Report on the outcomes of a Short-Term Scientific Mission

Action number: CA24157

Grantee name: Calvin Beck

Details of the STSM

Title: Establishing an International Action Group for Large-Scale Laboratory Modeling of Permafrost Processes (PERMALAB)

Description of the work carried out during the STSM

For the STSM, I was hosted by Prof. Daniel Fortier at the University of Montreal's Geocryolab. The main objectives were to establish an action group on the physical modeling of permafrost processes, exchange expertise on physical modeling, and discuss opportunities for standardization. The STSM was structured in a way that aligned with the PermaCOST Action work groups:

A. Community survey (analogous to PermaCOST WG1)

We conducted a community survey and received responses from more than 30 individual research institutions and working groups. We identified and contacted laboratories worldwide that conduct physical modeling of permafrost processes. The survey assessed the approaches used, the available facilities, and the respondents' interest in knowledge exchange and collaboration within the proposed action group.

B. Laboratory data collection and knowledge exchange (analogous to PermaCOST WG2)

We exchanged knowledge on different experimental approaches with local and visiting scientists from Canada, China, Iran, Germany, and France, as well as researchers involved in the newly established action group. We discussed the opportunities and limitations of these approaches and their potential for standardization, including cold-chamber designs, experimental cells, and reference materials. I also supported ongoing geophysical, hydrothermal and engineering experiment. These experiments were discussed in the context of the action group, including best practices for data processing and analysis (analogous to PermaCOST WG3). We focussed specifically on how to design a joint lab-field approach to directly link field observations and environmental conditions to laboratory studies.

C. Best practices for data processing and analysis (analogous to PermaCOST WG3)

Discussions on best practices for processing and analyzing data from diverse experimental methodologies, with a particular focus on the role of scale and its relevance to field applications, continued online after the STSM period.

D. Network promotion and development (analogous to PermaCOST WG5)

Building on the community survey conducted under WG1, we assessed the needs of the research community and identified opportunities to address current challenges in large-scale permafrost laboratory experiments. Based on these findings, we drafted the first version of an application to become an International Permafrost Association (IPA) Action Group for the period 2027-2028. As part of this initiative, we also proposed a session for EGU 2027 which was recently accepted.

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

The proposed STSM was designed to expand the PermaCOST Action by focusing on a specific methodological field, namely, the physical laboratory modeling of permafrost processes, which is currently not covered by the Action. Therefore, the STSM follows a structure analogous to that of the PermaCOST Action, allowing for the direct integration of its outcomes into the broader initiative. Specifically, the STSM activities correspond to: A. Community Survey (→ WG1), B. Laboratory Data Collection (→ WG2), C. Laboratory Data Analysis and Processing (→ WG3), and D. Network Promotion (→ WG5). The STSM has achieved all its key objectives and will continue to work on developing and growing the newly established action group. The action group is directly integrated into the PermaCOST action as a subgroup and the relevant outcomes are directly integrated into the WGs by regular exchange with the respective WG Leaders.

The main outputs of the STSM are:

- An overview table and graphical summary of laboratories performing or aiming to perform physical modeling of permafrost processes, including facilities, methodological approaches, and contact information. Together with WG1 leaders the obtained findings will be integrated into the general community survey.
- The establishment of an international network (PERMALAB) on the physical modeling of permafrost processes. We will soon hold our first meeting to expand the core group.
- The successful submission of an EGU27 session proposal as part of the action group. To ensure a sufficient number of submissions, we have opened the session to all cryospheric fields. The session conveners were selected to represent a diverse group in terms of gender, career level, and research fields relevant to the action group.
- The first draft of an application to become an official action group with the International Permafrost Association (2027-2028). We are waiting for the application process to officially open before finalizing the submission. The action group will keep its status as a PermaCOST subgroup.
- The development of initial best-practice guidelines and recommendations for the standardization of data acquisition and processing in physical modeling relevant to permafrost research. In the following months and years, we will continue this effort as part of the newly established action group. The goal is for these findings to result in a review article assessing the current state and future perspectives of the physical modeling of permafrost processes. We aim to highlight the unique opportunities offered by physical models and the need for them alongside sophisticated numerical modeling. Regular exchanges with WG2 and WG3 leaders will allow to synchronize and merge the findings of the different subgroups. The Permalab subgroup plays an important role in validating the WG2/3 field recommendations by testing limitations of approaches under controlled conditions, providing sensor calibrations, and having a direct field analog to isolate individual processes.
- All members of the Permalab action group are actively encouraged to join PermaCOST and to participate in the community survey.