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Aerosol height retrieval from satellite visible measurements: application to OMI 477 nm O_2-O_2 spectral band, based on Neural Networks

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The ability to monitor air quality and climate from UltraViolet-Visible (UV-Vis) satellite spectral measurements relies on accurate trace gas (e.g. NO_2, SO_2, HCHO, O_3) columns combined with aerosol properties and vertical distribution. In the absence of clouds, the most important error source on the observations of trace gases in the troposphere are aerosols, since their scattering and absorbing properties modify the average light path followed by the detected photons. Large impacts due to their vertical distribution uncertainties remain when retrieving vertical column densities of trace gases from UV-Vis air quality space-borne sensors [Krotkov et al., 2008; Boersma et al., 2011; Barkley et al., 2012; Hewson et al., 2015; Castellanos et al., 2015; Chimot et al., 2016a]. Aerosols and trace gases share, over urban and industrialized areas, similar anthropogenic sources, and their concentrations, as shown by the satellite observations, often present significant correlations [Veefkind et al., 2011].

We have recently developed a Multilayer Perceptron Neural Network (NN) algorithm to retrieve Aerosol Layer Height (ALH) from the OMI 477 nm O_2-O_2 absorption band [Chimot et al., 2016b]. This algorithm represents aerosols in the troposphere as a single scattering layer defined by its mean altitude and homogeneous optical properties. This algorithm enables the link between the OMI O_2-O_2 slant column density derived from the 477 nm spectral measurements and the aerosol layer altitude. A prior information about the Aerosol Optical Thickness (AOT) is needed to distinguish the effects due to the amount of fine particles and their altitude. Therefore, the ALH retrieval strongly benefits from a synergy between OMI 477 nm O_2-O_2 spectral measurements and MODIS AOT product.

Aerosol layer heights are currently retrieved with an uncertainty in the range of 260-800 m for scenes with AOT larger than 1. Improvement of these retrievals can be expected by improving assumptions on the aerosol single scattering albedo (impacts up to 600 m on average) and surface albedo (less than 200 m). We will present the results obtained for the first time on 3-year (2005-2007) cloud-free OMI observations over large urban and industrialized areas, in North-East Asia [Chimot et al., 2016b]. Some case studies, depicting the correlation between OMI ALH with collocated CALIPSO aerosol observations over some days of strong pollution in China and wildfires in 2012 in Russia, will also be presented.

Finally, we will discuss how this product may be used for an explicit aerosol correction in the retrieval of trace gases from UV-Vis satellite sensor. The focus will be on tropospheric NO_2 column, over scenes with a high aerosol loading.