Critical comments

Since this study is very close to my work, I have read it with great interest and would like to provide some comments for your consideration.

1. I wonder why rotation is omitted in this work. The model can not run with both rotation and orography (it is found in the code that there is no initialization routine for such case)? Since authors attempt to assess the relevance of this study for the real-data convective-scale data assimilation, it would be very interesting and even necessary to show the impacts on rotational and divergent part of dynamics (A similar study but for large-scale data assimilation study has been done by Zeng and Janjic 2016, showing the importance of reconstruction of the rotational part). However, the behavior may be different from the large scale. From this point of view, a study with rotation may be more appealing than with orography (Note: there is no discussion on importance of orography in this study).

2. Experimental settings: 1) The observational resolution is 50 km, which is much coarser than that of observations usually used in convective-scale data assimilation, e.g., resolution of Doppler radars $\sim O(1\ km)$. Therefore, from this point of view, it can not be considered as convective-scale data assimilation. 2) On one hand, to evaluate the skill of spread, a metric called "the spread skill ratio" (Aksoy et al., 2009) is often used, which is calculated as (Spread+Obs. Error)/RMSE. It is optimal if equal to 1. In this study, Spread/RMSE is used, which neglects the observation error and therefore results are probably underestimated. However, on the other hand, considering that the (truncation) model error could be accounted for by the specific additive inflation (the similar method is applied in Zeng et al. 2019, Zeng 2020), additional use of inflation like relaxation methods may result in overestimated spread, which may compensate the deficiency of Spread/RMSE. In my opinion, (Spread+Obs. Error)/RMSE should be used, and the tuning interval of relaxation factor should be efficiently chosen, currently a great part of experiments with larger relaxation factors are not necessary. To my experience, the additive inflation may be already sufficient to maintain the spread (A related study can be found in Zeng et al. 2018).

3. Miscellaneous: 1) There are adaptive RTPP and RTPS but the ones used in this study are obviously not adaptive (see Kotsuki et al. 2017; Ying and Zhang, 2015). 2) How is additive inflation Gaussian? and why are correlations are ignored? We have done similar study (Zeng et al. 2019), those additive perturbations are not Gaussian and we have not explicitly removed the correlations. 3) The typical lead time length for convective-scale data assimilation is 6 hours, instead of 3 hours used in this study. Furthermore, to validate forecasts, it would be more informative to see the plots of variations of RMSE with the lead time.

To sum up, I believe that this framework can be very useful for the community of convective-scale data assimilation, but the presentation needs to be greatly modified.

Reference

Zeng, Y., T. Janjic, A. de Lozar, S. Rasp, U. Blahak, A. Seifert, G. Craig, 2020: Comparison of methods accounting for subgrid-scale model error in convective-scale data assimilation. Monthly Weather Review, 148, 2457-2477.

Zeng, Y., T. Janjic, M. Sommer A. Lozar, U. Blahak, A. Seifert , 2019: Representation of model error in convective scale data assimilation: additive noise based on model truncation error. Journal of Advances in Modeling Earth Systems, 11, 752-770.

Zeng, Y., T. Janjic, A. Lozar, U. Blahak, H. Reich, C. Keil, A. Seifert, 2018: Representation of model error in convective-scale data assimilation: additive noise, relaxation methods and combinations. 2018, Journal of Advances in Modeling Earth Systems, 10, 2889-2911.

Kotsuki, S., Ota, Y., and Miyoshi, T.: Adaptive covariance relaxation methods for ensemble data assimilation: experiments in the real atmosphere, Q. J. Roy. Meteor. Soc., 143, 2001-2015. 2017.

Zeng, Y., T. Janjic., 2016: Study of Conservation Laws with the Local Ensemble Transform Kalman Filter. Quarterly Journal of the Royal Meteorological Society, 142, 2359-2372.

Ying, Y. and Zhang, F.: An adaptive covariance relaxation method for ensemble data assimilation, Q. J. Roy. Meteor. Soc., 141, 2898-2906, 2015.

Aksoy, A., D. C. Dowell, and C. Snyder (2009), A multiscale comparative assess700 ment of the ensemble kalman lter for assimilation of radar observations. Part I: 701 Storm-scale analyses, Mon. Wea. Rev., 137, 1805-1824.