

Review of the manuscript to AMT entitled

**“Three-way Calibration Checks Using Ground-1 Based, Ship-Based
2 and Spaceborne Radars”**

by A. Protat , V. Louf , J. Soderholm, J. Brook, W. Ponson

General comment:

The authors evaluate and assess the accuracy achieved of the recently developed radar calibration framework used to monitor the calibration accuracy of all operational radars of the Australian weather radar network in real-time. The technique is based on the comparison with spaceborne Ku-band radar observations from GPM applying a Volume Matching Method (VMM). After an additionally available ship radar (OceanPOL) and the radars from the network have been calibrated separately by comparison with the space-born measurements, measurements of all radars of the Australian network are compared to the ones of OceanPOL. These more accurate ship – ground radar comparisons are considered as an indirect evaluation of the GPM validation technique and exploited to demonstrate the value of using such GPM data as a single source of reference for the calibration of a whole national network. Indeed, for all seven radars the calibration difference with the ship radar lies within ± 0.5 dB.

Intercomparisons of gridded radar observations also revealed the potential to estimate calibration differences between radars with overlapping coverage to within about 0.3 dB at daily time scale and about 1 dB at hourly time scale, which can be exploited for additional calibration monitoring.

The accuracy and value of the outlined calibration strategy is of interest for the community. Furthermore, my list of edits and suggestions provided below includes nothing severe and therefore I suggest this manuscript for publication after their consideration. E.g. at several places the authors refer the reader to upcoming ‘later’ explanations without being precise. In case references to later subsections are required more often, restructuring of the manuscript may also be an option. At one or two places the introduction of subsections would make the structure of the text more transparent and for some aspects I am also missing some more detailed explanations (see ‘major’ points, even though they are not really major, but I distinguish them from pure formulation issues).

Major points:

Line 13: Maybe the advantage of using a ship-based radar should be shortly indicated here?

Lines 16/17: What about the range of differences before the calibration? Please see also my comment regarding line 165.

Line 29: The pointing accuracy is not mentioned again in this manuscript, right?

Lines 38/39: Are there references demonstrating/documenting the accuracy of the GPM radar? You also say in Line „...whose calibration is very accurately tracked by NASA.“ Can you be more precise here?

Line 50: Reads a bit weird that the advantages of using the ship radar will be discussed ‚later‘ (no precise statement), followed by the precise structure of the article in the following lines (section 2, section 3, section 4 contains this and that).

Lines 79, „more accurate source of reference“: For the third time the authors indicate here the special role /higher accuracy of the ship radar without explanation. I would suggest to unravel the secret earlier. I was wondering already while reading the abstract, why the ship radar is a reference. If I understand correctly, the solution is provided in lines 192ff and I would suggest to summarize this idea also in the abstract.

Line 91: What kind of additional quality control is done?

Line 123: Just for curiosity: Quite often ring structures are generated with gridding/compositing of radar data. Do you encounter similar problems? If yes, this could also impact the comparison.

Line 129ff: Not really clear to me what is done. The radius of influence is only applied to the same elevation but how do you decide whether an adjacent elevation is included?

Line 139: What about corrections for the ship movement? I thought such kind of things introduce different uncertainties for ship radars, but the authors only mention the superiority of OceanPOL.

Line 170, „discussed later and shown as black dots in Fig. 4)“: Such references to later paragraphs should be avoided if possible, or at least be more precise. When/where instead of ‚later‘? Or restructuring the manuscript should be considered in case too many references to later paragraphs are needed.

Line 188, frequency conversion: Should be mentioned how this is done/taken into account.

Line 188, most problematic in the melting layer: The melting layer is not excluded from the comparison? I suggest to be more precise how the comparison is performed.

Line 214, „We will get back to that point shortly.“: Again, referring to the unprecise future is not optimal.

Line 247: Maybe nicer, more structured, to introduce 2 subsections 3.1 and 3.2, with subsection 3.2 starting here dealing with the day-to-day variability.

Line 254: Again referring the reader to the unknown future „which will be discussed in more detail later.“ Please avoid.

Minor points:

Lines 81 and 83 contradict each other: Table shows all radars used in this study including different frequencies, but then it says this study uses only the C-band radars.

Line 90: Did you ever applied consistency of polarimetric variables for calibration of OceanPOL and checked the agreement with your calibration based on the GPM measurements?

Line 91, Version 5 of the GPM 2AKu product: A reference would be nice here.

Line 137/138: Are you using stratiform and convective events for the comparison?

Line 165, „All calibration results are summarized in Fig. 2.“: The calibration results should be mentioned in the text, not only written in the panels of the Fig.

Line 168/169: The older estimate also includes RCA checks or just for radar 63?

Line 173, „Looking at the time series of GPM calibration estimates for other radars than 63 ...“: Why not referring now to radars 63 AND 29?

Lines 173ff: So, at the end only radar 16 shows variations? Why not directly writing that instead of starting with 29, then adding 63 and finally the others? Would be easier to read.

Line 182, ‚In a perfect world‘ ...: I am not a native speaker, but sounds more like colloquial language to me.

Figure 3 caption: Here I suggest to write that the comparison with radar 63 is shown, but in the text you can write that the overall strategy for the OceanPOL comparison with any radar is illustrated using radar 63 in Fig. 3. I also suggest to rewrite the explanation of what is shown in panel b. Maybe something like „...a percentage of all OceanPOL reflectivity values in a resolved 0.5dB bin“. And I suggest to write „The number of samples N is 141978 (see panel a).“

Line 200: Instead of „as on the left panel of Fig. 3)“ -> Fig. 3a

Line 202: Better „Comparison of ...provides a better....and allows the detection...“

Line 206: Better „reflectivities less than 35 dBZ mostly contributed...“

Line 210: Delete ‚and‘

Line 215, „When including all days of observations for radars 63 and 77“: Is there a need to emphasize this? For the other radars not all measurements available are used?

Lines 217: ‚See‘ Fig. 4 for

Line 218, „The next best operational radar is radar 70 (Perth).“: Please reformulate.

Line 289: ...derived from all hourly not from all daily estimates, right?

Lines 304/305: „A major advantage of using a single source of reference is that all radars of the network are calibrated in the same way.“ This is also the case when other methods are used. If you choose to use the consistency method for your network, you also use the same method for your entire network. Not sure what you want to express here.

Lines 305-308: I guess this sentence can be better formulated. Bit hard to read.

Lines 350ff: For several publications the DOIs are provided, for others not.