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Incision rate changes in the upper Var River catchment, southern French Alps: from observations to models.

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Cosmic Ray Exposure (CRE) dating on river polished surfaces from gorges located in the Var River catchment (Southern French Alps) reveals high incision rate pulses (>10 mm.yr-1) related with climate changes, and in particular with glacial-interglacial transitions. In addition, they show that the onset of the last deglaciation in this area occurred shortly after the Last Glacial Maximum (LGM), i.e. ∼16-19 ka ago. Extrapolating these results to longer time scales suggests that the post 140 ka history of this landscape was dominated by fluvial incision. Inverse models based on the stream power law are then used to determine uplift rate variations in several small tributaries of this catchment with respect to the main channel. These inverse models show that all tributaries have consistent incision rate histories with alternating high and low values, and a comparison with global temperature curves shows that these variations significantly correlate with quaternary climate changes. We suggest that during warm periods, a wave of regressive erosion propagates in the main channel, while its tributaries deeply incise their substratum to catch up with the falling base-level. We then perform forward models of river incision and simulate the incision of the main channel system over a time span of 600 ka. This model allows us to extract time and space incision rate variations along the Tinée River channel (the largest tributary of the Var River). With a background of a few mm.yr-1, incision rate can increase up to more than 10 mm.yr-1 during short episodes, in agreement with CRE dating. The part of the channel located between 12 and 20 km downstream from the source has undergone several periods of rapid incision rates, which could explain the steep hillslopes and the triggering of a landslide ∼10 kyr ago.