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Investigation of key quantities for the first indirect aerosol effect contrasting MSG SEVIRI and ground site measurements

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The first indirect aerosol effect remains one of the main uncertainties in projections of anthropogenic climate change. Satellites provide a unique possibility to globally quantify the importance of the first indirect aerosol effect. Given a constant liquid water content within the cloud, a higher cloud droplet number concentration results in higher cloud albedo. But the cloud albedo is also altered by the geometrical cloud extent. Therefore the two key quantities for this investigation are the CDNC and the geometrical cloud extent. Both quantities can not be obtained directly from current geostationary satellites. Due to necessary assumptions and missing information about the vertical cloud structure, the retrieval of both quantities remains a great challenge. Our aim is to investigate the accuracy of current satellite retrievals by contrasting the key quantities with those obtained from ground-site. The satellite retrieval is based on the method described by Nakajima and King to derive the optical cloud depth and the effective radius. In a second step, the CDNC and cloud extent is determined, assuming an adiabatically increasing liquid water content above cloud base. Single-layer liquid water clouds are simultaneously observed with ground-based remote sensing instruments at different locations in Germany (Leipzig, Juelich, Melpitz). We use a ceilometer to detect the cloud base height, a 35 GHz cloud radar to detect the cloud top height and the reflectivity profile, and a microwave radiometer to obtain the liquid water path. We developed an Optimal Estimation approach to retrieve the CDNC as well as the liquid water content profile. Our observation vector consists of the radar reflectivity profile and the liquid water path. We compare the retrieved quantities from ground with the satellite perspective to closer investigate the assumption of adiabatic cloud profiles.