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. M. Van Roozendael: project leader UV-Vis
Dr. Martine De Mazière: project leader FTIR
Bart Dils, Katrijn Clémer, Caroline Fayt, François Hendrick, Christian Hermans, Jean-Christopher Lambert, Gaia Pinardi, Corinne Vigouroux, Tim Vlemmix: team scientists
José Granville: team support engineer

Project description:

UV-Vis (main results, significance of results, progress in 2011)
BIRA-IASB has been continuing the regular monitoring of stratospheric column amounts of ozone and nitrogen dioxide, which was started in 1990 with a SAOZ spectrometer. Similar to the work done in 2010 on the homogenization of the ozone data series (Hendrick et al., 2011), work has been continued on improving the quality of the NO_2 time-series. New calibrations were performed and a revised retrieval scheme was implemented to correct for a recently detected polarization sensitivity of the instrument. In addition a new data base of NO_2 AMFs has been created and applied to the Jungfraujoch measurements. Several intercomparison exercises took place. First NO_2 data from the SAOZ instrument were verified against those retrieved from the high-quality research-grade MAXDOAS instrument installed next to the SAOZ in 2010. Results showed an excellent agreement after polarization correction. In addition, the SAOZ historical NO_2 data were compared to available coincident FTIR measurements, and various sensitivity tests were performed to better understand the specificities of each data set in relation to the different sensitivities of the UV-Vis and FTIR techniques. Based on the resulting consolidated data sets, a long-term trend analysis was performed. Although a decrease of about -3.7%/decade was consistently derived from both techniques for the 1990-2009 period, this trend was found to be inconsistent with the increase of N_2O of about +2.5%/decade derived from simultaneous FTIR measurements. This suggests that, in the present case, N_2O would not be the main driver of the evolution of stratospheric NO_2. Possible causes for this apparent inconsistency have been discussed, including changes in the aerosols content, changes in the halogen content and possible changes of the atmospheric transport. A publication on these results is in preparation (Hendrick et al., to be submitted to ACP).

In addition to the SAOZ, a new 2-channel MAXDOAS system has been installed in June 2010, and continuously operated since then. This instrument duplicates the stratospheric NO_2 and O_3 measurements of the SAOZ, thereby minimizing the risks of gaps in the data series. In addition, it provides a number of additional measurement capabilities; among which the possibility to derive vertically resolved information on the species NO_2, O_3, H_2CO, BrO, H_2O, CHOCHO as well as on aerosols. First analyses have concentrated on the determination of the H_2CO columns and their comparison with FTIR measurements of the same molecule. In the framework of the

recently awarded EU FP7 NORS (Demonstration Network Of ground-based Remote Sensing Observations in support of the GMES Atmospheric Service) project, both the SAOZ and MAXDOAS measurements will be further exploited to derive stratospheric and tropospheric NO_2 and O_3 data products as well as tropospheric H_2CO and aerosols. The processing chain will be improved to allow for near-real-time data delivery to the NORS and NDACC data bases. More in-depth research activities will be performed to characterize the uncertainties and information content of the measurements. This will also include comparisons with FTIR and *in-situ* data sets to be made in collaboration with scientists from EMPA in Switzerland.

FTIR solar absorption spectrometry (main results, significance of results, progress in 2011)

BIRA-IASB collaborates with the University of Liège (ULg) for the exploitation of the Fourier transform infrared measurements at the Jungfraujoch and it coordinates a number of national (Belgian) and European projects in which the Jungfraujoch measurements play an important role.

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 2011, we have finalized 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. This work has been published by Dils et al., in 2011. It has been found that the substantial differences in sampled air masses, combined with the fact that the atmospheric life time of CO (~2 months) is too short for it to be well mixed throughout the free troposphere but yet is long enough to feel the influence of far away source regions (both qualities which makes CO an ideal component for tracer studies), makes that substantial differences between NDIR and FTIR can arise, especially with regards to the overall trend. It has also been demonstrated that the influence from Asian emissions is much larger in the FTIR observations than it is in the NDIR.data.

In 2011, we also made another update of the O_3 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 1995-2011. In agreement with many observations, we see a leveling off of the decreasing trends at Northern mid-latitudes since 1995-1996. The effect of the Effective Equivalent Stratospheric Chlorine decline is visible in the upper stratosphere. And one observes a correlation between lower stratospheric and tropospheric trends.

These results have been presented in a poster during the NDACC 2011 Symposium at Ile de La Réunion in November 2011.

The work on the coordinated validation of the IASI instrument on METOP-1, for the species CO and HNO_3 , using NDACC FTIR data, is coming to an end and will be published early 2012.

The Jungfraujoch is one of the 4 demonstration stations in the EU FP7 project NORS that started in November 2011 (http://nors.aeronomie.be). Concerning the FTIR measurements, we will work on CO, CH_4, NO_2 and H_2CO. The objective is to make a more rapid data analysis and submission to the NDACC database, for use in the validation of the GMES Atmospheric Service products. Research will be undertaken

as to common retrieval strategies for NO_2 and H_2CO, and regarding a better characterisation of the FTIR data products (error budgets, representativeness, …).

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 GEOMS format for UV-Vis DOAS data products has been implemented at the NDACC data base; first data submissions have taken place (for BrO vertical profiles)

The GEOMS HDF format for FTIR vertical profile data has been implemented at the NDACC database.

In the EU project GEOmon (finished in early 2011), data have been delivered to a dedicated Rapid Delivery ftp site at NILU at latest 3 months after data acquisition.

The SAOZ data have been also submitted to the Rapid Delivery ftp site at the GEOmon Data Center (http://www.geomon.eu/data.html)

In the frame of NORS, the data submission will be done in the GEOMS HDF format to the NDACC database, within 1 month after data acquisition.

Collaborating partners/networks:

Collaborations with University of Liège and NDACC partners

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

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-Zealand

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

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Data books and reports

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