Advancing the NO2 Retrieval for the (TROP)OMI Sensors

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Nitrogen dioxide (NO_2) and nitrogen oxide (NO) -- together usually referred to as NO_x -- are important trace gases in the Earth's atmosphere, present in both the troposphere and the stratosphere. In the troposphere NO_2 plays a key role in air quality issues, as it affects human health and ecosystems, it is a precursor of ozone and it contributes to aerosol formation. In the stratosphere NO_2 is involved in some photochemistry reactions of ozone and thus affects the ozone layer. Satellite observations are important to monitor and study NO_2 concentrations in troposphere and stratosphere.

The Tropospheric Monitoring Instrument (TROPOMI), to be launched aboard the GMES Sentinels-5Precursor Mission in 2015, will continue the early afternoon measurement record started in 2004 by OMI aboard EOS-Aura. A data-record of mid-morning NO_2 concentrations is provided by the measurements of GOME (ERS-2; 1995-2003), SCIAMACHY (ENVISAT; 2002-2012), and the currently operational series of GOME-2 instruments aboard MetOp-A (2007-present), MetOp-B (2013-present) and MetOp-C (planned launch in 2017).

For all these satellite instruments KNMI operates the same approach for the retrieval of stratospheric and tropospheric NO_2, in which the separation between these two components is based on information coming from a data assimilation system. This retrieval method will also be implemented for ESA's forthcoming TROPOMI measurements.

The presentation will focus on improvements to the KNMI NO_2 retrieval approach, with important implications for the TROPOMI NO_2 retrieval and for its successors aboard the GMES Sentinel-4 and -5 Missions.

It was recently suggested that OMI NO_2 slant columns are biased high relative to NO_2 slant columns from other UV-Vis sensors such as SCIAMACHY and GOME-2 (as reported by N. Krotkov at the EOS-Aura meeting in Sept. 2012). We show that the OMI fitting results improve significantly (smaller RMS errors and better agreement with SCIAMACHY and GOME-2 observations) when changing the fit window to 410-465 nm. Using this fit window also improves the agreement between OMI and ground-based stratospheric NO_2 measurements. We are investigating the cause (instrumental, fitting function, cross sections) of the remarkable improvements in slant column fitting when limiting the fit window to 410-465 nm (instead of the current 405-465 nm).

In the presentation we also illustrate the impact of the transition from the current chemistry transport model TM4 (which runs at 3 by 2 degrees) to TM5 (1 by 1 degrees) on the ability of the Dutch NO_2 retrieval algorithm to accurately estimate the stratospheric NO_2 amount with a data assimilation approach. Moreover, the transition to TM5 implies better resolved a-priori NO_2 profile shapes, leading to a much better understanding of gradients in pollution as observed from space. The switch to TM5 also means that the NO_2 emission estimates and the NO_x chemistry scheme are updated.

We further address some possible additional improvements, such as the introduction of a correction for errors in the cloud top pressure, and a correction for the cloud fraction due to the wavelength dependence of the surface albedo between the NO_2 fitting window and the O_2-A band (which is going to be used for the cloud retrieval of TROPOMI for use with trace gas retrievals).

TROPOMI has a spatial resolution of 7 by 7 km^2, which is much better than any of the existing or previous satellite instruments, provides daily global coverage, and has a good signal-to-noise ratio. This means that much is expected regarding the monitoring and studying of tropospheric NO_2 concentrations, the sources and sinks of NO_2, and the NO_2 transport in the atmosphere.