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Climate of the Past Discussions

Interactive comment on "Microbial Membrane Tetraether lipid-inferred paleohydrology and paleotemperature of Lake Chenghai during the Pleistocene-Holocene transition" *by* Weiwei Sun et al.

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1) The assessment of GDGT as paleoclimate and paleohydrology proxy lack of in-depth discussion on the complex interpretations of the lipids. For instance, the paper does not address the fact that it is well known that GDGT composition is highly affected by a variety of environmental factors including air and water temperature, pH, salinity etc., which can complicate the interpretation of the proxy used (e.g. Pearson et al., 2008, Wang et al., 2013). The paper also attempts to present and discuss the Lake Chenghai record in the context of the larger Indian Summer Monsoon region (including records

from China and Japan). However, there is a substantial lack of detailed comparison between the Lake Chenghai record and other records shown in Fig. 5. Specifically, there is almost no mention of the differences between records and there is little discussion on the causes of the climatic variation in the studied lake and what might cause the regional differences observed in the records presented in Fig. 5. Therefore, I suggest that the authors should provide more discussion on the use of GDGTs as proxy and how they perform in relation to other records (agree/disagree). Response: The pH and salinity are reported to influence the isoGDGT composition in the saline lakes, however, the salinity in Lake Chenghai is relatively low at present and not a saline lake was not possible during the H1 cold event when the climate was driest during the past 16 ka from the mineral composition (Sun et al., 2019). Thus we focus on the influences of lake level and air temperature in this study. We also compared the reconstructed temperatures detailed with those from the Indian monsoon region, and the records from East Asian monsoon region were deleted. In total, the magnitudes of temperature variations are consistent considering the RMSEs of the calibrations.

Sun, W., Zhang, E., Shulmeister, J., Bird, M.I., Chang, J., Shen, J.: Abrupt changes in Indian summer monsoon strength during the last deglaciation and early Holocene based on stable isotope evidence from Lake Chenghai, southwest China. Quaternary. Sci. Rev. 218, 1-9, DOI: 10.1016/j.quascirev.2019.06.006, 2019.

2) The authors mentioned in the method section that both isoprenoid and branched GDGTs were extracted and analysed. However, they use brGDGTs only to calculate BIT index but do not use any of the numerous brGDGT based temperature proxy (e.g. MBT/CBT, MBT'/CBT). Instead only isoGDGT derived TEX86 was adopted for temperature reconstruction. However, TEX86 was only applicable to approximately half of the core (57 out of 102 samples) due to the high contribution of soil derived isoGDGTs. As stated by the authors, there is scarcity of terrestrial temperature records from the studies region, therefore I strongly suggest that brGDGTs-based paleothermometers should be calculated and applied downcore in Lake Chenghai to increase the resolu-

tion and the knowledge of air and water temperature changes in the region. Finally, GDGT-based calibrations (in this case TEX86 inferred lake surface temp.) should not be "blindly" applied for downcore climate reconstruction. I strongly suggest that correlation analysis between iso (and eventually brGDGT) based proxies and modern water temperature and air temperature should be performed to test the validity of using GDGT for paleoclimate reconstruction. Response: Thanks. Firstly, The branched GDGTs are successfully used to reconstruct temperature in monsoonal Asia, such as Lake Tengchongqinghai, Lake Tiancai and Lake Ximenglongtan in southwest China. However, the areas of these lakes are relatively small and branched GDGTs are dominated from the catchment soil. In contrast, Lake Chenghai is much larger than these small lakes, and in-situ production of branched GDGTs in Lake Chenghai cannot be fully excluded. In fact, we tried to reconstruct the temperature based on branched GDGTs using the calibrations from both African lakes and temperate China, large uncertainties are shown with modern temperature. Secondly, the concentration of cren' in surface sediments are generally at the detection limit, resulting in TEX86 values could not be calculated and compared to the modern values.

3) I suggest that the introduction and the discussion should be throughout modified and potentially revised. In the introduction, there is not enough background on the proxies used (e.g. the producers, the environmental factors affecting TEX86, %cren, cren'/cren and GDGT-0/cren ratios), and there should be more clarification on why it is important to reconstruct lake level changes in the context of modern climate and future predictions. In the discussion, from line 220 to 254 the authors provide a literature review on the proxies used. This section should not be in the discussion, but rather be part of the introduction. Additionally, sections 4.2 and 4.3 are too descriptive and are not well connected between each other. As most of section 4.1 should be in the introduction I suggest to revise the discussion focusing on the a) interpretation (not description) of the proxies used, b) contextualise the climate and hydrological changes within the region and discuss in detail the causes of the changes and the implications for future scenarios, c) evaluate the proxies used for Lake Chenghai as mentioned in

point 1 above. Response: We modified the structure of this manuscript and move the section 4.1 to the introduction.

4) I strongly advise for this manuscript to be revised by either a professional translator or a native English speaker as there are large portions of the text which should be rephrased as they are difficult to follow/read. Additionally, I have noticed grammar and stylistic mistakes which I have tried to amend as much as possible. I have also provided suggestions on how to rephrase some of the sentences. Response: Thanks. The manuscript is revised by both James and Bird, both are native English speakers. We also amended the grammar and stylistic mistakes in the PDF.

5) In the introduction I think you should add a figure with the structure of iso and brGDGTs. Response: The structures of isoGDGTs are shown in the supplemental figure and branched GDGTs were not discussed in the manuscript further.

6) Lines 61 to 74: in this section you need to explain specifically why it is important to reconstruct lake level changes. What do these changes tell us about the hydrological budget? Response: In the revised manuscript, we focus on the reconstruction of temperature due to many studies about the ISM.

7) Line 80: You should be more specific and list the producers. We know for example the phyla that produce isoGDGTs (e.g. Euryarchaeota) Response: Modified.

8) Line 85 to 98: This is not enough introduction to TEX86 nor %cren, additionally there is no mention of cren'/cren ratio. I'd suggest you move section from line 220 to 254 here (see point 3 above) Response: Modified.

9) Line 129 – 130: you should make clearer that the chronology for this lake has already been published in Sun at el. 2019 Response: Yes, the chronology has been published, modified.

10) Lines 145-146: This is an unusual way for extracting lipids, can you add a reference? Response: The method follows Feng et al. (2019). Feng, X., Zhao, C.,

D'Andrea, W.J., Liang, J., Zhou, A., Shen, J.: Temperature fluctuations during the Common Era in subtropical southwestern China inferred from brGDGTs in a remote alpine lake. Earth. Planet. Sc. Lett. 510, 26-36, DOI: 10.1016/j.epsl.2018.12.028.

11) Line 169: This is the first time you mention brGDGTs. They should be briefly introduced in the introduction section alongside the BIT. Response: Added.

12) Line 202: You should report r not r2 (as r is the correlation coefficient) Response: Modified.

13) Lines 220 to 254: this section is a literature review and contextualizes the use and potential drawbacks of GDGTs and the GDGT-based proxy. Therefore, it should be rewritten into the introduction section. Response: Modified.

14) Line 257: which modern processes? what do you mean by that exactly? Response: The "modern processes" is deleted.

15) Lines 262 - 286: Here you are simply presenting the results of cren/cren' and GDGT-0/cren ratios with a bit of contextualisation within the literature. This should be better explained within the context of climate and hydrological changes. Response: Modified.

16) Line 293: "Deep lake conditions" Such as? Can you list some of the conditions affecting the Thaumarchaeota growth? Response: This sentence was deleted in the new manuscript.

17) Line 311/ Fig. 4 : Here you mention diatom record but in Fig. 4 you only plot the grain-size record. Could you add the acidophilous record in fig 4? Response: We add the diatom record in the figure.

18) Line 320: You should add what proxy you are talking about. E.g. "Lake levels inferred from %cren do not show a lowstand during the YD, which is generally recognised as a period of low rainfall due to the weakening of the ISM" Response: Modified.

19) Line 320-321: add the start and end dates for the YD Response: Modified.

20) Lines 327-330: You should discuss this more. Is it just due to the sensitivity or do other environmental factor affect the proxies that you are presenting? IsoGDGTs including cren and cren' are affected by air and water temperature, pH etc. which can complicate the interpretation of the proxy used. Discuss this further. Response: We mainly attribute this difference to the source change of isoGDGTs, such as soil erosion and deep-dwelling Thaumarchaeota group 1.1b.

21) Lines 336-339: So how does this impact your interpretation of the %cren record? Response: This is the secondary reason for the lake-level reconstruction, the source change of isoGDGTs may be the main explanation.

22) Lines 340-343: This needs to be further discussed and more details are needed. For instance, cren'/cren record during H1 event appears to be more variable than what you say with a substantial trough at approx. 15.5 cal ka BP, suggesting a shift in archaea community. This change occurs alongside changes in BIT and GDGT-0/cren and grain size. Expand on this. Response: We interpret the secondary peak of %cren centered at 15.2 cal ka BP as a centennial monsoon event, which was corresponding to the strengthened Ism recoded by speleothem from Dongge Cave in southwest China. In addition, we suggested that %cren values may be more sensitive to lake-level change when it was at lowstand.

23) Section 4.3 from line 344: This section does not discuss the causes of the warming during the early Holocene. You are simply comparing the Lake Chenghai record with other record from the region without offering any explanation on the reason of climate warming. Additionally, you don't highlight any differences between the records (and therefore the region) and what might the causes of the regional climate differences. There is a very brief discussion offered in lines 398-402 but this is not enough. Response: We expand this to a paragraph.

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