The Cryosphere Discussions

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Review report

Anonymous Referee #2

Referee comment on "Impacts of the photo-driven post-depositional processing on snow nitrate and its isotopes at Summit, Greenland: a model-based study" by Zhuang Jiang et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-92-RC2, 2021

Jiang et al. revisited previously published Summit snowpack nitrate isotope data using a snow photochemical column model (TRANSITS). It was found that post-depositional processes at Summit can explain the observed seasonal variability of d15N without considering the source variability of reactive nitrogen species. Although the modeling result may be further tested and improved by observation-based parameterizations of some parameters such as d15N of atmospheric nitrate, this work challenges previous expectations and highlights that post-depositional processes on isotopic compositions of cryospheric nitrate at a site with relatively high snow accumulation rates like Summit still should be carefully considered in the future. The model is scientifically sound and its uncertainties are well discussed. I expect that the findings will stimulate more studies. I recommend its publication in The Cryosphere and only have some minor suggestions to improve the clarity of this manuscript.

Lines 30-35: I would suggest the authors to introduce d15N as well because d15N is the major focus of this study.

Line 49: As stated later by the authors, “the degree of post-depositional processing and the induced effects on snow nitrate and isotopes vary site by site” (Line 56). The values presented here seem too precise to represent the fractionation factors “under typical polar conditions”.

Lines 51-55: The local atmospheric chemistry of photolysis product NO2 as stated earlier (lines 42-47) may also alter D17O values.

Lines 60-63: The logic may be more clear if the authors can give the snow accumulation rate at Summit and discuss whether post-depositional processes were expected based on this number.

Lines 65: It may be better to quantify "surface" (<3 cm?) so that readers can compare the number to 30-40 cm without reading Fibiger's papers.

Lines 82-89: The term "snow-sourced" nitrate appears many times in the rest of manuscript but not here. I would suggest the authors to define "primary" and "snow-sourced" nitrate at the beginning.

Line: 170: The value of k is not given.

Lines 178-182: It is unclear how the epsilon-d is determined and which value is used.

(I suggest the authors to give a table, in either main text or supplementary materials to show all parameters and values used in the model and sensitivity tests).

Lines 264-271: There are too many terms that are similar but not clearly organized (FD, FP, Fpri, snow-sourced). They could have been more clear. I would suggest the authors to define everything at the very beginning (e.g., Section 2). Otherwise it may be difficult for readers to follow.

Figure 2: Since FP is zero in winter, the authors may want to remove red lines during wintertime in panels b and c.

Lines 299: The definition is not clear. What is the baseline?

There are some grammatical errors that need to be corrected (e.g. Lines 172, 230, 248).