Reply on RC3
Angelica Feurdean

Author comment on "Experimental production of charcoal morphologies to discriminate fuel source and fire type: an example from Siberian taiga" by Angelica Feurdean, Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-1-AC1, 2021

General comments

This manuscript provides new and additional information to the increasing body of knowledge of using sedimentary charcoal for more robust reconstructions of past fire regime including fire severity, fuel sources and fire type. The study combines different features analysed from modern burned plant materials and based on that provide assessment of possible methodology for defining fire type and fuel source also from sedimentary records. It would be interesting to see a comparison of the features from plant material burned in laboratory with features from actual sedimentary charcoal record from the same study area. However, I understand that this could be further work in addition to this manuscript. In general, this manuscript is well organized and written in clear language. Introduction is informative and the aims of the study are clearly stated. Methods used in the study are relevant and justified and the approach provides novel information and methodology for using sedimentary charcoal in reconstructing past fire regime in boreal landscape. The results are interesting and I would have hoped to see more comparison of the results from this study to previous research also using laboratory techniques or sedimentary charcoal to analyze charcoal morphology in regards to the combustion temperature and fuel source. I was also partly missing clear numerical values when describing the morphological features. For example, I would have hoped more defined information of what is the size range of smaller and larger fragments, when morphometrically categorizing fuel types. More exact numerical information of size, ratios, mass retention etc. would make these results more comparable with later studies utilizing the methodology presented here. Overall, I think this work brings important addition to the literature and methodology of using combination of different charcoal features for more robust reconstructions of past fire regime. I havemade some minor suggestions for the author in the detailed comments. In my opinion, this paper would be in wide interest of the readers of Biogeosciences and I recommend this paper to be accepted to publication after suggested minor revisions.

R: Many thanks for the positive response that this paper was interesting and a useful contribution to the community, and for the useful and thoughtful comments to further improve this paper. I am currently working to 1) Expand the Discussion on how the results from this study compared to previous research using laboratory techniques or sedimentary charcoal to analyse charcoal morphology in regards to the combustion temperature and fuel source, including a table showing numerical information on aspect...
ratio, length, and area; 2) Clarify the numerical information that distinguishes the size range of smaller and larger fragments; and 3) I am working on a few selected fossil sample to compare the features from plant material burned in the laboratory with features from the actual sedimentary charcoal record in the study area.

Detailed comments:

L 79: I would suggest adding right in the beginning that these identified plant materials were the actual samples that were later burned in the laboratory.

R: Added: “Plant materials used for laboratory burning experiments were identified in the field, stored in plastic bags for transportation, and air-dried.

L 87-88: So, nothing was actually used to initiated flame, but the burning was due to high temperatures? How well does this mimic the natural conditions for fire and does it have an effect on the charcoal features compared to the ones in sedimentary record?

R: Right, nothing was done to initiate the flame. Laboratory burning conditions are not identically to the natural wildfires (see the response to Rev1 for limitation of laboratory burning experiments). Results from charcoal morphometrics obtained under open flame to those in muffle oven compare well (Umbanhowar and McGrath, 1998; Orvis et al., 2005) and charcoal features obtain in the laboratory with those from sediment wildfire (Mustaphi and Pisaric, 2014).

L 92-95: I would suggest to mark the mixed samples a bit more clearly. Now it takes some time to figure out that which proportion go to which sample.

R: Thank you, I agree that this is not that easy to read. In the current version I present these samples along a gradient of transition from predominant surface fuel fire that burn with lower intensity (graminoid and moss), to surface fuel that burns with intermediate- to high-intensity (shrub), and finally to crown fuel that burns at high-intensity crown fires (wood and tree leaf). I am working to make the labels clearer.

L 126-128: Here is reference to the Fig. 1. However, there isn’t as many types given in the figure as here in the text. This is a bit confusing and I recommend to fix this or adding some explanation for leaving some features out form the figure.

R: Many thanks. The description of Fig. 1 in the text follows the groping of similar fuel types at the bottom of this figure. In the revised manuscript I have better matched the names of these groups in Fig. 1 with those in the text. It reads: “The percentage of charred mass retained at 300 °C (an intermediate temperature) was as follows, in decreasing order: moss and fern > wood (shrub twig) > leaf (shrub) > leaf (forb) > wood (tree twig) > leaf (needles tree) > graminoid > Sphagnum > wood (trunk) (Fig. 1).”

L 197-199: Here average results across all temperatures are referred to Fig. 1, but as far as I understand the figure presents results from different burning temperatures rather than averaged over all temperatures. I would suggest this to be clarified.
R: Thank you, I have revised the text to better illustrate Fig 1. It now reads: "Comparison of results across temperatures suggest that graminoid, Sphagnum, and trunk wood produce the lowest amounts of charcoal per unit biomass and lost their mass more rapidly with increasing burning temperature (Fig. 1). Contrastingly, leaves of shrubs (Ericaceae), forbs, and ferns (Polypodiaceae), as well as fern stems (Equisetum), produced the highest amounts of charcoal per unit biomass and retained the most charred at higher temperatures (Fig. 1).

L 235-237: Here it is stated that larger fragments are more reliable to categorise fuel types. It would be useful to clearly state that what is the size ranges for what is considered larger and smaller fragments.

R: Indeed, in the original manuscript I have stated "Because smaller charred fractions tend to be rounder (lower aspect ratio) than larger fractions, it suggests that larger charcoal fragments can be more confidently used to morphometrically categorise fuel types". In fact, results from this study show that the smaller the particles, the smaller the aspect ratio was. From here I have extrapolated that larger charcoal fragments can be more confidently used to morphometrically categorise fuel types. However, it is difficult to find a clear cut of the actual size that could more reliably be used for aspect ratio, but I will explore this aspect further.