The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2021-87-RC2, 2021

Comment on tc-2021-87

Anonymous Referee #2

Referee comment on "The role of sublimation as a driver of climate signals in the water isotope content of surface snow: laboratory and field experimental results" by Abigail G. Hughes et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-87-RC2, 2021

General comments:

This paper examined the role of sublimation as a driver of isotope climate signal preserved in ice cores. This study conducted two experiments in laboratory and field (Greenland) and a modelling for lab experiment. Each of the three major topics, experiment, modeling, and field experiments, are interesting and the data will be valuable. However, I think that each topic ends up with insufficient discussion/interpretation. In addition, because of the three topics, it is difficult to understand the main findings of this study. Please see my comments for details. Overall, substantial revision is needed for this MS.

Major comments

(1) L310 "This contradicts the traditional theory of sublimation, which states that sublimation occurs layer-by-layer and does not alter the snow isotopic composition….(Dansgaard et al., 1973)".

>This is one of major arguments of this paper. Please explain why the traditional theory is wrong. During sublimation, the remaining ice is not mixed. Thus, the isotope ratio is not controlled by typical Rayleigh distillation. This basic concept sounds very reasonable and therefore many people believe it.

(2) The model used in this paper is based on a mass balance, in which input data is the observed vapor isotope ratio. Thus, it is not surprising that the model result agrees with the observation. I think different approach is needed to understand the physical process behind this experiment. For example, Figure 4 shows significant decrease of relative humidity. This should affect kinetic fractionation during sublimation. Thus, the net isotope

fractionation factor had changed during the experiment. How much this affects your observation? The impact of changing fractionation factor may be evaluated (i.e., Craig-Gordon model). This is important because the snow/vapor isotope composition changed because of changing fractionation factors.

(3) Please state clearly what is new compared to previous studies in Introduction. Sampling depths apper to be finer for this study? What new for the laboratory experiment?

(4) Maybe the originality of this study is that the combination of the tree topics (lab, field, and model). If so, what did you "learn" from the combination? As the authors themselves noted, the laboratory experiment is difficult to compare the field result because of extreme condition of the lab experiment.

(5) Reproducibility is the crucial for such experiment. Thus, please describe the setting of the experiment strictly (please refer to specific comments).

(6) I do not understand the exact purpose of the FB experiment because the condition (the box and cloth cover) is too far from nature. Maybe this is designed as an intermediate between laboratory and field?

(7) Please add the raw data and modelling code you used in supplementary material so that the readers can reproduce the figures.

Specific comments

L6 "how vapor-snow exchange and sublimation processes…."

>I think that the physical mechanism behind the vapor-snow exchange process is sublimation and deposition. Why did you say "the vapor-snow exchange and sublimation"? In fact, the two terms appeared several times throughout the paper.

L.18 "our results demonstrate that post-depositional processes such as sublimation play a role…"

>Please clarify the difference from the previous findings.

L92 “Plywood box” > Add thickness.

L.93 “PID-controlled heater” > Add details (e.g., what kind of heater (cable or panel)? Wattage?). Please also illustrate the location of the heater in Fig.1a.

L.93 “with a generator” > Add details (product name, manufacture name etc.).

L94 “mass flow controller” > Add details (product name, manufacture name etc.). Please also illustrate this in Fig. 1a.

L95. “continuously-running fans” > Add details (wind speed, product name, manufacture name etc.). How many fans exactly did you install?

L.96 “small boxes” > Please add material used for this box. Please also add thickness of the boxes.

L.115 “experiments used snow”ã□□> Please add details (type of snow, density etc.)

L.137 “partially buried” > How deep exactly?

L.137 “a cloth covering” > Please add details (material used, thickness, color). I do not understand why you used the cloth. Maybe the melting occurred because the boxes only “partially” buried?

L.161 “KNF pump” > please add details (product name).

L.304 “..a strong decrease in the d-excess. This indicates that the HD16O water isotopes are preferentially removed compared to H218O”

> A decrease in the d-excess does not necessarily indicate that the HD16O is preferentially removed compared to H218O (i.e., HD16O are almost always preferentially removed compared to H218O because of larger isotope effect). The change of d-excess

depends on changes in dD and d18O relative to slope of 8.

L.304 “this indicates that the HD16O water isotopes are preferentially removed compared to H218O” > Precisely, the HD16O is an isotopologue of water. Furthermore, there is NO water isotopes, only oxygen (or hydrogen) isotope exists. But I know that many people used this term, “water isotope”. Thus, it is not necessarily to revise “water isotope” throughout this manuscript. But this sentence is a bit strange.

L355 “A site such as Renland (east-central Greenland), which receives 45 cm per year …will be less affected…. ”

> The SE-Dome core is a more suitable example of a high-accumulation site, which receives 102 cm per year. Furthermore, the ice-core d18O record is remarkably similar to the isotope-GCM outputs, suggesting negligible influence of post-depositional effect (Furukawa et al., 2017).

Reference: Furukawa, R., Uemura, R., Fujita, K., Sjolte, J., Yoshimura, K., Matoba, S., & Iizuka Y. (2017). Seasonal-scale dating of a shallow ice core from Greenland using oxygen isotope matching between data and simulation. Journal of Geophysical Research: Atmospheres, 122, 10,873 – 10,887. https://doi.org/10.1002/2017JD026716