Modeling 3D circulation in the Choctawhatchee Bay and River System

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CARTHE CONSORTIUM for ADVANCED RESEARCH on TRANSPORT of HYDROCARBON in the ENVIRONMENT

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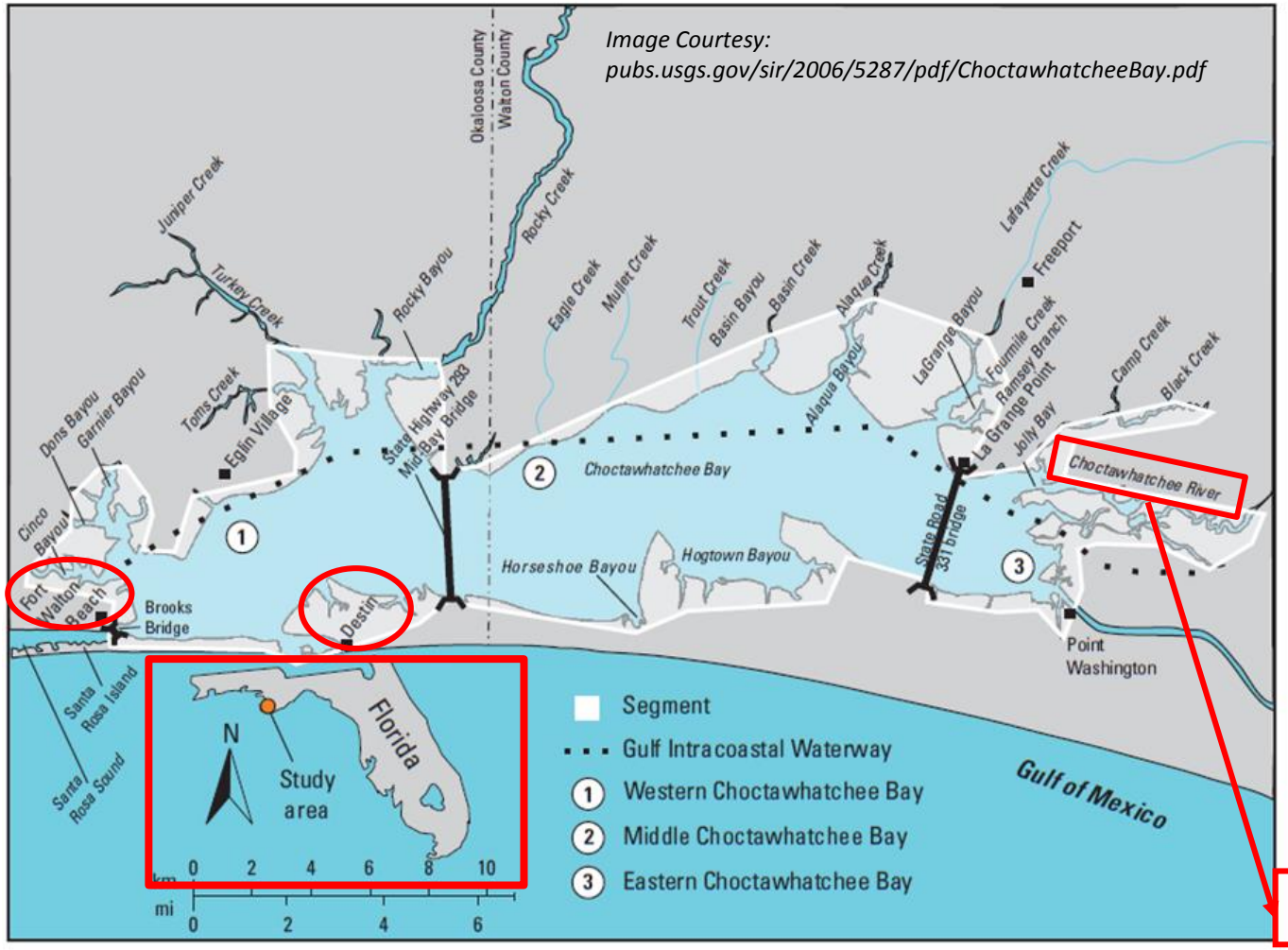
Study Area: Choctawhatchee Bay and River System

" An estuary is a semi-enclosed coastal body of water which has free connection to the open sea and within which sea water is measurably diluted with fresh water derived from land drainage." (Cameron and Pritchard 1993)

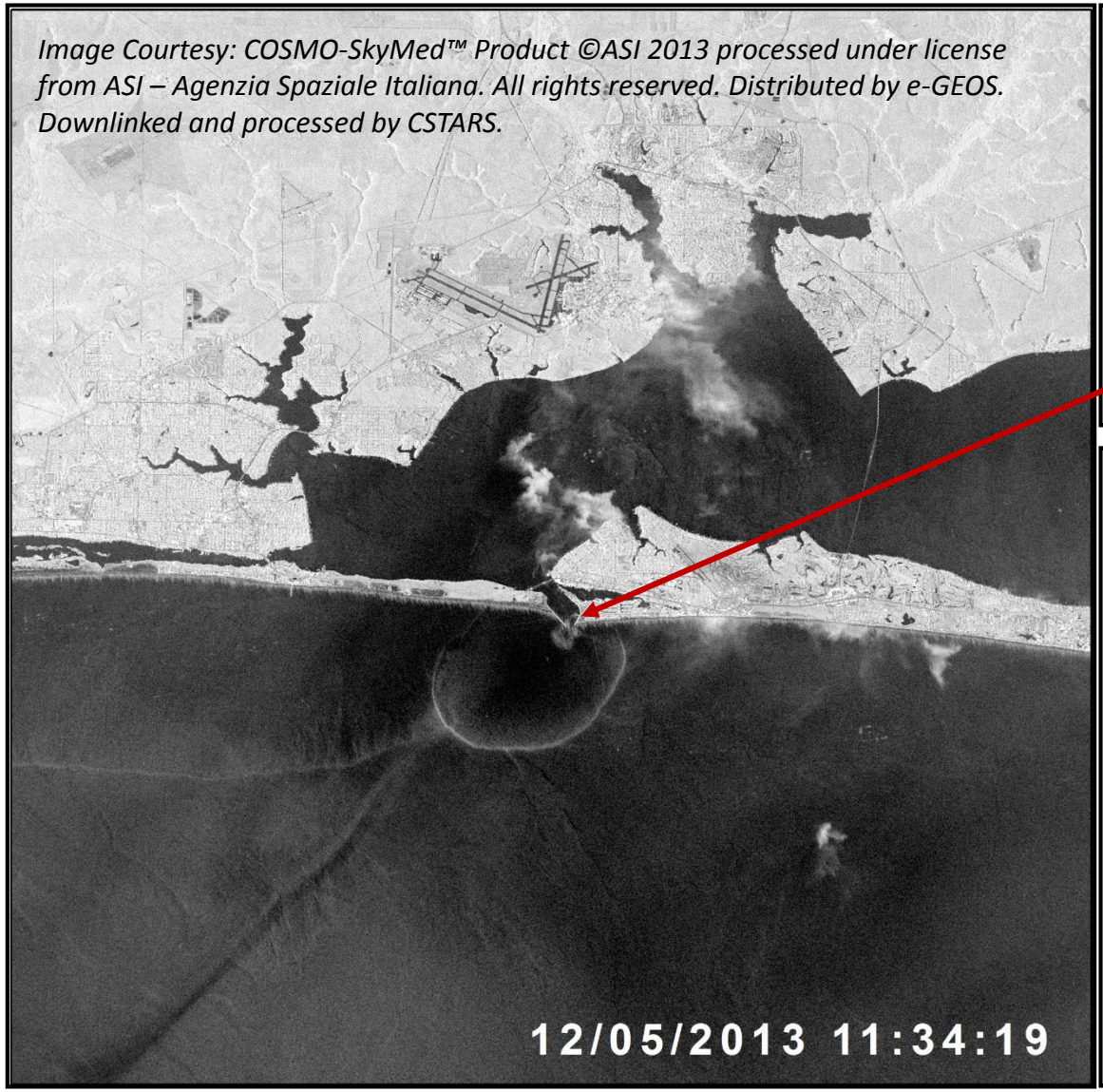


CARTHE CONSORTIUM for ADVANCED RESEARCH on TRANSPORT of HYDROCARBON in the ENVIRONMENT

- Series of experiments performed by **CARTHE** scientists in December 2013 to study **near-shore oil transport characteristics**
- **Surfzone Coastal Oil Pathways Experiment (SCOPE)**

Annual mean river discharge is ~240 m^3/s

SCOPE – Satellite Imagery



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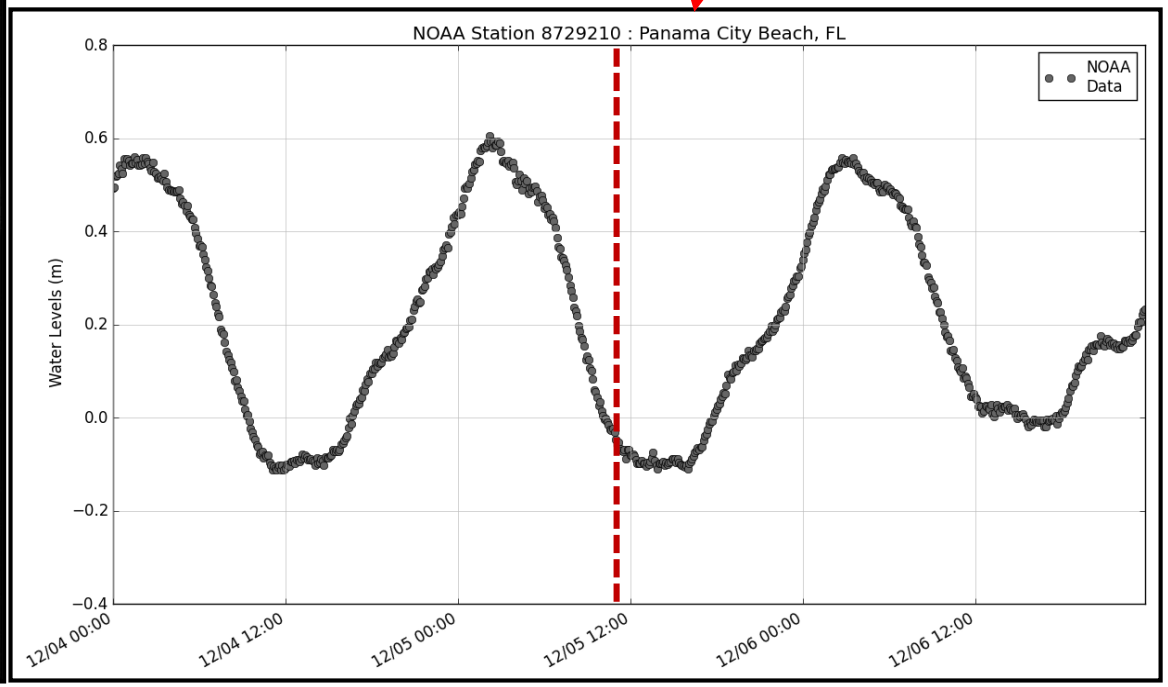
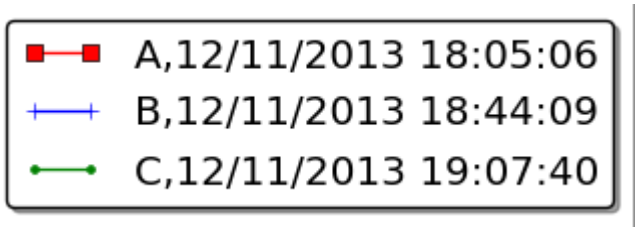
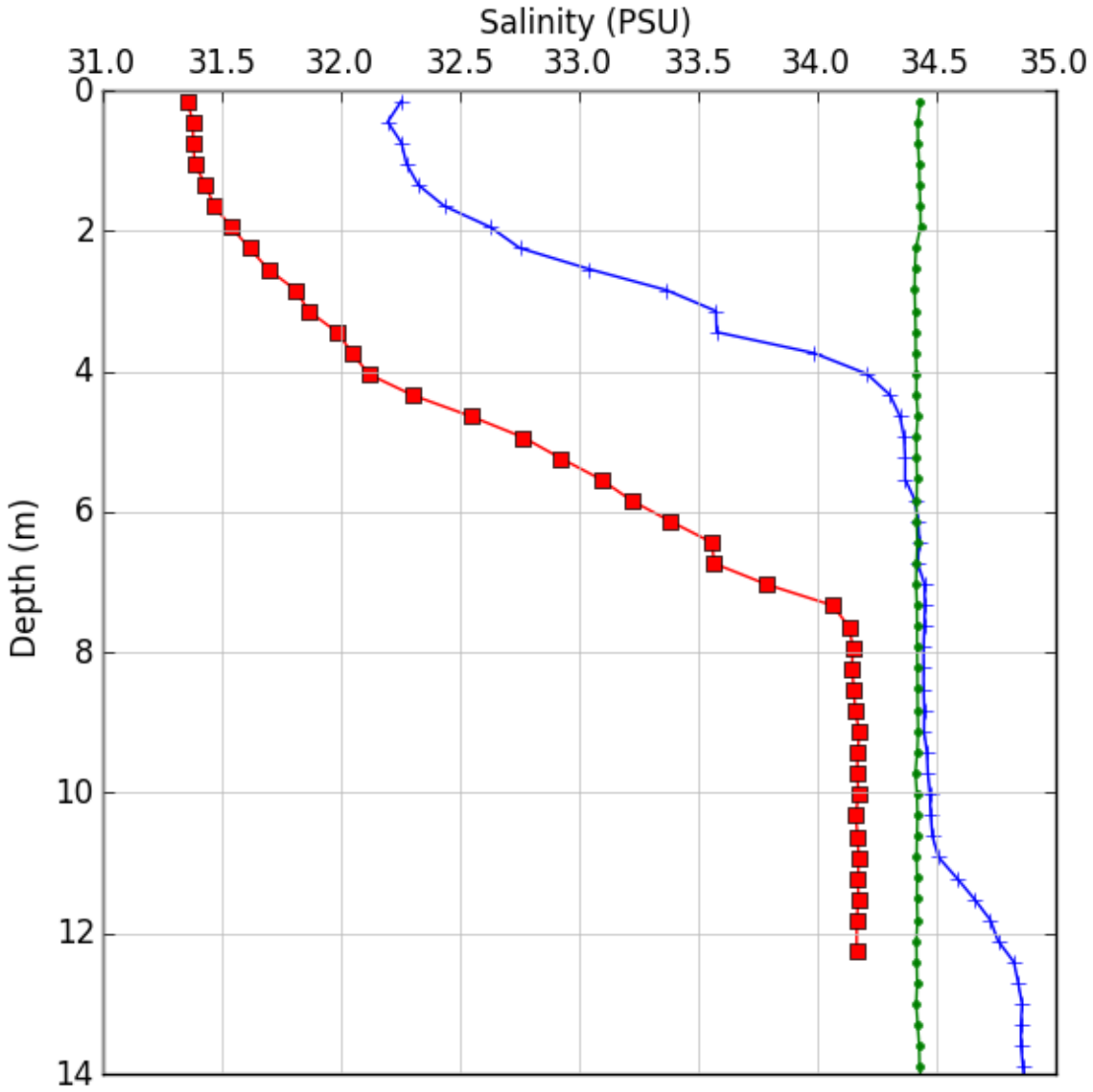


SCOPE – CTD Profiles





Research Objectives

- To **explore available experimental data** to understand the hydrodynamics within Choctawhatchee Bay and the behavior of the near-shore ocean currents in the vicinity of the bay

- To **develop barotropic and baroclinic modeling capabilities** to predict the 3D flow characteristics within the Bay and in the near-shore region
  - Starting with barotropic modeling using ADCIRC (2DDI and 3D)
  - Future work: Implementing ADCIRC 3D baroclinic

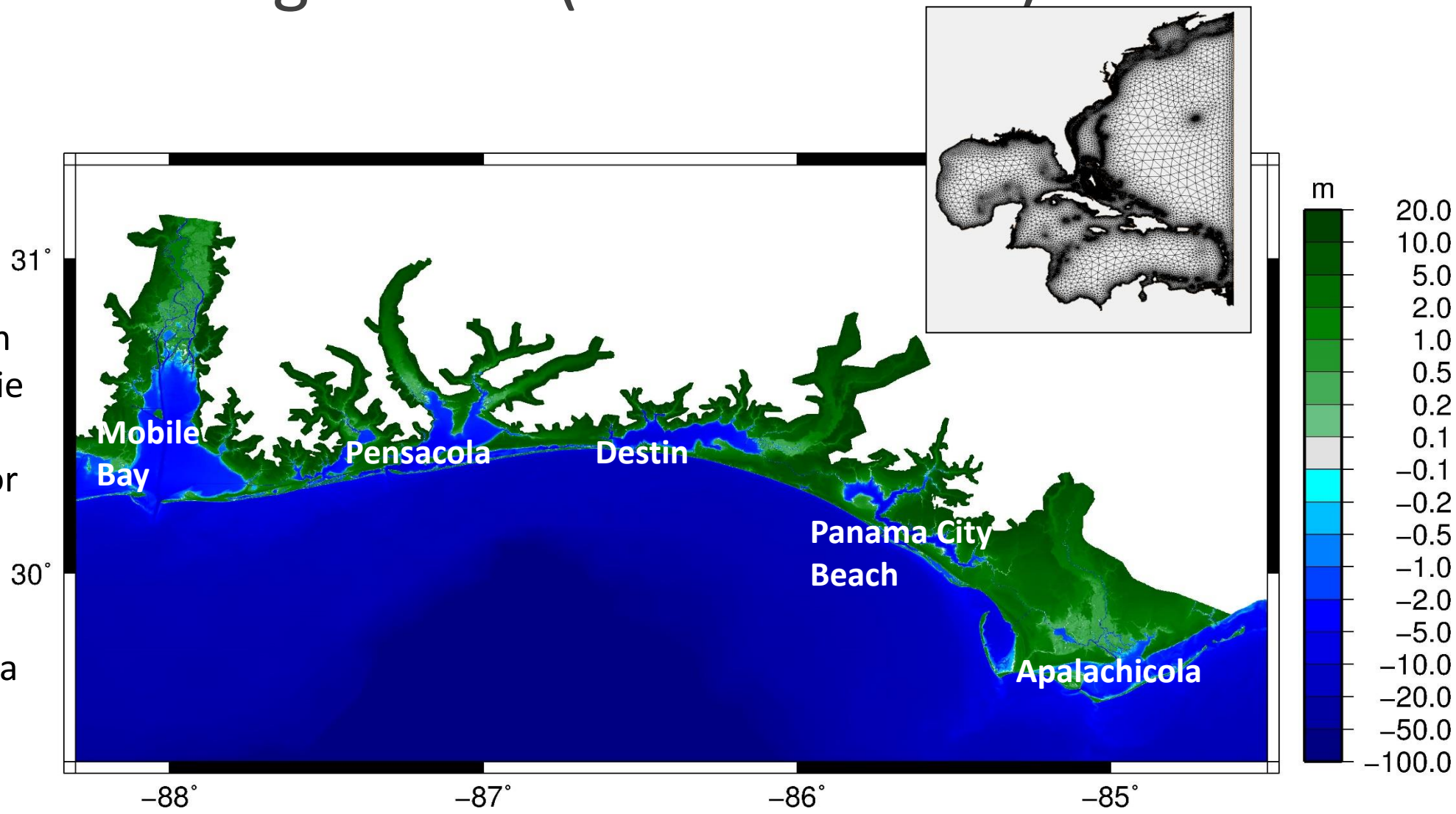
- To **model the influence of the incoming freshwater discharge from Choctawhatchee River** on the 3D flow characteristics within the bay
  - Starting with adding resolution to an existing ADCIRC mesh along the Choctawhatchee River
  - Future work: Implementing river boundary condition and modeling incoming freshwater discharge into the bay

- To **model the spatial extent and behavior of the freshwater plume** coming out through the inlet and its interaction with the shelf waters during the ebb phase

Modeling efforts (FLPHv.3 mesh)

Florida Panhandle v3 Mesh

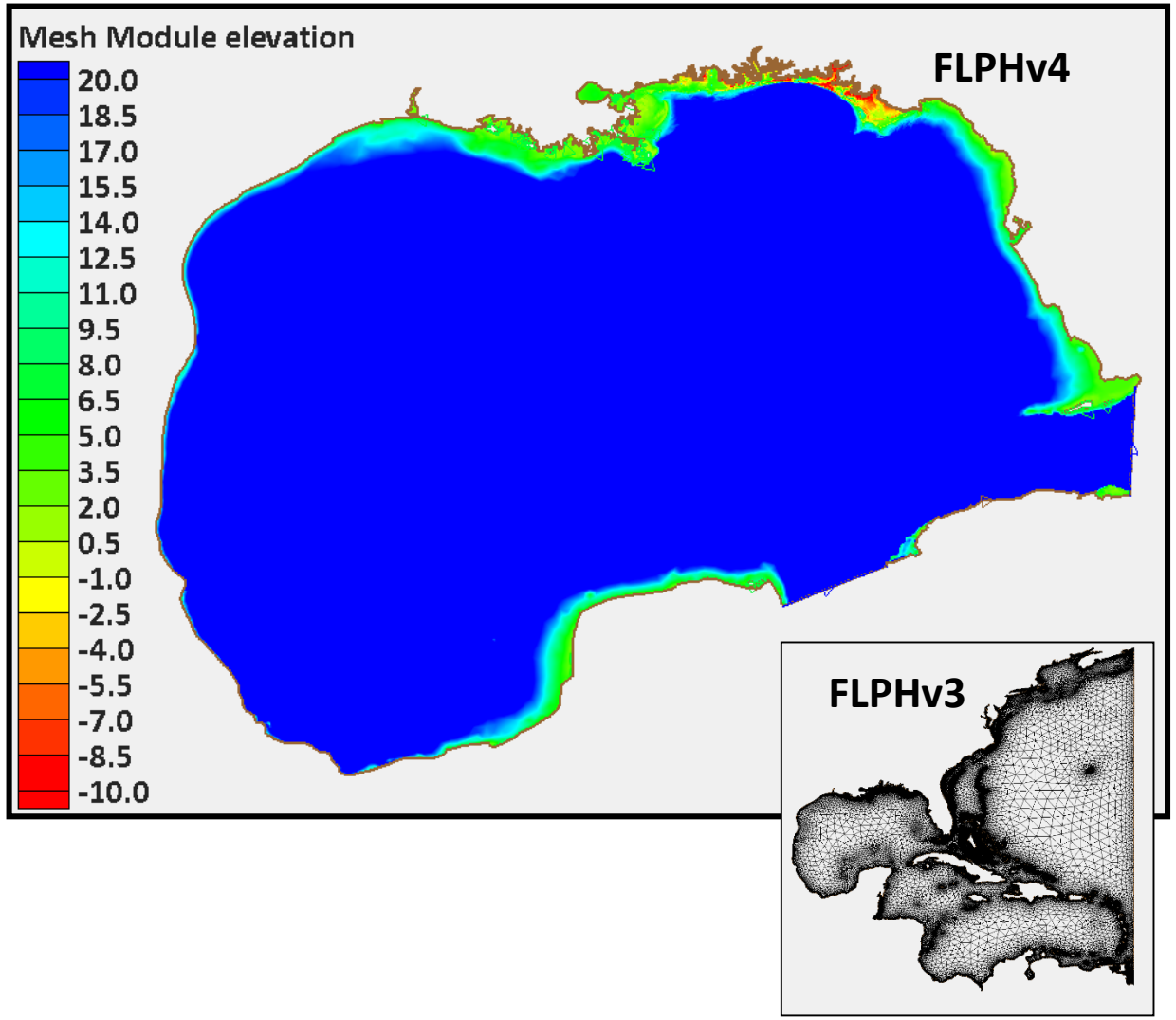
- Roughly 2 million nodes
  - Obtained from Dr. Scott Hagen and Matt Bilskie at LSU
- Used extensively for storm surge modeling and developing flood maps for the Florida Panhandle region



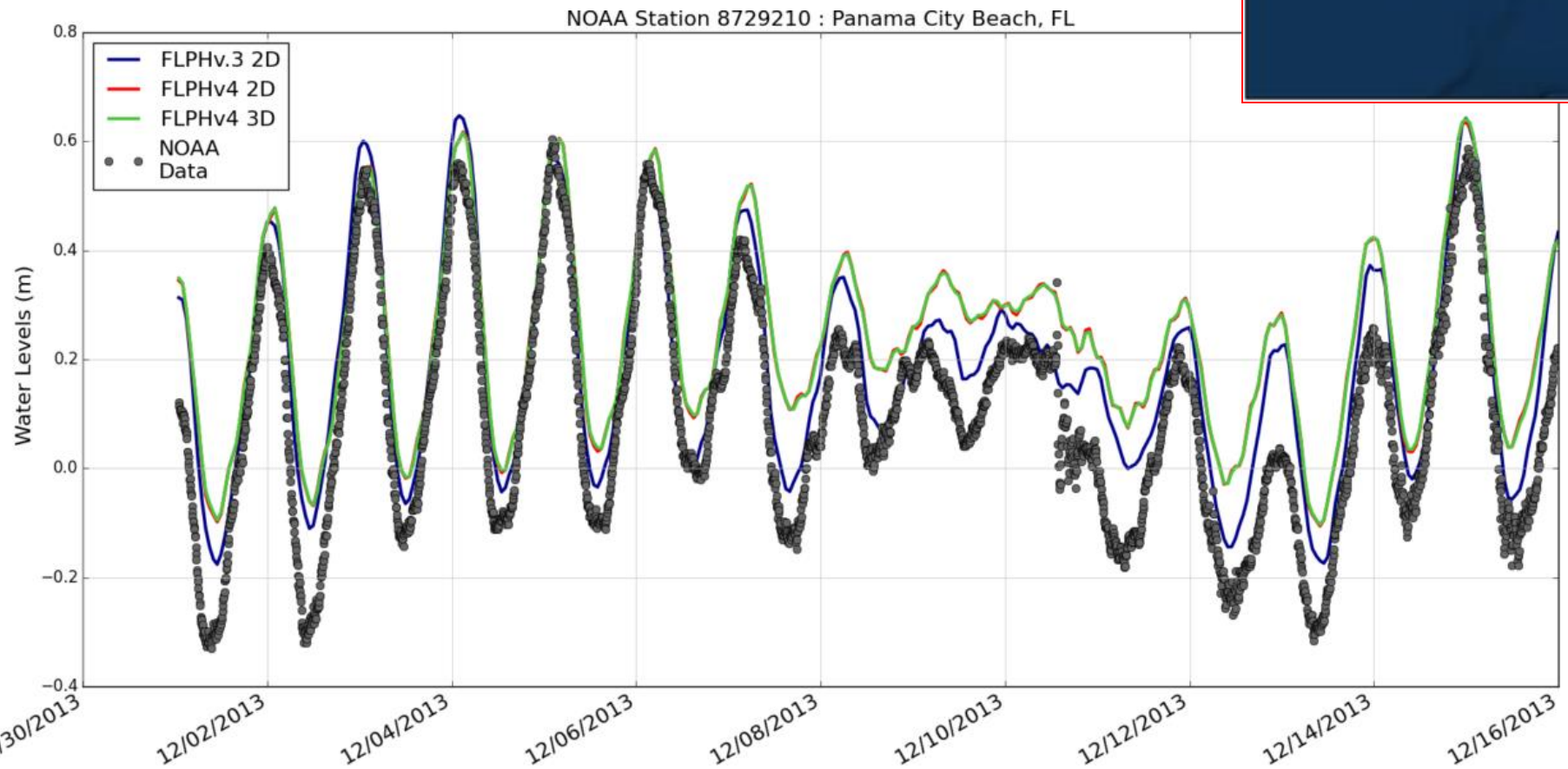
Modeling efforts using FLPHv3/v4

- The simulation period was chosen to align with the timing of the SCOPE experiment
  - 0 – 45 days from Nov 1 – Dec 15, 2013

- **FLPHv4 mesh – created from FLPHv3 by**
  - Cutting the FLPHv3 mesh at Gulf of Mexico
  - Removing a portion of the Mobile Bay
  - Increasing the resolution along the Choctawhatchee River in the FLPHv3 mesh
    - bathymetry along the river was interpolated from FLPHv3 mesh and do not reflect the true channel depths

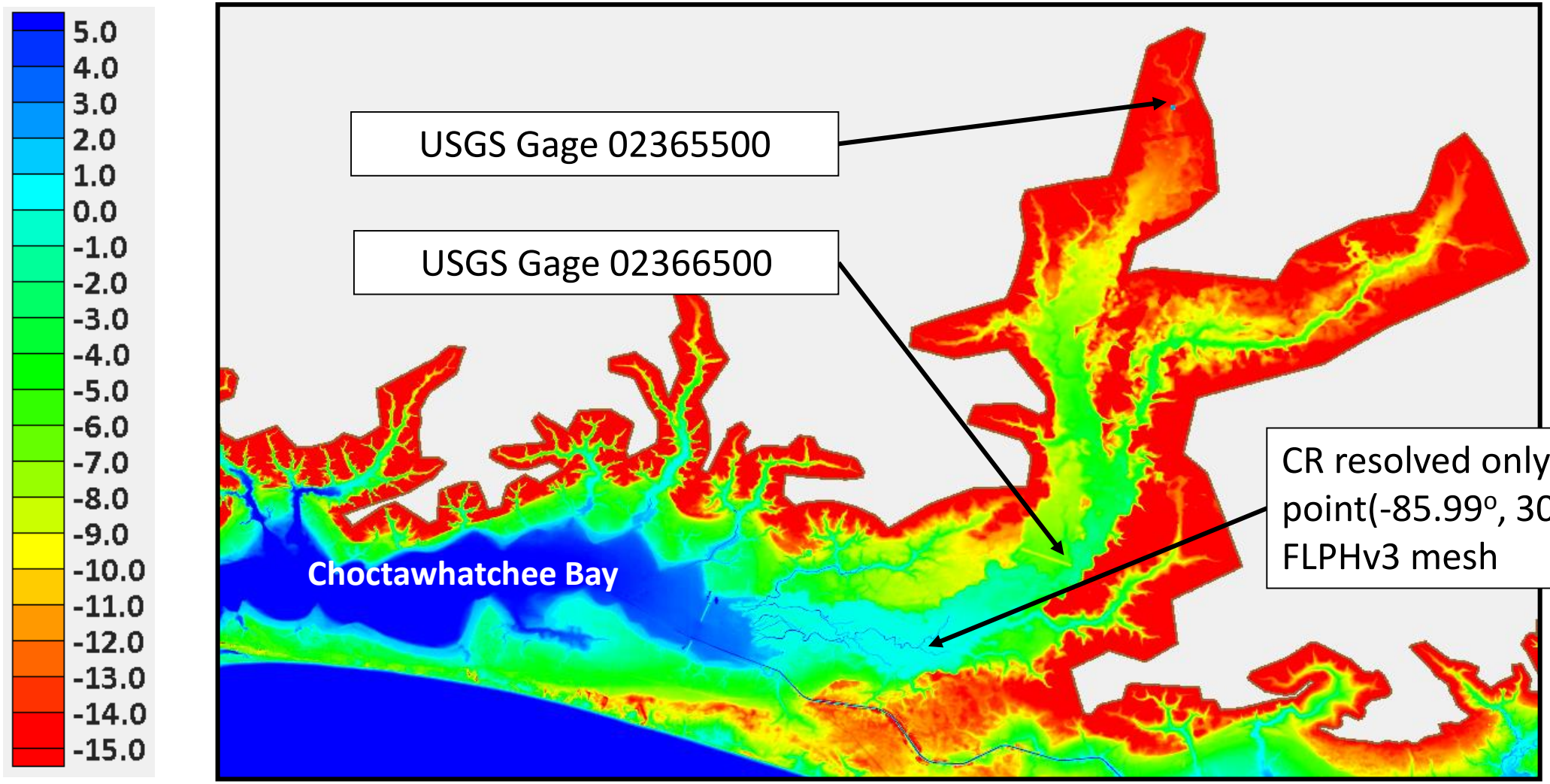


ADCIRC 2D/3D on FLPHv4 mesh



Mesh Refinement to resolve Choctawhatchee River (CR)

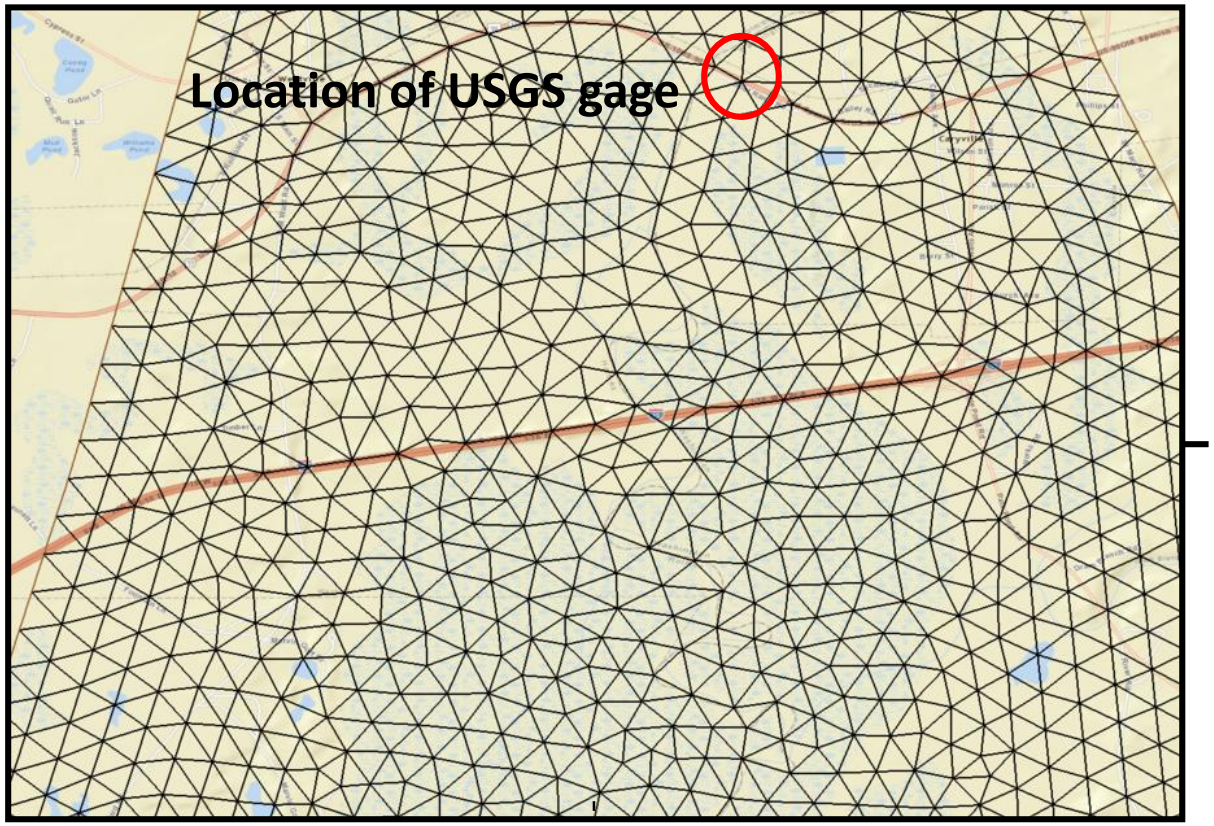
Step 1 Add more resolution to the FLPHv3 mesh along the river

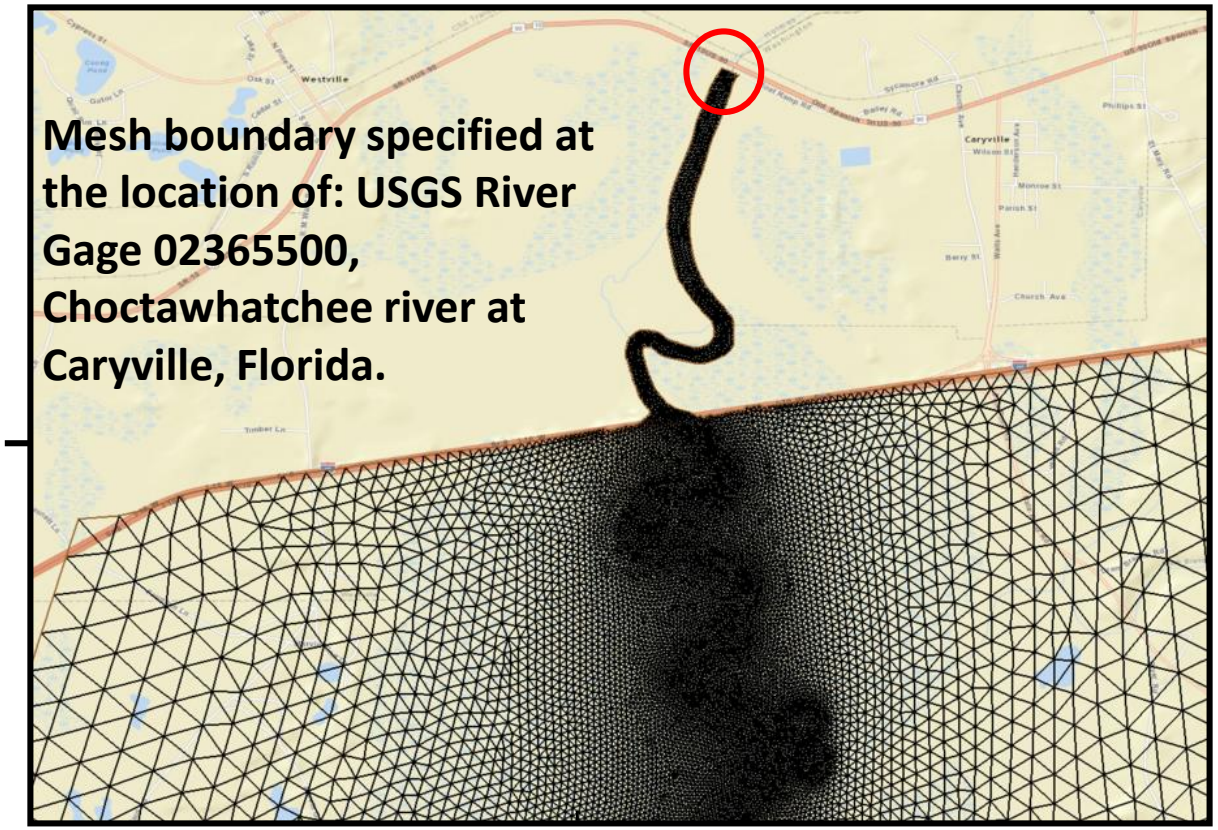


Mesh Refinement to resolve Choctawhatchee River (CR)

FLPHv3: 2260698 nodes

FLPHv4: 2152665 nodes





Updating bathymetry along Choctawhatchee River

Step 2 Update the river bathymetry

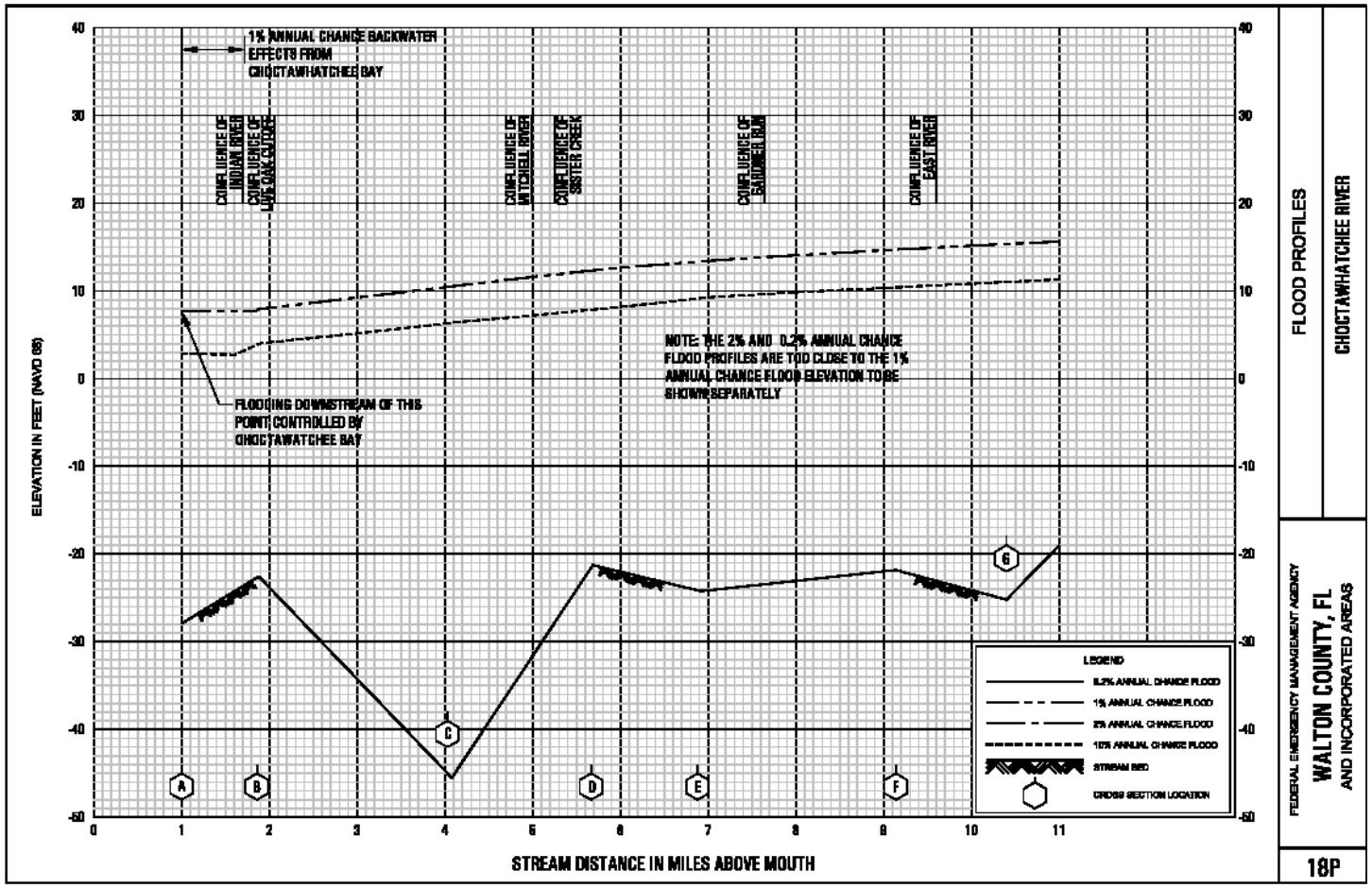
Searched online for bathymetry sources; recent data for upper reaches of CR not available online

FOIA request to US Army Corps

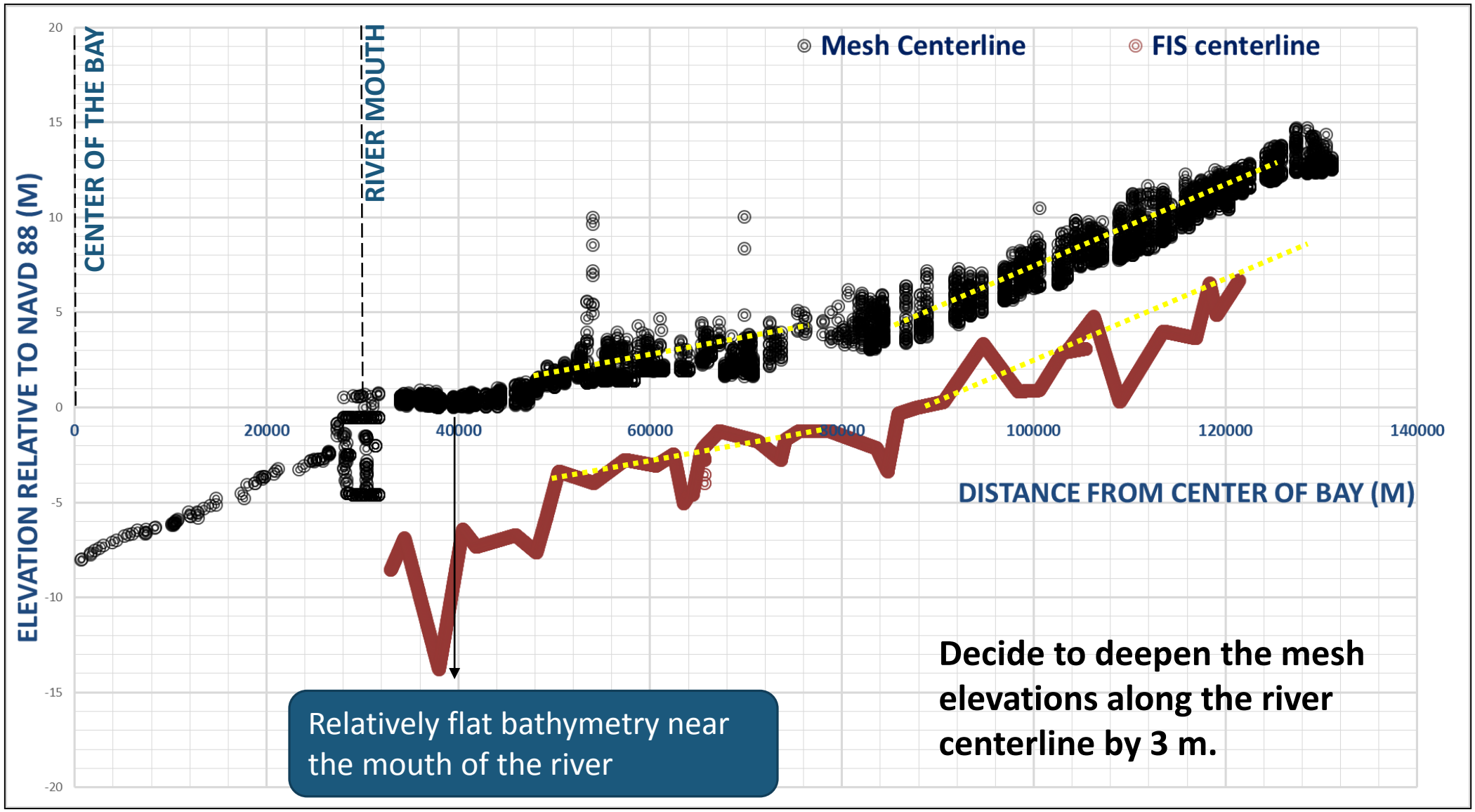
- *"… has not seen commercial navigation since the steamboat era. Therefore, the last (partial) surveys known to have been done seem to date back to the 1950's"*

Flood Insurance Study Report, Walton County (2008)

- ➢ Best (only) bathymetry source
- ➢ Example shown at right



Updating bathymetry along Choctawhatchee River



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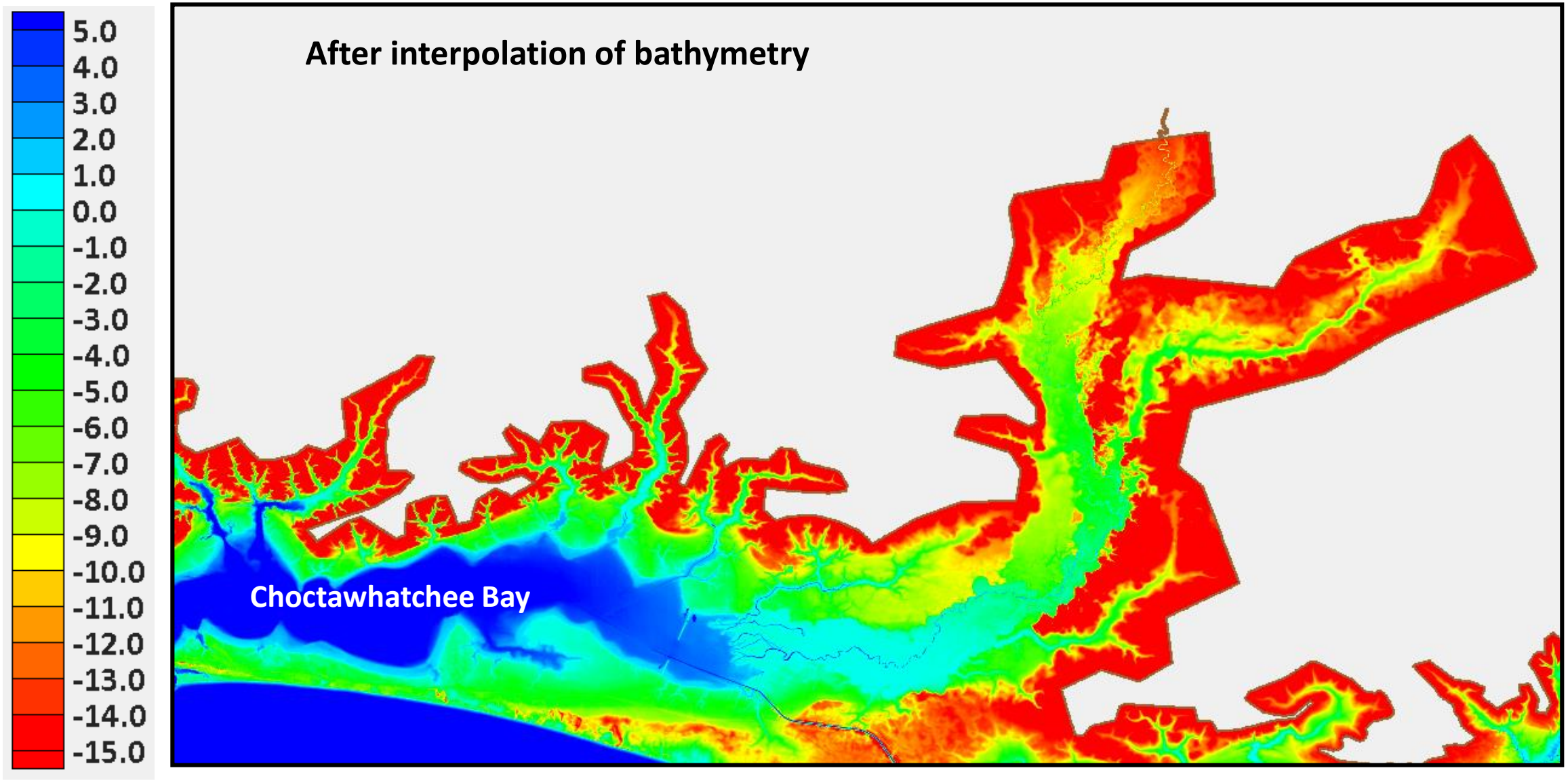
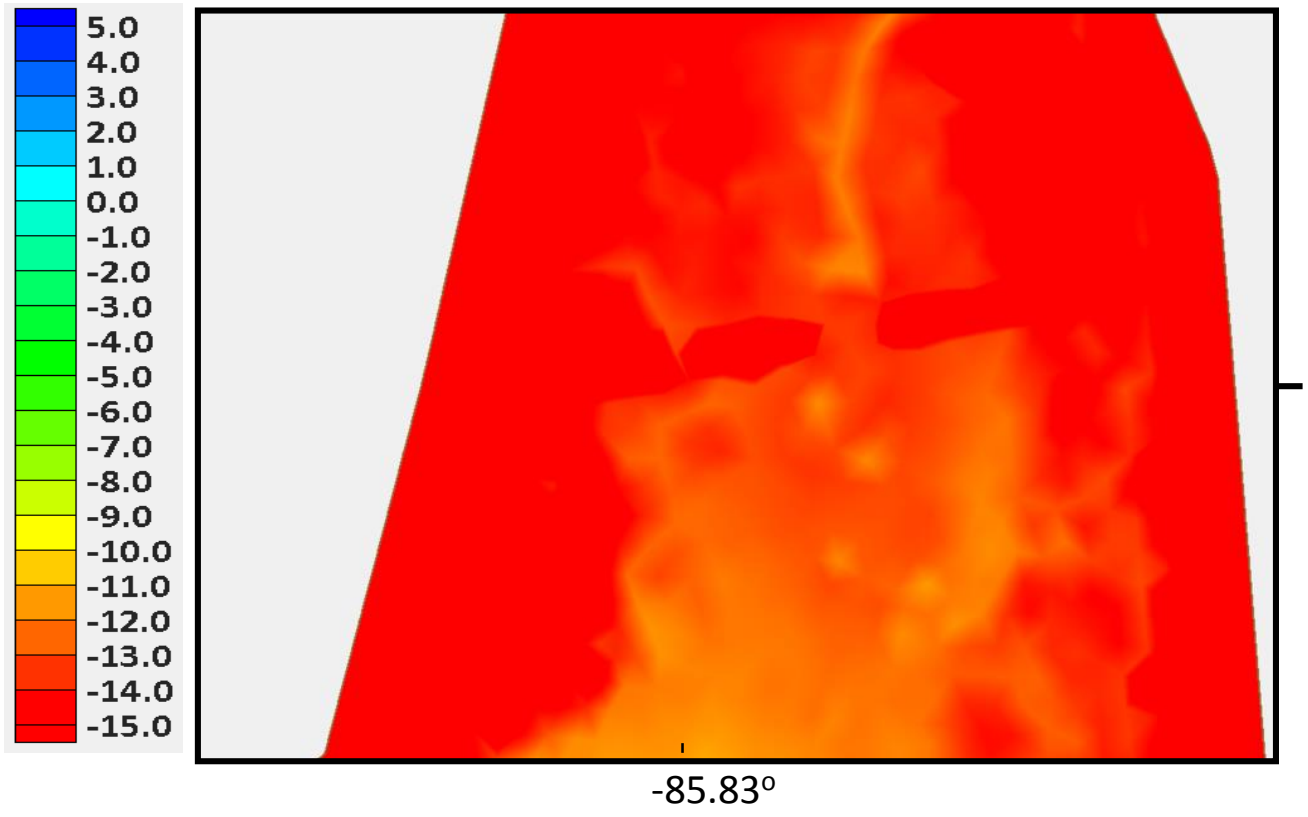
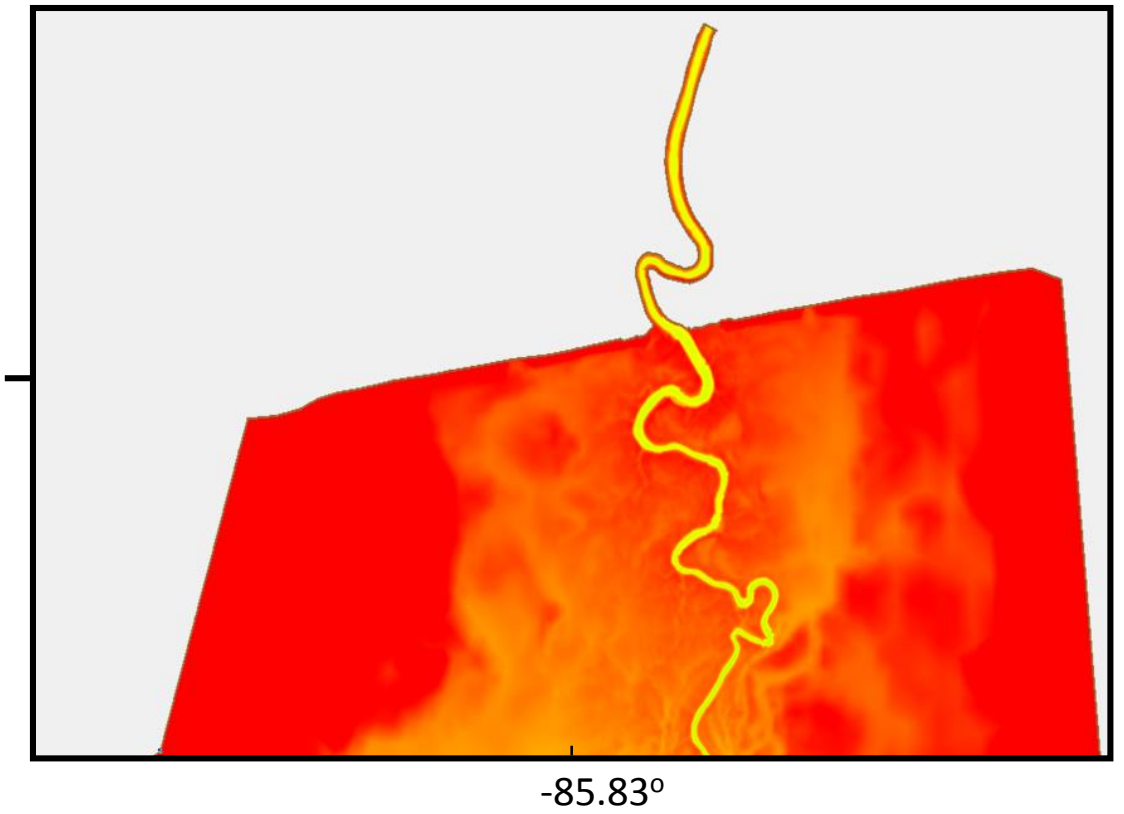


Updating bathymetry along Choctawhatchee River

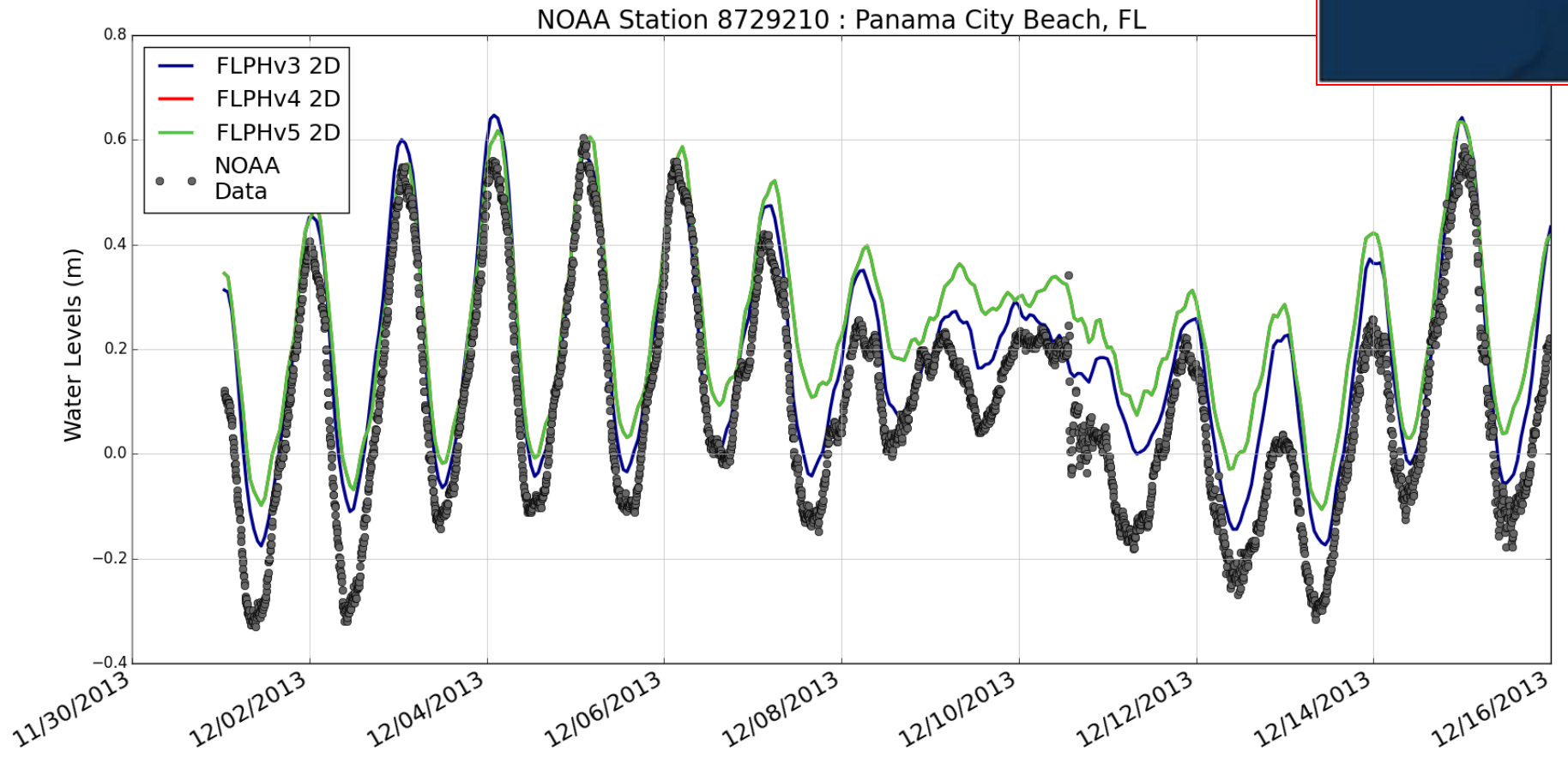
FLPHv3



FLPHv5



ADCIRC 2D on FLPHv5 mesh



FLPHv3

- Initial Mesh

FLPHv4

- Derived from FLPHv3
- Covers entire Gulf of Mexico
- Added resolution along Choctawhatchee River

FLPHv5

- FLPHv4 with Choctawhatchee River bathymetry updated

Future simulations with the refined mesh

Develop the capability to model the spatial extent of the plume

- Incorporate incoming freshwater discharge from Choctawhatchee River
  - Smoothing bathymetry to ensure downhill flow
  - Identify typical flowrates (50 m^3/s) from USGS gages
  - Develop input files for river inflows
- Implement ADCIRC 3D baroclinic runs on the refined mesh
  - Acquire initial/boundary conditions for salinity and temperature profiles
  - Explore the influence of time step, wet/dry criteria on stability
- Validate model results against observations
  - NOAA gages, Stage/discharge curves at USGS gages, CTD profiles, Satellite Imagery


THANK YOU!