Do mountains matter for global erosion and weathering?

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Introduction

Re-vitalization of interest in T.C. Chamberlin’s (1899) uplift-climate hypothesis has produced intense debate over the role mountains play in the physical and chemical denudation of Earth’s surface. Recent challenges to the uplift-weathering hypothesis include model results that suggest most of Earth’s sediment is generated from areas with gently sloping topography, rather than steep mountains (Willenbring et al., 2013). Here we show that the conclusions of Willenbring et al. (2013) are based on inapproporate use of a coarse-scale DEM to calculate global slope angles and demonstrate that mountains dominate sediment and solute fluxes to Earth’s oceans.

Methods

- Generated slope distributions from 2, 4, 6, 10, 30, 90, 250, and 1000 m resolution DEMs derived from LiDAR topographic data at four sites in the western U.S.
- Calculated global slope at both 3 (=90 m) and 30 (=1000 m) arc-second resolution
- Modeled global denudation as a function of slope using Willenbring et al.’s relationship based on 10Be measurements and 3 arc-second slope angles
- Modeled chemical denudation as a function of total denudation using two empirical relationships

Results- DEM scale matters for slope

Results- Slope matters for denudation

Conclusions

YES—mountains dominate the delivery of sediment and solutes to Earth’s oceans.