

Interactive comment on “Application of bias correction methods to improve the accuracy of quantitative radar rainfall in Korea” by J.-K. Lee et al.

Anonymous Referee #1

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“Application of Bias Correction Methods to Improve the Accuracy of Quantitative Radar Rainfall in Korea” by J.-K. Lee, J.-H. Kim, and M.-K. Suk

This discussion paper addresses radar-rainfall bias correction methods. The authors defined three types of bias so-called “reflectivity measurement (Z) bias, mean field bias, and local bias” and used some combinations of those biases to correct estimated radar rainfall fields. They used the national network of AWS rain gauges in Korea to estimate radar biases and analyzed the correction improvements based on the proposed combinations of the aforementioned three bias terms. They also evaluated bias correction performance according to rainfall types and concluded that the proposed bias

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correction improved the accuracy of radar rainfall estimates.

I think that the subject of this study is suitable for “Atmospheric Measurement Techniques” because this study represents precipitation measurement using weather radar and the development of correction methods for systematic errors in measuring or estimating quantitative precipitation amounts.

Overall, this paper lacks a number of critical components that are required for publication in scientific/technical journals such as AMT. Since relevant background information, assumptions/hypotheses, and analyses procedures were not well described in this paper, the presented results do not look reliable and it is hard to evaluate the value of this work. The major obstacle that makes it harder to understand this work is that the authors are only trying to explain obtained (seeming) results without any deep discussion on the implications underneath their assumptions or observed phenomenon that may affect their results. Therefore, I would not recommend this paper for publication without major revisions.

Major comments:

1. Please provide relevant background information. Please clearly define each bias term (i.e., reflectivity measurement, mean field, and local biases), and what causes these biases and why the authors need to correct them.

In Conclusion, the authors mentioned general factors (e.g., temporal and spatial sampling bias and ground and sea clutter) to explain the Z-bias. However, it looks to me that ground clutter and AP effects are more like data quality control issues, not much relevant to the estimated Z-bias by the proposed procedure presented in Figure 4. In addition, spatial sampling bias (systematic range effect) should not be an issue because reflectivity data are sampled at the same distance zones from involved radars in Figure 4 (and then what is the temporal sampling bias?). I think that Figure 4 addresses the relative calibration offset (e.g., Seo et al. 2014) between radars.

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I do not understand why the authors need the Z-bias correction. Since the WPMM application could partially represent the Z-bias issue (or calibration offset), the result shown in the Conclusion section proves that correction improvement is just little (e.g., correlation 0.83 vs. 0.84). I am not sure if this improvement is statistically significant.

Reference: Seo, B.-C., W.F. Krajewski, and J.A. Smith (2014) Four-dimensional reflectivity data comparison between two ground-based radars: Methodology and statistical analysis, *Hydrological Sciences Journal*, 59(7), 1320-1334.

2. Please clarify which rain gauges are used in each estimation (e.g., WPMM), bias correction, and validation steps. Just saying “321 for calibration and 321 for validation” is not sufficient. Please provide rain gauge locations and configuration of each calibration and validation set. This is related to “independence” in the analysis.

Did the authors use different rain gauges for WPMM and further bias (mean field and local) correction? In addition, the authors need to explain what causes the systematic bias (or why they need bias correction) even if rain gauge data were incorporated in the previous step (WPMM). Bias correction and rain gauge adjustment is usually required for radar-only product, but the product generated using WPMM is not radar-only.

3. Please evaluate the quality of reference radar using ground reference (e.g., rain gauges). There is only absolute (self) calibration procedure presented in the manuscript. There is no information on the accuracy or reliability of measured or estimated quantity by reference radar.

4. Since there is no evaluation of reference radar, I am not sure how accurate the presented results on estimated Z-biases in Table 3 are. The values ranging from 4 to 8 dB differences (Table 3) look very strange and suspicious. This might be caused by difference error sources (e.g., attenuation).

5. Many things are wrong in the “Local Gauge Correction method” in section 2.3.2 and different from Zhang et al. (2011) that the authors referred to. Please read Zhang

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et al. (2011) carefully. As an example, D is not a scan range, but the radius from a radar pixel where the additive error is interpolated (because there is no collocated rain gauge). The basic concept of the local bias correction is the additive error interpolation for radar pixel locations that do not have collocated rain gauges.

Minor comments:

1. Page 4012. Line 13. Please add “was” in front of “improved.”

2. Please use consistent expression e.g., Z bias or Z-bias?

3. Page 4013. Line 6-9. The authors should re-write this phrase like: “because one major reason is that weather radars indirectly measure rainfall amounts using the relations between measured radar variables and rainfall such as Z-R, Zdr-R, and Kdp-R.”

4. Page 4014. Line 15-16. What is the difference between Z-R relation and QPE model? I think that Z-R is a part of the QPE model used in this study.

5. Page 4015. Line 5-8. There is no verb in the sentence.

6. Page 4015. Line 13. Please remove the phrase “the rainfall event periods of”

7. Page 4015. Line 14. Please insert the phrase “and data period” between “Z bias” and “and Table 1b”

8. Page 4016. Line 20-26. I think that all four merging methods are not used in this paper. It is not necessary to provide descriptions that are not used in the paper.

9. Page 4016. Line 26. Since the maximum value method is used, I am concerning on how the authors deal with bright band effect. Is there any procedure that detect and correct bright band effect?

10. Page 4017. Line 9. Beam blockage is not “radar characteristics”, but the outcome of the earth surface and radar beam geometry.

11. Page 4017. Line 10. Again, “contaminated reflectivity” is a radar data quality

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control issue and not relevant to the systematic bias that is estimated in this study.

12. Page 4019. Line 19-21. When is the mean field bias correction performed? Individual or merged field?

13. Page 4022. Line 23. Please correct "Sect. 2.21."

14. Page 4024. Line 22. Why do the authors say "basin?" Is there any basin defined in this study?

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