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The Cryosphere Discussions

Interactive comment on "Frost flower chemical signature in winter snow on Vestfonna ice cap (Nordaustlandet, Svalbard)" *by* E. Beaudon and J. Moore

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Dear Mauri Pelto,

First of all, we would like to thank you for your positive comments and interesting remarks about points that were not always perfectly stated in the text. We address each of these points in this short reply. Providing our explanations are clear and satisfactory enough, we will use them to strengthen our paper.

MP:168-14: Given that Pit 2 is at a similar elevation and is further from the ocean in terms or precipitation tracks, why did a melt event occur here and not at Pit 1? This is an important question to address better.

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Interactive Discussion

Discussion Paper

ANSWER: The elevation difference between pit 1 and pit 2 is too small to invoke the altitude as a factor influencing the occurrence of melt. In addition, Vestfonna is a small ice cap and the whole Nordaustlandet Island is under oceanic influence. We think the spatial variability of melt events on Vestfonna is mainly due to local weather variability. During spring campaigns, it was not rare to work by clear sky while our colleagues experienced snowfall on the other end of the ice cap.

MP:168-2: The two prevailing wind directions are from the NW and SE at Ripfjorden. It makes sense given the enrichment in mean ion concentration at Pit 1, yet with similar accumulation rates as Pit 2, that the NW wind direction is the predominant wind direction during precipitation events. If this is true state this more plainly. Is the SE wind a localized down glacier wind or a regional wind direction?

ANSWER: In the revised manuscript we will insert a sentence stating that the SE winds are the main regional wind direction over Nordaustlandet, and that easterly winds are dominant during the winter (Niedzwiedz, 1997; Dagestad et al., 2006). At Ripfjorden station (sea level), SE winds could also be katabatic winds from Austfonna.

MP: A point that I would suggest elaborating upon: In the conclusion it is noted that frost flowers would from preferentially in areas lacking multi-year ice. Is it than likely that the appearance of a frost flower chemical signature layer is indicative of nearby open water? If so, in an area that is dominated by multi-year ice, say northern Ellesmere Island, would such a layer be a good indicator of a period of reduced multi year ice? To me this is the potential value of the identification of this frost flower chemical signature.

ANSWER: The FF would form preferentially in area of young sea ice formation. The detection of more FF chemical signatures in e.g. ice cores from areas around which present-day multi-year pack, could indeed indicate that young sea ice was more frequently formed at that time in the past. This deserves to be emphasized and we will use this remark to reformulate the conclusion.

MP: Table 1 illustrates the difference in ion concentrations between Pit 1 and Pit 2. I

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would also like the Frost flower layer data to be in this table. It is important to contrast the values of the layer to the Pit 1 mean and Pit 2 mean. This is done graphically in Figure x, but I should be done in the table 1 also for ease of comparison.

ANSWER: We made a new table giving the average ions concentrations in the FF layer. This new table will be inserted in our revised manuscript.

MP: Figure 2: What is the cause of the spike in Pit 1 of Log [Na+]/[Mg2+] ratio? It is noted earlier that an increase in this ratio indicates summer melting. What does it indicate in the winter? In Figure 3 this layer does not stand out in terms of ion concentrations. Yet, this obvious anomaly should be explained.

ANSWER: Log [Na+]/[Mg2+] is an indicator of melting (not only for summer melting). This ratio peaks at 35 cm deep in Pit 1. The ion concentrations in that peculiar layer are lower than the layers above and below and the stratigraphy shows a thin icy layer (0.5cm) at that depth. This can be interpreted as a short melting event in winter. There is no peak in nitrate (which is eluted more easily than other ions), in the FF layer. This indicates that ions in the FF layer were not introduced by melting of layers above.

MP: Figure 3: What is the reason for the NH 4 minimum in the frost free layer? As noted this is the exact opposite of that expected from a warm weather event. Why would a warm weather event associate with NH4 enhancement?

ANSWER: There is no minimum in NH4 in the FF layer; it and NO3 are the only species that do not show significant peaks in the FF layer. In general NH4 peaks in autumn (Virkkunen, 2007) and is often associated with NO3 (Kekonen et al., 2002). In general it has been proposed that NO3 arises from its precursor NOx, which is emitted from biotic activity in soils, biomass burning and oxidation of ammonia. Emissions from these sources plausibly peak in autumn. High Na and Cl concentrations in the FF layer are not likely to be caused by advection of warm air coming from the South. This is consistent with cold conditions required to form sea ice, and consistent with low NH4 and NO3 concentrations.

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Interactive Comment

MP: A minor comment P 165 line 14 major marine species: makes me think of mollusks. Change to clearly indicate chemical species not aquatic species.

ANSWER: We will replace it by "major marine ionic species"

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