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Geoscientific Model Development Discussions
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Interactive comment on "Description of the resolution hierarchy of the global coupled HadGEM3-GC3.1 model as used in CMIP6 HighResMIP experiments" *by* Malcolm J. Roberts et al.

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I found the manuscript by Malcom Roberts et al to be well organized, nicely written, and nice to read. It covered all the main components I would like to see addressed in a paper like this, the only major exception is it would have been interesting to see how the simulated Madden Julian Oscillation responds to resolution. In our experiments with E3SM, we see little to no improvement (and perhaps a slight worsening) of the MJO in our equivalent HH experiment. It would be interesting to see how the MJO responds to the various combinations tested here. I would encourage the authors to

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think about including a short discussion of this important intraseasonal oscillation, but do not believe it is necessary for this manuscript to be published.

Overall, I had no major objections. My two more general concerns are related to reproducibility and the values of parameters chosen for the simulations.

As noted by Dr. Griffies, I too was troubled by the statement in the data availability section that makes it impossible to reproduce these experiments except by folks within Hadley Center. This is an unfortunate decision by the Hadley Center, but I also don't think this should or can prevent publication of this work.

Second, in a few places I felt it would be helpful to more thoroughly mention the role of the chosen GM bolus kappa parameter. In particular, at low resolution the Drake Transport and simulated antarctic circumpolar current will be strongly dependent on the chosen bolus kappa value. I think it is important for the authors to more clearly state the dependence in Section 3.6 for example. I believe you could judiciously choose your value of bolus kappa to minimize the change in ACC transport across the resolutions studied.

I recommend publication with minor revisions, including point 2 above and the following line specific corrections.

1) Near Line 50 you could also reference our soon to be submitted manuscript on using E3SM to explore resolution effects under the highresmip protocol

Caldwell, P and co-authors, 2019: The DOE E3SM coupled model version 1: Description and results at high resolution, in prep for JAMES

2) on page 6, numerous subscript formatting needed for W/m2

3) right above 25, there are two MLs, I assume one should be LM?

4) Near line 25, I would also cite this paper on the large polynyas seen in other models

https://journals.ametsoc.org/doi/full/10.1175/JCLI-D-16-0741.1

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5) Near line 30, why not use iceSAT for both hemispheres? I believe ICESAT thickness is a preferred benchmark to PIOMASS volume in the sea ice community.

6) line 6 page 10 – need to say high resolution atmosphere.

7) Your descriptions of Figure 12 in text (pg L27) are not terribly clear to me, for example, by West North Pacific, is this the region directly above the dateline? So north just means north of the equator?

8) Pg 12, line 21, suggest moving this sentence before the figure 16 sentence to improve flow.

9) Line23 page 13 – Stephenson -> Stevenson

10) Figure 17 – I'm not sure this figure adds to the discussion. As you cite (Stevenson et al and Wittenburg et al) a much longer simulation is required to appropriately resolve the NINO34 spectra. Further, at least to my eye, all simulations reproduce the HadISST spectrum fairly well. I would consider dropping this figure but leaving the discussion about observed variability. The figure only confirms what is seen in previous literature.

11) Broad comment about the conclusions, it would be helpful to include references to figures when you discuss biases again.

12) Page 14 L8 – do you have references to support the "Based on previous work"?

13) in data availability I would suggest changing the link to the CICE code, our oceans11 server is going away soon. I would point people to the CICE consortium page https://github.com/CICE-Consortium.

14) Bias figures would benefit from a summary statistic on panels (similar to Figure 4).

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