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Synergy of microwave radiometry and lidar for high vertical temperature and water vapor profiling

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Atmospheric humidity and temperature are important variables to describe any meteorological event. Highly resolved, accurate and continuous measurements of these parameters are required to better understand atmospheric processes. Unfortunately, remote sensing instruments available nowadays are not able to provide sufficient spatial resolution to describe short time scale processes. In order to overcome the specific limitation of a given sensor, instrument synergies are gaining importance in the last years. Here, we present the synergy of a Microwave Radiometer (MWR) and lidar systems.

The retrieval algorithm that combines these two instruments is an innovative scheme, based on an Optimal Estimation Method (OEM). It allows a complete error description of the retrieved profiles. The method is designed for clear sky periods and simple cloudy scenarios.

Firstly, the OEM has been applied to the two months dataset of HOPE, a field campaign in Jülich, Germany. In addition to a ground-based multi-frequency MWR, a Raman lidar (RL) provides information on water vapor and although limited temperature profiles. Different experiments are performed to evidence the improvements of the synergy. We demonstrate that, when applying the combined retrieval to the HOPE period, the absolute humidity error is reduced by 60% and 38% on average, with respect to the retrieval using only-MWR data or only-RL, respectively. Further, we show that the joint use of temperature and humidity measurements provides improved relative humidity estimates, which is especially useful to study cloud formation in the vicinity of cloud edges. In general, the benefits of the sensor combination are especially strong in regions where Raman Lidar data is not available (i.e. overlap region, poor signal to noise ratio), whereas if both instruments are available, RL dominates the retrieval.

In addition to the ground-based application during HOPE, the algorithm is used with aircraft-based measurements. High Altitude and Long-range research aircraft (HALO) data, collected over the Tropical Atlantic by a 26-channel microwave radiometer and the Water Vapor Differential Absorption LIDAR (WALES) are analyzed and we present preliminary results. The talk will discuss the differences between ground-based and airborne geometries and the extension of the algorithm to cloudy cases.