March 13, 2023

Dear Editor,

The referees pointed out minor changes and asked for explanations on certain points. Below, we respond point-by-point in bold to the comments of the referees on our paper:

"**The classification of atmospheric hydrometeors and aerosols from the EarthCARE radar and lidar: the A-TC, C-TC and AC-TC products**".

The authors responded to all referees' comments and edited the paper accordingly. They further provided explanations for some of the referees' comments when they disagreed. Additions requested for the clarity of the article for readers have also been made e. g. new figures.

Two versions of the article are delivered, one showing all the modifications in blue and the other resembling the final version.

We believe the revised paper is now ready for publication in *the special issue of AMT*.

Sincerely,
For the authors
Abdanour Irbah

1- EGUsphere, referee comment RC1

https://doi.org/10.5194/egusphere-2022-1217-RC1, 2023

Comment on egusphere-2022-1217

Matthew Lebsock (Referee)

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-RC1, 2023

This paper describes the target classification products for EarthCARE using lidar, radar, and synergy lidar and radar algorithms. The paper provides a needed reference for the at launch algorithms for EarthCARE. There are elements of the paper, which are written, in too general a fashion. The specific instances that I noticed that require more detail are listed below. In general, only minor revisions are required to this manuscript.

Line 19: Nobody outside of EarthCARE knows what the Halifax scene refers to. Provide some description of what the Halifax scene is – i.e. a cloud resolving simulation.

The explicit reference to the ``Halifax scene'' has been removed. The sentence now reads: "Simulated EarthCARE observations based on combined cloud-resolving and aerosol model data are used to test the processors generating the target classifications."

Line 104: What is the Beta threshold?

Note that this section has been rewritten and more detail has been supplied in general, including simplified decision tree figures. A separate threshold for the troposphere and stratosphere can be specified. These thresholds are currently set to 1.0e-m/sr. It is expected that they will be updated on the basis of actual observations made during the commissioning phase. The current value does perform well for the considered test scenes.

Section 2.2: How are the layer integrated depol and attenuated backscatter used? Thresholds? If so what are they?

Note that this section is now 2.3.2. The layer integrated depol and attenuated backscatter are used in the same way as described in Hu et al 2009. That is, the region where a layer is located within layer integrated-backscatter-depolarization phase space determines the phase assignment.

Line 146: Describe the median filter resolution.

See now section 2.4. The median filter resolution is adjustable and is expected to be updated on the basis of commissioning phase observations. For the simulated tests scenes a resolution of 11 JSG pixels (about 10 km) along-track and 3 vertical pixels (about 300 m).

Line 162: use actual CloudSat and CALIPSO references:

The following references have been added and used:

- **Marchand, R., Mace, G. G., Ackerman, T., & Stephens, G. (2008). Hydrometeor Detection Using Cloudsat—An Earth-Orbiting 94-GHz Cloud Radar, Journal of Atmospheric and Oceanic Technology, 25(4), 519-533.**

- **Mace, G. G., and Zhang, Q.(2014), The CloudSat radar-lidar geometrical profile product (RL-GeoProf): Updates, improvements, and selected results, *Geophys. Res. Atmos.*, 119, 9441–9462, doi:10.1002/2013JD021374.**

Line 195: Is the reflectivity attenuation corrected?

The CPR reflectivity that is used as input to the synergistic target classification is corrected for gaseous attenuation, not hydrometeor attenuation.

Line 219: Add () around H.

Corrected

Line 225: change 'no' to 'non

Rewritten sentence

Line 235: '*The observed pixels above land and below 3 km altitude with reflectivity between -20 and -15 dBZ and temperatures not lower than 15 °C are classified as insects and/or artifacts.*' I don't understand why these couldn't be fair-weather Cu. Can you explain?

We agree with the reviewer that in terms of radar reflectivity value, it is possible to be a continental fair-weather cumulus cloud. However, there is a significant volume of past research conducted at the DOE ARM sites that clearly indicates that most radar echoes over land during warm seasons is due to insects (Luke et al., 2008; Chandra et al., 2013; Kollias et al., 2014; Lamer and Kollias, 2015). This experience explains our suggestion to classify these echoes as insects. Please not that when the temperature is lower than 15 °C, the CPR echoes are classified as liquid clouds. Here is the revised sentence in the manuscript:

"Over land and when the air temperature is not lower than 15 °C, there is a significant record of observations from profiling millimeter wavelength radars (cite: Luke et al., 2008; Chandra et al., 2013; Kollias et al., 2014; Lamer and Kollias, 2015) that suggest that most of the radar echoes are from deep insect layers. Furthermore, because if non-Rayleigh scattering, the insects radar reflectivity is typically below -20 dBZ. Based on the above information, all CPR echoes over land and below 3 km altitude with reflectivity lower than -20 dBZ and temperatures not lower than 15 °C are classified as insects."

References added:

Luke, Edward P., Pavlos Kollias, Karen L. Johnson, and Eugene E. Clothiaux. "A Technique for the Automatic Detection of Insect Clutter in Cloud Radar Returns", Journal of Atmospheric and Oceanic Technology 25, 9 (2008): 1498-1513, accessed Jan 23, 2023, https://doi.org/10.1175/2007JTECHA953.1

Lamer, Katia and Kollias, Pavlos, 2015, "Observations of fair-weather cumuli over land: Dynamical factors controlling cloud size and cover" Geophysical Research Letters Vol. 42, No. 20, pp 8693, 00948276

Chandra, Arunchandra S., Kollias, Pavlos, and Albrecht, Bruce A., 2013, "Multiyear Summertime Observations of Daytime Fair-Weather Cumuli at the ARM Southern Great Plains Facility" Journal of Climate Vol. 26, No. 24, pp 10031, 1520-0442

Kollias, Pavlos, Jo, Ieng, Borque, Paloma, Tatarevic, Aleksandra, Lamer, Katia, Bharadwaj, Nitin, Widener, Kevin, Johnson, Karen, and Clothiaux, Eugene E., 2014, "Scanning ARM Cloud Radars. Part II: Data Quality Control and Processing" Journal of Atmospheric and Oceanic Technology Vol. 31, No. 3, pp 583, 1520-0426

Line 275: I can't track the claim that the radar will only see effective radii > 15 micron. If you look at Eq 5 in Matrosov et al., 2004, we see that assuming a log-normal DSD an expression for effective radius is r_e = aZ^(1/6) with a = (2exp(0.5sigma*N^(1/6))^-1. Plugging in the reasonable values of sigma = 0.38 and N = 100 cm^-3, and radar sensitivity of Z = -35 dBZ, I get r_e = 5.6 micron.

- Matrosov, S. Y., Uttal, T., & Hazen, D. A. (2004). Evaluation of Radar Reflectivity–Based Estimates of Water Content in Stratiform Marine Clouds, Journal of Applied Meteorology, 43(3), 405-419.

We have therefore decided to delete this sentence since the main information on the sensitivity of radar and lidar to particles has also already been presented in the article. Indeed, the second referee (RC2) also has a comment on this point concluding that it could be the subject of a long debate:

"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."

Line 282: Is 'traduced' meant to be 'introduced'?

Line: "Each co-located pixel of the CPR and ATLID measurement profiles is attributed to a given class of Table 4 according to the probing properties of the instruments traduced in the decision matrix shown in Figure 2."

Is replaced by: "Each co-located pixel of the CPR and ATLID measurement profiles is assigned a class of Table 4 according to the probing properties of the instruments, resulting in the decision matrix shown in Figure 2."

Sections 4.5 and 4.6: Because the radar footprint is much larger than the lidar footprint (Across track) there may be instances where the radar detects a cloud edge that does not fill the radar footprint and is undetected by the narrower lidar beam. It seems the decision tree discounts this possibility.

There will be such instances, but mainly they will occur at cloud edges, where the radar may detect the cloud for a maximum of one extra pixel at the beginning and/or end of a series of

cloudy points. It is not true that the decision tree discounts this possibility: it can be seen in the top row of Fig. 2 that in such a situation the lidar-only "A-TC" classification would report either "0 Clear" or one of the various aerosol types. Looking down these columns we can see that if the radar-only "C-TC" classification sees ice or snow then this will correctly be fed into the combined AC-TC classification product. If the radar sees a signal warmer than the freezing level that is not seen by the lidar then if the lidar saw nothing it would be interpreted as insects, while if the lidar detected aerosols then the aerosol properties would be passed into AC-TC. Thus, the only possible mis-classification occurring in the situation identified by the reviewer would be in this example of insects being reported, but it would only occur in isolated pixels, most likely at the edges of clouds. During the satellite commissioning phase the products from EarthCARE, including AC-TC, will be examined in detail, and if this emerges as a problem then a slight adjustment will be made to the algorithm to correct it, for example replacing isolated reports of insects with clear sky.

Line 327: I have no idea what this sentence means: '*Concerning the clutter situation, it essentially relies on a specific processing of the radar reflectivity signal coming from areas assumed to be close to the ground. It will therefore be treated thanks to the obtained results and reported here using C-TC.*'

This sentence has been reworded as follows:

"Concerning the radar surface clutter region, it essentially relies on a specific processing of the radar reflectivity signal coming from zones assumed to be close to the ground. The C-TC classes resulting from this processing will be taken as such for this region."

Figure 3: Several things about this figure bother me. (1) There is something wrong with the radar noise in the top left of the panel F, (2) can you add two panels to separate the cloud/precipitation from the aerosol in panels A and B, (3) The labels are very small and difficult to read.

This figure has been re-worked, and the reviewer's suggestions incorporated.

Line 366: 'low resolution' has not been defined anywhere. Nor has medium or high.

This have been added to the text (see section 2.4). High resolution is 1-km, "medium" and "high" are configurable and currently set to about 50 and 100km respectively.

Line 385: I don't think the other two test scenes have been described in Section 5. Please provide some description.

A short segment of text has been added in section 5 to guide the reader e.g.

"In this paper only results for the "Halifax" scene are presented. AC-TC has also been applied to the "Baja" (which crosses western Canada, U.S. and the Baja peninsula) and "Hawaii" (tropical pacific) scenes ["The Generation of EarthCARE L1 Test Data sets Using Atmospheric Model Data Sets", Donovan et al. 2023 in the same EarthCare special issue of AMT]. Results for these other two scenes are presented within a wider evaluation context within [see the evaluation paper, Mason et al. 2022 in the same EarthCare special issue of AMT].

2- EGUsphere, referee comment RC2

https://doi.org/10.5194/egusphere-2022-1217-RC2, 2023

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

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.

References

Cazenave, Q., Ceccaldi, M., Delanoë, J., Pelon, J., Groß, S., and Heymsfield, A.: Evolution of DARDAR-CLOUD ice cloud retrievals: new parameters and impacts on the retrieved microphysical properties, Atmos. Meas. Tech., 12, 2819–2835,

https://doi.org/10.5194/amt-12-2819-2019, 2019

- 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 DARDARMASK. 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.

  A Figure similar to Fig. 5 of Ceccaldi et al. (2013) was made for C-TC and included in the revised paper: see Figure 5.
  For A-TC, the discussion has been revised. Two new (simplified) decision trees (one for the simplified classification and one for the main classification scheme) were added: see Figures 2 and 3.

- 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 APRO 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.

  In practice, A-PRO and A-TC are indeed tightly coupled, as realized in software, A-TC is contained within the A-PRO processor. The A-TC section has been rewritten and more detail given, at the price of some redundancy between this paper and the (still in preparation for the same AMT special issue) more extensive A-PRO paper.
  The description given here is intended to be more concise than the treatment in the A-PRO paper though.
  The HETEAC paper (Wandinger et al.,2022, submitted in the same special revue) is intended to describe the "theoretical famework" while here the aerosol type classification is a specific application of the framework.
  The suggestion to present decision trees has been adopted.

- 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.

  A new sub-section describing the layering determination has been added.

- 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.

  The choices made here relate to the limitations of the radar-lidar synergy: the classes in C-TC pertaining to “in clutter” in the near-surface region and the “heavy precipitation” classes assigned when CPR is dominated by multiple scattering or attenuation, and the classes with “possible liquid” that are assigned when ATLID is extinguished.

  This information about the uncertain content of regions where the instruments are not able to make a detection is encoded in the target classification, but the inferences are not built into the AC-TC decision matrix. This preserves as much information as possible without making a choice on the behalf of the user.

  We have added to discussions throughout the paper to make this more clear.

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

Yes, the reviewer is correct. The sentence is modified as follow:

«The Earth-CARE synergistic product is constructed differently from DARDAR-MASK although both are basically based on the same approach. Indeed, the radar-lidar measurements are combined at each altitude grid point to create a synergistic target classification product in a single step thanks to the already existing and validated EarthCare products, A-TC and C-TC. "

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

This reference has been added.

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

No. ATLID is pointing 3 Deg. off nadir. This will eliminate (90%+) of the specular reflection from HOICs.

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)?

The dominant type is defined by that aerosol type which has the highest probability amongst the considered types and still has a probability Paer > 0.011 (the threshold is determined by the low probability configuration threshold used within this paper). Since it is a configuration parameter, it may be adapted when real EarthCARE data is available.

In case of a pixel with a ‘low probability’ assignment (i.e. the maximum value of Paer is below 0.011), the pixel is assigned to the “unknown” class.

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

This has been added to the text.

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?

More detail covering the implementation of the class filter has been added (see section 2.4). Indeed, it is different from a “normal” median procedure in order to avoid the types of issues the reviewer raises here.

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

This has been added to the text (see section 2.4).

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

The word “texture” has been removed in the revised manuscript. In ground-based systems, the radar reflectivity texture (i.e., its localized (time-height) standard deviation) correlates well with the presence of insect echoes. We do not have yet such experience with spaceborne cloud radars. Thus, the reference to the radar reflectivity texture has been removed.

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.

The reviewer is correct, the wording is unfortunate and creates confusion. Here is the text added in the revised manuscript:

“The EarthCARE CPR target classification (C-TC) is based on a ``decision-tree'' algorithm with fixed rules and it is designed to work as a stand-alone product. The main steps of the detailed C-TC classification procedure are depicted in Figure 5. In order to facilitate its use and integration in the synergistic target classification we have adopted similar target classification definitions and names.”

L169: Is the definition of C-FMR layers analogous 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?

In the C-FMR, we only classify CPR echoes as “no significant detection”, “clutter” and “multiple scattering”. In effect, we only classify the CPR echoes are meteorological and non-meteorological.

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

The hydrometeor sedimentation Doppler velocities are first adjusted for density effects by referencing them to standard surface conditions before they are used as input to the C-TC algorithm. This sentence has been added in the revised manuscript.

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

Each atmospheric column sampled by the CPR is treated separately. We do not attempt cloud and precipitation systems classifications in terms of "cluster" overlap conditions.

L220: Awkward sentence, please rephrase.

See response for L230 below

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.

See response for L230 below

L230: In effect, this means that layers can be split into two different classes, correct?

The text between lines 220 and 230 (of the original manuscript) have been revised for clarity.

L241: Could you give this threshold in dB/km? dBZint depends on the resolution of the data.

We disagree. The integral of the radar reflectivity profile for values over 12 dBZ does not depend on the vertical resolution of the CPR observations.

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.

We agree with you. We have therefore decided to delete this sentence since the main information on the sensitivity of radar and lidar to particles has also already been presented in the 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.

We divided the impossible combinations into 2 types and tagged them:

- The first type that will be marked with an (*) corresponds to various combinations crossed out in the columns of classes A-TC 1, 2 and 3. They are due to wet bulb field issue causing a difference between the radar and the lidar: the fusion layers detected by radar are not the same for lidar

- The second type which will be marked with a (**) corresponds to impossible cases: radar seeing tropospheric targets and in clutter, and lidar detecting stratospheric features

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

The "simple-classification" is now discussed in this paper.

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

This figure has been re-worked.

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

This should have read "around 99%"; the value in the Table is 98.7%.

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.

The false positives due to these inferences are now shown (dark blue) in Figures 5, 6 & 7 updates and discussed especially in the case of liquid cloud, where the most false positives occur. The false positives due to inferring precipitation in the surface clutter and convective cores are near-negligible, at least in the test scenes.

The overestimation of the volume fraction of these classes due to misclassification and inferences can be quantified (and now added to the figures); but the significance of any false positives depends on how these inferences are used. As an example: within the ACM-CAP (see Mason's paper et al., also submitted in the same special revue) retrieval the liquid water content retrieved within rain, rimed snow and convective cores is represented with a very simplified vertical distribution that is not intended to recover the small-scale features of liquid clouds, and where the prior can be set very low. When the CPR attenuation and MSI solar radiance measurements justify higher liquid water contents, they can be retrieved—but this can only be done where the target classification allows. In other words, the problem is asymmetric: the error in the retrieval due to not inferring the presence of liquid cloud will be as large as the liquid water content not detected, but the error due to retrieving liquid cloud inferred where none in fact exists will generally be very small due to the low a-priori value. While this is borne out in the test scenes, this assumption will need to be continually assessed in the context of the ACM-CAP retrieval.

A lot of this relates to the retrieval rather than the target classification, but we have expanded on this discussion.

Technical corrections:

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

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

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

L203: Repeated sentence. **Done, sentence deleted**

L220: Awkward sentence, please rephrase. **Done**

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

L256: “points” -> “pixel” (?) **Done**

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

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

Done, sentence changed as follow: “The detection of liquid cloud is challenging for CPR but possible depending on the sensitivity and the presence of drizzle”

L286: “detecting liquid cloud presence” -> “to detect the presence of liquid clouds” **Done with L278**

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

Done: sentences changed to “The ground or “sub-surface” classification is assigned when radar or lidar can see it. It is also assigned when the radar sees the ground and the lidar signal is attenuated or has data issues (missing data)”

L327: Very unclear sentence.

Sentences reformulated as follow: “Concerning the radar surface clutter region, it essentially relies on a specific processing of the radar reflectivity signal coming from zones assumed to be close to the ground. The C-TC classes resulting from this processing will be taken as such for this region.”

L335: “developed to help develop” -> “designed to help develop” **Done with “... produced to facilitate the development and testing of ...”**

L336: The term “PDGS” was never mentioned before? **Done by adding “Payload Data Ground Segment (PGGS)”**

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

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”

Done by changing the sentence with ” which incorporates A-TC at all resolutions and C-TC” since only A-TC is built with many resolution not C-TC

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

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