Glaciers grow and shrink primarily due to climate change.

But on many valley glaciers rocky debris reduces melt rates and extends glaciers.

We modulate hillslope erosion with temperature by tracking frost-cracking damage (Rempel et al., 2016).

We use a numerical model of a debris-covered glacier to explore feedbacks between climate, erosion, and ice.
Debris tends to delay the timing of moraine formation. Debris allows glaciers to remain at maximum extents for longer.

The amplitude of erosion affects when the glacier retreats as well as the timing of moraine emplacement.
Steady erosion over four climate cycles

Length enhancement is larger in cooling climates than in warming climates. This occurs because melt rate reduction from both debris and low temperatures expand the glacier.

As temperatures rise much of the debris cover is removed from the glacier surface as the terminus retreats. In spite of rising temperatures, debris cover tends to extend the glacier. In this simulation temperature rise dominates the length-enhancing effect of surface debris.


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