Atmospheric composition monitoring at ISSJ

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1. Project description

1.1 UV-Vis observations

The monitoring of the stratospheric composition using ground-based UV-visible remote-sensing observations complementing FTIR measurements from the University of Liège is the focus of the BIRA-IASB observational activity at the Jungfraujoch. This measurement programme started in the early nineties using a SAOZ (Système d'Analyse par Observations Zénithales) developed by our French colleagues at CNRS/LATMOS and was continued until 2011. In 2010, we installed a MAX-DOAS instrument developed in-house, which allowed us to extend our monitoring to the composition of the free-troposphere. With this system, the long-series of stratospheric NO_2 and O_3 columns could be extended until 2018 and, in addition, measurements of the free-tropospheric background of HCHO and NO_2 could be explored (Franco et al., 2015). Next to their use for long-term trend analysis (De Mazière et al., 1998; and Hendrick et al., 2012) these measurements also served as fiducial reference measurements for the validation of satellite missions (see Verhoelst et al., 2021; Pinardi et al., 2020).

We unfortunately had to partially interrupt our UV-Visible monitoring in May 2016 and completely in June 2019 after a major instrumental breakdown that affected the whole system. Although it was our intention to refurbish the MAX-DOAS instrument without too much delay, the occurrence of the Covid-19 crisis followed by staff difficulties constrained us to interrupt our monitoring until March 2022. At this time a new zenith-sky instrument of the mini-SAOZ type was finally installed and successfully operated since then, allowing us to pursue our stratospheric NO_2 and O_3 column monitoring. Based on new resources gained as part of the Belgian contribution to the ACTRIS European Research Infrastructure, we also started working on an upgraded version of our MAX-DOAS instrument. A first mission dedicated to the installation of this upgraded system took place in August 2023, however only the visible channel could be restarted, and we also suffered from technical problems with our sun-tracker that required an additional maintenance at the manufacturer. Another mission is planned in February 2024, where we plan to relaunch the experiment in its full capacity. In this configuration, we will have two independent systems running in parallel, one (mini-SAOZ) focusing on stratospheric NO_2 and O_3 monitoring and the second one dedicated to tropospheric trace gas measurements (NO_2 and HCHO) using the MAX-DOAS technique. Since the MAX-DOAS instrument can also measure stratospheric species, there will be a redundancy in those measurements that should limit the risks of interruptions in the data series. With these systems, we will join in the process of labelling the Jungfraujoch as an ACTRIS Reactive Trace Gas Remote Sensing (RTGRS) National Facility (see below).

1.2 International coordination activities

BIRA-IASB is responsible for the Reactive Trace Gases Remote Sensing (RTGRS) component in the European ACTRIS Research Infrastructure (www.actris.eu). ACTRIS has been established officially as an ERIC (European Research Infrastructure Consortium) on April 25, 2023.

In ACTRIS, BIRA-IASB is also leading the Centre for Reactive Trace Gas Remote Sensing (CREGARS) Central Facility (https://www.actris.eu/topical-centre/cregars). Together with the University of Liège and the University of Bremen, BIRA-IASB manages the CREGARS-FTIR Unit. Likewise, it also manages the CREGARS-UVVIS unit in collaboration with CNRS/LATMOS, the University of Innsbruck and KNMI. The implementation of CREGARS-FTIR and CREGARS-UVVIS are well advanced.

BIRA-IASB also provides the Belgian National Contact Person for ACTRIS and, in this capacity, it coordinated the Belgian federal project ACTRIS-BE (15/12/2018-15/12/2022). It also succeeded in winning a follow-up 3-years national project called ACTRIS2BE that started in December 2023. These federal projects support the implementation and operation of CREGARS at the Belgian level and of the Belgian National Facilities, among which the RTGRS NF at the Jungfraujoch. The labelling process for the Jungfraujoch RTGRS NF will start in 2024.

The CREGARS Central Data Processing Systems and data quality control systems for the FTIR and UVVIS data are managed by BIRA-IASB and are ready to process the data from the UVVIS and FTIR instruments once the labelling process has started. The data will

then become available as ACTRIS data through the ACTRIS data Portal.

BIRA-IASB has also led the process to establish a Memorandum of Understanding (MoU) between NDACC (Network for the Detection of Atmospheric Composition Changes – www.ndacc.org) and ACTRIS, on the purpose of assuring data consistency between NDACC and ACTRIS for the common data products. This MoU will be signed after the next ACTRIS General Assembly in March 2024.

As in previous years, BIRA-IASB remains in charge of the CAMS2-27 contract, which aims at providing a rapid-delivery and quality-controlled NDACC data stream to CAMS. It uses these data (including the UVVIS and FTIR data recorded at the Jungfraujoch) in the CAMS2-82 project for the validation of products from the Copernicus Atmospheric Monitoring Service (CAMS), led by ECMWF.

Similarly, BIRA-IASB is in charge of the Sentinel-5 Precursor (S5P) operational validation service (VDAF) within the ESA S5P Atmospheric Mission Performance Center (ATM-MPC). In this context, BIRA-IASB coordinates the validation of the S5P products using NDACC data, including those recorded at the Jungfraujoch.

In the frame of the Copernicus Climate Change Service (C3S), BIRA-IASB is responsible for the ingestion of long-term NDACC ozone, CO, CH_4, NO_2 and HCHO time series in the Climate Data Store (CDS; https://cds.climate.copernicus.eu/). Long-term Jungfraujoch FTIR and UVVIS time series should be available soon through the CDS portal.

Finally, BIRA-IASB is also responsible for including the NDACC FTIR data in the TOAR-II (Tropospheric Ozone Assessment Report-II) activities. A publication is in preparation.

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Internet data bases

http://www.ndacc.org/ (data archival in NDACC data base)
https://evdc.esa.int/ (data archival in ESA CAL/VAL EVDC database at NILU)

Notes:

- All the data sets submitted in these data bases are generated using HDF GEOMS formats
- The NDACC database is 'read' by the CAMS validation server on a daily basis, for using the data for the validation of the CAMS NRT and re-analysis products. A similar facility has been implemented for the S5P-MPC VDAF system.

Collaborating partners / networks

Dr. E. Mahieu, Université de Liège, Liège, France
Dr. M. Chipperfield, University of Leeds, Leeds, UK
Dr. A. Pazmino, LATMOS, GuyaFrance, France
Prof. P. Coheur, Université Libre de Bruxelles, Brussels, Belgium

International Network for the Detection of Atmospheric Composition Changes (NDACC)
OMI, TROPOMI (S5P), and Metop GOME-2 and IASI satellite communities
KNMI and S&T for the CAMS and S5P MPC Validation Server
CNR (Italy) and ECMWF for the delivery of NDACC data to C3S
ACTRIS: Strong responsibilities at European and Belgian level

Scientific publications and public outreach 2023

Refereed journal articles and their internet access

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