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Evaluation of the COSMO model in polarimetric radar space – impact of uncertainties in model microphysics, retrievals and forward operators

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Polarimetric observation operators generate virtual observations from the models, which enable a direct comparison of observed and simulated radar signatures of microphysical processes. However, differences in polarimetric fingerprints between observations and models may result both from model deficiencies and faulty assumptions in observation operators. Using the Bonn Polarimetric Radar forward Operator (B-PRO), the evaluation of the German weather forecast model COSMO in radar observation space revealed deficiencies in the ice-snow partitioning and spurious graupel production near the melting layer. Follow-up sensitivity experiments with the model and forward operator (FO) guided the improvement of model parameters, namely the critical diameter of particles for ice-to-snow conversion by aggregation (Dice) and the threshold temperature responsible for graupel production by riming (Tgr), pushing the synthetic radar variables closer to the observations. However, the model still exhibited a low bias (lower magnitude than observation) in simulated polarimetric moments at lower levels above the melting layer (-3 to -13 ° C), where snow was found to dominate. Sensitivity experiments with the FO also could not explain this bias indicating shortcoming in the FO or missing cloud microphysical processes in the 2-moment cloud microphysical scheme of the model.