Biogeosciences Discussions

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Comment on bg-2021-1

Anonymous Referee #1

Referee 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-RC1, 2021

This is an interesting and useful combination of field work observation, sampling and lab experimentation to examine modern plant communities and charcoalized plant parts at different roasting temperatures for the purpose of improving the development and interpretation of palaeoenvironmental records of charcoal (a proxy for fire) in boreal forests. The results should be of interest to a wide variety of researchers in EGU fields and interested in biogeosciences related to fire at local to large spatial scales, palaeovegetation research, and archaeology.

OVERVIEW:

Overall I suggest some changes to clarify the intent of the author for certain words like "burned", 'impact', 'intensity' etc - detailed below.. And some expansion on the discussion with respect to additional charcoal morphology literature in paleoenvironmental studies and archaeological studies.

There should be some refinement on how explicit the 'decomposition' technique of the vegetation fuels was and thus, the use of the word ''burned''. Is it known if the material flamed in the oven? Was it roasted? combustion? Pyrolysis? The oxygen and time variables are largely ignored and this should be written as a caveat in the experimental design to be explored elsewhere or in future studies. Similarly, the words charcoal, charred, and (roasted, unused term in the study) may need to be defined early. 'Ashed' is

also used but not fully discussed - I suppose it meant a more complete combustion generating white ash that then crumbled apart into soot and flyash?

Was there an explicit purpose statement? Something like, characterising the diversity of charcoal morphologies produced by boreal forest vegetation fuels at X study site?

SPECIFIC COMMENTS:

L36 - This might be semantic, or a question of (spatial and time) scale and thus the need for clarity. The word impact is a bit ambiguous without further clarity on the context and use of this term. What is meant here '[a] fire impacts boreal forest''. Over the long duree, is it the changing attributes of fires and the fire regime that impact the boreal forests? Does this mean one fire is impactful? Boreal forests have a lot of spatial heterogeneity in vegetation structure that is in part caused by fire and in part also influences fire itself. A changing fire regime has significant outcomes on the land cover. But if fire is a process in boreal forests itself, it seems more of a feature than of the biome rather than something that just impacts it. Throughout the paper the framing of the disturbance regimes needs to be balanced with how these disturbance regimes (mostly fire explored here) are a part of the system, and not something that just happens to the boreal forest and changes (impacts) it.

L40 - Fire intensities in nature have been shown to be able to reach much higher temperatures, even flame temperatures can be higher than the range explored here. Is this really the gamut of temperatures in hot boreal fires? This needs to be framed as a subset (or modal?) temperatures of fires (maybe this can be estimated from MODIS intensities? i.e. energy output detected by satellite, or if there are some published field-based measurements.).

L49 - worth stating somewhere that the Courtney-Mustaphi and Pisaric, 2014 study discussed potential for not just focusing on known-fuel morphotypes for charcoal analysis but for categorising all morphologies found in a local-scale study to examine the variability; as this would be useful to explore relationships to not just the known-fuel-sources of charcoal but taphonomic processes and possibly fire types (or another variable).

L60 - It would be useful to make distinctions between studies using ovens, flames, and other pyrolysis and combustion methods.

L68 - spp? Or taxa? What was the minimal taxonomic resolution?

L69 - was there any testing in this study? It appears to be mostly a characterization study, which has merit. The purpose, objective, aims are not congruent with the content

L79 - complete dryness. Was this checked? Before burning in the oven were the samples dried? Often one would dry at 105°C for 24 hours to drive off most moisture. Of course this may only influence the combustion to a limited extent in this study - but worth documenting for future comparison studies.

L87 - what was the rationale for limiting oxygen? Were there any comparisons with oxygen not-limited burning and open flame burning?

L198 - is Ericaceae ever investigated in this study?

L231 - ‘’rounder’’, was this intended to mean circular? (as in 2-Dimensional), or roundedness as in the degree angles are eroded or not produced? Can these terms be written more explicitly for the reader. Note that both how circular something is, and roundedness can be quantified, semi-quantified or categorised. Was this done? Discussing if this may or may not be useful in future studies would be useful for readers and future analysts (Note Vanniere et al 2003 Journal of Archaeological Science, 30(10), pp.1283-1299, with reference to eroded charcoal in agricultural soils).

L264 - Add a caveat about the need to do detailed comparative studies on graminoid versus conifer needle fuels and subsequent charcoal. And perhaps among Graminoid growth forms themselves: Poaceae subfamilies, Cyperaceae, and others.

L279 - a useful document for comparing mosses etc for readers to compare in Quaternary and temperature ecosystems is Levesque et al 1988

Lévesque, P. E. M., Dinel, H., Larouche, A. 1988. Guide to the identification of plant macrofossils in Canadian peatlands. Land Resource Research Centre, Research Branch, Agriculture Canada, Ottawa.

L315 - intensity, as in heat/energy given off by fire?

General comments:

Introduction in general:

I think there needs to be a distinction between flame combustion, roasting by hot air (ovens), pyrolysis. This needs to come out more obvious to the read beginning in the abstract, methods, and discussions. It needs to be stated that dry roasting in an oven is a proxy for one type of heating of vegetation in a natural fire, different to flame burning, etc. This is evident in the statement by the authors on L124 that 'All plant tissue was reduced to ash at 450 °C (Fig. S1).' In natural fires, flame and air temperatures do reach higher.

I think the main items that need to be acknowledged is that the oven approximates some aspects of the heating conditions of natural fuels and that a crucial variable that is not explored is time at a (burning) temperature.

With roasting in an oven the influence of flame dynamics and turbulent air flow is missing to the same degree as fires outdoors. This needs to be acknowledged as part of the experimental design and open the need for additional research.

It would be useful throughout and within this paper (if anything was combusted in a different method) to add the categorical naming of how the material was 'burned'. See Table1 in the following publication: https://doi.org/10.1016/S0031-0182(00)00174-7

I have some broad suggestions on how certain details are communicated.

-The plant anatomy of bryophytes is treated rather colloquially and requires refinement.

- Are the species names known for the bryophytes? Many burn differently at low temperature because they hold water droplets differently, making some taxa more difficult to ignite even under the same fire weather conditions.

-The use of the word 'twig' needs some level of description here as twigs are different in deciduous, coniferous, herbaceous? and colloquial terms. Can this be more explicit throughout the paper as it may vary by plant types.

-There is a lot of comparison with Mustaphi and Pisaric 2014; could this be expanded to many of the other morphology papers. A table on charcoal morphometric technique studies and the usefulness could help link with the editors comment on this study not presenting a tangible application of the study in its current form.

FIGURES:

-Perhaps the black font text would be best placed outside the photograph because of the overlap and poor contrast between the letters and charcoal fragments.

FIGURE4 - are some of these not charcoal? Again the Levesque et al 1988 publication might be worth comparing.

FIGURE5 - 'chacoal production' spelling in bold (bottom left). Can you quantify the aspect ratios?

TABLE1 - can you add growth forms of plants? (sort of in the plant type column) and the anatomical parts investigated in this study? For instance, Does ''leaves'' include the

Petiole? The veins? Does twig also just mean wood? Or something else? Soft young wood? High water content?

ADDITIONAL PUBLICATIONS

Some important morphology studies are not discussed in the context of this study. It would be appropriate to discuss these studies in a comparative manner and to build the case for the overall usefulness of morphological metrics.

Additional literature on charcoal and lab burning:

Belcher, C.M., Collinson, M.E. and Scott, A.C., 2005. Constraints on the thermal energy released from the Chicxulub impactor: new evidence from multi-method charcoal analysis. Journal of the Geological Society, 162(4), pp.591-602.

Belcher, C.M., Hadden, R.M., Rein, G., Morgan, J.V., Artemieva, N. and Goldin, T., 2015. An experimental assessment of the ignition of forest fuels by the thermal pulse generated by the Cretaceous–Palaeogene impact at Chicxulub. Journal of the Geological Society, 172(2), pp.175-185.

Hubau, W., Van den Bulcke, J., Van Acker, J. and Beeckman, H., 2015. Charcoalâ□□inferred Holocene fire and vegetation history linked to drought periods in the Democratic Republic of Congo. Global Change Biology, 21(6), pp.2296-2308.

Additional literature on charcoal morphologies that would be worth promoting here for discussion as they also contain similar plant fuels (conifer forests):

https://doi.org/10.3389/fevo.2018.00209

Prince, T.J., Pisaric, M.F. and Turner, K.W., 2018. Postglacial reconstruction of fire history using sedimentary charcoal and pollen from a small lake in southwest Yukon Territory, Canada. Frontiers in Ecology and Evolution, 6, p.209.

Mustaphi CJ, and Pisaric MFJ. 2018. Forest vegetation change and disturbance interactions over the past 7500 years at Sasquatch Lake, Columbia Mountains, western Canada. Quaternary International 488, 95-106.

Courtney Mustaphi, C.J. and Pisaric M.F.J. 2014. Holocene climate-fire-vegetation interactions at a subalpine watershed in southeastern British Columbia, Canada. Quaternary Research 81(2): 228–239. DOI: 10.1016/j.yqres.2013.12.002

Vannière, B., Bossuet, G., Walter-Simonnet, A.V., Gauthier, E., Barral, P., Petit, C., Buatier, M. and Daubigney, A., 2003. Land use change, soil erosion and alluvial dynamic in the lower Doubs Valley over the 1st millenium AD (Neublans, Jura, France). Journal of Archaeological Science, 30(10), pp.1283-1299.

Transportation of charcoal, environmental 'sorting' literature

Courtney Mustaphi, C.J., Davis, E.L., Perreault, J.T., Pisaric, M.F.J. 2015. Spatial variability of recent macroscopic charcoal deposition in a small montane lake and implications for reconstruction of watershed-scale fire regimes. Journal of Paleolimnology 54 (1): 71–86.

Koff T, Vandel E (2008) Spatial distribution of macrofossil assemblages in surface sediments of two small lakes in Estonia. Est J Ecol 57:5–20

Blair JM, Kalff J (1995) The influence of lake morphometry on sediment focusing. Limnol Oceanogr 40:582–588

A.C. Scott, J. Cripps, G. Nichols, M.E. Collinson. The taphonomy of charcoal following a recent heathland fire and some implications for the interpretation of fossil charcoal deposits

Palaeogeography, Palaeoclimatology, Palaeoecology, 164 (2000), pp. 1-31

Vaughan, G.J. Nichols. Controls on the deposition of charcoal: implications for sedimentary accumulations of fusain Journal of Sedimentary Research, A65 (1) (1995), pp. 129-135

G.J. Nichols, J. Cripps, M.E. Collinson, A.C. Scott Experiments in waterlogging and sedimentology of charcoal: results and implications Palaeogeography, Palaeoclimatology, Palaeoecology, 164 (2000), pp. 43-56

Palaeo and charcoal morphology and anatomy:

Hubau W, Van den Bulcke J, Mees F, Van Acker J, Beeckman H (2012) Charcoal identification in speciesâ□□rich biomes: a protocol for Central Africa optimised for the Mayumbe forest. Review of Palaeobotany and Palynology, 171, 164– 178.

Hubau W, Van den Bulcke J, Kitin P et al. (2013a) Ancient charcoal as a natural archive for palaeofire regime and vegetation change in the Mayumbe, Democratic Republic of Congo. Quaternary Research, 80, 326– 340.

Hubau W, Van den Bulcke J, Kitin P, Brabant L, Van Acker J, Beeckman H (2013b) Complementary imaging techniques for charcoal examination and identification. IAWA Journal, 34, 147– 168.

Hubau W, Van den Bulcke J, Bostoen K et al. (2014) Archaeological charcoals as archives for firewood preferences and vegetation composition during the late Holocene in the southern Mayumbe, Democratic Republic of the Congo (DRC). Vegetation History and Archaeobotany, 25, 591– 606.

A large body of literature in the archaeobotanical literature is missing here. Worthwhile at least acknowledging these other parallel developments and applications (which also includes boreal and subarctic sites with charred wood).

For example

https://historicengland.org.uk/research/current/heritage-science/charcoal-wood-work-group/

https://bective.files.wordpress.com/2015/08/bective00lyonsappendix2.pdf

Susan Lyons. The environmental Remains: Archaeobotanical and Charcoal Analysis

de Melo Júnior, J.C.F., 2017. A new archaeobotanical protocol for collecting concentrated wood charcoal from archaeological bonfire sites. International Journal of Development Research, 7(08), pp.14241-14247.

https://www.jstor.org/stable/20210089

End of review