**Title**

Microphysical Retrievals in Mixed-Phase Clouds with low LWP using Cloud Radar

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**Abstract**

Mixed-phase clouds, which have a significant impact on the global climate, are complex systems where liquid water and various types of ice particles coexist at temperatures below the freezing point. A key process in mixed-phase clouds is riming which alters microphysical and scattering properties of ice particles. Cloud radar is a powerful instrument for observing and understanding the processes that occur within mixed-phase clouds. Observations from multi-frequency radars and simulation results were combined in recent research to retrieve microphysical properties of ice particles in snowfall and ice clouds. This report presents an ambitious attempt to retrieve all common microphysical properties of ice particles, such as maximum dimension, density, aspect ratio and number concentration in slight rime condition using Doppler spectra. Two mixed-phase cloud events with low liquid water path are studied for such purpose. Spectral dual-wavelength ratio is introduced to retrieve maximum dimension of particles. An iteration process is developed in order to retrieve aspect ratio and density of ice particles from observation of spectral differential reflectivity. The number concentration of particles is retrieved with additional spectral reflectivity. With all the retrieved microphysical properties, ice water content and particle size distribution can be further derived. Ice water content is compared with results from an empirical model. The retrieved properties obtained from using three distinct mass-size relations are compared. Also the bulk and spectral retrieved profiles are compared. The retrieval process can provide consistent microphysical properties of ice particles. It is found that the retrieved ice water content is generally smaller than that from empirical model. Besides, the mass-size relation has significant impact on all retrieved microphysical properties except maximum dimension. The resulting profiles from bulk retrieval are smoother, while spectral retrieval can provide values in regions where the former cannot. The possible error from different sources are discussed or estimated, including the effect on dual-wavelength ratio from the elevation angle of radar, the neglect of differential attenuation caused by liquid and the usage of soft spheroid model. Recommendations are discussed, which include the usage of the latest microphysical models for ice aggregates and Discrete Dipole Approximation for electromagnetic wave scattering simulation.