

## ***Interactive comment on “Applicability of time-lapse refraction seismic tomography for the detection of ground ice degradation” by C. Hilbich***

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Review on "Applicability of time-lapse refraction seismic tomography for the detection of ground ice degradation" by C. Hilbich

General comments

This is a highly interesting contribution highlighting the potential of RST for monitoring permafrost thaw depths. The results encourage the further use of refraction seismics in comparable environments. The changing thickness of the active layer during summer could be unequivocally monitored; it becomes clear that at both sites, propagation velocity in permafrost remains constant while there is a downward shift of the refractor depth. The results are widely confirmed by borehole data and ERT profiles. The paper

C30

is mostly well written, the figures are good and all necessary. The contribution deserves publication with minor revision.

My main complaint is the length of the paper. The results are good, but after all, it is a report on five seismic measurements which could be presented shorter without losing important information. Some self-evident facts are repeated several times; deleting the paragraphs in question might reduce the total length by c. 10% (see specific comments). A second critical point refers to the aim of "analyzing the reproducibility of the seismic signal" which cannot be achieved by two measurements within two months. The sentences in question should be left out (which is possible without any problems).

Specific comments

p. 79, line 15: Due to its complementary nature → unclear, seismic refraction is not per se complementary

80,11 seismic refraction is also less affected by temperature changes compared to ERT

80,21 ff "In exploration geophysics..." - I'm not sure if exploration geophysics is particularly relevant for shallow permafrost investigation - the next two paragraphs might be shortened

82-8 "Relating the temperature dependence to time" - leave out, better: Thus, thawing ...

83-12 "intervals of roughly 1.5 months in the summer season of 2008" is a bit misleading, as it comes out later that it is only two measurements at each site!

85,15 you should mention the different geophone spacing of 2m and 8m, respectively, even if it is shown in table 1

86,1 maybe you should briefly outline the settings?

86,10 "pointing to a high reproducibility of the seismic signal" - this is not quite correct.

C31

The waveform is relatively different between the dates and there is the pronounced shift (which you clearly address). In order to test reproducibility, it would have been better to measure a second time after two or three days when permafrost melt as a reason for deviations can be ruled out.

88,21 "The mean velocity of the only significant refractor" - is this zone C?

90,7-20 As bedrock depth is not the primary target of the investigations, the entire paragraph might be better left out. "The maximum depth of penetration is marked by a dashed line" (line 20) is the only important sentence.

91,1-12 "For the interpretation of velocity changes [...] or vice versa (blue colours)." Unnecessary repetition, self-evident - leave out. You should better describe clearly and simply what you can see in Fig 8: A pronounced red zone indicating a downward shift of the permafrost table.

91,12-15 "Consequently, a thorough interpretation of [...] is only possible with respect to the absolute velocities in the refraction seismic tomograms." - I don't understand this sentence, is it necessary?

91,24-25: "In addition to the data discussed in detail in the previous sections ..." - leave out

91,26-27: "... to show the potential application of a time-lapse refraction seismic approach in the context of operational annual permafrost monitoring" - leave out

94,5-7: "As both [...] interpreted for both sites." - leave out, redundant

95,16-20: "Also, the absence of pronounced changes [...] between frozen and unfrozen conditions occur." - leave out, self-explaining

96,7-8 "The latter hypothesis was already proposed from the analysis of ERT monitoring data (Hilbich, 2009)" - leave out, Hilbich 2009 is adequately cited in the previous sentence.

C32

96,14-15 "velocity changes correspond remarkably well to resistivity changes" - only if you look at it very generally; the overall pattern seems to be rather different.

99,8: As said before, in my opinion "the analysis of reproducibility of the seismic signal" has not been carried out!

99,6-12: These are not conclusions, this is repetition of the introduction - delete

99,13-14: Time-lapse data sets cannot "evaluate the performance" of the RSTM approach - reword

Fig. 3: Caption: Change the order of Lapires and Schilthorn

Fig. 8: The parts below the maximum depth of penetration should better be blanked out

Technical comments

82,16 delete second "a"

ERT, ERTM, RST, RSTM - you should explain the abbreviations the first time you use them (is M = monitoring?)

86,3-4 leave out, repetition

86,19 which is (not are)

94,9 add comma after 8a

95,21 delete "vividly"

96, 1 delete "an"

96,8 delete "strikingly"

96,18 add comma after 2008

96,19 delete "snow"

C33

97,10 better use solid instead of firm

97,11-14 the increase in penetration depth is not of particular interest; better leave out this paragraph

98,16 better mean than common

100,21 low instead of small

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Interactive comment on The Cryosphere Discuss., 4, 77, 2010.