

## ***Interactive comment on “800 year ice-core record of nitrogen deposition in Svalbard linked to ocean productivity and biogenic emissions” by I. A. Wendl et al.***

**Anonymous Referee #3**

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This manuscript reports 800-yr records of nitrate and ammonium from a new ice core drilled on Lomonosovfonna glacier/Svalbard in 2009. 20th-century nitrate and ammonium are both attributed mostly to anthropogenic emissions from Eurasia, whereas pre-industrial ammonium is linked to emissions from Siberian boreal forests. For pre-industrial times the authors report a high correlation between nitrate and methane sulfonic acid (MSA) on decadal time scales, which had not been noticed in a previous core drilled nearby. The association between nitrate and MSA is interpreted as a fertilising effect in the surrounding seas where increased atmospheric nitrogen input triggers phytoplankton growth and increased emissions of the MSA precursor dimethyl

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sulphide (DMS). Melt in the snow-firn column, a common feature on Lomonosovfonna glacier, is excluded having an impact on the measured chemical parameters.

After the 1997 core this is the second ice core recovered from Lomonosovfonna glacier and the authors have to be commended on their sound dating of the ice core, including age uncertainties as a function of depth. However the interpretation raises questions. Most importantly the authors' claim that post-depositional effects due to percolating melt water are small and do not affect the ion records at the site is questionable. Some of the features present at the higher resolution are masked when working with decadal averages. For example, Figure S2 in the appendix shows a marked decrease in absolute concentration, concentration amplitude (smoothing) and frequency of annual spikes for nitrate, MSA and to some extent also sodium (ammonium) over two depth intervals: one between 0 and 10 m-weq (~1994-2009) and one between 30 and 42 m-weq (~1912-1955); the interval between 10 and 30 m-weq stands out with comparably larger spikes. To my eye this suggests a post-depositional artefact. Indeed, during the 20th century annual melt fractions (not percent as the y-axis suggests) frequently exceed 0.8 (Figure S3) supporting the suspicion that they may be an impact of melt on the ion record. Before making any further strong conclusions based on an ice core record potentially biased by post-depositional processes the authors need to take advantage of the available high resolution chemistry data and a) report raw data in the main paper and b) investigate in more detail the relationship between melt fraction and relative position of ion spikes. Is there any (possibly preferential) elution and displacement of the measured ions? If so, could post-depositional displacement explain some of the observed inconsistencies between the Lomo97 and Lomo09 cores (e.g. a correlation between ammonium and nitrate in Lomo97 but not in Lomo09)?

A few more specific comments:

p24672 - l23 As acknowledged by the authors ammonium analyse can be tricky, and the lower values compared to the Lomo97 results raise confidence in the data. However, what was the ammonium blank concentration? Is it possible that the higher values

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in Lomo97 are due to a higher blank, which had not been corrected for?

p24673 - I16 It would be informative to show annual accumulation rate vs time along with the raw ion data, as well as relative change in temperature (from  $\delta^{18}\text{O-H}_2\text{O}$ ) to further check for post-depositional artefacts

p24675 - I11 Not really, Fig.3 shows that Holte05 ammonium is quite different compared to Lomo09.

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