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Subglacial channels, climate warming and increasing frequency of alpine glacier snout collapse

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Alpine glacier retreat has increased markedly since the late 1980s and is commonly linked to the effects of rising air temperature on surface melt. Less considered are processes associated with glacier snout-marginal surface collapse. A survey of 22 retreating Swiss glaciers suggests that collapse events have increased in frequency since the early 2000s, driven by ice thinning and reductions in glacier-longitudinal ice flux.

Detailed measurement of a collapse event at one glacier with Uncrewed Aerial Vehicles and ablation stakes showed 0.02 m/day vertical surface deformation above a meandering main subglacial channel, the planform of which was mapped with Ground Penetrating Radar measurements. However, with low rates of longitudinal flux (<1.3 m/year), ice creep was insufficient to close the channel in the snout marginal zone. We hypothesize that an open channel maintains contact between subglacial ice and the atmosphere, allowing greater incursion of warm air up-glacier, thus enhancing melt from below. The associated meandering of subglacial channels at glacier snouts leads to surface collapse due to erosion and internal melt as well as removal of ice via fluvial processes.