
Increased warming of the permafrost in Switzerland

The warming trend of the last two decades in permafrost in the Swiss Alps continues and intensifies during the hydrological year 2019/2020. This is shown by more than 20 years of measurements within the framework of the Swiss permafrost monitoring network PERMOS: permafrost temperatures have reached record levels in many places, as have the thickness of the active layer (the uppermost layer of the ground that thaws in summer) and the rock glaciers velocity.



Permafrost monitoring station on the Stockhorn plateau near Zermatt (3'400 m a.s.l., VS)

Image: Andreas Hasler

The hydrological year 2019/2020 was the warmest on record in Switzerland. Air temperatures of up to 1°C above the average of recent years were measured during the winter. A very warm spring followed, especially from mid-March to April, and the summer was marked by two heat waves. At high elevations, where permafrost occurs, snow arrived early in November 2019. Snow heights remained generally average throughout the winter and snowmelt occurred relatively early in permafrost areas.

Permafrost warming

The high air temperatures measured in 2019/2020 combined with the unusually early onset of the snow cover, which insulated the subsurface from winter weather conditions, resulted in very warm permafrost conditions across Switzerland. Ground temperatures measured near the surface at the end of September 2020 were close to or even above the previous records set in 2003, 2015 and 2018. This led to new record thicknesses of the so-called active layer (the uppermost metres of the ground above the permafrost that thaw in summer) in all the boreholes of the PERMOS network. In 2020, the active layer at the PERMOS sites ranged from just under 3 m (Flüelapass GR, 2400 m a.s.l.) to 11 m (Schilthorn BE, 2900 m a.s.l.). This means, for example, that the active layer thickness at Schilthorn has more than doubled since measurements began in 1998.

The warm conditions near the surface also led to an increase in permafrost temperatures at depth. The temperatures measured at 10 and 20 m depth have reached or even exceeded the previous record values of 2015. After more than 20 years of measurements, an increase in permafrost temperatures is evident at all sites in the PERMOS network. On the Stockhorn plateau above Zermatt (VS), for example, the permafrost temperature at a depth of 20 m has increased by about 0.8 °C in 20 years. This is comparable to the observations made on the Murtèl-Corvatsch rock glacier in the Upper Engadine (+0.5°C/10 years).

Acceleration of rock glaciers

The velocity of rock glaciers (downhill moving ice and debris masses found in high mountains) is an indirect indicator of permafrost conditions, as its temporal evolution follows that of permafrost temperature. In 2020, rock glaciers accelerated significantly with an average increase in velocity of +21% compared to 2019. Like surface and permafrost temperatures, rock glacier velocities in 2020 are close to or even above the previous record set in 2015.

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 six Swiss research institutions: the Universities of Lausanne, Fribourg and Zurich, the ETH Zurich, the University of Applied Sciences of Italian-speaking Switzerland (SUPSI) and the WSL Institute for Snow and Avalanche Research SLF. Measurements within PERMOS focus on three main elements: 1. ground temperatures near the surface and at depth, 2. changes in ice content and 3. permafrost creep velocities.

More information and illustrations : <http://permos.ch/MM2021/permafrost2020.html>

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