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Profiling snow-precipitating clouds with Doppler multi-wavelength radars

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Precipitation is an essential climate variable. Knowledge of precipitation and its underlying processes are required in a number of research and application disciplines directly related to the global energy and water cycle. At high latitudes precipitation typically occurs in the form of snow. All current active and passive remote sensing techniques are known to perform poorly when estimating snow-rate and even worse when trying to predict microphysical properties (e.g. snow size distribution, snow habit, coexistence of super cooled liquid water).
In this paper we investigate the potential of multi-wavelength Doppler radars in overcoming this problem. Subsets of frequencies are selected from the following set: 13.8, 35.0, 94.0, 150, 220 GHz. The first three values are associated with already deployed radar systems, the last two refer to new research avenues. The notional study is based on thermodynamic and bulk-microphysical profiles extracted from cloud resolving model simulations and on a database of scattering properties for non-spherical ice crystals. This framework allows the evaluation of the combined effect of spectral differential attenuation and differential reflectivity to be investigated. Dual-wavelength systems generally improve the capabilities in sizing the snowflakes while the use of very high frequency is particularly effective for the detection of mixed phased clouds. This work has relevance for the evaluation of ground-based and space-borne millimetre wave radar performances currently under study.