

Review of *The American Monsoon System in HadGEM3.0 and UKESM1CMIP6 simulations*  
by Garcia-Franco et al.

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Recommendation: Minor Revision

### **Major Comments**

The authors have presented a well-written manuscript on the important topic of analyzing bias in Global Climate Models in their transition to Earth System Models with coupling to the land/biosphere, ocean and sea ice and well as chemical cycles and aerosol interactions. In this case, the focus is on the American Monsoon System in the context of the HadGEM3.0 GC3.1 and the UKESM1 models. The basic presentation is clear and indicates where biases in the distribution and intensity of, for example, precipitation are found across the Americas. Nevertheless, I do have two particular criticisms of the manuscript: (1) there should be a little context given in terms of moving towards high resolution (towards kilometer scale) ESMs and, (2) some attempt at an explanation, even if speculative, as to why the biases and differences are observed in the model results (e.g., different physical parameterizations).

With respect to criticism (1), I think you could expand a little bit on the movement towards higher resolution ESM models that has arisen in the last few years. This would help better motivate the work done in this study. For example, these studies and commentaries (Stevens and Bony 2013; Marotzke et al., 2017; Schulthess et al., 2018; Palmer and Stevens, 2019; Stevens et al., 2019) could be relevant to better motivating this study. And (2) also related to the above mentioned studies in several cases, is to indicate which physical parameterizations in the model could be most associated with the model biases. Clearly, the spatial and temporal distribution of rainfall will be related to model convective and microphysical parameterizations and would be obvious choices to consider. Likewise, these parameterizations determine the distribution of rainfall in the tropics and associated latent heat release and are, therefore, fundamental to the intensity of large-scale circulation features such as the ITCZ and the displacement and intensity of the sub tropical high pressure systems, etc ...

### **Minor Comments**

Line 36 “ A bimodal regime characterises the seasonal cycle of precipitation in southern Mexico, Central America and the Caribbean that is typically referred to as Midsummer Drought (MSD)” Perhaps for completeness you can include the more local reference terms for this phenomenon. In Central America it is often called “El Veranillo” and in southern and eastern Mexico “La Canícula”. For example a bit more detail on the MSD can be found in these articles, Amador JA et al. 2016, Amador, J.A., et al., (2016), Durán Quesada et al (2017).

Line 41 . The complex interplay of moisture transport, evaporation and the dynamics...”  
When you say evaporation here you should probably clarify if you mean from the sea-surface or from land-surface or both, as terrestrial latent heat fluxes is a difficult quantity to measure and the effects on precipitation are unclear (e.g., moisture recycling).

Line 51 “The date of monsoon onset is also region-dependent; in northern South-America convection is observed from early October, whereas convection in southeastern Brazil typically starts in mid-November or later (Marengo et al., 2001; Nieto-Ferreira and Rickenbach, 2011).”

You probably want to clarify this. Do you mean deep convection and the associated rainy season? In the Central Amazon region, the rainy season begins late December and lasts until about April. Typically, in October, there may be intense deep convective events in the Central Amazon (see Adams et al 2013), but in terms of convective precipitation, January through April are very rainy (see Machado et al. 2004). How well models actually reproduce the geographic distribution of Amazon Basin rainfall is an important issue, you may want to discuss with a little more detail and citations.

Line 69 You should probably clarify what hemisphere you mean here when you say “fall”.

Line 73 “The next efforts to improve climate models include increased horizontal resolution, ...” This drive towards increased horizontal resolution is quite strong, down to the kilometer resolution for GCMs, you should refer to some of the literature I mention in the Major Comments section.

Line 83 “The study documents the main biases in the simulated climate of UKESM1 and HadGEM3.0 and compares the effect of increased horizontal resolution and Earth System processes on the representation of the AMS climate. The analysis provides a framework for using these climate models in scenario studies, to highlight possible sources of model error that may be corrected and to further understand variability and teleconnections in this region.”

Line 98 “GPCP, GPCC and CHIRPS are also used for their longer period, although arguably each of these datasets have shortcomings in either resolution or spatial coverage.”

You should probably include a few citation of studies that have used these data in similar context for the reader to consider, particularly studies where the shortcomings are discussed.

Line 113 “piControl”, I assume you mean pre-industrial, but you should spell it out for the reader.

Line 190 “Afterwards, the ITCZ migrates northward reaching a peak latitude and mean rainfall at 10 ° N by day 250, or May 30.” I think you have made a mistake here, you probably mean early September.

Line 213 Write “Negative  $\omega$  and low-level moisture biases in the central and East Pacific Ocean ...”

Line 221 “These are observed as negative zonal wind biases, indicative of significantly weaker upper-level westerlies resulting from the overturning circulation in the Pacific Ocean.”

This statement is a bit confusing, it sounds as if you are referring to the oceanic circulation within the Pacific Ocean.

Line 280 Rewrite using commas “The models also show a good representation of the transition from winter to summertime rainfall by representing, with relative skill, the smooth transition from 4 mm day<sup>-1</sup> in September to 6 mm day<sup>-1</sup> in November and close to 8 mm day<sup>-1</sup> in late December.”

Line 290 “these quantities characterise the strength and height of deep convection and the mid-level moisture.” This idea is a little unclear, what you do mean “the mid-level moisture”? Specific humidity has a vertical distribution associated with instability and convection. And OLR for convective cloudiness would be associated with high levels in the atmosphere.

Line 319 Check spelling “although”

## References

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