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Short-term morphodynamics of a submarine dune bank in a macrotidal environment: observations from the Creïzic bank (South Brittany, France)

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Marine sand dunes and sand banks can exhibit rapid morphological changes in coastal areas, which may pose a hazard for navigation in shallow water or generally in areas near marine infrastructures. Understanding their dynamics is still a scientific challenge, especially their migration processes and its consequences on the seabed topography and on sediment transport. In this study, the morphodynamics of a submarine sandbank in a macrotidal environment is investigated at short time scale. The aim is to quantify the morphological changes and migration of the bank and overlying dunes (primary and secondary sedimentary structures) in order to estimate sediment transport corresponding to bedform migration. The study site is the Creïzic submarine dune bank, located in the Gulf of Morbihan (South Brittany, France). The Creïzic bank is about 1200 m long, 600 m wide with dune heights from 0.1 m to 3.5 m. It is situated in water depths between 5 m and 20 m and is mainly composed of shelly and coarse sand. The main hydrodynamic forcing factor at play on this sand bank is a strong and unsteady tidal current. During storm events, waves, mostly from fetch, also have an impact as the bank is shallow. The bank features three main sedimentary structures: a central dune field at the middle of the bank and two dune fields on either side of the bank. Former studies at yearly time scales have shown that the central area is highly mobile with significant net migration of the dunes. To investigate the morphodynamics of the Creïzic bank, a 37-day field campaign has been carried out in the fall of 2017. A high-resolution (50 cm grid size) bathymetric dataset has been acquired using a mulitibeam echosounder (MBES), with repeated surveys at the time scales of a month (entire bank), a tidal cycle and hour scales (portions and patches on the bank). From this data, velocities and directions of migration are estimated by computing differential Digital Terrain Models (DTM), and quantified with a spatial cross-correlation algorithm. The preliminary analysis of the data set confirms the high mobility of the primary and secondary sedimentary structures at short time scales, with migration distances up to 1 m over one hour for bedforms with metric heights and wavelengths of the order of 30 m in the central zone, and reaching 50 cm over two hours for dunes with heights between 0.2 m and 0. 5 m and wavelengths between 2 m and 4 m on the south-east side of the bank.