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Finite height behaviour of tidal sand ridges: a nonlinear model study

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Tidal sand ridges are observed on the continental shelves with sandy beds where the tidal current is larger than about 0.5 m s^{-1}. Examples are the shelves of the North Sea and the East China Sea. These rhythmic seabed features have a typical wavelength (the distance from crest to crest) of 5-10 km and a height of order 10 m. So far, the long-term evolution of offshore tidal sand ridges has only been studied by using highly simplified models, in which tidal currents are rectilinear, and the sand transport formulation does not include a critical shear stress for sediment erosion. Furthermore, the topography is assumed to be uniform in one of the horizontal dimensions. However, field observations show that tidal currents are generally elliptical, and tidal sand ridges are actually 3D features. In this work, an idealised nonlinear numerical model is used to study the finite height behaviour of offshore tidal sand ridges. Specific aims are to quantify the effect of tidal characteristics and critical shear stress of sediment erosion on the nonlinear evolution of tidal sand ridges, both in the cases of 2D and 3D ridges. It is found out that if elliptical tides are imposed, the finite height of the ridges becomes lower, while if the critical shear stress is accounted for, the height of the ridges becomes higher and the crest becomes flatter. When the topography is allowed to vary in two horizontal dimensions, indeed quasi-3D sand ridges emerge.