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# Polarimetry-based hydrometeor classification from synthetic and measured radar observations for the evaluation of hydrometeor mixtures in numerical weather prediction models

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Polarimetric weather radars provide the opportunity to derive spatially and temporally high-resolved hydrometeor distributions to evaluate the representation of hydrometeors in the operational Numerical Weather Prediction (NWP) model ICON-LAM of the German Weather Service (DWD). However, differences in considered hydrometeor types in the model and radar-based hydrometeor classification schemes (HMC) complicate the task. Furthermore, ICON-LAM 2-moment scheme provides number and mass concentration of hail, graupel, rain, snow, cloud ice and cloud water for each model grid-box, while conventional radar-based hydrometeor retrievals indicate only the dominant hydrometeor class in in each radar volume.

In this study, a dual-strategy is proposed for model evaluation. A sophisticated HMC, adapted to the number and types of hydrometeors in the model is developed, which allows to estimate hydrometeor partitioning ratios from radar observations in two steps. First, radar measurements are clustered based on their multidimensional polarimetric signature similarity and afterwards a state-of-the-art HMC is used for the hydrometeor class identification of the resulting clusters. Secondly, the centroids derived from the multidimensional polarimetric clusters and their probability distributions are used for the determination of the hydrometeor partitioning ratios of the individual hydrometeor class. Using ICON's built-in radar polarimetric forward operator (PFO) EMVORADO (Efficient Modular VOlume scan RADar Operator) enables us to simulate synthetic radar observations from modelled hydrometeor distributions. Based on these tools, the dual strategy for model evaluation includes 1) the comparison of hydrometeor distributions derived from the measured and simulated polarimetric moments with the hydrometeor distribution simulated in ICON-LAM, and 2) a direct comparison of the simulated and measured polarimetric moments, which also provides feedback regarding the performance of the PFO and the HMC.

Comparisons of volumetric scans from DWD’s national C-band radars network for stratiform and convective case study days with model simulations revealed e.g. spurious graupel generation around the melting layer (ML). Furthermore, synthetic reflectivity (ZH) and differential reflectivity (ZDR) are too high in rain, most likely caused by raindrop size errors in the model.