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Characterization of the 3D distribution of ozone and coarse aerosols in the Troposphere using IASI thermal infrared satellite observations

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Both tropospheric ozone and aerosols significantly affect air quality in megacities during pollution events. Moreover, living conditions may be seriously aggravated when such agglomerations are affected by wildfires (e.g. Russian fires over Moscow in 2010), which produce smoke and pollutant precursors, or even during dense desert dust outbreaks (e.g. recurrently over Beijing or Cairo). Moreover, since aerosols diffuse and absorb solar radiation, they have a direct impact on the photochemical production of tropospheric ozone. These interactions during extreme events of high aerosol loads are nowadays poorly known, even though they may significantly affect the tropospheric photochemical equilibrium.

In order to address these issues, we have developed a new retrieval technique to jointly characterize the 3D distribution of both tropospheric ozone and coarse aerosols, using spaceborne observations of the infrared spectrometer IASI onboard MetOp-A satellite. Our methodology is based on the inversion of Earth radiance spectra in the atmospheric window from 8 to 12 μm measured by IASI and a «Tikhonov-Philipps»-type regularisation with constraints varying in altitude (as in [Eremenko et al., 2008, GRL; Dufour et al., 2010 ACP]) to simultaneously retrieve ozone profiles, aerosol optical depths at 10 μm and aerosol layer effective heights. Such joint retrieval prevents biases in the ozone profile retrieval during high aerosol load conditions. Aerosol retrievals using thermal infrared radiances mainly account for desert dust and the coarse fraction of biomass burning aerosols. We use radiances from 15 micro-windows within the 8-12 μm atmospheric window, which were carefully chosen (following [Worden et al., 2006 JGR]) for extracting the maximum information on aerosols and ozone and minimizing contamination by other species. We use the radiative transfer code KOPRA, including line-by-line calculations of gas absorption and single scattering for aerosols [Hoepfner et al., 2006 ACP]. As a priori inputs, we consider climatological ozone profiles, ECMWF meteorological fields and aerosol refractive index and size distributions based on desert dust [Hess et al., 1998 AMS] and smoke [Tsay and Stephens 1990] climatologies.

We have used our joint ozone/aerosol retrieval to analyse two major events: i) the Russian fires during the heatwave of summer 2010 in the Moscow area and ii) a desert dust outbreak reaching Beijing in springtime 2008. We propose to present our results on these two study cases, as well as the performance assessment of our technique.