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Effects of wave-topography feedbacks and radiation stresses on the nonlinear dynamics of shoreface-connected sand ridges

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On storm-dominated inner shelves of many coastal seas, patches of shoreface-connected sand ridges (sfcr) are observed. These ridges are obliquely oriented with respect to the coastline and have a rhythmic structure in the long-shore direction. Typical spacings between successive ridges range between 4 and 10 km, they evolve on a timescale of centuries and they migrate with velocities of several meters per year along the coast. In this contribution the initial- and long-term evolution of sfcr is investigated with a new nonlinear model (MORFO56) that employs finite difference methods, rather than spectral methods. MORFO56 uses depth-averaged shallow water equations, including sediment transport and bed updating. Moreover, it includes full wave-topography feedbacks, wave shoaling and refraction and wave radiation stresses. First, the consistency of MORPHO56 with earlier models based on linear stability analysis is verified, and the sensitivity of ridge characteristics on relaxing the rigid-lid assumption and quasi-steadiness is investigated by conducting a series of short-term runs. It turns out that assuming a free lid and unsteady flow results in larger wavelengths and larger migration speeds of sfcr. Next, it is shown that the new model is able to simulate the finite amplitude behaviour of sfcr for more realistic bottom slopes than earlier spectral models. Finally, the role of wave-topography feedbacks in the initial formation of sfcr is examined. Model simulations show that sfcr in the presence of these feedbacks are more trapped to the shoreface, with an offshore extent of approximately 1 km. Moreover, growth of sfcr is enhanced considerably by wave-topography feedbacks. The specific inclusion of radiation stresses does not affect this result.