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Inhomogeneous scene effects in OMI NO_2 observations

Andreas Richter (1), Andreas Hilboll (1), Abram Sanders (1), Enno Peters (2), and John P. Burrows (1)

(1) University of Bremen, Institute of Environmental Physics (IUP), Bremen, Germany (andreas.richter@iup.physik.uni-bremen.de), (2) Deutsches Zentrum für Luft- und Raumfahrt e.V, Institut für den Schutz maritimer Infrastrukturen , Bremerhaven, Germany

The Ozone Monitoring Instrument (OMI) is an imaging spectrometer performing space-borne nadir observations of the sun light backscattered from the surface and the atmosphere at spatial resolutions of up to 13×24 km^2. From these measurements, total and tropospheric columns of atmospheric absorbers such as nitrogen dioxide can be retrieved using the Differential Optical Absorption Spectroscopy (DOAS) method.

The OMI instrument is an imaging spectrometer with a two-dimensional detector on which wavelength is on one axis and the across-track position on the other. Therefore, no moving mirror is needed to scan the Earth's surface (push-broom configuration). As result of this optical set-up, any inhomogeneity in the intensity observed along-track during one measurement of typically 1 second will result in inhomogeneous illumination of the instrument slit and therefore a distortion of the spectrum. As a first order correction, the wavelength axis of the measurements is corrected for scene inhomogeneity in the calibrated OMI spectra using measurements taken at higher temporal resolution.

In this presentation we show that inhomogeneous scenes lead to much increased fitting residuals in OMI NO_2 retrievals. For most of the orbit, this is the largest contribution to the residuals, and only at large SZA, photon shot noise is more important. In addition to the increased residuals, NO_2 columns are also affected in inhomogeneous scenes, leading to systematic artefacts at ice edges, cloud rims or over snow covered mountains. Using a systematic analysis of the fitting residuals, a semi-empirical correction is developed and applied in OMI NO_2 fits. The result is a large reduction in fitting residual, the removal of the systematic artefacts, and an overall reduction in the scatter of NO_2 columns.

While so far a correction was applied only to NO_2 retrievals, other trace gas fits are probably also affected. The results are also relevant for other imaging spectrometers such as the recently launched TROPOMI on S5P and the upcoming S5 and S4 instruments.