



Impact of model bias on a hybrid data assimilation system

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In order to explore the impact of model bias on ensemble background error covariance (BEC) and a hybrid data assimilation system, a random model perturbation of the Linear Tendencies Bias Correction method was designed using GRAPES-REPS (Global and Regional Assimilation and Prediction Enhanced System–Regional Ensemble Prediction System) and GRAPES-MESO hybrid En-3DVar-TD-HLS (Ensemble three-dimensional hybrid data assimilation for Global/Regional Assimilation and Prediction system with Topographic Dependent Horizontal Localization Scale scheme), referred to as LTBC_SPPT, and compared with the multi-physical processes scheme method (referred to as MP) and the multi-physical processes with Stochastically Perturbed Parameterization Tendencies scheme method (referred to as MP-SPPT). For 7-day ensemble forecasts (1200 UTC 5 July 2015 to 1200 UTC 11 July 2015), the characteristics of the ensemble BEC, which is required for the GRAPES-MESO hybrid En-3DVar-TD-HLS system, were analyzed for these three methods; otherwise, 7-day hybrid data assimilation forecasts (0000 UTC 6 July 2015 to 0000 UTC 12 July 2015) were conducted. The results of the ensemble forecasts showed that LTBC_SPPT has better consistency [ratio between the root-mean-square error (RMSE) and spread] between the ensemble spread and the ensemble RMSE for wind and Pi (dimensionless pressure) at low model levels. Meanwhile, another advantage of this scheme also can be detected that correlation coefficient between the 12-hour ensemble spread and the ensemble mean forecast error of wind is slightly larger than other two schemes, and, of Pi is much larger from level 1 to level 22 and level 35-49. Besides, the single-point correlation of background errors at the 6th model level indicated that all data assimilation systems with respect to the three schemes have flow-dependent characteristics. As we know, a small ensemble size can induce false correlation between distant points. Our results from hybrid experiments show that this possibility can be reduced by the LTBC_SPPT scheme. In addition, the improvement is visible in the quality of the analysis fields produced by the data assimilation system with the LTBC_SPPT scheme. That is, the analysis fields produced by LTBC_SPPT have much smaller RMSE than those of the other two schemes, for all vertical model levels. The quality of the forecast fields can also be improved by this scheme. Furthermore, the improvement is much greater in the early stage of the cycle than the late. Generally, the quality of the hybrid data assimilation of GRAPES-MESO hybrid En-3DVar-TD-HLS can be efficiently improved by the LTBC_SPPT scheme.