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Effects of wave characteristics and beach groundwater table on the nearshore morphology and aquifer dynamics

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A Navier-Stokes hydrodynamic model with a VOF method and a turbulence closure solver was used to simulate wave motion on permeable beaches. Coastal aquifer dynamics, the interactions between the groundwater and the seawater, and the effects of wave motions were modeled using a variable-density groundwater flow model that was coupled with the hydrodynamic model. Infiltration/exfiltration that was computed from the groundwater model's output was used in a modified sediment transport formula. A series of numerical experiments was then performed for a range of beach watertable levels and incident wave conditions to simulate the morphology and aquifer characteristics. Wave-induced watertable fluctuations, salt-freshwater dynamics and the effects of infiltration/exfiltration on the foreshore profile changes were analyzed and discussed. The numerical results showed that, when the groundwater level is low, the largest berm develops above the still water level, the infiltration is higher and the salt wedge within the coastal aquifer moves landward. In addition, the formation of the berm above the still water level and beachface gradient are greater on coarse-grained beaches than on fine-grained beaches. Higher wave heights and longer wave periods induce a larger sediment transport rate and beach profile changes. The present process-based model is able to reproduce complicated flow and sediment transport processes and estimation of aquifer dynamics.