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Ensemble-based storm-scale analysis and prediction of severe convection: Assimilation of radar reflectivity

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Predicting severe convective storms remains challenging for numerical weather prediction (NWP) models. The chaotic behavior of the atmosphere implies that uncertainties in the initial conditions can quickly deteriorate the skill of forecast simulations, due to the fast growth of small errors. Improving the initial conditions through a better assimilation of observations can thus have very positive impact for predicting severe convective events.

Predictions of convective cells based on Nowcasting systems, which are mostly based on radar reflectivity observations, currently outperform NWP models for the first two forecasting hours. The assimilation of 3D radar reflectivities has thus a great potential to reduce uncertainties in the initial conditions of NWP models, and therefore to improve the forecasting skills. Ensemble-based data assimilation algorithms allow for the assimilation of radar reflectivities in a natural way, as they only require implementation of the radar forward operator, and have a large potential to improve the prediction of convective cells.

Direct assimilation of 3D radar reflectivities (as it is done with radiosondes observations, for example) in ensemble-based data assimilation algorithms does not always lead to a substantial improvement in the forecasting skills for individual storms. This can be partly explained because radar reflectivities are characterized by a very high spatial and temporal variability, thus conflicting with the Gaussianity assumption for observations of the assimilation method.

In this presentation we will focus on the assimilation of radar reflectivities in days with severe convective storms. We will discuss the challenges of assimilating radar reflectivities on the storm scale with an ensemble Kalman filter, and the different methods that we are testing to overcome these challenges. Examples of these methods are the transformation of the reflectivities into a more Gaussian variable, or the automatic trigger of warm bubbles to initiate convection when this is missing. We will discuss the impact of the new reflectivity assimilation methods on the short-time forecast (up to 12 hours), giving special emphasis on the prediction of the evolution of severe storms. The experiments are carried out with the combination of the Kilometer-scale Ensemble Data Assimilation (KENDA) system and the COSMO model from the German Weather Service. We focus on the period May-June 2016 over Germany, during which several severe storms were observed.