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The rate and extent of wind-gap migration regulated by tributary confluences and avulsions

Eitan Shelef and Liran Goren

Correspondence to: Eitan Shelef (shelef@pitt.edu)

Content

This file contains: (1) a description of automated procedure to approximate windgap locations, (2) a description of the procedure to compute energy dissipation in Figure 8 of the main manuscript, and (3) a figure showing the influence of the exponent n on windgap migration.

Automated procedure to approximate windgap locations

Windgaps locations were identified over GMTED DEMs (Danielson and Gesch, 2011) by delineating the drainage divides associated with a channel network mapped with drainage area thresholds of 200 and 12.5 km^2 for the Himalayas and Appalachia, respectively (values hereafter are reported in the same order for these two areas). To identify major divides at relatively low topographic positions (i.e., windgaps) we isolated high order divides (Scherler and Schwanghart, 2019), computed the local relief based on divide elevations within a radius of 30 and 5 km, respectively, and identified locations of minimal divide elevation within these radii. These radii are based on typical valley widths in these areas and are similar to the typical distance from divide to channel head based on the drainage area threshold that was used to define channels (scaled to distance via Hack's law). Of the locations of minimal divide elevation, we identified windgaps as locations with low along-valley-relief and high across valley relief. This was achieved by isolating locations of local divide relief that is higher than 200 and 100 m, respectively (i.e., common reliefs for valleys in these areas), and a vertical elevation difference between the divide and closest streams (on each side of the divide) that is less than 20% of the local divide relief. Note that this approach identifies only a subset of windgap locations as it depends on the predefined radii, relief, and order of divides.

Calculation of energy dissipation

Energy dissipation (P) was computed, following Sun et al. (1994a,b), as $P \propto \sum_i^N A_i^{1-m/n} \delta x$, where A_i is drainage area of the i'th model node, and δx is the distance between nodes. N is the number of nodes in the simulation, excluding the hillslope nodes close to the windgap (defined by their convex topography). Note that this approach computes the energy content of a steady state topography associated with a given distribution of drainage area.

The effect of varying the slope exponent n on simulated windgap migration

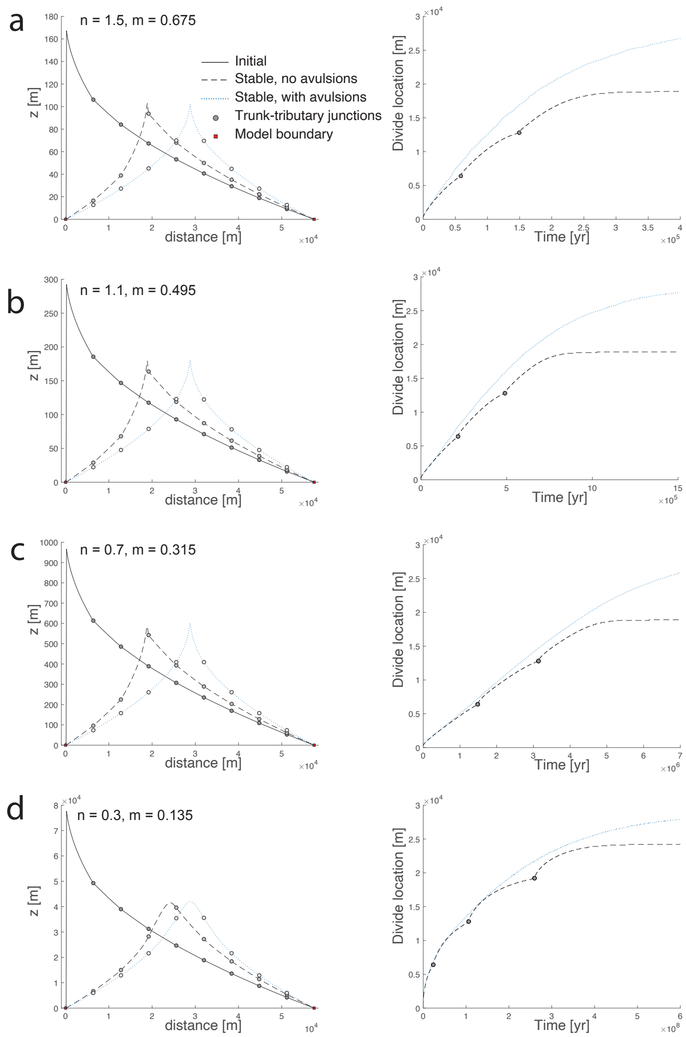

Figure S1: Windgap dynamics for simulations with different values of the exponents n and m where $m/n = 0.45$ in all simulations. (a)-(d) The left panels show an initial and simulated topographic profiles along the trunk channel with and without avulsions, similar to Figure 5b in the main manuscript. The right panels show simulated windgap location vs. time for the same simulations, similar to figure 5c in the main manuscript. All model parameters, except for m and n are the same as in figure 5 in the main manuscript. Note that the pattern of response remains the same, whereas the timescale and topographic details change. In panel d ($n = 0.3$), in the constant confluence (no avulsion) simulation, the windgap traverses three confluences before it attains a stable position, whereas for higher n values it traverses only two confluences. This is aligned with equation (2) in the main manuscript, where a lower n value increases the value of the LHS (note that we use the same D value for all simulations), thus destabilizing windgap locations that are stable with higher n values.

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