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Comment on egusphere-2022-1217

Anonymous Referee #2

Referee comment on "The classification of atmospheric hydrometeors and aerosols from the EarthCARE radar and lidar: the A-TC, C-TC and AC-TC products" by Abdanour Irbah et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-1217-RC2, 2023

The presented manuscript from Irbah et al. introduces algorithms for the classification of atmospheric hydrometeors using the synergy of spaceborne radar and lidar measurements from the upcoming EarthCARE satellite mission. The manuscript is obviously intended to serve as a reference for the A-TC, C-TC and AC-TC products which are an integral component within the EarthCARE production model. The algorithms inherit many lessons learned from the A-Train constellation and its classification products (e.g., DARDAR-MASK) but also exploits the novelties of EarthCARE, like the HSRL and Doppler capabilities. First, the authors introduce the standalone classification algorithms A-TC and C-TC designed for ATLID and CPR and continues with the description of the synergistic classification AC-TC. Here, the ATLID and CPR measurements are merged for the first time within the production model to produce an overall target classification which is essential for downstream scene reconstructions like ACM-CAP or ACM-3D. As previous studies have shown (e.g., Cazenave et al, 2019), the target classification can have similar impacts on retrieved cloud properties compared to microphysical assumptions. A diligent introduction and discussion of the design of such target classifications is therefore appropriate.

I personally appreciated the comprehensible description of the synergistic product AC-TC, where Fig. 2 will be a helpful tool for the discussion in future studies using EarthCARE products and excels similar products in its reproducibility. The discussion of the case study and its “omniscient” evaluation convinces the reader without overselling the benefits of the instrument synergy. Overall, the science seem sound and settled and ready to be applied to measurements in the hopefully not too distant future.

While in my opinion only minor revisions are required to this manuscript, there are some critical points which I would require to be made for it be published. Just like RC1 I missed some of the traceability of AC-TC for the description of A-TC and C-TC which are too general and missing some details. As a potential future user of these products, I would probably miss some hard numbers (e.g., used thresholds) but also a quick overview if I would come across the paper in the need to understand results from EarthCARE products

better. Some paragraphs are also poorly written and would benefit from a further editorial assistance from a native speaker. Specific points and instances for improvement are listed below.

General remarks

- The description of A-TC as well as C-TC would greatly benefit from two figures showing the mentioned "decision tree" for both products. In its current form, a reader needs to read all paragraphs to gain an overview of the approach. Similar works (e.g., Ceccaldi et al 2013 Fig. 5) became helpful references when working with data from DARDAR-MASK. It would eliminate some ambiguities in the text and could also increase the visibility of the manuscript when users will use them in their presentations in the future.
- For A-TC, it is not completely clear where A-PRO ends and the A-TC algorithm starts, or if it is part of it. Since the manuscript for A-PRO has not been submitted yet, it is a little bit unclear if sections 2.1-2.4 summarize steps which are already happening within A-PRO or which are implemented within A-TC and should be referenced with the present manuscript in the future. Are statuses -3 to -1 (detection of attenuation!) (Table 2) provided from somewhere else? This also extends to the HETEAC framework. Is the implementation described in Wandinger et al 2022 or is this happening in your manuscript? It adds to the confusion that you are both basically using the same Figure (Fig. 1 and Fig. 9 in Wandinger et al 2022) without a reference. Furthermore, Wandinger et al 2022 is also referring to Donovan et al. (2022b) for a further description of A-TC. This confusion could be settled by showing the inputs used in the "decision trees" in the previously mentioned figures.
- There is also no introduction what layers are and if you derive their mean quantities like "mean beta" or "mean temperature" by yourself. Depending on the spatial and vertical extent of these layers, properties like "mean temperature" or "mean beta" could get quite arbitrary. It would be nice to add a short summary how these layers are defined and detected within A-PRO.
- Further down during the evaluation of AC-TC you are referring to an "inference" technique (e.g., L386, L427, L532) to decide the likelihood for a specific class when no clear signal can be obtained. While the need for such an approach is obvious, it is never mentioned in section 4 describing the AC-TC product. This could be introduced when discussing the decision matrix in Fig. 2.

Specific remarks

L60: DARDAR-MASK also includes a radar-only and lidar-only mask before merging them.

L90: You could refer to the VFM product of CALIOP which also applies a layering approach.

L104: Give threshold values or refer to a table in the ATBD.

L114: Is there a strategy to differentiate supercooled from highly oriented ice crystals (HOIC)?

L138: How do you define “dominant” or “low” probability? Is this further described in Wandinger et al (2022)? As this is a static information it should be possible to draw corresponding domains in the S-rho space, correct (Fig. 1)?

L146: Was the term “weak targets” introduced before?

L146: Can you provide more specific numbers to this median filter? The median filter is applied to integer masks which are by themselves layers? Please elaborate more clearly what is done here and to what effect. Should this filter not produce masks with intermediate float values?

Fig 1: What are the lines? Isolines of quantiles? Some centers have 3, one has 4?

L149: A short reminder to what “high”, “low” and “medium” resolution means would be nice

L158: What is texture in this context? Spatial structure? How is this exploited?

L164: It is the other way round, AC-TC inherits from C-TC, correct? You probably want to say here that C-TC is designed to work as standalone product.

L169: Is the definition of C-FMR layers analog to the definition within A-FM? Is there a similar “simple classification” done in C-FMR as input for C-TC like within A-PRO?

L198: What do you mean with “increase of Doppler velocity … (at surface level

conditions)”?

L205: How are the position of layers defined? Totally or also partially overlapping layers? Or is this happening along profiles?

L222, L225: What does "almost certain" and the “overlap regime” mean here? Are you somehow mixing masks here or are there fixed thresholds? In this paragraph, a figure with the actual decision tree for C-TC would be most helpful.

L230ff: In effect, this means that layers can be split into two different classes, correct?

L 241: Could you give this threshold in dB/km? dBZint depends on the resolution of the data.

L275: Like RC1, I cannot track the r_min_eff > 15 microns as sensitivity threshold. In contrast to RC1, I would expect r_min_eff to be even higher in reality since most dBZ_min estimates are considered without Doppler broadening (see Mech et al 2014). The mentioned -35 dBZ is also only valid for the 10 km averaged product. I would refrain from giving numbers here since this discussion is worth its own paper.

Fig. 2: Some cases should be not only unlikely but impossible. How is A-TC supercooled water and C-TC warm rain possible? When using the same temp field this case should not exist. Same is true for stratospheric clouds (A-TC) and sub-surface (C-TC). To find these combinations they should probably get their own label (hatched in Fig. 2) to find them easily as soon as EarthCARE is in operation.

L351: Is this fall back to the A-PRO classification also true for A-TC? It was never described there

Fig. 3, Caption: Describe panel c, d, e, separately. Labels would also improve the figure.

L376: This list of references used obviously DARDAR-MASK. I would write that AC-TC will carry on the inheritance of DARDAR-MASK and similar products.

L437: How do you infer an 99% detection of total ice water content from Table 5? I only see lower numbers.

L459: Same is true here. To what cost does this inference come with respect to false positives? While the number looks impressive, the false positive rate enhancement is important here.

Technical corrections:

L29: “important to an understanding the climate” -> “important to understand the climate”

L53: “detected through the profile of the atmosphere” -> “detected throughout the atmospheric profile”

L94: “described here is described in” -> “is described in”

L203: Repeated sentence.

L220: Awkward sentence, please rephrase.

L227 “classify liquid clouds are warm” -> “classify liquid clouds as warm”

L256: “points” -> “pixel” (?)

L261: “defined different vertical grids” -> “defined on different vertical grids”

L278. Awkward wording, please rephrase. The whole paragraph is a little bit hard to read.

L286: “detecting liquid cloud presence” -> “to detect the presence of liquid clouds”

L321: Awkward wording: “is considered detected” … ”has issue with clutter” … “it is assumed detected”

L327: Very unclear sentence.

L335: “developed to help develop” -> “designed to help develop”

L336: The term “PDGS” was never mentioned before?

L369: “structures resolved resemble” -> “resolved structures resemble”

L374: “which has the great advantage of including inside A-TC at all resolutions and C-TC” -> “which incorporates A-TC and C-TC at all resolutions”

Fig. 7, Caption: “liquid cloud” -> “rain” (?)

L483: “aerosls” -> “aerosols”, please rephrase sentence.

References

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