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Modelling karst geomorphology on different time scales

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The evolution and flow in a karst aquifer is studied with numerical simulations, based on the KARST model (Karst AquifeR Simulation Tool). The aquifer consists of a three-dimensional interconnected network of conduits representing fractures in the rock, and a porous rock matrix representing the finer fissured system in the rock. Flow through the aquifer can be driven by both diffuse recharge from precipitation and localised sinking streams, and the aquifer drains towards a large karst resurgence representing the base level. Superimposed onto the karst aquifer is a landscape, which can evolve with time by small-scale diffusive processes, large-scale river erosion, and karst denudation. Fractures in the aquifer are enlarged with time by chemical dissolution, enhancing the secondary porosity of the karst aquifer. The enlargement of fractures results in a dramatic increase of the aquifer conductivity over several orders of magnitude, and a change of flow pattern from an initially pore-controlled to a heterogeneous fracture-controlled aquifer. During the evolution, the water table is falling from an initially high position close to the land surface to a lower level coinciding with the actual base level. A typical model scenario is studied to elucidate the long-term karst aquifer evolution in three dimensions. The evolution model is then complemented by event-type spring discharge modelling, which can be used as a predictive tool for karst spring discharge and contaminant transport.