Geophysical Research Abstracts
Vol. 16, EGU2014-14745, 2014
EGU General Assembly 2014
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Influence of cloud edges on atmospheric radiative transfer and its consequences for satellite retrievals

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Clouds have a strong influence on satellite measurements in general and the analysis of absorbing trace gases and aerosol optical depth in particular. Effects of 3D features like spatial heterogeneities and structured cloud boundaries increase when the spatial resolution of the instruments approaches the dimensions of cloud features and if the vertical and horizontal dimensions of clouds are similar: at coarser resolution opposing effects average out, at finer resolution 3D effects may be fully resolved. Hence, measurements by future satellite-borne spectrometers, like the Tropospheric Monitoring Experiment (TROPOMI) designed to resolve horizontal features of 7x7 km^2, will be strongly influenced by 3D cloud effects. This type of spectrometer is primarily used to measure trace gases, but aerosol properties may be retrieved as well.

In this study, the influence of important 3D effects on atmospheric radiative transfer are investigated using Monte Carlo simulations: effects of cloud shadows, illuminated cloud sides and structured cloud boundaries. We discuss the influence on trace gas retrievals, cloud fractions, and aerosol optical thickness. Additionally, the influence of cloud parameters (e.g. cloud top height, cloud optical density) and observation geometry will be studied. Special emphasis is put on visualising the different effects using the box air-mass factor concept.