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Sand dune morphology under the interaction between periodic waves and coastal structures

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Sand dunes are generally perceived in the coastal area. However, mechanism of sand dunes generation remains unknown. In this study, we want to discover the generation of the sand dunes and the relationship to the wave characteristics. The sand dunes development is related to the wave conditions and coastal structures. To describe the sand dunes dynamics numerically, the rheology model will be used with the Navier-Stokes equations. The conventional Bingham model is considered to be selected. However, due to the intrinsic characteristic, the Bingham model is not able to offer a satisfactory illustration on the stratified material such as sand dunes. In this study, we extend the Bingham model by introducing the discontinuous rheology relationship between the solid and liquid phases and using the shear rate as the indicator to identify the corresponding rheological prosperity. An in-house CFD model, Splash3D, was adopted as a foundational solver to resolve the full Navier-Stokes equations with PLIC VOF surface tracking algorithm. A newly developed non-Newtonian Discontinuous Bi-viscous Model (DBM) is used to specify the sand dunes dynamics. To explain the mechanism how the sand dunes are generated, we send different periodic waves into the domain with different wave height and wavelength. The numerical study shows that the sand dunes can be successfully generated by DBM. The formation of the sand dunes can be clearly witnessed. For cases with structure, we observe that the sand dunes development starts from the structure. A local scour around the structure can be seen as well. A lot of detailed flow patterns will be presented in the EGU presentation.

Keywords: Sand dunes, Ripples, Coastal structure, Bingham rheology model, Discontinuous Bi-Viscous Model, Splash3D, Local Scour