

HYDRODYNAMICS AND SEDIMENT FLUXES AT AN INNER SHELF WITH SHOREFACE CONNECTED SAND RIDGES

Muhammed Said Parlak, Istanbul Bilgi University, said.parlak@bilgi.edu.tr
Bilal Umut Ayhan, Istanbul Bilgi University, umut.ayhan@bilgi.edu.tr
John C. Warner, U.S. Geological Survey, icwarner@usgs.gov
Tarandeep S. Kalra, Jupiter Intelligence, taran.kalra@jupiterintel.com
Ilgar Safak, Istanbul Bilgi University, ilgar.safak@bilgi.edu.tr

INTRODUCTION

The region between the mid-shelf and the surf zone is highly dynamic due to continuous interaction among bathymetry, currents, waves, and sediment fluxes. This interaction needs to be understood in order to predict the resulting transport of particles along and across the shore which is crucial for the evolution of the nearshore and the coast. Warner et al. (2014) explored the interaction of shore-oblique sand ridges with the hydrodynamics by imposing an idealized, constant alongshore wind on an idealized shelf bathymetry. Parlak et al. (2022) advanced this by investigating these processes on the realistic bathymetry including the shoreface connected sand deposits of the inner shelf of Fire Island, New York, and concluded that wave skewness may be influential in controlling shelf-scale morphodynamics. Analysis of field observations of these hydrodynamics and sediment processes and process-based modeling validated with these observations will allow us to assess the role of event-scale cross-shelf transport on longer-term coastal evolution.

METHOD

In this study, previous observational and modeling studies were further advanced by accounting for the key physical processes based on direct measurements on realistic bathymetry. Field observations of atmospheric and oceanic flows, waves, and sediment processes were collected at the inner shelf of Fire Island and analyzed. By setting up, validating, and applying a coupled modeling system (COAWST; Warner et al., 2010), these processes were simulated during this experiment that captured a series of storms, relatively calm periods in between, and varying levels of stratification.

RESULTS

A two-day-long time-series of the observed and modeled conditions at 12 m depth are shown in Figure 1. Observed and modeled subtidal cross-shore currents had speeds reaching 0.1 m/s with a two-layer structure such that the cross-shore wind forcing was driving the currents at the surface, i.e., onshore in the first 18 hours and offshore in the rest of the event; the currents in the lower half of the water column were dominantly onshore. Observed and modeled wave heights peaked at about 2 m within the first day, then had a gradual decline in the rest of the event. Near-bed sediment suspensions and cross-shore bedload fluxes largely followed the wave energy and wave velocity skewness, respectively. Therefore, the model reproduced the flows, waves, wave skewness, and sediment processes that were observed in the realistic field conditions on the realistic bathymetry. Ongoing work is on analyzing the model results along and across the entire shelf in order to investigate the evolution of the

sand deposits and the coastline at the Island scale due to the hydrodynamic processes including wave asymmetry and its impacts on net cross-shore sediment fluxes. Those results will be analyzed in conjunction with the previous findings (Safak et al., 2017) where the evolution of the Island was largely explained by the alongshore fluxes and the unexplained residual was attributed to cross-shore fluxes driven by wave asymmetry.

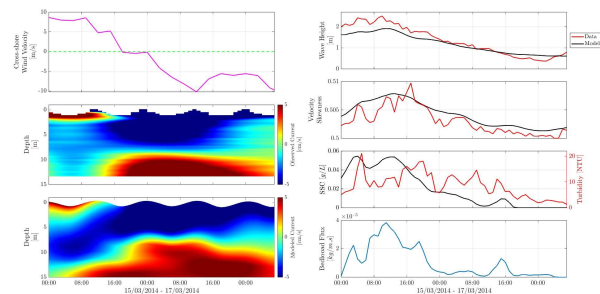


Figure 1 - A two-day-long time series of the cross-shore wind, vertical structures of the observed and modeled cross-shore residual currents where positive values in red and negative values in blue indicate onshore and offshore flows, respectively (left panels), wave height, wave velocity skewness, near-bed sediment suspensions, and cross-shore bedload fluxes (right panels). In the first, second, and third panels on the right, the red and black curves correspond to the observed and modeled conditions.

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