Reply on RC2

General comments

In this manuscript Pratap and co-authors seek to explore variations in temperature, hydroclimate and ocean circulation, primarily in the north Atlantic during the middle portion of the Common Era. This is achieved through the synthesis of previously-published records and their comparison to a data assimilation product (PHYDA) and a CCSM3 simulation spanning the past 21,000 years (accessed via PaleoView). The focus on the time from 800-1400 C.E., during the so-called Medieval Climate Anomaly, arguing that it is warm climate.

I am generally supportive of synthesis efforts and data-model comparison efforts. Every source of paleoclimate data has it's strengths and weaknesses, and combining them can often amplify mutual signals and minimize noise. However, the value of such syntheses should be to yield new insight and I find that Pratap and co-authors do not successfully achieve this. While I find no fatal flaws in their analyses, I also do not see that this study brings much new insight to the community. Given that other synthesis studies exist using similar data (e.g Moffa-Sanchez et al., 2019; https://doi.org/10.1029/2018PA003508), the authors do not make a clear case for what this study adds. Many conclusions seem either fairly well established (e.g. warm SST corresponds with warm continental temperature, cool SST drives the ITCZ southward, etc.) or are ambiguous (e.g. "the sensitivity of AMOC tracers across both space and time require further investigation"). Thus, I suggest the authors either more clearly articulate how their work advances understanding relative to previous synthesis studies or hold off on publication until they have a result that does advance knowledge.

We thanks the reviewer for thoughtful evaluation and for acknowledging the robustness of our analyses. While we understand your concern regarding the study's novelty, we would like to highlight several aspects that we believe make our work a valuable contribution to the community. Our study provides a comprehensive centennial-scale comparison of hydroclimate variability during the MCA across both Europe and North America, integrating multiple proxies and model-derived outcomes (i.e., from both assimilated and simulated sources). This dual approach offers a novel spatial perspective, as we examine hydroclimate patterns at both regional and continental scales– a matter of ongoing scientific investigation. By evaluating hydroclimatic coherence across these spatial scales, we offer insights into MCA variability that may inform understanding of present and future hydroclimate variability and oceanic changes under warm climate conditions. Specially, the relationship we observe between temperature and precipitation during a warm climatic phase provides further insight, particularly in the context of ongoing and projected global warming.

Additionally, our findings suggest a possible link between megadrought conditions in North America and southward shifts of the ITCZ, likely driven by low North Atlantic SSTs and weakened AMOC phases. This connection contributes to the limited but growing body of evidence on how ocean-atmosphere interactions influence terrestrial hydroclimate over centennial timescales. We emphasize how North Atlantic variability (i.e., SST and AMOC changes) under warm conditions may affect hydroclimate distributions across tropical and subtropical regions; an aspect that remains underexplored in MCA studies. Finally, our investigation into the combined influence of North Atlantic variability and ITCZ shifts on terrestrial hydroclimate helps disentangle their relative roles. This focus and effort to trace possible teleconnections provide new perspectives on the broader climatic mechanisms shaping hydroclimate variability during a known warm period, with implications for future climate scenarios.

Unlike prior studies such as Moffa-Sánchez et al. (2019), which focus primarily on variability in the northern North Atlantic and Arctic Oceans, our study conducts a coordinated centennial-scale synthesis of hydroclimate patterns across both Europe and North America and examines their links to North Atlantic variability. This cross-continental approach enables comparative insights into spatio-temporal variability. Second, we conducted a model–proxy evaluation, distinguishing between point-scale and grid-scale (continental average) model outputs to better align model resolution with the spatial distribution of proxy data. This approach reveals how spatial aggregation can mask important local variability. Third, we incorporate a δ^{18}O-based ITCZ reconstruction using records from both hemispheres to examine its relationship with SST and AMOC changes and its influence on regional hydroclimate patterns. 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 situated within the present migration range of the ITCZ. This hemispheric framework allows us to estimate ITCZ shifts, evaluate their connection to North Atlantic climate variability, and assess their influence on both regional and continental-scale hydroclimate patterns. Fourth, we interpret our findings in the context of warm climate conditions, framing the MCA as a partial analog for current and future warming. For instance, we show that warm periods during the MCA correspond to arid conditions in parts of North America, offering insights into potential hydroclimate responses under modern warming scenarios. Lastly, our study identifies regionally distinct temperature-precipitation associations and highlights spatial mismatches between model outputs and proxies-refinements that may guide future model development and calibration.

To articulate in a more clear way how our work advances understanding relative to previous studies within the revised manuscript, we summarized the above points to the following paragraph that has been introduced at lines 91 to 113 of the introduction.

A more specific concern regards how the authors approach the PHYDA data at its comparison to their work. The authors state that PHYDA is included to "assess the reliability of model-based paleoclimate outputs," and I fear they may be interpreting PHYDA as a model. Consistent with this, they suggest that poor correlations between their data and PHYDA highlight "the need for improvements in model performance." Rather, PHYDA is a data assimilation product that likely includes many of the same datasets considered by Pratap et al, but arguably synthesizes these data in a more sophisticated and physically-realistic way.

We agree with the reviewer's point that PHYDA is a data assimilation product, not a standalone climate model. We appreciate the reminder that it likely includes many of the same datasets as our proxy compilation and that its design reflects a more physically informed synthesis approach. Our previous phrasing may have unintentionally implied that PHYDA is a pure model output or that discrepancies with it reflect deficiencies in model performance. In the revised manuscript, we now clearly describe PHYDA as a paleoclimate reconstruction that integrates proxy data with climate model priors using a data assimilation framework. Clarifications have been made in both the Data and Methods (lines 157–165) and Results (lines 305–325) sections to ensure an accurate representation of PHYDA role and to avoid misinterpretation.