

Review of “Data assimilation of radar reflectivity volumes in a LETKF scheme ” by Thomas Gastaldo et al.

General comments:

I do recognize the authors’ efforts on assimilating the radar data in their regional data assimilation system, KENDA. However, I felt that the setups of the experiments cannot clearly illustrate the impact of radar reflectivity on precipitation prediction, given that radar information has been injected into the model state through latent heat nudging. Also, with a high-resolution setup, it is somewhat surprising that there is no benefit from more rapid updates. I am also concerned a potential systematic underestimation of precipitation (and humidity) when a strong dependence on radar data is tested. These seem to lead to issues of radar data quality or how the authors handle the raw radar data.

Based on these concerns, I will recommend major revision for this manuscript and hope the authors can address the following comments in their revised manuscript.

Major comments:

1. I understand that the assimilation configuration used in this study attempts to be close to the operation settings as much as they could. However, a big question is whether the justification of the impact from radar data on precipitation is fair, given that the precipitation nudging is always applied and the observations for verification contains both information of radar and surface rain gauges. Is it possible to conduct experiments without LHN for clean comparison? E.g. an experiment assimilates conventional data only and compares with the experiment that assimilates conventional and radar data. And, compare the results with the rain gauges data?
 - Does the result imply that LHN is more effective than radar data assimilation?
2. Intuitively, the assimilation of radar data is expected to improve the precipitation. It doesn’t seem to be a reasonable choice to me that only examining the absolute value of the components of SAL, without trying to distinguish the possibility of overforecasting or underestimation of the precipitation.
 - In most of the literature using radar data, the impact is mostly seen in the first 6-h forecast and some even only last for 3 hours. Do the authors see a clear impact for the 1-h or 2-h lead time?
3. It is not too surprising to me that rad60_BM has a worse performance since the perturbations used to augment the ensemble-based background error covariance may be in larger scale. I will suggest either remove this experiment or illustrate the reasons that degrades the performance.
4. It is unclear to attribute the degradation of using a sub-hourly assimilation window to location of rainfall nuclei (Page 13, line, 4). Can the authors explain why a more rapid update (15 or 30-min window) lead to a worse performance than the one using a 60-min window since using a short assimilation window does not introduce the imbalance issue?
5. The authors explain that a larger A component in SAL with the use of small observation error (roe0.5) is due to a systematic underestimation of the average precipitation over the domain or as the example showing a result of decreased humidity. With a strong confidence in observations, such results will be highly

dominated by the characteristics of the radar reflectivity data. Do the authors observe that the rain estimated by radar data is underestimated as compared with the rain gauge data? Is there a calibration issue such as the attenuating effect in radar data or the QC procedure ($O-B > 5\text{dBz}$) before the superobservations were constructed?

- In the experiments of rad60_roe10 and rad60_roe0.5, is the QC during assimilation the same?
 - I don't quite follow with the rationale in the last paragraph on Page 15. With rad15_roe0.5, It should be the assimilation introduces the small-scale features, instead of losing the ability to "correct" the small-scale errors. To verify this, I suggest that the authors can compare the KE spectrum before (background) and after (analysis) assimilation.
6. Information and setups about Radar data assimilation are not clear.
- Although Bick et al. (2016) had described the operator characteristics, and other radar data management. It will still be essential for this paper to briefly provide the important information related to data assimilation. For example, the volume used to construct the superobservation (degree, gate, etc..?). Are all the radar data from different observation intervals with different radars used for constructing the superobservations?
 - Page 7, line 6: Is there a precondition to reject ($O-B > 5\text{dBz}$) to avoid large innovations associated to non-precipitating signals? If ($O-B > 5\text{dBz}$), doesn't it mean that observation tend to have more rain water? Are the assimilation/forecast results sensitive to such choice?
 - If the horizontal grid-spacing of the analysis domain is 2.2km, isn't it too coarse to have superobservations with resolution of 10km?
 - Since Bick et al. (2016) used an observation error of 10dBz, is there a particular reason why this study reduces the observation error to 5dBz?
 - Page 7, line 28: Isn't the radial velocity also assimilated? It's not clear to me why the authors only emphasize on the contribution from reflectivity.

Minor comments

Please provide the following Information

- Page 3, line 28: what is the model top of the model?
- Page 5, line 4: please spell out the full name of the ICON model.
- Page 5, line11, 14: It's not clear the composite map is composed by what data? Radar only? Or weighted average with the surface rain rate? Is this the same as the observations employed to perform SAL? (Page 9, lines 16-17)
- Page, 7, line19: I would suggest to cite the original reference for the LETKF scheme: Hunt et al. 2007.
- Should I assume that the horizontal grid-spacing of the domain for assimilation is 2.2km?
- Page 10, line 20: "observed rainfall field consists of at least 1000 grid points"=> It would be better to change the observed target based on the definition of area (e.g. 50km x 50km?).
- Page 16, line 3-4: Actually, a lot of efforts have been devoted to assimilation of radar reflectivity data already. I am not sure why the authors have such statement.