

## ***Interactive comment on “Climatic history of the northeastern United States during the past 3000 years” by Jennifer R. Marlon et al.***

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Referee #2 requests a general revision of sections 3.3. and 3.4 to improve the clarity and understanding of the data interpretation. We appreciate this feedback and agree that some restructuring of the text would be helpful. Currently, we describe the oldest features in the temperature and hydroclimate data, and move towards present, instead of walking through each of the proxies in some kind of priority order. We chose this approach because each of the proxies has different strengths and weaknesses, so in fact we would argue that there is not a natural “priority” as to which is best. In addition, a primary objective of the paper is to understand whether the proxies share common features and signals when considering them all together, which is why we use a chronological framework for interpreting the data. However, we appreciate that our approach is not clearly stated at the beginning of these sections, and thus may

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be confusing. To address this, we will clarify our approach to interpreting the data in sections 3.3 and 3.4. We also agree that grouping model data together will help reduce confusion in these sections, which we note in the specific comments below.

1) Page 3, line 29, I am confused with 'bogs with groundwater-sourced inputs'. Do you mean that the bog is influenced by groundwater?

Yes, we will clarify to say simply groundwater.

2) Page 10, line 13, please rephrase this sentence.

Thank you – we will remove “Newby and colleagues”.

3) Page 16, lines 18-21, it is important to clarify why the two reconstructions have very different trends considering both used the same dataset.

Agreed. We explain this also in our response to Referee #1, reproduced here: The reconstructions by Viau et al. 2006 and Williams et al. 2011 reflect differences in the underlying fossil pollen data, age models, the modern calibration datasets, and the reconstruction method, although the methodological differences are likely the least important factor. Viau et al. 2006 used 752 pollen records and 4590 modern calibration samples. We used 863 pollen records from Williams et al. 2011, which had updated age models based on linear interpolation between age controls (Williams et al. 2004) and 4833 modern calibration samples (Whitmore et al. 2005). Both studies used slightly different versions of the modern analogue technique, which numerically compares the differences in fossil pollen composition of each sediment sample with the composition of each modern sample from a calibration dataset. The environmental characteristics of the most similar modern samples are then averaged and assigned to the target fossil sample (Williams et al. 2008).

4) Page 18, lines 11-12 are confusing and need clarification. It is not the case by visual inspection.

We appreciate this note – this is an error from an earlier iteration of the figure and we

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will update the text to reflect the new figure.

5) Page 20, line 6: Visual inspection did not show that bog water levels were lower at that time.

This is also correct and we will fix this text. The bog data show different patterns than the lake level data during this interval.

6) Figure 1: 'Proxy type' should be proxy type and sites? It is unclear that each of the pollen sites hosts a long-term climate history?

Agreed; we will fix this. We are not certain of the second question here. There is a long history of using pollen records to reconstruct climate, which we describe in the proxy section.

7) Figure 2: What do you mean by "E" in the Figure 2? It needs full name. The same is for Q, and others. Please check on the figure 2 to be sure all the descriptions are correct and complete.

This was indeed missing – E stands for “Evaporation.”

8) Figure 3: it is confusing and somewhat misleading why the temporal resolution (vertical axis) of trees varies from seasonal to 100 years. Please clarify and confirm it. The same question is for modern/Historical instruments.

We will change the y-axis label to say “Temporal climate variability reflected by data type” to clarify.

9) In Figure 4, bot- tom row, right panel: correct 'precipitation' as precipitation. What do you mean by 'NY, MN, and others'? Please provide the full name, and the compared common periods are also needed for clarification.

We will fix these problems.

10) Figure 5: It would be more logical to arrange the simulation curves together. Any-

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way, the curves in Figure 5 need to be re-arranged. The pollen data F, H and I are very different from each other. Which is more reliable? The difference is caused due to regional temperature differences as identified in Figure 6 or different methods or dating uncertainties? More discussion is needed for clarification, rather than just listing them together. I don't know why the G and F figures were arranged reversely. Did the North central and northeastern US simulations correspond to the west and the Atlantic margin in Figure 6 respectively? Liu et al., 2010 did not match with Liu et al. 2009 in the reference list. The Liu et al. 2009 simulation represents a long-term decreasing trend which is similar to most of reconstructions, but it is different from reconstructions in term of on medium-frequency domains. Also, I miss some discussions on driving mechanism in the study region considering that they used the GCM simulation results. To my knowledge, Esper et al. (2012) identified an orbital forcing in tree-ring data in high NH latitudes (to the north of 65 degrees north latitude), but the forcing weakens quickly towards middle- and lower-latitudes. The study region in this manuscript is located in middle latitudes. Perhaps the orbital forcing is not strong or non-existing. Anyway, more discussion is helpful for mechanism hinted for the last 3000 years.

We agree that Figure 5 can be reorganized and explained in a clearer manner, grouping the model output in particular. The pollen data span different spatial scales, and for our domain the curve in panel I is the most reliable because it is specific to the northeastern U.S., and includes more records than the reconstruction in panel H (as explained above). Regarding the north central and northeastern curves distinguished in the model data (panels G and J), yes, these do reflect areas similar to those highlighted by the EOF analysis in Figure 6. We can explain this more clearly in the text, and also correct the Liu et al. citation on the figure (it should be Liu et al. 2009). The mechanism behind the long-term decline in northern hemisphere temperatures observed in the pollen data and in the summer temperature simulations is orbital forcing, declining northern hemisphere summer insolation in particular (Liu et al., 2014). The trend is also consistent with a variety of broader paleoclimate and ecological data (e.g., alkenones and charcoal records) from the late Holocene (Marcott et al., 2013;

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Marlon et al., 2008).

Figure 7: The authors presented spatiotemporal patterns in the historical mean annual temperature anomalies from 1895 to 2010 as shown in Figure 6. Is it possible to organize or discuss the temperature variations over the last 3000 years separately for the east and west part of the study region, considering that the two parts of the study region represent very different temporal variations in temperature and it is possible that the same situation occurred in the past too. On the other hand, the Figure 6 represents the variations in mean annual temperature. It is recommended to present similar figures or results in the text because most of proxy records are sensitive to summer temperatures. The same suggestion is applied to moisture variations. Maybe a figure similar to the Figure 6 is helpful to guide the authors to organize the different archives based on the sub-regions in the study area. I guess that the moisture variations might have differed more regionally than temperature.

There are very limited hydroclimatic data available from the Midwestern part of our study area, but we can differentiate the western versus eastern bog records, and discuss the western tree-ring and bog data together before speaking about the remaining data, which effectively apply only to the eastern portion of the domain. Figure 8, which shows dominant patterns of spatial variations in drought from 1700-2005, is intended to be analogous to Figure 6, which shows the spatial variations in temperature in the region.

11) Figure 7: What do they mean by the '+' symbol? Please clarify it in the Figure legend. How about the dating uncertainties for lake or bog sediment records? It is crucial for comparison with other high-resolution data. It is possible that the dating accuracy affects poor correspondence among the proxies. An additional table outlining all the details including dating material, sampling resolution, temporal resolution, dating methods and so on is useful. As a result, a separate discussion paragraph is needed. What is the full name for NY, RI, ME and others? All the testate amoeba data are from the same region, west or eastern region? From Figure 1, the related data distribute

widely. Are they arranged regionally or not? Can they provide the simulation output results for moisture variations over the past 3000 years from GCM modeling? If so, it would be a very helpful addition.

The “+” symbol indicates time periods with high water table depths and thus signify drought events; we will add this to the figure caption. The dating uncertainties are always an important component of uncertainty in the sediment records, and they certainly have an impact on multi-proxy comparisons; we will provide a table containing details about the sediment records used in the analysis, with their sample and temporal resolution, dating methods, and related material. An additional paragraph discussing these differences in the proxy records can also be added. We will add the full names for the states, and also separate the testate amoeba records by region (they are currently organized by region but we can distinguish them in the figure as such). The moisture variations from the GCM modeling can also be included as requested. We greatly appreciate all of these helpful suggestions.

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