation infrared instrument, HALOE and 2) in situ measurements obtained by the SHADOZ network. With emphasis on the UTLS and TTL layers, the seasonality of cloud "decontaminated" MIPAS ozone and water vapour in this region will be presented.

Long Term Monitoring of GOME/ERS-2 Calibration Parameters

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Abstract

After more than 10 years of successful operation and data processing, the extensive data set of the most important GOME in-flight calibration parameters in the GDP database has been investigated, in order to analyse the long-term stability of the instrument.

This study focuses on the wavelength calibration, especially on the selection of the spectral lines from the PtCrNe lamp measurements. Several lines were identified to be inappropriate because of their asymmetric shape and instability problems. They should not be used anymore in operational data processing, in order to ensure highest quality of the wavelength calibration.

The detector's pixel-to-pixel gain (PPG) correction is quite small over the whole life time of GOME, but nevertheless not negligible, especially for the minor absorbers (e.g. BrO). In channel 2 an increase of the RMS of the PPG by more than 70% was detected, between 1995 and 2002. In all channels an abrupt decrease took place at the beginning of 2002.

The detector's leakage current behaviour is very stable. It does not show effects similar to that of the PPG.

The intensity of the sun mean reference spectra show a strong decrease by more than 80% at 240 nm in channel 1, and by more than 40% at 310 nm in channel 2, due to instrument degradation and the ERS-2 pointing problem.

In the PMD Q-factor's time series, several peaks and outliers were found . These correlate with GOME instrument anomalies such as cooler switch-offs, instrument and satellite switch-offs, as well as special operations.

Apart from the degradation in instrument throughput, the analysed calibration parameters show a good stability over the entire mission time frame of GOME.

The results of this study will be used to further improve the GOME data products.

A new Tool for SCIAMACHY level 1b to 1c processing

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Abstract

For most user applications, SCIAMACHY Level 1b data require processing to Level 1c.The official Level 1b-to-1c processing tools have been ESA's ENVIVIEW and BEAT toolkit.The software implementation of these processing tools is independent from the IPF software used in the operational Level 1b processor, or from the Level 1b-to-1c pre-processor used in the operational Level 1b-to-2 software.

In order to shorten the software update cycle, which may be necessary as the Level 1b processing evolves, ESA has initiated a developement to adapt the Level 1b-to-1c software of the prototype operational processor into a user-friendly tool.

In this paper we will present the user interface of this new "SciaL1c" tool, and we will give an overview of new features implemented.

Improvements of GDP Level 0-1 Processing software in the framework of CHEOPS-GOME

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Abstract

Over more than 10 years, the ERS-2/GOME Data Processor (GDP) has generated operational Level 1 data products with sufficient accuracy to obtain total column retrievals of Ozone and other trace gases, with high quality. As scientific algorithms were developed to perform retrieval of height-resolved Ozone profiles from GOME data, it became apparent that the standard GDP Level 1 product needed improvements, to cope with the enhanced requirements on instrument calibration posed by profile retrieval.

In the framework of the project CHEOPS-GOME, "Climatology of Height-resolved Earth Ozone and Profiling Systems for GOME", ESA has undertaken an effort to incorporate the necessary improvements in GOME calibration in the official Level 1 data. This will be achieved by changes in the GDP Level 0 to 1 Processing software.

In this paper we will describe the changes arising from the CHEOPS study, which comprise:

- background correction in band 1a
- azimuth dependence of the Sun diffuser BSDF
- correction of degradation in reflectivity, using a LUT generated by SRON
- improved polarisation correction, based on an algorithm used in KNMI's GomeCal software.

It is envisaged to reprocess the complete GOME Level 1 data record with the improved algorithms (containing also improvements in wavelength calibration, not covered by this study),and to disseminate the updated GOME Level 1 products, via FTP, in summer 2006.

Preliminary validation results of the OMI O2-O2 cloud product

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Abstract

Cloud correction is an important step in the retrieval process of trace gases from OMI spectra. There are two OMI cloud algorithms: one is based on the oxygen collission induced absorption band near 477 nm and the other is based on the filling-in of Fraunhofer lines by Raman scattering. Both retrieve an effective cloud fraction and cloud height. Verification and validation of these cloud products are relevant to the validation of the trace gas retrievals from OMI.

Since clouds are highly variable, a statistical approach is a logical way forward in this verification and validation process. The spatial and temporal consistency of the OMI O2-O2 cloud product is investigated using one year of data. This is mainly a verification of the retrieval algorithm. A comparison with external sources was performed. A first qualitative validation of the effective cloud fraction from OMI using MODIS/Aqua data shows good agreement. In this presentation a quantitative comparison between the cloud products of the two instruments will be shown.

Validation of the GOMOS high-resolution temperature product (HRTP) using lidar

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Abstract

At the beginning of 2006 the complete GOMOS mission data set, including the high-resolution temperature product (HRTP), covering the time period from July 2002 to January 2005 became available. Here, we present validation results of GOMOS high-resolution temperature profiles from comparison with all lidar stations, which contribute to the EQUAL project (ENVISAT Quality Assessment with lidar). A comparison with the data set from the pre-processor, which has been released in summer 2005 and which covers the time period from July 2002 to March 2003, will be used to document the improvement of the temperature data product.

Validation of IMK Ozone Profiles from MIPAS-Envisat

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Abstract

Vertical profiles of ozone are retrieved with the IMK scientific semi-operational processor from spectra measured by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) aboard the environmental satellite Envisat. The results are compared to profiles obtained by ground-based, balloon-borne, and satellite instruments.

The calculation of mean differences between MIPAS-Envisat and other instruments lead to bias determination. Furthermore, the comparison of common total random error (including smoothing error) and standard deviation of the differences gives an estimation of the precision of MIPAS ozone profiles.

Comparison of three simplified algorithms for atmospheric corrections of MERIS data over land

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Abstract

Today many different algorithms for atmospheric corrections are available. Most of them require detailed knowledge of atmospheric humidity, aerosols, and particles. This report describes two approaches to derive ground reflectances from satellite images without the need for detailed atmospheric observations. The first method makes use of the spectral signature of water, while the second method is based on the spectral signature of dark dense vegetation. The radiative transfer program MODTRAN is used to estimate the functional relationships between the atmospheric radiative properties and the difference between top of atmosphere (TOA) reflectance and ground reflectance for both, water and dark dense vegetation. The third method, based on the assumption of a very clear atmosphere, has been developed for the case of absence of water and dark dense vegetation in the scene. These methods have been extended and adapted for use with MERIS data. The algorithms are applied to the different spectral channels of MERIS and to MERIS data of different geographic regions. The results show the advantages and disadvantages of the different methods when applied to MERIS data. Based on these results some guidelines are derived to decide which algorithm should be selected for which conditions, i.e. wavelength and geographic region. The retrieved optical depth is compared to measurements of ground stations to estimate the accuracy of the different algorithms when applied to various conditions. The different methods are furthermore analyzed to determine the effect of modeling errors and the most crucial parameters and uncertainties, i.e. knowledge of the ground reflectance for the first two methods. The clear water method works well in the infrared, since the water reflectance is known to be very small. But in the visible wave length every lake has its own spectral signature, depending on turbidity, sediments, algae etc. Therefore a simple approach is used to determine the clearest water in the scene. But nevertheless the uncertainties remain large in the visible spectrum for this method. Since the dark dense vegetation method cannot be directly applied to the infrared channels, some form of extrapolation was necessary. Fortunately there is a strong correlation between the atmospheric radiative properties in the red and the infrared. This correlation is used to extend the dark dense vegetation method to the infrared. The third method is restricted to very clear atmospheric conditions. It will underestimate the influence of the atmosphere for hazy conditions. This method is advantageous if applied above mountains since the ground level elevation is considered in the algorithm.

SCIAMACHY radiometric calibration

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Abstract

We investigated certain aspects of the quality of the radiometric calibration of the satellite instrument SCIAMACHY, and find that there are errors in the radiometric calibration of SCIAMACHY. To be more specific: the reflectance of the level-1 product shows errors ranging from 10 to 20 percent, depending on wavelength. This result is confirmed by other sources as well, and may be relevant for people interested in the quality of SCIAMACHY level-1 data.

OMI in-flight wavelength calibration and the solar reference spectrum

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Abstract

The Ozone Monitoring Instrument (OMI) was launched in July 2004 and is one of four instruments onboard NASA's EOS-Aura satellite. OMI is a nadir-viewing UV-VIS spectrometer ranging from 270 to 500 nm, with a spectral resolution of roughly 0.5 nm. OMI obtains daily global coverage with a nominal sampling at nadir of 13x24 km.

This presentation discusses the in-flight wavelength calibration and the solar reference spectrum. Wavelength calibration is performed by means of fitting Fraunhofer structure in the radiance and irradiance spectra. It was found that when observing rapidly changing radiance signals, the wavelength scale changed in tune with this. We describe the details of this effect, explain the underlying optical mechanism and show that we can (and do) correct for it with a high degree of accuracy. This effect will be observable in any spectrometer with similar optics as that of OMI.

A prerequisite for any in-flight wavelength calibration method that uses Fraunhofer lines in the observed spectra, is a good quality high resolution solar reference spectrum. We describe how we calculate such a spectrum, based on combining high resolution ground based data, and medium resolution satellite mesurements.

NOTES

Session 3.1: Posters: Retrieval Algorithms

Retrieving the Velocities of Motion of Air Masses from Digital Images of Clouds

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Abstract

An interdisciplinary project, aimed at developing tools for the determination of the physical characteristics of the atmosphere by means of ground-based digital imaging in the visible range is now in progress. Determining the 3-dimensional field of velocities of motion of the air masses from digital images of clouds is among the central tasks. The idea of the approach is to identify patterns of the cloud structure with characteristic shape and to measure their angular displacement by tracking them in series of consecutive digital images, taken at optimal time intervals.

To do this, methods for the choice of appropriate patterns in the image of a cloud (that depends on the type of the cloud) and for recognizing these patterns on later images under the condition of continuous deformation of the cloud shape needed to be developed. We present here some results, obtained with the first versions of the computer codes we are now developing. A few images of relatively simple cloud systems have been digitally processed to: (a) automatically determine the cloud type; (b) automatically choose a few characteristic patterns in the image of the cloud, and (c) recognize each of these patterns in a sequence of images of the same cloud by adopting a parametric model of the deformations of the cloud shape with time (an assumption that is valid for sufficiently small time interval between the consecutive images). We also discuss the algorithms for obtaining the 3-dimensional field of velocities by means of parallel processing of synchronous images of the sky taken from distant points of view, and give an estimate of the accuracy of the method.

Evidence for Solar Signals in the Mesopause Temperature Variability above a Midlatitude Station in Europe

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Abstract

Nocturnal temperatures are almost continuously derived from OH* (3-1) near infrared emissions in the upper mesosphere (around 87 km) above Wuppertal (51°N, 7°E) from ground based measurements since 1980. The time series analyzed covers the time interval from 1980 until 2004 and consists of 4414 well documented night mean temperature data. OH*-temperature fluctuations on temporal scales of about 3-20 days are derived by removing seasonal and longer term trends from the data record by means of applying various spectral analysis techniques such as the harmonic analysis, maximum entropy method and the wavelet transform, respectively. The residuals are found to well reflect the activity of planetary waves. Temperature variations show a longer term modulation peaking around 1980 and 1996; minima are encountered around 1986 and 2005. Thus, no conclusive correlation with the solar F10.7cm flux is found. Reasonable agreement of planetary wave activity with the general solar bipolar magnetic field (22-year Hale cycle) is found instead. Further agreement is found with the length of the day (LOD) implying that the internal terrestrial magnetic field is superimposed by the solar magnetic field (Hale cycle) causing modulations of the total magnetic field in the Earth's interior and which leads – in turn - to a modulation of the electromagnetic coupling of angular momentum between the Earth's core and the Earth's mantle. As a result the Earth's rotation period - and thus the activity of planetary waves - should be modulated with the solar magnetic flux, e.g. the quasi 22 year Hale cycle. Planetary wave activity is further found to be modulated by a quasi two year oscillation. The modulation is strongest around 1994/1995 and lowest around 1988 and 2004, respectively. It is found that wave activity is enhanced always when the QBO is in its westerly phase. Keywords: Hydroxyl airglow; Planetary waves; Solar cycle influence; Mesopause temperatures; QBO

Regridding of remote sensing retrievals: formalism and application to GOME vs Microwave ozone profile comparison

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Abstract

One of the difficulties commonly arising in geophysical intercomparison studies is the inhomogeneity of the comparison data. As a matter of fact, two independent measurements of an atmospheric constituent profile to be compared to each other will generally be expressed in different units, and onto fully different vertical grids. For many applications, these differences can be most simply eliminated by the application of interpolation or averaging operators, or of auxiliary profiles such as temperature and pressure to achieve homogenized profile units. In the case of profiles retrieved from remote sounding measurements using advanced techniques such as optimal estimation, however, the situaton is complicated by the different dependency on a-priori information, expressed in differing averaging kernels. In order to solve this problem, a formalism was developed that allows the homogenization of retrieval products (and in particular of their numerical grids) without preliminary alteration of the respective retrieval algorithms. In a recent study, this formalism was applied to the comparison of independent ozone profile measurements by the Global Ozone Monitoring Experiment (GOME) and a ground-based microwave radiometer (MW) during 2000. We present the results of this study, and describe the employed linear profile transformation method.

A proposed algorithm for line-of-sight wind retrieval from MIPAS level 1 spectra

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Abstract

Because of their high spectral resolution (0.035 cm-1 unapodised), MIPAS spectra contain potential information on the Doppler shifts due to wind along the line-of-sight (LOS) in a given limb scan sequence. The intrinsic absolute stability of the MIPAS wavenumber scale is not granted to the required precision, however. The present ESA operational spectral calibration algorithm is relying on the position of the atmospheric emission lines themselves (assuming no wind effect and in a small range of tangent altitudes where lines are neither too broadened by pressure effects, nor too weak). An algorithm has been proposed that just relies on the relative stability of the wavenumber scale within a given limb scan sequence (usually 17 spectra recorded from about 65 to 10 km in approximately 75 s) to derive a vertical LOS relative wind profile. This LOS wind information is derived by an appropriate algorithm called ANA (for analytical method because an explicit formula is used) producing a wavenumber scaling factor between consecutive spectra in a given limb scan. This scaling factor is derived from a number of optimised wind spectra windows spanning the 5 bands covered by MIPAS. Because of the relative nature of the process, the absolute interband/interwindow calibration is not needed and an optimum weighted average value of the scaling factors can be derived with weights (and an associated occupation matrix) representing the impact of radiometric noise in each window w and for each pair of tangent heights. The average scaling factor is then converted to a relative LOS wind difference and, assuming the LOS wind is known at one level, an absolute LOS wind profile can be provided. The algorithm has been developed (through an ESA contract study), coded and tested on simulated spectra (to check the performances of the method and to establish the noise amplification error factors). We are in the process of testing the algorithm on a set of selected MIPAS spectra recorded in correlation with standard meteorological radio-soundings (providing T, u and v as a function of P). Preliminary results of this study will be presented including comparisons with ECMWF and sonde results, showing that a precision reaching the target of 5 m/s could be expected in the altitude range 20 to 35 km.

The Retrieval Algorithm of the SCIAMACHY Limb Processor Version 3.0

Adrian Doicu[1], Siegfried Hilgers[1], Albrecht von Bragen[1], and Bernd Aberle[1]

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Abstract

In this presentation we describe the main features of the retrieval algorithm for the SCIAMACHY limb retrieval processor. The regularization method used is the iteratively regularized Gauss-Newton method with a descending sequence of regularization parameters. The problem is solved iteratively and at each iteration step, a trust region method with simple bounda on the variables is employed to compute the new iterate. The regularization matrices are stochastic (the Choleski factor of the a priori covariance matrix) or deterministic (the discrete approximations to the derivative operators). The selection of the regularization parameters is based on the L-curve method and on the analysis of the residuals at each iteration step.

Uncertain Model Parameters for SCIAMACHY Limb Retrieval

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Abstract

In this presentation we describe two techniques for treating the uncertain model parameters for the SCIAMACHY limb retrieval processor. As uncertain parameters we consider the tangent height and the surface albedo. The first technique consists in a simultaneous estimation of the uncertain parameters and the target parameters, while the second technique is based on a generalized covariance matrix including all information on spectral sensitivity of the measured signal to the uncertain parameters.

Odin-SMR observations of the tropical upper troposphere

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Abstract

Background: Water vapour and clouds in the upper troposphere (UT) represent a major uncertainty for prediction of the future climate. This is because these constituents have a crucial impact on the radiative balance, but are today poorly treated in climate models. This in turn is caused by a lack of relevant measurement data. In short, the global observation systems of today fail to provide results that can be used for further improvement of climate models. Main considerations for satellite sounding of water vapour in UT are achievable vertical resolution and cloud penetration capability. These requirements are probable best addressed by microwave limb sounding. The sub-mm radiometer onboard the Odin satellite, Odin-SMR, was designed for strato- and mesospheric research and performs limb sounding at frequencies around 500 GHz since the launch in February 2001. The observations have sensitivity down to about 10 km, but spectra with tangent altitudes inside the troposphere have been ignored due to unknown impact of cloud scattering. This effect can now be rigorously simulated by a new radiative transfer software (ARTS) and first retrievals of tropospheric quantities have been performed.

Results: The possible tropospheric retrieval products of Odin-SMR are water vapour and cloud ice content, above 10 km. A first retrieval scheme has been developed, where only spectra with tangent altitudes below 9km are used. In this way spectra can be inverted individually, uncertainties in sideband filter characteristics can be ignored, and the presence of clouds is comparably easily determined. This retrieval scheme gives the (all weather) mean relative humidity between 10 - 14km, and column of cloud ice above 10 km. The main water vapour retrieval uncertainties are compensation for cloud scattering and spectroscopic information. Reliable validation data for tropospheric UT humidity are very sparse, but a first comparison with MOZAIC data showed that systematic errors are at least below 20%. Retrieved cloud ice columns have been shown to be in general agreement with corresponding ECMWF field, while large deviations were found in comparison to a climate model. The main retrieval issue for cloud ice is the necessary assumption on particle size distribution, a problem shared with, and probably more difficult for, all other existing remote sounding techniques.

In comparison to visible and IR measurements, the impact of clouds is here considerably weaker and this has two advantages: 1. Humidity is measured with a much smaller interference by clouds. 2. Estimates of cloud ice represent bulk properties (not biased towards the cloud top). The reference data set for UT humidity is also UARS MLS, that operated around 200 GHz where the cloud impact is even smaller. Since 2004 these observations are being continued by EOS MLS. The final quality of the MLS and Odin-SMR UT data should be similar, but with a a much less dense data set for Odin-SMR. However, Odin fills partly the gap between the UARS and AURA missions and gives an independent view of the tropical UT. The MLS and SMR cloud ice retrievals are an important complement to the CloudSat/CALIPSO mission. The latter performs lidar and radar observations that are most sensitive to smallest and largest ice particles, respectively. The passive sub-mm measurements give a lower spatial resolution, but the cloud signal is here more directly related to the total ice mass.

Temperature Measurements in the Mesopause Region (~87 km) on board of RV Polarstern from 54°N to 34°S (ANT XXIII/1)

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Abstract

Measurements of the hydroxyl rotational temperatures (OH*) were taken each night by a mobile ground-based IR-Spectrometer on board of the German research vessel "Polarstern" on its cruise from Bremerhaven (53.6°N, 8.6°E) to Cape Town (34.0°S, 18.5°E) from 13 October until 17 November 2005 (ANT XXIII/1).

Satellite-based measurements performed with the ENVISAT-SCIAMACHY instrument are compared to the ship-based data set over different climate zones. SCIAMACHY data are therefore validated over a wide latitude range with one instrument.

Temperature nightly means are analysed versus latitude and are compared to different climatologies (CIRA, MSISE90). Smaller scale temperature fluctuations are quantified versus latitude to analyse structures like systematic deviations in the data set in the different climate zones. A case study is presented showing the generation of gravity waves induced by low pressure systems over the Atlantic Ocean. Additionally other data sets like radiosonde and ozonesonde data are also analysed in terms of smaller scale variability.

ACE retrievals using Atmosphit, a user friendly fitting software based on the optimal estimation method.

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Abstract

A software running under MS-Windows operating system has been developed at ULB in order to simulate atmospheric infrared FTIR spectra and to retrieve vertical profiles of molecular abundances using the optimal estimation method (OEM). The software can handle several geometries (ground based direct solar absorption, space borne nadir observations and solar occultations) on single or multiple spectra. Output files allow for instance characterizing the retrievals for information content and error budget analyses. Atmosphit has been adapted to the instrumental properties of the Atmospheric Chemistry Experiment (ACE) instrument flying onboard the Canadian SCISAT satellite and applied to series of occultations on ozone and carbon monoxide retrievals.

Selected examples will be presented to pinpoint the major sources of error and the possible discrepancies between operational and OEM retrieved vertical profiles.

On The Selection Of Input Measurements For Neural Network Based Retrieval Algorithms

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Abstract

The derivation of atmospheric parameters from satellite remote sensing instruments plays a key-role in monitoring the Earth's atmosphere and understanding the chemical and physical processes therein. However, the atmospheric structure results from a complex interaction between radiative, physical and chemical processes. Neural Networks (NNs) can be a useful tool to face with such complexities. They are composed of many nonlinear computational elements (called neurons) operating in parallel and linked with each other through connections characterized by multiplying factors. This structure makes neural networks inherently suitable for addressing non-linear problems. The derivation of particular rules or statistical a priori information on the data to be processed is not necessary, and the neural networks establish the inverse mapping and the input-output significant relations on the base of data presented to them during the learning phase. Different NN-based algorithms for the estimation of atmospheric parameters from satellite data have been recently proposed. Since the satellite sensors provide measurements in a very large spectral range, the crucial point in the design of neural algorithms is the selection of the input measurements, which can significantly affect the final retrieval performance. In this work we focused on the inversion of vertical ozone profiles from GOME radiance measurements. Different methodologies, both automatic and model-based, aiming at the selection of neural network inputs have been analysed, and the obtained results have been critically discussed. According to this analysis, different neural algorithms schemes have been designed for the actual retrieval operation; the final selected topologies have been trained having in input the selected radiance values measured by the sensor, and in output the corresponding ozone profiles provided by the Rutherford Appleton Laboratory (RAL). Once trained, the estimation capabilities of the neural schemes has been extensively validated, either with satellite measurements of the Improved Limb Atmospheric Spectrometer (ILAS) boarded on ADEOS or with lidar observations performed at different stations belonging to the Network for Detection of Stratospheric Changes (NDSC), and the obtained results have been compared. It has to be reminded that the results of this study can be easily extended to the spectral measurements provided by other satellite instruments, such as SCIAMACHY, boarded on Envisat (2002), or OMI, carried by the EOS-Aura platform (2004).

New Global Static and Dynamic Ozone Profile Climatology - Validation, Comparison -

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Abstract

A new NNORSY-GOME (Neural Network Ozone Retrieval System for GOME) data set covers 8 years of global ozone profiles up to 61 km height and at full spectral resolution. It includes about 43.000 NNORSY-GOME orbits in the time range from June 1995 to June 2003. This data set was used to derive new global ozone profile climatology products. The specifications of the different climatology in-/outputs were defined within a user consultation.

First a static look-up-table climatology (LUT) was produced. User get monthly mean ASCII ozone profiles in 2.5° latitude by 10° longitude bins. Ozone profiles are offered in number density on 31 altitude intervals up to 61 km and also in volume mixing ratio on 28 standard pressure levels. Output information include climatological ozone profiles and error information. Furthermore a second and new approach based on neural network technique was followed to gain dynamical ozone profile climatology. To get ozone profiles optimized for current application besides information on date, time range and geographical position additionally total ozone and temperature profile can be used as dynamical input for a total of 4 differently specified neural networks. Each of them uses a separate combination of the named input parameters. Depending on the available input parameters the corresponding neural network is used to deliver a user specific climatological ozone profile. A software package for the dynamical climatology is available which comprises these 4 neural networks together with software tools for data conversion and interpolation. It allows the derivation of single climatological ozone profiles as well as user specific LUT climatologies.

Results of the different NNORSY-climatologies are presented. Also comparisons with other widely-used climatologies are shown.

Tropospheric and stratospheric BrO and NO2 columns derived by use of satellite observations and 3D CTM FinROSE

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Abstract

From satellite nadir measurements (GOME; SCIAMACHY; OMI) the total slant column densities (SCD) of NO2 and BrO can be retrieved using DOAS technique. In order to obtain tropospheric vertical column densities (VCD) two key problems arise: the quantification of the stratospheric column and the calculation of the tropospheric air mass factor (AMF). This work aims at combining satellite observations and chemical transport modelling to overcome these problems and to gain accurate tropospheric columns.

Stratospheric NO2 and BrO columns are derived at the instrument's overpass time by means of a stratospheric chemistry transport model, i.e. FinROSE-CTM, to take into account the stratospheric variability of these trace gases. To avoid a bias, the resulting stratospheric NO2 analysis is scaled to "clean" observation conditions by means of a reference sector. Reference pixels with optically thick and high clouds are selected for scaling the stratospheric model BrO output. In order to gain the trace gas tropospheric column the stratospheric slant column is subtracted from the DOAS slant column retrieval. The latter is taken from BIRA-IASB GOME product for BrO and KNMI GOME product NO2 slant columns.

MIPAS Reference Atmospheres

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Abstract

As part of the data processing activities for the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on ENVISAT, reference atmosphere profiles have been produced. These atmospheres consist of two forms: (1) a standard set of profiles for five typical atmospheric states ranging from tropical to polar winter (the data include typical, maximum, minimum and sigma profiles); (2) a four season, six latitude band climatology. Gases included in the climatology comprise not only the major trace gases retrieved operationally in the MIPAS trace gas processing suite but also a large number of species which contribute to the observed MIPAS spectra of the atmosphere. More than 30 trace gases are represented in the atmosphere files.

In this paper, an overview of the reference database will be given, known problems identified and expectations of future improvements will be provided. Particular attention will be paid to key molecules such as carbon dioxide, for which the climatology is now updated on an annual basis with considerable detail in the vertical profiles, and nitrous oxide where potential errors have been identified in pre-MIPAS data sets. The results will be of interest for retrieval, radiative transfer, instrument design and atmospheric model studies.

Bending Angle and Temperature Profiles from GOMOS in Comparison to Champ and Ecmwf Analysis Data

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Abstract

The Envisat platform, in orbit since March 2002, carries several instruments important for monitoring Earth's atmosphere, oceans, land, and ice. Amongst those the Global Ozone Monitoring by Occultation of Stars (GOMOS) instrument is dedicated to perform high-accuracy altitude-resolved global ozone monitoring as well as measurements of other atmospheric trace gases and of temperature. Depending on the selected star, measurements are carried out within an altitude range of about 15 km to more than 100 km.

We present results of GOMOS bending angles and retrieved temperature profiles compared to CHAMP and ECMWF analysis data. GOMOS temperatures are gained by exploiting pointing data of the Steering Front Assembly (SFA) and the Star Acquisition and Tracking Unit (SATU), which provide information on the refraction of the star light in the atmosphere and thus allow to derive refractive bending angle profiles. The bending angle profiles are then converted via refractivity and pressure profiles to temperature profiles. According to the SFA sampling rate and retrieval algorithm requirements we performed the retrieval at 10 Hz including down-sampled SATU data from 100 Hz. Bending angles were assumed to have errors of approx. 4 microrad. Statistical optimization of observed bending angles with model bending angles was used to provide adequate data quality for the Abel transform from the stratopause region upwards, which led to a significant gain in temperature retrieval accuracy up to 40 km height due to suppressed downward propagation of errors induced by Abel transform and hydrostatic integral.

A comparison to co-located sets of CHAMP GPS occultation profiles and analysis profiles of the European Centre for Medium-range Weather Forecasts (ECMWF) will be discussed. For temperature profiles we find global mean errors below 2 K from 23 km up to about 35 km. In a future add-on to the present analysis, SFA/SATU temperature data will also be compared to newly processed high resolution temperature profiles (HRTP) from GOMOS fast photometer data.

Retrieval of ozone concentration profiles from SCIAMACHY limb scatter measurements in the Hartley bands: Technique and applications

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Abstract

SCIAMACHY limb measurements in the Hartley bands of ozone are used to retrieve ozone concentration profiles at altitudes between 35 and 65 km. The method exploits the absorption of solar radiation at a set of discrete wavelengths. A non-linear Optimal Estimation scheme is used to match measured and modeled radiance profiles. Here the radiative transfer model SCIARAYS is used which is a spherical model considering up to two orders of Rayleigh scattering and includes analytical derivation of the weighting functions. The retrieval technique as well as sensitivity studies, error statistics, and validation results with HALOE and MIPAS, are presented. The results show that the retrieval technique provides reliable ozone concentration profiles in the upper stratosphere and lower mesosphere. Furthermore, the global morphology of ozone in the upper stratosphere and lower mesosphere is shown, as well as comprehensive observations of the ozone depletion during the Halloween solar proton storm in October and November 2003.

Recent Advances in SCIAMACHY Near Infrared Nadir Level 2 Algorithm Development

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Abstract

The near infrared channels of SCIAMACHY onboard ENVISAT can be used to derive information on CO, CH4, N2O, and H2O. A core element of the current operational level 2 data processor for nadir observations is the BIAS (Basic Infrared Absorption Spectroscopy) algorithm using a DOAS-type approach with a standard nonlinear least squares fit. In addition to the column scale factors for molecular densities a one-parameter ``closure term" is fitted to account for any other effects such as (single or multiple) scattering, surface reflection, or instrumental artefacts. However, recent sensitivity studies have shown the importance of adequate modelling the instrumental slit function; in particular an under- or overestimate of the slit function width can have a significant impact on the retrieved columns. Furthermore scattering can contribute substantially to the near infrared radiation.

Here we present work on recent advances towards a ``Better InfraRed Retrieval Algorithm", covering both the forward modelling and inversion aspect:

* Nonlinear least squares using a state-of-the-art trust region implementation optionally with inequality bounds (nb. positivity constraints) and exploiting special structure of model function

* Option for 'online' line-by-line absorption cross section computation (including continua, e.g. CKD) giving greater flexibility w.r.t. spectroscopic line parameter database, atmospheric data (pressure, temperature, densities for arbitrary altitude grid), and spectral microwindow

* Fit parameters: molecular columns and surface reflection/albedo. Option to fit the slit function half width (and other instrument parameters, e.g. baseline)

* Improvements with respect to the forward model utilize routines adapted from the MIRART line-by-line code, that computes transmission, radiance, and optionally Jacobians (by means of algorithmic derivatives) and has been verified by extensive intercomparisons for up/down-looking and limb-viewing geometries in the microwave, FIR, and MIR spectral regimes.
The poster shows first results of the improved algorithm applied to SCIAMACHY near infrared nadir observations.

Parameterization of internal gravity waves and turbulence in the stratosphere using scintillation measurements by GOMOS on Envisat

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Abstract

The upward propagating waves and their breaking into turbulence are of fundamental importance for the dynamics and mixing within the middle atmosphere. Exploitation of stellar scintillation is a new approach that allows studying air density irregularities in the stratosphere. In this work, we present algorithms for reconstruction of IGW (internal gravity waves) and turbulence parameters using scintillation measurements by the GOMOS (Global Ozone Monitoring by Occultation of Star) fast photometers on board the Envisat satellite. The forward model is based on two-component spectral model of air density irregularities: one of the components is generated by locally isotropic turbulence, the second, anisotropic one, is a consequence of the internal gravity waves activity. The retrieval of parameters of IGW and turbulence spectra - structure characteristics, inner and outer scale of the anisotropic spectrum – is based on the maximum likelihood method. The developed algorithms are tested on simulated and real data. It is shown that the measured scintillation spectra are in good agreement with the proposed model. It is demonstrated that structure characteristics, inner and outer scales on the IGW component can be reconstructed from scintillation spectra at altitudes above 25 km. The reconstructed parameters are in good agreement with previous analyses. Further analysis of the GOMOS scintillation data will give information about global distribution of IGW and turbulence parameters in the stratosphere.

Self-consistency analysis of MIPAS data using the trajectory hunting technique (THT)

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Abstract

We present an approach to the validation of MIPAS L2 products for Ozone and other target species, based on the use of the Trajectory Hunting Technique, aimed at testing the self-consistency of the instrumental dataset. THT launches backward and forward trajectories from the locations of measurements and finds air parcels sampled at least twice within a prescribed match criterion during the course of several days. Isentropic trajectories are calculated using the University of L'Aquila Global Trajectory Model; by using ECMWF meteorological fields, it solves the lagrangian equation of the transport for air parcels allowing to rebuild or foresee their movement and their thermodynamical history. The use of this lagrangian approach may extend significantly the number of data points useful to perform comparison beyond those that are simply co-located in space and time. As a preliminary test we consider a period during March 2003 in the Northern Hemisphere, corresponding also to ESA-ESABC validation activities, and compare the MIPAS data (version 4.61/4.62) against themselves. This procedure, called "self-hunting", provides a test for the precision of the instrument products and can be also used to estimate the quality of the trajectory calculated, thus assessing the noise in the technique and providing estimates of its possible extension to multiplatform comparison for the selected time period.

Providing convenient data services to the Atmospheric Science community

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Abstract

The development of the Netherlands Sciamachy Data Center (NL-SCIA-DC) is driven by the need of the user community to have access to good quality GOME and Sciamachy data and derived Dutch scientific products. Therefore, we aim at providing good quality level 1b data, access to co-located cloud and aerosol information and providing this data in a GIS friendly format.

The official Sciamachy level 1b product is of insufficient quality for several techniques to do trace gas retrieval, due to problems with the polarization correction, absolute radiance calibration, and ice on the infrared channels. Improved algorithms to calibrate Sciamachy data exist. However, reprocessing Sciamachy data is very computer intensive, and will not be made available before mid 2006 Therefore, we will offer, as an intermediate solution, improved level 1b products by patching existing level 1b data products. Patching the data is more efficient than reprocessing a level 1b product from a level 0 product. The NL-SCIA-DC will provide the patched level 1b dataset, from Jan 2003 up to now to the science user community. Improving Sciamchy data by providing patched data is an ongoing effort, in close cooperation with the science user community and ESA through the Sciamachy Quality Working group.

In parallel, we are in the process to extent the functionality of the NL-SCIA-DC with selection criteria based on cloud and/or aerosol information. This information is vital for a correct interpretation of trace gas retrievals from GOME en Sciamachy data, because clouds and aerosols affect the observed atmospheric column. Therefore, the availability of accurate and detailed cloud and aerosol information is requested by NL-SCIA-DC users working on development of trace-gas retrieval algorithms and scientist who are working with GOME and Sciamachy level 2 data products. The NLSCIA-D already provides cloud and aerosol information derived from GOME and Sciamachy data. But in addition we will provide high spatial resolution co-located cloud and aerosol information obtained from ATSR for GOME and AATSR and MERIS for Sciamachy. Which can alsp be used to verify/validate the cloud and aerosol products derived from GOME and Sciamachy data.

Currently the Atmospheric- and Geospatial communities use different toolsets to access similar datasets. The Atmospheric community uses data formats that are internally structured to the specific instruments. Atmospheric researchers and production systems are grafted to these complicated data structures that come with state-of-art instruments. In practice scientist spend a significant fraction of their time to extract data of interest and store it in a usable format. Therefore we aim at providing the data in a format, usable in a GIS environment, which can be directly used to fulfill user needs like data inter-comparison, regridding, selection, manipulation and visualization and will eliminate the need for a scientist to invent/develop their own converters.

The Major Revision of the SCIAMACHY Operational L1b-2 Off-line Data Processor

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Abstract

Recently, the operational data processor chain for SCIAMACHY from Level 0 to Level 2 was subject to major revisions in each part including not only the Level 0-1b and Level 1b-2 data processing but also the IECF. In this contribution, we present the revisions and upgrades of the algorithms for the Level 1b-2 Off-line processing which had been applied to the derivation of products for Nadir and Limb back-scattered light observations as well. The results will be discussed briefly.

In particular, the derivation of products from Nadir back-scattered light observations in the UV/VIS spectral region has been established by integration of most recently developments of state-of-the-art algorithms: The SDOAS algorithm of BIRA-IASB for the retrieval of column densities and the SACURA algorithm for the derivation of cloud-top height and cloud optical thickness based on cloud fraction provided by the DLR-IMF's OCRA algorithm. The combination of all three provides now the vertical column densities for Ozone and NO2. It worth to note, that the product list for cloud parameters is now substantially extended due to SACURA.

The derivation of Ozone and NO2 profiles from Limb back-scattered has been substituted by DLR-IMF's DRACULA retrieval package. Those in combination with optimised settings provide substantial improvements in profile information which are in very good agreement with scientific implementations of IFE Bremen.

Additionally we present an overview about developments for future implementations. Beside an evolution scheme for the future, this holds for the evolution of the DRACULA package and for the retrieval of BrO profiles from Limb observations.

Characterization of vegetation type using DOAS satellite retrievals

Thomas Wagner[(1)], Steffen Beirle[(1)], Michael Grzegorski[(1)], and Ulrich Platt[(1)]

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Abstract

Novel UV/vis satellite instruments measure the backscattered solar radiation with moderate spectral resolution (FWHM 0.2 – 0.4 nm). Thus they allow to analyse the spectral absorption features of various atmospheric trace gases. In addition to atmospheric scattering and absorption processes, the measured spectra are also influenced by the surface properties. We present results of the satellite DOAS analysis in the red spectral range (605-685nm). Here, in addition to the absorption features of O2, O4, and H2O, also spectral signatures of different vegetation types can be identified and analysed. From our results we conclude that at least deciduous tress and conifers can be distinguished. An additional advantage of our method is that it automatically corrects for atmospheric absorptions. We present the global yearly vegetation cycle using observations from GOME on ERS-2. Similar analyses will be possible for satellite observations from SCIAMACHY and the GOME-2 series.

Nonlinear Resonant Wave-Wave Interaction (Triad): Case Studies Based on Rocket and Satellite Data

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Abstract

Because of its low density, the upper atmosphere mainly addressed by satellites is important for the early detection of climate signals. There, gravity waves have significant influence on circulation and thermal structure by transporting energy and momentum. Knowledge about their sources, energy dissipation rates or the amount of energy which is transferred via nonlinear wave-wave interaction is essential. Using ozone data derived from GOME, regions of high variability (so called hotspots) were identified and are supposed to generate gravity waves. In this context, knowledge about occurrence of nonlinear resonant 3-wave interaction (triad) is important. In a case study a software instrument for the detection of a triad is presented. Due to the higher spatial resolution it is developed by using rocket data which were derived during the DYANA campaign. Furthermore energy dissipation rates are calculated. The improved methods of the case study are applied to GOMOS data of a hotspot. During the DYANA campaign four foil chaff and three falling sphere rockets were flown at Biscarosse (44°N,1°E), Southern France on 20th February 1990 during a period of only four hours. Vertical, meridional and zonal wind profiles from about 83 km to 98 km height as well as corresponding vertical temperature profiles were measured. By using cubic splines the wind data are detrended and gravity wave signals are obtained as residuals. In order to specify an appropriate number of spline sampling points the intrinsic disadvantage of the chaff method, namely non-sensitivity for small wavelengths in the upper region of the measurement is used. For a proof of a triad two criteria (k1 +/- k2 = k3, w1 +/- w2 = w3) have to be fulfilled. Maximum entropy method (MEM) in combination with former wavelet analysis shows nearly the same five wavelengths in all four flights in a height interval of 4 to 6 km. These can be combined to possible nonlinear wave-wave interactions. The problem of determining the right order of MEM is solved by an experimental criterion. Bispectral and hodograph analysis proves the results in parts. Indication for nonlinear resonant 3-wave interaction is found. Furthermore, energy dissipation rates are derived by using falling sphere experiments. In a first case study parts of the improved methods are applied to GOMOS ozone measurements also revealing nonlinear processes.

Nighttime NOx from SCIAMACHY lunar occultation measurements

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Abstract

Vertical profiles of stratospheric NO2 and NO3 have been retrieved from moderately resolution atmospheric lunar transmission spectra measured by SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric Chartography) on board the ENVISAT (Environmental Satellite). The measurements were taken over the high Southern latitude (60°S - 90°S).The global spectra fitting method by differential optical depth approach were used to fit NO2 and NO3 using the spectral window of 430-460 nm and 615-680 nm respectively. To assess the accuracy of the retrieved NO2 profiles the SCIAMACHY nighttime NO2 profiles were compared with daytime NO2 profiles measured by Halogen Occultation Experiment (HALOE), Polar Ozone and Aerosol Measurement (POAM-III), and the Stratospheric Aerosol and Gas Experiment (SAGE-III) using photo chemical correction model. The validation results show that the quality of SCIAMACHY nighttime NO2 is high within 15-30% in the altitude range of 20-40 km. The accuracy and internal consistency of the retrieved NO3 profiles were verified by comparing the retrieved profiles with model calculated NO3 profiles. The model calculated results are in agreement with the retrieval outputs.

SCIAMACHY solar occultation: Ozone and NO2 profiles 2003-2005

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Abstract

Beyond SCIAMACHY's capability to perform global nadir and limb measurements of the Earth's atmosphere in the ultraviolett, visible and near-infrared spectral range, solar occultation measurement are performed during sunrise at higher northern latitudes. Using an optimal estimation approach with the radiative transfer code SCIATRAN as forward model, these measurements are used to derive ozone and NO2 profiles. Here we present an almost complete dataset for the time period 2003 to 2005, including validation results with independent measurements from other satellite instruments and ozone sondes. Additionally, some first case studies for the retrieval of minor trace gases such as OClO are reported.

DOAS Retrieval of Glyoxal from space

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Abstract

Glyoxal (CHOCHO) has recently been demonstrated to be a novel indicator for fast VOC chemistry. In contrast to Formaldehyde (HCHO), direct emissions of CHOCHO are not a major source even in very large cities. CHOCHO has characteristic absorption bands in the blue spectral range, allowing remote sensing by DOAS. Ground based direct measurements of Glyoxal have been successfully performed e.g. in Mexico City. From space, the detection of enhanced Glyoxal column densities has recently been reported over Africa and Hong Kong.
Here we discuss the potential of the detection of Glyoxal from the satellite instrument SCIAMACHY. Sensitivity studies on fit parameters, cloud influence and possible spectral interferences are performed. First results show enhanced CHOCHO levels indicating photochemical hotspots during tropical biomass burning events and over heavily populated areas mainly in Eastern Asia.

Carbon monoxide, methane and carbon dioxide retrieved from SCIAMACHY near-infrared nadir observations using WFM-DOAS

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Abstract

The near-infrared nadir spectra of reflected solar radiation measured by SCIAMACHY on-board ENVISAT contain information on the vertical columns of important atmospheric trace gases such as the greenhouse gases methane (CH4) and carbon dioxide (CO2) and the air pollutant carbon monoxide (CO). The scientific algorithm WFM-DOAS has been used to retrieve this information. For CH4 and CO2 our main data products are dry air column averaged mixing ratios (XCH4 in ppbv and XCO2 in ppmv) determined by simultaneous measurements of the dry air mass obtained from, e.g., oxygen (O2). Our CO data product is the CO vertical column in molecules/cm2. The SCIAMACHY data set is unique because of the high sensitivity of the near-infrared measurements with respect to concentration changes in the atmospheric boundary layer. This sensitivity is a pre-requisite to get information on regional surface sources and sinks which are currently only poorly constrained globally by atmospheric measurements. We present the current status of this activity including comparisons with global and local reference data (MOPITT, ground based FTS, and global models).

A simplified forward model of limb infrared emission spectra in a two-dimensional atmosphere

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Abstract

Most frequently, atmospheric constituent profiles are retrieved from satellite radiance measurements assuming a spherical atmosphere made of homogeneous, concentric layers. Averaging kernels associated with the retrieval enable one-dimensional characterisation of the retrieved information as a function of altitude or pressure. Nevertheless, two-dimensional characterisation of the information retrievable from satellite measurements is highly desirable for an increasing number of scientific and operational applications.

Here, we describe a simple radiative transfer model capable of calculating limb radiance emission spectra in a two-dimensional, inhomogeneous atmosphere. Radiative transfer basics resemble those adopted in the operational processing of Envisat Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) data. However, to keep it as fast and flexible as possible, the model assumes several simplifications having no or weak influence on geometrical aspects of the ray tracing. The model is applied to MIPAS particulars (limb scanning strategy, global fit retrieval approach, spectral microwindows) in order to investigate the distribution of information content along the optical path.

Retrieval of Formaldehyde Columns from GOME as Part of the GSE Promote and Comparison with 3d-CTM Calculations

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Abstract

Formaldehyde (HCHO) is a central component of tropospheric chemistry. It constitutes an important indicator of hydrocarbons emissions in the troposphere. The photodissociation of HCHO also plays a role in the production of CO and NO2. Through quantification of the global abundance of formaldehyde using satellite instruments, one expects to provide new constraints on the emissions of non-methane VOCs (NMVOCs) as well as on the budget of CO, which play a key role in the budget of tropospheric ozone and the hydroxyl radical OH. Formaldehyde is a product of the air quality service of the PROMOTETEMIS project (ESAGMES Service Element Atmosphere) and of the Dragon project "Air quality monitoring and forecasting in China". In the present study, global distributions of formaldehyde columns are derived from GOME for the years 1996 to 2001. The retrieval process is based on a slant column fitting using the differential optical absorption spectroscopy technique (DOAS), followed by a conversion to vertical column using appropriate air mass factors (AMFs). For the later step, The TM4 chemistry-transport model provides best-guess profiles of HCHO, based on the latest emission inventories, atmospheric transport, photochemistry, lightning modeling and wet/dry removal processes. We focus on a discussion of the main error sources that affect the retrieval of both HCHO slant and vertical columns. Comparison with tropospheric chemistry models (IMAGES and TM4) are used to investigate the geophysical consistency of the retrieved columns. Furthermore, GOME HCHO is used to investigate the sensitivity of the global HCHO column distributions to change in anthropogenic, biogenic and pyrogenic NMVOC emissions as well as on potentially uncertain parameters in their degradation mechanisms in the IMAGES model.

Observational evidence of the middle atmospheric response to perturbation

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Abstract

We have studied the O3 and NO2 content of the middle atmosphere during the whole 2003, applying for the first time the advanced retrieval code Geo-MTR to data from the MIPAS instrument onboard the ENVISAT satellite.

As expected, we find evidence of the strong response of the middle atmosphere to the solar proton events that affected high latitude regions during October and November 2003. This well known event let us appreciate the fine capability of the new retrieval code, addressing issues not previously studied.

A strategy for detecting the response of weaker perturbations is tested on the annual global distribution of NO2. The results show that, within the uncertainties of our analysis, there is no evidence for any middle atmospheric perturbation such as transient luminous events (TLEs) to produce a detectable response on a year average. However, due to the large seasonal dependence of these phenomena, further correlation studies are needed.

Carbon Monoxide Measurements from MIPAS on Envisat

Bernd Funke[1], M. Lopez-Puertas[1], S. Gil-Lopez[1], H. Fischer[2], N. Glatthor[2], Udo Grabowski[2], M. Höpfner[2], S. Kellmann[2], M. Kiefer[2], A. Linden[2], M. Milz[2], T. Steck[2], G. Stiller[2], and Thomas von Clarmann[2]

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Abstract

Due to its long chemical lifetime and variable volume mixing ratio in the middle atmosphere, carbon monoxide serves as an excellent tracer for stratospheric and mesospheric dynamics. In the lower atmosphere, CO measurements allow for the characterization of emission sources and upper tropospheric/lower stratospheric (UTLS) exchange processes. Spectrally resolved non-LTE emissions of CO are measured by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) aboard the environmental satellite Envisat. Vertical profiles of CO volume mixing ratio are retrieved from 6 to 70 km with the scientific IMK/IAA data processor under consideration of non-LTE. In this paper we present a new data version (V7.0) with enhanced vertical resolution and an improved treatment of non-LTE emissions. We report on recent validation activities, and highlight scientific results related to the UTLS region and to the stratosphere/mesosphere.

Downward Transport of Upper Atmospheric NOx in the Polar Winters During 2002 and 2003

Bernd Funke[1], M. Lopez-Puertas[1], S. Gil-Lopez[1], H. Fischer[2], N. Glatthor[2], Udo Grabowski[2], M. Höpfner[2], S. Kellmann[2], M. Kiefer[2], A. Linden[2], M. Milz[2], T. Reddmann[2], T. Steck[2], G. Stiller[2], and T. von Clarmann[2]

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Abstract

NOx is produced in the upper atmosphere by auroral processes and energetic particle precipitation. Favored by dark conditions and dynamics during polar winter, large amounts of upper atmospheric NOx can be transported downwards into the stratosphere, where it acts as an important source of NOy in addition to the N2O oxidation. In this paper we use NOx measurements taken by the MIPAS instrument on Envisat to study the NOx downward transport during the 2003 Antarctic and 2002/2003 Arctic winters. MIPAS CO measurements are also used as a dynamics tracer. We found that significant amounts of NOx was deposited into the stratosphere (9% of the annual hemispheric N2O oxidation source) during the Antarctic winter 2003 while, due to unfavorable dynamical conditions, the upper atmospheric NOx contribution to the 2002/2003 Arctic winter stratosphere is negligible. The stratospheric NOx deposition derived from MIPAS data is compared to KASIMA 3D model calculations initialized with MIPAS NOx data at the upper boundary. The model calculations are also used to estimate the effects on the global ozone.

Retrieval of peroxyacetylnitrate (PAN) in the upper troposphere from MIPAS level-1B spectra

Norbert Glatthor[(1)], Thomas von Clarmann[(2)], Herbert Fischer[(1)], Bernd Funke[(3)], Udo Grabowski[(1)], Michael Hoepfner[(1)], Sylvia Kellmann[(1)], Michael Kiefer[(1)], Andrea Linden[(1)], Mathias Milz[(1)], Tilman Steck[(1)], and Gabriele Stiller[(1)]

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Abstract

Peroxyacetylnitrate (PAN) is produced in polluted atmospheres and thus an indicator of photochemical smog. When it is destroyed, NO2 is released. Its thermal decomposition rate is highly temperature dependent, ranging from 1 h at 298 K to 148 days at 250 K. However, due to photolysis its mean lifetime is restricted to 3 months. Because of its temperature sensitivity it can only be transported over a few hundred kilometres in the lower troposphere, but over distances of more than 10000 km in each hemisphere in the cold upper troposphere. Thus it serves as a reservoir and carrier of NOx via this region.

PAN has only weak broad-band signatures in the mid-infrared and requires a very accurate retrieval. At IMK, PAN retrievals were performed in the wavenumber region 775-800 cm-1, using new spectrocopic data provided by the University of Leicester. Besides PAN, all other major species contributing to the spectral radiance were also fitted. We present the retrieval method and first results obtained for the period October/November 2003.

NO2 Total and Tropospheric Vertical Column Densities from OMI on EOS Aura

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Abstract

NO2 is a trace gas, important in the chemistry of the stratosphere and troposphere. The Ozone Monitoring Instrument (OMI), which is on the EOS AURA satellite, retrieves vertical column densities (VCDs) of NO2, along with those of several other trace gases. The relatively high spatial resolution and daily global coverage of the instrument make it particularly well-suited to monitoring tropospheric pollution at scales on the order of 20 km. The OMI NO2 algorithm distinguishes polluted regions from background stratospheric NO2 using a separation algorithm that relies on the smoothly varying stratospheric NO2 and estimations of both stratospheric and tropospheric air mass factors (AMFs). The AMFs are calculated from a simplified set of profiles derived from 3D CTM model output. We present total and tropospheric vertical column densities of NO2 from one year OMI data and discuss the effects of algorithm assumptions on the retrieved VCD values and their uncertainties.

Determining Tropospheric Composition from Satellite Measurements

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Abstract

The direct measurement of tropospheric trace gases from space is difficult and so it is necessary to combine models and data to fully exploit the potential of observations. We present a new procedure for the quantitative determination of tropospheric total column amounts of trace gases from nadir viewing satellites such as the Global Ozone Monitoring Experiment (GOME) on-board the European Research Satellite 2 (ERS-2). The procedure constrains the stratosphere by assimilating chemical observations from the Halogen Occultation Experiment (HALOE) on-board the Upper Atmosphere Research Satellite (UARS) into the SLIMCAT/TOMCAT three-dimensional (3-D) chemical transport model (CTM). The chemical data assimilation method is performed using the sequential sub-optimal Kalman filter scheme and here we assimilate HALOE CH4, H2O, O3 and HCl. The assimilation scheme preserves tracer correlations and the overall effect is to produce a more realistic stratosphere in the CTM.

Using the stratospheric constraints from the CTM we then calculate tropospheric residuals. In the first instance we are applying this method to GOME observations of NO2, BrO, HCHO and SO2. Retrieved slant columns are usually converted to vertical column by an air mass factor. The calculated air mass factor is sensitive to surface albedo, cloud fraction and height and aerosol properties. Our method uses data on surface albedo, cloud and aerosol from the ERS-2 Along Track Scanning Radiometer 2 (ATSR-2). This data in conjunction with a multiple-scattering radiative transfer model (GOMETRAN) will enable a more accurate air mass factor calculation.

We will show preliminary quantitative results from July 1997 of derived tropospheric abundance of GOME-observed species using ATSR-2 cloud and aerosol data. We will discuss the advantages to this scheme, and the improvements obtained by including the model stratosphere and retrieved aerosol and cloud properties.

Spatial analysis of Anthropogenic SO2 emissions monitored by GOME on board ERS-2

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Abstract

Human activities over the last century particularly the burning of fossil fuels have changed the composition of the atmosphere in ways that threaten to dramatically alter the global climate in the years to come. These activities alter the chemical composition of earth's atmosphere by releasing toxic matter in addition to green house and chemically active trace gases (SO2, NOx, BrO, ClO etc.). Fossil fuels such as coal and oil contain significant amounts of sulfur. When burned, this sulfur is generally converted to SO2. Anthropogenic SO2 emissions are mostly related to fossil fuel consumptions. In this study our focus is on the SO2 emissions from sources of anthropogenic origin, such as power plants and other industrial activities. We analyzed GOME data for the time period 1996–2002. We present a time series of SO2 SCDs over Eastern USA. From these time series we find a substantial decrease in SO2 SCDs over North Eastern United States. We present spatial analysis of GOME observations for anthropogenic SO2 emissions from different parts of the world. Additionally, a comparison with GOME observations of anthropogenic NO2 column amounts is presented.

Effect of Forest Fires on the air quality in Seoul from MOPITT measurements

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Abstract

There have been extensive efforts to detect aerosol and estimate their amounts from satellite remote sensing to date. The Moderate-resolution Imaging Spectroradiometer (MODIS) provides aerosol optical depth(AOD) along with the fine mode fraction over ocean and darker land surfaces. At the same time, the Measurement Of Pollution In The Troposphere(MOPITT) onboard the Terra satellite provides quantitative information of carbon monoxide(CO). Measurements of CO whose principal sources arise from anthropogenic emissions such as biomass burning and forest fires, is very useful for tracing fire emissions in the atmosphere. In this study, intense fires in the southeast part of Russia in May, 2003 are studied with the satellite data from MODIS and MOPITT. The AOD distribution from the MODIS for May, 2003 show stretched regions of high AODs near the Korean Peninsula. The column densities of CO from the MOPITT for May, 2003 also show enhanced values. Correlation between CO and AOD are investigated for the forest fire case. This multi-instrumental approach to monitor the aerosol in the atmosphere is expected to contribute to the classification of the aerosol characteristics in the atmosphere, carbonaceous aerosol in particular. This study can provide additional information on aerosol amount near the source region over land where the AODs have large errors in remote sensing due to higher surface reflectivity.

SCIAMACHY Limb Measurements of NO2, BrO and OClO

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Abstract

The Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY) measures scattered sun radiances also in limb viewing mode, which allows determining vertical profiles of atmospheric trace gases. First results on the retrieval of NO2, BrO and OClO profiles from the SCIAMACHY Limb measurements are presented. For the profile retrieval we use a two step approach: First, differential Slant Column Densities (dSCDs) of the respective absorber are determined in the UV/VIS spectral range by Differential Optical Absorption Spectroscopy (DOAS). Inversion of the retrieved SCDs (as function of tangent height) yields vertical profiles of the trace gas concentration (as function of altitude). For that purpose, we apply an optimal estimation method, utilizing box air mass factors calculated by the full spherical radiative transfer model TRACY as weighting functions. The influence of several parameters on the quality of the profile retrieval, like the wavelength range chosen as fitting window, the trace gas reference spectra included in the DOAS fit or the choice of the Fraunhofer reference, is examined. In addition, the significance of the obtained dataset of concentration profiles of NO2, BrO and OClO for studies on stratospheric chemistry is discussed and the agreement with other space borne measurements of stratospheric trace gas profiles (SMR on ODIN, MLS on AURA) is investigated in case studies.

Composition Changes Caused by the 2003 Solar Storm: MIPAS Measurements and Model Simulations

Manuel Lopez-Puertas[1], Bernd Funke[1], S. Gil-Lopez[1], Thomas von Clarmann[2], Herbert Fischer[2], N. Glatthor[2], Udo Grabowski[2], M. Höpfner[2], S. Kellmann[2], M. Kiefer[2], A. Linden[2], M. Milz[2], T. Reddmann[2], T. Steck[2], G. Stiller[2], and Miriam Sinnhuber[3]

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Abstract

In this paper we show the atmospheric composition changes in the polar stratosphere and mesosphere caused by particle precipitation (protons and electrons) associated with the enormous solar storm in Oct/Noc 2003 as recorded by MIPAS. This solar storm further increased the concentrations of trapped electrons in the magnetosphere which led to a mid-term (months) enhancement of precipitating electron fluxes, an increase of the mesospheric and lower thermospheric NOx abundance and, subsequently, by it downwards transport in the polar night, a NOx enhancement in the polar stratosphere during the 2003/2004 NH winter.

Here we report the short-term (days) temporal evolution of the significant increase in NOx and decrease in O3. As a consequence of the NOx changes, alterations in other NOy species are also observed, e.g., in HNO3, N2O5, and ClONO2. The HOx composition is also perturbed by the solar proton events and evidence of its instantaneous change is observed in HOCl. These atmospheric composition changes have been studied by 1D and 2D models. While some changes are well understood (NOx, O3), others are not (HNO3, N2O5, ClONO2) and might require the revision of the chemical processes involved.

Favored by the dark condition and the downwards transport in the 2003-2004 NH polar winter, mid-term (months) composition changes have been observed down to the stratosphere. Significant enhancements in NOx and associated O3 depletion have been seen until March 2004. To quantify the O3 loss due to the solar storm, model runs with the 3D KASIMA model have been performed where NOx enhancements in the lower mesosphere have been taken from MIPAS observations. The results show a significant O3 depletion in the mid-upper polar stratosphere in this winter and subsequent spring.

Teleconnections between El Niño event and Tropospheric Trace Gases over Indonesia

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Abstract

The last major El Niño event of 1997/1998 caused dry conditions over the Indonesian area that were followed by large scale forest and savannah fires over Kalimantan, Sumatra, Java, and parts of Irian Jaya. Biomass burning was most intense between August and October 1997, and large amounts of ozone precursors, such as nitrogen oxides, carbon monoxide and hydrocarbons were emitted into the atmosphere.

In this work, we use GOME measurements to study the teleconnections between the El Niño event during 1997 and trace gases over Indonesia. Cloud anomalies measured by GOME show a decrease of clouds (cloud fraction) in October 1997 over the Indonesian region, with an increase of cloud-top pressure and cloud optical thickness. Similar results are observed on the global distribution of the GOME derived water vapour abundance in the atmosphere. The dry conditions induced fires over this region; the fires detected with ATSR-2 correlate well with the aerosol index derived by GOME. The large scale biomass burning over Kalimantan and Sumatra resulted in highly elevated tropospheric NO2, Formaldehyde and tropospheric ozone column, as shown by GOME.

This change of the atmospheric composition over large parts in Indonesia demonstrates the strong connection between the El Niño phenomenon in the Western Pacific and extreme (dry) weather conditions in the Eastern Pacific Ocean and neighbouring countries. We could show that GOME data can be used to measure simultaneously cloud, water vapour, aerosols and reactive trace gases in the troposphere under such atmospheric conditions.

Isoprene and Biomass Burning Emissions from Satellite Observations: Synergistic Use of HCHO and NO2 Trace Gas Measurements

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Abstract

We present case studies for combined HCHO and NO2 satellite observations, derived from GOME measurements. Launched on the ERS-2 satellite in April 1995, GOME has already performed continuous operations over 8 years providing global observations of the different trace gases. In this way, satellite observations provide unique opportunities for the identifications of trace gas sources. The satellite HCHO observations provide information concerning the localization of biogenic isoprene emissions and biomass burning (intense source of HCHO over the Amazon basin region and in central Africa). The HCHO data can be compared with NO2 results to identify more precisely the tropospheric sources (biogenic isoprene emissions, biomass burning events, human activities). For example the HCHO emissions situated in the northern part of the Amazon basin region are not correlated with forest fires. Only the southern part of the HCHO emissions correlates with the measured forest fires and also with the NO2 concentrations. The northern part of the Amazon basin HCHO concentrations can be attributed to biogenic isoprene emissions over the rain forest. In this case study the NO2 emissions are mostly due to the biomass burning. We propose to use this NO2-fires correlation through NO2/HCHO ratios to discriminate the HCHO due to biogenic isoprene emissions from the HCHO due to biomass burning. Biomass burning are important tropospheric sources for both HCHO and NO2. There seems also to be a dependence between the NO2 emissions during biomass burning and the vegetation type: NO2 correlate with HCHO over Africa (grassland fires) but not over Indonesia (forest fires). In south America, an augmentation of the NO2 concentrations can be observed with the fire shift from the forest to grassland vegetation.

GOME and SCIAMACHY Global Water Vapour Columns

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Abstract

Global water vapour total column amounts have been derived from measurements of the Global Ozone Monitoring Experiment (GOME) on ERS-2 and the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) on-board the European environmental satellite ENVISAT.

For this purpose, the Air Mass Corrected Differential Optical Absorption Spectroscopy (AMC-DOAS) approach has been applied to GOME and SCIAMACHY nadir measurements in the spectral region around 700 nm.

GOME and SCIAMACHY water vapour total column data are available over both ocean and land, but only measurements on the day side and under (almost) cloud free conditions can be used.

The derived water vapour columns compare well with correlative data from e.g. the Special Sensor Microwave Imager (SSM/I) and from the European Centrefor Medium-Range Weather Forecasts (ECMWF).

The GOME and SCIAMACHY results do not rely on any other measurement data, e.g. calibration factors derived from radio sonde data. The combination of GOME and SCIAMACHY data currently covers a time span of 10 years which may extend even further, depending on the life time of SCIAMACHY. In addition, the GOME-2 instruments on the series of operational meteorological satellites Metop (the first one to be launched 2006) will extend this data set.

Therefore, a combination of the results for these GOME-type instruments can lead to an additional, completely independent global water vapour data set suitable for climatological studies.

Transport studies in the stratosphere using MIPAS observations

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Abstract

The MIPAS infrared limb scanner instrument aboard ENVISAT has provided detailed information on the distribution of minor species in the stratosphere. We highligh of studies that we carried with the retrievals provided by ESA over the years 2002-2004, and focus on two topics. First, we examined how MIPAS observations revealed outstanding and long-lasting impacts of the Halloween 2003 solar storms on the nitrogen chemistry in the upper and middle stratosphere. We examine in particular the HNO3 and NO2 enhancements in the months following solar storms and geomagnetic perturbations. Second, we also show new results on the poorly-studied high-latitude stratosphere in the summer, as observed by MIPAS in 2003. We focus on the Arctic low-ozone pool, and its meridional displacements.

Monitoring of sulphur dioxide emissions from satellite as part of GSE PROMOTE

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Abstract

Sulphur dioxide (SO2) enters the atmosphere as a results of both natural phenomena and anthropogenic activities, such as fossil fuel combustion, oxidation of organic materials in soils, volcanic eruptions and biomass burning. Changes in the abundance of SO2 have an impact on atmospheric chemistry and on the radiation field, and hence on the climate. Effects of volcanic eruptions may have an impact on air traffic, as such eruptions are important sources of ash (aerosols) and SO2. Consequently, global observations of SO2 are important for atmospheric and climate research and for air traffic organisations.

Monitoring of SO2 concentrations is done on the basis of UV-Visible measurements by satellite based instruments, such as GOME and SCIAMACHY. In view of the two main sources of SO2, the monitoring is divided in two services: the Volcanic SO2 Service concentrates on regions with volcanoes known to have erupted after 1800, and the Air Quality SO2 Service concentrates on industrialised areas.

The data is delivered to users and the public via the web sites of the TEMIS and PROMOTE projects; see http://www.temis.nl/aviabtion/so2.php and http://www.temis.nl/airpollution/so2.php, respectively. These pages provide an archive of SO2 data based SCIAMACHY observations. This archive will be extended further and is intended to include data from other instruments as well. And in view of the possible effects of volcanic eruptions on air traffic, a service is set up to deliver SO2 data in near-real-time, i.e. within about 6 hours after observation. The web site also provides some background and data product information.

For the Volcanic SO2 Service there are close contacts with the Volcanic Ash Advisory Centres (VAACs) at Meteo France (Toulouse) and the UK Met Office (Exeter), who are particularly interested in a near-real-time service of SO2 data to aid them in monitoring volcanic eruptions. For the Air Quality SO2 Service the data users are environmental agencies of several countries, who are interested in both the archive and the near-real-time services.

Tropospheric NO2 Column and Aerosol Optical Properties from SCIAMACHY in the Northern Italy

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Abstract

Air Mass Factor (AMF) is a key parameter for definition of the accuracy of NO2 Tropospheric Vertical Column Density (TVCD) measurements obtained from space. Even when considering only clear sky conditions many factors have relevant influence on the AMF calculation and, over large polluted area, the aerosol loading is a leading factor that should be taken into account to improve the accuracy of the TVCD of NO2. For this purpose corresponding and simultaneous retrieval of the tropospheric aerosol optical properties related to the same column is advisable. In this work we use TVCD of NO2 from SCIAMACHY processed at ISAC with the Satellite DOAS Retrieval Processor (SDRP1.0) and simultaneous retrieved Aerosol Optical Properties (AOP) processed at ISAC/CGS by using Aerosol retrieval from SCIAMACHY data Processor (ASP2.2). We will focus the analysis on the Northern Italy geographical region where also satellite observations have demonstrated the presence of high level of tropospheric NO2 and aerosol. For selected case studies in the year 2004 the AOP observations will be assimilated in the PROMSAR radiative transfer model to calculate an ad hoc AMF related to each of the SCIAMACHY pixel in the area of interest. The effect on the NO2 TVCD retrieval is discussed also as a function of the season.

Carbon tetrafluoride (CF4) from MIPAS measurements

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Abstract

Carbon tetrafluoride (CF4 or FC-14) is produced mainly as a byproduct of the manufacture of aluminum. CF4 does not harm the stratospheric ozone layer, but it is a powerful greenhouse gas due to its absorption characteristics in the infrared. It is an inert tracer and has a very long lifetime in the stratosphere (probably many thousands of years). Thus it is expected to be uniformly mixed both geographically and vertically around the globe. Measurements of the fluorocarbon reveal that it is essentially independent of altitude up to at least 50 km (e.g. ATMOS observations).

The MIPAS experiment, onboard Envisat satellite, launched on 1st March 2002, is a high resolution Fourier Transform Spectrometer observing infrared limb emission spectra. From these measurements, profiles of atmospheric pressure, temperature and several species can be retrieved. MIPAS spectra contain also information on carbon tetrafluoride.

In the present study we use Envisat-MIPAS to retrieve carbon tetrafluoride and we quantify its concentration as a function of altitude in the altitude range 6-68 km. Here we present new measurements of CF4 mixing ratios at high altitude, where few measurements have been made in the past, based on two years of MIPAS data.

Vector spherical radiative transfer model MCC++: linearization with respect to BRDF surface properties

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Abstract

Application of radiative transfer models to optical remote sensing shows that remote sensing requires extra characteristics of radiance field in addition to the radiance intensity itself. Development of retrieval algorithms, analysis of retrieval errors and simulation of spectral measurements are in need of derivatives of radiance with respect to atmospheric properties under investigation. Models, which solve equation in derivatives of radiance simultaneously with transfer equation in radiance, have been termed linearized.

The radiative transfer model MCC++ employs Monte Carlo algorithms for multiple scattering simulation and takes into account radiance polarization and sphericity of the atmosphere. It treats also aerosol and molecular scattering, gas and aerosol absorption, and underlying surface described by the polarized Bidirectional Reflectance Distribution Function (BRDF). The polarized BRDF describes dependence of Stokes parameters of radiance scattered by surface from the incident and reflected directions.

Apart from the linearization with respect to the Lambertian surface albedo, a new version of the model becomes capable to calculate derivative with respect to parameters describing the polarized bidirectional refection distribution function. The new feature of the MCC++ model is significant in modeling of data of nadir-viewing satellite instruments for retrieval of aerosol and surface properties and may be applied for interpretation of backscattered radiance measurements of SCIAMACHY, OMI, GOME2, TOMS, and polarimetric measurements of POLDER. Formalizm for Monte Carlo calculation of the BRDF surface derivatives and examples of simulated BRDF surface weighting functions for multi-angle measurements are presented.

Ozone loss in the Arctic stratosphere over Kiruna, Sweden, during winter/spring 2005/06

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Abstract

Abstract: We will present the Arctic ozone loss of the recent winter as derived from measurements of KIMRA. The millimeter wave radiometer KIMRA is operated continuously at IRF Kiruna (67.8 N and 20.4 E). From the measurements we calculated ozone profiles between 15 and 60 km. We derived column densities for this altitude region including most of the atmospheric ozone. In order to estimate the Arctic winter ozone loss we took into account only those measurements that have been taken while Kiruna was located well inside the polar vortex as defined by the 'Equivalent Latitude' method. Although this method has problems during the phase of formation and break up of the vortex it has a more flexible definition of the vortex edge. This leads to a significantly higher number of data points for the ozone loss analysis. Ozone loss can be hidden in dynamic effects such as subsidence of air masses inside the vortex. In order to correct for this effect we use N2O data from the Odin satellite. Given a stable polar vortex and more occasions of extensive PSC coverage as already has been observed in early January by the IRF lidar system we expect a substantial ozone loss for the winter 2005/06.

Observations of Energetic Particle Effects on the Stratosphere

Annika Seppälä[(1)], Erkki Kyrölä[(1)], Pekka T. Verronen[(1)], Viktoria Sofieva[(1)], Johanna Tamminen[(1)], Seppo Hassinen[(1)], and Leif Backman[(1)]

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Abstract

A large solar disturbance like a flare or a coronal mass ejection can result in emission of high-energy protons and other ions from the Sun. If these particles reach the Earth they set off an event known as a Solar Proton Event. In addition to these events the Earth continuously undergoes precipitation of energetic charged particles originating from the near-earth space. The charged particles precipitate into the Earth's atmosphere causing ionization in the middle atmosphere. The primary effect is confined to the polar cap regions, where the particles are guided by the magnetic field. In the atmosphere the enhanced ionization leads to increased production of odd nitrogen (NOx) and odd hydrogen (HOx) which participate in catalytic reaction cycles decreasing the amount of ozone. HOx gases have a short chemical lifetime but the NOx gases are mainly destroyed by photodissociation. Hence during polar winter, when little or no sunlight is available in the atmosphere, the effect of the NOx cycles can be long-lasting and extend outside the polar cap regions though transport processes in the atmosphere.

We have used ozone and NO2 observations from the GOMOS instrument on board the Envisat satellite to study the effects of energetic particle precipitation on the stratosphere. Both solar storm and non-solar-storm related energetic particle precipitation cases have been considered. GOMOS observations indicate that high energy particle forcing has a great impact on the stratospheric composition.

FTIR ozone observations in Kiev

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Abstract

The first results for Ozone column and profiles for Kiev city in the frame of OMI Cal/Val (ESA-KNMI) project are reported. The comparison with OMI-TOMS and OMI-DOAS data are given.

Measurement of mesospheric constituents from SCIAMACHY limb measurements

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Abstract

When SCIAMACHY was launched in 2002, its primary focus was measurement of stratospheric and tropospheric trace gases, derived from absorption measurements. After the launch, it became apparent that information about a number of mesospheric parameters can also be derived from SCIAMACHY limb measurements.

A number of emission signals are observed that originate in the mesosphere: The IR emission of OH - chemoluminescence from the H + O3 reaction - as well as an electronic transition of OH in the UV at 308 nm, which is mainly from resonance fluorescence; the NO gamma bands between 220 and 280 nm; emissions from excited states of O2 and O as well as a number of metallic species and their ions, e.g. Mg, Mg+, Na, Na+, Fe, Fe+ and Fe++. From these emission signals, vertical profiles of number densities of the ground state can be derived if the emissivities originate from resonance fluorescence. A retrieval algorithm for this process has been developed, and first results will be shown for mesospheric profiles of NO, Mg and Mg+. As the observed 1Delta and 1Sigma band emissions of O2 originate partly from ozone photolysis, ozone can be derived from these emissions. Additionally, the total air density is derived from Rayleigh single scattering in the UV below 305 nm. Particle number densities and radii of polar mesospheric clouds can be derived if the backscattering signal deviates significantly from the Rayleigh background. Mesospheric temperatures are derived from the vibrational transitions of OH observed in the near-IR; in principle, mesospheric temperatures can also be derived from the gradient of the number density.

We will give an overview over the mesospheric parameters developed and retrieved in Bremen, and show first results of a number of these parameters. Measurements in the mesosphere are generally rare for a number of reasons, and the SCIAMACHY data set should enhance our understanding of this region of the atmosphere significantly; for some species - e.g., Mg / Mg+ - the SCIAMACHY measurements are the first ever measurements on a global scale.

Towards a climatology of stratospheric bromine monoxide from SCIAMACHY limb observations

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Abstract

Bromine compounds play an important role in the catalytic destruction of stratospheric ozone. SCIAMACHY/ENVISAT provides for the first time a global view on stratospheric bromine monoxide (BrO). Here we present a first climatology of stratospheric BrO derived from two years of SCIAMACHY observations. Using a photochemical model constrained by simultaneous NO2 observations from SCIAMACHY a budget of the stratospheric bromine loading is derived from the BrO observations.

Tomographic Retrieval of MIPAS Measurements in the UTLS Region

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Abstract

The Fourier transform spectrometer MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) on Envisat measures infrared emission of the Earth's atmosphere in a limb viewing mode. Due to the long ray path, limb sounders are sensitive to even little abundant species. However, horizontal gradients cause systematic errors within the retrieval if a horizontally homogeneous atmosphere is assumed.

A dedicated method of taking full 2-dimensional (2d) fields of state parameters into account is presented. The diagnostics comprise estimated random error and vertical and horizontal resolution. The method is applied to measurements of MIPAS in the special mode S6. The derived 2d ozone distribution show small-scale stratospheric intrusions into the troposphere similar to ECMWF analysis.

Enhanced upper stratospheric HNO3 during Antarctic winter 2003 and Arctic winter 2003/2004

Gabriele P. Stiller[1], Thomas von Clarmann[1], Herbert Fischer[1], Bernd Funke[2], Gizaw Mengistu Tsidu[1,3], Norbert Glatthor[1], Udo Grabowski[1], Michael Höpfner[1], Sylvia Kellmann[1], Michael Kiefer[1], Andrea Linden[1], Mathias Milz[1], Tilman Steck[1], Ding-Yi Yang[1,5], Manuel López-Puertas[2], and J. Steinwagner[4]

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Abstract

Vertical profiles of stratospheric HNO3 were retrieved from limb emission spectra recorded by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) onboard the Envisat research satellite during the Antarctic winter 2003. A high second maximum of HNO3 was found around 34 km altitude with abundances up to 14 ppbv HNO3 during July. Similar high abundances had not been reported in the literature for previous winters, but for the subsequent Arctic winter 2003/2004, after severe perturbations due to solar proton events. The second HNO3 maximum in the Antarctic stratosphere started to develop in early June 2003, reached peak values during July 2003, and decreased to about 7 ppbv by the end of August while being continuously transported downwards before finally forming a single HNO3 layer over all latitudes in the lower stratosphere together with the out-of-vortex primary HNO3 maximum. The HNO3 decrease in August 2003 was correlated with photochemical build-up of other NOy species as ClONO2 and NOx. From the time scales observed, it can be ruled out that the 2003 long-term HNO3 enhancements were caused by local gas-phase reactions immediately after the solar proton event on 29 May 2003. Instead, HNO3 was produced by ion cluster chemistry reactions and/or heterogeneous reactions on sulfate aerosols via N2O5 from high amounts of NOx being continuously transported downwards from the lower thermosphere during May to August. By comparing the evolution of the second upper stratospheric HNO3 maxima in the Antarctic winter 2003 and the Arctic winter 2003/2004, we conclude that it is likely that similar production processes took place during both winters.

The IMK/IAA MIPAS-ENVISAT TEAM is: T. von Clarmann (1), H. Fischer (1), B. Funke (2), Gizaw Mengistu Tsidu (1,3), N. Glatthor (1), U. Grabowski (1), M. Höpfner (1), S. Kellmann (1), M. Kiefer (1), A. Linden (1), M. López-Puertas (2), M. Milz (1), T. Steck (1), G.P. Stiller (1)

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Global distributions of HO2NO2 as observed by MIPAS

Gabriele P. Stiller[1], Thomas von Clarmann[2], Herbert Fischer[2], Bernd Funke[3], Gizaw Mengistu Tsidu[2,4], Norbert Glatthor[2], Udo Grabowski[2], Michael Höpfner[2], Sylvia Kellmann[2], Michael Kiefer[2], Andrea Linden[2], Mathias Milz[2], Tilman Steck[2], Ding-Yi Yang[2,6], Manuel López-Puertas[3], and J. Steinwagner[5]

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Abstract

HO2NO2 is a minor constituent of the stratosphere with a concentration of about an order of magnitude smaller than other compounds of the NOy family. Nevertheless, it is important for the understanding the polar stratospheric ozone depletion as it couples the NOx and HOx catalytic cycles of ozone destruction. Its stratospheric and upper tropospheric distributions have be retrieved from limb infrared spectral measurements of MIPAS on board of ENVISAT from the Q branch of the nu6 band at 802.7 cm-1 by constrained multi-parameter non-linear least squares fitting. A single profile precision in the order of 6 to 20 pptv in the altitude range 6 to 17 km, and 15.0 to 34 pptv in the altitude range 20 to 34 km was achieved. The vertical resolution of the retrievals is 5 km in the altitude range of the upper tropospheric and stratospheric maxima. The mean global distributions at equinox conditions have their maxima in terms of volume mixing ratios (vmr) in the subtropics to mid-latitudes at about 28 km with values up to 200 pptv, with a nearly perfect symmetry for the two hemispheres, while mean vmrs reach 80 pptv over the spring pole at 25 km and 50 pptv over the autumn pole at 22 km altitude. At solstice conditions (December and July) the maxima are shifted towards the summer pole reaching 215 pptv in December in Southern midlatitudes at 27 km at night, while day-time values over the summer pole reach 125 pptv at 22 km, and maximum night-time values over the winter pole are as low as 30 pptv at 27 km. In June, the Northern midlatitude night-time maximum even is as high as 225 pptv, while summer pole day-time volume mixing ratios are about 135 pptv. A second maximum in the upper troposphere and lower stratosphere appears from spring to the end of summer with maximum values of 50 pptv between 7 and 11 km, which, however, is more pronounced in the Northern hemisphere. Absolute day-time/night-time differences are most pronounced in December near 60oN, with night-time vmrs being up to 70 pptv higher than day time values. A quantitative comparison with published balloon-borne HO2NO2 measurements has been performed showing good consistency.

Mean age of stratospheric air as derived from MIPAS SF6 distributions

Gabriele P. Stiller[1], Thomas von Clarmann[1], Herbert Fischer[1], Bernd Funke[2], Gizaw Mengistu Tsidu[1,3], Norbert Glatthor[1], Udo Grabowski[1], Michael Höpfner[1], Sylvia Kellmann[1], Michael Kiefer[1], Andrea Linden[1], Mathias Milz[1], Tilman Steck[1], Ding-Yi Yang[1,5], Manuel López-Puertas[2], and J. Steinwagner[4]

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Abstract

The mean age of stratospheric air is a fundamental parameter of stratospheric transport. It allows to diagnose the ability of the atmosphere to transport tropospheric air parcels, contaminated with pollutants or climate gases, to certain places in the stratosphere. There is indication that the strength of the Brewer-Dobson circulation is correlated to the solar cycle, leading to longer residence times of trace gases in the stratosphere during solar maximum. A suitable tracer to study the variability of stratospheric transport and the mean age of stratospheric air is SF6. However, mid-infrared remote sensing SF6 observations are difficult due to the weak mid-infrared spectral signature of SF6, combined with the high accuracy needed to determine the age of the air. SF6 is a non-operational product from MIPAS generated, among other places, at IMK. The retrieval approach is discussed in detail, including systematic error sources. Mean age distributions of stratospheric air are presented and compared to expected values, and transport processes are discussed.

Retrieval of BrO Columns from SCIAMACHY and their Validation Using Ground-based DOAS Measurements

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Abstract

Bromine monoxide (BrO) is an important component responsible for stratospheric ozone depletion at the global scale. Several evidences have been reported from satellites, ground-based and balloon platforms suggesting the existence of substantial amounts of BrO also in the global free-troposphere. In particular, nadir observations from satellite platforms offer the opportunity to monitor the global distribution of total BrO columns in a long-term perspective, thereby allowing to address some important current issues regarding the inorganic bromine budget in both the stratosphere and the troposphere.

Building on the experience acquired with ERS-2/GOME , a scientific algorithm has been developed at BIRA-IASB for the retrieval of total BrO columns from SCIAMACHY nadir measurements. In order to overcome problems related to anomalies in the polarization response of the the SCIAMACHY instrument, specific BrO retrieval settings have been introduced, different from those used for the retrieval of GOME data.

In the present study, we focus first on an assessment of the accuracy of the SCIAMACHY slant column retrieval, through various sensitivity tests and comparisons with coincident measurements from GOME. Second, SCIAMACHY nadir BrO results are compared with independent correlative measurements of BrO columns resolved into their stratospheric and tropospheric contributions and photochemically matched to satellite observations. Correlative data are derived from DOAS observations performed by IASB-BIRA at three locations (Harestua 60°N, OHP 44°N, and Reunion Island 22°S), complemented by balloon-borne and SCIAMACHY limb stratospheric BrO profiles available from the literature. From the combined analysis of GOME, SCIAMACHY, ground-based and balloon-borne DOAS observations the overall consistency of the remote-sensing BrO observing system is evaluated and discussed in light of recent findings published in the literature. In particular our results strengthen the existence of a worldwide background of BrO located in the free-troposphere with mixing-ratios in the range from 1-2 pptv.

Monitoring volcanic activity from space: Retrieval of sulphur dioxide plumes from ERS-2/GOME backscatter data

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Abstract

We focus on the retrieval of volcanic sulphur dioxide (SO2) emissions from an analysis of atmospheric UV backscatter spectra obtained by the Global Ozone Monitoring Experiment (GOME) spectrometer on board the ESA European Remote Sensing Satellite (ERS-2). Here, the last major eruptions of Mt. Etna on Sicily (Italy) in July/August 2001 and October/November 2002 provided an excellent opportunity to study the retrieval of sulphur dioxide columnar amounts from ground-based, LIDAR and satellite measurements.

In general, the retrieval of volcanic sulphur dioxide emissions from space suffers from the sparse temporal and spatial coverage of actual satellite sensors but also from clouds in the troposphere. The short tropospheric lifetime of SO2 and the separation of the background SO2 content from volcanic emissions also hampers the estimation of the volcanic source strength. Other typically unknown but important parameters are the aerosol loading in and around the volcanic plume and the height above ground level of emissions (particles and gases).

A sensitivity analysis was performed to identify the main physical parameters that influence the retrieval results. We could show that the combination of trajectory analysis, ground-based measurements and GOME observations can be used to confirm the presence of large amounts of sulphur dioxide of volcanic origin away from the volcano. Although the latest eruptions of Mt. Etna were more powerful as others observed in recent years we believe that the bulk of emitted sulphur dioxide was confined in the troposphere, mainly between 700 hPa and 400 hPa which is confirmed by trajectory analysis, by LIDAR observations and AVHRR observations. For the first time, GOME-derived SO2 total columns were successfully validated against ground-based measurements from a Brewer spectrophotometer.

Our analysis further revealed that information about the plume height of volcanic eruptions and aerosol parameters is necessary for a reliable quantitative retrieval of sulphur dioxide from space-borne sensor data at periods perturbed by volcanic eruptions.

Simulation and retrieval of atmospheric spectra using ASIMUT

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Abstract

The ASIMUT software is line-by-line radiative transfer code coupled to an Optimal Estimation procedure to retrieve vertical profiles of atmospheric constituents, which has been developed to exploit the synergy existing between the growing number of different instruments working under different geometries. The main particularities of the software are: (i) The possibility to retrieve columns and/or profiles of atmospheric constituents simultaneously from different spectra, which may have been recorded by different instruments or obtained under different geometries. This allows the possibility to perform combined retrieval, e.g., of a ground based measurement and a satellite-based one probing the same air mass, or from spectra recorded by different instruments on the same platform; (ii) The analytical derivation of the Jacobians ; (iii) The use of the Optimal Estimation method (OEM), using diagonal or full covariance matrices ; (iv) Its portability; (v) Its modularity, hence the ease to add future features. Initially developed for the Earth atmosphere, its applicability can be extended to extraterrestrial atmospheres.

As an additional development, the ASIMUT can be coupled to an algorithm to retrieve aerosol features from nadir thermal radiance spectra. Based on the vertical optical depths obtained with ASIMUT, this algorithm uses an OEM to retrieve both the aerosol optical thickness and the surface temperature, assuming a thin horizontal layer of a mixture of two aerosol types located at an arbitrary altitude in the troposphere.

Simulation and retrieval results for different case studies will be presented and compared to existing well established codes like LBLRTM and SFIT.

MIPAS HOCl measurements

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Abstract

From atmospheric signatures at 1215.725 to 1275.550 wavenumbers HOCl volume mixing ratios (VMR) are retrieved at a precision of 25% of the peak volume mixing ratio at an altitude resolution of about 9 km. In general, the expected diurnal changes and latitudinal distribution are found. Beyond this, HOCl formation immediately after the solar proton event 2004 provided evidence of accelerated HOx chemistry, as well as perturbed chlorine chemistry. Measurements in the Southern polar vortex 2002 indicate heterogeneous HOCl formation in the lower stratosphere and a large increase of HOCl VMRs in the upper stratosphere when the vortex air was moved towards lower latitudes during the split vortex event.

Southern hemispheric biomass burning as seen by MIPAS

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Abstract

In the 2003 biomass burning season large amounts of pollutants were emitted into the atmosphere and transported around the globe.MIPAS has measured enhanced upper tropospheric C2H6, O3, HNO3 and PAN in a plume ranging from South America, Africa to Australia and beyond.Forward trajectories calculated for starting points where frequent forest fires were identified confirm that the observed plume was caused mainly by South American and African biomass burning.

Monitoring of the Stratosphere with SCIAMACHY Measurements of Limb-Scattered Solar Radiation

Christian von Savigny[(1)], Alexei Rozanov[(1)], Heinrich Bovensmann[(1)], Astrid Bracher[(1)], Kai-Uwe Eichmann[(1)], Guenter Rohen[(1)], Heiko Schroeter[(1)], Paul Ulasi[(1)], Marco Vountas[(1)], and John P. Burrows[(1)]

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Abstract

The Scanning Imaging Absorption spectroMeter for Atmospheric Chartography (SCIAMACHY) on the Envisat spacecraft is an 8-channel UV/visible/NIR grating spectrometer measuring scattered, transmitted and/or reflected solar radiation in Nadir, Occultation and Limb-geometry. The Limb-scattering geometry – the focus of this contribution – allows retrievals of stratospheric profiles of several minor constituents with good vertical resolution (about 3 km) and near-global geographical coverage.

Scientific data processors for the retrieval of stratospheric profiles of O3, NO2, BrO and within the polar vortex also OClO, were developed at the Institute of Environmental Physics in Bremen. O3 and NO2 are retrieved between 15 and 40 km altitude. In terms of BrO the 15 – 30 km altitude range is covered. For O3 a separate upper stratospheric/lower mesospheric retrieval is available covering the 35 – 65 km altitude range. The retrieval results are graphically provided to the public via the scia-arc web-interface (http://www.iup.physik.uni-bremen.de/scia-arc/) as value-added data products. Apart from the minor constituent profiles SCIAMACHY provides PSC (polar stratospheric cloud) maps, which are also available on the scia-arc website.

In this contribution an overview of the stratospheric applications of SCIAMACHY Limb-Scatter measurements including the data retrieval processors, their error budgets and validation results is presented. Furthermore, scientific mission highlights and data usage examples will be presented.

Measurement of NOx gases using MIPAS-ENVISAT

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Abstract

MIPAS is a high spectral resolution fourier transform spectrometer operating in the near to mid-infrared capable of detecting a large number of atmospheric species. The NOx gases: NO, NO2 and N2O5 play a central role in stratospheric chemistry. Retrievals of NO2 and N2O5 using MORSE (MIPAS Orbital Retrieval using Sequential Estimation) are presented. However, the retrieval of NO which is present almost exclusively during daylight hours is complicated by conditions of non-local thermodynamic equilibrium. Here, we use indirect methods to infer daytime NO concentrations. On the diurnal time-scale nitrogen is approximately conserved between NO2, N2O5 and NO during the day and NO2 and N2O5 at night. By retrieving NO2 and N2O5 at suitable points during the diurnal cycle, we are able to estimate daytime NO concentrations. Selected rate constants for NOx interconversion are also determined using NO2 and N2O5 retrivals through consideration of time since sunrise and sunset.

Impact of effective cloud fraction on tropospheric NO2 retrieval

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Abstract

In general clouds have shielding, albedo and in-cloud absorption effects on trace gas retrievals. To correct for these cloud effects the cloud fraction and cloud altitude are two important parameters. The effective cloud fraction is the cloud fraction of a Lambertan surface with fixed albedo (e.g. 0.8) yielding the same radiance at the top of atmosphere (TOA) as the cloud in the scene. The effective cloud fraction has been used in cloud correction of trace gas retrievals from GOME and SCIAMACHY.We simulated the impact of effective cloud fraction on tropospheric NO2 retrieval with the DAK model (Doubling Adding KNMI) by comparing the tropospheric NO2 air mass factors (AMFs) with Mie clouds with those of Lambertian clouds. We found that a Lambertian cloud with high albedo is a good assumption for cloud corrections. The tropospheric NO2 AMF differences between Mie cloud and Lambertian clouds of albedo 0.8 are within 10% if the geometric cloud fraction is smaller than 0.2.

Retrievals of O3 and H2O in the lower stratosphere and troposphere from Envisat

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Abstract

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) measures high resolution limb infrared emission spectra from the mesosphere down into the upper troposphere, allowing the concentrations of many trace gas species to be derived. Here, we describe the progress of an in house processing scheme being developed at the Rutherford Appleton Laboratory, specifically aimed at providing improved ozone and water vapour retrievals in the lower stratosphere and troposphere. In addition to standard 1D processing, a tomographic retrieval approach is also being developed which allows increased horizontal resolution along-track.

Further information on ozone in the troposphere can be provided by the use of limb-nadir synergy, which exploits the advantages of both limb-sounding (relatively high vertical resolution)and nadir-sounding (penetration to low altitudes in the absence of clouds). By accurately characterising the ozone profile at higher altitudes, limb-sounding observations permit tropospheric ozone to be retrieved more accurately than from nadir observations alone. Using this principle, limb observations from MIPAS (Envisat) can be combined in a synergistic retrieval with nadir observations from GOME (ERS-2), or SCIAMACHY (Envisat). Initially MIPAS operational Level 2 products have been fed into RAL's existing GOME O3 processing scheme with either GOME or SCIAMACHY nadir data. In the future improved results should be possible with the use of our new MIPAS ozone and water vapour data which have been optimised for the UTLS.

Satellite Observations of Trace Gas Enhancements in January 2005

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Abstract

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is an infrared Fourier transform spectrometer on ESA's ENVISAT satellite, launched in March 2002. The originally spectral resolution of MIPAS was 0.025cm-1 but since August 2004 MIPAS has been operating at a reduced resolution of 0.0625cm-1. An optimal estimation retrieval code (the MIPAS Orbital Retrieval using Sequential Estimation (MORSE)) was used to retrieve volume mixing ratios (VMR) profiles for key atmospheric species from the new low resolution ESA level 1B MIPAS data. Enhancements in certain trace gases such as Nitric acid (HNO3) and NO2 were seen in retrievals for January 2005. Other spacecraft and ground based instruments observed a Solar Proton Event (SPE) during the same period and similar enhancements were observed during a SPE in October/November 2003. It is therefore believed that these enhancements are caused by the influx of high-energy protons in the polar regions due to a large SPE.

Weighting function DOAS total ozone from GOME and SCIAMACHY during the last decade

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Abstract

Total ozone from GOME and SCIAMACHY using the weighting function DOAS (WFDOAS) approach from the last decade are presented. The GOME WFDOAS total ozone shows excellent agreement with Brewer and Dobson spectrometer results that are primary standards for ground observations. The WFDOAS algorithm has been successfully adapted to SCIAMACHY. Due to small differences in spectral resolution between GOME and SCIAMACHY and also between associated reference data, such as cross-sections measured with the flight models, careful adjustements in order to homogenize the combined GOME and SCIAMACHY data record are required. In this paper we describe the WFDOAS algorithm, long-term validation of GOME data, and the adaptation to SCIAMACHY. A few scientific highlights from GOME and SCIAMACHY such as the dramatic split ozone hole event above Antarctica are presented. In addition the question if ozone has recovered after the ban of man-made CFCs following the Montreal protocol and its amendments is adressed.

Distributions of nitric acid in the troposphere and the stratosphere

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Abstract

Reactive nitrogen compounds play an essential role in regulating the chemical composition of the low atmosphere. If the abundances of NO2 in the troposphere are now well monitored from satellite measurements in the UV, there remains significant lack of data regarding both the distributions of other nitrogen oxides (NO, HNO3, PAN) in the troposphere and basically of all NOy compounds at higher altitudes (upper troposphere and stratosphere). Additional HNO3 data, which would improve our understanding of chemical processes in the troposphere and the stratosphere, can be accessed using satellite measurements in the infrared spectral region. In this work we analyze the distributions of HNO3, retrieved from the infrared satellite measurements collected during mission of the Atmospheric Chemistry Experiment (ACE) on the Canadian Scisat satellite, for a two-year period extending from January 2004 to January 2006. The ACE Fourier transform infrared spectrometer operates in solar occultation and delivers highly-resolved vertical profiles for a series of trace gases, from the middle troposphere to the thermosphere. The HNO3 distributions in the upper troposphere and the stratosphere are presented and the seasonal variations are highlighted. The results are discussed by comparison with the distributions of other nitrogen oxides, obtained by the same instrument. A particular emphasis is put on the study of upper tropospheric data, which can be used as indicator of transported pollution and burning plumes. Unfortunately Solar occultation measurements do not allow probing the atmosphere below about 8 km due to the opacity of the lowermost atmospheric layers. Here we show that for HNO3, such measurements can be complemented by nadir soundings in the thermal infrared, which provide HNO3 abundances with some vertical information. For the purpose of illustration, we report on the first global distributions of HNO3 in the troposphere and the stratosphere, obtained from the analysis of measurements by the Interferometric Monitor of Greenhouse Gases (IMG), which operated onboard the ADEOS platform between 1996 and 1997. The results for 10 successive days of IMG operation in April 1997 are discussed.

The retrieval of oxygenated volatile organic compounds by remote sensing techniques

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Abstract

The oxidation of volatile organic compounds (VOCs) is an important step in the tropospheric photochemistry and in the formation of photochemical smog. But due to the complex pathways of the oxidation processes, it is difficult to quantify. Here, the first global measurements of the trace gas glyoxal, an intermediate in VOC oxidation, derived from stray light spectra in the visible region measured by the satellite instrument SCIAMACHY along with ground-based MAX-DOAS instruments are described. The analysis was carried out using the method of the Differential Optical Absorption Spectroscopy (DOAS). The work complementarily presents measurements of the trace gas formaldehyde. This work offers the opportunity to obtain a better estimate on the sources and sinks of VOCs in the atmosphere and therefore to identify photochemical hot spots. Case studies illustrate the significance of biogenic emissions and of biomass burning for the global distribution of the oxygenated volatile organic compounds.

NOTES

Session 6.1: Posters: Aerosols/Clouds/UV

Optical Thickness of Winter Clouds from Ground-based Visible Images

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Abstract

An interdisciplinary project, aimed at developing tools for the determination of the physical characteristics of the atmosphere by means of ground-based digital imaging in the visible range is now in progress. As a part of it, here we study the possibility of evaluating the optical thickness of winter clouds from ground-based images. Optical thickness is the main parameter related to the interaction of clouds with radiation. In many studies of the properties of clouds the optical thickness is retrieved from remote sensed data. Estimations of the optical thickness from satellite data on the brightness of the solar radiation reflected by clouds depend on the assumptions about the size distribution and the shape of water particles. The advantage of ground-based observations of clouds as compared to satellite ones is in the possibility of measuring the attenuation of solar radiation through the clouds, which in turn depends exponentially on the optical thickness. The main problem in such an approach is the need to take into account the effects of scattering and extinction of radiation through the atmosphere. The method presented here is based on relative photometric measurements in the visible spectral band of the clouds and of the brightness of an isotropic reflecting white surface. The estimates of the solar radiation scattered by the atmosphere are obtained using a model that also involves data on the horizontal visibility and other meteorological parameters. The brightness is measured from digital images taken at the earth surface. The proposed method for ground-based measurements of the optical thickness of clouds has been applied to winter clouds above the city of Sofia. The fresh snow cover, which practically satisfies the conditions for an etalon diffuse reflector is used. The possibility of comparing our results to the estimates of the optical thickness of clouds, retrieved from satellite data, is of great interest.

GOME-MERIS cloud products inter-comparison on global scale

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Abstract

This paper presents the inter-comparison of the operational GOME and MERIS cloud products: cloud fraction, cloud-top height/pressure and cloud-top albedo. The two instruments are flying onboard different platforms (ERS-2 and ENVISAT respectively). They are characterized by different space resolution, are based upon different measurement principles, and a significant time delay (25 minutes) exists between their measurements. Nevertheless, it is demonstrated here that cloud parameters estimated from GOME and MERIS can be inter-compared to assess their quality with excellent precision. Accurate determination of cloud information out of GOME/ERS-2 is needed for the (near-real-time) retrieval of ozone and other trace gases and it is crucial for more demanding applications like aerosol retrieval and the retrieval of trace gas concentrations in the troposphere. The cloud fraction is retrieved in GOME using the polarization measurement devices with a footprint size of 16x40 km2, while the cloud-top height and cloud-top albedo are derived using the spectral measurements in and around the oxygen A-band at 760 nm with a pixels size of 320x40 km2. Although the primary mission of MERIS is the measurement of sea colour in the oceans and in coastal areas with high space resolution, MERIS is also capable of retrieving cloud top pressure, water vapour total column, and aerosol load over land. The MERIS cloud optical thickness is estimated from measurements of channel 10 at 753.75 nm.. The MERIS cloud top pressure/height is estimated from reflected solar radiation within the oxygen A-band absorption centred at 760 nm. It is based on the assumption that the mean photon path length of the reflected solar radiation is related to the amount of absorption measured in the O2 A-band. In a cloudy atmosphere the mean photon path length is primary determined by the air mass above the cloud, the cloud top pressure. Hence the cloud top pressure can be estimated through the ratio of measured radiance 'in' and 'out' absorption window channels. The space resolution of MERIS (1x1 km2) is much higher than for GOME (320x40 km2), therefore an averaging procedure has been developed in order to resample the MERIS data onto the GOME ground pixel. The MERIS pre-processing algorithm consists of:

1. Selection of MERIS pixels contained in the GOME pixel.

2. Selection of valid MERIS products contained in the selected measurement set.

3. Computation of statistical quantities of selected products (i.e. mean, std, % valid products).

To process the 30Gb of GOME and 1.2Tb MERIS data needed for this study the ESRIN's Grid on-Demand Infrastructure and Services handling was used. The Grid on-Demand, which is run from ESRIN, offers access to, and support for, science-oriented Earth Observation GRID services and applications, including access to a number of global geophysical Envisat and ERS-2 products and ESA's toolkits like BEAT and BEAM. Comparison results are available from January to June 2003 where both GOME and MERIS data were available on a global scale. It turns out that GOME cloud fractions are in excellent agreement with corresponding MERIS results (correlation coefficient > 0.98). Cloud-top height and cloud-top albedo results will also be critically discussed.

Satellite on-board temperatures: proxy measurements of Earth's climate change?

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Abstract

Changes in Earth's outgoing radiance are expected to affect the thermal equilibrium of spaceborne instruments, and to produce detectable variations of satellite on-board temperatures (OBTs). In this study, temperatures of the Global Ozone Monitoring Experiment during the period July 1995 – August 2005 have been analysed. Results show that GOME temperatures are influenced by solar flux variations and strongly driven by radiation fluxes from the Earth. The long-term behaviour of the GOME OBT is characterized by periodicities related to orbital and atmospheric phenomena, and by a steady increase, starting from year 1998. The behaviour of OBTs is consistent with the evolution of the observed shortwave radiative forcing. The advantage of this technique resides in its simplicity. The proposed approach could be applied to all ever-flown and future satellite instruments with thermal characteristics similar to GOME, thus providing a long time series of a proxy indicator of Earth climate.

Spectral analyses of desert dust and biomass burning aerosol scenes

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Abstract

Desert dust and smoke from biomass burning events are important climatic factors and monitoring of dust blowing and biomass burning events is important for our understanding of current climate changes. Space-borne sensors are ideally suited for monitoring of these wide-spread and short-lived aerosol events. However, satellite measurements of aerosol properties are often hampered by sensitivity to surface reflectivity and cloud contamination, resulting in distinct sea-land boundaries in satellite-measurements derived aerosol products and large gaps due to severe cloud screening. A product which lacks these problems is the Absorbing Aerosol Index (AAI), which is a measure of a radiance difference in the UV and is sensitive to UV-absorbing aerosols, i.e. desert dust, biomass burning aerosols and volcanic aerosols. Global AAI maps are ideal for tracking of events of these types of aerosols, although the AAI itself is not an aerosol quantity.

As yet, no distinction can be made between desert dust and biomass burning aerosol scenes. However, using the high spectral resolution of space-borne spectrometer SCIAMACHY, the top-of-atmosphere (TOA) reflectance spectra of scenes with these types of aerosols are shown to be completely different. DDA spectra over land are dominated by the surface albedo, because desert dust source regions can be very bright in the visible and the near-InfraRed (near-IR), but over the oceans aerosol characteristics dominate. Desert dust aerosols (DDA) are large, inert, UV-absorbing particles usually found in dry hot air and a desert dust scene can typically be identified by a fine yellowish haze in an otherwise clear sky.

Biomass burning aerosols (BBA) spectra on the other hand, are very variable, because BBA are chemically very active and BBA characteristics change rapidly over time. BBA are small, very hygroscopic aerosols with usually a black carbon core, which is an efficient light absorber, and over land BBA scenes are typically identified by a grey haze. However, once a smoke plume is transported over the oceans, BBA scenes are invariably found in the presence of clouds, as the BBA are efficient Cloud Condensation Nuclei (CCN), and cloud screening algorithms will fail to identify these plumes. The AAI is not sensitive to scattering aerosols and clouds and can still identify plumes of UV-absorbing aerosols within clouds.

The TOA reflectance spectra of two typical DDA and BBA scenes were analysed, using SCIAMACHY data and a radiative transfer model (RTM). In the desert dust case an aerosol model with a simple bimodal size distribution of mineral aerosols is sufficient to explain the reflectance spectrum of the scene. In the biomass burning case an external mixture of small smoke aerosols and large cloud droplets is necessary to explain the reflectance spectrum. The interaction between cloud droplets and BBA produce spectra that can help to identify biomass burning scenes within clouds. This might be used in the future to improve cloud screening based aerosol algorithms of space-based sensors.

Systematic conversion of satellite AOD into near-surface mass concentrations

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Abstract

Thomas Holzer-Popp, Marion Schroedter-Homscheidt

At DLR-DFD a synergetic aerosol retrieval method SYNAER was developed, which exploits the complementary information content of the radiometer AATSR and the spectrometer SCIAMCHY, both onboard ENVISAT. This combination of two instruments allows to retrieve several parameters of the atmospheric aerosol loading: - aerosol optical depth (AOD) at 550 nm - aerosol speciation from a choice of pre-defined aerosol types

These two features of the aerosol properties can be used to calculate a systematic conversion of AOD values into aerosol mass concentrations (PM10, PM2.5, PM0.5) and their speciation. However, the vertical profile structure is an essential additional input for deriving accurate PM values under all cirumstances. This can be derived from operational chemistry transport models, e.g. the EURAD/MADE model. Using this singular auxiliary information and the SYNAER output provides a systematic conversion of AOD into PM values. This approach holds the potential to enable a global all-year application in comparison to experimental statistical correlations which have been demonstrated for several sensors but generally are restricted to a certain region or season.

It is the goal of this paper to summarize the results of this AOD-to-PM conversion approach including case study validation efforts.

Cloud Parameter Retrieval from MIPAS Level 1B Data

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Abstract

MIPAS is an infrared limb-sounding Michelson interferometer onboard the ENVISAT satellite.

At low tangent heights, clouds are frequently detected in the field of view and, when retrieving profiles of atmospheric composition, cloud-contaminated spectra are usually excluded.

Here we present results of an investigation into various cloud parameters which may be retrieved from such spectra: cloud top height, cloud depth, particle number density and effective radius.

Preliminary results are shown of a cloud top height retrieval from actual MIPAS spectra and compared with colocated spectra from the ACE solar-occultation instrument.

Ecological study of the aerosol optical characteristics and ozone concentration using lidar, radiometer and ozonemeter

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Abstract

The paper presents some results from the observation of the atmosphere over the urban area of the Sofia city. A scanning aerosol lidar, a optical multiwavelength radiometer, ozone meter and a ground meteorological station were used during the observation. The experiment aimed at: (i) concurring of the data obtained by the lidar, the radiometer and the ozone meter at particular meteorological conditions and (ii) estimating of the possibilities the air quality over an urban area to be determined on the basis of those data. The time of the temperature inversions destruction, that of the convective boundary layer (CBL) formation, and the extinction coefficient in the planetary boundary layer are determined from the lidar data. The radiometer data give the spectral distribution of the solar radiation dispersed by the earth atmosphere. The ozone concentration is measured by the chemiluminescence technique. The conception of the experiment is the air quality over the urban area to be estimated on the basis of a combined analysis of the lidar, radiometric, ozone meter and meteorological data. To determine the mixing layer height the lidar data are processed following the standard procedures. The aerosol extinction coefficient and its variation during the CBL formation are also determined. On the basis of the radiometric data an attempt is made of estimating the spectrum dependence of the extinction coefficient obtained from the aerosol optical characteristic in the atmosphere during the different stages of the CBL formation.The O3 variation detected is a manifestation of two processes: first formation of CBL and second the fast photochemical processes taking place in the ground layer under the influence of the changing solar irradiation. Juxtaposing and analyzing the obtained results (lidar, radiometric, ozonemeter and meteorological) the possibility of quantitatively estimating the air quality using the combined remote active and passive apparatus is determined.

Antarctic clouds from below and above

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Abstract

This presentation's aim is to introduce some of the objectives and proceedings of FOCAS (Forcings from the Ocean, Clouds, Atmosphere and Sea-Ice) which is part of the current programme ACES (Antarctic Climate and the Earth System), a contribution to the British Antarctic Survey's Strategy GSAC (Global Science in the Antarctic Context). One major aspect within FOCAS is the investigation of clouds and their role in the Antarctic climate system. The two objectives of FOCAS in this respect are the investigation of the formation and development of Antarctic clouds using detailed in-situ microphysical observations, and to develop a climatology of cloud coverage and properties over Antarctica using the new generation of satellite-borne instruments (MODIS, GLAS, CALIPSO), validated with in-situ observations. In a first step data from the US NOAA series of polar orbiting meteorological satellites contained in the ARIES HRPT (Antarctic Reception of Imagery for Environmental Science - High Resolution Picture Transmission) archive will be used for a comparison (1) with humidity profiles obtained from upper air soundings performed at the British Antarctic bases Halley (76°S, 27°W) and Rothera (68°S, 67°W) and (2) against information gained from a ceilometer at Halley. The ARIES receiver has been operated at the British Antarctic Survey base Rothera since February 1993. Upper air soundings are carried out daily at Halley and approximately every three days at Rothera. The ceilometer is in operation since January 2003. With its measurement range of up to 25000ft it delivers directly cloud base heights at up to three levels but the complete backscatter signal from the atmospheric column observed by the ceilometer will also be included in the comparison. During the conference I hope to present first results of these comparisons and also give an overview over our plans for the validation experiments to be carried out in the Antarctic season of 2006/2007.

The SCIAMACHY cloud products derived using the semi-analytical cloud retrieval algorithm

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Abstract

The paper is devoted to the presentation of the semi-analytical cloud retrieval algorithm developed at Bremen University. The algorithm is capable to derive the cloud top height using SCIAMACHY measurements in the oxygen A-band. The cloud optical thickness is derived from measurements outside gaseous absorption bands. The notion of the phase index is introduced and used to identify ice clouds. SCIAMACHY data for years 2004 and 2005 are analyzed. The global cloud properties as obtained from SCIAMACHY measurements are discussed.

Aerosol characterization over Northern Greece; aerosol loading derived from satellite observations and ground-based measurements

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Abstract

With the synergistic use of ground-based measurements and modelling predictions, the applicability of the Aerosol Index as extracted from TOMS/EarthProbe and OMI/Aura observations over the city of Thessaloniki is investigated quantitatively. Even though it is rightly assumed that the spade of satellite measurements will highly complement and aid the use of ground-based observations, great care is required in the interpretation of their joint findings.

Sunphotometer and lidar ground-based measurements of aerosol optical depth and space-born observations of the aerosol index from 1997 to 2001 (TOMS/Earth Probe) and from 2004 to date (OMI/Aura) were utilised in this work to study the varying aerosol load over Thessaloniki. The city is situated in a unique sea-side location, while being frequently affected by biomass burning and dessert dust particles arriving at the location from air mass trajectories from most directions. Local and regional pollution further affects the quality of the local air and the observed tropospheric optical depth.

Two categories of extreme atmospheric aerosol loading were examined in detail; with the combined use of dust loading modelling over the Mediterranean area and lidar measurements days with significant Saharan dust loading were identified. Further to this, ATSR-2 World Fire Atlas observations over Europe and Russia were superimposed over back-trajectory calculations of the air-mass arriving over Thessaloniki hence identifying biomass burning events. In addition, results from a three-month observational campaign during the summer of 2005, combining OMI/Aura overpasses with detailed sunphotometer, cloud cover and lidar measurements are presented.

A cloud climatology based on GOME

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Abstract

The precise knowledge of cloud parameters is essential for reliable trace gas measurements. Clouds influence the backscattered solar radiation and prevent the retrieval of trace constituents below them. Accurate GOME derived cloud parameters are needed for further interpretation and correction of retrieved trace gas results.

The cloud information provided with the operational GOME level 2 products is used to create a global cloud database covering more than 10 years of continuous measurements. The GOME cloud database include the following parameters: - Cloud Fraction - Cloud-Top Height (Pressure) - Cloud-Top Albedo (Optical Thickness) - Cloud Type

Cloud Fraction represents the GOME pixel area covered by clouds and it is estimated from the GOME Polarization Measurement Devices (PMDs). Cloud-Top Height and Albedo represent the mean location (km) of the top of the cloud above sea level and the mean cloud albedo at that location. These parameters are estimated from the GOME oxygen A-Band measurements. Cloud-top pressure and optical thickness are computed from the GOME retrieved cloud-top height and cloud-top albedo respectively. This information is used to assign a cloud type to each GOME pixel following the ISCCP cloud classification scheme: - High cloud types: Cirrus, Cirrostratus, Deep convective - Middle cloud types: Altocumulus, Altostratus, Nimbostratus - Low cloud types: Cumulus, Stratocumulus, Stratus

The GOME derived cloud parameters are compared with ISCCP and MSG data showing an excellent agreement. GOME and MSG data from 2004 show an average difference for cloud fraction of -0.08, for cloud-top height of -0.64 km, and for cloud-top albedo of 0.09. Seasonal patterns of GOME derived cloud type agree well with the ISCCP climatology.

Aerosol Optical Depth Retrieval over Land using Meteosat-8 SEVIRI Data

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Abstract

Geostationary sensors bear the potential to derive and analyze daily and seasonal trends of aerosol optical depth (AOD) from spatially homogeneous data. However, to date most AOD retrieval algorithms from geostationary sensors are limited to ocean surfaces. Thus, a multitemporal technique to retrieve AOD over land from the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) onboard the geostationary Meteosat-8 satellite is presented. The proposed method takes advantage of SEVIRI's high temporal resolution of 15 minutes and improved spatial resolution in comparison to its predecessors Meteosat-1 to 7.

The crucial issue is the decomposition of the measured signal into its surface and atmospheric contributing parts. Assumed that surface characteristics remain constant during a certain time period, changes in observed reflectances can be assigned to varying atmospheric constituents and varying sun zenith and azimuth angles. Surface reflectance is estimated by the determination of the lowest reflectance within the observed time period for each satellite observation time of the day. Since clouds seriously affect the retrieval of AOD, clouds, subpixel clouds, and cloud shadows are masked out and the data set is corrected for atmospheric gases prior to the AOD retrieval. Finally, AOD is calculated by means of the radiative transfer code SMAC.

The study area covers Switzerland and its neighboring areas (45.0N-48.5N, 5.0E-12.0E). SEVIRI data for the entire month of August, 2004 acquired daily between 6:12 and 17:12 UTC are used in order to test the method. In comparison to sun-photometer measurements from the Aerosol Robotic Network (AERONET) and remotely sensed aerosol products (MODIS), first results show promising AOD values.

Improvement of the FRESCO cloud algorithm for GOME and SCIAMACHY

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Abstract

FRESCO (Fast Fast Retrieval Scheme for Clouds from the Oxygen A-band) has been successfully used in GOME and SCIAMACHY cloud retrieval for several years. It simulates the measured reflectance at TOA at 15 wavelength at about 758, 761, 765 nm. In FRESCO only O2 absorption is considered until now. The reflectances are pre-calculated, and stored as a look up table. The FRESCO products are used in the cloud correction of trace gas retrievals from GOME and SCIAMACHY measurements. In the new version of FRESCO algorithm, single Rayleigh scattering is added in the reflectance database and the retrieval. The new reflectance database has been compared with DAK model (Double Adding KNMI) simulation. We have tested the new FRESCO algorithm with simulation and real measurements. The new FRESCO version is important for less cloudy pixels.

NOTES

Session 7.1: Posters: Data Assimilation

On the assimilation of the full information content of satellite observations

Rossana Dragani[(1)], Stefano Migliorini[(1)], Alan O'Neill[(1)], Richard Siddans[(2)], Brian Kerridge[(2)], and William Lahoz[(1)]

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Abstract

This talk presents a novel technique for satellite data assimilation which aims to improve the optimality of the analysis by assimilating the full information content of the measurements.

This technique, referred to as Quasi-Optimal Assimilation (QOA), can be used to assimilate either satellite retrievals or radiances, offering several advantages over traditional methods. When used to assimilate retrievals, QOA prevents the forecast and the observation errors to be correlated, and accounts for the retrieval vertical correlations, usually neglected when assimilating standard products. Furthermore, QOA reduces the amount of data to convey to the data assimilation system (DAS), according to the observation signal-to-noise ratio. This aspect is suited for both radiance and retrieval assimilation. The computational cost of the assimilation is reduced accordingly.

A retrieval-based version of QOA was implemented for ozone assimilation within the Met Office DAS. Two data assimilation experiments were carried out, covering the period from the mid September 2002 to the end of December 2002. Alongside the observations assimilated operationally, the ozone field was constrained by means of ozone retrieved at Rutherford Appleton Laboratory by the Global Ozone Monitoring Experiment (GOME) instrument. GOME ozone profiles were assimilated by using the QOA technique in the first experiment and the standard three-dimensional Variational Data Assimilation (3D-Var) technique in the second experiment.

Both the Observation minus Forecast (O-F) statistics and comparisons of the analyses against independent observations were used to validate the assimilation results. This validation showed that QOA is, in general, able to improve the comparison of the analyses with both the assimilated and independent observations, especially in the upper troposphere - lower stratosphere region.

Multi-year stratospheric and tropospheric ozone record by assimilating ERS2-GOME observations

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Abstract

Global stratospheric analyses and tropospheric column ozone are derived using 9 years of GOME-NNORSY and GOME-GDP 4.0 ozone data. By means of assimilating GOME stratospheric ozone profiles as derived by the Neural Network Ozone Retrieval System (NNORSY) and ozone column observations into the chemistry-transport model ROSE/DLR, the tropospheric residual ozone column is calculated. Sequential assimilation is performed using an optimum sequential interpolation scheme with diagnostic background errors. To make best use of NNORSY profile data improved assimilation parameters are derived. The assimilation consistency is checked by analysing chi2-diagnostics and observation minus first guess errors. Results will be discussed with respect to seasonal variations and particular atmospheric conditions. The study is complemented by comparisons with ozone sonde measurements, with air quality model fields, and with other tropospheric ozone retrieval methods applied to GOME data, such as the Convective Cloud Differential (CCD) method.

Towards Operational Data Assimilation of Satellite-based Aerosol Optical Depth and Type Observations in a Chemical Transport Model

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Abstract

Aerosol monitoring is of growing interest due to the impact of aerosol particle concentration on human health and the global climate. Additionally, increased attention is spent from the economic viewpoint towards aerosol-induced variations in surface solar irradiance which is the resource for solar electricity generation and a driver for electricity consumption in general. Air quality models as the EURopean Air pollution Dispersion model EURAD offer a continuous and operational monitoring and forecasting of the aerosol load in sufficient temporal and spatial resolution. But they fail in case of episodic emissions which are not covered by the underlying emission data bases used to describe aerosol sources. Also, emission data bases are in general still not sufficient in terms of accuracy, long term trends and temporal-spatial resolution.

On the other hand, satellite-based measurements as available from the European Environmental Satellite ENVISAT offer global measurements of aerosol optical depth and type both over land and ocean. These measurements distinguish between different aerosol components as sulphate/nitrate, soot, water insoluble erosion-based or industrial particles, sea salt and long-range transported mineral aerosols.

Such observations can be used to learn about and to overcome the restrictions of current emission data bases in air quality modelling. There is the need to couple model and observational information to achieve an optimum estimate of the atmospheric state by means of data assimilation. The work presented will show a first validation and impact analysis of ENVISAT component-wise aerosol optical depth measurements assimilated into the EURAD model using a variational assimilation scheme developed at RIU, University of Cologne. The scheme proposed holds also the potential to be used for the MODIS instrument onboard the TERRA and AQUA platforms and the GOME-2 and AVHRR instruments onboard the METOP satellite series.

Special focus is laid on the link between the typical model output giving mass concentrations of different chemical aerosol species and the optical perspective of satellites which deliver optical parameters as aerosol optical depth. Assumptions needed e.g. for the mapping of model aerosol species on satellite-typical aerosol components or the optical properties of modelled aerosol species will be discussed.

Four dimensional variational assimilation of MIPAS stratospheric trace gas observations into the SACADA global chemistry circulation model

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Abstract

Stratospheric trace gas observations from space borne platforms such as ENVISAT are by nature scattered in time and space. Thus a meaningful analysis of the atmospheric chemical state derived from these data involves the application of advanced spatio-temporal data assimilation methods. Four dimensional variational (4D-Var) data assimilation provides a powerful technique to combine observations, statistical information,and three-dimensional chemistry circulation models delivering a "Best Linear Unbiased Estimate" (BLUE) of the stratosphere's chemical state.

A 4D-var data assimilation system intended for operational application has been developed by the AFO-2000 project consortium SACADA. The System has several novel features: Kernel of the system is a stratospheric global chemistry circulation model (GCCM) and its adjoint version. The German Weather Service global forecast model (GME) serves as an online meteorological driver, its icosahedral grid structure, the horizontal transport and the parallelisation strategy are adopted to the GCCM. The stratospheric chemistry module accounts for 148 gas phase and 7 heterogenous reactions between 43 stratospheric constituents.

MIPAS stratospheric trace gas profiles from selected periods each covering six weeks in 2002 and 2003, have been assimilated into the new SACADA-system. Due to the superior efficiency and parallel performance of the new system, the computationally demanding 4D-Var technique is able to produce near-real-time results, reducing the discrepancies between observations and the model significantly while chemical consistency is maintained. Assimilated fields have been compared to independent data sets from the SAGE II and the HALOE instruments. The posteori statistical evaluation of quantities like observation minus analysis time series, provides a valuable means for the identification of possible inconsistencies between retrieved trace gas profiles and the current physical and chemical knowledge of stratospheric processes, which is encoded in the model. It is demonstrated that a 4D-Var system may be helpful to improve both, the atmosperic model and the trace gas profile retrieval process.

NOTES

Session 8.1: Posters: Applications

SCIAMACHY 4 years in space: Achievements, Data Usage and Outlook for the next 4 years

Heinrich Bovensmann[(1)], Noel Stefan[(1)], Michael Buchwitz[(1)], Andreas Richter[(1)], Alexej Rozanov[(1)], Christian von Savigny[(1)], and John Burrows[(1)]

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Abstract

SCIAMACHY on ENVISAT operates very succesfully since 2002 with an availability of over 90%. The operations of the instrument is flexible and very stable. Significant problems from the beginning of the mission, as for example the icing on the short wave infrared channels are now mitigated. Scientific and operational data products are now covering information from the surface, through troposphere, stratosphere and mesosphere as well as from the sun, with pathfinder applications in all areas. SCIAMACHY data is used in many international projects for example to constrain greenhouse gas sources and sinks, to quantify emissions from the industry and transport sector, to investigate the stratospheric bromine chemistry, to monitor the stratospheric O3 layer and to quantify solar-terrestrial interactions. The presentation will summarise the challenges and achievements w.r.t. SCIAMACHY data usage and will give an outlook towards the next 4 years of the mission.

Application Research and Development for Atmospheric Chemistry Products

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Abstract

Instruments on EOS Aura, EnviSat and other platforms are producing high quality measurements that can be used in pseudo-operational applications and for the development and demonstration of improved products and assimilation methods. Within NOAA, researchers are currently working with products from research instruments in the following areas: the assimilation of ozone products into numerical weather models, the development of ozone profile and other trace gas retrieval algorithms for use with future operational instruments, the development and validation of air quality models and forecasts, the improvement of UV Index forecasts, and the addition of new resources for hazard identification and ozone layer and ozone hole monitoring. This poster gives additional information on these applications and describes some of our research goals, activities and plans.

DUE GlobAEROSOL: Building components for air pollution and health monitoring services

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Abstract

Within the ESA DUE GlobAEROSOL project long series of aerosol products will be produced. One of the main applications is their use to support air quality and health monitoring systems which are main objectives of the GMES program.

GlobAEROSOL products will be intensively validated against ground based data. And inter-compared against other remote sensing data. As input data coming from (A)ATSR, SEVIRI, MERIS sensors will be used.

GlobAEROSOL project will carry out several exercises of CTM assimilation an inter-comparison of atmospheric chemistry models for particulate matter monitoring (PM10, etc). The inter-comparison is to be based on assimilation of a subset of the aerosol maps into the models, in order to produce daily particulate matter maps over Europe. This activity is in direct support to the implementation of operational air quality monitoring planned under the ESA GMES Services Element.

Particulate matter is of major concerns for public health, PM monitoring will support health services as PMs are responsible for some breath problems. Epidemiological studies show that an small increase in PM10 mass concentration results in an increase of 0.5 – 1.5 % in premature total mortality in case of short term/episodic exposure, and in an increase up to 5% in premature total mortality in case of long term/life long exposure. Seams that PM10 is associated with respiratory responses and PM2.5 with cardio-vascular diseases.

Use of stationary satellites will provide also high temporal resolution and global Europe coverage that will increase the performance of the final services and will open other important issues like fire monitoring: plumbs follow up.

The NorSEN network: Use of ENVISAT derived and ground-based aerosol information

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Abstract

The North Calotte Satellite Evaluation cooperation Network (NorSEN) was established in Northern Fenno-Scandia to provide a better QA/QC of terrestrial and aquatic surface reflectance data from spectral imaging staellite instruments including necessary ancillary data at high latitudes. To this purpose in-situ surface observations are combined with atmospheric measurements in order to validate both level-2 products of, e.g., MERIS, and the parameters which are needed for atmospheric corrections. In this context, aerosol extinction is of prominent importance. This parameter is monitored at Sodankyla, Finland, and ALOMAR, Norway, on a permanent basis, in addition to a number of other relevant atmospheric parameters. We shall present the NorSEN network and the plans to integrate atmospheric and surface information from in-situ and satellite measurements in order to achieve improved surface reflectance data in this region and other regions with comparable observation conditions.

Radiometer-based Estimation of the Atmospheric Optical Thickness

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Abstract

Atmospheric optical thickness affects the quality of satellite imagery, especially over urban areas where aerosol concentrations (sulfates, soot, mineral dust, etc.) are high. Optical thickness is usually provided by protometer or Lidar ground station measurements and introduced in empirical atmospheric correction models. But Lidar wavelengths don't correspond - in number and value - to those used by satellite sensors, therefore introducing drawbacks in atmospheric correction methods. Thus, in this paper a methodology was developed for estimating atmospheric optical thickness by the use of satellite images and ground radiometer (GER 1500). Lidar estimations of the optical thickness at two wavelengths: 355 nm (infrared) and 532 nm, served for validation purposes. Within this framework, two major issues are investigated. The first concerns the most appropriate target in an urban environment that yields the most accurate atmospheric optical thickness value. The second deals with the appropriate surrounding area of the target. Experiments were carried out in Athens, Greece. The study area has been selected because it presents high concentrations of air pollutants. .Radiometric and Lidar measurements simultaneous to SPOT XS satellite pass were implemented. Thus, radiance and reflectance of seven targets: grass (approximately 4cm high), bare soil, asphalt, bush (approximately 1m high), limestone, white pine, and olive leaves were measured. For each target, the extinction coefficient has been estimated on the basis of GER 1500 measurements and satellite image digital values and then compared to coefficient values provided by Lidar system measurements. Experiments have been repeated several times. Each time the targets have been placed in a different surrounding environment consisting of natural or artificial materials. Evaluation of results showed that using the methodology developed, targets of "white pine" within a white artificial area produce the most accurate atmospheric optical thickness. Validation of the method using other test areas that present various atmospheric compositions will be the objectives of next research work.

IGACO-O3: The First Step in Implementing IGACO

Anssi Mälkki[(1)], Leif Backman[(1)], Anders Lindfors[(1)], Tarja Riihisaari[(1)], Johanna Tamminen[(1)], Aapo Tanskanen[(1)], Kirsi Virolainen[(1)], and Geir Braathen[(2)]

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Abstract

The 'Integrated Global Atmospheric Chemistry Observations' (IGACO) theme is a component of the Integrated Global Observing Strategy (IGOS) partnership. IGACO is led by the World Meteorological Organisation (WMO) and it links to several WMO-led programmes, such as the World Climate Research Programme (WCRP), Global Climate Observation System (GCOS), International Geosphere-Biosphere Programme (IGBP), and also bears a strong link to the Global Earth Observation System of Systems (GEOSS). An international panel of distinguished experts prepared an IGACO theme report, which was published in September 2004.

The objectives of IGACO can be summarised as: 1. To ensure accurate, comprehensive global observations of key atmospheric gases and aerosols; 2. To establish a system for integrating ground-based, in situ and satellite observations using atmospheric models; 3. To make the integrated observations accessible to users.

The implementation of IGACO is proceeding with a focus on four areas: IGACO-Ozone, IGACO-Greenhouse Gases, IGACO-Aerosols and IGACO-Air Quality and Long Range Transport of Air Pollution (LRTAP). Each focus has a Secretariat hosted by a major research institution and a scientific advisory panel. The Finnish Meteorological Institute (FMI) hosts the IGACO-Ozone secretariat for the implementation phase.

In this presentation we will discuss the goals of IGACO-Ozone, present the current IGACO-Ozone implementation status and future steps to reach the objectives.

Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring

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Abstract

The major issues in atmospheric composition and chemistry are oxidising efficiency and air pollution in the troposphere, ozone depletion in the stratosphere and the coupling between atmospheric chemistry and climate change.

The anticipated recovery of the ozone layer will be affected by the climate change. The temperature in the lower stratosphere will decrease due to climate change. Major sources of stratospheric water vapour are oxidation of methane and intrusion of water vapour through the tropical tropopause. Changes in either methane amounts or tropical dynamics will affect water vapour amounts in stratosphere. Also stratospheric humidity increase during last five decades is larger than explained by tropospheric CH4 trends. Decreasing temperatures and increasing water vapour enhances possibility to increase occurence of polar stratospheric clouds (PSC) in the Artic stratosphere. Several data sources should be combined in order to efficiently monitor atmospheric composition during polar night. UV radiation is a source of energy in atmospheric chemistry, but harmful for environment and human health. The amount of UV radiation reaching surface is affected by high spatial and temporal variability of the following parameters total ozone clouds, aerosols and snow/ice cover. Changes in these parameters in future have impact on UV radiation affecting atmospheric chemistry. Aerosols have significant role in stratospheric chemistry e.g. by processing reservoir gases. After the Mt. Pinatubo eruption the ozone depletion was significantly enhanced. Detailed understanding of the space and time distribution of aerosols is required to understand the effects of volcanic eruptions.

Understanding the coupling between climate and chemistry is a challenge which requires an efficient monitoring system of O3, UV radiation, halogen sources, active halogens and their reservoirs, NOx, HNO3, water vapour, methane, distribution and properties of aerosols. EUMETSAT's Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring (O3M SAF) is former SAF on Ozone Monitoring. O3M SAF is part of the EUMETSAT's Polar System (EPS) Ground Segment. The purpose of the SAF is to produce operationally a set of near real-time and offline products based on Metop data and validation services. Near real-time products are GOME-2 total ozone and ozone profile, and UV clear-sky fields. Offline products derived from GOME-2 data are total column amounts of ozone, NO2, BrO, ozone profile, aerosol index, aerosol optical depth, and UV fields including cloudiness and albedo also HIRS total ozone is produced.

This paper describes O3M SAF distributed operational system, current status of the satellite data products and research objectives for the future.

Using GRID services for Sciamachy data sharing and processing in NL-SCIA-DC

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Abstract

The Netherlands Sciamachy Data Center, the data service center provided by SRON and KNMI, will be upgraded to offer additional functionality for end-users of Sciamachy data. One of the functionalities provided will be the possibility to select and process multiple Sciamachy files using different data processors, which can lead to intensive use of the limited computing and data storage resources available to NL-SCIA-DC, i.e. the NL-SCIA-DC will run out of resources. These limitations can be overcome by using GRID technology.

GRID technology provides secure ways of sharing resoures (e.g. data storage, computing power) between organizations over the Internet. Several large GRID environments have been successfully deployed, i.e. by the European EGEE project.

Our aim is to add user-requested functionality to NL-SCIA-DC for which currently the computer and/or storage resources are not available to the partners KNMI and SRON. GRID technology helps us to extent the functionality of NL-SCIA-DC without losing the current high-standard of security and to make efficient use of the resources available at KNMI, SRON and elsewhere.

The end result will be an integrated 'griddified' NL-SCIA-DC, integration of two organization domains (SRON and KNMI) using standard and open general purpose protocols and interfaces, delivering non-trivial quality of service to the Dutch and international atmospheric research community.

Modeling CO2 sinks and sources of European land vegetation using remote sensing data

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Abstract

Quantifying sources and sinks of climatological relevant trace gases as well as understanding their exchange between atmosphere and land surface have become essential research topics in atmospheric sciences during the last years. Modeling of the net CO2 uptake by vegetation (Net Primary Productivity, NPP) has become an important tool to study the mechanisms of CO2 exchange and to quantify the magnitude of terrestrial sinks and sources.

At the German Aerospace Center (DLR) the vegetation model BETHY/DLR (Biosphere Energy Transfer Hydrology Model, Knorr, 1997) is used to perform simulations of NPP over Europe. The model is driven by remote sensing data of leaf area index (LAI) and land cover classification and meteorological input from the ECMWF (European Center for Medium Range Weather Forecast).

As a step towards an operational NPP-modeling system for Europe we will present first results of the geographical distribution of NPP for different land cover classes, such as coniferous forests and grasland. Also regional evaluation results of our simulations with ground-based measurements from CARBOEUROPE-stations will be presented.

NOTES

Session 6: Aerosols/Clouds/UV

GlobAEROSOL from Earth Observation - aerosol maps from (A)ATSR and SEVIRI.

Elisa Carboni[(1)], Gareth Thomas[(1)], Don Grainger[(1)], Caroline Poulsen[(2)], Richard Siddans[(2)], Brian Kerridge[(2)], Celestino Gomez[(3)], and Pierre-Yves Deschamps[(4)]

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Abstract

GlobAEROSOL (ESA Data User Element project) will produce global aerosol maps for 1995-2005 from ATSR-2, AATSR, MERIS and MSG SEVIRI data. Products will include aerosol optical depth at 550 and 865 nm, the Angstrom coefficient and level of aerosol speciation. We present a description of the GlobAEROSOL project focus on ATSR-2, AATSR and SEVIRI aerosol products which are derived using the Oxford-RAL Aerosol and Clouds retrieval algorithm (ORAC). This optimal estimation based retrieval scheme will be described and preliminary results will be presented, including a detailed validation by comparison to ground based and other satellite data. The complete GlobAEROSOL data set is expected to be produced for use by the wider community during the coming year.

SCIAMACHY TOA reflectance correction effects on Aerosol Optical Depth retrieval

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Abstract

Aerosol retrieval from SCIAMACHY data processing at ISAC-CNR has been carried-out to retrieve Aerosol Optical Depth (AOD) at 500 nm wavelength together with a parameter (class) which defines a set of chemico-physical properties pertaining to suspended particles. SCIAMACHY level 1B data from nadir measurements both over ocean and land are used as input for this processor. SCIAMACHY, onboard ENVISAT, is a remote sensing spectrometer measuring sunlight scattered, transmitted and reflected by the Earth's surface-atmosphere system. Its wavelength range spans from about 240 nm to about 2440 nm, with a spectral resolution varying from 0.24 nm in the UV to 1.56 nm in the NIR. In this aerosol retrieval algorithm, working wavelengths are selected in the UV-VIS range characterized by negligible gases absorption, i.e. lower than 1%. At these wavelengths, the measured TOA reflectances are corrected taking into account that SCIAMACHY underestimates the reflectance in the ultraviolet and visible range by 10 to 25% and by 10 to 20%, respectively. Once reflectances, presenting values of cloud coverage fraction lower than 0.05, are properly corrected, they are fitted with modelled reflectances. The couple formed by AOD and class which minimizes the merit function represent the retrieved aerosols parameters for the spectrum being analysed. SCIAMACHY data relative to 2003 and 2004 and in spatio-temporal coincidence with AERONET measurements have been considered. The effect on the aerosol retrieval of the applied reflectance correction factors will be critically discussed and quantified.

Aerosol Products from the Aura-OMI Sensor

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Abstract

Near-UV and visible observations by the Ozone Monitoring Instrument (OMI) on the AURA satellite are used in an inversion algorithm to retrieve aerosol extinction and absorption optical depth. The sensitivity to aerosol absorption, a unique capability of the OMI measurements,is based on the interaction of particle absorption and molecular scattering in the near-UV spectral region. OMI near-UV aerosol retrievals are obtained over the oceans and most land areas including deserts where traditional single view visible and near-IR retrieval methods fail. Results of the OMI near-UV aerosol algorithm will be discussed in the context of other satellite and ground-based measurements.

Variability and trends in global cloud parameters from Oxygen A-band measurements by GOME and SCIAMACHY

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Abstract

Clouds are the most important factor in determining the Earth's albedo. A change of only about 1 % in global cloudiness can either mask or double the radiative effect of a decade of greenhouse-gas emissions. Recent studies by Palle et al. and Wielicki et al. published in Science report either an increase or a decrease in the Earth's albedo in the period 2001-2004. To assess this controversy in an independent way, we derive for the first time a global time series of cloud parameters from satellite measurements in the Oxygen A-band around 760 nm.

Usually, visible and infrared thresholding methods are being used to detect clouds with meteorological satellite imagers, e.g. the ISCCP and similar algorithms. IR methods, however, depend on an assumed atmospheric temperature profile. With GOME on ERS-2 and SCIAMACHY on Envisat we have a unique opportunity for an independent measurement of clouds, namely via the absorption of oxygen. Since oxygen is a well-mixed gas, the reflectance in and around the oxygen A-band is a direct measurement of the amount and altitude of clouds. We use the FRESCO (Fast Retrieval Scheme for Clouds from the Oxygen A-band) algorithm for deriving the effective cloud fraction and cloud top pressure, and apply this to GOME as well as SCIAMACHY Oxygen A-band measurements for the period 1995-2005. We compare with available cloud products from both ISCCP and the ECMWF Re-Analysis project.

We find a clear seasonal cycle in cloud parameters, dominated by clouds over the oceans. Furthermore, a significant increase is found in the global effective cloud fraction since 2001. The results are compared to and corroborated with ISCCP cloud measurements over this period.

MIPAS discovers Antarctic nitric acid trihydrate (NAT) polar stratospheric cloud (PSC) belt

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Abstract

The mid-infrared limb-emission sounder Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on Envisat is the first instrument able to monitor continuously the development of PSC appearance and composition with full coverage of the polar regions even during polar night.

We have analyzed MIPAS wintertime observations over Antarctica with respect to PSC composition. Coincident lidar observations from McMurdo were used for comparison. By application of new refractive index data we could identify a distinct spectral signature at around 820 cm-1 observed by MIPAS as the nitrate nu_2-band of NAT. This has been the first evidence for the existence of NAT PSCs on a large scale. We could not find spectroscopic evidence for the presence of nitric acid dihydrate (NAD) from any MIPAS PSC observation.

During the initial phase of PSC development over Antarctica the MIPAS measurements reveal the formation of a belt of NAT PSCs in mid-June 2003. By mesoscale microphysical simulations we have shown that this sudden onset of NAT was caused by heterogeneous nucleation on ice in the cooling phases of large-amplitude stratospheric mountain waves over the Antarctic Peninsula and the Ellsworth Mountains. This suggests a more significant role for mountain waves in Antarctic PSC formation than has heretofore been appreciated. MIPAS observations of PSCs in a period of three weeks before this event show no indication for the presence of NAT clouds, but are consistent with supercooled droplets of ternary H2SO4/HNO3/H2O solution (STS). Simulations indicate that homogeneous surface nucleation rates have to be reduced by three orders of magnitude to comply with these observations.

Cloud retrieval from SCIAMACHY using broad band spectrometers and absorptions of O2 and O4

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Abstract

The SCanning Imaging Absorption spectrometer for Atmospheric ChartographY (SCIAMACHY) on ENVISAT allow measurements of different tropospheric trace gases (e.g. NO2, SO2, CH4, HCHO, CO, BrO, H2O) using the DOAS technique. Cloud retrieval algorithms are essential for the calculation of precise vertical column densities.

This presentation describes the concept, validation and application of the Heidelberg Iterative Cloud Retrieval Utilities (HICRU), which retrieves cloud parameters directly from SCIAMACHY data. The most important cloud parameter is the effective cloud fraction. Especially a more accurate retrieval of cloud free pixels is needed with respect to the correction of the evaluation of tropospheric trace gases. The Heidelberg Iterative Cloud Retrieval Utilities (HICRU) determines cloud fraction using the Polarization Monitoring Devices (PMD). The advantage of these instruments is a higher spatial resolution compared to the instruments with high spectral resolution. This provides additional information about cloud heterogeneity. The algorithm combines the widely used threshold method with a sophisticated, iterative algorithm using image sequence analysis. The cloud fraction received from the HICRU algorithm is combined with DOAS evaluation of O2 and O4 at 630nm to retrieve additional information about clouds. The retrieval of cloud top height, a matter of particular interest for the retrieval of tropospheric trace gases, is discussed across the presentation.

The algorithm is validated through intercomparison with other cloud algorithms for GOME and SCIAMACHY as well as cloud information received from other satellite platforms.

Three years of ENVISAT synergetic aerosol retrieval

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Abstract

At DLR-DFD a synergetic aerosol retrieval method SYNAER was developed, which exploits the complementary information content of the radiometer AATSR and the spectrometer SCIAMACHY, both onboard ENVISAT. This combination of two instruments allows to retrieve several parameters of the atmospheric aerosol loading: - aerosol optical depth at 550 nm - aerosol speciation from a choice of pre-defined aerosol types

In the meantime, 3 years of ENVISAT AATSR and SCIAMACHY level 1 nadir data have been acquired (2003-2005). This period includes the exceptional hot summer of 2003. Processing of these data over the MSG field of view (Europe, Africa, Atlantic) and parts of Asia has been started within the ESA GSE project PROMOTE, where SYNAER contributes to the air quality monitoring service. SYNAER products are provided daily in near-real time as input for data assimilation into chemistry transport models, and as long-term archive.

It is the goal of this paper to summarize the results of this monitoring effort. The presented results will range from individual daily datasets to monthly mean maps. Whereas the daily datasets exhibit large data gaps due to the san patterns of the synergetic sensor pair (SCIAMACHY nadir limb switching, AATSR swath width) and cloudiness, the monthly mean datasets provide reduces temporal resolution, which is not sufficient for near-real time purposes. The mid-term perspective for the SYNAER products promises a long-term dataset ranging from 1995 with ERS-2 (ATSR-2 and GOME) to 2020 with METOP (AVHRR and GOME-2), as the algorithm development was always focused on applicability to all these 3 platforms (thus not using special features as e.g. SCIAMCHY mid infrared channels or ATSR dual view).

Stratospheric aerosols and PSCs as observed by GOMOS on Envisat: results for the period 2002-2005.

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Abstract

GOMOS (Global Ozone Monitoring by Occultation of Stars) is a UV/Visible spectrometer that was launched onboard the European Envisat satellite in March 2002. Using measurements of star light that is transmitted through the Earth's atmosphere it is possible to retrieve altitude concentration profiles for a number of gasses (neutral air, O3, NO2, NO3, OClO, O2, H2O) and altitude extinction profiles for particulate matter (aerosols, PSCs, PMCs). Here, we will present the main results for stratospheric aerosol and PSC extinction coefficients for the time period 2002 to 2005, and draw conclusions on their temporal evolution and spatial distribution on a global scale. Some preliminary results on particle sizes are also discussed.

Retrieval of Cloud Fraction and Pressure from the Ozone Monitoring Instrument (OMI)

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Abstract

The Ozone Monitoring Instrument (OMI) is the Dutch-Finnish contribution to the NASA EOS-Aura platform, which was launched in July 2004. OMI is the first of a new generation of UV-Visible spaceborne spectrometers that use two dimensional detectors. These detectors enable OMI to measure atmospheric trace gases and aerosols over the entire Earth within a single day and with high spatial resolution (13 km by 24 km at nadir), which makes this instrument extremely suitable for tropospheric research. For satellite remote sensing of the lower troposphere, clouds are often a limiting factor. As an example, for the retrieval of tropospheric NO2 from UV/VIS spectrometers, uncertainty in the cloud fraction and pressure contribute strongly to the error budget. To reduce this uncertainty accurate information on cloud properties is needed. To support the retrieval of trace gases from the Ozone Monitoring Instrument (OMI) a new cloud retrieval algorithm has been developed. This algorithm uses the O2-O2 absorption band around 477 nm to derive an effective cloud fraction and cloud pressure. In this contribution this algorithm will be described and results will be presented. In addition, a future outlook will be given on how cloud correction can be further improved using new algorithms and new instrument characteristics.

Retrieval of cloud fraction, optical thickness and top-height from GOME and SCIAMACHY

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Abstract

We present an algorithm to simultaneously retrieve cloud fraction, optical thickness and top-height from reflectance measurements of spaceborn nadir viewing spectrometers as SCIAMACHY, GOME and GOME-2. Knowledge of these cloud parameters is needed to accurately retrieve trace gas profiles and columns from these instruments. However, none of the present cloud retrieval algorithms retrieves all three cloud parameters from the measured reflectances simultaneously. The here presented algorithm makes use of the measurements in and around the Oxygen A band between 755 and 775 nm and additionally of measurements in the UV between 350 and 400 nm. Since clouds shield the underlying atmosphere and reflect light back into space, the relative depth of the Oxygen A band and the continuum around it are sensitive to the cloud fraction, optical thickness and top-height. However, retrieval of all three parameters from the Oxygen A band alone is ill-posed. Extra information about the cloud fraction is contained in the spectral range between 350 and 400 nm, where the Rayleigh scattering optical thickness is large. This is because most Rayleigh scattering takes place below the cloud top and therefore the relative contribution of Rayleigh scattered light to the measurements depends on the cloud fraction. In this paper, a retrieval algorithm based on this concept is presented and its accuracy and main error sources are discussed. Additionally, we present results of the algorithm applied to GOME data. These results are validated with independent data. The retrieved cloud parameters will be used to improve the retrieval of tropospheric ozone concentrations from GOME and SCIAMACHY data.

Probing internal cloud properties from space

Thomas Wagner[1], Steffen Beirle[1], Tim Deutschmann[1], Michael Grzegorski[1], Suniti Sanghavi[1], and Ulrich Platt[1]

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Abstract

Novel UV/vis satellite instruments measure the backscattered solar radiation with moderate spectral resolution (FWHM 0.2 – 0.4 nm). Thus, in addition to the observation of the broad band radiance, they also allow to retrieve the spectral signatures of many atmospheric trace gases and of rotational Raman-scattering (the so called Ring effect). For trace gases with known (and constant) atmospheric concentrations like molecular oxygen and its dimer O4, it is in particular possible to derive information on the atmospheric light path distribution. This information is complemented by the analysis of the Ring effect. We present simultaneous measurements of the Ring effect and the O4 and O2 absorptions for different cloudy scenes and give estimates of the light path distributions inside the clouds.

Surface UV irradiance from OMI on EOS-Aura

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[(1)] *Finnish Meteorological Institute, Erik Palmenin aukio 1, 00101 Helsinki, Finland*

Abstract

The Ozone Monitoring Instrument (OMI) onboard the NASA EOS Aura spacecraft is a nadir viewing spectrometer that measures solar reflected and backscattered light in a selected range of the ultraviolet and visible spectrum. The instrument has a 2600 km wide viewing swath and it is capable of daily, global contiguous mapping. We developed and implemented a surface ultraviolet (UV) irradiance algorithm for OMI that produces noontime surface spectral UV irradiance estimates at four wavelengths (305, 310, 324, 380 nm). Additionally, noontime erythemal dose rate and the erythemal daily dose are estimated. The paper includes a brief overview of the OMI surface UV algorithm, current processing status, recent validation results and plans for further development of the surface UV algorithm.

Solar variability measured by GOME and SCIAMACHY in the UV/visible/NIR spectral range (1995-present)

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Abstract

GOME (Global Ozone Monitoring Experiment, 1995-present) and SCIAMACHY (SCanning Imaging Absorption Spectrometer for Atmospheric CHartographY, 2002-present) measure daily solar spectral irradiances in the visible and near UV at moderateley high spectral resolution (0.2-0.4 nm) since 1995. SCIAMACHY that was launched in 2002 extends the coverage to the near IR with some gaps up to 2380 nm. The irradiance measured by SCIAMACHY is compared with results from other data sources such as SIM, SOLSPEC, SOLSTICE, and SUSIM and is generally in good agreement within 2 to 3% in most cases. The Mg II index is derived from daily solar observations in the near UV spectral region which provides a good measure of the solar EUV variability. In this presentation we are focusing more on the derivation of suitable solar variability proxies in the visible that are more representative of total solar irradiance variations. The largest contribution to TSI ("solar constant") comes from the optical range beyond 400 nm. A few examples are given how solar variability is linked to atmospheric variability, in particular, ozone and temperature.

NOTES

Session 7: Data Assimilation

The ASSET intercomparison project

William Lahoz[1], and ASSET intercomparison team[2]

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Abstract

ASSET (Assimilation of Envisat data; http://darc.nerc.ac.uk/asset) is a EU-funded project, whose objectives are: (1) assess the strategies for exploiting research satellite data by the Numerical Weather Prediction (NWP) community, and (2) investigate the distribution and variability of atmospheric chemical species by exploiting research satellite data. To address these objectives, ASSET will assimilate Envisat observations and produce quality-controlled analyses of ozone and other species using a variety of assimilation models and techniques. To evaluate these analyses and the different assimilation approaches, ASSET has carried out an analyses intercomparison project for the period 1st July – 30th November 2003: 1) Separate assessments of each model / data product: Assimilation groups will describe the impact of Envisat data on their analyses. Retrieval teams can validate their data. 2) Intercomparison of analysis ozone, to be extended to other species where possible. 3) Report on distribution and variability of photochemical species: This will make use of information from the assimilation of Envisat NOy observations, stratospheric aerosol analyses, tropospheric photochemical analyses, and ozone analyses. 4) Report on linear ozone photochemistry: Based on comparisons in 1) and 2) above, the Cariolle linear chemistry scheme, and variants thereof, will be evaluated against observational data and Chemistry Transport Models (CTMs).

This presentation will provide first results from the intercomparison project. There will also be a discussion of how the results from the intercomparison help address a number of key issues in the assimilation of chemical constituents.

Ozone data assimilation of GOME, SCIAMACHY and OMI measurements

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Abstract

Since 2000 the KNMI is providing operational ozone analyses and forecasts based on the assimilation of GOME and SCIAMACHY ozone measurements. These forecasts are currently coupled to UV-index and dose calculations performed in several countries. Within the context of the ESA-GSE PROMOTE project reanalysis data assimilation runs have been performed for the latest retrieval data sets available, including GDP-4 for GOME and TOSOMI for SCIAMACHY. From these combined measurements of GOME and SCIAMACHY we have compiled a consistent long-term record of total ozone fields spanning a period of 10+ years. This record will be further continued with OMI data that has recently become available, and will be extended towards the past with TOMS datasets. The overlapping periods between the instruments and the comparison with ground-based data is used to remove biases between the instruments and retrieval approaches. In our talk we will give an overview of this KNMI ozone data assimilation work, including first results for the OMI instrument.

Simultaneous assimilation of ENVISAT/MIPAS and ODIN/SMR ozone profile into a chemistry transport model

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Abstract

Because of its role both in troposphere and in stratosphere, ozone is one of the most important trace species in the atmosphere. In the context of an increasing number of space-based remote sensing instruments, data assimilation is the most appropriate way to combine the information provided by the observations and the numerical models.

We have developed a 3D-Fgat assimilation algorithm to analyse the ozone profiles from satellites using the Météo-France chemistry transport model Mocage. This algorithm is successfully used with the March 2003 GOME measurements and the July to November 2003 MIPAS measurements. We further plan to assimilate SMR ozone profiles during the same period than MIPAS ones. The comparison of the two analysed ozone fields from respectively the assimilation of MIPAS and the assimilation of SMR will give precious informations on the bias between the two datasets and their respective errors. This information will be used to implement the simultaneous assimilation of the measurements from both instruments.

The paper will describe the methodology used to assimilate simultaneous satellite ozone data supplied by several instruments. Results from the assimilation of MIPAS and SMR ozone profiles will illustrate this methodology.

Variational assimilation of combined satellite retrieved and in situ aerosol data in an advanced chemistry transport model

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Abstract

The advent of satellite retrieved aerosol information allows for the preparation of assimilation based analysis maps. In combination with aerosol in situ measurements an avenue is opened for verification or complementary estimates of aerosol burden.

ENVISAT aerosol retrievals along with in situ data is assimilated in the RIU at University of Cologne Chemistry-Transport-Model EURAD-CTM (EURopean Air Dispersion and pollution CTM). A three-dimensional (3Dvar) type of data assimilation scheme has been developped and applied using PM10 and PM2.5 data from SYNAER (SYNergetic Aerosol Retrieval of DLR - DFD) aerosol retrievals of ENVISAT-SCIAMACHY-AATSR measurement data. SYNAER produces PM10 and PM2.5 information from Aerosol Optical Thickness (AOT) measurements. As background (or first guess) PM10 and PM2.5 data is delievered by the aerosol model MADE (Modal Aerosol Dynamics model for Europe) in combination with the Secondary Organic Aerosol Module (SORGAM), both implemented as integral part of the EURAD model. The presentation includes a description of the formulation of the variational approach, namely the design of the non-factorized 3D-background error covariance matrix with related formulation of anisotropic and inhomogeneous influence radii, to account for regional differences. As satellite retrievals are available in near real time, this approach aims at the applicability of PM10 and PM2.5 assimilation in an operational forecast model. This is of considerable value adding, as retrievals offer the opportunity to include irregular aerosol emission processes like biomass burning, volcanic eruptions and desert dust outbreaks in future operational products.

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Session 8: Applications

Towards a robust estimate of the global lightning nitrogen oxides source using in situ and remote sensing data and model results

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Abstract

A weighted least square fit method is introduced which provides best estimates for the annually mean global source strength S of lightning induced nitrogen oxides (LNOx) together with random and systematic error bounds. The method is applied to data measured in-situ with airborne instruments near deep convection over a tropical continent at altitudes up to 20 km in Southern Brazil in February 2004 and 2005 during the project "Tropical Convection, Cirrus, and Nitrogen Oxides Experiment" (TROCCINOX). Several different global chemical transport models simulating air chemistry for these periods are used which provided results for at least two values of S. Robust LNOx estimates are obtained not only from NO mixing ratio data measured close to thunderstorms with fresh LNOx sources, but also from O3, CO and possibly CH4 data with LNOx sensitivity due to tropospheric photochemistry during the chemical life-time of theses species. The best LNOx source estimate computed for the given data is S = 4 +- 2 Tg/a (in mass units of nitrogen per year) for the best fitting model. The random errors are smaller than any systematic errors. The robustness of the results with respect to various parameter variations is shown. The value obtained from TROCCINOX itself is just a preliminary result. Inclusion of data from (in-situ or remote sensing) measurements at other periods and latitudes may still change this result.

In order to come to the best practically achievable result we are now rerunning the models for a period of ten years (1996-2005). With the given method, the model results are analysed together with existing measurements in various regions of the world and at various times during that decade. The data include high quality airborne measurements of chemical composition, data from the global ozone sonde systems, and from remote sensing results from satellite sensors such as SCIAMACHY, MOPITT and others.

Finally we indicate that the present method may also be applied to determine other parameters of Earth system models. For example, if models were run with two set of aviation emissions, the best fitting emission rate may be determine by a similar study using data mainly from the mid-latitudes. Even more important, such a study would reveal the consistency of state-of- the-art photochemical models in representing aviation effects. If the models simulate an aviation NOx impact on NOx, O3, and CO concentrations consistent with the data and among each other (see section 5.5), then this provides some validation for the suitability of the models for aviation related assessments. If however, the consistency is weak, this would indicate that important processes are still to be included into the models. By careful analysis of the discrepancy and further parameter studies one should be able to detect "missing chemistry" such as heterogeneous chemical processes. Hence, this approach opens a whole new venue for research and assessments.

Regional air quality forecasting over Greece within PROMOTE

Anastasia Poupkou[(1)], Dimitrios Melas[(1)], Ioannis Kioutsioukis[(2)], Iraklis Lisaridis[(1)], Panayiotis Symeonidis[(1)], and Dimitrios Balis[(1)]

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Abstract

An air quality forecast system is set up in order to predict air pollutants levels over Greece. The forecast system consists of the prognostic meteorological model MM5 and the photochemical air quality model CAMx and runs operationally on a daily basis to issue 72-hours forecasts. The meteorological model is implemented for two nested grids. The coarse grid covering the greater part of the Balkan Region has a horizontal mesh width of 30 km. The fine grid is embedded within it with a horizontal spatial resolution of 10km. Both grids have the same vertical structure of 33 σ levels. MM5 simulations are initialized and develop lateral boundary conditions using GFS Global Forecast. The CAMx modeling domain is a part of the MM5 fine grid and covers Greece and a part of the neighboring Balkan countries with a horizontal grid resolution of 10 km. There are 5 vertical layers extending up to approximately 2.5 km above ground. The emission data used are hourly values of biogenic NMVOCs and anthropogenic NOx, NMVOCs and CO emissions. The biogenic emissions were calculated following the methodology of the EMEP/CORINAIR emission inventory guidebook. The anthropogenic emission fields were estimated using data of official national emission inventories (e.g. the transport sector emission inventory for Greece) and of international emission databases (e.g. EMEP, CORINAIR). The boundary concentrations of the chemical species are based on predictions of the European scale Chemistry Transport Model EURAD-CTM. The Carbon Bond Mechanism (CB-IV) is employed for solving chemical kinetics. The air quality forecasts are used and evaluated by Greek environmental authorities.

Gaseous and Particle Emissions of International Shipping as seen by Satellites

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Abstract

Seagoing ships emit exhaust gases and particles into the marine boundary layer and significantly contribute to the total budget of anthropogenic emissions from the transportation sector. For example, annual NOx emission from ships are similar to NOx emission from road traffic. In addition aerosol (or particulate matter PM) from ships is by far the dominating component from all transport-related PM emissions. For an accurate assessment of the impact of emissions from shipping on the atmosphere and to improve transportation management w.r.t. the environmental impact of international shipping, detailed knowledge on the emission patterns and fluxes is required.

With the availability of satellite sensors being able to detect relevant trace gases (here NO2) and aerosols with sufficient spatial resolution to identify emissions along the major shipping corridors, new methods are emerging to verify bottom-up emission inventories and to estimate the climate effect of shipping activity with data from satellite observations. For example, tropospheric NO2 data from the SCIAMACHY (Scanning Imaging Absorption spectroMeter for Atmospheric CHartographY) instrument on board the ENVISAT satellite shows clear indication for NO2 produced from ship emissions over the Red Sea and along the main shipping lane to the southern tip of India, to Indonesia and north towards China and Japan. In addition, aerosols emitted by ships significantly change cloud optical thicknes and droplet size, which is observable from satelite instruments like AATSR or MODIS. With these data the impact of cloud modifications by ships on the Earth radiation budget can be estimated.

The talk will give first results of observing shipping emissions like NO2 and aerosol from satellites. The results highlight the importance of ship emissions for the marine boundary layer and at the same time demonstrate the potential of satellite observations to estimate and monitor the global impact of ship emissions.

Atmospheric applications on GRID with a focus on GOMOS and MIPAS

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Abstract

The GRID provides an efficient, and highly collaborative tool to faster process and interpret large amounts of Earth observation data. The GRID combines storage and computing elements, which are located in different geographic locations and combines them to a single access point. As such GRID is, amongst other interfaces, the perfect environment to sophisticatedly treat scientific results coming from a variety of atmospheric instruments. Due to e.g. geographically dislocated research groups, data and processing resources, single instrument applications are often lacking proper comparison or even validation mechanisms with similar instruments or equivalent data products.

At ESA the current functionality in GRID for atmospheric science purposes provides access to sounding data via the integrated BEAT libraries (Basic Envisat & ERS-2 Atmospheric Toolbox). Similar to BEAM (Basic ERS & Envisat (A)ATSR and Meris Toolbox) and BEST (Basic Envisat SAR Toolbox), the development of this toolbox was initiated by ESA and implemented by European companies. BEAT gives not only access to data, furthermore it provides high level ingestion routines to make the inter-comparison of e.g. the trace gas ozone or the atmospheric temperature possible.

In this work we focus on an exploitation and comparison of GOMOS (Global Ozone Monitoring by Occultation of Stars) and MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) ozone and temperature data. In the case of GOMOS, profiles are taken from the official ESA product and are as well generated by YAGOP (Yet Another GOMOS Processor) a processor running on GRID. For the YAGOP ozone processing we take GOMOS transmission data and feed an optimal estimation routine by incorporating a-priori data. YAGOP temperatures are gained by exploiting pointing data of the Steering Front Assembly (SFA) and the Star Acquisition and Tracking Unit (SATU), which provide information on the refraction of the star light in the atmosphere and thus allows to derive refractive bending angle profiles. For MIPAS we selected data, which were reprocessed by the GeoFit/MRT algorithm. The reprocessing campaign and comparison include all available datasets from the beginning of the mission in 2002 up to now.

Use of atmospheric remote sensing for solar energy purposes: Experiences made in the ENVISOLAR project

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Abstract

Within the Earth Observation Market and Development programme at the European Space Agency, the ENVISOLAR project aims at an intensified use of Earth Observation-based information products in the solar energy industries. Existing services for investment decision, plant management, load forecasting and for science and consulting rely on high quality surface solar irradiance measurements and credible processing chains to deliver such information regularly.

Within the scope of the project Heliosat-3 (contracted within the 5th Framework Programme of the European Union), the usage of atmospheric remote sensing technologies based on the Meteosat Second Generation and the ENVISAT satellites has been evaluated.

Up to now, based almost exclusively on the visible among the 3 available Meteosat channels, cloudiness as input for surface solar irradiance calculations has been retrieved as a mixture of cloud amount and cloud opacity. Turbidity information has been taken from climatologies mainly. The Meteosat-8 SEVIRI, with its 12 spectral channels, allows not only a much more precise characterisation of clouds, but also retrieval of atmospheric water vapour, ozone and, partly, aerosols. The measurement of aerosols is completed by exploitation of the ENVISAT instruments AATSR and SCIAMACHY. Knowledge of these components allows considering use of fast radiative transfer parameterisations for solar irradiance estimates.

The ENVISOLAR consortium has identified a list of blockages that prevent the increased use of Earth Observation techniques up to now. The paper will describe how the Heliosat-3 and ENVISOLAR projects contribute to solving some of the identified blockages.

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Session 9: Future Missions

Possible Future Atmospheric Earth Explorer Missions

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Abstract

Following 6 Earth Explorer missions which are currently in extended feasibility study or in implementation phases, ESA issued a call for ideas for new Earth Explorer core missions in 2005. In addition to the general Earth observation themes identified in the Science and Research Elements of ESA's Living Planet Programme, this call focuses on 4 specific areas, namely the global water cycle, the global carbon cycle, atmospheric chemistry and its interaction with climate, and the human element. 24 responses to the call were received, 14 of them capitalised on atmospheric observations. These address various scientific issues, e.g. radiative and dynamical processes in the UTLS, air quality and the transport of pollutants in the troposphere, sources and sinks of greenhouse gases and aerosols, the evolution of the stratospheric ozone layer, the distribution of water vapour and its radiative effects, climate records of trace gases, cloud, temperature and precipitation patterns, and the impact of lightning on the abundances of nitrogen oxides. The proposals are undergoing review in scientific and technical panels. Recommendations on selection of proposals for pre-feasibility studies will be made by ESA's Earth Science Advisory Committee.

Definition of Future Operational Atmospheric Composition Monitoring Satellite Missions: Final Results of the CAPACITY study

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Abstract

Future extensions of the operational system for the global monitoring of atmospheric composition have been investigated. Focus has been given to applications in air quality forecasting, ozone/UV forecasting, air quality monitoring and assessment, protocol monitoring (e.g. Montreal, Kyoto) and assessments of climate change and ozone layer recovery. Level-2 data and instrument requirements have been derived for each of the envisioned applications. At present it is most urgent is to set up a system that can meet Air Quality requirements. Stringent requirements on temporal resolution and horizontal spatial resolution can not be met with the missions that are planned for the next decade (2010-2020). A combination of satellites is needed, either in a combination of a mission in low-earth orbit and a mission in geostationary orbit, or by multiple satellites in low-inclination orbit. Climate protocol monitoring can be efficiently integrated in the Air Quality combined mission. Total ozone monitoring is at present guaranteed by GOME-2 on MetOp. For the monitoring and assessment of the upper troposphere and stratosphere it is recommended to add an operational limb component to the system in the post-EPS timeframe (2015+) The definition of the required satellite components as part of the future integrated observation system for atmospheric composition has been carried out by a large European consortium in an ESA commissioned 18-month study named CAPACITY (2003-2005). Operational monitoring of atmospheric composition is called for within, e.g., GMES (Global Monitoring of Environment and Security), the European contribution to the international Global Earth Observation System of Systems GEOSS.

GOME-2 on MetOp

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Abstract

The Second Global Ozone Monitoring Experiment (GOME-2) will perform operational global monitoring of ozone column densities and profiles, and column densities of other atmospheric trace gases such as NO2, BrO, OClO, HCHO, SO2 and H2O. GOME-2 is an improved version of the Global Ozone Monitoring Experiment (GOME-1) launched 1995 onboard the second European Remote Sensing Satellite (ERS-2) It will be embarked on the MetOp series of three polar-orbiting operational meteorological satellites, to be launched in 2006, 2010, and 2014. Although GOME-2 is considered a "recurrent" instrument - the basic design of GOME-2 being the same as that of GOME-1 - a number of technical improvements were made based on the experience with GOME-1 operations and data analysis and in response to more stringent user requirements. Particular improvements concern spatial resolution, polarisation measurements, and calibration. Level 0 to 1 processing will take place in the Core Ground Segment (CGS) at EUMETSAT while level 1 to 2 processing will be performed by the partner institutes of the Ozone Monitoring Satellite Application Facility (O3MSAF).

This paper presents the GOME-2 instrument characteristics and the main improvements as compared to GOME-1. Instrument calibration aspects will be discussed, covering on-ground calibration results, actual instrument performance, in-orbit verification during the first weeks after launch, and the scenario for routine in-orbit calibrations. We will present an overview of the on-ground processing of GOME-2 data from raw instrument packets (level 0) via calibrated (ir)radiances (level 1) to geophysical data (level 2). Additionally the post-launch GOME-2 calibration and validation activities, planned to be carried out centrally at EUMETSAT HQ will be discussed. This includes real-time verification and quality checking of the GOME-2 level 1 products, in addition to full validation activities taking into account feedback from the retrieval of geophysical parameters. As GOME-2 data will provide long time series of a number of trace gases, GOME-2 instrument and processing performance have to be monitored throughout its lifetime. The tools developed for this purpose will also be described.

IASI instrument performances just before the launch of MetOp

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Abstract

At the eve of the launch of the MetOp satellite (nominally from 30 June 2006), a status is given concerning the Infrared Atmospheric Sounding Interferometer (IASI), which will be, as a second generation IR operational sounder, one of the key instrument of the first European polar orbit satellite for operational meteorology, with very promising capabilities for Earth sciences including atmospheric composition and climate. The operational and science objectives of IASI will be briefly reviewed together with an overview of the overall IASI programme run in common by Eumetsat and CNES. The performances of the first model to be flown have been extensively assessed during the qualification process performed by the prime contractor (Alcatel Space Alenia) under the overall responsibility of CNES. Results demonstrating the spectral and radiometric performances will be presented. IASI products (level 1 and 2) will be reviewed together with their expected precision and space/time coverage. The role of the Technical Expertise Centre (TEC) for optimizing and controlling the instrument parameters once in orbit together with the calibration/validation plan will be discussed.

Future NASA Atmospheric Missions

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Abstract

Following on the successful launch of Aura in July 2004, NASA will continue to add to the A-train with the spring 2006 launch of the CALIPSO and Cloudsat missions, followed by the fall 2008 launch of the Orbiting Carbon Observatory (OCO). The CALIPSO mission has three nadir-viewing instruments: a cloud-aerosol lidar for measuring aerosol and cloud height and properties, a 3-channel thermal infrared imaging radiometer, and a wide field cloud camera. The Cloudsat mission has a 94 GHz cloud profiling radar, returning cloud structure vs. height profiles. Orbiting Carbon Observatory (OCO) is a mission focused on precision measurements of total column CO2 using reflected sunlight. These missions and how they relate to the other parts of the A-train will be presented. A brief report from a NASA workshop on future atmospheric science missions will also be presented.

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