



Validation of reprocessed GOME-2 HCHO and NO₂ columns using ground-based MAXDOAS columns

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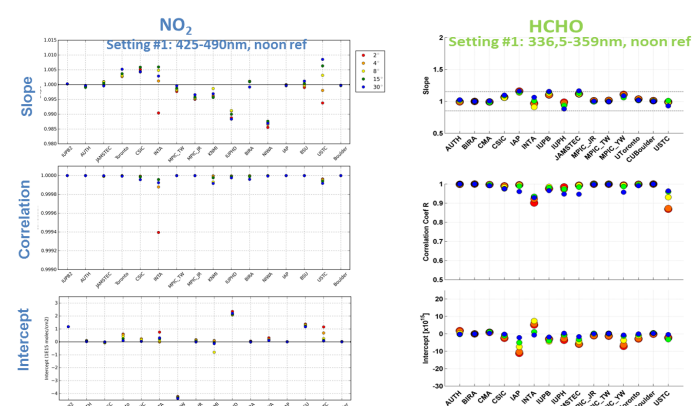
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Introduction

The value of ground-based MAXDOAS measurements for the validation of satellite nadir observations of air quality species like NO₂ and HCHO has been increasingly recognized over the last few years. Within the EUMETSAT Atmospheric Composition Monitoring SAF, data of ~20 MAXDOAS stations have been gathered for a first assessment of the quality of the reprocessed GOME-2 NO₂ product (Pinardi et al., 2014; 2015). In this study, we report on a similar approach for the **extension of the GOME-2 HCHO validation**, and we focus on the **impact of the current limitations of the existing MAXDOAS datasets**, that suffer from a **lack of harmonization** in terms of data acquisition, data processing and data reporting. We **report on efforts recently undertaken** as part of two successive EU FP7 projects to **improve on MAXDOAS network data harmonization**, namely the **NORS** (Network Of ground-based Remote Sensing Observations in support of the Copernicus Atmospheric Service) and the **QA4ECV** (Quality Assurance for Essential Climate Variables) projects.

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 and scatter plots wrt to a ref (IUPB or BIRA):

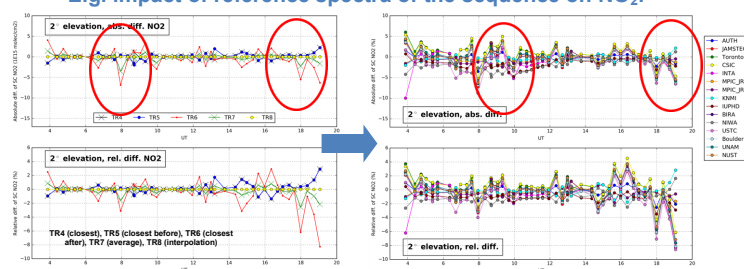


Most differences between groups are related to the slit function choice (measured or optimized/analytical), the details of the calibration procedure and the sequential reference selection.

As expected, the NO₂ analysis are more stable and coherent than the HCHO: differences of retrieved slant columns between $\pm 1\%$ for NO₂, and $\pm 15\%$ for HCHO (when using noon reference spectra) and up to 1×10^{16} molec/cm² or 8% and 2×10^{16} or 50% (with sequential reference).

Sensitivity tests performed with one code (IUPB and BIRA QDOAS) to identify sources of differences between groups and optimize the analysis precision. Dominant effects: the choice of the reference spectrum, the slit function treatment and the wavelength calibration. [Peters et al.; Pinardi et al in prep]

E.g. impact of reference spectra of the sequence on NO₂:

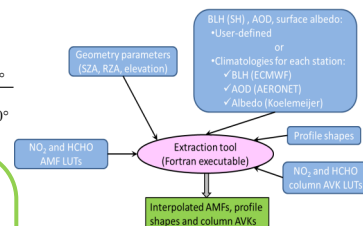
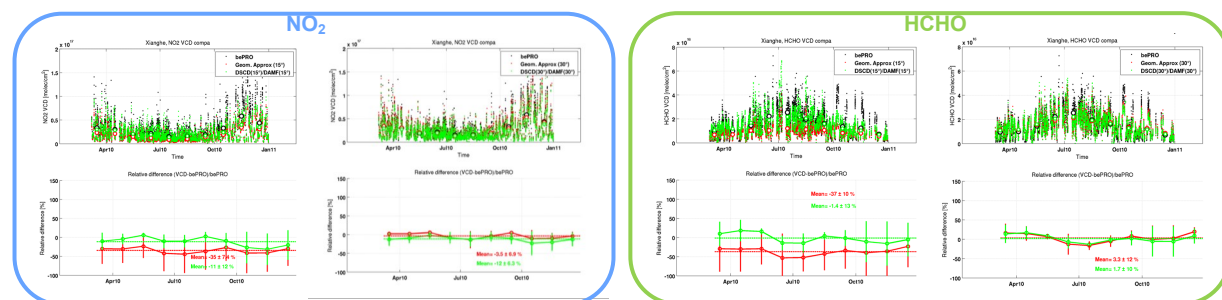


2. NO₂ and HCHO harmonized LUTs of AMFs and profile shapes

■ 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 ($\alpha > 10^\circ$)

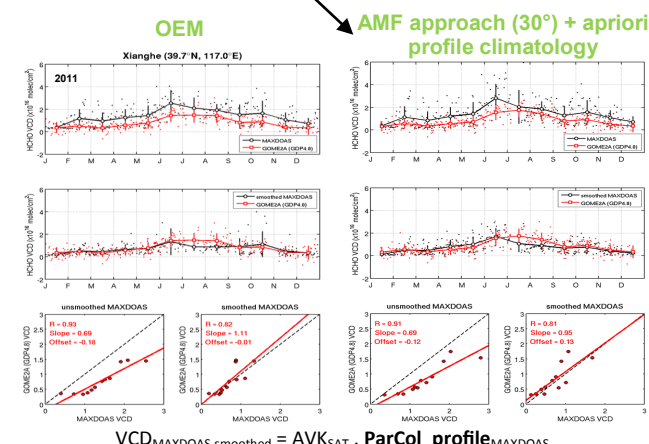
■ Example of application in Xianghe and comparison to GA and OEM (bePRO):

$$VCD_\alpha = \frac{DSCD_\alpha}{DAMF_\alpha} = \frac{SCD_\alpha - SCD_{90^\circ}}{AMF_\alpha - AMF_{90^\circ}}$$

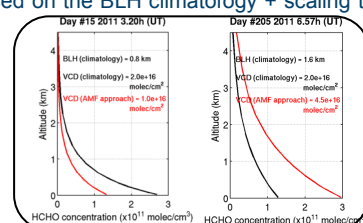


Better agreement with OEM when using the LUT AMF approach instead of GA (lower bias and less marked seasonality of the differences with OEM)

■ Use of the a-priori profile climatology for the comparison with satellite: extraction of the profile based on the BLH climatology + scaling to the retrieved VCD and then convolute the scaled profile to the satellite column AVK



Very promising first comparisons of HCHO validation results with OEM and with LUT approach



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 AVKs) at the 12 QA4ECV MAXDOAS stations.
- First validation results with this LUT approach for HCHO in Xianghe are very promising; good consistency with the results obtained when using the profiles coming from the bePRO OEM.
- Extension of the GOME-2 GDP validation tests with this approach to NO₂ and other stations are ongoing.

Selected References

Roscoe et al.: AMT, 3, 1629-1646, 2010; Pinardi et al.: AMT, 6, 167-185, 2013; Peters et al.: in preparation for AMT; Pinardi et al.: in preparation for AMT