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Characterisation of cloud properties from MAX-DOAS observations

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Multi AXis (MAX-) DOAS observations observe the scattered sun light a various, mostly slant, elevation angles. From MAX-DOAS observations it is possible to retrieve the vertical column density of several important trace gases like NO_2, HCHO, SO_2, H_2O, BrO, and also aerosol extinction. Usually, limited profile information for the lowest atmospheric layers (below about 5 km) can be obtained.
Clouds strongly affect the atmospheric radiation transport. Thus they also have a strong effect on the interpretation of MAX-DOAS results. In many cases, especially for high clouds, it is still possible to retrieve reasonable trace gas and aerosol results in the presence of clouds. However, for low clouds and in particular for optically thick and vertically extended clouds, usually no meaningful MAX-DOAS retrievals are possible. Thus accurate information on cloud properties is crucial for the characterisation of the uncertainties of MAX-DOAS observations.
In this study we investigate the suitability of several cloud-sensitive quantities, which can be retrieved from the MAX-DOAS observations themselves. Besides the measured radiance, we also analyse the so called colour index (intensity ratio at selected wavelengths), the absorption of the oxygen molecule (O_2) and the oxygen dimer (O4) as well as the Ring effect. The effects of clouds on these quantities is investigated in detail and the respective results are related to cloud information based on sky images taken from ground and satellite. In addition also radiative transfer simulations are performed.
As a main result of our studies we present recommendations for robust and effective cloud classification schemes based on MAX-DOAS observations.