

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2022-112

Anonymous Referee #1

Referee comment on "A local data assimilation method (Local DA v1.0) and its application in a simulated typhoon case" by Shizhang Wang and Xiaoshi Qiao, Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-112-RC1>, 2022

Review of "A local data assimilation method (Local DA v1.0) and its application in a simulated typhoon case" by Wang and Qiao

This work introduces a local DA method to perform hybrid and simultaneous multiscale DA for each grid or column group individually. Both model- and observation-space localizations are implemented in this method. The OSSE with a simulated typhoon case is used to assess the method. This study examines the impacts of hybrid covariances vs. pure dynamic covariances, fixed localization vs. multiscale localization, and compares the relative effects on the reduction of analysis errors between hybrid covariances and localization. Finally, they explore the discontinuity issue by the CG method and the computational cost issue. Generally, this is an interesting work, and the Local DA method is attractive. However, I don't feel the authors presented convincing results that their new developments are actually useful, undercutting their efforts. I suggest a major revision before accepting for publication.

Major comments:

- Section 2.2: can the authors provide on details on the realization of the multiscale localization analysis from a formula perspective? For example, what does the control variable V_0 look like in the multiscale localization approach? Does it need to be extended to realize the multiscale localization approach compared to the fixed

localization approach? How is the Cmo is changed? How is the increment defined in this approach? Without these details, it is hard for the readers to follow the realization of this approach.

- L235: is the static correlation always identical to all variables? I do not think it is realistic. For example, convective-scale variables usually have a smaller spatial correlation length than horizontal winds and temperature. The authors need to give some explanations on how they solve this issue in the static correlation.
- L240: what is the purpose to force the second term on the RHS of Eq. (14) to zero? If it is desired to force cross-variable covariances to zero, could the authors comment that how to realize the update of unobserved variables in this Local DA method?
- Section 3.1: what is the performance of the simulated typhoon against the observation? It is better for the nature run in OSSE to agree with the real atmosphere within predefined limits, according to Hoffman and Atlas (2016, BAMS).
- L365: Please elaborate on how these localization lengths and wavebands are selected. Given the deficient ensemble used in this study, a broad localization may significantly degrade the analysis. For example, I could imagine that LDA_ctrl will obtain worse results as a fixed localization of 200 km is used to assimilate radar observations. You may add a subsection in the results part to discuss the selection of these parameters or the sensitivity to these parameters.

Minor comments:

- L160: If only observation "u1" is available, Eq. (7) seems to be incorrect. Is this a typo? Should it be "where observations "u1", "u2", and "ps" are available"?
- L180: remove "s" after elements
- Section 2.4: the author may need to provide some results of the bandpass filter. What do the perturbations at each decomposed scale look like?
- L390-395: The inefficient minimization may be caused by the assimilation of radar reflectivity due to the use of the mixing ratios as state variables. Too small hydrometeor mixing ratio values can lead to overestimated cost function gradient. See Sun et al. (2005), Wang and Wang (2017), and Liu et al. (2021).
- L425: Please elaborate on the comparison between LDA_OS and LETKF_OS. The current statement is difficult to follow.
- L429, L434, L475: As said in the above major comment e, I am wondering if a tight localization length can reduce this noisy analysis as the ensemble is deficient.
- L505: Does the number of wavebands affect memory usage? if so, how is the memory is affected when increasing the number of wavebands? Can you discuss this as well?