Reply to Comments of Referee 3 to the Manuscript of Jungandreas et al. "How does the explicit treatment of convection alter the precipitation-soil hydrology interaction in the Holocene African humid period?"

Thank you very much for your valuable comments!

Main comments:

* At 5 km there is explicit convection but it may be more accurately named convection-permitting rather than explicit convection or storm-resolving.

There is a long debate in the literature of how to call this type of simulations. We follow the more recent view that what such type of simulations do is to resolve storms, as, as noted by the reviewer, they do not resolve the whole spectrum of convection. In the revised version we will consistently use storm-resolving.

* One of the major conclusions here is that the intensity of precipitation events is very different between the E and P models. This difference is shown to modify the soil moisture and hence the land-atmosphere feedbacks. One thing that is missing is any analysis of how this intensity distribution of precipitation events actually differs between the E and P models. I realise that it has already been shown in the previous work but it might help to include this here also.

We will add a similar figure in the Appendix.

* Related to this, many convection-permitting models overestimate the intensity of rainfall events (e.g. Kendon et al (2021, doi: /10.1098/rsta.2019.0547) because they do not resolve all convection at this resolution. The land-atmosphere feedbacks are dependent on this intensity, so can you comment on this potential caveat? Does ICON overestimate these downpours? More speculatively, would more-fully resolving convection (e.g. down to sub-kilometre scale resolution) address this, or could it sbring to light other effects not considered?

Figure 6 in Stevens et al. (2020) shows pdf of rain intensity for simulations conducted with a grid spacing of 312 m, 625 m and 2.5 km over the tropical Atlantic and for simulations conducted with a grid spacing of 625 m and 2.8 km over Germany. Over the tropical Atlantic, there is a clear dependency with resolution with much more frequent downpours at coarse resolution, whereas this effect is not present over Germany. Using the same model version as the one used in this study, Paccini (2021, https://pure.mpg.de/rest/items/item_3367420_4/component/file_3367464/content) investigated the representation of the pdf of rainfall intensity over Amazon, see her Fig. C3. There we can see that ICON with 5-km grid spacing matches very well observations. Hence, although we cannot prove it as the outset, we believe that this effect might be small in ICON. We will add these considerations in the revised version.

Minor points:

Page 7, line 147-156 and point 2: It's not clear what is meant here by the 75th and 85th percentile values? What are these used for? This explanation does not make sense to me.

We modified the vegetation cover in the GS simulations. To be consistent we also need to modify different parameters in the external parameters that are related to vegetation cover, e.g., surface roughness, LAI, NDVI,… . To prescribe reasonable values for these parameters in the GS simulations, we calculate mean or percentile values from all grid points of present-day vegetation cover of a specific vegetation type. For each parameter, we decided which value - mean, 75th or 85th percentile – are most reliable based on the present-day maps.
We will clarify this point in the revised version of the manuscript.

The fact that the overall precipitation response is not wildly different between the explicit and parametrised convection agrees with studies of future precipitation change in Africa, e.g. Kendon et al (2019, doi: 10.1038/s41467-019-09776-9). It might be worth citing that study here.

We will cite it in the revised manuscript.

Technical corrections:

Appendix: Please can you add the full descriptions of what each figure shows to the captions in the Appendix figures as well as writing "as in figure x". Otherwise the reader has to switch between the main text and the Appendix to understand what each figure shows.

Page 7, line 150: "Ee" should be "We".

Table 1: This values would be better at 1 decimal place. Adding an anomaly column GS - DS would be helpful.

Line 204 "Africa thus influences" -> "Africa and thus influences".

Line 366: "Also how the land surface (soil moisture and runoff) reacts to specific precipitation characteristics (drizzle or shower) needs"

-> "How the land surface (soil moisture and runoff) reacts to specific precipitation characteristics (drizzle or shower) also needs"

Line 377: "This study highlights the importance to consider..."

-> "This study highlights the importance of considering...", or similar.

The technical corrections will be implemented in the revised manuscript.