

Interactive comment on “Methoxy aromatic acids in an Arctic ice core from Svalbard: a proxy record of biomass burning” by Mackenzie M. Grieman et al.

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Comments by Michel LEGRAND on the manuscript entitled “Methoxy aromatic acids in an Arctic ice core from Svalbard: a proxy record of biomass burning” by Mackenzie M. Grieman et al.

This paper reports on the concentrations of aromatic acids (vanillic and parahydroxybenzoic) measured along a Svalbard Arctic ice core covering more than 800 years. These acids that are used as proxies of biomass burning were measured by using a technique (IC-ESI-MS/MS) recently developed at the department of Earth System Science at Irvine (CA). The obtained records are then compared to those derived from

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another ice core extracted at the Akademii Nauk ice cap located in the Eurasian Arctic. Data on past frequency of boreal fires are of great importance since the boreal forest represents an important carbon reservoir and experiences predominantly natural fires of which the severity is expected to change with future warming and the subsequent modification of spring/summer/fall conditions. In contrast to Canadian fires, Siberian fires are far less documented except for the very last decades when satellite data has strongly increased the accuracy of estimated burned area of this region. The Svalbard experiencing air masses from Siberia and to a lesser extent from Europe, this paper provides new information together with those recently extracted from the Akademii Nauk on Siberian fires over the past. The paper is therefore of great interest for scientific communities working on forest fire records in ice cores and lake sediments as well as for the general topic of climate/fire conditions/vegetation interactions. Overall the manuscript is well organized and clearly written. The discussion of data is generally well conducted and very good. I therefore recommend publication of the manuscript, after authors consider the following (minor) points rise below.

Overall comment: Several recent papers have launched the discussion on the quality of different potential proxies to reconstruct past biomass burning activity from ice (see Rubino et al., 2016; Legrand et al., 2016). There are two types of fire proxies: (1) minor organic species like levoglucosan and different resinic and aromatic acids, and (2) various major inorganic species including ammonium that was extensively used to reconstruct North America fires in Greenland ice (see Savarino and Legrand, 1998; Fischer et al., 2015, for instance). There are now two studies having investigated past biomass burning from sites exposed to air masses coming from Eurasia (Grieman et al., 2016, and the present work) by using organic markers. At least for the Svalbard ice core, major ions including ammonium are also available (Wendl et al., 2015). Checking the ammonium profile (Figures 3 and 4 in Wendl et al.), I see three time periods with elevated ammonium levels (around 1370, 1545, and 1900) but nothing in 1300. Can we conclude from that ammonium is not an adequate biomass burning tracer in this region? Is this difference for ammonium between Arctic and Greenland sites related

to difference of altitude of plumes (more scavenging at the low elevated marine site of Svalbard??). Please comment if possible. Please also note that Wendl et al., discussed the ammonium record in Svalbard as follows: "A period of exceptional high fire activity around 1600–1680 in Siberian boreal forests of Eurasia was detected in the ice core fire tracer records from the Siberian Altai (Eichler et al., 2011). This unique period did not lead to a maximum in the Lomo09 NH₄⁺ record. Therefore, we conclude that biomass burning is not a major source of NH₄⁺ arriving at Svalbard." Fischer, H., Schüpbach, S., Gfeller, G., Bigler, M., Röthlisberger, R., Erhardt, T., Stocker, T. F., Mulvaney, R., and Wolff, E. W.: Millennial changes in North American wildfire and soil activity over the last glacial cycle, *Nat. Geosci.*, 8, 723–727, doi:10.1038/NGEO2495, 2015. Eichler, A., Tinner, W., Brusch, S., Olivier, S., Papina, T., and Schwikowski, M.: An ice-core based history of Siberian forest fires since AD 1250, *Quaternary Sci. Rev.*, 30, 1027–1034, 2011. Savarino, J. and Legrand, M.: High northern latitude forest fires and vegetation emissions over the last millennium inferred from the chemistry of a central Greenland ice core, *J. Geophys. Res. Atmos.*, 103, 8267–8279, 1998.

Minor points: Abstract: Please specify for which season air mass back trajectories were computed and for how many days. Page 4, Line 5-8: Please specify for how many days air mass back trajectories were computed. Page 2, line 9: Please clarify the reference Rubino et al. (2015): In my record the paper had appeared in 2016: The Anthropocene Review 2016, Vol. 3(2) 140–162. Page 6, Line 30-33: Please specify for how many days air mass back trajectories were computed for both sites (5 days ?, 10 days ?). Figure 7: Sodium at GISP 2: This figure will not really convince the reader that the NAO influences the sodium record in central Greenland. By the way, what tell us the sodium record at the Svalbard site (available in Wendl et al., 2015) in Figure 3 and 4. May be a comment is welcome in the discussion here (in section 3.4).

End of the review

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