Using Doppler Velocity Difference from 3- and 35-GHz Vertically Pointing Radars to Retrieve Vertical Air Motion and Raindrop Size Distributions

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Vertically pointing radars can observe the vertical structure of precipitation as precipitation advects over the radar site. By operating two vertically pointing radars (VPRs) side-by-side and transmitting at 3- and 35-GHz, the measured Doppler velocities from these two radars will be different due to Rayleigh scattering occurring at 3 GHz and Mie scattering occurring for larger raindrops at 35 GHz. Thus, as long as raindrops larger than approximately 2 mm are within the radar resolution volume, the two radars will measure different mean Doppler velocities while observing the same distribution of raindrops. This Doppler velocity difference (DVD) is dependent only on the shape of the raindrop size distribution (DSD) and is independent of the measured reflectivity and signal attenuation through the rain column. After estimating the DSD, the vertical air motion is estimated as the difference between the observed 3-GHz VPR mean Doppler velocity and the simulated Rayleigh scattering radar-weighted DSD terminal mean fall speed.

This presentation will describe a retrieval method using four radar moments to estimate vertical air motion and three parameters of a DSD in the vertical column of precipitation. At each range gate, the inputs include 3-GHz VPR mean Doppler velocity and unattenuated reflectivity factor and 35-GHz VPR mean Doppler velocity and spectrum variance. To account for different VPR sampling volumes, radar observations were accumulated over 45 seconds and over 100 meters in range to represent time-space scales larger than either VPR sample volumes.

Retrievals were performed using observations from the Mid-latitude Continental Convective Cloud Experiment (MC3E) held in Northern Oklahoma in April – June 2011. The retrieved DSDs and vertical air motions are within the retrieval errors estimated from retrievals using the co-located 449-MHz VPR which is sensitive to both Bragg scattering (due to changes in air motion turbulent refractive index) and Rayleigh hydrometeor scattering.