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The Cryosphere Discussions

Interactive comment on "Influence of surface heterogeneity on observed borehole temperatures at a mountain permafrost site in the Upper Engadine, Swiss Alps" *by* S. Schneider et al.

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This manuscript represents a strong contribution to the study of how ground thermal regimes in mountain permafrost are influenced by the high spatial variability of ground surface characteristics and soil specific factors generally found in alpine terrain. Based on an extensive measurement setup, the authors present new results on the influence of surface heterogeneity on observed borehole temperatures at a mountain permafrost site in the Upper Engadine, Swiss Alps. The manuscript is clearly within the scope of The Cryosphere. I will recommend that it should be published but with changes and suggestions as indicated below. In addition there are some specific comments

that need further clarifications and considerations before the paper is acceptable for publication.

The Introduction could be made shorter and more concise. Consider starting with a broad basis, introducing the topic of the paper, and then narrows it down to your particular field of study and research problem. As it stands now it is in my opinion too long to inform the reader about the rationale behind the work, justifying why your work is an essential component of research in the field. Consider to move some of the text in an own chapter 2, that could be titled "Research Context" etc.

The "Results" is partly difficult to follow and part of the text could be moved into the discussion. Consider to hold all discussion of the significance of the results for the Discussion section.

Specific comments:

Abstract, P2630, L7-9. The following sentence is somewhat unclear and need some clarification: "The results show that during the last eight years material specific temperature changes were more significant than for all boreholes consistent, climate-induced temperature trends"

P2630-2631, L25-27: In addition to temperature rise and phase changes of ice to water, permafrost degradation in bedrock is influenced by frost weathering leading to a reduction of rock strength as well as by advective processes by percolating meltwater.

P2631, L5: "the thermal responds" –> "the thermal response"

P2633, L25-27: What about the variability in duration snow cover/maximum snow depth between the borehole sites? This may be included here as an additional important factor.

P2634, L10-12: You write: "The micrometeorological measurements at Murtel rock glacier are considered to be representative for the whole study area", and in P2638, L26: "Though all sites are influenced by the same meteorological input values,...".

Referring to the comment above, is this really true regarding snow cover/snow depth? In general there is an inhomogeneous snow distribution in such alpine terrain. The effects due to snow variability have a significant influence on the thermal responses in the near-surface layers. I miss some information and discussion on about e.g. duration of the snow cover at each borehole site, based on the GST measurements, and if available information about differences in snow depth between the boreholes (could be included in e.g. Table 2).

P2642, L4-5: To identify variations and possibly trends in your borehole data down to 6 m depth, consider to use a lowâĂŘpass Gaussian filter. This method ensures easier comparison between the monitoring sites as it reduces highâĂŘfrequency variations of the annual mean along the time series and makes it easier to identify local maxima and minima as well as trends. For annual ground temperatures at 1.5-2m depth and below, a simple 365 day moving average filter could be used. An additional figure presenting such data could be interesting and could really confirm that there are no trends. See e.g. figure 2, 6 and 10 in Isaksen et al. 2011 –> Permafrost Periglacial Processes, DOI: 10.1002/ppp.728.

Table 2: Consider to include the exact duration of the snow cover at each borehole site, based on the GST measurements.

Figure 5 and related text: I miss some discussion of your results compared to other studies. E.g. in southern Norway recent studies (also performed in mountain permafrost on gentle slopes), MAGST varied by 1.5-3.0°C over distances of 30-100 meters (Isaksen et al. 2011, Permafrost Periglacial Processes. DOI: 10.1002/ppp.728). Further, are there any influence of 3D thermal effects of the varying snow cover around your boreholes than can explain part of the temperature difference at 6m depth from the GST ? This effect was found to very important in southern Norway, see Farbrot et al. 2011 (Permafrost and Periglac. Process, DOI: 10.1002/ppp.733) and Isaksen et al. 2011 (Permafrost Periglacial Processes, DOI: 10.1002/ppp.728).

Interactive comment on The Cryosphere Discuss., 5, 2629, 2011.