Response to Reviewer 2

Our responses are in blue italics, embedded into the reviewer's comments.

*** general comments**

The authors describe and provide an extensive set of in-situ meteorological, snow and soil data to force and evaluate snow schemes in a tundra environment. Such an extensive set of forcing and evaluation data, especially for snow, is unprecedented in the litterature in this type of environment. As the most complex snow models to date fail to represent tundra snow charateristics, despite their huge significance at the global scale and w/r to global warming, this paper and dataset are in my opinion an important contribution to snow science.

Thank you for this encouraging appreciation.

The site and the dataset are well described, the quality assessment of the data is thorough, and the corrections performed to the data are well explained and justified (see just some minor clarification needs in the specific comments). I recommand the paper for publication in ESSD after these minor comments have been addressed.

Thank you for this positive evaluation.

*** specific comments**

L51-52: "The explanation proposed (Domine et al., 2019;Domine et al., 2016b) is that Crocus and SNOWPACK were designed primarily for avalanche forecasting in the Alps, i.e. for mid latitude warm thick snowpacks while the Arctic features cold thin snowpacks." It would seem more faithful to me to cite also the other applications of these models besides avalanche forecasting (something like " were designed for avalanche forecasting and process-studies/other applications in the Alps")

Indeed, we agree. Even though the original main motivation for developing these models was avalanche, they have been used for a wide range of application, and in particular for land surface studies, and climate and hydrological issues (Brun et al., 2013; Barrere et al., 2017; López-Moreno et al., 2020). This will be mentioned. Thank you for pointing this out.

- L58-59 : "This process is not simulated by Crocus or SNOWPACK, leading to erroneous outputs." I think the attempts to partially account for this process in both models (Touzeau et al., 2018 and Jafari et al., 2020), should be mentioned here. Touzeau, A., Landais, A., Morin, S., Arnaud, L., and Picard, G. (2018). Numerical experiments on vapor diffusion in polar snow and firn and its impact on isotopes using the multi-layer energy balance model crocus in surfex v8.0. Geosci. Model Dev. 11, 2393–2418. doi: 10.5194/gmd-11-2393- 2018

Jafari M, Gouttevin I, Couttet M, Wever N, Michel A, Sharma V, Rossmann L, Maass N, Nicolaus M and Lehning M (2020) The Impact of Diffusive Water Vapor Transport on Snow Profiles in Deep and Shallow Snow Covers and on Sea Ice. Front. Earth Sci. 8:249. doi: 10.3389/feart.2020.00249

This is true, both these papers attempt to include water vapor diffusion in Crocus and SNOWPACK. However, they do not model the water vapor transport process involved in Arctic snow, which is convection. Convection is at least an order of magnitude more efficient at transporting water vapor than diffusion, as already indicated decades ago by (Benson and Trabant, 1973) and confirmed by studies in Alaska (Johnson et al., 1987; Sturm and Benson, 1997) and at Bylot Island (Domine et al., 2016). (Touzeau et al., 2018) do a fine job at modeling diffusion in firn on ice sheets but "focus on the movement of water isotopes in the vapor in the porosity, in the absence of macroscopic air movement." (page 2394, 2nd column, 2nd paragraph). Their work is therefore not relevant to Artic snow and will not help Crocus performance in the Arctic. Their objective in any case was for isotopic exchange on ice sheets and not mass distribution in Arctic snow. The work of (Jafari et al., 2020) details water vapor diffusion in Arctic snow but to obtain a significant mass transfer these authors have to use water vapor diffusion coefficients in snow that are significantly greater than in free air. Latest work of the subject demonstrate that water vapor diffusion in snow is lower than in free air (Fourteau et al., 2021), although we admit this is a controversial topic. Furthermore, (Jafari et al., 2020) state "We acknowledge that vapor transport by diffusion may in some snow covers—such as in thin tundra snow—be small compared to convective transport, which will have to be addressed in future work.", in their abstract. In any case, we feel it would be misleading to suggest that Crocus or SNOWPACK are able to simulate water vapor transport in Arctic snow. To avoid any misunderstanding, we will stress that convection is the main process responsible for water vapor transport in Arctic snow and cite references on the subject.

- L181 : "Based on several years of simultaneous temperature measurements of the HCS2-S3-XT and CNR4 sensors, we corrected the CNR4 sensor values. We found that there was no bias between the two temperature measurements and a RMSD=0.784°C" I am rejoining the comment from Referee #1 on this : Details on the correction (does it involve radiations ?) would be welcome as an help/ a reference for other people encountering similar problems at their sites

As stated in our response to Reviewer 1, our initial text was in error and we used the data logger temperature sensor. Yes, radiation was a variable in the correction and this will be detailed.

-L332 : "Figure 2 may also indicate a decrease in summer air temperature" The statement is too vague, please clarify.

It is indeed too vague. Discussing a temperature trend based on just 6 years of data is in fact not very interesting. We will remove this statement.

- L345: At several places like this one "However, all these criteria are not 100% certain, and there may be some data in the absence of snow." the honesty of the authors is much appreciated !

Thank you. We feel it is important to state clearly the limits of our data set.

- L358 : "The deepest sensor was placed just above the frozen soil layer" Maybe it would be more clear if you specify that this is the frozen layer at its summer position.

We will replace this by "The deepest sensor was placed at the base of the summer thawed layer"

- L 395 : "Briefly, the amount of correction decreases with increasing snow density and is about 1.1 for dense wind slabs and 1.5 for soft depth hoar" Is this a multiplicative factor ? Thanks in advance for clarifying this

Yes, measured values have to be multiplied by a factor between 1.1 and 1.5, increasing with decreasing snow density. This will be reworded.

- Dataset : As a suggestion for later updates of this dataset, a time-series flag for each meteorological variable indicating whether the data has been gapfilled, corrected, or is the raw measure, could be usefull and more precise/exhaustive than what is currently written in the paper (for wind speed for instance)

We agree 100% and apologize for not having done that. We will certainly do that when the data set is incremented. In fact, we will start right now. For our new downwelling LW data, we will add a column to specify whether the data points are from the CNR4 or are ERA% modifies data.

References

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