MORPHODYNAMIC MODELLING OF A COMPLETE ACCRETIONARY BEACH SEQUENCE

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Wave-dominated sandy beaches are one of the most dynamic and vulnerable coastal environments. Most of sandy beaches exhibit underwater ridges of sand, referred to as surf-zone sandbars, that act as a natural protection against storm-driven hinterland flooding and erosion by dissipating wave energy offshore through depth-induced breaking. Following [1], sequential erosive (upstate) and accretive downstate sequences characterize the dynamics of intermediate beaches, which are ubiquitous worldwide. Despite these sequences have been observed through field surveys and video monitoring for decades, to date there is no morphodynamic model able to simulate these sequences entirely. As hypothesized by [4], we advocate that the main reason is that these morphodynamic models do not account for state-of-the-art parametrizations of cross-shore sediment transport driven by the respective contribution of wave nonlinearities and undertow. In this study, we focus on the full downstate sequence that describes the transition through four beach states under accretionary wave conditions. The cross-shore sediment transport processes described in detail in [3] are implemented in a coupled wave-current-sediment transport model [2]. Simulations start from a nature-like concave alongshore-uniform single-barred beach bathymetry, with constant wave and water-level conditions. Fig.1 shows, to our knowledge, the first complete modelled downstate sandbar sequence, with: (1) the evolution from an initial alongshore-uniform longshore bar-trough state to a rhythmic sandbar state characterized by a crescentic sandbar (fig.1a-b), (2) the attachment of the sandbar horns to the shore give rise a transverse bar and rip state (fig.1b-c) and finally (3) the complete welding of the sandbar to the shore with the formation of a terrace cut by shallower rip channels (fig.1c-d). This full down-state beach sequence modelling offers a unique opportunity to address the respective contributions of the different sediment transport modes to the different sequences. These respective contributions as well as additional simulations showing the influence of the main offshore wave characteristics, namely wave height, period and direction, will be presented.
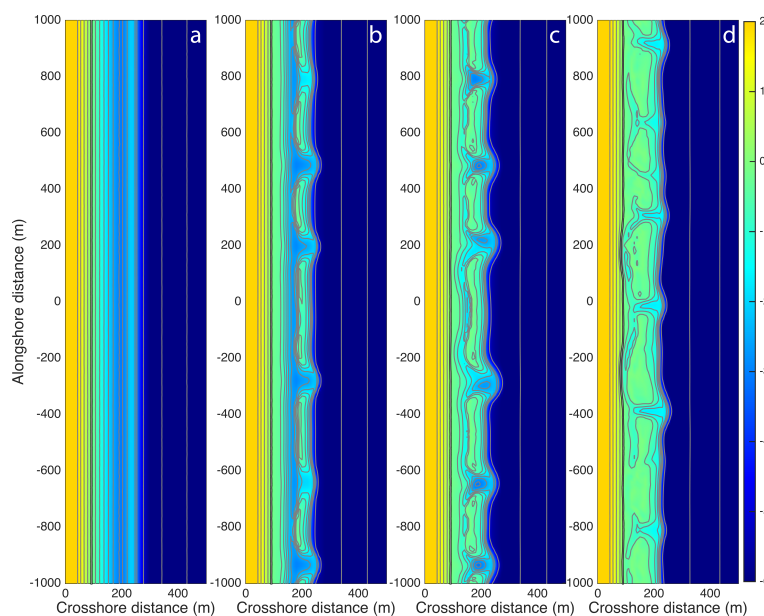

Figure 1. Simulation of a complete downstate beach evolution showing the sequential transition (a) LBT state - (b) RBB state - (c) TBR state - (d) LTT state. Colours indicate water depth, the black line shows the still water shoreline and the iso-contours of the bathymetry are contoured in the background.

References

[1] L. D. Wright and A. D. Short, *Morphodynamic variability of surf zones and beaches: A synthesis*, Marine Geology. **56**, 93-118 (1984).

[2] B. Castelle and B. G. Ruessink, *Modeling formation and subsequent nonlinear evolution of rip channels: time-varying versus time-invariant wave forcing*, Journal of Geophysical Research. **116**, (2011).

[3] B. Dubarbier and B. Castelle and V. Marieu and B. G. Ruessink, *Process-based modelling of beach profile behavior*, Coastal Engineering. **95**, 35-50 (2015).

[4] H. Michallet and B. Castelle and E. Barthélemy and C. Berni and P. Bonneton, *Physical modeling of three-dimensional intermediate beach morphodynamics*, Journal of Geophysical Research. **118**, 1-15 (2013).