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Impact of global warming on the snowpack seasonality at high elevation in the Swiss Alps

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In alpine regions, climate change is expected to cause major modifications on the environment, in particular through changes in the snow conditions. The effects of the temperature increase on the snowpack and on the time of snowmelt are critical for alpine ecosystems, as well as for winter tourism or hydrological regimes. Despite these potentially considerable impacts, studies focusing on how global warming has modified snowpack seasonality are largely missing in the scientific literature, likely due to the difficulty to obtain long-term series of snow depth records at high elevation.

Here, we analyzed snow depth and temperature data from 114 meteorological stations, ranging from 1139 to 3000 m asl in the Swiss Alps over the period 1970-2016. We aim (i) to describe the temporal patterns of the snowpack over the study period, (ii) to spatially assess the influence of air temperature on snowmelt timing regarding the potential consequences for alpine vegetation, as the snowpack offers them a good protection against frost. We developed a methodological framework to accurately determine the onset and snowmelt dates.

Our results show a significant decrease in all snowpack parameters over the study period in the Swiss Alps, irrespective of the elevation, location or local climatic conditions. In particular, the snow cover duration declined at all the study sites over the last decades, mainly due to an earlier snowmelt rather than a later snow onset, in connection with a stronger temperature increase in spring.