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Glacier long profiles in regions of active uplift, and their role in orogen dynamics.

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Glacial erosion dominates many active mountain belts. However, the study of such systems has been lacking a simple framework equivalent to what is available for fluvial erosion. The physics of fluvial erosion has long been characterized by a whole class of stream-power erosion laws, and these laws lead straightforwardly to the classic concave-up longitudinal river profiles, whose shape is a simple function of the governing model parameters.

We present such a framework for steady-state glacier longitudinal profiles, wherein the glacial erosion rate equals the rock-uplift rate. Combining glacial-erosion and glacial-flow laws produces strikingly realistic glacier profiles. For such profiles, the relative importance of rock-uplift and mass-balance rates, and the response to their spatial patterns, can be understood in terms of simple combinations of the model parameters and the choice of erosion law.

For active, convergent orogens dominated by glacial erosion, glacial erosion laws can also be combined with the geometry of a critical Coulomb wedge to derive scaling relationships that predict the relative importance of the climatic and tectonic factors controlling the orogen size.

These simple frameworks and scaling relationships provide insight into the relative importance of different physical processes, and are a benchmark for more complicated numerical models.