Fingerprinting of microphysical processes in Arctic clouds by tracking Doppler radar spectra features

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Cloud Radar Doppler Spectra offer a wealth of information about cloud processes. However, interpreting the evolution of the Doppler spectra itself and its moments (such as reflectivity (Ze), mean Doppler velocity (Vd), spectrum width, or skewness) with respect to the evolution of the cloud particle number size distribution is complicated due to the influence of dynamics. To follow a cloud particle population path through a cloud, the horizontal advection and the particle fall speeds have to be taken into account.

In this study we use vertical profiles of horizontal winds (derived from radiosoundings or cloud radar multi-azimuth RHI scans) and particle terminal velocities (represented by Vd) to track cloud particle populations and their microphysical properties. We analyze the evolution of (multi-frequency) Doppler spectra and its moments along these tracks to identify cloud microphysical processes in ice and mixed-phase clouds such as depositional growth, aggregation and riming. We also compare the results to different tracking techniques like vertical reflectivity correlation or non-tracking methods like a standard temporal averaging approach. The methodology is demonstrated using vertically pointing cloud Doppler radar measurements from the Department of Energy (DOE) Atmospheric Radiation Measurement Program's (ARM) site at the North Slope of Alaska (NSA).