Review of :

Observations and simulations of the seasonal evolution of snowpack cold content and its relation to snowmelt and the snowpack energy budget,

by Jennings et al.

The authors address the issue of the drivers of cold content evolution based on the exemple of two seasonal snowpacks from a single observation catchment in the Western US. They also assess, in a much shorter part, the effect of cold-content on snow-melt timing and rates.

The paper is well written and well illustrated. The take-home message is clear and the objectives assessed in Introduction are achieved with scientific quality. I found the paper both an appreciable synthesis of existing litterature on the topic, and enlightning regarding the conclusions achieved.

In addition to the few suggestions made below, there is in y opinion one minor contradiction in the Result section (point 9 below), that I would recommand the authors to adress with priority as it affects the consistency of the paper. Note that this apparent contradiction may come from misunderstanding from my side, or an edit mistake from the side of the authors.

1. Introduction – p2 L1-6 : not the snowmelt itself is critical for the cited applications, but the timing of surface/subsurface runoff from Snow melt, which may not be the same when surface melt occurs and refreezes (as just mentionned earlier in the manuscript). For consistence I suggest changing « snowmelt » into « runoff from snowmelt » in the current sentence.

2. Introduction – p2 L16-18 : Aren't the « dominant processes » well-resolved by Method-3 (residual of the energy balance) at places where energy-balance models like SNOWPACK are routinely validated against data regarding most components of the energy balance ? In that case, isn't it rather a lack of investigation into the process of cold content development, than a lack of validation data, that limits knowledge of the prevailing processes ?

   Furthermore, the dominant processes involved in cold content development likely depend on the climatology of the investigated sites. Event though it is well stated in the Discussion, specifying the perimeter of validity of your study should be done here already. Typically, I suggest transforming research question #1 (p3 L6) into « What are the meteorological and energy balance controls on cold content development **at two alpine and sub-alpine sites from the Western US** ? »

3. Introduction – p2 L22-26 : conduction fluxes within the snowpack, and from snowpack to the ground, can mitigate the impact of the intense negative fluxes reported here. If a gradient around 100 W/m develops within the snowpack as a result of intense surface cooling, around 20 W/m2 propagates downwards (upon hypothesis of a 0.2 W/m/K conductivity for Snow), which should somewhat prevents the snowpack from locally reaching unreaslitic temperatures (?)

4. Introduction – p3 L1 : uncertainties -> unknowns (suggestion)

5. Methods – p5 L28 : « vapour diffusion » in SNOWPACK is actually only calculated to compute Snow grain/bounds growth rates. There is no mass redistribution between different snow layers as a result of vapour diffusion in current versions of SNOWPACK. I therefore suggest to suppress this item from the list of existing SNOWPACK routines, as it would be otherwise misleading.

6. Methods – p6 L7-10 : could you specify here or in appendix the result of your calibration procedure for the parameters leaf area index, vegetation height, direct canopy throughfall, and wind speed reduction ? Note that these parameters are usually estimated from field data, and that any observation-based estimate of them would help assess the soundness of the calibrated parameter or of the canopy model.

   Additionnal, the rough size of the clearing where sub-alpine snowpits were made, should be specified (p4 L1) to justify the use the canopy module of SNOWPACK, instead of an open-area version SNOWPACK with just wind attenuation.

7. Results – p5 L15-16 : « Peak cold content and peak SWE respectively occurred 33 d and 10 d later in the alpine than subalpine ». Add « on average » to this sentence and the next.

8. Results- p7 L25-27 : « This is likely due to the increased variability of winter precipitation, the coefficient of variation of which is 2.9 and 2.7 times greater than that of air temperature in the alpine and subalpine, respectively ». I assume that by « increased » you mean « higher » ? I would suggest that snow-atmosphere heat transfers occuring during cold air temperatures periods are less efficient in cooling the snowpack, than the direct addition of cold Snow from fresh snowfall.

9. Results- p7 L29-30 : « During periods of SWE accumulation, Q_{net} was typically near 0 W m^{-2} (Fig. 4a), indicating a large negative energy balance was not responsible for cold content development. » First, here, you infer Q_{net} from the variation in CC between 2 snowpit dates, so where is the link to energy balance ? Second, based on Eq 3, Q_{net} ~ 0 W m^{-2} indicates no cold-content increase, meaning there is no visible snowfall-driven cold-content increase in the snowpit data. In my mind this contradicts the other results of the study, e.g. Fig 3 and 7 – please justify, or explain me where I am wrong. May I suggest using different names for Q_{net} in Eq. 3 and Q_{net} in Eq. 4 ? Like $Q_{net\text{-}pit}$ and $Q_{net\text{-}EB}$ respectively.

10. Results- p8 L7 : could overestimated densities be the reason for cold-content overestimation at alpine location ? (as Snow temperature tend to be overestimated ?) Maybe a line on that could be added to the Result or Discussion section.