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To: Dr. Qiuzhen Yin

Editor

Climate of the Past

Dear Dr. Qiuzhen Yin,

On behalf of the co-authors, we are very grateful to you for giving us an opportunity to revise our manuscript. We really appreciate your positive and constructive comments together with suggestions on our manuscript entitled 'BrGDGTs-based seasonal paleotemperature reconstruction for the last 15,000 years from a shallow lake on the eastern Tibetan Plateau' (MS No.: cp-2023-32). We have therefore studied reviewer' comments carefully and tried our best to revise our manuscript accordingly. Notably, the changes are highlighted in track-changes manuscript. Please see below for a point-by-point response to the reviewers' comments and concerns.

Editor and Reviewer comments:
Reviewer#2:

Overall, I am satisfied with the replies of the authors to my questions and comments and would like to thank the authors for their efforts. However, there are a few issues remaining that I recommend following up upon prior to accepting this manuscript for publication.

- L35: replace 'The results demonstrate…' by 'In these studies, brGDGTs have been interpreted to reflect either mean annual air temperature or growing season temperature. In both cases, brGDGTs reflect a gradual warming trend….'

Response: Thank you for your suggestion. we have rephrased this.

This omits the use of 'warm bias' in your text, adding to my earlier comment on

referring to mean air temperatures for months above freezing (MAF) as reflecting a 'warm bias'. The use of this term is very confusing as it raises the question where the bias is compared to. I'm guessing the authors mean MAT, but if MAF is reconstructed, this comparison is not valid. Thus, please refer to MAF, as the proxy actually reconstructs and avoid comparing apples with oranges.

Response: Thanks for your meaningful comments. We have changed 'warm-biased temperature' into 'the mean air temperatures for months above freezing (MAF)' throughout the text.

- L136: The 'moreover' should be a 'however', as this sentence contradicts part of what you are saying in the previous sentence (brGDGTs in lakes have mixed sources vs brGDGTs in lakes are produced in situ).

Response: Thanks for your reminder, we have changed "moreover" into "however".

- L266 + L272: change abundance to abundant

Response: Thanks for the suggestion, we have corrected it.

- Fig. 3. Which compound does IIa'' refer to? The molecular structure is not given in Fig. S2. How would it look like?

Response: Thanks for your reminder. The compound IIa'' in Fig. 3 should be IIa''' and we have corrected it. The compound IIa''' was only found in Gahai catchment soil samples and is shown in the revised Fig. S2.

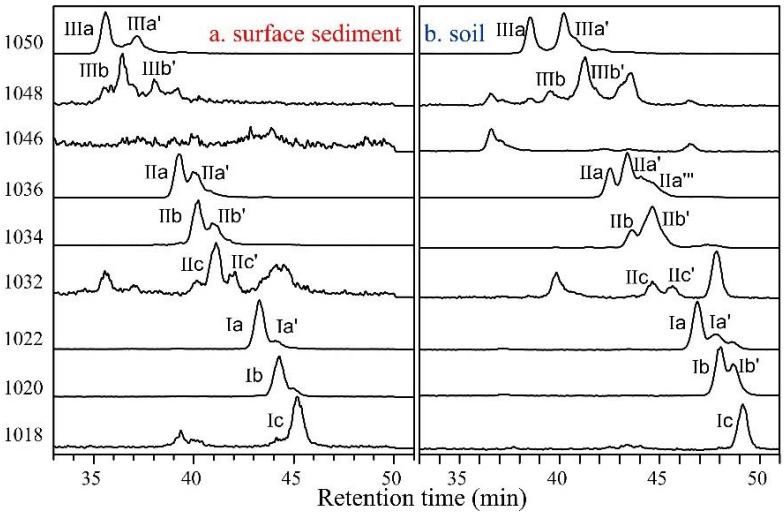

Fig. 3 Representative high-performance liquid chromatography/atmospheric pressure chemical ionization-mass spectrometry (HPLC/APCIMS) chromatograms of brGDGTs from (a) surface sediments from Gahai lake, and (b) soils in the catchment of Gahai lake.

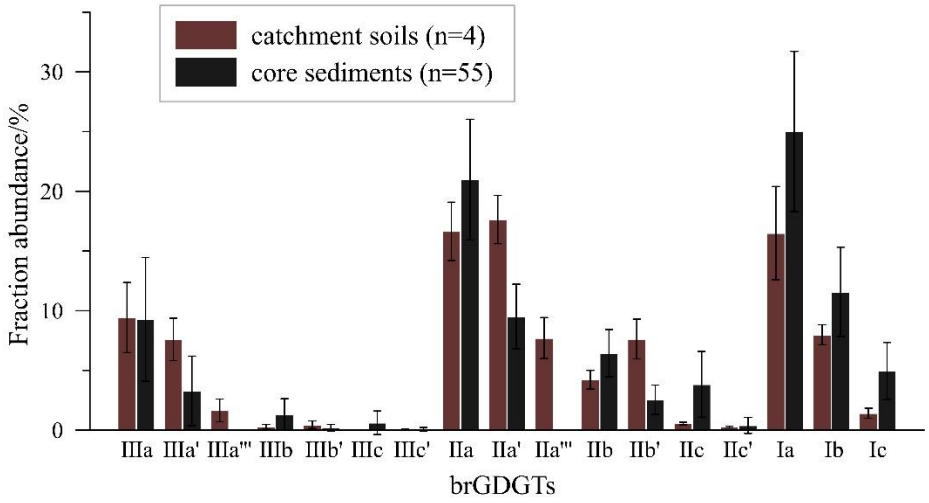

Fig. S2 Mean fractional abundances and standard deviations of brGDGTs in the downcore sediments and 19 catchment soil samples at Gahai lake.

- L319: the unknown producers of brGDGTs and their response to changes in autotrophic biomass production has already been mentioned in L313. Remove the repetition.

Response: Thanks for your meaningful comments. We have deleted this sentence.

- L342-377: in my opinion, this part of the discussion is redundant as you have just

made the argument that the calibration of Martinez Sosa et al should be used to reconstruct MAF. Partially repeating the comment in my previous review:

I follow (and agree with) the rationale of the authors to use the Martinez-Sosa calibration. Note, however, that this study is based on the fact that brGDGTs in lakes are in situ produced (i.e., have an autochthonous source), and that brGDGT distributions in lakes and soils are substantially different (see the discussion in their section 4.1). Hence, this makes the use of additional calibrations redundant, in particular considering that the fact that most brGDGTs in Gahai Lake have an autochthonous source, is used as the main motivation. Since most of these calibrations are based on (a variation of) the MBT'5me, this exercise mainly just changes the absolute temperature values rather than doing anything else (such as revealing new insights).

Thus, I still suggest the authors to make a clear, motivated decision on the choice of calibration (you can even mention that other calibrations exist but are based on the same principles, just using a different dataset, and will thus generate a record with the same trends just different absolute temperatures), and then interpret just that record. Leave all discussion about the other calibrations out to keep the discussion focused on the interpretation of the trends and timing of changes in the temperature record.

Response: We thank Reviewer for the meaningful comments and suggestions. We have rephrased this part in the revision as follows:

'Using calibration of Martínez-Sosa's et al. (2021), we reconstructed the surface sediment temperature of Gahai lake, resulting in a temperature estimate of 9.4°C. This reconstructed temperature closely matches the ice-free season temperature recorded by meteorological stations in the Gahai region (8.8°C for May to September). Furthermore, considering the significant contribution of autochthonous brGDGTs in Gahai lake, we also attempted to reconstruct the Holocene paleotemperature record using previously published lake-specific brGDGTs-temperature calibrations (e.g., Günther et al., 2014; Martínez-Sosa et al., 2021; Russell et al., 2018; Sun et al., 2011; Wang et al., 2016). As depicted in Fig. S3, most of these calibrations exhibit qualitatively similar temperature change patterns when applied to the sediment core from Gahai Lake. This similarity

arises from their shared same principles, just utilizing distinct datasets, resulting in records that display analogous trends but vary in absolute temperatures.'

- L459: 'this is a known issue in temperature reconstruction using biomarkers'. I am not sure where this statement comes from and why this is a known issue. There are many different biomarkers that are used for temperature reconstruction in both terrestrial and marine realms, but I have never noticed this issue, which should be quite prominent if true.

Response: Thanks for your meaningful comments. We have deleted this sentence.