Particle Filters for Convective Scale NWP

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Abstract

We discuss the setup of the ensemble data assimilation (EDA) and forecasting systems (EPS) which have been developed and are under development at the German Weather Service DWD and its COSMO partners.

DWD operates the ICON global+mesoscale model (two-way nested), 13km/6.5km resolution, with its hybrid ensemble variational data assimilation (LETKF+EnVAR) run on a 3h cycle, and the ensemble prediction system ICON EPS. Second, this system drives the high-resolution ensemble data assimilation system COSMO-KENDA (Kilometer Scale Ensemble Data Assimilation) with 2.2km operational resolution at DWD and up to 1km resolution at further members of the COSMO consortium (Germany, Switzerland, Italy, Russia, Poland, Romania, Greece and Israel) to provide initial conditions for the high-resolution ensemble forecasting systems, e.g. the operational COSMO-D2-EPS or experimental ICON-LAM EPS. The system is also successfully run on GPU based supercomputers.

Central part of the talk is to discuss and show results on the tests of localized adaptive particle filter (LAPF) and a localized Markov chain particle filter (LMCPF), which are being tested for the convective scale as well as global model setup, currently in the standard experimental global resolutions of 2.8km over central Europe and on the 40km resolution globally.

We discuss how to overcome filter collapse or divergence by adaptive rejuvenation, mapping into ensemble space based on spread estimators. We also discuss how to keep balances intact when drawing from probability distributions in combination with

localization. We employ incremental analysis update (IAU) for the ICON model system, whereas IAU is not used for COSMO on the convective scale. The LMCPF incorporates model error and explicitly calculates a posterior distribution in ensemble space based on radial basis function approximations of the prior. We show new results on the particle filter on the convective scale, where LMCPF now also shows stable behavior and good scores.

Different further versions of particle-filters and hybrid ensemble-particle filters are under test both for ICON on the global scale as well as for COSMO or ICON-LAM on the convective scale in collaboration with colleagues from ETH, Reading and Potsdam.

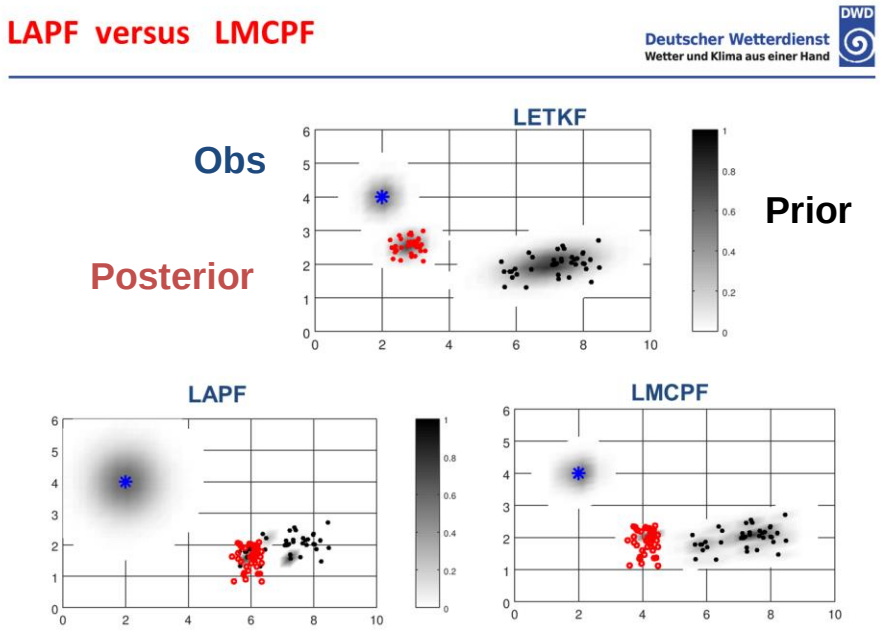

Figure: Basic Idea of LETKF, LAPF and LMCPF applied to a simple prior distribution and a measurement in tw o dimensions. Including Model error for each particle leads to the shift of particles in ensemble space for the LMCPF.

References:

- Roland Potthast, Anne Walter and Andreas Rhodin: A Localised Adaptive Particle Filter within an Operational NWP Framework. Monthly Weather Review 2018.
- Christoph Schraff, Hendrik Reich, Andreas Rhodin, Annika Schomburg, Klaus Stephan, Africa Perianez and Roland Potthast: Kilometer Scale Ensemble Data Assimilation for the COSMO Model (KENDA), QJRMS, Volume 142, Issue 696, pages 1453–1472, April 2016 Part A.