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Interactive comment on "A multi-model CMIP6 study of Arctic sea ice at 127 ka: Sea ice data compilation and model differences" *by* Masa Kageyama et al.

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As part of the Paleoclimate Modeling Intercomparison project, the purpose of this paper within the 6th phase of the coupled model intercomparison project (CMIP6) is to review the results from 12 climate models in terms of Arctic sea ice. The point of the project is to compare how the models produce Arctic sea ice during the Last Interglacial (LIG). I would like to say up front that what I most enjoyed about this paper is the honesty expressed in the evaluation. They admit that they cannot accurately state what sea ice was like during the last interglacial, but they can frankly say how the models compare.

I make suggestions to make the paper a bit more accessible to non-modelers like me. I have added comments to the pdf and created a comment summary.

The results show a wide range of minimums for summer sea ice but the mean of the 12 models suggests a 59% reduction in summer sea ice; they found that winter sea ice extend was about the same in LIG compared to Pre-Industrial (PI) (not thickness mind you, only extent). For "ground truth" they used only sediment cores from the Arctic Ocean and Fram Strait region (Table 1) with sea ice presence or absence heavily weighted toward proxies like dinocycsts and IP25, both of which have large errors associated with them. For example, the calibration of the dinocycsts for sea ice used 1955 to 2012 (page 6) and the error of prediction is +/- 12%. So one has to propagate the error in the proxies along with the differences in the models to compare with the same data.

One strong point for the results of this paper is that all version 6 models focused on a uniform set of model experimental protocols, because version 5 failed to do this and the results were more difficult to evaluate. For this simulation, they used sea ice base line for 1982 to 2001 (this is what they consider most realistic for PI), given that most remote sensing of sea ice started in 1979. True preindustrial sea ice extent and thickness can only be judged from historical data.

More detailed comments:

Comment 1, page 4: The decrease in summer sea ice is also supported by the migration of treeline documented by Lozhkin and Anderson 1995 showing range extensions of 600km for many tree species; treeline was north of the Brooks Range and similar extensions are shown in some sites on Baffin Island containing 80% birch pollen. One could go on but the paper is focused on ocean records. Note that the models used in this paper do include land surface processes, but only 2-3 models allow interactive vegetation (shown in Table 2). Comment 2, Page 10: It is now pretty widely accepted that Greenland gave up at least 2 meters of sea level equivalent during MIS 5e (LIG).

Dorthe Dahl-Jensen supports this now which is significant! So it would seem to make much more sense that CMIP6 should use the best current configuration of a 5e Greenland Ice sheet. I suggest for clarity that the authors here include an explanation why CMIP6 is not using smaller ice sheets. Lots of examples like The Cryosphere Discuss, https://doi.org/10.5194/tc-2018-225; Stone et al, 2013 C-P; Helsen et al. 2013 also published in C-P. Comment Figure 2 – Add axes labels to all boxes. Increase the font on the key, there is plenty of space for that.

Comment 3 page 14 – I could be wrong but what about propagating the error from the proxies given that dinos are +/_ 12%. Evaluate the proxy error vs the model comparison miss match?

Page 15 – You start here using 1pctCo2 for the first time. Please add something to explain this, like… Idealized 1% per year increase in Atmospheric CO2? Etc etc. Remember that not everyone reading this is a modeler so this term should be defined and add why its important.

Page 16 – consider this additional important point. Low sedimentation rates in the Arctic Ocean also means that the proxy resolution from the cores you are using are low enough to be missing 1000 yr intervals of no summer sea ice etc. These limitations may also complicate or explain the mixed messages from the 12 models. You should add this to the discussion – a few sentences.

Smaller comments are attached to the text using comment boxes. See the file named "Supplement" for details and picky editorial comments. I suggest this paper be published with minor revisions.

Please also note the supplement to this comment:
https://www.clim-past-discuss.net/cp-2019-165/cp-2019-165-RC1-supplement.pdf

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Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2019-165, 2020.