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Atmospheric Measurement Techniques Discussions

Interactive comment on "Implementation of a GPS-RO data processing system for the KIAPS-LETKF data assimilation system" *by* H. Kwon et al.

Anonymous Referee #2

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This contribution discusses observation processing for GPSRO observations in a pair of forecast systems. First, GPSRO observations are processed using the operational global model at KMA. The background error statistics of the prior estimates of GPSRO observations with and without the observation processing are compared. Second, the GPSRO observations are used in a pair of data denial experiments with an LETKF assimilation system with a low-resolution climate model, CAM-SE. A control assimilates only radiosonde observations and surface pressure while a second two-week experiment also assimilates GPSRO. The spread and adaptive inflation of the two cases are compared. In addition, the ensemble mean analyses are compared to an externally

produced reanalysis product. The case that assimilates GPSRO is found to have reduced spread, especially in areas that have limited radiosonde coverage, and reduced differences from the reanalysis.

The results presented show that the observation preprocessing with the operational KMA system leads to the rejection of observations that disagree with the prior estimates. While this is a necessary condition for a reasonable preprocessing system, it is not possible to conclude much from the results. In particular, there is no evidence presented to support the conclusion that the observations being rejected by the background checks are fundamentally problematic. It is possible that good observations are being rejected in places where the model background is particularly inaccurate. A more careful analysis and comparison to other established operational quality control systems would be useful additional information to increase confidence that the background check is functioning appropriately.

The description of the observation processing system for the ensemble assimilation is not as clear as it could be. It does not seem that any information from the prior ensemble statistics is used in the quality control although this is one of the great advantages of having an ensemble system. Instead of using some multiple of a specified observational error variance to determine if a prior is too far from the observation, ensemble systems can also incorporate information from the prior ensemble spread to determine the rejection threshold. If the system did use this type of quality control, it should be made clear.

Also unclear is exactly how the background check was implemented. The report states, "...whereas our CAM-SE background is the forecast from the analysis assimilating sonde and surface pressure station data only". This seems to indicate that the quality control was done only using the first LETKF case with no GPSRO assimilation. A more appropriate approach would be to do the data processing as an integral part of the GPSRO assimilation case as one would do with an operational system. Again, the authors should make sure to clarify exactly what they did and why.

The first results shown comparing the two LETKF cases display differences in spread. The reduced spread in the case assimilating GPSRO is argued to be an indicator of a correct implementation. However, there is no attempt to validate the correctness of the spread in either system through, for instance, a spread/skill analysis or the use of tools like rank histograms. The spread decreases in places where there are few sondes, as one would expect, but again, this is only a necessary condition for a correctly functioning system.

The authors do provide a comparison of ensemble means to an independent reanalysis and this does show that, on average, errors are reduced using the GPSRO. However, the impacts are quite mixed in sign, even in the southern hemisphere, and appear to be negligible in the northern hemisphere. The impact appears to be quite small compared to similar published data denial experiments. I recommend that the authors compare their error change results to other published examples from the early years of GPSRO observations. Finally, it would be a good idea to compare the forecast fits to observations within the LETKF systems, rather than just comparing to an external reanalysis.

In summary, it's difficult to use these results to assess much about the correctness of the implementation. Comparison to similar data denial activities in a well-tested system would provide much more information.

The authors briefly discuss localization of GPSRO impact and suggest that they might limit it to only impacting T state variables. There is a lot of published work on localization including multivariate localization. This work supports the idea that different localizations for different types of state variables is often appropriate, but definitely does not suggest that completely eliminating impact on winds would be appropriate. If the authors do explore this, they should carefully evaluate the effects on the balance of model forecasts.

Minor comment: Figures 3a,b, 4a, 5a, b: Can't see the dotted count in the figure.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 11927, 2014.