Response to Reviewers of GMDD-8-7983-2015, 'Impact of ocean coupling strategy on extremes in high-resolution atmospheric simulations'

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Response to Reviewer #1

The aim of this paper is to emphasize the role of the model configuration in the computation of the atmosphere/ocean fluxes as well as their feedback on TCs. When the ocean grid is coarser than the atmospheric one, wind stresses computed on the coarser grid tend to be underestimated and cannot modulate the atmospheric winds, leading to overestimated TC strength. The authors demonstrate that fluxes should be calculated on the finest grid to allow better equilibrium between the two models.

The paper is clear and well written and the problematic is easy to understand for the reader. The experimental protocol has been well constructed to answer the question. Some deterministic simulations have been performed to illustrate the effect of the resolution on forecast of the real case of Leslie.

For the reasons explained in the next section, I do not think that the paper is ready for publication. Nevertheless, since the changes that I would suggest to do are not so large (addressing other characteristics of TCs in the first part and comparing deterministic simulations with observations of Leslie, deeper discussion on surface heat fluxes), I suggest that the paper may be accepted after minor revision.

Reply: Thank you for your prompt review and insightful comments.

It would have been interesting to assess some other characteristics of TC activity, such as life duration, track density (are the tracks impacted by the way stress are calculated) as well as associated phenomena such as rainfall but it would result in a longer paper.

Reply: We have added average storm duration to Table 1 since it was a trivial calculation given the post-processed tracking output. Mean storm lifetime only differs by approximately 2% between the simulations. This further underscores that the overall distribution of storms produced is similar; it is the tail of the intensity distribution (most extremes TCs) that is shifted due to the coupling feedback described in this manuscript. A cursory look at track density for all tracked TCs (Fig. 1) shows no fundamental shifts (spatially) that appear to be significant. 'The same relationship holds true for mean storm lifetime. Spatial plots of TC track density also show no discernible difference (not shown).' has been added to the manuscript to address both of these points.

Since precipitation is driven by dynamical processes within the core of the TC, we anticipate the differences in precipitation between configurations would be somewhat analogous to that seen in intensity, with most intense precipitation rates associated with TCs being higher in the configuration which produced stronger TCs (ne120_gx1v6). Using precipitation data from 1980-1993 (this data was already regridded for analysis purposes), the mean integrated precipitation rate (within 2° of the sea level pressure minimum) for all TCs was 2% higher in the ne120_gx1v6 configuration, although there is significant variability between individual storms, likely due to differing sizes. 'This is further corroborated by the mean TC precipitation rate (integrated over a 2x2° domain over the TC center for all storms), which is approximately 2% higher using the ne120_gx1v6 configuration' has been added to the revised manuscript to note this.

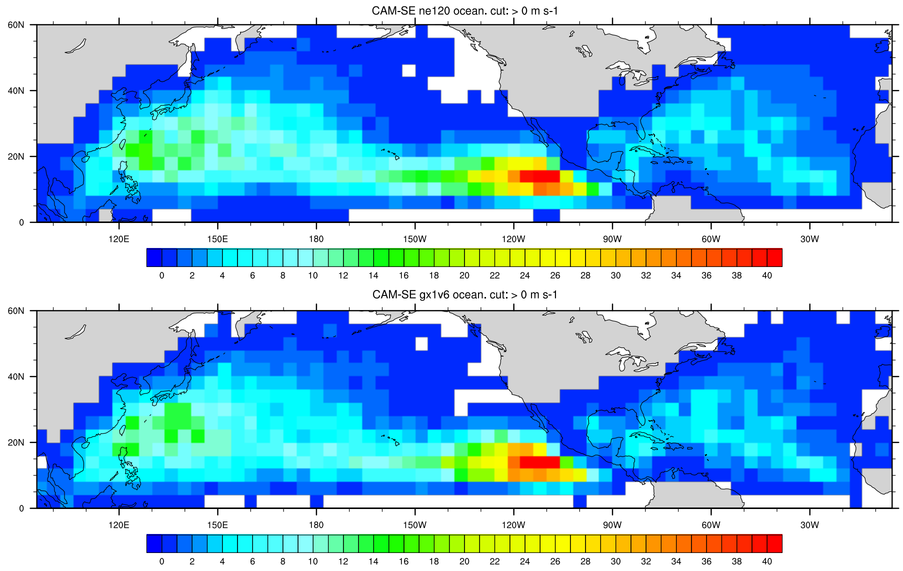

Figure 1: Mean annual track density for 4x4° gridboxes for the ne120_ne120 (top) and ne120_gx1v6 simulations (bottom). A 'hit' occurs when a 6-hour tracked TC location occurs in a particular gridbox.

Deterministic simulations of hurricane Leslie are done to illustrate what have been showed in the climate simulations. If the effect of the grid resolution on wind stresses is clear in figure 5, the realism of the simulated hurricane has not been assessed, which should be, in my sense, the objective of such simulations. For example, it is not clear in figure 5 if resulting winds are different between the different simulations and which one is the nearest to real winds observed during Leslie. I do not really understand the usefulness of such simulations if comparison with observations is not undertaken. Climate simulations may be sufficient to demonstrate the impact of the resolution on wind stresses by a statistical approach.

Reply: We have added 'The simulated intensity of Hurricane Leslie at 120 hours (as measured by minimum sea level pressure) was 950 and 958 hPa for the ne240_gx1v6 and ne240_ne240 configurations, respectively. Both configurations predicted a TC stronger than the observed intensity at that forecast time (988 hPa), in broad agreement with previous work that has shown CAM5-SE produces TCs which are (on average) too intense in forecast frameworks at 0.125° resolution [Zarzycki and Jablonowski, 2015]. However, it should be emphasized that we are not concerned with forecast verification, but rather, the relative differences that arise due to coupling strategy despite identically-initialized cases to confirm differences suggested by the analysis of the decadal simulations. Highly similar results to those highlighted here would be expected when using different historical TCs or even more idealized frameworks.' which addresses this point.

Essentially, the choice of simulation is not critical to the results of this study. The same results were seen with a different TC during the 2012 season (Hurricane Michael, not shown). The only criteria is that the simulations are initialized with identical initial conditions, use identical forcing, and are on identical grids except for the one used to calculate the air-sea fluxes and wind stresses.

Figure 5 d, e and f show some results on surface heat flux (SHF); I wonder whether these results and related comments are useful in the paper. Indeed, since the reader understands well in which wind stress feedback impact strength of TCs, he may not be aware on the effect of SHF differences on TC characteristics. I suggest to suppress this part or explicitly show in what way differences in SHF influence the TCs.

Reply: To further show how heat flux patterns can influence TCs, we have added the following text: 'The pattern of surface heat and moisture fluxes underneath TCs has been shown to be critically important in intensification processes [Peng et al., 1999, Chan et al., 2001, Wang and Wu, 2004]. Therefore, the choice of coupling grid may play an indirect role in storm energetics, with the 1° ocean grid providing a larger, more diffuse source of surface heating to the boundary layer within the TC core.'

While we understand that the impact of enthalpy (sensible and latent heat) fluxes on TC structure and intensity are highly complex, we feel that prior research (e.g., Peng et al. [1999], Chan et al. [2001], Wang and Wu [2004]) has indicated that the spatial patterns and subsequent phasing of these quantities with other dynamical aspects of the storm (e.g., moisture convergence) are critically important to TC representation. While the wind stress appears to play a much larger role in the mean climatology, it is worth noting that the aspects of coupling discussed in this manuscript may also play roles in other TC processes.

Title*: You should mention explicitly 'tropical cyclones' instead of 'extremes' since it is the only phenomena assessed in the study.*

Reply: We have changed the title to 'Impact of surface coupling grids on tropical cyclone extremes in high-resolution atmospheric simulations' (see also Reviewer #2's comments regarding the title).

Page 7987, Line 26*: The expression ?prescribed ocean/ice model? seems to me as misleading. It would be better to mention the ocean grid instead. Indeed, what I understand is that observed SST and ice are prescribed via the coupler CLM as in a fully coupled model but no ocean/ice model is run. I suggest to reformulate the sentence.*

Reply: Agreed. To address this, we have changed the referred section to read 'The first simulation uses prescribed ocean and sea ice conditions applied on a grid where the polar point is displaced over Greenland, which is at approximately 1° horizontal resolution (ne120_gx1v6). This is coarser than both the atmosphere and land models. The second simulation is identical to the first, except the ocean/ice conditions are applied on the same 0.25° (ne120) grid as the atmosphere and land (ne120_ne120).'

References

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