

## ***Interactive comment on “Fire, vegetation and Holocene climate in the south-eastern Tibetan Plateau: a multi-biomarker reconstruction from Paru Co” by Alice Callegaro et al.***

### **Anonymous Referee #1**

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#### General comments

In this manuscript, A. Callegaro and colleagues present a multi-proxy investigation from a sediment core retrieved from a Lake on the Tibetan Plateau. They conducted relatively novel biomarker analysis to reconstruct past fire activity and vegetation in this area over the last 11 kyr.

The paper is relatively well written and structured, and addresses scientific questions relevant to the scope of Climate of the Past. However the presentation of the results (figure) and more importantly the discussion and argumentation need to be improved and strengthened. I will highlight several cases under my “specific comments – major

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issues” where the argumentation was too superficial. Several possibilities for interpretation or explaining the discrepancies are often presented (e.g. fire activity, different transport, different fire temperature), which is good. But in the end the authors need to clearly state which one they favor and why. Looking at the figures, I mostly see discrepancies between the proxies. It may well be the case as the authors are comparing quite different indicators sometimes only marginally influenced by the parameter they are investigating (e.g. the effect of fire on n-alkanes). I strongly advise the authors not to go into too many directions, especially too many comparisons with other proxies or records that do not match. But rather make sure they have good arguments for their interpretation in the end. I would rather recommend showing a record of ISM intensity or temperature over the Holocene.

The data are always presented with moving averages, which makes it difficult for the reader to appreciate for himself the original data obtained.

Specific comments Major issues:

- Page 9 line 2: I have to admit that I am quite skeptical about the high fluxes observed in both MAs and PAHs. As you state a few lines down, these high fluxes are the result of the higher sedimentation rate observed in the bottom part of the core. There is only one age point that is causing this high sedimentation rate, and no errors on this radiocarbon age are provided. Could it be that the sediment was distorted (stretched) during the coring process, causing these higher sedimentation rates. After checking Bird et al. (2014), it appears they dismissed a date which was much older (17.7 cal kyr) at 388.6 cm, as it was bracketed in between two ages in stratigraphic order. It could also be that your last one is a contamination during coring or bioturbation and that instead sedimentation rates were much lower in the bottom part of the core. Alternatively, the very high sedimentation rates could reflect an erosive event in the catchment. The TOM shows lower values for these older sediments. Erosion of catchment soil could bring also older fire biomarkers into the lake. Looking at the fluxes on figure 2b (ignoring the high peak), the MAs and PAHs don't show such similar patterns, except for the first

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maximum around 10.5 kyr BP and the following decrease to 10-9 kyr BP. You do make this statement further down on lines 23-24. You never actually explain this difference. - Page 10 Line 25-26: You also never explain what could cause the difference between the 2 ratios L/M and L/(M+G), and which ratio is the more trustworthy, or which one you use for reconstructing the vegetation. - Page 11, GCD results: I don't quite follow your argumentation. Why did you compile charcoal records over such a vast area? Are you expecting similar climatic trends over the Holocene, over this entire area 1000s of km across? If yes, then you should make it clear why (monsoonal systems etc). If no, then it doesn't make much sense to compile all of these into one record. You should also discuss in more details the different temperature of production of charcoal and levoglucosan, what does it imply? What explains different fire temperature, and what fire would you then expect to explain your data. - Page 13: It would have been useful to show a record of changes in monsoon strength (e.g. precipitation) along your own records. - Page 13: If you would rather not trust your PAH record as a fire record, then you should make it much clearer earlier on, and mention that you will then only discuss MAs. Given the high variability of your PAHs, it may be your best option. - Page 14 line 7: Are you now arguing that the MAs peak at 5.6 is due to transport, and not fire activity? A bit earlier you were discussing the Bond Event 4 and monsoonal precipitation. This is somewhat confusing. If both could play a role, you should add a summary sentences stating that.

Smaller issues:

- Title: I recommend adding "Lake" to Paru Co - Abstract, line 24: I would briefly explain why PAHs decreases but MAs remain high. What is the distinction to the intense biomass burning during the early Holocene where both were high? - Page 2, line 5: In the sentence just before you state that fire contribute to greenhouse gases, this contradicts the end of the sentence here. - Page 2, line 6: Why do you use "therefore"? I don't see a clear link into this last sentence. It makes sense that these sentences are in the introduction, but there is not much flow, or logical order to these sentences. They just

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seem to be put together. Please improve the argumentation. - Page 2, line 13: (and throughout the manuscript) List references in chronological order, the oldest one first, the most recent one last) - Page 2 line 16: Can you specify what type of ecosystem processes? - Page 2, line 18: Ice cores from where, also the TP? - Page 2 line 26: I don't see what you mean by specific environmental conditions? - Page 2 line 31: I would clarify here that the following list of marker you are discussing are Mas - Page 4 line 25-26: Please rephrase this sentence: the first part of the sentence is about difficult access to paleoclimate archives and then you mention few investigations into species diversity and plant communities. Where is the relationship? - Page 5 line 19: Define ecosystem functions or use another word, e.g. vegetation distribution? - Page 5 and Figure 1: It would have been more useful to have a more precise catchment map showing these features than the large google map on figure 1 or the satellite picture showing only the lake. - Page 6 Line 8: The  $^{137}\text{Cs}$  determination method is not cited here, whereas the radiocarbon is. - Page 8 line 7: How did you obtain wet density? - Page 8 line 11: for the other ratios you clearly state what they are useful for. You should do the same with the ACL, what can it tell you? - Page 8 line 29: please provide these latitude and longitude ranges. How many records did you compile in total? - Page 9 line 7: or you had erosion of older compounds in the catchment (soil). - Page 9 line 30: Why didn't you look at the correlation between BiSi and PAHs and TOM and PAHs? - Page 9 line 33: It would have been good to summarise here how the link ISM-BiSi works. - Page 10 line 1-9: These correlations should be presented when you first describe similar trends of both PAHs and MAs, at the beginning of the section! - Page 10 line 2: the (negative) correlation between MAs and TOM was larger than this (-0.54) and with a more significant p-value. Maybe there is something to discuss there, even though it is not positive as you expected. - Page 10 line 5: how does it vary? Does it vary with time, depending on the main climate? - Page 10 lines 5-9: These last two sentences should probably be moved to the discussion section. - Page 10 line 7: Unfortunately we don't see the original concentration in your figures, only the fluxes. - Page 10 line 8: can you specify what you mean by "biogenic origin"? combustion of biomass is also biogenic

for me - Page 10 Line 13-15: I don't fully understand this sentence, can you rephrase it to be more clear? - Page 10 line 15: Is the statistic done only for this interval, or for the entire core? please specify - Page 10 line 19: please provide some examples of these changes in the terrigenous environment. - Page 10 line 28: It would be useful to either state the published range in the text, or in the figure. Are those ranges for L/M, or for L/(M+G) - Page 11 line 1: the second part of this sentence is rather vague. n-alkanes do not record all organic input into the lake, and they also record organic production within the lake. - Page 11 line 15: Here you should list the other FeSts, especially those that would have indicated the presence of humans. - Page 11 Line 16-17: Are there other information (e.g. archeology) which could support this finding? No known settlement in this area, too high elevation, ...? - Page 11 lines 19-23: All this first part should be in the method section. - Page 11 line 31: I only counted 3 colour bars where the arrows go in the same direction, that's pretty bad as a similarity... - Page 12 line 31: I wouldn't call this composite record regional, it's almost continental - Page 13 line 5: How do these different burning temperature occur? You need to discuss this point in further details. Would we then have low or high temperature fire during this interval, and why, what caused this type of fire? - Page 13 line 14: The PAHs show a clear minimum at 8kyr. The Sum of MAs show a peak from 8 to 9 kyr BP. The 8.2 cal ky BP was a short and abrupt event, if the ISM was peaking then, I would not expect a 1000 year long dry interval. - Page 15 line 4: that warm period would fall right into the 8.1 to 7.2 cold intervals (1-2 degrees cooling) you are mentioning a few lines up... that's contradictory - Page 15 lines 6-7: please specify the time interval here. As you were just mentioning relatively young intervals (<2.7 kyr BP) where you don't have fire records it is confusing. Do you mean for the early Holocene? - Page 15 line 18-19: I wonder which one (forest or shrub) tend to have more fire? I also wonder if the presence of forest or shrub has an influence on the fire temperature? - Page 15 line 22-24: In this sentence it is hard to follow what the observations were, and what are the suppositions, could you reformulate more clearly what has been observed, and what is assumed? - Page 15 line 32-33: I don't follow your argumentation. How can you infer

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that this mechanism would also occur in the sediments? - Page 16 line 1-2: leaf waxes can also be abraded and transported by the wind, as well as in streams in suspended sediments, leaves are not necessarily requested for their transport and deposition - Page 16 line 6: I don't understand what you insinuate here? What details would you look into? Please be more specific and/or provide examples. - Page 16 line 25: No, they can also be transported quite far by winds. - Page 17 line 1: what do you mean by paleoreconstruction information, this is too vague, could be paleotemperature, paleoprecipitation... - Page 17 line 27: You should not discuss something for the first time in the conclusion. This expansion of Bronze Age civilization should have been mentioned earlier. In the text, you mention 4.2k as the collapse of Chinese Neolithic cultures - Page 31 – figure 5: Your lake is located at 30N, why do you use the insolation at 40N? - Page 31 – figure 5: There are dots in between the Paq and the ACL graphs, to which graph do they belong to? - Page 31 – figure 5: I wonder what signal you would obtain if you were to use the same 5pt moving average on the Paq and the ACL. It seems to me that the Paq data without moving average show a signal similar to the sitostanol - Page 31 – figure 5. I am not quite convinced by the insolation driven trend. Or at least I don't think this is the signal you should be looking for in your n-alkanes data over the Holocene. I am also not convinced by your green bars highlighting similar oscillations in Norm 31 and sitostanol. The youngest peak is relatively coeval, the one before is already almost opposite (sitostanol peak is closer to the Norm31 minimum than to its maximum). The third Norm31 peak is not coeval with any peak in Sitostanol. And the 4th peaks are again quite offset. - Page 32 Figure 6: The figure is of poor resolution. The blue dots on the map in panel a are not described/explained. If not used these should be removed. The oscillations in panel b (charcoal) can barely be seen. The curve and its envelope (dotted curves) are not explained. I suggest deleting “resulted” and “analysis” from the figure caption. The figure caption should also describe what the blue green and red arrows are for.

Technical corrections - Page 2, line 11: delete provided - Page 2 line 28: delete "in buried sediments" - Page 2 line 31: You could add “and longer timescales” after “the

Holocene” - Page 3 line 17: I would here mention “diverse distribution of chain length”  
- Page 4 line 1: replace “anthropological” with “archeological”? - Pag 4 line 2: replace  
“quantification” with “determination” (I wouldn’t say that we can truly quantify the pres-  
ence of humans. We are not there yet. - Page 5 line 5: You could mention the Younger  
Dryas & Bolling Alerod in your text. - Page 5 line 12: You could maybe use "superim-  
posed on these oscillations" instead of “even with these oscillations”. - Page 8 line 3: I  
would rather use data “analysis” instead of “elaboration” - Page 8 line 9: Replace “sig-  
nificative” with “significant” - Page 8 line 11: what do you mean with "useful for work"?  
I would rather say "useful for our study, or for our interpretation" - Page 8 line 30: Here  
you should refer to the figure presenting this data - Page 9 line 17: use "up to" instead  
of "touching values till" - Page 9 line 21: remove the comma - Page 13 line 27: delete  
the second "not" - Page 15 line 2: Is there a word missing? (“a limited abrupt to”???) -  
Page 15 line 13: I would rather use another verb, for instance "place the Paru Co..." -  
Page 15 line 15: specify the time interval considered - Page 15 line 26: I would rather  
call this "long term trend" than "millenial scale". - Page 15 line 29: can you indicate by  
how much on average? - Page 15 line 30: same here, by how much? is it significant?  
- Page 16 line 4: “it seems that” - Page 16 line 11: slash and burn -> at which time? -  
Page 16 line 11: Please indicate Lhasa on Figure 1. - Page 16 line 12: where exactly?  
Please show on the map. - Page 16 line 16: compared to (or "with respect to") - Page  
16 line 32: Comparing data that resulted from (or originated from) - Page 16 line 33:  
“processes that happened” - Page 19 line 6: The journal and pages are missing. -  
Page 29: Specify in the figure caption that the BSi axis is inverted

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