Geophysical Research Abstracts
Vol. 15, EGU2013-2189, 2013
EGU General Assembly 2013

Nonlinear response of inner shelf sand ridges to human interventions

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On storm-dominated inner shelves of many coastal seas, patches of shoreface-connected sand ridges are observed that are obliquely oriented with respect to the coastline and which have a rhythmic structure in the long-shore direction. Typical spacings between successive ridges range between 4 and 10 km, they have heights of several meters, they evolve on a timescale of centuries and they migrate with velocities of several meters per year along the coast. Examples of these ridges are observed on the inner shelf of Long Island, and on the inner shelf of the North Sea. Shoreface-connected sand ridges absorb part of the energy of the incoming waves and thereby contribute to the stability of the coast. Because of the large amount of sand available on these ridges, they are potential candidates for sand extraction. However, there could be significant morphological consequences for extracting sand from them.

The main focus of the present work is to assess the consequence of sand extraction on the nonlinear dynamics of shoreface-connected ridges. For this, results will be shown of a large number of runs that have been conducted with a numerical model that simulates feed-backs between currents, waves and the sandy bed on the inner shelf. The response of the system to extracting different quantities of sand and to different geometries and locations of sand pits will be presented. In particular, the sand exchanges between the inner shelf and the nearshore zone, as well as between inner and outer shelf, are shown and the underlying physics will be discussed.