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The Cryosphere Discussions

Interactive comment on "Optimisation of quasi-3D electrical resistivity imaging – application and inversion for investigating heterogeneous mountain permafrost" *by* D. Schwindt and C. Kneisel

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First of all we would like to thank Håvard Juliussen for the constructive review and his comments and improvements on the manuscript. Below we reply to all comments. Reply to the general comments RC1a) The description of the grid layouts in p.3389 line 27 to p.3390 line 4 as well as in table 1 and figures 1 and 2 must be improved.

- The description of the grid layouts has been expanded in the text and we tried to improve the caption for Fig1. Regarding the description of Table1 and Fig2 we refer

to the following referee comment. - The extended paragraph (new passage in italic letters): The grid-size in x-direction was predefined by the size of the geocryologic model. Array length and number of electrodes were adjusted for each of the applied electrode spacings to fit the grid size of the geocryologic model. To achieve an even array length in relation to the number of electrodes grid size in x-direction slightly differs between 2 m, 3 m, and 5 m arrays. - Extended description for Fig1: Grid size in y-direction for each different setup is based on the assumption of using 36 electrodes per array. Maximum grid size in x-direction is predefined by the geocryologic model.

RC1b) The # of lines does not add up to the specified grid size. How do the grid size and # of lines in table 1 relate to the grids shown in fig 2?

- By mistake we wrote in the captions that an electrode spacing of 2 m was used for the example in Fig2. Actually the Figure is based on using an electrode spacing of 3m. This has been changed. Many thanks for this correction! - We suppose the description for Table1 and Fig2 is adequate with the mistake being corrected.

RC1c) Uncertainty about what is X and Y direction adds to the confusion. In the manuscript you must specify when you use a complete XY-grid, half X-grid and no X-grid. This is not specified in sections 3.1, 3.2 and 3.3.

- Information on which x/y-arrangement is used is specified in section 3.1. and has been inserted for 3.2. As section 3.3 only refers to the figures introduced in sections 3.1 and 3.2 no changes have been applied to the text in this paragraph. - Nonetheless, a further passage in section 2.3 on the grid arrangement to avoid any confusion has been included.

RC2) As already noted by the handling editor, you should consider the term "permafrost" and if it in some of your cases could be replaced by "ground ice" or a similar term.

- We agree. The term permafrost has been avoided in many places by changing the

sentence and replacing it by other terms, as suggested.

Reply to specific comments

RC1) p.3385, line 2-4: many of the factors you mention in line 3 and 4 are microclimatic factors and should therefore not be listed specifically as you have already written microclimatic conditions in line 2.

- The sentence has been changed to: In mountainous regions in particular, permafrost distribution is characterised by a small scale heterogeneity induced by a variety of factors affecting microclimatic conditions, including solar radiation, as a result of topography and aspect, snow cover, surface and subsurface material, but also vegetation cover and soil/humus characteristics.

RC2) p.3385, line 6: “periglacial and geocryological” instead of “permafrost related”?

- Done

RC3) p.3387, line 24-25: I do not understand this. To my knowledge you cannot verify assumptions drawn from synthetic modeling using field data. But you can do the opposite; use synthetic modeling to verify assumptions made from field data.

- Of course you are right! But in this case the aim of the synthetic modeling was to suggest methods for optimizing/minimizing the quasi-3D measurements. Field data were used to test the applicability of the minimized setup under field conditions. Nonetheless, as we agree with you, that the sentences might be confusing we changed the sentence by replacing “to verify” with “to test”.

RC4) p.3390, line 27: “divided in half”, not “divided by half”.

- Done

RC5) p .3391, line 12: “high-resistive”, not “high resistive”. This should be updated for the entire manuscript.

- Done

RC6) p .3393, line 25-26: Reproduced matrix values are not reasonable beneath larger high resistive structures.

- Correct. The sentence has been changed towards: Except for areas below high resistive anomalies reasonable results were achieved regarding resistivity values of the matrix.

RC7) p .3393, line 28: you write that ALL arrays underestimated resistivity values, but in p.3394 line 3 you write that the double dipole OVERestimated the resistivity by 200%. Please check this contradiction.

- We agree, this contradiction was avoided by changing the phrasing to “almost all arrays”

RC8) p .3394, lines 9-15: This paragraph is a bit messy. First you write about underestimation, then about overestimation, and then about underestimation again. Can you reorganize the sentences without losing information content?

- The paragraph has been reorganized by switching the sentences.

RC9) p.3396, line 9: although the increase is dramatic, it does not appear to be exponential

- exponentially has been changed to drastically

RC10) p.3397, line 9: “mountain permafrost” instead of “permafrost”. (Large permafrost areas exist in the forested taiga areas).

- We agree, the sentence has been changed to: “Only few mountain sites are known where permafrost has been detected below the timberline”

RC11) p.3397, line 12: “input”, not “income”

- Done

RC12) p.3398, line 10: “Due to the conductive humus. . .” is repetition and should be deleted.

- The sentence has been deleted

RC13) p.3399, line 16: “divided”, not “devided”

- Done

RC14) p.3406, line 26: “triple”, not “t riple”

- This mistake must have appeared during typesetting, as it does not appear in my original manuscript.

Reply to comments on the figures

RC1) The X and Y directions (and Z) should be indicated in all the figures, especially since you refer to X and Y positions in the text.

- X and Y directions will be included into the figures

RC2a) Fig 4. The positions of the Virtual Boreholes are not indicated in the XZ-slices.

- Virtual borehole locations will be implemented into the xz-slices

RC2b) I also suspect there are some errors in the geocryological models as presented in the Virtual Boreholes: The virtual boreholes show a gradual transition from the high-resistive anomalies to the matrix resistivity that is not shown in the geocryologic model to the left in the figure. I believe this is a plotting error made in the Virtual boreholes.

- We are not sure if we understood this comment correctly. The geocryological model to the left in Fig4 represents a horizontal depth slice (as shown in Fig1, depth 2-5m) and was first of all meant for locating the virtual boreholes and xz-planes. The vertical size of the resistive structures is given in the xz-planes 1 and 2 and is indicated in the virtual boreholes, only. Thus, we think the virtual boreholes are plotted correctly, but the figure caption should be improved with the geocryological model being identified

as a horizontal (xy-) slice and by referring to Fig1.

RC2c) The axes labels and text in the Virtual Borehole panels is too small.

- We agree. Label size will be improved for the final manuscript

RC3) Fig. 6. The Block 3 Level 2 is not visible in the right panel (probably because it is below another line). Is it possible to change the appearance of the lines so that all lines become visible (different line thickness and colour?) or at least be mentioned in the figure caption?

- You are right, colors and line thickness will be changed to improve the visibility.

RC4) Fig. 8. What is the Z value of the shown XY-slice?

- The depth slice in Fig8 was meant for a better localization of the VB; nonetheless the z-value is 2.5-3 m, taken from the dipole-dipole/Wenner quasi-3D image. This information will be included.

Interactive comment on The Cryosphere Discuss., 5, 3383, 2011.