

Dear Editor,

We sincerely thank you for your thoughtful comments on our revised manuscript. Below, we respond to each point individually. For clarity, the original comments are reproduced in plain text, and our responses are provided in bold.

On behalf of co-authors

Yong-Fei Zhang

Editor's comments of manuscript EGUSPHERE-2025-2807 (Version 20260517, V4)

Summary

This ms presents an evaluation of sea-ice concentration (SIC) data assimilation (DA) on subseasonal Antarctic forecasts using GFDL's SPEAR_MED. Overall, the technical logic, structure, and physical insights (such as the ice–albedo feedback analysis explaining performance degradations in December/January) are well-articulated.

However, several minor inconsistencies, typographical errors, etc. remain in the text and figure captions that should be addressed before final publication.

We are grateful to the editor for their careful reading of our manuscript and for bringing the typographical errors and formatting issues to our attention. Please see point-to-point responses.

* Typically abbreviations are not defined in the abstract but on first occurrence in the body of the text.

* You re-introduce the abbreviations "SIC" etc. at the beginning of the "Conclusions". Pls remove.

Thanks for the comment. We've corrected the abbreviations throughout the paper to have them defined on first occurrence in the body of the text.

l 128 & 136: The text introduces BSOSE (Biogeochemical Southern Ocean State Estimate) at Line 136, citing Mazloff et al. (2010) and Verdy & Mazloff (2017). However, in the preceding paragraph (l128), it states: "sea ice thickness (SIT) analysis data from the Global Ice-Ocean Modeling and Assimilation System (GIOMAS...)". In line 136 the authors then state "Another SIT reference dataset we use is from the Southern Ocean State Estimate (SOSE)...".

-> Ensure the text clearly notes that SOSE/BSOSE is used as a data-assimilating model baseline rather than direct SIT observations, clarifying why it was selected alongside GIOMAS.

We thank the editor for this helpful suggestion. We have revised Line 136 to explicitly justify our selection of SOSE/BSOSE alongside GIOMAS. In the revised text, we now state

that we chose SOSE/BSOSE for its higher regional resolution and dynamically consistent ocean circulation fields, which complement the global coverage of GIOMAS.

We also wish to respectfully clarify that our original text already notes that neither GIOMAS nor SOSE/BSOSE assimilates SIT directly; both derive SIT through coupled model physics. We have retained this statement in the revision to ensure the methodological distinction is unambiguous.

The revised text is also copied below.

“We selected SOSE/BSOSE alongside GIOMAS because its higher regional resolution, dynamically consistent ocean circulation fields, and constraints from assimilated ocean profiles, SST, and SIC observations provide a complementary SIT reference that GIOMAS, with its global coverage and coarser resolution, cannot offer.”

l 342–345: Spatial/Sector Description Mismatch:

l 189: "...slight bias increases along the coastal Indian sector, part of the coastal West Pacific in summer (Figure 3i) and spring (Figure 3l)."

lines 343–345: "...particularly in the West Pacific sector (where the negative bias in SPEAR_IC becomes slightly more negative), and in the East Weddell and Indian sectors (where the negative bias in SPEAR_IC becomes positive)."

-> Pls align the sector descriptions between Section 3.1.1 and the Conclusions so that the geographical callouts in the text precisely reflect Figures 3i–3l.

Thanks for the edit. We have modified the text to make them consistent. The modified text is now in Line 352–354 and is also pasted below.

“A slight bias increase in SICDA_IC emerges along the coastal Antarctic in summer and spring, particularly in the West Pacific sector (where the negative bias in SPEAR_IC becomes slightly more negative), and in the Indian sector (where the negative bias in SPEAR_IC becomes positive).”

l 256: "The initial skill gaps between the two reforecast experiments are more prominent in the Antarctic than in the Arctic for all seasons except summer (compared solid to dashed lines)." -> Rephrase to avoid parenthetical imperative instructions, e.g., "(compare solid vs. dashed lines in Fig. 9)".

Thanks for the suggestion. We have rephrased L256 to remove the imperative instruction. The revised text now reads as follows.

“The initial skill gaps between the two reforecast experiments are more prominent in the Antarctic than in the Arctic for all seasons except summer (solid vs. dashed lines in Figure 9).”

Figures and captions

Fig. 3 Caption: Contains a double dash typo in "(e—h)".

Thanks for the edit, we've corrected the typo.

Fig. 6 Caption: Missing space between the sentence and error bar description: "(black), and BSOSE (gray). The values".

Thanks for the edit, the missing space is now added.

Fig. 7: Sub-panel label duplicate/misalignment in caption: "(b) SICDA_IC, (c) GIOMAS, and (d) BSOSE, and (e)". Pls label clearly.

Thanks for the edit, the label is corrected to match with sub-panel label in the plot. The corrected label is copied as follows.

"Spatial map of the 5-year mean SIV for each season from the four data sets: (a) SPEAR_IC, (b) SICDA_IC, (c) GIOMAS, and (d) BSOSE, and (e) SICDA_IC - SPEAR_IC."

Fig. 10 Caption: Refers to red and blue filled/open circles, but the text (1 284) refers "95% statistically significant." Ensure the confidence intervals and bootstrap test parameters (e.g., number of bootstrap samples, block size) are explicitly stated in Section 2.6 or the figure caption.

We thank the editor for pointing out the technical details we forgot to mention in the text. We have added it in Section 2.6. The text is pasted below.

"We apply a bootstrap resampling method (with 1000 iterations) to determine whether the reforecast skills of two experiments differ significantly. For ACC of SIC, at each grid cell and iteration, we resample with replacement from the time series of each experiment and the corresponding observations, and compute the skill metric for both. We then calculate the area-weighted ACC for each experiment and their difference. After 1000 iterations, we consider experiment A to be significantly better than experiment B if its skill value exceeds that of experiment B in at least 950 (i.e., $\geq 95\%$) of the bootstrap samples, and vice versa. The same procedure is applied to nSPS, with the skill metric computed across the 1000 iterations."

Minor corrections required:

l 100: "Reanaysis" -> "Reanalysis"

Thanks for the edit. The typo is corrected.

l 101: "linked DART(Anderson" -> "linked DART (Anderson"

Thanks for the edit. We've corrected the format.

l 104: "documented in (Zhang" -> "documented in Zhang"

Thanks for the edit. We've corrected the format.

l 128: "System (GIOMAS; Zhang and Rothrock,2003)" -> "System (GIOMAS; Zhang and Rothrock, 2003)"

Thanks for the edit. We've corrected the format.

l 146: "Bushuk et al. (2021)(also in Figure 1)" -> "Bushuk et al. (2021; see also Fig. 1)"

Thanks for the edit. We've corrected the format as suggested.

l 216: "A&B sector" -> "A&B sector" (or 'Amundsen–Bellingshausen sector')

Per the editor's suggestion, we have replaced 'A&B sector' with the full geographic designation 'Amundsen–Bellingshausen sector' for clarity.

l 274: "passes DP at ~day 20... passes DP at ~day 15" -> "outperforms DP at ~Day 20..."

We thank the editor for the word choice. We've replaced “passes” with “outperforms”.

l 342: "sptially" -> "spatially"

Thanks for the edit, the typo is corrected.

l 460:

"<https://doi.org/https://doi.org/10.1002/2013GL058755>" ->

"<https://doi.org/10.1002/2013GL058755>"

Thanks for the edit. The citation has been updated to the following.

“Tietsche, S., Day, J. J., Guemas, V., Hurlin, W. J., Keeley, S. P. E., Matei, D., Msadek, R., Collins, M., and Hawkins, E.: Sea-sonal to interannual Arctic sea ice predictability in current global climate models, *Geophysical Research Letters*, 41, 1035–1043, <https://doi.org/10.1002/2013GL058755>, 2014.”

l 468: "S outhern O cean" -> "Southern Ocean"

Thanks for the edit. The citation has been updated to the following.

“Verdy, A. and Mazloff, M. R.: A data assimilating model for estimating Southern Ocean biogeochemistry, *Journal of Geophysical Research:Oceans*, 122, 6968–6988, 2017.”

l 405: Listed with missing volume/page numbers ("Journal of Climate, pp. 1–63, 2022"). Update to final publication volume and page ranges if available.

Thanks for the edit. The citation has been updated to the following.

“Bushuk, M., Zhang, Y., Winton, M., Hurlin, B., Delworth, T., Lu, F., Jia, L., Zhang, L., Cooke, W., Harrison, M., et al.: Mechanisms of Regional Arctic Sea Ice Predictability in Two Dynamical Seasonal Forecast Systems, *Journal of Climate*, 35, 4207–4231, 2022.”

1 430: Listed as "The Cryosphere Discussions, 2021, 1–21, 2021". If this manuscript was subsequently published in The Cryosphere, update the citation to the final peer-reviewed article.

Thanks for the edit. The citation has been updated to the following.

“Liao, S., Luo, H., Wang, J., Shi, Q., Zhang, J., and Yang, Q.: An Evaluation of Antarctic Sea Ice Thickness from the Global Ice-Ocean Modeling and Assimilation System based on In-situ and Satellite Observations, *The Cryosphere*, 16, 1807–1819, 2022.”

1 454: Cited as "The Cryosphere Discussions". Update to the final The Cryosphere peer-reviewed citation if available.

Thanks for the edit. The citation has been updated to the following.

“Shi, Q., Yang, Q., Mu, L., Wang, J., Massonnet, F., and Mazloff, M.: Evaluation of sea-ice thickness from four reanalyses in the Antarctic Weddell Sea, *The Cryosphere*, 15, 31–47, 2021.”

1 485: Listed as "Journal of Climate, pp. 1–48, 2022b". Update to final volume/pages.

“Zhang, Y.-F., Bushuk, M., Winton, M., Hurlin, B., Delworth, T., Harrison, M., Jia, L., Lu, F., Rosati, A., and Yang, X.: Subseasonal-to-Seasonal Arctic Sea Ice Forecast Skill Improvement from Sea Ice Concentration Assimilation, *Journal of Climate*, 35, 4233–4252, 2022b.”