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## Observations of sediment sorting over rapidly developed marine bedforms, using multibeam backscatter

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Grain-size sorting in bedforms is well known in river dunes. On continental shelves, however, datasets aimed at grain-size sorting over bedforms, are limited. More extensive observations of sediment sorting over bedforms may help to understand their morphodynamic processes, and are key in habitat mapping, since grain-size is a main control on the composition of benthic fauna. A time series of seven multibeam (MBES) bathymetry and backscatter measurements and box cores were collected for the monitoring of a coastal nourishment in a tidal inlet at Ameland, Netherlands. Prior to the nourishment (April 2017), 10-15 m long and 1.5 m high megaripples occurred. The time series shows the rapid development of high and steep megaripples in the newly replenished sediment, with a wavelength of 40 m and height of 2.5 m within three months (during-nourishment; October 2017), which then grew into 120 m long and 3 m high sand waves in relatively shallow water (10 - 14 m) within 5 months (post-nourishment; March 2018).

Relative backscatter (BS) strengths, which are corrected for, among others, transmission losses and bed morphology, represent seabed sediment characteristics. Bed classification of BS strengths, using an unsupervised Bayesian method, resulted in a high-resolution map of 5 acoustic classes (ACs), to which sediment types were assigned using the box cores as ground truthing. These box cores, however, were not taken at the detailed level of sand wave crests and troughs. The acoustic sediment classes (ASCs) exhibit a repetitive pattern, indicating horizontal sediment sorting over bedforms, that shifted and intensified during the growth of the megaripples into sand waves. The ASC megaripple pattern is less consistent, but generally comprises finer sediments (ASC2-3: sand) on the stoss sides and coarser sediments on the lee sides (ASC3-4: sand to slightly gravelly sand). The sand wave pattern is very consistent and comprises coarse sediments on the stoss sides (ASC5: gravel- and shell-containing sands), finer sediments towards the crests (ASC2-3: sand) and even finer sediments (ASC1: sandy mud) in the troughs. In the course of one year, both the morphological and sorting patterns seem to repeat itself. A similar sorting evolution was observed during the growth of megaripples just farther offshore.

In a different data set, farther offshore on the Netherlands Continental Shelf and built up over several years, grab samples were collected in transects, specifically at crests and troughs of sand waves and long bed waves, and were analysed for grain size, organic matter and CaCO<sub>3</sub> contents. Median grain sizes in the troughs of bedforms are consistently finer than at the crests, and reveal significant signatures between sand wave fields, with crest-trough differences among sites ranging

between 10 and 85 micrometer. Unfortunately, MBES-BS data are not available for establishing large-scaled, spatial sorting patterns.

This evolution of horizontal sediment-sorting patterns during the growth of marine bedforms may support modelling studies of hydrodynamic responses of flow over undulating beds and may explain the morphodynamic evolution of marine bedforms, as relevant in marine ecology. However, coherent empirical datasets are required.