

Interactive comment on “Resolution capacity of geophysical monitoring regarding permafrost degradation induced by hydrological processes” by B. Mewes et al.

Anonymous Referee #2

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The paper by Mewes et al. describes synthetic studies and a field application of geophysical monitoring on alpine rock glaciers. As such, the topic is well suited for The Cryosphere. I have read the paper with great interest, and I judge that the author's approach has a considerable potential. However, I have a few critical comments concerning the structure of the paper and its contents that should be considered, before the paper can be accepted.

1) The structure of the paper and the associated workflow in Figure 2 are unnecessarily complicated. Likewise, I find the convoluted discussion on “forward-inverse-cycles” (page 5) not at all helpful. What the authors essentially do is the following.

(i) Setup of four synthetic models (inspired by an actual field scenario)

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- (ii) Inversion of synthetic data followed by a 4PM analysis
- (iii) Inversion of observed data followed by a 4PM analysis
- (iv) Appraisal of the significance of the field data results using the findings of the synthetic study.

I recommend restructuring the paper following the outline above. The models SYN1 to SYN4 are a very crude approximation to the assumed Bec-de-Bosson rock glacier structure. When introducing the synthetic models, it is therefore sufficient to mention that they were inspired by the Bec-de-Bosson rock glacier. Consequently, most of the material contained in section 2 can be moved to the field data analysis part.

2) The inversion results of the synthetic data are very poor. This is not only due to the sparse acquisition geometry and (probably) the too short offsets of the ERT and RST layouts, but also reflects the inherent resolution limits of the two methods. The ERT image of SYN1 shows a greatly blurred high resistivity zone, and none of the other features are visible. SYN2 is dominated by a blurred version of the conductive feature introduced. It totally obscures the underlying resistive zone. Likewise, the ERT results for SYN3 and SYN4 do not really mimic the true structures. Similar conclusions can be drawn from the RST tomograms. This is not surprising, because it is well known that low-velocity layers are difficult or even impossible to resolve with RST. For high-velocity zones only the upper boundaries can be usually resolved.

Considering the poor tomograms, it is very surprising that the 4PM results represent the features introduced in SYN2 to SYN4 relatively well. In contrast to a joint inversion, where the complementary nature of ERT and RST data are exploited, the 4PM model is a mere combination of the (poor) tomograms. Therefore, one is kept left wondering, as to whether the results in Figure 8 can be generalized, or if they are a remarkable coincidence. This needs to be further analyzed and discussed.

3) The 4PM results for the true synthetic models (Figure 7) are in my view not useful.

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I guess that the resistivity and velocity values have been chosen, such that they are compatible with the 4PM model. Therefore, the good results should be obvious.

4) The authors emphasize the importance of a prescribed porosity model for the 4PM analysis. However, such a model is not available for the field data. How was the porosity model for the field data established, and how trustworthy is it?

5) Considering (i) the very poor inversion results from the synthetic data, (ii) the simplified assumptions made in the 4PM model, and (iii) the lack of a reliable porosity model raise the question about the significance of the field data results. It seems to me that the authors have provided good evidence for NOT trusting their field tomograms and the associated 4PM models!

The small-scale features introduced in the models SYN2 to SYN4 are obviously beyond the resolution limits of ERT and RST (with the given experimental layout). It might be useful to check with another synthetic simulation, what size of anomaly could be actually resolved. This would be helpful for interpreting the field data results from the Bec-de-Bosson rock glacier.

[Interactive comment on The Cryosphere Discuss.](#), doi:10.5194/tc-2016-229, 2016.

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