English translation of the press communiqué of the Swiss Academy of Sciences SCNAT on the 6. June 2024

https://naturwissenschaften.ch/snow-glaciers-permafrost-explained/uuid/i/0e9c1fe4-7fee-5fab-8239-60f0fed3d8a9-Keine_Erholung_für_den_Permafrost_in_der_Schweiz

https://sciencesnaturelles.ch/snow-glaciers-permafrost-explained/uuid/i/0e9c1fe4-7fee-5fab-8239-60f0fed3d8a9-Pas_de_répit_pour_le_pergélisol_en_Suisse

https://scienzenaturali.ch/snow-glaciers-permafrost-explained/uuid/i/0e9c1fe4-7fee-5fab-8239-60f0fed3d8a9-Non_c'è_tregua_per_il_permafrost_in_Svizzera

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Rock surface temperature logger installed at the top of Piz Corvatsch in the Engadin at 3300 m asl. Elevation. Picture: Matthias Lichtenegger.

No respite for the permafrost in Switzerland

After two years with little snow and very hot summers, permafrost in Switzerland remained warm during the hydrological year 2023, ground ice content continued to decrease in many places and rock glacier velocity is still high. These are the latest findings of the Swiss Permafrost Monitoring Network PERMOS.

The hydrological years 2022 and 2023 were extremely warm in Switzerland, with air temperatures 1.5 to 1.9 °C higher than the average of the 1991–2020 period. The hydrological year 2023 (October 2022 to September 2023) was even the warmest on record since measurements began in 1864. The winters 2022 and 2023 were characterized by relatively late onset of the snow cover at high elevation and below-average snow heights, especially in mid-winter.

Winters with little snow mitigated the effects of hot summers

These weather conditions influenced permafrost in the Swiss Alps in different ways: record-high surface temperatures were reached at many stations of the Swiss permafrost monitoring network PERMOS,

exceeding the previous record values from 2003, 2015 and 2019. The winters with little snow, on the other hand, led to a significant cooling of the ground surface due to the lack of insulating snow cover.

The surface temperatures only reach greater depths after a delay of a few months and are dampened. In 2023, a slight warming compared to the previous year was measured at most locations at 10 and 20 metres depth. However, at some sites, winter cooling predominated and led to slightly lower permafrost temperatures. As a result, the ground ice content increased or only decreased slightly depending on the location. The velocity of rock glaciers decreased slightly in eastern and central Switzerland and increased marginally in western Switzerland compared to the previous year.

The temperature measurements also showed that in the Swiss permafrost regions the active layer thickness in summer 2023 were similar to the record values of the previous year. At Schilthorn in the Bernese Alps, the active layer was over 13 metres deep in 2023, which is around three times as thick as 20 years ago. Over the same period, the active layer thickness increased at the observation sites, ranging from a few decimetres, on the Schafberg rock glacier above Pontresina for example, to a few meters as at the Stockhorn above Zermatt, where it increased by to 2 meters to 5.2 meters in 2023.

The trend is likely to continue in 2024

The latest data already shows the first effects of the winter of 2024: the early onset of the snow cover at high elevations in autumn 2023 stored the heat of the very warm summer 2023 in the ground. This led to very high temperatures during the winter in the uppermost metres of the ground, which will continue to propagate at larger depths in the coming months.

In general, all observed variables after the hydrological year 2023 continue to show warm permafrost conditions in the Swiss Alps. Despite brief cooler periods and more or less important inter-annual variations, the warmer climatic conditions of recent decades are leading to increasingly marked warming and degradation of the permafrost, as well as increasing rock glacier velocity.

PERMOS

The Swiss Permafrost Monitoring Network PERMOS has been documenting the state and changes of permafrost in the Swiss Alps since 2000. It is currently financed by MeteoSwiss within the framework of GCOS Switzerland, by the Federal Office for the Environment (FOEN) and by the Swiss Academy of Sciences (SCNAT). It draws on the expertise of seven research institutions: The Universities of Lausanne, Fribourg Innsbruck and Zurich, the ETH Zurich, the University of Applied Sciences of Southern Switzerland (SUPSI) and the WSL Institute for Snow and Avalanche Research SLF. Measurements in the framework of PERMOS focus on three main variables: 1. ground temperatures near the surface and at depth, 2. changes in ice content and 3. permafrost creep velocities.

Permafrost

Permafrost is a thermal phenomenon defined as earth material (i.e. rock, debris, soil, etc.) that remains below 0°C for at least two consecutive years. In Switzerland, it underlies around 5% of the country and is typically found in cold talus slopes and rock faces above about 2’500 m asl. The occurrence and evolution of permafrost are primarily driven by the ground surface temperature, which in turn is strongly governed by air temperature, solar radiation and the timing of the snow cover.

Rock glaciers

Rock glaciers are landforms indicative of the presence of ice-bearing permafrost. They consist of a mixture of loose material (i.e. rock debris) and ice that moves downhill. They are recognizable in the landscape by their tongue-like shape and their velocity is an indirect measurement of the permafrost thermal conditions.