HCHO and NO₂ MAXDOAS retrieval harmonization as part of the QA4ECV project

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Introduction

Over the last years, ground-based MAXDOAS measurements have played an increasing role for the ground-truthing of space-based observations of air quality relevant trace gases such as NO₂ and HCHO. Current MAXDOAS network data however lack harmonization in terms of data acquisition, data processing and data reporting. This issue is addressed as part of the ongoing EC FP7 QA4ECV project (Quality Assurance for Essential Climate Variables, http://www.qa4ecv.eu) which aims at developing standardized quality control procedures for Climate Data Records generation. In particular, tools and best-practices for MAXDOAS measurements are developed and tested on a selected number of sites to be used as Fiducial Reference Measurement (FRM) as part of the project.

We present a status of the QA4ECV MAXDOAS harmonization activities addressing spectral fitting and air mass factor calculations. Results from a large scale intercomparison exercise involving 15 groups are presented for both NO₂ and HCHO. We also introduce an approach allowing for harmonized conversion of slant columns into vertical columns through application of generic look-up tables of air mass factors parameterized as a function of solar and viewing angles, wavelength, boundary layer height, aerosol optical depth (AOD) and surface albedo. The advantages and drawbacks of the LUT approach are investigated and the application of the data set for comparison with GOME-2 satellite measurements is discussed.

1. NO₂ and HCHO slant column intercomparison

- Efforts in the past (Roscoe et al., 2010; Pinardi et al., 2013) to evaluate the agreement between groups (different instruments and different retrieval codes).
- Here: estimation of agreement of different DOAS retrieval codes on common data and settings, and identification of systematic differences. Exercise opened to the DOAS community (more than 20 groups involved).
- Compare DSCD of each group for different angles; scatter plots wit a ref.

As expected, NO₂ analysis are more stable and coherent than HCHO. Differences are of retrieved slant columns between 1% for NO₂, and 10% for HCHO (with noon reference spectra) and up to 1x10⁻⁴ molecule/cm⁻³ or 8% and 2x10⁻⁴ or 50% (with sequential reference). Differences between groups are mostly related to slit function choice (measured or optimized/analytical), details of the calibration procedure and sequential reference selection.

2. NO₂ and HCHO harmonized LUTs of AMFs and profile shapes

- Harmonization of the conversion of NO₂ and HCHO SCDs to VCDs within the QA4ECV groups through the use of AMF LUT applied to high elevation angles (α>10°)
- Example of application in Xanghe and comparison to GA and OEM (BePRO).

VCD = \frac{DSCD}{DAMF₃₆} = \frac{SCD - SCDₚ}{AMF₃₆ - AMFₚ₆}

- Use of the a-priori profile climatology for the comparison with satellite:
- A) extraction of the profile based on the BLH climatology + scaling to the retrieved VCD
- B) convolve the scaled profile to the satellite column AVK

Conclusions and outlook

- Harmonization of MAXDOAS retrieval steps is in a very good shape, with revisited slant columns and homogeneous conversion into VCD (+ profile shapes and AMFs) at the 12 QA4ECV MAXDOAS stations.
- First validation results on GOME-2 GDF data with the QA4ECV LUT approach for NO₂ and HCHO at BIRA stations are very promising, good consistency with the results obtained when using the profiles coming from the BePRO OEM. Tests on other stations are ongoing.

Selected References

Roscoe et al.: AMT, 3, 1629–1846, 2010
Pinardi et al.: ATM, 8, 159–185, 2013
Peters et al.: in preparation for AMT
Pinardi et al.: in preparation for AMT