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Interactive comment on "Evaluation of a Unique Approach to High-Resolution Climate Modelling using the Model for Prediction Across Scales (MPAS) version 5.1" *by* Allison C. Michaelis et al.

James Done (Referee)

done@ucar.edu

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General Comments: This study presents a novel experimental design to advance our understanding of climate change effects on high-impact mid-latitude and tropical weather events. Rather than simulating climates using continuous simulations over many years, the authors selectively sample years of varying ENSO phase, and run under current climate and future climate. Current climate is simply analyzed SSTs and future climate is created by adding a climate change perturbation to the analyzed SSTs, enhancing greenhouse gas concentrations and reducing sea-ice. This Pseudo-Global Warming (PGW) approach has been done many times for regional domains where the

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daily synoptic-scale variability is constrained to replicate current climate variability. In this global model context, however, there is no such constraint on the synoptic-scale variability, and the atmospheric variability is free to respond to the future climate.

The authors make a strong case that well-thought-out experimental designs such as this one promise to make significant advances in our understanding of climate change effects on high-impact global weather.

The paper is a pleasure to read – it is well structured, well written, and the figures are clear and useful. The introduction includes a comprehensive review of previously published work, and provides good motivation for the study. The methodology appears sound, and assumptions are acknowledged. The paper contains an important evaluation of the simulated current climate by MPAS – a relatively new global atmospheric model. MPAS is shown to be credible at reproducing many aspects of the observed large-scale dynamics in current climate. I have a few specific issues described below that should be addressed prior to consideration for publication.

Specific Comments: 1) The claim is made that the experiment assesses future thermodynamic environments. I understand that the frequency distribution of ENSO phases is the same in current and future climate. But MPAS will permit some large-scale circulation change in response to the future SSTs so I'm not sure circulation change is small compared to the thermodynamic change. Please clarify the contributions of thermodynamic change and circulation change permitted by your experimental setup. Perhaps checking the magnitude of circulation difference fields would help. More generally, can you provide more guidance on how the future change results should be interpreted? How should we interpret future changes based on fixed ENSO phase frequencies but variable atmospheric circulation response?

2) A related issue is that the experimental approach assumes that SSTs in all phases of ENSO change by the same magnitude and spatial pattern. Can you comment on how realistic this assumption is and any implications for the results?

3) Please explain why this study chose to sample ENSO phases and not phases of some other interannual of decadal mode of climate variability?

4) The discussion of missing cool-wakes in the simulations on page 8 is well stated. But that is only half the story. The reanalysis SSTs will contain the cool wakes of observed TCs, so this could unphysically dampen simulated TCs that cross these 'phantom' cool wakes.

5) The evaluation shows MPAS does a reasonable job at capturing the climatological spatial distribution of TCs. Given that your approach emphasizes ENSO phases, can you also check whether MPAS captures the observed TC response to ENSO phase in the Atlantic and Pacific.

6) MPAS misses TCs that develop from easterly waves over the eastern North Atlantic. I agree that one possible reason is enhanced shear. Another reason could be that the westward shift in the African Easterly Jet means that the wave energy accumulation zone (as discussed in Done et al. 2011) is also shifted westward.

Done, J.M., Holland, G.J. and Webster, P.J., 2011. The role of wave energy accumulation in tropical cyclogenesis over the tropical North Atlantic. Climate dynamics, 36(3-4), pp.753-767.

7) The purpose of Fig. 10 is to compare seasonal cycles of TCs. I suggest plotting the normalized distributions to remove the effect of differences in absolute numbers.

8) The motivation for this experimental design is to assess future changes in high-impact weather. But no results on future changes to high impact weather are presented. I read in the final section that results will be forthcoming in a separate publication. To set readers expectations I suggest adding a note earlier in the manuscript, perhaps at the end of the introduction.

Technical corrections: None

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