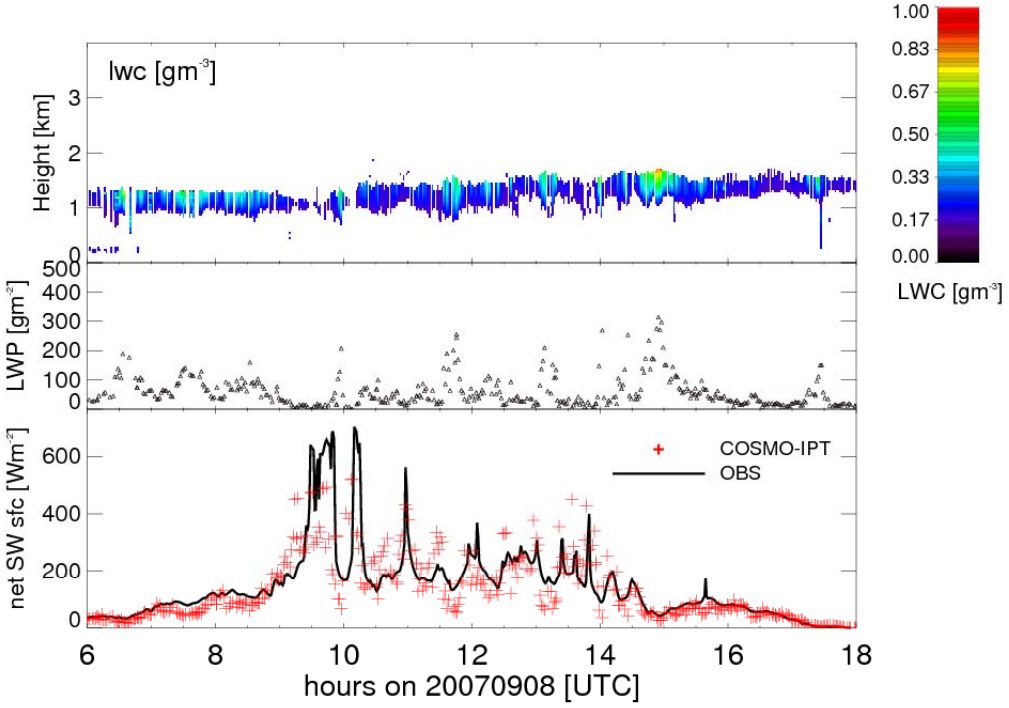
Advances in multi-instrument liquid cloud property retrievals: New synergies and applications

The deployment of the ARM Mobile Facility in the Black Forest, Germany during 2007 has brought forward a unique data set of active and passive remote sensing measurements for the application and evaluation of multi-instrument cloud property retrieval methods. Data from four microwave radiometers with frequencies between 21 and 150 GHz, as well as continuous AERI data, cloud radar, ceilometer and micro-pulse lidar data provide valuable and complementary information on cloud parameters such as liquid water content, effective radius and cloud optical depth. Frequent radiosonde measurements (4 times daily) of temperature, humidity and pressure can be used to constrain the cloud property retrievals.

The Integrated Profiling Technique (IPT) combining cloud radar and microwave radiometer data within a Bayesian retrieval framework has been applied to the whole period of the AMF deployment for the retrieval of temperature, humidity and LWC profiles. These retrievals can only be applied to liquid water clouds with liquid water path (LWP) greater than ~30 gm^{-2} because low-LWP clouds are difficult to detect with standard microwave radiometers and cloud radar. The number of independent retrievable cloud levels is discussed as a function of the a priori assumptions and the microwave frequencies chosen. Additionally, the effect of the retrieval errors is analyzed with respect to their impact on radiative forcing.

Not many reliable observational methods exist to measure the low-LWP (1-50 gm^{-2}) clouds. However, it is well known that these clouds have a very high radiative impact, especially in the short-wave part of the spectrum. The combination of the AERI and higher-frequency microwave observations (90/150 GHz) exhibits a high potential for cloud property retrieval of effective radius and cloud optical depth. Within the integrated retrieval approach we show how both instruments can be used to synergistically retrieve profiles of temperature and humidity as well as mean cloud layer optical depth and effective radius. A subsequent error analysis will discuss the advances achieved with the synergetic retrieval as opposed to the single instrument retrieval.

Image Caption:
Time series of IPT-derived cloud liquid water content (top), liquid water path (center) and calculated net short-wave flux at the surface in comparison to direct observations (bottom) (AMF, Black-Forest on September 8, 2007).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