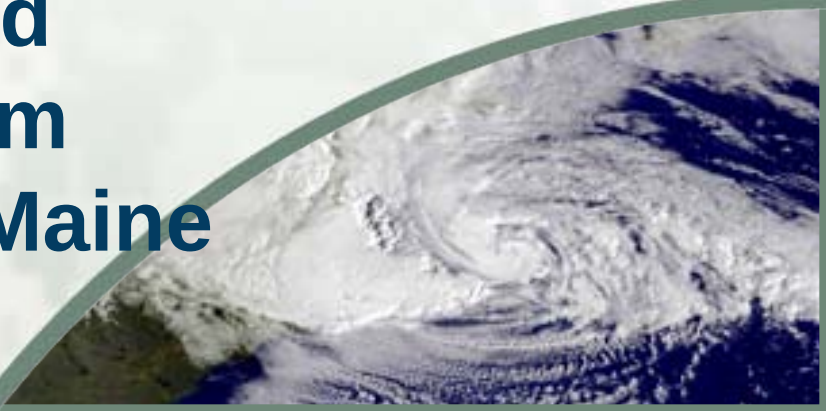
CSTORM-MS COASTAL STORM MODELING SYSTEM

ERDC Engineer Research and Development Center

Computing the Joint Probability of Hurricane Sandy and Historical Coastal Storm Forcing Parameters from Maine to Virginia



Chris Massey and Jeff Melby

USACE-ERDC

Coastal & Hydraulics Lab

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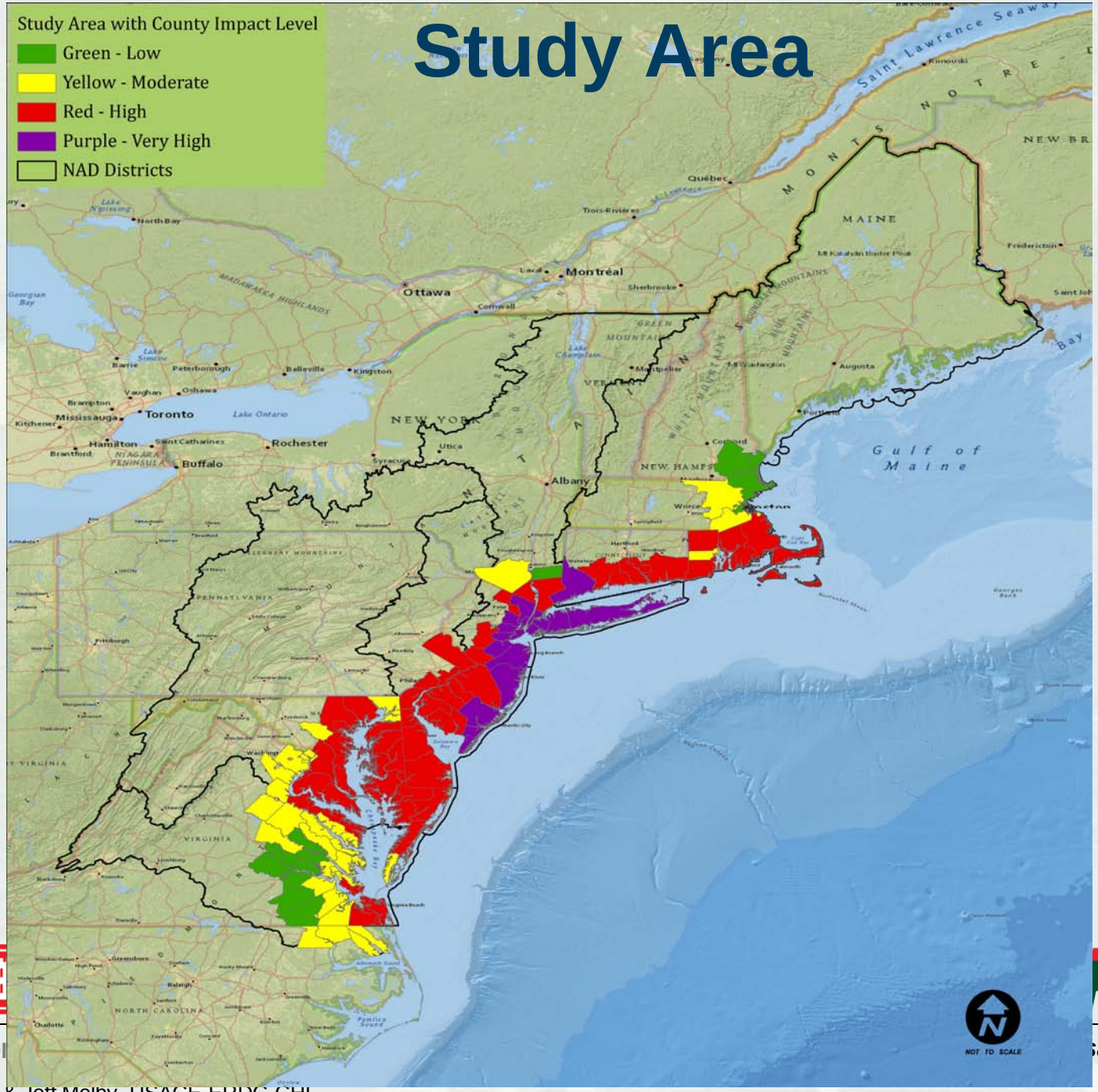
Study Area

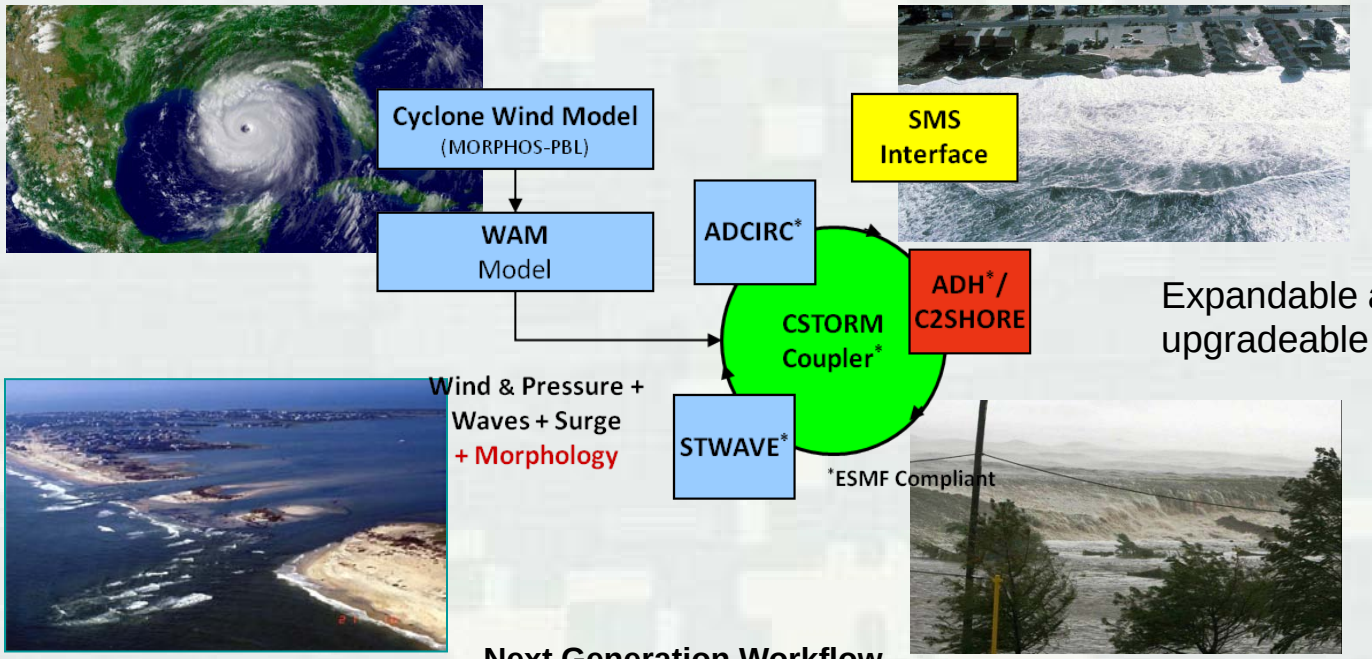

Study Area with County Impact Level
Green - Low
Yellow - Moderate
Red - High
Purple - Very High
NAD Districts
Saint Lawrence Seaway
Québec
Trois-Rivières
Montréal
Ottawa
Cornwall
Sherbrooke
MAINE
Fredericton
Augusta
Portland
Concord
NEW HAMPSHIRE
Albany
Utica
Syracuse
NEW YORK
Rochester
Buffalo
Toronto
Hamilton
Mississauga
Brampton
Kitchener
Barrie
Peterborough
Belleville
Kingston
Oshawa
Vaughan
Lake Ontario
Lake Champlain
Montpelier
Mt Washington
Gulf of Maine
Georgian Bay
North Bay
Lake Nipissing
Lake Simcoe
Pittsburgh
Philadelphia
Washington
Baltimore
Pennsylvania
Virginia
Norfolk
Greensboro
Raleigh
North Carolina
Charlotte
Pamlico Sound
Georges Bank
NOT TO SCALE

ERDC's Coastal Storm-Modeling System

(ERDC CSTORM-MS)

Application of high-resolution, highly skilled numerical models in a tightly integrated modeling system with user friendly interfaces

Not just hurricanes and not just in the Gulf of Mexico.



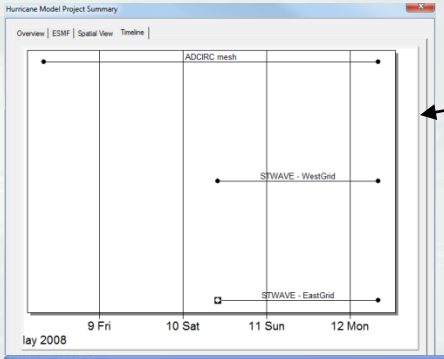
Expandable and upgradeable system.

Next Generation Workflow

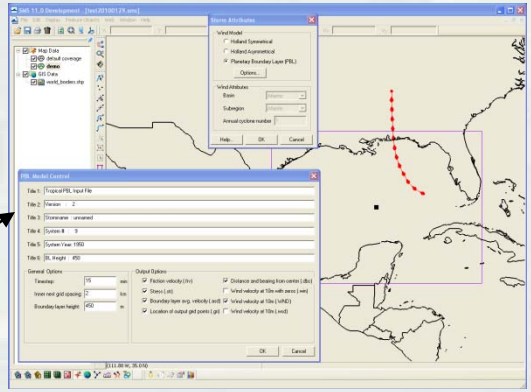
Provides for a robust, standardized approach to establishing the risk of coastal communities to future occurrences of storm events.

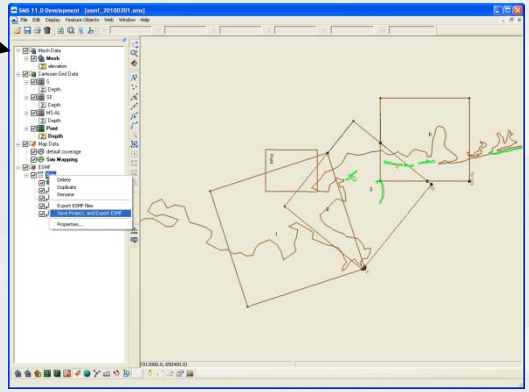
SMS GUI's

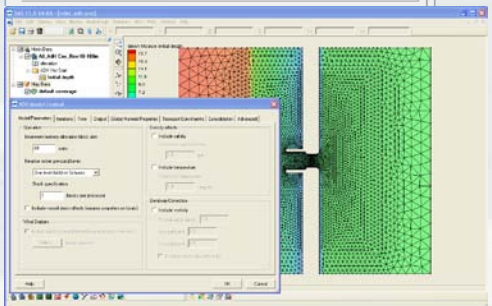
Through the SMS GUI's users can setup and execute models as well as visualize model results.

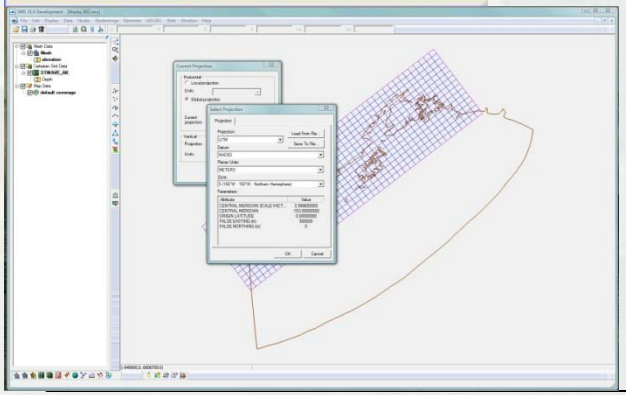


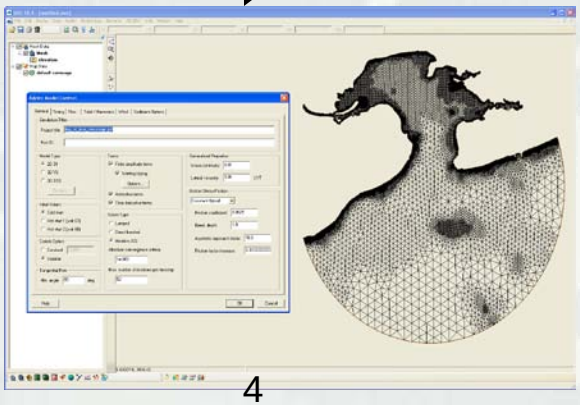
- New GUI for Project Overview
- New GUI for MORPHOS PBL Cyclone Model
- New GUI for CSTORM Coupled Models
- Updated GUI for AdH
- New GUI for WAM Wave Model
- Updated GUI for STWAVE
- Updated GUI for ADCIRC

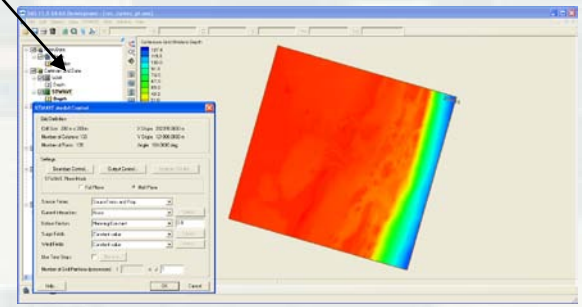




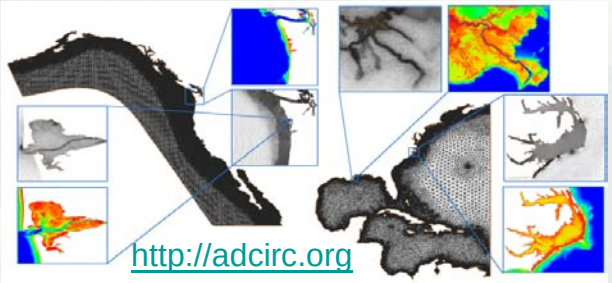




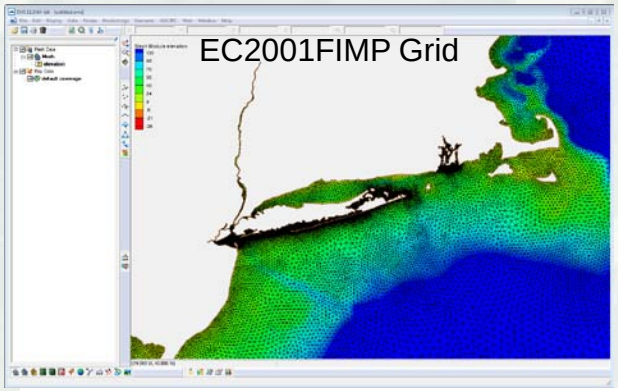


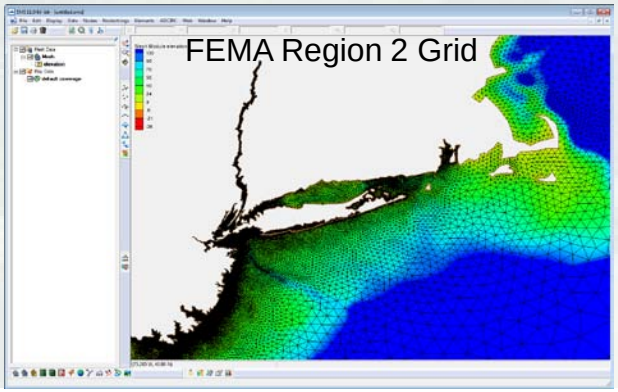


ADCIRC Coastal Circulation and Storm Surge Model



- An unstructured finite element hydrodynamics model
- 2D and 3D simulations
- Wetting/Drying algorithm allows for storm surge inundation over previously dry land
- Highly portable code
- A part of ERDC's Coastal Storm Modeling System





Preliminary Surge Modeling for Sandy

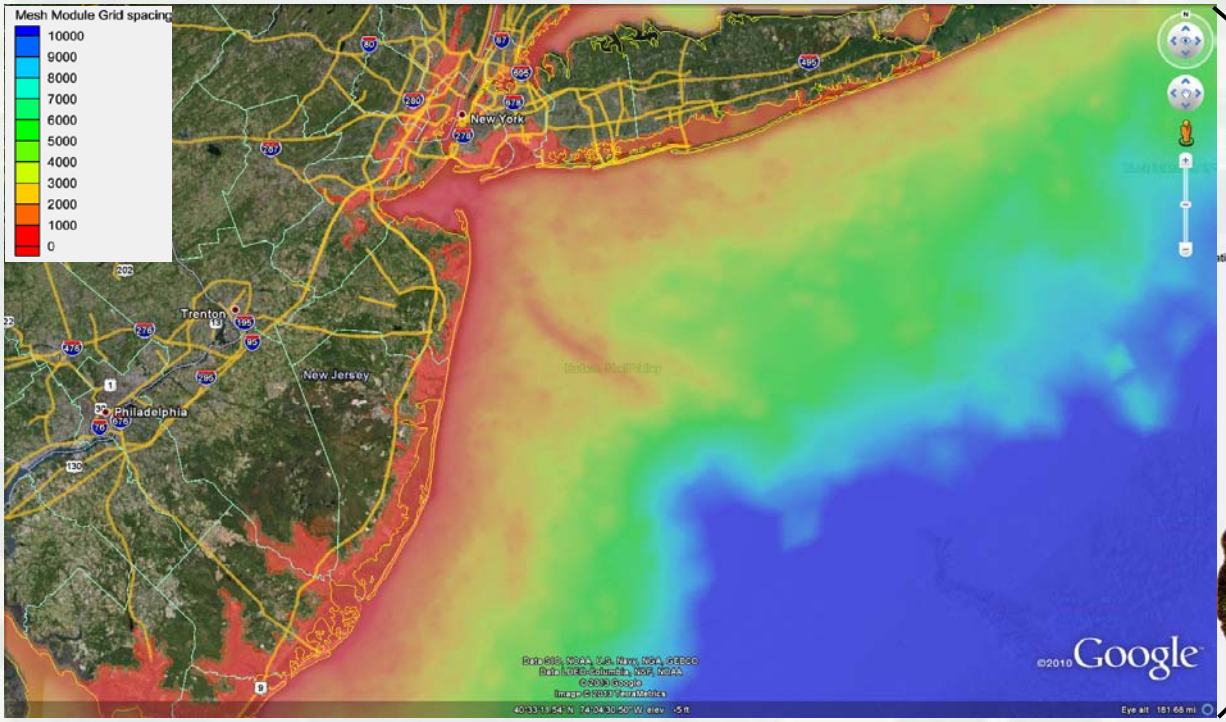
- Used two meshes
  - EC2001FIMP Grid
  - FEMA Region 2 Grid
- Used tidal forcing and the imbedded asymmetric vortex Holland wind/pressure model*
- Wind model inputs derived from the NHC forecast using the ASGS
- Advisories 22 – 31 were simulated
- Advisory 26 results sent to NAN.

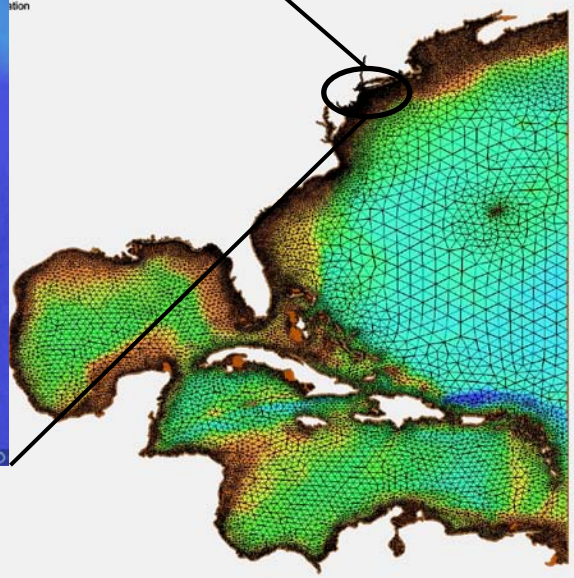
CSTORM-MS COASTAL STORM MODELING SYSTEM

Innovative solutions for a safer, better world

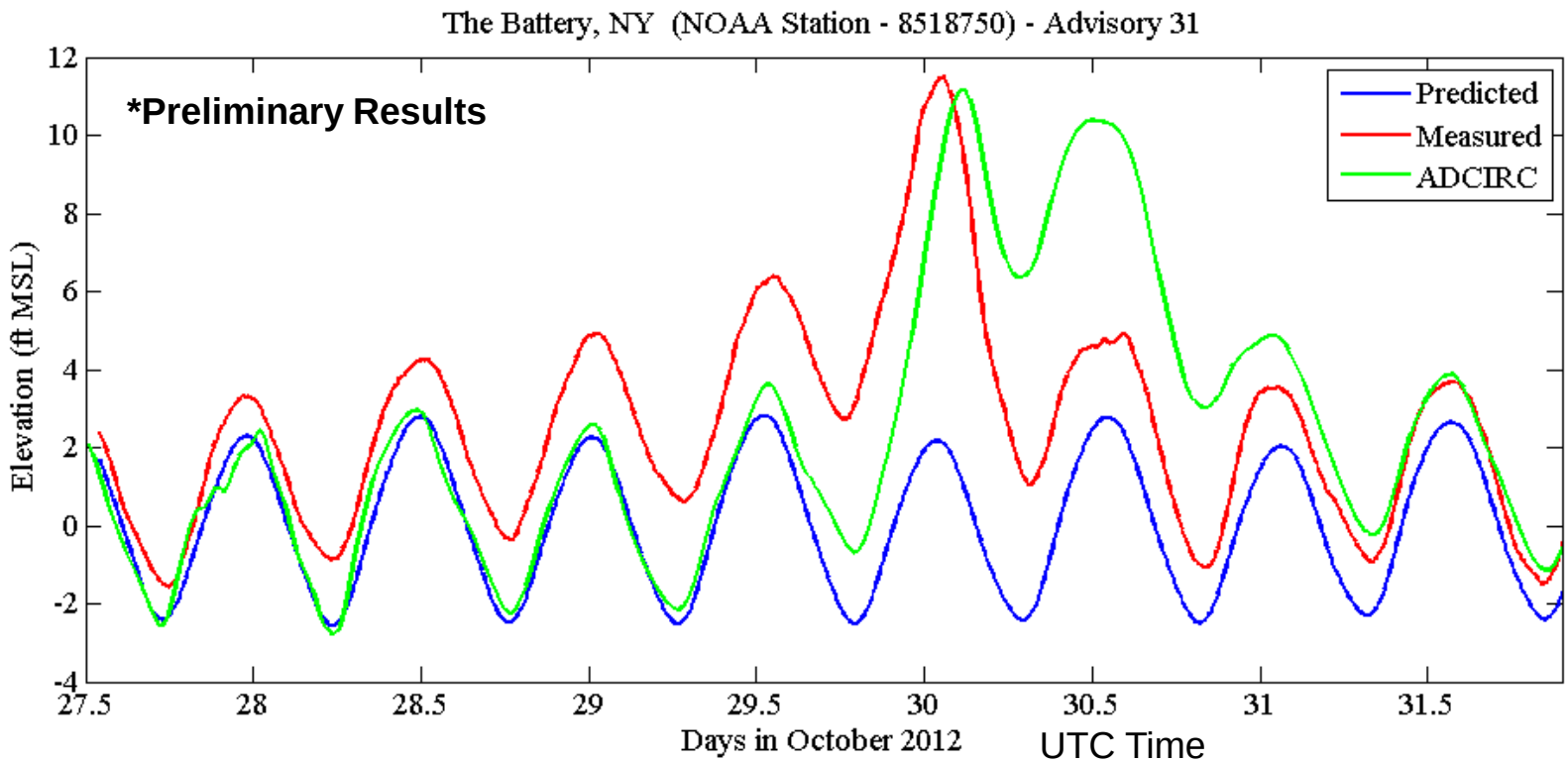
FEMA Region II Mesh Details

Colors Represent Element Size in Meters





Comparison of Hurricane Sandy Water Elevations (ft MSL) at the NOAA Gauge at the Battery, NY



Datum Conversions at this Location
MSL to NAVD88 subtract 0.21 ft
MSL to MLLW add 2.57 ft

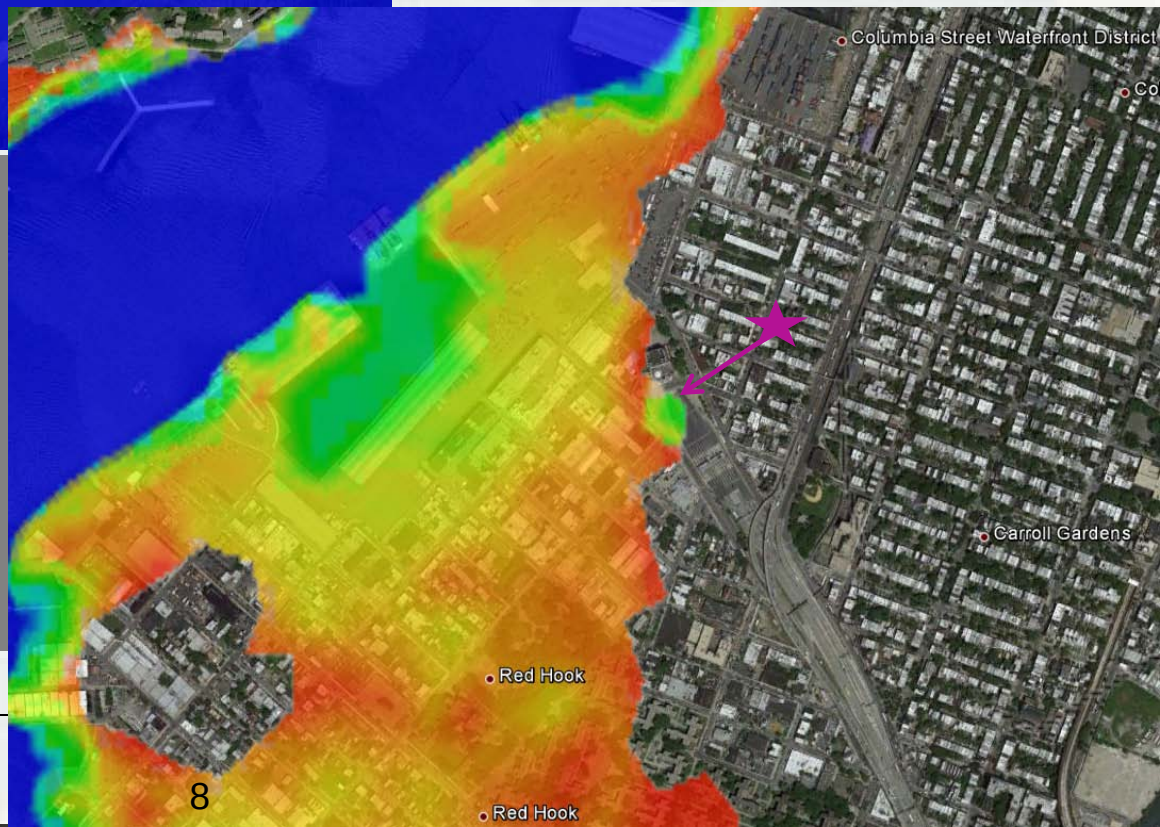
ERDC

Innovative solutions for a safer, better world

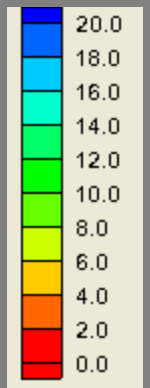
ADCIRC Total Water Depth (feet MSL)

Results from ADCIRC, using the FEMA Region 2 Mesh and NWS Forecast Winds from Advisory 31 of Hurricane Sandy.

***Preliminary Results**



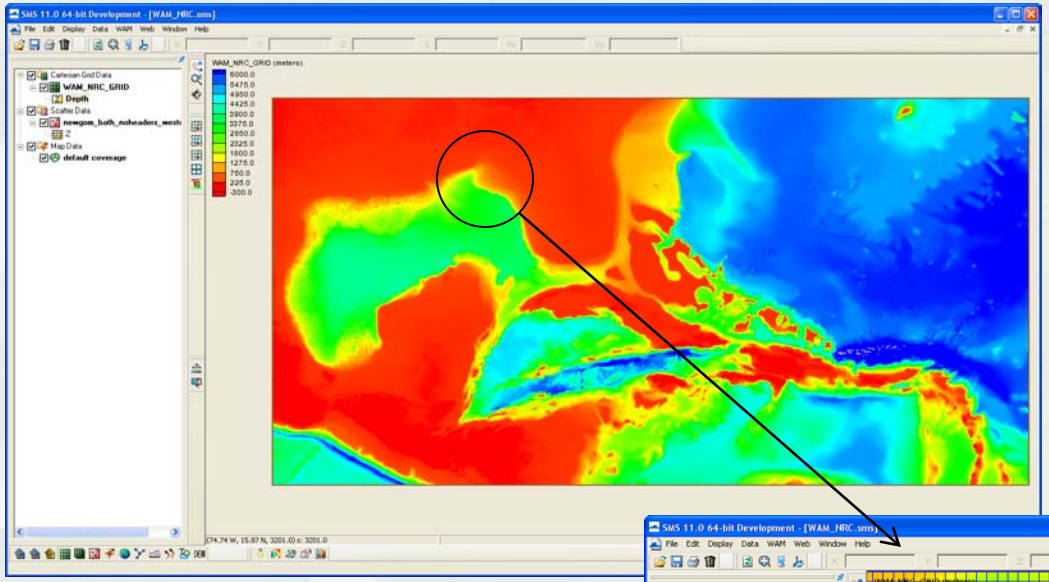
Total Water Depth (ft MSL)

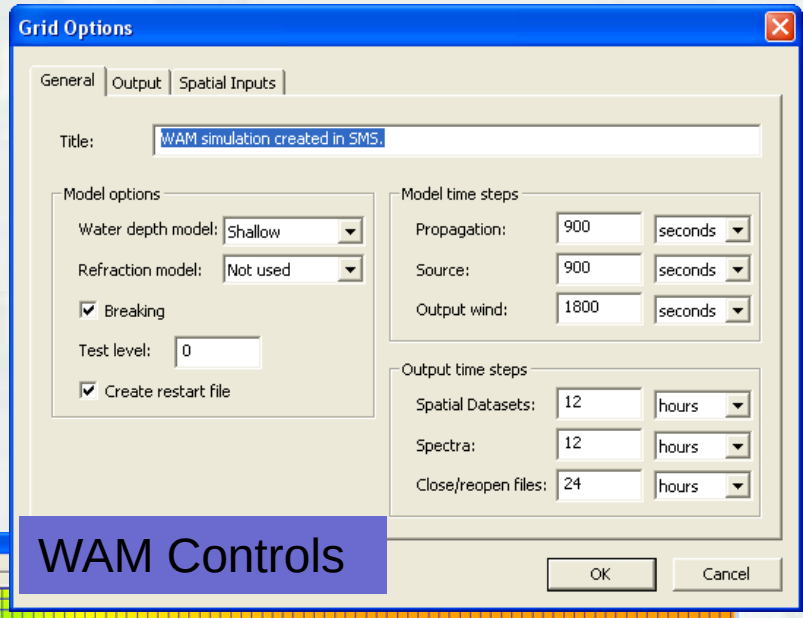


★ Location of Tunnel Entrance/Exit

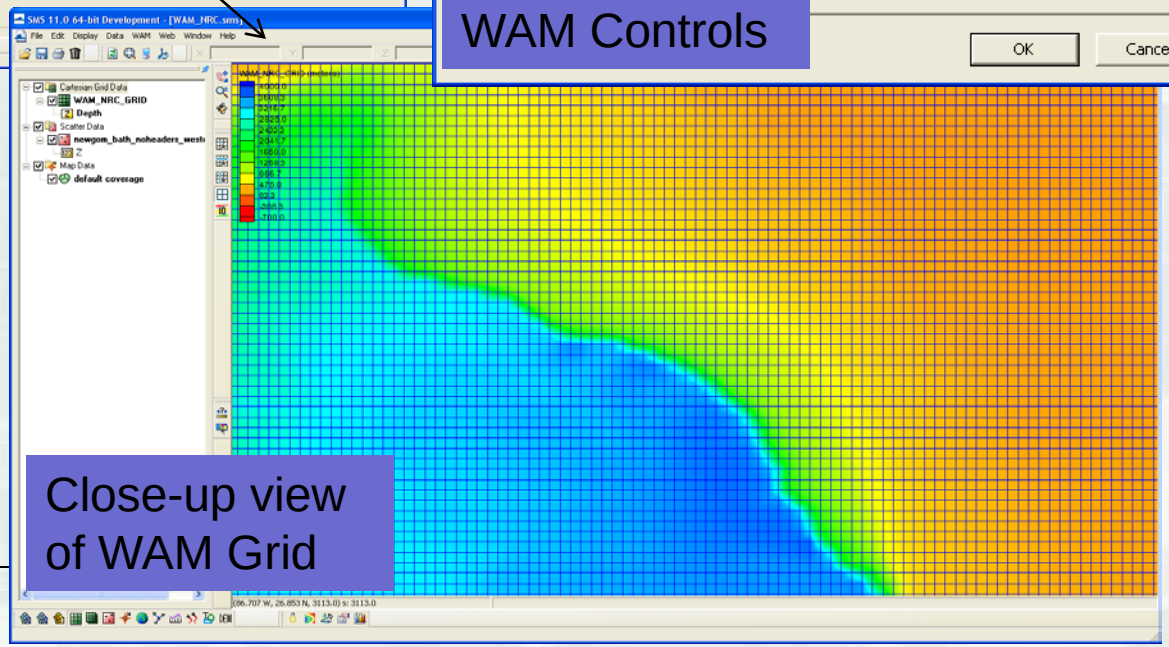
Datum Conversions at this Location
MSL to NAVD88 subtract 0.21 ft
MSL to MLLW add 2.57 ft

SMS GUI for WAM





WAM Controls



Close-up view of WAM Grid

New to the SMS

- Create and visualize WAM grids and model results
- Setup input/control files
- Execute WAM

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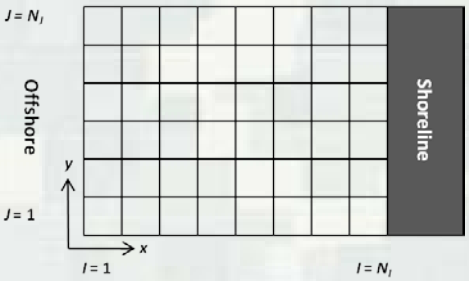
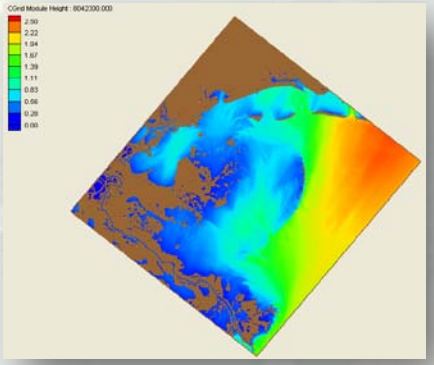
STWAVE Version 6.0

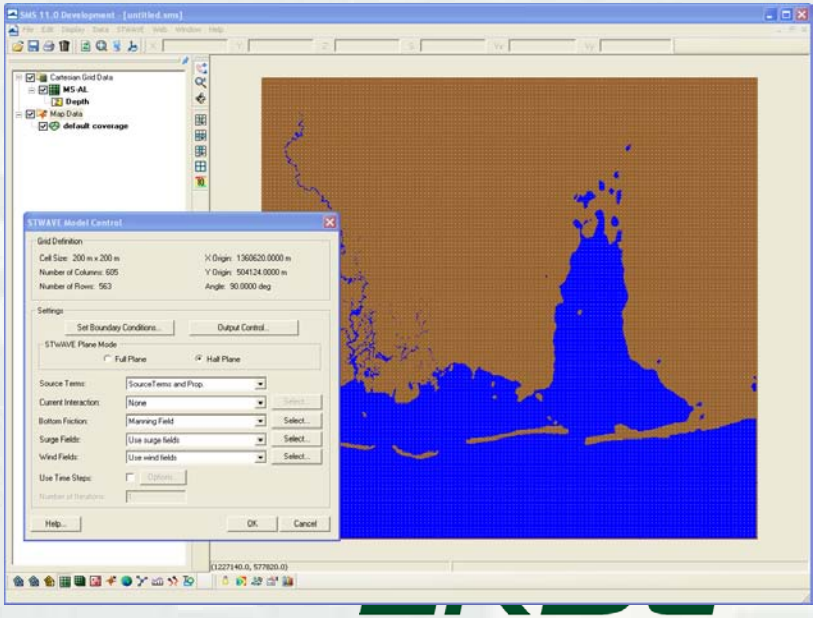
- STWAVE is a steady-state finite difference model based on the wave action balance equation.

- The model is used to compute wave transformation (refraction, shoaling, and breaking) and wind-wave generation.





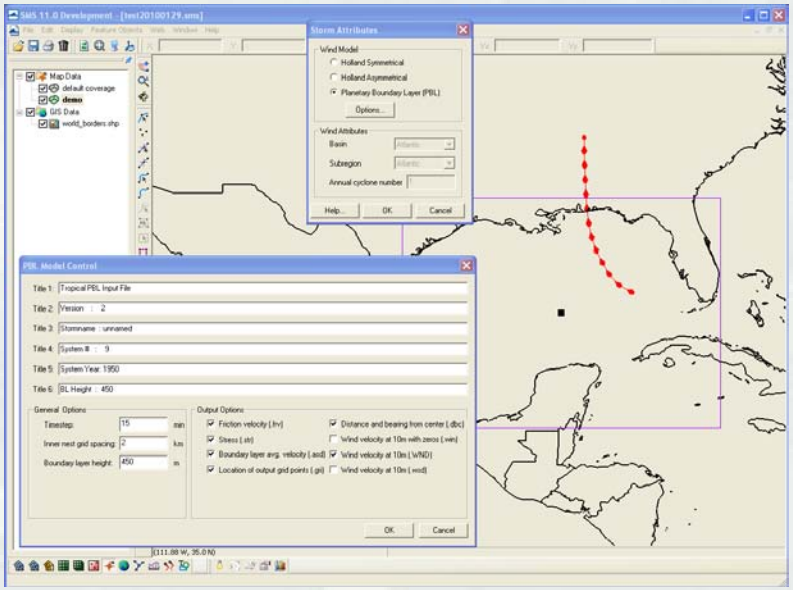
SMS GUI for STWAVE



Some features of the full-plane model include:

- Wave transformation and generation on the full 360-deg plane.
- Option for spatially variable winds and surge.
- Option for spatially constant or spatially variable bottom friction.
- Option for one-dimensional wave transformation on lateral boundaries.

SMS GUI for Cyclone Models

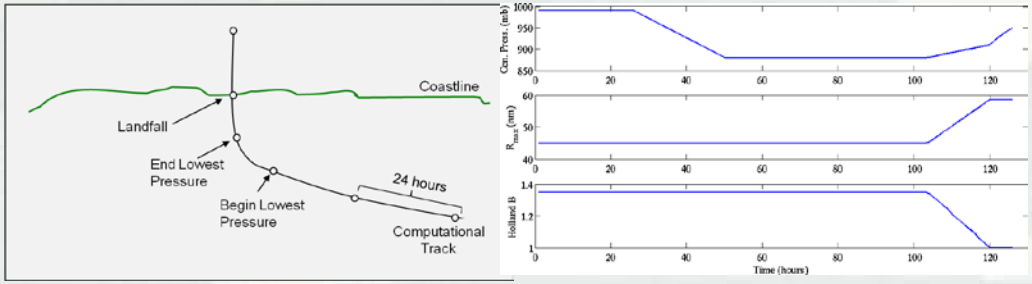


- Setup and run the MORPHOS-PBL Cyclone Wind Model*

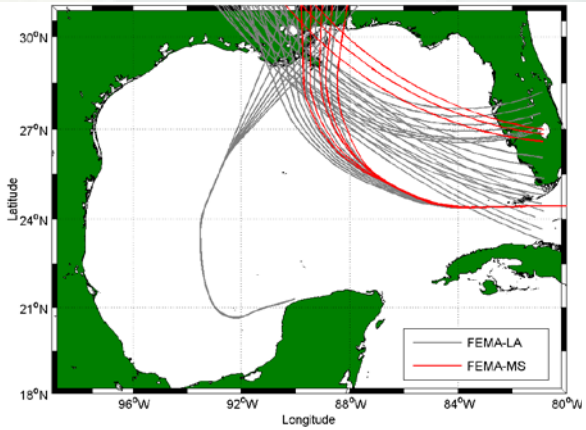
*Updated version of TC96

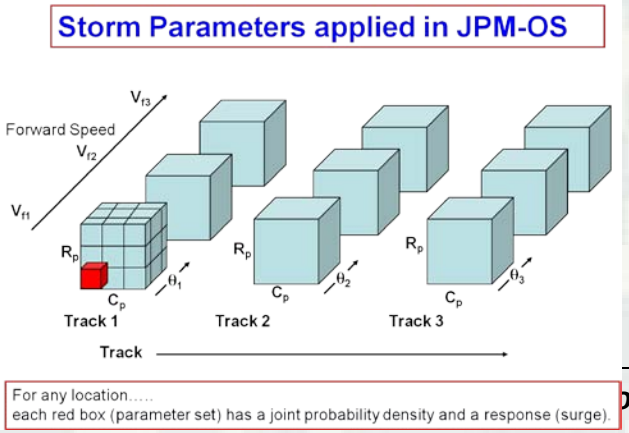
- Import storms from HURDAT

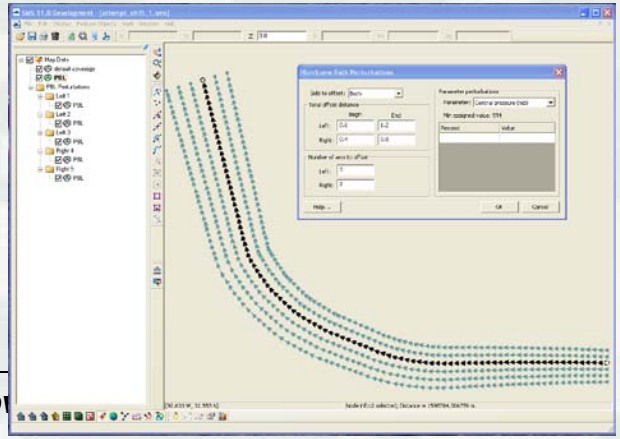
Synthetic storm profile generation routine



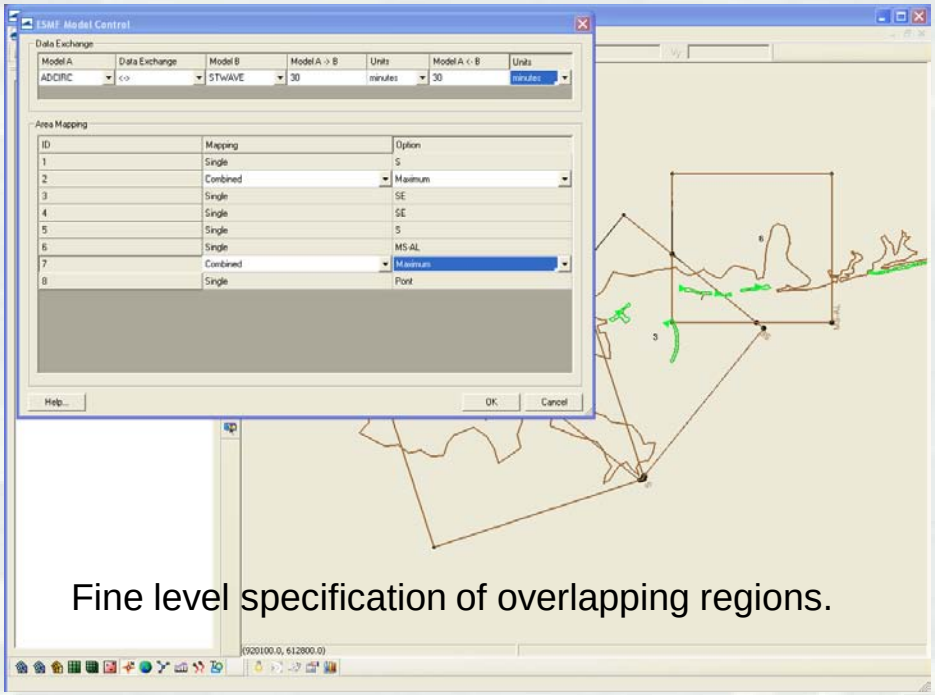
Easily create perturbations for storm track/characteristic



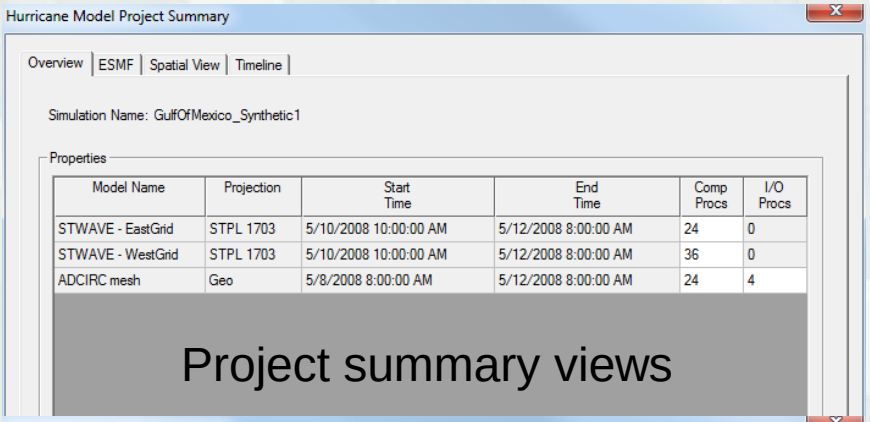




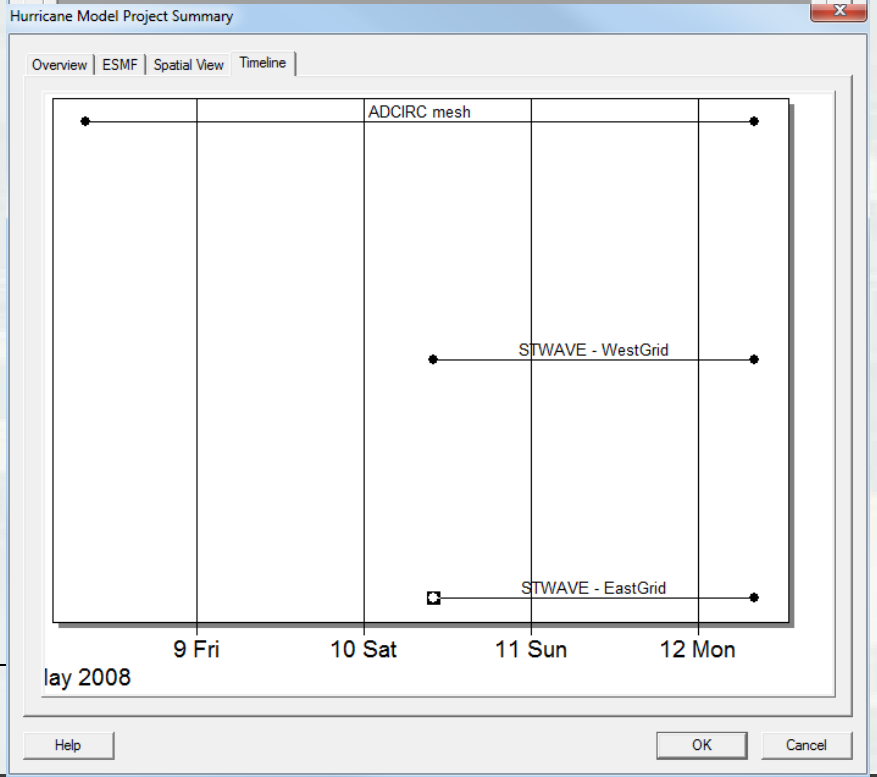
Example SMS GUI's for CSTORM-MS



Fine level specification of overlapping regions.



Project summary views



BUILDING STRONG®

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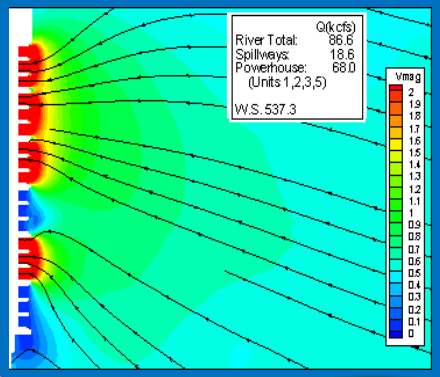
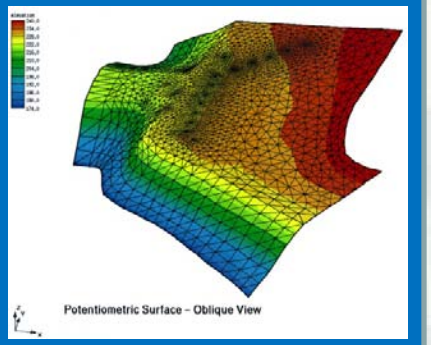
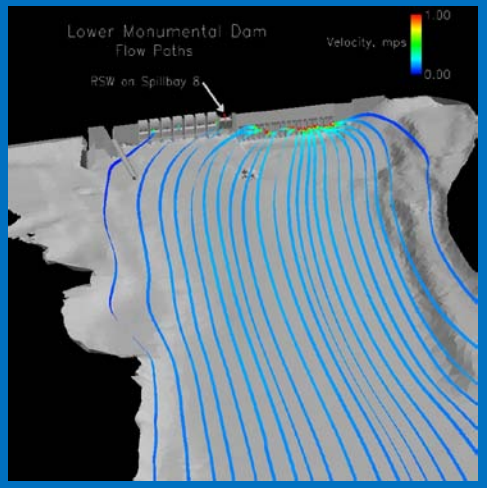
AdH

Navier-Stokes Equations

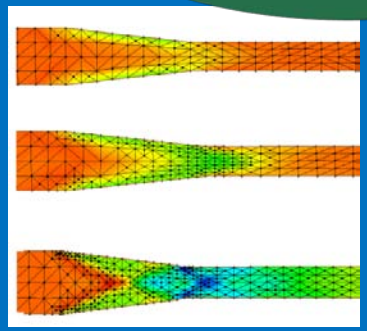


Unsaturated Groundwater Equations

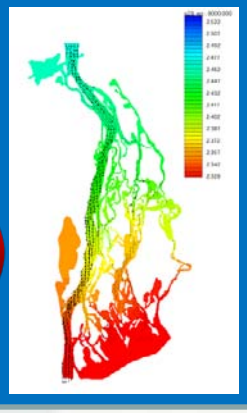




Computational Engine (FE utilities, preconditioners, solvers, I/O to xMS GUIs)



Shallow Water Equations



Features of ADH Shallow Water

- Adaption
- Part of System-wide program
- Links to CRREL, HEC, NFS
- Internal links to groundwater
- Supercritical and subcritical flow
- Vessels
- Static lids (culverts, floating guidewalls, . . .)
- Friction Library (vegetative, Manning's, ice)
- Linking to WQ library and ICM
- Structures (weirs, flapgates, …)
- Bendway correction
- Baroclinic
- Coupled sediment transport (sands, clays, mixed)
- Wave effects on sediment
- Portable – PC to distributed memory HPC
- Dam failure, levee over-topping (example Ark-White-Miss River)
- Local Mass Conservation
- 3D companion for 2D shallow water

Advances in Morphology Response

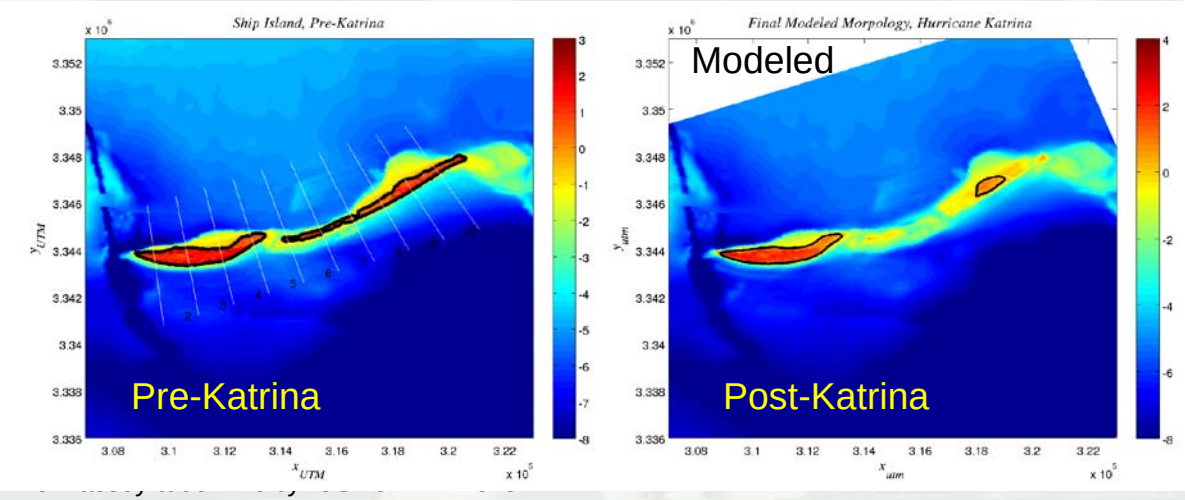
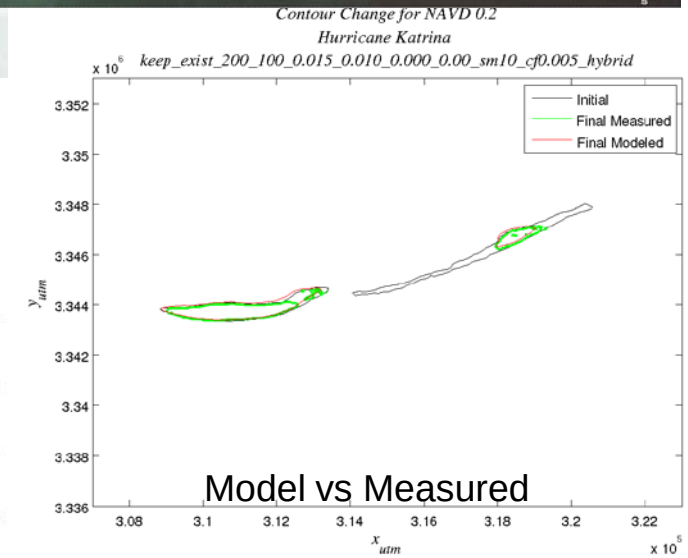
Philosophy: Efficient and Robust

Model Components

- Quasi-3D Shallow Water Hydrodynamics
- Probabilistic Representation of Sediment Transport
- Includes both Wave and Current Transport
- Bed load and Suspended load

CSHORE → C2SHORE

Profile Response | Quasi-2D | 2DH

Mississippi Coastal Improvement Program (MsCIP)

Ship Island Lidar