Author Reply to Anonymous Referee #2

General Comments:
The paper by van Bree and coauthors lays out a clever study to examine crucial questions on the relationship between measured brGDGTs and climate parameters. Their main takeaway is that measured brGDGTs likely represent variations in bacterial com-munities that respond to seasonal stratification change, and thus downcore are indirectly, but significantly, related to climate parameters such as temperature. They thoroughly examine this in a very clear way by taking time series data from all potential sources of brGDGTs, along with DNA data, and then use rigorous statistical comparisons to demonstrate their findings. I think the writing and organization is very clear, logical, and direct, and I was left without a doubt that their findings are backed with robust analyses. I learned a lot reading this manuscript and I recommend it for publication. Please find my specific comments/questions along with technical corrections and comments on the paper's figures below.

Reply: We thank the referee for this positive feedback on our manuscript.

Specific Comments:
Lines 37-38: What does (sub-) mean? Are you talking about the tropics or subtropics? Speleothems are in both?

Reply: We refer to both tropics and subtropics in our text as an area where lake sediment may provide valuable archives of continental climate history, as opposed to ice cores. Speleothems are indeed also used for tropical paleoreconstructions, so we will no longer mention them in the revised version.

Lines 46-47: Why is temperature the most important climate parameter to reconstruct? Particularly if you're focusing on the tropics, temperature doesn't change much.

Reply: While temperature change in the tropics is indeed relatively modest even on glacial-interglacial time scales (3-4 °C at sea level; e.g. Loomis et al., 2017; Chevalier et al., 2020), this has major impact on tropical continental rainfall through its control on sea-surface evaporation and on the temperature contrast between the ocean and adjacent continents. Therefore, no rainfall or moisture-balance reconstruction from the tropics can be properly interpreted without knowing local/regional temperature history as reference frame. More broadly, a record of past tropical temperature evolution is needed as low-latitude end-member to determine the meridional temperature gradient, and to reconstruct global heat distribution, through time.

Really nice thorough introduction, very clear and informative. Please include a brief (one sentence) analysis of the samples run in the two different labs. Was there any significant difference in any way? If not, I think just stating that there were no discernable differences would be fine.

Reply: The instruments in both labs are tuned towards the same standards. Although the sensitivity (and thus detection limit) of the mass spectrometer was slightly different between labs, this has had no influence on the brGDGT-based indices and proxy values. We will add a sentence on this topic in the revised manuscript.

Be clearer at the end of the discussion section about the drawbacks of applying brGDGTs to downcore studies. What time scales would work best? Could we trust the absolute T values, or focus on variability?

Reply: As can be seen in our 53-month record of brGDGTs in settling particles (Fig. 7), there is no clear recurrent pattern in both the flux and composition of brGDGTs, and a direct link to temperature is also absent. Interestingly, the flux-weighed average brGDGT signal in the settling particles, as well as that of the sediments, translate into a temperature that is close to the measured temperature using the Russell et al. (2018) East African Lake calibration. This indicates that brGDGTs can be used to reconstruct absolute temperatures for sediments that integrate at least several years. We will clarify this at the end of the discussion section in our revised manuscript.

I think the authors should consider adding some of the folks named in the acknowledgments to the author list if they contributed a large amount of work, particularly the first three people, which sounds like they did.

Reply: We thank the referee for the suggestion. However, the contributions to this study made by the people named in the acknowledgements are of a technical (supportive) rather than scientific (interpretative) nature. We feel confident in having properly defined as author those people who made a scientific contribution to this work.

Technical Corrections:

Reply: Thank you for pointing out these (mostly) textual issues. We will address them during the revisions. As also indicated in our reply to reviewer #1, we will carefully re-read our manuscript and make further textual corrections where appropriate.

Line 16: SPM is defined, but not used in the rest of the abstract
Line 48: revise 'supposed to be' to 'supposedly'
Line 61: remove comma
Line 63: remove comma after 'additional'
Line 67: remove comma after '(IIIa")'
Line 68-71: this sentence is unclear due to the structure and perhaps misplacement of the word 'for' and 'with'. Please revise.

Reply: we will revise this sentence as follows: "Furthermore, comparison of the stable carbon-isotopic composition ($\delta^{13}C$) of brGDGTs from lakes and nearby soils indicates distinctive signatures, and thus sources of the lacustrine and soil-derived brGDGTs, with lacustrine brGDGTs being significantly more ^{13}C-depleted (Weber et al., 2015; 2018; Colcord et al., 2017)".

Line 75: add comma after 'Also', but I suggest using a different word, such as 'Further'.
Line 81: add comma after 'soils'
Line 83: add comma after 'factors'
Line 84: separate out light and mixing regime even if they're from the same study.
Line 85: add comma after 'chemistry'
Line 86: add comma after '2010)'
Line 103: SPM is defined as suspended particles, but perhaps use suspended particulate matter

Line 190: revise to 'into apolar, neutral and polar fractions' Line 192: remove 'then' and revise 'similar' to 'similarly'
Line 193: rewrite this sentence perhaps to something like 'The lake sediment samples were also extracted and processed like the SPM'.
Line 203: what is Ø?

Reply: Ø refers to the diameter of the BEH particles in the column.

Line 423: remove 'is shown in Fig. 8' and reword so that Fig. 8 is just cited
Lines 427 and 519: formatting of R2 >0.2, the spacing is weird
Line 454-456: rephrase or remove the 'on the one hand' and 'on the other'
Line 491: add comma after 'Chala'
Line 515: remove 'but indirect' or add commas around it
Lines 521-522: rephrase to be more direct. 'only a few of the comparisons between. . ... are moderately correlated' or something.
Line 546: change 'less extensive' to something less negative
Line 555: change 'realized' to 'noted'
Line 559: remove 'also'
Line 648: change 'temperate' to 'temperature'
Line 666: add 'other' after 'variable'
Line 683: add something like ', which is indirectly related to climate' at the end of the sentence.

Formatting inconsistencies:
Include n values with your r2 and p values, particularly when you make a conclusion from the relationship (or lack there of).
Sometimes the Oxford comma is used (e.g. title of section 2.2.1.), but often it's not. Either is fine, but be consistent.
Sometimes supplemental info is cited in the text as 'Table S.2' and sometimes as 'Table S4'. Either is fine, but be consistent.
Sometimes $^{\circ}$C follows the temperature value directly, and other times there's a space between. Either is fine (I think?), but be consistent.
Sometimes R2=# and sometimes R2 = #. Either is fine, but be consistent.

Reply: we will check our manuscript for these inconsistencies and make changes accordingly.

Figures:
In general, they look nice, but appear as different people made different plots – I suggest using consistent fonts throughout. Also, the fonts are very, very small. I view the plots as full page graphs, and can still barely see a lot of the axis labels and numbers, particularly in figures 4, 6, and 7. This is crucial to change.
Fig. 2: Show where in East Africa this is with an inset map.
Fig. 3: The key is confusing because not all the colors are in it. I understand that the descriptions are in the caption, but perhaps have a clearer key with differently weighted lines. For instance, for the water T at various depths have solid lines in different colors (perhaps a bit thinner than what's there), as you do, and then different dashed lines for other variables plotted.
Fig. 4: Font is very small. . . will need to be whole page to barely see it. Perhaps get ride of the y axis labels on the second and third columns, smush them together, and make the axes and colorbar font much larger

Fig. 7: very blurry, but perhaps that's an artifact of the submission system. If not, it'd be great to update it to higher resolution.
Fig. 8: looks really nice!

Reply: we thank the referee for the feedback on the figures. We will carefully consider the suggested changes and revise the figures accordingly.

References:
Chevalier et al., 2020 Geology, in press (https://doi.org/10.1130/G47841.1)
Loomis et al., 2017 Science Advances 3, e1600815
Russell et al., 2018 Org. Geochem 117, 56-69