Response to Reviewer 1

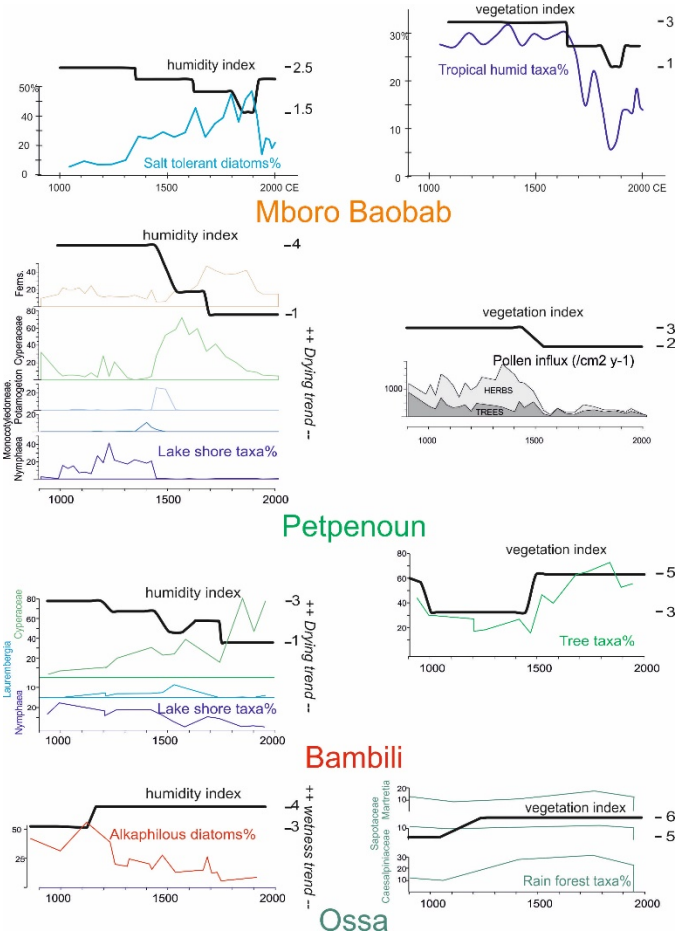
The manuscript presented by Lézine et al deal with the climate changes experienced in tropical West Africa during the last millennia. The manuscript first makes use of a number of paleo-records in the study area to define two new indices able to quantify the hydrological and vegetation context. The goodness of these paleo records is first evaluated by computing two multi-proxy indices which are validated against instrumental data for the period 1840-present with good results. Then, the authors make use of modelled data (from 850 to 1850) to characterise the precipitation in pre-instrumental period, subsequently discussing the relation between the modelled climate and the observed variability of the paleo-records, offering an interesting discussion and relevant results.

The 1erforme well written and in general it is clear. Personally, I find this work quite interesting, as it deals with a region still poorly characterised because of the sparsity of instrumental or even proxy records. Therefore, I recommend its publication in Climate of the Past.

I however have some concerns (general comments) that, if addressed, will probably improve the clarity of the manuscript :

The most important is related with the methodology used to homogenize the paleo data in section 2.1. As far as I understand, the method 1erform based on rescaling each individual paleo record (table 1) to a common 6-level scale. However, the details of this conversion are not explained in the manuscript making it impossible to know how this index is ultimately computed (this is essential at the time of evaluating the goodness of the original data or even to allow reproducibility). In my opinion, the authors should describe a little more the way this rescaling has been performed.

This paper is based on a *qualitative* description of regional environmental and climate conditions. As is now shown in the supplementary figure (see below), the index synthesizes data from different proxies types (e.g. pollen percentages or influxes, diatom percentages…) from which the main features indicative of aridity are extracted based on a step-scale.
The supplementary figure shows that we relied on proxy such as salt-tolerant diatoms concentration (at Mboro site) which allows identifying the development of aridity based on the salinity levels of lake waters. We also relied on several pollen taxa (such as at Petpenoun), where the development of aridity is deduced with the transition from plants typical of open water (Nymphaea) to plants typical of lake edge (ferns).
The purpose of these step-scale indexes is to homogenise the information provided by the heterogeneous and complex original data sets. The step-scale is built to capture the major transitions to allow distinguish the signal from the noise.
The figure illustrates the method with an example from each of the major vegetation zones considered in the paper: the sahel (Mboro Baobab), the savanna zone (Petpenoun), the mountain forest (Bambili) and the lowland evergreen forest (Ossa). The index is drawn manually from original data.



Supplementary figure

Another question is related to the reason why the authors have limited their study period to 850-1850. I'm not familiarised with the past1000 experiment data but ending in 1850 most probably indicates that the past1000 experiment was conceived to model the pre-industrial era. However, if possible, 2erform be extremely interesting that the modelled precipitation series were extended to present time. This would allow to compare the model results with the instrumental ASWI (figure 2 of the manuscript) and, providing the result is good, it would add a lot of confidence to the results. Anyway, I would like to stress that I find figure 2 very interesting as, beyond some indirect evidence, the humid period described by the ASWI between 1840-1890 had not be confirmed by independent data up to now.

We restricted our model-data comparison to the pre-industrial past1000 period as the transition between the past1000 and the historical period since 1850 marks a large change in the signal-to-noise ratio between the magnitude of the external forcing and the internal variability. Any model-data comparison allowing the validation ASWI index and the model skills over the historical period would require a different strategy. A previous study by Villamayor et al, 2018 relying on an ensemble of experiments with the atmospheric component of the IPSL coupled model with imposed observed sea surface temperatures has indeed shown a good consistency with the ASWI index regarding the late nineteenth-Century

Sahel humid period suggesting that sea surface temperatures in the Atlantic basin played the dominant role (https://doi.org/10.1175/JCLI-D-18-0148.1).

It is also worth mentioning that coupled ocean-atmosphere models display however large uncertainties over the historical period related to the emergence of anthropogenic forcing (GHG, tropospheric aerosols, land-use changes). Previous work attributes this uneven CMIP6 model response to anthropogenic forcing to dynamical changes (Phal et al. 2017) linked to the Northern Hemisphere and tropical Sea Surface Temperatures, identified as important sources of uncertainty for the simulated Sahel rainfall over the historical period (Park et al. 2015; Zhang and Li 2022).

Apart of these questions, there are some minor aspects that could help to clarify the text (specific comments) :

Lines 31-32. The west African monsoon is not only driven by land-sea contrast, but it is also a consequence of the migration of the ITCZ (see for example Gagdil et al. https://doi.org/10.1007/s12040-017-0916-x).

We agree with the reviewer as we show in our study that the ITCZ migration is a key mechanism driving the West African monsoon variability over the last millennium. We corrected the sentence and added the suggested reference on lines 31-33 of the revised manuscript.

Line 50. I consider that this manuscript is not a "review" but a "research".

corrected

Table 1 : Maybe expressing the latitude and longitude in sexagesimal form will be clearer.

The latitude and longitude are expressed in decimal form in most of the international databases and geographic information systems.

Line 97 : In my view, the validation performed is not indicating that the methodology is "realistic" but instead, it is testing the similarities between the paleo-data and the instrumental ASWI.

corrected

Figure 1. The blue arrows are a little difficult to see where the underlying colour is also blue.

Redrawn in dark grey

Line 180. I believe that the way the past1000 index is constructed should be more explained.

Following this suggestion, we have made an effort to simplify and clarify the methodology employed to calculate the past1000 index of Sahel precipitation. Please note the changes in the revised manuscript in lines 239-250:

"Then, to characterize the simulated Sahel rainfall multidecadal variability over the past millennium and contrast to the reconstructed environmental series, an index is performed as the 10-year low-pass-filtered Sahel precipitation anomalies in the rainy season from past1000 simulations. Seasonal precipitation anomalies from July to September (JAS), relatives to the piControl climatology, are area-weighted and averaged across the Sahel region (red box in Fig. 3A), then filtered with a 10-year moving mean. An ensemble-mean index is also performed to highlight the forced component of the Sahel multidecadal variability in response to natural forcings that are common to the three past1000 members, such as the effect of large volcanic eruptions, in contrast to the internal variability."

Figure 4. I'm sure that presenting such amount of series in a single figure is not easy, but it is quite difficult to interpret some of the y-axis scales in this figure. For example (not the only case) in figure 4A "Jikaryia" the axis is scaled by not consecutive values (3, 1.5, 2 , 0.5). Please clarify.

corrected

Line 326. Please indicate the methodology used to compute statistical significance.

Please note the correction in the caption of Figure 6 in the revised version of the manuscript: "Stippling indicates full agreement across the three past1000 members on the sign of the represented difference."

Line 352. The local term "Heug" could be unknown by readers not familiarised with the climate of this region. Please explain.

done