

Review of the manuscript:

Multidecadal Preconditioning of the Maud Rise Polynya Region

By Authors

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Reviewer Decision: Acceptable after minor revision.

I am happy to see that the authors have addressed most of my mentioned concerns. However, the revisions bring into light some new concerns and I hope the authors can address them.

- 1) Has either SOM or SOM\* ever been observed in nature? or any model other than CESM/POP? If not then explicitly state it and appropriately reduce the relevance throughout the manuscript. The authors on multiple occasions throughout the manuscript over sell this idea of SOM and SOM\* but that is misleading since as far as we know this is a CESM/POP simulation artifact only captured in 4 CESM simulations so far. My main concern here is that the authors need to be upfront about the hypothetical nature of this study.
- 2) Lines 37-40 in Section 3: I'm really not convinced about your reasons for choosing different area for calculating SOM\* index. The new area is (a) significantly smaller than the originally proposed area, and (b) is away from the region where EOF pattern has maxima/minima. Just because the correlation between SOM\* index and Weddell Gyre strength is greater, that alone doesn't justify your choice.
- 3) The authors also need to make it clear that the fact that subsurface heat accumulation is useful in Weddell Sea Polynya formation in model studies, it has not been validated in any observational studies as a pre-requisite for Maud Rise Polynya formation.
- 4) Line 31 in Section 3: Why is there the phase difference between PC1 and SOM/SOM\* index ? Is it significant ? Would it affect the proposed causal relationship with the Weddell Gyre strength?
- 5) Line 34 in Section 3: what is the correlation coefficient between PC1 and WG strength? for both models?

- 6) Lines 48-50 in Section 3: Despite the 60-month smoothing the percentage of variance explained is small implying a large part of regions variability is dominated by spatial noise. Correct?
- 7) Line 68 in Section 3: how long would a high-resolution CESM simulation need to be to have SOM? more than 100 years? Recent high-resolution model simulations that best reproduce the Maud Rise Polynya (Kurtakoti et al. 2018; Kaufman et al. 2020) show no evidence of SOM or SOM\* in their ~130 years long CESM simulation. In fact, there is no periodicity in the subsurface heat accumulation in the Weddell Sea.
- 8) There is a line count reset in Section 3 after Fig. 3. Please fix that.