

Dear Editor and Reviewer,

We thank you for accurately reading and commenting on the manuscript and suggesting how to improve it. Detailed answers to each of your comments are provided hereafter. We hope you find them satisfactory. Reviewer comments are in black, followed by our response in blue, which includes changes and/or additions to the text.

For the authors,

Francesco Cocetta

The authors extend the evaluation of sea ice in the CMEMS GREP Ensemble Reanalysis Product from the Antarctic (Iovino et al., 2022) to the Arctic in this manuscript, focusing on panArctic scale performances and the Marginal Ice Zone (MIZ) properties. As MIZ is an increasing proportion of the Arctic sea ice regime under climate change, accurately representing their spatiotemporal variabilities is becoming a key benchmark for sea ice modeling skills.

Overall, this manuscript is well-structured and well-written. More importantly, the proposed scientific questions are sound and adequately discussed. I like the authors' indication of ocean-sea ice reanalysis application scenarios, especially for the hottest machine learning techniques at the moment, where reanalyzed data is not only complementary to observed data, but also may be a more recommended dataset for training models. This is another valuable guideline beyond the data quality assessment for reanalysis users.

I recommend the publication of this excellent manuscript after addressing the following detailed issues, which are rather minor:

- Introduction: The authors have thoroughly reviewed the Arctic sea ice changes under climate change and ORAs' role in this subject. However, I am unfortunate to find Chevallier et al. (2017) and Uotila et al. (2019), two very comprehensive assessments of sea ice in global/regional reanalyses, surprisingly uncited. I believe the Introduction will be completed by connecting your work with theirs.

Thank you for the suggestion which enabled us to enhance the introduction by linking our work more closely with state-of-the-art literature. In the revised version of the paper, we updated the text in lines 46 and lines 50-56, accordingly.

- Line 129: "(SMOS)" firstly appears in line 122.

Thank you. We moved the explanation of the acronym from line 129 to line 122.

- Line 135: "NSIDC" has been defined in line 110.

Agreed, thank you. We removed the explanation of the acronym in line 135.

- Line 144: "wide" should be "wider".

Done, thank you.

- Line 147: "(f) to (e)" should be "(f) to (h)".

Agreed, thank you.

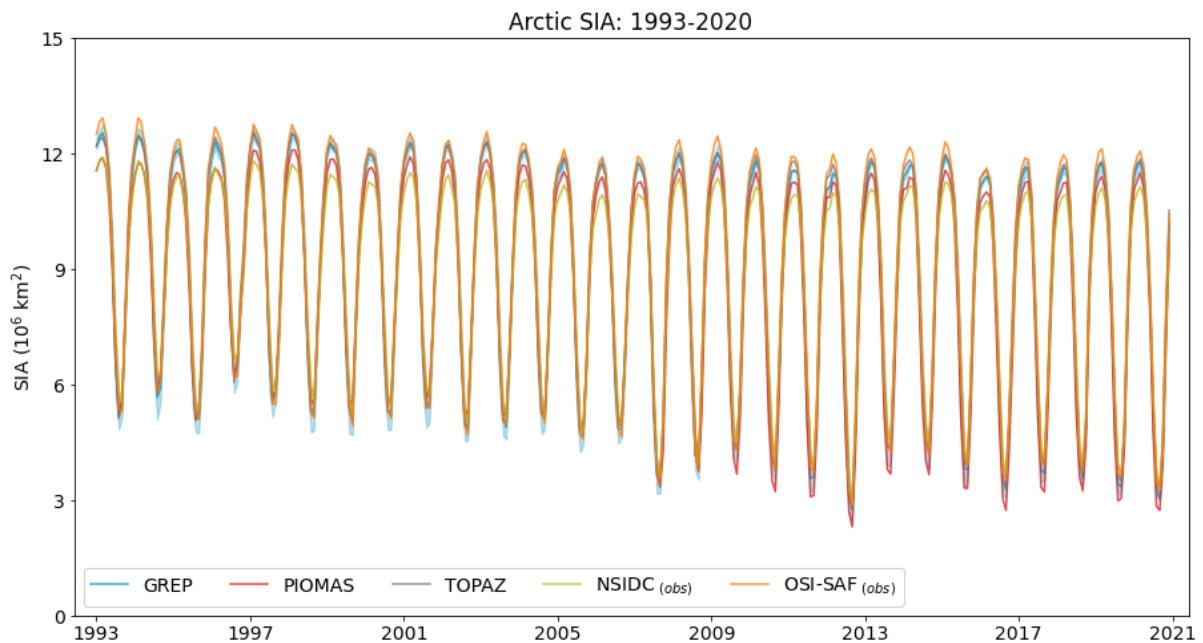
- Line 158: "Figure 3(a)" should be "Figure 2(a)"?

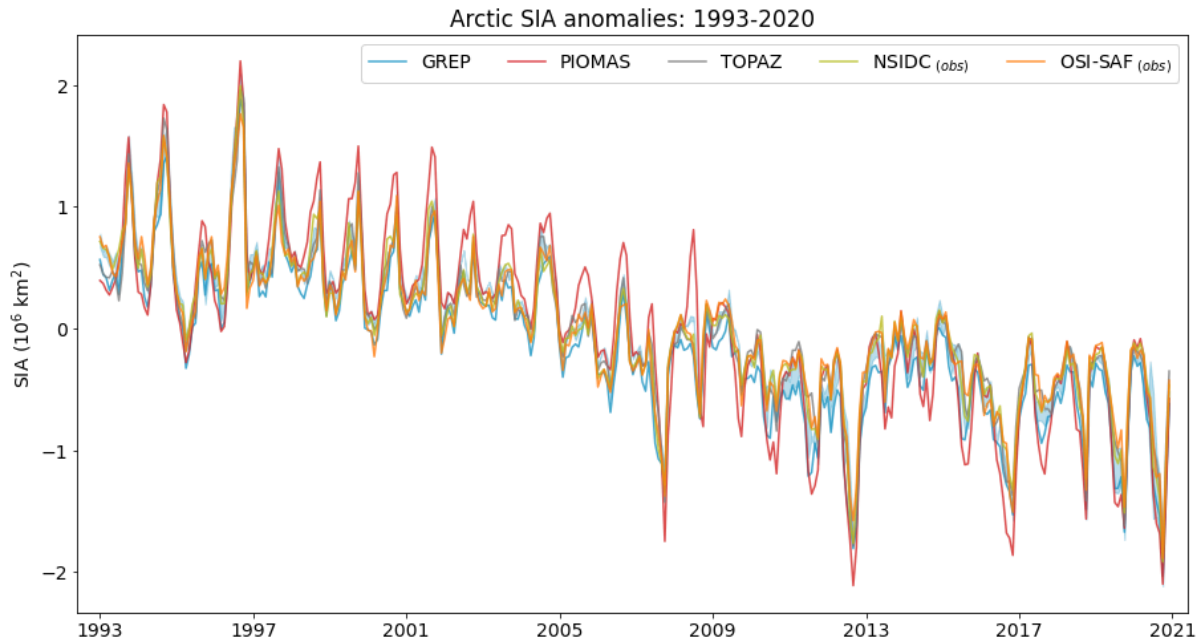
Agreed, thank you.

- Line 160: The seasonal cycles in Fig. 2(a) contain information on both climatology and interannual variability, with the former dominating the curve. This makes it difficult to signal interannual variability directly from the figure. I wonder if drawing anomalies would be more intuitive.

We acknowledge this limitation of the plot. However, plotting the time series of the sea ice area as it is, helps us to illustrate when annual minima and maxima occur, justifying the maps of March and September we show in Fig. 1.

Following the other reviewer's comment, in the new version of the paper, we will make the plots in Fig.2 easier to read by shortening the x-axis while extending the y-axis as follows. Below is also the plot of SIA anomalies.





- Figure 3: Although you have mentioned the meaning of the individual line types in the text, I suggest that it would be clearer to the reader if you also specify it in the figure legend.

Implemented, thank you for the comment.

- Line 163-164: It seems to me that September has the smallest spread, within the range of two observations, while March has the largest.

Yes, the spread of the GREP envelope is larger in September compared to March, when it fits within the range of the two observations, which is larger in March.

- Line 200: Does "1 10<sup>6</sup> km<sup>2</sup>" mean "1x10<sup>6</sup> km<sup>2</sup>"?

Yes, we leave this to the typesetting phase.

- Line 198: "Fig. 2(b)" should be "Fig. 4(b)".

Fig. 2(b) is correct. However, we acknowledge that "variations" can be misleading if referred to that figure. Therefore, we use "time series".

- Line 204-205: I find it difficult to understand this sentence, please rephrase it.

Thank you for the comment. Here, we wanted to highlight that, for almost the entire period, the GREP ensemble mean is within the range of observed products at annual maxima, although the spread of GREP members is constantly larger than the observed products' range before 2009.

We rephrased the sentence as follows: “Interestingly, this happens throughout the entire period, although the spread of GREP members at annual maxima is constantly wider than the observation products’ range before 2009”.

- Figure 4: It might be better to rearrange the subfigures in Fig. 4 in the order in which they were written in the main text.

Considering that Fig. 2(b) in line 198 is correct, the arrangement of subfigures in Fig. 4 is OK.

- Table 3: Why not directly list these four quantities in Fig. 5?

Thank you for the comment. We tried to follow the suggestion but we found it difficult since we would have to move the legend to the top of the July panel and the result is not appealing.

- Line 225: I do not get what "MIZ SIA" means.

Thank you for the comment. We replaced the wording with MIZ area.

- Line 255: Should the section number read "4.3"?

Agreed. Thank you.

- Table 4: Also, I would recommend directly listing these three quantities in Fig. 7.

We keep the table detached from the figure in consistency with the choice made for Table 3.

- Additionally, I recommend labeling the SICs throughout the text in %, including the colorbars in figures.

Thank you for the suggestion. In the revised version of the paper, we switched from fraction numbers to percentages when describing SIC.

## References

Chevallier, M., Smith, G. C., Dupont, F., Lemieux, J.-F., Forget, G., Fujii, Y., et al. (2017). Intercomparison of the Arctic sea ice cover in global ocean–sea ice reanalyses from the ORA-IP project. *Climate Dynamics*, 49(3), 1107–1136. <https://doi.org/10.1007/s00382-016-2985-y>

Uotila, P., Goosse, H., Haines, K., Chevallier, M., Barthélemy, A., Bricaud, C., et al. (2019). An assessment of ten ocean reanalyses in the polar regions. *Climate Dynamics*, 52(3–4), 1613–1650. <https://doi.org/10.1007/s00382-018-4242-z>