Project: 1314
Project title: Snow Single-Scattering
Principal investigator: Davide Ori b381492
Report period: 2025-07-01 to 2026-06-30

Introduction and general comments

The Snow Single-Scattering computing project, connected to the DFG-funded PROM-PRISTINE initiative, aims to use the DKRZ computing resources to perform snowflake scattering simulations in the microwave. These simulations are used to enhance the capabilities of EMVORADO, which is the polarimetric radar forward operator for the ICON model.

The project has continued sustained production during the reported period. The main limitations encountered were connected to the limited human resources allocated to the project and the fact that some of them changed career path. Nonetheless a considerable amount of the expected goals have been achieved and the project is currently compelting its final phase. One publication is currently under review and 3 more are being finalized for subssion.

Description of the experiments

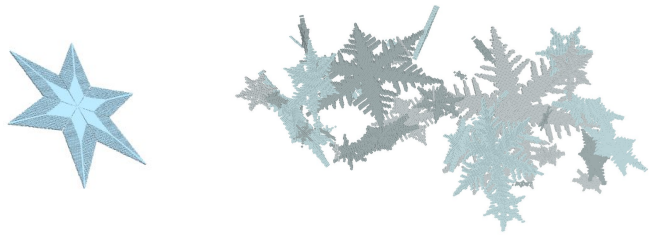

Figure 1: Rendering of two targets used for the scattering simulations. A pristine dendritic ice crystal on the left and an aggregate of dendrites on the right.

The first phase of the project focused on the most commonly found snowflakes in the database for representative single ice crystals and snowflake aggregates (Fig. 1). The next phase of the project involved the realization of a larger set of snowflake shapes representing the natural variability of such particles. This effort involved the simulation of thousandss of different snowflake shapes.

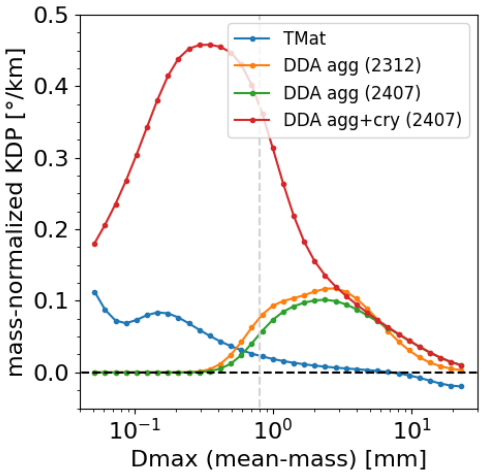

Figure 2: Comparison of normalized differential phase shift simulated with realistic DDA approaches in comparison with the legacy T-matrix simulations (blue curve). In particular the addition of individual oriented single crystals largely explain the known biases between observations and current simulation of the radar polarimetric properties of snowstorms.

This dataset has been implemented in the EMVORADO forward simulator of the ICON model. Despite the limits of the approach the implementation already demonstrated how the realistic simulation approach can fill the current gaps in observation-model comparison of polarimetric radar quantities. As an example Fig. 2 shows how the DDA scattering approach connected with a physically based prediction of ice crystal shapes can highlight the radar polarimetric response of frozen hydrometeors in terms of radar differential phase shift (KDP), while legacy approaches such has T-matrix continue to lack significant contributions. The results of this effort are currently being prepared for the submission to a scientific journal.

The results highlight how the simulation approach can identify the radar polarimetric signatures of frozen precipitation and pave the way for the direct assimilation of such observation into the numerical waether prediction framework.