Ground-based multi-instrument retrievals of the atmospheric state: the Integrated Profiling Technique

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An integrated retrieval technique (IPT) for simultaneously determining the thermodynamic profile of the atmosphere together with the macro- and micro-physical properties of liquid clouds is presented. Principally the method is suited for combining all on-site sensors bearing significant information content. Momentarily IPT relies on various remote sensing (passive microwave and infrared, cloud radar, ceilometer) and in-situ measurements which are combined in an optimal way.

The latest IPT development includes the combination of spectrally resolved passive microwave and infrared observations. A clear-sky retrieval procedure is presented that utilizes measurements from a standard microwave profiler (HATPRO) and an infrared spectrometer (AERI) by applying the IPT to each instrument separately. This optimal estimation based technique has additionally been applied simultaneously to the combination of both AERI and HATPRO measurements. Retrieval accuracies and information content in clear sky scenes are investigated. The anticipated benefit from the multi-instrument IPT retrievals in cloudy scenes will also be discussed. For profiling liquid clouds, the synergy of active and passive measurements within the IPT is mandatory. Together with the actual profiles of liquid water content, IPT also yields accuracy estimates. Prior to algorithm application the use of a sophisticated target classification scheme developed within the European COST720 action ensures a correct discrimination of cloud type and phase and thus leads to a consistent retrieval.

A successful optimal estimation framework relies on an accurate description of measurement error and forward model error. However, microwave absorption models at frequencies above 60 GHz possess unknown uncertainties. A unique data set of microwave observations at 150 GHz taken during the ARM Mobile Facility deployment to the Black Forest (Germany) in 2007 is presented and compared to simulated brightness temperatures from co-located radiosonde ascents. By adjusting the water vapor continuum contributions of three standard absorption models to meet the measurements at 150 GHz, the model differences, not only at 150 GHz, but across the microwave spectrum can be significantly reduced.