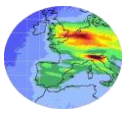
ACCENT
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK OF EXCELLENCE



Troposat-2

Remote Sensing of the Troposphere from Space

Sixth AT2 Workshop
Observing trace substances from space and integrating the results with models

Workshop Report and Abstracts

1. Workshop Report

1. Venue and Date

The Sixth AT2 workshop was held in the Atlantic Hotel Universum, Bremen from Monday 18th (13.00) to the Wednesday 20th June 2007 (13.00). Some 56 people attended, the majority of whom gave presentations and participated in the discussions (see **section 4** for a list of participants).

2. Future Directions in AT2.

The workshop was opened by the coordinator, *John Burrows*, who pointed out that GOME had been yielding measurements of trace species for more than 12 years, SCIAMACHY for about 5 years; fortunately GOME-2 was well under way, enabling the sequence to be continued, augmented of course by the various other instruments which are now operational.

During the coming months we would be concerned with winding up AT2 as ACCENT itself came to an end. Among the issues to be tackled in the coming months were the following.

- Good attendance at the ACCENT Urbino Symposium.
- Synthesis and integration of our results, which would be carried out within the structure of the AT2 final report.
- There will be a "no-cost" extension to ACCENT from March to December 2009.
- The possibility of a project to follow ACCENT is in the balance.
- Whether the TROPOSAT group should continue, whatever the fate of ACCENT?

In the discussion the view was strongly expressed that we should do our best to keep the TROPOSAT group going since it performed a useful function in bringing the community together to informal workshops where ongoing science could be properly discussed in an informal forum.

3. News and Feedback Session.

The workshop continued with a business session to report developments and enable PIs to provide feedback. A detailed account is given in **section 2**. One important point to be stressed is the need to demonstrate the added value of AT2. In this context PIs will be asked in their final report to consider the questions:

- What clear benefits have come from AT2: communication, research direction etc.?
- Are you better off, in terms of knowledge, capability and clarity of research focus, etc. because of AT2? Kindly provide specific examples.

4. Scientific Sessions

The meeting continued with the scientific sessions at which there were some 29 presentations. The detailed programme is given in **section 3**. The contributions had been selected on the basis of short abstracts, which are presented in **section 5.**

5. Conclusion

The coordinator, in closing the workshop, pointed to both the high quality and the quantity of the scientific work being done. The group was making an appreciable

contribution to the exploitation of remote sensing from satellites and hence to regional air quality and the observation of global atmospheric change.

The "take home" messages were:

- We had a worthwhile workshop which showed the viability of the European tropospheric remote sensing community.
- PIs should support the work for the groups with their reports and with attendance at the appropriate workshops.
- There will be some need for reflection next year to achieve a good synthesis and integration report.
- There is some steady progress with synergy using the results from different instruments.
- Thought should be given to how best to continue the work of this activity during the undoubted changes which will occur during the next couple of years.

Peter Borrell
P&PMB Consultants
Newcastle-under-Lyme
10th July 2007

AT2 Sixth Workshop

2. AT2 News and Feedback Session

18th June, Bremen

Agenda

1. **Report from ACCENT**. *John Burrows*, coordinator.

The coordinator's report is given under **Future Directions** on page 3 above.

2. **Funding for meetings and PIs**

It was reported that the Steering Group had approved the following applications for the year 2007 – 8. Some further applications would be considered at the next steering group meeting.

Maria Kanakidou	Heraklion	International Aerosol Workshop April 2007	up to 5k€
Coordinator	IUP, Bremen	6th AT2 workshop 18th – 20th June 2007	up to 30k€
Gerrit de Leeuw	IUP, Bremen	Aerosol Retrieval Workshop 21st – 22nd June2007	7.5 k€
Ankie Piters	KNMI, de Bilt	Tropospheric NO_2 workshop 10th 12th September 2007	up to 10 k€
Thomas Holzer Popp	RIU and DLR-DFD	Aerosol retrieval from space 2 students	1000 €
Peter Borrell	ACCENT T&TP	Air Quality and Climate Change 4th Barnsdale Expert Meeting 5th – 7th November 2007	10 k€
Diego Loyola & Thomas Wagner	Brussels	H_2O vapour retrieval workshop November 2007	3.5 k€

AT2 members are invited to apply for funds to facilitate exchanges or to support meetings. An application help sheet is available on the web site and on request together with templates for submitting proposals and reports.

3. **Annual reports**

2005-6. The report was published early in 2007. The report is available on the web and copies were circulated to all PIs in January 2006.

2006-7. PI contributions were requested for June 30th 2007; The various overviews will be prepared during the summer and it is hoped to publish the report later in the year. PIs were urged to submit their contributions promptly.

4 **Web Page & Portal.** The AT2 web page and the ACCENT web portal are run in synchrony, and are regularly updated.

5. **Future Meetings**. The steering committee has approved the following schedule.

Aerosol Retrieval Workshop	21st – 22nd June 2007 Gerrit de Leeuw & Alexander Kokhanovsky (*AT2 supported meeting*)	IUP, Bremen
ACCENT Symposium	23rd – 27th July 2007	Urbino
Tropospheric NO_2 workshop	10th – 12th September 2007. Ankie Piters	KNMI, de Bilt
H_2O vapour retrieval workshop	November 2007 Diego Loyola & Thomas Wagner (*AT2 supported meeting*)	Brussels
Air Quality and Climate Change	5th – 7th November 2007,	Barnsdale Hall Hotel

4th Barnsdale Expert Meeting	Peter Borrell (*AT2 supported meeting*)	
Intercomparison of independent SCIAMACHY Carbon Dioxide (CO_2) retrievals	November 2007, Michael Buchwitz (*AT2 supported meeting*)	IUP, Bremen
H_2O vapour retrieval workshop	November 2007 Diego Loyola & Thomas Wagner (*AT2 supported meeting*)	DLR, Oberpfaffenhofen
9th Steering Group & AT2 book authors meeting	18th December 2007	MPI, Mainz
4th International DOAS workshop	March 2008	China
AT2 book – 2nd authors meeting	June 2008	tbd
7th and final AT2 Workshop	30th September – 1st October 2008	FNMI, Finland

6. **Reports from AT2 supported workshops**

Brief reports were given on the two following AT2 supported meetings.

- IR workshop: Johannes Orphal
- International Aerosol Workshop, Heraklion: Maria Kanakidou

7. **e-Learning Module.** *Peter Borrell* reported on the e-learning workshop, held by the ACCENT Training and Education Project in Interlaken in May 2007. One question for AT2 is whether we should complete the AT2 module on Remote Sensing, by constructing a section on Applications. The steering group will discuss this on Wednesday.

8. **AT2 – Book**. **The Remote Sensing of Atmospheric Composition from Space**. It was reported that the steering group is planning a book on remote sensing. It will be further discussed at the steering committee on Wednesday.

9. **Task Group Reports**.

TG1 *Thomas Wagner* reported on the TG1 session. Among the future plans was a special effort to try to make a sophisticated comparison between models and measurements. A perennial problem is defining criteria for the comparisons and criteria for goodness of fit. There is also a question of how much models are used in the extraction of data (particularly with profiles) and how valid comparisons with models will then be.

There is to be a workshop on H_2O retrievals in November.

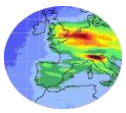
TG3 *Ankie Piters* reported the TG3 was likely to re-focus its objectives to concentrate on NO_2, CO and possibly tropospheric ozone.

There is to be a workshop on NO_2 in September. The group will also look at what is needed to assess profiles obtained from MAXDOAS.

oOo

Peter Borrell
P&PMB Consultants, Newcastle-under-Lyme
July 2007

ACCENT
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK OF EXCELLENCE



Troposat-2

Remote Sensing of the Troposphere from Space

Sixth AT2 Workshop
Observing trace substances from space and integrating the results with models

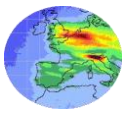
3. Workshop Programme

Mon. 18th June	**2007**	
from 12.00	**Registration**	
12.30 – 14.00		*Lunch*
14.00	**Workshop start**	
	Peter Borrell P&PMB Consultants, UK	**AT2 News and Feedback Session** *See below for the agenda for this session*
15.30 - 16.00		*break for coffee or tea*
	Task Groups 2 & 3	***Chair: John Burrows***
16.00	Dominik Brunner (TG3) EMPA, Duebendorf	Reconstructing fine-scale air pollution structures from coarsely resolved satellite observations
16.20	Hendrik Elbern Uni-Cologne	Combined variational assimilation of satellite data in a chemistry transport model
16.40	J.-L. Attié Uni-Toulouse	Dual assimilation of MOPITT and MLS carbon monoxide in the MOCAGE model
17.00	Stelios Myriokefalitakis Uni-Heraklion	Global 3-D modelling of trace gases and aerosols and comparison to satellite observations
17.20	Kryštof Eben Acad. Of Sciences, Prague	A comparison of satellite-retrieved tropospheric NO_2 columns with model values from a mesoscale model
17.40	Julian Meyer-Arnek DLR, Oberpfaffenhofen	Synpotic near-real time maps of tropospheric NO_2 vertical columns obtained with statistical methods
18.15	EPS Committee Meeting	

Tues. 19th June		***Chair: Brigitte Buchmann***
09.00	N.A.D. Richards Uni-Leeds	Interpretation of Global Satellite Observations of PAN and Acetone
09.20	Maria Sfakianaki Uni-Crete, Heraklion	Validation of Bremen aerosol retrieval (BAER) approach, applied to MERIS and SeaWiFS data over the Mediterranean
09.40	Lisa Bock DLR, Oberpfaffenhofen	Comparison of operationally available cloud top height level-2-data
10.00	N.A.D. Richards Uni-Leeds	Validation of test ozone profiles (*additional talk*)
	Task group 1: aerosol	
10.20	E. Carboni Uni-Oxford	Aerosol, Cloud and Trace Gas Measurements in the Troposphere and Lower Stratosphere
10.40 – 11.10		*break for coffee or tea*
11.10	Wolfgang von Hoyningen-Huene, IUP Bremen	Retrieval of particulate matter concentration (PM_{10}) from MERIS observation and validation over Germany
11.30	Dmytro Martynenko DLR, Oberpfaffenhofen	An update on the synergetic aerosol retrieval
11.50	Renske Timmermans TNO Apeldoorn	An Observing System Simulation Experiment (OSSE) for aerosols
12.10	Jim Drummond Dalhousie University	Carbon Monoxide over Indonesia (*additional talk*)
12.30 – 14.00		*Lunch*
	Task group 1: UV/visible	***Chair Gerrit de Leeuw***
14.00	Steffen Beirle MPI, Mainz	Impact of clouds on tropospheric trace gas retrievals
14.20	Michael Buchwitz IUP, Bremen	Three years of global simultaneous measurements of tropospheric methane, carbon dioxide and carbon monoxide retrieved from SCIAMACHY using WFM-DOAS
14.40	Anton K. Kaifel ZSW, Stuttgart	New DYNAMIC ozone profile climatology based on NNORSY-GOME
15.00	Diego G. Loyola DLR, Oberpfaffenhofen.	Retrieval of cloud information from GOME-2/MetOp: First Results
15.20	Sebastian Mieruch IUP, Bremen	Water vapour trends from GOME and SCIAMACHY satellite measurements
15.40	Robert Parker Uni-Leicester	A Synergistic Approach Towards Studying Biomass Burning From Space
16.00 – 16.30		*break for coffee or tea*

16.30	Fred Prata NILU	Trace Gas Detection using AIRS data: Spectral matching and retrieval algorithms
16.50	Andreas Richter IUP, Bremen	Observation of changes in tropospheric SO2 from space
17.10	Anja Schoenhardt IUP, Bremen	Observation of IO from Space using SCIAMACHY
17.30 - 18.30	***Task group Meetings***	
19.30	*Haus am Wald*	*Workshop Dinner*
Wed. 20th June	***Task Group 1: Infrared***	***Chair: Maria Kanakidou***
09.00	Thomas Wagner MPI, Mainz	Global patterns of the temperature dependence of cloud fraction, cloud top height and total column precipitable water
09.20	J Kar Uni Toronto	A study of low altitude CO over India using MOPITT data and GEOS-CHEM model
09.40	J. Orphal LISA, Paris	The consistency of the UV-visible and infrared absorption coefficients of O_3, NO_2, and H_2CO
	First results from IASI & GOME-2	
10.00	Pieter Valks DLR Oberpfaffenhofen	First results of tropospheric NO_2 and SO_2 from the GOME-2 instrument on MetOp
10.20	Folkard Wittrock IUP, Bremen	Early results on trace gases from GOME-2
10.40	P.F. Coheur	Upper tropospheric plumes from the ACE-FTS and first IASI data
11.00 – 11.30		*break for coffee or tea*
11.30	**Task Group Plans**	
	TG3 - Anki Piters TG1 - Thomas Wagner	
12.00	John Burrows	Conclusions: Where do we go from here?
12.30	**Workshop Finish**	
12.30 – 13.30		*Lunch*
	14.00 – 17.00	**AT2 Steering Committee Meeting**

ACCENT
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK OF EXCELLENCE



Troposat-2

Remote Sensing of the Troposphere from Space

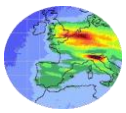
Sixth AT2 Workshop
Observing trace substances from space and integrating the results with models

4. List of Participants

Prepared by *Susanne Themm*, IUP, Bremen

Jean Luc	Attie	University Toulouse/F
Steffen	Beierle	MPI, Mainz, D
Lisa	Bock	DLR, Oberpfaffenhofen, D
Peter	Borrell	P&PMB, UK
Patricia	Borrell	P&PMB, UK
Heinrich	Bovensmann	IUP Bremen
Dominik	Brunner	EMPA/CH
Brigitte	Buchmann	EMPA/CH
Michael	Buchwitz	IUP Bremen, D
John	Burrows	IUP Bremen, D
Elisa	Carboni	Oxford University, UK
Pierre	Coheur	Uni-Libre, B
Gerrit	deLeeuw	TNO, NL
James	Drummond	Dalhousi University, CA
Krystof	Eben	Inst. of Comp.Science, Prag, CZ
Hendrik	Elbern	RIU, Universität Köln, D
Albert	Goede	FOM
Thomas	Hamercher	IPP, Garching
Andreas	Heckel	IUP Bremen, D
Wolfgang	Hoyningen-Huene	IUP Bremen, D
Anton	Kaifel	ZSW, D
Maria	Kanakido	Universtiy of Crete, GR
Jay	Kar	University Toronto, CA
Johannes	Keller	PSI,Villingen/CH
Iryna	Khlystova	IUP Bremen, D
Alexander	Kokhanovsky	IUP, Bremen
Annette	Ladstätter-W.	IUP Bremen, D
Joana	Laitao	IUP Bremen, D
Robert	Levy	NASA-GSFC
Diego	Loyola	DLR, Oberpfaffenhofen, D
Dymytrio	Martynenko	DLR Oberpfaffenhoffen
Julian	Meyer-Arnek	DLR, Oberpfaffenhofen, D
Sebastian	Mieruch	IUP Bremen, D
Stelios	Myriokefalitakis	University of Crete, GR
Stefan	Noel	IUP Bremen, D
Justus	Notholt	IUP Bremen, D
Johannes	Orphal	CNRS,LISA,Creteuil/F
Rob	Parker	University of Leicester, UK
Ankie	Piters	KNMI,DeBilt, NL
Ulrich	Platt	IUP Heidelberg, D
Fred	Prata	NILU, Kjeller, N
Philipp	Reichl	IUP Bremen, D
Jaroslaw	Resler	Inst. of comp. science, Prag, CZ
Nigel	Richards	Uni-Leeds, UK
Andreas	Richter	IUP Bremen, D
Günther	Rohen	IUP Bremen, D
Anja	Schönhardt	IUP, Bremen
Marix	Sfahianaki	UOC, Heraklion
Maria	Sfakianaki	University of Crete, GR
Renske	Timmermans	TNO, NL
Pieter	Valks	DLR, Oberpfaffenhofen, D
Mihaelis	Vrekoussis	University of Crete, GR
Thomas	Wagner	IUP Heidelberg, D
Jan	Wuite	KNMI,DeBilt, NL

ACCENT
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK OF EXCELLENCE



Troposat-2

Remote Sensing of the Troposphere from Space

Sixth AT2 Workshop
Observing trace substances from space and integrating the results with models

5. Short Abstracts

The PIs making presentations at the workshop submitted the following short abstracts.

Aerosol, Cloud and Trace Gas Measurements in the Troposphere and Lower Stratosphere

A contribution to ACCENT-TROPOSAT-2, Task Group 1: Aerosols

E. Carboni and R.G. Grainger

Atmospheric, Oceanic & Planetary Physics, Clarendon Laboratory, Parks Road, Oxford, UK

The principal focus of the Earth Observation Data Group is the retrieval of atmospheric properties (*e.g.* temperature, pressure, trace gas concentrations, aerosol and cloud properties) from data gathered by Earth Observing satellites.

The aerosol and cloud retrievals are based on the ORAC aerosol retrieval algorithm, developed at the University Oxford and the Rutherford Appleton Laboratory for the visible and near infrared channels of (A)ATSR and MSG SEVIRI. The scheme has been used and validated in several projects including NERC GRAPE and ESA Globaerosol. The aerosol parameters retrieved are optical depth (at 550 nm) and effective radius. During the last year algorithm improvements include a non-Lambertian surface reflectance model and the extension to use the (A)ATSR dual view. The ORAC aerosol retrieval algorithm has also been improved to include the two SEVIRI infrared window channels for the analysis of desert dust event over bright surface e.g. the Sahara desert. We are working on a reanalysis of aerosol and cloud retrieval from ATSR-2 data (GRAPE). In this context we have introduced a new aerosol optical model and we are working on extending the cloud retrieval to include a ship track detection algorithm. Laboratory aerosol activities include the retrieval of complex refractive index using transmission measurements (desert dust, volcanic ash, sea salt, ammonium sulfate and ammonium nitrate aerosols). We are investigating the influence of aviation on cirrus — this year the aerosol microphysical model has been expanded to simulate ice particle growth.

Upper tropospheric and stratospheric trace gas activities retrievals of O_3, H_2O, CH_4, N_2O, NO_2 HNO_3, CF11, CF12, $ClONO_2$, N_2O_5 and CO have been performed for selected days throughout the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) mission (5 years) using the Oxford retrieval algorithm MORSE (MIPAS Orbital Retrieval using Sequential Estimation). MIPAS data is being used to:

* assess trends in stratospheric temperature and composition in order to understand whether these are real changes in the atmosphere or are simply an artefact of the instrument/retrieval system,
* perform a joint retrieval of CO and vibrational temperature,
* observe the distribution of NO_y (NO, NO_2, N_2O_5 and HNO_3) gases during the period July 2002 - March 2004, and
* as input to an optimal estimation-type of retrieval of three cloud parameters (cloud top height, cloud top temperature, cloud extinction coefficient).

Combined O_3 retrievals have been performed using MIPAS and the Tropospheric Emission Spectrometer (TES) data. The main advantage in combining limb and nadir geometries is that it allows the stratospheric and tropospheric ozone concentrations to be separated which makes it possible to improve the tropospheric ozone retrieval.

MODIS Satellite Observations and Meteorological Surface Characterization to Evaluate $PM_{2.5}$ Concentrations

A contribution to ACCENT-TROPOSAT-2, Task Group 1: Aerosols

W. Di Nicolantonio[1], A. Cacciari[1], E. Bolzacchini[1], L. Ferrero[1], E. Pisoni[2] and M. Volta[3]

[1]Carlo Gavazzi Space S.p.A at ISAC-CNR, via Gobetti, 101, 40129 Bologna, Italy,
[2]Dipartimento di Scienze dell'Ambiente e del Territorio, University of Milano-Bicocca, P.za della Scienza 1, Milano, Italy
[3]Dipartimento di Elettronica per l'Automazione, University of Brescia, via Branze 38, Brescia, Italy

Air Quality monitoring at urban and regional scale is typically performed using in-situ measurements. Also chemical transport models are employed to assess and predict air quality.

During the last few years, attention has been devoted to evaluate the possibility to monitor surface particulate matter (PM) concentrations using satellite observations. In particular, the capability of NASA sensors MODIS on board Terra and Aqua platforms, to retrieve tropospheric Aerosol Optical Depth (AOD) has been exploited to verify the degree of correlation between satellite AOD at 550 nm and surface $PM_{2.5}$.

However, several factors affect the relationship between columnar AOD and surface PM concentrations. Among these, the two most important are the aerosol vertical distribution and the relative humidity of the suspended particles.

In our analysis, NASA official MODIS Aerosol Optical Properties at spatial resolution of 10 x 10 km^2 in terms of Aerosol Optical Depth at 550 nm due to fine fraction particles have been employed together with PM2.5 concentrations measured at the ground in six sampling sites in Lombardia region.

Moreover, as ancillary meteorological parameters, relative humidity at surface and mixing layer height at spatial resolution of 5 x 5 km^2 derived from MM5 simulations has been considered in this study.

All the data refer to whole 2004 over an area of about 300 x 300 km^2 around Milan city involving a great part of the Po Valley in northern Italy.

In the above six sampling sites, best fit parameters were retrieved for the relationship between AOD and $PM_{2.5}$, then, by means of a spatial interpolation they were extended to the whole analysed area.

This work is carried out in the frame of ESA PROMOTE-2 (Protocol Monitoring for the GMES Service Element: Atmosphere) and ASI QUITSAT (Italian Space Agency Pilot Project for Air quality assessment through the fusion of Earth observations, ground-based and modelling data projects).

Retrieval of Particulate Matter Concentration (PM_{10}) from Meris Observation and Validation Over Germany

A contribution to ACCENT-TROPOSAT-2, Task Group 1: Aerosols

Wolfgang von Hoyningen-Huene, Alexander A. Kokhanovsky, Günter Rohen, John P. Burrows, Berndt Kahra* and Marion Wichmann-Fiebig*

Institute of Environmental Physics, University of Bremen, Otto-Hahn-Allee 1, D-28334 Bremen
**Umweltbundesamt, Dessau, Germany*

An estimation of quantitative information on particulate matter from space-borne observations requires more than a retrieval of one value of an aerosol optical thickness (AOT). The determination of PM10 from AOT the needs: a size information, the aerosol concentration for a given size distribution, the height of planetary boundary layer (PBL), the fraction of AOT within the PBL the humidity status of the aerosol. Although meteorological parameters, like PBL height and relative humidity need to be contributed from prediction or analytical forecast models, the required columnar information on size and concentration need to be determined from a retrieval of spectral AOT over land, giving AOT and spectral slope Angström α.

Bremen AErosol Retrieval (BAER) separates the spectral aerosol reflectance from surface and Rayleigh path reflectance for the short wave range of the measured spectrum of top-of-atmosphere reflectance less than 0.670 µm. The advantage of MERIS is the existence of several spectral channels in the blue and visible range enabling the spectral determination of AOT in 7 channels (0.412–0.670 µm) and additionally channels in the NIR, which can be used to characterize the surface properties. A dynamical spectral surface reflectance model for different surface types is used to obtain the spectral surface reflectance for this separation. Normalized differential vegetation index (NDVI), taken from the satellite observations, is the model input. Spectral AOT is obtained from aerosol reflectance using look-up-tables, obtained from radiative transfer calculations with given aerosol phase functions and single scattering albedo either from aerosol models, given by OPAC or from experimental campaigns. Validations of the obtained AOT retrieval results with AERONET data over Europe gave a preference for experimental phase functions derived from almucantar measurements.

PM_{10} concentrations are estimated, using the BAER AOT retrivals, estimating columnar number concentration and effective radius for a monomodal logarithmic size-distribution model from AOT and their spectral slope Angström α. The validation with ground-based PM10 concentrations, provided by German Umweltbundesamt showed the importance of consideration of meteorological parameters, especially height information on planetary boundary layer.

An update on the synergetic aerosol retrieval

A contribution to ACCENT-TROPOSAT-2, Task Group 1: Aerosols

Dmytro Martynenko and Thomas Holzer-Popp

DLR, Deutsches Fernerkundungsdatenzentrum (DFD)
Oberpfaffenhofen
D-82234 Wessling
Tel.: +49-(0)8153-28 2657
e-mail:thomas.holzer-popp@dlr.de
Fax: +49-(0)8153-28 1363

At DLR-DFD a synergetic aerosol retrieval method SYNAER was developed (Holzer-Popp et al., JGR, 107, 2002), 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 aerosol optical depth at 550 nm and 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). Processing of these data over the MSG field of view (Europe, Africa, Atlantic) 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 since June 2005 as input for data assimilation into chemistry transport models, and as long-term evolving archive. Furthermore, first examples of converting SYNAER AOD and aerosol type into near-surface particulate matter concentrations and assimilation into the EURAD chemistry-transport model to improve the treatment of episodic emission patterns have been achieved. Validation of these SYNAER results is an ongoing activity. The validation efforts so far showed the potential to estimate the aerosol type from space (AOD error around 0.1 from UV to NIR, which is in perfect match with the expected noise level for the exploited pixel size), but also revealed cases of large AOD errors. Suspected reasons for these are surfaces with higher albedo and cases, where the sun-photometer observation is not representative for the satellite pixel of 60x30km2.

Several parts of the retrieval methodology have therefore been assessed in more detail to better understand these issues. This includes a stringent analysis of the information content for different surface-atmosphere conditions and illuminations (up to 3 degrees of freedom for the type of aerosol). Furthermore, an investigation of airborne surface spectra was conducted to improve the dark field treatment based on characterizing the 670nm surface albedo from 1.6 micron channel reflectance and vegetation index. Preliminary results of this refinement effort will be summarized and discussed.

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. SCIAMACHY mid infrared channels or ATSR dual view). This presentation summarizes the status of the activity “Derivation of aerosol composition from space” as a contribution to subproject ACCENT-TROPOSAT-2 (AT2), Task Group 1 (and 2).

An Observing System Simulation Experiment (OSSE) for Aerosols

A contribution to ACCENT TROPOSAT 2: Task Group 1: Aerosols

Renske Timmermans[1], Peter Builtjes[1], Stephen Tjemkes[2], Martijn Schaap[1], Richard Siddans[3], Robert Vautard[4] and Hendrik Elbern[5]

[1] *TNO, Apeldoorn, The Netherlands*
[2] *EUMETSAT, Darmstadt, Germany*
[3] *RAL, Chilton, United Kingdom*
[4] *LSCE, Gif-sur-Yvette, France*
[5] *RIU, University of Köln, Köln, Germany*

Monitoring aerosols over wide areas is a scientific challenge with important applications for human health and the understanding of climate. Space-borne observations of Aerosol Optical Depth (AOD) can improve the highly needed analyzed and forecasted distributions of ground-level aerosols in combination with models and ground-based measurements.

Following consultation with representatives of the operational meteorological and air chemistry/air quality community, resolution requirements have been documented for space-borne Aerosol Optical Depth (AOD) measurements used for operational air quality applications.

To determine whether these requirements are necessary to have an impact on the forecast and analysis of $PM_{2.5}$ levels over Europe and to investigate if AOD measurements with more relaxed requirements in time and space will lead to noticeably less impact, an Observing System Simulation Experiment (OSSE) is developed.

OSSEs are commonly used to quantify the impact of observations from future observation systems such as satellite instruments or ground-based networks on, for example, weather forecasts. In this study we apply such an OSSE to AOD measurements from future satellite instruments using the LOTOS-EUROS chemistry transport model and the ensemble Kalman filter data assimilation method.

The OSSE shows, among others, that assimilation of hourly synthetic total AOD measurements from an imager improves the analysis of ground-level $PM_{2.5}$ concentrations. The level of improvement depends on the vicinity of simultaneously assimilated ground-based measurements.

In the presentation we will share our experience with an OSSE for air quality applications concerning aerosol concentrations, show results and discuss some of the critical points of performing such an OSSE.

Tropospheric Composition Measurements using Infrared Satellite Sounders: Upper Tropospheric Plumes from the ACE-FTS and First IASI Data

A contribution to ACCENT-TROPOSAT-2, Task Group 1: Infra red

P.F. Coheur[1], C. Clerbaux[1,2], C. Wespes[1], D. Hurtmans[1], H. Herbin[1], A. Razavi[1], S. Turquety[2], J. Hadji-Lazaro[2] , M. George[2], A. Boynard[2,] C. Booone[3] and P. F. Bernath[3]

[1] *Spectroscopie de l'Atmosphère, Service de Chimie Quantique et de Photophysique, Université Libre de Bruxelles, Brussels, Belgium*
[2] *Service d'Aéronomie / CNRS, Institut Pierre-Simon Laplace, Paris, France*
[3] *Department of Chemistry, University of Waterloo, Waterloo, Ontario, Canada*

The solar occultation infrared sounder ACE-FTS, which is the principal instrument of the Atmospheric Chemistry Experiment (ACE), measures atmospheric transmission spectra from the upper troposphere to the mesosphere, with an average vertical resolution of 4 km. In the best cases, sounding deep into the troposphere down to 6 km is possible. The instrument combines high spectral resolution (0.02 cm^{-1}) and excellent radiometric performances (Signal-to-noise-ratio in excess of 300:1 over most or the spectral range). We have taken benefit of the resulting high sensitivity of the ACE-FTS to characterize upper tropospheric plumes, notably focusing on the measurement of weakly absorbing pollutants. We report on the measurements of tropospheric NOy (HNO_3, HNO_4, PAN and N_2O_5) and of organic compounds from biomass burning plumes: the measurements of C_2H_4 (ethene), C_3H_4 (propyne), H_2CO (formaldehyde), C_3H_6O (acetone), CH_3COOH (acetic acid) are the first reported space-based detections using infrared occultation from satellites.

In addition, we will briefly present the first nadir spectra acquired by the Infrared Atmospheric Sounding Interferometer (IASI), which has been launched onboard the Metop platform in October 2006. Relying on our current knowledge of the capabilities of similar sounders (IMG, TES), we will shed light on the expected performances of IASI to probe several tropospheric trace species, such as CO, O_3, HNO_3 and the water isotopologues $H_2{}^{16}O$, $H_2{}^{18}O$ and HDO.

A Study of Low Altitude CO over India using MOPITT Data and GEOS-CHEM Model

A contribution to ACCENT-TROPOSAT-2, Task Group 1: Infra red

J. Kar[1], James R. Drummond[1], J. L. Attie[2], D. B. A. Jones[1], J. Liu[1], J. Zou[1], F. Nichitiu[1], D. P. Edwards[3], M. N. Deeter[3], J. C. Gille[3] and A. Richter[4]

[1]*Department of Physics, University of Toronto, Toronto, Canada*
[2]*Laboratoire d'Aérologie, Université Toulouse III, Toulouse, France*
[3]*National Center for Atmospheric Research, Boulder, USA*
[4]*University of Bremen, Bremen, Germany*

We explore the possibility that daytime MOPITT retrievals in the lower troposphere over land can provide useful information on the source regions of CO emissions in the tropics. It is shown that CO mixing ratios at 850 hPa level show localized enhancements over the Indian subcontinent which correlate well with similar enhancements seen in the tropospheric NO_2 columns from the SCIAMACHY instrument as well as the MODIS fine mode aerosol fraction. The CO averaging kernels indicate a fair degree of sensitivity of the retrievals to CO in the boundary layer. In particular, the Indo Gangetic basin with its high level of biofuel burning is clearly delineated in all the three species in spring. In winter, MOPITT 850 hPa retrievals can detect the strongest source areas over the eastern states of Bihar and West Bengal thus confirming the so-called “Bihar pollution pool” in CO which was detected earlier in the aerosol measurements. GEOS-CHEM model results tend to support these observations by MOPITT thus indicating that MOPITT is indeed fairly sensitive to CO in the boundary layer, contrary to what has been assumed so far.

High-resolution Laser Spectroscopy Concerning the Consistency of the UV-Visible and Infrared Absorption Coefficients of O_3, NO_2, and H_2CO

A contribution to ACCENT-TROPOSAT-2: Task Group 1: Infra red

N. Ibrahim[1,2], P.-M. Flaud[1,3], A. Gratien[1], P. Chelin[1], J. Orphal[1], A. Perrin[1] and J.-M. Flaud[1]

[1]*Laboratoire Interuniversitaire des Systèmes Atmosphériques, Université Paris-12 et -7, Créteil, France*

[2] *New address: Laboratoire de Physique des Lasers, Université Paris-13, Villetaneuse, France*

[2] *New address: Institut des Sciences Moléculaires, Université de Bordeaux 1, Talence, France*

Using two different high-resolution laser experiments and LISA we have investigated the consistency of the UV-visible and infrared absorption coefficients of O_3, NO_2 and H_2CO.

For studying ozone, we have used a dual-beam set-up comprising a tunable diode-laser working at 80-95 K in the 1030-1060 cm^{-1} region with a spectral resolution of about 30 MHz (0.001 cm^{-1}), and a Silicon diode-array spectrometer together with a pulsed Xenon lamp for the 260-290 nm region. The accuracy of the experimental set-up was validated by measurements of O_2 broadening parameters which are in good agreement with the HITRAN database. Although significant differences (on average about 7 %) concerning the consistency of the UV and infrared absorption coefficients compared to HITRAN were observed, systematic errors cannot be excluded. Further experimental work is required to resolve this issue.

For NO_2, we used a difference frequency laser (DFG) system developed in our group that covers the 3-5 μm range with a resolution of about 1 MHz (0.00003 cm^{-1}), and the same diode-array spectrometer but with a Hg arc lamp to cover some wavelengths around 400 nm. With this set-up we studied the $\nu_1+\nu_3$ infrared band around 3.6 microns and observed excellent agreement (better than 3 %) between the UV-visible and infrared absorption coefficients.

Finally, we used the same DFG set-up for dual-beam experiments together with the pulsed Xenon lamp to cover the 200-400 nm range where the H_2CO absorption bands in the UV are located. Although at the weak resolution of the UV diode-array spectrometer (1.1 nm) the "saturation" of the H_2CO bands leads to systematic errors, there is clear indication of very significant systematic differences between the UV cross sections recommended in HITRAN and the most recent high-resolution studies of H_2CO in the infrared. In addition, systematic differences concerning individual line intensities in the infrared were observed. To investigate further the latter problem, we recorded a high-resolution FTS spectrum that confirms our observations. Clearly, there is need for improvement for the spectroscopic database of H_2CO.

Impact of clouds on tropospheric trace gas retrievals

A contribution to ACCENT-TROPOSAT-2, Task Group 1: UV/visible

Steffen Beirle, Tim Deutschmann, Michael Grzegorski, Ulrich Platt and Thomas Wagner

MPI, Mainz

Spectroscopic measurements from nadir-viewing satellite platforms allow the retrieval of column densities of several atmospheric trace gases. The retrieval of tropospheric columns is thereby strongly affected by clouds: Clouds shield boundary layer and lower tropospheric trace gases, leading to an underestimation of the actual column. On the other hand, the high albedo of clouds, as well as multiple scattering within the cloud, increase the visibility of trace gases at and above the cloud top.

Cloud parameters like cloud fraction, cloud top height or cloud heterogeneity can also be directly deduced from satellite measurements, using intensity measurements and spectral absorption features of O_2, O_4 or the so-called "Ring-effect".

Here we analyze the dependency of tropospheric NO_2 columns on several cloud parameters. This empirical study is complemented by theoretical radiative transfer modelling studies using the 3D-Monte-Carlo Model TRACY-2, that is in particular capable of modelling radiative transfer in clouds.

With these investigations we check and improve our understanding on the different cloud effects on radiative transfer (shielding, path-length enhancement and albedo increase). Improved knowledge on the impact of clouds on trace gas columns allows to interpret clouded pixels, that are currently discarded in most analyses. Temporal or spatial variations of the observed dependencies of NO_2 columns on cloud parameters hold additional information on *e.g.* the NO_2 profile.

Three Years of Global Simultaneous Measurements of Tropospheric Methane, Carbon Dioxide and Carbon Monoxide Retrieved from SCIAMACHY using WFM-DOAS

A contribution to ACCENT-TROPOSAT-2, Task Group 1: UV/visible

Michael Buchwitz, Oliver Schneising, Iryna Khlystova, Heinrich Bovensmann and John. P. Burrows

Institute of Environmental Physics (iup) / Institute of Remote Sensing (ife), University of Bremen FB1, Otto Hahn Allee 1, 28334 Bremen, Germany,

The three "carbon gases" methane (CH_4), carbon dioxide (CO_2), and carbon monoxide (CO) are important atmospheric constituents affecting climate and air quality. Vertical columns of all three gases can be retrieved from the SCIAMACHY/ENVISAT near-infrared / short wave infrared (NIR / SWIR) nadir measurements of reflected and backscattered solar radiation.

Here we present new data sets of global, simultaneous measurements of all three gases covering the time period 2003-2005. The retrieval has been performed using the latest versions of our retrieval algorithm WFM-DOAS: WFMDv1.0 methane and CO_2 (unpublished; not yet released) WFMDv0.6 CO [Buchwitz *et al*., 2007; released].

The data sets will be discussed including comparisons with local and global reference data such as ground-based FTS measurements, other satellite data (CO from MOPITT), and global models (NOAA's global assimilation system CarbonTracker for CO_2, JRC's TM5 model for methane).

A New DYNAMIC Ozone Profile Climatology Based on NNORSY-GOME

A contribution to ACCENT-TROPOSAT-2, Task Group 1: UV/visible

Jasmine S. Kaptur and Anton K. Kaifel

Zentrum für Sonnenenergie- und Wasserstoff-Forschung, Baden-Württemberg (ZSW), Industriestr. 6, D-70565 Stuttgart, Germany

From the Neural Network Ozone Retrieval System (NNORSY) developed at Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW) a global ozone profile data set was built using UV/VIS spectra measured by GOME (Global Ozone Monitoring Experiment). The latest NNORSY-GOME V3 Level 2 data set includes global ozone profile data covering 8 years from start of ERS-2 in July 1995 to June 2003, when a failure of the tape recorder of ERS-2 occurred. About 43.000 GOME orbits with ozone profile retrievals at full spatial and temporal resolution of the GOME instrument are offered.

In the frame of the ESA funded project CHEOPS-GOME (Climatology of Height-resolved Earth Ozone Profiling Systems for GOME) this data set was used to derive new global ozone profile climatology products. Besides the compilation of standard look-up-table (LUT) climatologies special effort was made to follow a new approach for a dynamic ozone profile climatology. It allows very fast generation of appropriate ozone profiles in not only using standard input information such as date and geographical position (required) but also deals with optional dynamic input parameters like total ozone column and/or temperature profile.

The climatological ozone profiles are given as number densities and reach from ground up to 61 km with a sampling rate of 1 km. If not already available and needed, the dynamic climatology can also derive ozone profile error information and climatological temperature profile information.

The dynamic NNORSY-CLIMATOLOGY is offered as a software package which comprises of 4 different neural network climatologies. The differences between these single climatologies lie in the handling of available input data. While the simplest climatology deals only with time and latitude/longitude as inputs, the others can take account for total ozone column and/or temperature profile. The software can be implemented in classical ozone profile retrieval schemes based on optimal estimation as well as for assimilation of total ozone and building of station specific ozone profile climatologies.

Results of the different NNORSY-CLIMATOLOGIES are presented including comparisons with other widely-used climatologies. For different locations the climatologies are compared to measured sonde time series data with special emphasis to tropospheric ozone. It is shown, that the dynamic NNORSY-CLIMATOLOGY is capable of representing special dynamical effects such as ozone hole conditions.

Retrieval of Cloud Information from GOME-2/MetOp: First Results

A contribution to ACCENT-TROPOSAT-2, Task Group 1: UV/visible

Diego G. Loyola R.

German Aerospace Center (DLR)
Oberpfaffenhofen, D-82234, Wessling, Germany

Accurate cloud information is required for the trace gases retrieval; especially for the determination of tropospheric contents and aerosols. This work presents the first results of applying OCRA/ROCINN to GOME-2/MetOp data as part of DLR's operational trace gas products generated as part of EUMETSAT's O3M-SAF.

The operational GOME/ERS-2 cloud products are generated using a combination of two algorithms [*Loyola et al.*, 2007a]. The first algorithm OCRA determines the *cloud fraction* using the PMD measurements. The second algorithm ROCINN determines the *cloud-top height* and *cloud-top albedo* using spectral information in the oxygen A-band in and around 760nm. Comparisons with SEVIRI/MSG show that the GOME/ERS-2 cloud products fulfill the 10% accuracy required for trace gas retrieval [Loyola *et al.*, 2007b].

OCRA/ROCINN is being applied to GOME-2/MetOp data. The following figure shows the first results of the obtained cloud information compared to the corresponding MSG data.

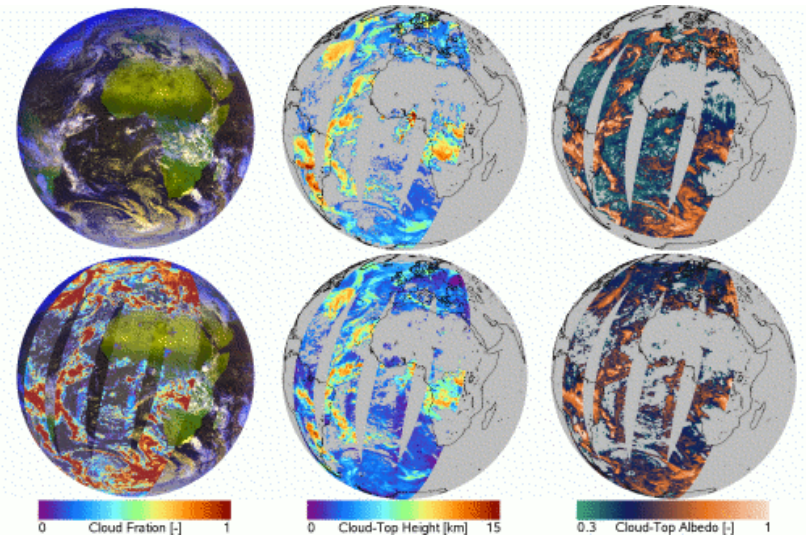


Figure 1. Illustration of GOME-2/MetOp orbit tracks and the MSG-1 full disk showing the cloud fraction (left panel), the cloud-top height (centre panel), and the cloud-top albedo (right panel). SEVIRI data from 04 February 2007, 8:45 UTC are regridded to GOME-2 resolution.

Water Vapour Trends from GOME and SCIAMACHY Satellite Measurements

A contribution to ACCENT-TROPOSAT-2, Task Group 1: UV/visible

Sebastian Mieruch, Stefan Noël, Heinrich Bovensmann and John P. Burrows

Institute of Environmental Physics/Remote Sensing, University of Bremen, Otto-Hahn-Allee 1, D-28359 Bremen, Germany

Global water vapour total column amounts have been retrieved from spectral data provided by the Global Ozone Monitoring Experiment (GOME) flying on ERS-2 which was launched in April 1995 and the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) onboard ENVISAT launched in March 2002. For this purpose the Air Mass Corrected Differential Optical Absorption Spectroscopy (AMC-DOAS) approach is used. The combination of the data from both instruments, which requires special treatment at the interchange, provides us with a long-term global dataset spanning already now more than 11 years with the possibility of extension up to 2020 by GOME-2 on Metop. Thus this dataset is well suited for a trend analysis.

Using linear and nonlinear methods from time series analysis as well as standard statistics the trends of water vapour contents and their errors are calculated. Several factors affecting the trend such as the length of the time series, the magnitude of the variability of the noise and the autocorrelation of the noise are investigated. Special emphasize lies on the calculation of the significance of the observed trends which reveal local significant changes (decrease as well as increase) of water vapour concentrations distributed over the whole globe.

The derived water vapour trends can be used as tracers for several climatic problems connected with the greenhouse effect; warming, drying, glacier melting, groundwater consumption, agricultural irrigation *etc*.

A Synergistic Approach towards Studying Biomass Burning from Space

A contribution to ACCENT TROPOSAT-2: Task Group 1: UV/visible

Robert Parker, John J. Remedios, David P. Moore, Manasvi Panchal and Vijay Kanawede

EOS, Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH, U.K.

Biomass burning is the pyrogenic combustion of living and dead vegetation. As this burning is strongly regional, seasonal and displays high interannual variability, its study is especially suited to the use of remote sensing Earth observation data. Of particular importance is the need to understand the transformation between source emissions at the surface and impacts in the middle and upper troposphere.

This work describes the progress made in using a synergistic approach to studying biomass burning from space by utilising a combination of Earth observation datasets, primarily from the limb sounding Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) and the nadir sounding Measurements Of Pollution In The Troposphere (MOPITT) instruments.

The MOPITT instrument provides information on the concentration of carbon monoxide in the atmosphere. CO is a marker of large-scale influences of pollution on regional and global scales. Not only is it strongly enhanced in regions of biomass burning but it also traces the regional and inter-continental transport of polluted air masses. This CO information, when used in combination with the trace gas concentrations retrievable from MIPAS infrared spectra, provides a means of identifying regions where significant trace gas signals from biomass burning would be expected to be observable. Furthermore, it is possible to use MOPITT data, particularly in daytime, to distinguish between lower troposphere and upper troposphere enhancements which focuses the MIPAS analyses but also provides information on outflow characteristics. Hence MOPITT/MIPAS synergy

Biomass burning in Alaska, Africa and Indonesia is discussed using this approach, in particular with reference to the detection of biomass burning products such as ethane, ethyne and peroxyacetyl nitrate (PAN) from MIPAS. The potential for the incorporation of further datasets such as those from the Atmospheric Chemistry Experiment (ACE) and the Infrared Atmospheric Sounding Instrument (IASI) is also discussed.

Application of Linearized Radiative Transfer Models for Tropospheric Investigation

A contribution to ACCENT-TROPOSAT-2, Task Group 1: UV/visible

O.V. Postylyakov

A.M. Obukhov Institute of Atmospheric Physics of Russian Academy of Sciences
Pyzhevsky per. 3, Moscow 119017, Russia

Radiative transfer models provide the link between radiance measurements and the state of the atmosphere. Integrated use of the radiance measurements and calculations allows improving understanding of a researcher on atmospheric substance distributions. Usually, iterative or statistical estimation algorithms are applied for the retrieval of atmospheric substances. Retrieval algorithms require calculation of the derivatives of measured radiance with respect to atmospheric properties under investigation.

The model MCC++, describing transfer of the polarized light in the spherical-shell atmosphere, was linearized to provide derivatives of four Stokes parameters with respect to the aerosol volume scattering coefficient and some parameters of the aerosol scattering matrix. The developed method of calculation allows a insignificantly increased time of calculation in comparison with calculation of four Stokes parameters only. The model MCC++ was previously linearized to calculate derivatives with respect to the volume absorption coefficient, the Lambertian and BRDF surface properties. The deduced representations of derivatives improve ability of the RT model to investigation of the aerosol retrieval capability of different types of satellite measurements. Formalization for Monte Carlo calculations of the derivatives and examples of numerically simulated aerosol measurements are presented.

Trace Gas Detection using AIRS Data: Spectral Matching and Retrieval Algorithms

A contribution to ACCENT-TROPOSAT-2: Task Group 1: UV/visible

Fred Prata

Norwegian Institute for Air Research, Instituttveien 18, N-2027 Kjeller, Norway

The Atmospheric Infrared Sounder (AIRS) on board the Aqua platform has up to 2378 channels in the infrared part of the spectrum, with many channels suitable for measuring tropospheric trace gases. A spectral gas matching algorithm has been developed that can be used to identify specific gas species in the presence of other gases and a standard least squares estimation retrieval technique is applied to determine partial (or total) column abundances. The method is fast, easy to implement and requires little or no ancillary information. It is therefore ideal for use in an operational environment where timeliness is important and where resources may be limited. We illustrate the technique by using some examples of tropospheric SO_2 detection from volcanoes. The spectral matching technique for SO_2 has been used for the 4.0 and 7.3 μm features of SO_2, but we show that the method is quite general and can be used for other gases and spectral regions. We discuss how this method could be used to determine vertical profile information.

Observation of Changes in Tropospheric SO_2 from Space

A contribution to ACCENT-TROPOSAT-2: Task Group 1: UV/visible

Andreas Richter, F. Wittrock, C. Lee and J. P. Burrows

University of Bremen, Institute of Environmental Physics, Otto-Hahn-Allee 1
D-28359 Bremen, Germany

Data from the three UV/visible instruments GOME, SCIAMACHY, and GOME-2 have been analysed for tropospheric SO_2 columns. A number of sensitivity studies were performed, and potential error sources were identified and partly quantified. Data from the three instruments was compared and good agreement was found in the time periods of overlap (August 2002 to June 2003 for SCIAMACHY and GOME) and March/April 2007 for GOME and GOME-2) at least for large signals.

While over most of the globe the SO2 columns are small outside of volcanic eruptions and possible changes are below the detection limit, a significant downward trend is observed over parts of the US and a strong upward trend over China. Possible reasons for these signals including emissions changes and changes in the measurement sensitivity are discussed.

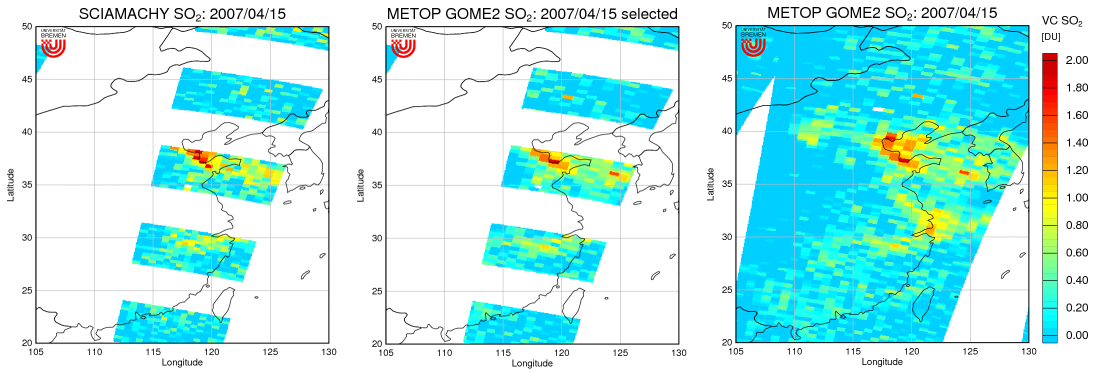


Figure 1. Comparison of SCIAMACHY (left) and GOME-2 (right and middle) measurements of SO_2 for April 15th, 2007 above China. The agreement is good in spite of the 30 minutes difference in overpass time and the larger ground pixels of GOME-2.

Observation of IO from Space using SCIAMACHY

A contribution to ACCENT TROPOSAT-2: Task Group 2: UV/visible

A. Schoenhardt, F. Wittrock, A. Richter and J.P. Burrows

Institute of Environmental Physics (iup) / Institute of Remote Sensing (ife), University of Bremen FB1,
Otto Hahn Allee 1, 28334 Bremen, Germany

Over the last years, several measurements and model studies have shown that iodine species are of potential relevance in certain areas of current atmospheric research. Iodine has a high ozone depletion potential and can additionally lead (via higher iodine oxides) to the formation of new fine particles in the atmosphere. This has been observed previously in the marine boundary layer by ground-based measurements. The importance of iodine species on a global scale is not yet known. Satellite data analysis is used in this study to observe iodine oxide (IO) on a larger spatial scale.

After the release of iodine compounds to the atmosphere, photolysis causes the production of atomic iodine. Via the reaction with ozone, IO radicals form and this can lead to ozone destruction in the troposphere. Owing to its strong differential absorption lines in the blue wavelength range, IO is a suitable trace gas for the detection with the DOAS (Differential Optical Absorption Spectroscopy) method. The objective of the presented work is the detection of IO with SCIAMACHY, a UV/vis/IR-spectrometer onboard the ENVISAT satellite. Atmospheric IO levels are relatively small, and are therefore close to the detection limit of SCIAMACHY. This limit lies at about $5 \cdot 10^{12}$ molec/cm^2 for a single measurement and depends on various parameters like the ground spectral reflectance, the averaging of spectra as well as on possible systematic errors. In case of enhanced IO amounts, however, the absorption signal is visible in the satellite measurements. The largest amounts (slant columns of about $8 \cdot 10^{12}$ molec/cm^2 for the seasonal average) are observed in springtime Antarctica, while no pronounced IO values are detected on the Northern Hemisphere.

Over Antarctica, the satellite results show a widespread increase of IO starting in September and reaching a maximum in October. Slightly lower levels are revealed in summertime and a second increase in Antarctic autumn. In the winter period, no IO above the detection limit has been detected. Local ground-based measurements in Antarctica have also shown enhanced iodine levels in springtime. First comparisons between IO retrieved from SCIAMACHY measurements and these ground-based results are qualitatively in good agreement. First considerations for the interpretation of these findings are also presented.

First Results of Tropospheric NO_2 and SO_2 from the GOME-2 Instrument on MetOp

A contribution to ACCENT TROPOSAT 2: Task Group 1: UV/visible

P. Valks, D. Loyola, L. Butenko and W. Zimmer

German Aerospace Centre, Münchnerstraße 20, Oberpfaffenhofen, Germany

The Global Ozone Monitoring Experiment-2 (GOME-2) is one of the new-generation European instruments carried on MetOp, which has been jointly established by ESA and EUMETSAT. GOME-2 will continue the long-term monitoring of atmospheric ozone and minor trace gases, started by GOME on ERS-2 and SCIAMACHY on Envisat. GOME-2 is a scanning spectrometer that measures the Earth's backscattered radiance and extraterrestrial solar irradiance in the ultraviolet and visible part of the spectrum (240-790 nm), and contains two Polarisation Measurement Devices (PMDs). The advanced GOME-2 observes four times smaller ground pixels (80 x 40 km) than GOME on ERS-2, and provides a global coverage within about one day. The ozone and minor trace gas column retrieval algorithms for GOME-2 have been developed by DLR, in the framework of EUMETSAT´s Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring (O3M-SAF).

In this contribution, we present the first results of the GOME-2 NO_2 and SO_2 products, derived with the Differential Optical Absorption Spectroscopy (DOAS) method. The operational NO_2 retrieval algorithm for GOME-2 is based on the state-of-the-art GOME Data Processor (GDP) version 4.0, and includes a new algorithm for the retrieval of the tropospheric column density of NO_2 for polluted conditions. For the calculation of the tropospheric NO_2 column, an Air Mass Factor based on an assumed tropospheric NO_2 profile is used, which has been derived from a MOZART-2 NO_2 climatology. We present maps of total and tropospheric NO_2 column densities, as well as of SO_2 from volcanic eruptions. In addition, comparisons with other satellite data products of NO_2 and SO_2, such as derived from GOME-1, SCIAMACHY and OMI will be shown.

Global Patterns of the Temperature Dependence of Cloud Fraction, Cloud Top Height and Total Column Precipitable Water Derived from Satellite Observations

A contribution to ACCENT TROPOSAT 2: Task Group 1: UV/visible

Thomas Wagner, Steffen Beirle, Michael Grzegorski and Ulrich Platt

MPI, Mainz

From new UV/vis satellite instruments like GOME and SCIAMACHY it is possible to retrieve the total column precipitable water over both oceans and continents with similar sensitivity. In addition, also information on cloud properties from the measured absolute intensity and the absorption of atmospheric O2 can be derived. From the absolute radiance (top of the atmosphere albedo) an effective cloud fraction (HICRU) is retrieved. Using radiative transfer modelling and maps of the average surface albedos, it is also possible to determine the average cloud top height from the measured cloud fraction and O2 absorption. The global maps of the average cloud top height show a good agreement with similar maps from the ISCCP project.

From the time series of these cloud fraction, cloud top height and the total column precipitable water from 1996 to 2003 we calculated monthly mean anomalies. We correlated these anomalies with those of the surface near temperature, which allows us to extract information on climate feedback mechanisms. We find a substantial positive correlation between temperature and the total column preciptable water almost over the whole globe. In contrast, the correlation between cloud fraction and temperature is almost negative. The correlation of the cloud top height and temperature is mostly positive.

Early Results on Trace Gases from GOME-2

A contribution to ACCENT AROPOSAT-2: Task Group 1: UV/visible

A. Richter, M. Vrekousis, F. Wittrock, S. Noel, M. Weber and J. P. Burrows

Institute of Environmental Physics (iup) / Institute of Remote Sensing (ife), University of Bremen FB1, Otto Hahn Allee 1, 28334 Bremen, Germany,

A short review of trace gas data products from GOME-2 using the University of Bremen retrieval algorithms will be presented. In summary GOME-2 is working well and all the target species are observable.

Dual Assimilation of MOPITT and MLS Carbon Monoxide in the MOCAGE Model

A contribution to ACCENT TROPOSAT-2: Task Group 2

J.-L. Attié[1], L. El Amraoui[2], P. Ricaud[1], V.-H. Peuch[2], B. Barret[1], N. Semane[2], S. Massart[3] and A. Piacentini[3]

[1] University of Toulouse, CNRS Toulouse
[2] Météo-France, Toulouse
[3] Cerfacs, Toulouse, France

We present results of assimilation of level 2 carbon monoxide (CO) data from both the Measurement Of the Pollution In the Troposphere (MOPITT) and the Microwave Limb Sounder (MLS) instrument. The system consists of the chemistry transport model MOCAGE (MOdèle de Chimie Atmosphérique à Grande Echelle) developed by Météo-France in its global configuration (2° x 2°), the 3DFGAT assimilation technique and the PALM coupler from Cerfacs. MOPITT is a nadir tropospheric sensor while MLS is a limb instrument which measure data in the upper troposphere and lower stratosphere. We present the technique for assimilating the data from these two different sensors and the CO fields obtained covering the atmosphere from the lower troposphere to the lower stratosphere.

Comparison of Operationally Available Cloud Top Height Level-2 Data

A contribution to ACCENT TROPOSAT-2: Task Group 2

Lisa Bock[1], Julian Meyer-Arnek[1], Frank Baier[1], Thilo Erbertseder[1], Pieter. Valks[2], G. Gesell[1] and D. Loyola[2]

[1] German Aerospace Center (DLR),German Remote Sensing Data Center (DFD)
[2] German Aerospace Center (DLR), Remote Sensing Technology Institute (IMF), Münchener Straße 20, D-82334 Wessling, Germany

At the German Aerospace Center (DLR), 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 ROSE/DLR. Secondly, the tropospheric vertical NO2 column is computed from the tropospheric slant column by applying a tropospheric air mass factor (AMF). The AMF is calculated using the LIDORT radiative transfer model (v2.2+) and tropospheric NO_2 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. The tropospheric NO2 VCD derived with this method for the European area yield results which are qualitatively and quantitatively comparable with NO_2 column amounts derived from different approaches.

A very critical parameter with respect to the altitude resolved air mass factor approach the knowledge of the correct cloud top height (CTH). Therefore an intercomparison of 4 different operationally available CTH retrieval algorithms is performed. The algorithms being considered in our study are SACURA (SCIAMACHY), APOLLO (AVHRR), OMI and ROCINN (GOME-2).

The SemiAnalytical CloUd Retrieval Algorithm (SACURA), applying data from the SCanning Imaging Absorption SpectroMeter for Atmospheric ChartographY (SCIAMACHY), derives CTH from measurements of the oxygen A-band (755-775 nm). This algorithm applies semi analytical solutions of the radiative transfer equation and fits it to a theoretical model. The AVHRR Processing scheme Over cLouds, Land and Ocean (APOLLO), which operationally processes measurements of the Advanced Very High Resolution Radiometer (AVHRR) at DLR, determinates cloud top temperatures which are converted into CTH using meteorological data. Effective cloud fraction and CTH retrieved from the Ozone Monitoring Instrument (OMI) is based on spectral information at the O_2-O_2 absorption band near 477 nm. CTH information from the Global Ozone Monitoring Experiment (GOME)-2 is derived at DLR by using 'The Retrieval of Cloud Information by a Neural Network' (ROCINN). This algorithm is based on spectral information at the O2 A-band and neural network inversion techniques.

The intercomparison study yields a good overall agreement between APOLLO, ROCINN, OMI and SACURA. Major meteorological features are well depicted by all different approaches. It seems that CTH derived from OMI exhibits a low bias in comparison to GOME-2-CTH, whereas SACURA yields a high bias.

Impact of Climate Change on Dynamics and Chemistry of the UTLS: Investigations with a Climate-Chemistry Model

A contribution to ACCENT TROPOSAT-2: Task Group 2

Martin Dameris

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Physik der Atmosphäre Oberpfaffenhofen, 82234 Wessling, Germany

Long-term simulations (1960-2004) with the interactively coupled climate-chemistry model E39C-A (an updated version of E39C; Dameris *et al.*, 2005; 2006) have been carried out and are compared with observations, especially those derived from satellite instruments. Investigations focus on variability and long-term changes (trends) of dynamical and chemical quantities. The aim is to identify and quantify trends which can be related to climate change. A region of particular interest is the tropical tropopause region. First results of analyses of model results will be presented and discussed.

A Comparison of Satellite-retrieved Tropospheric NO_2 Columns with Model Values from a Mesoscale Model

A contribution to ACCENT TROPOSAT-2: Task Group 2

Kryštof Eben, Jaroslav Resler, Pavel Juruš and Michal Belda

Institute of Computer Science, Academy of Sciences of the Czech Republic

Differences between satellite-retrieved tropospheric NO_2 columns and their model counterparts are the key input for any assimilation routine which makes use of this kind of data. Statistical properties of these innovations are examined. The comparative experiment is based on a longer-term simulation of the model pair WRF-CAMx for a domain covering Europe (horizontal resolution 27 km) with two nested grids (resolution 9 km and 3 km respectively) covering the Czech Republic. The impact of model resolution on the innovations is studied. The relation of both satellite-retrieved and model tropospheric columns to ground-level values measured at monitoring stations is also examined, with respect to a possible contribution of satellite measurements to the quantification and modelling of a "local component" in ground-level observations. The ground-level data are obtained from the AirBASE database.

Combined Variational Assimilation of Satellite Data in a Chemistry Transport Model

A contribution to ACCENT TROPOSAT-2: Task Group 2

Hendrik Elbern, Elmar Friese, Lars Nieradzik and Achim Strunk

Rhenish Institute for Environmental Research at the University of Cologne (RIU)
Aachener Strasse 209, 50931 Köln, Germany

The presentation gives a survey of experiences gained with assimilation of satellite data in a chemistry transport model. The system set-up includes a suite of satellite data as NO2 tropospheric columns from SCIAMACHY and GOME retrievals, MOPITT CO retrievals, GOME ozone neuronal network retrievals and SYNAER aerosol retrievals. Retrieval data are assimilated in a comprehensive chemistry transport model EURAD. For gas phase data assimilation the four-dimensional variational technique is developped and applied, while for the aerosol assimilation te 3D-var technique has been adopted. The system is the first with demonstrated ability to apply the 4D-var technique in nested mode. Further, 4D-var has been developed as a generalized inversion tool for emission rate estimates.

The presentation describes the progress made with multiple satellite data asimilation and the limits of satellite data to improve predictive skills of the model system. Approaches for validation and assessment of benefits from satellite data assimilation will be presented.

Synpotic Near Real-time Maps of Tropospheric NO_2 Vertical Columns obtained with Statistical Methods

A contribution to ACCENT TROPOSAT-2: Task Group 2

Julian Meyer-Arnek[1], Lisa Bock[1], Frank Baier[1], Thilo Erbertseder[1] and Pieter. Valks[2]

[1] German Aerospace Center (DLR), German Remote Sensing Data Center (DFD)
[2] German Aerospace Center (DLR), Remote Sensing Technology Institute (IMF), Münchener Straße 20, D-82334 Wessling, Germany

At the German Aerospace Center (DLR) tropospheric vertical columns densities (VCD) of NO2 are routinely derived using a synergistic approach combining SCIAMACHY measurements and results from stratospheric and tropospheric chemistry models. This work is performed in the framework of PROMOTE (PROtocol MOniToring for the GMES Service Element: Atmosphere). The stratospheric slant NO_2 column is derived from the chemistry and transport model ROSE/DLR. The tropospheric vertical NO_2 column is then computed from the tropospheric slant column by applying a tropospheric air mass factor (AMF). The AMF is calculated using the LIDORT radiative transfer model (v2.2+) and tropospheric NO_2 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. The tropospheric NO_2 VCD derived with this method for the European area yield results which are qualitatively and quantitatively comparable with NO_2 column amounts derived from different approaches. Compared to the summer composite, the winter composite shows enhanced tropospheric NO_2 VCD due to increased anthropogenic emissions and different photochemistry. Tropospheric NO_2 VCD derived from SCIAMACHY measurements are relatively sparsely distributed in space and time due to the measurement geometry and cloudiness. In order to close the gaps between the measurements and to generate synoptic maps of tropospheric NO_2 VCD, Kriging is applied. By Kriging the best linear unbiased estimation for interpolated values based on the statistical distribution of the measurements is achieved. Near real time maps of tropospheric NO_2 VCD are generated by combining averaged data from the most recent 10 to 30 days (depending on the number of successful measurements) with today's data applying the method "Kriging with external drift". The qualitative and quantitative agreement of the Kriged tropospheric NO_2 VCD is evaluated and compared to results obtained from the EURAD/RIU air quality model.

Global 3-D Modelling of Trace Gases and Aerosols and Comparison to Satellite Observations

A contribution to ACCENT-TROPOSAT-2, Task Group 2

Stelios Myriokefalitakis[1], Kostas Tsigaridis[3], Giorgos Kouvarakis[1], Mihalis Vrekoussis[2], Maria Sfakianaki[1] and Maria Kanakidou[1]

1Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete, P.O.Box 2208, 71 003 Heraklion, Greece.
2Institute of Environmental Physics and Remote Sensing, IUP, University of Bremen, Germany
3Laboratoire des Sciences du Climat et de l'Environnement, 91191 Gif-sur-Yvette Cedex, France

This presentation will summarise modelling and evaluation work performed at the University of Crete with the global 3-d chemistry transport model, TM4. The model is able to describe all major aerosol components together with the ozone, NOx, hydrocarbon chemistry including isoprene, terpenes and secondary organic aerosol (SOA) formation. Recent development performed to improve simulations of dicarbonyls, organic acids and SOA in the troposphere are outlined. Comparisons with satellite observations are performed and discussed.

Interpretation of Global Satellite Observations of PAN and Acetone

A contribution to ACCENT-TROPOSAT-2, Task Group 2

N.A.D. Richards[1], S.R. Arnold[1], M.P. Chipperfield[1], D.P. Moore[2], J.J. Remedios[2]

[1]Institute for Atmospheric Science, School of Earth and Environment, University of Leeds, U.K.,
[2]Earth Observation Science, Space Research Centre, Department of Physics and Astronomy, University of Leicester, U.K.

Peroxyacetyl nitrate (PAN) is a key species in tropospheric chemistry. It acts as a reservoir for NO_x, allowing it to be transported over large distances in the cold upper troposphere (UT). When UT air masses descend and warm PAN breaks down and the NO_x released can lead to O_3 production. PAN therefore plays an important role in the long-range transport of pollution to remote clean areas. Acetone, a PAN precursor, also has a strong influence on tropospheric oxidising capacity. Large uncertainties still exist regarding the role of the oceans as an acetone source or sink as well as the magnitudes of other acetone sources. This uncertainty also impacts on our understanding of acetone as a source of OH in the UT. Therefore, global observations of both PAN and acetone are critical to improving our understanding of these species and consequently our understanding of the oxidising capacity of the troposphere.

Recently, the first global measurements of upper tropospheric PAN and acetone have been retrieved from the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) instrument on board ENVISAT. MIPAS is a Fourier transform spectrometer which detects limb emission spectra in the middle and upper atmosphere for the retrieval of atmospheric trace gases. We will present these new observations (along with other available species such as C_2H_6) and compare them to simulated PAN and acetone from the TOMCAT 3-D chemical transport model (CTM), which has recently been updated to include new temperature-dependent quantum yields for acetone photolysis. Implications for our understanding of the tropospheric chemistry of PAN and acetone will be discussed.

Validation of Bremen Aerosol Retrieval (BAER) Approach, applied to MERIS and SeaWiFS Data over the Mediterranean

A contribution to ACCENT-TROPOSAT-2, Task Group 2

Maria Sfakianaki[1], Wolfgang von Hoyningen-Huene[2], Stelios Myriokefalitakis[1], John P. Burrows[2] and Maria Kanakidou[1]

[1]*Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete, P.O.Box 2208, 71 003 Heraklion, Greece*
[2] *Institute of Environmental Physics and Remote Sensing, IUP, University of Bremen, Germany*

Atmospheric aerosols have important impacts on human health, environment and climate. They are highly variable in time and space. Mediterranean is affected by different aerosol types. Thus, anthropogenic pollution, forest fire plumes, desert dust transports from Sahara as well as natural aerosol from the surrounding continents and ocean contribute to the aerosol loading over this region [Lelieveld *et al.*, 2002 and Mihalopoulos *et al*., 1997]. Satellite remote sensing techniques provide a great opportunity for the better understanding of the aerosol's behaviour since they allow good spatial and temporal sampling of the atmosphere.

The present work investigates the seasonal variability of Aerosol Optical Thickness (AOT) over the Mediterranean during the year 2003 by combining the aerosol retrievals from MERIS and SeaWiFS satellite observations with Aerosol Robotic NETwork (AERONET) ground based sun photometer data and the results of TM4, a global three-dimensional chemical transport model [Tsigaridis *et al.*, 2006 and Myriokefalitakis, S., 2006].

The Bremen AErosol Retrieval (BAER) approach [von Hoyningen-Huene *at al*.,2003] has been used for the aerosol retrievals from nadir scanning multiwave-length radiometers: MERIS (at spatial scale of 1.2 × 1.2 km^2) and SeaWiFS (at spatial scale of 4 × 4 km^2) over land and ocean. The results are presented and thoroughly discussed.

References

Lelieveld, J., H. Berresheim, S. Borrmann, P. J. Crutzen, F. J. Dentener, H. Fischer, J. Feichter, P. J. Flatau, J. Heland, R. Holzinger, R. Korrmann, M. G. Lawrence, Z. Levin, K. M. Markowicz, N. Mihalopoulos, A. Minikin, V. Ramanathan, M. de Reus, G. J. Roelofs, H. A. Scheeren, J. Sciare, H. Schlager, M. Schultz, P. Siegmund, B. Steil, E. G. Stephanou, P. Stier, M. Traub, C. Warneke, J. Williams, H. Ziereis,2002, Global Air Pollution Crossroads over the Mediterranean, *Science*, **298**, 794-799

Mihalopoulos, N., E.G. Stephanou, M. Kanakidou, S. Pilitsidis, and P. Bousquet, 1997, Tropospheric aerosol ionic composition in the Eastern Mediterranean region. *Tellus*, **49B**, 314-326.

Myriokefalitakis, S., 2006, Development of chemical code and application for the study of the global distribution of Glyoxal and Formaldehyde with the use of the three-dimensional chemical transport model TM4, Master Thesis, Univesity of Crete, Greece

Tsigaridis K., M. Krol, F. J. Dentener, Y. Balkanski, J. Lathière, S. Metzger, D. A. Hauglustaine and M. Kanakidou, 2006, Change in global aerosol composition since preindustrial times, *Atmos. Chem. Phys.*, **6**, 5143–5162

von Hoyningen-Huene, W., M. Freitag, and J. B. Burrows, 2003, Retrieval of aerosol optical thickness over land surfaces from top-of-atmosphere radiance, *Journal of Geophysical Research*, **108D9**, 4260-4279, doi: 10.1029/2001JD002018, 2003.

Reconstructing Fine-Scale air Pollution Structures from Coarsely Resolved Satellite Observations

A contribution to ACCENT-TROPOSAT-2, Task Group 3

Dominik Brunner, Daniel Schaub and Brigitte Buchmann

EMPA, Swiss Federal Laboratories for Materials Testing and Research, Laboratory for Air Pollution and Environmental Technology, 8600 Duebendorf, Switzerland

With the introduction of the SCIAMACHY and OMI instruments satellite observations of tropospheric air pollution became available at spatial resolutions suitable for studying air quality on the regional scale. Pollution patterns (*e.g.* of NO_2) are more or less immobile as they are tied to stationary emission sources like cities, motorways, power plants, *etc.* By combining the views from multiple satellite overpasses it is therefore possible to resolve details beyond the resolution of the individual satellite footprint. We demonstrate this using a series of algorithms available for image reconstruction and resolution enhancement such as algebraic reconstruction techniques (ART) [Gordon *et al.,* 1970; Early and Long, 2001] and Richardson-Lucy deconvolution [Lucy, 1974]. The techniques are applied to both a synthetic observation data set constructed by randomly placing satellite pixels over an artificial high-resolution air pollution field (in fact a 3×3 km^2 NO_x emission inventory over Switzerland) and to real satellite observations.

We demonstrate that in the case of observations with no or little noise the algorithms are able to successfully reconstruct the fine-scale details of the original air pollution patterns. However, in reality, these patterns are not completely stationary due to varying meteorology and noisy observations additionally complicate the reconstruction. Any image reconstruction method tends to amplify the (high-frequency) noise which poses important constraints on the success of the different algorithms. We therefore performed a number of sensitivity studies by varying the level of noise added to the synthetic observations and by varying the sampling density (i.e. the number of satellite overpasses).

Applicability of the method to real data is demonstrated based on NO_2 observations from OMI. First, the "noise level" of the OMI data (either due to real NO_2 variations or due to measurement noise) is determined. The idealized simulations then provide the optimal configuration (such as the number of iteration steps) for the different algorithms given the actual noise level.

Finally, the comparison between the real OMI observations and the synthetic fields based on the high-resolution NO_x emission inventory provides an indication for the ability of OMI to observe regional scale air pollution structures in Switzerland and potentially allows identifying deficiencies in either the observations or the inventory.

References

Early, D. S., and Long, D. G. (2001). Image reconstruction and enhanced resolution imaging from irregular samples, *IEEE Transactions on Geoscience and Remote Sensing,* **39 (2),** 291-302.

Gordon, R., Bender, R., and Herman, G. T. (1970). Algebraic reconstruction techniques (ART) for three-dimensional electron microscopy and x-ray photography, *J. Theor. Biol.,* **29 (3)**, 471-481.

Lucy, L. (1974), An iterative technique for the rectification of observed distributions, *Astron. J.,* **79**, pp. 745.