A Eulerian Two-Phase Modeling of Sand Ripple Dynamics under Oscillatory Flow

A.Salimi-Tarazouj[1], T.J. Hsu[1] , P. Traykovski[2] , J. Chauchat[3]
[1]Center for Applied Coastal Research, University of Delaware, USA
[2]Woods Hole Oceanographic Institution, USA
[3]University of Grenoble Alpes, France

The evolution of ripple geometries and their equilibrium states due to different wave forcing parameters are investigated by a Reynolds-averaged two-phase model, SedFoam, in a two-dimensional domain. Modeled ripple geometries, for a given uniform grain diameter, show a good agreement with ripple predictors that include the wave period effect explicitly, in addition to the wave orbital excursion length. Furthermore, using a series of numerical experiments, the ripple's response to a step-change in the wave forcing is studied. The model is capable of simulating "splitting", "sliding", "merging", and "protruding" as the ripples evolve to a new equilibrium state. Figure 1a and 1b demonstrate the model's capability to simulate the reduction and increase of ripple length and height due to two scenarios. The simulation is initialized with three orbital ripples in the domain resulted from a 5 sec wave of orbital velocity 0.48 m/s. In the first scenario (Figure 1a), we reduce the period to 3 sec and hence the orbital length is also reduced. This causes three large ripples to first split and then merge into 6 smaller ripples. In the second scenario (Figure 1b), we increase the orbital velocity to 0.8 m/s and three large orbital ripples evolve into four smaller sub-orbital ripples via merging and sliding. The model can also simulate the transition to sheet flow in energetic wave conditions and ripple reformation from a nearly flat bed condition. More details on the model validation, the effect of the wave period on the ripple geometry, and the relationship between the suspended/bed load ratio on ripple migration and ripple evolution will be presented at the conference.

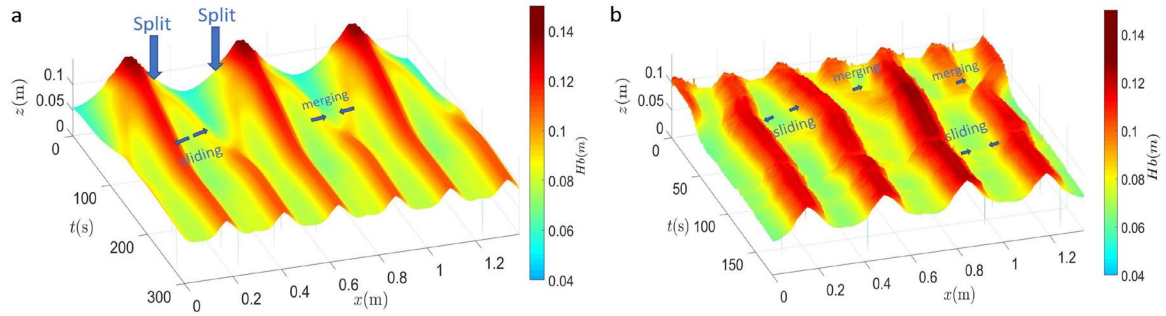

Figure 1: a) Time-series of the ripple evolution from larger ripples to smaller ripples. b) Time series of the ripple evolution from smaller ripples to larger ripples.

Reference:

Chauchat, J., Cheng, Z., Nagel, T., Bonamy, C., Hsu, T.-J., 2017. SedFoam-2.0: a 3-D two-phase flow numerical model for sediment transport 105194, 4367–4392. https://doi.org/10.5194/gmd-10-4367-2017

Traykovski, P., Hay, A.E., Irish, J.D., Lynch, J.F., 1999. Geometry, migration, and evolution of wave orbital ripples at LEO-15. J. Geophys. Res. Ocean. 104, 1505–1524. https://doi.org/10.1029/1998JC900026

Salimi-Tarazouj, A., Hsu, T.-J., Traykovski, P., Cheng, Z., & Chauchat, J. (2021). A numerical study of onshore ripple migration using a Eulerian two-phase model. Journal of Geophysical Research: Oceans, 126, e2020JC016773. https://doi.org/10.1029/2020JC016773