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Geoscientific Model Development Discussions

Interactive comment on "Applying a new integrated mass-flux adjustment filter in rapid update cycling of convective-scale data assimilation for the COSMO-model (v5.07)" *by* Yuefei Zeng et al.

Anonymous Referee #1

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The paper introduced a new integrated mass-flux adjustment filter in Ensemble Kalman Filter (EnKF) to correct the analyzed wind field and suppress the unphysical increase of the surface pressure tendency in the analysis. An idealized supercell storm was used to examine the performance of the new filter. The root-mean-square error, ensemble spread, cool pool, surface pressure tendency, and supercell detection index were investigated. The results show that the new filter slightly degrades the analysis accuracy, which is still acceptable, but this filter alleviates the imbalance problem caused by the data assimilation. The forecast skill in terms of fractions skill scores (FSSs) of reflectiv-

ity composite and the number of spurious convection is improved after using the new filter. This paper is interesting and well-written. I recommend that the paper should be accepted with Minor revisions and I include my few comments below.

Specific comments L5-6: Readers who are not familiar with dynamic problems associated with data assimilation may be confused with the words: "suppress the increase of the surface pressure tendency in the analysis". Please spend a bit more words on why the increase of the surface pressure tendency in the analysis should be suppressed.

L63-66: Why exclude the vertical mass flux?

L76-78: How to understand the words: "a realistic integrated mass-flux divergence if this variable is directly updated?" Do authors mean that using the cross-variable covariance between observations (e.g., HX of Vr and HX of Z) and the integrated mass-flux divergence to update? If so, please directly tell readers how to update the integrated mass-flux divergence and think about whether the word "realistic" is suitable here, because an accurate analysis depends on the accuracy of covariance which is not also reliable in EnKF especially in the first few cycles.

L91-92: Please tell the physical meaning of this function. Why design the function in the form of Eq. (5).

L105: Please briefly list some key points of configurations in Zeng et al (2020b)

L115: If possible, add a plot of radar locations or list the radar locations. I am not sure whether radars observed the entire storm, especially at low levels. Without low-level airflow information, the analysis of integration mass-flux divergence may not be accurate as expected.

L124: Environment errors were introduced? A brief description of the difference between profiles will be appreciated.

L126: Why is 0.75?

Figure 3: It seems that the imbalance mass flux mainly affects the first few cycles. The amplitudes of surface pressure tendency in E_VrZ_6m are not much larger than those in E_VrZ_6m_f after the first few cycles, except for those after 14:30 UTC. If stop using the mass-flux filter after the first several cycles, what will happen? In addition, please adjust the position of the legend in Figure 3b (the right one).

Figure 4: The loss of accuracy is OK, but it is better to concern the relatively rapid increase of forecast error in u just after 14 UTC. Reducing mass-flux error does not certainly ensure a lower forecast error? Additionally, in some analyses after 14 UTC, the RMSE of qr becomes larger after analysis. It seems that the cross-variable error covariance is not so reliable after using the mass-flux filter. A bit more discussion on the potential negative impact of using the new filter will be helpful for others who would like to adopt the filter.

Figure 5: It is a good result, but what is the physical relationship between the mass-flux filter and this better cold pool? Is it valid in most cases or is case dependent?

L180-181: Please directly point out what is better. The areas of spurious convection are smaller? The environment perturbation may also introduce spurious convections. How to extract the contribution of the new mass-flux filter from the final forecast results?

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