

Interactive comment on “Aromatic acids in a Eurasian Arctic ice core: a 3000-year proxy record of biomass burning” by Mackenzie M. Grieman et al.

Anonymous Referee #2

Received and published: 9 January 2017

General comments:

Grieman et al. present a biomass burning record that is “modulated by emissions and transport” yet that provides insight into past fire activity from Siberia, a region which currently has scarce paleoclimate records published in international journals. This paper compares their results to ice cores from the perimeter of Siberia (the Altai, Kamchatka, and Greenland) to place their results into a broader perspective and demonstrating substantial regional consistency between biomass burning records. As Siberia contains vast swaths of peat and boreal forest that sequester carbon but can emit this carbon fires, having a record of past biomass burning from this region is essential to greater understanding of the carbon cycle.

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The authors both modify the core's age scale, as well changing as the previous methodology for determining vanillic acid (VA) and pata-hydroxybenzoic acid in ice cores to achieve their results. This paper convincingly argues for the reasons for updating the analytical methodology. However, the paper does not sufficiently address why they changes the depth-age scale, and as this chronology is the basis of the entire work, the authors such better explain why they made such a substantial change.

Specific comments:

Abstract: The end of the discussion section provides evidence that “the similarity in timing between the Siberian biomass burning pulses, the Bond events, and the monsoonal changes likely suggests a link in this region between fires and large-scale climate variability on millennial time scales” (page 11, lines 11-13). This combination of factors is the main strength of the paper, yet the abstract only mentions the similarity between the timing of Bond evens with the timing of increased biomass burning in the Akademii Nauk ice core.

Page 1, Lines 19-21: A more recent paper, Marlon et al., 2016, demonstrates a recent rise in Northern Hemisphere biomass burning after ~2000 AD. This compilation in the Marlon et al., 2016 paper is for the entire Northern Hemisphere, verus the synthesis of high latitude Northern Hemisphere charcoal records in Marlon et al., 2008. However, the recent rise in fire activity is driven in part by newly incorporated high latitude records (such as those in Quebec) and the findings from this newer paper should be mentioned at this point. (Marlon J.R., R. Kelly, A-L. Daniau, B. Vannière, M.J. Power, P. Bartlein, P. Higuera, O. Blarquez, S. Brewer, T. Brücher, A. Feurdean, G. Gil Romera, V. Iglesias, S.Y. Maezumi, B. Magi, C.J.C. Mustaphi, and T. Zhihai. “Reconstructions of biomass burning from sediment-charcoal records to improve data-model comparisons.” *Biogeosciences* 13 (2016): 3225-3244. DOI: 10.5194/bg-13-3225-2016)

Page 2, Lines 8 and 9: Cite Rhodes et al., 2016 (Rhodes, R. H., X. Faïn, E. J. Brook, J. R. McConnell, M. Sigl, O. Maselli, J. Edwards, C. Buizert, T. Blunier, J. Chappellaz,

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J. Freitag, 2016. Local artifacts in ice core methane records caused by layered bubble trapping and in-situ production: a multi-site investigation. *Climate of the Past*, 12, 1061-1077, doi:10.5194/cp-12-1061-2016. <http://www.clim-past.net/12/1061/2016/> regarding in situ production of methane in ice cores.

Section 2.1: As you developed an entirely new age scale for this ice core, it is essential to mention in this section why you developed this new age scale and any strengths/weaknesses of this age scale compared to the previously existing depth-age relationship.

Section 3.1: While I completely appreciate the amount of time and effort it takes to run 3,294 samples, why were ~700 fewer samples run for p-HBA than for VA? Were fewer samples run for p-HBA as the concentrations were often (76% of the time) below detection limits? The discussion on syringic acid in this section was one of the most interesting parts of the paper, and thank you for including this discussion the vast majority of the samples were below the detection limit, as this discussion is a service to the scientific community.

Page 7, Lines 33-34: Refer the reader back to the supplementary information regarding the age-depth scale.

Page 8, Lines 8-13: Cite these ecofloristic subdivisions in Table 1.

Page 8, Lines 13-14: Why did you start the back-trajectories at 100 m above ground level?

Page 9, Lines 14-24: To what do you ascribe the difference between the Akademii Nauk and Kamchatka Peninsula VA nad p-HBA concentrations in the 20th century? Figure 7 highlights this offset and readers are left wondering if this difference may reflect local or regional difference in biomass burning.

Page 10, Line 11-17: While describing all of the possibility interactions between the PDO and Indian Ocean monsoon is beyond the scope of this paper, mentioning that

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these two phenomenon interact and are not completely separate from one another demonstrates that the cited papers are not in conflict with one another.

Conclusions: The final statement of the discussion that “the similarity in timing between the Siberian biomass burning pulses, the Bond events, and the monsoonal changes likely suggests a link in this region between fires and large-scale climate variability on millennial time scales” is the true conclusion of the paper. While the points outlined within the conclusion section are valuable, they are weaker than the finding of the connections between North Atlantic and Central Asian climate resulting in increased fire activity and then recorded in a Siberian ice core. I suggest rewriting the conclusions to emphasize the climatic aspects of this work rather than concentrating (as in the current form) on the use of VA and p-HBA as biomass burning proxies.

Figure 8: Why do you use the Pages 2K temperature reconstruction if this record does not encompass the entire time period that you are examining? If you are absolutely convinced that this temperature reconstruction must be used, then also incorporate other high latitude Northern Hemisphere temperature reconstructions that extend back through the entire record.

Technical corrections:

Abstract, line 13: Define “it” (ie. “this study”, “or results”, etc.)

Page 2, line 3: Replace “difference” with “different” and use another adjective rather than repeating “very different” twice in the same short sentence.

Page 9, Line 7: Define “this” (ie. “This result”).

Page 11 Lines 11-14. You repeat the same sentence twice.

Interactive comment on Clim. Past Discuss., doi:10.5194/cp-2016-126, 2016.

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