

Interactive comment on “Measurements of tropospheric NO₂ with an airborne multi-axis DOAS instrument” by P. Wang et al.

P. Wang et al.

Received and published: 28 January 2005

Specific comments Given the above, I have very few, just few suggestions for the discussion of the impact of clouds at the end of section 3: Fig 3 indicates that the NO₂ enhancement over cloudy area is not permanent, meaning that the NO₂ concentration in the upper part of the cloud varies horizontally. Moreover, it shows a tendency for NO₂ enhancement at the edge of the clouds (though not at all edges and not always). Any suggestion for that? Some indication on the meteorology: location of high pressure, presence of front, and type of clouds, indicative of vertical stability, and wind field at surface level or 700 hPa, indicative of horizontal advection, could help understanding if transport could contribute. What about a photochemical contribution because of sunlight extinction within the cloud? or heterogeneous chemistry / dissolution / wash-out?

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

The reviewer raises the point why the NO₂ enhancement over the cloud is largest at the cloud edge and not homogeneous over the cloud. This can at least partly be understood when considering the following aspects:

The cloud measured by AMAXDOAS on Mar. 19th, 2003 is a stratus cloud, which can be clearly identified from the AVHRR and Meteosat images. The clouds under the AMAXDOAS flight track over the north of Germany and the Netherlands were large, covering about 2 degrees longitude and half a degree in latitude. The cloud was thick and moved slowly, and could already be seen at 6 UT on the Meteosat visible images.

According to the weather chart on 03:00 UT, Mar. 19th, 2003 a low pressure system was at the north west of Scandinavia (965h pa, at 70°N, 40°E). The low center can be clearly identified from the AVHRR map at 09:55 UT at a similar position. A cold front of the lower center was at 62°N. The cold front was running from Scandinavia to the south. An anticyclone, Liliانا was over the UK (1030 hpa, at 50°N, 0°E).

From the radiosonde data at De Bilt taken at 12:00 UT on March 19th the surface pressure was 1031 hpa, controlled by high pressure. The wind was mainly from north to south and very stable from the surface up to 800 hpa. The wind direction was about 350° (north is 0°) and wind speed was smaller than 8 kn. The wind direction shows that the front was moving from north to the south.

The Stratus cloud indicated the position of the cold front. When the cold front was moving over the Netherlands and the northern part of Germany, the warm air close to surface was lifted up and with the NO₂ close to the surface.

In the Stratus cloud advection is small so the NO₂ was not spread out in the horizontal direction within the cloud. Thus the NO₂ from a localized source remained localized within the cloud. This can explain why the NO₂ is at the edge of the cloud and the measurement was a single NO₂ peak. Also, NO₂ in the cloud should only be observed close to pollution sources unless long range transport becomes important. This can explain the observed variability in NO₂.

The flight track crossed the cloud and cold front nearly perpendicularly which is another reason why the NO₂ enhancement appeared as a single peak. If the flight track would have been along the cloud edge, the NO₂ enhancement might have been a strip.

Photochemistry and removal by heterogeneous reactions in the cloud may also play a role, but our measurements do not provide much insight into this aspect. Certainly the NO to NO_x ratio will change significantly in the presence of the cloud, reducing the observed NO₂ columns for a given amount of NO_x.

We have added more information on the meteorological situation and possible explanations for the observations to the text.

Unfortunately we could not put the weather chart and satellite images in the reply, sorry for the inconvenience.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 7541, 2004.

[Full Screen / Esc](#)[Print Version](#)[Interactive Discussion](#)[Discussion Paper](#)