Identifying Liquid Cloud Droplets and Frozen Hydrometeors in Mixed-Phase Clouds using 35-GHz Vertically Pointing Radar Velocity Spectra

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This study presents processing steps to identify, isolate, and quantify liquid cloud droplets and frozen hydrometeors in mixed-phased clouds using a vertically pointing 35-GHz (Ka-band) radar deployed at Oliktok Point, Alaska. Since the fall speed of cloud droplets and frozen hydrometeors are different, two spectral peaks are observed in vertically pointing radar Doppler velocity spectra with one spectral peak corresponding to cloud droplets and the other to frozen hydrometeors. This work identifies the two peaks and estimates the radar moments for each peak. The observations used in this study were produced by the US Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) program using their Ka-band zenith pointing radar, also known as KAZR (Ka-band ARM Zenith Radar).

The first processing step is actually a Quality Control (QC) step that identifies and removes ground clutter in the Doppler velocity spectra. Ground clutter from point targets produce narrow spectral peaks compared to broad spectral peaks produced by atmospheric clouds. Theoretically, the hard-target returns would produce delta functions in the Doppler velocity spectra. But, in actual radar signal processors, the delta functions appear as sinc functions with finite width. The QC processing step identifies large drops in spectrum power and then performs an interpolation across the narrow spectral (i.e., clutter) peak to remove the ground clutter.

The second processing step identifies multiple peaks in the Doppler velocity spectra and calculates high-order moments (including spectrum skewness and kurtosis) for the primary peak, sub-peaks, and separate peaks. Identifying multiple peaks is actually a process of identifying integration limits used in the moment calculations.

While the processing methods are described in Williams et al. (2018, J. Atmos. Meas. Tech., doi: 10.5194/amt-2018-66), the presentation at the conference will focus on using these methods to identify liquid cloud droplets and frozen hydrometeors in mixed-phase clouds observed with the 35-GHz Ka-band KAZR vertically pointing radar at Oliktok Point, Alaska.