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Exploring coastal dune adaptation through a simplified process-based model

Susana Costas[1], Katerina Kombiadou[2], and Dano Roelvink[3]
[1]Centre for Marine and Environmental Research (CIMA), University of Algarve, Faro, Portugal (scotero@ualg.pt)
[2]Centre for Marine and Environmental Research (CIMA), University of Algarve, Faro, Portugal (akompiadou@ualg.pt)
[3]IHE Delft institute for Water Education, Water Science and Engineering Dept., Delft, the Netherlands (d.roelvink@un-ihe.org)

Coastal dunes result from the accumulation of wind-blown sand transferred inland from the beach and trapped by physical barriers such as vegetation. Vegetation also plays an active role on dune growth through the onset of feedbacks with the dune topography and the air flow. All these complexities have been tentatively captured by recent numerical models, which also may help to better understand dune response to disturbances as well as possible evolutionary patterns. Duna is a simplified process-based model, which integrates air flow, sediment transport and vegetation dynamics to reproduce the morphodynamic response along the dune profile. The present work focuses on extending Duna to include the influence of fetch-limited conditions and to accommodate different wind incidence angles by using projected wind-parallel dune profiles.

The performance of the model was assessed by comparing model outputs with wind profile and sedimentation observations from contrasting dune morphologies and environments, showing a good agreement and promising results. Duna was further used to test several hypotheses related to air flow dynamics and topography and to explore sediment transport and accumulation patterns across a series of different dune morphologies, including basic biogeomorphic feedbacks.