Linking Tropospheric NO_2 Measurements from SCIAMACHY to the GOME Time Series

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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 data today. Although primarily designed to deliver total ozone columns, measurements from the GOME instrument have been used to determine columns of NO2, BrO, OClO, SO2, HCHO, H2O and also vertical profiles of O3.

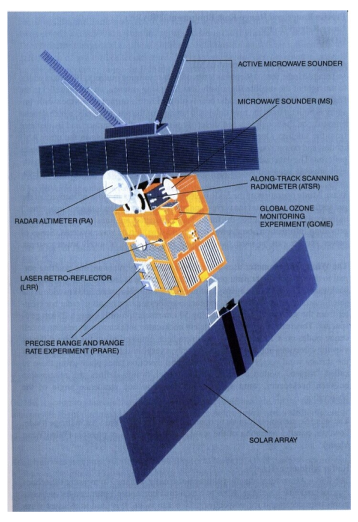
In March 2002, the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) was launched on board of ENVISAT. This instrument is in many respects an extended version of GOME, providing better spatial resolution, a wavelength range that extends into the NIR and most importantly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

In this poster, tropospheric NO2 columns derived from GOME and SCIAMACHY nadir measurements are compared and the impact of clouds and pixel size is studied.

GOME and SCIAMACHY Instruments

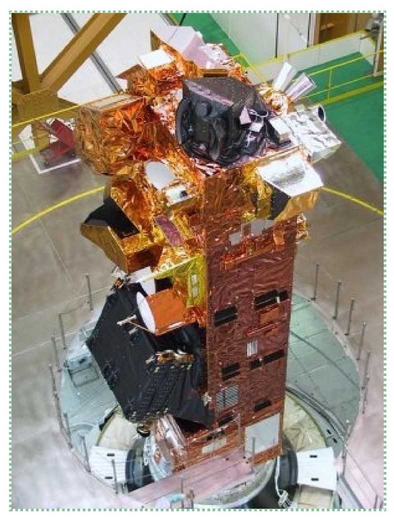
GOME (Global Ozone Monitoring Experiment):

- 4 channel UV/visible grating spectrometer
- nadir viewing
- ground pixel 40 x 320 km2
- global coverage in 3 days
- data from July 1995 - June 2003
- operating on ERS-2
- sun-synchronous orbit, 10:30 LT equator crossing

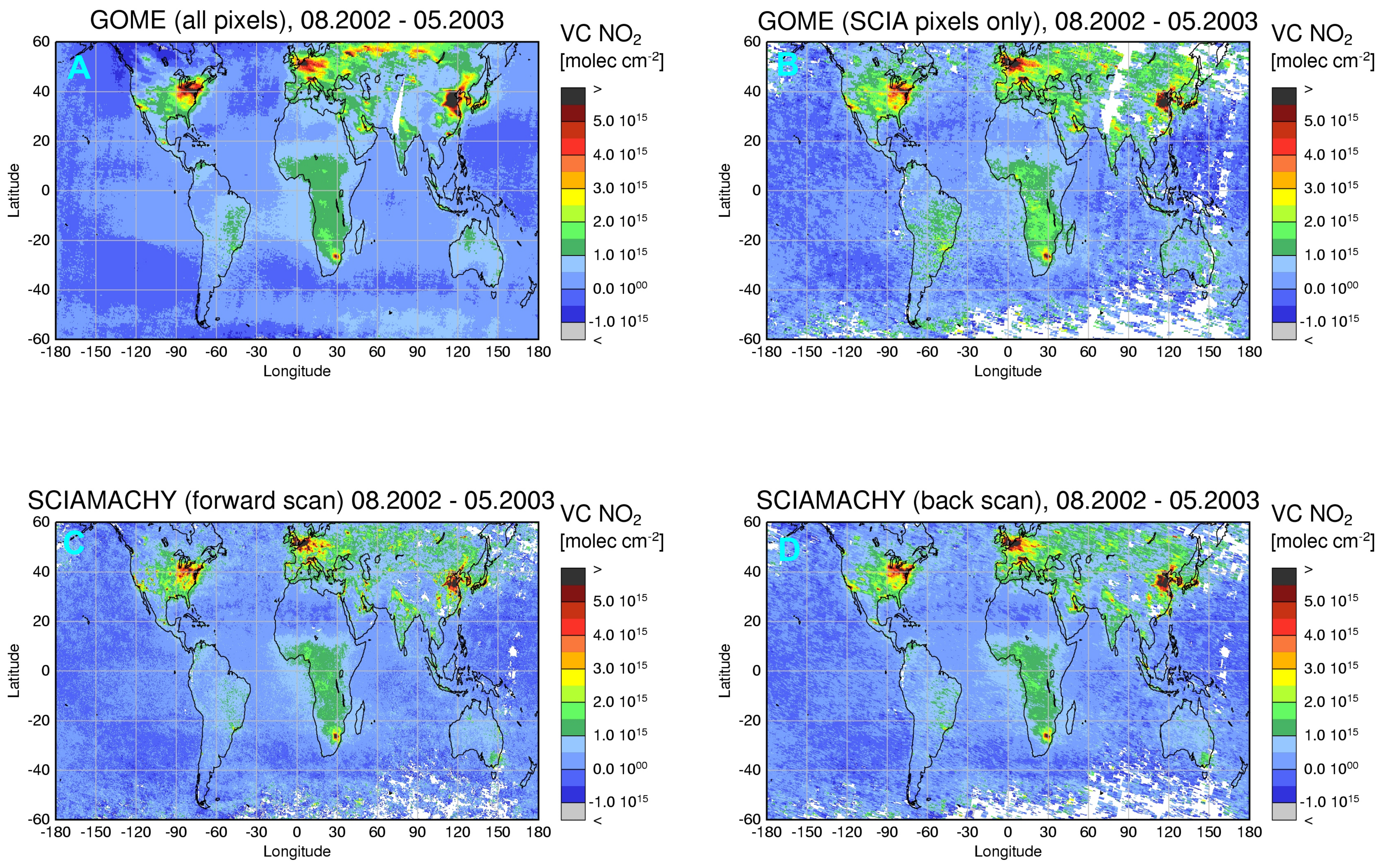


SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric Chartography:

- 8 channel UV/visible/NIR grating spectrometer
- nadir viewing, limb, solar & lunar occultation
- ground pixel 30 x 30 .. 30 x 240 km2
- global coverage in 6 days
- data since August 2002
- operating on ENVISAT
- sun-synchronous orbit, 10:00 LT equator crossing



Comparison GOME vs. SCIAMACHY

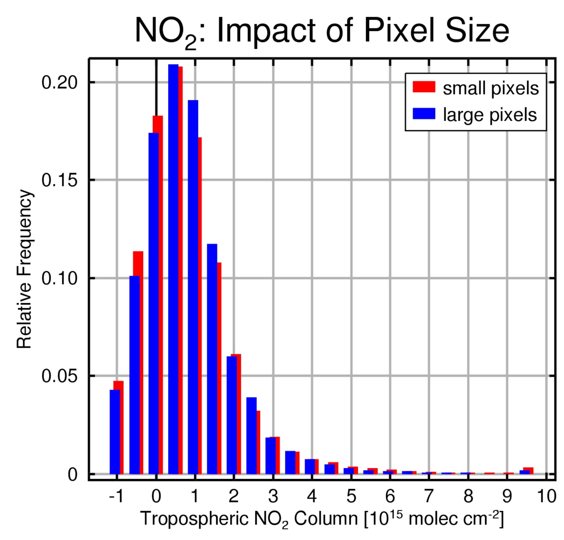


In the figures, GOME and SCIAMACHY tropospheric NO2 columns are shown for the time period of overlapping measurements. A simple retrieval has been used which is based on the reference sector or tropospheric excess method where the stratospheric NO2 is corrected by subtracting measurements over the clean Pacific region. A simple airmass factor for a 1.5 km NO2 layer close to the surface, an albedo of 5% and a maritime aerosol has been used for all measurements. Therefore, the numbers given in the plots are not accurate but consistent between the two instruments. A simple cloud filter has been used on both measurements based on an intensity criterion.

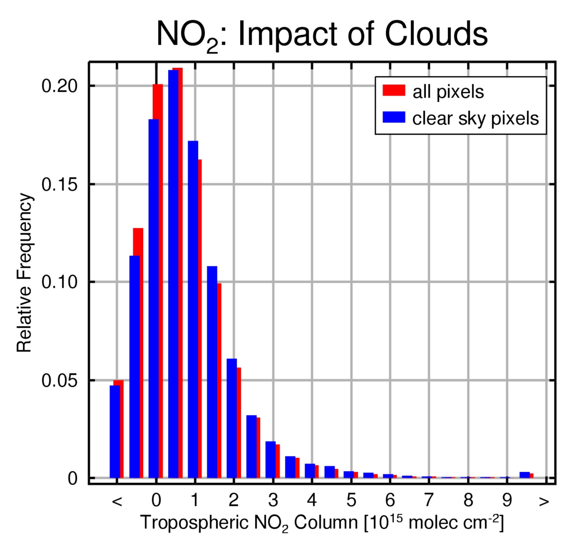
- the overall agreement is very good between data from the two instruments *A and C(
- the agreement improves further if only GOME data are used for which SCIAMACHY data exist within a certain radius (B)
- the agreement further improves if only the back scan with the lower spatial resolution (30 x 240 km2) is used (D)

Some differences remain which are mainly related to the difference in overpass time (in particular at higher latitudes in winter when solar zenith angles change fast) and also structures introduced into the GOME data by the diffuser used for solar measurements, a problem that does not affect SCIAMACHY data.

Resolution and Cloud Effects



To investigate the impact of pixel size, SCIAMACHY data from August 2003 taken over the US have been selected for pixel size using either the forward scan only (30 x 60 km^2) or the backward scan (30 x 240 km^2). The frequency distribution of the measured tropospheric columns is shown in the figure to the left. As expected, the smaller pixels see more cases of very large NO_2, probably over localised sources. The effect is large in relative numbers but surprisingly small in absolute numbers



A similar selection has been performed to study the impact of clouds, again using the data from August 2003 over the US. The cloud selection was done using a simple intensity criterion, and no differentiation of cloud top height is included. As shown in the figure, the differences are relatively small but the frequency of very large values is higher for clear scenes. Also, the frequency of negative values is reduced for clear sky pixels, a finding that points at an effect of clouds on the data retrieval. One possible explanation is a change in tropopause height that is associated to pressure systems and might influence the stratospheric correction applied. another possibility is a subtle change in stratospheric AMF over clouds that would have a similar effect.

Conclusions

- Tropospheric NO2 columns derived from SCIAMACHY agree very well with GOME data but show unprecedented detail in the spatial distribution
- The better spatial resolution of the measurements has in general the impact to increase the frequency of very large values, but the effect is surprisingly small judging from the analysis of one month of data taken over the US.
- The impact of clouds on the measurements is twofold: for clear pixels, higher values are observed, but also the frequency of negative values is reduced, probably due to an impact of clouds on the stratospheric correction applied to the data. Again, the changes are smaller than expected. There is also clear evidence for NO_2 above clouds over some parts of Europe.
- The results presented here for SCIAMACHY are in good general agreement with those from a recent study of GOME narrow swath data (Beirle et al., 2004)

Acknowledgements

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