Coupling of ADCIRC and wind-wave model for the Northern Gulf Coast

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Understanding Coastal Resiliency from Hurricane Impacts Using Integrated Modeling and Observations

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The long term goal of this study is to improve our understanding of coastal resiliency from hurricane impacts using integrated numerical modeling and in-situ observations and remote sensing techniques within an interdisciplinary and multiple-institutional approach.

- Improve the wind forcing input for storm surge and wave models (MSU/LSU)

- Extend the NOAA ocean wave prediction model WAVEWATCH III to coastal regions with wetlands (NOAA/LSU).

- Develop and test a coupled wave, surge and sediment transport model system for coastal regions using the Breton Sound and Wax Lake Delta as a natural "laboratory" (LSU/NOAA/MSU)

- Conduct numerical simulations to test hypotheses of resiliency (LSU/MSU/NOAA)
Outline

- Introduction
- Measurements
- Modeling
- Results
- Summary
Introduction

http://weather.unisys.com/hurricane/atlantic/2008H/track.gif
Introduction

http://www.stormpulse.com/hurricane-gustav-2008
Measurements


Wind and waves
Measurements

- NOS/CO-OPS [http://tidesandcurrents.noaa.gov/](http://tidesandcurrents.noaa.gov/)

Wind and surge
Measurements

- University of Notre Dame

Surge and waves
Modeling

Wind Model

SWAN

Interaction

ADCIRC

An improved parametric model based on the asymmetric Holland vortex formulation (Xie et al, 2006). (Submitted to Ocean Modelling by Hu et al.)

A third-generation wave model for obtaining realistic estimates of wave parameters from given wind, bottom and current conditions (by TU Delft)

(Submitted to Journal of Atmospheric and Oceanic Technology by Dietrich et al.)

A highly developed computer program for solving the equations of motion for a moving fluid on a rotating earth using the finite element method (by R.A. Lueettich, Jr. and J.J. Westerink)
Wind model

- the Coriolis parameter is taken into account in the determination of the shape parameter $B$ and the range limitation of $B$ is released to eliminate the potential error in the modeled maximum wind speed.

- the effect of the translational speed of a hurricane is excluded from the specified wind intensities before applying the Holland vortex.

- a method has been introduced to develop a weighted composite wind field that makes full use of all wind parameters
Wind swath

(a) H*wind

(b) SWIM winds

(c) Mattocks and Forbes (2008) winds
Wind comparison

Wind speed (m/s) vs. date for stations 42001, 42003, 42007, 42035, 42036, 42039, 42040, 42055, and 42056.
Wind comparison
Wind comparison
Wind comparison
ADCIRC + SWAN

Hot start: after 30 days of tide simulation
Parallel run: 816 processors* run 24 hrs for 12 days’ simulation (Aug 27 ~ Sep 7, 2008)

Mesh SL15v7 (2409635 nodes; 4721491 elements)
Time step 1s
Open boundary 7 tidal constituents (K1, O1, Q1, N2, M2, S2 and K2)

Time step 60 min
Direction every 10 degrees; nd=36
Frequency fmin=0.031384 Hz; nf=30

*on a supercomputer from the Louisiana Optical Network Initiative (LONI), Queenbee: 668 Compute Nodes; each node with two 2.33 GHz Quad Core Xeon 64-bit Processors and 8 GB Ram
Bathymetry
Bathymetry

Wax Lake Delta
Wave direction
Average period
Peak period
Surface elevation

- Usco Freeport
- Galveston Pleasure Pier
- Sabine Pass North
- Calcasieu Pass
- Lawna, Amerada Pass
- Grand Isle
- Pilots Station East
- Shell Beach
- New Canal Station
- Day Waveland
- Coast Guard Sector Mobile
- Dauphin Island
- Freshwater Canal Locks
- Cypremort Point
- Port Fourchon
- Pascagoula Noaa Lab
Surface elevation

[Graphs showing water level fluctuations for different stations over time]

Longitude (deg)

Latitude (deg)
Contribution of surge to \( H_s \)
Contribution of surge to Hs
Contribution of waves to surge
Contribution of waves to surge
• Coupling of ADCIRC and wind-wave model is essential and important for the rational simulation of both storm surge and hurricane waves in coastal areas, especially during an extreme hurricane event.

• Some wave parameters (e.g. wave breaking) in coastal areas need further validation.

• Bottom friction should be carefully calibrated for wetlands or salt marshes (vegetation effect).
Thank you!