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

Action number: CA24157

Grantee name: Varsa Vass

Details of the STSM

Title: Fieldwork participation at Stockhorn (PERMOS) and joint inversion toolbox collaboration, University of Fribourg

Description of the work carried out during the STSM

During the STSM, I participated in three alpine permafrost monitoring campaigns and worked on setting up the time-lapse petrophysical joint inversion (TLPJI) toolkit at the University of Fribourg. Beyond the Stockhorn campaign named in the application, I was offered the opportunity to join for two other sites: Schilthorn and Gandegg.

At Stockhorn, I partook in the annual monitoring campaign and helped with the maintenance of the automated ERT (AERT) line. This year's campaign did not include SRT measurements, which is a deviation from the initial plan, therefore the toolkit's demo dataset is planned to be extended with ERT-only timesteps.

At Schilthorn, we spent two days on site maintenance, including an overnight stay, to replace the AERT profile. This involved disassembling the old profile, replanting electrodes, laying out and connecting new cables for an extended 71-electrode setup, and digging and covering the cable trench.

At Gandegg, we re-measured two out of 5 ERT profiles that were first measured as part of Prof. Hauck's PhD thesis roughly 25 years ago and had not been measured since.

On days without fieldwork, I worked on the TLPJI toolkit while consulting with the Cryosphere research group. I had meetings with group members who currently use TLPJI to discuss what an ideal toolkit should support, including the ability to choose between different petrophysical models for both resistivity and velocity, and a time-gap-aware approach to temporal regularisation. Based on this feedback, I set up a git repository and committed a cleaned, reusable version of the core inversion and petrophysics modules from my thesis codebase to serve as the basis for the toolkit. Collecting the data needed for the toolkit's demo scripts, including additional data for prior constraints such as soil moisture, is pending.

Finally, during the weekly group meetings, I learned about other cryosphere projects underway in Fribourg and more broadly in Switzerland.

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the Grant Holder Manager to verify the grant documents compliance and proceed with the payment.

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

The STSM met both of its planned goals of gaining hands-on experience with alpine field campaigns and solidifying the requirements of the TLPJI toolkit with the Cryosphere group in Fribourg. This toolkit is intended to contribute to WG3's aim of homogenising permafrost data processing. Its main goal is to provide a general and reusable implementation of time-lapse inversion for multimethod geophysical data, which is a use case that could benefit numerous monitoring sites. Seeing three alpine permafrost sites in person gave me a clearer picture of the acquisition challenges in the field and the data gaps and quality constraints that monitoring records can contain. I also became familiar with instruments I had not used before, such as soil moisture sensors and UTL loggers, and with the physical demands of working at high altitude.

The feature set for the initial release of the toolkit was established during this mission. It consists of tuneable per-phase temporal coupling, freely combinable resistivity and velocity models, and customisable spatial priors. The toolkit will build on the existing modular design and include a demo script and configuration file to provide a walkthrough of the processing flow for new users, along with searchable documentation. This configuration-based design enables users to assemble and parameterise a complete inversion workflow with minimal coding. Building on the codebase committed during the visit, the planned additions are further petrophysical relations, more elaborate temporal coupling options, an improved implementation of the prior constraints, and more extensive result and quality-control plotting.

The demo dataset is planned to cover four years of the Stockhorn record: two years with three combined ERT and SRT surveys and intermediate ERT-only timesteps, followed by two years of ERT-only timesteps without SRT. Most timesteps in the final two years have no direct SRT neighbour and therefore require further refinement of the temporal coupling, including accounting for the length of the time gap. I plan to examine how the quality of these ERT-only steps degrades as they get further away in time from SRT-constrained dates, to inform the kind and strength of temporal coupling.

The initial release of the toolkit, with the complete feature set detailed above, is scheduled for the end of October or early November. In the long term, further releases are planned to add a graphical user interface and the option to include induced polarisation (IP) data. These releases are anticipated to be developed in consultation with the Cryosphere group in Fribourg and the Geophysical Imaging and Monitoring group in Aachen, strengthening the collaboration between the two institutions. Possibilities for future publication on TLPJI were also discussed during this mission.



Stockhorn field site, picture taken by Christin Hilbich.



Stockhorn team from left to right: Cécile Pellet, Varsa Vass, Christin Hilbich, Sina Jaeger. Picture taken by Cécile Pellet.



Selfie at the Stockhorn field site, taken by Varsa Vass.



Monitoring stations, and ERT and AERT lines at Stockhorn. Picture taken by Varsa Vass.



Schilthorn site, picture taken by Varsa Vass.



Gandegg site, with Christian Hauck (left) and Tomasz Gluzinski (right). Picture taken by Varsa Vass.



Gandegg ERT profile 2, picture taken by Varsa Vass.



Gandegg ERT profile 2, with Paula Johns (left) and Tomasz Gluzinski (right). Picture taken by Varsa Vass.