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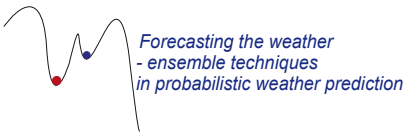

Development of 4D Relaxation Kalman Filter (4D-REKF) data assimilation for supporting weather-critical applications

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A Four-Dimensional Relaxation Ensemble Kalman Filter (4D-REKF) model system for mesoscale analysis and forecasting is being developed at NCAR. 4D-REKF integrates the recent advances in ensemble Kalman Filter (EnKF) data assimilation technologies into the NCAR operational real-time four dimensional data assimilation (RTFDDA) and forecasting system. In a nutshell, 4D-REKF is implemented by replacing the spatial weight functions in the standard Newtonian-relaxation station-nudging FDDA formulations with the Kalman gains computed with a local ensemble transform Kalman Filter (LETKF) approach. 4D-REKF retains and leverages the advantages of both the Newtonian-relaxation and the Ensemble Kalman Filter data assimilation schemes. It eliminates the ad-hoc specification of spatial weight functions in the current station-nudging FDDA formulation. Two algorithms have been implemented for computing the Kalman gains. In the first approach, the Kalman gain is computed using multiple-perturbation mesoscale ensemble forecasts; and the second approach uses the "climate forecast ensemble", i.e. the recent and past very short-term (3 – 12h) high-resolution model forecasts, as an alternative to the dynamical ensemble. Both approaches realistically consider the highly flow-dependent anisotropic covariance structures over complex terrain and thus achieve accurate analyses and forecasts by maximizing the observation impact and mitigating the dynamical imbalances. The first approach, aiming toward a formulation of a seamless ensemble data assimilation and ensemble prediction paradigm, forms a next-generation 4D weather system for the US Army. Nevertheless, the second approach, referred to as "4D-REKF-proxy", allows us to take the advantage of 4D-REKF without running mesoscale ensembles. 4D-REKF has been employed for real-time operational mesoscale weather analysis and forecasting experiment for the Army test ranges over complex terrain. The advantages of 4D-REKF and the improvements from the current RTFDDA-based operational system will be demonstrated.