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Step length influence in modelling advection and diffusion of bed-load particles

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ABSTRACT

A bed-load transport model has been derived in order to attain a better prediction of particle motion along river beds. Scientific studies have now moved towards a particle based approach in order to physically address the actual motion characteristics of the bed grains, such as the distance between entrainment and deposition, i.e. the step length. Step length clearly accounts for the heterogeneity faced by a grain along its path, such as bed roughness, flow intensity, river morphology. In this study particles' step lengths are regarded as a stochastic variable denoted by a lognormal distribution, whose statistics account for the effect of both bed arrangement and the near bed shearing flow. The 1D Exner equation is then reformulated to account for tracing particles by considering the deposition term as a function of the upstream entrainment events and the displacements computed by a particle before stopping. The implemented numerical method enables the computation of the concentration of bed-load tracers in time and space. As revealed by the model results, the step length distribution acts as a source of diffusion for particle motion along the river bed. The extent of advection and diffusion is not only controlled by the statistics of the step length, but it is also strongly influenced by the level of bed roughness. The thickness of the exchange layer also plays a role in the transport behaviour, as it delays particles temporarily stored in the active layer.