Vacancy for a PhD student in
Coupled hydro-thermal and geophysical modelling of impact of heat waves on permafrost

Starting date: November or as soon as possible

We have an open PhD position (4 years) at the University of Fribourg, Switzerland, Department of Geosciences, Cryosphere & Geophysics Research Group (https://www.unifr.ch/geo/cryosphere/en/) within the recently funded Swiss National Science Foundation project:

Tipping points and resilience of mountain permafrost under increasing frequency of heat waves (TREAT)

Background

Mountain permafrost in the European Alps is undergoing major changes under contemporary climate change with a clearly detectable increase in borehole temperatures, active layer thickness (i.e. maximum thaw depth) and ground ice loss. Besides drilling, ground ice is only detectable by indirect geophysical techniques, with quantitative estimations of ice content through the combined application of several techniques, such as Electrical Resistivity Tomography and Refraction Seismic Tomography. Further methodological improvements regarding geophysical measurements and joint inversion allowing for better ice quantification have recently been suggested (e.g. Wagner et al. 2019, Mollaret et al. 2020, Maierhofer et al. 2022), which can subsequently be applied to quantify explicit ground ice loss in mountain permafrost over longer time periods.

Recent observations and future projection of increased frequency of extreme temperature events such as heat waves raise questions regarding the impact of heat waves on permafrost thaw, the rate of ground ice loss and the potential existence of tipping points. In particular, it is unknown, (a) under which conditions mountain permafrost will become wetter (due to additional water input from melting ground ice) or drier (due to direct drainage of the melt water and enhanced evaporation under climate warming), (b) whether substrate-specific tipping points exist leading to irreversible permafrost thaw and (c) which landforms are most resilient to climate warming and why.

In our newly funded Swiss National Science Foundation project TREAT we attempt to provide answers to the above questions. This will be achieved by linking direct observational evidence (air and borehole temperature, soil moisture) and indirect geophysical evidence (electrical, seismic and electromagnetic techniques) with state-of-the-art hydro-thermal modelling and newly developed coupled inversion schemes.

Job description

The successful PhD candidate will use data from our permafrost observatories (meteorological data, borehole temperatures, geophysical data, etc.) in the Swiss Alps to analyse the existence of tipping points and identify factors that increase the resilience of permafrost occurrences to future heat waves. Together with a second PhD student based at TU Wien and two further PostDocs within the project you will (i) analyse geophysical data over time and relate them to temperature and ice content changes in the ground, (ii) set-up the permafrost model CryoGrid (Westermann et al. 2023) for permafrost simulations at several observatories for different substrates, (iii) develop coupled inversion procedures to link geophysical data with thermo-hydraulic model simulations from CryoGrid and (iv) analyse the results with a focus on the specific impacts of heat waves on different substrates, the existence of tipping points and the future evolution of permafrost in high mountain areas.

Besides the modelling activities, it is further expected that the successful candidate will participate in the operational geophysical field monitoring activities of the TREAT project partners as well as in the set-up of a new project-specific test site in the Berner Oberland, Swiss Alps.
More about the position

The optimal starting date for the position is November 2023, at the start of the project. This will allow having sufficient time for familiarising with the CryoGrid model and the various geophysical techniques before the start of the field summer. Workplace will be Fribourg/Switzerland, a small and lively University town situated at the language boundary between the German and French speaking part of Switzerland.

The position is associated with the Cryosphere & Geophysics Research Group within the Department of Geosciences of Fribourg University (https://www.unifr.ch/geo/cryosphere/en/). The Cryosphere group has currently a staff of 24 scientists (including 10 PhD students) with strong expertise in surface processes of glaciers and ice sheets, snow, permafrost and geophysics.

The position is further associated with the project partner Department of Geosciences, University of Oslo/Norway (Prof. Sebastian Westermann), where the permafrost model CryoGrid is developed and applied to a large variety of permafrost occurrences all around the world. Research stays of the successful PhD candidate with members of this group are planned within the project. Further project partners with a strong background in geophysical techniques are Prof. Adrián Flores Orozco, TU Wien/Austria, and Prof. Florian Wagner, RWTH Aachen University/Germany. Regular project meetings (online and in person) with all project participants will take place during the course of the 4-year project duration.

Qualification requirements

We seek motivated, independent and creative individuals with technical understanding and strong interests in subsurface modelling, geophysics and permafrost.

The following requirements for the position apply:

- The applicant must hold an MSc within geosciences, geophysics, atmospheric sciences, hydrology or in a closely related field.
- Computer programming skills are mandatory, preferably using Matlab, Python, Julia, C++, R, or similar languages. Please provide specific examples in the application letter.
- The applicant must have very good verbal and written communication skills in English. Besides English, communication within the Department is in German or French (University of Fribourg is a bilingual University German/French), therefore, the capability or willingness to acquire language skills in one or the other language is beneficial.

The following points represent assets for the candidates:

- A solid background in the application of thermal, geophysical and/or hydrological models
- Demonstrated competences in the applications of geophysical measurements (such as geoelectrics or seismics)
- Scientific background regarding the analysis of extreme atmospheric or hydrologic events (such as heat waves) or permafrost
- Experience in mountain fieldwork or the willingness to participate in high mountain field campaigns. Mountaineering skills are considered an asset for the application, but as the focus of the position is on permafrost modelling, these skills are not mandatory
We offer

- Salary according to the standards for PhD students of the Swiss National Science Foundation
- A professionally stimulating working environment and the ability to participate in a multi-national research project
- The possibility to participate in teaching and other research activities of the Department
- The opportunity to gain experience in supervision of BSc and MSc students
- Rich opportunities for culture and outdoor activities in the city and surroundings of Fribourg.

The Department of Geosciences (https://www.unifr.ch/geo/en/) offers an interdisciplinary, international work environment within the bilingual (German/French) University of Fribourg, Switzerland, situated close to the Fribourg Prealps and the nearby lakes of the Dreiseenland. Our group has a strong, internationally recognised expertise in the monitoring and modelling of physical processes of the cryosphere with a focus on climate change related impacts.

How to apply

The application must include:

- Application letter (briefly summarizing your motivation to apply for the position and how you see your expertise fit with job description and required qualifications)
- CV
- Copies and transcripts of educational certificates
- Contact details of 2-3 references (name, affiliation, relation to applicant, e-mail & telephone number)

*Please send your application merged into one pdf file by e-mail to christian.hauck(at)unifr.ch. Evaluation of applications will start 21st of September and continue until the position is filled.*

Open-access references (all freely available under the respective links below):


