Breakout Session Report
ARM/ASR User and PI Meeting
March 16-20, 2015

Session Title: Radar Science—Doppler Spectra
Session Date: Thursday, March 19, 2015
Session Time: 8:00–10:00 a.m.
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Description

The ARM Climate Research Facility maintains a growing archive of Doppler spectra data from its zenith-pointing radars, offering a rich source of much-needed observations for cloud and precipitation process analysis and model development. These observations are often complemented by other measurements from collocated profiling and scanning cloud and precipitation radars, and ancillary meteorological and surface precipitation data. This session shared presentations on recently completed or currently progressing work on cloud and precipitation processes and model development that exploits radar Doppler spectra data.

Main Discussion

Discussions during the two prior ASR radar Doppler spectra breakout sessions (spring and fall 2014) mentioned the difficulty and importance of progress in modeling and forward simulation of ice particles. This session focused almost entirely on ice, with central themes on the characterization of ice particle fall velocities and ice electromagnetic scattering models. The first two talks dealt with works in progress on the retrieval of snow sedimentation velocities using dual radar wavelengths and the modeling of ice sticking efficiency constrained by radar moment observations. Going forward, the latter project intends to use the full Doppler spectrum. The third talk described a recently completed work for quantifying ice Z-V relationships using forward modeling of Doppler spectra, higher-order radar moments (e.g., skewness, kurtosis, etc.), and insitu data from the ARM Facility Indirect and Semi-Direct Aerosol Campaign.

A nice job was done in quantifying the information content added by using higher-order radar moments. Both the second and third talks employed Bayesian methodologies. The final two talks dealt with progress made in the development of specific electromagnetic scattering libraries of ice particles. Tradeoffs in using Mie, T-matrix and DDSCAT (Discrete Dipole Approximation for Scattering and Absorption of Light Fortran code) in ice and mixed conditions were described in the first. The second discussed progress and pitfalls in applying dual-Doppler wind analysis (DDA) and Rayleigh-Gans-Theory techniques.

In the group discussion that followed, there was debate over the preferred emphasis of particle mass, diameter, area, and density in capturing fall speed relationships. Emerging techniques exploiting triple-wavelength radar observations were identified as a potential means to break away from dependence on the aforementioned difficult-to-measure properties. The Finland ARM Mobile Facility deployment data set supports these techniques and can be used to validate available scattering libraries.

Needs

In terms of future observations, the availability of state-of-the-art ground-based imaging probes for characterizing ice/snow particle properties (maximum diameter, internal structure, fall velocity, number

concentration) was identified. In addition, the participants agreed on the value of adding profiling X-band observations at the NSA sites (i.e., Barrow and Oliktok).

Future Plans

During the next six months, we will focus on several activities: consolidation of available scattering databases of non-spherical particles (pristine shapes, aggregates, rimed particles) and a sensitivity study to examine the impact of different scattering libraries on the moments of the radar Doppler spectrum. Eugene Clothiaux will lead this effort. We will also aim to conduct a similar study for the fall-velocity of non-spherical particles. Pavlos Kollias will lead this effort.