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Combining Optimal Estimation and a DOAS–like approach for efficient and accurate retrievals of columns of weakly absorbing gases

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Retrieval of column abundances of absorbing trace gases like NO_2, O_3, HCHO, and SO_2 from remotely sensed spectra is often based on Differential Optical Absorption Spectroscopy (DOAS) which is based on the Lambert-Beer attenuation law. Corrections for scattering are made by using an air mass factor (AMF). The AMF is the amount of absorbing molecules encountered along the mean path of photons when they reach the detector relative to the vertical column. Look-up tables for the AMF can be calculated using radiative transfer models for different surface albedo values, solar zenith angles, viewing directions and variable amounts of clouds and aerosol in the atmosphere. However, selecting the correct entries for the look-up table required information on the scene observed e.g. the altitude of clouds, fraction cloud cover, and the current surface albedo. Some information on the scene can be obtained from the radiances observed, but this information is ignored in the standard DOAS approach because only differential structures are analyzed. Hence, not all information that is available in the measured spectrum is used in the standard DOAS approach.

A fully developed retrieval approach that includes proper estimates of the errors in the retrieved parameters is Optimal Estimation. Application of Optimal Estimation to measured spectra of trace gases requires modeling of the differential absorption by the trace gases which, in turn, requires radiative transfer calculations at many wavelengths. For operational retrieval algorithms this is not a feasible approach.

We have recently developed a method that combines the power of Optimal Estimation with an efficient DOAS-like approach. This makes it possible to retrieve trace gas columns and scene information using calculations at just a few well chosen wavelengths. The method is called DISMAS (DIfferential and SMooth Absorption Separated). It is planned to use DISMAS for operational retrieval algorithms using spectra measured by the TOPOMI instrument on board of the Sentinel 5 precursor platform, scheduled to be launched in 2015.

The DISMAS method will be presented and results of some sensitivity studies will be shown.