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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 #2

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This manuscript proposed a new integrated mass-flux adjustment filter. For the convective-scale data assimilation, data assimilation cycles from a twin experiment showed that the integrated mass-flux adjustment preserved the main structure of cold pools and primary mesocyclone properties of supercells, although it degraded the priors and posteriors. The 3-h free forecast showed that the integrated mass-flux adjustment obtained more skillful forecasts after one hour and alleviated the imbalance caused by data assimilation, although the surface pressure tendency showed a spin-up feature. The integrated mass-flux adjustment for the LETKF is applied for rapid update

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cycling of convective-scale data assimilation in this study, but it can also be applied for synoptic-scale data assimilation. Imbalance caused by intermittent data assimilation is an essential problem, especially for applications favorable balanced atmospheric states. The manuscript is scientifically sound and well written. My recommendation is between minor and major. Please see detailed comments as below.

1. l28-30, this statement about IAU is unclear. There are four-dimensional IAU (4DIAU) that takes into account temporal variations of increments and has advantages over the commonly used 3DIAU (Lei and Whitaker 2016). Thus the IAU could be suitable for rapid cycling with short data assimilation windows. Moreover, a recent study showed that with more frequent updates, i.e., short data assimilation windows, the imbalance caused by data assimilation is reduced, while the 3DIAU/4DIAU are still helpful to reduce the imbalance but with smaller impacts (He et al. 2020).

2. l92-93, how the integrated mass flux method be sensitive to the choice of f(z)? Any validation for the choice of f(z)?

3. l120-121, it would be helpful to give the function of vertical localization length scales.Âă

4. l133-134, how to get the priors and posteriors of the deterministic forecast for the assimilation cycles? This question also applies to the plot contents of Figures 3-6.

5. l148-149, is this the opposite? The correlations between integrated mass flux divergence and surface pressure tendency are mainly “inside” the convective regions?

6. l157-159, it would be helpful to provide some explanations for the degradation of errors caused by the integrated mass flux divergence. Intuitively, by adjusting the integrated mass flux, a more balanced analysis could be obtained, which is preferable for improved forecasts. Could this intuitive hypothesis be true for large scale applications? Since E_VrZ_6m_f has larger errors and spread than E_VrZ_6m, especially for later times, E_VrZ_6m_f might have smaller increments than E_VrZ_6m. The smaller

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increments might not be large enough to correct the prior errors, although it is better balanced?Âă

7. l175, why the spin-up shows in E_VrZ_6m_f but not in E_VrZ_6m? Since the spin-up show in E_VrZ_6m, does it mean that the adjustment based on integrated mass flux is too much?Âă

8. l178-86, the results of forecasting are based one forecast launched at 15:00 UTC. To draw statistically significant conclusions, more than one forecast is preferred. Can the forecast be launched at different hours, so that more general conclusions can be obtained?

References: H. He, L. Lei, J. S. Whitaker, and Z.-M. Tan, 2020: Impacts of Assimilation Frequency on Ensemble Kalman Filter Data Assimilation and Imbalances. J. Adv. Model. Earth Syst., 12, e2020MS002187, doi: https://doi.org/10.1029/2020MS002187.

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