Reply on RC1

General comments

Review of "Changes in precipitation and temperature patterns related to the state of the North Atlantic Ocean during the Medieval Climate Anomaly" (cp-2024-68)

In this paper the authors are interested in temperature and hydroclimate of the MCA and compare a range of proxy data sources with a paleoclimate data assimilation product and a model simulation. In general I think the paper does a decent job of accomplishing the stated goals and the conclusions are in line with the somewhat ambiguous and somewhat conflicting results of the underlying data.

We thank the reviewer for a constructive and positive review. We have addressed the issues raised and provide more detailed responses in the following. In particular, we acknowledge the lack of clarity in some parts of our manuscript and have amended it accordingly.

Other comments

1. PaleoView data source: This source appears to just be a way of accessing the TRaCE21ka simulation? Some places in the paper the authors appear to categorize it as a data assimilation product like PHYDA (e.g., lines 270-271) but that is not accurate. They authors need to make it more clear that PaleoView is the TRaCE21ka simulation data alone and is not modified by proxy data in the same way that PHYDA is.

We agree that PaleoView provides access to the TRaCE-21ka transient simulation data and is not a data assimilation product. In the revised manuscript, we have clarified this distinction in the Data and Methods section (lines 160-165) and corrected the relevant statements in the Results and Discussion section. Specifically, we have removed any language that may have implied PaleoView involves data assimilation or is analogous to PHYDA. We now explicitly state that PaleoView represents a purely model-based simulation.

2. Reference to "grid" values throughout the text: I recommend using something like "continental average" (or perhaps some abbreviation indicating regional average) to indicate that this is a regional averaged value. Calling it "grid" is a little strange or unclear what is meant if you are also using "point" estimates because the terms grids and points are often used interchangeably or are at least closely related.

In our study, the term 'grid' was originally used to denote a continental average. However, we have revised the manuscript to clarify the ambiguous use of the term "grid" by employing more precise wording. Specifically, we now state that grid-scale outputs reflect spatially averaged conditions across the entire continent, while point-scale outputs represent values extracted at the exact locations of proxy data collection sites (lines 307-309).

3. Hydroclimate variables: I'm confused as to why the authors used the variable label "P-E" throughout the comparisons between proxy, model, and reconstructed data. Having some proxies be approximately P-E is plausible enough but then the TRaCE21ka data is just temperature or precipitation (so missing E) and PHYDA is PDSI, which is much more complicated than P-E. I think the authors should indicate in Figs 8,9, Table 1 that these values are not actually P-E. This may also account for some of the discrepancies that the authors see in their analyses between the data sources.

We agree that using the term 'P-E' universally could be misleading. To address this concern, we have revised the terminology throughout the manuscript and in the section focusing on comparisons between proxy- and model-derived outcomes, including the labels and captions in Figures 8 and 9 and in Table 1, to clearly indicate the specific variable used in each case. These revisions now reflect the appropriate hydroclimate metric: P-E for the proxy-based records, PDSI for the PHYDA data, and precipitation for the PaleoView simulations. In Table 1, we have adopted the term 'hydroclimate indicator' to refer collectively to these three variables (i.e., P-E, PDSI, and precipitation). The table

caption has also been updated to clarify that this term represents distinct metrics-each serving as a proxy for hydroclimatic state.

4. ITCZ: So the ITCZ is a deep-tropical phenomena yet very little proxy data analyzed here is from the tropics. It was unclear to me how it was justified and used to be an indicator of the ITCZ? Also I noticed that the authors frequently use ITCZ for assessing North Atlantic variability. I don't think this makes sense given that the ITCZ and North Atlantic are dynamically and geographically separate things.

We acknowledge that the ITCZ is inherently a tropical phenomenon. In this study, our objective is to investigate its latitudinal shifts (northward or southward) in response to North Atlantic variability, particularly changes in AMOC and SSTs. We have revised the manuscript to clarify that the ITCZ is used as a response indicator rather than a driver of North Atlantic variability. Given the absence of direct records of past ITCZ shifts, we employ δ^{18}O values from stalagmites as a proxy for reconstructing ITCZ variability, following the methodology of Tan et al. [2019] and Chawchai et al. [2021]. Our study is the first to compile more than two ITCZ indicators, specifically, 11 δ^{18}O records from sites in the Northern Hemisphere and 5 from the Southern Hemisphere, all located within the present migration range of the ITCZ across both hemispheres. This spatial framework allows us to estimate hemispheric shifts in the ITCZ and examine their relationship to North Atlantic climate conditions. We have revised the manuscript to clarify this methodological justification and the role of the ITCZ in our study.

References

Chawchai S, Tan L, Löwemark L, Wang HC, Yu TL, Chung YC, Mii HS, Liu G, Blaauw M, Gong SY, et al. (2021) Hydroclimate variability of central indo-pacific region during the holocene. Quaternary Science Reviews 253:106779

Tan L, Shen CC, Löwemark L, Chawchai S, Edwards RL, Cai Y, Breitenbach SF, Cheng H, Chou YC, Duerrast H, et al. (2019) Rainfall variations in central indo-pacific over the past 2,700 y. Proceedings of the national academy of sciences 116(35):17201–17206