**5. Conclusions**

To investigate hydroclimate during the Holocene, a new multi-proxy dataset was compiled to characterize qualitative changes in terrestrial precipitation amount and effective moisture. Regional compilations indicate a coherent spatiotemporal pattern among and between the tropics and extra-tropics over the past 12ka (Figure #TBD). Evidence from individual proxy records sensitive to circulation dynamics and simulations from model models suggest that the primary driver of these observed hydroclimatic shifts is a first order response caused by shifting insolation and temperature. As a result, long-term millennial-scale trends drove major hydroclimate transitions which exceeded centennial-scale variability, and many areas experienced significant differences in regional hydroclimate during the early-Holocene relative to the last millennium, and.

Comparisons between proxy and model results demonstrate relatively similar overall patterns of Holocene hydroclimate evolution. In general, agreement among and between observations and models is highest in monsoon regions where larger magnitudes of change and a more direct climate forcing overcome local variability and uncertainty. In the mid-latitudes, the direction of change is less clear. Most notable among these disagreements is the aridity identified by proxy records in Western and Eastern North America during the early and mid-Holocene when model simulations almost uniformly show wetter conditions in these regions. At high latitudes, both proxy and model data indicate a strong positive covariance of moisture availability and temperature, consistent with theory and projections for increased precipitation in these regions with continued future warming (Bintanja and Selten, 2014; McCrystall et al., 2021).

Despite the challenges of quantifying hydroclimate variability (Williams et al., 20210; Shepherd, 2014; Cheng et al., 2021), within many regions there is better qualitative consensus between proxy and model reconstructions than there is for temperature comparisons. For assessing transient trends, proxy-model hydroclimate agreement is partially attributable to the greater dissimilarity between models of simulated effective moisture as compared to temperature; the lack of model agreement means that at least one model is likely to match the proxy composites. However, including CMIP simulations of 6ka show that the result of greater proxy-model transient first order agreement for hydroclimate is robust with a larger sample of ensemble members. This conclusion is somewhat surprising, as temperature changes are more spatially uniform than hydroclimate; however, the consistent disagreement between proxy and simulated Holocene temperatures has been well-described and consistently observed. Therefore, the better proxy-model agreement with Holocene hydroclimate than temperature indicates a systematic bias driving the Holocene Temperature Conundrum which is not apparent in the hydroclimate comparison for which there is greater uncertainty among paleoclimate data but also a more coherent spatial pattern between proxies and models.

Because polar amplification is a key feature of both mid-Holocene and modern anthropogenic warming, the mid-Holocene, when the Arctic was warm, the LTG was reduced, and ice-sheet extents were minimal, may serve as a partial analog for future changes in hydroclimate. Results presented here demonstrate that such hemispheric warming in the past had global implications for atmospheric circulation and moisture dynamics including an expanded and intensified monsoon domain corresponding with greater aridity for mid-latitudes regions in the Northern Hemisphere. Unlike, the Holocene when variations in radiative forcing were asymmetrical across northern and southern latitudes and seasons, future warming is projected to be global meaning that similar changes may occur over both hemispheres.

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**Figure #TBD. Example (from a different publication) potential new figure for the conclusion which was suggest by Darrell. I would create a modified version more applicable to my results. I also think including a figure like this in the conclusion could make my Fig1 conceptual diagram in the introduction unnecessary**