Climate of the Past Discussions

Clim. Past Discuss., referee comment RC1
https://doi.org/10.5194/cp-2021-164-RC1, 2022

Comment on cp-2021-164

Anonymous Referee #1

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-RC1, 2022

The article by Hällberg et al. presents an interesting and well thought study of seasonal variability of rainfall and climate over the last deglaciation in the Island South-East Asia (ISEA) region. The authors focus on how rainfall has changed regionally above the main landmass, that have themselves considerably been reshaped and shrinked along the deglacial eustatic sea level rise, and compare their transient model output with landmark paleoclimate (speleothem) reconstructions from different localities in the indonesian archipelago. They detail, in particular, the seasonality which seems to have been greater at 12 ka as compared to nowadays, and manifest as the development of a dry austral summer dry period in the southernmost part of the ISEA. They discuss their results in light of peat deposits that started accumulating during the Holocene, leading to a potential savanna corridor connecting the main islands of Indonesia and plains in the Sunda and Sahul shelves prior to their exundation.

The analysis is nice, and I believe it should be published after some corrections that may be easy to deal with but could improve the manuscript, as detailed below.

First, the PI temp and precip patterns should be compared to modern data in Figure 3 or elsewhere, to highlight the ability of the model to reproduce local-scale climate variability, and even perhaps at seasonal and interannual timescales. The model seems to perform well, but rainfall seasonal and interannual variability at equatorial latitudes is, I think, notoriously challenging to reproduce with fully coupled GCMs. The authors should do better to convince the reader that the model is able to reproduce with a decent precision and accuracy at least the modern climate variability prior to inferring the transient evolution of past regional rainfall in such a complex environmental setting, with coastlines constantly varying. I think you may also want to discuss in greater details the large-scale outputs of PMIP4 outputs to highlight such point: those recent results indicate extreme variability in LGM rainfall model output scattering in the ISEA region (Kageyama et al., 2021, their figure 6 is particularly instructive).

I also think that some important data available should be cited and discussed as follows:

- On ENSO, you cite Clement, Koutavas and Sadekov to suggest that ENSO was enhanced durng the LGM, without discussing the contrasting results of Leduc et al., 2009, Ford et al., 2015 and Liu et al., 2017 that point to a reduced ENSO variability during the LGM. Those results that demonstrate that the LGM ENSO state is still debated should be explicitely discussed along with the Clement, Koutavas and Sadekov articles.

-I wonder why you choose to not discuss leaf wax isotopes (the Niedermeier and Konecky papers), other speleothem records (Griffiths), etc. without attempting to highlight them in Figure 2, as you've done for the tree other speleothem records. Also, the original paper evidencing a dry and open vegetation during the LGM at the Konecky site is Russel et al., 2014, and should also be cited, as dD interpretation is puzzling at this site as evidenced in Konecky.

-I also think you should better discuss what has happened at 12 ka in more details in the data as long as you opt for focusing on that time period. The results obtained in the simulation does not always fit to the data you highlight in Figure 2 for that time period, and there is a kind of overshoot in precip seasonality after 12 ka, when then YD resumed. I understand you can't describe everything in its full complexity but your statements for the 12 ka in particular are not always met in reconstructions, and a lot happens before and after 12 ka in both data and climate simulation, as shown in Figure 2.

Some other minor details:

-Fig 5b & d, I don’t really see stronger vs weaker trade winds in the lower branch of the Hadley cell in panels a and c, but rather an eastward displacement of the convection site above the western Pacific at 12 ka WRT nowadays

-Still on Figure 5, the situation shown in panel c looks quite like the LGM situation as seen in Holstein et al., 2018 (their figure S6), it is interesting to note that the LGM and YD have the same effect on the convective cell displacement during those two contrasting yet cold time periods

-You state in the discussion and the conclusion that the deglacial interval « resembles to ENSO », but you show only variability and seasonal features. Is it possible to differentiate variability in rainfall that occurred at interannual timescale ? The article by Liu et al., 2014, may help.

Ford, H. L., Ravelo, A. C., & Polissar, P. J. (2015). Reduced El Niño–Southern oscillation during the last glacial maximum. *Science*, *347*(6219), 255-258.

Hollstein, M., Mohtadi, M., Rosenthal, Y., Prange, M., Oppo, D. W., Méndez, G. M., ... & Hebbeln, D. (2018). Variations in Western Pacific Warm Pool surface and thermocline conditions over the past 110,000 years: Forcing mechanisms and implications for the glacial Walker circulation. *Quaternary Science Reviews*, *201*, 429-445.

Kageyama, M., Harrison, S. P., Kapsch, M. L., Lofverstrom, M., Lora, J. M., Mikolajewicz, U., ... & Zhu, J. (2021). The PMIP4 Last Glacial Maximum experiments: preliminary results and comparison with the PMIP3 simulations. *Climate of the Past*, *17*(3), 1065-1089.

Leduc, G., Vidal, L., Cartapanis, O., & Bard, E. (2009). Modes of eastern equatorial Pacific thermocline variability: Implications for ENSO dynamics over the last glacial period. *Paleoceanography*, *24*(3).

Liu, Z., Lu, Z., Wen, X., Otto-Bliesner, B. L., Timmermann, A., & Cobb, K. M. (2014). Evolution and forcing mechanisms of El Niño over the past 21,000 years. *Nature*, *515*(7528), 550-553.

Russell, J. M., Vogel, H., Konecky, B. L., Bijaksana, S., Huang, Y., Melles, M., ... & King, J. W. (2014). Glacial forcing of central Indonesian hydroclimate since 60,000 y BP. *Proceedings of the National Academy of Sciences*, *111*(14), 5100-5105.

Zhu, J., Liu, Z., Brady, E., Ottoâ□□Bliesner, B., Zhang, J., Noone, D., ... & Tabor, C. (2017). Reduced ENSO variability at the LGM revealed by an isotopeâ□□enabled Earth system model. *Geophysical Research Letters*, *44*(13), 6984-6992.