The Impact of Observed Tropical Cyclone Characteristics on Storm Surge Heights for the U.S. Atlantic & Gulf Coasts

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Introduction

Motivation

- Tropical cyclones (TCs) can be some of the most costly natural disasters in the world
- These storms present a danger throughout the entire North Atlantic
- Storm surge is a particularly deadly characteristic of TCs

Photo courtesy of Kathy Anderson, The Times-Picayune

Photo courtesy of Xinhua/ Landov, Barcroft Media

- **Goal**: Compare observational record with climate model results in Reed et al[1] to see if the same trends are occurring

Methods

- Used the NOAA Best Tracks Dataset[2]
  - Wind, pressure, radius of maximum wind (RMW), latitude, longitude
- Worked with the SurgeDat Database[3]
  - TC surge and storm tide
- Conducted a Principal Component Analysis of TC characteristics to find which affected storm tide and surge the most

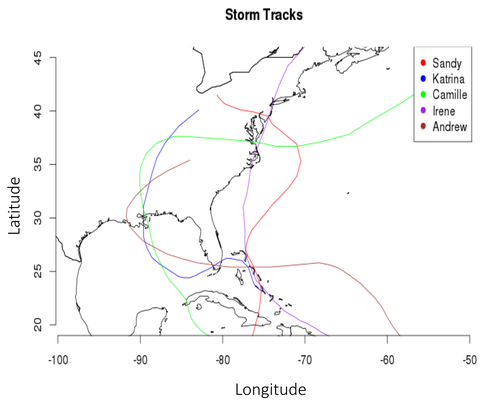

Figure 1. The path of a TC can be created on a map by using latitude and longitude points that are taken every six hours from the NOAA Best Tracks Dataset. On the left is a map with the storm track of superstorm Sandy (red) and hurricanes Katrina (blue), Camille (green), Irene (purple), and Andrew (brown). This can be done for any storm within NOAA Best Tracks Dataset in the North Atlantic Basin.

Results

Basin Wide

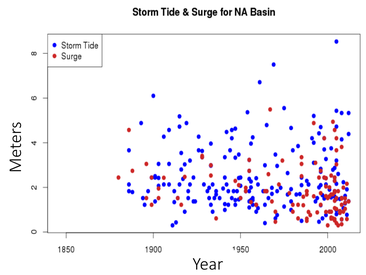

Figure 2. Time series plot of the storm tide (blue) and the storm surge (red) for TCs in the North Atlantic Basin.

PCA for North Atlantic Basin

	RMW	Wind	Pressure
Standard Deviation	43.0442796	35.4856204	5.71687773
Proportion of Variance	0.5891809	0.4004263	0.01039287
Cumulative Proportion	0.5891809	0.9896071	1.00000000

Figure 3. A table of the Principal Component Analysis for TC characteristics. RMW is weighted most heavily among characteristics that impact storm tide and surge accounting for 58.9% of the variance. RMW was only able to be recorded from 1988 and on, therefore there is a large deviation between observations. The wind accounts for another 40% of the variance of storm tide and surge. Lastly, pressure accounts for only 1% of the variance storm tide and surge.

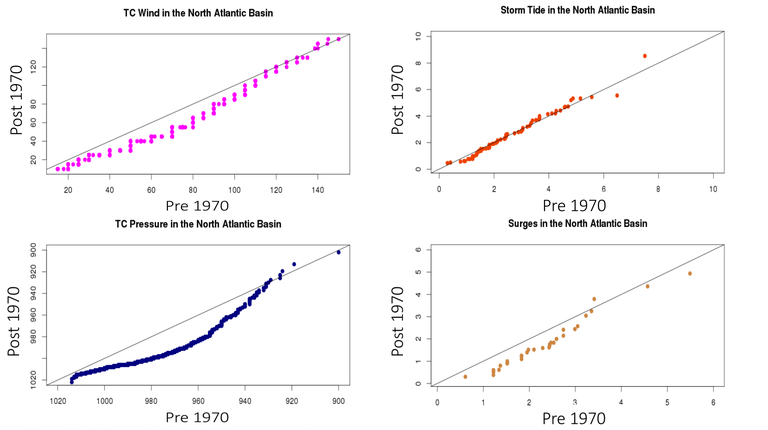

Figure 4. Q-Q plots for the wind and pressure for the North Atlantic Basin. Both the wind and pressure are becoming slightly more intense post 1970.

Figure 5. Q-Q plots of the storm tide (top) and storm surge (middle) of TCs in the North Atlantic Basin. Both plots show extreme values for storm tide and surge.

Specific Locations

New Orleans

Wilmington

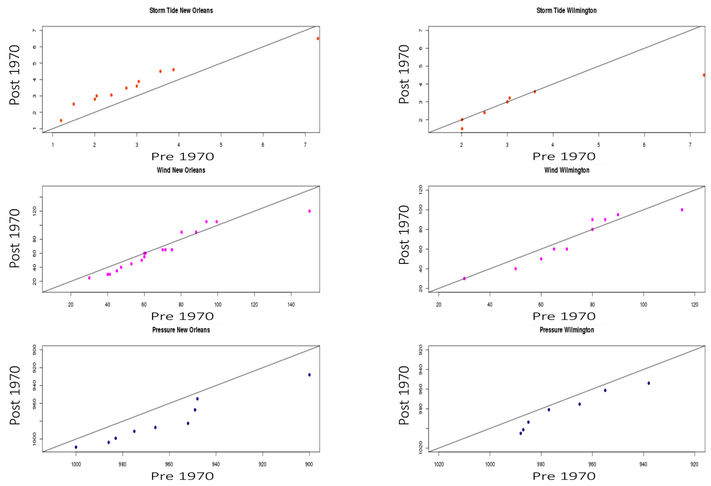

Figure 6. Q-Q plots of the storm tide (top), wind (middle), and pressure (bottom) for TCs that come within a 250 kilometer range of New Orleans, LA. The data point closest to landfall was used for each storm dating back to 1850 in order to obtain TC characteristics right before the storm hit the coast.

Figure 7. Q-Q plots of the storm tide (top), wind (middle) and pressure (bottom) for TCs that come within a 250 kilometer range of Wilmington, NC. The data point closest to landfall was used for each storm dating back to 850 in order to obtain TC characteristics right before the storm hit the coat.

Discussion

Data Availability

- Along with New Orleans and Wilmington, New York was a site of interest, but with lack of data in the observational record no effective analysis could be completed
- Since RMW values were recorded from 1988 onward, it is difficult to provide an accurate analysis of RMW

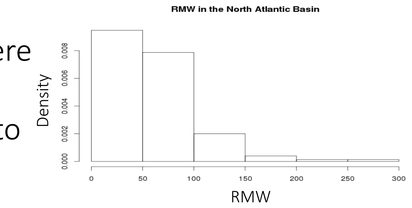

Figure 8. A histogram of the RMW values for TCs in the North Atlantic Basin.

Conclusions

- The observational record is consistent with the climate model results found in Reed et al, (2015)[1]
  - ➢ Most intense storms in the tail are become more intense in the modern time period
  - ➢ PCA of the observational results agree with the model results indicating that variance in storm surge is primarily from RMW, an indicator of storm size, and secondarily from wind, an indicator of storm intensity
- Sea level rise is not accounted for in the storm tide and surge, therefore even a slight rise in the most severe events could have catastrophic effects

Photo courtesy of David J. Phillip, Gerald Herbert / Associated Press

Future Work

- Expanded Best Tracks Dataset would include more data to work with
- Using tide gauge data
- Incorporate sea level rise to see how flood heights have changed in the North Atlantic Basin

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References

1. Reed, Andra J., Michael E. Mann, Kerry A. Emanuel, Ning Lin, Benjamin P. Horton, Andrew C. Kemp, and Jeffrey P. Donnelly. "Increased Threat of Tropical Cyclones and Coastal Flooding to New York City during the Anthropogenic Era." *Proceedings of the National Academy of Sciences Proc Natl Acad Sci USA* 112.41 (2015): 12610-2615. Web.
2. NOAA Best Tracks Dataset obtained from http://www.ncdc.noaa.gov/ibtracs/index.php?name=wmo-data
3. SurgeDat Database obtained from http://surge.srcc.lsu.edu/data.html

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