The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
https://doi.org/10.5194/tc-2021-98-RC1, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

# Comment on tc-2021-98

Anonymous Referee #1

---

Referee comment on "Multilayer observation and estimation of the snowpack cold content in a humid boreal coniferous forest of eastern Canada" by Achut Parajuli et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-98-RC1, 2021

---

In this study, the authors have employed a combination of empirical modelling and measurements to assess the evolution of the cold content of the snowpack in four closely located boreal forests in Québec, Canada. The general methodology of the study is explained sufficiently well and the results are of interest to the forest hydrology and water resource communities, as well as the land surface and snow modelling communities. I feel that the results are worthy of publication, but I would like to see a little more effort towards examining the differences between the snowpack properties and CC estimates between the sites.

Specific Comments:

In Figure 5, can the authors infer from the detailed snow pit data whether the underestimated SWE is caused by excessive sublimation or melt in the model or underestimated precipitation? Are the latent heat flux measurements of any help here at two sites?

In Figure 6, the density of the top layer may be underestimated if the density of fresh falling snow is underestimated, or if densified snow falling from the canopy is not accounted for. If density is underestimated then CC will be too small even if temperature is correct. Site 1 which has a larger fraction of the canopy buried shows a smaller underestimation of density, suggesting that canopy effects are stronger at Sites 2, 3 and 4.

Would Figures 7 and 10 be more informative if small x-y plots were employed, with the $r^2$ or bias value shown? This would also provide the ability to show nonlinear or curvilinear relationships.

Section 4.2: Site A1 is more exposed to turbulence, solar radiation and longwave losses, and so probably has more rapid temperature changes as weather systems change. I believe the authors are capable of adding more interpretation here. Can they infer snowfall, sublimation, decoupling, and canopy effects? I like the discussion about Site A3 on lines 334-341. I see times in Figure 2 when site A3 has the coldest temperatures. Can the authors relate this to periods with stable conditions and/or low wind speeds to bolster this discussion?

Figure 12 and related discussion: Are the authors comparing the formulae for the density of fresh falling snow against the density found in the top 10 cm of the snowpack? I would only consider this a valid comparison if the snow survey were conducted immediately after a snowfall event and before unloading or density changes had taken place.

Line 364-6: If the snow density estimates were disastrous when employing the Brun model, why did the authors not change to a different model or to fixed values of 100 $kg/m^3$ for fresh snow?

Minor points and Corrections:

Line 50: I would phrase this as "plays a central role in the timing of snowmelt". "Delaying" makes it seem like the snow is not melting at the correct time.

Line 59: I would replace “resorted to” with “employed”. “Resorted to” implies that snow pits are not a good method. They are labour intensive, but can provide much information.

Line 62-64: Is “Of note, a slight contrast was observed by Seligman et al. (2014), who reported that the contribution of spring snow storms to CC had a smaller impact on delaying snowmelt than the porous space from dry fresh snow” intended to mean, that in spring storms the snow is near 0°C and so adds the minimum possible heat content based on its mass, whereas the pore space in cold dry low density snow results in a low thermal conductivity which delays snowmelt more than the cold content of the warm spring snow? If so, a few extra words would make that more clear.

Line 64-65: “However, Jennings et al. (2018) reported shifts in the onset of snowmelt by 5.7 h and 6.7 h at alpine and subalpine sites, respectively, when CC at 6:00AM was less than 0 MJ $m^{-2}$.” Shifts from when to when, caused by what? By definition, CC must be ≤ 0

MJ $m^{-2}$ but surely the amount would affect the timing of snowmelt.

Line 81: I would delete “our” unless the field observations were provided to a different group.

Line 83: I would change “resort to” to “employ” or “use”.

Line 91: I would change “forested” to “forest”.

Line 93: I would change “was” to “were”.

Line 136: I would change “enabling the stability of the prognostic modelled variables” to “ensuring an uninterrupted time series of the prognostic variables”.

Line 152: Change “weighting” to “weighing”.

Line 152-3: I would acknowledge that there can be significant differences in snowfall for some snowfall events over a 4 km distance. It is probably not a consistent spatial bias, however, so the methodology is acceptable as long as there is such an acknowledgement.

Figure 2: Could site A1 be a brighter blue to aid in seeing it as distinct from site A4? The dots are otherwise fine as long as none are completely hidden. If any are completely hidden, perhaps some can have no fill or have the sizes made smaller.

Figure 11: I am not sure what the light blue shading in the caption is referring to.