Climate
of the Past

Open Access

EGU

Discussions

CPD

Interactive
comment

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.

Mackenzie M. Grieman et al.

mgrieman@uci.edu

Received and published: 30 January 2018

The referee raised several points and the comments are appreciated. The manuscript has been changed as described below to take them into account. Referee comments are numbered and our responses follow.

1. Page 1 Lines 5 and 6: "Vanillic acid levels are high (below the limit of detection to 0.1 ppb) from 1200-1400 CE, then gradually decline into the 20th century." Concentrations below the level of detection cannot be high by definition.

This sentence has been changed to: "Vanillic acid levels are high (maximum of 0.1

ppb) from 1200-1400 CE, then gradually decline into the 20th century."

2. Page 1 Line 9 to 10: Are Siberia and Europe the primary source regions throughout the time period of the entire study? Or are they the primary modern source regions?

This sentence has been changed to: "10-day air mass back trajectories for a decade of fire seasons (March-November, 2006-2015) indicate that Siberia and Europe are the principle modern source regions for wildfire emissions reaching the Lomonosovfonna site."

3. Lines 19 to 20: "Boreal wildfire areal extent appears to have increase significantly with warming during the past few decades" needs a citation.

This sentence has been removed.

4. Page 3 Lines 20-29: Why do you use ten-year bin averages rather than, for example, 10-year moving averages? If the dating uncertainty below 80 m is 10 years, then are ten-year bin averages too narrow of a time frame? It is essential to explain your reasoning in this section.

The choice of bin-averaging over moving averages is not significant. To demonstrate this, we added moving averages to Figure S8 for comparison to the bin average. The differences between the two are very slight and would not impact the interpretation.

We note that the dating uncertainty is an issue of absolute age assignment, not time resolution, so it is not really related to the issue of resolving signals.

5. Page 4 Line 5: Why did you choose to start the trajectories at 100 m above the ice surface?

We were initially concerned about how representative ground-level back trajectories would be given the potential for shallow, highly stable boundary layers, inversions, etc. So, we conducted trajectories starting at multiple levels from the surface to 500m above surface. These all gave very similar results. We arbitrarily selected 100m.

6. Page 4 Lines 8 and 9: What is the latitudinal boundary for North America, Siberia and Europe in your study?

The following sentence was added beginning on Page 4, lines 19-20: "The boundaries of North America, Siberia and Europe were defined using global self-consistent, hierarchical, high-resolution geography database GIS shapefiles (Wessel et al., 1996)."

Wessel, P., and W. H. F. Smith, A Global Self-consistent, Hierarchical, High-resolution Shoreline Database, J. Geophys. Res., 101, 8741-8743, 1996.

7. Section 3.1: Either refer to this section in Page 3 Lines 20-29 or else move the entire section to immediately follow the current Page 3 lines 20-29 where you first describe that you use 10-year bins for your data.

A reference to Section 3.1 has been added to Page 4, line 10: "Ten-year bin averages are used to illustrate short-term variability in the data (see Section 3.1)."

8. Page 5 Lines 13 and 14: Were the geometric means and standard deviations used because of the skewness? I think that this is what you would like to say, but please rephrase to your meaning is clear.

Page 5, Lines 13-14 were changed to the following: "Geometric means and standard deviations were used for all statistics because the frequency distribution of the data was skewed towards lower concentrations."

9. Page 5 Line 15: At the deepest section of the core, how many samples do you have in each 10-year bin?

The time bin from 1221-1225 contains two samples. The first 10-year time bin from 1225-1235 contains 4 samples. The long-term declining trend also is shown using 40-year bin averages.

10. Page 5 Lines 28-30: Can this long-term decreasing trend be caused by decomposition or degradation of VA and p-HBA through time? (Refer the reader to Section 3.6

to demonstrate that you have considered these possibilities).

Degradation of VA and p-HBA would cause a long-term increasing trend because VA and p-HBA deeper in the ice core would have degraded.

11. Section 3.4 and Conclusions: Stating that an "atmospheric reorganization" due to changes in the SNAO affects the differences in biomass burning tracers is quite a bold statement. Although you describe the spatial patterns of the SAO, a figure can better demonstrate the influence of the SNAO on transport affecting these two ice cores sites. The back trajectories for the positive SNAO index (1970-1979 CE) and negative (1948-1957 CE) can help depict the source regions and transport paths. Figure 2 of Folland et a., (2009) is an excellent example of the spatial extent of the summer NAO. However, plotting an example of the spatial patterns for a positive SNAO (1970-1979 CE) and negative SNAO index (1948-1957 CE) can also add essential support to your argument.

We agree that the statement was perhaps too strong. We revised Page 10, line 15 to: "We suggest that a change of high latitude northern hemisphere atmospheric circulation patterns occurred at this time,. . ."

We took the suggestion to make a new figure. Figure 9 was removed because it did not add to the argument. Figure 9 was replaced with a new figure. The following text has been added, Page 10, lines 30-33: "Figure 9 shows the major spatial clusters of 10-day air mass back trajectories for each time period (computed using Hysplit) superimposed on the sea level pressure (SLP) anomalies relative to mean SLP from 1948-2017. The high SNAO period is characterized by 1) high pressure over Scandinavia, favoring drier conditions, and 2) trajectories generally originating at lower latitudes, with a larger fraction of transport from Scandinavia."

12. Section 3.5: You mention that "the long-term trends in the VA/p-HBA ratio presumably reflect changes in the relative contributions of fuel types or changes in atmospheric transport". I kept expecting you to tie these possible changes in atmospheric transport

back to the discussion of the SNAO. This lack of a mention of causes of these atmospheric changes is surprising in light of the previous section.

The following has been added to section 3.5: "There are significant long-term changes in the Lomonosovfonna VA/p-HBA ratio over time. The ratio is relatively high during the MCA (0.8), decreases by a factor of two from 1200-1400 CE, remains low through the LIA until around 1800 CE (Fig. 3). There is also an increase in VA/p-HBA after 1800, although VA is close to the detection limit and the uncertainty in the ratio is consequently large. Interestingly, the changes in the VA/p-HBA ratio broadly mirror changes in the phase of the paleoreconstructions of the NAO and SNAO (Fig. 8). One might speculate that the associated changes in climate and transport mentioned earlier contribute to the variations in the VA/p-HBA ratio but the specific causes are not understood at this time."

―――――――――――――――――――

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2017-121, 2017.