A Testbed for the Evaluation of Coupled Wave, Storm Surge and Inundation Models for Tropical Storms

Rick Luettich, University of North Carolina at Chapel Hill

Linda Akli, Gary Crane, SURA
Jesse Feyen, NOAA CSDL
Anne Kramer, Amy Haase, Arthur Taylor, NOAA MDL
Jamie Rhome, Cristina Forbes, NHC
Don Slinn, Univ Florida
Harry Wang, VIMS
Joannes Westerink, Patrick Kerr, Aaron Donahue, Univ Notre Dame
Lianyuan Zheng, Bob Weisberg, Univ South Florida
Numerous Other Contributors

6 March 2012
66th Annual Interdepartmental Hurricane Conference

SURA

IOOS
INTEGRATED OCEAN OBSERVING SYSTEM

Objectives

Provide evaluation of models in or under consideration for "operational use"

- Implementation requirements
    - Resolution
    - Physics
    - Parameterization
    - Computer capacity

- Payoff
    - Accuracy
    - Robustness
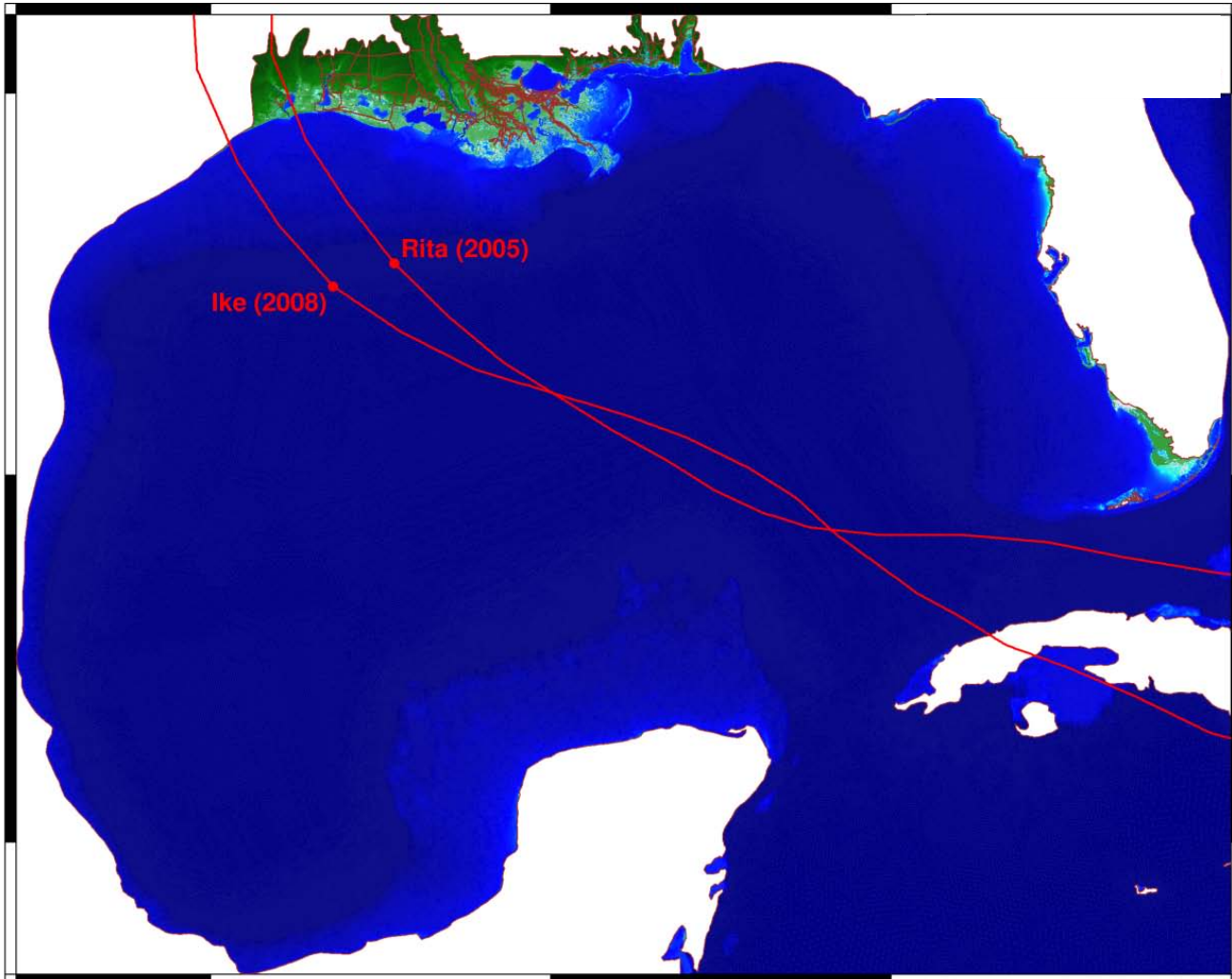   - Execution speed

Objectives

Develop testbed infrastructure to greatly facilitate future model evaluation

- Standards

- Interoperability

- Model evaluation tools (e.g., IMEDS skill assessment)

- Data/model archives and access

TC Testbed Domain: Gulf of Mexico

Tides, Hurricanes Ike (2008), Rita (2005)

TC Models & Participants

ADCIRC + unstructured SWAN
- Joannes Westerink – U Notre Dame

FVCOM + SWAN
- Bob Weisberg – U South Florida

SELFE + WWM II
- Harry Wang – VIMS

SLOSH + SWAN
- Don Slinn – U Florida
- Arthur Taylor, Amy Haase, Ann Kramer, Cristina Forbes, Jamie Rhome - NOAA

MANY OTHER WORKERS

Unstructured Base Grid
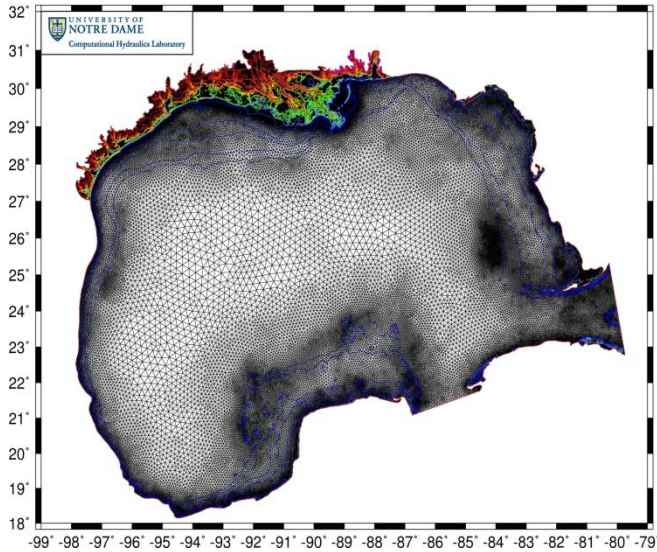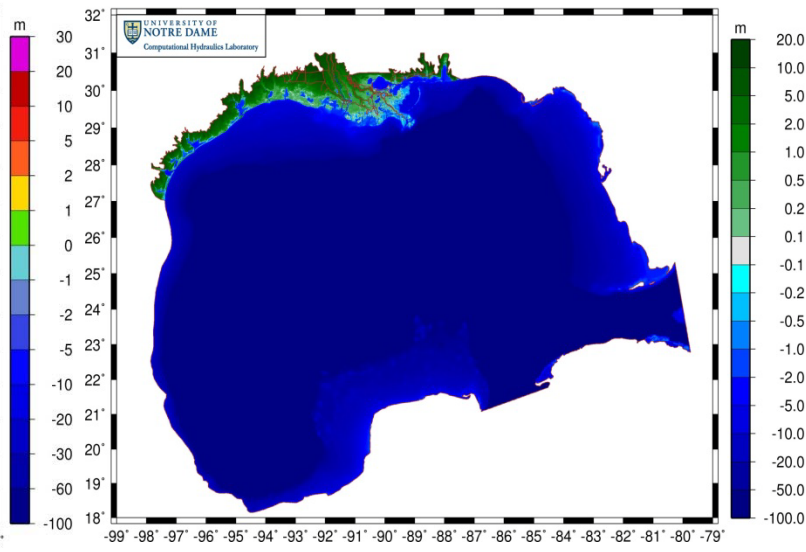
424,485 nodes

Inter-model comparison - unstructured grids
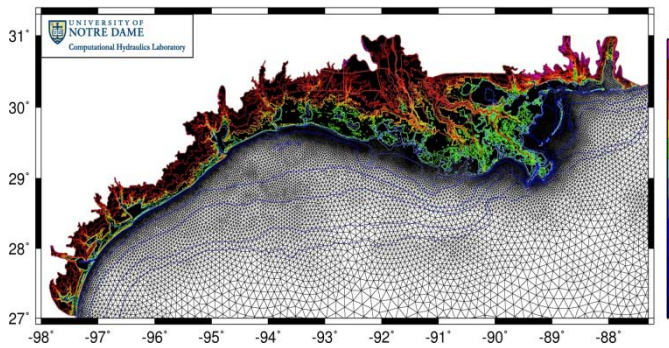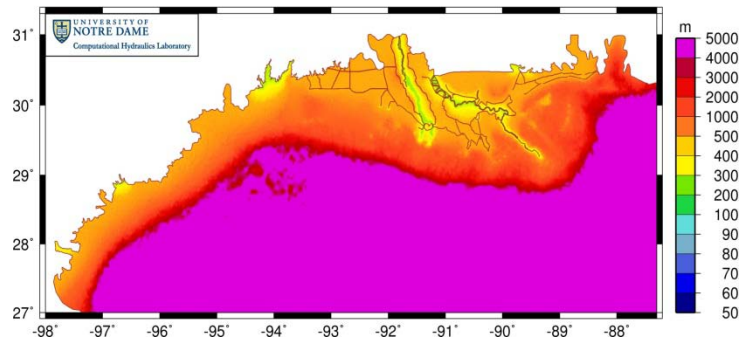
High Resolution Grid vs Base Grid

424,485 nodes

Inter-grid comparison

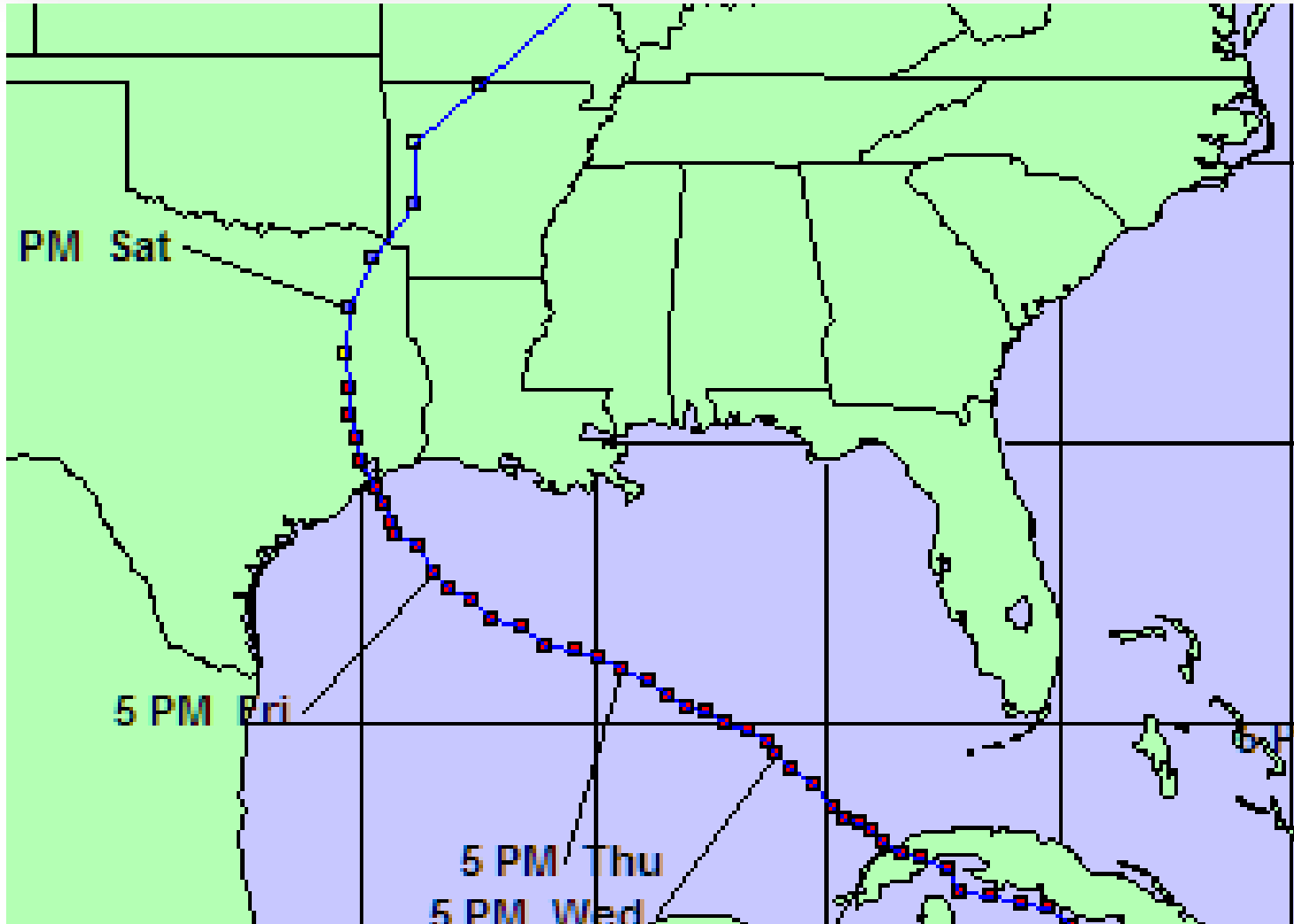9,288,245 nodes
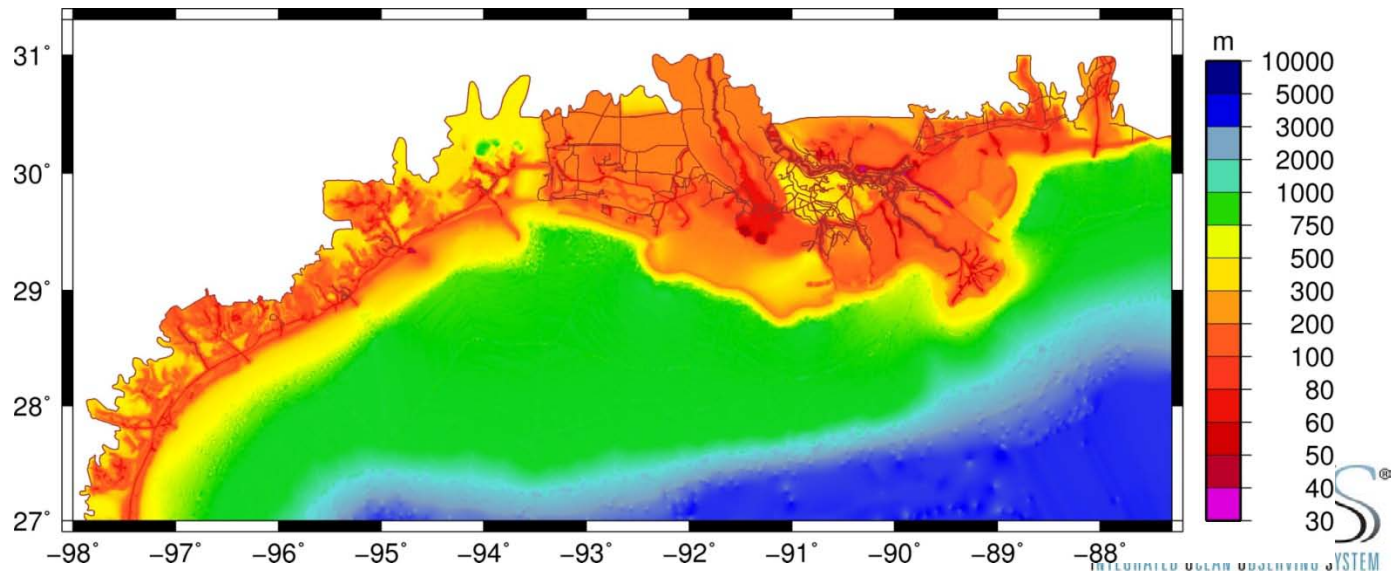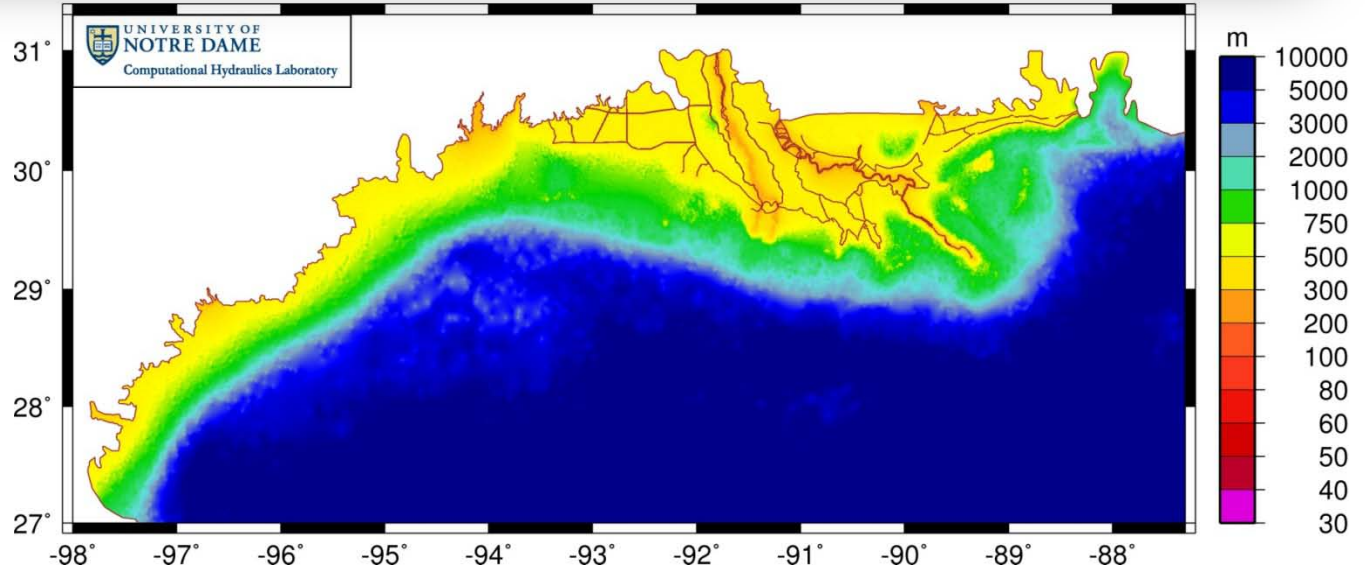
SLOSH Grids

Galveston 3 Slosh Basin
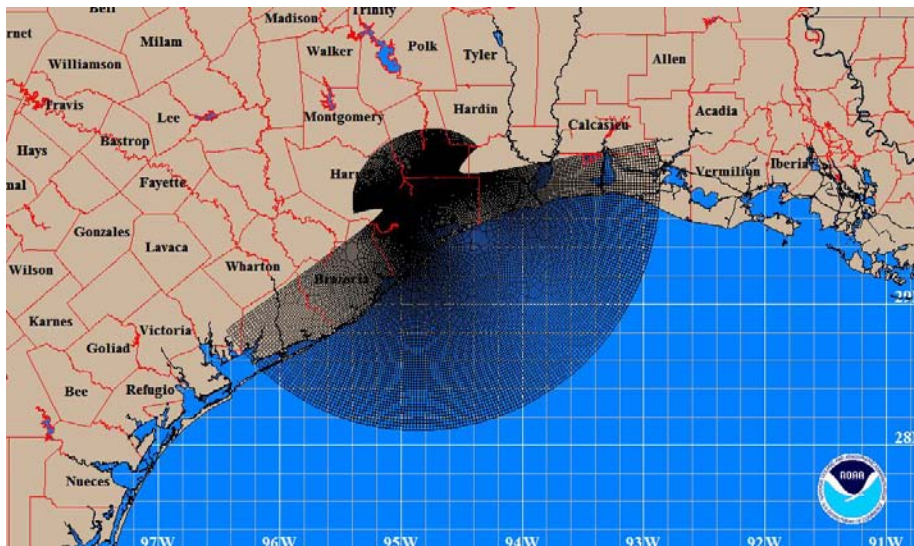
Sabine Pass Slosh Basin
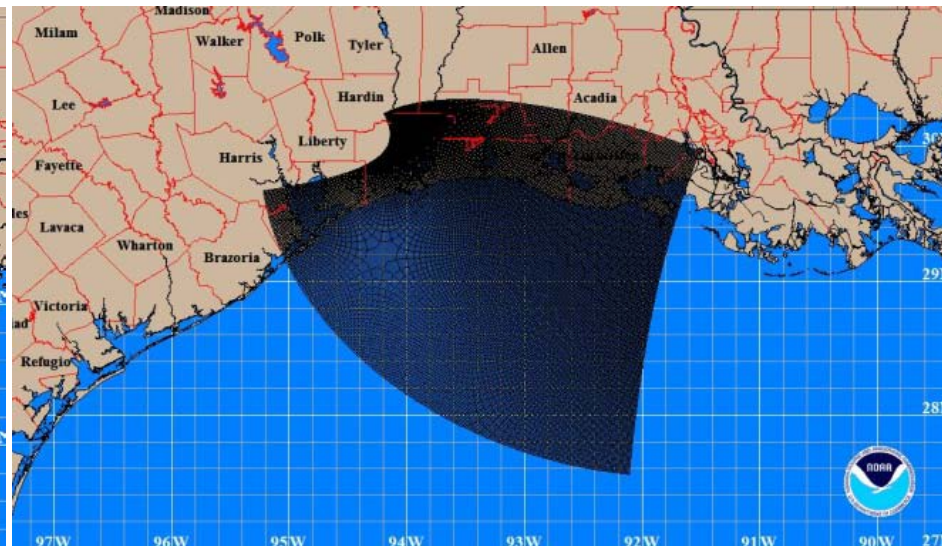
500-2,000 m resolution

GoMx Extratropical
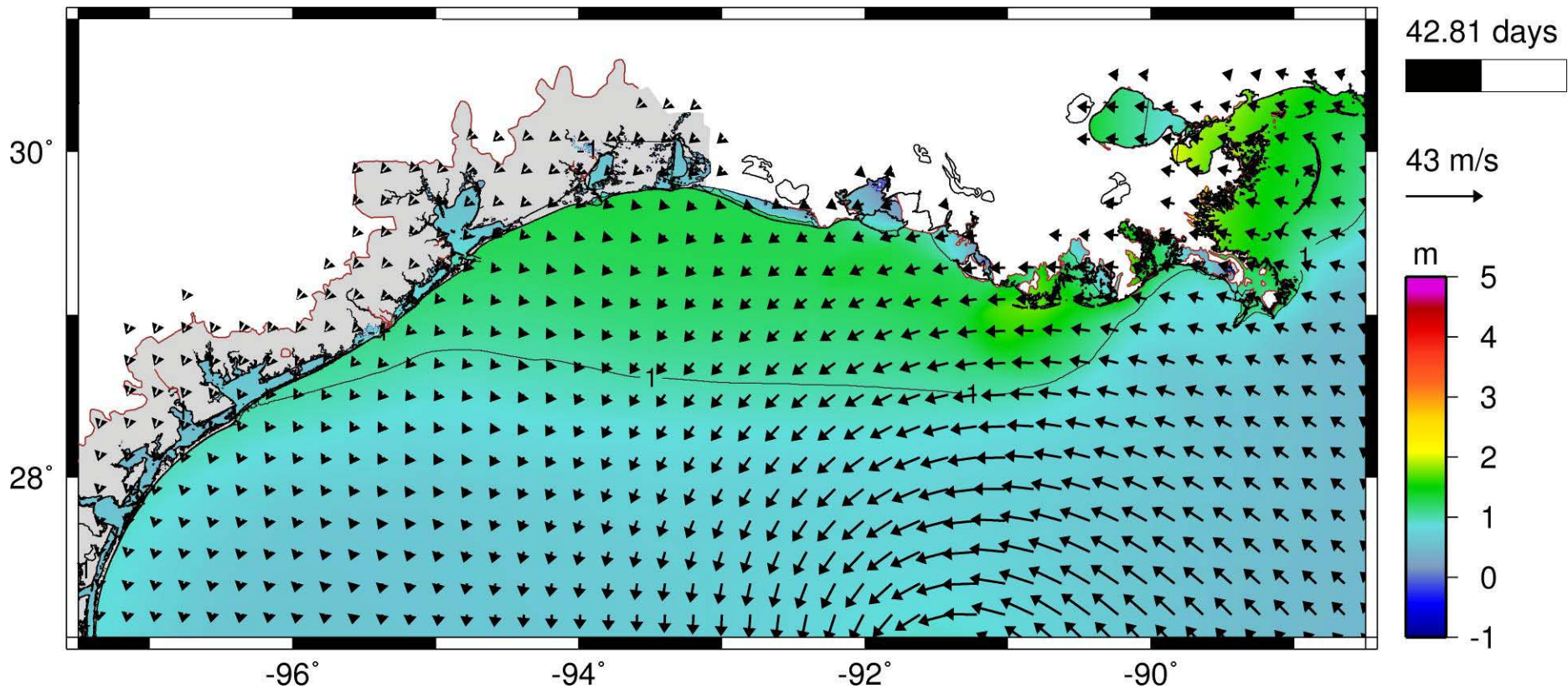Storm Surge Grid
185,409 nodes,
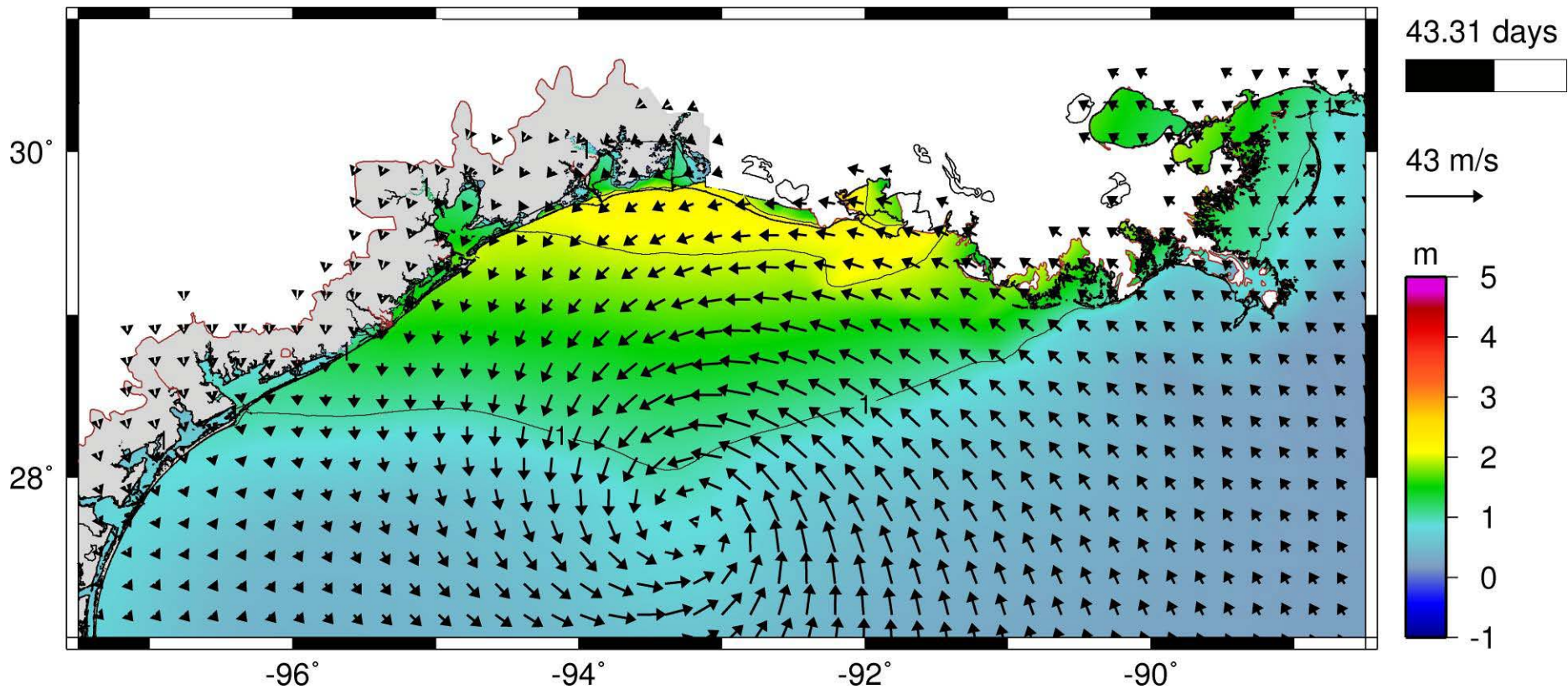~3,000m resolution
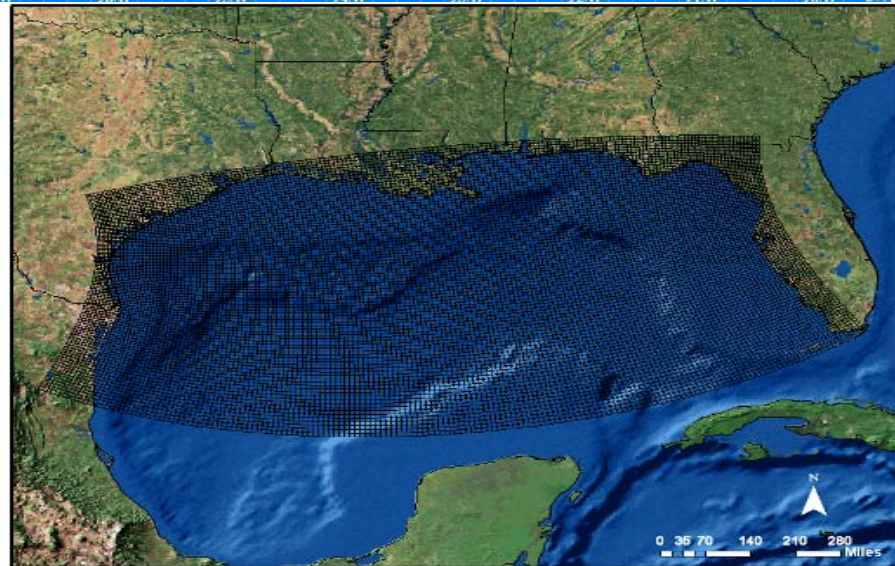
SURA

Hurricane Ike (2008)

PM Sat

5 PM Fri

5 PM Thu
5 PM Wed

SURA

IOOS
INTEGRATED OCEAN OBSERVING SYSTEM

Ike surge contours and wind vectors

r09 c8+tides Water Surface Elevations + Winds

- 24 hrs

Ike surge contours and wind vectors
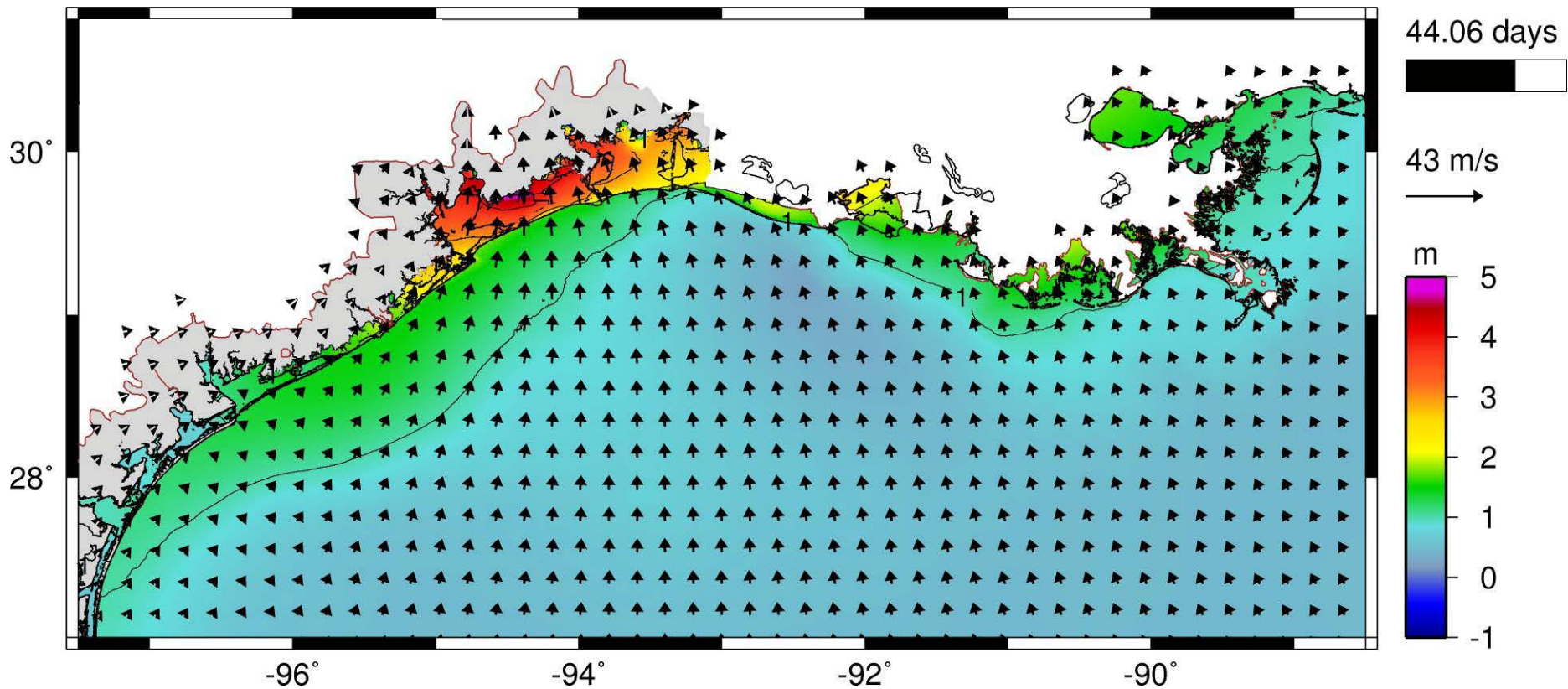
r09 c8+tides Water Surface Elevations + Winds

- 12 hrs

Ike surge contours and wind vectors

r09 c8+tides Water Surface Elevations + Winds
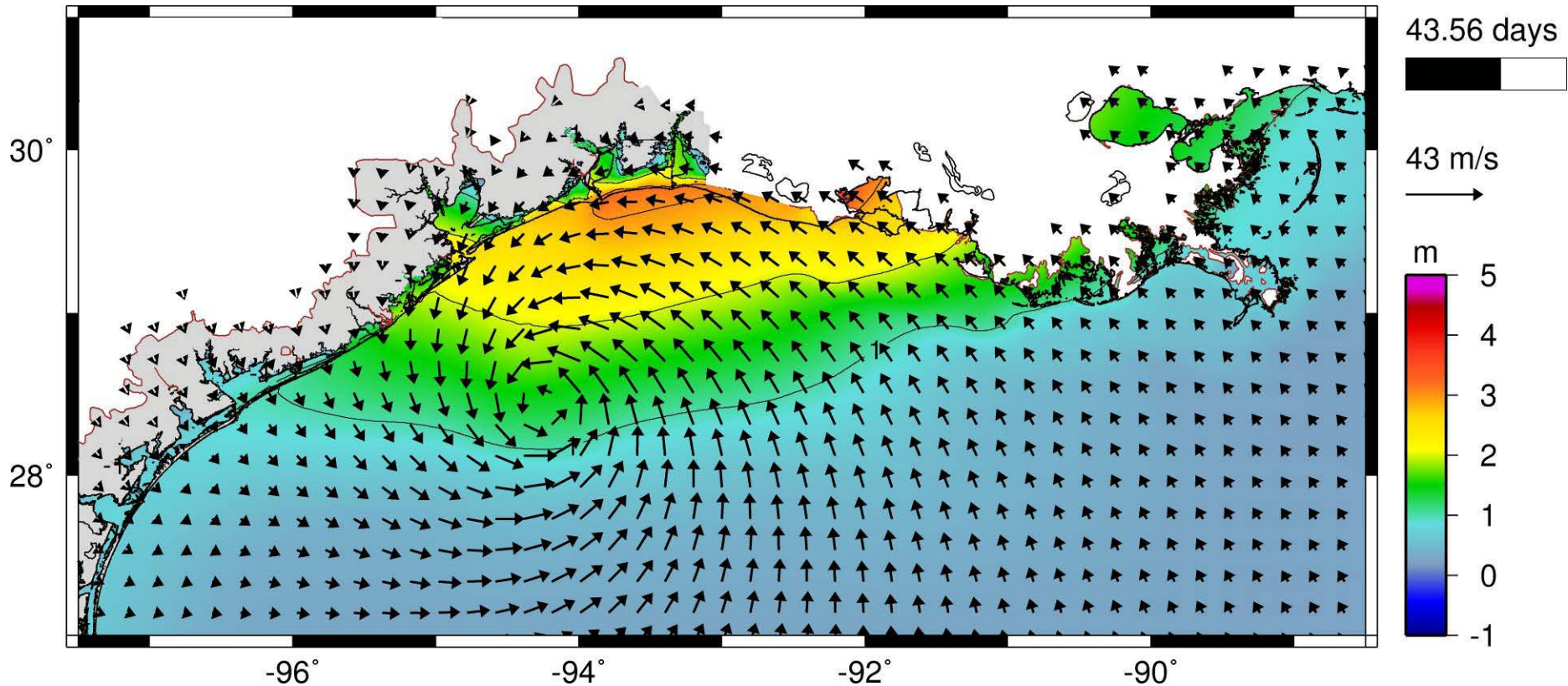
- 6 hrs

Ike surge contours and wind vectors
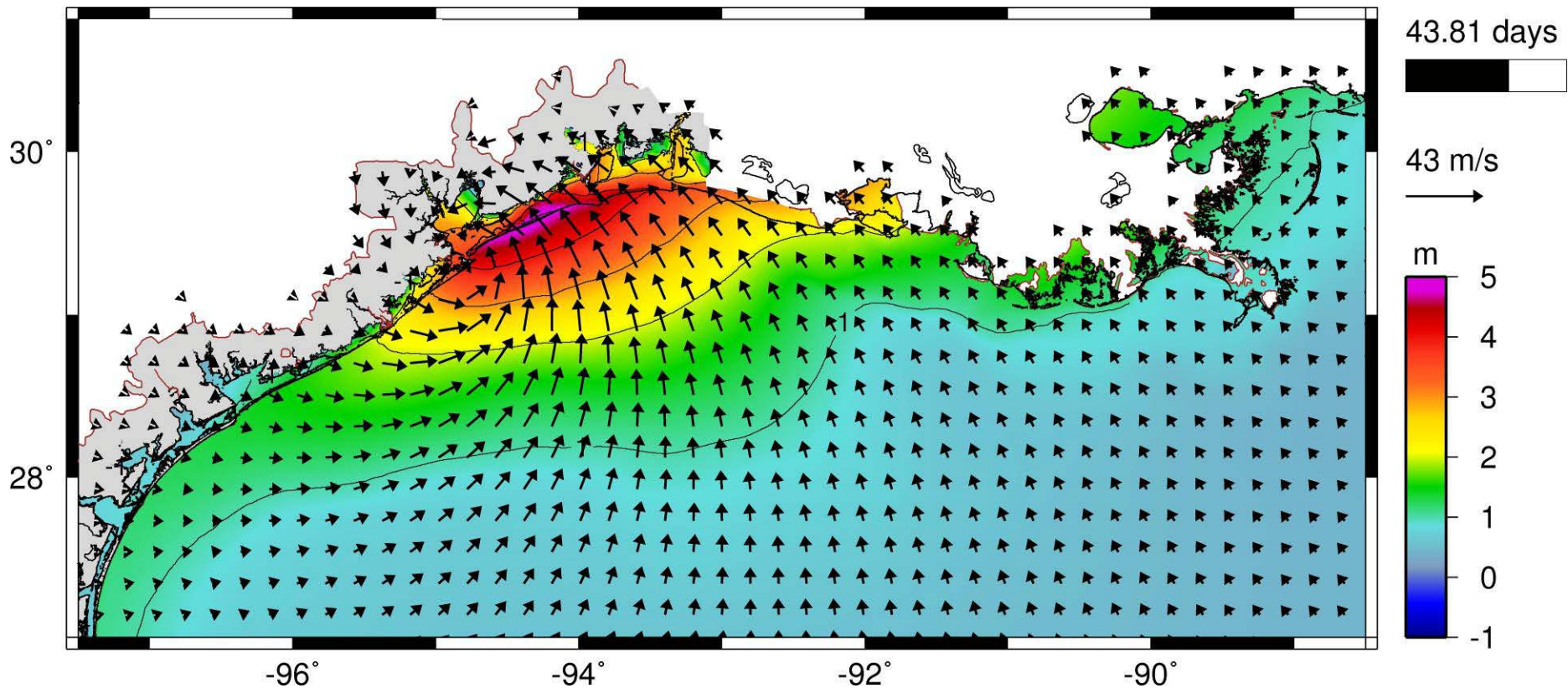
r09 c8+tides Water Surface Elevations + Winds

LANDFALL 0 hrs

Ike surge contours and wind vectors

r09 c8+tides Water Surface Elevations + Winds

+ 6 hrs

Hurricane Ike: Measured Time Series Data

- Water Level
  - CRMS (487)
  - CSI (6)
  - NOAA (40)
  - TCOON (26)
  - UNDKennedy (8)
  - USACE(52)
  - USACE-CHL(6)
  - USGS-PERM (59)
  - USGS-DEPL (105)

- Significant Wave Height
  - CSI (6)
  - NDBC (10)
  - USACE-CHL (6)
  - UND Kennedy (8)

- Mean Wave Direction
  - CSI (6)
  - NDBC (10)

- Mean Wave Period
  - CSI (6)
  - NDBC (10)
  - USACE-CHL (6)

- Peak Wave Period
  - CSI (6)
  - NDBC (10)
  - USACE-CHL (6)
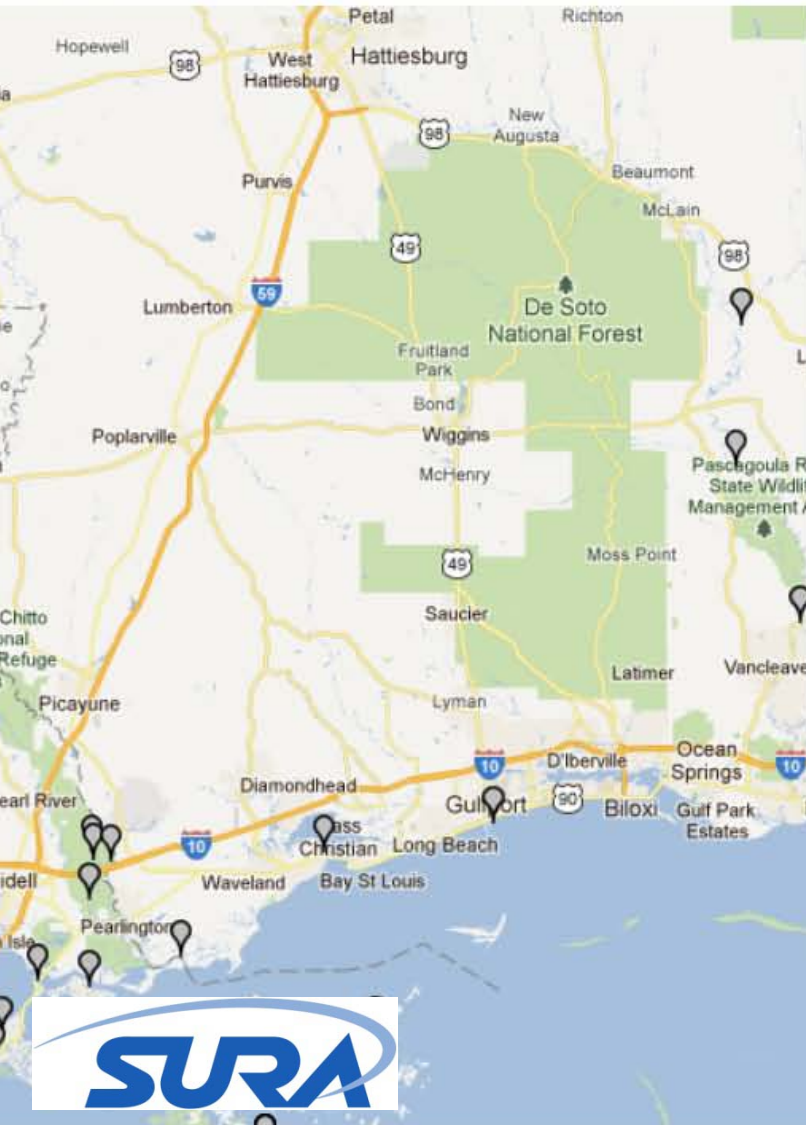 - UND Kennedy (8)

Inter-Model Comparison Hurricane Ike
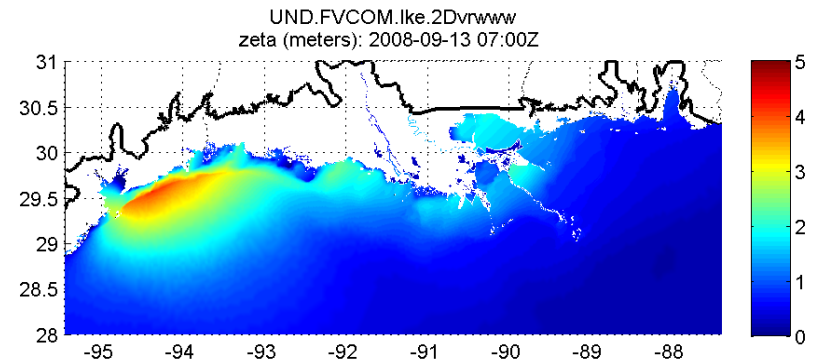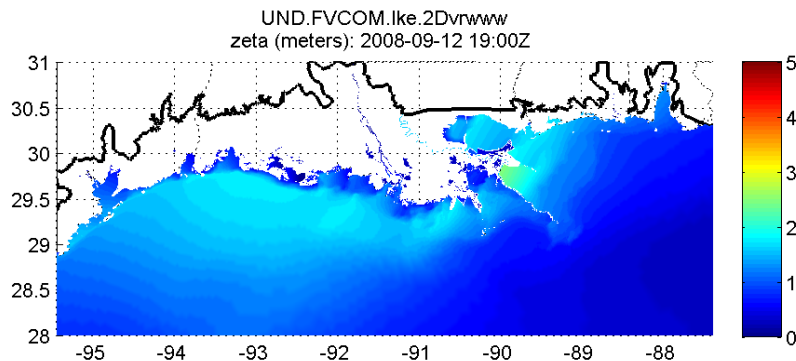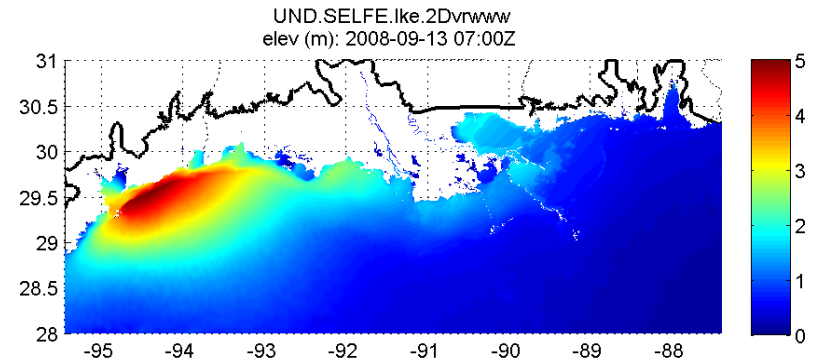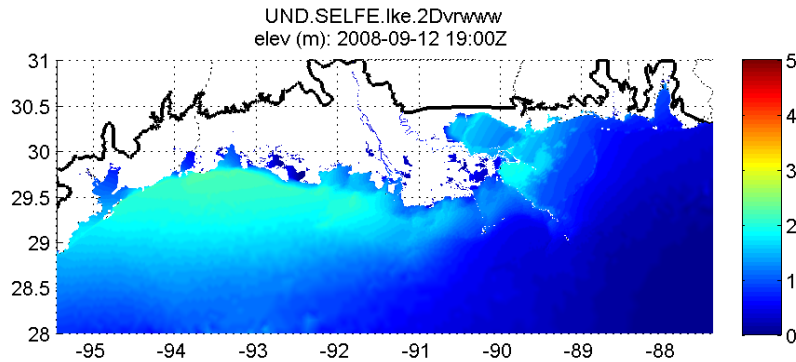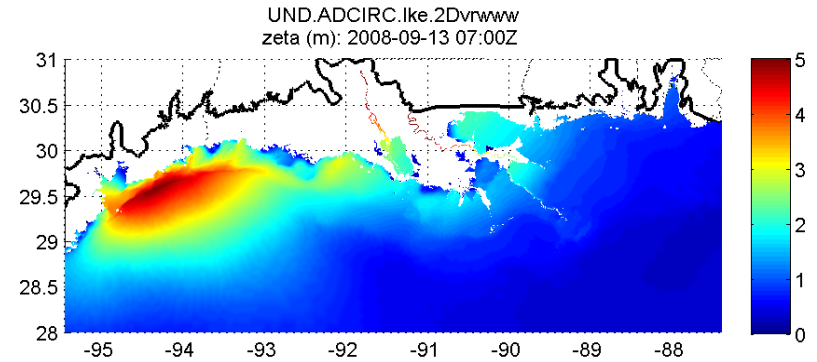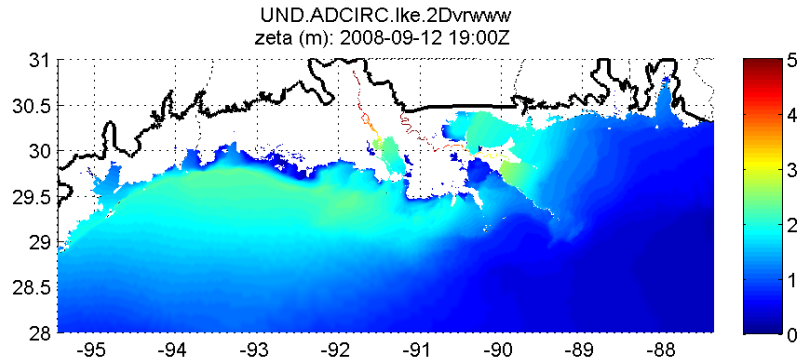
Water Level (m)

Inter-Model Comparison Hurricane Ike
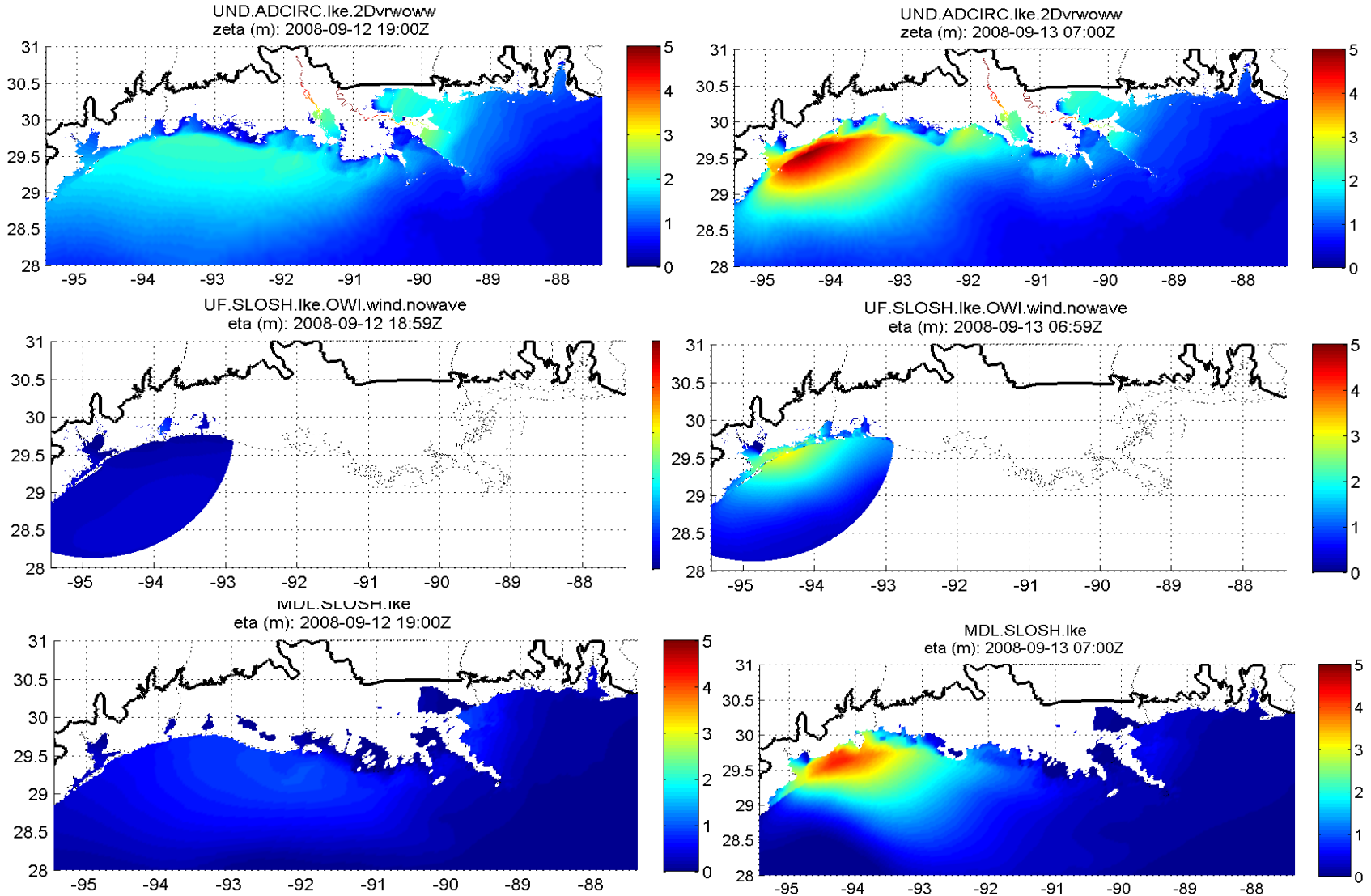
Water Level (m)

Inter-Model Comparison Hurricane Ike
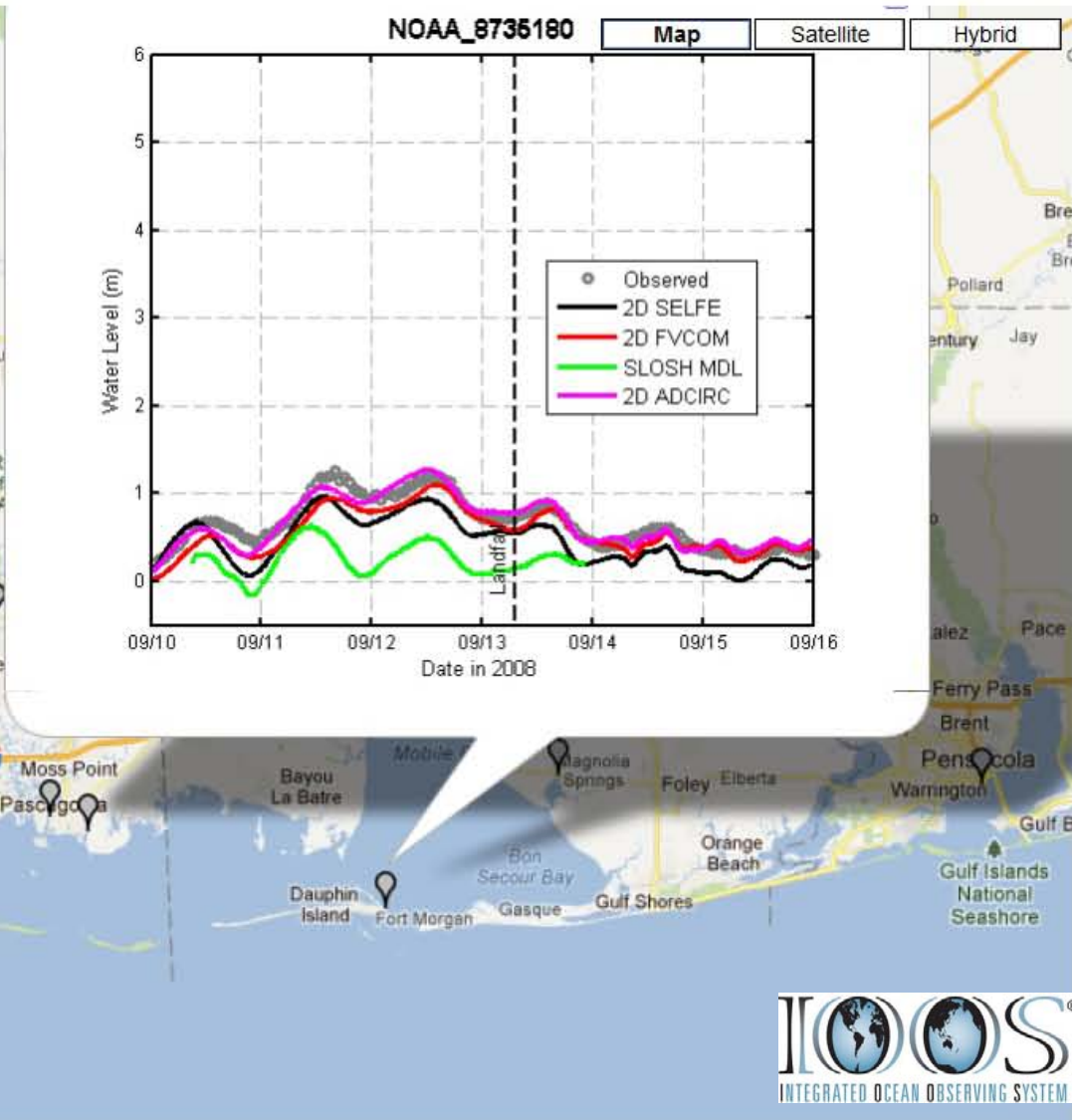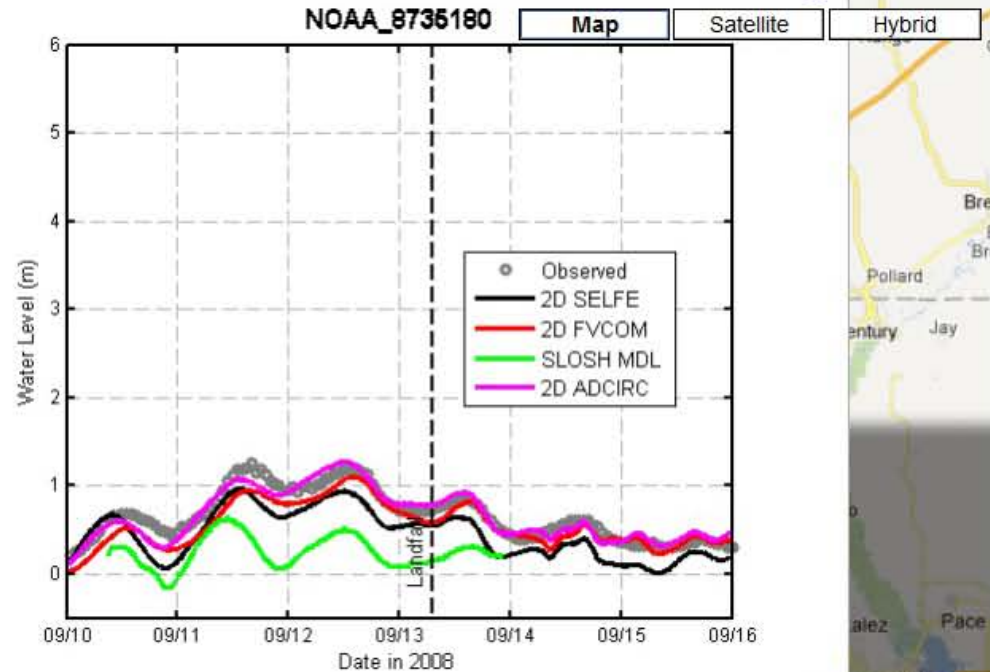
Water Level (m)

Inter-Model Comparison Hurricane Ike

Water Level (m)

Inter-Grid Comparison Hurricane Ike

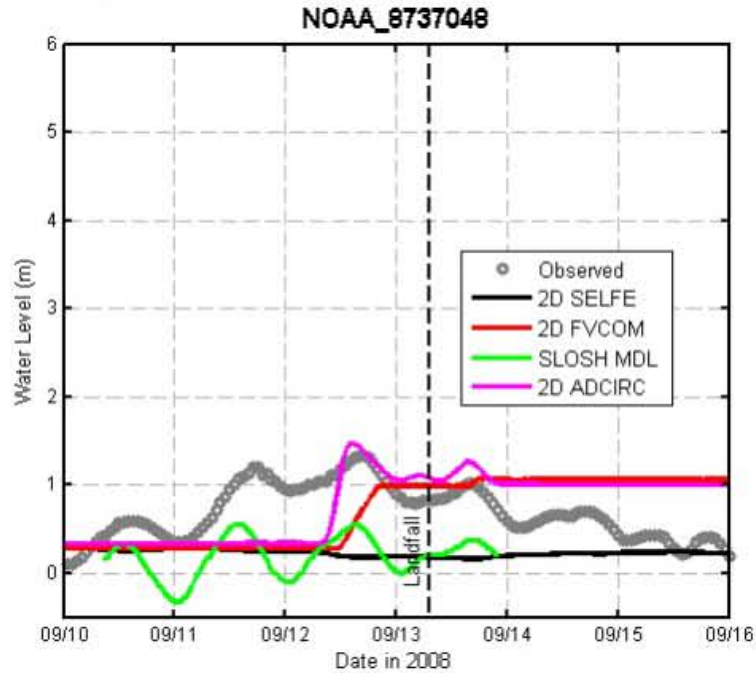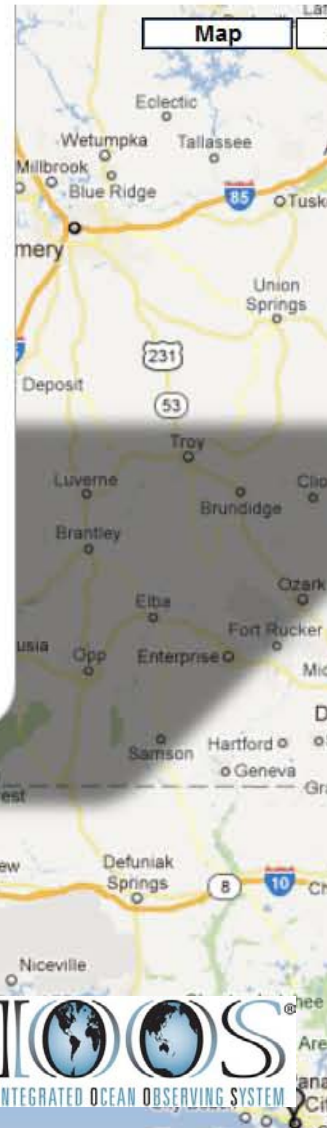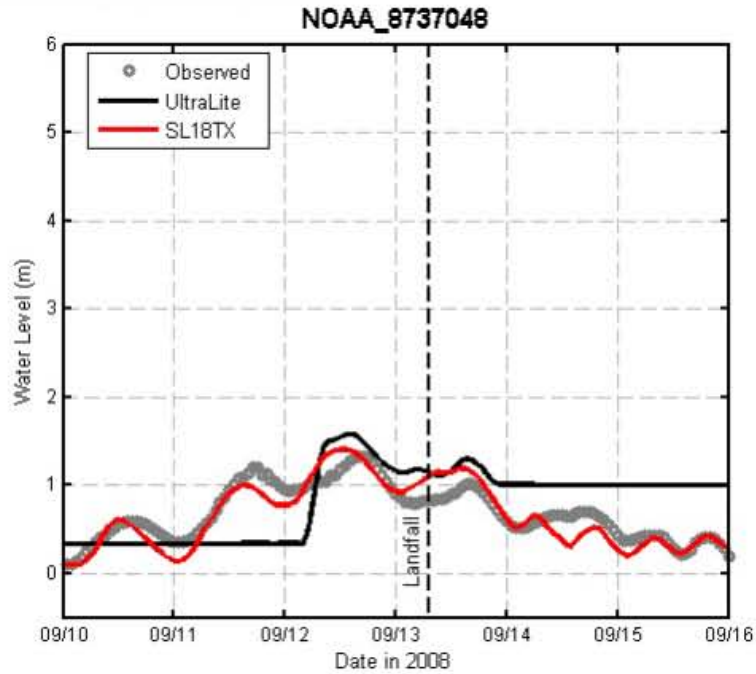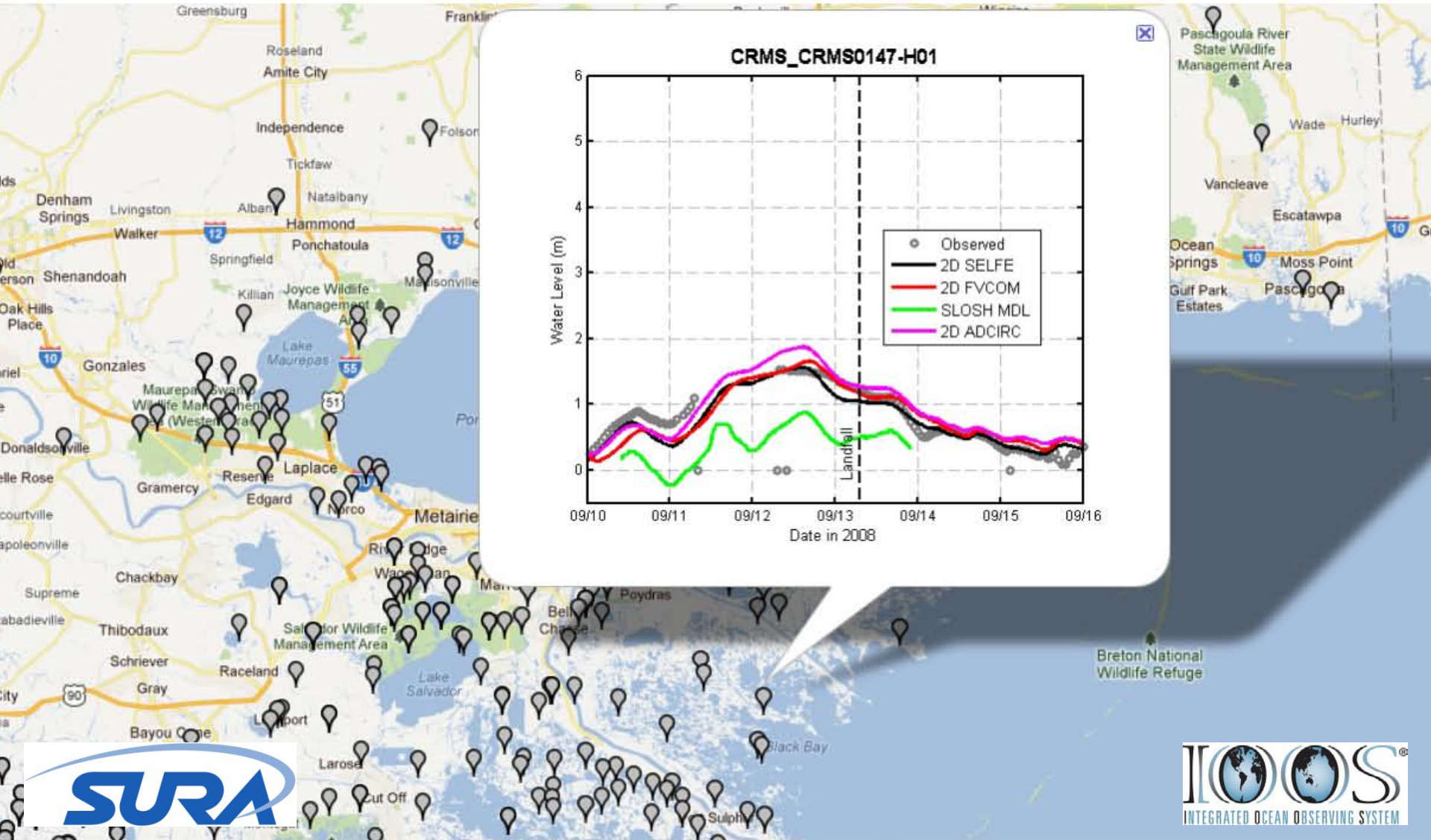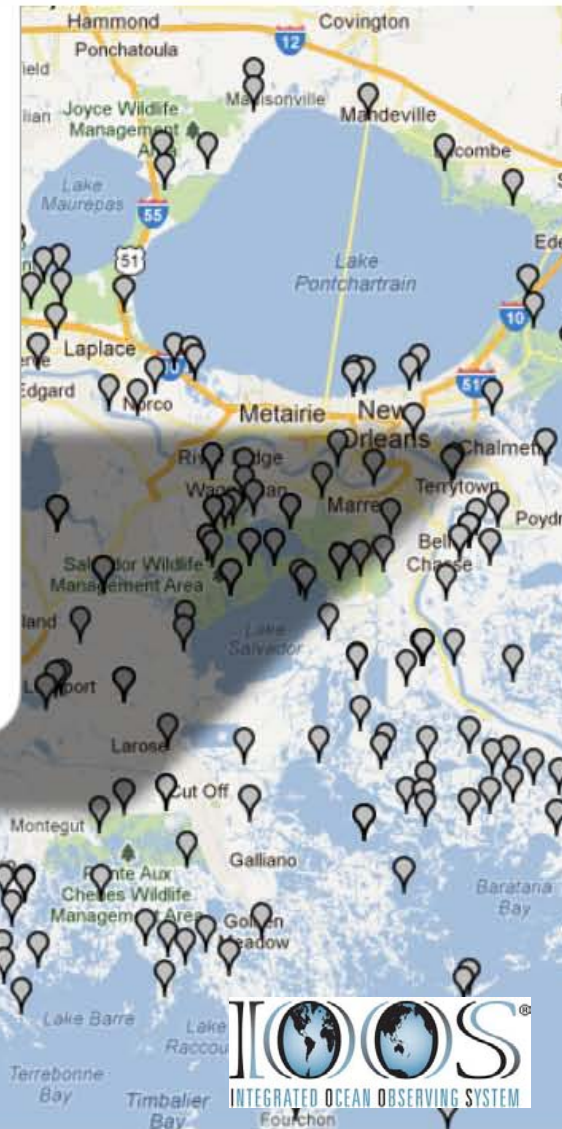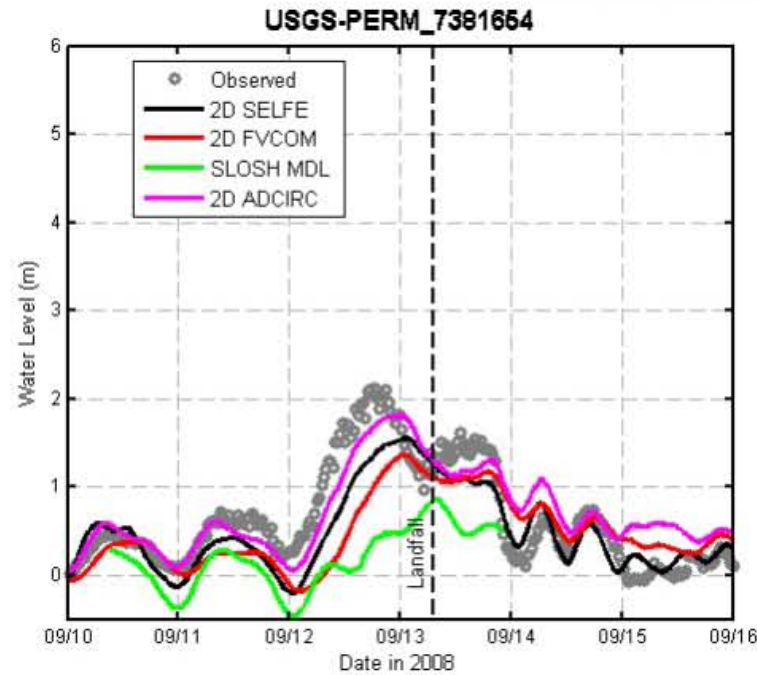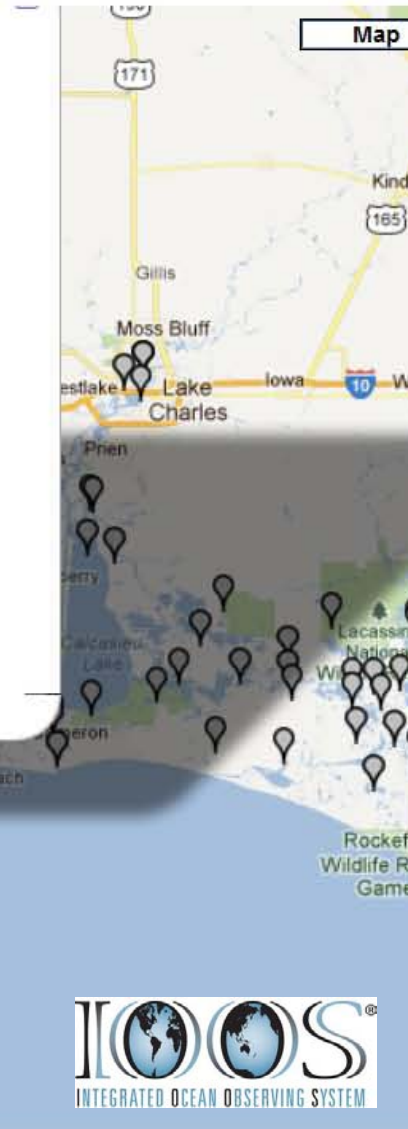## Water Level (m)
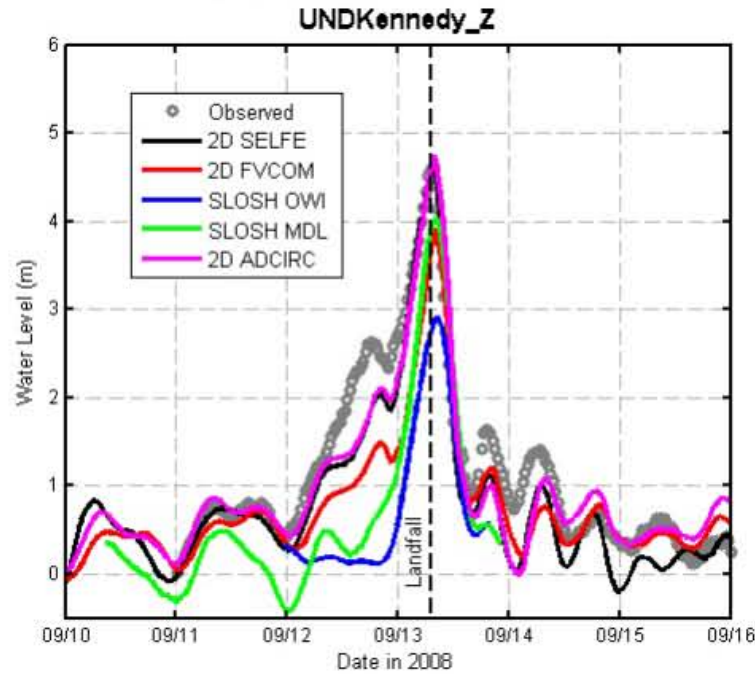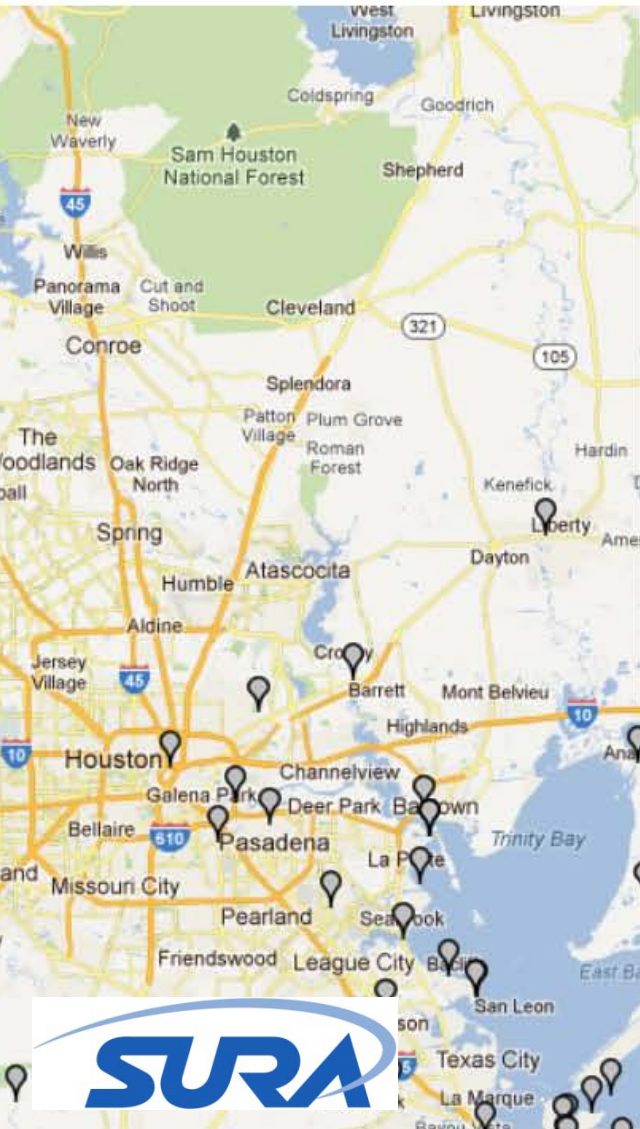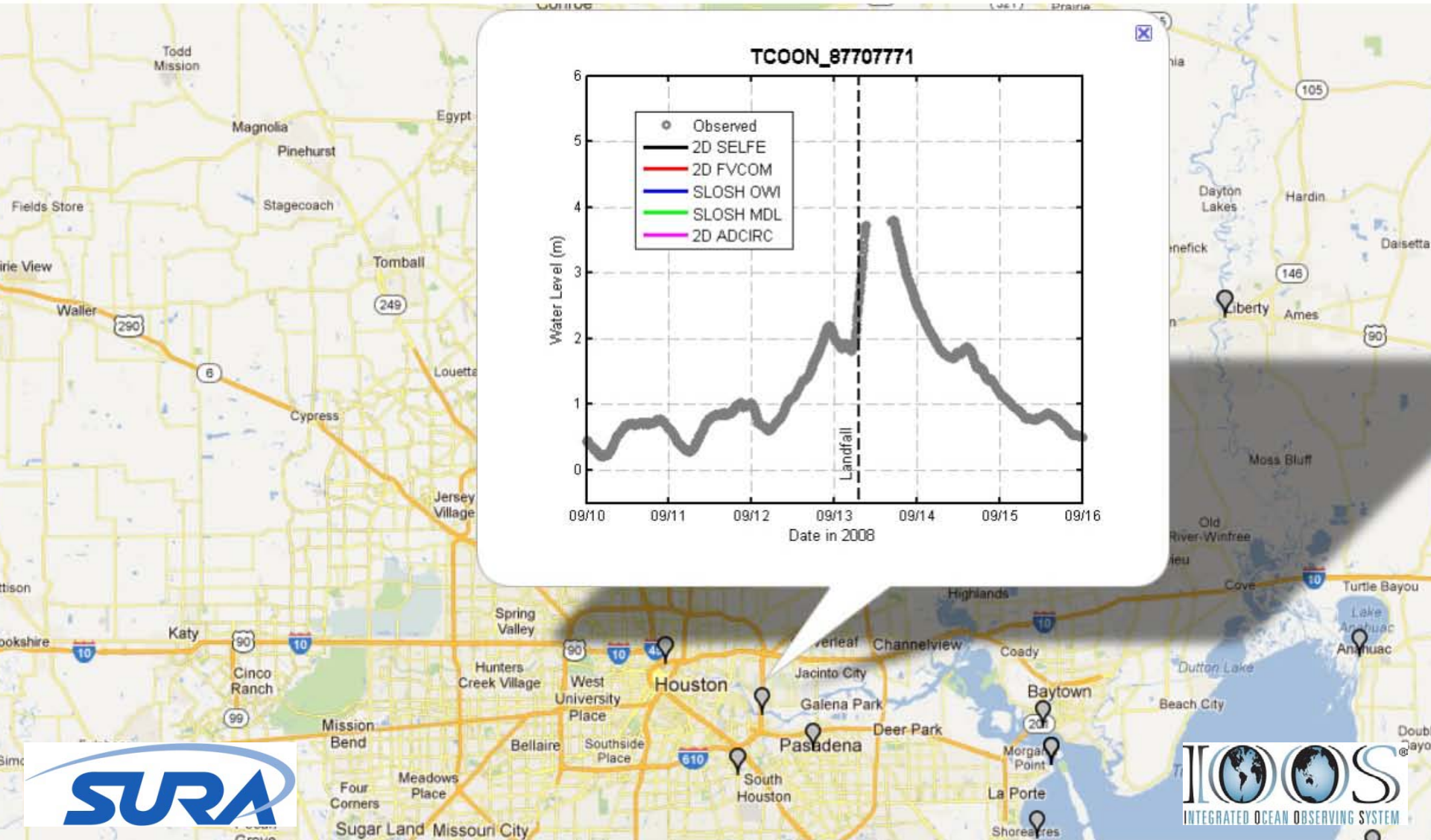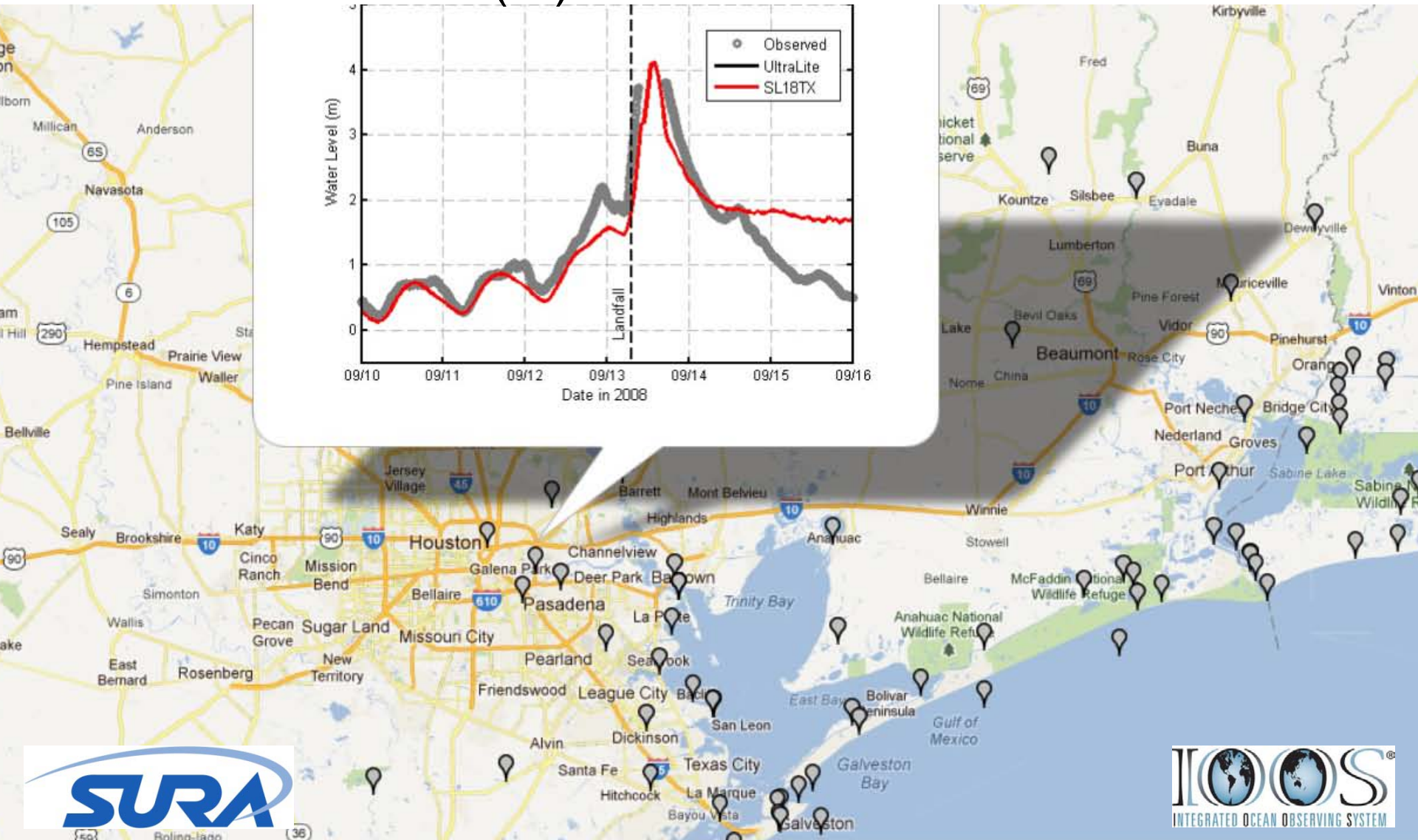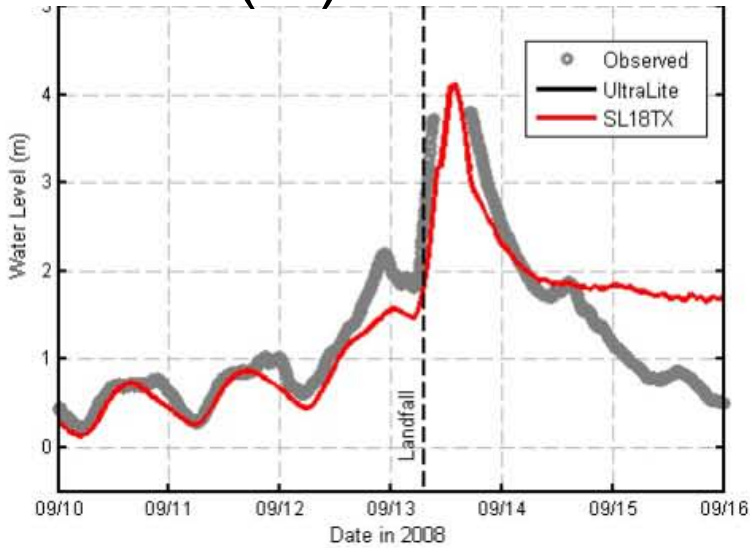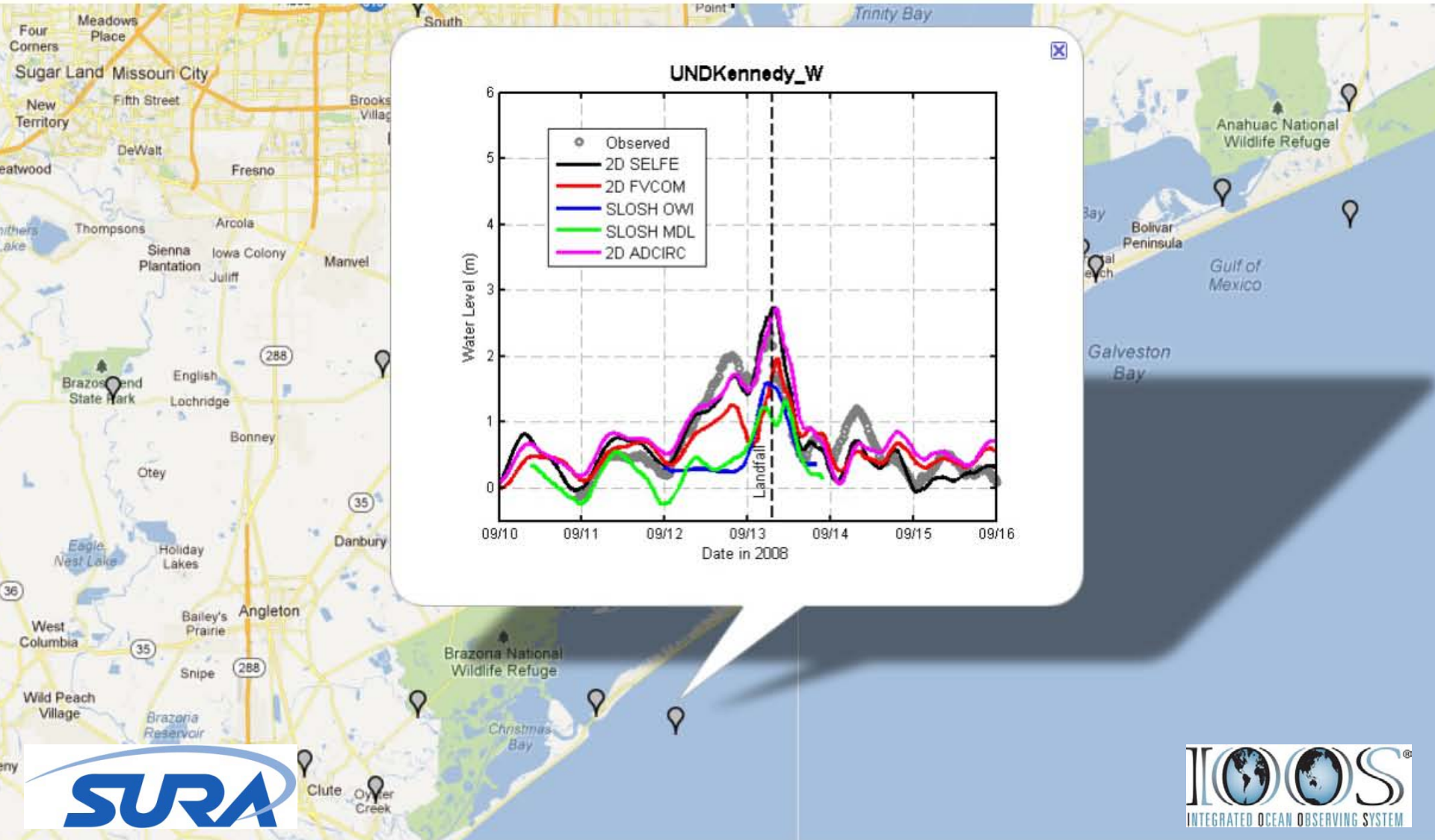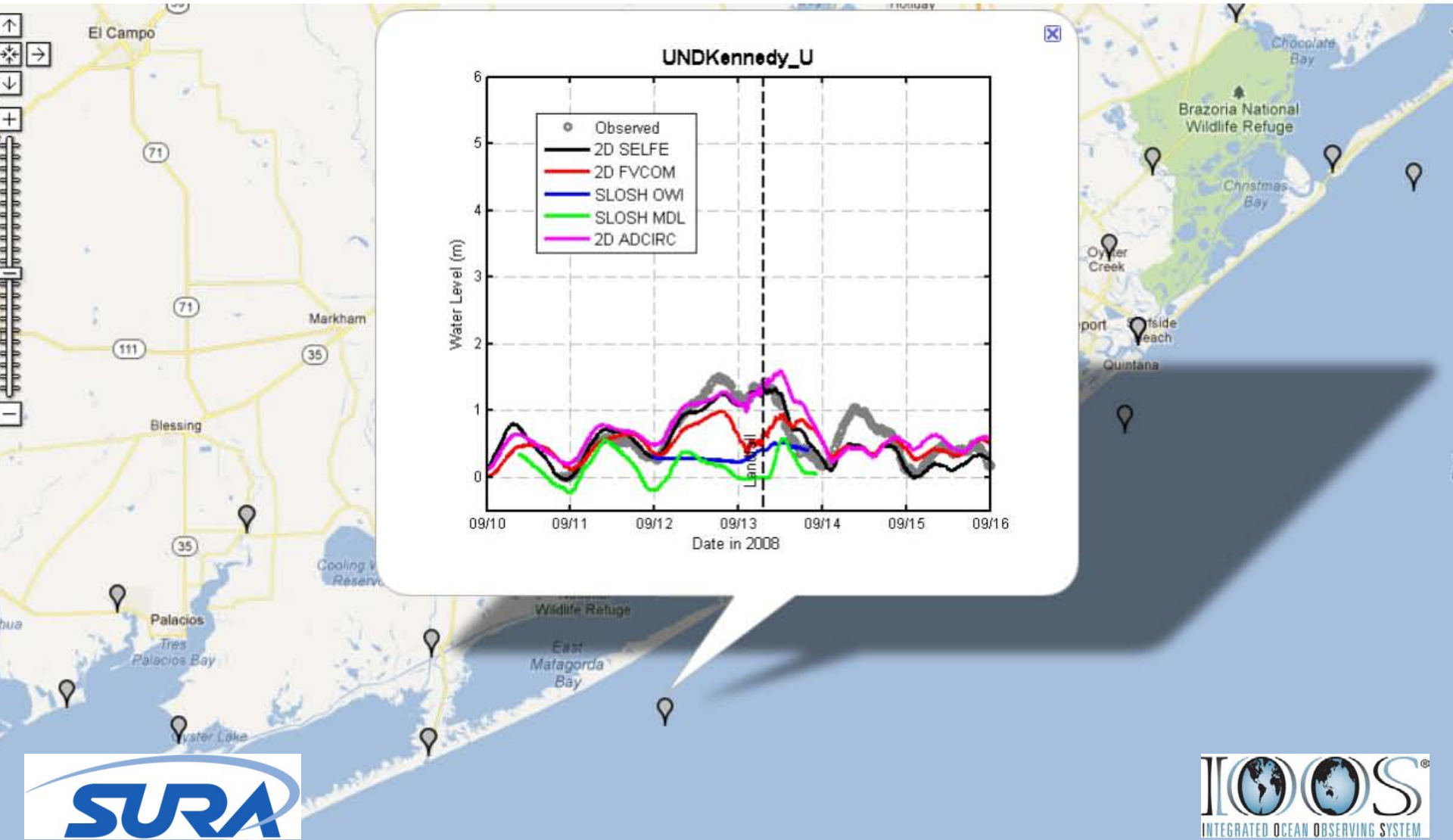
Inter-Model Comparison Hurricane Ike

Water Level (m)
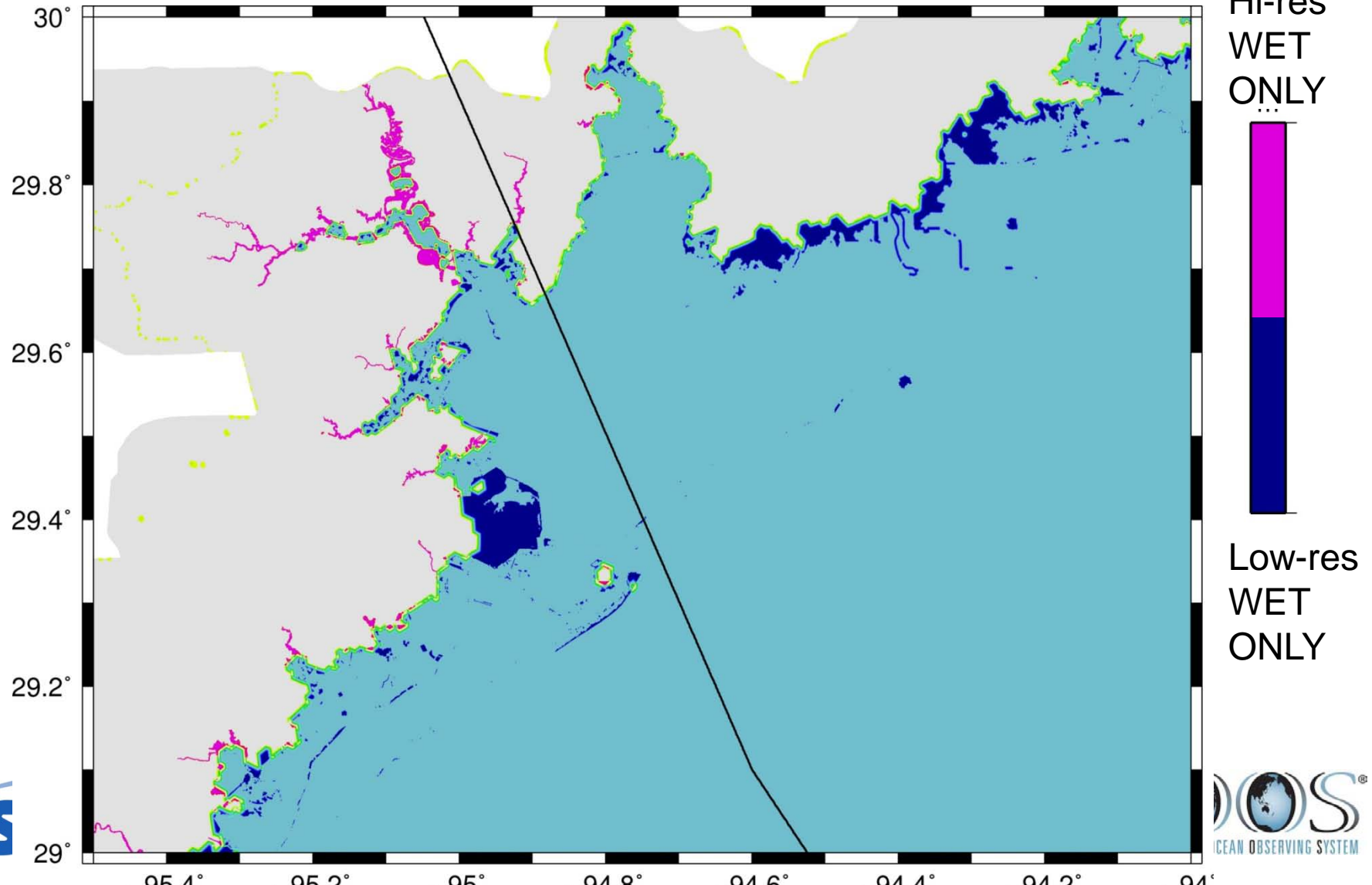
Water Level (m)

Inter-Model Comparison Hurricane Ike

Water Level (m)

Water Level (m)

Water Level (m)

Water Level (m)

Inter-Model Comparison Hurricane Ike

Water Level (m)

Water Level (m)

Hurricane Rita (2005)

Inter-Model Comparison Hurricane Rita
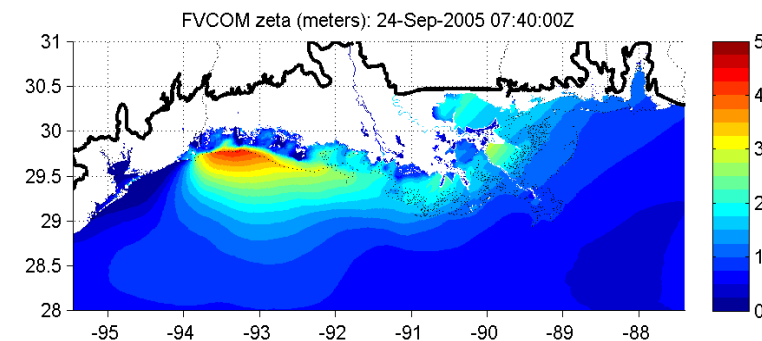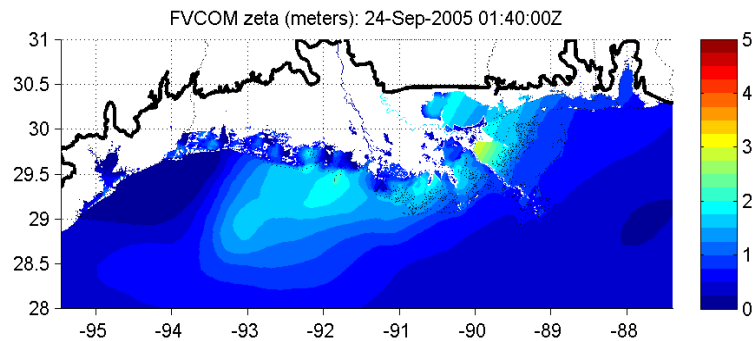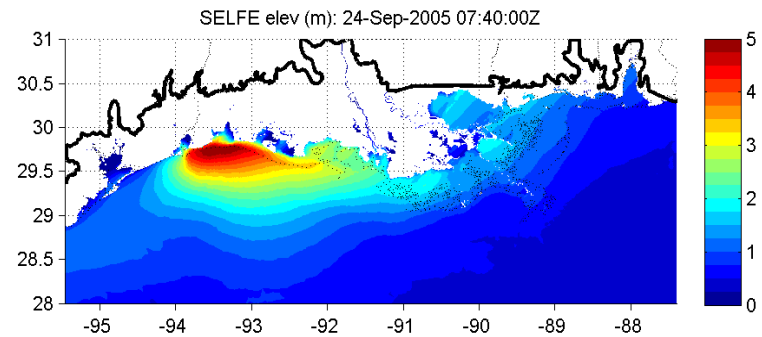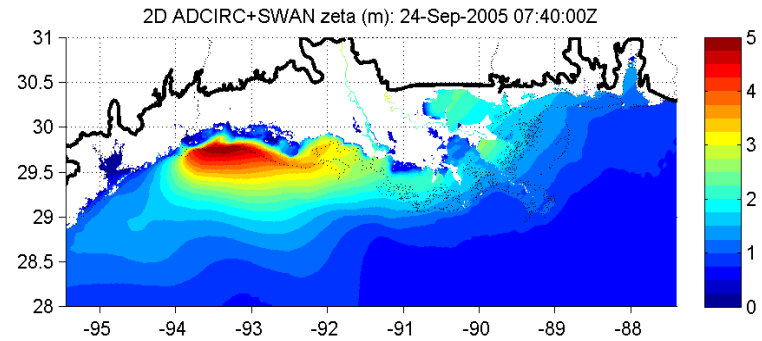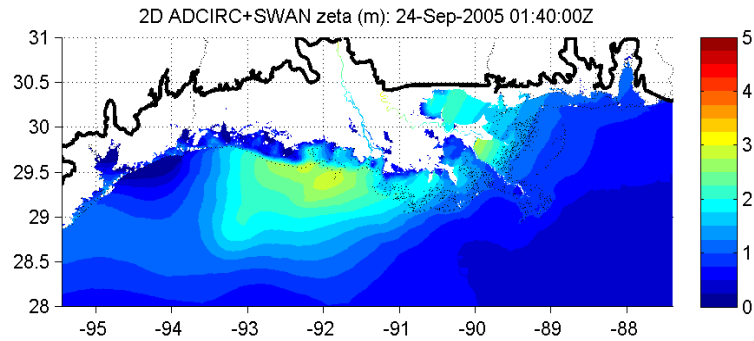
Water Level (m)

Inter-Model Comparison Hurricane Rita

Water Level (m)
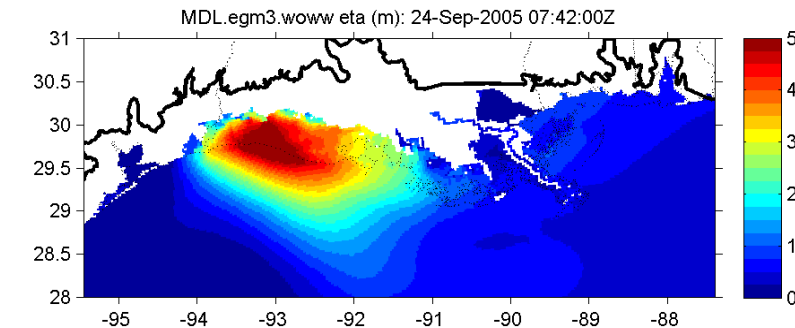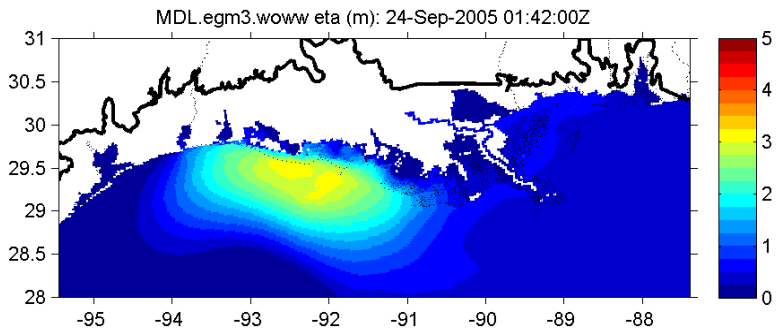
Conclusions – Hurricane Wind Waves
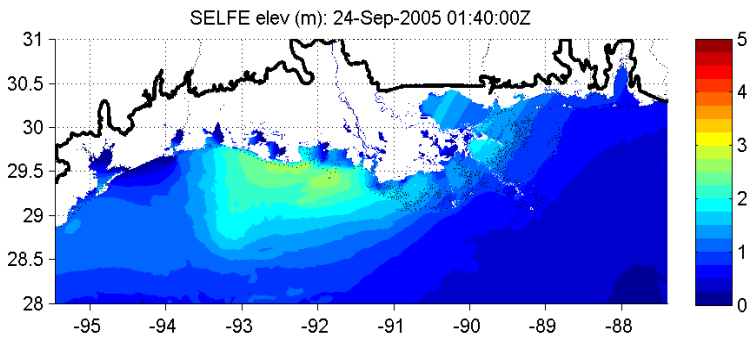
- In general, the base resolution grid performs quite well for open water and near shore waves.

- Inland locations will require more detailed resolution to better capture propagation and feature driven depth limited breaking and attenuation

Conclusions – Hurricane Storm Surge

- ADCIRC and SELFE perform about the same on base resolution grids, capturing hurricane forerunner, peak surge near the track and away from the track and continental shelf waves
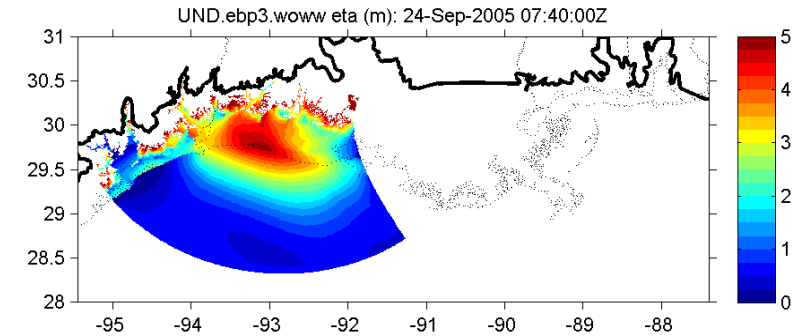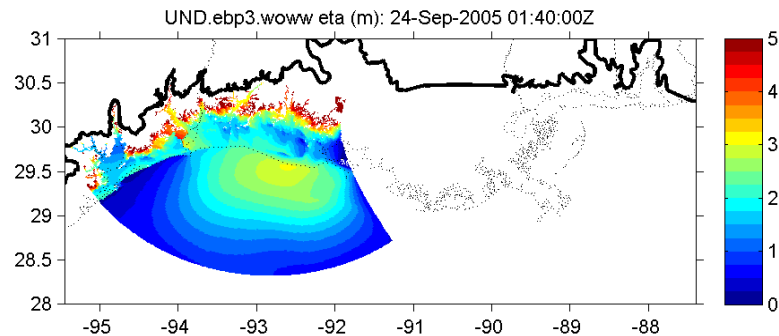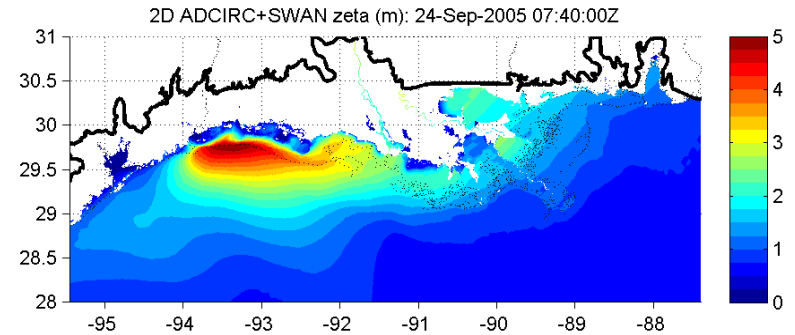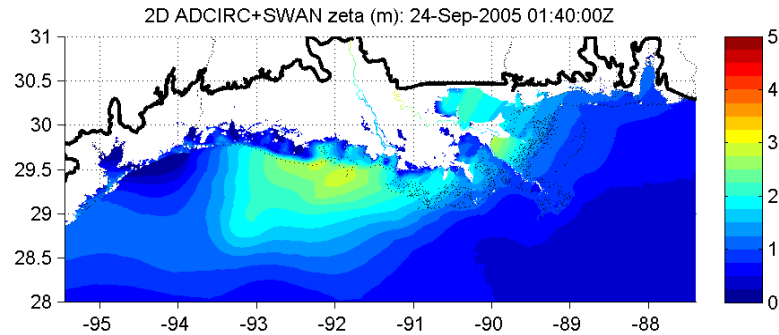
- FVCOM is more damped than ADCIRC and SELFE

- SLOSH does not predict forerunner, continental shelf waves or surge away from the track for Ike

- SLOSH appears to over inundate for Rita

Conclusions – Hurricane Storm Surge

- For high levels of inundation, the base resolution grids perform well

- For surge in rivers and through narrow inlets, high resolution is again necessary and improves overall model skill

- For low energy surge, geometric details become very important and high resolution inland is again essential

- 3D physics does not show systematic improvement over 2D physics

SURA

IOOS
INTEGRATED OCEAN OBSERVING SYSTEM