Ground-based synergistic observations of cloud properties and their uncertainties

Kerstin Ebell, Emiliano Orlandi, Ulrich Löhnert, Patric Seifert, Holger Siebert, Anja Hünerbein, Christine Chiu, Susanne Crewell

Clouds and precipitation play an important role in the climate system. However, our understanding of cloud and precipitation processes and their implication for climate prediction is poor. Accurate observations of the vertical structure of cloud properties together with their respective uncertainties are a key ingredient to evaluate and subsequently improve climate models. Most detailed observations are available from ground-based cloud observatories that operate a multitude of remote sensing instrumentation. Liquid water content and its uncertainty can be retrieved from these measurements using a 1DVAR retrieval scheme, i.e. the Integrated Profilinq Technique (IPT) developed by Löhnert et al. (2004, 2008). Within the project HD(CP)^2 (High definition clouds and precipitation for advancing climate prediction) funded by the German Research Association the IPT is currently further improved, thoroughly evaluated and will be applied to long measurement time series at different observatories.

The IPT has been enhanced and provides continuous estimates of vertical profiles of temperature, humidity, cloud water content, and effective radius. A separate treatment of drizzle water content and effective radius is under development. The retrieval scheme integrates meaurements, i.e. brightness temperatures of a multichannel microwave radiometer and cloud radar reflectivities, and prior information, i.e. climatological profiles of radiosondes or forecast data from a numerical weather prediction model, together with their uncertainties in a physically consistent way. Thus, we provide a best-estimate product for the vertical column with maximum information content. Note that the retrieval framework directly provides uncertainty estimates of the retrieved parameters, which is essential for the assessment and the exploitation of the retrieval results.

Here, we will demonstrate the application of the IPT by means of some case studies and also compare the retrieval results to other retrieval methods and observational data sets.
At the Jülich Observatory for Cloud Evolution (JOYCE), the cloud optical depth and effective radius from sunphotometer observations in cloud mode (Chiu et al., 2012) as well as cloud properties from satellite observations (SEVIRI) are incorporated in the analysis. In-situ observations of a persistent stratocumulus cloud case were performed in Melpitz close to Leipzig during HOPE (HD(CP)^2 Observational Prototype Experiment)-Melpitz by the helicopter-borne Airborne Cloud Turbulence Observation System ACTOS. By means of these data sets, a comprehensive assessment of the IPT results is performed. Within 2014, the IPT will be operationally implemented at the ground-based cloud observatories in Jülich, Lindenberg, and Cabauw.