EGU2020-11177
https://doi.org/10.5194/egusphere-egu2020-11177
EGU General Assembly 2020

Divide mobility controls knickpoint migration on the Roan Plateau

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Knickpoints in longitudinal river profiles provide proxies for the climatic and tectonic history of active mountains. The analysis of river profiles commonly relies on the assumption that drainage network configurations are stable. Here we show that this assumption must made cautiously if changes in contributing area are fast relative to knickpoint migration rates. We study the Parachute Creek basin in the Roan Plateau, Colorado, United States. Low spatial variations in climate and erosional efficiency permit us to reveal and quantify drainage-area loss that occurred in one of the subbasins where observed knickpoint locations are farther upstream than predicted by a model that takes present-day drainage areas into account. We developed a Lagrangian model of knickpoint migration which enables us to study the kinematic links between drainage area loss and knickpoint migration and that provides us with constraints on the temporal aspects of area loss. Modelled onset and amount of area loss are consistent with cliff retreat rates along the margin of the Roan Plateau inferred from the incisional history of the upper Colorado River.