# 1.19 MULTI-FREQUENCY RADAR RETRIEVAL OF SNOWFALL MICROPHYSICS

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We have developed a method for retrieving the microphysical properties of falling snow from multi-frequency radar measurements. The method uses recent advances in simulating the radar reflectivity of snowflakes as the basis of its forward model. The microphysical properties are retrieved using a Bayesian approach that does not require the use of iterative algorithms; this enables the retrieval to be performed quickly and robustly. An exponential particle size distribution and a power-law mass-dimensional relationship are assumed. The attenuation correction scheme takes advantage of the availability of multiple frequencies, allowing stable correction of reflectivity at frequencies affected by attenuation.

Plentiful test data with collocated multi-frequency radar measurements is available from recent field campaigns. We tested the algorithm using triple-frequency radar data available from the OLYMPEX/RADEX field campaign. This dataset contains collocated airborne radar measurements collected by the NASA APR-3 radar at Ku band (13.4 GHz), Ka band (35.6 GHz) and W band (94 GHz). We compared the results to hydrometeor identification using the NPOL radar, which was also present at the campaign, and was often overflown by the DC-8 aircraft carrying the APR-3. We also assessed the retrieval performance using the in situ data collected by the University of North Dakota Citation aircraft. Using these data, we examined the sensitivity of the algorithm to the a priori assumptions and to the number of available radar frequencies.

The results show that multi-frequency radars have a substantial advantage over single-frequency radars for constraining snowfall microphysics, especially the size of snowflakes. The benefits of a third frequency are more limited, but three-frequency radars can be used to detect occurrences of graupel, which has a particularly high density. Among the three frequencies, there does not seem to be any single one that would be preferable from an information content perspective, nor is any of the dual-frequency combinations particularly better than any other. Even with the triple-frequency configuration, the retrieval results are somewhat sensitive to the prior assumptions; this emphasizes the importance of accurate climatological statistics for the microphysical parameters.