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Climate of the Past Discussions

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 #1 requests two key areas in need of improvement in the paper: 1) revisions to Figures 5, 6, and 7 to facilitate understanding and interpretation of the paleoclimate data, and 2) additional information and explanation of the seasonality of different data sources and how this plays out in the reconstructions. We appreciate the recommendations and agree that both of these issues need to be addressed. We also appreciate the attention to detail on the figures, and can correct each issue identified.

To improve the figures (5, 6, and 7) we will correct the axes and labels, add the loading legend, and reorganize the time series so that they are grouped in a more intuitive fashion, with modeled series together at the bottom. This will allow the interpretation to flow more easily and clearly from the data. To address the second item, we will add

a short explanation of the seasonality of each proxy in their descriptive sections, and then tie these to the discussion of the features and trends in the multiproxy figures. For example, we will clarify that the PDSI reconstruction is calculated for June, July, and August, so it is a summer reconstruction, and therefore may reflect different dimensions of drought than those observed in the bog data.

The bog data presented here most closely reflect the length and severity of the summer moisture deficit, which is usually related to summer precipitation (Charman 2007, Booth 2010). There can be important differences in seasonal sensitivities however across both space and time, and the relative importance of precipitation versus temperature may also vary among sites (Booth, 2010). Thus in some cases, changes in water table depth may be more closely correlated with summer PDSI, while elsewhere it may reflect annual PDSI more closely. Still other bogs may respond to temperature more than precipitation variations, which may be correlated with each other and thus produce effects that are very difficult to disentangle. Overall then, it is not surprising that a summary of inferred drought events from many different bog records across a broad region do not closely parallel tree-ring-based PDSI that reflect a narrower set of physical and biological processes, and differing resolutions and chronological uncertainties makes these comparisons more uncertain. It should be noted, however, that North American bog records are correlated with local PDSI data (e.g., Booth 2010) and similar correlations with temperature and precipitation have been found at European sites (Charman et. al 2004, 2012; Charman 2007; Schooling et al. 2005).

Figure 4: This figure has 6 panels, adding the a, b, c, d, e, f for each panel is helpful for a smooth reading. Now the order of figure is confusing.

We will add panel labels and change the order of the panels to be more intuitive, moving from the most direct data comparisons (with the least uncertainty) to the more indirect comparisons (with more uncertainty). The top row will show observed versus reconstructed PDSI from tree rings (left) and observed versus reconstructed water table depths (WTDs) from bog data (right). The middle panel will show observed versus

reconstructed annual precipitation from pollen (left) and observed PDSI versus reconstructed bog WTDs (right). The bottom panel will show reconstructed precipitation from pollen versus reconstructed P-E from lake level data (left) and reconstructed lake levels from two different lakes (right).

Page15 line 9: Figure 5A, should be Figure 4e (New Long versus Deep Pond water elevations from southeastern MA for the past 7000 yrs).

Agreed; we will fix this.

Page15 line 12: Figure 5B should be Figure 4f (Deep Pond lake-level derived P-E reconstruction versus the mean annual precipitation reconstruction based on the mean of multiple records in the region). Agreed; we will fix this.

Page15 line 19: Figure 5C should be Figure 4c (observed versus predicted paleohydrological variables, based on proxies found in lake and bog archives, and inferred using space-for-time paleoclimatic transfer functions and validated using cross-validation. Left: pollen data from (Marsicek et al., 2013)).

Agreed; we will fix this.

Page15 line 31: Figure 5D should be Figure 4d (observed versus predicted paleohydrological variables, based on proxies found in lake and bog archives, and inferred using space-for-time paleoclimatic transfer functions and validated using cross-validation. right: testate amoebae data from across North America (Booth, 2008)). Agreed; we will fix this.

Page16 line 4: Figure 5E should be Figure 4A (instrumental (observed) versus reconstructed values correlated in time. Left: NY PDSI for 1895-2000).

Agreed; we will fix this.

Page 16 line 23: Figure 1I should be Figure 1 or Figure 5I. It is Figure 1; we will fix this.

Page 16 line 24-26: The mean annual temperature anomalies based on pollen records

from across North America from Viau et al. 2006 (Figure 5H) also show a long-term but more subtle decline.

Agreed; we will adjust text to reflect this.

Page 16 line 31-32: add more explanation on the reason why long-term difference between reconstruction by Williams et al. 2011 (Figure 5I) and Viau et al., 2006 (Figure 5H).

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).

Figure 5: the x axis should not contain “0” for CE. Same for Figure 7.

Agreed; we will fix this.

Figure 6: add the loading legend. Which color indicates positive loading? Adding the a, b, c, d to each panel.

The sign of the loadings is arbitrary; the green on the map corresponds to the green temperature anomalies below, and likewise for the brown colors. Axis one scores are larger than Axis two scores, consistent with PCA more generally. We will add the labels to the panels.

Page 17 line 19-26. The sentence is not clear. Does brown line (Figure 6c) means temporal variations of EOF1?

The brown line refers to the negative loadings of EOF 1; we will clarify this sentence.

Page 18 line 12: during the past 9000 years should be 900 years. Figure 7c does not show clear long-term trend. Maybe it does not preserve low frequency signal so much.

Agreed; we will address this in the text.

Page 18 line 14-15: Could you give explanation why there is no correlation between tree-ring based PDSI and varve-based index? Both tree ring and varve records could be calibrated with instrumental data, but they are not correlated. Please give more information on reconstructed PDSI, seasonal PDSI? Or annual? Same as varve-based reconstruction.

The apparent lack of correlation calculated from the PDSI and varved record was due to differences in the spatial domain for the PDSI reconstruction; we have corrected this so that our results are now consistent with those published in Hubeny et al. – in fact the two series are correlated, most strongly on a mean annual basis.

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