

Report on the 2015 NDACC UV-vis Working Group meeting, July 2015

The UV-vis Working Group (WG) meeting was held at BIRA in Brussels, Belgium on Thursday, 9 July 2015. The idea of this report is to provide all of us with a summary of the presentations & discussions. The presentations are available on the NDACC UV-vis WG website. The meeting agenda and list of the participants is attached at the end of this report.

Session 1 provided a status update of NDACC stations and an update of ongoing activities.

Jean-Pierre Pommereau (LATMOS) gave the first presentation on the SAOZ network summarizing the current status of the stations (funding overall secure) with 30 stations running SAOZ or Mini-SAOZ instruments to measure total column O₃ and NO₂. Aging SAOZ instruments are progressively replaced with Mini-SAOZ and the report on Mini-SAOZ NDACC qualification is currently in preparation. The latest data processing version, V3, includes the most recent NDACC UV-vis WG recommendations and near real-time data is available on SAOZ web page. Andrea Pazmino is the scientist in charge of the SAOZ network.

Olga Puentedura (INTA) gave a presentation on the current INTA DOAS activities and reported on their involvement in the AVATAR (AViation and ATmosphere: an AeRospace aerosol-gas study) project which also provides national funding to support the INTA NDACC stations:

- 1) At El Arenosillo (during campaigns): NO₂, IO, glyoxal and O₃ measured by MAX-DOAS.
- 2) At Madrid (where INTA is located): the INTA MAX-DOAS will be used as part of a campaign in 2017 to measure emissions from military aircrafts operated close to INTA.
- 3) And at Izana (subtropical station): BrO, HCHO (UV) and NO₂, O₃, IO (vis) measured by MAX-DOAS.

HELADO (Halogens in the Antarctic atmosphere and its role in the Ozone distribution) is another national project providing support for Antarctic INTA stations (Ushuaia, Marambio and Belgrano II) and funding to further upgrade the DOAS instrumentation with MAX-DOAS instruments at these stations.

Xiaoyi Zhao (University of Toronto) reported on the status of the Eureka (PEARL) site. The funding outlook is very positive with 5-year science funding for PEARL from NSERC's Climate Change and Atmospheric Research Program (2013-2018) in place and additional funding for student involvement and science projects available. Both MAX-DOAS instruments, UT-GBS and PEARL-GBS, have recently been upgraded; both instruments have zenith sky and MAX-DOAS capabilities plus PEARL-GBS has also direct sun capability. Data processing follows NDACC recommendations and the data have been submitted to the NDACC data base up to 2012; 2013-2014 have been processed.

Myojeong Gu (MPIC) reported on the status of the Kiruna site. Since 1996, a zenith-sky DOAS has been operated at Kiruna, Sweden to measure total column NO₂ and BrO, but e.g. also SO₂ on 10 Sep 2014 (during a volcanic eruption). The measurements are supported and running well but there is currently no financial support for routine data processing and submission to

the NDACC data base. However, there is a possibility that some funding might be made available in the next year. Future plans include to also analyse OCIO, O₃ and HCHO.

Clio Gielen (BIRA) gave a presentation on the MAX-DOAS measurements and data retrieval at BIRA-IASB. BIRA operates MAX-DOAS instruments at 6 different sites. The OHP instrument is getting old, which is affecting the quality of the data, especially the vertical profile retrievals. The vertical columns can still be exploited. For data processing, QDOAS and an in-house profile retrieval is used. The format used for data delivery is GEOMS hdf. Clio also reported on BIRA's involvement in projects such as NORS and QA4ECV and the knowledge these projects provide and how the outcomes will improve our understanding of error sources and QA/QC control. The BIRA rapid data delivery system was discussed and future plans include automated near-real time QDOAS analysis for all sites and a further quantitative investigation of the error budget.

Ankie Piters (KNMI) reported on ship-board MAX-DOAS activities and MAX-DOAS observations at Cabauw. KNMI is currently purchasing a Pandora instrument which will be located at Cabauw and operated in direct sun and MAX-DOAS mode.

Rainer Volkamer (University of Colorado) reported on the MAX-DOAS measurements at Mauna Loa running since January 2014. The measurements are made in the 330-485 nm wavelengths range and there is an approximately 9 month overlap with the NDACC certified NIWA zenith sky DOAS instrument. There are also plans for a new MAX-DOAS to be employed at the Maito Observatory at Reunion Island.

Session 2: Presentations on NDACC MAX-DOAS activities and the link with Pandonia

Francois Hendrick (BIRA) presented a summary of the main achievements of the **NORS** (Demonstration Network Of ground-based Remote Sensing observations in support of the GMES Atmospheric Service) project and how the targets achieved under NORS will optimize existing NDACC data products (such as total column NO₂ and O₃) and support the introduction of future products (such as HCHO, tropospheric NO₂ and O₃, and profiles). One important aspect is the standardization of the retrieval settings and parameters to improve the consistency in the data provided to the data users. Recommended settings as well as AMF climatologies and corresponding extraction tools have been made available on the NDACC UV-vis Working Group webpage under Tools (<http://ndacc-uvvis-wg.aeronomie.be/tools.php>). Another outcome of the NORS project was to improve the data and metadata homogenisation and promoting the transfer from the NASA-AMES text format to the GEOMS hdf format. Four templates (ZENITH, OFF-AXIS, DIRECTSUN, and AEROSOL) have been created for reporting UV-vis data in the GEOMS hdf format. A description of these templates as well as guidelines for the creation of the GEOMS hdf files have been made available on the AVDC database (<http://avdc.gsfc.nasa.gov/index.php?site=1876901039>). A rapid data delivery service has been also developed and data files from the Jungfraujoch and Xianghe stations have been submitted on a daily basis to the NDACC/NORS Rapid-Delivery

database. These data have been used for the validation of ECMWF models in the framework of the MACC-II/III projects. This service is being continued within the operational Copernicus Atmospheric Monitoring Service (CAMS). For further details and links, see Francois' presentation.

Alexander Cede (Luftblick) presented the plan for the **Pandonia** network, which will provide long-term, homogeneously calibrated time series of O₃ and NO₂ (and possibly other trace gases) for air pollution monitoring and satellite validation. The core instrument used is the Pandora and the processing is centralised for all stations of the network. Timeline: Starting August 2015 and the Pandonia network has to be completed by the end of 2016 to support the validation of existing and upcoming satellite missions. ESA sponsors the mobile and 6 stationary reference instruments and will provide operational support. The Pandonia network instruments themselves will need to be paid for and will be operated locally. Pandonia is also using the GEOMS hdf format and it has been decided to merge both Pandonia and UV-vis templates. It was also agreed that a close collaboration between the NDACC UV-Visible Network and the Pandonia Network (<http://www.pandonia.net/>) would be beneficial for both communities.

Thomas Wagner (MPIC) reported on the further developments regarding the **MADCAT** (Multi Axis DOAS – Comparison Campaign for Aerosols and Trace Gases) campaign held in Mainz, Germany in summer 2013. The campaign included 16 stationary MAX-DOAS instruments, car-based MAX-DOAS by 3 groups and a NO₂-CE-DOAS (IUP Heidelberg) plus complimentary instrumentation (e.g. ceilometer, AERONET station). The MADCAT web page (http://joseba.mpch-mainz.mpg.de/mad_cat.htm) provides all relevant information and available data products. The campaign provided a wealth of valuable data sets and several studies are currently carried out such as the comparison of spatial gradients from azimuth scans and car MAX-DOAS, comparison of HONO, HCHO and CHOCHO, and quantitative comparison of O₄ absorption.

Michel van Roozendael (BIRA) presented the **QA4ECV** project (2014-2017). The main objectives of this project are to generate long-term data records relevant to air pollution and climate change, and to develop a generic (traceable) quality assurance system to evaluate the maturity of satellite data sets. The later approach is also applied to independent reference data used in the validation of satellite ECV products such as NO₂ and HCHO. To achieve this, NO₂ and HCHO reference data from different MAX-DOAS sites will be collected and a data base of harmonised products will be available by June 2016 with a first preliminary product by the end of this year. This process includes harmonization of data processing for the different sites, a characterisation of uncertainties and a validation of the MAX-DOAS data against long-path DOAS, in-situ measurements and NO₂ sondes. The outcomes of this project will be vital for introducing tropospheric NO₂ and HCHO into the NDACC database.

Karin Kreher (BKS) talked briefly about a new 3 year Horizon-2020 project **GAIA-CLIM** (Gap Analysis for Integrated Atmospheric ECV CLImate Monitoring). The aim of this project is to lead to significant advances in the consistency and validation of long-term space-based measurements using high-quality ground-based data streams, and to provide a better overview of the uncertainties in the available measurements to generate reference quality

climate data records. The goals of GAIA-CLIM seem at first sight not very dissimilar from QA4ECV but the project covers overall different species. Relevant for the UV-vis working group are the two tasks on the uncertainty characterization and on further development of total column and tropospheric O₃ using the (MAX-)DOAS technique.

Michel van Roozendael (BIRA) presented an update on the planned **ESA CEOS Intercalibration** project to build a centralised processing system for NRT delivery of MAX-DOAS data products (NO₂ column and profile, aerosol AOD and extinction profile, HCHO column and profile). The project will use CINDI-2 (see Session 3 below) data as a demonstration of the developed system, starting with Level 1 data (calibrated spectra), and it will have links to Pandonia.

The following topics were raised as part of the discussions:

- 1) Which data format should be used for the NDACC UV-vis data submission in future: GEOMS hdf or NetCDF?
Arguments for a conversion to GEOMS hdf format are: (1) This format is already used by other communities (Pandonia, FTIR) and by the AURA and Envisat validation server, (2) Specific templates for UV-vis data are already available, and (3) GEOMS is also used within the framework of MACC. It certainly is important for the NDACC UV-vis community to replace the NASA-AMES format as it is currently used, so that NDACC UV-vis data will be used and included in future major validation projects (e.g. Copernicus).
- 2) What tropospheric MAX-DOAS data products should be included in the NDACC database? As a first step, it was suggested to agree on a simple approach and to e.g. start with only tropospheric NO₂ columns. Good documentation using metadata is vital, the metadata should include cloud flags but so far no uniform cloud identification process exists yet.
- 3) The correction factor to be applied on the O₄ XS remains an open issue. Further investigations are needed to understand why in some cases such a correction factor is needed to get a good agreement between measured and simulated O₄ slant columns while in some other cases not. R. Volkamer investigated the link between the need for this correction factor and the a priori knowledge of the aerosol vertical profile. T. Wagner also presented results from the MAD-CAT campaign about the dependence on the elevation viewing angle of the agreement between measured and calculated O₄ slant columns. M. Van Roozendael suggested to fit directly the correction factor in the profiling tools.

Session 3: CINDI-2 campaign and S5P Cal/Val activities

CINDI-2 is the next intercomparison campaign to be held at Cabauw, Netherlands for approximately 4 weeks during September 2016. The local coordinator is Arnoud Apituley (KNMI). Emphasis will be on the inter-calibration of MAX-DOAS instruments but the campaign will also include a couple of long-path systems, CE-DOAS and in-situ systems for different altitudes on tower 2D and scanning DOAS (imaging) instruments. More participants and

instruments than during the last CINDI campaign are expected and the limiting factors would potentially be power, internet and the availability of accommodation. ESA will provide some financial support, e.g. for campaign participation (travel cost and accommodation, etc.) and ESA will also provide support for the TROPOMI validation (launch scheduled for May/June 2016).

NDACC twilight observations of NO₂ and O₃ (total column) will again be one of the aspects and if possible, NO₂ sondes will also be included in the campaign. The other target species are molecules relevant for Sentinel 5 satellite observations such as HCHO and O₃. While SO₂ is probably not relevant at Cabauw, it was suggested to investigate whether glyoxal can be analysed. Recommendations for calibration procedures and how to synchronize the acquisition of different measurements (e.g. how to take spectra using the same elevation angles at the same time) will be discussed in advance, e.g. so that acquisition software can be adjusted if necessary. Information on how to best achieve proper horizontal adjustment will be provided by Udo Friess and Thomas Wagner.

Alexis Merlaud (BIRA) summarized the status and first outcomes of the AROMAT campaigns. AROMAT-1 (Airborne Romanian Measurements of Aerosols and Trace gases) was held in Romania in September 2014 including stationary, mobile (car-based) and airborne platforms. AROMAT-2 is planned for 17 – 29 August 2015 and AROMAT-3 for summer 2017 as a cal/val activity for TROPOMI.

Gaia Pinardi (BIRA) reported on the S5P NIDFORVal (NItrogen Dioxide and FORmaldehyde Validation) project using NDACC and complementary FTIR and UV-Vis DOAS ground-based remote sensing data to provide accurate NO₂ and HCHO data that fulfill the S5P validation requirements.

List of participants

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