

Name of research institute or organization:

Department of Geography, University of Zurich

Title of project:

PERMASENSE & PERMOS: Measuring permafrost in Alpine rock walls

Project leader and team:

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Project description:

The Swiss Permafrost Monitoring PERMOS operates a number of measurement sites around Jungfraujoch that are serviced once or twice per year. PERMASENSE is a multidisciplinary consortium aiming at the development of ultra low-power wireless sensor networks (WSNs) suitable for autonomous operation in high-mountain environments. This is done at the example of diverse permafrost-related measurements and the installations around Jungfraujoch provide insight into the temperature and moisture dynamics of rock masses undergoing freezing and thawing, the temperature dynamics of ice faces as well as the effect of rock fracture on subsurface temperature.

Since February 2009, the PermaSense WSN on Jungfraujoch is operational and has had only few interrupts until the end of 2010. Ten sensor assemblies around Sphinx gather information about rock and ice temperatures every two minutes at differing depths below the surface and transmit this to a repository in Zurich. Based on these measurements, the first comparison of temperatures in rock and ice faces has been made. Furthermore, the postulated effect of predominantly lower mean annual temperatures at greater depth in the rock could be demonstrated, implying more permafrost in Swiss Mountains that previously estimated with computer simulations. Two permanent 2D geoelectrical profiles were installed at the southern rock face at Jungfraujoch in September 2009 to monitor the small-scale evolution of the permafrost. The installation of rock fall protection during 2010 in the same rock face invalidates these measurements and requires moving of this measurement setup.

During April 2010, six acoustic emission sensors (Figure below) were placed in the rock face above the research station and signals were recorded using an off-the-shelf data acquisition unit. This pilot campaign is the basis for current research about cryogenic rock weathering in the second phase of PermaSense that has started during 2010. Acoustic emissions indicate the timing and intensity of rock damage that is until now only understood in laboratory conditions. During the pilot campaign, we

have observed several thousand acoustic emission events. These obeyed a power-law scaling over several orders of magnitude in both the time and energy domains. This indicates rock damage to likely be a phenomenon influenced by self-organization and avalanching propagation of damage. Currently we develop a statistical mechanical model capable of simulating damage driven by time series of temperature and rock moisture as well as wireless acoustic sensing devices for outdoor measurements.



Key words:

Permafrost, monitoring, wireless sensor network

Internet data bases:

See www.permasense.ch and www.permos.ch.

Collaborating partners/networks:

Permafrost Monitoring Switzerland (www.permos.ch) and the National Center of Competence in Research on Mobile Information and Communication Systems NCCR-MICS (www.mics.org)

Scientific publications and public outreach 2010:

Data books and reports

PERMOS 2010. Permafrost in Switzerland 2006/2007 and 2007/2008. Noetzli, J. and Vonder Muehll, D. (eds.), Glaciological Report (Permafrost) No. 8/9 of the Cryospheric Commission of the Swiss Academy of Sciences, 68 pp.

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