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Tracking the motion of individual particles under distinct transport conditions

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Even though sediment transport has been studied for decades, there is still a need to investigate particle transport characteristics (at particle scale) as well as rates (bulk solids transport parameters), for a range of flow regimes. This study focuses on the quantification of individual particle transport statistics in turbulent flows, from near threshold to higher solids transport flow conditions. The effect of flow hydrodynamics, bed roughness's, and particle density on particle transportation rates is assessed.
The observations and results of this research are obtained from experiments carried out using a 12 meters long and 0.9 meters wide, tilting and water recirculating flume.
The flume walls comprise of smooth transparent glass that enables observing particle transport from the side and the bed surface generally is layered with coarse gravel. Considerations are taken to ensure that each experiment started at the same relative conditions, and that the flow is uniform and fully developed at the test section. The mean flow is measured by measuring max U in the centerline of the recirculation pipe with an electromagnetic current flowmeter. Top and side cameras were set in suitable fixed positions, for side and upstream camera to maximize view without blocking the view of particle's motion, and so as to be minimally intrusive. A "smart-sphere" is used to study particle's motion and the calibration for its sensors is undertaken before starting each experiment to ensure optimal operation. The flow velocities are assessed with acoustic Doppler velocimetry along characteristic locations over which the particles motion, for all of the flow conditions used herein (eight in total). The experimental matrix is comprising of four particle densities and four bed surface roughness's.
After running the experiments, the obtained videos are analysed to calculate the sphere velocities under different conditions and modes of transport. In addition, the sensor data are statistically analysed to obtain the "smart-sphere's" accelerations and angular velocities for the range of flow and bed surface conditions tried herein.