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Impact of clouds on tropospheric trace gas retrievals

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Spectroscopic measurements from nadir-viewing satellite platforms allow the retrieval of column densities of several atmospheric trace gases. The retrieval of tropospheric columns is thereby strongly affected by clouds: Clouds shield boundary layer and lower tropospheric trace gases, leading to an underestimation of the actual column. On the other hand, the high albedo of clouds, as well as multiple scattering within the cloud, increase the visibility of trace gases at and above the cloud top.

Cloud parameters like cloud fraction, cloud top height or cloud heterogeneity can also be directly deduced from satellite measurements, using intensity measurements and spectral absorption features of O_2, O_4 or the so-called "Ring-effect".

Here we analyze the dependency of tropospheric NO_2 columns on several cloud parameters. This empirical study is complemented by theoretical radiative transfer modelling studies using the 3D-Monte-Carlo Model TRACY-2, that is in particular capable of modelling radiative transfer in clouds. With these investigations we check and improve our understanding on the different cloud effects on radiative transfer (shielding, path-length enhancement and albedo increase). Improved knowledge on the impact of clouds on trace gas columns allows to interpret clouded pixels, that are currently discarded in most analyses. Temporal or spatial variations of the observed dependencies of NO_2 columns on cloud parameters hold additional information on e.g. the NO_2 profile.