

Author’s response

April 16, 2026

We would like to thank the reviewers and the editor for their time and effort with this paper. It is greatly appreciated and has been invaluable to make the final work much more clear and precise. Below are the itemised list of our replies (in yellow) to all the comments.

1 Reviewer 1

The authors have made a number of constructive revisions in response to the reviewer comments, and I appreciate their efforts to clarify terminology, expand discussion of limitations, and improve aspects of the manuscript. In particular, the clarification regarding the intended meaning of “orthogonal,” the rewording of statements implying model “accuracy,” and the expanded discussion of limitations related to sea ice thickness constraints have improved the conceptual framing of the study.

However, several areas would still benefit from further refinement prior to publication:

1. Figures and Presentation While some corrections were made, the figures would benefit from more thorough revision. In particular, color bar labels should be incorporated directly into the figures themselves rather than relying solely on LaTeX annotations, and care should be taken to ensure aspect ratios are not distorted. Clear, self-contained figures are essential for reproducibility and long-term usability of the published work.

No images are distorted from their original production and are displayed in their chosen projections. Colour bars and labels are now self contained within the image files rather than annotations

2. α Sensitivity and Physical Justification The explanation for restricting α to values ≤ 5 is clearer in the revision, but given that multiple reviewers independently raised this issue, the manuscript would benefit from a slightly more explicit justification within the main text. Even if additional experiments are not feasible, the rationale for parameter bounds and the implications for ocean thermodynamic balance should be clearly stated so that readers understand both the strengths and limitations of the approach.

We have added the following discussion points to the main text (where green indicates the new content):

“Due to the computational cost of running global reanalyses we have limited the number of tests and note that optimisation of this parameter could be further refined. Here we are conservative and do not test larger values than implemented in ORAS6, as the induced temperature increments could be compensating for errors in the forcing and not in the ocean state. The largest impact from α is seen in the ice edge regions, and verifying significant temperature changes in these regions is challenging given the limited in situ temperature measurements at depth. Consequences of such changes that are not visible to in situ observations may only emerge after extended periods of model integration.”

3. Conclusions and Framing The expanded discussion of why ice-induced temperature increments produce the largest performance gain is welcome. The conclusion could still be strengthened by more

clearly separating (i) demonstrated findings from (ii) speculative future developments, so that the primary contributions of the present study stand out more distinctly.

We have gladly separated these pieces into demarked subsections.

Overall, the manuscript presents a meaningful technical contribution to operational sea-ice data assimilation. With continued attention to clarity of presentation, parameter justification, and figure quality, it will be well positioned for publication.

2 Reviewer 3

In response to the authors' query:

"However reading their paper it is not clear which forecast lead time to use to appropriately compute such forecast tendencies given the First Guess at Appropriate Time (FGAT) methodology we use. We will need to discuss with Smith et al. in this regard."

The forecast lead time used for the Rescaled Forecast Tendencies (RFT) method would in their case would be the lead time at the end of the assimilation trial "forecast," which would either be a 7-day lead/window for full 3-D assimilation or a 1-day lead/window for daily surface SST/sea ice update cycles (so the daily forecasts always incorporate the latest available SST and sea ice fields between weekly 3-D assimilations). This would be done as direct insertion.

Thanks for this - it is incredibly useful for our further understanding.

Sole Comment: Technically, I believe it is conventional to not include units if a field is identically zero. So my demand to include a unit (K) for the parameter alpha would not be required for alpha values of 0 (Titles of Figures 8d, 9a, 9c). However, this is just a convention, and I am not going to request the authors make further changes due to my lack of full clarity in my previous suggestion.

We have happily adopted this convention throughout.

3 Editor

I have looked through the reports from our two referees and am happy that this paper is now acceptable for publication in The Cryosphere subject to minor corrections as outlined in the referee reports.

Please note in particular the comments from Anonymous Referee #1 related to the figures. I have given the figures an appraisal myself and I agree that some attention there would be beneficial for the quality of the manuscript. In particular I find that the stark contrast between two different "families" of figure is not helpful to the reader. By this I mean the fact that Figs 4, 5, 6, 9 use a standard red-to-blue colourbar that has been nicely discretised to allow the reader to gauge the magnitude of the differences. Meanwhile Figs 2, 7, 8 are not discretised and Figs 7 & 8 use a very different blue-to-red colourbar. These inconsistencies mean that the reader has to work a bit harder and so I encourage the authors to think harmonising these figures in the interest of readability.

We have changed the perceptually uniform colour scales to the standard blue-white-red colour scale and given them the same contour levels as the others.