Combined state-parameter estimation with the LETKF for convective-scale weather forecasting

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We investigate the feasibility of addressing model error by perturbing and estimating uncertain static model parameters using the localized ensemble transform Kalman filter. In particular we use the augmented state approach, where parameters are updated by observations via their correlation with observed state variables. This online approach offers a flexible, yet consistent way to better fit model variables affected by the chosen parameters to observations, while ensuring feasible model states. We show in a nearly-operational convection-permitting configuration that the prediction of clouds and precipitation with the COSMO-DE model is improved if the two dimensional roughness length parameter is estimated with the augmented state approach. Here, the targeted model error is the roughness length itself and the surface fluxes, which influence the initiation of convection. At analysis time, Gaussian noise with a specified correlation matrix is added to the roughness length to regulate the parameter spread. In the northern part of the COSMO-DE domain, where the terrain is mostly flat and assimilated surface wind measurements are dense, estimating the roughness length led to improved forecasts of up to six hours of clouds and precipitation. In the southern part of the domain, the parameter estimation was detrimental unless the correlation length scale of the Gaussian noise that is added to the roughness length is increased. The impact of the parameter estimation was found to be larger when synoptic forcing is weak and the model output is more sensitive to the roughness length.