Interaction between wave-induced nearbed vortex structures and cohesionless sediments: numerical results

Marco Mazzuoli[1], Paolo Blondeaux[1] Giovanna Vittori[1], J. Simeonov[2] & J. Calantoni[2]

1. *Dipartimento di Ingegneria Civile, Chimica e Ambientale, Università degli Studi di Genova* (Italy)

2. *Ocean Sciences Division, U.S. Naval Research Laboratory, Stennis Space Center, Mississipi, U.S.A.*

In the framework of the research project "FUNdamentals of BREAKing wave-induced boundary dynamics" (FUNBREAK) and of the ONR Global research project aw. nr. N62909-17-1-2144, we performed and analysed direct numerical simulations of the turbulent oscillatory flow generated close to the bottom by the propagation of surface waves. The bottom was composed of cohesionless spherical particles which are free to move when dragged by the surrounding fluid. The hydrodynamic stress over the surface of each sediment grain was explicitly computed by means of the immersed boundary approach. Hence, the force and torque acting on the sediment grains were readily evaluated. Numerical simulations were made for a range of flow Reynolds numbers and sediment particle dimensions that are typical of shallow coastal areas. An example of the results is given in the figure where the instantaneous position of the sediment grains is plotted along with the turbulent vortex structures generated by the interaction of the turbulent eddies with the spherical particles. The results were used to develop and test physically based models for bedload transport and reference bed concentration of suspended sediment in oscillatory flow.

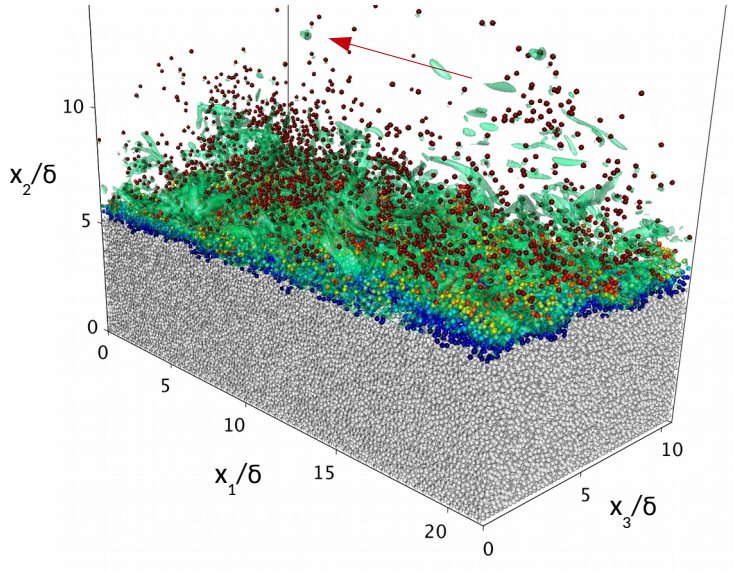

Figure 1. Vortex structures generated within the oscillatory boundary layer above a cohesionless sediment bottom right after the phase of maximum external velocity for R_δ = 1000 and d/δ = 0.168.

References

Mazzuoli, M., Blondeaux, P., Vittori, G., Uhlmann, M., Simeonov, J. & Calantoni, J. Interface-resolved direct numerical simulations of sediment transport in a turbulent oscillatory boundary layer. Journal Fluid Mechanics, 2020, **885**, A28

Vittori, G., Blondeaux, P., Mazzuoli, M., Simeonov, J. & Calantoni, J.. Sediment transport under oscillatory flows. International Journal of Multiphase flow, 2020, **133**, 103454