Numerical investigations of bottom boundary layer hydrodynamics under a dam-break-driven swash event on a mobile bed

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The swash zone is characterized by its dynamic nature and is the beach region quasi-periodically covered and uncovered by water in the uprush and backwash. Bed shear stress is an important hydrodynamic parameter that determines the mobilization and entrainment of sediment particles in the flow. In this study, a state-of-the-art bottom boundary (BBL) sub-model is investigated to simulate the hydrodynamics at the bottom boundary layer in the swash zone, with focus on the bed shear stress and the distribution of horizontal and vertical velocity within this region. The BBL sub-model was initially developed by Briganti et al. (2011). It is implemented in a 1D Nonlinear Shallow Water Equation (NSWE) model, so as to better represent bed friction than the usual Chezy-type relation. In this study, which has already been compared with the experimental data of a dam-break generated swash event on fixed, impermeable beds that were reported by Kikkert et al. (2012), is also compared against corresponding simulation data for the same event, generated from a 2DV RANS (VOF) equation solver (Kranenborg et al., 2022). We reproduce depth, depth-averaged velocity, horizontal and vertical velocity depth profiles, and other parameters, and compare against--where it exists--experimental data, and against the NSWE model incorporating the BBL sub-model. We anticipate that the comparison will allow us to improve the BBL sub-model, by revealing near-bed deficiencies in modelling of the bed shear stress, as well as the degree to which hydrostatic pressures pertain throughout the swash event. Ultimately, we anticipate an improvement in the BBL for a mobile bed too. The initial comparison between two models regarding the simulation of water depth, depth-averaged velocity, and vertical profile of horizontal velocity is presented, respectively, in Figure 1.

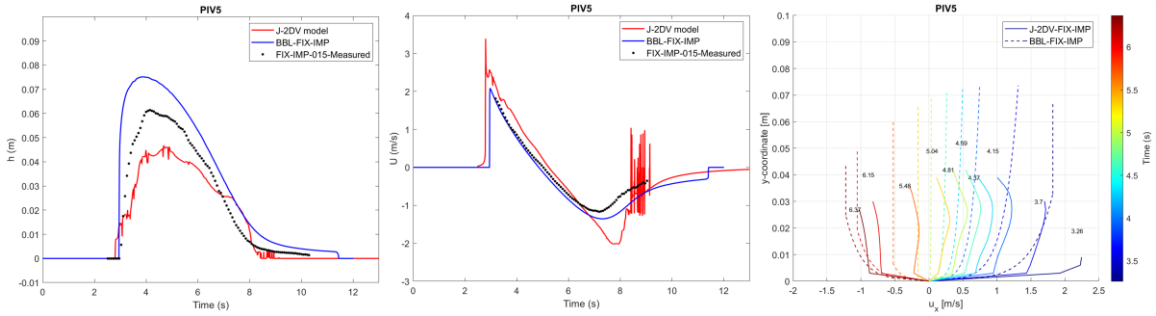

Figure 1. Comparison between BBL sub-model and 2DV RANS model regarding (left) water depth, (center) depth-averaged velocity, and (right) vertical profile of horizontal velocity.

References

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