Microwave Radiometry For Obtaining Atmospheric Parameters

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In contrast to electromagnetic waves in the solar or infrared spectral range, microwaves can penetrate clouds and even rain. At the same time water vapour and several other gases as well as water in its liquid and solid phase emit, respectively scatter, microwave radiation making this spectral range particularly interesting to provide information on the cloudy atmosphere from the ground as well as from satellite. In this paper we explain the basic concept of microwave radiometry meaning the passive exploration of the atmospheric state by interpreting its thermal emission and further interactions with microwave radiation. In addition to vertically integrated amounts of water vapour, cloud water and even rain water also temperature profiles can be extracted from measurements along absorption lines and bands of molecular oxygen. Because of the large wavelengths and the rather low energy amount compared to other spectral regions special detection and calibration techniques are required which will be discussed here. Examples of atmospheric measurements and interpretations from the ground will be shown demonstrating the suitability of microwave radiometry for all weather conditions.

While classical instrumentation for continuous observations of the liquid water path, temperature and humidity profiling is well established for monitoring purposes the last years have brought forward new approaches which a) use hemispheric scanning techniques to derive water vapour advection; b) combine multiple radiometers for tompographic analysis; c) exploit polarimetric signals for the characterization of hydrometeors. In addition to an overview on current activities the multi-wavelength dual-polarized ADMIRARI (ADvanced MIcrowave RAdiometer for Rain Identification) radiometer will be presented in detail.). The radiometer has 6 channels working in horizontal and vertical polarization at 10.65, 21.0 and 36.5 GHz, and it is completely steerable both in azimuth and in elevation. Polarization effects introduced by the non-spherical shape of larger rain drops allow to separate the signal originating from cloud and rain water. The sensitivity of the ADMIRARI signal to 3D effects, raindrop size distribution, and axial ratio parameterizations has been investigated via detailed 3D radiative transfer calculations. A Bayesian retrieval scheme based on many atmospheric state realizations simulated by a cloud resolving model has been developed and applied to measurements during field campaigns in Europe and South America.