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Propagating uplift controls on formation of low-relief, high-elevation surfaces in the SE Tibetan Plateau

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The SE Tibetan Plateau has extensive broad, low-relief, high-elevation surfaces perched above deep valleys, as well as in the headwaters of the three rivers (the Salween, the Mekong, and the Yangtze). However, understanding the presence of these low-relief surfaces is a long-standing challenge because their formation process remains highly debated. While alternate mechanisms have been proposed to explain the low-relief surface formation in this setting (e.g., drainage-area loss mechanism due to horizontal advection; Yang et al., 2015, Nature), a long-standing hypothesis for the formation of low-relief surfaces is by a step change in uplift and incision into a pre-existing, low-relief surface (Clark et al., 2006, JGR; Whipple et al., 2017, Geology).

The morphology of low-relief surfaces in the SE Tibetan Plateau is largely consistent with formation by a step change in uplift, but one problem with this model is that low-relief surfaces formed by a step change in uplift are relatively short-lived, since they are incised and steepened by erosion, which sweeps upstream at the response time of mountain ranges (in the order of several million years). Using a landscape evolution model that combines erosion, sediment transport and deposition processes (Yuan et al., 2019, JGR), we demonstrate that propagating uplift form large parallel rivers, with broad low-relief, high-elevation interfluves that persist for tens to hundreds of million years, consistent with various dated ages. These low-relief surfaces can be long-lived because the drainage areas in these interfluves are insufficient to keep up with rapid incision of the large parallel mainstem rivers. Our simulated features match various observations in the SE Tibetan Plateau: (i) low-relief surfaces are approximately co-planar in headwaters, and decrease in elevation smoothly from northwest to southeast across the plateau margin; (ii) χ-elevation plots of the mainstem rivers are convex; (iii) low-relief surfaces have low erosion rates; and (iv) erosion rates are high in the mainstem rivers at the propagating margin.

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