An Investigation of the Forerunner Surge Produced by Hurricane Ike on the Texas and Louisiana Shelf

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Study Domain
The unique onshore and offshore features of the Louisiana-Texas (LATEX) coast make the area extremely susceptible to flooding caused by tropical cyclones. The Texas Gulf coast is a system of barrier islands, narrow, shallow bays and low-lying coastal floodplains. Additionally there are several large bays that act as hydraulic conduits allowing surge generated by tropical cyclones to penetrate far inland.

Offshore, the continental shelf is over 200 km wide at some points, allowing for highly localized current gradients that are ordinarily not generated by tropical cyclones.

Event
Hurricane Ike struck the Texas Gulf coast near Galveston as a strong category 2 hurricane on September 13, 2008. Ike was characterized by a steady path and a large wind field in which radius to tropical storm force winds (>34 knots) was over 200km. Of particular note in Ike was the early rise in water along the LATEX coast. Over 24 hours before landfall inland flooding began to occur with some areas receiving 1.5 m of inundation 15 hours before landfall. Flooding occurred when winds at the coast were shore-parallel or slightly offshore.

Model
Using the coupled SWAN+ADCIRC wave and circulation model, water surface elevation, currents, and wave characteristics were hindcasted for Hurricane Ike. The model was applied to the tx2008 computational mesh, which consists of 3.3 million nodes and 6.6 million triangular unstructured elements as small as 30m encompassing the entire Gulf of Mexico and Caribbean Sea.

ADCIRC solves for depth integrated currents and water surface elevations via the Generalized Wave Continuity Equations (GWCE). SWAN solves the wave action balance equation to determine the wave energy spectrum, from which statistical wave characteristics can be determined.

Influence of Coriolis Effect on Geophysical Flows
As demonstrated, geostrophic setup occurs when a shore parallel current is present. During Ike, a strong shore parallel current was generated due to a large wind field and wide continental shelf.

Influence of Bottom Friction on the Forerunner
Unlike the shelf in the Eastern Gulf which is predominantly sand, the LA-TEX shelf is muddy and smoother. To determine the effect bottom friction had on the generation and propagation of the forerunner, bottom friction on the shelf was increased. The result shows that increased shelf friction has an effect similar to Coriolis. In areas near landfall, the peak surge is not effected, however in areas away from landfall, the forerunner surge accounted for much, if not all of the flooding.