

Interactive comment on “Air-snow transfer of nitrate on the East Antarctic Plateau – Part 1: Isotopic evidence for a photolytically driven dynamic equilibrium” by J. Erbland et al.

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Erbland et al. report observations of d15N, d18O and D17O of nitrate in surface air and in snow pits along a transect between DDU and Dome C. They also report results from a field experiment measuring the isotopic fractionation associated with evaporation of HNO₃ from snow. Overall, this paper is excellent. The loss of nitrate from Antarctic snow from photolysis and evaporation has implications for Antarctic boundary layer chemistry and the preservation of nitrate and possibly other chemical species in ice cores. The observations reported here, and their interpretation, provide and will enable more quantitative estimates of these processes in snowpack and improve our

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understanding of Antarctic boundary layer chemistry and ice core records of nitrate.

The only significant comment that I have is related to the evaporation experiments. I found myself wondering exactly how to interpret the reported fractionation constant, as I wasn't sure whether or not to think of it as an open or closed system and how closely this experiment mimics the real world. For example, how much does potential redeposition of HNO₃ influence the fractionation constant? Two types of transport within the firn exist (diffusion and windpumping), while in the experiments it will only be diffusion. How important is this in determining the amount of redeposition in the firn, given that the lifetime in the snowpack interstitial air may be longer than in the real world?

My remaining comments are relatively minor are an attempt to help make the manuscript more clear.

Abstract: It is not clear at this point what an apparent fractionation factor is. Also, the abstract is long and has too many details. Just focus on main points, and leave the details to the text.

Page 28560 Line 6: Be specific upfront on what you mean by nitrate loss. Loss by what process?

Page 28560 Line 13: replace "in parallel to" with "in parallel with".

Page 28560 Line 14-15: Can you just say evaporation, rather than physical release? It seems more specific and clear to me this way.

Page 28560 Line23: "3-4 weeks" should read "3-4 week".

Page 28564 Line 10-11: What does "isotopic transfer function of nitrate at the air-snow interface" mean? Be specific as to process or processes at this early stage in the manuscript.

Page 28566 Line 25: Replace "loading and the total" with "loading to the total".

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Page 28566 Line 26: Give unit for nitrate concentrations (e.g. ng/m³)

Page 28568 Line 5: Replace “explicited in the above paragraph” with “explained above”.

Page 28568 Lines 24-25: Radiative transfer of snow is expressed as e-folding depth. . .

Page 28568 Line 26: My memory of the France it al paper is that the e-folding depth ranges from 10-20 cm, not just 10 cm. You can also use calculations in Zatko et al., ACPD, 2012 of the e-folding depth at 305 nm, which is the more relevant wavelength for nitrate photolysis than 350 or 400 nm.

Page 28569 Line 10: Replace “is used for the calculation” with “are used for the calculation”.

Page 28570 Line 4: Snow, not snowe.

Page 28570 Lines 23-24 and Figure 7a: What is the asymptotic nitrate flux? Flux up? Flux down? Net flux? This should be explained in section 2.4, and it is not mentioned here.

Page 28571 Line 9: Replace “the two others” with “the other two”.

Page 28572 Line 14: remove “further”.

Page 28572 Line 18: d15N(NO₃⁻) of nitrate in the atmosphere or in the snow?

Page 28572 Line 21: Replace “by the end” with “at the end”.

Page 28573 Line 5: Remove “Indeed”.

Page 28574 Line 6 and elsewhere: Don’t refer to -8.5 to be “near zero”. Although closer to zero than the photolysis fractionation factor, it is not near zero. This is confusing.

Page 28574 Line 16: Replace “Antarctic sites” with “Antarctic site”.

Page 28575 Line 24: Replace “a low average” with “an”.

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Page 28578 Line 13: Does HNO₃ have a shorter lifetime than NO_x? If so, why?

Page 28579 Line 20: Replace “close” with “similar”.

Page 28581 Line 8-9: Remind the reader here what is your slope, for ease in comparison with the Freyer study.

Page 28582 Line 5: MIF occurs during deposition? I think this would be mass-dependent, and thus not impact the D17O.

Page 28582 Line 6: Define what you mean by “reservoir effects”.

Page 28583 Line 20: “involve” not “involved”.

Section 5: What about a discussion of the impact of “light”HNO₃ derived from the photolysis of snow nitrate depositing downwind of its emission? Wouldn't this impact (lower?) the apparent fractionation factor?

Page 28586 Line 3: “. . .still be mobilized via evaporation, but any net loss. . .”

Last 2 sentences of 2nd to last paragraph (beginning with “Nitrate recorded in ice cores. . .”): I do not know what you are saying in these 2 sentences, especially the second one. I think it's just too vague. Be more specific about your implications.

Last sentence: Remove “(undergoing)”.

Figure 5. Describe x-axis in caption. Figures should be stand alone.

Figure 9 caption: I don't understand what the last sentence means.

Combine Figures 9 and 10.

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