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 Pinardi, Corinne Vigouroux: team scientists
Pierre Gérard, José Granville: team support engineers

Project description:

UV-Vis

BIRA-IASB operates a SAOZ (Système d'Analyse par Observations Zénithales) UV-visible spectrometer installed on the Sphinx platform since June 1990. Measurements of the ozone and nitrogen dioxide total columns are performed twice a day at twilight and used for long-term climatological studies as well as for satellite validation as part of the Network for the Detection of Atmospheric Composition Change (NDACC, former NDSC). SAOZ total ozone and NO_2 data are regularly submitted to the NDACC and ENVISAT Cal/Val databases and used for the geophysical validation of relevant satellite instruments. The SAOZ instrument suffered from a major breakdown in June 2007, which prevented the further acquisition of measurements in 2007. The instrument has now been fixed and will be put back into operation in February 2008. In the course of 2007, the existing long-term total column NO_2 and ozone data series have been used in the context of the validation of a number of atmospheric chemistry instruments, including SciSat/ACE (Kerzenmacher et al., 2007), Aura/OMI (Celarier et al., 2007; Brinksma et al., 2007), MIPAS on ENVISAT (Wetzel et al., 2007) as well as the recent GOME-2 instrument onboard METOP (Lambert et al., 2007). In addition the SAOZ measurements have been used for the delta-validation of the most recent version of the SCIAMACHY level 2 data product (version 3.01).

FTIR solar absorption spectrometry

BIRA-IASB participates in the measurement of the atmospheric composition by Fourier transform infrared spectrometry coordinated by the University of Liège (see report by ULg).
BIRA-IASB has finalised a publication concerning trends of tropospheric and stratospheric ozone above Europe derived from FTIR observations (Vigouroux et al., 2007b); in this context it has been responsible for the analysis of the Jungfraujoch data. At the Jungfraujoch, we find a small but significant positive total ozone trend of (0.41± 0.21)%/year over the period 1995-2004; the largest contribution to this trend comes from the lower stratosphere (10-18 km altitude). For this same period, we observe no significant trend in tropospheric ozone.

Jungfraujoch FTIR data have been used together with FTIR data from other NDACC stations worldwide for the validation of satellite experiments, in particular for the validation of vertical profiles of O_3 (Cortesi et al., 2007), HNO_3 (Wang et al., 2007; Vigouroux et al, 2007a), and N_2O and CH_4 (Payan et al., 2007) from MIPAS and from

ACE. For the latter, BIRA-IASB has coordinated the validation of the CH_4 vertical profiles (De Mazière et al., 2007).
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 2006, we have initiated comparisons between both data sets, and their interpretation using trajectory modelling, in collaboration with colleagues from the University of Liège and EMPA in Switzerland. This work has continued in 2007. In particular, we have detected some events with large differences in the CO concentrations observed by both techniques, that we have been able to explain via transport processes. We have also detected a difference in the long-term trends between both data sets, for which the explanation is still under investigation. This work should be published in 2008.

BIRA-IASB also coordinates the Belgian AGACC project that aims – among others - at an advanced exploitation of the ground-based FTIR and MAXDOAS measurements at the Jungfraujoch. University of Liège is responsible for the FTIR measurements, BIRA-IASB for the MAXDOAS measurements. A preparatory campaign for the measurement of H2CO by (simultaneous) FTIR and MAXDOAS observations has been performed at Uccle in the second half of 2006. The data have been analysed in 2007: a good agreement between the MAXDOAS and FTIR data has been demonstrated. The strategy developed for the FTIR and MAXDOAS data analysis of H2CO at Uccle has also been applied successfully to data at the Ile de La Reunion (21°S, 55°E), and will be further explored at the Jungfraujoch in 2008. A publication in this respect is in preparation.

Key words

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

Internet databases

- The data are archived in the NDACC database (http://www.ndacc.org/), in the NADIR/NILU database (http://www.nilu.no/nadir/).
- Data processed for ENVISAT validation purposes are also submitted to the ENVISAT CAL/VAL database (http://nadir.nilu.no/calval).
- Revised FTIR vertical profile data have been submitted to NADIR/NILU in a dedicated database for UFTIR (see http://www.nilu.no/uftir). They will be copied to the NDACC database as soon as this one is upgraded to accept FTIR profile data.

Collaborating partners/networks:

- Collaborations with University of Liège and NDACC partners
- Collaboration with European FTIR 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 S. Reimann, B. Buchmann, D. Folini, D. Brunner and M. Steinbacher of EMPA

- Collaborations with A. Prévot (PSI) and I. Bey (EPFL)
- Collaboration with the GOME, ENVISAT, ACE and MetOp satellite communities.

Scientific publications and public outreach 2007:

Refereed journal articles

Brinksma, E. J., G. Pinardi, R. Braak, H. Volten, A. Richter, A. Schoenhardt, M. E. J. an Roozendael, C. Fayt, C. Hermans, R. J. Dirksen, T. Vlemmix, A. J. C. Berkhout, D. P. J. Swart, H. Oetjen, F. Wittrock, T. Wagner, O. W. Ibrahim, G. de Leeuw, M. Moerman, R. L. Curier, E. A. Celarier, W. H. Knap, J. P. Veefkind, H. J. Eskes, M. Allaart, R. Rothe, A. J. M. Piters, and P. F. Levelt, The 2005 and 2006 DANDELIONS NO_2 and Aerosol Validation Campaigns, accepted for publication in *J. Geophys. Res.* (2007).

Cortesi, U., J.-C. Lambert, C. De Clercq, G. Bianchini, T. Blumenstock, A. Bracher, E. Castelli, V. Catoire, K. V. Chance, M. De Mazière, P. Demoulin, S. Godin-Beekmann, N. Jones, K. Jucks, C. Keim, T. Kerzenmacher, H. Kuellmann, J. Kuttipurrath, M. Iarlori, G. Y. Liu, Y. Liu, I. S. McDermid, Y. Meijer, F. Mencaraglia, S. Mikuteit, H. Oelhaf, C. Piccolo, M. Pirre, P. Raspollini, F. Ravegnani, W. J. Reburn, G. Redaelli, J. J. Remedios, H. Sembhi, D. Smale, T. Steck, A. Taddei, C. Varotsos, C. Vigouroux, A. Waterfall, G. Wetzel, and S. Wood, Geophysical validation of MIPAS-Envisat operational ozone data, Atmos. Chem. Phys., 7, 4807-4867, 2007

Celarier, E.A., E.J. Brinksma, J.F. Gleason, P.F. levelt, J.P. Veefkind, A. Cede, D. Ionov, F. Goutail, J-P. Pommereau, J-C. Lambert, M. Van Roozendael, G. Pinardi, and E.J. Bucsela, Overview of the Validation of Nitrogen Dioxyde Retrieved from the Ozone Monitoring Instrument, accepted for publication in J. Geophys. Res. (2007).

De Mazière, M., C. Vigouroux, P. Bernath, T. Blumenstock, C. Boone, V. Catoire, M. Coffey, P. Duchatelet, J. Hannigan, L. Harvey, N. Jones, E. Mahieu, G. Manney, C. Piccolo, C. Randall, C. Senten, K. Strong, J. Taylor, K. Walker, S. Wood, Validation of ACE v2.2 methane profiles from the upper troposphere to lower mesosphere, Atmos. Chem. Phys. Disc., Special Issue 'Validation Results for the Atmospheric Chemistry Experiment (ACE)', 7, 17975-18014, 2007.

Gardiner, T., A. Forbes, P. Woods, M. De Mazière, C. Vigouroux, E. Mahieu, P. Demoulin, V. Velazco, J. Notholt, T. Blumenstock, F. Hase, I. Kramer, R. Sussman, W. Stremme, J. Mellqvist, A. Strandberg, K. Ellingsen, and M. Gauss, Method for evaluating trends in greenhouse gases from ground-based remote FTIR measurements over Europe, Atmos. Chem. Phys. Discuss., 7, 15781-15803, 2007

Neefs, E., M. De Mazière, F. Scolas, C. Hermans and T. Hawat, BARCOS an automation and remote control system for atmospheric observations with a Bruker interferometer, Rev. Sc. Instrum., 78, 035109-1 to -8, 2007.

Payan, S., Camy-Peyret, C., Oelhaf, H., Wetzel, G., Maucher, G., Kleim, C., Pirre, M., Engel, A., Volk, M. C., Kuttippurath, J., Cortesi, U., Raspollini, P., Vigouroux, C., De Mazière, M., Piccolo, C., Payne, V., Bracher, A., Glatthor, N., Stiller, G., Grunow, K., and Butz, A.,Validation and data characteristics of methane and nitrous oxide profiles observed by MIPAS and processed with Version 4.61 algorithm, Atmos. Chem. Phys. Discuss., 7, 18043-18111, 2007.

Kerzenmacher, T., M. A. Wolff, K. Strong, E. Dupuy, K. A. Walker, L. K. Amekudzi, R. L. Batchelor, P. F. Bernath, G. Berthet, T. Blumenstock, C. D. Boone, K. Bramstedt, C. Brogniez, S. Brohede, J. P. Burrows, V. Catoire, J. Dodion, J. R. Drummond, D. G. Dufour, B. Funke, D. Fussen, F. Goutail, D. W. T. Griffith, C. S. Haley, F. Hendrick, M. Höpfner, N. Huret, N. Jones, J. Kar, I. Kramer, E. J. Liewellyn, M. López-Puertas, G. Manney, C. T. McElroy, C. A. McLinden, S. Melo, S. Mikuteit, D. Murtagh, F. Nichitiu, J. Notholt, C. Nowlan, C. Piccolo, J.-P. Pommereau, C. Randall, A. Richter, M. Schneider, O. Schrems, M. Silicani, G. P. Stiller, J. Taylor, C. Tétard, M. Toohey, F. Vanhellemont, T. Warneke, J. M. Zawodny, and J. Zou, Validation of NO_2 and NO from the Atmospheric Chemistry Experiment (ACE), submitted to Atmospheric Chemistry and Physic, 2007.

Vigouroux, C., M. De Mazière, Q. Errera, E. Mahieu, P. Duchatelet, S.Wood, D. Smale, S. Mikuteit, T. Blumenstock, F. Hase, and N. Jones, Comparisons between ground-based FTIR and MIPAS N_2O and HNO_3 profiles before and after assimilation in BASCOE, ACP 7, 377-396, 2007a.

Vigouroux, C., M. De Mazière, E. Mahieu, P. Demoulin, P. Duchatelet, F. Hase, T. Blumenstock, I. Kramer, J. Mellqvist, A. Strandberg, V. Velazco, J. Notholt, R. Sussmann, W. Stremme, A. Rockmann, T. Gardiner, M. Coleman, P. Woods, K. Ellingsen, M. Gauss, and I. Isaksen, Evaluation of O3 tropospheric and stratospheric trends over Western Europe from ground-based FTIR observations, submitted to ACPD, UFTIR Special Issue, 2007b.

Wang, D. Y., Höpfner, M., Blom, C. E., Ward, W. E., Fischer, H., Blumenstock, T., Hase, F., Keim, C., Liu, G. Y., Mikuteit, S., Oelhaf, H., Wetzel, G., Cortesi, U., Mencaraglia, F., Bianchini, G., Redaelli, G., Pirre, M., Catoire, V., Huret, N., Vigouroux, C., De Mazière, M., Mahieu, E., Demoulin, P., Wood, S., Smale, D., Jones, N., Nakajima, H., Sugita, T., Urban, J., Murtagh, D., Boone, C. D., Bernath, P. F., Walker, K. A., Kuttippurath, J., Kleinböhl, A., Toon, G., and Piccolo, C., Validation of MIPAS HNO_3 operational data, Atmos. Chem. Phys., 7, 4905-4934, 2007.

Wetzel, G., A. Bracher, B. Funke, F. Goutail, F. Hendrick, J.-C. Lambert, S. Mikuteit, C. Piccolo, M. Pirre, A. Bazureau, C. Belotti, T. Blumenstock, M. De Mazière, N. Huret, D. Ionov, M. López-Puertas, G. Maucher, H. Oelhaf, M. Sinnhuber, G. Stiller, M. Van Roozendael, and G. Zhang, Validation of MIPAS-ENVISAT version 4.61 NO_2 data, Atmos. Chem. Phys., 7, 3261-3284, 2007.

Data books and reports

Lambert, J.-C., I. De Smedt, J. Granville, and P. Valks, Initial validation of GOME-2 nitrogen dioxide columns (GDP 4.2 OTO/NO2 and NTO/NO2): March – June 2007, TN-IASB-GOME2-O3MSAF-NO2-01, O3MSAF Technical Report, EUMETSAT, 22 October 2007.

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