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CLIMATOLOGY OF VERTICAL AIR MOTION DURING RAINFALL IN NIAMEY, NIGER AND BLACK FOREST, GERMANY USING AN INNOVATIVE CLOUD RADAR RETRIEVAL TECHNIQUE

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ABSTRACT

In recent years, the DOE Atmospheric Radiation Measurement (ARM) program has deployed its ARM Mobile Facility (AMF) to collect continuous measurements in several climatologically distinct locations, including a year-long stay in Niamey, Niger and eight months in Germany's Black Forest. The AMF includes a vertically pointing 95 GHz cloud radar, a tool of choice for profiling non-precipitating clouds at high spatial and temporal resolutions, but commonly considered poorly suited to the quantitative study of precipitation, due in large part to attenuation. However, an innovative technique first explored by Lhermitte in the late 1980s, and subsequently by others, sidesteps much of the quantitative uncertainty imposed by attenuation by exploiting non-Rayleigh resonance effects of scattering from raindrops at 95 GHz. Given a modest range of suitable drop sizes, non-Rayleigh resonances appear as distinct peaks and valleys in Doppler spectra, which once identified, can be directly mapped to known drop sizes by Mie theory. Although attenuation in rain at 95 GHz is substantial, key to the technique is that all non-Rayleigh peaks and valleys in a given Doppler spectrum are affected equally, preserving their relative positions and magnitudes (barring feature extinction). Vertical air motion is retrieved very accurately by taking the difference between the measured Doppler velocity of a resonance feature (usually the first valley) and the known terminal velocity of its associated drop size. We have achieved promising retrieval accuracies at spatial and temporal resolutions of 30 meters and 2 seconds. Here we present lessons learned when the retrieval technique is automated and applied to measurements taken in rain over the full durations of the Niamey and Black Forest AMF deployments, comparing vertical air velocity patterns of monsoonal precipitation over the African desert with those of the orographically influenced precipitation in Germany's mountains.
