

Name of research institute or organization:

Belgian Institute for Space Aeronomy (BIRA-IASB)

Title of project:

Atmospheric physics and chemistry

Project leader and team:

Dr. Martine De Mazière: project leader FTIR

Dr. M. Van Roozendael: project leader UV-Vis

Bart Dils, Caroline Fayt, François Hendrick, Christian Hermans, Jean-Christopher Lambert, Gaia Pinaridi, C. Senten, Corinne Vigouroux, Gauthier Vanhaelewyn: team scientists

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Project description:

UV-Vis

The monitoring of stratospheric column amounts of ozone and nitrogen dioxide, started in 1990 with a SAOZ spectrometer, has been successfully continued in 2009. The length of the actual time-series now covers almost two complete decades. Moreover, efforts have been devoted to further improve the homogeneity of both O₃ and NO₂ data sets. Concerning O₃, recommendations have been elaborated and communicated in view of improving the overall consistency of the NDACC UV-VIS network. This included revised spectroscopic parameters and the development of a new data base of air mass factors, applicable at any site of the network. After application to the whole SAOZ network, significant improvement of the total ozone data set was obtained as demonstrated in June 2009 following a WMO/GAW validation exercise presented at the annual O₃-SAG meeting in Helsinki. Likewise, the NO₂ column data set has been revisited and homogenized. As part of this work, the consistency between SAOZ and FTIR NO₂ measurements performed at the Jungfraujoch has been further investigated, taking into account the different sensitivity of both techniques to the NO₂ vertical distribution as well as the impact of the NO₂ photochemistry on the comparison. It was found that after careful analysis, both UV-VIS SAOZ and FTIR data sets provide a coherent picture of the time evolution of the NO₂ column. This will serve as an input for a global trend analysis study of NO₂, currently under way within NDACC.

Concerning MAXDOAS instrumental and algorithmic developments, work has been ongoing in 2009. BIRA-IASB has been heavily contributing to the CINDI campaign, organized in June-July at Cabauw, The Netherlands. Results from the CINDI campaign will lead to major progress in the assessment of the accuracy and information content of MAXDOAS measurements of aerosols and trace gases. This experience will be fully exploited with the installation of a new high-quality MAXDOAS system at the Jungfraujoch in the course of 2010.

FTIR solar absorption spectrometry

BIRA-IASB participates in the measurement of the atmospheric composition at Jungfraujoch using Fourier transform infrared spectrometry in collaboration with the University of Liège (see report by ULg).

The concentration of CO at Jungfraujoch is measured on a continuous basis at the surface by in-situ observations, with a non-dispersive infrared detection method. It is also observed regularly by FTIR remote-sensing methods in the boundary layer. In 2009, we have continued the work on comparisons between both data sets and associated long-term trends, and their interpretation, in collaboration with colleagues from the University of Liège and EMPA in Switzerland. While the in situ NDIR measurements detect local CO concentrations at the site, the FTIR technique provides integrated measurements along the line-of-sight. Nevertheless, the pressure broadening of the spectral absorption lines recorded at high resolution enables retrieving information on the vertical distribution of CO, mainly in the troposphere, including its concentration near the surface. To provide enough information content we derive from the FTIR profile data the averaged volume mixing ratio (vmr) between 3.58 and 7 km, and then we compare this average vmr with coincident in-situ surface concentration data from the NDIR observations. Both datasets show a significant negative trend over the investigated time period (1997-2007). However, the NDIR dataset's negative trend is much stronger. In 2009, we looked further into possible causes for the different trends using backtrajectory modeling performed by EMPA colleagues. We will publish the final results of this study in 2010.

In 2009, we also made an update of the O₃ trends (total column trends and partial column trends in 4 atmospheric layers over Europe based on FTIR data) that were published by Vigouroux et al. in 2008 for the period 1994-2004, now for the period 1994-2008. We found that the impact of the way in which the instrument line shape function is dealt with in the retrievals can have a significant impact on the trend values. At Jungfraujoch, we found no significant trends, except for a slightly positive trend (0.12 ± 0.10 %/year) in the upper stratosphere (27-42 km altitude layer). The results from this update will be included in the 2010 WMO Scientific Assessment of Ozone Depletion.

In the frame of the EU HYMN project, we made a coordinated validation study of SCIAMACHY CH₄ total column data products, using ground-based FTIR data from all European NDACC FTIR stations and a few non-European NDACC stations. We also used the ground-based FTIR data of CH₄ vertical profiles to evaluate a number of models (TM4, the Oslo CTM and the INCA model). These results will be published in 2010.

Similarly, we started working on the coordinated validation of the IASI instrument on METOP-1, for the species CO, HNO₃ and CH₄, using ground-based FTIR data. These results have already been presented at international symposia and will be published in 2010.

In 2009, we worked with the Infrared Working Group (IRWG) of NDACC and with the managers of the Envisat Cal/val database, the AURA Cal/val database and the NDACC Data Handling Facility on the finalization of an appropriate HDF format for archiving the NDACC FTIR data. This format is now implemented at all these datacenters. We started submitting data in this new format in NDACC, as well as in the GEOmon data centre.

We, J. Hannigan and M. De Mazièren, co-chairs of the NDACC IRWG, have launched an effort in the NDACC IRWG to better homogenize the data retrievals at

all IRWG NDACC stations, for the 10 atmospheric gases that are mandatory. It was demonstrated in the EU project HYMN that such homogenization is very beneficial, among others for satellite validation. A first evaluation of the effort was made during the annual IRWG meeting in June 2009. Various retrievals strategies had to be tested and the findings from several teams had to be compared. This work is still ongoing and will be discussed again at the next IRWG meeting in May 2010.

Key words:

atmospheric composition, long-term monitoring, optical remote sensing, vertical inversion methods, satellite validation

Internet data bases:

The data are archived in the NDACC database (<http://www.ndacc.org/>), in the NADIR/NILU database (<http://www.nilu.no/projects/nadir>).

Data processed for ENVISAT validation purposes are also submitted to the ENVISAT CAL/VAL database (<http://nadir.nilu.no/calval>).

The new HDF format for FTIR vertical profile data has been implemented at the NDACC data base : we started submitting FTIR data in the new HDF format in NDACC

In the EU project GEOMon, data are delivered to a dedicated ftp site at NILU at latest 3 months after data acquisition: these are the so called Rapid Delivery data.

The SAOZ data are also submitted to the Rapid Delivery ftp site at the GEOMon Data Center (<http://www.geomon.eu/data.html>)

Collaborating partners/networks:

Collaborations with University of Liège and NDACC partners

Collaboration with European FTIR and UV-Vis teams and modelling teams in the frame of the EU projects GEOMon and HYMN;

Collaboration with M. Chipperfield of Univ. Leeds.

Both the UV-Vis and FTIR observations contribute to the international Network for the Detection of Atmospheric Composition Changes (NDACC, or the former NDSC).

Collaboration with B. Buchmann, D. Brunner, S. Henne and M. Steinbacher of EMPA

Collaboration with F. Goutail and A. Pazmino of LATMOS, France

Collaboration with K. Kreher and P. Johnston of NIWA, New-Zeland

Collaboration with the GOME, ENVISAT, ACE and MetOp GOME-2 and IASI satellite communities.

Scientific publications and public outreach 2009:

Refereed journal articles and their internet access

Dupuy, E., K. A. Walker, J. Kar, C. D. Boone, C. T. McElroy, P. F. Bernath, J. R. Drummond, R. Skelton, S. D. McLeod, R. C. Hughes, C. R. Nowlan, D. G. Dufour, J. Zou, F. Nichitiu, K. Strong, P. Baron, R. M. Bevilacqua, T. Blumenstock, G. E. Bodeker, T. Borsdorff, A. E. Bourassa, H. Bovensmann, I. S. Boyd, A. Bracher, C. Brogniez, J. P. Burrows, V. Catoire, S. Ceccherini, S. Chabrillat, T. Christensen, M. T. Coffey, U. Cortesi, J. Davies, C. De Clercq,

D. A. Degenstein, M. De Mazière, P. Demoulin, J. Dodion, B. Firanski, H. Fischer, G. Forbes, L. Froidevaux, D. Fussen, P. Gerard, S. Godin-Beekman, F. Goutail, J. Granville, D. Griffith, C. S. Haley, J. W. Hannigan, M. Höpfner, J. J. Jin, A. Jones, N. B. Jones, K. Jucks, A. Kagawa, Y. Kasai, T. E. Kerzenmacher, A. Kleinböhl, A. R. Klekociuk, I. Kramer, H. Küllmann, J. Kuttippurath, E. Kyrölä, J.-C. Lambert, N. J. Livesey, E. J. Llewellyn, N. D. Lloyd, E. Mahieu, G. L. Manney, B. T. Marshall, J. C. McConnell, M. P. McCormick, I. S. McDermid, M. McHugh, C. A. McLinden, J. Mellqvist, K. Mizutani, Y. Murayama, D. P. Murtagh, H. Oelhaf, A. Parrish, S. V. Petelina, C. Piccolo, J.-P. Pommereau, C. E. Randall, C. Robert, C. Roth, M. Schneider, C. Senten, T. Steck, A. Strandberg, K. B. Strawbridge, R. Sussmann, D. P. J. Swart, D. W. Tarasick, J. R. Taylor, C. Tétard, L. W. Thomason, A. M. Thompson, M. B. Tully, J. Urban, F. Vanhellemont, T. von Clarmann, P. von der Gathen, C. von Savigny, J. W. Waters, J. C. Witte, M. Wolff, and J. M. Zawodny, Validation of ozone measurements from the Atmospheric Chemistry Experiment (ACE), *Atmos. Chem. Phys.*, Special Issue ‘Validation results for the Atmospheric Chemistry Experiment (ACE)’, **9**, 287-343, 2009.

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Conference papers

Meijer, Y.J., T. Fehr, R.M. Koopman, A. Pellegrini, G. Buswell, I. Williams, M. De Mazière, S. Niemeijer, R. van Deelen, GECA: ESA's Next Generation Validation Data Centre, Proceedings of the 8th International Symposium on Tropospheric Profiling: Integration of Needs, Technologies and Applications (Delft, 18-23 Oct., the Netherlands, 2009).

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Buswell, G., Ivan Williams, Rob Koopman, Yasjka Meijer, Alberto Pellegrini, Martine De Mazière, Evolution of Validation Data Centres for Earth Observation Data Processing: Generic Environment for Cal/Val Analysis (GECA), in Proceedings

of the Remote Sensing and Photogrammetry Society Annual Conference 2009, entitled New Dimensions in Earth Observation, (Leicester, Sept. 8-11, 2009).

Hendrick, F., A. Rozanov, P. V. Johnston, O. Puentedura, H. Bovensmann, M. De Mazière, M. Gil, K. Kreher, B.-M. Sinnhuber, N. Theys, J. P. Burrows, and M. Van Roozendael, Trend analysis of stratospheric BrO: comparison between SCIAMACHY limb and ground-based UV-visible observations, in Proceedings of the ESA Atmospheric Science Conference (Barcelona, Sept. 7-11, 2009), 2009.

Magazine and Newspapers articles

Radio and television

Belgian Press release «Top of Europe» prend le pouls du climat (“Top of Europe” neemt de pols van het klimaat), Dec. 2, 2008

RTL news flash about the visit of Minister Laruelle to Jungfraujoeh, Nov. 17, 2009

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<http://www.geomon.eu>