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Effect of migrating bed topography on tracer dynamics

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Instantaneous, high-resolution bed elevations, velocity fluctuations and sediment transport rates along with travel distances of tracer particles representing the grain size distribution of bed material were measured, for a range of discharges in a series of flume experiments conducted at the St. Anthony Falls Laboratory at the University of Minnesota. Statistics of tracer travel distances reveal a strong dependence of travel distances on the multi-scale variability of bed elevation fluctuations. Specifically, we document that the statistics of tracer travel distances depend on the spectral slope of bed topography and that the larger particles move farther (once entrained) than smaller particles for the same duration of time. For the case of higher discharges with pronounced bed topography, the length of the bed form dominates tracer travel distances. Results also show that mean travel distances of smaller particles do not get much affected by bed topography as their dynamics is mainly dominated by particle hiding effect. The implications of these results for predictive modeling of sediment transport are discussed.