Report on the outcomes of a Short-Term Scientific Mission[1]

Action number: CA24157

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Details of the STSM

Title: Utilization and challenges of A-ERT system for active layer thickness monitoring

Description of the work carried out during the STSM

My STSM with Prof. Christian Hauck at the University of Fribourg took place from May 25th to June 6th. In accordance with the proposal, the first week was dedicated to discussions on specific objectives. During the second week, I participated in an ERT workshop, which aligned perfectly with the scope of the STSM. The mission followed the proposed plan, addressing four key objectives. The progress for each point is as follows:

1) Identification of the inaccuracy source and mitigation of the problem

This point was the main scope of my STSM in University of Fribourg. We identified the potential source of the issue which is very likely high heterogeneity of the condition during sudden freezing events. I learnt the principles of synthetic modelling as a potential way of solving the issues. However, this is more complex problematics which was not possible to solve easily during two weeks. We decided this topic deserve more attention when comparing data from other A-ERT sites.

2) Data analysis and freezing point definition

We discussed the possibilities of freezing-point depression estimates. We conclude it is necessary to be caution especially with the data interpretation. The observed values are valid only in the specific site and specific profile. Whether our approach works well in our A-ERT site, the specific ground-truth data are necessary for other localities on James Ross Island or elsewhere else.

3) Evaluating user-friendly inversion software options

I had a possibility to test Res2DINV for time-lapse inversion during the STSM and compare it with the datasets produced by pyGIMLi. For the way how we work with the datasets (temporal analysis), the results obtained by pyGIMLi are more consistent and reliable. We learnt at the workshop in 2nd week, that new application of A-ERT data processing is under development. In my opinion, data processing of

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large volume of data is remaining one of the biggest tasks for A-ERT utilization by non-geophysicist. Further, I had the opportunity to test application ResIPy, which I found highly valuable for testing the various scenarios through synthetic modelling.

4) Integrating complementary datasets

Complementary datasets measuring different parameters are crucial, particularly in heterogeneous environments. These additional data allowed us to better understand the sudden shifts observed in the resistivity data. For this purpose, we utilized data on soil temperature, moisture, texture, and the presence of snow cover. Because these datasets are typically generated using relatively low-cost equipment, it is my personal opinion that this integration should become standard practice for any A-ERT site.

Description of the STSM main achievements and planned follow-up activities

1) Main Achievements

The STSM was highly beneficial for deepening my understanding of A-ERT measurement principles, inversion procedures, and methods for handling data and testing various scenarios using synthetic modeling. Having had no prior experience or specialized knowledge in this field, this mission successfully bridged a critical gap in my technical expertise. Furthermore, the opportunity for face-to-face collaboration with Prof. Hauck was invaluable for accelerating the progress of our joint research. Through these in-person discussions, we successfully advanced a manuscript focusing on the freeze-thaw characteristics of James Ross Island by effectively integrating A-ERT data with complementary soil temperature and soil moisture datasets.

2) Planned Follow-up Activities

Our collaboration will actively continue beyond the conclusion of the STSM, with the immediate objective being the finalization and submission of the joint manuscript. Within this study, we aim to formulate specific recommendations on the utilization of complementary datasets, which offer the vital ground-truth data necessary for the accurate interpretation of A-ERT results. These conclusions will be based on three years of measurements on James Ross Island, which already provide a robust dataset. Consequently, we believe our findings will be highly transferable to other sites with ongoing A-ERT monitoring programs. This output will contribute directly to the objectives of Working Group 2 (WG2) of PermaCOST. Additionally, our data processing methodology and the benchmarking of its suitability will be shared to contribute to WG3. Moving forward, we also plan to investigate specific case studies to better understand the technical specifications and methodological approaches required for managing temporally high-resolution A-ERT datasets.