On applicability of spheroidal shapes to describe observed cloud radar depolarization ratios of ice hydrometeors

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Information on ice hydrometeors habits (shapes) is important for many practical applications ranging from modeling cloud radiative impact to remote sensing. Scanning radar polarimetric measurements provide an opportunity for estimating hydrometeor shape parameters. Cloud radars operating in the millimeter-wavelength region often measure only one polarimetric variable, i.e., depolarization ratio. This generally limits a number of potentially retrievable shape parameters. This study evaluates the applicability of a spheroidal particle model for describing depolarization properties of ice hydrometeors. For a given particle type (e.g., planar or columnar types), the spheroidal model is the simplest one describing a general particle shape by means of a single parameter, which is the aspect ratio. The evaluation is performed by means of comparisons of theoretical calculations of depolarization ratios with measurements of these ratios from scanning W-band cloud radar. Radar measurements were obtained during a three month field campaign conducted in Steamboat Springs, Colorado during winter months of 2010-2011. A large variety of ice hydrometeor species ranging from single pristine crystals to complex aggregates was observed during this campaign. It is shown that the spheroidal model results approximate observed depolarization ratios reasonably well. It is suggested that a slant linear (or circular) depolarization ratio difference between low angle and zenith radar pointing can be used for prospective remote sensing methods to infer particle aspect ratios from cloud radar depolarization measurements. The median value of this difference of -1.4 dB observed during the field campaign corresponds to aspect ratios of about 0.52 which agrees rather well with typical aspect ratios of ice particles as reported in literature.