

ERDC's Coastal Storm-Modeling System (CSTORM-MS)

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and Mary Cialone

USACE-ERDC-CHL

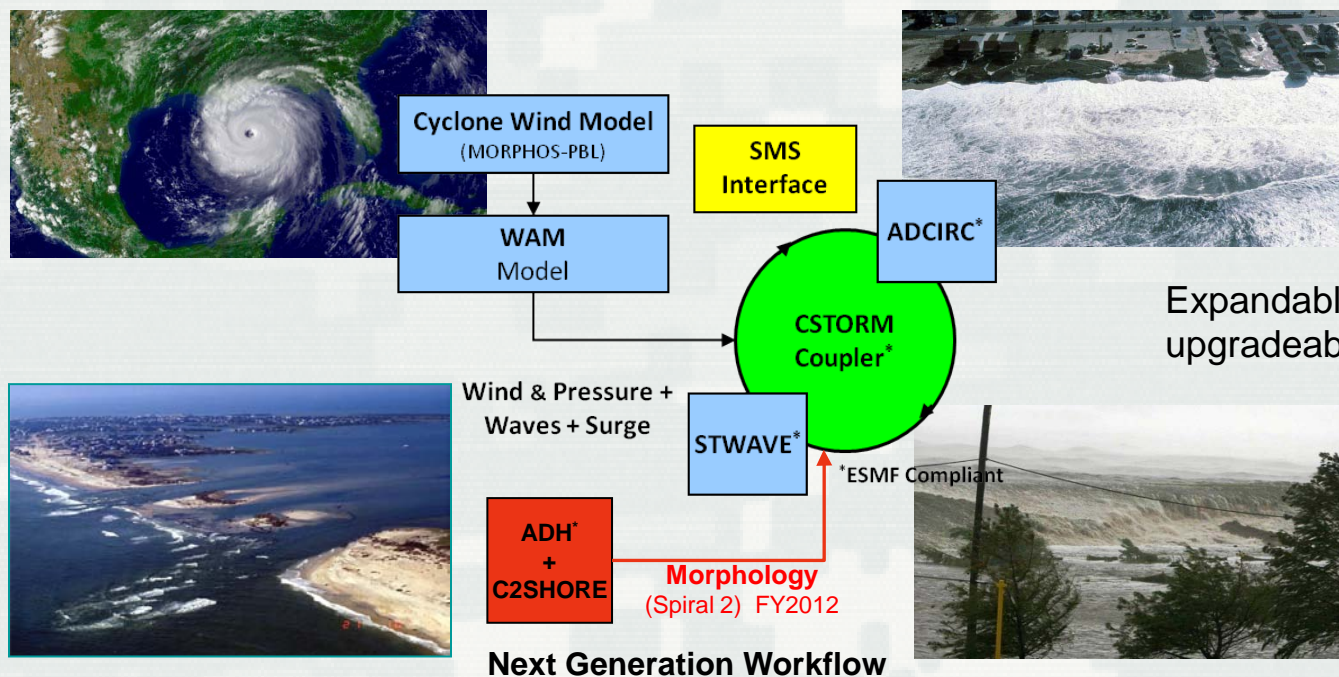
POC: Chris.Massey@usace.army.mil



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.

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

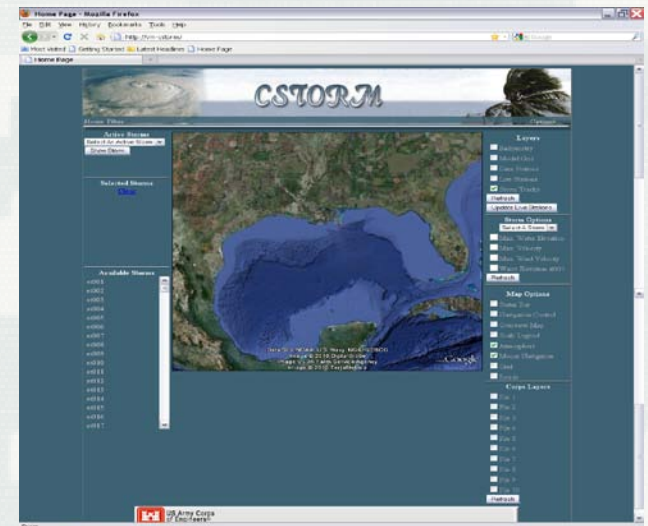
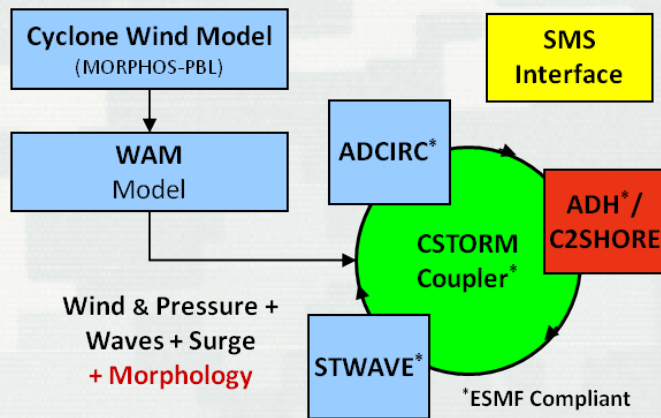
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Results

- CSTORM-MS is an efficient, robust, extensible modeling system for quantifying the risk of coastal communities to storm events.
- Its' streamlined workflow saves time and reduces both computational and personnel cost.
- Model data feeds into CSTORM-DB for easy access and reuse purposes.



Spiral 2 coming Oct 2012

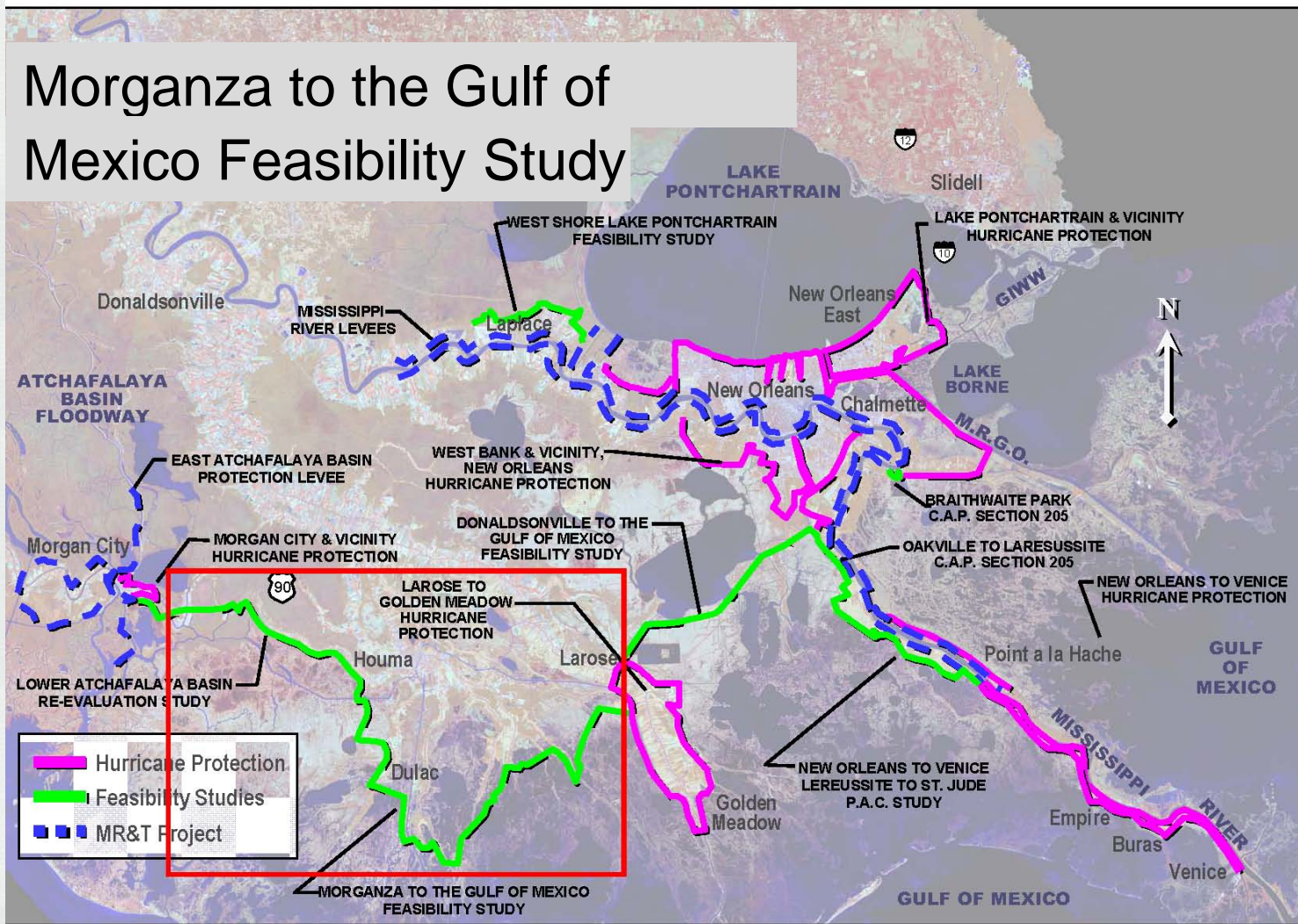
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Example Problem

Morganza to the Gulf of Mexico Feasibility Study





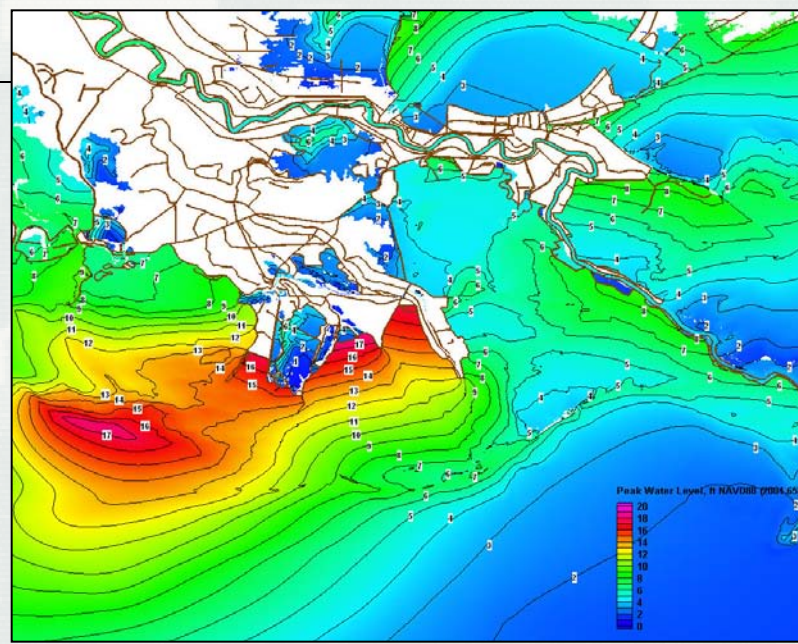
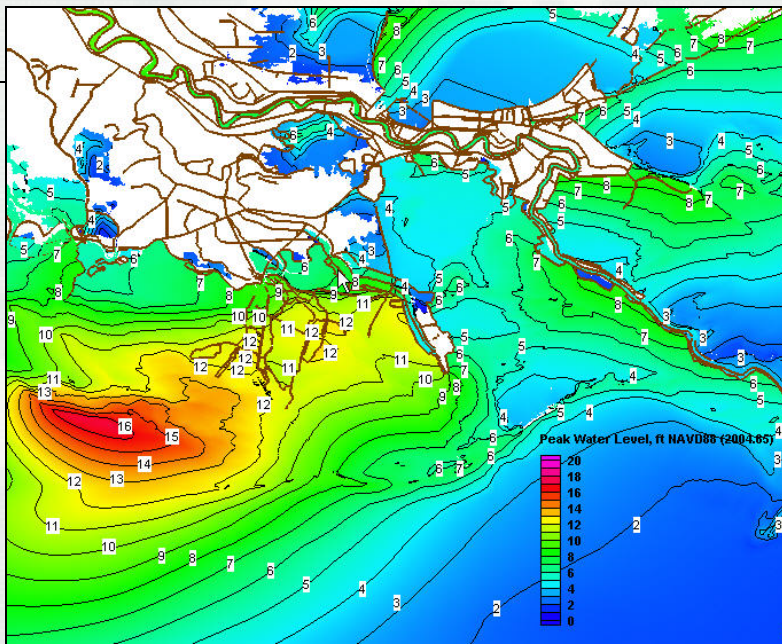
Without Project

With Project

Storm 314

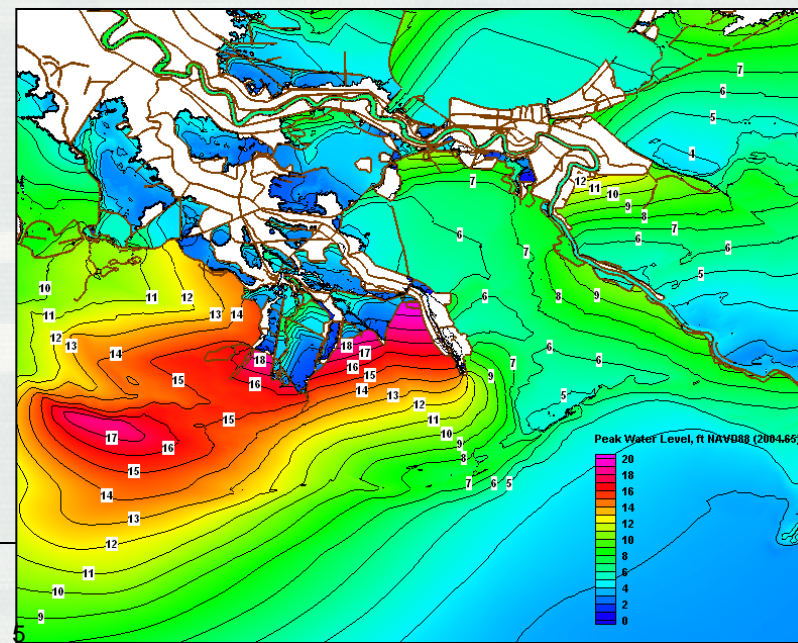
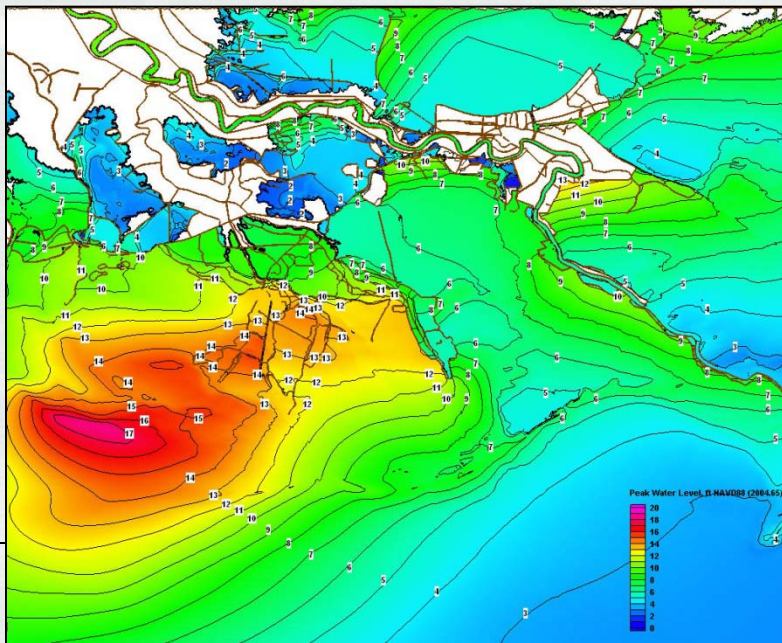
Existing Water Level

Existing Water Level



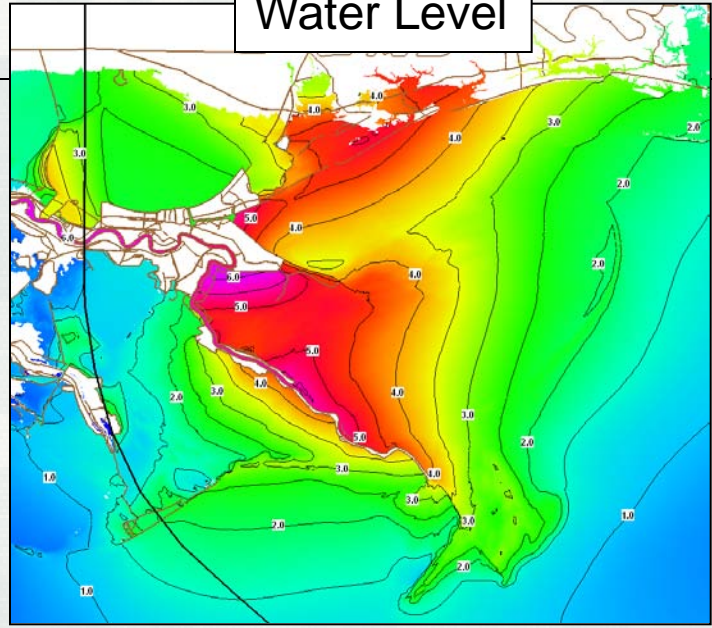
Sea Level Rise 0.35 m

Sea Level Rise 0.35 m

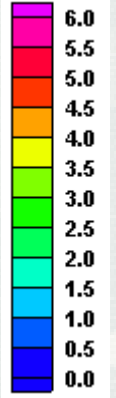




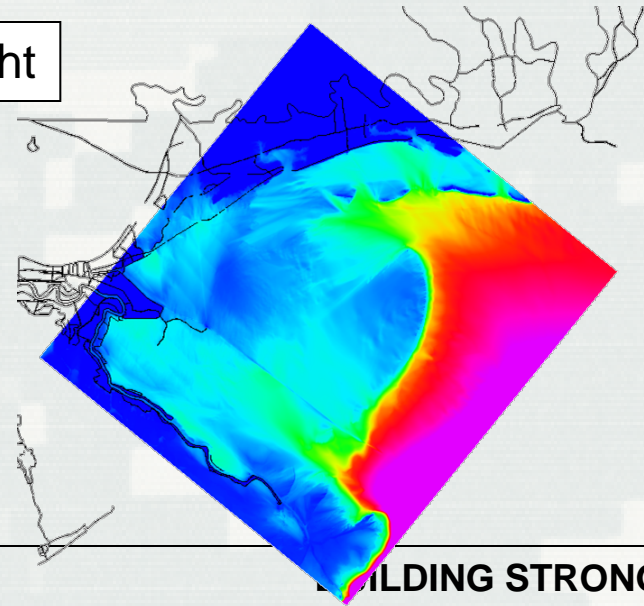
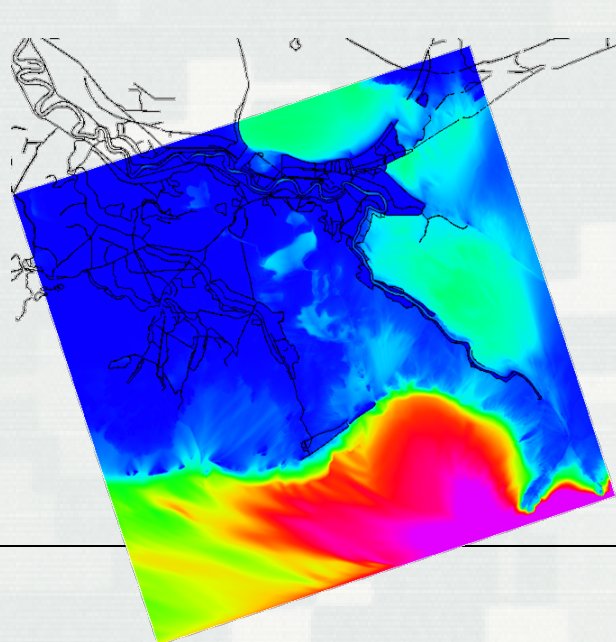
Water Level



m, NAVD88 (2004.65)



Wave Height



Max Waves (m)

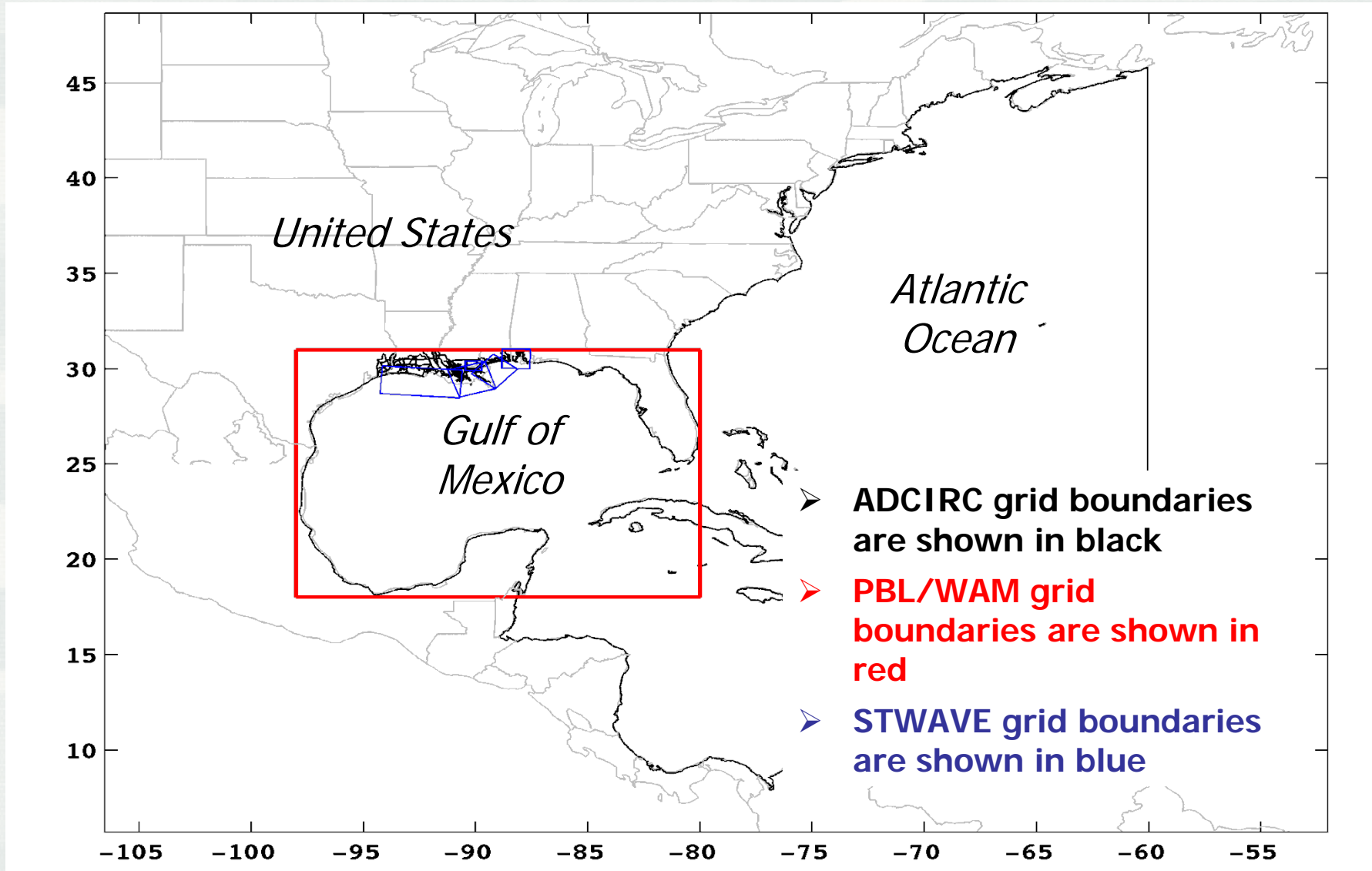


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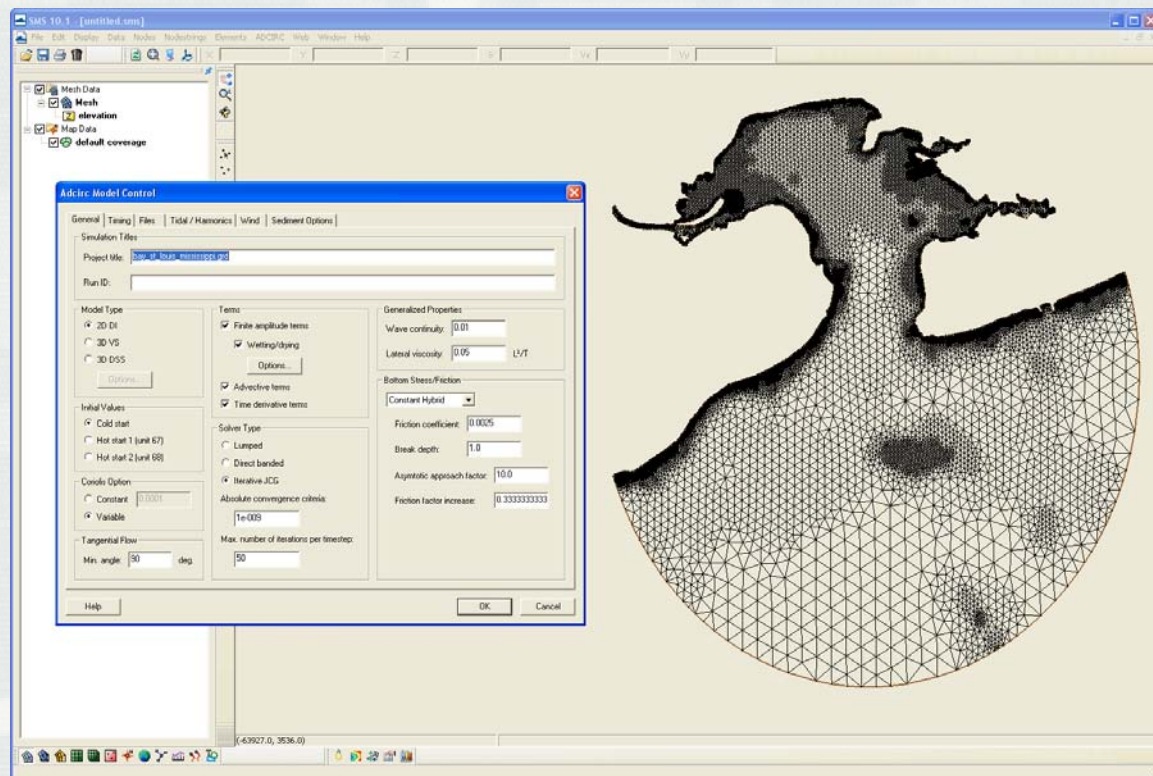
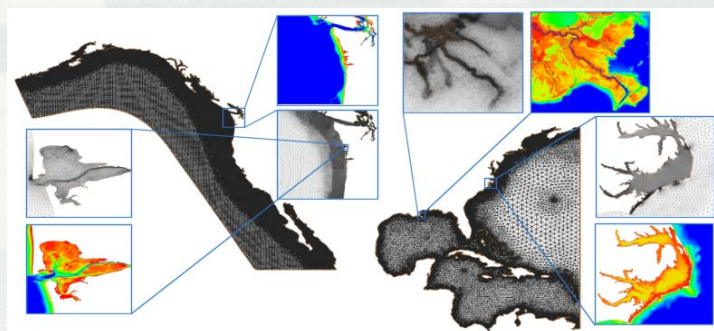
Example Model Domains





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



SMS GUI for ADCIRC

<http://adcirc.org>

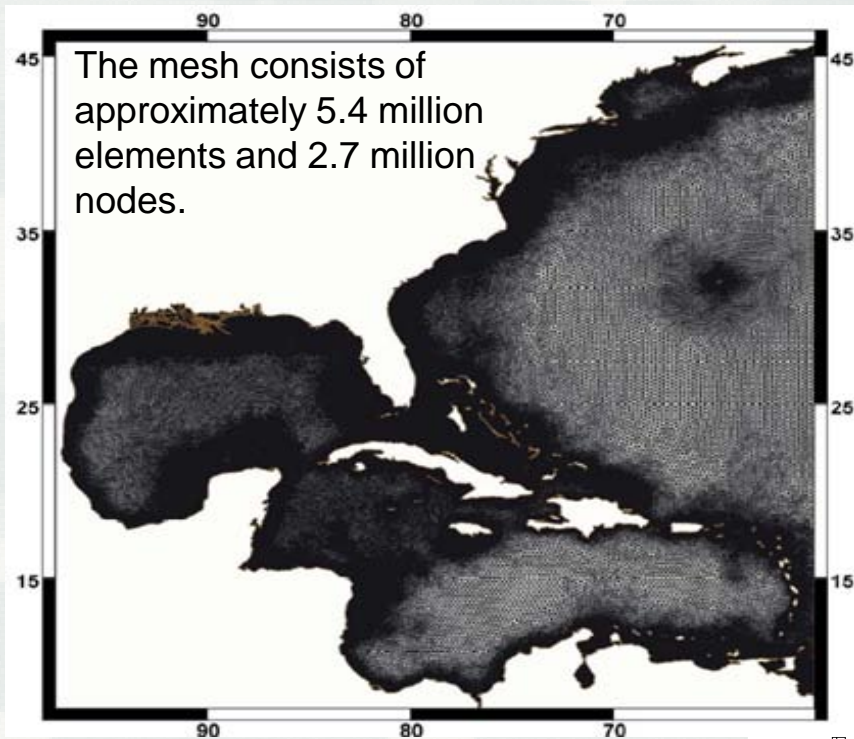
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Dr. Chris Massey, ERDC-CHL

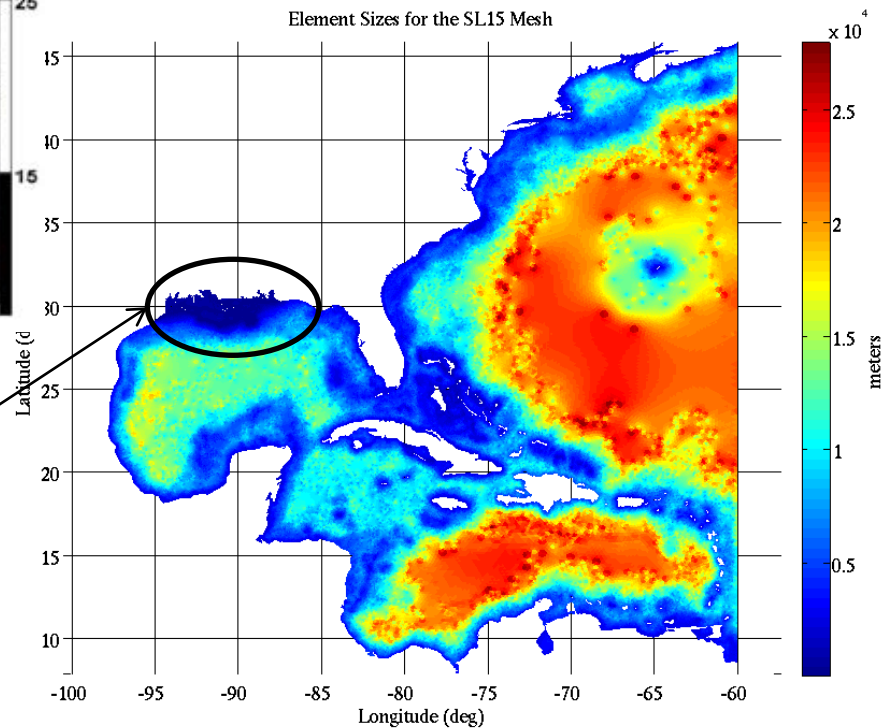


Example ADCIRC Unstructured Mesh



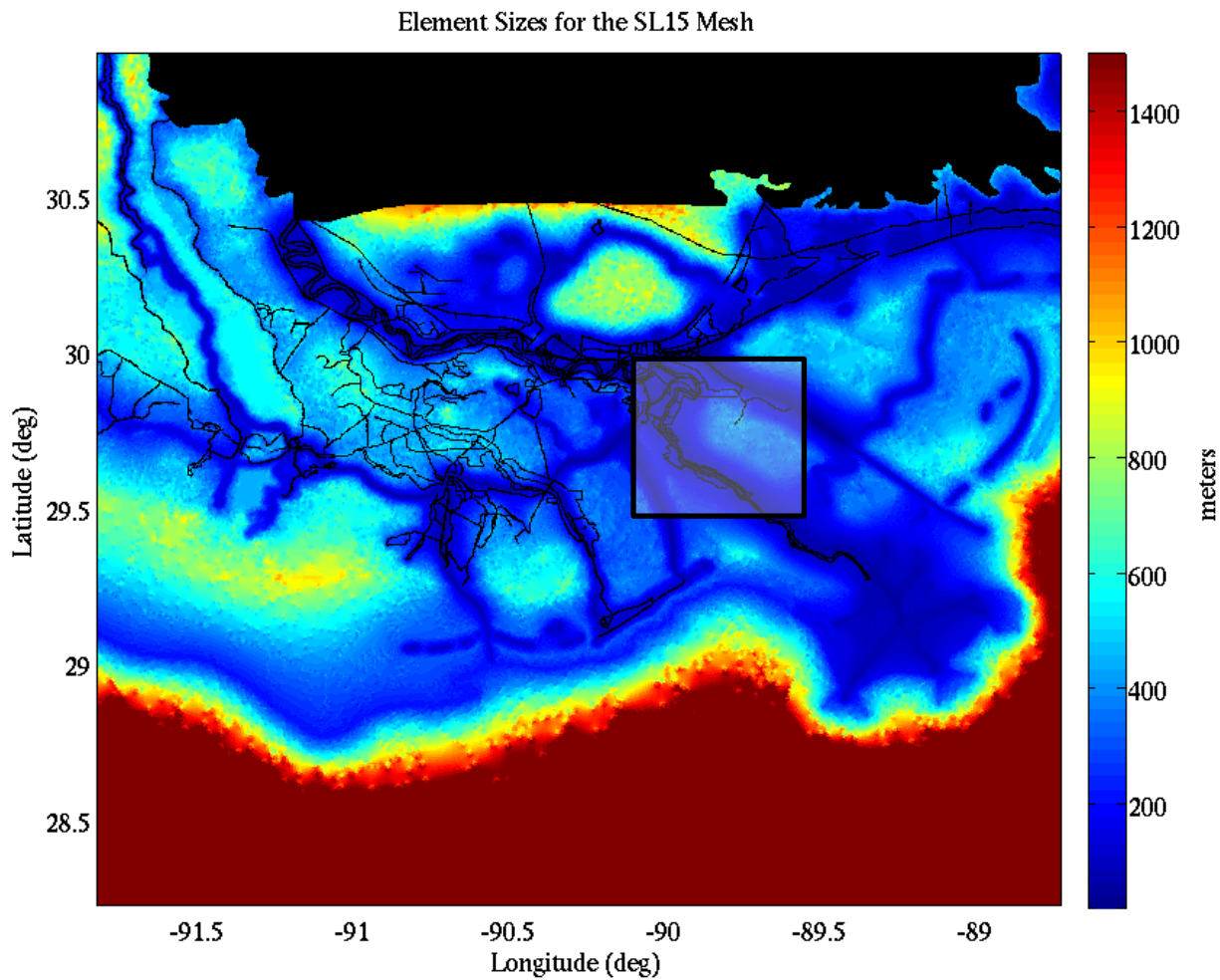
Mesh resolution
From 28 km down to 23 m

Approximately 98% of all elements are in the study area.



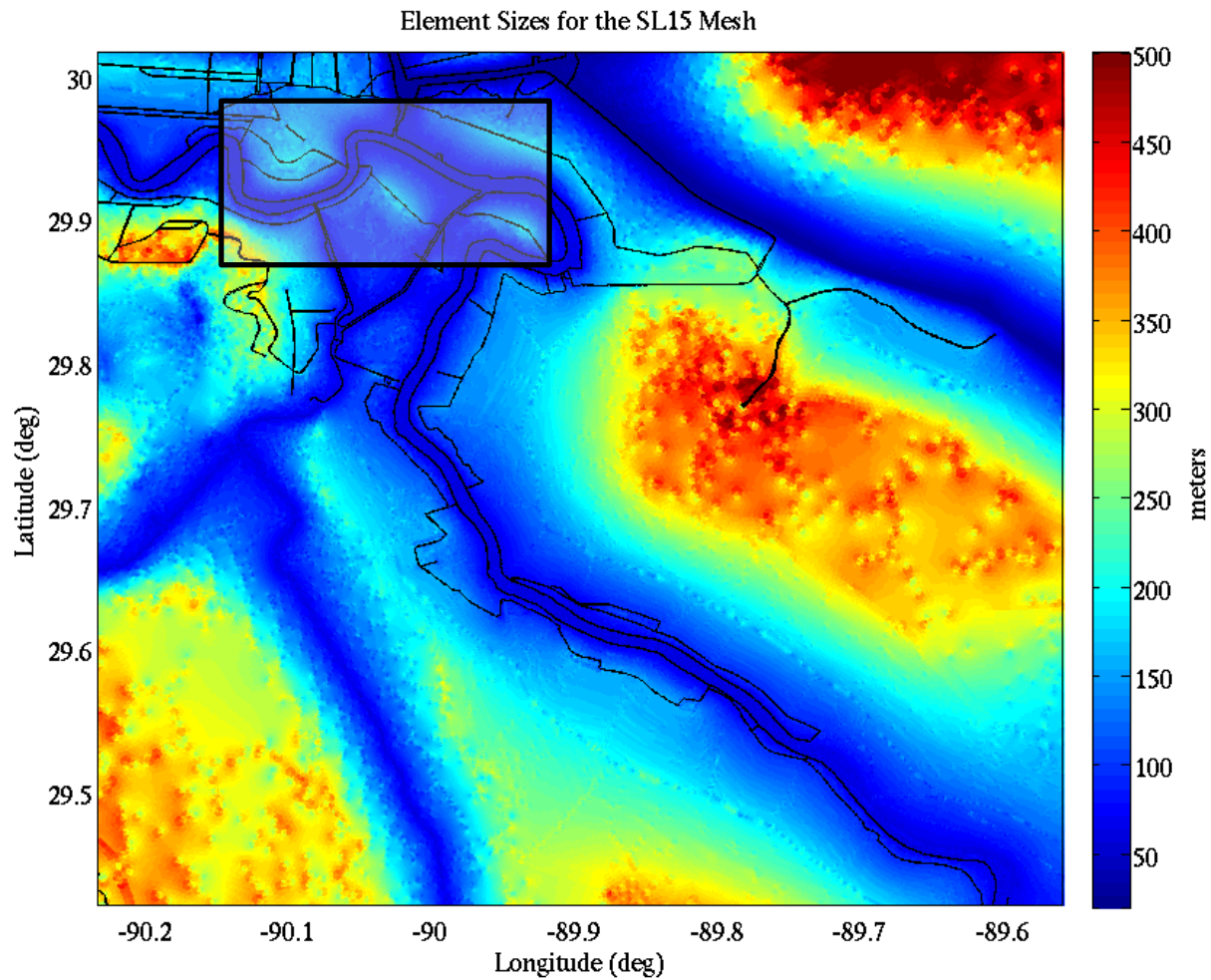


SL15 Mesh Resolution



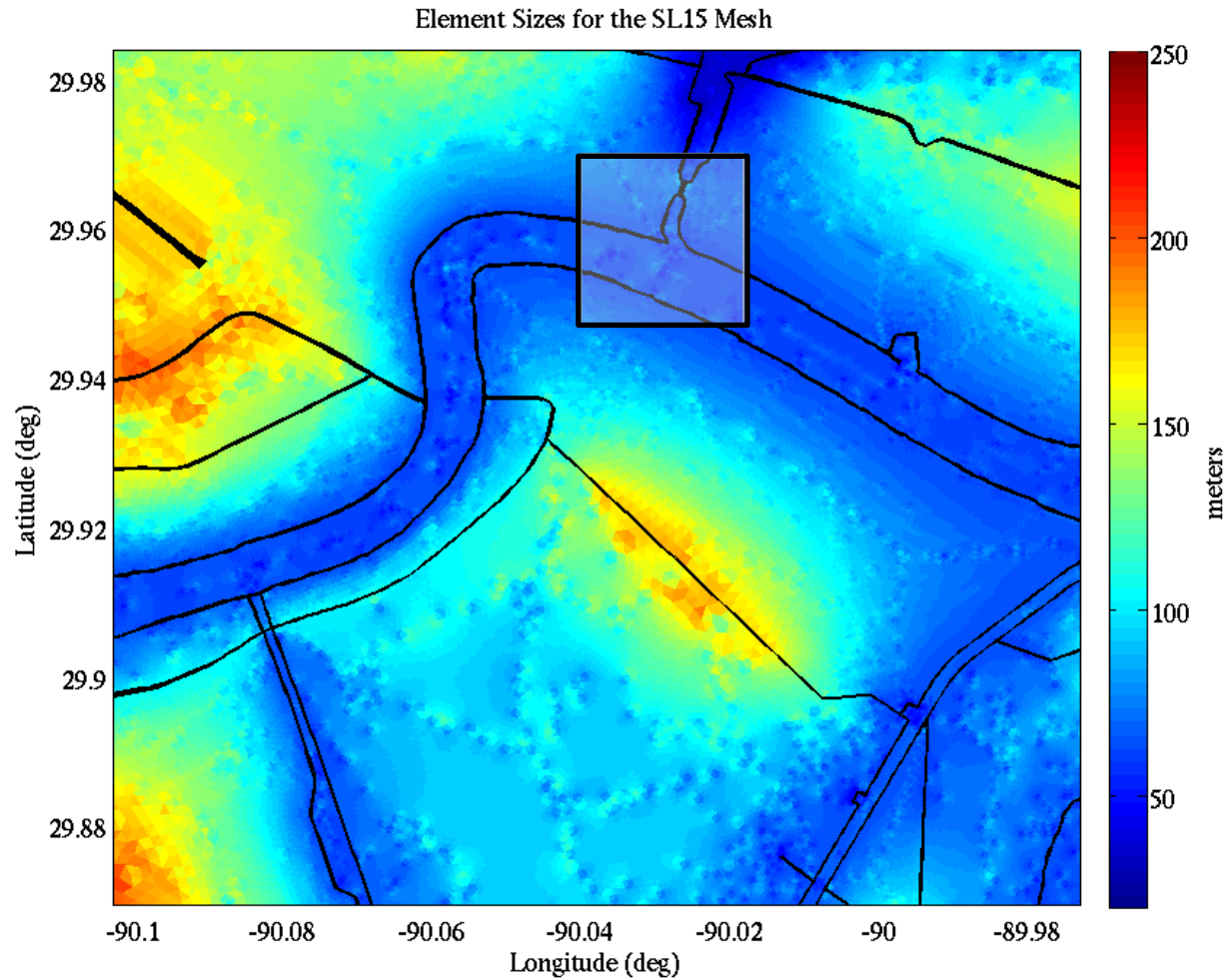


SL15 Mesh Resolution



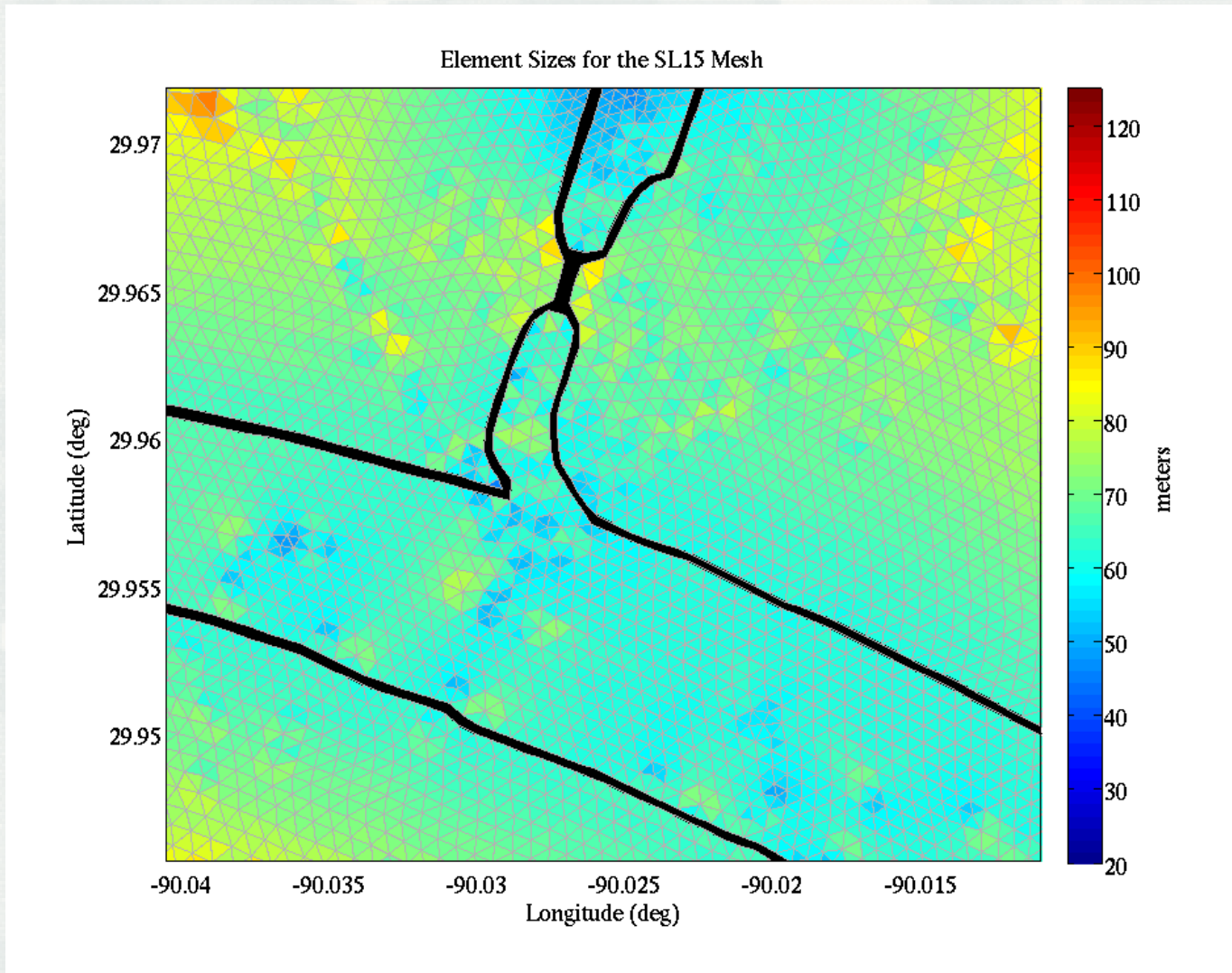


SL15 Mesh Resolution





SL15 Mesh Resolution





WAM Wave Model

The global ocean wave prediction model WAM is a third generation wave model.

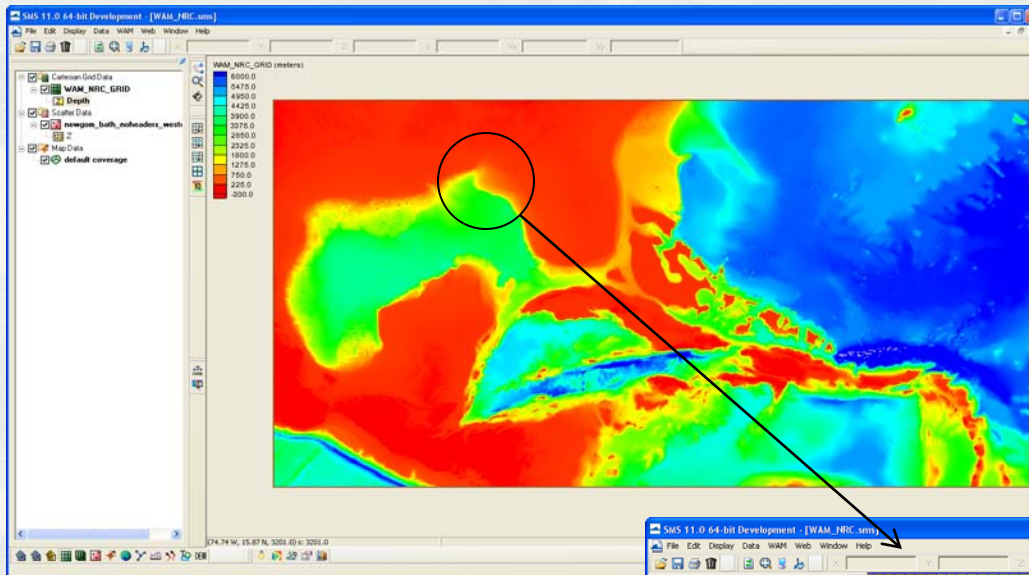
Model Assumptions

- Time dependent wave action balance equation.
- Wave growth based on sea surface roughness and wind characteristics.
- Nonlinear wave and wave interaction by Discrete Interaction Approximation (DIA).
- Free form of spectral shape.
- High dissipation rate to short waves.





SMS GUI for WAM



Grid Options

General | Output | Spatial Inputs

Title: WAM simulation created in SMS.

Model options

- Water depth model: Shallow
- Refraction model: Not used
- Breaking
- Test level: 0
- Create restart file

Model time steps

- Propagation: 900 seconds
- Source: 900 seconds
- Output wind: 1800 seconds

Output time steps

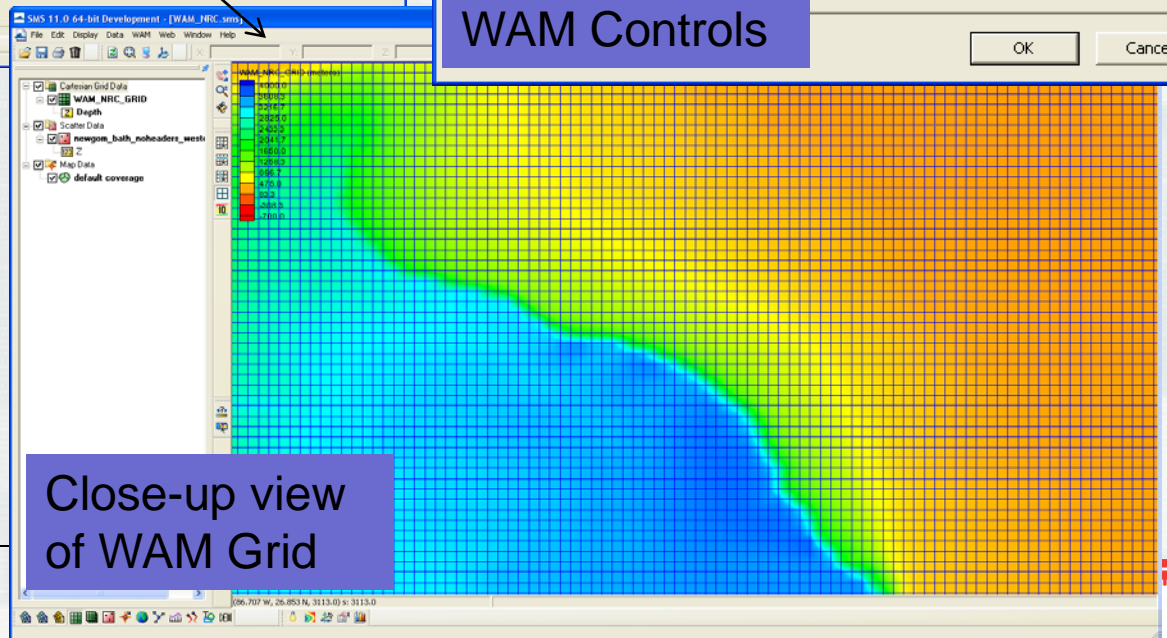
- Spatial Datasets: 12 hours
- Spectra: 12 hours
- Close/reopen files: 24 hours

OK Cancel

WAM Controls

New to the SMS

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



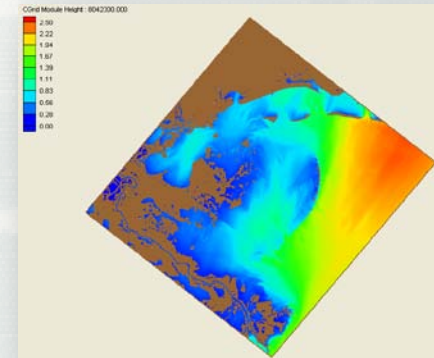
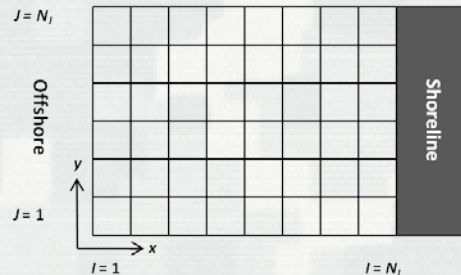
Close-up view of WAM Grid

STWAVE Version 6.0

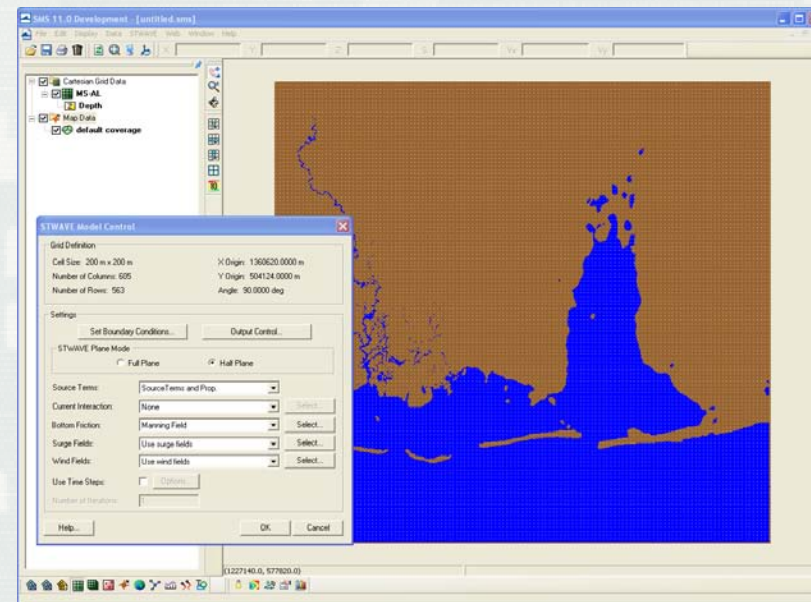
- STWAVE is a steady-state finite difference model based on the wave action balance equation.
- The model is used to compute wave transformation (refraction, shoaling, and breaking) and wind-wave generation.

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.

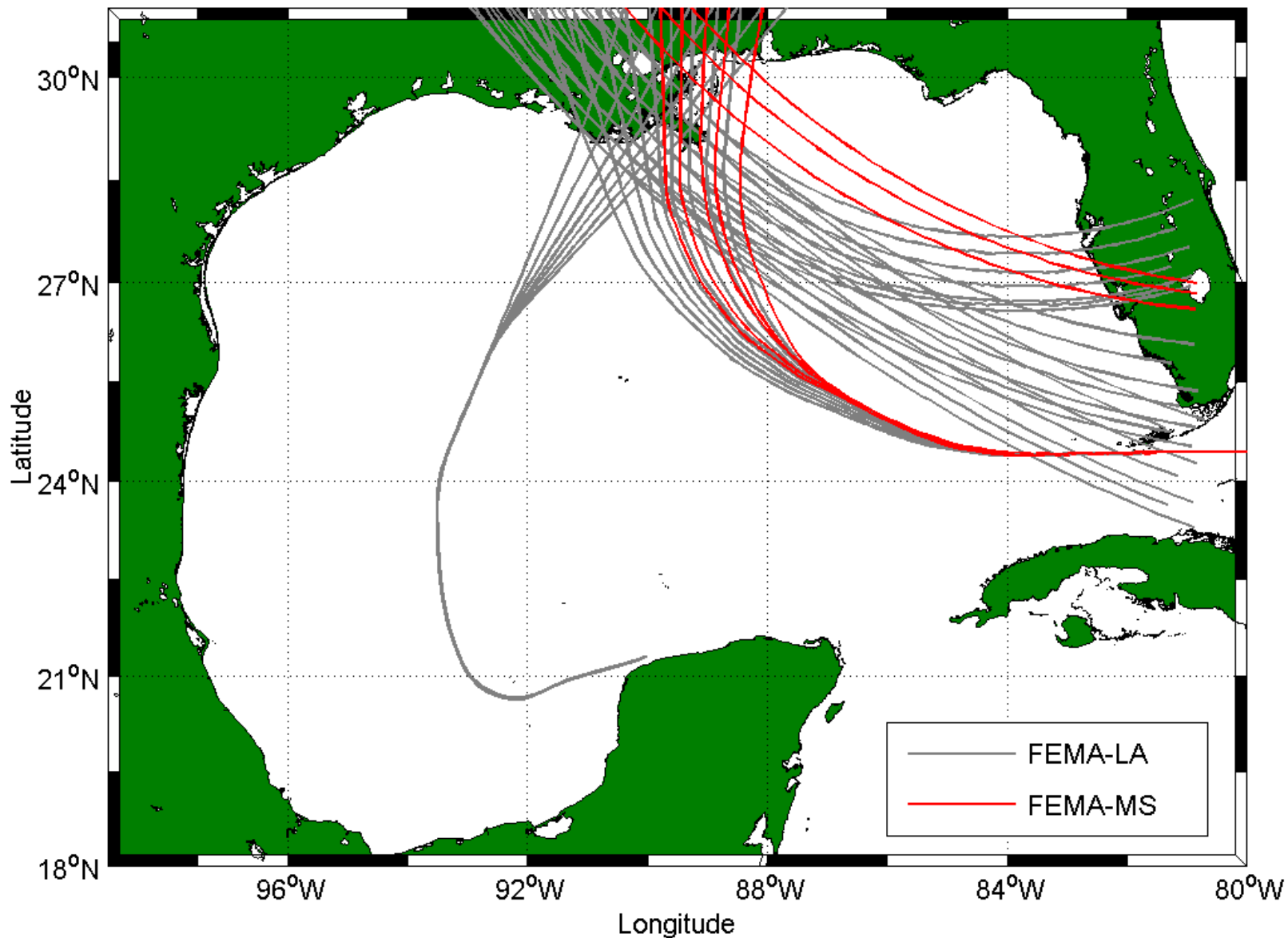


SMS GUI for STWAVE



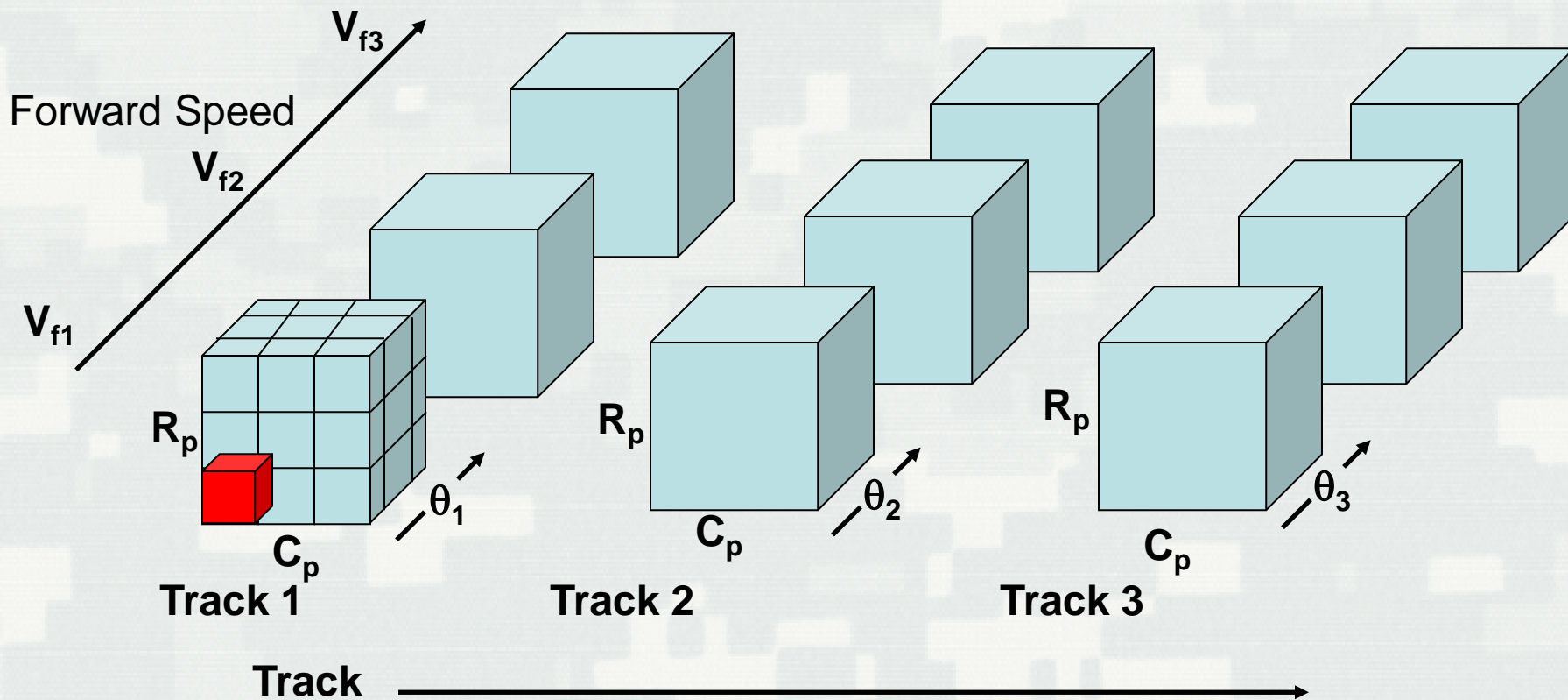


Storm Tracks – Eastern LA & MS





Storm Parameters applied in JPM-OS

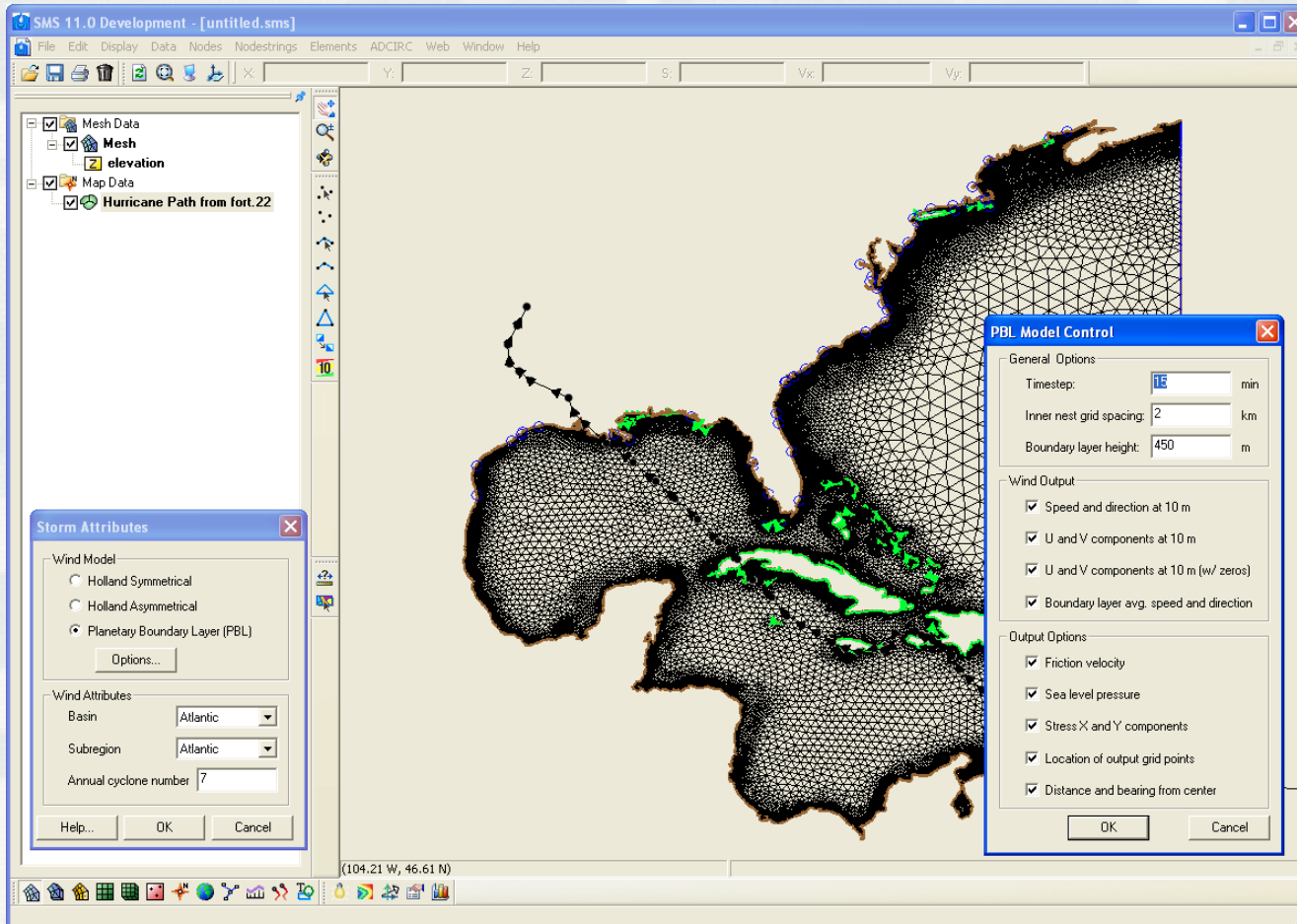


For any location.....
each red box (parameter set) has a joint probability density and a response (surge).

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SMS GUI for Cyclone Models



1. Support for MORPHOS-PBL Cyclone Model*, ADCIRC's internal Holland models and **ATCF Best Track** formats
2. Ability to read/modify existing cyclone track and characteristics
3. Ability to create cyclone track via "point-n-click" and add storm characteristics
4. Ability to auto perturb cyclone data:
 - Track
 - Speed
 - Intensity
 - Size

Note: NOAA uses the ATCF Best Track.

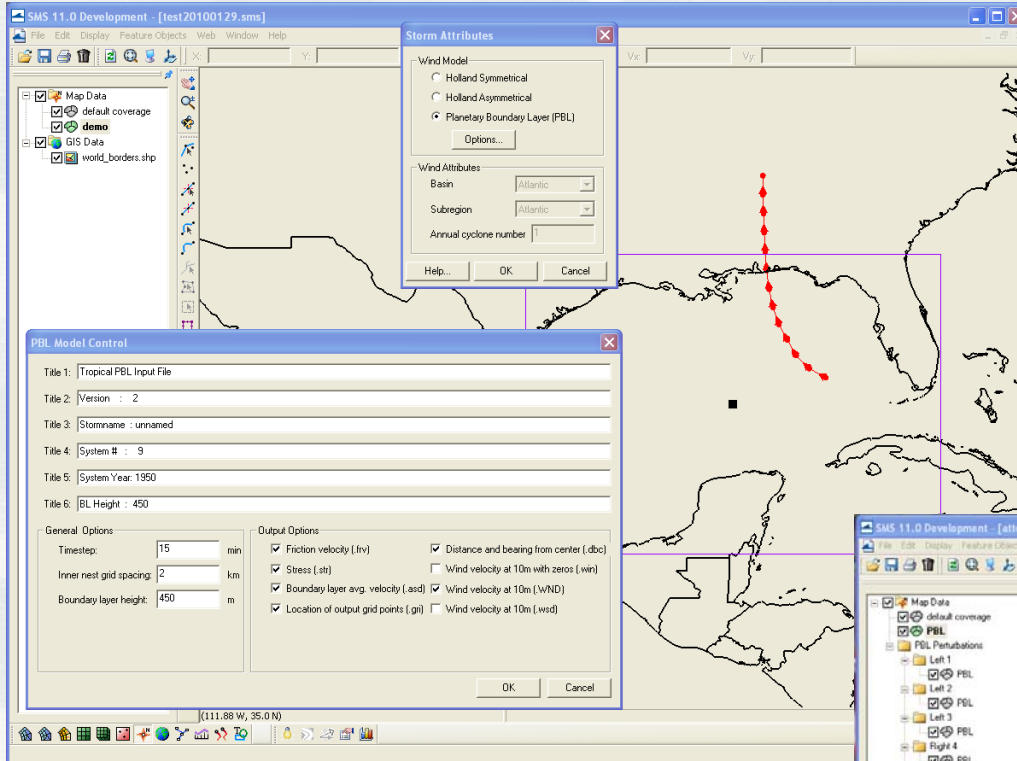
*Updated version of TC96

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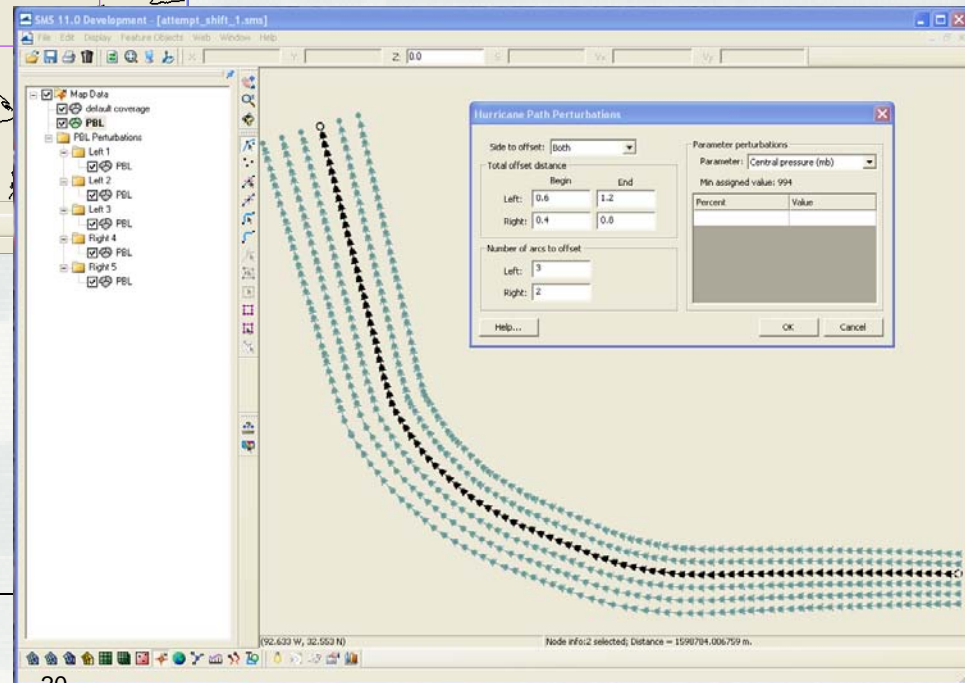
SMS GUI for Cyclone Models



Setup and run the MORPHOS-PBL Cyclone Wind Model*

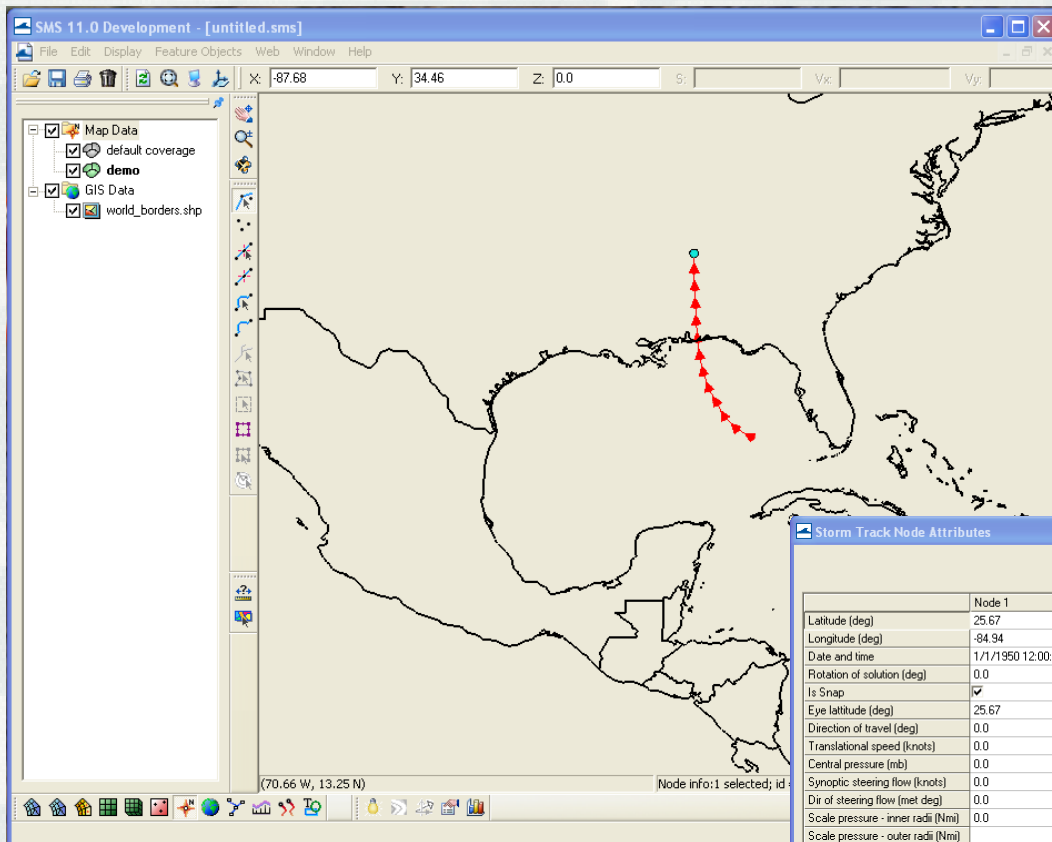
*Updated version of TC96

Easily create perturbations for storm track/characteristic.





SMS GUI for Cyclone Models



Point-and-Click to create storm track.

Specify/Edit storm characteristics.

Storm Track Node Attributes

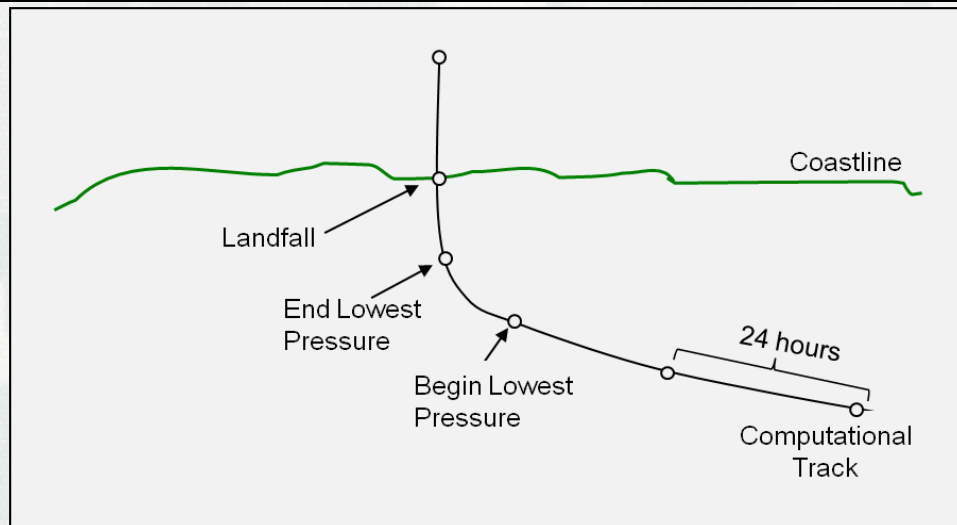
	Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	N
Latitude (deg)	25.67	26.06956	26.62815	27.31069	27.98925	28.72977	25
Longitude (deg)	-84.94	-85.6618	-86.2288	-86.6106	-86.976	-87.237	-8
Date and time	1/1/1950 12:00:00 AM	1/1/1950 12:00:00 AM	1/1/1950 12:00:00 AM	1/1/1950 12:00:00 AM	1/1/1950 12:00:00 AM	1/1/1950 12:00:00 AM	1/1
Rotation of solution (deg)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Is Snap	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Eye latitude (deg)	25.67	26.06956	26.62815	27.31069	27.98925	28.72977	25
Direction of travel (deg)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Translational speed (knots)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Central pressure (mb)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Synoptic steering flow (knots)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Dir of steering flow (met deg)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Scale pressure - inner radi (Nmi)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Scale pressure - outer radi (Nmi)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
% of RAD1 pressure drop (0-100)	1	1	1	1	1	1	1
# of active profiles	1	1	1	1	1	1	1
Profile 1	defined	defined	defined	defined	defined	defined	de
Azimuth (deg)							
Holland's B for RAD1							
Far Field pressure (mb)	1013.0	1013.0	1013.0	1013.0	1013.0	1013.0	1013.0
Holland's B for RAD2							
Profile 2							
2-Azimuth (deg)							
2-Holland's B for RAD1							
2-Far Field pressure (mb)	1013.0	1013.0	1013.0	1013.0	1013.0	1013.0	1013.0
2-Holland's B for RAD2							
Profile 3							
3-Azimuth (deg)							

Help... Delete... Interpolate... OK Cancel

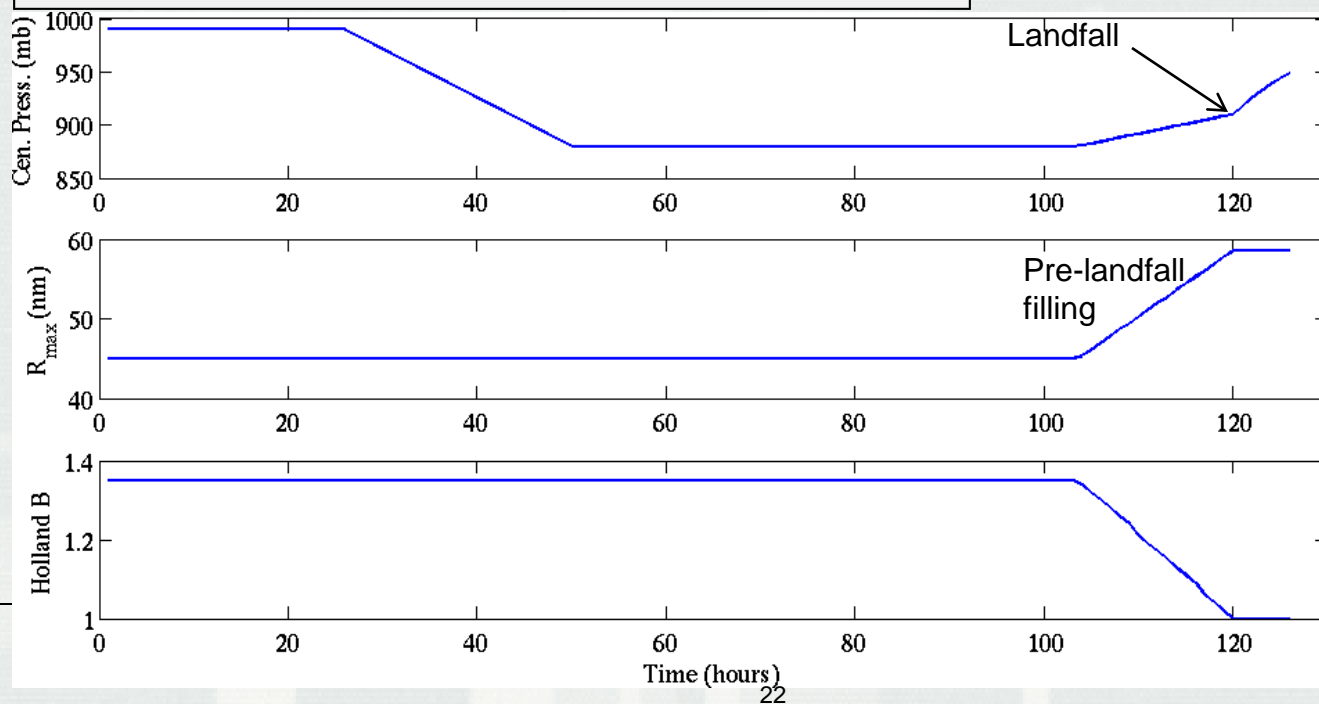




Synthetic Storm Profile



A synthetic storm profile generation routine is being included in the SMS. It generates storm profiles similar to those used in the IPET and other JPM-OS type storms.



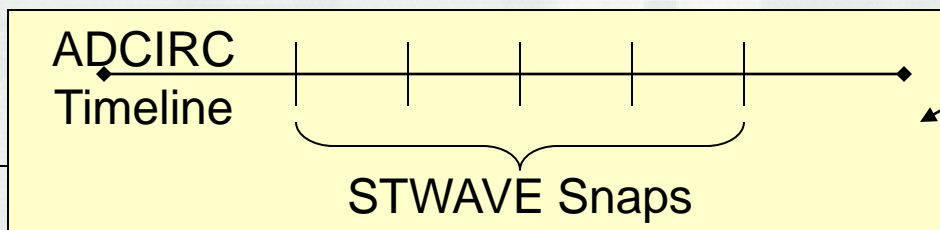
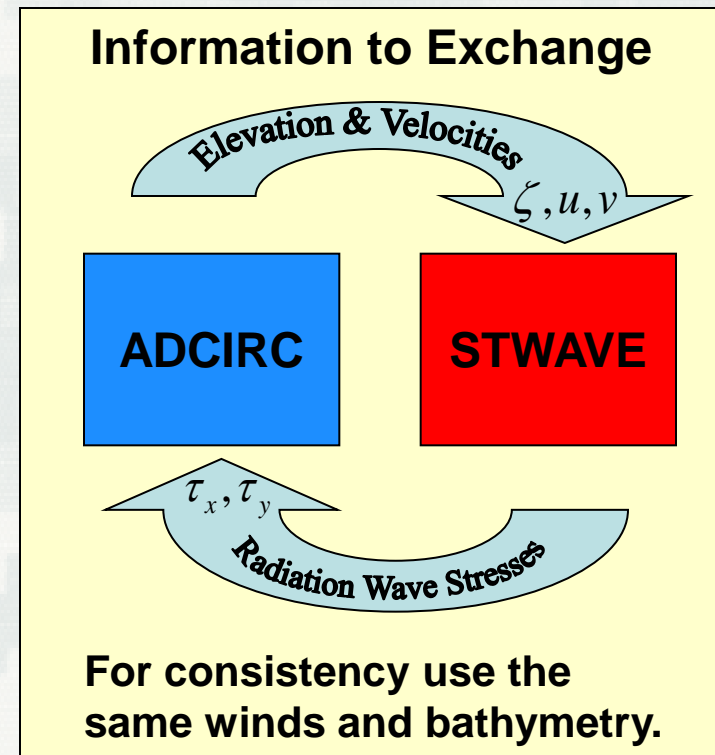
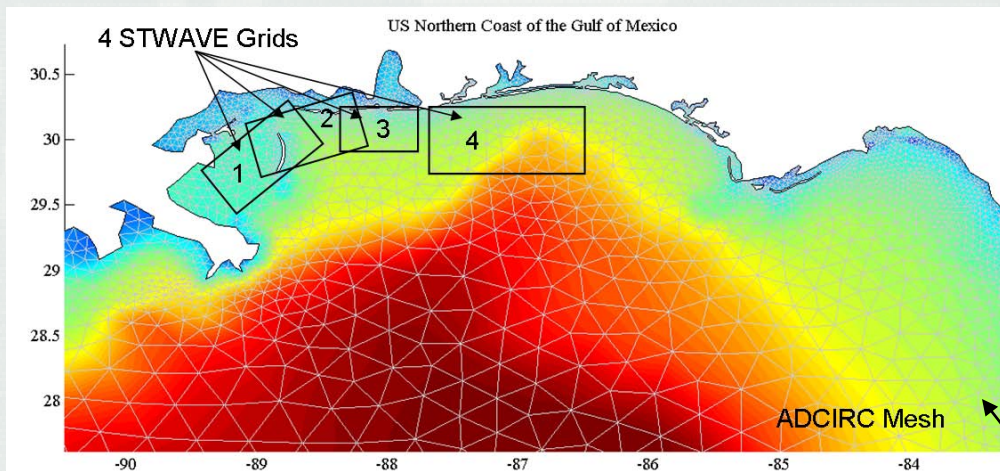
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Circulation \leftrightarrow Wave Coupling

- One unstructured finite element circulation mesh
 - A single instance of ADCIRC
- One or more structured wave grids
 - Multiple instances of STWAVE
 - Half-Plane
 - Full-Plane



Need to be able to synchronize both time and spatial frames of reference.

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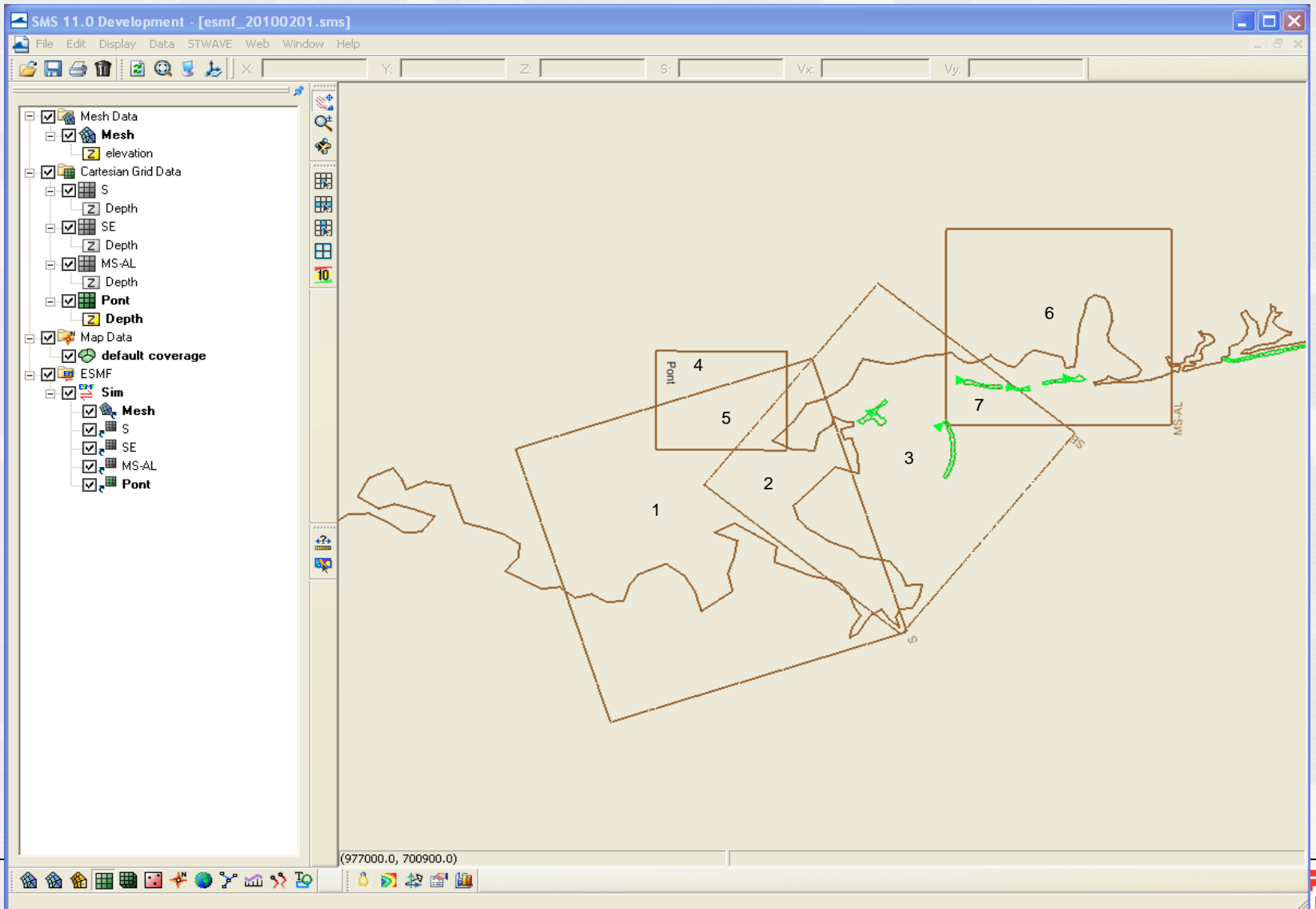
The Earth System Modeling Framework

- The ESMF has multi-agency buy in.
- Having our models ESMF compliant makes them readily available to be linked with each other and with other agencies' ESMF compliant models.
- This leads to expanded collaborations and funding opportunities.





SMS GUI for Coupler





SMS GUI for Coupler

The screenshot displays the 'ESMF Model Control' dialog box overlaid on a map interface. The dialog box contains the following sections:

Data Exchange

Model A	Data Exchange	Model B	Model A -> B	Units	Model A <- B	Units
ADCIRC	<>	STWAVE	30	minutes	30	minutes

Area Mapping

ID	Mapping	Option
1	Single	S
2	Combined	Maximum
3	Single	SE
4	Single	SE
5	Single	S
6	Single	MS-AL
7	Combined	Maximum
8	Single	Pont

The map view shows a geographical area with a brown boundary and green arrows indicating flow directions. A rectangular box highlights a specific region. The map includes labels '3', '6', and 'MS-AL'. The status bar at the bottom of the map shows coordinates (920100.0, 612800.0). The Windows taskbar is visible at the bottom of the screen.





Project Management Summary View

Hurricane Model Project Summary

Overview | ESMF | Spatial View | Timeline

Simulation Name: GulfOfMexico_Synthetic1

Properties

Model Name	Projection	Start Time	End Time	Comp Procs	I/O Procs
STWAVE - EastGrid	STPL 1703	5/10/2008 10:00:00 AM	5/12/2008 8:00:00 AM	24	0
STWAVE - WestGrid	STPL 1703	5/10/2008 10:00:00 AM	5/12/2008 8:00:00 AM	36	0
ADCIRC mesh	Geo	5/8/2008 8:00:00 AM	5/12/2008 8:00:00 AM	24	4

Help

Hurricane Model Project Summary

Overview | ESMF | Spatial View | Timeline

ADCIRC mesh

STWAVE - WestGrid

STWAVE - EastGrid

9 Fri 10 Sat 11 Sun 12 Mon
lay 2008

Help OK Cancel

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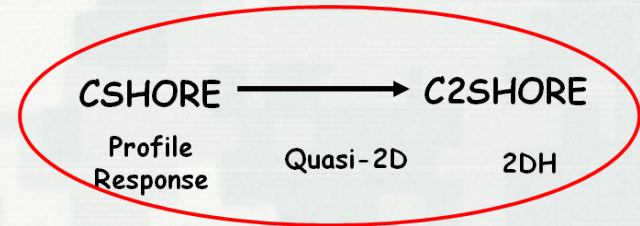


Advances in Morphology Response

Philosophy: Efficient and Robust

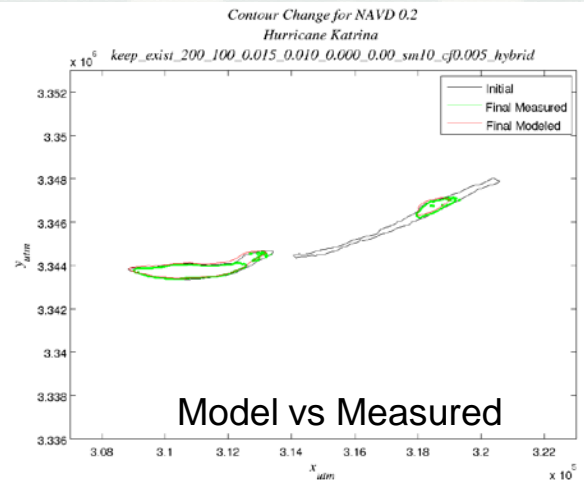
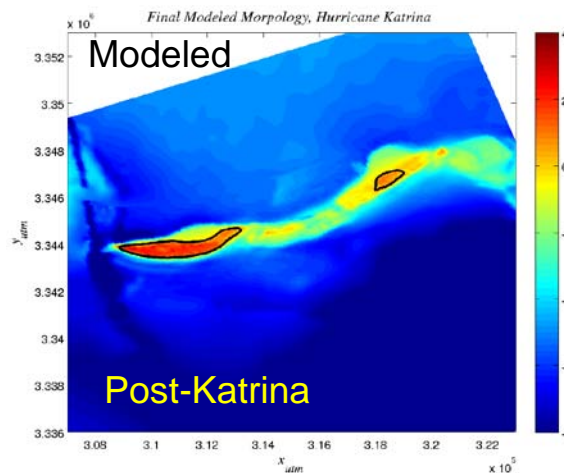
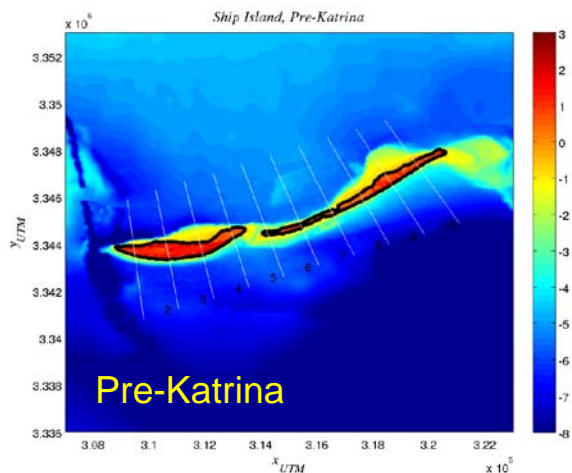
Model Components

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



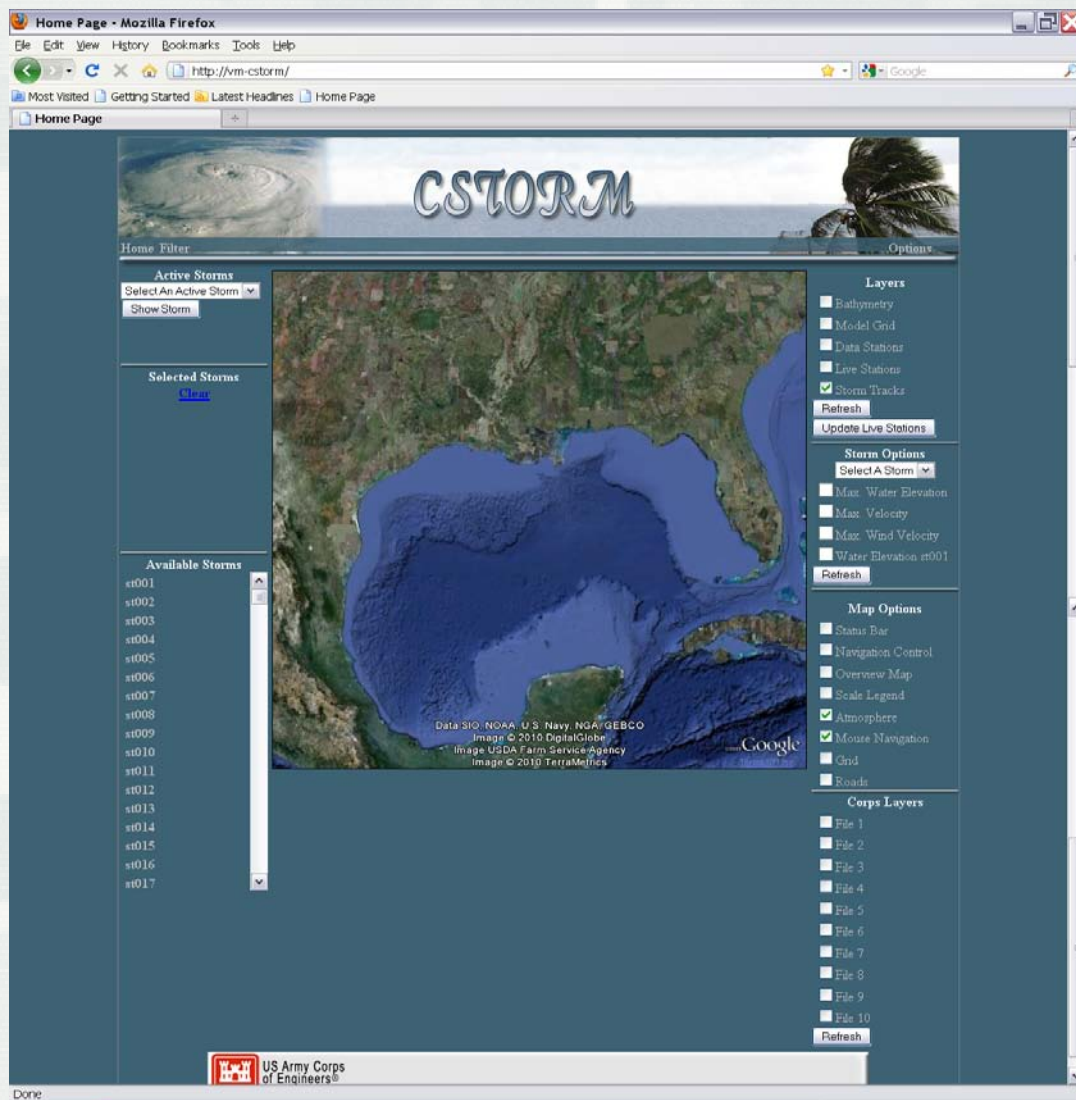
Mississippi Coastal Improvement Program (MsCIP)

Ship Island Lidar





Coastal Storm - Database and Data Mining Tool



Goals

- Develop long-term archive/database of measured and modeled coastal storm data
- Make data easily accessible and understandable to team members
- Integrate contextual data products and tools that support federal decision making
 - Emergency management
 - Risk management/assessment/communication
 - Project design and evaluation

POC: Jeffrey A. Melby, PhD

USACE ERDC Coastal and Hydraulics Lab

Jeffrey.A.Melby@usace.army.mil

2 Mar 2010

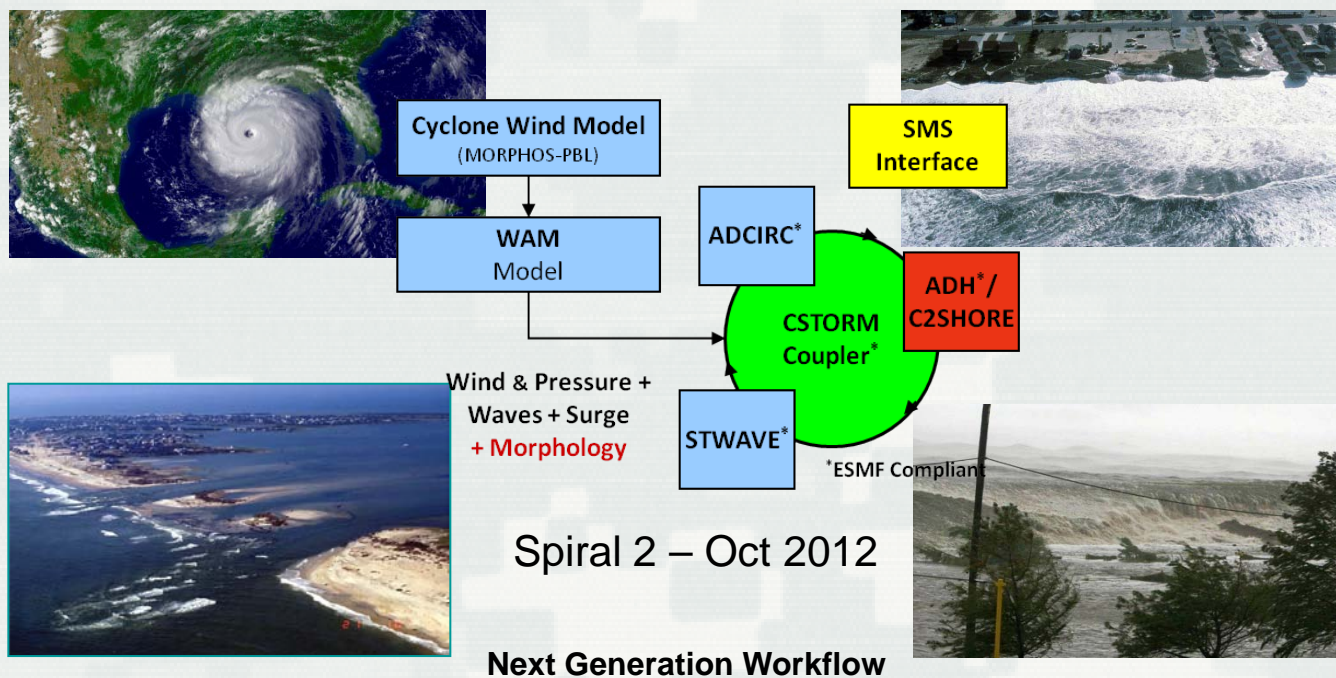
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CSTORM-MS

- Expandable
- Upgradeable
- Multi-Scale
- Multi-platform
PC to HPC
- More than Hurricanes
- Relocatable to your area



Thank You.

Chris.Massey@usace.army.mil

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