

## ***Interactive comment on* “Sources of anions in aerosols in northeast Greenland during late winter” by M. Fenger et al.**

### **Anonymous Referee #2**

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This paper provides size segregated aerosol data from March 2009 for Station Nord in Greenland. The dataset here is very limited (just 9 discrete sampling periods), and ordinarily would not warrant a paper in ACP. However, its novelty lies in the fact that the size segregation allows new discussion of possible sources for a region where little is known. As a station truly facing the high Arctic, and relatively close to some ice core sites, there is certainly interest in gaining this knowledge. The paper needs clarification in a few places, and a little work at copyediting stage on the English (“the” is used in places where it should be omitted and vice-versa). Additionally the interpretation of nitrate in particular seems incomplete to me. Finally, the paper is written in a vacuum, without any discussion of what has been found in previous work at this station: this should be rectified. I will discuss all these details below.

Introduction: Please summarise what has been concluded from earlier work (Heidam papers) at this station. I know that sulfate and nitrate at least over several years have been reported in these papers. In particular, please describe the typical concentrations encountered in March (so we can understand whether the values in the current paper are typical), and the context of the seasonality observed in previous data, plus any insights given in previous work about sources. This will all serve to set the scene for this paper.

Page 14817, lines 10-20 and Fig 2. I am not sure why you include Fig 2, or such an extensive discussion of wind speeds, as they are not used in the later analysis. I would recommend removing Fig 2 and replacing it with a plot of the data (see under section 3).

Page 14818, line 13. Is this the detection limit for each stage (if so, please say so)? But I need to question how these detection limits were reached. As an example, in the original version of this paper, the SD of the blank for nitrate analysis in the filter extracts was stated as 0.07 mg/L. With 6 mL of extraction water, that means the standard deviation for analysis of a filter is 0.42 ug. With a flow rate of 30 L/minute, 3 days gives 130 m<sup>3</sup> of sample. Therefore one would calculate an uncertainty of at least  $0.42 \times 1000 / 130 = 3$  ng/m<sup>3</sup> (9 ng/m<sup>3</sup> for 1 day samples). And yet you give an SD 10 times lower than that. This requires some explanation (similar for other anions), or else changes in the table.

Page 14819, lines 10-11, please clarify that these concentrations are the totals for each stage. Line 13: please explain what these standard deviations are. They are clearly not the SD of an anion across the 9 samples (for Cl, the mean value is 266 and the SD is 151 ng/m<sup>3</sup>). So what are they (indeed I can't understand how there can be a range of SDs for each anion).

Same section. The paper needs a plot of the data. I suggest a bar chart to replace Fig 2, showing the dates of sampling, and for each sampling period, a bar showing the

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total concentration, either broken down into each size range as different colour steps on the bar, or as fine fraction ( $< 1 \mu\text{m}$ ) and coarse ( $> 1 \mu\text{m}$ ) or similar. Please also show with some symbols which type of trajectory each sampling period represents. (Fig 3 (NO<sub>x</sub>) could easily be incorporated into the same figure, though I don't insist on that.) This will be much more informative to the reader than the description of the data and sampling periods, which is very hard to retain in the reader's mind.

Page 14820, line 21. Is Grube 2012 or submitted (also in ref list please state to what journal submitted)? line 21-24. This sentence needs rewording: it is not sulfate that has a climate effect but the aerosol containing sulfate.

Page 14821, line 24-27. I don't understand this part of the sentence, please rewrite it another way.

Page 14822. While frost flowers could explain the large particles, also consider the possible source from blowing snow (Yang, X., Pyle, J. A. and Cox, R. A.: Sea salt aerosol production and bromine release: Role of snow on sea ice, *Geophys. Res. Lett.*, 35, L16815, doi:10.1029/2008gl034536, 2008.) Presumably you have data on blowing snow occurrence at the station at least.

Page 14823, line 5. While I agree the lab may not correctly mimic the field, remember that a similar result was found for some Arctic frost flowers (Obbard, R. W., Roscoe, H. K., Wolff, E. W. and Atkinson, H.: Frost flower surface area and chemistry as a function of salinity and temperature, *J. Geophys. Res.*, 114, D20305, doi:10.1029/2009JD012481, 2009.)

Page 14823. For nitrate there is plenty of evidence elsewhere that nitrate reacts with sea salt, and may exchange with chloride, and therefore end up partly in the size range of sea salt. For the Antarctic this is discussed in e.g. (Rankin, A. M. and Wolff, E. W.: A year-round record of size-segregated aerosol composition at Halley, Antarctica, *J. Geophys. Res.*, 108, 4775, doi:10.1029/2003JD003993, 2003.), and I am sure there must be some Arctic studies on this as well. Please consider this.

End of page 14823. While I have no doubt that snow photochemistry is an important source of NO<sub>x</sub>, I don't understand the point being made here. The whole nitrate discussion is very messy and needs rethinking.

References: Heidam 2004 has some non standard characters that have come out wrong. Table 1: What is DG? (do you mean DL?). Figure 8, please add a star or mark for the location of the station.

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