Synergy benefit in temperature, humiditiy and cloud property profiling by integrating ground based and satellite measurements

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Accurate, highly vertically resolved temperature, humidity and cloud property profiles are needed for many applications. They are essential for climate monitoring, a better process understanding and the subsequent improvement of parameterizations in numerical weather prediction and climate models.
In order to provide such profiles with a high temporal resolution, multiple wavelength active and passive remote sensing techniques available at ground based observatories, e.g. the Atmospheric Radiation Measruement (ARM) Program and Cloudnet facilities, need to be exploited. In particular, the Integrated Profiling Technique (IPT, Löhnert et al., 2008) has been successfully applied to simultaneously derive profiles of temperature, humidity and liquid water by a Bayesian based retrieval using a combination of ground based microwave radiometer, cloud radar and a priori information. Within the project ICOS (Integrating Cloud Observations from Ground and Space – a Way to Combine Time and Space Information), we develop a flexible IPT, which allows for the combination of a variety of ground based measurements from cloud radar, microwave radiometer (MWR) and IR spectrometer as well as satellite based information from the Spinning Enhanced Visible and InfraRed Imager (SEVIRI) onboard of METEOSAT. As ground based observations are mainly sensitive to the lower parts of the troposphere, the satellite measurements provide complementary information and are thus expected to improve the estimates of the thermodynamic and cloud property profiles, i. e. hydrometeor content and effective radius, considerably. In addition to the SEVIRI IR measurements, which are provided with a high repetition time, information from polar orbiting satellites could be included. In paticular, the potential of the Advanced Microwave Sounding Unit-A (AMSU-A) and Microwave Sounding Unit (MHS) in the retrieval is investigated.

In order to understand the improvement by integrating the measurements of the above mentioned instruments into the IPT, sensitivity studies with different measurement combinations and different assumptions in the error covariance matrix are performed. The information content is calculated and the optimal combination of instruments will be identified for the retrieval of the atmospheric profiles. In clear sky cases, for example, the number of degrees of freedom, i. e. the number of independent pieces of information, in the retrieved temperature (humidity) profile are doubled (quadrupled), if the ground based MWR observations are combined with ground based spectral IR, as well as AMSU-A, MHS, and SEVIRI observations. In this way, uncertainties in the temperature and humidity profiles can be reduced by 50% and 40%, respectively.