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Ensemble-based storm-scale analysis and prediction of severe convection: Single- vs double-moment microphysics

Axel Seifert, Alberto de Lozar, and Ulrich Blahak
Deutscher Wetterdienst, Offenbach, Germany (axel.seifert@dwd.de)

The next generation of numerical weather prediction (NWP) systems envisioned for 2020 will aim to predict the formation and evolution of individual deep convective storms. This is necessary to improve the severe weather warnings including hail, flash floods and severe gusts in the time frame from 0 to 12 h and transition from the current observation-based warnings to a warn-on-forecast strategy.
Here we study the impact of the bulk microphysical parameterization on the analysis and prediction of severe storms. Experiments are performed using the COSMO kilometer-scale ensemble data assimilation system (COSMO-KENDA) at horizontal mesh sizes of 1 km. KENDA is based on a four-dimensional local ensemble transform Kalman filter (LETKF) and 3d volume radar reflectivity and radial winds can be assimilated directly using an advanced radar forward operator.
The single-moment microphysics scheme of the COSMO model, which is currently operational in COSMO-DE, is compared with a more sophisticated double-moment scheme. The latter includes an explicit treatment of hail formation. In principle, the double-moment scheme does provide a better description of the microphysical properties and structure of convective storms and improves the simulated radar reflectivities. Simulations
that apply the single-moment scheme without hail often lack reflectivities that exceed 45 dBZ. With the double-moment scheme we can also explore more advanced features like the explicit prediction of melt water on graupel and hail. Whether the improved simulation of the cloud microphysics and storm structure does also lead to better forecasts is still an open question. We focus on the severe convection period of summer 2016 like, for example, the supercells and hail storms observed on 27 May 2016 in Southern Germany.