

## Review

Journal: Atmos. Meas. Tech. Discussion

Title: Using ground radar overlaps to verify the retrieval of calibration bias estimates from spaceborne platforms

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## General comments

This study verifies estimates for calibration bias of ground (S- and C-bands) radars using spaceborne radars such as TRMM PR and GPM DPR (KuPR). To extend a methodology by Crisologo et al. (2018) for using radars at higher frequencies for C- and X-bands, the current study introduces a quality-control index as a function of PIA. The calibration biases of each ground radar are individually estimated from the spaceborne radars, which is evaluated by comparing between the calibrated ground radars. This study also examines temporal adjustment of the calibration change from only infrequent matchups between spaceborne and ground radars.

This study demonstrates an application for cross calibration of ground radars using spaceborne radars as a reference, which will contribute to a cross calibration of ground radars all over the world. I think the paper can be published after some corrections and edits.

## Specific comments

- 1) In section 2, descriptions of used data are overall lacked. How to originally calibrate the ground radars? Don't some references and/or descriptions of the ground radars exist? How to treat/correct the precipitation attenuation for ground/spaceborne radars? Does the current study compare what parameters of radar reflectivity with or without the attenuation? This study mentions Crisologo et al. (2018) and Warren et al. (2018), but it makes readers to feel unkindly. Especially, data of the C-band ground radar because this study newly utilizes the data. Please describe appropriately. I suggest some references of attenuation-correction methods for spaceborne radar data as follows: Iguchi et al. (2009) and Seto and Iguchi (2015).
- 2) This study uses the two ground radars at frequencies of S- and C-bands and the spaceborne radars at a frequency of Ku-band. How to consider the difference in a frequency? From Crisologo et al. (2018), a conversion due to the Mie-scattering effect from Ku-band to S-band is empirically considered in this study. However, the conversion among S-, C-, and Ku-bands is not described anything. Is the residual difference of the two ground radars mixed with the frequency difference? Please describe explicitly.
- 3) This study tries a temporal adjustment of calibration changes for ground radars from only

infrequent matchups with spaceborne radars. The relative calibration adjustment with ground clutter (e.g., Silberstein et al. 2008, Louf et al. 2019) is one of typical methods. Each of the relative calibration methods with the ground clutter and the matchup with spaceborne radar has its merits and demerits. Please discuss in the manuscript.

#### Technical corrections

- 1) Page 2 line 23: The sentence in a parenthesis after “*estimation errors (in...*” is too long, so I might be better to replace it. For examples: “The estimation errors are defined as retrieval errors of the precipitation rate... the radar reflectivity factor  $Z$ ; then the errors are caused by...”.
- 2) Page 2 line 4: I do not understand “let it be ...”. What does it mean?
- 3) Please specifically indicate the frequency or wavelength of the radars in Sections 2.1 and 2.2.
- 4) “Bandwidth” in Table 1 is wrong. I think “Frequency” is appropriate.
- 5) Page 7 line 27 and Page 15 first paragraph in Section 4.4: SR has been already defined at Page 2. Why did you redefine SR? In Section 5 (summary), I understood the redefinition as a refresh.
- 6) Page 7 line 33: I can not find Table 3 in Crisologo et al. (2018). Is it Table 2 in Crisolog et al. (2018)? Please indicate the correct number.
- 7) Table 2: -5 and -7 is should be -5.0 and -7.0 if the significant digit of those values is correct in this study.
- 8) Some references lack information such as URL (e.g. Iguchi et al. 2010, Jone et al. 2014). Please check [https://www.atmospheric-measurement-techniques.net/for\\_authors/manuscript\\_preparation.html](https://www.atmospheric-measurement-techniques.net/for_authors/manuscript_preparation.html). Incidentally, Iguchi et al. (2010) is too old for a reference. Please update appropriately as follows: <https://pmm.nasa.gov/resources/documents/gpmdpr-level-2-algorithm-theoretical-basis-document-atbd>.

#### References

- 1) Crisologo, I., Warren, R. A., Mühlbauer, K., and Heistermann, M.: Enhancing the consistency of spaceborne and ground-based radar comparisons by using beam blockage fraction as a quality filter, *Atmospheric Measurement Techniques*, 11, 5223–5236, <https://doi.org/https://doi.org/10.5194/amt-11-5223-2018>, 2018.
- 2) Iguchi, T., T. Kozu, J. Kwiatkowski, R. Meneghini, J. Awaka, and K. Okamoto, 2009: Uncertainties in the Rain Profiling Algorithm for the TRMM Precipitation Radar. *J. Meteor. Soc. Japan*, 87A, 1–30, doi:10.2151/jmsj.87A.1.
- 3) Louf, V., A. Protat, R.A. Warren, S.M. Collis, D.B. Wolff, S. Raunyar, C. Jakob, and W.A. Petersen, 2019: An Integrated Approach to Weather Radar Calibration and Monitoring Using Ground Clutter and Satellite Comparisons. *J. Atmos. Oceanic Technol.*, 36, 17–39,

<https://doi.org/10.1175/JTECH-D-18-0007.1>

- 4) Seto, S. and T. Iguchi, 2015: Intercomparison of Attenuation Correction Methods for the GPM Dual-Frequency Precipitation Radar. *J. Atmos. Oceanic Technol.*, 32, 915–926, <https://doi.org/10.1175/JTECH-D-14-00065.1>
- 5) Silberstein, D.S., D.B. Wolff, D.A. Marks, D. Atlas, and J.L. Pippitt, 2008: Ground Clutter as a Monitor of Radar Stability at Kwajalein, RMI. *J. Atmos. Oceanic Technol.*, 25, 2037–2045, <https://doi.org/10.1175/2008JTECHA1063.1>