Numerical simulation of alluviation in bedrock channels

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Abstract. Mixed bedrock-alluvial rivers characteristically have a sediment supply that is less than the channel's transport capacity, which can result in a discontinuous pattern of alluvial cover. Prediction of where, and how much, alluviation occurs is important for modeling bedrock incision and landscape evolution. Here, we use a two-dimensional morphodynamic model to investigate controls on the relationship between sediment supply and alluvial cover. The model solves the shallow-water equations to compute patterns of water depth, velocity, and boundary shear stress, which are then used to compute bedload transport rates and patterns of bed alluviation. The model uses an essentially non-oscillatory (ENO) scheme based on Lax-Friedrichs flux splitting in its computation of free surface flows and alluvial layer thickness. We apply the model to experimental channels of different slope, and for each channel we vary the ratio of sediment supply to transport capacity, as well as initial sediment cover conditions. For lower bed slopes, the fraction of bedrock exposure decreases approximately linearly as the ratio of sediment supply to capacity is increased. Simulations over channels with steeper slopes and no initial sediment cover remain unalluviated at low sediment supply; the sediment passes through without settling on the bed. When the sediment supply exceeds a threshold, however, the bare bed suddenly becomes completely covered in a process known as "runaway alluviation." These results suggest that bed slope and antecedent conditions play an important role in determining the nature and pattern of alluvial cover in bedrock channels.