

Changes of tropospheric NO₂ as observed by GOME and SCIAMACHY

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Introduction

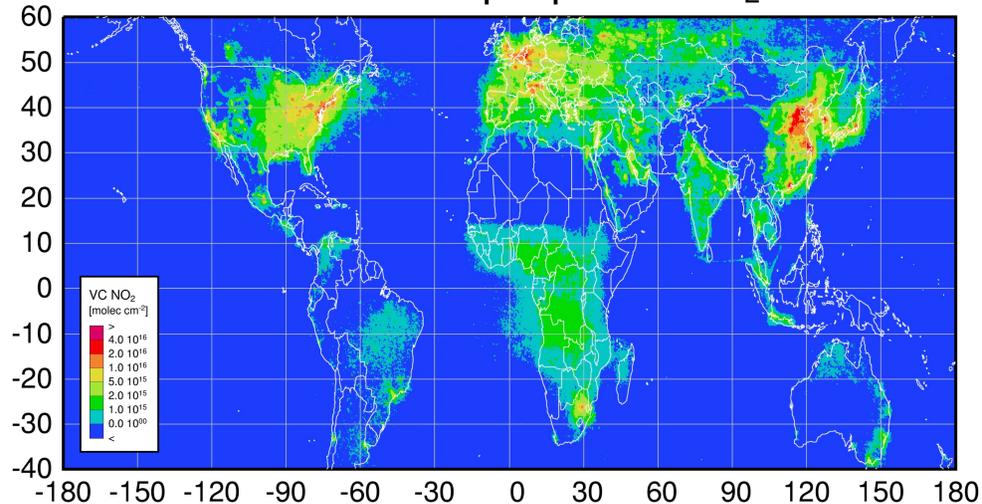
In the troposphere, NO₂ is one of the key species for ozone formation, acidification and also radiative forcing. Sources of NO₂ are both natural (soil emissions, lightning, wild fires) and anthropogenic (fossil fuel combustion, biomass burning).

Anthropogenic emissions are expected to change as a result of increasing use of fossil fuels, in particular in the rapidly developing parts of the world, changes in land use and also progress in emission control. This has important consequences for tropospheric ozone concentrations and tropospheric chemistry in general.

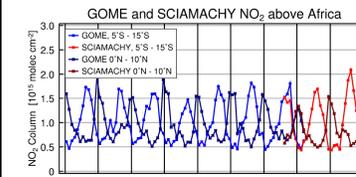
Global measurements of tropospheric NO₂ are only possible from space, and two satellite instruments, GOME and SCIAMACHY provide such measurements. The combined time series now covers more than 9 years, and is expected to be continued by data from SCIAMACHY and other instruments such as OMI and GOME-2.

In this poster, the GOME-SCIAMACHY time series is analyzed for its consistency and possible changes over the last years.

SCIAMACHY Tropospheric NO₂ 2004

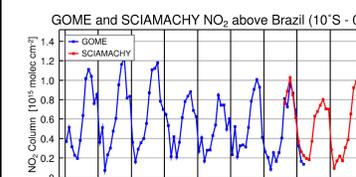


Biomass Burning

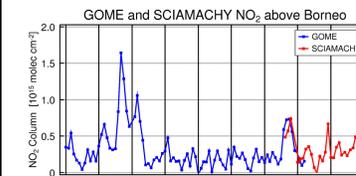


In areas of biomass burning at low latitudes, the NO₂ columns are dominated by changes in emissions, and not by changes in NO₂ lifetime.

As an example, the figures show NO₂ columns over different parts of Africa, where biomass burning seasons move in latitude with season. While between 0° and 10°N the maximum is in Dec/Jan/Feb, the highest values over Kongo are reached in Aug/Sep.



A similar pattern is apparent over Brazil, with the largest columns in Jul/Aug/Sep. In contrast to Africa, there seems to be less NO₂ now than in 1996 - 1998, which could be related to changes in forest fires.



On Borneo, biomass burning mainly occurs during el Niño years, and in between there is very little NO₂. A similar pattern can be observed in Northern Australia (not shown).

Again, GOME and SCIAMACHY measurements agree well in the overlapping time periods.

GOME and SCIAMACHY



The Global Ozone Monitoring Experiment (GOME) and the SCanning Imaging Absorption spectroMETER for Atmospheric CHartography (SCIAMACHY) are two space borne nadir viewing grating spectrometers covering the spectral region from the UV to the NIR at moderate spectral resolution.

GOME was launched on ERS-2 in April 1995, providing global coverage until June 2003 and limited coverage thereafter. The spatial resolution of GOME is 320 x 40 km² with global coverage after 3 days.

SCIAMACHY was launched on ENVISAT in March 2002. It offers spatial resolution of 30 x 30 km² to 240 x 30 km² depending on illumination and wavelength with global coverage in 6 days. It also performs limb and occultation measurements and has dedicated channels in the IR.

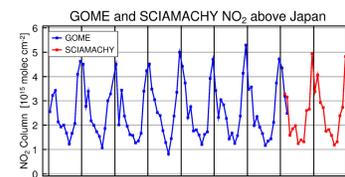
Using the *Differential Optical Absorption Spectroscopy* (DOAS) technique, a number of atmospheric trace gases can be retrieved from the spectra of the two instruments, including O₃, NO₂, BrO, OClO, SO₂, HCHO, and H₂O. In the absence of clouds, a large part of the photons observed in the nadir have penetrated down to the troposphere, and global maps of tropospheric concentration fields can be derived from the data.

Nadir UV/vis measurements from GOME and SCIAMACHY are very similar with the exception of the improved spatial resolution and the reduced coverage of SCIAMACHY.

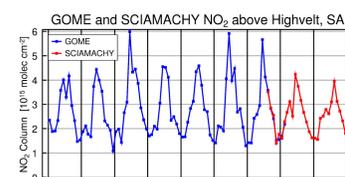
Acknowledgements

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Polluted Regions

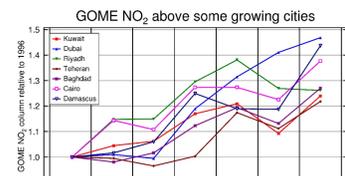


Over polluted regions in mid-latitudes, the seasonal cycle of the tropospheric NO₂ is dominated by changes in lifetime, and not of emissions. In winter, OH concentrations are lower and therefore the NO₂ lifetime longer which leads to larger winter than summer columns (see examples for Japan and the South African Highvelt region).



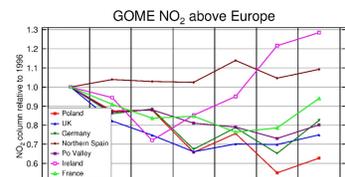
GOME and SCIAMACHY time series match well in the time of overlapping measurements in spite of the reduced coverage of SCIAMACHY.

Depending on region, the interannual variability can be large, depending on meteorology and sampling (mainly due to data gaps from clouds)



Over the 7 years of GOME measurements, tropospheric NO₂ columns changed systematically over some areas. As examples, the figures show changes relative to the 1996 values for some major cities in North Africa and the Middle East and regions in Europe. The main observations are

- increasing values over growing cities
- decreasing values over parts of Europe



The accuracy of the annual changes is of the order of 15%, and some of the data are not significant. Also, the spatial resolution of GOME is poor and the regions selected are not all independent. For individual years, meteorology can also be relevant. Interpretation of the data therefore requires caution.

Conclusions

- GOME and SCIAMACHY provide a time series of global tropospheric NO₂ measurements that now covers more than 9 years
- GOME and SCIAMACHY measurements are consistent in the time period of overlapping measurements (August 2002 - June 2003)
- the seasonal and interannual changes of NO₂ over polluted regions can be studied and analysed for changes related to NO_x emissions
- there is indication for reducing NO₂ columns over parts of Europe and increasing NO₂ over large cities in North Africa and the Middle East
- the signature of biomass burning can be identified, and the seasonality follows the burning seasons
- year to year variability of biomass burning NO₂ over Africa is small, but larger over South America and in particular over Borneo

Selected References

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see also: <http://www.doas-bremen.de>