Authors' Response to Reviews of

Enhanced Prediction Skill of Antarctic Sea Ice through Sea Ice Thickness Assimilation

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RC: ***Reviewers' Comment***, AR: Authors' Response, □ Manuscript Text

Dear Editor, Mitchell Bushuk and Anonymous Reviewers

Firstly, we would like to thank you all very much for the constructive comments and suggestions for the manuscript "Enhanced Prediction Skill of Antarctic Sea Ice through Sea Ice Thickness Assimilation". Your insights are very useful in enhancing the quality of our work. Based on the comments and suggestions, we will revise the manuscript accordingly.

Please find our detailed point-by-point responses to the correction comments in the following sections. Below, we list each comment (Reviewer Comment, **RC**) and insert our response (Authors' Response, **AR**) along with the corresponding revisions of the manuscript (inside the **black box**).

Sincerely,

Nicholas Williams
On behalf of all the authors

1. Final Corrections Response

RC: ***Line 36: Typo: "This predictive skill wMarchi"***

AR: We have corrected this sentence structure:

> Marchi et al. (2019) further showed that the effectiveness of this mechanism depends on mixed-layer depth in the model, with deeper mixed layers yielding higher prediction skill.

RC: ***Line 204: Should be "Antarctic SIT" rather than "Arctic SIT"***

Fixed, thanks.

RC: ***Line 206: Regarding my earlier comment on SIT observational uncertainty, the authors mentioned in their response that typical values for February and September were added to the revised manuscript. I couldn't find these values, but possibly I missed them.***

AR: Apologies, this was missed from our revised manuscript, we have corrected this now to include the following:

> The deterministic EnKF framework used in NorCPM does not treat the observations as the exact representation of the true sea ice state but uses the prescribed observational uncertainties from LEGOS SIT (and the additional sampling error handling techniques described above in Section 2.2) to determine the strength of the observational constraint on the model state. In September, typical uncertainty values for LEGOS SIT range between 0 and 1 m across most of the sea ice cover, reaching up to 2.5 m for the thickest ice in the Weddell Sea. In February, the uncertainty values show slightly greater spatial variability over the remaining sea ice at the end of the melt season but within a similar range.

References

Marchi, S., Fichefet, T., Goosse, H., Zunz, V., Tietsche, S., Day, J. J., and Hawkins, E. (2019). Reemergence of antarctic sea ice predictability and its link to deep ocean mixing in global climate models. *Climate Dynamics*, 52(5):2775–2797.