Long-Range Transport of tropospheric NO\textsubscript{2} as seen by GOME and SCIAMACHY

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Introduction
Recent studies show that air pollution from anthropogenic emissions is not only a problem locally but can travel far distances and even reach other continents. To understand the influence of this long range transport on air quality along its path it is crucial to investigate frequencies and patterns of transport events. Satellite instruments provide a unique data set of continuous measurements to study these transport events. The satellite instruments GOME and SCIAMACHY provide a long term data set of almost 20 years of continuous tropospheric NO\textsubscript{2} measurements. The resulting maps of tropospheric NO\textsubscript{2}, well known and nicely show global patterns of anthropogenic NO\textsubscript{2} pollution. The examination of this time series of global measurements reveals typical pathways and conditions for the export of NO\textsubscript{2} from the North American continent eastward into the Atlantic Ocean and to Europe. In this poster we focus on patterns and frequencies of enhanced tropospheric NO\textsubscript{2} over north Atlantic.

Instruments

GOME (Global Ozone Monitoring Experiment):
- 4 channel UV/visible grating spectrometer
- nadir viewing
- ground pixel 40 x 320 km\textsuperscript{2}
- global coverage in 3 days
- global 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 x 240 km\textsuperscript{3}
- global coverage in 6 days
- data since August 2002
- operating on ENVISAT
- sun-synchronous orbit, 10:00 LT equator crossing

NO\textsubscript{2} Transport Climatology

Approach
Slant columns of NO\textsubscript{2} are retrieved using the Differential Optical Absorption Spectroscopy (DOAS) technique. The tropospheric column is basically the excess column after subtraction of the measurements over a reference sector in the pacific. Applying an air mass factor yields the tropospheric vertical column of NO\textsubscript{2}.

Enhancements of the NO\textsubscript{2} columns in a zonal band between 50-60°W and 20-60°N (Fig. 1) were counted applying two threshold values. Measurements exceeding 2 10\textsuperscript{15} molecule/cm\textsuperscript{2} and covering an area of more than 10 km\textsuperscript{2} were taken into account for our analysis.

Results
Figure 2 shows the results of this analysis using seven years of GOME data. The export of pollution from the boundary layer in the eastern US across the North Atlantic is nicely visible. This process is well known. It is the effect the warm conveyor belt (WCB) of cyclones that quickly lift the polluted air mass into the free troposphere where it is transported very fast to northern Europe.

Conclusions
The storm track from North America across the Atlantic is clearly reproduced in the NO\textsubscript{2} data. Maximum during winter season with at least one NO\textsubscript{2} export event per week. During other month less than one event in two weeks on average. Evidence for regular patterns of high NO\textsubscript{2} over subtropical Atlantic in spring, but not conclusive if source is lightning or not resolved convection.

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Selected References
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