Atmospheric Measurement Techniques Discussions

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Comment on amt-2021-95

Anonymous Referee #2

Referee comment on "Interpreting estimated observation error statistics of weather radar measurements using the ICON-LAM-KENDA system" by Yuefei Zeng et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-95-RC2, 2021

Zeng et al present an interesting paper about observation error statistics for radar reflectivity and Doppler radar wind measurements. Their study includes an estimation of the covariances arising from the error due to unresolved scales based on model data, and estimation of the full observation observation error covariances using the Desroziers et al (2005) assimilation diagnostics method. While the results for the Desroziers et al (2005) diagnosis of the Doppler radar winds are a little incremental (these have been published for a previous version of the DWD KENDA assimilation system by Waller et al, 2019), their comparison with the model-derived representation error statistics provided some fresh ideas. Furthermore, diagnosed estimates of the radar reflectivity error covariances have not been published in the mainstream literature before. I found the paper to be lacking a little background information, which might provide a deeper understanding of the results presented. I also had some minor questions about the experimental methods and results. I believe that these can be addressed very straightforwardly by the authors. My specific comments follow:

- There was very little review provided of the expected sources of uncertainty for the observations. I believe that giving this background could provide more insight in the results. For instance:

  (a) There is previous literature noting the dependence of the reflectivity error variability on the reflectivity value e.g.,

  Doviak, R. J., and D. S. Zrnic´, 1993: Doppler Radar and Weather Observations. 2nd ed. Academic Press, 562 pp.

  Xue, M., Jung, Y., and Zhang, G. (2007). Error modeling of simulated reflectivity observations for ensemble Kalman filter assimilation of convective storms. Geophysical research letters, 34(10).

  (b) Waller et al (2019) pointed out the contributions to the Doppler radar wind observation errors from the DWD superobbing scheme.

(c) How might reflectivity attenuation (in a heavy storm) affect the results?

- A little more information about the form of the operator T is needed. The reader should not need to access Zeng et al (2019) in order to understand what this operator does.

- Localization: Waller et al (2017) pointed out an issue using the Desroziers et al (2005) method together with localization, and provided some criteria to establish which observation pairs can be used in the calculation. Was this method followed in this paper? What is the localization radius used in the experiments?

  J.A. Waller, S. L. Dance, and N. K. Nichols, 2017: On diagnosing observation-error statistics with local ensemble data assimilation. Quart. J. Roy. Meteor. Soc., 143, 2677–2686, https://doi.org/10.1002/qj.3117.
- There is a further recent publication (Waller et al, 2021) providing model-based estimates of errors due to unresolved scales that are more appropriate for convection-permitting lengthscales than the earlier 2014 paper that is cited. The Waller et al (2021) statistics for zonal and meridional wind standard deviations decrease with height, as is also largely reflected by the black lines in the relevant panels in Figure 5 in this paper (above the first few km). However, the opposite holds for the radial winds in Figure 7 (i.e. the error standard deviations for the radial winds increase with height). I did not understand the explanation for this difference in the paper.

  Waller, J.A., Dance, S.L. and Lean, H.W. (2021), Evaluating errors due to unresolved scales in convection permitting numerical weather prediction. Q J R Meteorol Soc. Accepted. doi:10.1002/qj.4043

- L18 and L40 are a little out of date. The current operational system at the UK Met Office uses 4D-Var. Some more up to date references:

  Milan, M, Macpherson, B, Tubbs, R, et al. Hourly 4D-Var in the Met Office UKV operational forecast model. Q J R Meteorol Soc. 2020; 146: 1281– 1301. https://doi.org/10.1002/qj.3737

  Hawkness-Smith, LD, Simonin, D. Radar reflectivity assimilation using hourly cycling 4D-Var in the Met Office Unified Model. Q J R Meteorol Soc. 2021; 1516– 1538. https://doi.org/10.1002/qj.3977

- L44 The JMA have also used the Desroziers et al (2005) method with radar data and this should be noted. See for example,

  Fujita, T., Seko, H., Kawabata, T., Ikuta, Y., Sawada, K., Hotta, D. and Kunii, M. (2020) Variational Data Assimilation with Spatial and Temporal Observation Error Correlations of Doppler Radar Radial Winds. Research activities in Earth system modelling. Working Group on Numerical Experimentation. Report No. 50.WCRP Report No.12/2020. WMO, Geneva.

  (available online at http://bluebook.meteoinfo.ru/index.php?year=2020&ch_=2)

- A short study estimating reflectivity variances using Desroziers et al (2005) was carried out by a Masters student using UK Met Office trial data. Some comparison could be

made with these results.

Kouroupaki, V. (2019). Investigating radar reflectivity uncertainty in data assimilation for high impact weather prediction. MSc Thesis. University of Reading, UK.

- Fig 2. Is not referred to in the text until p14. It would be better to refer to this figure earlier, in section 3.

- Fig 3 caption – what is meant by "scratch"?

- Line 113 what do you mean by "statistically insignificant" here? How many samples are needed for reliable estimation?

- Section 4.1 Do these RE estimation experiments include superobbing?

- Section 4.1 Does the representation error exhibit a bias? At line 132 "systematic error" is mentioned, but the plots only show standard deviations, so cannot give an indication of biases.

- Fig 4a Why is there a sharp gradient at very low levels?

- Reflectivity correlations: For the standard deviations a clear dependence on reflectivity value was shown. Might this also apply to the correlation lengths? Would it be appropriate to produce correlation plots separated by reflectivity value rather than beam elevation?

- Section 4.2 Please could you clarify what happens to the "dry" observations (zero/small reflectivity)? Are they assimilated? In the text there is some mention of "no reflectivity data" (line 193, 222) but it wasn't clear to me what this referred to.

- Section 4.2: Are the O-As and O-Bs used for calculating the Desroziers et al (2005) diagnostic unbiased? If not, is the bias subtracted before computing the covariances?

- Fig 11 (and later figures). The right hand panel (no of samples) displays a zig-zag pattern (most obvious for purple and blue lines). Why is this?

- Line 255 you explain a difference in size of standard deviation compared with previous work due to a scaling factor in R. Can you explain this more clearly? Is this to do with the deficiencies of the diagnosis technique?
- The earlier paper on Doppler wind error estimation with the KENDA system (Waller et al, 2019) emphasizes the role of the superobbing procedure in generating error correlations. Is the superobbing procedure used here the same? Do some of the error correlations arising here stem from the overlapping superobbing wedges?
- Figure 9 is not referred to in the main text. It does not seem useful to include if it is not referred to.

- Figure 10 could be cut as it does not tell us very much.
- I feel that the paper would benefit from being a bit more selective about which figure panels to show to make the relevant points e.g., is it necessary to show correlations for every elevation? Or could the key points be made from one or two elevations, and the rest of the figures put in supplementary material.

Typos and Small corrections

Line 46 “authors’s”

Line 70 and throughout “setup” is rather informal.

Line 80 Parentheses needed around Waller et al (2016b)

Line 101 EMVORDAO

Line 137 grauple