Decision on amt-2021-216

Dear Editor,

Thank you a lot for your effort and comments on our manuscript. In the following lines you may find our replies written with blue color. The indicated lines refer to the manuscript version with track changes.

Thank you for your time.

Kind regards,
Eleni Tetoni

Dear authors,
Thank you for submitting your revised manuscript and your responses to the reviewers.
After consideration I am again asking for minor revisions. Specific points to address are below.
Regards,
Raquel Evaristo.

Comments from reviewer 4 were responded carefully, however, I noticed there was little or no effort in including the points raised in the manuscript.
In particular, concerning the comments numbered 2 and 4, the authors took a lot of effort to respond to the reviewer, but none of that was included in the document. The reviewers comments are supposed to be a way to improve your manuscript, and not merely a response to certain personal doubts.

Very specifically, when responding to comment 2. you say that "This advantage has been stressed out in a lot of parts of our manuscript, e.g., lines 26-29 or 886-889", but these two instances are describing results. I believe the reviewer meant that you should formulate clearly the advantage of your approach. Ideally this should be included in the introduction as a motivation point for this study (your section 1.3), while comparing and stressing the advantages over other approaches.
Thank you a lot for your suggestion. We have now added a new paragraph in Sect. 1.3 mentioning the advantages of our approach. (Lines: 238–247)

Then include the response to comment 4 in your discussion, effectively showing you compare your calculation with the calculation from other methods and obtain a result that seems to be more accurate (at least according to your comparison with the IWP from MODIS, for example). Ideally in situ observations should be taken for validation. Would be good to add a comment on this point.
Thank you for your comment. We have now added a new section in our discussion part which includes parts of our replies to this referee comment 4. You can find this new section in lines: 959–988.

Same with comment 6. Lines 684-693 discuss the error propagation and how it affects Dm but never mention how it affects IWC. Your response to this comment, and particularly the end, acknowledging that this point needs sensitivity studies to improve the methodology in the future should be included in the paper.

We have now included a new Fig. 13 showing the Dm and IWC error considering the calibration and beam width as well as spatiotemporal mismatch errors. We also added some new lines in the text including information to this respect (Lines: 728–749). Thank you for pointing this out.

Minor comments:

Lines 32-33:
" terrestrial radiation interfering to the Earth's evergy budget" replace with:
" terrestrial radiation interfering with the Earth's evergy budget"
"To" is now replaced with "with". Thank you. (Line: 37)

Line 55: Include references concerning dual frequency.
Thank you for your suggestion. We have now included literature using dual-wavelength methods. (Lines: 59)

Line 57: "to the" is repeated
The sentence is now corrected. (Line: 61)

Line 110: replace "constrained" with "constrain"
The typo is now fixed, thank you. (Line: 115)

Line 123: Include a reference where the readers can find information on polarimetric variables.
Thank you for your suggestion. We have now included two references giving a description about the polarimetric radar variables mentioned in the text. (Line: 126–127)

Line 234: replace "resulting to a single radar cross-section" with:
"resulting in a single radar cross-section"
The typo is corrected. (Line: 225)

Line 236: The sentence is not constructed properly. Maybe add "In another approach…"
Thank you for pointing this out. We have now improved the sentence according your suggestion. (Lines: 232)

Line 240: replace "This approach can result nine…" with:
"This approach can result in nine…"
Thank you. The phrase is now changed as you suggest. (Line: 236)

Line 359: Appendix B is mentioned before Appendix A. Switch the Appendixes accordingly so that A comes first.
Although Appendix A is mentioned in parenthesis in Section 3.1 (Line: 357), it indeed comes before Appendix B (first mentioned in Line: 375). However, we have now removed the parenthesis in line 357 so that the reference to Appendix A to be more obvious.

Lines 376 -380: You are using an event from the 4th of April 2019 to find the calibration bias for events in January 2019. How can you be sure of the stability of the calibration more than 3 months later?
Thank you for your comment. We have now added some lines advocating the use of the same calibration bias in ZDR. (Lines: 391–398)

Line 401: I suspect that here it should be “calculate DWR errors” instead of “calculate DWR values”. Please check.
Thank you for pointing this out. We have now corrected the indicated phrase. (Line: 418)

Line 418 (legend of figure 5): “the POLDIRAD and MIRA-35 spatial mismatch” is repeated.
Unfortunately we couldn’t spot the repetition of “the POLDIRAD and MIRA-35 spatial mismatch”. However, we now rephrased the sentence deleting the second “the POLDIRAD and MIRA-35” part. (Line: 459)

Line 559: replace “Combining the PSD and with the m(Dmax)” with “Combining the PSD with the m(Dmax)”
We have how rephrased the sentence. Thank you a lot. (Line: 605)

Figure 11 a: Adjust the color scale between reasonable values for your variability.
Thank you for pointing this out. We have now replaced Fig. 11.

Line 812: This formulation “once with twice…” is confusing.
Suggest: “...for oblate ice particles, 1) with twice and 2) with half the density…”
Thank you a lot for this suggestion. We improved the text accordingly. (Line: 905)

Line 949 Legen of figure A1: panel c) shows a scatterplot of the median Zdr vs height. Why are there only a few points? How were these points selected?
Thank you for your comment. We have now changed lines 394–398 to include information about your questions. Specifically we write: *“In Fig. A1 (Appendix A), examples of radar reflectivity Z_e, differential reflectivity ZDR as well as a scatter plot showing the average ZDR offset are presented. The scatters in the last panel (Fig. A1c) indicate the median ZDR value averaged over the full measurement period, shown in Fig. A1a, for each vertical radar bin within the cloud layer. The data were acquired by super sampling the 150 m pulse in 75 m range steps to enhance the signal statistics.”*

Lines 965 to 974, Appendix B:
There are polarimetric algorithms available for melting layer detection designed for RHIs. One example is Wolfensberger et al. 2016. This discussion could be shorter if you just mentioned other optimized methodologies could be used instead of your hard thresholds.
Wolfensberger, D., Scipion, D. and Berne, A. (2016), Detection and characterization of the melting layer based on polarimetric radar scans. Q.J.R. Meteorol. Soc., 142: 108-124. https://doi.org/10.1002/qj.2672
Thank you for your suggestion. We have now included a comment that an already established melting layer detection algorithm (using your suggested literature) could also be used as our thresholds need more investigation and evaluation using more “ML case studies”. However, we still keep Fig. B1 as an example for this statement (Lines: 1103–1112).

Line 974: “only few ice hydrometeors were detected above the 0°C isotherm”. This does not make sense to me. Please check.
Thank you very much for pointing this out. This sentence was indeed confusing. We have now replaced it with the new sentence *“In our investigated case studies, a ML was never detected and only a very small part of the cloud cross-section was masked using the 0° isotherm at some cases.”* (Lines: 1111–1112)