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Equilibrium beach profiles: Quasi-3D process-based morphodynamic modeling.

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Equilibrium beach profile models are widely used on coastal engineering and coastal research as an indicator of the beach state and behavior in front of mean wave conditions and sediment characteristics.

There have been a number of attempts to model the equilibrium beach profile. Most of these are based on field or laboratory observations to derive a parametric formulation (e.g. Bruun, 1954) or analytical approaches that consider the equilibrium beach profile as the result of a constant wave energy dissipation (e.g. Dean, 1977) or constant sediment fluxes (e.g. Bailard, 1981). To date, the number of numerical models that compute equilibrium beach profiles is limited. Process-based models for the evolution of the beach profile have been recently improved by considering the net onshore directed fluxes due to wave non-linearities as well as the net offshore directed fluxes due to mean currents by using parameterizations of the undertow (Fernandez-Mora et al., 2015, Dubarbier et al., 2015). Moreover, the effects of wave non-linearities on equilibrium beach profiles have been already analyzed (Fernandez-Mora et al., 2013). However, these models consider alongshore uniformity and dismiss the strong three-dimensional nature of the near-shore zone.

Beach morphology, which is highly variable, is the result of the interactions between a large number of processes at different scales. Bi-dimensional patterns formation, changes in the average beach profile or shoreline variation are frequently observed simultaneously. Thus, it is essential to account for these three-dimensional interactions on analyzing the equilibrium beach morphodynamics. Indeed, the objective of the present work is to investigate the equilibrium beach profile by considering three-dimensional near-shore processes. To this end, a novel quasi-3D process-based morphodynamic model is used. The model couples non-steady wave propagation, currents (including the effect of rollers), sediment transport and bed evolution. Innovative features of the model includes flooding and mobile shoreline, estimation of the depth-dependent velocities, and cross-shore transport.
The model allows to couple the dynamics of patterns, profile and shoreline. Several numerical experiments on long-term evolution of beaches under different constant forcing conditions have been held. We analyze whether results fit with analytical approaches of the equilibrium beach profile and the equilibrium beach profiles resulting from a process-based beach profile numerical model (Fernandez-Mora et al., 2013).