EGU23-4521, updated on 18 May 2023
https://doi.org/10.5194/egusphere-egu23-4521
EGU General Assembly 2023

Complex morphological changes in marine coarse sediment bedforms

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On inner continental shelves, a variety of coarse grained bedforms, such as gravel dunes, are shaped by hydrodynamic and morphodynamic processes. Repeat, high-resolution, multibeam surveys are crucial to identify geomorphological changes on the seafloor, especially in the extremely dynamic shallow waters (< 200 m water depth). Timeseries bathymetric datasets allow us to measure and monitor spatial- and temporal changes in submarine bedforms and determine their evolution patterns. This is important for a better understanding of the sediment transport processes and the related hydrodynamics, but also to determine the settings for benthic ecosystems and identify changes in seafloor geomorphology to prevent potential damage of offshore infrastructure and maritime pathways.
We present three multibeam data sets acquired in 2017, 2020 and 2021 over a field of gravel-sand bedforms located in the high-energy Cook Strait / Te Moana-o-Raukawa. In this study we combine timeseries bathymetric data, ground-truth data (video footage and sediment samples) and oceanographic modelling to understand the sediment dynamics in the area. Results show that coarse sand and gravel field of dunes with superimposed megaripples have undergone intricate morphological changes. The ~100-m length and ~15-m height submarine dune crests bifurcate, becoming more complex between 2017-2020, followed by the reforming of dune crests between 2020-2021. Hydrodynamic modelling suggests there is an interaction between the tidal near-bottom currents and the sediment transport, creating a morphological positive feedback, which might be leading the complex bedform morphological changes observed in the repeated mapping surveys.
This study reveals the dynamic nature of the seabed over short time-scales (years) in highly dynamic areas, such as the tidally vigorous Cook Strait region. Our findings demonstrate the importance of repeat multibeam mapping in understanding of the rate and scale of changes on the seafloor.