The Synergistic Use of Passive Microwave and Infrared Observations to Retrieve Liquid Water Cloud Properties

U. Löhnert, D.D. Turner, H. Czekala and S. Crewell

There are very few reliable observational methods that accurately measure liquid water path (LWP) in low-LWP (0-100 gm-2) clouds. However, it is well known that these low-LWP clouds have a very high radiative impact in both the shortwave and longwave portions of the spectrum. To achieve an accurate measurement of LWP, the combination of passive microwave (MW) and infrared (IR) observations offers a high and largely unexploited potential for cloud property retrieval of effective radius, cloud optical depth and liquid water path. Here we propose two methods for enhanced accuracy retrievals.

First we present a standard microwave humidity and temperature profiler (HATPRO) of the second generation that has been additionally equipped with two broadband infrared radiometers, the first with a bandpass from 10.2 to 11.9 microns, the second from 11.1 to 12.8 microns. Thin water clouds have different sensitivities towards cloud optical depth and effective radius in these infrared bands. Additionally, it is well known that the HATPRO microwave channels are sensitive to liquid water path (LWP). We will discuss the potential of retrieving cloud optical depth, effective radius and hence LWP through a combination of the broadband infrared and microwave channels and show expected accuracies as well as applications to first measurements.

Second, within a 1D-Var integrated retrieval approach, we show how microwave profiler measurements and spectrally highly resolved infrared measurements, i.e. from the Atmospheric Emitted Radiance Interferometer (AERI), 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.