**We thank the editor for giving us the opportunity to resubmit in addition to the helpful suggestions provided below. We have included responses to each point in addition to updated sections from the manuscript where necessary.**

**In response to Reviewer 1's comment, we are now including results from PMIP4 LGM simulations. Since the PMIP4 LGM data is relatively new and the sea-ice data has not been published yet, we had to directly ask modeling groups for their data. To acknowledge their contributions to our revised manuscript, we therefore invited these authors to be co-authors of our manuscript. As a result, we have now added five co-authors: Deepak Chandan, Gerrit Lohmann, W. Richard Peltier, Xiaoxu Shi and Jiang Zhu.**

EDITOR COMMENTS on cp-2020-155, Green et al. "Evaluating seasonal sea-ice cover over the Southern Ocean from the Last Glacial Maximum" submitted 03 Dec 2020

The authors have put careful thought into addressing the comments of 3 reviewers and one posted comment. Having read their responses and noted the positive inclusion of the new, PMIP4 analysis, I think that the authors are in a good position to move forward to "reconsider after major revisions." In addition to the well-documented changes planned by the authors, I have noted the following for the authors to consider in their final manuscript revision:

1) The authors have indicated that one of the goals of this manuscript is to provide updated LGM proxy datasets. I suggest that the authors could better document in their methods section how they harmonized chronologies (what was the choice of LGM time period), methodologies, and determined consistencies (if needed).

While we were first to submit this dataset in our original manuscript, the dataset has since then been published by Lhardy et al. (2021). Due to this, we can no longer claim to provide an unpublished, updated LGM sea-ice proxy dataset. However, some of the SST data we use was not included in Lhardy et al. (2021). We have clarified this now in the second paragraph of our introduction, lines 45-49:

"Since 2005, additional SO sea-ice data has been published (Allen et al., 2011; Benz et al., 2016; Ferry et al., 2015; Ghadi et al., 2020; Nair et al., 2019; Xiao et al., 2016), and recently merged into an updated compilation (Lhardy et al., 2021). Within this updated sea-ice compilation, certain cores also contain summer SST estimates. We use this sea-ice proxy data along with the summer SST proxy data to better constrain the minimum and maximum LGM sea-ice cover."

In addition, we would like to provide some information on the updated datasets here just for your reference.

The new compilation is mainly based on two large regional datasets: Gersonde et al. (2005) and Benz et al. (2016), which both follow Gersonde et al. (2005) rules for quality levels in the chronologies and estimations. The quality levels are all reported in these papers. For the additional datasets (Allen 11, Ferry 15, Nair 19, Ghadi 20, Xiao 20): Regarding their stratigraphic quality levels, most use either radiocarbon dating complemented with d18O stratigraphy, biostratigraphy or magnetic susceptibility. They all fall at stratigraphic quality levels better than 3. Chronologies were not harmonized as most cores present 14C-based chronologies with recent calibrations. This should ensure consistency between the cores. Regarding estimation quality levels, the mean winter sea-ice (WSI), summer sea ice (SSI), *Fragilariopsis curta+cyclindrus* (*FCC*), *F. obliquecostata* (*Fobliq*) and sea-surface temperature (SST) were calculated on the EPILOG timeslice (19-23 ka) to follow on Gersonde et al. (2005) recommendations. The quality of the mean obviously depended on the number of samples present in the timeslice. We believe all cores presented several points over the EPILOG timeslice. Quantitative estimates had good dissimilarity or communality, thus being assigned high-quality levels of 1-2 over 3. Qualitative estimates (*FCC* and *Fobliq*) are assigned a lower community level of 3 over 3.

2) Similarly, as the LGM proxy data set update was an identified goal, the authors should devote at least one paragraph at the outset of their Results section outlining what the new compilation shows (prior to their comparison to simulations). Such a paragraph could also help to address concerns of R2 regarding zonal asymmetry. How prominent is zonal asymmetry in WSI cover for both time periods in the proxy data?

Again, we no longer include an updated LGM sea ice dataset within our goals. Nevertheless, please find below some information for your reference.

Overall there are no great changes in winter sea-ice (WSI) extent between the new compilation (Lhardy et al. 2021) and the old one (Gersonde et al., 2005), despite WSI being a bit more expanded in the Scotia Sea (Allen et al., 11). There was more WSI in the Atlantic (off the Weddell Sea) and the Pacific (off the Ross Sea) than in the Indian and eastern Pacific. This is visible in the distance between the WSI edge and the continent (~20° of latitude at 0° of longitude off Weddell Sea; 17-18° of latitude at 150°W off Ross Sea; 13-15° of latitude at 90°E in the Indian sector; ~11° of latitude at 90°W in the western Pacific). Summer sea-ice (SSI) extent would have been the same if restricted to the control points.

3) R1's comments about the feedbacks between winds and sea-ice are important ones. In their response, the authors do a thorough job of clarifying that the goal of the paper is not to address (a) how accurately the models reproduce winds, or (b) how sea-ice feedbacks ultimately influence wind positions. Rather, the authors are focussing on each model's relationships between winds and sea ice.

The first point (a) appears to be well-addressed by the proposed text for Results section 3.4 (below), but the additional sentences added to Results section 3.3 to address point (b) (also) below jumps topics and does not appear positioned well. I suggest adding this response to paragraph just above section 3.2 (ca. line 155 in the original manuscript), and to state it more clearly as "we recognize that the presence or absence of sea ice also has a direct influence on surface winds (Kidston et al. 2011; Sime et al. 2016). However we are focused on the influence of winds on sea ice…."

TEXT FROM AUTHORS: Results section 3.4:
“While latitudinal position and magnitude of southern hemispheric westerlies at the LGM is poorly constrained (Kohfeld et al., 2013; Sime et al., 2016), here we want to assess the impact of the simulated windstress curl on ocean dynamics in each model. We thus use the simulated windstress outputs to estimate the location and strength of the SO upwelling, and its potential impact on sea-ice cover. “

TEXT FROM AUTHORS: “Results section 3.3:
“The strength and location of the southern hemispheric westerly and polar easterly winds impact Southern Ocean circulation, sea ice transport and therefore sea-ice distribution (Purich et al., 2016; Holland and Kwok, 2012). On the other hand, the presence or absence of sea ice also has a direct influence on surface winds (Kidston et al. 2011; Sime et al. 2016). The divergence created by the wind stress curl over the Southern Ocean leads to an upwelling of warmer deep waters and thus heat loss to the atmosphere. This upwelling can therefore also impact Southern Ocean sea-ice distribution.”

We thank the editor for these helpful suggestions to clarify our goal of the paper in relation to winds and sea ice. Since we have restructured our results, we decided to include both of the above “TEXT FROM AUTHORS” in the first paragraph of our results section 3.4-Drivers of inter-model variability. This paragraph is shown below:

Lines 265-273:

“The strength and location of the southern hemispheric westerly and polar easterly winds impact Southern Ocean circulation, sea ice transport and therefore sea-ice distribution (Purich et al., 2016; Holland and Kwok, 2012). On the other hand, the presence or absence of sea ice also has a direct influence on surface winds (Kidston et al., 2011; Sime et al., 2016). Here, we are focused on the influence of winds on sea ice through the divergence created by the wind stress curl. Within the Southern Ocean divergence leads to upwelling of relatively warm circumpolar deep waters and thus heat loss to the atmosphere. This upwelling can therefore also impact Southern Ocean sea-ice distribution. While the latitudinal position and magnitude of southern hemispheric westerlies at the LGM is poorly constrained (Kohfeld et al., 2013; Sime et al., 2016), we want to assess the impact of the simulated windstress curl on ocean dynamics in each model. We thus use the simulated windstress outputs to estimate the location and strength of the SO upwelling, and its potential impact on sea-ice cover.”

4) R2 is concerned that zonal averages will smooth out zonal asymmetries in the sea-ice edge, but authors are unclear on a better way to conduct this analysis. Note that when using paleo-data we get around issues of zonal asymmetry by using a feature like the modern-day polar front and expressing changes in variables (e.g. LGM minus PI) against location, where location is expressed as latitudinal difference from the modern-day front. This would be one approach for addressing this concern. Understandably, although this approach may be very useful, this new analysis may be beyond the scope of this manuscript at this stage. However, it would be useful for authors to address this limitation in the manuscript by (a) describing any zonal asymmetries observed in the paleo-data and

(b) explaining that their analysis does not address how these asymmetries can affect the overall (zonally averaged) estimates of summer and winter sea-ice extent.

We understand this concern and appreciate the suggestion. As you mentioned, at this late stage of the manuscript we do not plan to conduct any more significant additions to the analysis that isn't already presented. However, we now include a paragraph in our discussion that highlights these zonal asymmetries in the proxy data and the implications that they have on our LGM summer sea-ice estimate.

Discussion lines 317-322:

"Our estimate for the LGM SSI edge is a zonally averaged estimate and therefore assumes a fairly circular SSI distribution, similar to that simulated by AWI-ESM-1 and FGOALS-G2 (Figure 1). While the LGM SSI proxy data is limited, Lhardy et al. (2021) suggest the three basins behaved very differently, with a LGM SSI edge at 54°S in the Atlantic, 65-66°S in the Indian, 63°S in the western Pacific and 66-68°S in the eastern Pacific. If this indeed was the case, our suggested LGM SSI edge would potentially overestimate the sea ice edge in some regions while potentially underestimating it in other regions. Additional proxy data from the Pacific and Indian basins would reduce the uncertainty of our estimate."

5) Please include latitude/longitude grid lines in your new figures so that readers can see latitudinal positions of data and modeled sea ice extents (e.g. Figure 1).

We appreciate this suggestion and have done this.

6) The authors might better address R2's comment about regridding of model simulations by simply indicated in figure captions where this has occurred, or putting one sentence in the methods.

We have decided to keep all figures and tables based on the regridded data and due to this, we chose not to include this information in every figure caption. In hopes of clarifying the method of interpolation for Reviewer 2, we have adjusted the following sentence to section 2.1 of the Methods, lines 101-102:

"To ease the comparison, we used bilinear interpolation to standardize each model to a 1˚x 1˚grid with the CDO software (Climate Data Operators, Schulzweida et al. 2014)."