J. Tierney
Climate of the Past
Response to Reviewer Comments
Authors: D'Anjou et al.

12/14/2012

Dear Dr. J. Tierney,

The authors want to thank you for taking the time to review our paper. Your expertise in the field and the comments you offer here are much appreciated. Incorporating the changes and elaborating on the sections you identified as requiring further detail will undoubtedly improve this manuscript.

In accordance with your suggestions, we made the following changes:

J. Tierney C1:

"I'll second Phil Meyers' suggestion that organic carbon concentrations, if available, would be useful to have a look at and normalize the biomarker concentrations to. If TOC has not been analyzed, another way to isolate the effect of organic carbon concentration on the biomarker concentrations would be to normalize the biomarker concentrations to each other; e.g., look at the concentration of diols / sum(concentrations of all biomarkers measured). Looking at the biomarker variability in this manner may help clarify whether the variations are due to production or preservation."

Response to J. Tierney C1:

We agree with both you and Dr. Meyers, and offer you the same response as provided for him:

"Your comment concerning the missing TOC data are valid, and we agree with the incorporation of this data into the revised manuscript. As such, TOC data is now included in the manuscript. At the time of data analysis and initial drafting of this manuscript the TOC data was not available, which lead us to normalize to g dry sed^{-1} rather than g OC^{-1}. In regards to mass accumulation rates, the researchers involved directly with this study were not present at the time of sub sampling, and necessary data such as bulk density are not available. Furthermore, uncertainly in the age model precludes confident conversion to mass accumulation rates. We have decided not normalize biomarker concentrations to g OC^{-1}, as we note in the revisions (section 5.1) for a couple of reasons. First, the response of TOC in Lake El' gygytgyn during Quaternary glacial and interglacial periods is not consistent throughout the record (Figure 3G), and the mechanisms behind this variability are not well characterized. An example of the variable nature of the TOC record occurs during the MIS 2 glacial period, where %TOC is actually much higher than during the two surrounding interglacial periods, MIS 1 and 3 (Holland et al., 2013). The TOC data from MIS 9 and 11 reveal a somewhat contrasting response with slightly

elevated TOC values during MIS 11 in comparison to the surrounding glacials, MIS 10 and 12 (Figure 3G). However, TOC data from MIS 9 cannot readily be demarcated from the surrounding interglacials MIS 8 and 10, as they are all characterized by relatively similar values. In contrast, all other biological based proxies from Lake El'gygytgyn (ie biogenic silica) clearly show elevated values corresponding to interglacial periods throughout the entire Pleistocene, including both MIS 9 and 11(Figure 4H), making them easily discernible from the surrounding glacial periods. Second, ongoing organic geochemical work in our group suggests that the non-solvent extractable portion of TOC varies considerably, and independently of glacial/interglacial cycles, at Lake El'gygytgyn. As such, we chose to present our biomarker concentration data as normalized to g sediment extracted. We note that when normalized to TOC, MIS 9 and 11 still stand out as being characterized by generally elevated biomarker concentrations in comparison to the surrounding glacial intervals; however, the biomarker records become spikier due to variability in the TOC data."

J. Tierney C2:

"Concerning the interpretation of the MBT/CBT temperature signal as a summer temperature signal: While this could make logical sense given the fact that ice covers the lake for much of the year (although, not knowing the ecology of the producers, this is still speculation) I don't personally see a similarity between the insolation curve and MBT/CBT"

Response J. Tierney C2:

We recognize that the trends in the MBT/CBT records are weakly correlated for some time periods and stronger correlations during others to summer insolation. When initially analyzing the data we discussed investigated further tuning the biomarker records to the insolation curve. Using Analyseries software, we were able to align the biomarker record to reflect these corresponding trends in summer insolation within the chronological uncertainty inherent to our record. However, we felt this was a misrepresentation of the data and would have compromised the integrity of our interpretations made from this altered data. Therefore we include the insolation curve as a reference for the reader. The existing interpretations were made as a logical argument rather than one based on the alignment of the two records; however we agree further discussion is warranted, and the text has been revised accordingly. We agree that without modern samples from Lake El'gygytgyn we can only speculate that MBT/CBT might reflect a summer temperature signal. We have revised the text to clarify this point.

J. Tierney C3:

"Concerning the diols and specifically the diol index. The authors state on p. 4762 that the diol index, when calculated, looks similar to MBT/CBT. This would be useful to see in a figure. In addition, they speculate that the record of the C30 alkyl diol alone could "corroborate" the brGDGT temperatures. I'm not really clear on what is meant here. Is it that the concentration of

this compound alone could be useful as a temperature proxy? How would that make sense from a mechanistic point of view? More generally speaking, it would be useful at this point in the text to discuss the mechanistics and interpretation of the diol index proxy as it is new and readers are on the whole not going to be familiar with it. My understanding is that the inferred relationship between the diol index and temperature is completely empirical; e.g., has no basis in known membrane lipid adaptations of species thought to make diols. I think it would be appropriate here to interrogate the diol proxy a little bit further and discuss its potential applicability/non-applicability to a lake system like Lake E."

Response to J. Tierney C3:

We agree that, given the content and text of the originally submitted manuscript, the diol index should be plotted in the figure alongside the branched GDGT temperature records. However, we have revised the text substantially, removing any reference to the diol index, and in the revised text simply refer to the sum of all identified long-chain *n*-alkyl diols ($C_{32,}$ C_{30} and C_{28} 1,15 *n*-alkyl diols) and interpret it as a record of aquatic productivity possibly from Eustigmatophyte algae, however recognize that this is still a large unknown. The diol index in Lake El' gygytgyn will be explored in depth in a separate publication, where we can give the subject the in-depth discussion the topic warrants, one that could not justifiably be included in this manuscript given the existing data set.

J. Tierney C4

"-p. 4752, top: Might be appropriate here to add an additional sentence noting that Acidobacteria are suspected source of brGDGTs and some strains do seem to produce one of the brGDGTs (brGDGT-I; Sinninghe Damste et al., 2011, Appl. Environ. Microbiol.)"

"With respects to the different MBT/CBT calibrations: it would be useful to list the calibration equations used (perhaps in Table 1) just so that readers not familiar with them can see the differences in the equations."

"Fig. 3: I think the reference should be Tierney et al. 2010 (GCA) not Tierney et al. 2009. Also, is this the MBT/CBT-based calibration or the fractional abundances calibration?"

Response J. Tierney C4:

Discussion of Acidobacteria as a potential source for brGDGTs, a table containing the different calibration equations used, and a corrected reference of the Tierney et al. 2010 publication is now included in the revised manucript.

We appreciated the time you spent on these revisions, and feel that incorporating your suggestions into the revised manuscript will improve the final version.

Yours sincerely,

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