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Can 2D and 3D cloud effects be characterised from spectrally resolving UV/vis satellite observations?

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Clouds have a strong influence on the radiative budget in the atmosphere, both in the long wave and short wave spectral range. Besides the microphysical properties of clouds, also their 3-dimensional structure plays an important role. In this study we investigate the effects of the 2- and 3-dimensional structure of clouds on different quantities which can be derived from spectrally resolving UV/vis satellite instruments like GOME-1/2, SCIAMACHY or OMI. In addition to the measured radiance (and its spectral dependence), we also analyse the absorptions of the oxygen dimer (O4) in different spectral ranges. Since clouds have a strong influnce on the atmospheric light path distribution, the O4 absorptions are strongly affected by clouds. Finally, we also analyse the so called Ring effect, which describes the 'filling-in' of solar Fraunhoer lines due to rotational Raman scattering. Also previous studies indicated that the described quantities are strongly affected by the presence and properties of clouds, and that information on cloud properties can be derived from satellite observations of the Ring effect and the O4 absorptions. However, here our focus is on the effect of spatial heterogeneities in the cloud structure on the observed quantities. One particular aim is to investigate how well spatially (horizontally) heterogenous clouds can be distinguished from horizontally homogenous clouds from spectrally resolved satellite observations of the O4 absorption and the Ring effect. Here it should be noted that these cloud heterogeneities are by far lower than the typical ground pixel sizes of the used satellite instruments.
For our study we apply the fully spherical 3-dimensional Monte Carloe radiative transfer model TRACY-2. We simulate radiances, O4 absorptions and Ring effect in the presence of clouds with similar cloud top albedo but varying their spatial heterogeneity on different scales (ranging from 1m to 5km). First results indicate that the spatial scales of cloud heterogeneities have a distinct effect on the observations of te O4 absorption and the Ring effect from satellite instruments.