Using CHIMERE to reduce the NO_2 and H_2CO horizontal representativeness errors between GOME-2 and MAX-DOAS data

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Introduction

Ground-based remote-sensing measurements of trace gas columns are essential to the validation of space-based instruments monitoring the earth atmosphere at a global scale. This validation is however difficult since ground-based measurements sample air masses close to the instrument site while satellite observations sample air masses at larger scales. These differences, together with the heterogeneities of the investigated trace gases within a satellite pixel, lead to horizontal representativeness errors. Such errors, which are independent from the instrumental errors, often constitute the main uncertainty source when comparing ground-based and space-based measurements.

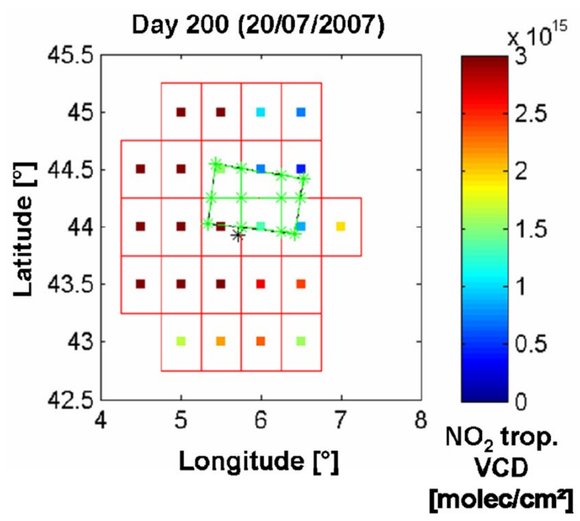
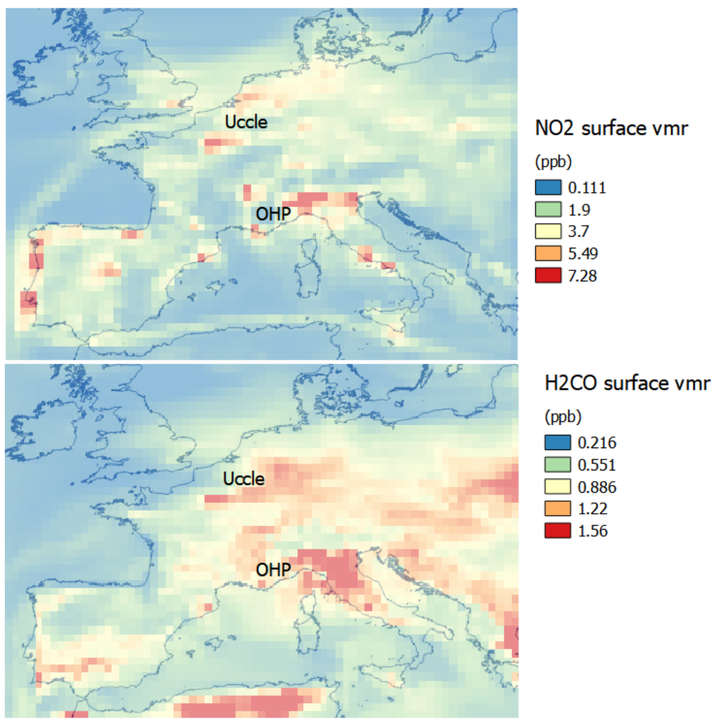


*Figure 1. Example of the spatial distribution of the tropospheric NO_2 obtained by the CHIMERE model (coloured squares) around OHP (the black * in the figure) and the position of the closest GOME-2 pixel (green rectangle) on the Julian day 200 (20/7/2007).*

We use the Chemistry-Transport Model CHIMERE to account for the horizontal representativeness errors between GOME-2 measurements of NO_2 and H_2CO and MAX-DOAS measurements at Uccle (urban site, Belgium) and OHP (rural site, France). For each GOME-2 overpass, we calculate a correction factor corresponding to the ratio between the CHIMERE pixel at the site and the CHIMERE pixels averaged within the satellite pixel.

Chimere runs

CHIMERE RUN FOR 17 August 2014 at 08:00 AM UT



Resolution: 50 km (0.5°)

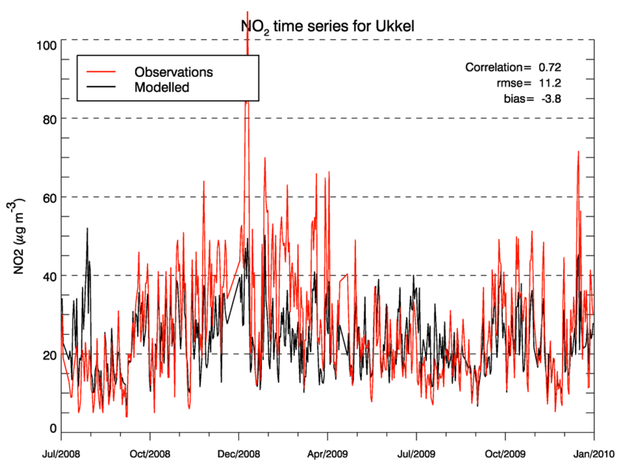
Emissions: EMEP

Meteo: ECMWF (IFS)

Levels : 8 until 500 hPa (5.5 km)

Chemical scheme: Reduced Melchior scheme

Figure 2. Examples of CHIMERE runs for NO_2 and H_2CO



The CHIMERE NO_2 surface concentration was validated against several in-situ stations in Belgium (Dessel, Houtem, Moerkerke, Uccle). Correlations lie between 0.6 and 0.82.

Figure 3. Validation of CHIMERE NO_2 at Uccle with the Air Quality station

Results

We have studied GOME-2 measurements above Uccle and OHP and Uccle in 2012, 2013, and 2014.

For NO_2, the CHIMERE-based correction improves the agreement between the ground-based and satellite measurements for the 6 tested cases. The regression slope between GOME-2 and the GB measurements always gets closer to unity. Note that the correction goes in opposite direction in the two sites. This is consistent with the observations: at Uccle, the urban MAX-DOAS measurements are larger than vertical column amounts seen by GOME-2, whose pixels of 80x40 km^2 encompass rural areas with low NO_2, while the opposite holds true for the rural station of OHP, surrounded by populated areas.

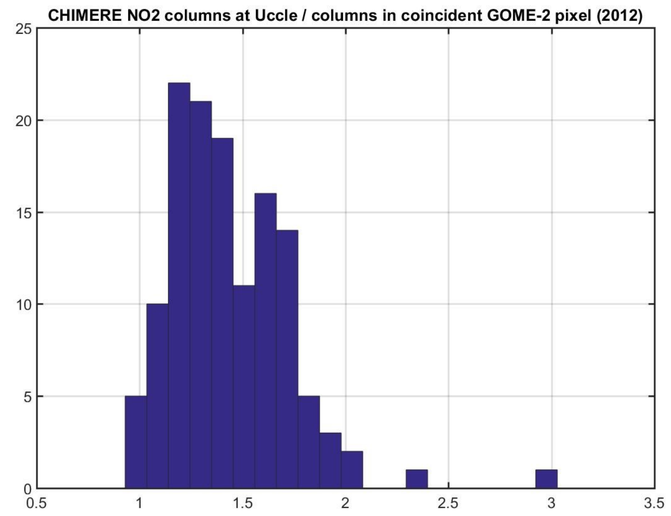


Figure 4. Distribution of the CHIMERE-derived correction factor for NO_2 in Uccle for 2012. The mean value of 1.4 indicates that the urban MAX-DOAS measurements typically overestimate the Satellite measurements, according to CHIMERE.

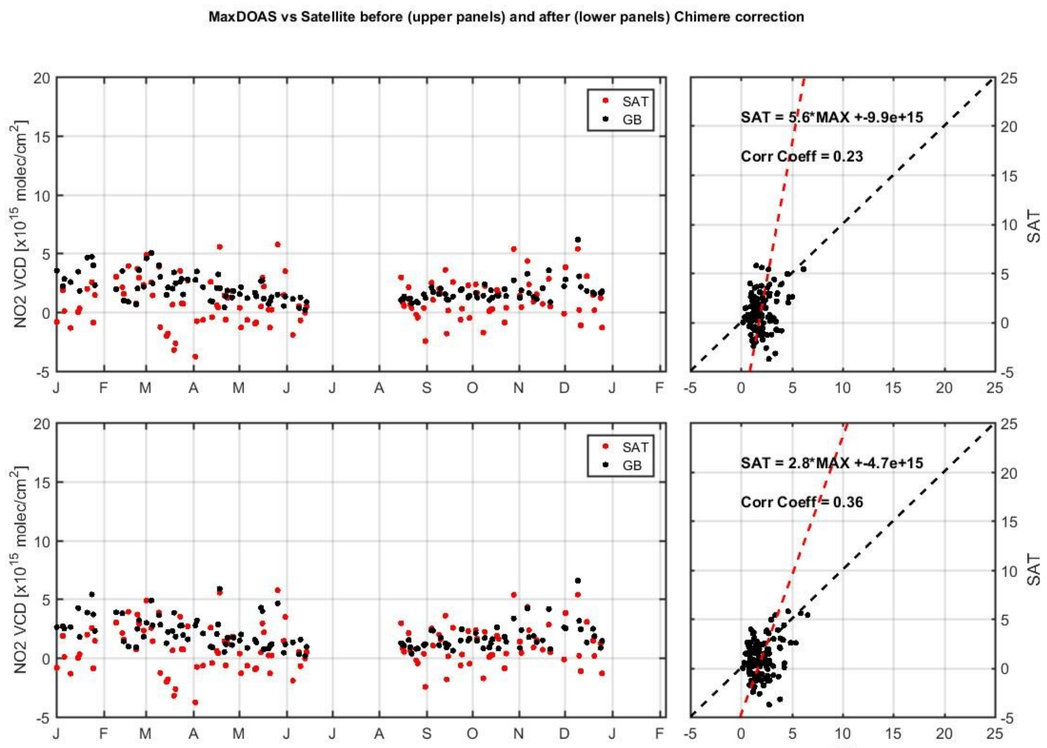


Figure 5. Time series and correlation plots of the ground-based and satellite measurements at OHP in 2014, without (upper panels) and with (lower panels) the CHIMERE correction.

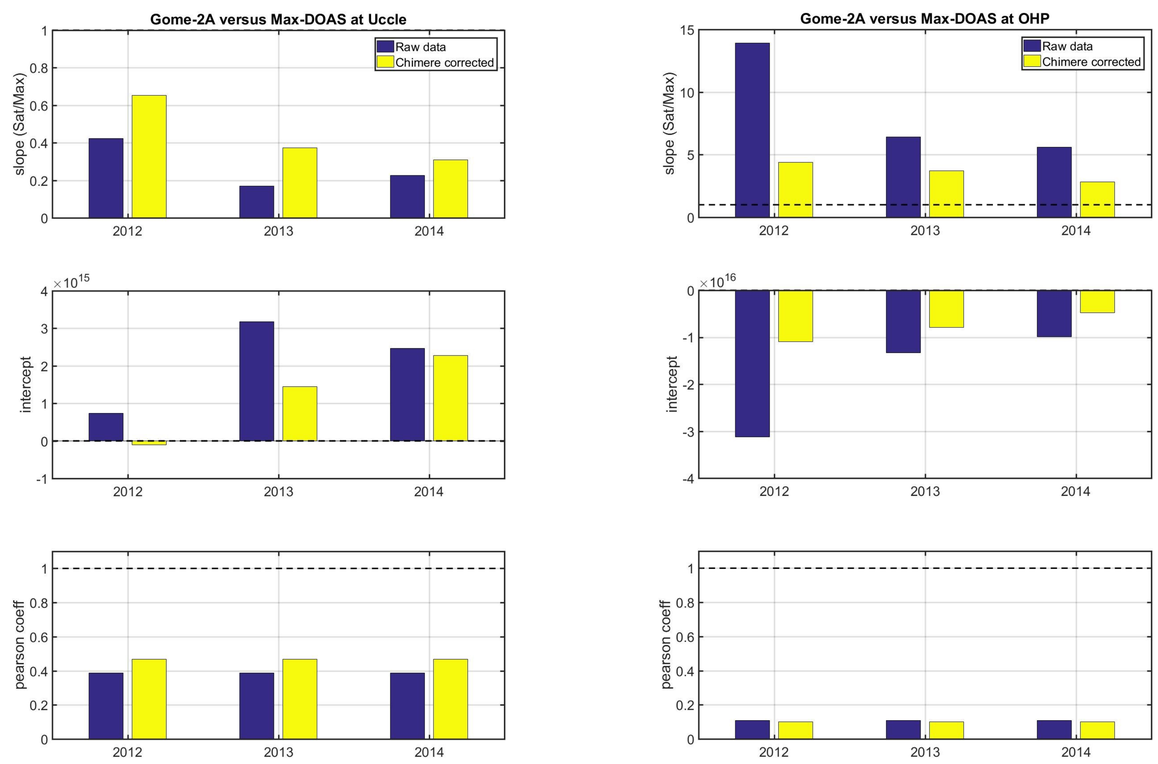


Figure 6. Results of the CHIMERE-based correction for NO_2 in Uccle and OHP for 2012, 2013, 2014.

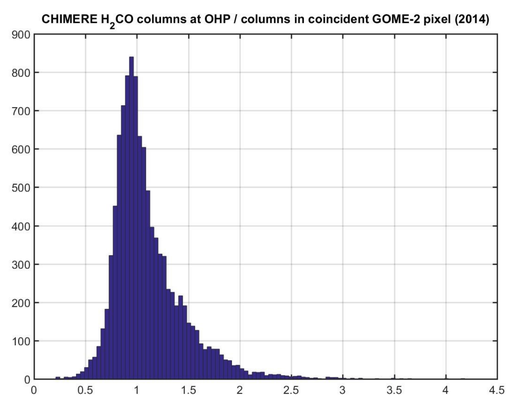


Figure 4. Distribution of the correction factor for H_2CO at OHP for 2012.

For H_2CO, no clear effect appears by introducing a CHIMERE-derived correction factor.

The H_2CO factor is closer to unity than for NO_2, thus the correction is less relevant.

The latter was however not validated, contrary to NO_2.

The same work should be tried with other models, such as IMAGE or TM5.