Climate of the Past Discussions

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# Comment on cp-2020-162

Anonymous Referee #3

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Referee comment on "Influence of the representation of convection on the mid-Holocene West African Monsoon" by Leonore Jungandreas et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2020-162-RC3, 2021

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Review of "Influence of the representation of convection on the mid-Holocene West African Monsoon"

**Manuscript Summary**

The authors examine the influence of parameterized/resolved convection and model resolution on the simulation of mid-Holocene African climate. The simulation with parameterized convection exhibits greater and more widespread (further north) rainfall over northern Africa. The authors point to an important role of soil moisture and evaporation in driving differences in the parameterized/resolved convection simulations. Specifically, they find that isolated, heavier rain events in the simulation with resolved convection enhance runoff, reducing the amount of water in the soil and ultimately reducing evaporation and moisture recycling.

The manuscript is organized and well written. The hypothesis that heavier rain events reduce the amount of moisture available for recycling is very interesting. I suggest the authors address the following comments to strengthen the manuscript.

**Suggested Revisions**

1)

Your closing point in the Discussion about the potential influence of plants on the results is a major one. You should make this point earlier in the manuscript. Perhaps you could end

Section 2.1 with a sentence or two about this. I also suggest highlighting the potentially important influence of proper vegetation-soil moisture interactions when comparing parameterized versus resolved-convection simulations in the Abstract.

2)

The mid-Holocene simulation does not exhibit precipitation amounts that match those estimated from proxies (the simulation is too dry). This should be noted, and the implications of this for the interpretation of your results should be discussed.

3)

At line 105 you note:

“To test the importance of the timing of the diurnal cycle for the representation of the monsoon propagation during the mid-Holocene, we perform a second set of nested simulations where we modify the timing of the diurnal cycle in the simulation with parametrization convection.”

From that description, it doesn’t appear you modified the diurnal cycle in the resolved convection simulation. However, in Figure 3b, the 5km-E simulation has different precipitation values from the 5km-E simulation in panel (a).

4)

How is runoff calculated in Figure 9? At line 333-334 you mention that the runoff is “surface runoff”. Is subsurface runoff not included?  If you are currently only showing surface runoff, you should also include a figure of total runoff.

5)

At lines260 and 332 you note:

“The lower soil moisture in the 5km-E simulation is due to higher amounts of surface runoff”

“The higher evapotranspiration rate is due to a higher soil moisture content throughout the whole simulation period. This is due to much weaker surface runoff in the 40 km-P than in the 5 km-E simulation”.

I’m not sure you can attribute the soil moisture differences solely to the runoff differences. The greater precipitation in 40km-P likely contributes to greater soil moisture. Additionally, the heavier rainfall in the 5km-E simulation may promote more infiltration, and that may also explain why the soil moisture in the top layer is reduced in 5km-E. Does the soil moisture content for the entire soil column also differ between the simulations? I recommend showing this.

6)

In lines 334 – 336, you note:
“In the 40 km-P simulation, light drizzle moistens the upper soil layers constantly, which makes it easier to trigger convection and to produce precipitation.”

Can you provide some discussion about this? Is this true of all convective schemes or just the Tiedtke scheme? Has drizzle been shown to influence subsequent convection in the real world? A citation or two here would be helpful.

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From Figure 5, it is apparent that the African Easterly Jet is weaker in the 5km-E simulation. This may have a few effects on precipitation in the simulation. One, a weaker AEJ should result in less moisture export from the continent (e.g., Cook 1999), keeping the atmosphere more humid in the Sahel in the 5km-E simulation. Two, it could result in weaker African Easterly Waves (AEW) through reduced baroclinic and barotropic energy conversions. Though it is hard to say without doing an AEW analysis, it is possible that weaker AEWs result in fewer precipitation events in the 5km-E simulation.

Cook, K. H. (1999). Generation of the African Easterly Jet and Its Role in Determining West African Precipitation, *Journal of Climate*, *12*(5), 1165-1184.

8)

In addition to the Skew-T diagrams in Figure 6, could you also present summer-average values of CIN, CAPE, etc. at 12UTC? These could be in a table. It seems a bit arbitrary to select a single day to demonstrate the differences between the simulations. By showing that these differences are consistent across the summer, your results will be more robust.