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3D modelling of nearshore coastal morphodynamics

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Coastal 3D nearshore processes were considered with an emphasis on the effects of oceanic forcing and beach characteristics on sediment transport in both cross- and alongshore directions, as well as on foreshore bathymetry changes. In our numerical experiments, we combined the FLOW module of the Delft3D model with the WAVE solver of Xbeach models. LES and k-ε turbulence closures were used to resolve the three-dimensional Navier-Stokes equations for incompressible flow and the beach morphology. The sediment transport module simulates both bedload and suspended load transport of non-cohesive sediments. A series of numerical experiments was performed for a range of control parameters. For each case, the general morphological response was determined in the shore-normal and shore-parallel directions. The simulations confirmed that the sole wave forcing is sufficient to drive a sediment circulation pattern that results in bar and berm formation. The wave characteristics have a considerable effect on the cumulative erosion/deposition, cross-shore distribution of longshore sediment transport, and the sediment transport rate across and along the beach face. For the same oceanic forcing, beach morphology exhibits different erosive characteristics depending on grain size. Fine beach sands were transported offshore, whereas coarse sands moved onshore-wards. Sediment movement increases with wave height, which was shown to be the most dominant factor controlling the beach face shape. In the surf zone, the sediment transport rate increases towards the shore until the wave collapses whereas in the swash zone it decreases. The present model is able to reproduce complicated flow and sediment transport processes and estimation of beach face dynamics.