Radar and lidar depolarization ratios of snowflakes

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Identification and classification of ice particles is an important step in deciphering microphysical processes that take place in ice clouds and precipitation. Given that shapes of ice particles are non-spherical, polarimetric radar or lidar measurements can be used for ice particle classification. Most cloud radars and lidars operate using nadir or zenith pointing. In this geometry, if compared to other polarimetric variables, (linear, volume) depolarization ratio measurements carry useful information about hydrometeor properties. To understand the relation between ice particle properties and depolarization signatures of snowflakes we have collected data during the winter 2021/2022. During this observation period our standard instrumentation that include W-band cloud radar, Vaisala CL61 ceilometer, NASA particle imaging package and weighing gauges was supplemented by University of Leipzig Video in Situ Snowfall Sensor (VISSS).

We find that enhanced radar LDR values tend to be caused by needles or aggregates. The impact of riming on radar LDR is not what we expect. Riming tends to decrease LDR, and not to increase as previously expected. This LDR behavior is another manifestation of "nonspheroidal scattering", previously observed in 3λ space. Lidar volume depolarization provides additional information and improves particle classification. Lidar volume depolarization reacts both to riming and aggregation. For example, riming of dendrites would increase the depolarization ratio from 0.1 to 0.65. Aggregates of dendrites will have depolarization ratios of 0.53, and needle aggregates 0.40.