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# The nature and role of advection in advection-diffusion equations used for modelling bed load transport

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The advection-diffusion equation arises quite often in the context of sediment transport, e.g., for describing time and space variations in the particle activity (the solid volume of particles in motion per unit streambed area). Stochastic models can also be used to derive this equation, with the significant advantage that they provide information on the statistical properties of particle activity.
Stochastic models are quite useful when sediment transport exhibits large fluctuations (typically at low transport rates), making the measurement of mean values difficult. We develop an approach based on birth-death Markov processes, which involves monitoring the evolution of the number of particles moving within an array of cells of finite length. While the topic has been explored in detail for diffusion-reaction systems, the treatment of advection has received little attention.
We show that particle advection produces nonlocal effects, which are more or less significant depending on the cell size and particle velocity. Albeit nonlocal, these effects look like (local) diffusion and add to the intrinsic particle diffusion (dispersal due to velocity fluctuations), with the important consequence that local measurements depend on both the intrinsic properties of particle displacement and the dimensions of the measurement system.