

Interactive comment on “Modelling past and future permafrost conditions in Svalbard” by B. Etzelmüller et al.

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General comments

The submitted text is a well formulated, clearly structured and straightforward description of a ground-thermal modeling study with careful calibration using recently collected borehole-temperature data. The results are interesting and new, references to the existing scientific literature are abundant and up to date, and the graphs and tables are well designed and easily understandable. The authors may wish to consider the following thoughts for further improvement of their already fine paper.

Specific comments

The title could be more precise. “Modeling permafrost conditions” would involve the
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treatment of such aspects as subsurface ice, unfrozen water content, processes at sites – for instance, talus, rock glaciers, frozen moraines, subglacial environments, etc. – with strongly different conditions than observed in the available boreholes from predominantly flat/low-altitude sites. Furthermore, the term “past and future” may be too general as the paper explicitly deals with the 20th and 21st century and not, for instance, with the Holocene or the present millennium. Something like “Modeling the temperature evolution of Svalbard permafrost for the past and present century based on recent borehole data” or so could be more adequate.

The final paragraph on possible consequences is an (unavoidably somewhat vague) outlook rather than an integrative part of the modeling exercise. It could be more clearly marked as such and the recommendation for more in-depth investigation of the involved complex processes could be strengthened.

Technical corrections

Abstract, line 5: better write “. . . project possible future ground temperatures”.

Page 1878, line 17: better use a term like “expression”, “effect”, “consequence” or so. Changes in permafrost temperatures are not straightforward “indications” of climate change but the result of highly complex atmosphere/ ground interactions, strongly influenced by a variety of environmental aspects, buffer effects and feedbacks at the surface and in the active layer.

Page 1879, lines 1 to 3: Vegetation can have a predominant effect, even though perhaps not in Svalbard, and should be mentioned. Lines 9/10: Write “. . . rates . . . are . . .” or “. . . rate . . . is . . .”. Line 14: write Thermal State of Permafrost (capitals) to explain the acronym.

Page 1880, line 16: What is the annual precipitation at Isfjord Radio? Line 17: Write mean (not means).

Page 1881, line 2: Replace “is” by “are”. Line 9: Better write “. . . and the beginning of

the 21st ...". Line 10: Better write "... empirical-statistical downscaling ...".

Page 1882, lines 1 to 3: how about the influence of grain size in the active layer (this has an extreme effect in rock glaciers or mountain-top detritus, etc.)? Line 21: Better write "... is characteristic for equal ..."

Page 1883, line 14: Add "(cf. explanation on page 1885)" where a more precise definition is provided about the depth scale considered.

Page 1886, The sentence under 3. has no end (eliminate "for" and make full stop?).

Page 1887, line 9: as only temperatures are calculated it may be more careful to write something like "... permafrost conditions continue to exist until 2100."

Page 1888, line 28: The authors are, of course, free to believe whatever they want. But what scientific argument exists for assuming that "the median of the ... is the most reliable indication"? Would it be more appropriate to say something like "the scenario with the highest probability" or "the most realistic estimate" or so? Or perhaps just leave it as it is – the median is the median and everybody can have his/her own interpretation about probabilities?

Page 1889, line 1: Write "contains" (not contain). Line 12: This may be oversimplified – a thinner snow cover also has a tendency to disappear earlier in springtime and thereby to let the subsurface warm earlier and during a longer time interval. Line 20: Is the (correct) idea that spatial heterogeneities are strongly smoothed at depth, because lateral heat exchange tends to have the effect that temperatures at greater depths integrate over larger surface areas?

Page 1891, line 18: The relation of the last sentence in this paragraph to the explanations in the preceding sentences is not clear. What exactly is meant with "This" at the beginning? Line 23: Write "... temperatures (not temperature) are modeled ...".

Page 1892, line 9: write transition zones (not transitions zone). Line 11: Write "... this effect ..." not this effects. Line 21: Better write "... to the anticipated (or assumed,

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not proposed) changes ...". Line 27: Better replace "our model" by "a heat conduction model" (this is more precise).

Table 1: The values for the water content are very low, do they relate to the active layer only?

Figure 1, caption, line 4: Write "borehole locations" rather than borehole location.

Figure 3, caption, line 6: Write "various depths"

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