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The power of fluctuations: bedload transport, turbulence and bed morphodynamics

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Accurate prediction of the evolution of rivers and landforms requires quantification of the total sediment flux transported by a river. In recent work, based on data collected in a large experimental facility at St. Anthony Falls Laboratory, the following results were obtained: (a) it was demonstrated that bedload sediment transport at very small time scales can be an order of magnitude larger or smaller than the long-time average; (b) bed morphodynamics can be inferred from the spectral properties of turbulent velocity fluctuations above the bed; and (c) the nature of scaling and the degree of complexity and non-linearity in bed elevation fluctuations and sediment transport rates depends on the bed shear stress. These results are discussed in the context of understanding and exploring the dependence of sediment transport scaling on near-bed turbulence, bed topography and particle-size distribution, and derive stochastic transport models which give rise to the observed scaling and relate microscale dynamics of particle movement to the macroscale statistics of sediment transport via minimum complexity stochastic models.