

Interactive comment on “Temporally-Delineated Sources of Major Chemical Species in High Arctic Snow” by Katrina M. Macdonald et al.

Anonymous Referee #3

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Review for Atmos. Chem. Phys. Discuss. Temporally-Delineated Source of Major Chemical Species in High Arctic Snow
General review: The paper provides apportionment of chemical components in high Arctic snow, which is of interest. Some of the interpretation of source region and emission source connected to the PMF factors was not sufficiently supported and seemed stretched; this was particularly true for the discussion for the sulfate factor and the attribution of V, As and Se to dust/crustal materials in the dust factor. Improved consistency is needed for naming across the text, figures, and tables. I agree with comments provided by the previous referees.

Detailed comments:

P 3 Ln 5-7. You need to give a bit more detail here, regardless of whether you are following previous protocol as this paper needs to be able to stand alone.. How are

these melted? How is the filtration accomplished? What is the storage protocol? How are the blanks?

P6 Ln 17: Please make this more explicit, especially for ones where there is temporal overlap in the peak concentration of the factor.

P8 Ln12: Please make all factor names consistent: sea salt/marine sea salt/marine factor, choose one and use for all tables, text and figures.

P9 Ln13: You should be able to find the ice extent for these specific time periods for the locations mentioned. Also, based on the heat map in Figure 3 for Factor 1 (you should really include the Factor names here as well, as it is difficult to keep track of which factor is which across a couple figures), the longest residential time is north of Greenland and Siberia – are these areas open water in January 2015? Wouldn't the open water have to have been close to the site for the correlation to local wind speed be relevant for sea spray sourcing?

Figure 1: clarify whether these are soluble, insoluble or total metals.

P11 Ln3: make all factor names consistent throughout the manuscript: crustal metals vs dust. Also, the high contribution of V, As and Se might indicate anthropogenic pollution (i.e. coal or heavy oil combustion) not just "dust".

Figure 3: the cyan diamonds and green triangles are very difficult to see.

P14 Ln10: for Russian BC sources, there have been two new studies in the last year that should be included here and incorporated into the discussion: Evans, Meredydd, Nazar Kholod, Teresa Kuklinski, Artur Denysenko, Steven J. Smith, Aaron Staniszewski, Wei Min Hao, Liang Liu, and Tami C. Bond. "Black carbon emissions in Russia: A critical review." *Atmospheric Environment* (2017). Winiger, Patrik, August Andersson, Sabine Eckhardt, Andreas Stohl, Igor P. Semiletov, Oleg V. Dudarev, Alexander Charkin et al. "Siberian Arctic black carbon sources constrained by model and observation." *Proceedings of the National Academy of Sciences*(2017): 201613401.

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P14: for detailed comparison with previous high Arctic snow apportionment studies, do also take into account more of the potential impact of Arctic location. The Hegg studies were quite different in the study design, representing PMF of a large number of Arctic sites as opposed to PMF at a single Arctic site.

Table 2: include location of the studies. The location is very relevant in terms of understanding BB impact across the Arctic. For the apportionment/co-variance (again, use the same terms in the text and tables to avoid confusion), include types of species used in the modeling for BC apportionment.

Pg16 In 1: I think this sentence has been truncated “. . .linked with both biomass burning plumes. . .” and?

P17 In13: where are source areas shown in Figure 2?

P17 In15-16: It's not clear how this factor coincides with increased transport over the ice-free Norwegian Sea and northern Atlantic. Remove unless you can support

P18 In 20-21: the Flexpart in Figure 3 does not seem to match with the assignation of sulfate to volcanoes and the Smoking Hills.

P18-19: the explanation for the sulfate factor was a bit forced to match volcanism. If the metals factor was combined with sulfate in the six factor solution, it would seem that would indicate an anthropogenic source. When comparing to the connected Macdonald paper, the co-variance of sulfate and MSA (or MS, as it was called in the previous paper), might be spurious as MSA is only high in the early part of the campaign.

Figure 4: use the same naming for factors across all figures, text and tables. The abbreviation is difficult here.

P21 In 13: again, take location into account for comparison with other Arctic BC studies.

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