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Scattering properties generated from real shaped ice crystals and snowflakes for ICON's Radar Forward Operator EMVORADO

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Radar Forward Operators (RFO) act as an important link between the physical properties of cloud and precipitation and the observed radar quantities. A major source of uncertainty in radar forward operators is identified in the scattering properties of frozen and mixed-phase hydrometeors. Appropriate modeling of the internal structures of complex-shaped hydrometeors plays a pivotal role in the simulation of their polarimetric scattering properties. When RFOs are applied to weather model output, it is also desirable to ensure the consistency between the properties of hydrometeors assumed in the weather model and those implemented in the scattering simulations. Failing to do so, would impede a correct interpretation of model-observation comparison studies. The present study aims to model the microphysical and scattering properties of realistic ice crystals and snowflakes using the snow particle aggregation and DDA scattering models. The aggregation model includes realistic monomer generators for various ice crystal shapes. The simulated scattering properties are implemented into the EMVORADO RFO of the ICON model. Simulated properties are primarily kept consistent with the ICON microphysical assumptions. The shapes of snowflakes and ice crystals (dendrites and plates) are generated from the aggregation model, and used as input to the DDA scattering model to compute multi-frequency polarimetric radar scattering properties. The derived scattering properties are expected to explain better the observed polarimetric radar signatures of ice crystals and snow aggregates. Nonetheless, when simulating the snowflake shapes, one must make some decisions regarding its monomer composition. This study also explores the use of the innovative Lagrangian-particle cloud model McSnow in combination with the snowflake aggregation simulator. McSnow is able to simulate the snowflake evolution based on the physical and thermodynamic profiles of clouds and thus informs the aggregation model about the snowflake composition in terms of monomer shapes, size, and number. The synergy of these models is expected to elucidate the link between ice cloud processes and the polarimetric properties of cold clouds.