Hurricane Storm Surge Simulation with ADCIRC: Case of Ike

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Abstract

This study presented the numerical simulation of the hurricane Ike storm surge on the US coast using the ADvanced CIRCulation (ADCIRC) code. The model encompassed the domain between longitudes 93.0 W to 96.3 W and latitude 27.6 N and 30.0 N with 325 km (202 miles) linear coastline centered on Galveston, Texas. The maximum storm surge from the simulation was 14 ft., close to the actual National Hurricane Center record of 15-20 ft. above normal tide level. The storm surge evolution at the landfall point was compared to near Galveston conditions.

1. Introduction

Through the years, numerical models have been developed to estimate the storm surges generated by hurricanes. These models forecasts help to inform the population of potential flooding area about disposition to take or issue emergency evacuation. United State National Oceanographic and Atmospheric Administration (NOAA) has developed and use the computer model SLOSH (Sea, Lake, and Overland Surge from Hurricanes). Several other numerical models have developed and are being used by other organizations, especially in the academic domain. ADCIRC (Advanced Circulation) developed at the University of North Carolina at Chapel Hill is also in used (Luettich et at, 2004). These computer models use the hurricanes parameters (pressure, radius, max winds, location, direction, forward speeds) and the landing point topography and bathymetry (FEMA et al, 2003) to do their predictions. In this study, ADCIRC was used to simulate hurricane Ike storm surge and the evolution of the surge from quiet sea level to the full surge at hurricane landing and after the hurricane passed.

2. Numerical model using ADCIRC

For this study of hurricane Ike storm surge around Galveston, the modeled domain covered a coast length of 325 km (202 miles) and encompassed an area of 45225 km^2 (17461 mi^2), Figure 1. It included Sabina Pass at the East and ended at Matagorda Bay at the West (the bay was not modeled). The coastline and bathymetry data were imported from National Geographical Data Center (NGDC). The shoreline data has a resolution of 1:250,000 and the bathymetry a resolution of 1 minute. It can be observed that with this resolution of coastline data, it is was not possible to map the Houston ship channel. The pre-processing and post-processing of ADCIRC files were done using the Surface-water Modeling Solution (SMS) software.

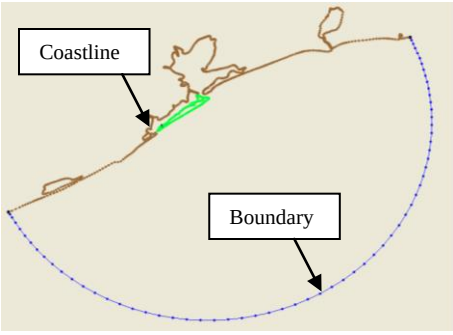


Figure 1: Numerical model domain: coastline and boundary

A total of 12696 triangular elements were used to mesh the domain. The smallest triangular mesh had a side length of 500 m and the biggest one had about 10,000 m for a side length. Two rows of recording stations were placed in the model: one at Ike landing point (East) and the second near Galveston (West), Figure 2.

3. Results and Discussion

A maximum of 4.2 m (14 ft.) storm surge was obtained from the simulation compared to 15-20 ft. recorded by National Hurricane Center, Figure 2. As shown in Figure 3 (a, b, c) and Figure 4 (a, b, c), the storm surge evolved from no elevation increase, Figures 3 and 4 (a), to full surge, Figures 3 and 4 (b), and then returned to the initial conditions on the East and West recording stations. The surge was highest at the coasts, as expected. The storm surge, once at the coast, extended up to 30 miles in the ocean, Figure 3 and 4 (b). With more refinement of the FEM meshed and better resolution of the bathymetry and coastline data, more details may be obtained.

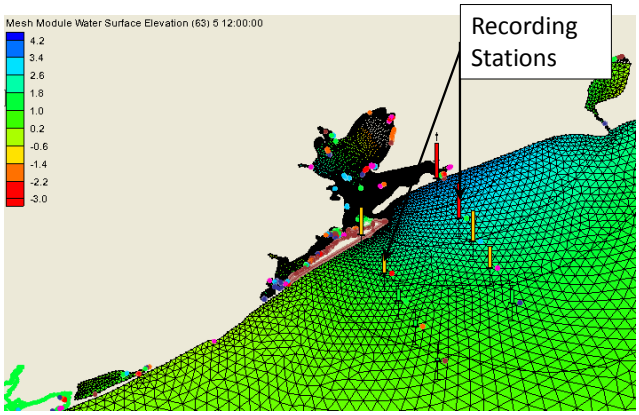
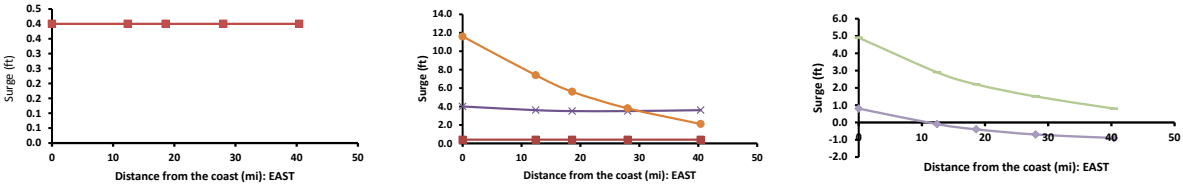
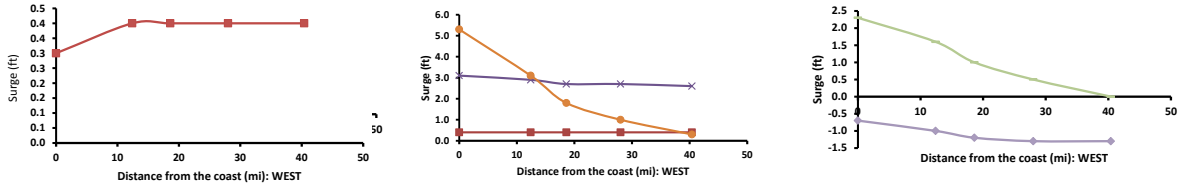


Figure 2: Numerical results with the recording stations.



a.) b.) c.)

Figure 3: Surge variation before, during and after hurricane at the landfall location (EAST).



a.) b.) c.)

Figure 4: Surge variation before, during and after hurricane near Galveston (WEST).

4. Conclusion

Hurricane Ike storm surge was numerically modeled using ADCIRC code. The simulation storm surge was 14 ft compared to the 15-20 ft recorded by the National Hurricane Center. The profiles of water elevation before, during and after the hurricane on two rows, one going through the hurricane landing point and the other near Galveston were presented. The storm surge at landfall had effect up to 30 miles inside the golf from the coast.

5. Acknowledgment

The ADCIRC PC and parallel codes were provided by Dr Luettich, Professor at University of North Carolina at Chapel Hill. Thanks to TLC2 (Texas Learning and Computer Center) for the training in the use of the supercomputer at the University of Houston.

6. References

FEMA, URS and USZ Army Corps of Engineers (2003) "SLOSH Display Training". September 2003, 95p.

Luettich, R. and Westerink, J. (2004) "Formulation and Numerical Implementation of the 2D/3D ADCIRC Finite Element Model Version 44.XX". Published on December 8th 2004, 74p.