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Quantifying the basal accretion-induced erosion rate variability – A numerical landscape evolution modeling approach

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The Late Cenozoic growth of the Himalaya is mainly thought to be a result of basal accretion due to duplexing at the subsurface. However, over geological time, the complex nature of the response of Himalayan topography and erosion rates to the basal accretion along the Main Himalayan Thrust (MHT) fault remains ambiguous. Mandal et al. 2021 hypothesized that the punctuated basal accretion along the MHT brings the landscape out of equilibrium and results in periodic temporal variations in erosion rates. We seek to build on this idea by exploring the growth of the topography and resulting erosion rates due to long-term basal accretion processes along the MHT. To simulate the changes in topography and consequent variation in precipitation pattern, we are linking an orographic precipitation model (Hergarten & Robl, 2021) to the landscape evolution model used in Mandal et al. 2021. We introduce a migrating zone of high uplift (HUZ) in the model landscape, where the uplift rates are ~5 times greater than the background uplift rate. The orographic precipitation model works by controlling the influx of water in the cells of the model space and subsequently distributing the water volume based on the changes in topography due to overall surface uplift patterns. We calculate the spatially-averaged erosion rates, integrated over the time step length, by considering the uplift rate and the elevation difference between the previous time step and the current, updated elevation grid. In Mandal et al. 2021, feedbacks among the basal accretion-driven rock uplift, river steepening, and erosion rate were observed with the upstream migration of knickpoints and the migration of the ramp over time. With the introduction of the orographic precipitation model, we aim to understand the coupling between duplex-induced growth of the topography and rainfall variation and consequent temporal variability in erosion rates.