The Cryosphere Discussion: “A new model for quantifying subsurface ice content based on geophysical data sets” by Hauck, C., et al.

GENERAL COMMENTS

This manuscript presents a new method for estimating volumetric fractions of rock, air, liquid water, and ice from geophysical data collected using the electrical resistivity tomography (ERT) and seismic refraction methods in rugged environments underlain by rock glaciers. The two geophysical methods are gaining popularity among permafrost researchers, particularly those working in rugged alpine environments where installation of boreholes is very difficult or impossible. However, the interpretation of geophysical data is not straightforward due to similarity in electrical or seismic responses of different materials (e.g. rock and ice). The manuscript makes a timely and useful contribution in improving the quality of geophysical data interpretation for alpine permafrost studies. The manuscript is well written and the data analysis is generally sound. I suggest that the manuscript be accepted after a moderate revision addressing the specific issues listed below.

SPECIFIC COMMENTS

1. P790, L7, “the resistivity of the probe”. Does it really refer to the probe? Should it be the resistivity of the material?
2. P791, L16. I understand f_w refers to “water”, but it really should refer to liquid water (ice is the solid form of water). Please use liquid water to avoid any confusion.
3. P792, L7. I suggest changing “insulator similar to the air and the rock matrix” to “insulator similar to the air”, to be consistent with the definition of Eqs. (2)-(4), which treat ice as part of pore space, similar to the air.
4. Figure 3. These figures need scales. I suggest using elevation maps instead of (or in addition to) oblique-angle photographs.
5. P796, L3-11. The description of calculation is too brief and abstract. Please include sufficient details so that the reader can understand how all solutions are calculated. It will be useful to demonstrate an example with graphs.
6. P798, L18. Please include a sentence or two describing the method for temperature measurements and laboratory sample analysis, so that the reader does not have to read the reference.
7. P800, L12, “appear larger”. Please indicate values. It looks to be about 15-20% in the figure.
8. P800, L16, “smaller than 15%”. Figure 5a shows a blank region below 20-m depth, which is inconsistent with the texts. Please revise the texts.
9. P801, L27, “extending over the tongue”. This is inconsistent with Figure 3, which shows the line terminating just after the tongue. Again, I suggest that maps be used in Figure 3, rather than oblique-angle photographs.
10. P802, L23-24. This sentence is difficult to understand. What does “respectively” refer to?
11. P804. I suspect that the results are somewhat dependent on parameters listed in Table 1. Just to demonstrate such dependence, it will be very useful to include sensitivity analysis. For example, how will the results be affected by uncertainty and spatial variability in Archie’s law parameters?

12. After reading the entire manuscript, I felt that the second example from Murtel rock glacier does not add substantially more to the paper. I think that the paper will become stronger if the authors remove the second example and add more information on the first example. However, it is up to the authors to decide if the second example is really important for the paper.
13. Figure 4. Please explain in the figure caption what the dashed white line in (a) indicates and what the red regions at the top of (b) indicate.
14. Figures 5 and 6. Please indicate B1 and B2 in the figures for the reader's convenience.
15. Figure 6(c). Is the color scale (0-20%) correct in this figure? It will be nice to use consistent color scales in all of (a) – (c).
16. Figure 7. Please show only the data discussed in the texts.
17. Figure 10. Is the color scale in these figures correct? At a distance of around 150 m, all three phases do not appear to add up to 100%. How is that possible?