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Fluvial bedrock erosion by sediment in suspension couples hillslope processes and channel evolution

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Computational landscape evolution models that simulate long-term denudation of mountain ranges are often based on the stream-power model for detachment-limited fluvial erosion. When integrated with models for long-term hillslope erosion and sediment transport, the stream-power model predicts realistic landscapes with concave steady-state river profiles.
However, the rate of stream-power erosion depends solely on the amount of surface runoff (precipitation) and the channel bed slope. This does not agree well with global estimates of erosion rates based on in-situ produced cosmogenic nuclides, which link high erosion rates to tectonic activity rather than high precipitation rates and topographic relief (von Blankenburg, 2005).
As an alternative to the stream-power model, Sklar & Dietrich (2004) have proposed a saltation-abrasion model for river incision by saltating bed load. In the saltation-abrasion model, the sediments in suspension erode the riverbed when grains collide with the bedrock. In this presentation, we show with three-dimensional landscape evolution models that river incision by saltating bed load depends critically on sediment delivery from the un-channelized hillslopes. Such sediment delivery is achieved through landslides in tectonically active regions. The saltation-abrasion model therefore pinpoints the critical processes that potentially explain the observed pattern of global erosion rates that highlight the importance of tectonic activity.

References

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