The article presents a data analysis from the ground-based Concordia Station, Dome C, on the Antarctic Plateau. The cloudiness from 2014 to 2021 is discussed and compared with measurements from the nadir viewing satellite IASIS.

The Atmospheric measurement technique challenge is clearly stated first sentence of the abstract. Authors carefully describe the methodology, with figure 2 for example, and expose the possible biases in their datasets with Figure 1 and 3 for example. The first part of the article describes in detail the different steps of this analysis. I liked figure 4 showing nice measurements made from 2014 to 2021.

We thank the Reviewer for the appreciation.

We would like to note that, in accordance with the AMT interactive review procedure, the present document contains our responses to the Referee and a description of the revisions that will be incorporated into the manuscript. The final version of the revised manuscript itself has not yet been prepared and will be submitted only after completion of the discussion phase. Therefore, references to additions, modifications, or new analyses should be understood as planned changes to be implemented in the revised version.

However, I am not satisfied with the comparison between IASIS and the ground-based measurement. I would like the article to provide more explanations on these comparisons and especially on the reasons for the anticorrelations observed. Intuitively, I would trust more the ground base measurements and the CIC analysis. Therefore, I agree to take the CIC/REFIR-PAD cloud products as a reference for the comparison, as was done Figure 7 to 14. I don't understand why ANN, NWP, and cldnes >=3 are anticorrelated with CIC/REFIR-PAD and the authors don't give any explanations.

We thank the Reviewer for raising the point.

First, it is important to note that to account for the comments of Reviewer 1, we further investigated the temporal structure of the 2020 correlation transition and found that it coincides with an update in the IASI Level 2 processing chain (v6.5), as indicated by product metadata.

The different behaviour between pre-v6.5 and v6.5 IASI Level 2 cloud products was already noticed in the AMT article Whitburn et al. (2022) [1]. Analogously to what we observe in the present study, using independent data they found discrepancies in 2012-2019 and much better agreement after the v6.5 update:

"Good agreement in the seasonality is also found with the L2 cloud product from version 6.5 of the L2, but, oddly, the seasonality seems out of phase […] between 2012 and 2019 (corresponding to version 5.3 to version 6.4 of the L2). The reason for the differences has not been investigated further."

They also report consistent results regarding a CALIOP comparison with IASI products:

“The latter shows a clear improvement over the previous version (v6.4) when compared to the cloud products from the CloudAerosol LIdar with Orthogonal Polarization (CALIOP) on board the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO; Winker, 2007), as reported in the CALIOP-CALIPSO IASI Level 2 geophysical products’ monitoring reports available at https://www.eumetsat.int/ iasi-level-2-geophysical-products-monitoring-reports (last access: 10 August 2022).”

Poor comparison performance of 2014-2019 IASI Level 2 cloud products was therefore already noticed before in terms of global cloudiness comparison, while in the present study we show that on the Antarctic Plateau it is present also (and perhaps more meaningfully) at a one-by-one scene classification level.

For what regards the explanation of the observed anticorrelations, it seems unlikely that they originate from the collocation methodology or from differences in spatial resolution, as the same products change from anticorrelated to positively correlated following the introduction of processing version 6.5 in December 2019, while the collocation procedure remained unchanged. Likewise, the behaviour cannot be readily attributed to limitations in the information content of the IASI spectra, since IASI cloud products exhibit positive correlations with the CIC/REFIR-PAD reference after the update. The most plausible explanation is therefore that the anticorrelations arise from characteristics of the individual retrieval algorithms rather than from the instrument itself or the comparison methodology. In particular, for the NWP product, a possible cause is a bias in the NWP-derived clear sky radiances over the Antarctic Plateau. Such a bias could affect the cloud classification directly and may also propagate to the cldnes flag, which uses the NWP classification as one of its inputs.

The above considerations will be incorporated in the revised manuscript, and the description of the individual IASI products will be expanded.

The reported reference will be mentioned and discussed.

Maybe, a better description of the IASIS data product would help to understand why it is the case ?

It is worth noting that, to the best of our knowledge, the publicly available EUMETSAT documentation for IASI Level 2 products are:

1. *IASI level 2: Product Guide (year 2017): IASI Level 2: Product Guide*
2. *IASI Level 2: Product Generation Specification (year 2017): IASI Level 2: Product Generation Specification*

None of them describes the changes introduced with processing version 6.5. We therefore searched for additional information in the literature and found that Whitburn et al. (2022) -see reference [1] - explicitly attribute the version 6.5 update to the introduction of a new cloud detection scheme.

The same paper states that the algorithm is described in the MTG-IRS Level 2 Algorithm Theoretical Basis Document (ATBD) https://user.eumetsat.int/s3/eup-strapi-media/MTG_IRS_L2_ATBD_be6f60ded9.pdf, which is not listed among the standard IASI Level 2 reference documents made available by EUMETSAT for IASI users. Consequently, our interpretation of the v6.5 discontinuity is based on the information reported in Whitburn et al. (2022) and on the corresponding MTG-IRS ATBD referenced therein.

For the convenience of the Reviewer we extract from [1]: "Since version 6.5 released in December 2019, a new cloud detection scheme has been introduced. It is based on an IASI-only optimal estimation algorithm that retrieves the cloud fraction and the cloud top pressure. The distinction between cloudy and clear-sky scenes is based on the retrieved cloud fraction. The same algorithm is planned to be used for the measurements of the future IASI-NG (New Generation) (Crevoisier et al., 2014) and MTG-IRS (Meteosat third generation) sounders."

This will be discussed in the next version of the manuscript where a better description of the IASI data products will be provided (since the additional documentation describing the algorithm has been identified). Please see below for additional discussion regarding the impact of version 6.5 on the results.

It seems that cldnes is a combination of other indicators from what I understood (including ANN, NWP). Why do the authors focus on lower levels indicators like ANN and NWP ? What do we learn from it ?

Yes, cldnes is a combination of other indicators. However, this does not imply that it should replace the analysis of individual components. The ANN product shows moderate positive correlation with the ground-based reference in the warmest months, while NWP and cldnes exhibit mostly anticorrelation. This demonstrates that different classification approaches within the same product family can behave differently, information that would be hidden if only the highest-level product were considered.

Thus, the analysis of lower-level indicators allows us to disentangle the contribution of the different classification approaches entering the cldnes product.

In the new version of the manuscript we will better justify our choice to analyse low level indicators.

In the opposite the "cloud phase" indicator seems independent from the other ones, because this one is well correlated with ground base measurements. Is it the case ? how "cloud phase" is measured on IASIS ?

The cloud phase indicator is largely independent of the other products, as it is derived solely from three brightness temperature channels (see L147–150 referencing the IASI Level 2 product documentation).

In the revised manuscript, we will highlight this information on the cloud phase indicator by expanding the description of the index with a bullet paragraph as done in the case of other indexes.

As the 1st reviewer said "the analysis is primarily the comparison of mean values and (Matthews) correlation coefficient, without an in-depth analysis of the causes for the discrepancy or how the analysis could inform algorithm developers or IASI users about best practices for using the satellite products in atmospheric research. Along this line, the repetition of findings in a summary section, and the exclusion of a discussion and conclusion sections …" I do also find that in this revised version, there is too much repetition in the summary section, and no clear conclusive statements are made.
One such statement I would expect is ""cloud phase" is the best IASIS indicator for cloudiness" or "NWP in IASIS does not agree with ground base observation, which questions the simulated clear-sky radiance derived from numerical weather prediction in IASIS data product", could we say that ?

We want to underline that no revised version of the original manuscript has been yet issued since the discussion protocol requires that a new version is uploaded only after all the Referees' comments are obtained.

Following the comments of the first Reviewer, we prepared a Discussion and a Conclusion section that will be incorporated in the revised manuscript. In the Discussion the 2020 regime shift will be issued, especially in light of the v6.5 processing update. The possible explanation of the 2014-2019 anticorrelations observed for some products will be discussed. In the Conclusion section, recommendations will be made on the use of IASI Level 2 cloud products on the Antarctic Plateau, both regarding the use of cloud presence tests and the use of the cloud phase retrieval in the two periods.

Also, it will be highlighted that the correlation improvement is likely to be due to enhanced true clear sky rate of the IASI products, rather than to increased true cloud rate (see next reply to your comment).

The "dramatic improvement in 2020" of IASIS data needs to be questioned also. I doubt that this was never discussed in any paper concerning IASIS data or IASIS new data products.

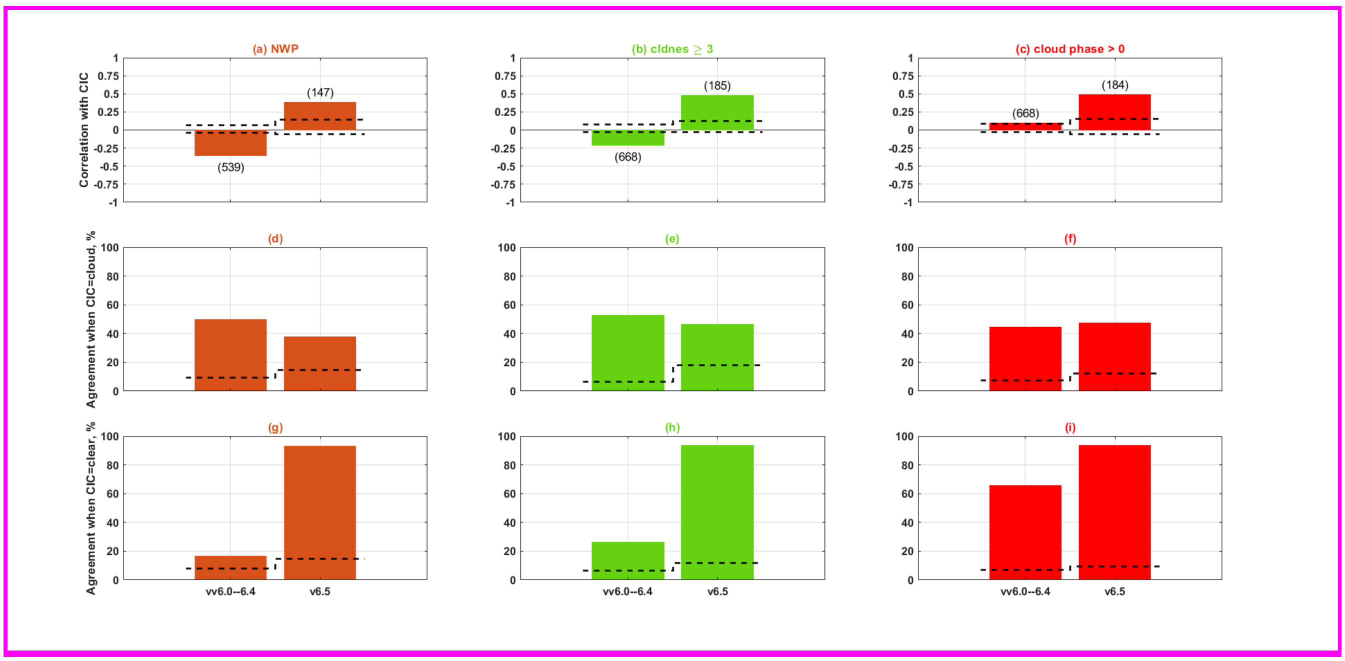
We thank the Reviewer for raising the important point. In fact, the correlation improvement is a main finding of this study. We note that in literature, studies reporting comparison between passive satellite cloud retrievals and ground-based observations are rare (which makes the present research, in our opinion, more valuable).

As explained above, several independent lines of evidence indicate that we are detecting a genuine effect of a IASI L2 processing update. Specifically

1) *The IASI L2 product metadata indicate the introduction of processing version 6.5 in December 2019;*
2) *In [1], as said at the beginning of the present document, consistent findings were reported based on cloudiness comparisons (not correlation analysis of individual scenes). This is the only study that we have found on the topic and we thank the referee for encouraging us to an in-depth analysis on the subject matter.*
3) *The improvement affects all considered IASI L2 cloud products at the same time;*
4) *The collocation strategy underwent no change;*
5) *The generation of ground-based products underwent no change.*

The IASI algorithmic processing explanation of the 2020 improvement is therefore well supported by both evidence and argument.

Moreover, following the comments of Reviewer 1, we extended the analysis of the causes that brought about the 2020 change. We found that the increase in the correlation is due to an improved agreement in scenes classified as clear (by the CIC/REFIR-PAD), while the agreement for cloudy cases remains mostly unchanged. The image below shows the finding for the products NWP and cldnes >= 3 (for which the agreement in CIC/REFIR-PAD clear scenes passes from about 20% to more than 90%), and for cloud_phase > 0 (for which it passes from 65% to over 90%). In parentheses, the number of collocated scenes used for the calculations is shown.



This indicates that the v6.5 update improved the ability to correctly identify clear sky conditions over the Antarctic Plateau (i.e., increased cloud specificity), rather than changes in *cloud sensitivity. This represents an additional novel finding useful for both users and developers.*

All of these aspects will be properly discussed in the revised manuscript (including the new Figure).

Small comments :

Several times, the reference style is not correct like L24 or L27 L34 L77 etc… where the date is missing for example : Liou **2022.**

We thank the Reviewer.

More description of the IASI instrument would be relevant : is a nadir-viewing satellite with wavenumber range X …What is the wavenumber range and the spectral resolution

We thank the Reviewer for the suggestion that will be implemented.

L98 : It is only said that the classification is based on a machine learning technique, but I believe it is trained to detect slight differences in the radiance properties of the particles ? I would appreciate a word on the physics behind

The Cloud Identification and Classification (CIC) algorithm is a supervised machine learning algorithm developed for the classification of high resolution radiance data. It is trained using a dataset of radiances labeled using backscattering and depolarization data of a collocated lidar. For each training set the principal components (PCs) and the relative eigenvalues (variance along the PCs) are computed. The algorithm classifies a spectrum by measuring the change it induces on PCs and relative eigenvalues when it is concatenated with each training set. In the revised manuscript the algorithm will be described more thoroughly. For reference, one could see for example [2] to [4].

MCC classification : it was not clear on how many scenes the MCC was calculated ?

Hundreds of collocations were used for overall 2014-2019 and 2020 correlation scores (see, for example, the image above). In the revised manuscript, we will indicate the number of collocated scenes used for each MCC calculation.

L171 watch the formatting of the hypertext link

We thank the Reviewer.

L250 : it might be interesting to mention that the 4 months harmonic period also occurs in temperature, even though it is slightly below the 99% confidence level. Especially to reenforce your novel observation of this 4-month oscillation.

We thank the Reviewer for the suggestion that will be implemented.

L355 analysing or analyzing ?

Both spellings are used in the literature; the manuscript will be standardized as requested by the Journal's guidelines.

Figure 4, 5, 7, 8 , 9,10 ,11 ,12,13,14, legend : replace words (“left upper panel” etc) with letters (a,b,c …), as labeled in the figure.

We thank the Reviewer.

Appendix A : I did not understand the implications of this results, I don’t know what “Hit Rate” is and how it is helpful for the paper.

“Hit Rate” is simply a synonym for classification accuracy commonly used in parts of the machine learning literature. The quantity 0.5(HR_0+HR_1) is therefore the balanced accuracy, a standard metric that is not affected by class imbalance. In the revised manuscript, we will define it explicitly.

The result is useful because, as explained in the methodology and in Appendix A, the REFIR-PAD field of view is narrower than the IASI footprint. Consequently, a cloud detected by CIC/REFIR-PAD should also be classified as cloudy within the larger IASI footprint, whereas a CIC/REFIR-PAD clear sky observation may still correspond to a partly cloudy IASI footprint. While it is intuitively expected that a higher correlation between the two instruments is preferable to a lower correlation, the result reported in Appendix A provides a formal basis for this interpretation.

A note on the subject matter will be inserted at the beginning of Appendix A.

Federico Donat, Tiziano Maestri and co-authors

References

[1] Whitburn, S., Clarisse, L., Crapeau, M., August, T., Hultberg, T., Coheur, P. F., and Clerbaux, C.: A CO_2-independent cloud mask from Infrared Atmospheric Sounding Interferometer (IASI) radiances for climate applications, Atmos. Meas. Tech., 15, 6653–6668, https://doi.org/10.5194/amt-15-6653-2022, 2022.

[2] Donat, Federico, et al. "The cloud identification and classification (CIC) algorithm for high spectral resolution observations in the far-and mid-infrared part of the spectrum." Remote Sensing of Clouds and the Atmosphere XXIX. Vol. 13193. SPIE, 2024.

[3] Maestri, Tiziano, William Cossich, and Iacopo Sbrolli. "Cloud identification and classification from high spectral resolution data in the far infrared and mid-infrared." Atmospheric Measurement Techniques 12.7 (2019): 3521-3540.

[4] Cossich, William, et al. "Ice and mixed-phase cloud statistics on the Antarctic Plateau." Atmospheric Chemistry and Physics 21.18 (2021): 13811-13833.