Algorithm Description

SCIAMACHY OClO Slant Columns

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Forward Model:

The OClO Slant Column product is not based on radiative transfer calculations, and thus makes no use of an atmospheric forward model.
The data analysis which is based on the DOAS technique (see next section) uses Lambert Beer's law of absorption and thus implies the "forward model" of an optically thin atmosphere.

Inversion Procedure:

The inversion procedure is based on the well known Differential Optical Absorption Spectroscopy (DOAS) method (e.g. Platt, 1994).

The basic concept of the DOAS retrieval on satellite measurements is application of Lambert Beer's law to the earthshine measurements using an absorption free direct solar irradiance measurement as background spectrum. To separate the effects of broad band extinction by Rayleigh and Mie scattering from the structured absorption by the trace species of interest, a polynomial of low order is fitted to the optical density simultaneously with the absorption cross-sections of all relevant absorbers. The resulting fit coefficient is the slant column density, i.e. the integrated amount of molecules per unit area averaged over all contributing light paths through the atmosphere.

Details on the implementation of the DOAS algorithm can be found in Richter, 1997; a description of the application to GOME data is given in Richter et al., 2005.

The following settings have been used in the DOAS analysis:

Parameter	Value
wavelength window	365 - 389 nm
absorption cross-sections	NO_2 (Bogumil et al., 2003, 223 K) O4 (Hermans et al., 1999) OClO (Krominga et al., 2003) Ring (Vountas et al., 1998) Undersampling
empirical functions used	Eta nadir Key data Zeta nadir Key data Ratio of cloudy and cloud free measurement
degree of polynomial	5 coefficients
offset and slope correction	offset and slope
background spectrum	daily ASM solar measurement
normalisation	none
data source	uncalibrated lv0 and lv1 data

Table 1: DOAS settings used for the OClO retrieval from SCIAMACHY measurements

Auxiliary Data:

No auxiliary data is used with the exception of the absorption cross-sections listed above.

Sensitivity and Error Analysis and Algorithm Validation:

No dedicated algorithm validation has been performed. However, the same algorithm has been used for GOME OClO column analysis (Richter et al. 2005). Comparison of the GOME and SCIAMACHY data products shows good agreement. Some differences remain which are to the difference in time of measurements which implies a difference in solar zenith angle and thus OClO photochemistry.

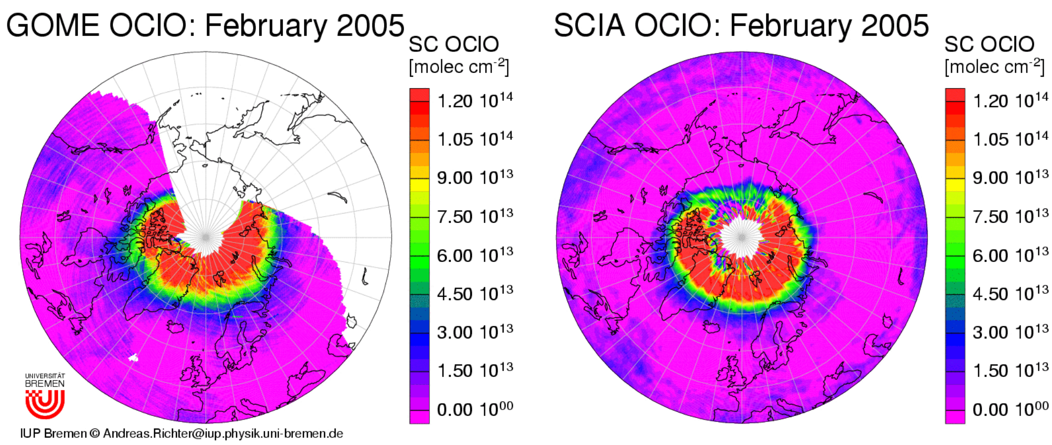

Fig. 1: Comparison of GOME (left) and SCIAMACHY OClO slant columns for February 2005. As result of the permanent failure of the tape recorder on ERS-2, only partial coverage is available from GOME. Similarly, SCIAMACHY measurements have less coverage owing to the alternating limb nadir measurements. Note that the solar zenith angle at overpass is different for the two instruments, resulting in different OClO photochemistry.

An initial validation study of SCIAMACHY OClO columns has been performed using zenith-sky measurements in Ny-Alesund, Summit, and Bremen in spring 2005. First results indicate very good agreement, but further work needed before any firm conclusions can be drawn (Oetjen et al., manuscript in preparation, 2006)

Compared to GOME measurements, the SCIAMACHY OClO columns have larger scatter, mainly as result of the reduced ground pixel size. They therefore should only be interpreted after averaging.

The OClO retrieval has several problems which impact on the data quality:

- an yet unexplained interference can lead to artificially large OClO columns over bright surfaces and clouds. To compensate this, an empirical function (the ratio of two measurements, one over a bright cloud and one from a close clear pixel) is included in the analysis
- there is indication for offsets in the OClO data but so far, no attempt has been made to correct for them

No cloud clearing has been applied to the OClO product, but this should have no impact on the accuracy as OClO is expected to be located in the stratosphere.

Recommendations for Product Validation:

Validation of OClO slant columns should concentrate on situations with high signal as is observed when the chlorine in the polar vortex is activated. As result of the rapid OClO photochemistry, validation has either to be done at the exact time of satellite overpass using a ground-based zenith-sky observing spectrometer or photochemical corrections have to be applied to transfer between the situation of e.g. a balloon borne observation at twilight and the satellite overpass.

References:

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