

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.

Malcolm J. Roberts et al.

robertsmalcolm@yahoo.com

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Reviewer 2: Luke Van Roekel (Referee) 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 think about including a short discussion of this important intraseasonal

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oscillation, but do not believe it is necessary for this manuscript to be published.

Response: An additional Figure 22 has been included to show the wavenumber/frequency spectra in the tropics from models and observations, which includes a component of the MJO. Additional text has been included on page 14, line 27.

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.

Response: See above response to Reviewer 1, the text has been clarified.

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.

Response: The dependence of the Drake Passage transport on this kappa parameter indeed has been shown (Kuhlbrodt et al. 2012), but only for models that have a single fixed scalar value for the eddy-induced diffusivity. In N96ORCA1 however, this parameter is calculated at every time step and at every grid column as a function of the vertical density gradient (Kuhlbrodt et al. 2018, Storkey et al. 2018). In this case the relationship to DP transport is much less clear. I have added some text to the end of Section 3.6 to reflect this comment.

1) Near Line 50 you could also reference our soon to be submitted manuscript on using

E3SM to explore resolution effects under the highres mip protocol Caldwell, P and co-authors, 2019: The DOE E3SM coupled model version 1: Description and results at high resolution, in prep for JAMES.

Response: Done, page 2, line 17, this is included though I need the full author list for the reference.

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

Response: Done

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

Response: Done

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>

Response: Done

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.

Response: The problem with ICESat is that it was only around from 2003-2008 and did not have complete temporal coverage (the data is only available for parts of the year). As the laser onboard ICESat failed virtually from the onset, they had to use "campaign mode" and only turned on the laser for short periods every now and then (like focussed aircraft campaigns). So there isn't a huge amount of data and it doesn't get used much for these purposes (we've never seen anyone use it for large-scale climate model evaluation as here). PIOMAS has been shown to compare well with ICESat thickness for the periods where ICESat is present (Schweiger et al. 2011) and this gives us confidence to use the data throughout the year and over the longer evaluation period 1990-2009. However we should make clear that PIOMAS is used as a reference here rather than for direct validation. It is a good reference because it

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is well used and well understood. We have added some text to page 8, line 5 to this effect.

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

Response: Done

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?

Response: I have tried to make the text clearer.

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

Response: Done

9) Line23 page 13 – Stephenson -> Stevenson

Response: Done

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.

Response: I have changed the figure to just show the models that have enough years of simulation (LL, MM), and added to the text that other resolutions show little difference (given their shorter simulation length), page 14 line 7.

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

Response: I have added references to figures in the conclusions.

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

Response: Added Jackson et al. (2015).

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](https://github.com/CICE-Consortium).

Response: The code used within this modelling framework is now mentioned in this section.

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

Response: Done (Figures 7, 12).

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-148>, 2019.

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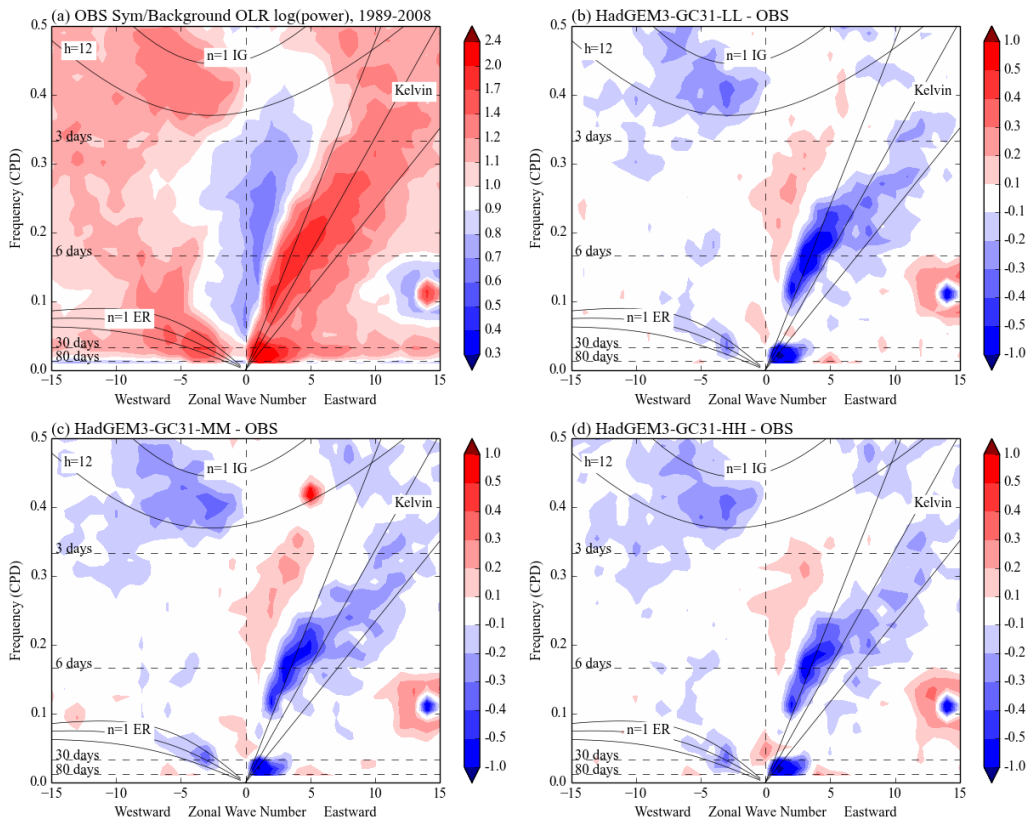


Fig. 1. Frequency-wavenumber showing MJO and other waves

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