Geophysical Research Abstracts
Vol. 15, EGU2013-714, 2013
EGU General Assembly 2013

Vital improvements to the retrieval of tropospheric NO_2 columns from the Ozone Monitoring Instrument

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Nitrogen oxides (NO_x = NO + NO_2) play an important role in tropospheric chemistry, they catalyze the production of ozone (O_3) and contribute to aerosol formation. NO_x is linked to the oxidizing efficiency of the atmosphere since O_3 plays an important role in the formation of OH. Satellite observations of NO_2 are important for monitoring and studying concentrations of nitrogen oxides, but considerable uncertainties on the accuracy and robustness of the retrievals, and their fitness for model evaluation still persist. These uncertainties pertain to all aspects of the retrieval: (1) spectral fitting, (2) stratospheric background correction, and (3) air mass factor calculation.

Here we present a number of relevant improvements to the tropospheric nitrogen dioxide column retrieval algorithm from OMI (DOMINO v3). We revisit the 405-465 nm spectral fitting window for the OMI NO_2 slant column retrievals, and suggest adaptations to this window to improve agreement with (stratospheric) columns obtained from SCIAMACHY and GOME-2, as validated with independent FTIR NO_2 columns observed from the ground at Jungfraujoch. Furthermore, stronger nudging of the stratospheric O_3:HNO_3 ratios in the TM5 chemistry transport model (used to estimate the stratospheric background NO_2) with those observed by the ODIN instrument, enables us to improve stratospheric NO_2 simulations with substantial benefits for the assimilation and stratospheric NO_2 corrections in the retrieval. A third important innovation is the coupling of the Dutch OMI NO_2 retrieval to the TM5 model with a global resolution of $1^\circ \times 1^\circ$. As suggested previously by Boersma et al. [2007] and demonstrated by Heckel et al. [2011], the better resolved a priori profile shapes lead to a much better understanding of pollution gradients observed from space. In addition to the increased resolution, updated chemistry and emissions (improved soil and ship NO_x emissions) in TM5 make the OMI retrieved tropospheric NO_2 columns significantly more realistic. Tropospheric columns over western Europe decrease, while the wildfire related increased concentrations are better captured. The improvements discussed here are applicable to current OMI retrievals, but are also highly relevant in view of algorithm needs for the future TROPOMI (8×8 km^2) and GMES Sentinel-4 sensors.