Geophysical Research Abstracts, Vol. 9, 03126, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03126

How meaningful are mean denudation rates? Evidence from a model landscape

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We can now estimate denudation rates over a wide range of timescales. Short-term (<100 yr) sediment-yield based erosion rate estimates tend to be highly variable due to the stochastic nature of surface process interactions, e.g. rare high-magnitude floods and/or landslides can dominate landscape-scale sediment fluxes. Thus geologically meaningful erosion rate estimates must be integrated over an adequate timescale. It is generally assumed that the 1-100 kyr integration time of cosmogenic nuclide erosion rate estimates adequately captures this stochastic variability, provided that climate and tectonic forcing remains constant. We present evidence here that autogenic processes can generate sediment-flux variability that exceeds the typical integration time of cosmogenic nuclide based erosion rate estimates. Indeed some of these autogenic signals are of such long temporal and spatial length-scale that they could impact low-temperature thermochronologic denudation estimates. Our data is based on physical modeling of orogen-scale dynamics. Our experimental apparatus is an erosion box in which two opposing panels can slide independently, so simulating base-level fall or rise across emerging topography. Rainfall is generated by an ultra-fine misting apparatus. Digital topography is generated from telemetric laser measurements and sediment flux is directly measured on both sides of the model orogen. In our model autogenic dynamics are due to, in increasing length-scale: landsliding, knickpoint propagation, 'river' capture events, catchment reorganisation and drainage divide migration. At the longest length-scale drainage divide mobility results in very different erosive 'histories' on either side of the divide.