

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 Roozendaal: project leader UV-Vis

B. Dils, Caroline Fayt, François Hendrick, Christian Hermans, Jean-Christopher Lambert, Gaia Pinaridi, Corinne Vigouroux, P. Olamba: team scientists

Pierre Gérard, José Granville, T. Jacobs: team support engineers

Project description:

UV-Vis (main results, significance of results, progress in 2005)

BIRA-IASB operates a zenith-sky looking UV-visible spectrometer installed on the Sphinx platform since June 1990. Of the French CNRS SAOZ (Système d'Analyse par Observations Zénithales) design, this instrument has been qualified for operation within the international NDSC (Network for the Detection of Stratospheric Change). Twice daily at twilight, it provides measurements of the ozone and nitrogen dioxide total columns suitable for long-term climatological studies and for satellite validation. In 2004-2005, the SAOZ NO₂ and O₃ column data have been submitted to the NDSC and ENVISAT Cal/Val databases and used for the geophysical validation of NO₂ and O₃ column data from ERS-2 GOME and ENVISAT SCIAMACHY within the ESA/PRODEX CINAMON project (AOID158, coordinated by BIRA-IASB). SAOZ data have also been used in the context of the implementation of a new operational algorithm for the GOME instrument as part of the ESA UPAS/GDOAS GDP4.0 project. The stratospheric NO₂ vertical profile inversion algorithm, developed in 2003 as part of the EU project QUILT (<http://nadir.nilu.no/quilt>), has been applied to selected data sets from the Jungfraujoch. Its usefulness for the validation of NO₂ profile measurements from space has been demonstrated in the framework of the ENVISAT validation. Instrumental developments have also taken place during 2004-2005, with the preparation of a new multi-axis DOAS spectrometer, which will be installed in the course of 2006 to complement SAOZ observations. In comparison to SAOZ, the new DOAS instrument has improved performances for NO₂ detection, and enhanced capabilities to derive vertical profile information in both the troposphere and the stratosphere. It also enables the detection of additional trace gases (HCHO, BrO, SO₂) relevant to the monitoring of air quality.

FTIR solar absorption spectrometry (main results, significance of results, progress in 2005)

BIRA-IASB participates in the observations and their analysis of the atmospheric composition by Fourier transform infrared spectrometry coordinated by the University of Liege (see report by ULg).

In 2005, the EC project UFTIR (<http://ww.nilu.no/uftir>), coordinated by BIRA-IASB, went into its third year. The Jungfraujoch as well as all other European NDSC stations equipped with FTIR instruments are included in the project. The project aims at optimising the vertical inversion of 6 species, that are O₃, CO, N₂O, CH₄, C₂H₆, and HCFC-22, re-analysing the existing time series, and comparing them with model

results. After having defined a common retrieval strategy in the previous years of the project, a large part of 2005 has been devoted to the revision of the target timeseries. The BIRA-IASB team has been responsible for the revision of the FTIR ozone timeseries at Jungfraujoch, covering the period 1995-2005. Comparisons with CTM2 from Oslo University show a good agreement, although the model slightly overestimates the total ozone amount. The discrepancy probably comes from the dynamics in the model that is taken from ERA40 and that includes a too fast Brewer-Dobson circulation. The long term trend of the ozone amount above Jungfraujoch has been evaluated using a bootstrap resampling method and indicates a non-significant trend in the troposphere, and a slightly positive annual trend in the total column ($0.37\% \pm 0.21\%$ of the 2000 value, per year)

In 2005, the validation of ENVISAT SCIAMACHY and MIPAS data using Jungfraujoch and other ground-based NDSC FTIR data has continued in the frame of the ESA/PRODEX project FTIRval (AOID126, coordinated by BIRA-IASB) and in the frame of the EC project Evergreen (<http://www.knmi.nl/evergreen>). It has been demonstrated that the vertical profile information retrieved from the FTIR data can be very well exploited for the validation of MIPAS profiles, in particular for O₃, HNO₃ and N₂O profiles. Comparisons have also been performed between the FTIR data and 4D Var data assimilation analyses from the BIRA-IASB BASCOE system. They have highlighted the benefits and limitations of the present assimilation system (Vigouroux et al., 2006). It has also been shown that the FTIR total column data of CO, CH₄, N₂O and CO₂ represent a very valid contribution to the validation of the SCIAMACHY near-infrared products, and of comparable model data from TM4 and TM5.

Key words

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

Internet databases

- The data are archived in the NDSC database (<http://www.ncep.noaa.gov/>), 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/>)
- Revised FTIR timeseries in the frame of UFTIR have been submitted to NADIR/NILU in a dedicated database for UFTIR (see <http://www.nilu.no/uftir>). They will be copied to the NDSC database as soon as this one is upgraded to accept FTIR profile data.

Collaborating partners/networks:

- Collaborations with University of Liège, NDSC partners and partners of the EC projects QUILT, UFTIR, Evergreen.
- Collaboration with modellers, in particular M. Chipperfield of Univ. Leeds.
- Both the UV-Vis and FTIR observations contribute to the international Network for the Detection of Stratospheric Change (NDSC), now re-baptized NDACC, Network for the Detection of Atmospheric Composition Changes.
- Collaboration with S. Reimann, B. Buchmann, and D. Fiolini of EMPA
- Collaborations with A. Prévot (PSI) and I. Bey (EPFL)
- Collaboration with the GOME, ACE and MetOp satellite communities.

Scientific publications and public outreach 2005:

Refereed journal articles

Bach M., S. Fally, P.-F. Coheur, M. Carleer, A. Jenouvrier, A. C. Vandaele Line parameters of HDO from High-Resolution Fourier Transform Spectroscopy in the 11 500 - 23 000 cm⁻¹ Spectral Region, *J. Mol. Spectrosc.*, **232(2)**, 341-350, 2005.

Barret B., D.Hurtmans, M. Carleer, M. De Mazière, E. Mahieu and P.-F. Coheur, Line narrowing effect on the retrieval of HF and HCl vertical profiles from ground-based FTIR measurements, *J. Quant. Spectrosc. Radiat. Transfer.*, **95(4)**, 499-519, 2005.

De Mazière, M., C. Vigouroux, T. Gardiner, M. Coleman, P. Woods, K. Ellingsen, M. Gauss, I. Isaksen, T. Blumenstock, F. Hase, I. Kramer, C. Camy-Peyret, P. Chelin, E. Mahieu, P. Demoulin, P. Duchatelet, J. Mellqvist, A. Strandberg, V. Velazco, J. Notholt, R. Sussmann, W. Stremme, A. Rockmann, Evaluation of tropospheric trends of primary and secondary greenhouse gases over Europe from ground-based remote sensing observations and model analyses, *Proceedings of the Fourth International Symposium on Non-CO₂ Greenhouse Gases (NCGG-4), Science, Control, Policy and Implementation, Utrecht (The Netherlands, 4-6 July 2005)*; also in *Environ. Sciences, Special Issue 2 (2-3)*, 283-293 (2005).

Denis, L., H.K. Roscoe, M.P. Chipperfield, M. Van Roozendael and F. Goutail (2004). A new software suite for NO₂ vertical profile retrieval from ground-based zenith-sky spectrometers, *JQSRT*, **92**, 321-333, doi:10.1016/j.jqsrt.2004.07.030.

Dils, B., M. De Mazière, T. Blumenstock, M. Buchwitz, R. de Beek, P. Demoulin, P. Duchatelet, H. Fast, C. Frankenberg, A. Gloudemans, D. Griffith, N. Jones, T. Kerzenmacher, E. Mahieu, J. Mellqvist, S. Mikuteit, R. L. Mittermeier, J. Notholt, H. Schrijver, D. Smale, A. Strandberg, W. Stremme, K. Strong, R. Sussmann, J. Taylor, M. van den Broek, T. Wagner, T. Warneke, A. Wiacek, S. Wood, Comparisons between SCIAMACHY scientific products and ground-based FTIR data for total columns of CO, CH₄, CO₂ and N₂O, *ACPD*, **5(3)**, 2677-2717 (to be published in *ACP*), 2005.

Hendrick, F., M. Van Roozendael, A. Kylling, A. Petritoli, A. Rozanov, S. Sanghavi, R. Schofield, C. von Friedeburg, T. Wagner, F. Wittrock, D. Fonteyn, and M. De Mazière (2005). Intercomparison exercise between different radiative transfer models used for the interpretation of ground-based zenith-sky and multi-axis DOAS observations, *ACP* **6**, 93-108, 2006.

Meijer, Y.J. , D. P. J. Swart, M. Allaart, S. B. Andersen, G. Bodeker, I. Boyd, G. Braathen, Y. Calisesi, H. Claude, V. Dorokhov, P. von der Gathen, M. Gil, S. Godin-Beekmann, F. Goutail, G. Hansen, A. Karpetchko, P. Keckhut, H. M. Kelder, R. Koelemeijer, B. Kois, R. M. Koopman, G. Kopp, J.-C. Lambert, T. Leblanc, I. S. McDermid, S. Pal, H. Schets, R. Stubi, T. Suortti, G. Visconti, M. Yela, Pole-to-pole validation of Envisat GOMOS ozone profiles using data from ground-based and balloon sonde measurements, *J. Geophys. Res.*, **109**, D23305, doi:10.1029/2004JD004834, 2004.

Piters, A. J. M., K. Bramstedt, J.-C. Lambert, and B. Kirchhoff, Overview of SCIAMACHY validation: 2002-2004, Invited paper, *ACP* **6**, 127-148, 2006.

Spurr, R., W. Balzer, D. Loyola, W. Thomas, E. Mikusch, T. Rupper, M. Van Roozendael, J.-C. Lambert, V. Soebijanta, GOME Level 1-to-2 Data Processor

Version 3.0: A Major Upgrade of the GOME/ERS-2 Total Ozone Retrieval Algorithm, accepted for publication in *Appl. Optics*, 2005.

Tolchenov R., O. Naumenko, N. Zobov, O. Polyansky, J. Tennyson, M. Carleer, P.-F. Coheur, S. Fally, A. Jenouvrier, A. C. Vandaele, Water vapor line assignments in the 9250 – 26000 cm⁻¹ frequency range, *J. Quant. Spectrosc. Radiat. Transfer*, **233(1)**, 68-76, 2005.

Vandaele, A. C., C. Fayt, F. Hendrick, C. Hermans, F. Humbled, M. Van Roozendael, M. Gil, M. Navarro, O. Puentedura, M. Yela, G. Braathen, K. Stebel, K. Tørnkvist, P. Johnston, K. Kreher, F. Goutail, A. Mieville, J.-P. Pommereau, S. Khaikine, A. Richter, H. Oetjen, F. Wittrock, S. Bugarski, U. Frieb, K. Pfeilsticker, R. Sinreich, T. Wagner, G. Corlett, R. Leigh, An intercomparison campaign of ground-based UV-Visible measurements of NO₂, BrO, and OClO slant columns. Methods of analysis and results for NO₂, *J. of Geophys. Res.*, **110**, D08305, doi:10.1029/2004JD005423, 2005.

Zander, R. and M. De Mazière, Atmospheric composition changes: causes and processes involved (2004). Belgian Global Change Research 1990-2002, Assessment and Integration Report, Main Eds.: M. G. Den Ouden and M. Vanderstraeten, Scientific editors: R. Ceulemans, M. De Mazière, I. Nijs, J.-P. Vanderborght, J.-P. Van Ypersele, R. Wollast, R. Zander, Chapter 1, Belgian Science Policy (D/2004/1191/48).

Zander, R., E. Mahieu, P. Demoulin, P. Duchatelet, C. Servais, G. Roland, L. Delbouille, M. De Mazière, and C.P. Rinsland (2005). Evolution of a dozen non-CO₂ greenhouse gases above Central Europe since the mid-1980s, Proceedings of the Fourth International Symposium on Non-CO₂ Greenhouse Gases (NCGG-4), Science, Control, Policy and Implementation, Utrecht, The Netherlands, 4-6 July 2005; also in *Environ. Sciences, Special Issue 2 (2-3)*, 295-303, 2005.

Balis, D., J.-C. Lambert, M. Van Roozendael, D. Loyola, R. Spurr, Y. Livschitz, P. Valks, V. Amiridis, P. Gerard, and J. Granville, Reprocessing the 10-year GOME/ERS-2 total ozone record for trend analysis: the new GOME Data Processor Version 4.0 – Paper 2: Product Validation, submitted to *Journal of Geophysical Research – Atmosphere*, 2005

Neefs, E., M. De Mazière, F. Scolas, C. Hermans, and T. Hawat, BARCOS: a system for making atmospheric observations with a Bruker FTS in an automatic or remotely controlled way, submitted to *Rev. Sci. Instruments*, 2006.

Vigouroux, C., M. De Mazière, D. Fonteyn, E. Mahieu, P. Duchatelet, S. Wood, D. Smale, S. Mikuteit, T. Blumenstock, N. Jones, Comparisons between ground-based FTIR and MIPAS N₂O and HNO₃ profiles, before and after assimilation in BASCOE, ACP, to be submitted, 2006.

Vaughan, G., P. T. Quinn, A. C. Green, J. Bean, H. K. Roscoe, M. Van Roozendael and F. Goutail SAOZ measurements of stratospheric NO₂ at Aberystwyth, 1991-2004, submitted to *Journal of Environmental Monitoring (JEM)*, 2005.

Book sections

Blumenstock, T., S. Mikuteit, F. Hase, I. Boyd, Y. Calisesi, C. DeClercq, J.-C. Lambert, R. Koopman, S. McDermid, S. Oltmans, D. Swart, U. Raffalski, H. Schets, D. De Muer, W. Steinbrecht, R. Stubi, and S. Wood (2004). Comparison of MIPAS O₃ profiles with ground-based measurements, Proceedings of the Second Workshop on the Atmospheric Chemistry Validation of ENVISAT (ACVE-2) (Esrin, Italy, May 3-7, 2004), SP-562 (ESA).

De Clercq, C., J.-C. Lambert, Y. Calisesi, H. Claude, R. Stubi, et al. (2004). Integrated characterisation of Envisat ozone Profile data using ground-based network data, in Proceedings of Envisat & ERS Symposium, Salzburg, Austria, 6-10 September 2004, ESA SP-572, 10.

Kelder, H., A. Piters, R. Timmermans, K. Bramstedt, and J.-C. Lambert (2004). SCIAMACHY Validation Summary, Proceedings of the Second Workshop on the Atmospheric Chemistry Validation of ENVISAT (ACVE-2) (Esrin, Italy, May 3-7, 2004), SP-562 (ESA).

Meijer, Y. J., D. P. J. Swart, M. Allaart, S. Andersen, G. Bodeker, I. Boyd, G. Braathen, Y. Calisesi, H. Claude, V. Dorokhov, P. von der Gathen, M. Gil, S. Godin-Beekmann, F. Goutail, G. Hansen, A. Karpetchko, P. Keckhut, H. Kelder, R. Koelemeijer, B. Kois, R. Koopman, J.-C. Lambert, T. Leblanc, I. S. McDermid, S. Pal, G. Kopp, H. Schets, R. Stubi, T. Suortti, G. Visconti, and M. Yela (2004). GOMOS Ozone Profile Validation Using Data From Ground-based and Balloon-sonde Measurements, in Proc. Atmospheric Chemistry Validation of ENVISAT-2 (ACVE-2) Conference, ESA/ESRIN, Italy, 3-7 May 2004, ESA SP-562, 9.

Van Roozendaal, M., I. De Smedt, C. Fayt, F. Hendrick, F. Wittrock, A. Richter, and O. Afe (2004). First validation of SCIAMACHY BrO vertical columns, Proceedings of the 2nd Workshop on the Atmospheric Chemistry Validation of ENVISAT (ACVE-2), ESA-ESRIN, Frascati, Italy, 3-7 May 2004.

Conference papers

Bach, M., Fally, S., Vandaele, A.C., Coheur, P.-F., Carleer, M., Jenouvrier, A. (2005) Fourier transform absorption spectroscopy of HDO in the visible and near-IR spectral regions, European Geosciences Union General Assembly 2005, Vienna (Austria), 24-29 April 2005.

Fally S., M. Carleer, P.-F. Coheur, C. Clerbaux, L. Daumont, A. Jenouvrier, C. Hermans, A. C. Vandaele, M. Kiseleva (2005). Water vapor continuum absorption and O₂-X collision-induced absorption by laboratory Fourier transform spectroscopy, CECAM workshop on water dimers and weakly interacting species in atmospheric modeling, Lyon (France), 25-27 April 2005.

Jenouvrier A., L. Daumont, L. Regalia-Jarlot, V.I.G. Tyuterev, M. Carleer, S. Fally, A.C. Vandaele, S.N. Mikhailenko (2005). Long path Fourier Transform absorption Spectroscopy of water vapor in the 4200-6600 cm⁻¹ spectral range, The 19th Colloquium on High Resolution Molecular Spectroscopy, Salamanca (Spain), 11-15 Sept. 2005.

Tashkun S. A., Schwenke D. W., Tyuterev V.I.G., Jenouvrier A., Mikhailenko S., Carleer M., Fally S., Vandaele A. C., Daumont L., Regalia L., Barbe A. (2005). Global modelling of rovibrational line intensities of the water vapour in the IR and visible range and extended comparisons with new long-path experimental spectra,

European Geosciences Union (EGU) General Assembly, Vienna, (Austria), 24-29 April 2005.

Data books and reports

Lelieveld, J., M. De Mazière, S. Fuzzi, C. Granier, N. Harris, Ø. Hov, U. Schumann (2005). Atmospheric Change and Earth System Science - AIREX III: Research Challenges.

Address:

Belgian Institute for Space Aeronomy
Ringlaan 3
B-1180 Brussels
Belgium

Contacts:

Martine De Mazière
Tel. +32 2 373 03 63
Fax: +32 2 374 84 23
e-mail: martine@oma.be

Michel Van Roozendaal
Tel. +32 2 373 04 16
Fax: +32 2 374 84 23
e-mail: michelv@oma.be

URL:

<http://www.oma.be/BIRA-IASB/>
<http://www.nilu.no/uftir>