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African Epeirogeny in the Geomorphic Record

Conor O'Malley[1], Nicky White[2], Gareth Roberts[1], and Simon Stephenson[3]
[1]Department of Earth Science and Engineering, Imperial College London, SW7 2AZ
[2]Bullard Laboratories, Department of Earth Sciences, University of Cambridge, CB3 0EZ
[3]Department of Earth Sciences, University of Oxford, OX1 3AN

A range of geological evidence documents the growth of African topography as a result of sub-plate support throughout Cenozoic times. Recent studies used inverse modeling of drainage networks governed by the linear stream power law to quantify the spatio-temporal history of uplift and erosion across the continent. Here, we test predictions of this uplift rate history by applying it as tectonic forcing to naturalistic landscape evolution simulations. These simulations parameterise dynamic drainage reorganisation, track sedimentary flux, and permit variable erodibility, none of which are feasible in inverse models. Modelled topography, river profiles, drainage planforms and sedimentary flux patterns broadly match observations. We test the sensitivity of forward model prediction to variations in erodilibity by employing spatio-temporally variable precipitation rate. Forward model predictions are relatively robust to even large excursions, suggesting landscapes contain internal feedbacks which modulate these effects and permit close recovery of the geomorphic record of uplift. Wavelet power spectral analysis reveals observed African river profiles are self-similar at wavelengths >~ 100 km, meaning longest-wavelength features have the highest amplitudes. At shorter wavelengths, spectral slopes increase, implying sharper features are generated only at wavelengths <~ 100km. Synthetic fluvial profiles recovered from simple landscape evolution models driven by uplift forcing obtained from inverse modeling of observed river profiles are self-similar across all wavelengths. This self-similarity solely reflects the tectonic forcing applied. When noise in erodibility or uplift rate forcing is added to forward simulations, power spectra of resulting fluvial profiles more closely approximate spectra of observed profiles. Thus sharp signals in observed river profiles arise from factors which do not correlate between neighbouring tributaries, e.g. lithological constrasts, self-forming hydraulic shocks, or human alteration. The recoverability of regional uplift from observed fluvial profiles is made possible by the fact that most topographic power is generated by regional uplift and resides at long-wavelengths.