Combination of inflation schemes in Local Ensemble Transform Kalman Filter (LETKF) for improving thunderstorm prediction

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The ensemble data assimilation method have been challenged for its consistently underestimated ensemble spread resulted from imperfect model physics, nonlinear behavior of the atmosphere, and sampling errors caused by a limited ensemble size. This issue of insufficient ensemble spread was significantly found in the Local Ensemble Transform Kalman Filter (LETKF) system at Central Weather Bureau (CWB), which led to degraded forecast ability for convective-scale weather systems. To enhance the ensemble spread during the LETKF forecast-analysis cycle, two kinds of covariance inflation schemes are evaluated in this study, including relaxation to prior ensemble spread (RTPS) (Whitaker and Hamill, 2012) and random additive noises (Dowell and Wicker, 2009; Caya et al. 2005). Their impacts are evaluated with an afternoon thunderstorm case during August 2018 in Taiwan.

With the covariance inflation schemes, the analysis ensemble spread as well as the spread-error relationship are both improved. In addition, from the verification of short-term quantitative precipitation forecast (QPF), the originally under-predicted precipitation without the inflation could be mitigated with the combination of RTPS and random additive noise inflation schemes, and the 6-h QPF are clearly improved. However, in the verification against surface observation, benefits are found for the first 3 forecast hours in humidity, but surface temperature and wind speed forecast are slightly degraded. More case studies as well as sensitivity experiments regarding several parameters in the inflation schemes will be conducted in the near future.

Keywords:Local Ensemble Transform Kalman Filter (LETKF), Covariance Inflation, Ensemble data assimilation