

Review to *The Importance of Initial Conditions in Seasonal Predictions of Antarctic Sea Ice*

## 1 Overall evaluation:

This study employs two versions of the Australian Bureau of Meteorology's ACCESS seasonal forecasting system (ACCESS-S1 and ACCESS-S2), which share an identical model configuration but differ in their initialization strategies, to investigate the role of initial conditions in Antarctic sea ice prediction. The results are promising and broadly consistent with findings from previous studies. Overall, the manuscript is suitable for publication in *The Cryosphere*. However, I recommend that the authors address the comments outlined below before publication.

## 2 General comments:

### **Improper methodology for addressing the stated objective:**

The manuscript emphasizes the importance of sea ice initialization (e.g., L28–29, L56–57, and L85). While ACCESS-S1 and ACCESS-S2 share identical model configurations (e.g., L54 and L65–73) and both use atmospheric initial conditions derived from ERA-Interim (L74), their ocean and sea ice initial conditions differ substantially in both assimilation methods and observational datasets (L74–84). Consequently, a direct comparison between ACCESS-S1 and ACCESS-S2 does not isolate the impact of sea ice initialization alone, as ocean initialization is known to play a critical role in sea ice predictability. Furthermore, the ensemble generation strategies differ between the two systems (L93–100), which may also affect the comparison of ensemble-mean results.

I therefore suggest revising the stated objective of the manuscript and explicitly analyzing the combined impacts of ocean, atmosphere, and sea ice initialization, rather than attributing the results solely to sea ice initialization, given the fully coupled nature of the system.

**Quality of figures:**

I have several specific comments regarding the figures. Improving their quality and clarity would substantially enhance the overall quality of the manuscript and improve its readability.

### 3 Specific comments:

L64, Section 2.1 (ACCESS-S1 and ACCESS-S2): Please ensure consistency between the section title and its content. Clarify whether this section sufficiently describes the key differences between ACCESS-S1 and ACCESS-S2 that are relevant to this study.

L125, Section 2.3: The current version of Section 2.3 primarily describes RMSE and skill scores. However, bias is extensively used in Section 3 (Results) and should therefore be formally introduced and documented in the methodology section. In addition, correlation is also employed (e.g., Fig. 5) and is a widely used metric for evaluating seasonal sea ice forecasts; it should be described as well. Furthermore, the authors should report the statistical significance or confidence intervals for RMSE and correlation.

L126–127: It is unclear how the ensemble mean sea ice extent (SIE) is calculated. Do the authors first compute the ensemble mean of sea ice concentration (SIC) and then derive SIE from the mean SIC, or do they compute SIE separately for each ensemble member and then analyze the ensemble mean of SIE? This should be explicitly clarified in the text.

Figures 3 and 4: These figures are difficult to read. Adding latitude–longitude grid lines would improve readability. In addition, narrowing the colorbar range (e.g., from  $-1$  to  $1$  to  $-0.5$  to  $0.5$ ) may help highlight relevant spatial patterns.

L194: The term “skillful” is ambiguous here. Please clarify whether it refers to skill assessed using RMSE, correlation, or another metric.

L214–215: It appears that the magnitude of sea ice anomalies in ACCESS-S2 is too small, rather than too large, as currently stated. Please verify and revise this interpretation.

L245: “June cannot be forecasted...”?

Figures 9 and 10: Figure 10 largely overlaps with the information presented in Figure 9. It may not be necessary to include Figure 10, or its added value should be better justified.

Figures 11–13: These figures are difficult to interpret. Consider using an alternative colorbar, narrowing the colorbar range, and adding longitude grid lines to improve clarity.

Caption of Figure 14: Please clarify the lead time shown (e.g., 1, 3, and 30 days?).

L277–278: As shown in Fig. 14c1, the two systems clearly differ.

L279–280: How is the standard deviation computed? Is it calculated across years, ensemble members, or both? Please clarify.

Figure 14: The methodology used to decompose the forecast error spread into the mean standard deviation and the standard deviation of the ensemble-mean error is not sufficiently clear and should be explained in more detail.

L307–308: Please clarify how ACCESS-S1 updates sea ice states during the assimilation step. Specifically, does the assimilation update both sea ice concentration and volume across different thickness bins, or does it retain the prior thickness distribution and adjust sea ice volume proportionally during the post-processing of the assimilation step?

L313–314: I kindly disagree with the authors’ statement here; please refer to my general comments for further explanation.

Additional references: I recommend citing the following two studies, which are highly relevant to the discussion of Antarctic sea ice initialization and predictability:

<https://journals.ametsoc.org/view/journals/clim/34/15/JCLI-D-20-0965.1.xml>

<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2024MS004382>