## Response to comments by editor

Dear Zhe-Xuan Zhang and co-authors, we have received two revisions of your resubmitted manuscript. Minor revisions will be needed before we can accept this manuscript for publication. The following changes are requested: i) clarify the copyright of the maps in Fig. 1 (see statement from review file validation), ii) add the range of RIX values in the soil either in the text (fi L 640) or in the Fig. 8F (see comment reviewer report# 2), iii) plotting the BIT index alone does not allow to conclude that there is in-situ production, this needs to be accompanied for instance with concentration changes. To avoid making this part of the discussion too bulky by providing all lines of evidence (which might still be non-conclusive?), the authors can stress the hypothetic nature of their interpretation of the BIT index values, iv) the minor comments from reviewer report #2 will improve the manuscript, I recommend the authors to follow these too.

We would like to thank the editor for her comments. A point-by-point reply to the comments is provided below and is colored blue. The text which has been added into the revised manuscript is shown in orange italics. The line numbers correspond to those of the manuscript with tracked changes.

i) We have added the credit in the caption of Fig. 1 as follows (line 173):
"*The map was generated based on the layer from Agence de l'Eau Seine-Normandie.*"

ii) We have also added the ranges of RIX values for the soils in the text (line 641):
*"The RIX in river (0.51±0.06, SPM) and upstream estuarine (0.40±0.07, SPM and sediments) samples is significantly higher than for soils (0.21±0.13) and downstream estuarine (0.23±0.06, SPM and sediments) samples."*

iii) We agree with the editor and reviewer that our interpretation of BIT is not conclusive. We thus tone down this statement in the revised manuscript as follows (lines 742-743; lines 754-755).
*"One hypothesis for this distinction could be the sedimentary in situ production of brGDGTs (Peterse et al., 2009)."*

*"One potential hypothesis for the variability in BIT values could be related to the in situ production of brGDGTs within sedimentary environments"*
iv) We have also addressed all the minor comments by reviewer report #2 as shown below.

## Response to comments by reviewer

Zhang et al. analyzed brGDGTs and brGMGTs from the Seine basin's land-sea continuum. The authors thoroughly discussed the brGDGT and brGMGT distributions in up/down streams, rivers, and soil, as well as their spatial-temporal variations. Specifically, the authors proposed a new RIX index to evaluate the riverine organic matter inputs and show this index is applicable in two different regions. This is a well-designed research with plenty of valuable data, and shows the potential of the application of brGMGTs which we still know little about, and a limited dataset is available. My focus is on the revised manuscript, and I found it's overall in very good shape, but I still try to put in some thoughts and hope they are helpful.

When the authors try to show their RIX is working perfectly in the region (Fig. 8f), it would be necessary to present the RIX of soils, given the brGMGT distribution in downstream and soils are visually similar (Fig. 6). I understand the FA of H1020c, 1020b, and 1034b are statistically different between downstream and soil, and authors did the evaluation in Fig. S12. It's still meaningful to show that the range of soil RIX has some similarity with the downstream samples. I'm not suggesting moving Fig. S12 into the main text but feel the soil RIX needs to be presented somewhere in the main text, probably in Fig. 8f.

The authors use sedimentary in situ production of brGDGTs to explain the difference between BIT and RIX in Fig. 10 (Lines 740-755). In my opinion, this is sort of unnecessary and the relevant discussion probably needs to be removed because the contribution from sedimentary in situ brGDGTs is not clear yet. As the authors stated in the introduction section, it is already very complex to interpret BIT, and bringing in the sedimentary in situ brGDGTs did not really help clarify anything. For example, the authors speculate the high BIT during and after post-PETM could be attributed to the sedimentary in situ brGDGTs. What if the BIT during that period is 'normal', whereas the other 'good' BIT index is actually disturbed and biased to lower values?

We thank the reviewer for their valuable comments. A point-by-point reply to the comments is provided below and is colored blue. The text which has been added into the revised manuscript is shown in orange italics. The line numbers correspond to those of the manuscript with tracked changes.

We have now indicated the ranges of RIX in soils and tone down the interpretation of BIT for the paleorecord in the revised manuscript. Please kindly refer to our reply to the editor.

Some minor suggestions:
L60, better to just say temperature, rather than 'Mean Annual Air Temperature (MAAT)', because recent studies suggest that the brGDGTs may be used to reconstruct warmer season temperatures, especially for the mid to high-latitude lake and soil settings (e.g., Martínez-Sosa et al., 2021; Raberg et al., 2021, 2024).
Corrected.

L61, Consider cite Raberg et al., (2021) and Zhao et al. (2023) for the brGDGTs in lake sediments.
Thanks for the suggestions. These references have been cited in the revised manuscript.

L62, I suggest removing 'and CBT''. This index is just not that widely applied in paleoclimate research yet.
Corrected.

L73, I feel this statement needs some adjustment. There is a large body of studies showing the in situ brGDGT productions in the aquatic environment. I won't list them here, but this is not new, and I feel the authors should be more confident about this argument.
We agree with the reviewer and have modified this sentence in the revised manuscript as follows (lines 73-75):

*"In addition to terrestrial sources, brGDGTs can also originate from aquatic settings, including rivers*

*(e.g. De Jonge et al., 2015; Freymond et al., 2017; Kim et al., 2015; Zell et al., 2014, 2013), lakes (Tierney and Russell, 2009), and marine settings (Dearing Crampton-Flood et al., 2019; Zeng et al., 2023).”*

L445, is it a ‘fact’ that the riverine 6-methyl brGDGTs are degraded faster? I could be wrong, but I don’t remember any cultural experiment that proves such preferential degradation. It’s more like a hypothesis at this stage. The degradation of brGDGTs is generally slow so I feel the difference between homologues is better interpreted as mixed sources or overprinted by the in-situ production.

Thank you for this comment. This is indeed a hypothesis. We have deleted “the fact” in this sentence.

L670, This doesn’t make sense to me. The RIX values of soils are lower than that in rivers, but way higher than in marine settings. The soil input, if there is any, won’t decrease the RIX in marine sediments, but increase.

Thank you for the comment. To clarify, we have rephrased this sentence in the revised manuscript as follows (lines 666-669):

*“Significant differences in RIX between the soils, SPM and sediment samples from the Godavari River basin are observed ($p<0.05$, Wilcoxon test; Fig. 9). RIX values in soils (0.49±0.16) around the Godavari River basin are significantly higher than those the marine samples ($p<0.05$, Wilcoxon test; Fig. 9). Therefore, the potential soil contribution would increase the RIX in marine sediments.”*

L425, 463, 532, 943 Dearing Crampton-Flood et al., 2021

Corrected.

References used in the comments:

Martínez-Sosa, P., Tierney, J. E., Stefanescu, I. C., Dearing Crampton-Flood, E., Shuman, B. N. and Routson, C.: A global Bayesian temperature calibration for lacustrine brGDGTs, Geochim. Cosmochim. Acta, 305, 87–105, doi:10.1016/j.gca.2021.04.038, 2021.

Raberg, J. H., Harning, D. J., Crump, S. E., de Wet, G., Blumm, A., Kopf, S., Geirsdóttir, Á., Miller, G. H. and Sepúlveda, J.: Revised fractional abundances and warm-season temperatures substantially improve brGDGT calibrations in lake sediments, Biogeosciences, 18(12), 3579–3603, doi:10.5194/bg-18-3579-2021, 2021.

Raberg, J. H., Crump, S. E., de Wet, G., Harning, D. J., Miller, G. H., Geirsdóttir, Á. and Sepúlveda, J.: BrGDGT lipids in cold regions reflect summer soil temperature and seasonal soil water chemistry, Geochim. Cosmochim. Acta, 369(January), 111–125, doi:10.1016/j.gca.2024.01.034, 2024.

Zhao, B., Russell, J. M., Tsai, V. C., Blaus, A., Parish, M. C., Liang, J., Wilk, A., Du, X. and Bush, M. B.: Evaluating global temperature calibrations for lacustrine branched GDGTs: Seasonal variability, paleoclimate implications, and future directions, Quat. Sci. Rev., 310, 108124, doi:10.1016/j.quascirev.2023.108124, 2023.