A new 94 GHz radar/radiometer suitable for studying cloud edges

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Abstract

A novel FMCW 94 GHz radar/radiometer (JOYRAD-94) was deployed at the "Jülich Observatory for Cloud Evolution" (JOYCE), Germany, in October 2015. JOYRAD-94 is capable of providing Doppler spectra with high temporal and vertical resolution of up to 3 s and 5 m, respectively. The accuracy of the radar was cross-validated using, firstly, a metal-sphere reflector in the far-field of the radar, and secondly, comparing cloud observations to a 35 GHz cloud radar that is located a few meters next to JOYRAD-94. For both tests an agreement of better than 0.5 dB was found.

In addition, JOYRAD-94 is equipped with a radiometer channel measuring at 89 GHz, hence, providing information on the liquid column (LWP) with a temporal resolution of 1 s. Moreover, both components collect radiation over the same antenna, i.e. perfect beam matching is accomplished. The latter gives, in combination with the high vertical resolution, the opportunity to derive cloud properties even at cloud edges.

We will present an overview of the performance of JOYRAD-94 including an analysis of LWP retrievals using the 89 GHz channel. In addition, we will show in a model study that perfect beam matching is highly beneficial when retrieving liquid water content profiles by combining active and passive microwave radiometry, especially in regions of spatial inhomogeneity, i.e. at cloud edges. We will show how much information on cloud structure will be lost, if the sampling volume is increased.

An accurate forecast of cloud cover and cloud type is crucial to predict available solar energy in power grids. Of interest are clouds exhibiting high temporal and spatial variability while efficiently exctincting incoming solar radiation, such as thin liquid water clouds. The highly resolved profiles retrieved from JOYRAD-94 are a promising tool to evaluate forecast models, which can be complemented by relating cloud properties to solar surface radiation.