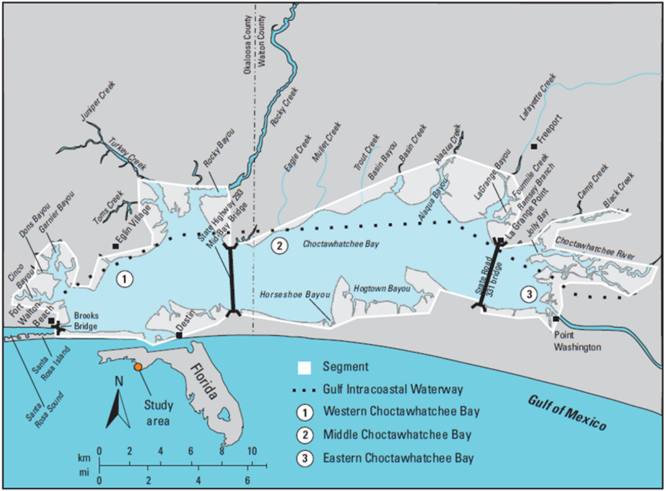
Circulation Dynamics and Transport Characteristics of Density-driven Flows in the Choctawhatchee Bay and River System

Rosemary Cyriac[1], Casey Dietrich[1], Arash Fathi[2], Clint Dawson[2], Kendra Dresback[3], Cheryl Ann Blain[4], Matthew Bilskie[5], Scott Hagen[5], Hans Graber[6]

[1]North Carolina State University, [2]University of Texas at Austin, [3]University of Oklahoma, [4]Naval Research Laboratory, [5]Louisiana State University, [6]University of Miami

ADCIRC Users Group Meeting
May 3-5, 2017

Choctawhatchee Bay and River System



Source: Handley, L., Altsman, D., and DeMay, R., eds., 2007, Seagrass Status and Trends in the Northern Gulf of Mexico: 1940–2002: U.S. Geological Survey Scientific Investigations Report 2006–5287, 267 p.

Surfzone Coastal Oil Pathways Experiment (SCOPE)

12/05/2013 11:34:19

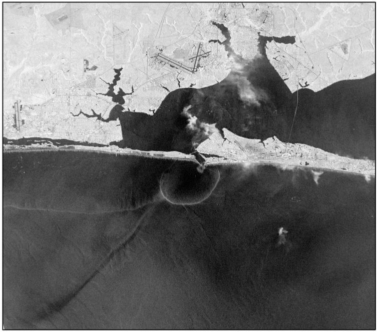
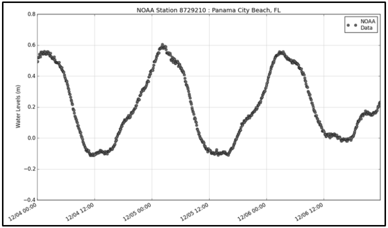
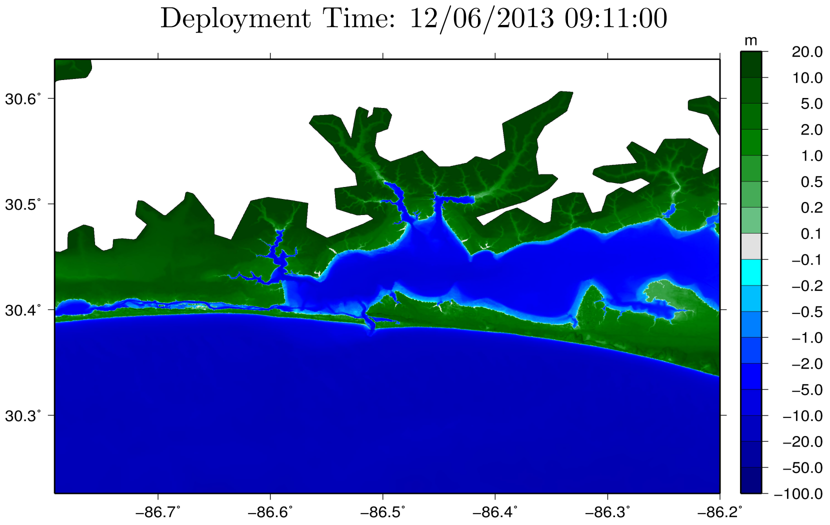


Image Courtesy: COSMO-SkyMed Product ASI 2013 processed under license from ASI Agenzia Spaziale Italiana. All rights reserved. Distributed by e-GEOS. Downlinked and processed by CSTARS.



SCOPE Drifter Deployment

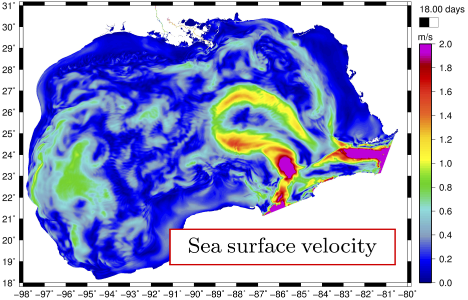


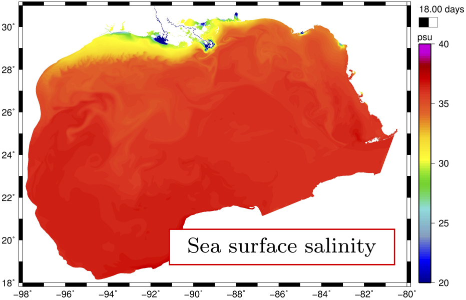
Research Objectives

Do the ocean currents at Destin Inlet act as natural barriers for surface transport?

- Leverage recent improvements to 3D ADCIRC to build a 3D baroclinic model for the Choctawhatchee Bay and River system
- Perform mesh editing to represent Choctawhatchee River, the primary source of freshwater into the bay
- Apply preprocessing steps to develop realistic initial conditions and perform bathymetry smoothing
- Analyze preliminary results for surface currents and salinities in the bay

Density Driven Flows in the Open Ocean

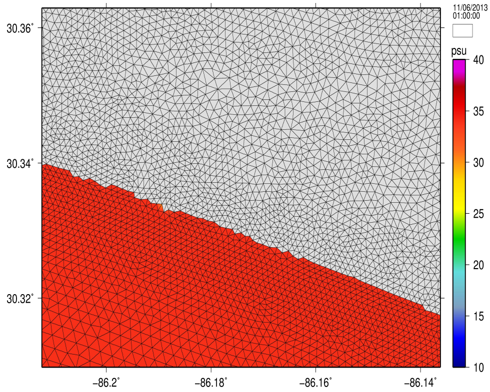


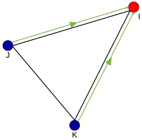


Source: A Fathi, J. C. Dietrich, C. N. Dawson, K. M. Dresback, A. Samii, R. Cyriac, C. A. Blain, R. Kolar. Prediction of surface oil transport in the Northern Gulf of Mexico by using a three-dimensional high-resolution unstructured-grid baroclinic circulation model. Ocean Circulation, 2017. *In Preparation.*

Improvements by Dr. Arash Fathi
-Accurate computation of the baroclinic pressure gradient
-Biharmonic horizontal viscosity/diffusion operators and adjustable (modified Leith) viscosity/diffusion parameters
-Scale-adaptive filtering of the velocity field
-Bathymetry smoothing

Salinities and Temperatures at Wetting & Drying Fronts

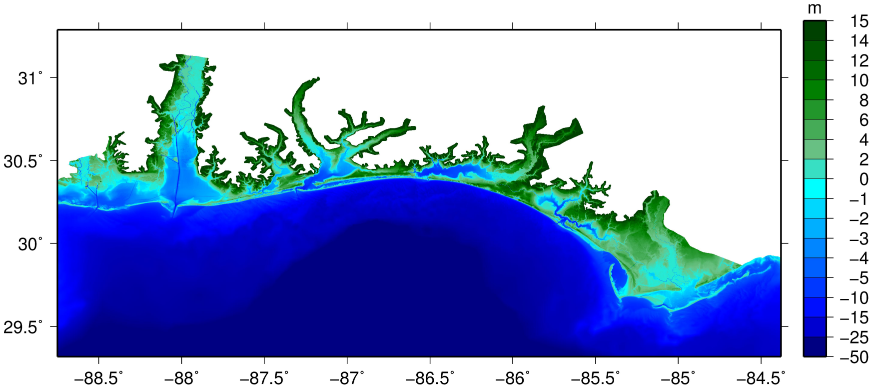




$$SAL(I) = \frac{SAL(J) + SAL(K)}{2.0}$$

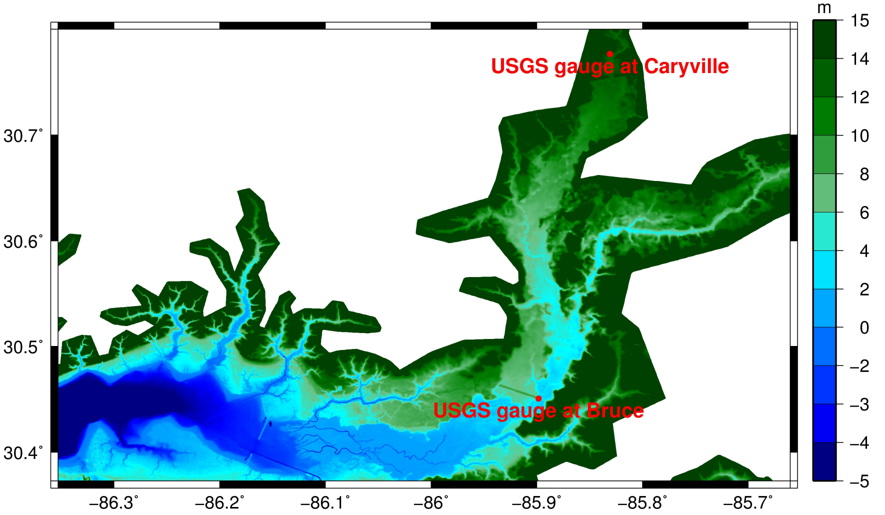
$$TEM(I) = \frac{TEM(J) + TEM(K)}{2.0}$$

Florida Panhandle ADCIRC Mesh

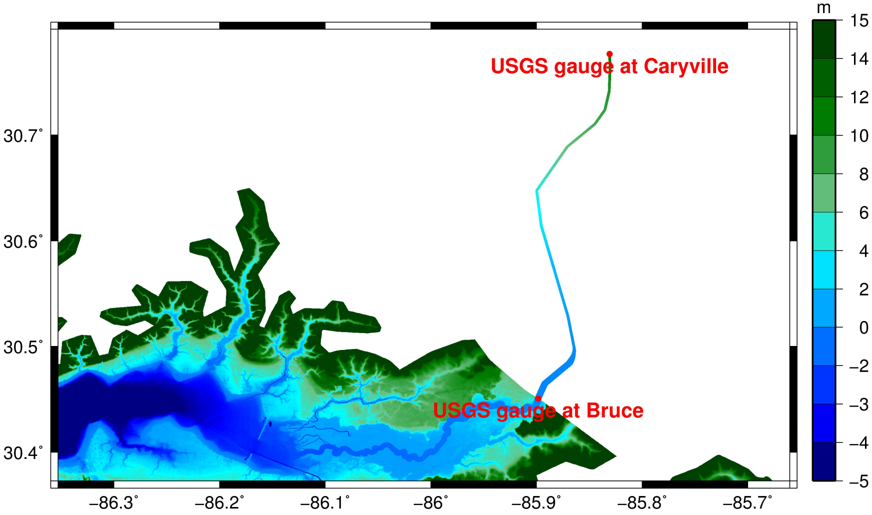


Source : S. Hagen , A. Daranpob, P. Bacopoulos, S. Medeiros, M. Bilskie, D. Coggin, M. Salisbury, J. Atkinson and H. Roberts. Storm Surge Modeling for FEMA Flood Map Modernization for the Northwest Florida and Alabama Coast, Digital Elevation Model and Finite Element Mesh Development. Prepared for the Northwest Florida Water Management District and the Federal Emergency Management Agency, 2011.

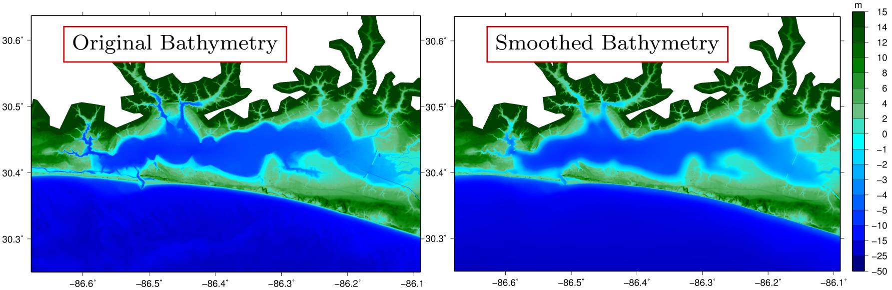
Identifying USGS Gauges



Developing Synthetic Channel



Bathymetry Smoothing



-Regions of steep bathymetric gradient introduced instability
-Smoothing Indicators (rx0, rx1) were computed
-Smoothing approach similar to that used by Sikiric et. al. (2009)

$$rx_0 = \frac{|h_i - h_j|}{h_i + h_j},$$

$$rx_1 = \frac{|h_i^k - h_j^k + h_i^{k-1} - h_j^{k-1}|}{h_i^k + h_j^k - h_i^{k-1} - h_j^{k-1}}$$

Run Properties

Diagnostic Run: Nov 1, 2013 - Nov 6, 2013

Prognostic Run: Nov 6, 2013 - Dec 15, 2013

Number of Vertical Layers: 11

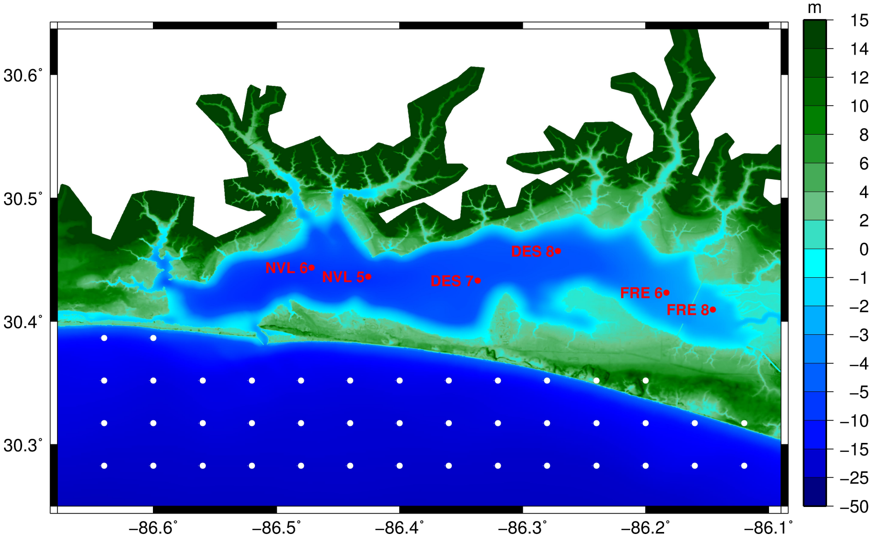
Initial and Boundary Conditions: HYCOM salinities, temperatures and heat flux

Forcings: Tides, Winds and River Discharge

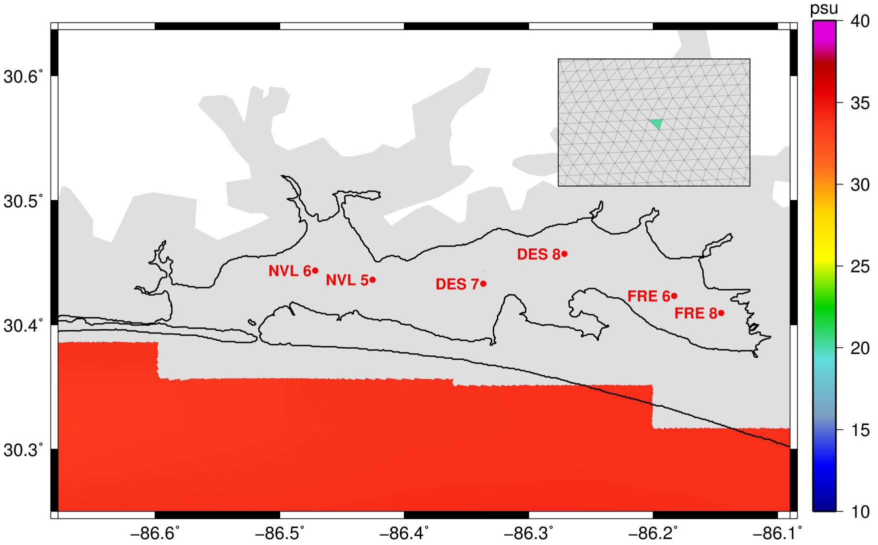
Time step: 0.5s

CPU time: 5 days of simulation takes 20 hours on 1920 cores

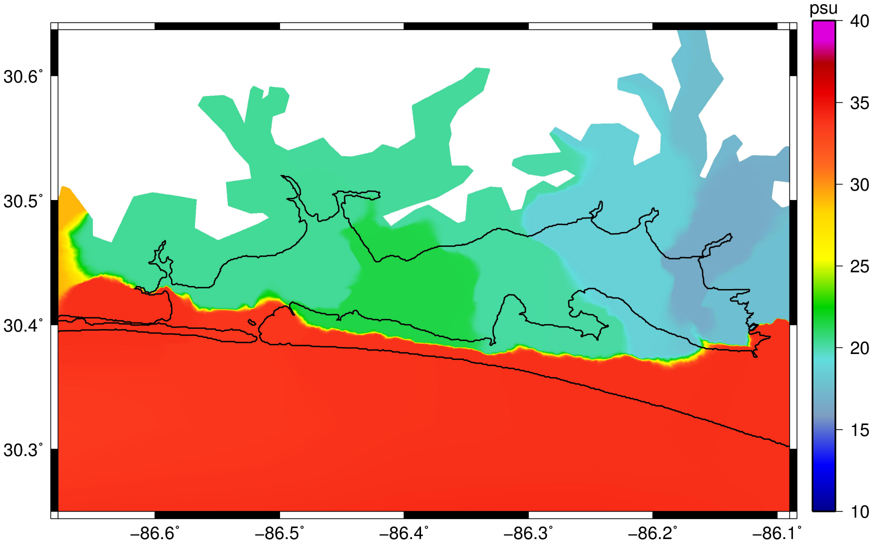
Developing Initial Conditions from HYCOM and Measurements



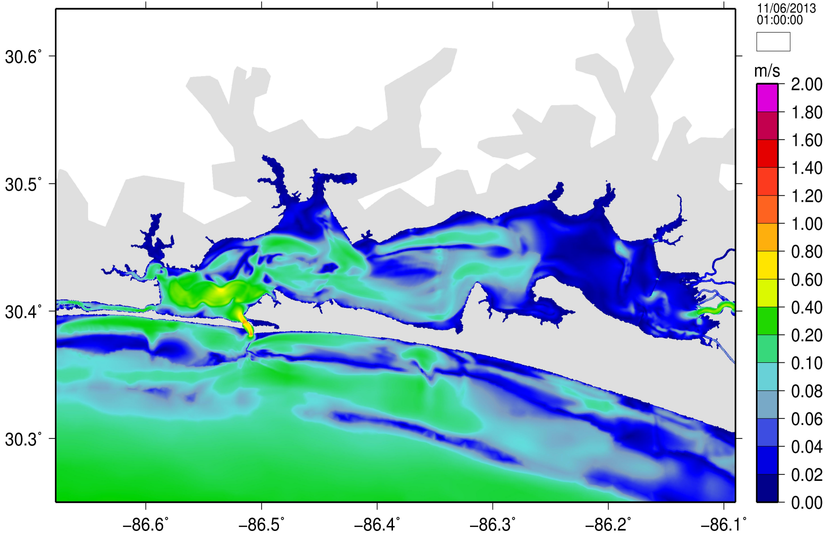
Developing Initial Conditions from HYCOM and Measurements



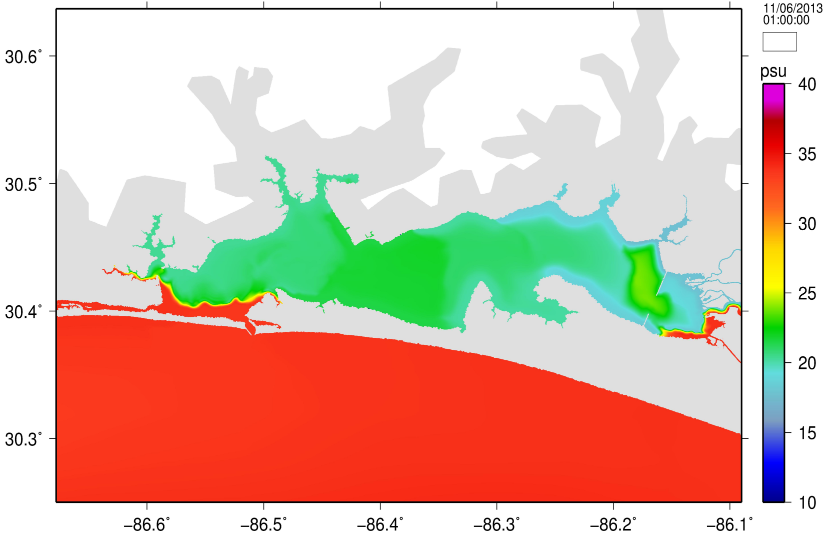
Initial Salinities for Current Run



Surface Currents

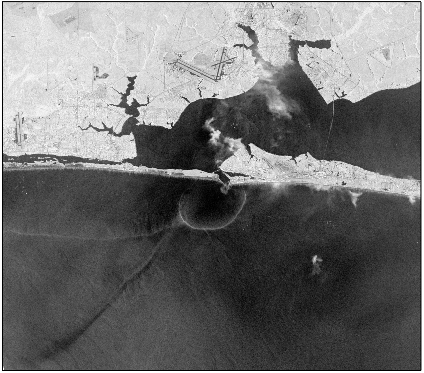


Surface Salinities



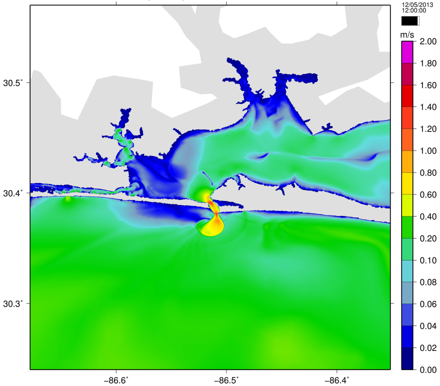
Comparison with Satellite Imagery

12/05/2013 11:34:19

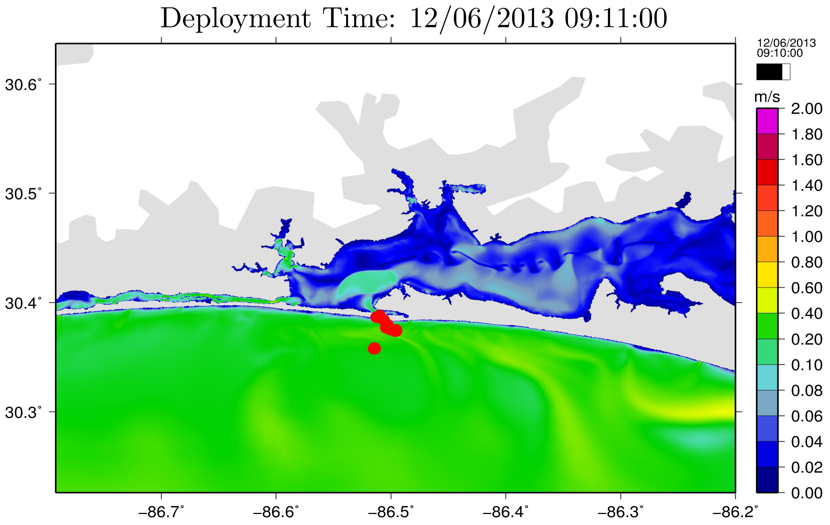


Source: COSMO-SkyMed Product ASI 2013 processed under license from ASI Agenzia Spaziale Italiana. All rights reserved. Distributed by e-GEOS. Downlinked and processed by CSTARS.

12/05/2013 12:00:00



Drifter Trajectories



Summary

Modeling density driven flows in the Choctawhatchee Bay and River System using ADCIRC 3D capabilities

- Mesh Editing
- Bathymetry smoothing
- Initial conditions from HYCOM and measurements

Future Work

- Improve mixing characteristics in the model
- Improve preprocessing steps for initial conditions and bathymetry smoothing
- Continue model validation through comparisons with SCOPE and CBA measurements
- Analyse model results to determine degree of stratification, vertical mixing and residence time for the bay