12.8 PARAMETRIZATION OF FALLING SNOW MICROPHYSICS AND ITS APPLICATION TO DUAL-FREQUENCY RADAR RETRIEVALS

D. MOISSEEV[12], A. VON LERBER[2], J. LEINONEN[3], J. TYYNELÄ[2]

[1] Institute for Atmospheric and Earth System Research / Physics, University of Helsinki, Finland

[2] Finnish Meteorological Institute, Helsinki, Finland

[3] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

dmitri.moisseev@helsinki.fi

Since the launch of NASA Global Precipitation Mission and continuous proliferation of cloud profiling sites equipped with multi-frequency radars, operated by e.g. DOE ARM or the European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases (ACTRIS), there is a renewed interest in deriving ice cloud and precipitation properties from multi-frequency radar observations. To develop a robust retrieval method, snow microphysical properties, such as particle size distribution and mass-dimensional relations, need to be parametrized. Additionally, these properties have to be linked to radar observables. Both steps present a challenge.

To improve our knowledge of snow microphysics and to derive parametrization characteristic to high-latitude snowfall, comprehensive snow measurements at the SMEAR-II research station of University of Helsinki located in Hyytiala, Finland are being carried out since January 2014. Using observations of precipitation accumulation, PSD and particle fall velocity snowflake masses are derived using the general hydrodynamic theory. There are several ways to describe the PSD of ice particles, in this study we have adopted the normalized PSD approach and expressed the PSD as a function of the melted equivalent particle diameter, which provides an unambiguous measure of particle dimension. From the analysis of more than 40 snowfall cases, we have observed that generalized Gamma distribution provides a better fit to the data than the standard Gamma PSD used in many studies. Additionally, we have found that the observed snowflakes are typically larger and heavier than in the currently used parameterizations.

To link these findings to multi-frequency radar observations, forward modelling study is performed. To model scattering properties of snowflakes we have used both "soft-spheroid" particle approximation and complex ice particle models. Scattering properties of "soft-spheroid" models were computed using T-matrix method, while single scattering properties of complex ice particles were taken from the existing scattering databases. It was found that the difference between two methods is not as big as was previously expected. Furthermore, it is found that snowfall rate retrievals can be greatly constrained by using dual-frequency radar observations. The parameters of the normalized PSD represented in the generalized Gamma form most suitable for dual-frequency radar analysis were also derived.