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Atmospheric Measurement Techniques Discussions

Interactive comment on "A novel approach for absolute radar calibration" *by* C. Merker et al.

Anonymous Referee #1

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The manuscript "A novel approach for absolute radar calibration" by C. Merker et al. raises an important issue and is well written. I recommend the manuscript for publication, but the authors have to describe and discuss the uncertainty of their method in more detail. An overall error of 1% is certainly too small.

1 General comments

1. I think the most important issue is that the authors take $N(D)$ as measured by MRR no. 3 for granted. However, vertical air motion can lead to strong biases of $N(D)$ and extinction (The authors should know e.g. Peters et al. 2005). How do these errors propagate to the calibration estimate and how does this affect the uncertainty estimate of 1% to 11%?

2. If the MRR is mounted horizontally on a mast, the main-lobe will hit the ground after some km due to the beam width of 1.5 degrees (and the side-lobes even earlier). This can cause additional attenuation due to the surface. Can this potentially bias the results?
3. There are some additional, minor sources of uncertainty which the authors should at least mention.
   (a) How well is the pointing of the MRRs, do the volumes really match?
   (b) Does the different size of the observation volumes due to the different distance to the antenna matter?
4. I'm not sure whether I understood section 4 correctly. The authors used the measured, attenuated reflectivity field and assumed it to be real. Then they applied Gaussian noise to each pixel and checked whether they get a correction factor of 1.0? Maybe the beginning of the section can be updated to make the general concept more clear.
5. What happens if the method is applied to the Lindenberg data? How do real, measured distributions compare to Figure 6? In case a calibration offset is found for the MRR, is the offset stable?
6. I would expect interference if three FMCW radars are operated with the same frequency. Why is this study not affected by that?
7. How do the results depend on used integration time?
8. How was the data of MRR no 1. and 2 processed? as far as I know, the Z provided by the standard MRR software is calculated from the measured $N(D)$ and not by simple integration of the power spectrum. For a slanted MRR, $N(D)$ cannot be estimated correctly and therefore the Z would be wrong. In this case, a method like e.g. Kneifel et al. 2011 or Maahn and Kollias 2012 should be used.

2 Specific comments

p. 1672, l. 14 Please highlight that 30 dBz refers to reflectivity. For attenuation, the unit would be wrong.

p. 1672, l. 24f I think stating an error of only 1 % is non-credible, see also general comments. At least I would recommend to add the found range, i.e. 1 to 11 % error.

p.1673, l. 3 "Most accurate" sounds like gauge measurements would be actually accurate, but they are not. Please provide a typical error

p.1673, l. 17 Recent weather radars use also polarimetric variables for precipitation measurements which are far more accurate and not affected by calibration.

p. 1674, l. 4 Please provide a short introduction for the MRR. At least the operation frequency should be included.

p. 1675, l. 2 When calibrating the other MRRs I see one problem: As far as I know, the MRR is calibrated with a wet antenna. Calibration with a dry antenna can result in a difference of some dB (Would be actually interesting to study this with the novel method). The antenna of no. 3 is certainly wet, but are the antennas of no. 1 and 2 also wet? This depends not only on the question whether it is raining at 1 and 2 as well, but also on the mounting of the two vertically pointing MRRs. From Fig. 1 it looks like the antennas were mounted such that the antennas cannot get wet during precipitation.

p. 1675, eq. 1 introduce s_0 and s_{max}

p. 1676, l. 3 Please explain the method by Atlas et al. 1973 briefly. In addition, please highlight that $Z \propto N$. What assumptions are required for this approach?

p. 1676, eq. 4 Doesn't N_3 depend on h as well?

p. 1678, l. 18 Do the results change when this condition is removed? I.e. apply the Gaussian function to smaller bins and then average Z to the MRR resolution.

p. 1678, l. 22 I would say Z depends on DSD and the backscattering cross-section

p. 1679, l. 15 Even though mathematically correct it is slightly confusing to use the inverse of C_3. Maybe this can be introduced earlier?

p. 1682, l. 3 Why was 1.4dBz chosen as threshold?

p. 1683, l. 13 Please include that this result is valid only for Lindenberg

p. 1684, l. 7f This would be true if precipitation would be normal distributed, but is that true?

p. 1684, l. 24 The numbers in abstract and conclusions should be the same.

Table 1 Can these numbers be included in Figure 6?

Figure 4 I find the colorscale of the left plot confusing.

3 References

- Kneifel, S., M. Maahn , G. Peters and C. Simmer, 2011: Observation of snowfall with a low-power FM-CW K-band radar (Micro Rain Radar), Meteorol. Atmos. Phys., 113, 75-87. doi:10.1007/s00703-011-0142-z
- Maahn, M. and Kollias, P., 2012: Improved Micro Rain Radar snow measurements using Doppler spectra post-processing, Atmos. Meas. Tech., 5, 2661-2673, doi:10.5194/amt-5-2661-2012

- Peters, G., B. Fischer, H. Münster, M. Clemens, and A. Wagner, 2005: Profiles of Raindrop Size Distributions as Retrieved by Microrain Radars. J. Appl. Meteor., 44, 1930–1949, doi:10.1175/JAM2316.1

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 1671, 2015.