Synergetic retrievals of low-level vertical cloud structure with potential for evaluating and developing EarthCARE satellite products

Ulrich Löhnert, Susanne Crewell
Institute for Geophysics and Meteorology, University of Cologne, Germany

Oleg Krasnov, Herman Russchenberg
Technical University of Delft, The Netherlands

Ewan O'Connor
University of Reading, UK

This contribution presents advances in ground based thermodynamic profiling of the lower troposphere through sensor synergy. The well documented Integrated Profiling Technique (IPT), which uses a microwave profiler, a cloud radar and a ceilometer in synergy to simultaneously retrieve vertical profiles of temperature, humidity and liquid water content of non-precipitating clouds, has been extended towards an enhanced performance in the boundary layer and lower troposphere. In order to improve the quality of liquid water content measurements in clouds we incorporate a sophisticated target classification scheme developed within the European cloud observing network Cloudnet. It allows the detailed discrimination between different types of backscatterers detected by cloud radar and ceilometer. Additionally, to allow liquid water retrieval during drizzling cases, we integrate an LWC profiling method developed at the Technical University of Delft. This technique classifies the detected hydrometeors into three different size classes using certain thresholds determined by radar reflectivity and/or ceilometer extinction profiles. By inclusion into IPT, the retrieved profiles are made physically consistent with the measurements of the microwave profiler. Results of the IPT application within the LAUNCH campaign (European COST720 action) and from the international TWP-ICE campaign are analysed and the importance of synergetic profiling for satellite application and numerical weather prediction model evaluation is underlined. The method is currently installed at Cabauw, NL and Lindenberg, GER and is continuously updated concerning additional measurement techniques and/or physical constraints. Once EarthCARE is airborne, a sound validation data basis of physically consistent thermodynamic profiles - and additionally radiative flux profiles - will be available for evaluation purposes.

Although the EarthCARE satellite will fly no microwave sensors, the presented methodology of synergetic retrieval algorithm development may be well suited for retrieving microphysical properties of low-level liquid clouds from the EarthCARE measurements. The proposed optimal estimation equations (derived from Bayesian probability theory) have the potential of combining arbitrary measurements and methods for retrieving physically consistent profiles of liquid water content or effective radius. For example, radar/lidar techniques for retrieving liquid water content can be combined with the MSI or broadband flux measurements, which will act as an additional physical constraint.