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The Cryosphere Discussions

Interactive comment on "Significant water vapor fluxes from the Greenland Ice Sheet detected through water vapor isotopic (δ^{18}O, δD, deuterium excess) measurements" *by* Ben G. Kopec et al.

Anonymous Referee #1

Received and published: 10 December 2020

General comments: This paper examined the magnitude of Greenland Ice sheet (GrIS) vapor flux based on a 2-year water vapor monitoring data in NW Greenland. Although the data is 2-year long, the authors focused on very short periods to investigate isotopic signature of water vapor derived from the GrIS. The objective of this MS is very interesting. Intuitively, I think it is possible to see the effect of sublimation on the d-excess value. However, my major concern is that there are important issues regarding the multiple regression analysis. In addition, given that the main argument is based on the simple multiple linear regression, the overall length can be significantly shortened. Overall, substantial revision is needed for this MS.

(1) Interpretation of multiple linear regression (Figure 5 and Supplementary figure): The two major variables, humidity and wind-speed are not independent. Those two factors seem to be negatively correlated (i.e., lower humidity under higher wind as generally expected). Thus, the correlation of d-excess vs wind-speed (or vs humidity) may be an apparent correlation without physical mechanism. Generally, multiple regression itself is difficult to apply such situation because of "multicollinearity".

(2) For the regression analysis are based on humidity and windspeed data from THU_L site. Logically, the humidity and wind-speed data in moisture source area should be used. Such data would be obtained by using backward trajectory analysis or other methods. At least, the authors prove that the THU_L data is essentially similar to those of moisture source area.

(3) As described in Section 4.1, the d-excess vs wind-speed relation is complicated. But in general, the relationship is expected to be a non-linear form (Merlivat and Jouzel, 1979).Thus, I don't understand why the author expect a linear relationship between d-excess and wind-speed. In section 4.1, the author noted that "...we anticipate wind speed to have a dominant effect where higher wind speeds cause higher d-excess values whether that is a direct or indirect influence.". I cannot understand the logic of this paragraph. Maybe katabatic wind influence d-excess, but why indirect mechanism results in the linear relationship of d-excess and wind-speed?

Specific comments L167. "A station less than 1 km north" > please specify the distance (i.e., 850 m).

L191-192. "The sublimation source area is likely larger than the melt extent.."> It is often unclear how to separate "sublimation" and "evaporation" for the entire MS. Maybe the d-excess signal you observed is from "evaporation" from melted ice rather than enhanced sublimation.

L.441 "This effect is reduced to 4x greater by including.."> 4 times? The meaning of "reduced to 4 times greater" is not clear.

L.445-448. “It is possible ....argues against this” > This long sentence is difficult to understand.

L.449-450. “Meltwater evaporation would likely have a relatively high d-excess compared to that of local marine-source moisture but is lower than sublimated vapor so...”. >More data is needed to justify this argument.

L465. “It is plausible that the negative phase of NAO...”> More data is needed to justify this argument.

L.480.”typlically anticorrelated” > Please add citations.

L.525-528. “evaporation has similar effect on the vapor ...” > A big difference between evaporation and sublimation is that the remaining water is enriched for evaporation but NOT for sublimation. In the case of sublimation, the remaining ice is not mixed, so the isotope ratio is not affected by Rayleigh distillation. Of course, in reality, sublimation in firn layer is much more complicated.

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