The complexity of variational retrieval of liquid cloud properties

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Warm clouds, consisting of liquid droplets only, are assumed to be the simplest cloud type to be observed. However, the retrieved liquid water content (LWC) and droplet effective radius (REF) may differ significantly among different ground-based remote sensing retrieval methods. Uncertainties may arise from retrieval assumptions but also from measurement biases.

Here, we will present the results of a 1D-Var retrieval method, the Integrated Profiling Technique (IPT), which combines ground-based microwave radiometer (MWR), cloud radar and a priori information to derive profiles of temperature, humidity, LWC and REF. In contrast to other commonly used cloud radar-MWR-methods, which are based on simple relations to retrieve LWC and REF, the IPT provides physically consistent profiles implying that the measurements can be reproduced from the retrieved profiles within their assumed errors.
We will test the IPT performance using synthetic observations. Knowing the true atmospheric profiles, we can simulate what the instruments would observe. In this way, we can test how the retrieval behaves under ideal conditions and can also analyse the complex interplay of prior, measurement and forward model uncertainties in the retrieval. In the "real world", it is likely that measurements are prone to have (unknown) biases. Furthermore, the forward model with its assumptions, e.g. the assumed droplet size distribution, might not be appropriate. We will also assess how such discrepancies affect the retrieved cloud property profiles.
In addition, the results will also be set into context to other commonly used cloud radar - MWR cloud retrieval algorithms.