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Collisional Langevin approach to bed load sediment velocity distributions

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Bed load experiments reveal a range of possibilities for the downstream velocity distributions of moving particles, including normal, exponential, and gamma distributions. Although bed load velocities are key for understanding fluctuations in transport rates, existing models have not accounted for the full range of observations. Here, we present a generalized Langevin model of particle transport that includes turbulent drag and episodic particle-bed collisions. By means of analytical calculations, we demonstrate that momentum dissipation by particle-bed collisions controls the form of the bed load velocity distribution. As collisions vary between elastic and inelastic, the velocity distribution interpolates between normal and exponential. These results add context to conflicting experiments on bed load velocities and suggest that granular interactions regulate sediment dynamics and transport rate fluctuations.