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Cloud effects in satellite observed tropospheric NO_2

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Satellite observations of atmospheric composition have become an important tool in the investigation of tropospheric chemistry. In particular, retrievals of tropospheric NO_2 columns from nadir scattered light observations of the GOME, SCIAMACHY, OMI, and GOME-2 instruments have been applied in many studies as they can be linked to NO_x emissions from a variety of sources.

As the retrievals of NO_2 are performed in the visible part of the spectrum, clouds have a large impact on the results. Optically thick clouds shield the NO_2 below the cloud from the satellite view, thereby limiting the sensitivity of the observations. However, as the result of multiple scattering within the cloud and enhanced backscatter from the cloud top, the sensitivity to NO_2 within the upper part of the cloud and above cloud top is enhanced. Depending on the vertical structure of the cloud and the relative vertical position of absorber and cloud, NO_2 signals can be much reduced or even enhanced in the presence of clouds.

Here, we present a statistical analysis of GOME-2 and SCIAMACHY NO_2 observations taken at different cloud fractions. The results show surprisingly small cloud effects in many regions, and systematic cloud induced enhancements of NO_2 in regions dominated by pollution transport and biomass burning. Analysis of the impact of cloud top on the signal shows the expected larger enhancement over lower clouds in some regions, but not in all. The results have implications for the interpretation of cloudy satellite observations and the assumptions on the vertical NO_2 distribution.