NO_2 product specification document (version 1)

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Introduction

This document contains a description of the nitrogen dioxide (NO_2) profile product from SCIAMACHY limb scattering. It also cites many references which contain addition detail.

Product description

Each product file contains an NO_2 profile retrieved from a single limb scan. The observations are azimuthally averaged. The retrieved profile is given in number density (molec/cm^3). NO_2 is retrieved from 11 to 41 km, typically. There are 16 retrieval levels, and vertical spacing between adjacent retrieval levels is 2 km. The actual vertical resolution is ~3 km. The number density reported at (*e. g.*) 15 km is effectively the number density in the 1 km thick layer between 15 and 16 km. The retrieval algorithm linear interpolates the number density between 15 and 17 km to obtain the number density at 16 km (*i.e.* in the 16-17 km interval) priori to each forward model iterations.

Currently, the only data accompanying the retrieved NO_2 profile is the cloud top height, if any.

For more information on the algorithm, see the NO_2 profile from limb-scattering algorithm document.

Product format specification

The data is currently stored in Microsoft Excel spreadsheet format (*.xls). Column C of each spreadsheet (rows 12-26) contain a list of 'header-type' information, input parameters and geographical information, including the tangent point azimuth difference and solar zenith angles, the reference tangent height (TH, in km), the latitude of the retrieved profile,

and the latitude and month of the pressure ,temperature and O_3 climatology. All input parameters are labeled in adjacent cells (column B).
The latitude of the retrieval is given by the average latitude of the tangent points for the elevation step at ~20 km (thus the latitude is azimuthally-averaged) and is located in cell C17. The product also contains the latitude selected from the latitude and month-dependent database of model atmospheres.
The retrieval altitude vector and the NO_2 number density profile are found in columns T and U (rows 15-30), respectively.

The averaging kernel matrix is given in the block from AD3-AL17. Each column contains the averaging kernel for the altitude given in row20 (spanning columns AD-AL). Remember this is a theoretical quantity and the instantaneously viewed TH range (2.6 km) and TH sampling may, in practice, worsen the vertical resolution over this idealized calculation.

Software release history

This is the initial software release, namely version 1.

Implementation details

The following calibrations are applied to the L1b data using SciaL1C (EnviView 2.2.7):

memory effect
spectral
pixel-to-pixel gain
stray light
etalon signature
dark current

Selection criteria:
-the averaged SZA at TH=30 km is <90°
AND
-observed SCD uncertainty is <50% for at least one tangent height in the retrieval range

Analysis of observed spectra:
Fraunhofer reference: co-addition of limb spectra from same scan at tangent heights in ~46-70 km range.
Fitting window of observations: ~434.7-494.9 nm

Absorption cross sections:
NO_2 - Bogumil *et al.* (2003) at 203, 223, 243 K
O_3: - Bogumil *et al.* (2003) at 203, 223, 243 K
O_2 dimer - Greenblatt *et al.* (1990) for TH < 27 km

Closure polynomial: 3rd order

Pseudo-absorbers:
1) 'tilt' [Sioris *et al.,* 2004]

2) de-trended ratio of the spectral radiance at the lowest reference tangent height to the co-addition of all of the other normalizing radiances
3) $1/I_0$

Retrieval range: set to cloud top height, if cloud top > 11 km

Analysis of simulated spectra:

Fitting window of simulations: 435.0-493.76 nm
Wavelength step size, simulations: 0.52 nm

Reference TH, simulations: 55 km

Absorption cross-sections:
NO_2 - Burrows *et al.,* 1998
O_3 - Burrows *et al.*, 1999
O_4 - Greenblatt *et al.*, 1990 (for TH ≤ 26 km)

Closure polynomial: 3rd order

Convergence criteria: to within 3% of observed SCDs (see Sioris *et al.* [2004] for more details)

List of known issues

The pointing correction applied in the current version of the data product is based on an outdated climatology of O_3 number density versus altitude. This can affect the pointing by ~1 km. The next version of the algorithm will update the O_3 climatology used to determine the pointing offset.
The L2 data does not include the filename of the L1b product used to generate it, the time, geographical extent, assumed surface albedo, and pointing correction. All of this will be corrected in the next version of the data product.

Data quality assessment

A coincidence with HALOE [Sioris *et al.*, 2004] showed typical agreement of 8% between 17 and 41 km, after diurnal scaling with a photochemical model to match local times. The reader is referred to Butz *et al.* [2006] for further validation results versus the DOAS balloon-borne instrument. This study shows that profiles retrieved with this algorithm may have residual pointing errors.

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