# Comment on bg-2022-57

Sarah Feakins (Referee)

Referee comment on "Carbon isotopic ratios of modern C3 and C4 vegetation on the Indian Peninsula and changes along the plant–soil–river continuum; implications for (paleo-)vegetation reconstructions" by Frédérique Kirkels et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-57-RC2, 2022

The study is interesting, and would likely be suitable for Biogeosciences after moderate revision.

Summary points:

I agree with the other reviewer that I was surprised to find this was a bulk OC carbon isotope based study. In fact, I assumed the study was based on plant wax when I accepted the request to review based upon the paper coming from a biomarker lab. Of course using bulk methods doesn't invalidate the study, but it could be more clearly signaled for the reader. Using the word "bulk" at first reference to on line 32 "In this study we investigated the bulk carbon isotopic signature.." may suffice.

The authors appear to have neglected the changing atmsopheric d13C over recent decades and how that would affect carbon in modern plants, and potentially older soils and fluvial SPM. Literature comparisons span 1970s to present and it needs accounting for. Please add discussion of (likely) age of materials and the Suess effect, throughout wherever relevant, and account for this numerically.

There is some duplication of graphs Figs 1c and 2a, Figs 2b and 3a – that would ideally be organized so that data are only presented only once graphically.

Detailed line by line comments follow:

Line 45 "Our analysis revealed that the reconstructed C3/C4 vegetation composition was sensitive to the plant δ13C end-members used as mixing model input." Please do not frame this as a new 'analysis revealed' as it is well known that the C3 'endmember' is a flawed concept as it has a very wide spread. Informed choices about more meaningful endmembers may be possible in some instances e.g. if it is known to be wet rainforest or dry C3 desert for example. However there have been other attempts to work around this mathematically including the Fwoody cover approach with a nonlinear fit [1].

Godavari specific endmembers, this would be more generally interesting if we were told right away if this is the wet or dry end of C3 etc, unlikely that there are regional plant species effects, likely it is just the usual canopy etc effects.

Line 49 " Hence, incorporating region-specific plant δ13C end-members and drought correction of the C3 end-member in mixing models need to be considered to determine C3 and C4 distributions of modern- and paleo-vegetation in monsoonal regions." Rephrase this sentence.

Line 56 – all the cited references refer to bulk plant tissue and are references that span 1970-2010. The difference in plant d13C between 1970 and 2020 is ~2 per mil. Please check and see what a recent collation of data has reported after correction for the date of collection, or do the work to update this to a consistent modern value suitable for comparison to your plants. Your soils and river samples may integrate more time however and thus the temporal shift may also be relevant to summarize here in the introduction.

Line 89 – the concept of endmembers is flawed, especially for C3, instead it is important to describe the spread of C3 plants as context for any central estimate. This section of text is also flawed in that it misses the timescale of sampling. Internal to a study the C4 response to dryness has been found to be quite small 1 per mil (Cerling) not absent as concluded in this plant study in the results section, but perhaps the n is too small to be sure? Line 94 is on C4, then line 95 returns to C3 again, and another switch is found later on – the flow needs organizing.

Line 110 – I do not find the concept of a 'global average' C3 plant d13C to be useful.

Line 111 – regional average is also not very useful, more useful to think in terms of the vegetation category average e.g. closed forest, open woodland etc.

Line 116-119 – sentence needs revisiting – rephrase. Note that this refers to a study that is also conceptually based on the endmember approach.

Consider moving away from the outdated concept of a C3 endmember and moving to something like the non linear Fwoody cover approach that deals with the issues of spread in C3 plants. Or if you insist upon a linear mixing model make sure you propagate the uncertainties caused by the C3 distribution upon those C4% estimates. If you do error propagation, you'll see the issue.

Paragraph beginning 121 discusses plant to soil to river degradation fractionations well. It neglects to discuss the age of the OC and the Suess effect means that 2 per mil needs to be accounted for when comparing today's plants and a couple decade old OC in soil/sediment. Old OC would be 2 per mil more enriched compared to today's OC without any degradation fractionation.

Line 153 why (paleo-)vegetation reconstructions? "vegetation reconstructions" suffices. Same issue throughout e.g. line 586 and conclusion title line 589.

Methods

Plant and river sampling methods are appropriate and well described. The only question I'm left with is are the plant samples representative, when sampling bulk from a tree, the trunk is the bulk of the biomass, although the production of leaves may have a faster rate. When sampling leaf wax the leaves are appropriate, but when sampling bulk is the leaf sampling appropriate? I can see it is hard to homogenize a tree unlike sampling grasses (or leaf waxes) where the sampling task is simpler.

Line 236 "robust relationship between MAP and d13C has been shown to prevail in C3 plants around the world" yes there is a trend but also a lot of scatter. This is acknowledged on line 249 a long way after for the reader, and the solution we are told is "binning'" on line 249 but binning is not explained, that I have found in the text.

Results and Discussion

Line 289 the plants falling in the "lower" end of the global range is consistent with the comparison of modern plants and an older global literature reference comparison. However just on numerical comparison "lower end" also seems to be a misrepresentation as closed tropical forest would be lower. Reconsider.

Line 354 – binning – apologies, if I've missed it but I don't see this explained yet, and so I struggle to follow this.

Line 439 remove "interestingly" which is subjective, and this well-known issue is one reason why reviewer 1 questioned the use of bulk, it becomes problematic in estuarine and marine settings as is well known (and perhaps no longer that interesting).

line 529 – though we found some wood far offshore in the Bengal Fan
[2]

Conclusions

Line592 – the discussion makes it sound like there is something regionally unique about the d13C when they fall within the global plants dataset and likely overlap with similar vegetation types. Thus it is more vegetation type/habitat/MAP considerations rather than geographic regions that should be emphasized, and so doing would make it more globally of interest than local.

Figures:

Fig 1 – the map figures are useful, for the third panel showing MAP is the partition of the upper and lower basin based on the MAP, if so or otherwise, please give the numerical basis for the partition in the caption for this panel. Preferably change to a green-brown or blue saturations color scale rather than rainbow to be intuitive visually, and provide a legend that can be read in a quantitative sense, see comment on Fig 2a). Please note the repetition of data visuals, Fig 1c and Fig 2a are duplicative. Duplication should be removed. Fig 1c can be removed, as 2a conveys data at the site sampling points as well as the basemap.

Fig 2 a) apart from other concerns regarding the rainbow color scheme that have been widely reported, I would also not encourage the use of scale bar that is purely qualitative for the MAP data. It is not possible to read between the numbers 430 and 2300 mm/yr and know what 'yellow' or 'green' represents in terms of MAP. You can use a scale with incremental output and a color scheme that is a saturation of a single color which will help to allow for visual quantitative evaluation of where is wetter and drier.

d13C data points with the rainbow colors can be discerned by most readers using the legend, the coloring is not intuitive, for wet to dry try green to brown for example, and it would be better to pick a color scheme that can be seen by all readers.

b) Why are upper and lower basins parsed. Are these much different, probably not as the C4 distribution in lower basin falls within that for the upper basin, and the same for C3 with the upper basin just having a bit more range. Maybe overlay the two bar charts or

use violins, to display the data if you want to keep with this 2 category, but if you do an T or F test do you find they are significantly different? (this panel is repeated in fig 3) fig. 2b can therefore be deleted.

Fig 3 – shows a bar chart of the same data as in figure 2b but in box and whisker format. The data only need to be shown once. As this plot is better this is the plot that should be retained and 2b deleted.

Fig 4 – why show 'global C4' as a line = -12 per mil. Where does this derive from? Is it the mean of a collection of plants over several decades, without representation of the scatter in that dataset or correction for the accelerating d13C change in atmospheric CO2 over the last 2 decades. I assume your plants are simply showing scatter consistent with the global dataset, after correction for atmospheric d13C and pCO2 change over time.

I disclosed prior to accepting this review, that I collaborated with Kirkels and Peterse previously: Following my field and lab work in 2013-5 in the Andes, the GDGT aliquots went to Kirkels/Peterse, and their lab analyses for that project and collaborative discussion was done in 2015-2017 including conference poster and manuscript preparation, their manuscript was submitted in 2019 and the publication dated 2020 [3].

I hope these suggestions help to strengthen the manuscript.

Sarah Feakins

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- Lee, H., V. Galy, X. Feng, C. Ponton, A. Galy, C. France-Lanord, and S.J. Feakins, *Sustained wood burial in the Bengal Fan over the last 19 My.* Proceedings of the National Academy of Sciences, 2019. **116**(45): p. 22518-22525.
- Kirkels, F.M.S.A., C. Ponton, V. Galy, A.J. West, S.J. Feakins, and F. Peterse, *From Andes to Amazon: Assessing Branched Tetraether Lipids as Tracers for Soil Organic Carbon in the Madre de Dios River System.* Journal of Geophysical Research: Biogeosciences, 2020. **125**(1): p. e2019JG005270.