High-Resolution Modeling of Surge during Hurricane Matthew (2016)

A. Thomas[1], J.C. Dietrich[1], J.G. Fleming[2], B.O. Blanton[3], T. Asher[4], R.A. Luettich Jr[4]

[1]Civil, Construction and Environmental Engineering, North Carolina State University;
[2]Seahorse Coastal Consulting; [3]Renaissance Computing Institute, UNC Chapel Hill; [4]Marine Sciences, UNC Chapel Hill

NC STATE UNIVERSITY

COASTAL RESILIENCE CENTER
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1. INTRODUCTION

- Hurricane Matthew was a category 5 storm that caused significant damage along the U.S. east coast during October 2016
- For much of 9.5 days as a hurricane, Matthew chugged along slowly – between 3 and 14 mph

Figure 1: Path of Hurricane Matthew

2. HYPOTHESES

- The variation in Matthew's impact would have been caused by how it interacted with the tides as the storm moved along the coastline
- The extent of flooding would have been also influenced by forward speed of the storm

3. MODEL SETUP & VALIDATION

- Coupled ADCIRC+SWAN model
- Unstructured high-resolution mesh that extends inland to the 10m topographic contour at most places

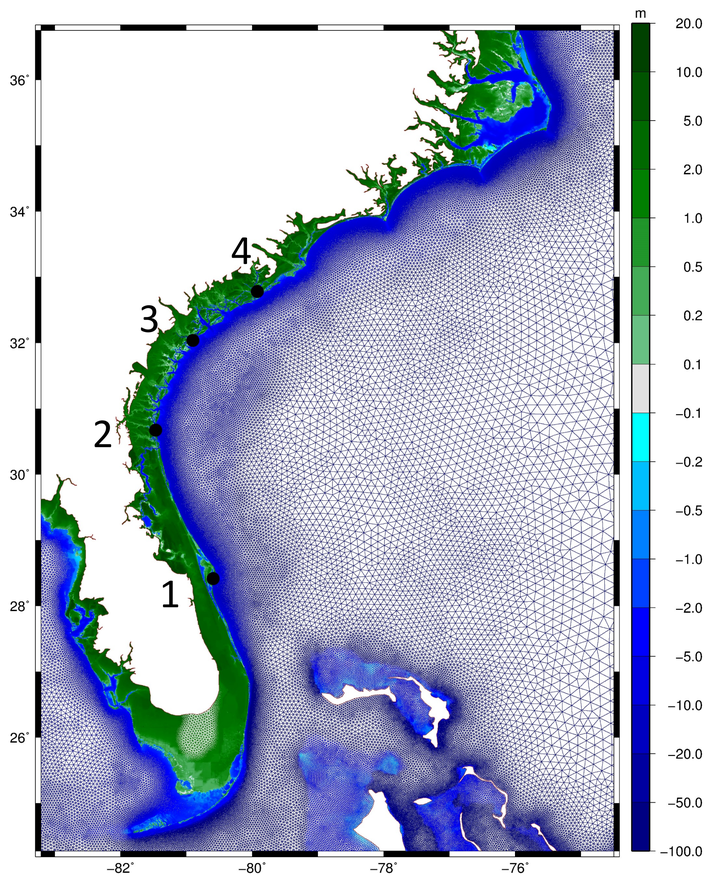

Figure 2: The HSOFS mesh (1.8 million nodes). Labels indicate locations for which water levels are shown in Figure 3

- Good agreement to observations
- RMSE of 0.28m and Bias of 0 for 241 time series plots analyzed
- Peak comparison with 623 observations yielded a RMSE of 0.28m and R-squared of 0.78

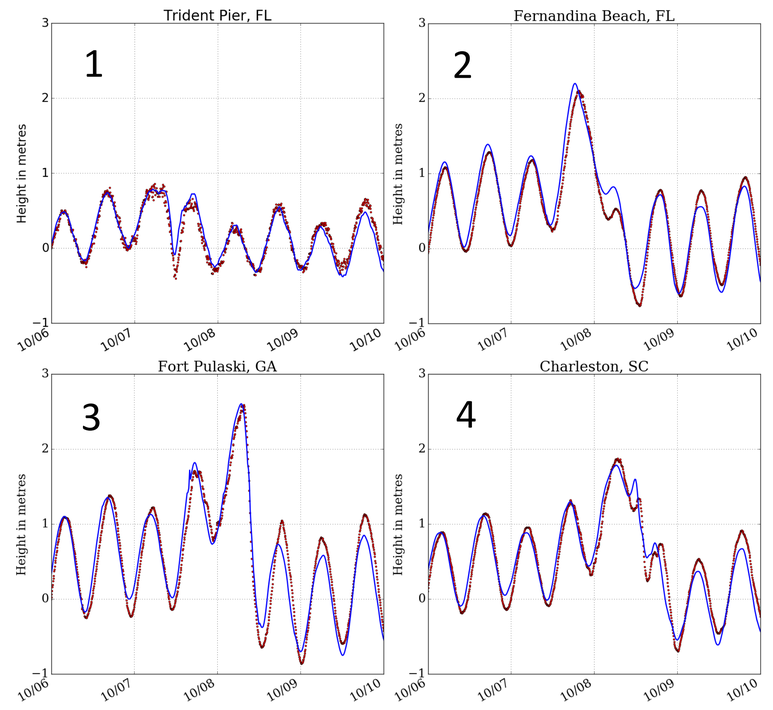

Figure 3: Time Series of water levels at locations shown in Figure 2. Red dots indicate observations and blue line indicate modelled results.

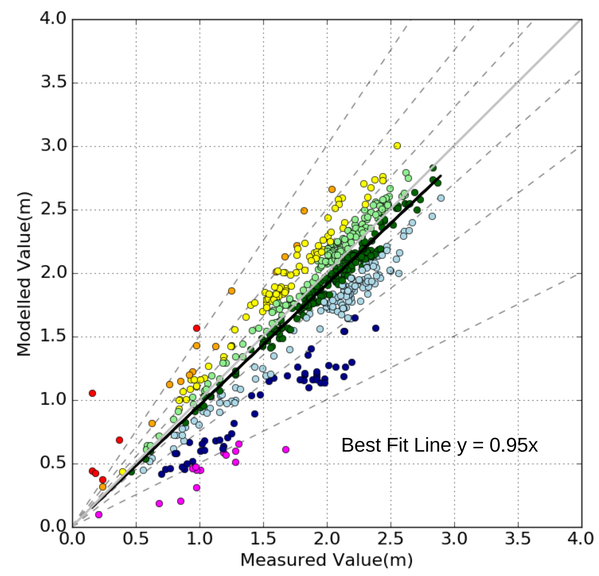

Figure 4: Peak Comparison (The best fit line is shown in black; 1 to 1 line in solid grey and grey dashed lines on either side of it indicate 10%, 25% and 50% error limits)

4. CHANGES IN TIMING AND SPEED OF THE STORM

- The storm was delayed by one half M2 tidal period (6.21 hours), keeping the tides on
- The forward speed of the storm was also varied (increasing the speed by 100%), keeping the tides off

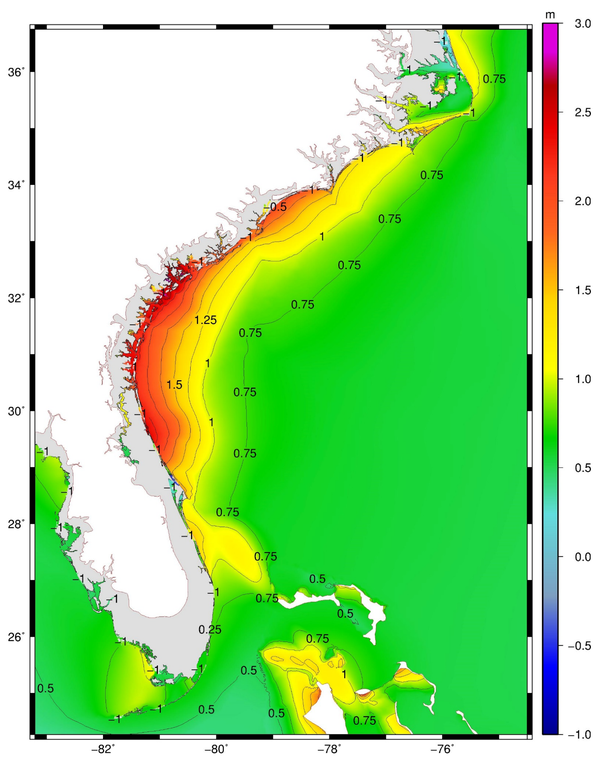

Figure 5: Maximum water levels during Matthew

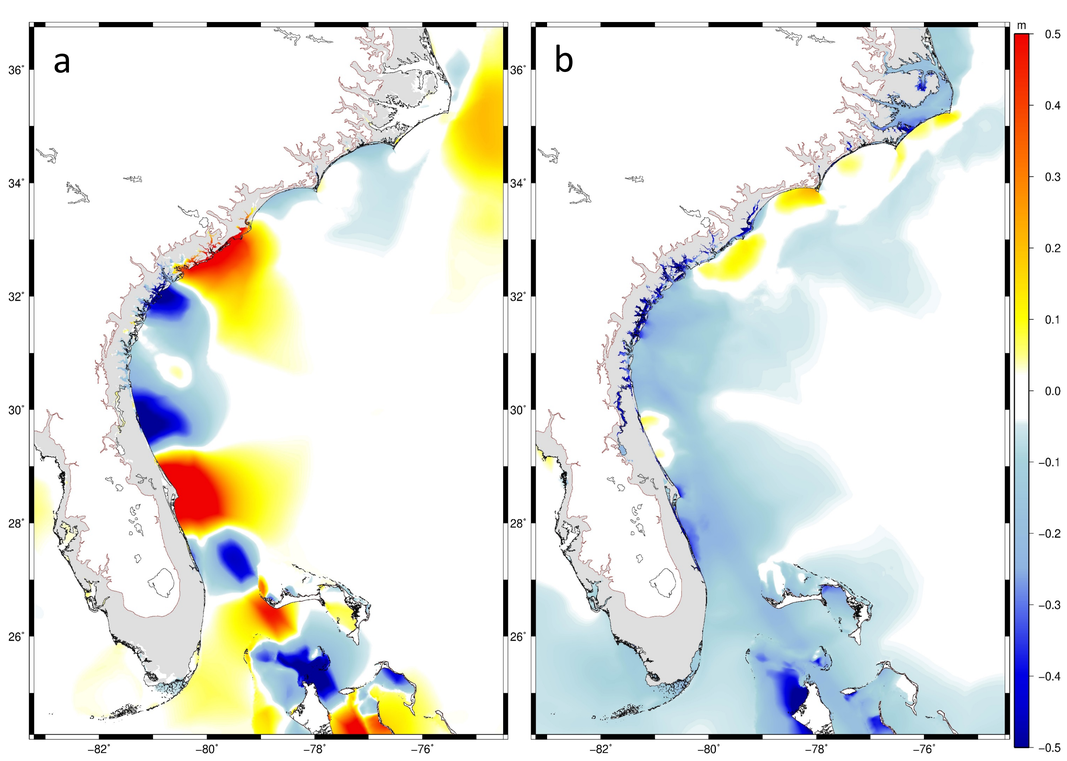

Figure 5: Change in maximum water levels on: a) delaying the storm by 6.21 hours (tides on) and b) increasing the storm speed by 100% (tides off)

Table 1: Change in peak water levels (m) at locations shown in Figure 2 due to change in timing (with tides) and speed of the storm (without tides). +ve and –ve indicates increase and decrease in peaks respectively.

Change in the storm	1. Trident Pier, FL	2. Fernandina Beach, FL	3. Fort Pulaski, GA	4. Charleston, SC
Late (+ 6.21 hours)	+ 0.6	- 0.2	- 0.6	+ 0.7
Fast (100% faster)	- 0.2	- 0.3	- 0.3	- 0.2

5. CONCLUSIONS

- By changing the time of occurrence of the storm, it was seen that there were differences in storm surge along the coast due to regions coinciding with different periods in the tidal cycles
- These differences were as high as one meter at certain locations
- The faster storm is seen to move quickly across the shoreline thus flooding only a narrow section of the coast and producing lesser inundation

6. FUTURE RESEARCH

- Studying the effect of other time variations and the storm occurring earlier
- Looking at the effect of slowing down the storm on coastal flooding
- Exploring the non-linear interaction between the storm and tides