UNIVERSITY of DELAWARE

East Coast Progress Report

NTHMP Annual Meeting, February 11, 2015

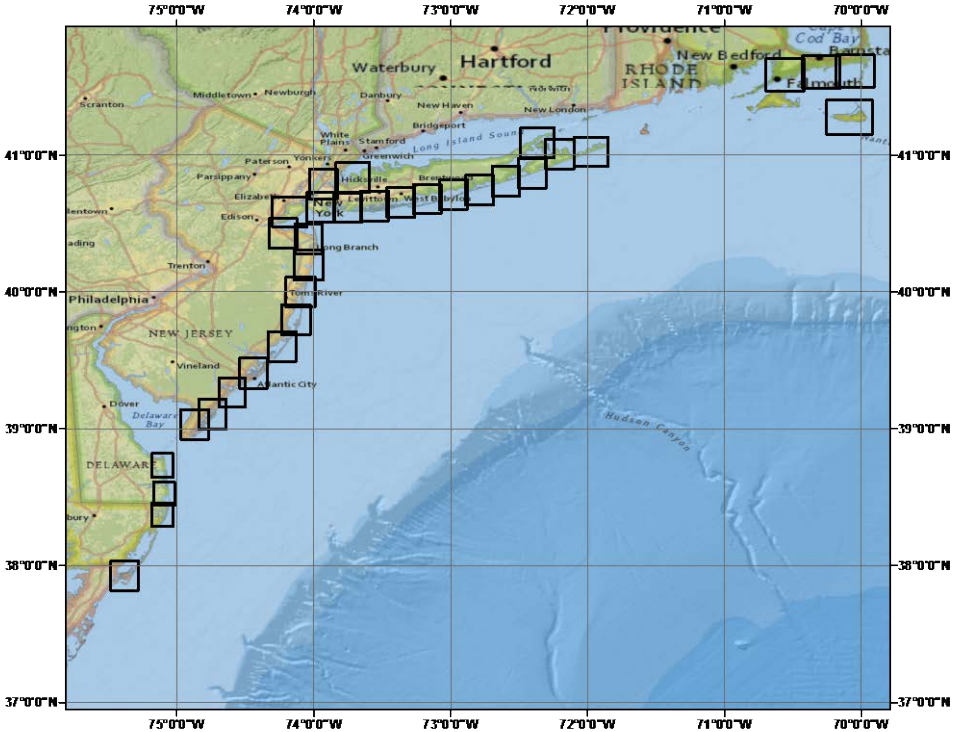
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

Center for Applied Coastal Research

THE UNIVERSITY OF RHODE ISLAND

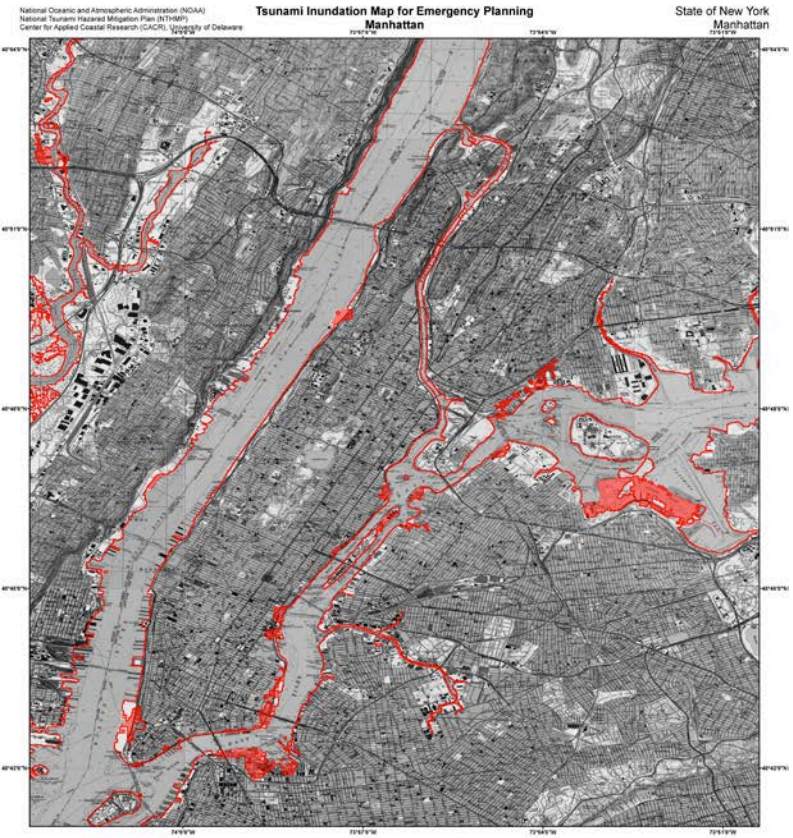
Warning Guidance
Mitigation
Hilo Bay
Hazard Assessment

Location of Maps Generated for the Upper East Coast (FY10-12)



Reporting:

1. Source reports
   - Organized by event or class of event.
2. Inundation reports
   - Organized by DEM
   - Provide:
     - Information on sources for each region
     - Arrival time information
     - Description of maps
     - Description of additional products (mainly maritime, momentum flux estimates on land)
     - ArcGIS information.
3. Maps!



METHOD OF PREPARATION

Tsunami source modeling was performed by the University of Rhode Island (URI) funded by the National Tsunami Hazard Mitigation Program. First, a large earthquake in the Puerto Rico Trench (PRT) in the well-known Caribbean Subduction Zone (CSZ) was modeled (Grilli and Grilli, 2013a). The other common source that was studied here is located on Azores Gibraltar plate boundary (Grilli and Grilli, 2013b). Both of these sources are generated according to the standard Okada method. Cumbre Vieja volcano (CVV) collapse located in Canary Islands is also considered to be another significant tsunami source which threatens the location of study. A multi-Root 3D Slamer Slides solver (TWT3S) was used to compute the volcano collapse tsunami source (Grilli and Grilli, 2013c). Also, in this project four different locations are chosen on the US east coast shelf break as the most probable to experience a submarine mass failure tsunami (Grilli et al., 2013). The landslide movement is simulated with NHWAVE model.

For bathymetry data, the integrated bathymetric-topographic digital elevation model (DEM) generated by National Geophysical Data Center (NGDC) is used for high-resolution inundation mapping. For ocean basin tsunami propagation, the depth values were obtained from the 1 arc-minute ETOPO-1 database, while nearshore bathymetry and topography were obtained from NGDC's Coastal Relief Models, which are typically provided on a 1/3 arc-second grid.

Tsunami nearshore propagation and onshore inundation were performed by University of Delaware funded by the National Tsunami Hazard Mitigation Program. Here, we used FUNWAVE-TVD code to obtain the tsunami inundation line. FUNWAVE-TVD (Shi et al., 2012) is a public domain open-source code that has been used for modeling tsunami propagation inside ocean basin, nearshore tsunami propagation and related inundation problems. We used the recorded data on the boundaries of Ocean City, NGDC DEM to perform our nesting approach to achieve high resolution results close to the shoreline. Simulations with grid sizes of roughly 225.0 meters (about 9 arc-sec) are implemented on the grid to record proper data around four DEMs with resolution of 1 arc-sec (extracted from 1/3 arc-sec Ocean City DEM) inside the main region. Using this data, 1 and 1/3 arc-sec grids were used to generate the inundation line (Yalciner et al., 2014).

The accuracy of the inundation line shown on this map is constrained by several factors such as the accuracy of the models used here as well as the bathymetry data inaccuracy. It should be noted that the inundation line depicts the envelope of the inundation lines for all the tsunami sources studied here and does not demonstrate one particular source.

References:

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Yalciner,A.C., Averkiadiadi, S., Kirby, J.T. Callahan, J. K. Shi, F., 2014, "Tsunami Inundation Mapping for Ocean City, MD-NGDC DEM". Technical report, No. CACR-14-04, Center for Applied Coastal Research.

TSUNAMI INUNDATION MAP FOR EMERGENCY PLANNING

States of New York
Manhattan

February 1, 2015

Scale 1:40,000

0.7 0.35 0 0.7 1.4 Miles

3,000 1,500 0 3,000 6,000 Feet

0.65 0.33 0 0.65 1.3 Kilometers

Tsunami sources modeled for the Ocean City coastline

	Sources	Location
Local sources	Submarine Mass Failure 1	72.21 W , 39.22 N
	Submarine Mass Failure 2	71.46 W , 39.70 N
	Submarine Mass Failure 3	73.19 W, 38.41 N
	Submarine Mass Failure 4	73.60 W, 38.10 N
Distant Sources	Puerto Rico Trench Zone (M=9.0)	Caribbean Subduction Zone
	Azores Convergence Zone(M=8.6-9.0)	Azores Gibraltar plate boundary
	Cumbre Vieja volcanic (CVV) collapse	Canary Islands

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MAP EXPLANATION

Tsunami Inundation Line

Tsunami Inundated Area

PURPOSE OF THIS MAP

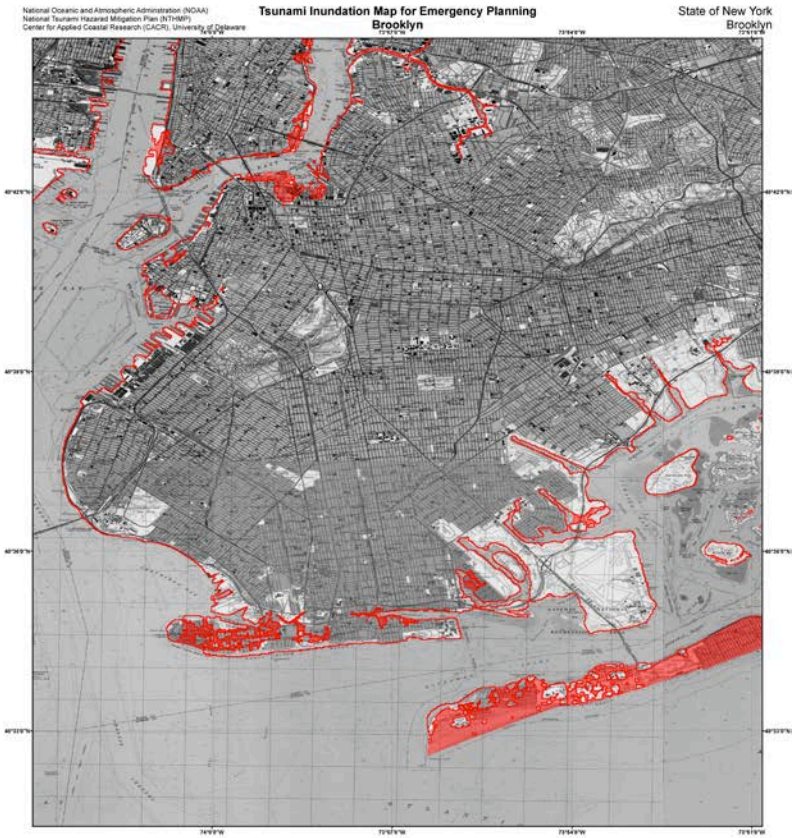
This tsunami inundation map was prepared to help coastal communities to identify their tsunami hazard. This map is not a legal document and does not meet disclosure requirements for real estate transactions nor for any other regulatory purpose. The inundation map has been obtained through using the best available scientific information. The inundation line represents the maximum tsunami runup extent utilizing a number of extreme, yet scientifically realistic, tsunami sources. This map is supposed to portray the worst case scenario and does not provide any further information about the return periods of the events studied here.

MAP BASE

Topographic base maps prepared by U.S. Geological Survey as part of the 7.5-minute Quadrangle Map Series (originally 1:24,000 scale). Tsunami inundation line boundaries may reflect updated digital topographic data that can differ significantly from contours shown on the base map.

DISCLAIMER

The National Tsunami Hazard Mitigation Program (NTHMP), the University of Delaware (UD), and the University of Rhode Island (URI) make no representation or warranties regarding the accuracy of this inundation map nor the data from which the map was derived. Neither the NTHMP nor UD shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.



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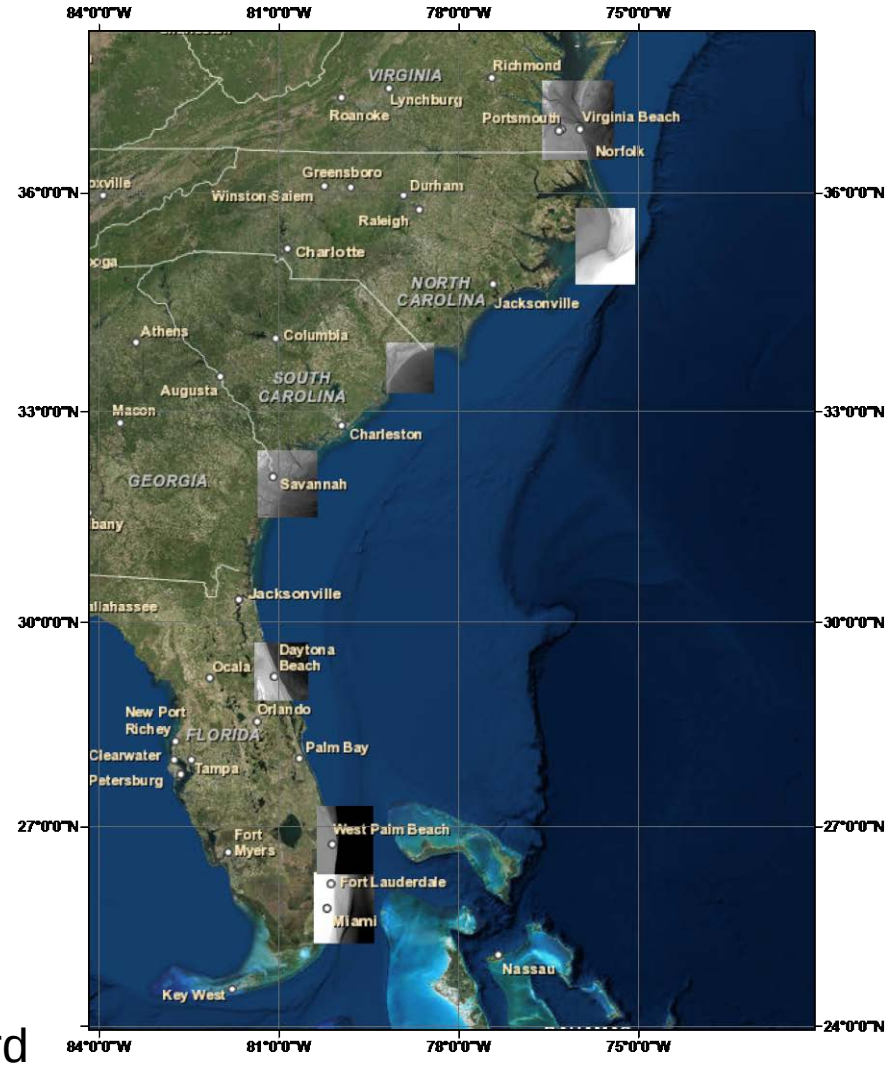
South East DEMs (FY13, 14)

- Virginia Beach, VA
- Cape Hatteras, NC
- Myrtle Beach, SC
- Savannah Beach, GA
- Daytona Beach, FL
- Palm Beach, FL ?maybe southern N.C.
- Miami, FL



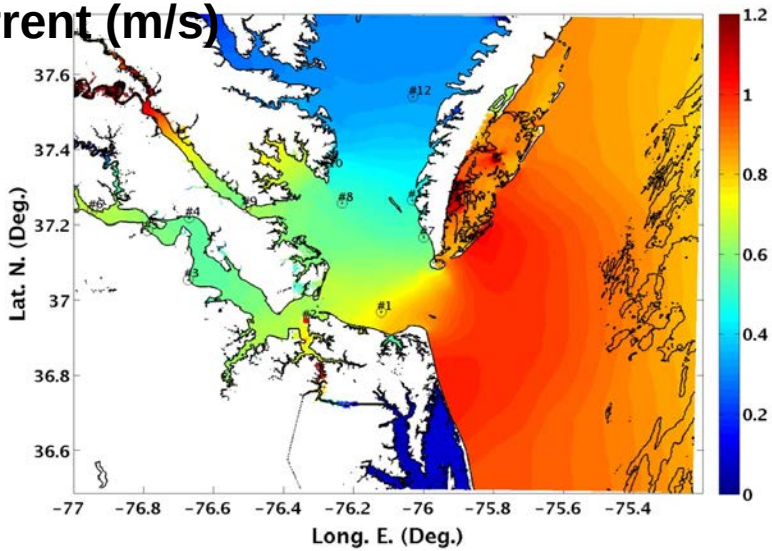
Information being collected:

- Input to basic inundation mapping
- Results (velocity, momentum flux vorticity) for future maritime hazard assessments, building code input, etc

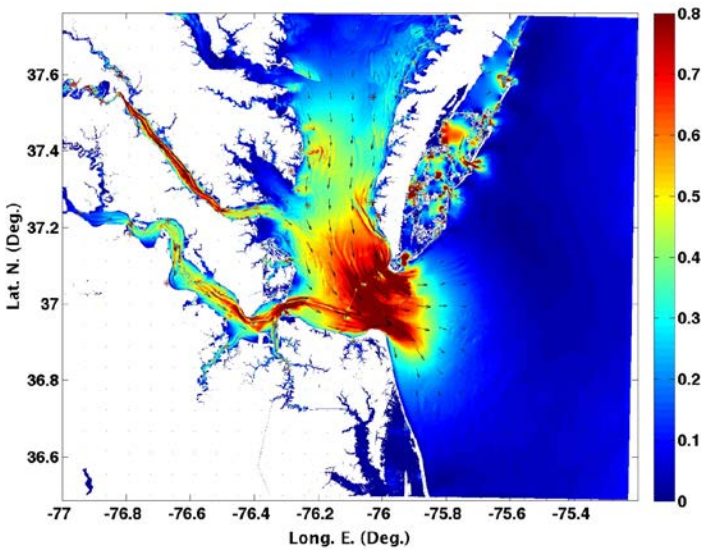
Progress on tide-tsunami interactions

- In large estuaries and Bays (e.g., Chesapeake Bay and Hudson River/New York Harbor on the USEC), with strong tidal flow, the nonlinear combination of tides and tsunamis may create more hazardous conditions and larger inundations.
- The arrival of the tsunami at different phases of the tide may both influence this nonlinear combination and the resulting inundation.
- Because tide and tsunami are nearly linear long waves in deep water, their elevation and current can be linearly combined along an offshore boundary of the model to perform combined tide-tsunami simulations. The model is also initialized (ramped-up) with the calibrated tide prior to the arrival of the tsunami.
- Chesapeake Bay simulations have been done and calibrated for the M2 10% exceedance tide only (based on NOAA tide gage data). The usual extreme tsunami sources, from LSB, PRT, CVV and CRT, were then superimposed and model run for 8 different phases of the tide.
- Hudson River/New York harbor tide simulations were done and the combined tide-tsunami simulations are in progress.

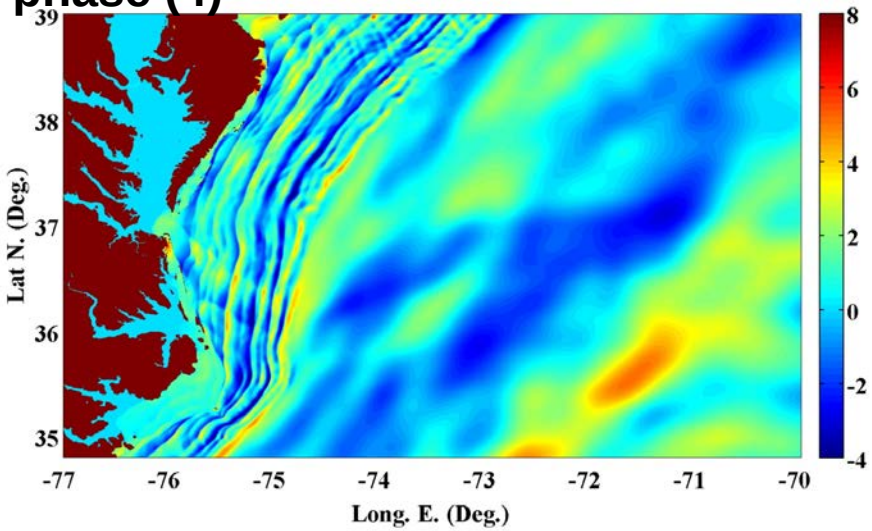
M2 Tide (10% exceedance) max. elevation (m)



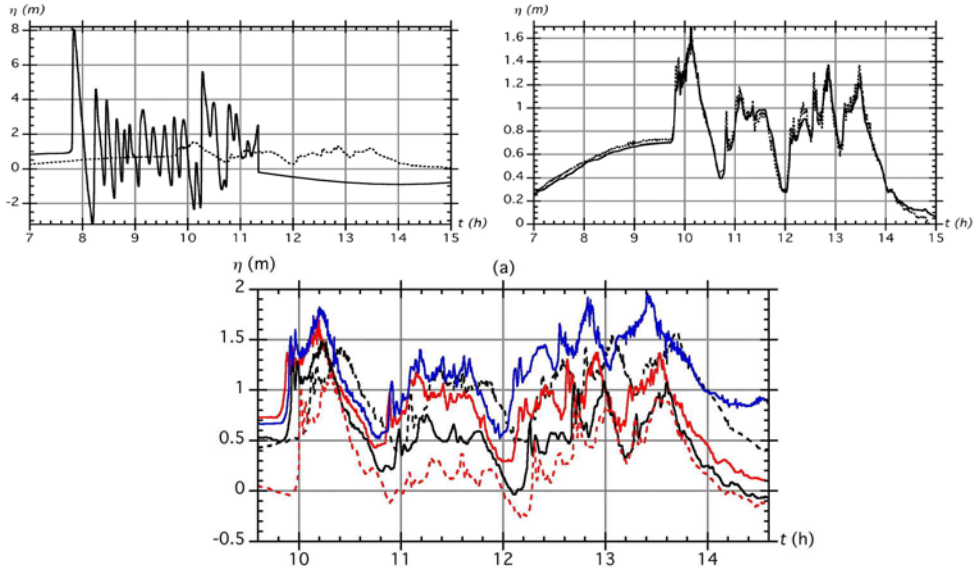
Instantaneous ebb current (m/s)



Incoming CVV extreme tsunami elevation (m)



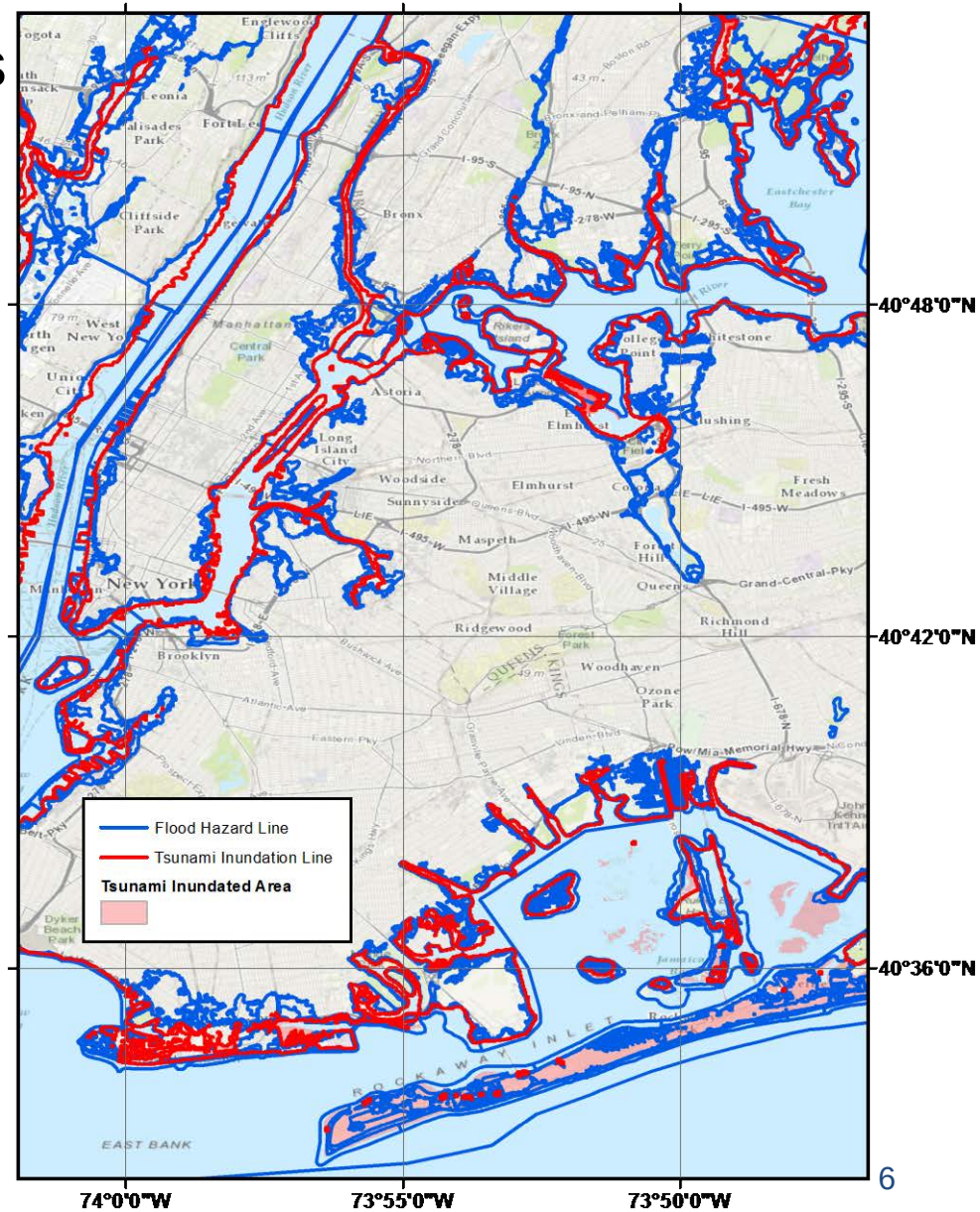
Combined tsunami/tide phase (4)

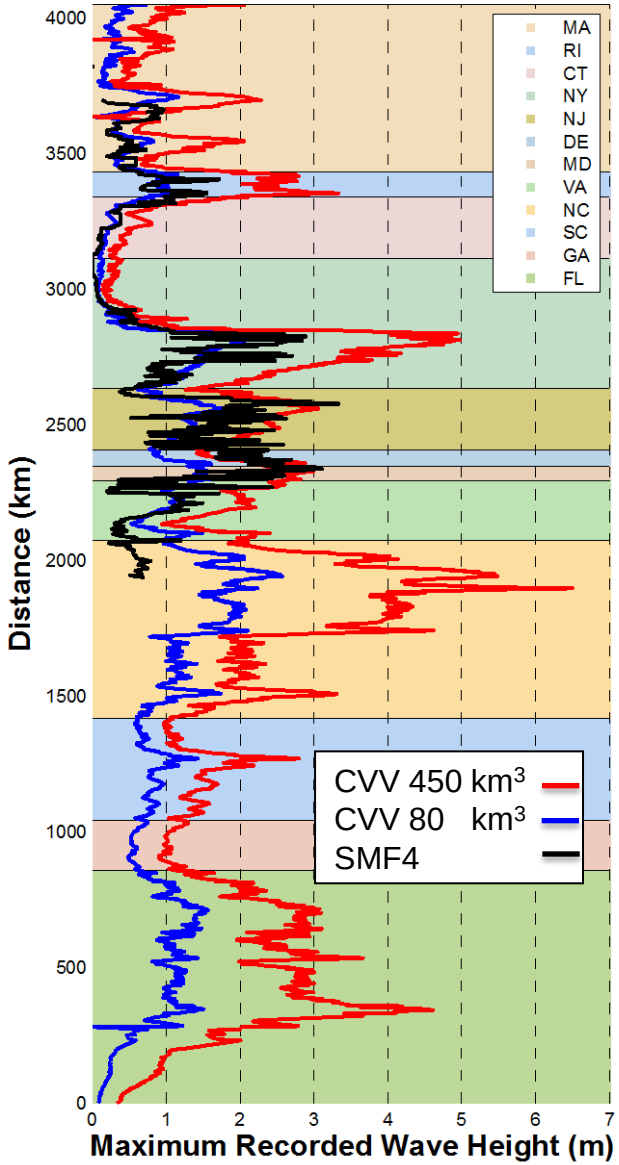


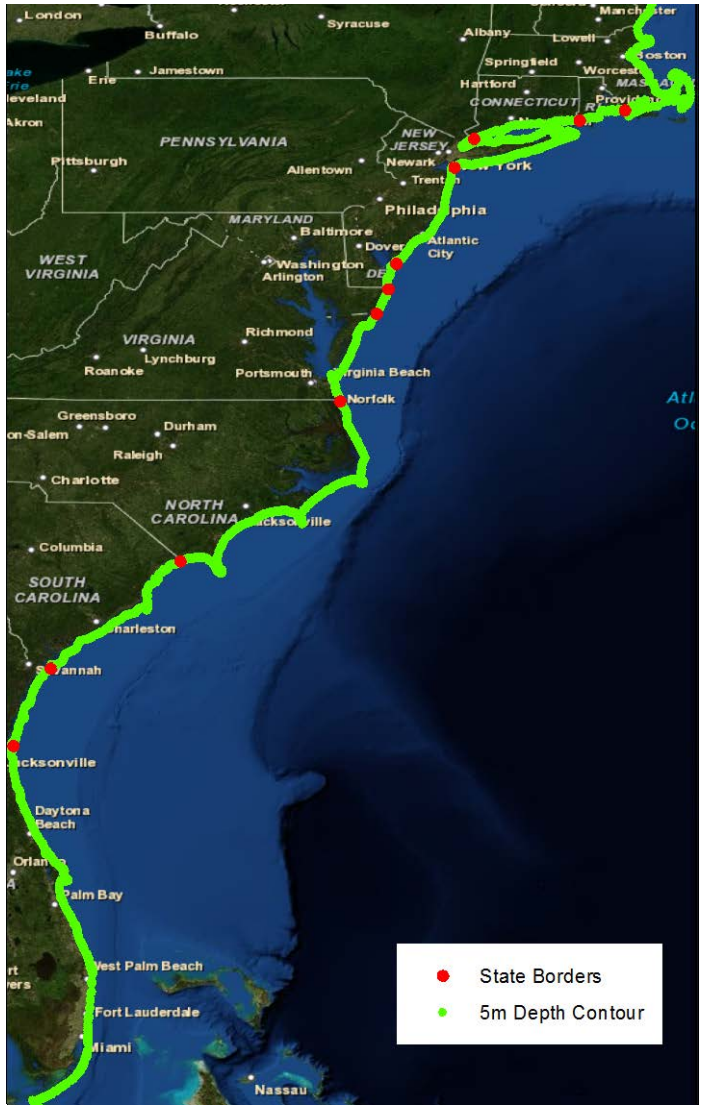
Guidance for unmodeled areas

Comparison of tsunami inundation line and Storm Surge hazard maps

- Tsunami inundation is dominant in areas directly facing open water.
- In the areas behind barrier islands or other protected areas, storm surge effects are dominant.





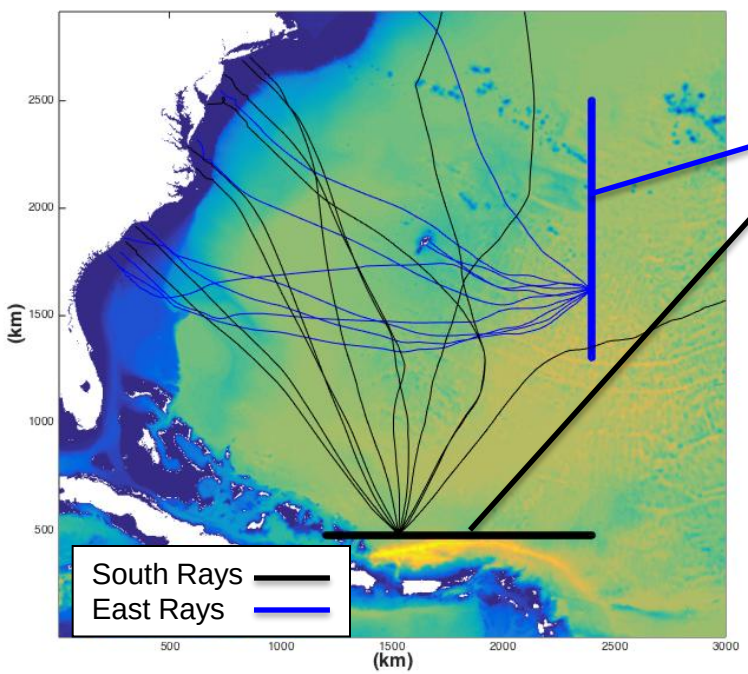


- A similar wave height distribution pattern was observed for all of the sources simulated in this study.
- Tsunami wave height distributions along the east coast suggest that the tsunami propagation is determined by the bathymetry due to the existence of a wide shelf.

Wave Ray Analysis

- To investigate the hypothesis of the bathymetric features determining the propagation pattern of tsunamis, a wave ray analysis over the shelf is being performed.

- We traced more than 3000 rays with various angles in the north direction originating from the south to replicate the PR source. Also, we performed the same analysis for waves propagating toward the west to replicate the CVV source conditions.



Starting Locations of Wave Rays

Wave Ray Concentration is the number of rays that end up in a circle with 0.1° radius at a certain location on the shoreline