Review #2 of Dugerdil *et al.* for *Biogeosciences*

Joseph B. Novak

Summary

I thank the authors' for their efforts to address my previous comments. After rereading the manuscript, I found a handful of issues that need to be addressed, the most critical of which is my comment regarding line 567. Otherwise, I congratulate the authors on presenting a thorough manuscript that advances our understanding of branched GDGT molecules in complex arid environments.

Warm regards,

Joseph B. Novak

Major Comments

Figure 1 and the soils dataset: some sort of justification should be given for the inclusion of the moss polsters in the soils dataset. Strictly speaking, a moss polster is not a type of soil, and I foresee this as a sample type that many who primarily work on the application of the brGDGT proxy to geologic deposits will not be familiar with. It is probably also best to mark these samples with a different marker face color so that they can be easily picked out on the map. Also, the color scheme for this figure is not colorblind accessible, particularly panel D (red symbols with green background). The simplest solution to that would be to change the marker face color of the red symbols to something else.

L567: It looks like a new sentence (or perhaps paragraph) was started but not finished here.

Minor Comments

L14: I think "Despite this" is a bit confusing since it seems reasonable to expect a weak relationship between brGDGT methylation and environmental temperature given the significance relationship between the various aspects of the brGDGT distributions and salinity, pH, etc.

L24: I think "paleotemperatures" is probably a better term here

L31–33: It might be best to specific that you are talking about the global dataset here since you highlight in the abstract that there is a weak relationship between brGDGT methylation and temperature in ACA.

L43–46: "These two important indices" follows a sentence where three indices are defined. Probably best to specific which two indices you mean, or to break the previous sentence into two sentences.

L51: "have" rather than "has"

L63: the first "they" in this sentence should be replaced with a noun, as it reads it is a bit confusing whether you mean the brGDGTs or the environmental variables.

L76: What is meant by "specific isomer distribution?" This is a bit confusing – do you mean that the distribution of 5-methyl vs. 6-methyl vs. 7-methyl isomers is more variable?

L82: Some additional citations are appropriate here to further support the idea that bacteria community composition complicates application of the brGDGT paleothermometer. I suggest:

(Ajallooeian et al., 2025) https://doi.org/10.1029/2025JG009132

(De Jonge et al., 2019) https://doi.org/10.1016/j.orggeochem.2019.07.006

L84: Probably best to add "in some environmental contexts" since substantial variations in IR_{6Me} have been seen in freshwater environments also (e.g., Novak et al., 2025).

Section 2.3: Would it be appropriate to add a citation to the seminal paper by Hopmans et al. (2016) since the method used here separates the 5-methyl and 6-methyl brGDGT isomers?

L218: I think you mean Figure 1D

L283: *solonchak* should be defined since this is an English language journal. It can be as simple as "*solonchak* (salt marsh) samples."

L593–594: By "actual observations," do you mean measurements of lake surface salinity? Also, it would be best to specific that So et al. study referenced here is not from the ACA region (which is fine, the data are obviously relevant, but the distinction should be made).

Figure 10B: by "over cold" and "over warm" do you mean cold and warm biased?

4.4 section title and subsection titles: I suggest changing "in the past" to "in the geologic record" since I think this better describes what you are discussing here

L737: check subscript here