We are grateful for the comments provided by two Referees. Please find below our replies (in blue) to the Referee comments (in black). Changes to the text are provided in italic font.

RC1: 'Comment on amt-2022-34', Anonymous Referee #1, 07 Apr 2022 reply

Evaluation of overall quality

This manuscript presents an investigation whereby the authors use primarily CALIPSO lidar data from six years to determine the ideal sites to observe altocumulus (Ai) and cirrus (Ci) clouds with a clear line of sight with ground-based lidar systems. However, due to its sun-synchronous orbit, CALIPSO only collects data at 0130 and 1330 local time. To determine the representativeness of Ai and Ci data collected from CALIPSO, these data were compared to International Space Station-based, CATS lidar system, which collects data throughout the diurnal cycle. Results from these analysis found that CALIPSO night time observations were representative for at least the first 9 hours of the day and the afternoon observation is able to capture the period with the greatest anomaly, which is much more pronounced when observing the diurnal variability of cirrus clouds. The authors demonstration that when averaged overall times the global distribution of cirrus and altocumulus clouds derived from CATS and CALIPSO qualitatively compare well, despite both CALIPSO and CATS not including the same analysis period. The resultant maps of location siting for cirrus and altostratus observations is both useful and relevant, but its utility toward shorter term field campaign studies is limited because the shown maps lack any seasonality, which would be crucial for field campaign planning.

We thank the Referee for suggesting to present our findings also with higher temporal resolution. Such maps are now included in the manuscript. Please see our replies below for more details.

In addition, the original manuscript was riddled with grammatical errors and the overall tone was at times colloquial.

Thank you for thoroughly working through the manuscript. We have followed most of the Referee's suggestions regarding grammar and typos. We have carefully checked the entire manuscript for grammar and language.

However, I do feel that this manuscript does fit within the mission of AMT and I would recommend the paper for publications following major revisions.

Thank you for the overall positive evaluation of our work. Please find our detailed replies to your specific comments below.

Specific Comments/Questions

Major:

The scientific relevance and utility of this manuscript lies in ability to show the best locations to deploy ground based instruments to monitor altocumulus and cirrus clouds with an emphasis on both field campaigns and multi-year observation sites based upon 6 years' worth of CALIPSO data. However, the focus on field campaigns that may last a few weeks to a couple of months, which I strongly believe demands that the authors also address the seasonality of their results. I would expect that the best study regions will shift following the season cycle and the associated shift in storm track and seasonal weather patterns, such as the monsoon. To address this concern, I feel that the authors need to generate a version of Figure 9 for all four seasons and include these in the manuscript as additional figure.

We thank the Referee for this comment. We hesitated to add a seasonally resolved version of Figure 9 to the original submission as the number of figures was already quite large in relation

to the overall length of the manuscript. In addition, the seasonal maps we had compiled were rather noisy. However, we agree with the Referee that maps as in Figure 9 with higher temporal resolution are very useful particularly for planning the short-term deployment of a ground-based lidar for cloud observations. As we are now considering all CALIPSO data from 2007 to 2021 (see also reply to minor comment below), we have a volume of data that is large enough to present four new figures showing seasonally and monthly resolved versions of Figure 9 for Ac and Ci. The figures have been place in the Appendix and look like this:

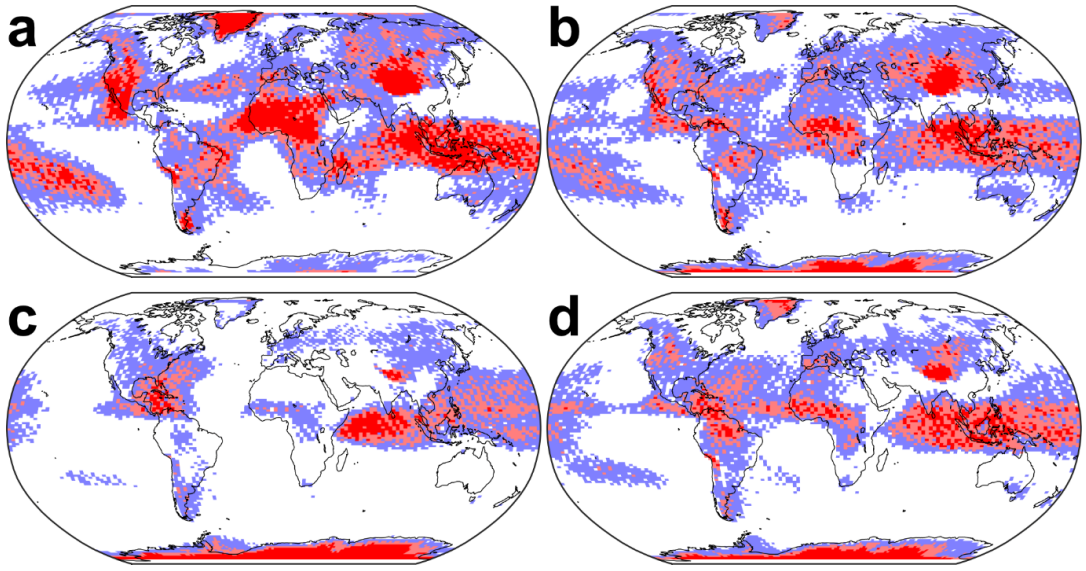

Figure 1 (Figure A5 in the Appendix). Same as Figure 9a but for the three-month periods (a) DJF, (b) MAM, (c) JJA, and (d) SON.

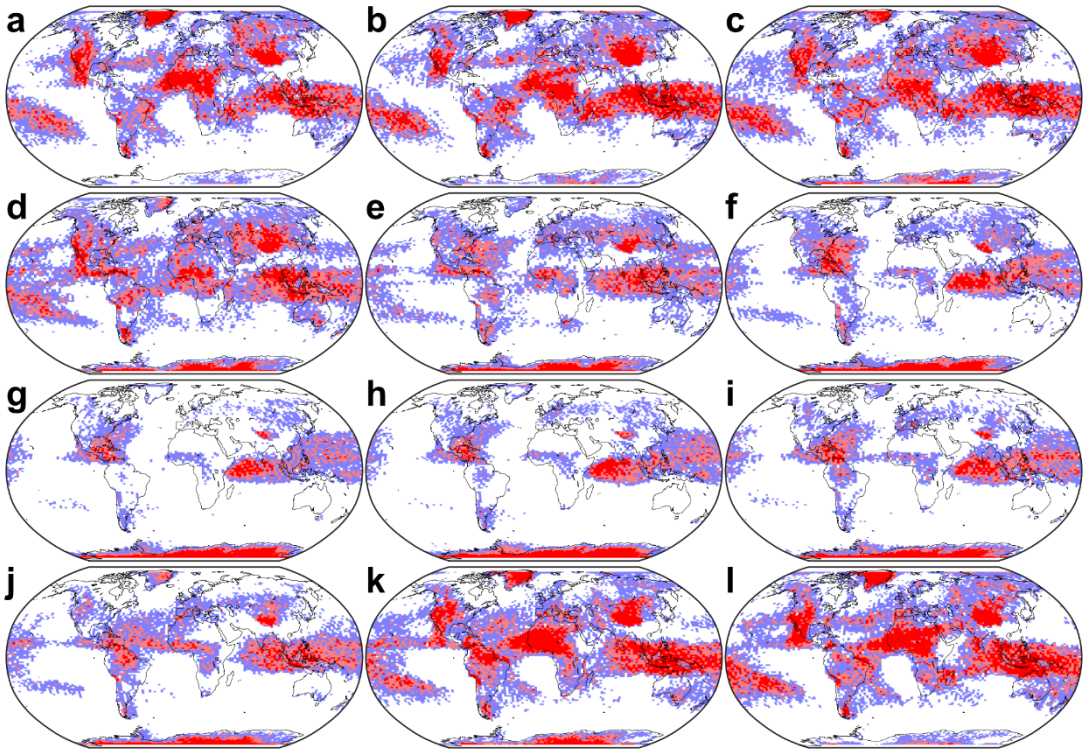

Figure 2 (Figure A6 in the Appendix). Same as Figure 9a but for individual months: (a) January, (b) February, (c) March, (d) April, (e) May, (f) June, (g) July, (h) August, (i) September, (j) October, (k) November, and (l) December.

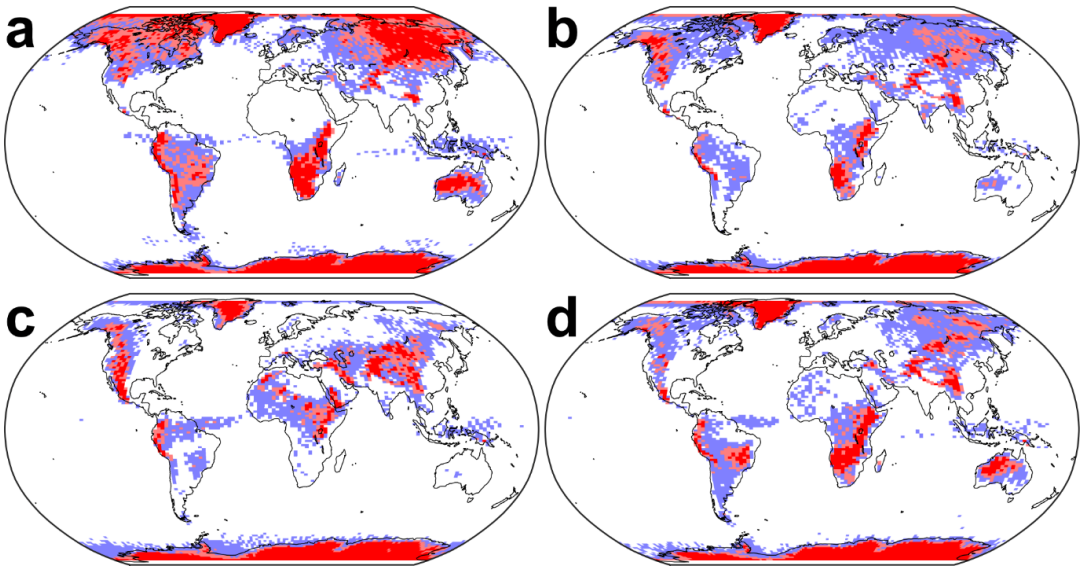

Figure 3 (Figure A7 in the Appendix). Same as Figure 9b but for the three-month periods (a) DJF, (b) MAM, (c) JJA, and (d) SON.

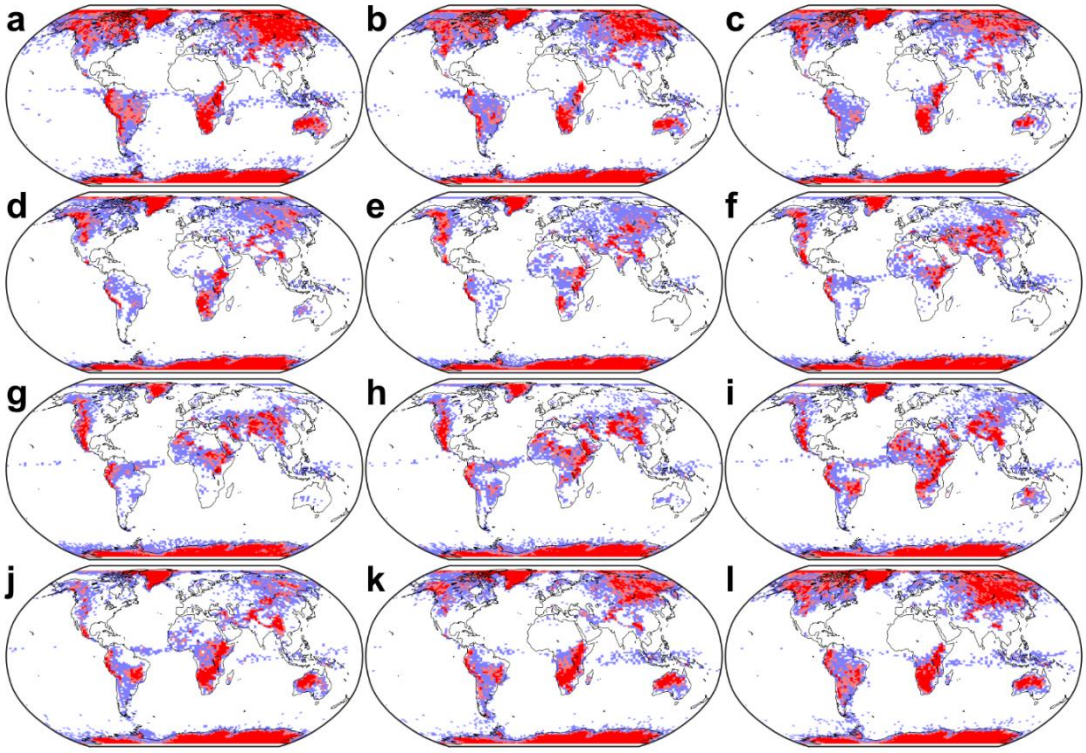

Figure 4 (Figure A8 in the Appendix). Same as Figure 9b but for individual months: (a) January, (b) February, (c) March, (d) April, (e) May, (f) June, (g) July, (h) August, (i) September, (j) October, (k) November, and (l) December.

The following statement was added to the end of Section 3.4: *Figures A05-A08 provide seasonally and monthly resolved displays of the data in Figure 9. The figures reflect the annual variation of observational conditions for consideration when planning the deployment of lidar instruments for observing mid-level or high clouds during dedicated field experiments or shorter-term measurement campaigns.*

Minor:

Were cloud aerosol determination confidence score also applied to filter CALIPSO and CATS data for problematic data points?

Excerpt from CALIPSO User's Guide: Cloud / Aerosol

For cloud and aerosol layers, feature type QA is directly related to the cloud-aerosol discrimination (CAD) score, as follows:

high confidence	= |CAD score| ≥ 70
medium confidence	= 50 ≤ |CAD score| < 70
low confidence	= 20 ≤ |CAD score| < 50
no confidence	= |CAD score| < 20

Were the cloud feature sub-type identifications used to denote cirrus, altostratus, and other cloud types?

I think that such details need to be clearly identified in the CALIPSO data and methodology section and doing would help clarify the authors assumptions and help establish any potential limitations to study's results. While QA filtering was applied (only values larger than 5 are included), I personally feel it might also be helpful to also filter by the CAD score too to increase cloud identification confidence, which is vital for the aims of this manuscript.

We thank the Referee for this important point. QA flags have been considered in the CATS data for which we had to create our own cloud flag for comparison to CALIPSO products. In the CALIPSO cloud data analysis, we included all height bins flagged as cloud without considering the CAD score. However, during this revision we have investigated the effect of filtering for cloudy height bins with a CAD score ≥ 70 for several years of data. While this quality-control measure decreases the amount of considered data by as much as 20% (depending on the combination of cloud-profile types in the analysis), it has no impact on the overall patterns presented in the plots and the conclusions drawn from their interpretation. This is likely because we are extracting merely qualitative information on the type of cloud, e.g. low-level, altocumulus (transparent), or cirrus. Filtering according to CAD scores would be absolutely crucial if we were to retrieve quantitative results such as the cloud extinction coefficient or cloud optical thickness. We are therefore confident in the reliability of our findings and conclusions.

Why are CALIPSO data retrieved only for years 2011, 2012, 2015, 2018, and 2019? On the surface, this selection of years comes across as somewhat arbitrary, especially given both the lack of any clear rationale provided by the authors.

The considered years were selected based on the data available to us at the time from previous work. We have now revised the analysis to consider all CALIPSO Level 2 cloud profiles collected from 2007 to 2021. The respective figures have been updated accordingly. They main change is that maps are now smoother than before. The 2.5-fold increase in considered data does not change the identified patters or the overall conclusions. However, the data volume is now large enough to consider a finer temporal resolution as already mentioned in our reply to the first mayor comment.

For Figure A1, I would suggest adding a panel C where the CALIPSO and CATS cloud fraction are differenced. Although these data look similar, I think it would be of interests to reader to be readily able to identify where CATS and CALIPSO cloud fractions vary and by how much.

Good idea. We have added the suggested panel and Figures A1 and A3 now look like this:

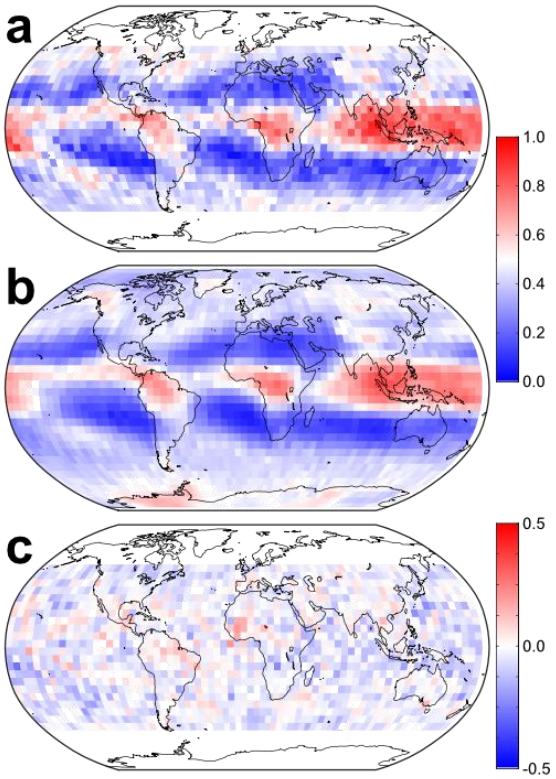

Figure 5 (Figure A1 in the Appendix). Global distribution of the fraction of cirrus clouds in observations with the (a) CATS and (b) CALIPSO lidars and (c) difference between CALIPSO and CATS for the time period from March 2015 to October 2017. Only CATS data within ±1 hour around the fixed CALIPSO overpass times are considered.

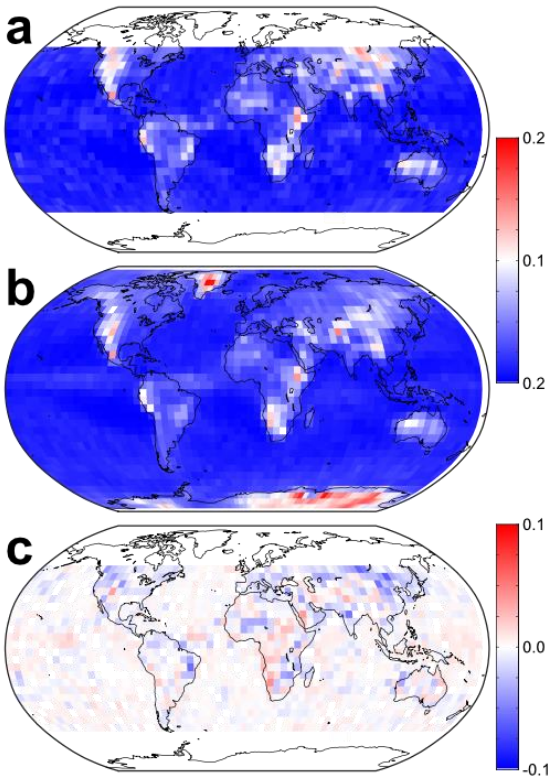

Figure 6 (Figure A3 in the Appendix). Global distribution of the fraction of mid-level clouds in observations with the (a) CATS and (b) CALIPSO lidars and (c) difference between CALIPSO and CATS for the time period from March 2015 to October 2017.

When comparing CATS and CALIPSO in Appendix A, the authors hypothesize that "noise induced from the decreased amount of grid boxes for deriving the values is likely to affect the comparison". While this is certainly plausible, I believe it would be insightful to at least qualitatively map out this noise in both I believe this would best be accomplished via a figure showing interquartile range as a function of latitude. If the noise is indeed a root cause, I would expect the CATS data to have a wider interquartile range.

The purpose of the comparison between cloud fractions as inferred from CALIPSO and CATS is to demonstrate that the different definitions of Ci and Ac from the data sets of the two instruments give plausible and consistent results. This is demonstrated in the currently presented figures. While a deeper dive into the differences of the two cloud data sets would certainly be interesting, it is beyond the scope of the present study.

In Figures A2 and A4, it is clearly see that the latitudinal variability in varies little between CATS and CALIPSO. CATS however has a persistent low bias in cloud fraction near the cloud fraction maximum. Can this be explained by noise or is there something else possibly afoot. Personally, I agree with the authors assertion that CATS and CALIPSO both compare well, but I think it would be useful to include a sentence or two highlighting what might be behind these differences in cloud fraction at high altitudes for both cloud types. This suggestion is optional.

The Referee rightfully points out that we did not comment on the differences in the absolute maxima of the cloud-fraction profiles in Figures A2b and A4b. We have therefore added the following statement to the discussion of Figure A4b: *As in the case of cirrus in Figure A4b, different absolute maxima in the profiles of cloud fraction from CALIPSO and CATS are most likely the result of slight differences in how these cloud types are inferred from the measurements of the two instruments.*

Diurnal variability analysis in section 3.3. is slightly problematic because CALIPSO and CATS comparison is not for the same time period. Figures 1A and 4A, as described in the methodology, specify CALIPSO data was collected from the years 2011, 2012, 2015, 2018, and 2019 (Figures 1A and 4A), whereas the CATS cloud fraction plots (Figures 7A and 8A) are created using 2015-2017 data. I would suggest generating cirrus and altocumulus cloud fraction plots from CALIPSO from the same period as CATS and add these to the appendix to remove any potential interannual variability complications from the analysis.

We have now compiled plots as in Figures 1a and 4a using CALIPSO data for the time period of CATS measurements from 03/2015 to 10/2017 (Figure 7 below). We find that results over the 32-month CATS period are virtually identical (though noisier) to the result of considering the CALIPSO time period of 15 full years. The following statement was added to the first paragraph of Section 3.3 referring to the figure below: *A comparison of the occurrence of high- and mid-level clouds in CALIPSO observations that cover just the CATS time period versus the 15 full years considered in Figures 1 - 6 reveals no change in the observed patterns (not shown). We hence conclude that the findings of this section can be generalized to CALIPSO observations that don't fall within the time during which CATS has been active*.

No extra figure has been added to the Appendix.

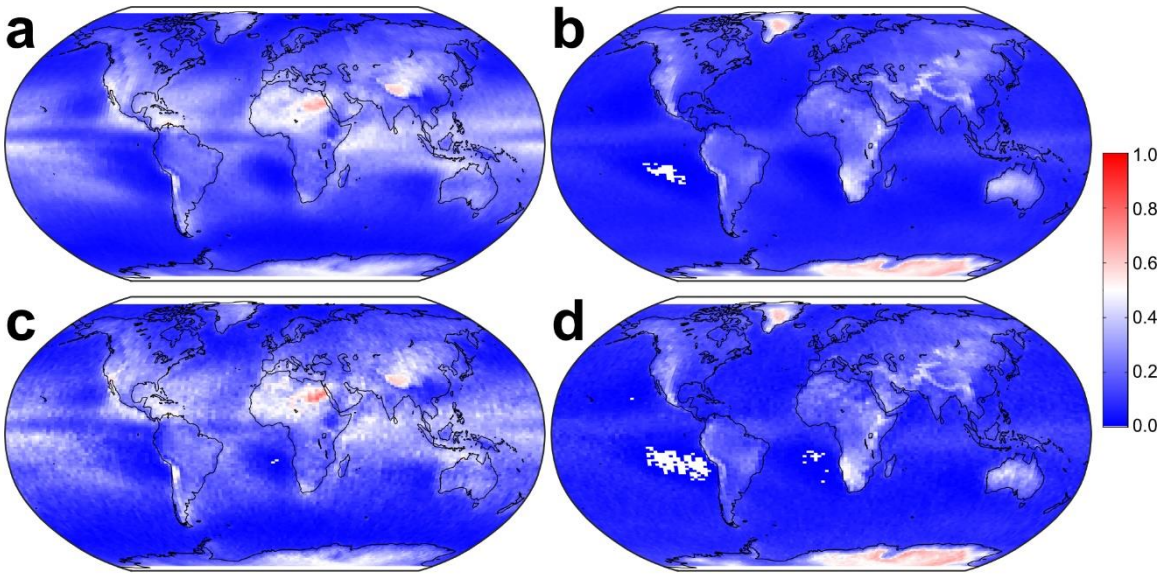

Figure 7. Global distribution of (left column) the ratio of CALIPSO profiles that contain cirrus clouds in the absence of opaque low- and mid-level clouds versus all cloudy profiles and (right column) the ratio of CALIPSO profiles that contains transparent altocumulus in the absence of opaque low-level clouds versus all cloudy profiles. The plots cover time periods of (upper row) 15 full years from 2007 to 2021 and (lower row) 32 months during which CATS was operational from March 2015 to October 2017.

Technical Corrections

General comments:

I found a number of grammatical and spelling issues in the manuscript (detailed below) and request that the authors carefully check for similar error when revising the manuscript with fresh eyes.

We appreciate the Referee's detailed comments regarding language and grammar as neither author is a native English speaker. We have screened the text, revised most of the suggested items, and provide detailed replies for issues where no change was made below. In any case, we trust that Copernicus language editing will sort instances where we didn't follow the Referee's suggestions.

Common spelling error. Please check to make sure all usages of the word "focussed" are replaced with "focused".

Changed for both occurrences of the word.

Common grammatical error. Often the phrase "mid-level and high cloud" is used throughout the manuscript, which lacks parallelism. I would strongly advise modifying this phrase to read "mid- and high-level cloud". Doing this change removes any potential ambiguity.

Changed throughout the manuscript.

When using sentences that point to or contain references *:i.e.", and "e.g." these phrases should be segregated within rounded parentheses and not as part of the sentence, which grammatically is incorrect.

It doesn't seem that there is a specific rule that supports the Referee's suggestions. Instead, this is a matter of personal preference. No changes were made in the text. Instead, the matter is left to Copernicus language editing.

Make sure figure caption labelling is consistent. For Figures 1 through 6, the letter (i.e., (a), (b), etc.) comes before what is described, whereas after Figure 7, the letters come after what is

described. I would advise putting the letters prior to what they describe in the caption. Regardless, please to be consistent.

Changed to have letters before what it described in all figure captions. Thank you for catching this inconsistency.

Figure color bar labels are a bit on the small side, especially from Figure 7 and onwards. I would advise making them larger.

Thank you for the advice. The font size of the labels of color bars has been increased.

Please format Table 1 in a consistent and clear way. Please revise Table 1 to have the same alignment. I would also consider increasing the font size and adding commas to the numerical values to improve the legibility and interpretation.

The table is formatted in the Copernicus style provided in the LaTeX template. Commas have been added to improve the legibility of the provided numbers.

Figures 7 and 8, the "local time" X-axis label in panel C should be removed.

Done.

Line 212, misleading statement. CATS has a cloud flag (as in there is or is not a cloud), yet it lacks the cloud sub-type flag that CALIPSO has to specific transparent cirrus and other cloud types. Please correct this sentence to reflect this.

Changed to: "*In contrast to the CALIPSO data set, the CATS data set includes a cloud flag that states whether or not cloud is present but does not provide more detailed information on cloud type.*"

Specific comments:

We thank the Referee for the detailed comments regarding typos and grammar errors. We have made all suggested changes except for the ones listed below.

Page 2, line 59: typo, should read as "Level two CATS-ISS…."

We prefer to keep the writing in line with the name of the CATS data product we are referring to.

Page 4, lines 96-97: spelling error, please replace "Over water" with "Overwater"

We keep over water and leave the final decision to Copernicus language editing

Page 6, line 175: grammar error, please change, "is" to "are"

We keep "is" as it refers to "the combination"

Page 6, line 181: grammar error, please add a comma before the phrase "and the Caribbean"

No comma added as the two are supposed to be understood as one region in this context.

Page 7, line 219: typo, "overland" is one word, not two, please correct

The writing as two words seems to be more obvious to us. In any case, Copernicus language editing will clarify.

Page 8, line 247: please remove comma and extra space after "and"

Changed to "*, and thus*"

Page 9, line 251: unclear antecedent, it is not clear as to what "This" refers to.

Revised to "*This agreement*"

Page 9, line 256: typo, please add a hyphen between “noise” and “induced”

We intend to state that noise is induced rather than using noise-induced as an adjective. No change made.

Page 9, line 266: suggested revision, I think the sentence reads more cleanly if the phase “as well as the zonal average of the fraction of isolated ice clouds as seen by CATS” has commas before and after

Revised to: “*Figure A2 shows that the vertical profile and the zonal average of the fraction of isolated ice clouds as seen by CATS match those seen by CALIPSO very closely*.”

Page 10, line 291: typo, “Acknowledgments” is misspelled, please revise

We stick to the template’s pre-set non-US English writing of acknowledgement

RC2: 'Comment on amt-2022-34', Anonymous Referee #2, 20 Apr 2022 reply

This paper takes satellite measurements to evaluate regionality supporting ground-based observations of mid-level/mixed-phase and cirrus clouds. The thought here is that this study would lead to insights in supporting studies aimed at these clouds with only the least amount of low-level cloudiness that would otherwise attenuate lidar-based measurement and limit the numbers of cloud scenes available for monitoring and data collection. Methods are clear, as are images. The subject matter is suitable to consideration by AMT.

This is the first time this reviewer has read this paper.

This is a rare instance whereby I'm going to pass this through with minor revisions, but don't really have anything positive to say about this manuscript. If authors want to publish this, then so be it. There is no hypothesis. This isn't an experiment. This is more an atlas of climatologically-driven observations to suggest where future observations may or may not take place. And, in that, authors have done a fine job, and are well within their rights to put this in the peer-reviewed literature.

We thank the Referee for the criticism and acknowledge that nothing particularly negative was stated either.

That said, the idea that observability might even be a consideration to how people may or may not set up ground-based observing systems for mid and upper-level clouds is really not one I'm comfortable with, and authors do nothing to suggest otherwise. Ken Sassen, speaking of cirrus clouds, once wrote that cirrus are (paraphrasing) the result of regional weather features. Therefore, if you want to study specific cloud processes or isolate convection, anything, you're going to go to the place where that sort of cloud is present. If you're limited by 10-20%, but you're getting the data that you want? Is that a deal-breaker? I don't see it. Perhaps there are more specified observing scenarios that the authors envisioned, but don't necessarily come out in the narrative? Mixed-phase/altocumulus-type clouds are very common in the Arctic. Yet, ground infrastructure is highly limited. I don't see folks turning to observability in deploying ground-based sensors, though I acknowledge that they ultimately could.

The Referee is correct that there will always be measurements that are motivated by a very precise scientific objective and might focus on local or regional features. However, there are also increasing efforts to establish atmospheric observatories for long-term measurements. One of the purposes of our work – besides the guidance of instrument deployment for future measurement campaigns – is to provide a reference for the statistical analysis of clouds observed at such observatories. For instance, our maps enable the assessment of whether or not a study of cirrus properties at a site at a specific location is representative or not when weighing the observed cases against the considered time period.

This paper reads like a study without a mandate. But, I cannot fault the process by which they've studied and processed their datasets, and presented their results.

I'm attaching some technical notes to help with parsing of the narrative. Of specific concern, I strongly encourage you to look at and reference the wonderful paper of S. Gedzelman, Weatherwise (1988; I believe) in talking about altocumulus.

We have considered most of the technical notes as outlined in the marked-changes file. The reference to the excellent paper by Stanley Gedzelman has been added to the text.

Otherwise, I wish you good luck.

Thank you.