2022 SECOORA Undergraduate Data Challenge

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1. Introduction

For the 2022 SECOORA data challenge, we used historical SECOORA wind and wave data from Jan. 1, 2006 to Dec. 31 2022 to investigate weather events with the potential for significant sediment mobilization in the South Atlantic Bight (SAB). Events were identified as periods where wave induced seafloor stresses exceeded 0.27 Pa for at least 24 hours with a minimum of 24 hours beneath this threshold between events. For our analysis we choose to use observations from NDBC 41025, NDBC 41013, NDBC 41004, and NDBC 41009 which are located at depths of 33-48m. In our proposal we had planned to include NDBC 41008 and CORMP OB27 however these were ultimately left out of the project. OB27 has a data gap spanning 2005-2012 and it would have been difficult to compare with the more complete records at our selected moorings. NDBC 41008 has a depth of 15m and was excluded to keep the moorings relatively consistent as storm induced seafloor stresses were expected to shrink with increasing depth [1].

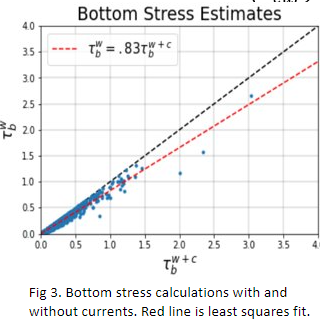
1. Methods

The first step was to collect historical wave frequency spectrum data from the online archives. This was done in Scrape\_Data.ipynb using a python web scraper located in the pybuoy module. Before calculating sea floor stresses at the four moorings, a preliminary analysis was done using wave spectrum data from OB27 and a simple 1d model of wind driven currents. The model is outlined in Lentz (1993) and can be found at <https://github.com/CMS-Physical-Oceanography/Buoy-Class/tree/main/simple> [7]. To estimate wave induced bottom stresses, we use the 1D wave spectrum to calculate near bottom orbital velocities, , as [1]

(1)

where and are the period and wavenumber corresponding to the frequency bin in the wavespectrum, and *h* is the mooring depth. Values of were calculated using the Newton-Raphson method and the wave dispersion relation. Seafloor stress calculations were done in IdEvents.ipynb using functions in the pybuoy module. Values of were then used along with modeled near bottom currents and a sand grain roughness length to calculate a friction factor [8]. To calculate we used an iterative scheme from the boundary layer model outlined in Madsen (1994) [8]. The grain roughness length describes the texture of the seafloor and is given by where is the median grain size[4]. A value of mm was used to match the mean median grain size within the SAB from the USGS East Coast Sediment Database[5]. Finally seafloor stress was calculated as

(2)

where is the density of seawater. When comparing values of calculated with and without the addition of wind driven currents we found that waves accounted for over 80% of the estimated seafloor stress in the time series at OB27 (fig 1). Because of this and the lack of current observations to validate model outputs at other moorings we chose to calculate seafloor stresses without the addition of wind driven currents for the rest of the project.

Estimations of were then used to identify events at each mooring. These were defined as periods in the timeseries where exceeded 0.27 Pa for at least 24 hours with a minimum of 24 hours between events. The stress threshold was chosen as it is sufficient to mobilize fine grain sands with a diameter of 1.3mm or smaller [6].This was done in IdEvents.ipynb. Events were then ranked by time integrating the bottom stress and the 10 largest storms from each mooring were saved in table form. Finally, the hurricane and winter storm database from NC State's Climate Office was used to find storm names and classifications when applicable.

1. Results & Products

Of the 40 events saved in our record twenty nine coincided with named hurricanes, four with extratropical events such as Nor’easters and blizzards, three with tropical storms, and one with a subtropical storm. The remaining three were left as unknown. Overall there were twenty seven unique events with many large named hurricanes such as Sandy (2012) and Florence (2018) occurring in the top 10 at multiple moorings.

In order to index our catalog and display data from events a python dashboard was created and made available in dash.ipynb. The dashboard allows users to select any of the 40 events identified in our analysis and display buoy data along with model outputs from a 25 year Regional Ocean Modeling System (ROMS) reanalysis provided by the Ocean Observing and Modeling Group (OOMG) at NC State [9]. We originally intended to use ROMS near bottom current outputs, along with a regional wave reanalysis to make maps of seafloor stress across the SAB however, we were unable to obtain wave data. Instructions on how to use the dashboard can be found in dash.ipynb and in the video provided on GitHub. All of the products and code used in this project can be found in the DataChallenge GitHub repository located at <https://github.com/twhesford/DataChallenge>.

References

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