The Cryosphere Discuss., 5, C1883–C1888, 2012
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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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1.) 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 Introduction was split in 1.1 General Setting and 1.2 Research Context. The General Setting informs the reader about the rationale behind the work, while the Re-

search Context gives the state of the art of the research.

2.) 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.

-> The Result section was revised. The order of some sentences was changed and some parts were moved to the Discussion section.

Specific comments:

3.) 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”

-> The results show that during the last eight years material specific temperature changes were more significant than climate-induced temperature trends.

4.) 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.

-> The sentence was changed as suggested.

5.) P2631, L5: “the thermal responds” –> “the thermal response”

-> The word was changed as suggested.

6.) 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.

-> Though the climatic parameters can be assumed to be similar for all borehole sites, there is a strong variation of the snow cover duration, the snow depth as well as the

TCD
5, C1883–C1888, 2012

subsurface material and the ice content in which the boreholes are drilled.

7.) 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).

-> The duration of the snow cover at each borehole site based on GST measurements were included in Table 2. In addition to that, the snow depth was included for all available places: For the RMc site the snow depths based on micrometeorological measurements and for RCf Bb and Bv measurements based on i-buttons fixed on a snow pole were included in Table 2. A new figure, showing the influence of the snow cover was added.

8.) P2642, L4-5: To identify variations and possibly trends in your borehole data down to 6 m depth, consider to use a low- pass Gaussian filter. This method ensures easier comparison between the monitoring sites as it reduces high-pass frequency 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.

-> A low-pass Gaussian filter was applied for the GST- measurements and a 365-day

moving average filter was applied for ground temperatures below 2m depth for all sites. A new figure, showing the filtered temperature data was added.

9.) 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).

-> Within the Discussion section were some comparisons of the results with other studies included.

10.) 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).

-> At the beginning of the Discussion section was a new part concerning the distribution and influence of the snow cover included.

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

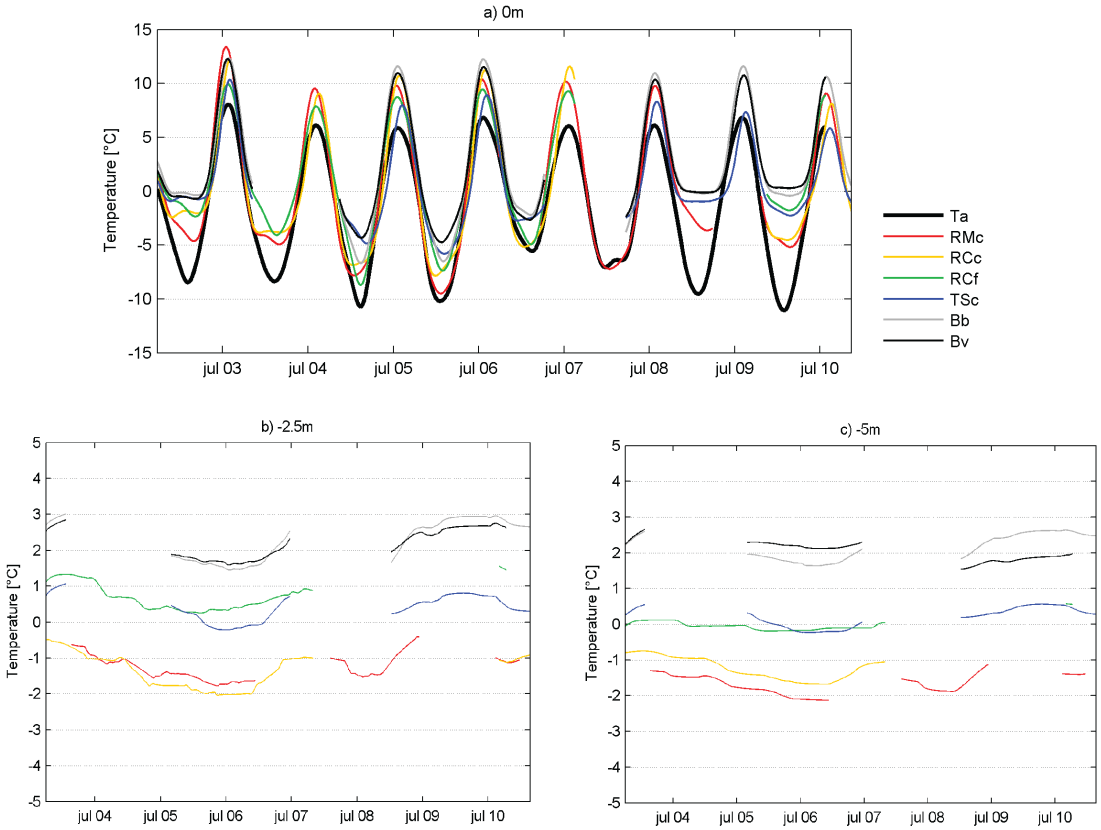

Fig. 1. Filtered temperatures from 2002-2010 for all sites and different depths, a) air temperature and ground surface temperature, b) subsurface temperature at -2.5m and c) subsurface temperature at -5m. Fo

TCD
5, C1883–C1888, 2012

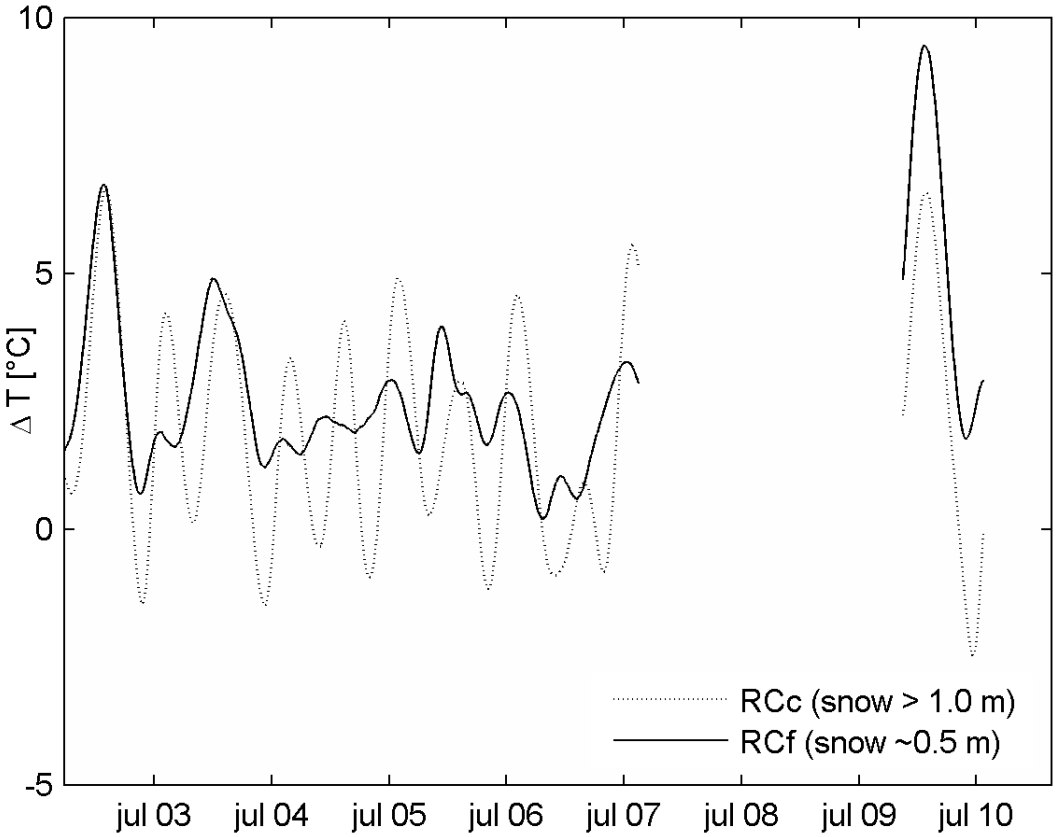

Fig. 2. Temperature differences between ground surface temperature and air temperature for a site with a maximum snow cover of 1m and a site with a thin snow cover of around 0.5 m.