EMS Annual Meeting Abstracts
Vol. 10, EMS2013-270, 2013
13th EMS / 11th ECAM

High-resolution radar data assimilation using a Local Ensemble Transform Kalman Filter

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The prediction of convective events is a difficult task due to the non-linear and chaotic behaviour of the atmosphere on this scale. Therefore, data assimilation is crucial to enhance numerical weather prediction (NWP) for short lead times. In the project Object-based Analysis and SEamless prediction (OASE, part of the Hans-Ertel-Centre for Weather Research), an observation composite consisting of radar, satellite, and lightning measurements is currently under development. A possible improvement of short-term model forecasts of high-impact weather events could be given by the assimilation of this composite data. In a first step, the assimilation of 3-dimensional radar data with rapid update intervals will be investigated.
At the German Weather Service (DWD), a pre-operational Local Ensemble Transform Kalman Filter (LETKF) for the NWP model COSMO-DE was implemented (project KENDA: Km-scale ENsemble-based Data Assimilation). The LETKF is particularly suitable for this task, because it is able to deal with strong non-linearities in the model equations and provides a probabilistic forecast. Moreover, the LETKF offers the possibility to assimilate observations, which are not directly forecasted by the numerical model. Since the comparison between the observation and the model forecast is usually done in the observation space, an appropriate forward operator needs to be applied. For this purpose, a radar forward operator was developed at DWD and the Karlsruhe Institute of Technology, Germany. The radar forward operator allows the simulation of synthetic radar reflectivities and radial velocities of full volume scans, based on the COSMO-DE model output. However, the LETKF assumes Gaussian distributions, which are likely not valid on the convective-scale. Thus we will study, to what extent the forecast skill is affected by this violation and how rapid update cycles impact both forecasts at short and larger lead times.