

Review of “Persistent EarthCARE underflight studies of the ITCZ and
organized convection (PERCUSION): Contribution to EarthCARE
Validation” by S. Groß and 23 Coauthors

<https://egusphere.copernicus.org/preprints/2026/egusphere-2026-112/>

I found this to be a very interesting and worthwhile paper, though it was not quite what I was expected from reading the abstract. The abstract tells me that during the PERCUSION campaign, HALO made “33 passes under the EarthCARE satellite during 30 research flights”. Based on this, I was looking forward to long, comprehensive descriptions of the validation measurements, coupled with multiple analyses of the EarthCARE instruments’ performance relative to these measurements. What I found instead was a well-crafted advertisement for the use of the HALO and PERCUSION data sets in future, more in-depth EarthCARE validation studies. This is not at all a bad thing. Still, I believe the authors should rework their abstract so that it clearly states the scope of the studies presented in the manuscript. The analyses that are described are both well designed and informative, but sufficient only to scratch the surface of a comprehensive validation paper. That said, attempting to validate all four instruments in a single publication is a Herculean task that would no doubt yield a book length manuscript. The multi-sensor validation overview given in the paper is a fine first step. The PERCUSION mission appears to have been meticulously planned to satisfy EarthCARE validation targets. The manuscript is well written, very well referenced, and entirely appropriate for publication in Atmospheric Measurements Techniques.

We thank you very much for your time you dedicated to review this manuscript, for your careful reading and valuable comments that helped us improve the quality of this manuscript. Based on the reviews we revised the manuscript more substantially to better bring out the main points of this study.

Below I’ve attached an annotated version of the authors’ manuscript with (mostly minor) comments sprinkled throughout. I ask that the authors consider all of these in crafting a final draft of their publication.

We have considered all your comments and will give a point-by-point response. Answers are given in italics and bold. Text changes are marked in italics, bold, and blue.

Abstract:

l. 26: sup → sub

We removed sub-tropics.

l. 27: Add a sentence of two describing validation success (or failure) to the abstract. In very general terms, what worked well and what (if anything) did not

We agree that the abstract did not well capture the main objective of the paper or well summarized the findings. We revised the abstract:

‘In May 2024, the Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) satellite was launched. For the first time a satellite combines two active instruments, i.e., the Atmospheric Lidar and the Cloud Profiling Radar, together with two passive instruments, a multi-spectral imager and a broad-band radiometer, on one single spacecraft platform. EarthCARE is thus the most complex satellite mission to date to for collocated aerosol,

cloud, radiation and precipitation measurements. To utilize the data collected by the EarthCARE mission to its full extent and to support and quantify the data quality and measurement uncertainty, careful and holistic validation activities are needed. For this purpose, we set up an airborne instrument payload on the German High Altitude and Long-range research aircraft (HALO), which is similar to the EarthCARE instrumentation. We used this payload during an extensive measurement campaign in summer and fall 2024 in the tropic and mid- to high-latitudes targeting to validate the EarthCARE measurements and data products early in its commissioning phase. With this manuscript we aim to give a detailed overview of the PERCUSION mission, and to advertise the use of its data in future more detailed validation studies. We give examples of how to use PERCUSION data to approach the validation of all for instruments of EarthCARE as well as of higher level (i.e. multi-sensor) products, and give first confidence in the quality of EarthCARE data.'

Introduction:

l. 48: Langsdale et al., 2025 is not listed in the references section

We added the missing reference.

l. 50f: Consider citing Gimmestadt et al., 2017 here

Thanks for making us aware of this. We added a reference to Gimmestad et al.

l. 60: the LaRC HSRL was also a critically important component of CC-VEX

Thanks for making us aware of this. We changed it as follows:

'deploying an elastic backscatter lidar and a W-band cloud radar on the ER-2 aircraft and NASA's HSRL (Hair et al., 2008) system on the Beechcraft B-200 King Air. '

l. 70: one → ones

Done

l. 77f: one would think the causal connection between the two activities would be reversed; that is, rather than acquiring measurements designed to be "consistent with corresponding [...] simulations", the simulations should be revised to be consistent with the measurements.

Right! We changed the sentence accordingly.

Section 2 – Requirements for validation:

l. 101ff: For each instrument, please include references to the papers that provide descriptions of the engineering specifications and measurement capabilities; e.g., similar to the papers listed in table 3 for the HALO instruments. For CALIOP, a good example of this sort of paper is Hunt et al., 2009 (<https://doi.org/10.1175/2009JTECHA1223.1>).

We discussed this issue with responsible people at ESA. The recommendation we received was to refer to the general overview (Wehr et al.) of the mission and retrieval (Eisinger et al.) and the publication referred to within. We follow their recommendation.

l. 114: in level products → according to data processing level.

We changed that.

l. 123: described by [who? what?] and

Sorry, the reference was missing. We added it.

l. 124: unites → units

Done

l. 124: hyphen is unnecessary

Done

l. 125: the following → Table 2

Done

Table 2 (cloud layer detection): should cloud phase be explicitly included in this list?

We agree that the cloud phase was missing. We added this to the macrophysical properties.

Table 2 (AOT – aerosol types): wouldn't ATLID measurements also be helpful in distinguishing between different aerosol types?

Right! However, we expect, the main problem here is the sensitivity of the passive sensor to the underlying surface. Thus, we want to keep this point separately.

l. 132: are multi-layer aerosol scenes (e.g., dust lofted above marine) part of this category?

To our understanding this includes also multi-layer aerosol scenes. To make that clear we added this sentence to the text.

l. 136: be characterized → characterize

Done

l. 138 (is challenging): perhaps soften this by saying "can be challenging". A-Train observations show that most marine stratocumulus is readily detected by either CloudSat or CALIOP (though not always at the same time, and, as the authors note, CALIOP frequently fails to detect the true base of optically thick clouds)

Thanks for that advice. We reformulated the text accordingly.

l. 147 (detect): would "identify" be a better word choice here?

Changed it.

l. 153: Combination of radar and lidar → Combined radar and lidar measurements are

Done

Section 3 – The HALO PERCUSION mission

l. 167 can the authors provide a reference describing this activity?

We are not sure what reference would be a valuable contribution here or how to reference our activities. During the PERCUSION campaign (and during following campaigns we performed for validation) our flight planning was closely coordinated with any activities on ESA side regarding the calibration of instruments or maneuvers for orbit adjustments. This close coordination helped to have EarthCARE always fully operational when an underpass was performed.

l. 170 (15 km): good for mid-latitude observations but insufficient for measuring a large fraction of tropical cirrus

That's true; even a flight altitude of 15 km was often insufficient to fully capture cirrus clouds in the tropics. However, convection in the tropics wasn't always fully developed, and we were able to conduct good validation measurements even at these latitudes. However, we are aware that due to this (and also other limitations, e.g. no in-situ measurements) the word 'ideally' is not right here and changed it to 'well'.

l. 174: Doppler should be capitalized

Done

Table 3 (HAMP): please define the acronym

It is HALO Microwave Package

Table 3 (MIRA): please define the acronym

That's the manufacturer's model name. Unfortunately, we can't provide a definition.

l. 183: is it safe to assume that the EarthCARE operational algorithms were also adapted for use with the HALO measurements?

This is true for some but not all of the operational algorithms, e.g. we applied the CAPTIVATE (radar-lidar) retrieval also on HALO radar and lidar data.

l. 186: which one? the reference section lists two Gutleben et al., 2019 papers

Thanks for making us aware. We clarified that throughout the text.

. 195: Next → In addition

The paragraph was rephrased.

Table 4 (water path): ice water path AND liquid water path, or ice water path only?

Our main focus is on the ice water path. We changed that accordingly.

Measurement strategy: holy moly! what a barrage of acronyms!!

Sorry for that ;-)

l. 224: During this part → This

Done

l. 225: it was aimed → was organized

Done

Figure 1: the Sal and Barbados plots are difficult to interpret, as it's not immediately clear what the circles represent. why are there no circles in the Oberpfaffenhofen plot? if possible, add legends that assign flight dates to each color used

Thank you for this comment. We thought of adding the flight dates for each flight / color. However, the plot got too overloaded. We added a description of what purposes the circles were for in the figure caption and in the text.

l. 238f: please include this information in the caption of figure 1

Done

l. 246: caught → flew directly beneath

Done

l. 246: northern → the northern

We changed that to 'in the northbound and southbound direction'.

l. 247: meeting point → closest coincidence

Done

l. 256: cross-track distance, yes?

Yes, we added this.

l. 257: generally, yes. but probably not for small scale boundary layer cumulus.

Yes, this is right, but even for small scale structures we found from previous studies that the aircraft and satellite measurements can be compared to give a meaningful evaluation of height distribution and horizontal extend. We added the following sentence:

'However, care is to be taken when comparing small scale structures, e.g. boundary layer clouds, in those cases.'

l. 264: meeting → coincident

Done

Table 5: reminder on target scenes

We don't know, what is meant here. The targeted scenes are given in the table.

Table 5: on the orbit numbers, what do the C, D, and E postfixes indicate?

C, D, E, ... give information on the latitude of the orbit. The orbits are thus subdivided according to their position.

Section 4 – PERCISON's potential for EarthCARE Validation

l. 271: overview, → overview

Done

l. 271ff: I found this paragraph very useful in bounding my expectations of the material that follows. it would be a big help to other readers if a synopsis of this statement of intent was clearly given in the abstract. (if it's meant to be there, I missed it.)

We have revised the abstract to be more precise.

l. 283: here and elsewhere, please also convert along-track temporals resolution to approximate spatial resolutions

Done

l. 288: sentence fragment

We rephrased this section and integrated the fragment into a longer sentence.

l. 292: using the coordinates in table 5 and looking at google earth tells me that this data segment was acquired over ocean. including an orbit track map would be helpful. explaining that the "signatures of low clouds" are shown in black in both images would also make the info content of these images more readily accessible.

We followed this advice and mention that the measurements were performed over the ocean and that clouds are indicated by black signatures.

Figure 2: consider adding wavelength info to the legends

Due to the space limits in Figure 2 we did not add the wavelength information there, but it is noted in the text and on the 2D Plots, as well as in the legend of Figure 3.

Figure 2: the different wavelengths, the cirrus attenuation, and the different measurement time scales make it difficult to directly compare the backscatter magnitudes. (at first glance ATLID appears to underestimate WALES.) but isn't the depolarization of dust largely independent of wavelength at 355 and 532? so perhaps an additional comparison of the depolarization ratios in the dust layer would yield some useful insights?

As this reviewer states further below, we are providing a comparison of the depolarization ratios. In this plot we focus on the comparison of the Level 1 data. We included sub-headlines to better highlight if we are comparing L1 or L2 data.

Figure 2: why was this comparison not centered around the coincident location shown by the dotted line?

Around the point of best match, the aerosol structure is spatially very inhomogeneous and thus more susceptible to differences on small scales. On the other hand, the signal of ATLID had to be averaged over longer distances to let systematic differences stick out from the noise. Thus, a region as close as possible to the best match time was chosen for which the aerosol layer is as homogeneous as possible. The plot region was extended to better show the inhomogeneous parts on this side.

l. 305: what is "A-NOM"?

ATL_NOM_1B is the product name in the ESA database. We changed A-NOM to the correct name and give the explanation in the text.

l. 312: evaluating of the → evaluating the

Done

l. 315: can the authors comment on any specific metrics that might be applied in future, more quantitative analyses?

This manuscript does not intend to give a full validation. However, we do a careful validation that will be presented in a following manuscript. In our analysis we are doing a case-by-case validation as well as a statistical validation; taking into account the differences in the mean profile as well as of the mean properties sorted by scene, height and feature.

Figure 3: interesting. Floutsi et al., 2023 (<https://doi.org/10.5194/amt-16-2353-2023>) suggest that lidar ratios for Saharan dust are $\sim 53 \pm 8$ sr at both 355 nm and 532 nm.

There are several studies addressing the lidar ratio of Saharan dust at different wavelengths from this group as well as of Floutsi et al.. It was found, that the lidar ratio for Saharan dust depends on the dust source region and on dust transport pathway/time. Furthermore, it has been shown from direct comparisons that the lidar ratio derived from HSRL instruments is sometimes found to be lower than the values derived from Raman lidar systems (e.g. Esselborn et al., 2008, Tesche et al., 2009) due to the different averaging needed in for the Raman signals. Since it is not the objective of this manuscript to investigate the lidar ratio of Saharan dust but to evaluate the quality of the derived values from EarthCARE, we decided to keep this paragraph as is. Deploying the same high-quality method (HSRL) we prevent of adding systematical biases to this comparison.

Figure 3 (Lidar ratio): add units

Done

Figure 3: a-ha! here is the depolarization comparison I asked for earlier. how much vertical smoothing is done to generate these plots?

For the WALES data no vertical smoothing is applied, only horizontal over the given average interval. For ATLID the retrieval algorithm decides on its own how to locally smooth the data. The size of these regions can be seen as the blocks of constant color in the 2D plots for the depolarization.

l. 334f: please be more specific; provide more detail on "issues in the layering of the A-EBD properties"

We have rephrased this sentence to be more specific:

'Early comparisons between HALO measurements and ATLID L2 optical properties have identified an error in the layer specification for EarthCARE A-EBD algorithms, resulting in overly coarse layering. This problem could be before data have been made publicly available and are no issue anymore in the current baseline.'

l. 336: please provide examples of these problems and comment on their severity

We have removed this sentence since the information is given now already in the information given. See prior comment.

l. 349: : → .

Done

l. 350: ~16:19?

Done

l. 353: indicative of → indicates

Done

l. 356: these algorithms are used only on the WALES data. yes? aren't the ATLID layer boundaries determined using the algorithm described by van Zadelhoff et al., 2023?

We agree that the previous wording was not sufficiently clear. For the WALES backscatter data shown in Fig. 2a, a height-dependent threshold-based algorithm was developed to distinguish explicitly between cloud and no-cloud conditions. This algorithm is described in detail in Krüger et al. (2026, in preparation) and is applied exclusively to the WALES observations. Regarding the A-TC product, Irbah et al. (2023) describe that the classification of atmospheric targets is based on height-dependent thresholds applied to ATLID backscatter and depolarization ratio, together with information on the tropopause height.

To clarify this distinction, the corresponding paragraph in the manuscript (ll.356-362) has been revised as follows:

"Threshold-based detection algorithms are commonly applied to determine atmospheric targets from lidar observations such as clouds and aerosols (Groß et al., 2013; Marinou et al., 2019). In this example, however, the focus is exclusively on the validation of EarthCARE cloud products. In particular, we focus on cloud macro-physical properties from the target classification product (A-TC), providing information on the vertical distribution of clouds and the cloud top height product (A-CTH). The A-TC classification itself applies height-dependent thresholds to ATLID backscatter and depolarization together with information on the tropopause height to distinguish between atmospheric target (Irbah et al., 2023). For the validation, cloud pixels and the altitude of the uppermost cloud layer are independently determined from the WALES backscatter ratio (BSR) data using a height-dependent threshold-based algorithm similar to approaches used in previous studies (e.g., Groß et al.,

2014; Urbanek et al., 2017; Gutleben et al., 2019; Dekoutsidis et al., 2024). The specific implementation of this algorithm is described in detail in Krüger et al. (2026, in preparation) and is applied exclusively to the WALES observations.”

We also provide the new references included in the text:

Dekoutsidis, G., Wirth, M., and Groß, S.: The effects of warm-air intrusions in the high Arctic on cirrus clouds, *Atmos. Chem. Phys.*, 24, 5971–5987, <https://doi.org/10.5194/acp-24-5971-2024>, 2024.

Irbah, A., Delanoë, J., van Zadelhoff, G.-J., Donovan, D. P., Kollias, P., Puigdomènech Treserras, B., Mason, S., Hogan, R. J., and Tatarevic, A.: The classification of atmospheric hydrometeors and aerosols from the EarthCARE radar and lidar: the A-TC, C-TC and AC-TC products, *Atmos. Meas. Tech.*, 16, 2795–2820, <https://doi.org/10.5194/amt-16-2795-2023>, 2023.

Krüger, K., Groß, S., and Wirth, M.: Validation of cloud macrophysical properties from the ATLID L2a products A-TC, A-FM, A-CTH using airborne lidar observations during the HALO missions PERCUSSION, ASCCI and NAWDIC, (to be submitted to AMT, 2026).

Figure 4 (small values): what are the units of the x-axis?

Addressed in the comment below

Figure 4: please explain the significance of the red and gray lines in the figure caption

We thank the reviewer for the suggestion regarding the x-axis. The unit of the lower x-axes is indeed in degrees latitude. To improve clarity, we have updated the figure as follows:

- **Adjusted the backscatter colorbar by reducing the number of colors and setting new thresholds, corresponding to Krüger et al. (2026, in prep.).**
- **Added a legend showing cloud tops from WALES (red) and the A-CTH product (gray). Only WALES cloud tops that could be unambiguously identified—i.e., where the distance between the cloud and the aircraft was sufficiently large—are displayed now.**
- **Included a proper labelling of the lower x-axes in panel (a) and (b) (°N).**

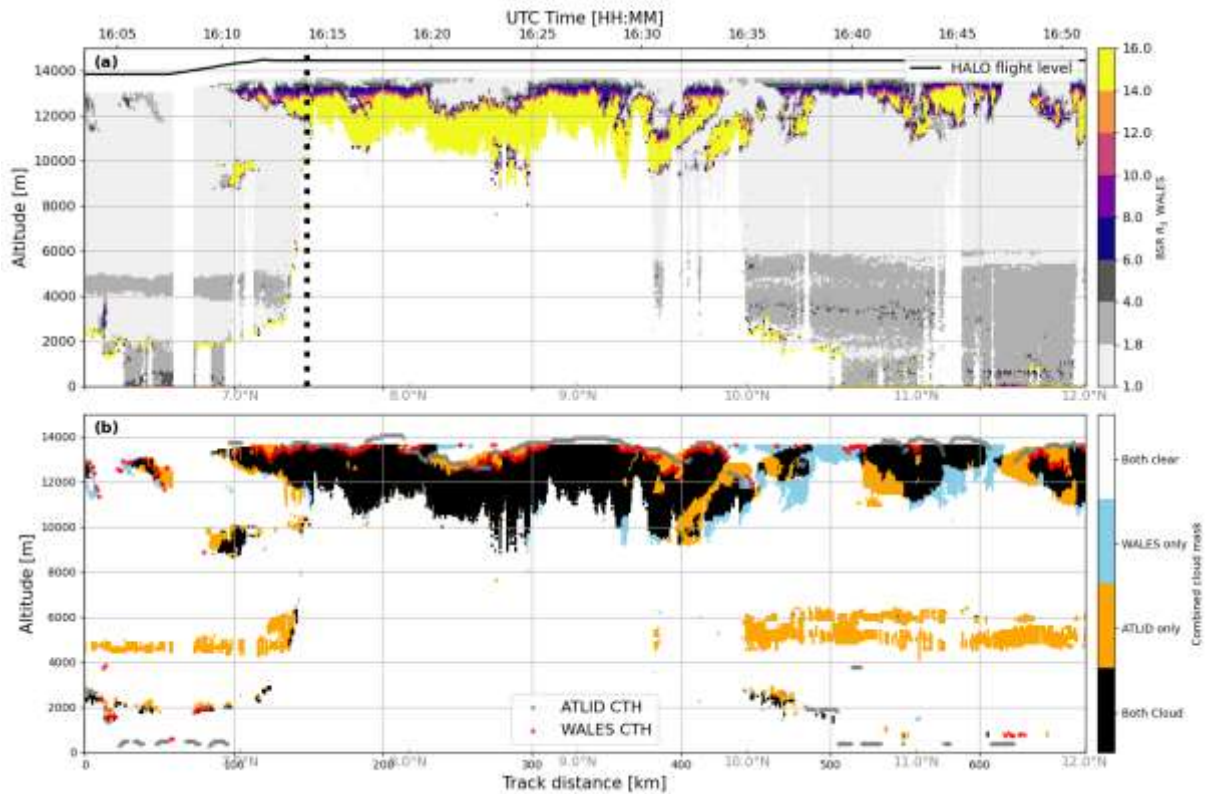
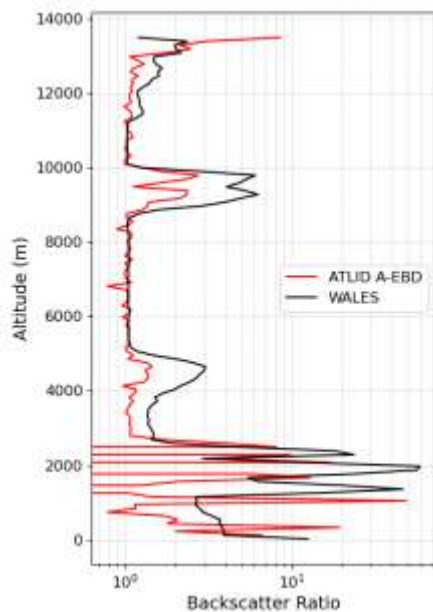


Figure 4: interesting. is the thin area of relatively strong scattering also seen in the ATLID data? or was there a noticeable change in cloud backscatter here between the two sensors?

Thanks for your comment. We tried to improve the figure caption also by including a statement how to interpret and compare WALES and A-CTH cloud top altitudes.

“Figure 4: Distance–altitude cross sections for the HALO flight on 16 August 2024 showing (a) the backscatter ratio measured with the WALES HSRL, along with the flight altitude of the HALO aircraft (black solid line) and the EarthCARE underpass track (thick black dashed line). Panel (b) shows the combined cloud mask derived from the WALES BSR data and the collocated EarthCARE Level-2 target classification product (A-TC). Black shading indicates cloud pixels detected by both WALES and A-TC, while blue and orange colors represent cloud pixels identified exclusively by WALES or A-TC, respectively. White denotes regions with no cloud detection by either product. The red markers indicate the cloud top height derived from the WALES backscatter ratio, while the gray markers represent the cloud top height from the A-CTH product. Note that cloud tops from WALES are displayed only when they could be unambiguously identified (e.g., when the cloud top was sufficiently far from the HALO aircraft), while A-CTH reports a cloud top for these cases.”

Figure 4: it would be helpful to have latitude/longitude coordinates on the x-axis rather than along-track distance



We are not entirely certain which specific area the reviewer is referring to. To clarify this point, we calculated the mean backscatter ratio (BSR) profiles for the first 100 km of the flight legs where both instruments observed the same atmospheric features. These segments include (i) ice cloud patches between approximately 9–10 km altitude and (ii) slightly enhanced WALES BSR values around 4–6 km within the aerosol layer.

It should be noted that a direct quantitative comparison of the BSR magnitudes is limited because the instruments operate at different wavelengths (WALES at 532 nm and ATLID at 355 nm). Due to this wavelength dependence of scattering, the BSR peaks observed by ATLID are expected to be smaller than those measured by WALES.

Nevertheless, the vertical positions of the enhanced backscatter are consistent between both instruments. Both instruments show pronounced features at approx. 5 km altitude associated with the aerosol layer, as well as strong signals between about 9–10 km corresponding to the ice cloud.

l. 377: from looking at the images, the tendency that you allude to here is not apparent to me

We realize that these statements could be misunderstood in this context. We report that the ice clouds in the A-TC product are thicker vertically, which generally means that their upper limits are higher. However, the cloud upper limit in A-TC (for example, the uppermost cloud pixel in this product) is not analyzed in this example. Instead, we note that the cloud tops from the independently generated A-CTH are above those from WALES in the high-altitude clouds, which is consistent with the data from A-TC. A detailed and statistical validation of the A-CTH product will follow in Krüger et al., 2026 (in prep.).

l. 378: some comments on WHY this misclassification occurs would be enormously helpful

Thanks for your comment! In general, potential sources of misclassification include issues with averaging and layering procedures (see comment below), limitations in the depolarization channel, and the use of semi-optimal thresholds in the co-/cross-polar and Rayleigh channels by the processor to separate clouds and aerosols.

We agree that, in order to improve the quality of the ATLID level 2 products, it is necessary not only to detect misclassifications but also to identify their underlying causes. However, the aim of this section is to demonstrate the potential of the WALES HSRL data set for validating ATLID Level 2 cloud products. Identifying the exact causes of misclassification is therefore beyond the scope of this paper and a more robust, and statistical validation approach based on more cases, and would benefit of the involvement of the algorithm developers.

l. 383: plus a hefty dose of false positives. so presumably the A-TC product under-represents aerosol presence in this scene.

We agree that the overestimation in ice cloud pixels in this case may cause an underrepresentation of aerosol pixel in this case. We decided to emphasize this point more clearly and added a sentence in the manuscript.

“For this case study, this type of misclassification leads to an overestimation of cloud pixels and presumably a corresponding underestimation of aerosol pixels within this altitude layer.”

l. 385: this is the second time I've encountered this phrase. please explain what it means.

By “bad layering,” we refer to Section 2.1.1 of Irbah et al., 2023. This section describes that, for generating the target classification, the Feature Mask is used as input. The Feature Mask (A-FM, van Zadelhoff et al., 2023) serves as the starting point for ATLID Level 2 processing. Its purpose is to provide the best possible strategies for optimal averaging (e.g., determining boundaries between clear-sky and optically thin pixels), which are then used to generate further downstream Level 2 products. If transitions between different flags are less sharp, this can lead to suboptimal processing (for example causing optically thin clouds to be misclassified as aerosol). For further details, we refer to Irbah et al., 2023.

We have tried to clarify this sentence somewhat and have decided not to use the expression “bad layering” as follows:

“There is indication that cloud pixels in A-TC, especially ice clouds, appear too large horizontally and vertically, which could be due to suboptimal averaging in ATLID Level 2 processing (see Irbah et al., 2023).”

l. 386: as a prospective data users, I'd very much like to know which product is the more reliable (and why)

We agree that it would be useful for the user to know which product is more reliable. However, this is beyond the scope of the present paper, which only presents the cloud distribution (A-TC) and cloud tops (A-CTH) products for a single case. Drawing conclusions about the reliability of individual products requires a careful statistical validation. Such a validation study is currently in progress (Krüger et al., 2026, in prep.).

l. 388: using the CPR acronym to refer to the radars on both platforms could get a bit confusing for readers.

Right. We now use ‘MIRA’ or ‘radar onboard HALO’ if we refer to the airborne radar.

l. 395: here and elsewhere, Doppler should be capitalized

Done

Figure 5: image annotations are blurry (perhaps they originated as highly compressed JPEGs?)

We provided an improved version.

Figure 5 caption: Earth CARE → EarthCARE

Done

l. 404: are these anomalies also present in the standard data products or are they largely confined to this example?

These anomalies are a feature that appeared during the commissioning phase. They are not present in the provided data products. We added the following sentence to make that clear:

'This led to the apparent Doppler gradient in clear-sky regions (Figure 5c) biasing low echo cloud regions which disappeared after switch to the operational signal processing unit (SPU-B) on 4th December 2024.'

l. 409: to the uninitiated, it's not at all clear what BA, CA, and CB are supposed to indicate. are they data processing versions? if so, please provide a pointer to a document that explains the nomenclature.

Right, BA, CA, ... indicate the processing versions. Unfortunately, there is no overview of all release notes, however, we added a link to the current release note for ESA products ([EarthCARE Data - Earth Online](#)) and JAXA products ([EarthCARE - Earth Clouds, Aerosols and Radiation Explorer](#)).

l. 420: Ewaldet → Ewald et

Done

l. 425: how close is close enough in space? according to the text around line 257, the instruments were within 500 m of each other, except for the two first flights, where they were within ~1000 m.

This is a very general question and cannot be fully answered, as it depends on the variability of the scene, the size of the features being examined, and the viewing angle. The point being made here is that, due to the different viewing geometry of the instruments, a direct comparison can only be made with respect to the nadir pixel, regardless of how precisely EarthCARE was underflown.

Figure 7: IMO, all of these images would benefit from using larger fonts for the axis labels, titles, and legends

We enlarged all font sizes and lines.

Figure 7 caption: in b → panel b,

We applied all suggested changes.

l. 433: "tropical North Atlantic" is an oxymoron (the North Atlantic is certainly not in the tropics!)

Thanks, we changed this to 'northern tropical Atlantic':

l. 434: radiances

This has been applied.

l. 443: unclear; isn't this whole orbit segment over the ocean? do you specifically mean cloud-free skies over the ocean?

We clarified this and changed the sentence to: Good agreement between the two instruments is particularly also observed for clear-sky pixels over the ocean...

l. 456: have there been any attempts to use MSI data to help characterize ATLID multiple scattering in cirrus, as in Garnier et al., 2015 (<https://doi.org/10.5194/amt-8-2759-2015>)?

We are not sure, how this question refers to the validation of MSI radiances. The ATLID retrieval and multiple scattering treatment are published by Donovan et al., 2024. We use the HALO measurements during PERCUSION (and following HALO campaigns with the WALES system) to characterize ATLID multiple scattering in cirrus using different multiple-scattering codes and different retrievals for the assumed particle size.

Figure 8: this map makes a very welcome contribution to this figure. maps would be equally helpful for figures 2, 4, 5, and 7.

We agree that including the underpass location on a map would provide valuable information; however, the main objective of this manuscript is to provide all necessary information about the PERCUSION campaign and its use for EarthCARE validation. Therefore, we will refrain from providing a map for each example. We will, however, gladly consider this suggestion for the individual validation papers.

BBR: I don't have much insight to offer on this topic, so I hope some other reviewer will be confident to evaluate the material.

l. 498: perhaps add another appendix that decodes the various data product names (does BMA_FLX_2B have an English translation?) and explains the differences between the data processing versions (.e.g., AB)

Thank you for this comment. We considered following this reviewer's advice but ultimately decided against it, as a truly comprehensive explanation would be too lengthy for this manuscript. The data products are described in detail by Eisinger et al. We refer to this publication and description in the manuscript. We furthermore added a link to the current release notes from ESA.

l. 493: released with → reported in

Done

l. 494: product → product, available

Done

l. 516: hight → height

Done

l. 526: the → an

Done

l. 526: estimate → estimation

Done

l. 543: delete 'will be'

Done

l. 544: acronym already defined

Right. Changed.

l. 586: sentence fragment

Corrected

l. 660: change to final version

Changed

l. 728 (Groß et al., 2014: missing DOI

Corrected

l. 883: is → are

Corrected

l. 887: seve → serve

Corrected

l. 890: date and time → dates and times

Done

l. 899: Earth CARE → EarthCARE

Done

l. 903: → measurements,

Done

l. 907ff: suggested revision: However, our combined active (lidar and radar) and passive remote sensing payload (Stevens, et al., 2019) bridges both satellite missions with correlative airborne lidar and radar measurements underflying both CALIPSO/CloudSat and EarthCARE.

Done

l. 909: unterflight → underflights

Rephrased

Table B1: are these data also available via a Zenodo link?

We uploaded the basic lidar and radar properties as for the WALES lidar data and the MIRA cloud radar data from A-Train underflights with HALO as two combined datasets on Zenodo:

'The basic lidar and radar products are analyzed and available as two combined datasets for WALES lidar data and MIRA cloud radar data from A-Train underflights with HALO via Zenodo (Ewald and Wirth, 2026; Ewald, 2026).'

Ewald, F.: MIRA cloud radar data from A-Train underflights with HALO (Radar reflectivity) [Data set]. Zenodo, <https://doi.org/10.5281/zenodo.19317830>, 2026.

Ewald, F., and Wirth, M: WALES lidar data from A-Train underflights with HALO (Backscatter coefficient) [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.19318124>, 2026.