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The influence of climate on hill-slope sediment supply: Insights from numerical modeling

During the last decade, a great number of field and modeling-based studies have fueled the debate on whether climate or tectonic was the main control for the observed enhanced river incision during the Quaternary. Field studies and the emergence of sediment-flux dependent incision models have challenged or supported the assumption that variations in sediment delivery to river channels can play a key role on river incision rates. However, in many surface process models (SPMs), short-range processes acting on hill-slopes are typically represented by a simple linear diffusion equation where the diffusion coefficient is assumed constant over long time scales.

The purpose of the work we present here is to better understand and quantify the impact of the Quaternary climate variations on sediment delivery from hill-slopes to river channels, and especially the transient behavior of the system and its response time under different climate scenarios, transport model parameters and hill-slope geometries. To achieve this, we developed a new numerical model of soil production and soil transport on hill-slopes, in which climatic variables such as air temperature and precipitation rate are explicitly integrated. The parametrization of soil transport laws includes periglacial processes (solifluction and shallow active-layer land-sliding) which, combined with transport of soil by overland flow, are known to play a major role in the efficiency of hill-slope sediment supply during cold phases and cold-warm transitions of the Quaternary in NW Europe, our area of interest. The link between climate and sediment fluxes is made trough the computation of an active layer depth (based on a simple 1D analytical model of temperature vs. soil depth) and the resulting transmissivity (TOPMODEL). Time steps and time scales are optimized for easily interfacing this new SPM with global or regional climate model outputs.