First NO_2 Results from SCIAMACHY UV/vis Nadir Measurements

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Introduction

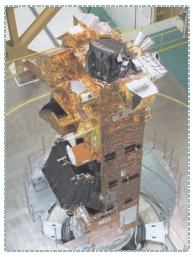
In the last years, more and more measurements of atmospheric species from space have become available. One of the arguably most successful instruments for atmospheric chemistry research from space is the Global Ozone Monitoring Experiment (GOME) launched on ERS-2 in April 1995 and still providing global data until June 2002.

In March 2002, the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) was launched on board of ENVISAT. This instrument is in many respects an extended version of GOME, providing better spatial resolution, a wavelength range that extends into the NIR and most importantly the ability to measure alternatingly vertical profiles and nadir columns.

As the SCIAMACHY time series is intended as a continuation of the GOME data set, good consistency between the two instruments and a detailed understanding of the differences are essential.

In this poster, results from the first year of NO2 retrievals on SCIAMACHY UV/vis nadir measurements are presented and compared to collocated GOME measurements and independent measurements from the ground.

SCIAMACHY Instrument

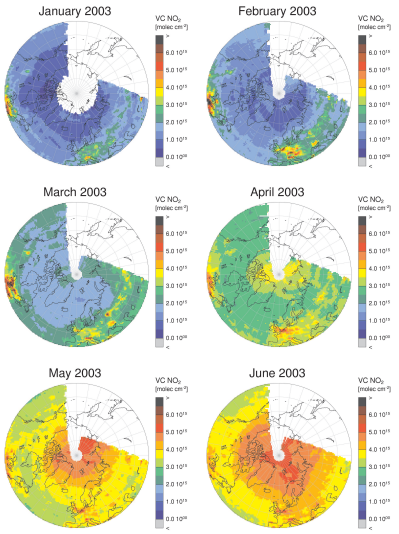


The SCIAMACHY instrument is a 8 channel grating spectrometer measuring in nadir, limb, and occultation (both solar and lunar) geometries. SCIAMACHY covers the spectral region from 220 to 2400 nm with a spectral resolution of 0.25 nm in the UV, 0.4 nm in the visible and less in the NIR. The size of the nadir ground-pixels depends on wavelength range and solar elevation and can be as small as 60 x 30 km2. The instrument was launched on ENVISAT in a sun-synchronuous orbit on March 1st, 2002 and is in nominal operation since August 2002.

Using the *Differential Optical Absorption Spectroscopy* (DOAS) technique, a number of atmospheric trace gases can be retrieved from the spectra, including O_3, NO_2, BrO, OClO, SO_2, HCHO, and H_2O. In the absence of clouds, a large part of the photons observed by SCIAMACHY in the nadir have penetrated down to the troposphere, and global maps of tropospheric concentration fields can be derived from the measurements.

Compared to GOME, the SCIAMACHY instrument has several advantages for nadir measurements, in particular the better spatial resolution and the ability to provide a nearly collocated stratospheric profile for each nadir measurement, which in principle will enable accurate tropospheric columns to be derived without external information.

Total NO2

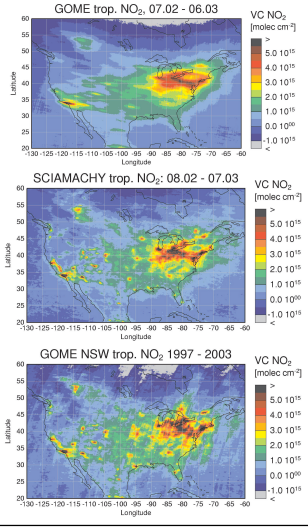


Currently, only a very limited number of operational products are available for SCIMACHY. However, from the uncalibrated radiances, NO2 columns can be retrieved using the DOAS algorithm developed at the IUP Bremen for the GOME data retrieval. The only changes necessary are the exchange of cross-sections and solar background spectra.

Although SCIAMACHY has now been taking measurements for over one year, only a fraction of all raw data is available for the users. This is evident from the data gaps in the figures to the left that show monthly averages of SCIAMACHY NO2 in the Northern Hemisphere, but much more data is missing for individual days.

However, even this preliminary data set nicely shows both the seasonal variation of stratospheric NO2 and the enhanced values over regions with tropospheric pollution.

Tropospheric NO2



To the left, tropospheric NO2 derived from SCIAMACHY measurements from August 2002 to July 2003 is compared to tropospheric NO2 from GOME in the same time period. In the upper panel, all GOME measurements (320 x 40 km2) from July 2002 to June 2003 have been used, in the lower panel only "narrow swath" pixels (80 x 40 km2) from GOME are taken into account (see also poster by Beirle et al.). As the data basis is small for the narrow swath scans, all data from 1997 to 2003 has been used. Please note that no cloud correction has been applied and a simple tropospheric airmass factor was used for all plots.

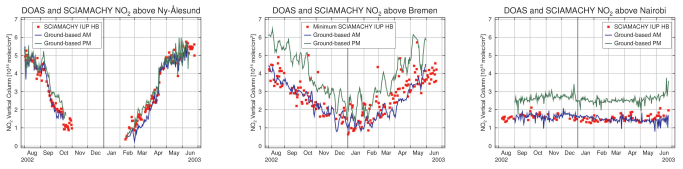
The main results are

- good qualitative agreement between GOME and SCIAMACHY tropospheric NO2 products
- much more detailed NO2 fields with higher local maximum values from SCIAMACHY as a result of the better spatial resolution (60 x 30 km2)
- SCIAMACHY and narrow swath GOME measurements provide a consistent image. Differences are probably explained by the differences in time and sampling

Validation

To validate the SCIAMACHY NO2 columns, they are compared to ground-based DOAS measurements from the BREDOM network (see posters of Medeke et al. and Fietkau et al.).

The comparisons show excellent agreement at 79°N, 53°N, and 1°S. SCIAMACHY values are closer to the AM measurements indicating a possible low bias of yet unknown origin.



Conclusions

UV/vis nadir measurements of the SCIAMACHY instrument on board of ENVISAT have been analysed for NO2 columns using the IUP Bremen DOAS algorithm. The results have been compared to co-located GOME measurements and ground/based DOAS measurements, and good agreement was found.

The tropospheric NO2 columns from SCIAMACHY agree qualitatively with those retrieved from GOME, but have a much better spatial resolution. They are consistent with NO2 columns retrieved from the GOME narrow swath data, although the latter are based on much less individual measurements.

The only disadvantage of SCIAMACHY data is the decreased spatial coverage resulting from the alternating limb and nadir measurements. This affects both the sampling statistics and the opportunities for validation of the tropospheric data products.

The SCIAMACHY NO2 data set produced in this study is well suited to continue the existing GOME data set for both stratospheric and stratospheric columns. As operational products of sufficient quality are not yet available, the IUP Bremen data product is available form the authors on request (richter@iup.physik.uni-bremen.de).

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Selected References

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see also: www.iup.physik.uni-bremen.de
www.doas-bremen.de

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