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Aerosols correction of the OMI tropospheric NO_2 retrievals over cloud-free scenes: Different methodologies based on the O_2-O_2 477 nm band

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Numerous studies have drawn attention to the complexities related to the retrievals of tropospheric NO_2 columns derived from satellite UltraViolet-Visible (UV-Vis) measurements in the presence of aerosols. Correction for aerosol effects will remain a challenge for the next generation of air quality satellite instruments such as TROPOMI on Sentinel-5 Precursor, Sentinel-4 and Sentinel-5. The Ozone Monitoring Instrument (OMI) instrument has provided daily global measurements of tropospheric NO_2 for more than a decade. However, aerosols are not explicitly taken into account in the current operational OMI tropospheric NO_2 retrieval chain (DOMINO v2 [Boersma et al., 2011]). Our study analyses 2 approaches for an operational aerosol correction, based on the use of the O_2-O_2 477 nm band.

The 1st approach is the cloud-model based aerosol correction, also named “implicit aerosol correction”, and already used in the operational chain. The OMI O_2-O_2 cloud retrieval algorithm, based on the Differential Optical Absorption Spectroscopy (DOAS) approach, is applied both to cloudy and to cloud-free scenes with aerosols present. Perturbation of the OMI cloud retrievals over scenes dominated by aerosols has been observed in recent studies led by [Castellanos et al., 2015; Lin et al., 2015; Lin et al., 2014]. We investigated the causes of these perturbations by: (1) confronting the OMI tropospheric NO_2, clouds and MODIS AQUA aerosol products; (2) characterizing the key drivers of the aerosol net effects, compared to a signal from clouds, in the UV-Vis spectra. This study has focused on large industrialised areas like East-China, over cloud-free scenes. One of the key findings is the limitation due to the coarse sampling of the employed cloud Look-Up Table (LUT) to convert the results of the applied DOAS fit into effective cloud fraction and pressure. This leads to an underestimation of tropospheric NO_2 amount in cases of particles located at elevated altitude. A higher sampling of the variation of O_2-O_2 SCD and continuum reflectance as a function of effective cloud parameters in case of low effective cloud fraction values is requested for applying an aerosol correction. The updates of the OMI O_2-O_2 cloud algorithm, based on the scheduled new OMI cloud LUT, will be presented in terms of impacts of the effective cloud retrievals and reduced biases of tropospheric NO_2 columns over cloud-free scenes dominated by aerosols in China.

A 2nd approach is investigated, assuming a more explicit aerosol correction. Previous analyses pointed out that the O_2-O_2 spectra contain information about aerosols: the continuum reflectance is primarily constrained by the Aerosol Optical thickness (AOT) while the O_2-O_2 Slant Column Density (SCD) mostly results from the combination of AOT and aerosols altitude. We have developed a first prototype algorithm allowing to retrieve information about AOT and aerosol altitude from the O_2-O_2 DOAS fit. We will discuss preliminary sensitivities and the potential accuracy of the associated explicit aerosol correction, without the use of effective cloud parameters.