

THE NDACC MAX-DOAS CENTRAL PROCESSING SERVICE IN SUPPORT TO AIR QUALITY SATELLITE SENSORS VALIDATION

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FRM₄DOAS web site:
https://frm4doas.aeronomie.be

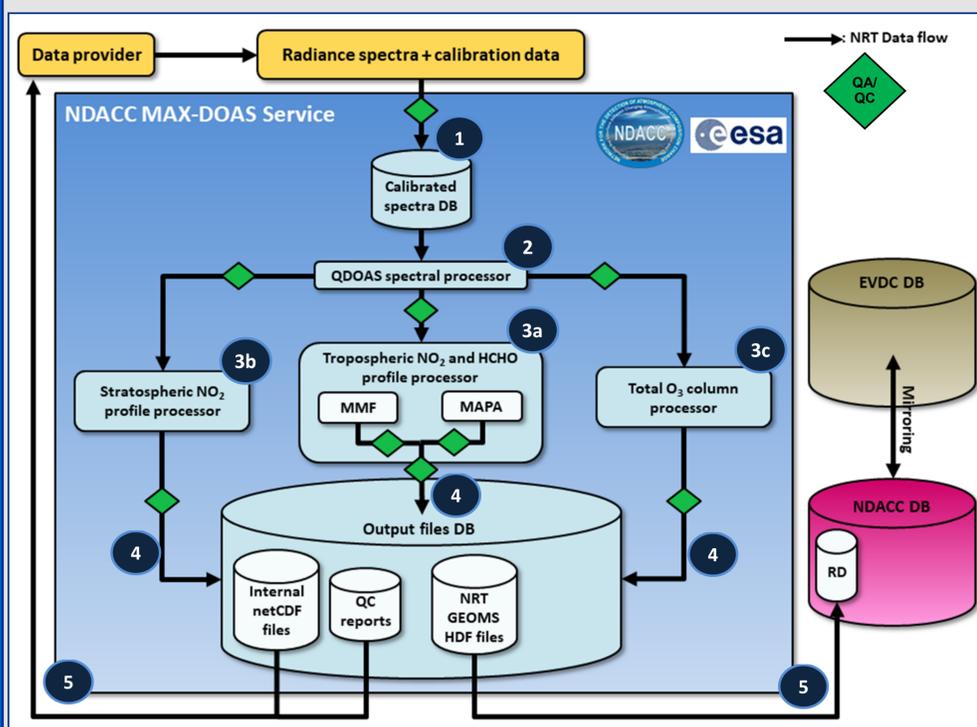
I. SUMMARY

In order to ensure that products delivered by air quality satellite sensors meet user requirements in terms of accuracy, precision and fitness for purpose, it is essential to develop a robust validation strategy relying on well-established and traceable reference measurements. In this context, the ESA Fiducial Reference Measurements for Ground-Based DOAS Air-Quality Observations (FRM₄DOAS) activity is aiming at further harmonizing Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) measurements. Since it provides vertically-resolved information on atmospheric gases at an horizontal scale approaching the one from nadir backscatter satellite sensors, the ground-based MAX-DOAS technique has been recognized as a valuable source of correlative data for validating space-borne observations of atmospheric species such as NO₂, HCHO, SO₂, O₃, etc.

Here we present the main aspects and status of the first near-real-time (24h latency) central processing service for MAX-DOAS instruments that has been developed in the framework of the FRM₄DOAS activity and which is operated as part of the Network for the Detection of Atmospheric Composition Change (NDACC). Since November 2020, the processing system, which includes state-of-the-art retrieval algorithms, delivers on a daily basis tropospheric NO₂ vertical profile and total O₃ column data from about 15 stations to the NDACC Rapid Delivery and ESA Validation Data Centre (EVDC) databases.

The new FRM₄DOAS-2.0 R&D follow-up project, which started in September 2021 with the main objective to develop new additional MAX-DOAS products (cloud and urban tropospheric NO₂ products) and to consolidate existing ones (stratospheric NO₂ and tropospheric aerosol products), is also presented.

II. NDACC MAX-DOAS CENTRAL PROCESSING SYSTEM



Main processing steps:

- 1 Uploading of level-1 files (spectrally calibrated radiance spectra) on a dedicated incoming FTP server by instrument PIs and storage of the files on a dedicated database
 - 2 DOAS analysis using the QDOAS spectral fitting software (Fayt et al., 2011)
 - 3 Level-2 data product retrievals using the following algorithms:
 - 3a Parameterisation-based MAPA (Beirle et al., 2019) and Optimal-Estimation-based MMF (Friedrich et al., 2019) for lower tropospheric profiles and vertical columns of NO₂, HCHO, and aerosols (see also Frieß et al., 2019)
 - 3b BIRA-IASB Optimal-Estimation-based profiling tool for stratospheric NO₂ vertical profiles (Hendrick et al., 2004)
 - 3c Standard AMF-based NDACC approach for the total O₃ column retrieval (Hendrick et al., 2011)
 - 4 Generation of level-2 data files: (1) internal netCDF files that contains the complete and fully traceable set of retrieval variables and ancillary data, and (2) standard GEOMS HDF4 files
 - 5 Automatic submission of the GEOMS HDF4 files to the NDACC Rapid Delivery repository with mirroring on the EVDC database + delivery of netCDF files to instrument PIs
- + various QA/QC and diagnostic checks throughout the processing chain

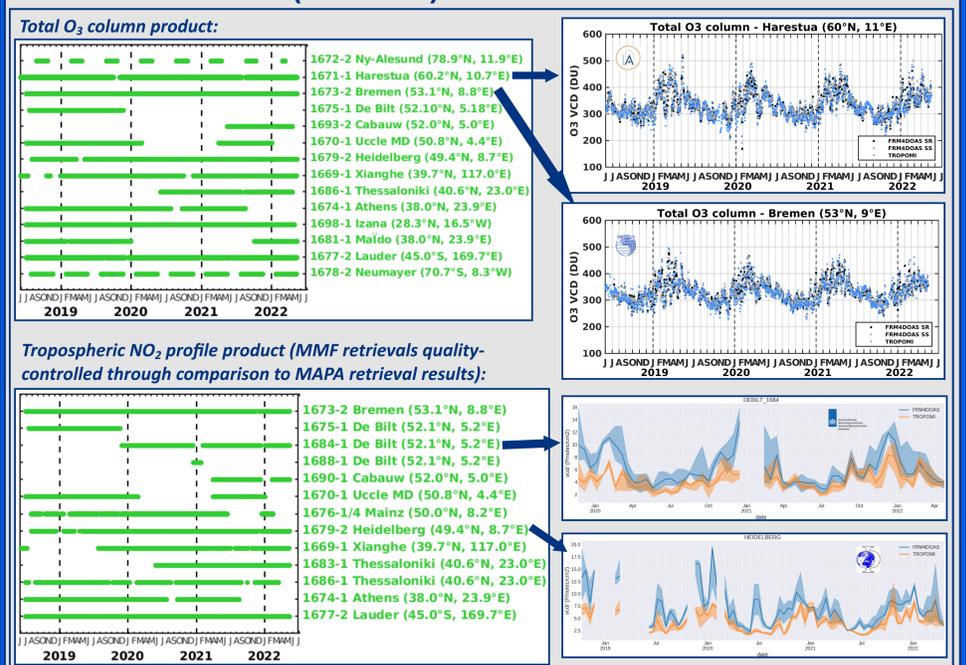
Products Maturity:

Extensive verification and validation exercises have shown that:

- Total O₃ column and tropospheric NO₂ vertical profile products are mature enough for submission on NDACC and EVDC databases
- Stratospheric NO₂ and tropospheric HCHO vertical profile products need to be further consolidated and therefore are currently not submitted on NDACC and EVDC

For more details, see https://frm4doas.aeronomie.be/ProjectDir/Deliverables/FRM4DOAS_CCN02_D21_Operational_Processing_System_and_Test_Report_document_v1.0_20200623.pdf

III. DATA SETS AVAILABLE ON NDACC/RD AND EVDC REPOSITORIES (05/2022)



IV. NEW MAX-DOAS R&D DEVELOPMENTS

New or consolidated MAX-DOAS products are currently under development as part of the FRM₄DOAS-2.0 R&D project (09/2021-08/2025):

Consolidated stratospheric NO₂ product

- Improvement of the current standard product:

NRT cloud product

- Cloud classification algorithms (Gielen et al., 2014; Wagner et al., 2014) will be evaluated and pros/cons will be assessed. One algorithm will be selected.
- Algorithm will be applied to a selection of MAX-DOAS measurements
- Results will be evaluated based on mini-camera images

Consolidated aerosol product

- Selection of suitable validation test sites.
- Comparison of FRM₄DOAS aerosol products from validation sites with co-located measurements (sun photometers, ceilometers, etc)
- Comparison of aerosol products from the two algorithms currently implemented in the processing system (MAPA and MMF)
- Optimisation of the MMF and MAPA aerosol retrieval settings

Urban tropospheric NO₂ product

- Evaluation of existing algorithms for the derivation of horizontal information from MAX-DOAS measurements
- Development of an algorithm to extract horizontal NO₂ information from FRM₄DOAS type measurements. Used approaches:
 - ⇒ Flagging
 - ⇒ Averaging over azimuthal angles
 - ⇒ Quantifying variations
 - ⇒ Retrieving horizontal gradients

V. REFERENCES

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VI. ACKNOWLEDGEMENTS

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