**The Cryosphere
Discussions**

Interactive comment on "Spatial and temporal variability of snow depth and SWE in a small mountain catchment" *by* T. Grünewald et al.

R. Dadic (Referee)

dadic@atmos.washington.edu

The authors present an interesting study on the melt evolution in a mountain catchment. To my knowledge, this is the first high-resolution dataset to focus on snow melt. The paper does not only present a new dataset, but also brings up the discussion on lateral energy transport, which has not been studied much in the past and of which little is known. The method of using a terrestrial laser scanner is a promising tool to measure high resolution snow distribution accurately and relatively cheap. The lower cost also allows for a higher temporal resolution than ALS. The manuscript is good and well suited for a publication in the cryosphere. My suggestions for revisions are below:

- General comment 1: The authors have done a lot of very interesting work, which

is only briefly mentioned. It would be nice to see a more detailed discussion on the snow density measurements and the corresponding correlation analysis or on the TLS validation against the tachymeter and ALS.

- General comment 2: There should be more references to figures in the text, so it is more clear where the statements in the text come from.

- General comment 3: I do not understand what the aim of the analysis of the average SWE in time is, when only cells that have snow are used (P10, L28). The analysis is not teaching us anything about physical processes of snow (nor are the results relevant for what the authors are presenting), but seems more like a statistical misrepresentation of the real processes. Also, the spatial variability would not have been constant through time (P12, L26) if always the same cells were used. The authors should consider removing this part of the paper, as well as Figure 4b.

- General comment 4: Seeing that several weather stations are available in the area, it would be interesting to compare some of your data/model results with the measured data, such as the incoming shortwave radiation. But this is just a suggestion for a future study.

Specific Comments

- The title should either emphasize SWE or snow depth, because these two are closely correlated in this paper, and the data properly covers only the snow depth, while SWE is linearly dependent on density.

- P1, L11–12: Seeing that SWE is determined by multiplying the snow depth with a constant factor for density, the spatial patterns of SWE and snowdepth are

similar by default (as it is correctly stated on P7, L27). Delete this sentence from the abstract.

- P5, L24: It is not clear from the text, why you compare TLS and tachymeter measurements up to 250 m only. I assume that this is the reach of the tachymeter, but it should be stated in the text.

- P6, L1: Is the deviation random or does it have a pattern?

- P6, L4: The differences between ALS and TLS should be discussed more. Figure 2 shows that in places the difference is positive and in places the difference is negative (blue and red colors have the same absolute value), so it is not clear where the differences increase with distance. It would be helpful, if topography contours were overlaid on Figure 2.

- P7, L13–19: It would be very interesting to see the described density-analysis. You could show some of the figures from it and discuss it more in detail. Table 1 can be included in the text. It is not clear which ρ in used in which periods? E.g, do you use 345.2 or 388.6 from 26 April - 13 May or do you linearly interpolate between the dates?

- P7, L27 –P8, L3: delete sentence "As the SWE maps, ..., appropriate."

- P9, L9: Are clouds considered in the ISWR model?

- P9, L9: I do not understand why the SWE at the end of the season should have any influence on melt, if only cells that have snow at the end of the season are considered. Please explain.

    itemP10, P17: I do not understand what "cross-slope accumulation" refers to. Please explain.

C37

- P10, L28: The remark that mean SWE values remained constant is confusing because they are actually not, because you are averaging over different areas (as explained on P11, L7). You should consider removing this entire paragraph (P10, L28–P12, L1) as well as Figure 4b, because the statistics are not representative and they do not say anything about the actual snowcover.

- P11, L28: replace "random" with "less correlated with topographic factors".

- P13, L1–5: One reason for the shift of dominating processes is also that the sun is much higher later in the season, which leads to less difference in the potential incoming radiation for varying expositions.

- P13, L11: Add that snowfree patches will probably be larger in areas, which are more exposed to the sun (e.g. the northernmost slope in Fig 6c still has the lowest melt rate). Another reason for the patchiness of the snowcover is the irregularity of the underlaying topography.

- P14, L21: Instead of having the slope angle correlated with the melt, it would be more useful to have the incoming solar radiation plotted. Please consider changing this plot.

- P14, L29: replace "may be" with "are". The authors should consider comparing the modeled ISWR with the data from one of the weather stations that are in the area to estimate the how far the model might be off.

- Figure 4b should be deleted. See comment to P10, L28.

- Figure 9: It would be more interesting to see the correlation with ISWR than with the slope angle. Consider redoing the figure.

Technical Comments

- P1, L14: replace the second "rate" with "season".

- P2, L26: delete " for instance".

- P3, L28: delete "On the other hand".

- P4, L18–22: Rewrite "We first ....tasks and challenges", so it is unique for this paper and tells the reader what to expect.

- P5, L20: What is the variety of checks? Maybe it is more clear to write "We compared all TLS data to tachymeter measurements and to ALS. The comparison with the tachymeter revealed ....."

- P8, L7–12: make reference to Fig 2 and mark the areas on the Figure, so what you describe in the text is obvious for the reader.

- P8: L15–17: delete "on the one hand" and "on the other hand".
  I assume "detailed" only refers to the spacial and not to the temporal resolution, since the spatial resolution is much larger than the temporal one.

- P8: L18–20: refer to the corresponding figures.

- P10, L12: replace "line-like" with "linear".

- P13, L28-29: delete "on the one hand", "on the other hand" and replace "explanatory" with "relevant".

- P14, L7-8: Sentence is unfinished.

- P15, L18: replace "remarkable" with "significant".

- P16, L1: replace "rich" with "extensive".

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

- P16, L14: delete "qualitatively".

- Figure 2: Elevation contours should be added to the Figure, and the areas NE and VL should be emphasized.

- Figure 6 should be larger, it is hard to read.

Interactive comment on The Cryosphere Discuss., 4, 1, 2010.