

## Response to Reviewers

EGUSPHERE-2024-3490 | Research article

Challenges in identifying Antarctic coastal polynyas in satellite observations and climate model output to support ecological climate change research

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*Responses in blue italic text.*

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### Editor Comments

Public justification (visible to the public if the article is accepted and published):

Many thanks to the authors for revising the manuscript and for two of the reviewers for evaluating this latest version. I am happy to accept for publication pending minor revisions.

Additional private note (visible to authors and reviewers only):

Please consider the minor comments raised by reviewer #1 and make changes as appropriate. I also note that both reviewers commented that there were a number of typos and technical errors in the manuscript. Please work carefully through the manuscript to reduce these - this will both save the typesetters time but also speed up the whole process.

*Thank you for providing this round of feedback from the two reviewers. We believe we have addressed their concerns thoroughly and are happy to resubmit the manuscript for consideration.*

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### Reviewer #1

*For final publication, the manuscript should be: **accepted subject to technical corrections***

I thank the authors for their patience dealing with my comments throughout these three rounds. I note the extensive rewriting that was done once again, and particularly appreciate the addition of the trends in the observational products. "Remarkable" is indeed the right term to describe their inconsistencies.

The narrative still goes a bit back and forth and is sometimes hard to follow, but by now I am ready to accept that this is a me-problem.

I therefore recommend the manuscript be accepted pending technical corrections, which can also be left to the copy-editors:

- as much as I appreciate the use of bold fonts, I don't think the journal accepts them;
- there are many typos caused by your rewriting, e.g. words that should have been deleted but were accidentally left out of the cut, or verbs that still are in plural form even though the subject now is just one model. Nothing dramatic or that impedes understanding.

*Thank you for this feedback and patience with this process as well. We have re-read the document and fixed a number of typos.*

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**Reviewer #2** (Tarkan Bilge, tarlge@bas.ac.uk)

For final publication, the manuscript should be: **accepted subject to minor revisions**

I would like to thank the authors for responding to my previous comments, I can see that they have a much more concise submission now that the element of future projections associated with a fully coupled CESM2 has been omitted, and they have more clearly set out the motivations of the study. I also think that replacing the monthly analysis with seasonal analysis has improved the conciseness and robustness of the arguments. I think the authors now have a valuable narrative surrounding the limitations in identifying polynyas and comparing their characteristics on different grids and timescales.

*Thank you for your suggestions - we agree that these changes have made the work more clear and understandable.*

I have a few minor comments for the authors to consider:

In primary question 1 (L116), the authors ask the question about whether 'coupled ESMs' can capture polynyas, but the study is now focused on a forced ESM, so I think it would be more appropriate to remove reference to 'coupled' (the ocean and atmosphere are no longer coupled if it is forced with JRA). I don't think this detracts from the value it is just important to get the wording right. The authors should also consider other instances in which the term 'coupled ESM' is used in the text.

*This is a good point and we have fixed this text throughout the manuscript.*

In section 3.2. the authors explain that they have used a range of SIC and SIT thresholds (15-85% for SIC), did the authors test each threshold individually (15%, 16%, 17%)? I can see in Figure 3 that the range 15-85 has been spanned but it is unclear what increment was used.

*Yes, you are correct that we tested the ranges using 1% increments for SIC and 0.01m (1 cm) increments for SIT. We now clarify this in the text.*

In section 4.2.1. I am not sure that 'autocorrelation' is really the right word for the correlation coefficient between a model and its re-gridded self. Normally this is reserved for the correlation of a timeseries with a delayed version of itself. I would recommend either a) changing this to self-correlation or b) at least making this more clear in the text what you mean by 'autocorrelation' given that this is not the normal usage. L394 reads as confusing especially because you do include temporal analyses (e.g. trends), it reads as if when you regrid it, you

are losing polynya persistence (which would create autocorrelation, and is a feasible outcome). Same for L434 'temporal autocorrelations'.

*Thanks for pointing out these confusing sentences. We have added these sentences to the methods section (3.2) for clarity:*

*We calculate correlations between polynyas both within products and between products. We use the term “self-correlation” to refer to correlations calculated from the same product (e.g. polynya areas calculated using the NOAA CDR on the EASE grid correlated with those calculated from the NOAA CDR regridded to the model grid) and “cross-correlation” for correlations between different data sources (e.g. polynya areas identified using the OSISAF data and the model data).”*

*We also replaced “autocorrelation” with “self-correlation” in the text and figures thereafter.*

In section 5.2. L615 the authors suggest using a SIT-based metric for coastal polynya identifications in model output. I would prefer if this was a recommendation to 'try' or 'consider' SIT-based thresholds. I don't think there is enough evidence in this paper to suggest that SIT-based thresholds are more appropriate than SIC for model output. There are no SIT-SIT comparisons (because of lack of observational data), and it could be that the JRA-CESM model just does not produce enough coastal polynyas due to its underlying model mechanisms. Changing to a SIT threshold alleviates this problem (by classing more polynyas) but I can't see a lot of evidence that this would necessarily apply to other models, if a different ESM simulated too many coastal polynyas then switching to SIT-based thresholds could further increase this and take it further from observations.

*We understand your point about the SIT threshold being better was only proven for this model. However, we feel that many models \*may\* have similar conditions based on the fundamental differences between models and satellite observations, as well as the fundamental uncertainty in satellite observations in thin ice conditions. We think this is an important point to make as a recommendation to model/observation comparison. We have changed the text to clarify.*

Can the authors make more of a conclusion on primary question #2, is the conclusion that with the current methodologies, observational products cannot be used to quantitatively validate temporal characteristics (e.g. trends) of coastal polynyas in ESMs? That seems like quite a significant result. Or are they concluding that there is a negative trend which contradicts with previous work (L630). Regardless of the conclusion, I think that it should be clarified in the 'Conclusions' section as well as the Discussion section (where there is already some discussion). In general, the Conclusions section is a tiny bit brief, but I can see that a lot of the conclusions are essentially placed in the Discussions section, can these sections be merged? Or can at least the main conclusions be slightly expanded in the Conclusions section - it just ends the study very abruptly.

*We find that there is enough uncertainty in the observational products that we cannot quantitatively validate a temporal trend, which we agree is “remarkable”. We decided to keep the Discussion and Conclusions sections separate, as the paper itself is relatively long and*

*complex. We elected to utilize the conclusions section to highlight (and summarize to some degree) primary results as they related to our original research questions.*

There are also quite a few spelling and grammar errors that need correcting, here are some line-by-line comments:

- L14: reword this sentence, perhaps 'The spatial distributions of Antarctic coastal polynyas are significantly correlated between two observational products as well as between the observational products and the model data.'
- L26: Many of coastal polynyas, particularly in Eastern Antarctic -> Many coastal polynyas, particularly in the Eastern Antarctic
- L86: 'CMIP 6' -> 'CMIP6'
- L131: ', assess if our' -> 'and assess if our'
- L174: thicknes -> thickness
- L222 'polynya-gridcell-areas' -> 'polynya grid-cell areas'
- L249: reword
- L305: grammar, needs to be reworded.
- L334: 'form the original' -> 'from the original'
- L393: should this be bold?
- L568: 'monthly averaged by' -> 'averaged monthly'
- L649: 'require careful ' -> 'requires careful'
- Figure 3: label x-axis (e.g. 'Threshold value'). I am confused about how both SIT and SIC thresholds are shown on one axis, for SIC the unit is %, is the unit for SIT cm? Is this clear?

*Thanks for finding these typos and confusing sentences. We have fixed the typos and reworded the confusing lines in the manuscript. We've added a line explaining the x-axis units ("X-axis units are 15-85% for SIC and 15 - 85 cm for SIT") to Figure 3 caption.*