General comments

Authors analysed the spatial and temporal variability of snow depth and interactions between snow and vegetation in a subarctic landscape with coniferous forest, mixed forest, and peatland areas. To determine the variability of snow depth, they used high-resolution maps acquired from four UAS surveys in a one winter season verified by manual snow course measurements and one automatic snow depth station. Authors used interesting approach of creating a tree-mask to remove canopy areas from analysis due to poor penetration of the UAS camera. Authors found that both snow depth and its variability increased with the canopy density. Authors also described the snow depth increase and then decline with a distance from canopy, as well as the increase of the peak value distance from tree as the season progressed.

In my opinion, authors did an interesting work which certainly has a scientific relevance. I think this is an important pure and thorough field study. Therefore, the study has clear potential to be published. However, I do not see much novelty in the study both in terms improving our knowledge or methodological approaches. I see some methodological novelty in using the tree mask to limit the data, but the question is whether it is really novel. I am not saying that the study lacks novelty at all, but I think the authors should better define what is new in the study and how it goes beyond the previous studies. Besides, I have a few other comments listed below, which should be addressed before I can recommend the manuscript for publication.

Response: We thank the reviewer for her/his comments and suggestions. We have now improved the description of novelty and done suggested changes. In below, please find our point-by-point replies to comments and suggestions. Following changes (in italic) were made in introduction to better define the novelty of this study.

L80–L85: "To our knowledge, no studies have used the high-resolution data from UAS-SfM to study snow accumulation and ablation processes, and interactions between vegetation and snow in the subarctic boreal region, *consisting for mosaic of forested and peatland areas with challenging climate factors, such as variable light conditions and very cold temperatures*."

L86–L94: "The overall aim of this study was to evaluate the variability of snow accumulation and melt in high spatial resolution using UAS-SfM. With these novel datasets, we studied interactions between snow cover and vegetation in different subarctic land cover types. *We compared the acquired snow depth data with manual snow transect measurements and assessed the spatial representativeness of a single point snow depth measurement in relation to UAV-SfM derived data.* The specific research questions were: *1) how spatiotemporal snow depth variability differ across forested and open mire landscapes, and 2) what canopy controls on this variability can be revealed with high spatial resolution UAS-SfM snow depth surveys."*

Major comments

I did not fully understand why authors used CORINE land cover data since they worked with precise UAV based data describing the specific pixel distance from the canopy/trees (which were used to create canopy masks). Maybe I just did not understand it correctly from the text, but why they did not use accurate canopy structure data for the whole analysis? Or was CORINE data used only for general description of the land cover types in individual plots? Please explain it in more detail (probably in methods).

Response: Thank you for pointing out this possibility. We used Corine data because we wanted to have classification method for land cover that is readily available and widely used, and that can be applied for larger areas than are feasible for UAV surveys. The use of Corine data provides a possibility to easily expand the study for larger regions and other areas. The analysis was done with detailed canopy structure data.

Result section 4.3 contains three figures; however, the related text doesn't contain detailed explanation and interpretation (it consists only in three short paragraphs). Please extent the related text substantially to provide the reader with detailed description and interpretation of the related figures.

Response: We will expand the discussion in interpretation of the figures.

In my opinion, conclusion section is too brief and general. I would suggest including more details (including numbers) about individual conclusions. As it is now, it looks like a summary describing what authors did rather than main study conclusions.

Response: Conclusion part will be changed as the reviewer suggested.

Specific comments

L 21: One of the study conclusion is that differences between UAS and ground measurements highlights "the poor representation of point measurements even on the sub-catchment scale". This might be certainly true; however, this may also show that point measurement location is not fully representative for the wider area. Could you please add some more discussion related to this issue?

Response: Sentence changed in abstract. L21–L22: "This highlights the poor representation of point measurements in selected location even on the sub-catchment scale."

We also added a sentence in discussion L360–361: "The representativeness of a point measurement location must be considered carefully, not only for a sub-catchment scale but also for wider areas in operational or scientific use."

L 29–31: Authors stated that "This study highlights the potential of the UAS-SfM in high-resolution monitoring of snow depth in multiple land cover types …". UAS is nowadays standardly applied and well-established method for snow depth monitoring (even in diverse vegetations). Therefore, the statement that "it has a potential" might be relevant perhaps 5–7 years ago, but not nowadays. Please consider reformulation.

Response: Potential reformulated to applicability.

L 44-45: Although I agree that individual factors control snow depth at different spatial scales, I do not think that such distinct limit (100 m) can be defined. Maybe consider reformulation.

Response: Added sentence. L47: "However, in nature the distinct limits for factors controlling snow depth at different spatial scales are varying. "

L 79–87: Here authors explain the novelty of their study. Besides others, authors see the novelty in applying UAS imaging in boreal regions. Why this is specifically novel? How the UAS imaging in boreal regions differs from imaging in other areas? I think that application of UAS in boreal regions just because it was never used there before, doesn't mean novelty per se. Please consider more specific explanation.

Response: Reformulated. L82–L85: "To our knowledge, no studies have used the high-resolution data from UAS-SfM to study snow accumulation and ablation processes, and interactions between vegetation and snow in the subarctic boreal region, consisting of a mosaic of forested and peatland areas with challenging climate factors, such as variable light conditions and very cold temperatures."

L 85: One of the research questions is how UAS can be used for snow depth imaging during poor light conditions (probably because the study plots are far beyond the artic cycle). Authors addressed this question rather marginally in Section 5.4, but maybe this might be one of the novel issues which might deserve more attention (see also my general comment and the previous comment).

Response: Thank you for this comment. Similar criticism was found in reviewer comments for manuscript part 1. So, is it possible to expand the discussion in part one?

Fig. 2: Lines with min/max snow depth means snow depth evolution of the one winter season with highest/lowest snow depth or each date on x-axis means maximum/minimum value for this date from all winters at the study period? Please clarify.

Response: Sentence added to Fig. 2 caption: "In x-axis, the min and max snow depth evolution shows the minimum and maximum value for each date from all winters in the period of 2006–2018."

L 123–124: Could you be a bit more specific why two of the surveys were discarded?

Response: Information added, and the sentence was split in three. L132–L134: "Two of the surveys were discarded due to challenges that hindered the data collection. Camera mechanics were frozen in January with very cold temperatures (-30 °C) that caused unfocused pictures. On May, only very small patches of snow, insufficient for the analysis, were remaining in study plots."

Table 1 (and maybe also Table 2 and 3): Consider adding also absolute values of snow depth and not only differences between point measurements and UAS data.

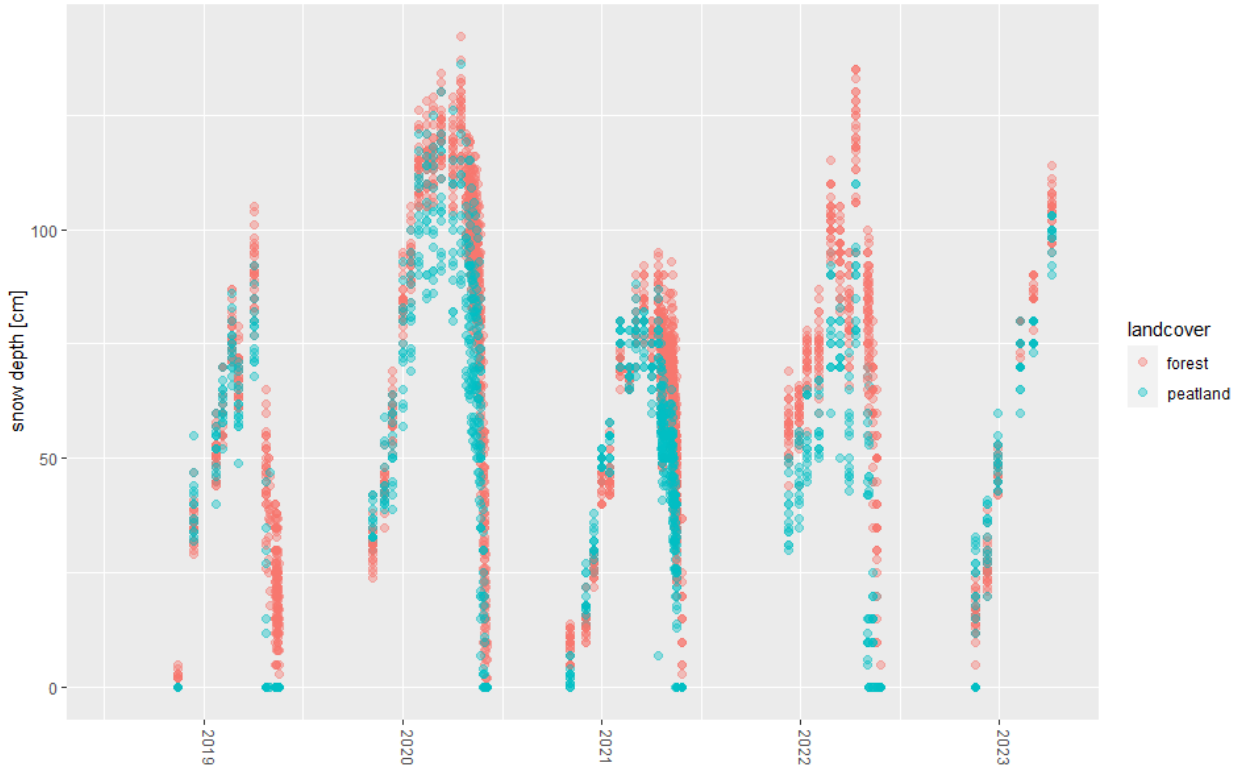
Response: Absolute snow depth added to Table 1. Tables 2 and 3 contains already lots of information and we do not see need to add absolute snow depths to tables 2 and 3.

Fig. 6: What is the physical explanation of increasing differences of the snow depth near canopy with progressing season? How important is the longwave radiation emitted by trees which increases the snowmelt rates near tree trunks? Please discuss shortly.

Response: Discussion added. L382–385: "This variability could be explained by increased shortwave radiation towards spring absorbed by the canopies, thus increasing the emitted longwave radiation that can increase the snowmelt rates near tree trunks. The longwave radiation is a function of tree temperature, which may be significantly different from air temperature and increase as spring progresses (Webster et al 2016)."

L 338: While I generally agree with provided explanation of highest snow depth in forested areas, do you have any data to support this interpretation?

Response: Added sentence. L355–L357: “Even though we do not have direct measurements of interception, our snow survey transect monitoring shows that the snow depths are typically higher in forested landscapes in different years.” See data below.



L 345: While this is rather trivial conclusion, I think it might be beneficial for end users (e.g., operational services) and thus it may appear also in the conclusion section.

Response: Added a sentence to the conclusions. L452–L455: “While we found that the widely used snow course data produced a realistic picture of areal snow depth conditions that can be used in operational services, the UAV-SfM derived data can be used to extend the spatial scale of snow course measurements, in snow model calibration and validation on a catchment scale, and improved forecasts for operational and decision-making purposes.”

L 357–361: I see the point, however, why it should be interesting? Could you explain it in more detail?

Response: The interesting point is that with the UAV-SfM method this kind of behaviour related probably to the tree well effect and emitted long wave radiation from the canopies could be detected. Sentence was slightly changed.

L378–L379: “Interestingly, with UAV-SfM derived data we detected that the median snow depth had a peak value around 1 m from the tree mask during accumulation season, but this peak distance increased up to 2.5 m in the middle of the melt period.”

We also added possible physical explanation for this behaviour:

L382–L385: “This variability could be explained by increased shortwave radiation towards spring absorbed by the canopies, thus increasing the emitted longwave radiation that can increase the snowmelt rates near tree trunks. The longwave radiation is a function of tree temperature, which may be significantly different from air temperature and increase as spring progresses (Webster et al., 2016).”

Technical corrections

L 65: Instead of “submitted to the same journal”, I would specify its name.

Response: Changed.

Fig. 2: Please consider change of individual line colours/types to increase readability.

Response: Will be done as suggested.

L 362: “For open peatland landcover, this peak may be explained …” It is not clear what “this” refers to. Please consider reformulation.

Response: Details added in sentence:

L387–L388: “For open peatland landcover, this snow depth peak near canopies may be explained by the wind distribution process that transports the snow to the edges of the open areas, where it’s trapped by trees.”