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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Data assimilation of radar reflectivity volumes in a LETKF scheme" *by* Thomas Gastaldo et al.

Anonymous Referee #1

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In this paper several experiments are conducted to explore the sensitivity of a convective scale ensemble-based data assimilation system to the: length of the assimilation window, inclusion of additive inflation, variance of the reflectivity error. The experiments are conducted using real radar observations and combining latent heat nudging with the assimilation of conventional observations and radar reflectivity.

Although the topic is relevant and the experiments presented by the authors are interesting I think that some aspects of the manuscript needs improvement. I give details of these in the following comments.

Major comments:

Some aspects of the presentation needs to be improved. For example, some para-

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Discussion paper

graphs needs to be reorganized to improve the clarity of the manuscript. Also some figures can be merged in order to reduce the total number of figures in the paper. I provide examples of these changes as minor comments.

In this paper Latent Heat Nudging is combined with “direct” assimilation of radar reflectivity using EnKF. The introduction suggests that what is examined in this paper is the assimilation of radar reflectivity, however all the experiments use Latent Heat Nudging of precipitation estimated from radar reflectivity. I feel that the objective of the work should be reformulated since what is being explored is the added value of the LHN with “direct” assimilation of reflectivity. In this context an experiment which do not used LHN will also provide interesting results for comparison and discussion and will strength the conclusions. Also, if this is the focus of the paper references of previous work discussing these issues should be included in the introduction. I believe that LHN and EnKF has been combined in the development of the Rapid Update Cycle developed for the US.

Minor comments

P1L6 - We evaluated the impact or In this work the impact of . . . is evaluated P1L8 - SAL is not described. P1L9 - Missing stop before Results P1L12 of additive inflation P1L19 from the issue of . . . to decision making in . . . P1L22 - convection allowing models are a significant improvement in this direction. I think this should be mentioned explicitly because it allows the use of reflectivity data to improve the initial conditions. P2L9 - can you provide a reference for this? P2P14 - Recently particle filter has been successfully applied to convective allowing data assimilation see for example: Poterjoy, J., 2016: A Localized Particle Filter for High-Dimensional Nonlinear Systems. Mon. Wea. Rev., 144, 59–76, https://doi.org/10.1175/MWR-D-15-0163.1 P2L25 There are some previous work as well that deal with the issue of assimilation reflectivity in an EnKF starting (as far as I know) from the following paper: Snyder, C. and F. Zhang, 2003: Assimilation of Simulated Doppler Radar Observations with an Ensemble Kalman Filter. Mon. Wea. Rev., 131, 1663–1677, https://doi.org/10.1175//2555.1 P2L29 I think

this sentence may need more clarification. There is no mention to non-linear effects. I believe that one of the main reasons why a short window is desirable is because non linear effects will become important for longer windows. P2L32: Why when reflectivity volumes are assimilated the window length becomes more crucial? P3L1 by the use of short localization scales. P3L2 replace instability by imbalance (this also applies to other parts of the manuscript). P3L6 are known P3L4 In this paragraph the issue of observation error correlation should be mentioned as an additional challenge when dealing with radar data assimilation Figure 2, 3 and 4 can be merged into one single figure. P4L14 Is this scheme an online estimation scheme? What is the horizontal localization scale used in the experiments? P5L4 A discussion of possible implications of using a B matrix designed for low resolution models should be presented here. It would also be good to discuss previous work that shows positive impact associated with the inclusion of additive noise for convective scale data assimilation: Dowell, D.C. and L.J. Wicker, 2009: Additive Noise for Storm-Scale Ensemble Data Assimilation. J. Atmos. Oceanic Technol., 26, 911–927,https://doi.org/10.1175/2008JTECHA1156.1 P5L13, the paragraph starting here should be merged with the previous paragraph. P5L15 remove the :). Also it would be good to provide a reference for the quality control that is applied to radar data in general. How is the issues associated with complex terrain handled in this case (e.g. beam blocking) P6L1 This sentence is not clear please revise it. Figure 3 should include the effect of beam blocking to have a better idea of the area actually covered by the radar P6L15 Here it would be nice to add a reference for the data quality control. P7L5 Is the superobbing approach used also in the vertical? Is the superobbing considered in the observation operator as well? P7L10 What do the authors mean by “on average along the vertical”? P7L13 In this section a description of the experimental setting is presented. The clarity of the first two paragraphs needs to be improved. For example some operational systems are mentioned that are not used in the rest of the paper. It would be good to have a comparison between the operational systems and the experimental system, but in this section only the information regarding the experiments should be included. Table I caption, replace

trial by experiment Which is the output frequency of the model for the data assimilation cycle? P8L13 from February 3rd to February 7th P8L16 new precipitation systems Verification: It would be nice to show some examples of how the analysis look like and how the forecast look like in comparison with the observations. This will help to have a general idea on how well the system is working and how accurate the forecasts are. The figure in which the areal averaged precipitation is shown is based on the use of dependent data for the verification of the assimilation system. The authors said that since all the experiment are verified in this way this should not be a problem. However for me this is not convincing, since validating with dependent data might not detect issues like overfitting. An analysis closes to the observation is not necessarily the best analysis. P9L15 Describe the SAL acronym P9L17 Here the authors said that SRI observations are not independent, however the SAL approach is applied to the precipitation forecasts and not to the analysis. In this sense the observations are independent because these observations has not been assimilated yet. P9L30 Please provide more detailed explanation on this limitation of SAL. My understanding from this paragraph is that SAL can only work with one precipitation system at a time. But this is difficult to guarantee even if the domain is very small as proposed by the authors. P10L16 Only results concerning 1 mm are shown. Are the results sensitive to the threshold used in the SAL method? Can the authors comment on the results obtained with other thresholds as well? P12L8 It is not clear how the kinetic energy spectra can be used to identify the effect of the imbalance. May be the evolution of the spectra with the forecast lead time would be a better tool to detect the presence of small scale noise that arises as a consequence of the assimilation of observations (in a similar way as it is done with pressure tendencies).

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