Sediment transport in an oscillatory boundary layer: characterisation of particle trajectories

M. Mazzuoli[1], P. Blondeaux[1] and G. Vittori[1]
[1] Department of Civil, Chemical and Environmental Engineering, University of Genoa, Via Montallegro 1 16145 Genoa, Italy

The cohesionless sediment particles lying on a flat bottom and subject to the action of an oscillatory flow exhibit an amazing variety of dynamics that have fascinated different scientific communities. The collective behaviour of the sediments, which is often investigated considering a continuum approach, actually results from the average dynamics of individual sediment grains. Such dynamics depend on the flow and sediment properties and progressively changes with the distance from the bottom surface at each phase of the oscillation cycle. In the present contribution, we exploit the enormous amount of particle data obtained by means of particle-resolved direct numerical simulation to describe statistically the particle motion. In the laminar regime, the moving particles can be observed to roll and slide on top of the resting ones. In these conditions, rolling grain ripples, namely the smallest bedforms observed on the sea floor, can form and the wavelength of the rolling-grain ripples can be related to the excursion length of the moving particles (Mazzuoli et al., 2019). If turbulence appears during the oscillation cycle, particles can be lifted up by turbulent vortices. The length and the height of jumps of the particles increase for increasing values of the Reynolds and the particle mobility numbers until particles persist in suspension (c.f. figure 1). The properties of saltating and suspended particle trajectories are investigated with the purpose of improving bedload and suspended sediment transport predictors (Mazzuoli et al., 2021).

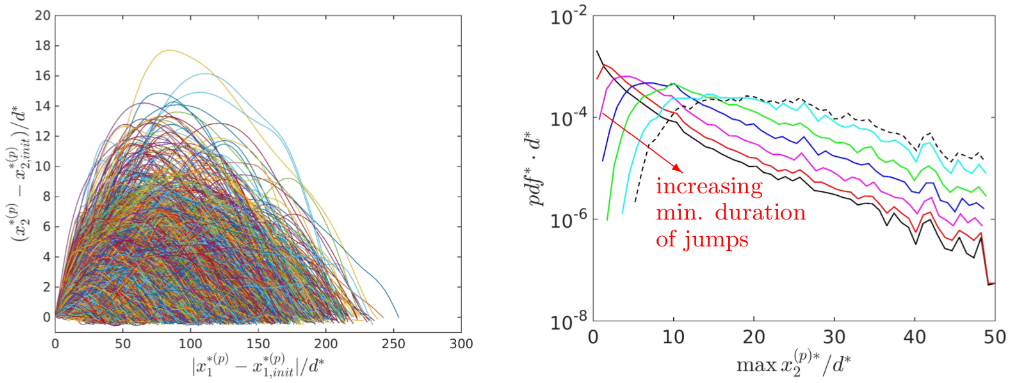

Figure 1: (*a*) Trajectories of saltating particles, projected in the vertical plane, around the phase of maximum flow velocity. (*b*) Pdf of the maximum saltation height reached by saltating particles selected by jump duration. $R_\delta = 1000$, $d^*/\delta^* = 0.168$.

References

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