Clim. Past Discuss.,
https://doi.org/10.5194/cp-2019-82-AC2, 2020

Climate of the Past Discussions
Open Access
EGU

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

Weiwei Sun et al.

elzhang@niglas.ac.cn

Received and published: 14 January 2020

1) Proxies. The authors use a suite of proxies based on GDGTs, such as TEX86 for temperature, the BIT index, %cren, cren'/cren, GDGT-0/cren. However, the proxies and the mechanisms underlying the proxies are only poorly introduced and explained, if at all (e.g. cren'/cren results are presented (L199) but the ratio is not mentioned in the introduction). Also the interpretation of the proxy data and the assessment of the applicability of the TEX86 proxy, and thus the reliability of the produced temperature record, is very marginal and should be improved. Response: We have integrated the

Printer-friendly version

Discussion paper

section 4.1 to the introduction and the underlying mechanisms about isoGDGT-based proxies are introduced more detailed.

2) Structure: This comment may already resolve part of my comment on the proxies, as some of the explanation is presented in the discussion rather than in the introduction. Actually, most of section 4.1 consists of a literature overview of the proxies. This should be moved to the introduction. Instead, use the discussion to actually interpret and discuss your own data. This is also true for the other sections of the discussion. Response: We have integrated the section 4.1 to the introduction.

3) Lake Chenghai: In order to interpret the GDGT data it is important to provide some more details on the modern lake. Please add basic information on the lake type (i.e. mixing regime), nutrient status (ammonia!), oxygen content, etc, and possible links to climate (e.g. is mixing related to windiness or precipitation, or: : :?). Response: Lake Chenghai is a seasonal mixed lake in summer and a eutrophic lake at present.

4) Lake level reconstruction: The authors use %cren and cren'/cren to reconstruct the lake level over time, for which they assume that crenarchaeol will be produced more during lake highstands, and less during lowstands. This is in turn linked to mixing of the lake, where more mixing is related to oxic conditions, supposedly occurring during low lake levels. In order to go with this interpretation it is crucial to understand the production of crenarchaeol in lakes, for which you need to discuss the exact niche of crenarchaeol-producing Thaumarchaeota in the lake water column. Several studies have shown that they primarily occur just above the oxycline (as correctly reported in L238). This means that the position and the stability of this oxycline is very important for the amount of crenarchaeol that is produced in a lake. Hence my request for more information on the mixing regime of Lake Chenghai. For example, Buckles et al. (2013, Environmental Microbiology) hypothesize that crenarchaeol is mainly produced during years. Check Loomis et al., 2014 GCA, Weber et al., 2015 GCA, Weber et al., 2018 PNAS, Colcord et al 2015 Org geochem, Colcord et al., 2017 Org geochem , Buckles et al., 2014 GCA. The BIT index is basically an indication of crenarchaeol and/or brGDGT

production in the lake. As BIT is a ratio, both cren and brGDGTs can drive changes in BIT, which can only be assessed with absolute abundances of the GDGTs. Without these data any changes in BIT should be interpreted with care. Since BIT and GDGT-0/cren practically show the same trends in Lake Chenghai (Fig. 3) it can be assumed that these changes are caused by changes in cren rather than brGDGTs and GDGT-0. So instead of enhanced soil input, the absence of crenarchaeol production then explains a high BIT (and high GDGT-0/cren) in the interval from 6-14ka. It is up to the authors to find an explanation for the limited/disturbed niche of the Thaumarchaeota in the water column (outcompeted? Ammonia depletion?). Also, if BIT is so high (>0.5) that application of the TEX86 is limited, then why did the authors not attempt to use brGDGT-based paleothermometry? Response: Compared the permanently stratified Lake Challa, Lake Chenghai is a seasonal stratified lake and the nutrient mainly dependent on the terrestrial orgnic matter input, not mixing and vertical transportation from bottom water. This case is consistent with the results from Lake Qinghai in northwest China. In addition, we also suggest that some part of brGDGTs might be derived from both soil and in suit water column, and difficult to trace the source at present. Thus we did not consider the BIT values anymore in filtering the TEX86 values for lake surface temperature reconstruction. The temperature series expand to 74 data.

5) L82: take more time to introduce the proxies here and to explain their underlying mechanism(s). Response: Thaumarchaeota have a physiological mechanism to increase the weighted average number of cyclopentane rings in their membrane lipids with growth temperature and underlying mechanisms about isoGDGT-based proxies are introduced more detailed.

6) L89: index is not reliable in small lakes – mention why not? Response: The index may not be a reliable proxy for past temperature in small lakes due to substantial amounts of soil and/or methanogenic archaea isoGDGTs identified in the same lacustrine sediment and variability in the depth of iGDGT production in aquatic ecosystem.

7) L91: explain this better. Also elaborate on the link between lake level and depth of

the oxycline. Response: The influences of water depth and nutrient are expanded.

8) L141: was any standard added for GDGT quantification? Response: There was not any standard added for GDGT quantification.

9) L180: Castaneda and Schouten 2015 is not correctly listed in the reference list. Please check. Response: Both Castaneda and Schouten 2011 and 2015 were list in the references.

10) L189: it would make sense to start with presenting the age model. If these are not your results (it seems like they are already published?), then add a brief description to the methods. This also allows you to already indicate the position of H1 and the YD in your record. Response: Yes, the results are published and the position of the H1 and YD event are clear.

11) L199: This is the first mention of the crenarchaeol'/crenarchaeol ratio. Include this in the introduction (if you want to use it)! Response: The ratio was added in the introduction.

12) L204: GDGT-0/cren ratios >2 generally indicate anoxic bottom water conditions. Is this also visible in the lake core? Is the interval with values >2 also laminated? Such an easily obtained visual aspect of the core can be used to confirm/strengthen your interpretation of the GDGT record. Response: GDGT-0 is a common lipid and derived from a variety of archaea, not limiting to methanogen, thus GDGT-0/cren >2 may not indicate anoxic bottom water condition in Lake Chenghai during both the H1 dry event and present.

13) L219: the title of this section suggests a discussion of all proxy records, however, it mainly comprises a literature review that focuses on aspects that may or may not affect the applicability of the TEX86 proxy. Hence, content does not fit the title. All proxy description should go in the introduction, and this section should focus on the data presented here. Interpretation of the data may be more thorough and critical. As

illustrated in my main comments there may be multiple explanations for certain trends in the proxy records (e.g. BIT, influence of mixing regime on cren production) that need to be evaluated here. Response: Thanks, we modified this section to trace the provenance of isoGDGTs and the previous contents were integrated into the introduction.

14) L221: instead of citing the GDGT review by Schouten et al., 2013, refer to the original paper instead, giving credit to the right people. Response: Blaga et al. (2009) and Powers et al. (2010) were added as the references.

15) L241-248: pay special attention to linking %cren to high- and low lake levels, as there are multiple ways to explain cren production in lakes. Think about the niche of the Thaumarchaeota and the mixing regime of the lake, and how this is related to climate. Response: Mixing regime and nutrient status are considered to interpret the differences in the responses of Lake Challa and Lake Chenghai to lake-level change.

16) L253: as outlined above, the BIT index can no longer be linked to soil input. There is too much evidence for a primarily aquatic source of brGDGTs in lakes. See suggested references in main comments. Also note that brGDGT production in lakes takes place in the anoxic part of the lake. Hence, high BIT could be coupled to stratified water column conditions and reduced mixing. Check if this coincides with the concentrations of GDGT-0 and potential lamination of the core. Response: The sources of branched GDGTs were not identified at present, but the high BIT values did not indicate an anoxic condition during the H1event when compared with other records from this region.

17) L267: check the cren'/cren ratios and associated DNA analysis in the water column of Lake Malawi (Kumar et al., 2019, Org Gechem). They reach values up to 0.12 without soil input. Response: The results show that the deep-dwelling Thaumarchaeota is also likely a Group I.1b population, similar to the soil source. However, the total production of isoGDGTs by this group appears to be much lower than the surface-dwelling Thaumarchaeota.

18) L283-286: see earlier comment on the contradiction between high GDGT-0/cren

ratios implying anoxic bottom waters and reduced mixing and low %cren supposedly indicating more mixing due to a lowstand. Response: GDGT-0 is a common lipid and derived from a variety of archaea, not limiting to methanogen, thus GDGT-0/cren >2 may not indicate anoxic bottom water condition in Lake Chenghai during both the H1 dry event and present.

19) L327: different responses in GDGTs between H1 and YD, where similar climatic conditions are expected, should be better explained. Also take into account that not only temperature changed during the YD, but that also windiness and precipitation varied. All these parameters have different effects on the GDGT signals in the lake. Response: Wind may influence the mixing regime on the short-term scale. However, the long-term wind record in this region is still lack and we could not compare it with our record. Based on the relationship between windy days and precipitation in Africa, there would be more windy days when the climate was dry and lake level was low. In this case, windy and dry climate would limit to growth of Thaumarchaeota in Lake Chenghai, resulting low %cren values and high GDGT-0/cren ratio.

20) L336: How realistic is the reduced sensitivity of %cren at high lake level? How much variation in lake level do you expect? The %cren in your record varies between 0 and 60%, which would correspond with a lake level change of $\sim$1000m based on the relation of Wang et al 2019. Is this feasible? Response: The absolute value of lake level reconstructed from the calibration is not feasible for Lake Chenghai, due to an outflow may appear when the level increase to 1540 m a.s.l.. However, this calibration tells us that the relationshiop between wath depth and %cren values in not linear, and the %cren values would be more sensitive to climate change when the lake-level was low. 21) L344: I will refrain from providing detailed comments on the spatial context of the record, as there are currently too many aspects about it that are not well known or explained. In a next version however, do pay (more) attention to differences between the records and what they mean (are they really caused by climate or are they caused by comparing different proxies that record not exactly the same). Response: We have

focused on the temperature records from the Indian monsoon region, and paid more attention to differences between these records and possible forcings.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2019-82, 2019.

Printer-friendly version

Discussion paper