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Climate of the Past Discussions

Interactive comment on "A 900-year New England temperature reconstruction from *in situ* seasonally produced branched glycerol dialkyl glycerol tetraethers (brGDGTs)" *by* Daniel R. Miller et al.

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We would like to thank Dr. J. Hou for the insightful comments on our manuscript. We feel these comments will aid in creating a more well-rounded publication, and we will address these comments in an revised manuscript.

Miller et al. presented a well-designed experiment to investigate the seasonality of brGDGT proxies in this paper, which is helpful to understand the mechanism of the potential temperature proxy. The authors reconstructed temperature variation in the past

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Discussion paper

900 years and suggested they could differentiate anthropogenic and natural changes. I think it is a good try to understand the seasonality of brGDGT proxies, which is worthy to be published. However, there are some problems that the authors need to address before it is accepted for publication. Main comments:

1. The authors did not construct a transfer function between MBT'5ME and temperature, as they claim their proxy likely reflect September temperature. I suggest the authors try to construct a transfer function to show the temperature variation quantitatively.

This is addressed in the supplementary information provided with the manuscript. Although a temperature to MBT transfer function would be ideal, creating a temperature calibration based on 4 data points (see supplement) would be dubious. Upon further reflection and taking into consideration the comments of referee #2, we decided it would not be appropriate to discuss this in the manuscript text. This point is valid, but it is beyond the scope of this manuscript as it cannot be adequately addressed with the currently available data.

2. The authors compared their temperature reconstruction with pollen, hydrogen isotope and other records. The authors better explain difference between September T and pollen-inferred T. If they represent T variation in different seasons, why do they show similar variation?

In response to this point as well as to a comment by Referee #2, we will clarify the differences and similarities between temperature reconstructions based on pollen and brGDGTs (Page 9 Lines 4-6). We agree that the discussion of different proxy seasonality in this section was confusing, so we will clarify this discussion. In general, summer and fall temperature fluctuations share some variation, and the differences in the proxy reconstructions presented in Figure 7 are unlikely to be solely due to differences in the exact timing of proxy production. Rather, the differences are likely attributable to discrepancies between the age models and resolution of the published records. We

will update the text to reflect this.

3. The authors attributed different trends in reconstructed T and measured T at the Basin Pond to Rotenone treatment. It seems that the Rotenone affected the algal community. What would the changes in algal community affect the bacteria?

We show reconstructions both for algal biomarkers and for higher plant biomarkers (ß-sitosterol/stanol). Our intent was to show a widespread response of the biota in Basin Pond to the 1955 Rotenone treatment. We will add text to speculate on the response of brGDGT producers in Basin Pond to the 1955 treatment. However, it is unclear to us how this treatment may have affected bacteria, and to the best of our knowledge, little work has been done to investigate this. Because other aspects of lake productivity changed, we speculate that this may have affected the microbial community of Basin Pond, including brGDGT producers. Further work to quantify the impacts of anthropogenic changes on brGDGT producers, as well as more work to identify brGDGT producers (which remain unknown), is needed to better understand these relationships, which is beyond the scope of this manuscript.

If bacterial community changed, why the proxy did not reflect temperature? In this case, why the proxy MBT'5ME would reflect over the past 900 years.

This is a good point, but we feel it is a bit of an oversimplification of our argument. The veracity of our 900-year brGDGT-based temperature reconstruction is supported by its comparison to other paleorecords, and the clear relationship between MBT'5Me and local temperature measured at Basin Pond. However, if we focus on simply the last 100 years, we find a surprising cooling since 1970, in contrast to instrumental records of temperature change for the state of Maine (Figure 9). We will add text detailing a few possible mechanisms for this effect (Page 11, Lines 20-22). We note that all of these mechanisms may be affected by changes to the Basin Pond ecosystem initiated by the addition of Rotenone in 1955. We note that any post-depositional changes occur in the upper $\sim$3.5 cms of the sediment column, and that the 900-year brGDGT-based

temperature reconstruction would not have been altered by anthropogenic impacts. This is supported by our comparison of the brGDGT-based record to other regional records, as well as by other published data (i.e. the age model for the Basin Pond cores BP2014-5D, BP2014-3D, which show no 14C age reversals) (Miller et al. 2017).

The examples that the author listed in Section 5.1 were all from surface sediment. Were they affected by anthropogenic activities?

The answer to this question is location-specific and varies regionally in terms of the type and extent of anthropogenic influence for each of the records/studies mentioned in this section. It is beyond the scope of this study to address this question and revisit all of the existing calibrations for signs of possible anthropogenic influence. Nevertheless, this is an interesting question and merits study in the future.

Overall, it seems to me that the interpretation is not convincing.

We hope that our responses to Referee #1's comments have clarified and supported our interpretation. We will modify Section 5.3 so that it explicitly and clearly lays out our interpretation of the 900-year brGDGT-based record. We also note that while uncertainties to some aspects of the interpretation exist and may not be conclusively resolved at this time, our brGDGT and algal biomarker records from Basin Pond add a new and high-resolution record to the available paleoclimate records. In particular, there are relatively few land temperature reconstructions from Maine and our study helps to fill this gap. It is likely that as the brGDGT temperature proxy becomes better understood, that interpretation of our Basin Pond record, as well as other previously published brGDGT records, will evolve accordingly.

I wish the authors address the concerns in revision.

Referee #1's concerns will be addressed in the revision.

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