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Assessment of ground-based cloud liquid water profiling retrieval techniques

The microphysical properties of boundary-layer liquid water clouds are essential for describing and predicting the development of the boundary layer, especially concerning their impact on radiative forcing, but also on atmospheric heating rates as well as the onset of precipitation (drizzle). Hence, it is imperative to assess currently used methods to derive the microphysics of liquid clouds in terms of cloud droplet number concentration (N), effective radius (Reff), liquid water content (LWC) and their related uncertainties. Within the scope of the COST action ES0702 EG-CLIMET four different ground-based remote sensing methods employing cloud radar, microwave radiometer (MWR) and laser-ceilometer have been developed and applied to model output and real measurement data. All methods use the same information on cloud phase & type, cloud boundaries, radar reflectivity, ceilometer-backscatter MWR-derived LWP and MWR brightness temperatures, respectively. Using this information as a common constraint, all four methods are applied to synthetic measurements calculated from model output using suited forward models available from the EarthCARE Simulator (ECSIM). In this case retrieved microphysical properties can be directly compared to the original model output and thus the accuracy is evaluated as a function of height above cloud base. Systematic differences are assessed and it is shown that the N and Reff retrievals are much more dependent on the retrieval method parameters than LWC. Additionally, the retrieval methods are applied to real measurements collected during the COPS campaign in Germany by the ARM Mobile Facility and evaluated through a short-wave radiative closure experiment using simultaneous broad-band pyranometer measurements.