

Anonymous Referee #2 Received and published: 8 January 2018

General comments: The paper presents a study of a long term data record from an X-band weather radar which would be an interesting and useful contribution to the community were it not for the notable omissions, inconsistencies and lack of detail within the paper. These deficiencies can be summarised as follows:

1. A lack of detail on the processing applied to the data from the X-band radar and any scientific discussion of how this processing, or omission of, could be affecting the results. The most striking statement in this regard is the following "This is surprising since ZDR has not been calibrated for the MZZU radar" (page 10) which is then not followed up in any relevant way, such as a discussion of whether an adjustment of the calibration is necessary given the data available. Other issues to consider which are not mentioned but highly relevant are the possibility of reflectivity miscalibration, partial beam blockage, attenuation and differential attenuation correction and the calculation of specific differential phase. There have been several studies recently which covered many of these issues for X-band radar, for example Park et al (2005), Giangrande et al (2014) and Diederich et al (2015).

We appreciate this reviewer comment. We have revised this wording in our document to describe that although ZDR has not been calibrated, some of the errors may seem to offset over the long-term, revealing issues with long-term studies as opposed to short-term analyses. We are aware that it is ideal for, at least, S-band radars to fall within +/- 0.2 dB for accurate R(Z,ZDR) or R(ZDR,KDP) estimates. However, the system ZDR (ZDR offset) data, receiver/transmitter/sun biases were not available for analyses, but will be for future studies. Furthermore, previous studies by the authors have shown that over long-term, misses/false alarms do, indeed, tend to offset to perceive the data as "good" whereas, in reality, they may have large, long-term errors. This prompted the usage of the FPA and MPA to determine these errors, which were both still relatively small given the time period.

2. There is also a lack of detail regarding the scanning strategy applied by the radar and any possible impact of this on accuracy. The authors state only 0.5 degree elevation scans are used but how frequently do these occur? Are they regularly spaced or does the scan change throughout the two year period? Is the rotation speed of the radar constant or changeable and what is the rotation speed? Each of these factors will impact on the accuracy of the QPE obtained from the radar and should be covered in the paper.

Thank you for this comment. We have provided information as to the scanning strategy as well as the typical scanning elevation.

3. There is a lack of ground observations for verification and an assumption that 4 gauges at different ranges can characterise range effect without considering azimuthal differences or random variation. The paper would benefit greatly from the addition of more ground observations, for example Diederich et al. (2015) use 133 gauges and Giangrande et al. 2014 use 34 sites for their respective studies.

Thank you for this comment. Although HADS, CoCoRaHS, GHCN, USHCN, etc. have gauges for Missouri, they tend to be sparsely available for the center of the state. We have gathered data from many of these networks and will provide a more in-depth analyses of fewer algorithms with more gauges to

prove the robust capabilities of the algorithms implemented. However, for many regions (particularly to the West), gauges are lacking to validate QPE, which was demonstrated for this paper.

4. It is difficult to follow which algorithms have been applied (108 in total, page 4 or 68, page 10). What value is there from presenting so many, most of which are not described in any detail in the text? The paper would be better if a smaller, more focused selection of algorithms were applied, and these would be best presented in a table similar to table 2 to allow them to be compared easily.

We appreciate this comment, and look forward to providing a more in-depth analysis of the best-performing algorithms over a broader-range of ground-truthed rainfall sources. We are also getting ready to implement disdrometer data to help with calibration and, hopefully, derive our own equations.

5. The discussion and conclusions are insubstantial. Having compared so many algorithms the discussion on page 16 is lacking. Is there a reason for the algorithms containing reflectivity always having a negative bias, such as miscalibration or beam blockage? Similarly what could be the cause of the persistent positive bias when using KDP? Again the R(Z,ZDR) and R(ZDR,KDP) algorithms “performed the best” yet have the lowest overall correlation coefficients but there is no consideration of why this should be the case. Looking at figure 6 it is clear that all the methods shown underestimate higher rainfall accumulations yet this is not covered in the text at all. Recommendation Though the general idea of the paper has potential the paper requires significant improvement and rewriting before it is suitable for publication. I would recommend the authors focus more on a reduced number of carefully selected algorithms with more discussion on the relative merits of each of them while providing more detail on the processing of the data and the limitations inherent within. If possible a greater number of rain gauges should be used to allow more robust findings to be demonstrated, particularly if the authors wish to concentrate on the effect of range both on the suitability of different algorithms and the overall accuracy of X-band radar QPE.

Diederich, Malte, Alexander Ryzhkov, Clemens Simmer, Pengfei Zhang, and Silke Trömel. 2014. “Use of Specific Attenuation for Rainfall Measurement at X-Band Radar Wavelengths. Part II: Rainfall Estimates and Comparison with Rain Gauges.” *Journal of Hydrometeorology* 16 (2):503–16.
<https://doi.org/10.1175/JHM-D-14-0067.1>.

Giangrande, Scott E., Scott Collis, Adam K. Theisen, and Ali Tokay. 2014. “Precipitation Estimation from the ARM Distributed Radar Network during the MC3E Campaign.” *Journal of Applied Meteorology and Climatology* 53 (9):2130–47. <https://doi.org/10.1175/JAMC-D-13-0321.1>.

Park, S-G., M. Maki, K. Iwanami, V. N. Bringi, and V. Chandrasekar. 2005. “Correction of Radar Reflectivity and Differential Reflectivity for Rain Attenuation at X Band. Part II: Evaluation and Application.” *Journal of Atmospheric and Oceanic Technology* 22 (11):1633–55.
<https://doi.org/10.1175/JTECH1804.1>.

C3

AMTD

Interactive comment

Printer-friendly version

Discussion paper

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-439, 2017.