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Thicker Snow Cover Triggers Permafrost Carbon Loss Through Both Enhanced Warming and Surface Runoff

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Snowfall has been intensifying across extensive parts of the Arctic, and this may amplify the loss of permafrost carbon. Thicker snow packs insulate the ground from the coldest winter temperatures, effectively warming the soil. This deepens active layers, causes surface subsidence, and modifies pathways of permafrost carbon loss. However, our understanding of the effect of snow cover on the mobilization of carbon from permafrost soils is severely limited. Moreover, vertical carbon fluxes receive more attention than lateral losses into the aquatic domain. In this presentation, we present results from a snow fence experiment in Adventdalen on Svalbard and show that thicker snow cover not only causes permafrost degradation through warming, but also extensive erosion and mobilization of sediment due to increased surface drainage and runoff. These two processes amplified each other and triggered a dramatic change in the landscape: within six years, the mere presence of a 6 m long snow fence led to the collapse of a 50 m long ice wedge network, forming a deep gully that acted as a hotspot for CO_2 production. In addition, we estimate that lateral carbon losses were roughly 60 to 275 times larger per unit area than the carbon uptake from the atmosphere by nearby ecosystems. Surface hydrology can be an important driver of permafrost carbon loss and should be considered in future projections of the permafrost carbon feedback.