

ESTIMATING METEO-TSUNAMI OCCURRENCES FOR THE US EAST COAST

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INTRODUCTION

Meteorological tsunamis, also called meteo-tsunamis, are significant ocean surface waves generated by atmospheric forcing. The waves typically result from energy transfer from atmosphere to ocean through the Proudman resonance phenomena, where translation speed of the storm system in the atmosphere coincides with the free wave speed of long surface waves. These tsunami-like waves can be hazardous, either through direct inundation of shorelines or through generation of harbor oscillations and other disruptions to maritime activities. The wide continental shelf bathymetry of the United States (US) East Coast provides a long potential fetch length for the resonant generation process, making the region particularly susceptible to meteo-tsunamis. In this study, we carry out a probabilistic analysis of potential meteo-tsunami hazard on the US East Coast, extending the earlier work of Geist et al. (2014) to include a wider range of storm conditions and additional response types including coastally-trapped edge waves. The work, carried out under the auspices of the National Tsunami Hazard Mitigation Program (NTHMP), extends the previous efforts of Geist et al. to include a representation of inundation and maritime hazards in at-risk areas. The work is conducted using the fully nonlinear Boussinesq wave model FUNWAVE-TVD (Shi et al., 2012), extended to include atmospheric pressure and wind forcing.

METHODS

A new module to simulate pressure forcing was developed for FUNWAVE-TVD. The pressure forcing is modeled using a two-dimensional Gaussian shape function with major and minor axes and maximum pressure anomaly as inputs. The pressure anomaly is given by

$$P = dPe^{-\left(\frac{(x'-x_0)^2}{2\sigma_x^2} + \frac{(y'-y_0)^2}{2\sigma_y^2}\right)} \quad (1)$$

where dP is the change in pressure in mb, x' and y' are coordinates in a frame rotated to align with the direction of storm track that follows a given storm translation speed, and x_0 and y_0 are the initial position of the field. σ_x and σ_y define the width and length of the pressure source.

MODEL VERIFICATION

A significant meteo-tsunami event occurred on the shelf offshore of the New Jersey coastline on June 13, 2013. The event originated from a rapidly moving mesoscale convective system traveling from the Great Lakes region to the Mid-Atlantic coastline (NOAA, 2014). The centerline of the storm traveled through New Jersey and across the continental shelf, generating a wave, which reached the mid-Atlantic shelf break and was reflected

back to shore. Tide gauges from North Carolina to Massachusetts recorded the event. Data was collected using NOAA gauges about the pressure jump, speed of the system, and wave amplitudes of the event, at multiple locations from New Jersey to Massachusetts. Time series of modeled surface displacements were compared to data to determine the accuracy of model predictions. A time series comparison of the 2013 event in Atlantic City, NJ is shown in Figure 1, which shows model results (red) versus the de-tided tide gauge signal (blue). Similar trends and heights for wave amplitude were seen between observed data and modeled data at tide gauges distributed over the modeled mid-Atlantic shelf region.

PROBABILISTIC ANALYSIS

A set of candidate atmospheric events are being determined based on historic weather records in order to carry out a probabilistic analysis of meteo-tsunami activity for the US East Coast. Results will be presented in terms of both maximum probable events and event magnitudes based on return period.

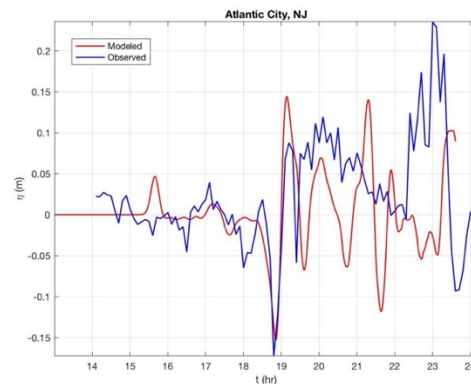


Figure 1 - Time series comparison of surface displacements between observed and modeled data for the 2013 East Coast meteo-tsunami event.

REFERENCES

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