

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-5

Anonymous Referee #1

Referee comment on "Effect of ephemeral snow cover on the active layer thermal regime and thickness on CALM-S JGM site, James Ross Island, eastern Antarctic Peninsula" by Filip Hrbáček et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-5-RC1>, 2021

The manuscript "Effect of ephemeral snow cover on the active layer thermal regime and thickness on CALM-S JGM site, James Ross Island, eastern Antarctic Peninsula" reports on the effect of a large summer snowfall event on the active layer progression and thermal regime at a remote Antarctic location. The event is definitely interesting, but I am not convinced that there is any wider significance in documenting it in such detail. It seems to have a rather small impact on ground temperatures and active layer thickness, and it remains unclear under which conditions such events could play a role. I also have concerns on the evaluations and interpretation of some of the data that the authors should consider and address by providing additional data and analyses.

Major comments:

-Essentially, the impact on the ground thermal regime seems to be rather limited. To me, it looks like the main findings can largely be explained by the fact that ground surface temperatures are kept at 0°C for a prolonged period during the event. This is clearly visible in Fig. 4. So the effect is not really different from that of a long-lasting snow pack which reduces the thawing degree days and thus the active layer thickness. It is just that the timing is different. Since the snow cover lasts for only a small fraction of the thaw season, the changes in the end-of-the season thaw depth are relatively small and certainly smaller than the spatial variability due to ground conditions.

-I do not believe the statement "... the active layer refroze completely after a snowstorm" (l. 190). Fig. 6 shows that thaw depths go to zero almost as a straight line at the onset of the snow cover, but at the same time 5cm temperatures remain at 0°C for the entire time. This means that no energy related to the phase change water/ice can be lost through the surface, so the only possibility for the AL to refreeze would be by cooling from the colder permafrost below. However, this is not the case either, since the 50cm temperature also shows 0°C. The likely explanation is that the ground between 0 and 50cm is isothermal at 0°C, but no or only little new ground ice forms between 0 and 50cm. This also explains why the thaw depths increase sharply after the event and do not

show a more gradual progression like in spring. Some limited refreezing down from the ground surface and up from the permafrost table is certainly possible, but the active layer must have remained largely unfrozen.

-In Fig. 7, only GPR evaluations are available for the areas below the snow cover. These suggest a large difference between snow-free and snow-covered areas. However, it is unclear how the GPR evaluation was performed for the snow-covered parts, and how a possible frozen surface layer and changes in soil moisture due to melting snow would affect the results. Was it possible to pick reflections from all these layers? Was the two-way travel time through the snow accounted for? For such application, a detailed uncertainty assessment of the GPR evaluations should be provided, also covering the effect of soil moisture and its spatial variability. The GPR velocity was calibrated with frost probe measurements, but these are only available for the areas outside the snow cover. Is it reasonable to assume that soil moisture is the same under the (possibly melting) snow cover?

Minor comments:

L. 20: It is estimated... These statements are too general, this will depend on the snow properties, e.g. the snow density and thermal conductivity.

L. 21: same here, this depends on the timing. During polar night conditions, any snow cover will insulate, while during the summer it can cool.

L. 27: the thaw depth is not necessarily affected by the snow cover, at least other factors are much more important, so that it is difficult to detect this relationship in the field. For a very thick snow cover that persists throughout most of the summer the active layer thickness is actually reduced compared to shallower snow covers.

L. 31: In many cases, this does not work as the frozen ground does not permit water flow.

L. 73: "The active layer thickness..." - please provide a few more details on this study, this is relevant in the light of the AL changes that are presented in this manuscript.

Fig. 1 has very poor resolution and overall quality.

L. 78: REF

L. 94: it is not really an AWS if it only measures ground temperature. Consider renaming to active layer temperature station or similar.

L. 130: does that mean that snow depth data are not available in 2016/17?

L. 132: how was the georeferencing done, did you use ground control points with known location?

L. 146: bracket too much.

L.147: Better use "Mean summer ground temperatures" for clarity.

L. 150: There is a strong offset between TDDa and TDD5. Are the reasons for this understood?

Fig. 4 has a very poor quality

L. 236: thawing

Fig. 6: Indicate that the first year is on the left side. Also, replace ALT by thaw depth, ALT in the most simplified definition corresponds to the annual maximum thaw depth.