

## General Comments

This manuscript presents a study of polarimetric relationships to estimate rainfall rates at Darwin, Australia, based on radar retrievals from the C-band dual-polarization radar (CPOL). The retrieved relationships are validated against a co-located two dimensional video disdrometer (VDIS) via statistical metrics. I find the manuscript relevant for publication in AMT but I suggest the authors to perform major revisions related mainly to the organization of speech and clarity of explanation throughout the manuscript.

**We thank the reviewer for their valuable comments. Their suggestions greatly improved the readability of the paper. In addition to the responses below, other reviewers also asked for more information regarding the experimental setup of the radar and disdrometers, so a figure has been added showing this setup with relevant discussion. A The principal component analysis section has also been rewritten at a reviewer's request in a format that is easier to interpret. Details behind these edits are visible in the attached manuscript with changes noted.**

1) For instance, in the Introduction, many of the sentences need a fundamental reorganization (more specifics are presented in the Technical Comments). The overall meaning is understandable but often words are missing or displaced and the flow of the speech is negatively affected.

**We have responded to the specific comments regarding the grammar of the paper of the reviewer as below.**

2) It is mentioned in the manuscript that the VDIS is co-located with the CPOL radar but no picture of the area where the two sensors are located nor their coordinates are provided by the authors. I suggest to clarify this and include a picture of the field of study in Darwin.

**We have added a figure in Section 2 showing the location of the radar and Disdrometer on a map of the Darwin region.**

3) I have some issues with the description of a couple of Figures. In paragraph 3.1 is described Figure 1. A mention is missing of the dashed and solid lines that separate two types of precipitation, even though the selection criteria for convective-stratiform precipitation are described later. Similar remarks apply to Figure 3 and its description in paragraph 3.2. It would be good for a better reader understanding to mention which curve (and in which panel) represents the data fit.

**For both of these sections, there is now more text showing the descriptions of these lines in each paragraph.**

4) In Section 4.1, it is stated that the Ah-based estimators give the lowest spread for

R<10mm/hr and Kdp-based estimators give the lowest spread for R>10mm/hr. This is true only if a combination of different moments is not taken into account but this is not mentioned in the text.

**We have rephrased this sentence:**

*“In Figures 5ab, the  $A_h$ -based estimators give the lowest parametric uncertainty, followed by  $K_{dp}$  then  $Z_h$ -based estimators for time periods when  $R < 10 \text{ mm hr}^{-1}$  when only a single radar observable is considered.”*

Specific Comments/Technical Corrections

1) Page 1, line 17. Please define ‘VDIS’.

**We have changed “VDIS” to say “video disdrometer.”**

2) Page 2, line 4-5. Please reformulate: ‘is that the phase and magnitude the diurnal cycle of precipitation are not adequately resolved due to the parameterization of Convection’.

**We have rephrased this sentence to use active voice to make it more readable:**

*“A known problem of many GCMs, including the U.S. Department of Energy’s Earth Energy Exascale System Model (E3SM), is that GCMs do not adequately resolve the phase and magnitude of the diurnal cycle of precipitation (Golaz et al., 2019). This is due to the fact that GCMs parameterize convection rather than explicitly resolve it (Del Genio, 2012).”*

3) Page 2, line 12-14. Please reformulate the sentence.

**This sentence has been simplified:**

*“In addition to cloud top height and hydrometeor type datasets, long term datasets of accurate rainfall accumulations and rates are also useful for evaluating or improving convective parameterizations in E3SM and other GCMs (Tang et al., 2019).”*

4) Page 2, line 15. ‘Similar summary’?

**Done as suggested.**

5) Page 2, line 20. Please replace ‘this’ with ‘a’.

**Done as suggested.**

6) Page 2, line 22. Please define ‘R’ in the Introduction.

**Done as suggested.**

7) Page 3, line 1. Please replace 'found in the limits of' with 'in'.

**Done as suggested.**

8) Page 3, line 5. Please replace with 'with DSD observations subject to comparable Limitations'.

**Done as suggested.**

9) Page 3, line 7. Please insert 'the' before 'aforementioned'.

**Done as suggested.**

10) Page 3, line 12. Please define 'DOE ARM'.

**Done as suggested..**

11) Page 3, line 19. Please define 'MC3E'.

**Done as suggested.**

12) Page 3, line 24. Please define 'RMSE'.

**Done as suggested.**

13) Page 3, line 25. Please remove 'and' before 'using'.

**Done as suggested.**

14) Page 3, line 32-33. I don't understand this sentence. Do you want to state the aim of this research? What are the challenges?

**We have revised this line (now lines 5-6, page 4):**

*"Creating accurate multidecadal, climate-research quality rainfall rates datasets at TWP Darwin at C- and X-band, as mentioned previously, is useful for evaluating and improving model predictions."*

15) Page 3, line 34. 'Efforts' don't have access to data.

**We have removed the "efforts" language when this paragraph was reorganized.**

16) Page 4, line 7. Please replace 'for' with 'in'.

**Done as suggested.**

17) Page 4, line 7. No need to say 'rainfall rate R'. Either 'rainfall rate' or 'R' but make sure you defined 'R' previously.

**We defined R previously, and removed "rainfall rate."**

18) Page 4, line 7. Please use present tense: 'This study uses'.

**Done as suggested.**

19) Page 4, line 11. 'on these quantities' is superfluous.

**Done as suggested.**

20) Page 4, line 21. Please remove 'a' before '250 m' and '1'.

**Done as suggested.**

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21) Page 4, line 30. Please define 'Z-PHI method' and include a reference.

**We have added the description at page 5, lines 8-10:**

*"The Z-PHI approach provides an estimate of the specific (differential) attenuation ( $A_{dr}$ )  $A_h$  as a linear function of  $\phi_{dp}$  that varies depending on the presence of convective "hot spots" (Gu et al., 2011)."*

22) Page 5, line 4. Are JW disdrometers less optimal for assessing dual-polarization radar efforts in lighter rain and/or small-drop conditions than? And, once again, 'efforts' are not a measurable variable. The authors mean 'radar moments' or 'meteorological Quantities'.

**We have rephrased this sentence:**

*"However, J-W disdrometers are potentially less optimal for calculating dual-polarization radar quantities in lighter rain and/or small-drop conditions than in heavier rain."*

23) Page 5, line 16. Please rephrase as 'After the application of these thresholds'.  
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**Done as suggested.**

24) Page 5, line 21. Incorrect reference to Wang et al. (2018) and Giangrande et al. (2019).

**Done as suggested.**

25) Page 6, line 3. I would not use the verb 'stratify' in a sentence where 'stratiform' is referred to the type of precipitation. Please use 'separate' or 'divide'.

**Done as suggested.**

26) Page 6, line 13-14. 'other datasets around the world' is too generic.

**Done as suggested.**

27) Page 6, line 17-18. Please finish the sentence starting with 'Prior studies find that tropical-oceanic cloud behaviors do not solely drive most of the surface rainfall here'. They drive what else then?

**We have rephrased this sentence:**

*"Prior studies find that both tropical-oceanic cloud and continental cloud behaviors drive surface rainfall here."*

28) Page 6, line 26. Please define 'W'.

**We now define this as liquid water content.**

29) Page 6, line 34. The authors mean 'T15' here.

**Done as suggested.**

30) Page 7, line 16. Please add ',' after 'Therefore'.

**Done as suggested.**

31) Page 7, line 32-33. The sentence starting with 'A bootstrap' is a bit convoluted and needs rephrasing.

**We have rephrased this sentence:**

*Following Wang et al. (2018), Table 2 shows confidence intervals calculated from 1000 fits from 10,000 randomly chosen DSDs, with replacement, from the VDIS dataset.*

32) Page 7, line 33 – page 8, line 1. 'The width of the 95% confidence intervals of a, b, and c of each fit (Table 2) are less than 5% of the mean a, b, and c for each randomly generated fit'. Please mention some numbers in the text for a better understanding.

**We have added an approximate order of both the widths of the confidence intervals and the mean of each coefficients to this sentence.**

33) Page 8, line 6. Please define 'p.d.f.'.

**This sentence was rephrased to match with newly adopted terminology in the paper.**

34) Page 8, line 6,7,9. Be consistent with the use adverbs: 'firstly', 'secondly', and then 'Finally'.

**Done as suggested.**

35) Page 8, line 26. Please remove one instance of 'only'.

**Done as suggested.**

36) Page 8, line 29. Please remove 'use of'.

**Done as suggested.**

37) Page 9, line 28. Please replace 'possible' with 'possibly'.

**Done as suggested.**

38) Page 10, line 3. It is valid for X-band radar only based on the figure.

**This section was modified in accordance to suggestions of another reviewer with a correct interpretation of the PCA analysis. Therefore, this statement is no longer present.**

39) Page 10, line 23. I suggest to mention, for clarity, that the estimator is represented by the dashed line.

**Done as suggested.**

40) Page 11, line 8. Incorrect reference to 'Thompson et al. (2018)'

**We have corrected this citation to use the proper format.**

41) Page 11, line 10. Please insert a coma after 'previous studies' instead of after 'Here'.

**This comma has been inserted.**

42) Page 12, line 4. 'Algorithms using Ah' for what?

**This has been rephrased to say “R-Ah based estimators” instead of “Algorithms using Ah”**

43) Page 12, line 6. Please replace ‘based off of’ with ‘based on’.

**This replacement has been done.**

44) Page 12, line 7. ‘Therefore’ between comas.

**These commas have been inserted.**

45) Page 12, line 8. Please use the past tense here: we ‘used’ instead of ‘use’. Check through the manuscript that the tenses are consistent.

**The past tense is now used here.**

46) Page 12, line 13. ‘The applicability’ to what?

**Since the conclusion has been reworked to include more discussion of the three sections, this sentence has been changed to make this comment no longer relevant.**

47) Page 12, line 17. Please replace ‘fitted’ with ‘modeled’ or a more exhaustive explanation of the way the fit was performed.

**In the reworking of the conclusion, this sentence was removed.**

48) Page 12, line 18. Please replace ‘similar’ with ‘similarly’

**This sentence has been removed from the manuscript in response to another reviewer.**