

Clim. Past Discuss., referee comment RC2
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Comment on cp-2021-164

Anonymous Referee #2

Referee comment on "Seasonal aridity in the Indo-Pacific Warm Pool during the Late Glacial driven by El Niño-like conditions" by Petter L. Hällberg et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-164-RC2>, 2022

Review of Hallberg et al.

Overall, I like the concept of the manuscript: describing seasonal changes in western tropical precipitation during the Younger Dryas climate event. However, I cannot accept the manuscript in its current form, and I suggest major revisions to the manuscript. The primary cause for the revision is to clearly separate which forcings are responsible for differences between the Younger Dryas state and Pre-Industrial (PI).

In the intro (paragraph on lines 49-55): the jury is still out as to how ENSO changed during the glacial times, including during the deglaciation. This paragraph and the paper should depict the current state of ENSO research. Reviewer #1 provides many important references.

The major issue: by comparing 12 ka to PI, the authors are conflating several different forcings that could drive the precipitation changes, such that it is not clear if the conclusions hold as presented. The summary of the difference in forcings between 12 ka (Younger Dryas) and 0 ka are:

- Precession of the equinoxes.
- Sea Level changes and the presence of large ice sheets on land
- Freshwater forcing reducing AMOC

To separate the forcings, and hence attribute what is causing the differences between the paleo and PI runs, the authors should compare different timeslices, in addition to the 12 ka and 0 ka.

- Usually the early Holocene (~10 ka) or the mid-Holocene (~6 ka) compared to 0 ka is used to identify changes forced by precession of the equinoxes, like in the PMIP protocol. This is *especially important when considering changes in the seasonal cycle, as precession has little effect on mean annual changes in insolation, but instead causes very large impacts on the seasonal distribution of insolation (e.g. Huybers, Science, 2006 or Huybers, QSR, 2007). The insolation changes in turn lead to changes in precipitation. Therefore, the authors need to make major changes to the manuscript, as the seasonal cycle is a major point of focus for this manuscript.
- Comparing the time interval just before the Younger Dryas, i.e. the Bølling–Allerød interstadial (BA) at 13-14 ka, with 0 ka will address both orbital changes and sea level/ice sheets. By then using the 10 ka run, which addresses precession only, and the ~13 ka run, one can isolate the climate effects due to sea level and ice sheets.
- Comparing the run during the BA with the YD will isolate the climate effects due to AMOC changes.

I am not suggesting to do any additional runs, such as 10 ka. Rather, present what runs have been completed, and present the output accordingly. Schenk, et al., *Nature Comm.*, 2018, ran the BA interval. So that should be readily available to the authors. The 0, 12, and 13 ka runs should be used to better describe which forcings are driving the seasonal changes in precipitation of the western tropical Pacific.

Plot the coast lines in Figure 3-7 using the boundary conditions in the model, not modern observations of coastlines or bathymetry. This greatly facilitates the interpretation of the precipitation signals. One should look at where the model has land – not the actual planet.

If you want to use the term “El Niño like” to describe the mean state, one should include changes in the thermocline and sea surface salinity (Di Nezio, *Paleo.*, 2011). Sea surface temperatures alone are not sufficient to describe the mean state when discussing changes in ENSO. Furthermore, what is the ENSO signal in the runs? 150 years is not adequate enough to converge on the median of the ENSO response (Lawman, et al., *Science Adv.*, 2022), but it would be nice to see how the Niño 3.4 SSTA at 12 and 13 ka responds in CESM1, as it has a realistic ENSO.

Please update the Borneo record to use the recently published version (Buckingham, et al., *GRL*, 2022). It has a clear YD signal. I realize that this manuscript was submitted before the *GRL* manuscript was published. This is not to penalize, but rather to update, this manuscript. Also, the interpretations in that manuscript may help strengthen this manuscript.