

US EPA ARCHIVE DOCUMENT

Development of Coupled Physical and Ecological Models for Stress-Response Simulations of the Apalachicola Bay



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Outline

1. Background (Study site, Ecosystem diagnosis, Objective, etc.)
2. Methodology (Coupled Physical-Ecological Model System)
3. Current Progress (A. Hydrodynamic model; B. EPA WASP water quality model; C. River model; D. Ecological models (salt marsh, oyster, habitat suitability, landscape model))
4. Future Development

1. Background



Apalachicola
Bay, Florida:
The Last
Great Bay in
USA



Apalachicola
Bay
Ecosystem

Florida LANDSAT GeoCover 2000

<http://geology.com/satellite/florida-satellite-image.shtml>

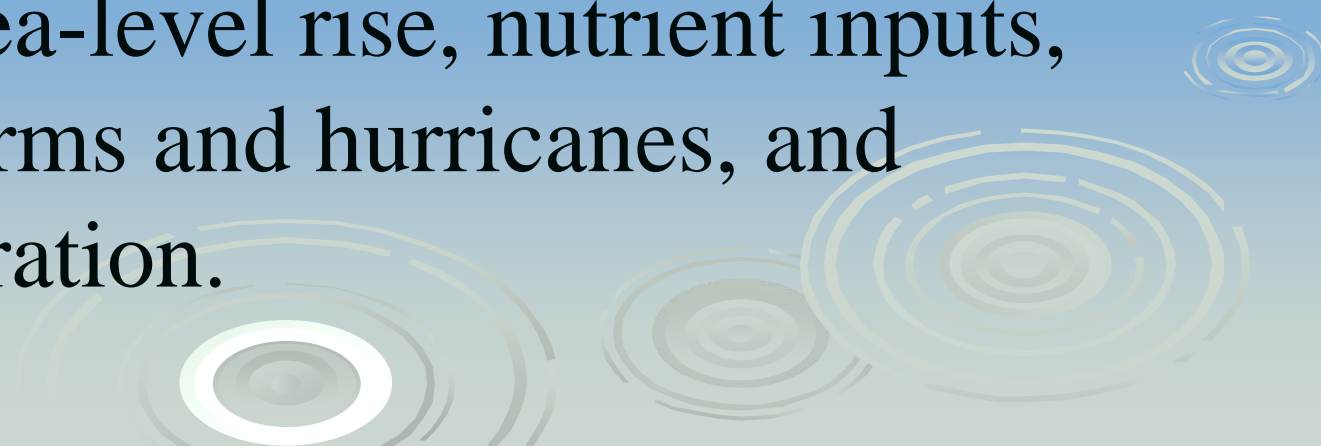
Apalachicola Bay System



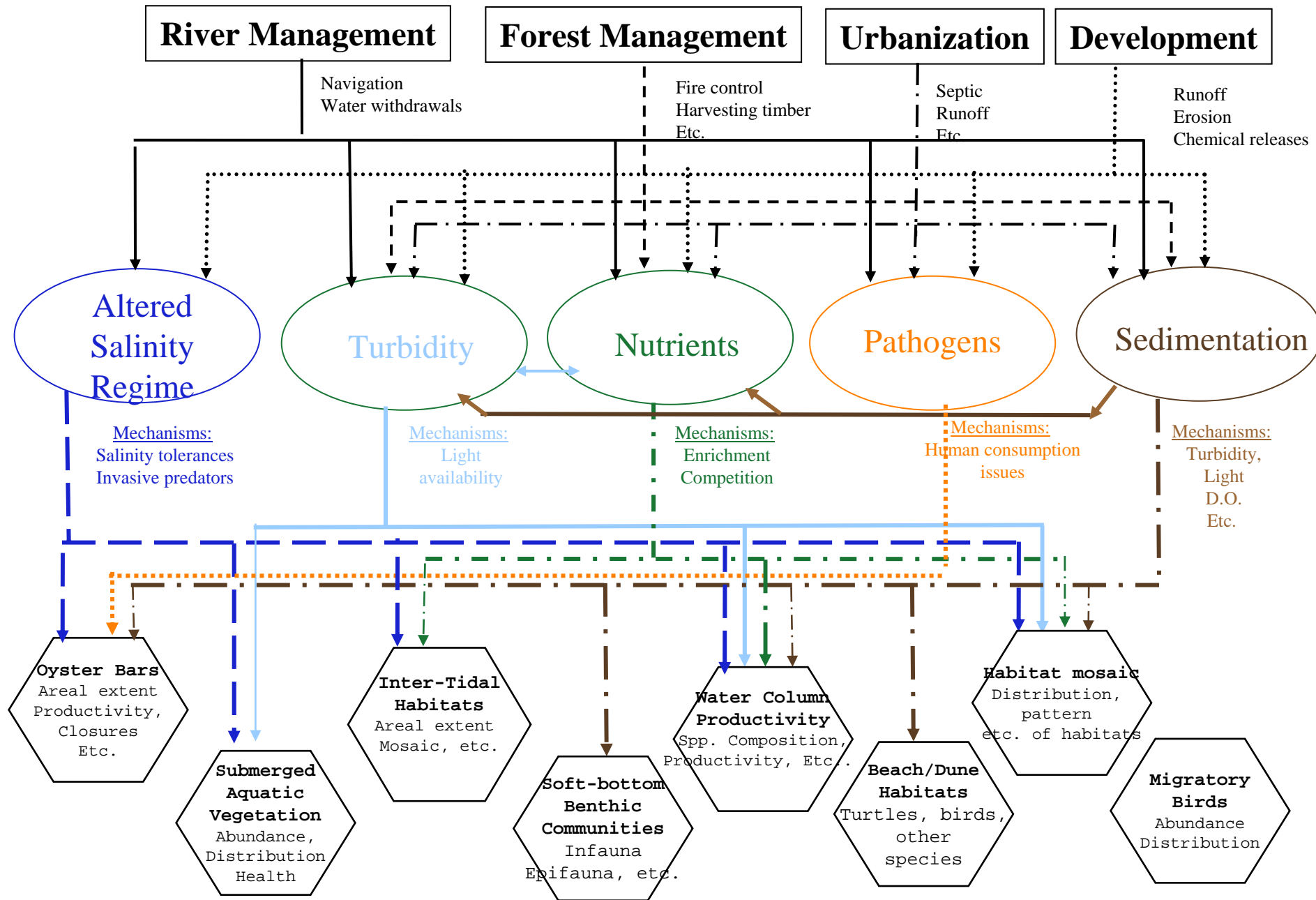
Valued Ecosystem Components (VECs) vs. Stressors

VECs: Oysters, recreational fisheries, salt marshes, and associated aesthetic, endangered, and recreational species of birds, fish, and invertebrates.

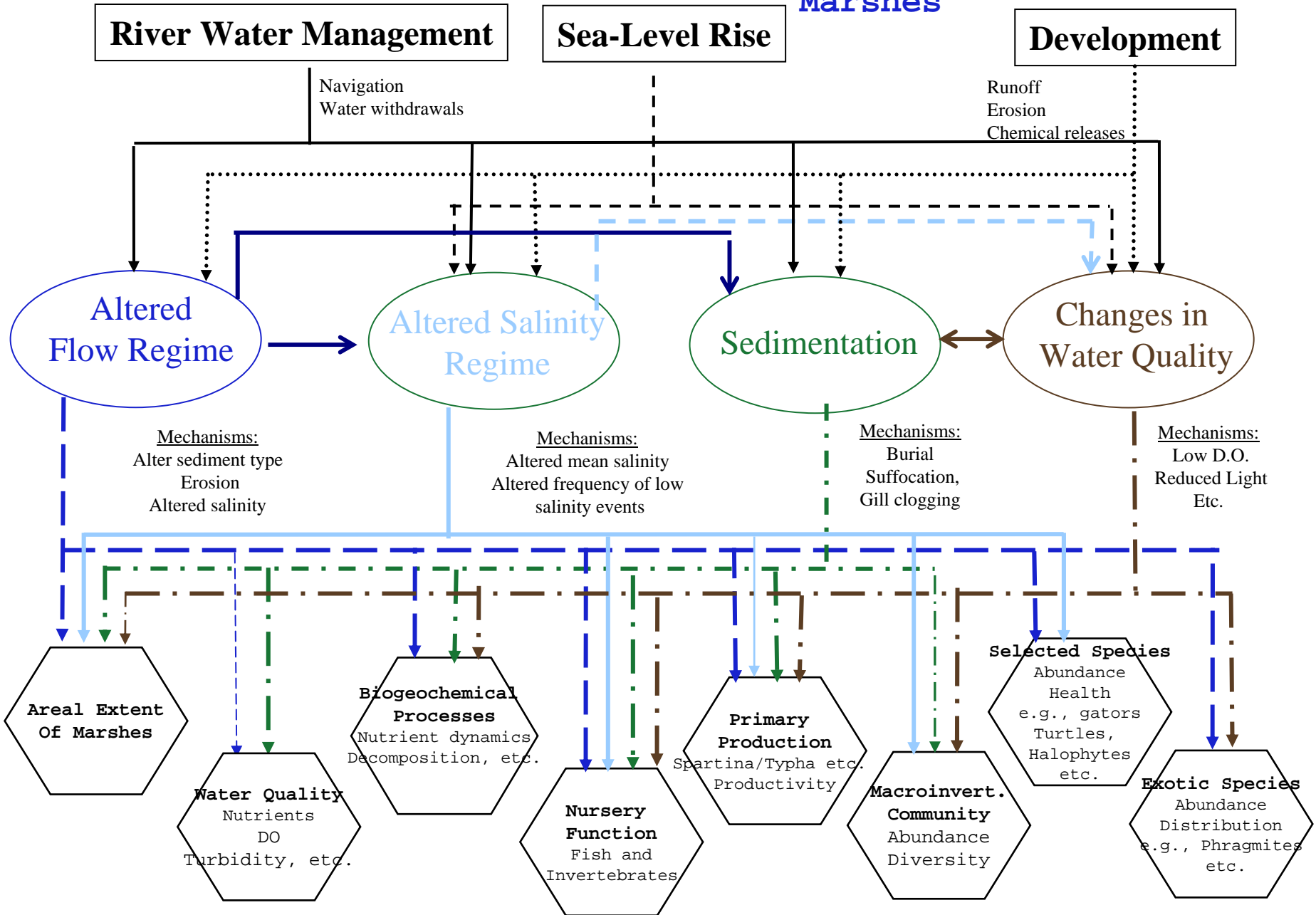
Stressors: Changes in salinity and turbidity, sea-level rise, nutrient inputs, tropical storms and hurricanes, and habitat alteration.

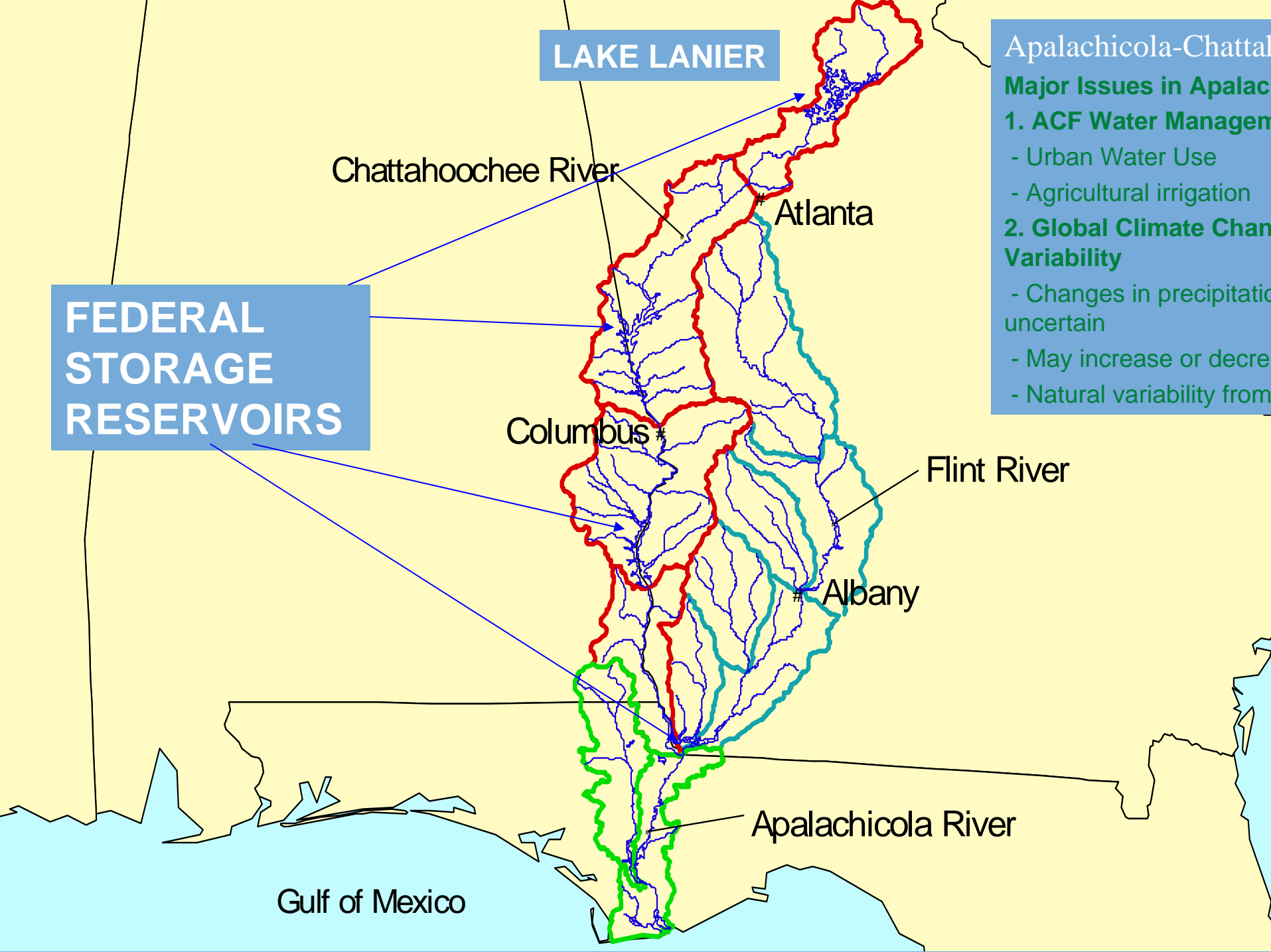


Apalachicola Bay



Apalachicola Bay Salt and Freshwater Marshes





LAKE LANIER

Chattahoochee River

Atlanta

FEDERAL STORAGE RESERVOIRS

Columbus

Flint River

Albany

Apalachicola River

Gulf of Mexico

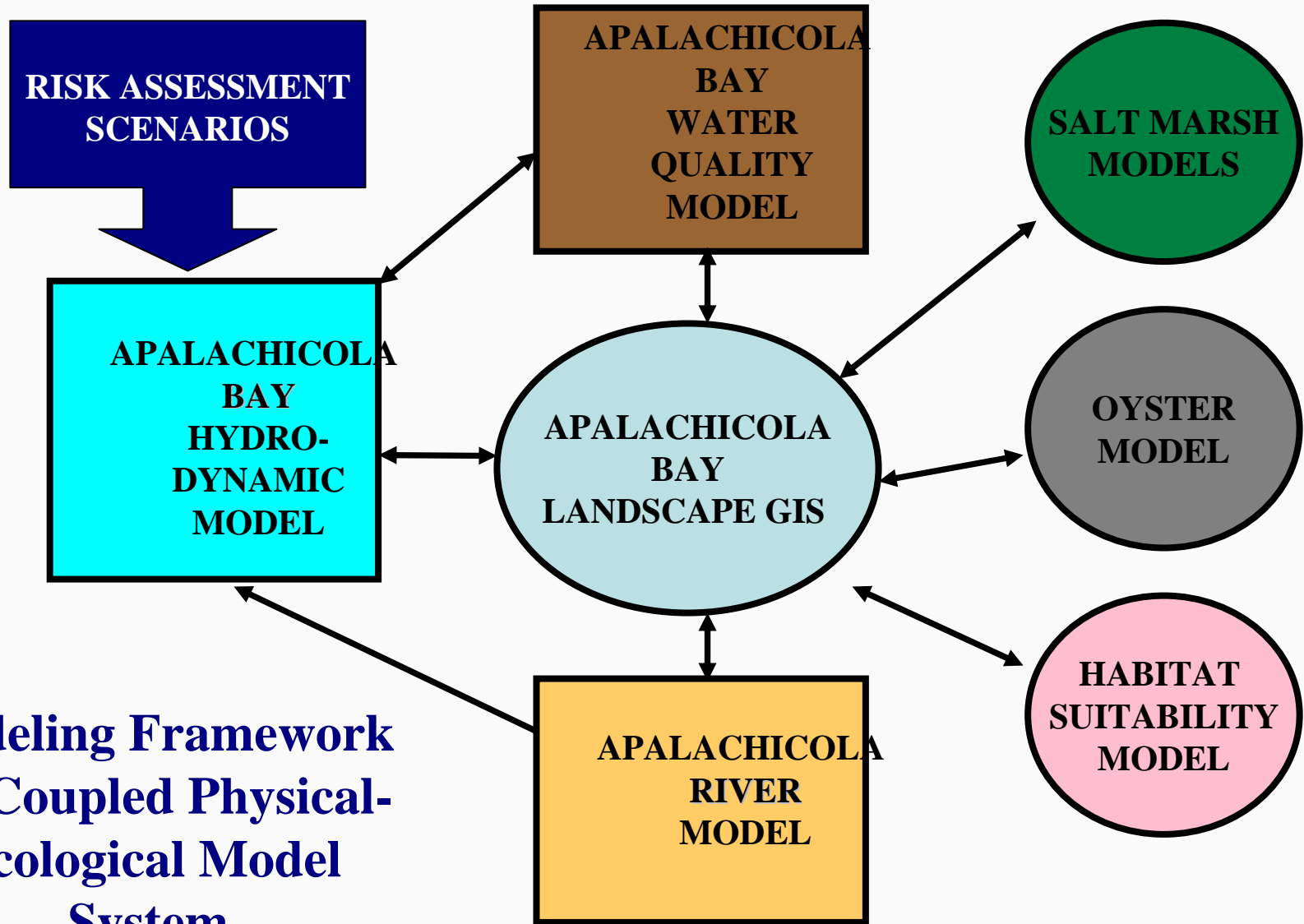
Apalachicola-Chattahoochee-Flint
Major Issues in Apalachicola-Chattahoochee-Flint
1. ACF Water Management
- Urban Water Use
- Agricultural irrigation
2. Global Climate Change and Variability
- Changes in precipitation patterns are uncertain
- May increase or decrease precipitation
- Natural variability from El Niño and La Niña

Research Project Objective

To develop a coupled physical-ecological model of the Apalachicola Bay ecosystem that can be used as a quantitative tool to assess the ecosystem responses to natural and anthropogenic stressors.




2. Methodology



**Modeling Framework
for Coupled Physical-
Ecological Model
System**

Research Tasks

- 1. Adopt 3-D hydrodynamic model to Apalachicola Bay (based on Princeton Ocean Model)**
 - 2. Interface hydrodynamic model with EPA WASP WQ Model**
 - 3. Calibrate River Flow Model to Apalachicola River**
 - 4. Ecological and WQ data gathering - using existing info, including high-resolution hyperspectral imaging**
 - 5. Develop ecological models for salt marsh, oysters, and landscape systems**
 - 6. Integrate data and models via GIS data layers**
 - 7. Conduct demonstration ecological risk assessment**
- 

3. Current Progress

- A. 3D Hydrodynamic Model (Based on Princeton Ocean Mode, POM);
- B. EPA WASP 6 Water Quality Model;
- C. Apalachicola River Model
- D. Ecological Models (Salt Marsh, Oyster, Habitat Suitability, Landscape).

3-1. The Hydrodynamic Model

- Princeton Ocean Model (POM) (Blumberg and Mellor, 1987);
- Determine spatial and temporal changes in water surface elevation, circulation, salinity, temperature, and velocity in response to wind, tide, buoyancy and Coriolis force;
- Model parameters: bottom drag coefficient, bottom roughness, horizontal diffusion and viscosity, etc.;
- Calibrated and validated using field observations of hourly surface elevation and salinity at several stations in the Apalachicola Bay.

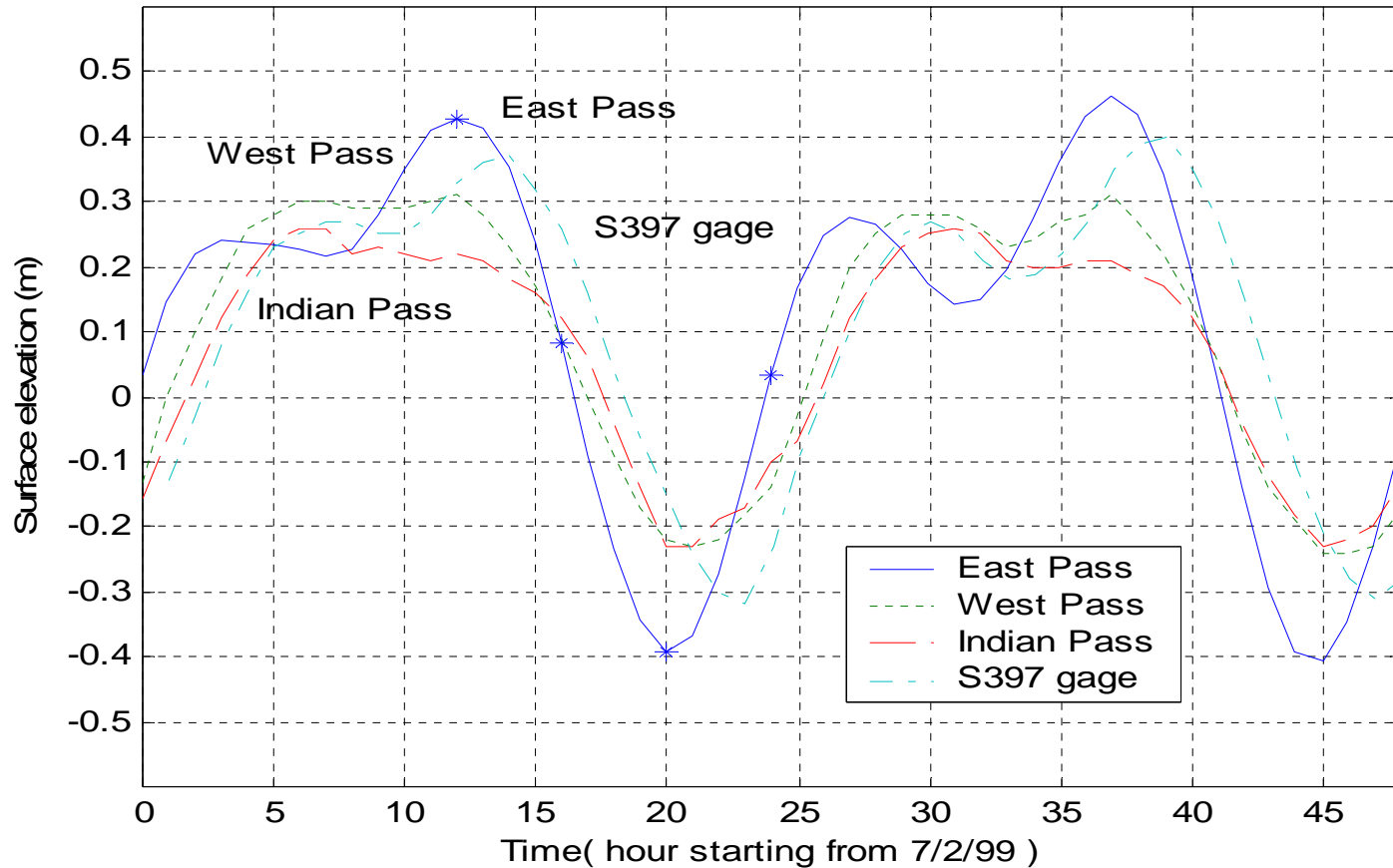
Characteristics of Apalachicola Bay

- Shallow water, multiple tidal boundaries;
- Strong freshwater discharge:
 $Q_{\min}=155 \text{ m}^3$, $Q_{\text{ave}}=770 \text{ m}^3$, $Q_{\max}=2300 \text{ m}^3$.
- River discharge perpendicular to the estuarine axis and a long barrier island;
- Strong vertical stratification near the river mouth.

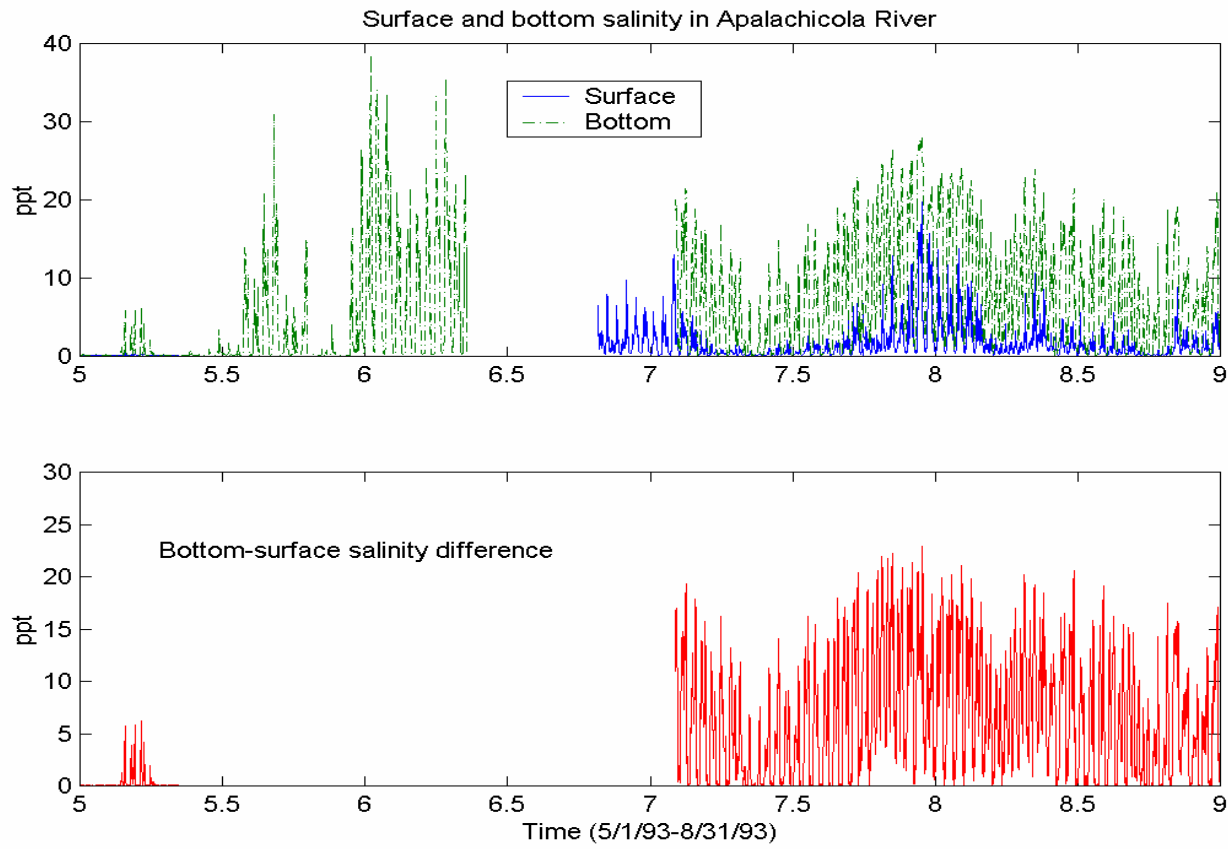


Multiple tidal forces with different amplitudes

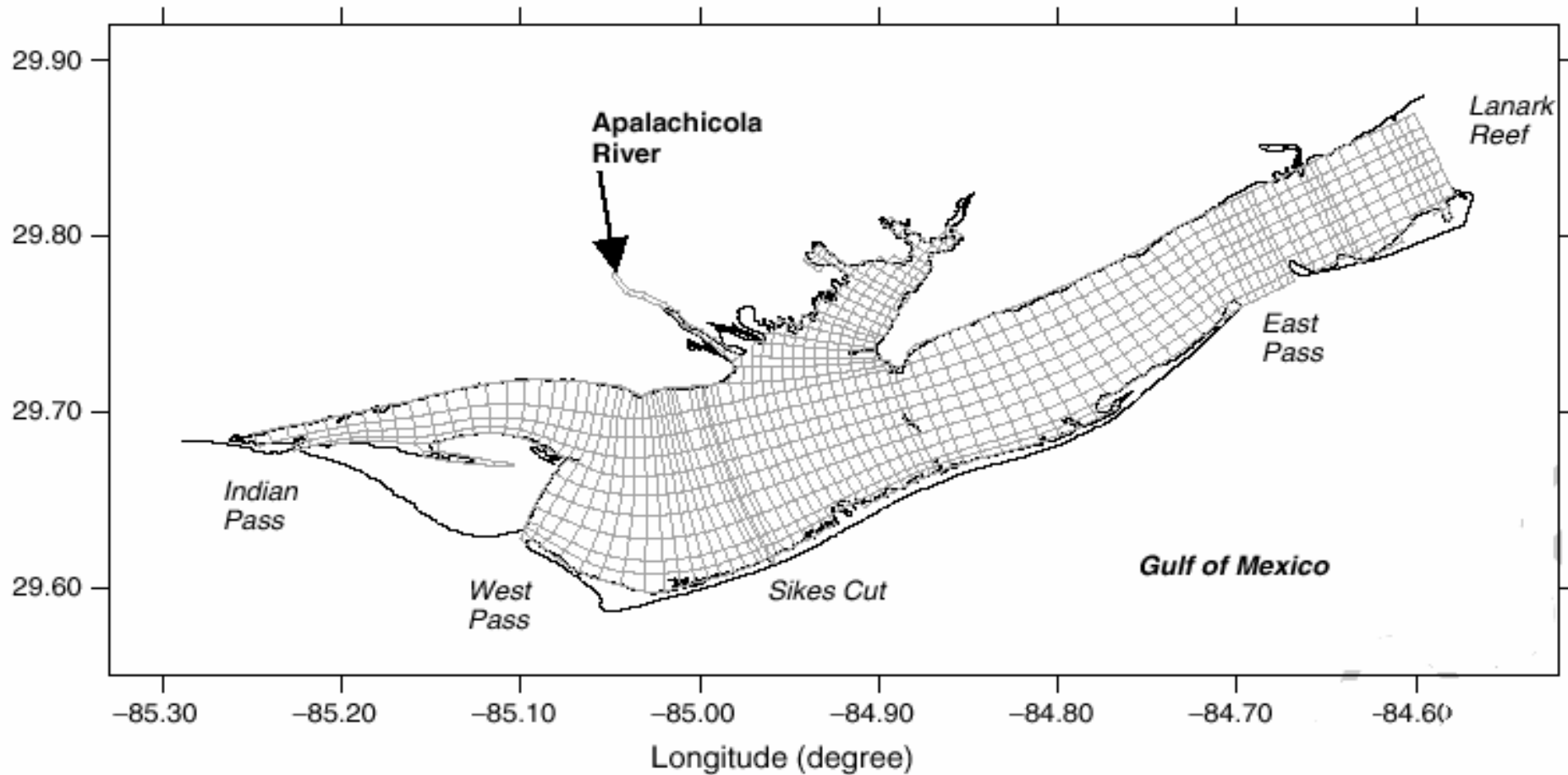
Figure 2. Time series observations of surface elevation



Strong Vertical Stratification

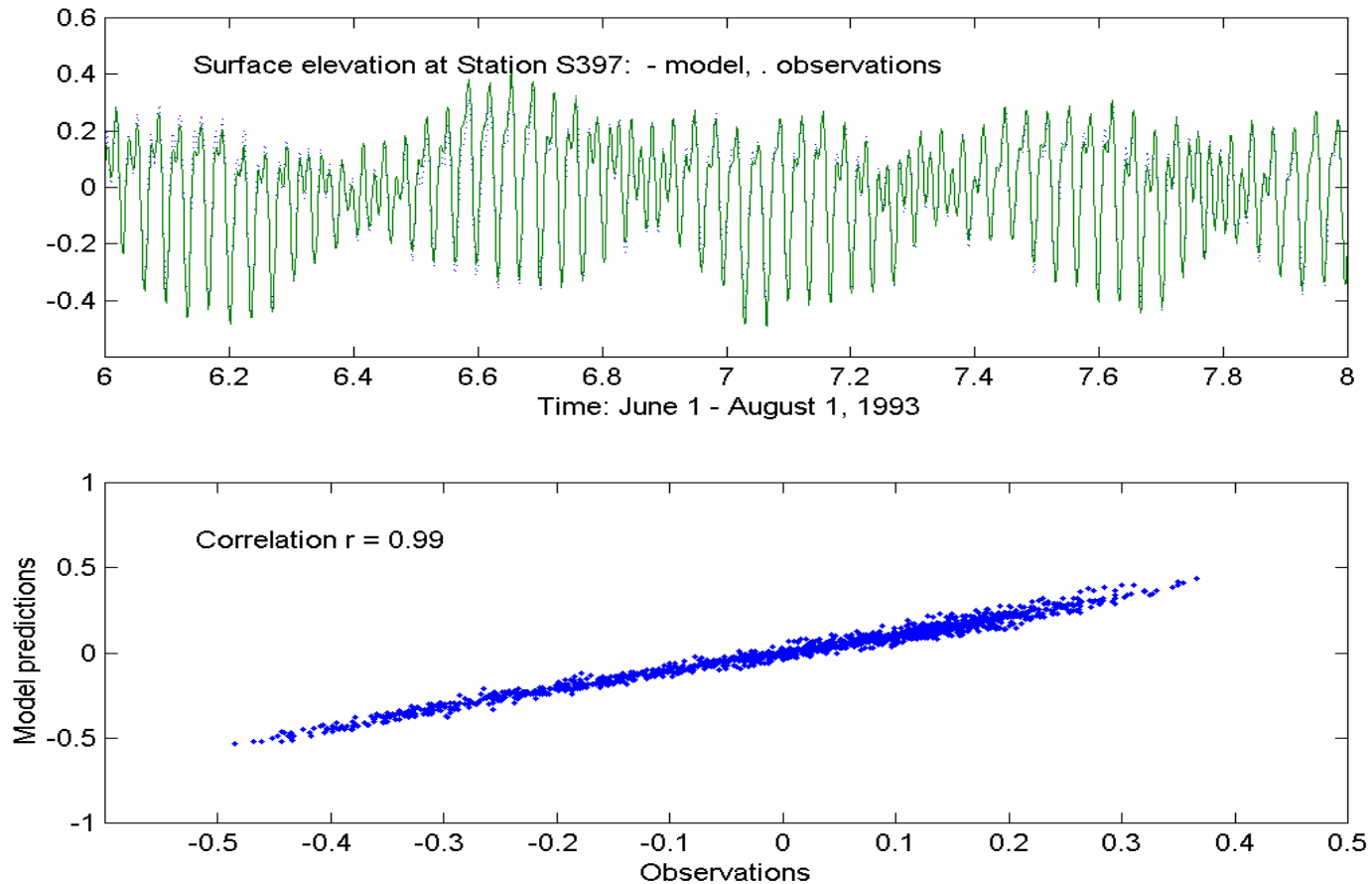


Model grid



Apalachicola Bay hydrodynamic model grid system

Model Calibration: Surface Elevation at S397



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Model Calibration: Salinity

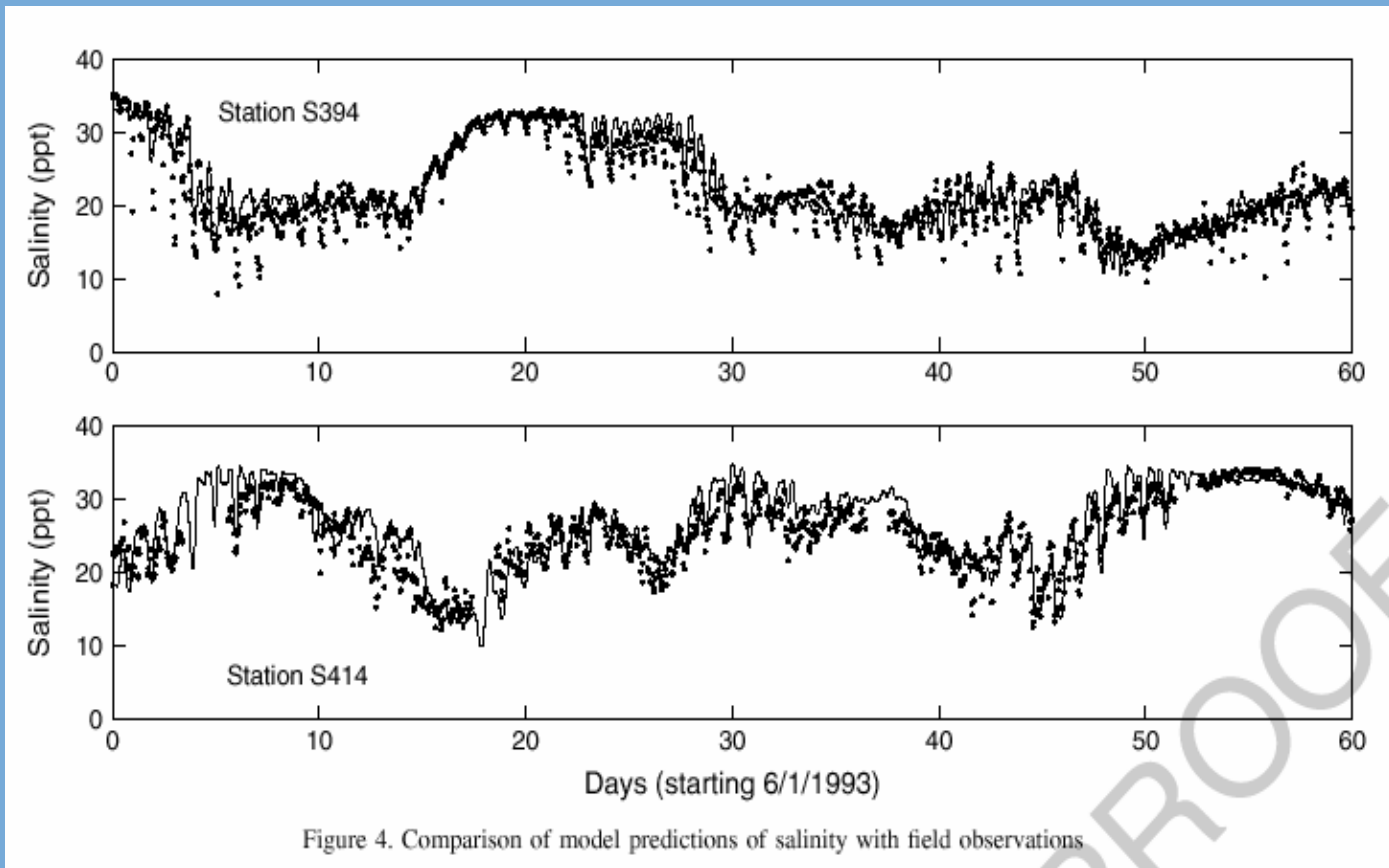
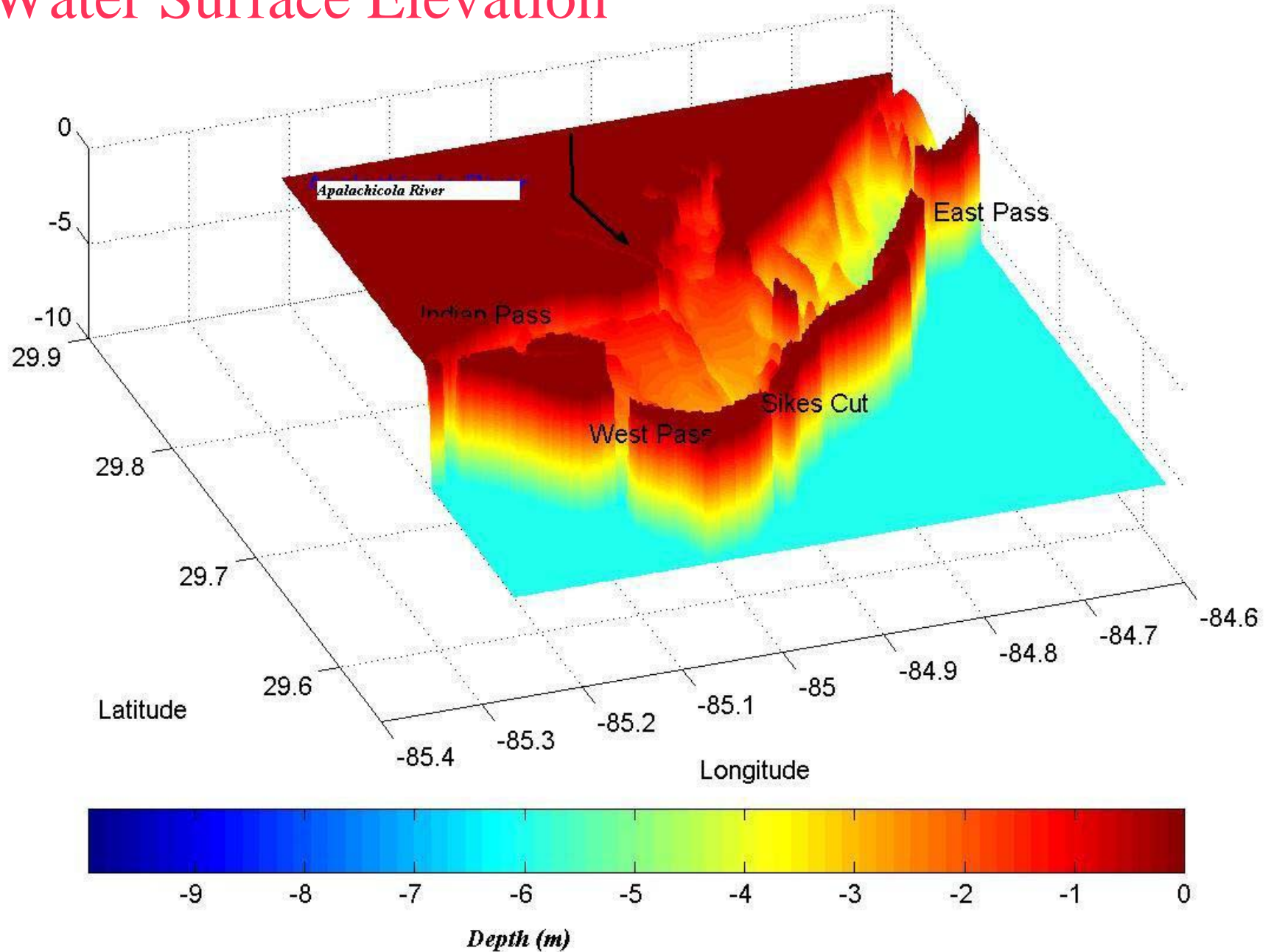


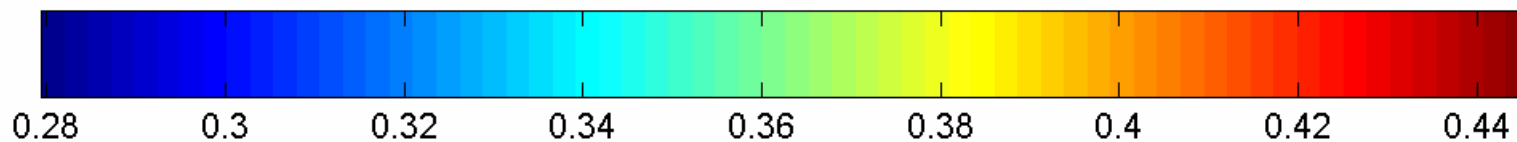
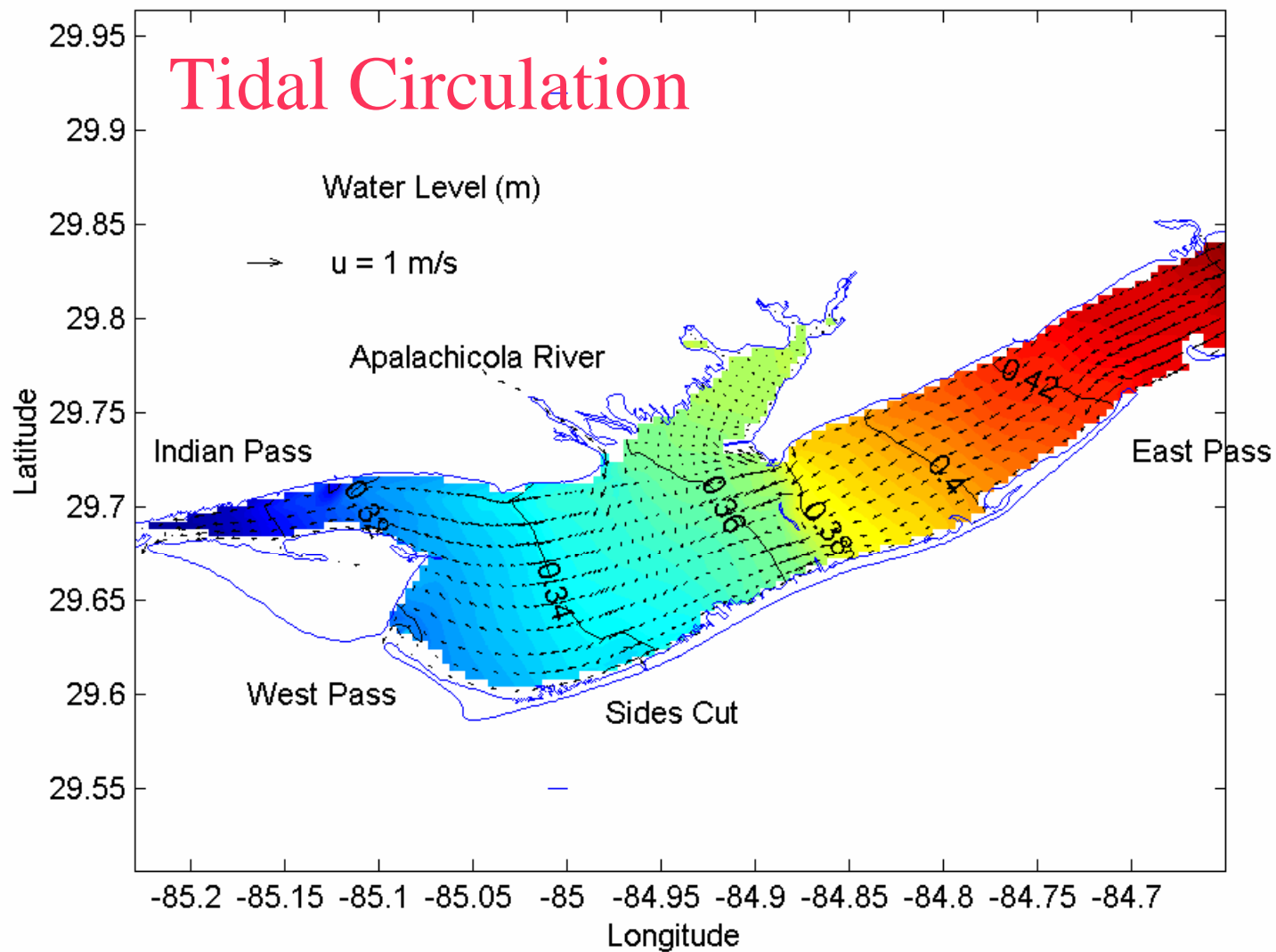
Figure 4. Comparison of model predictions of salinity with field observations

Water Surface Elevation

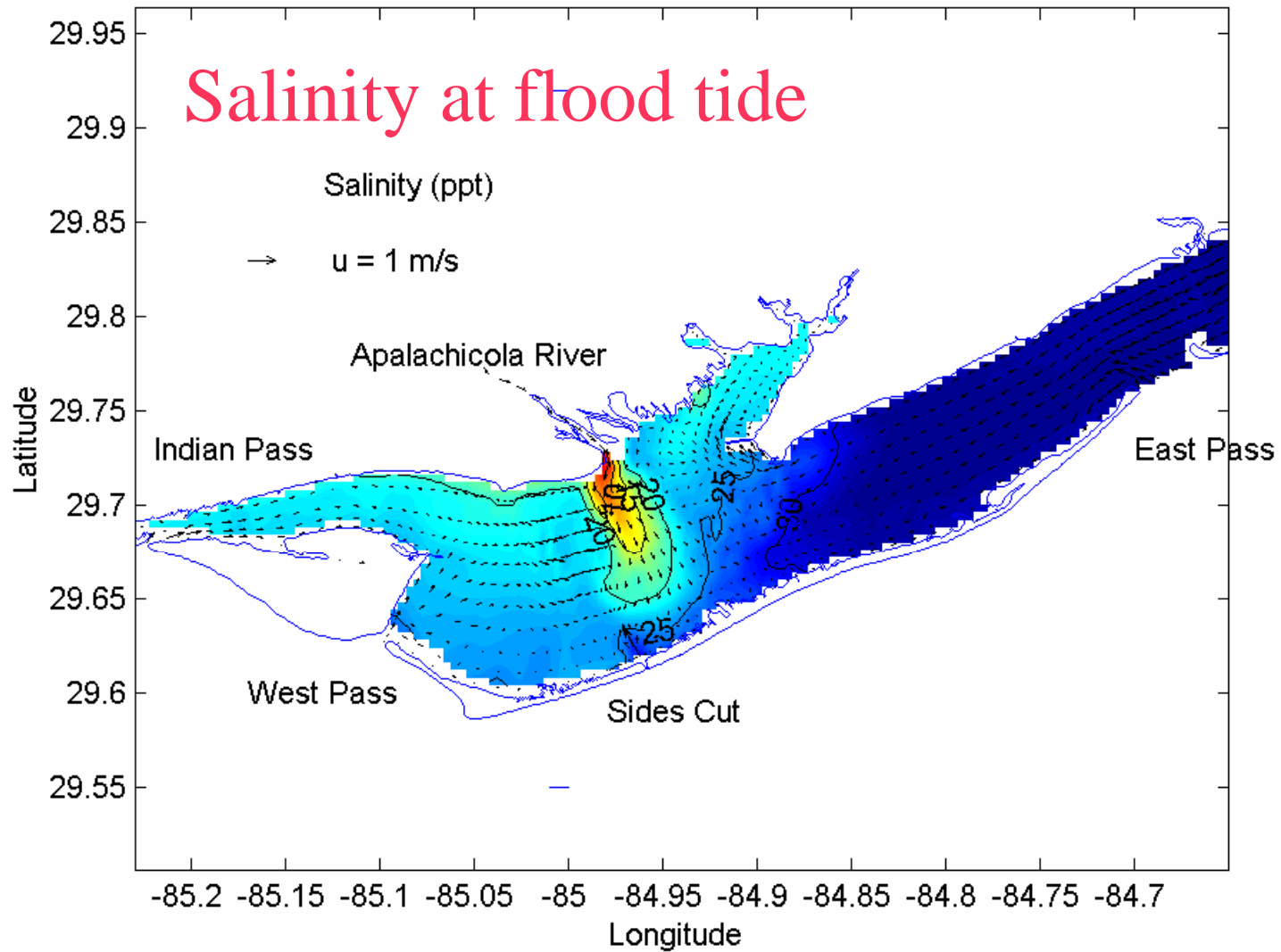


Time = 12 hr, high tide

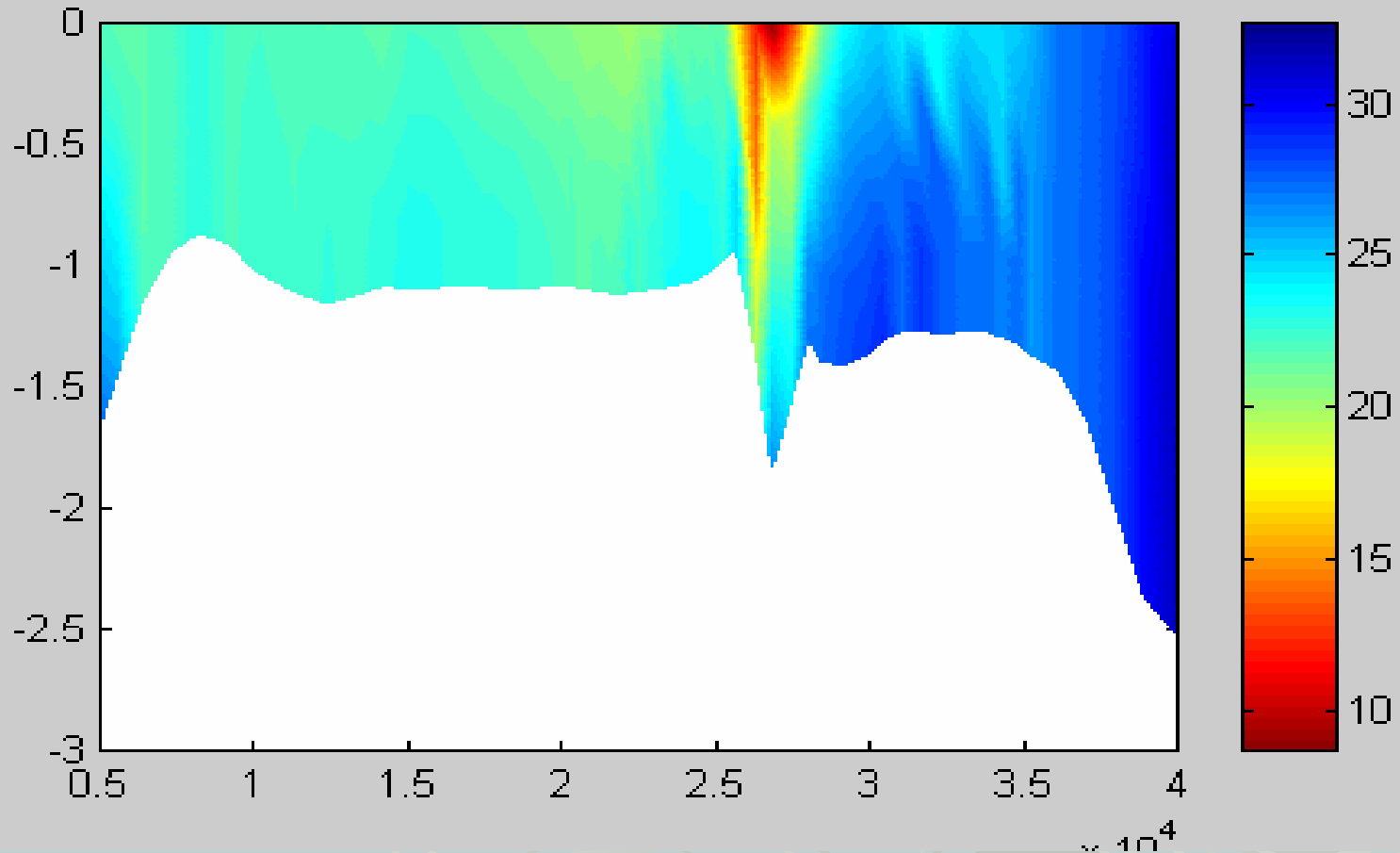
Tidal Circulation



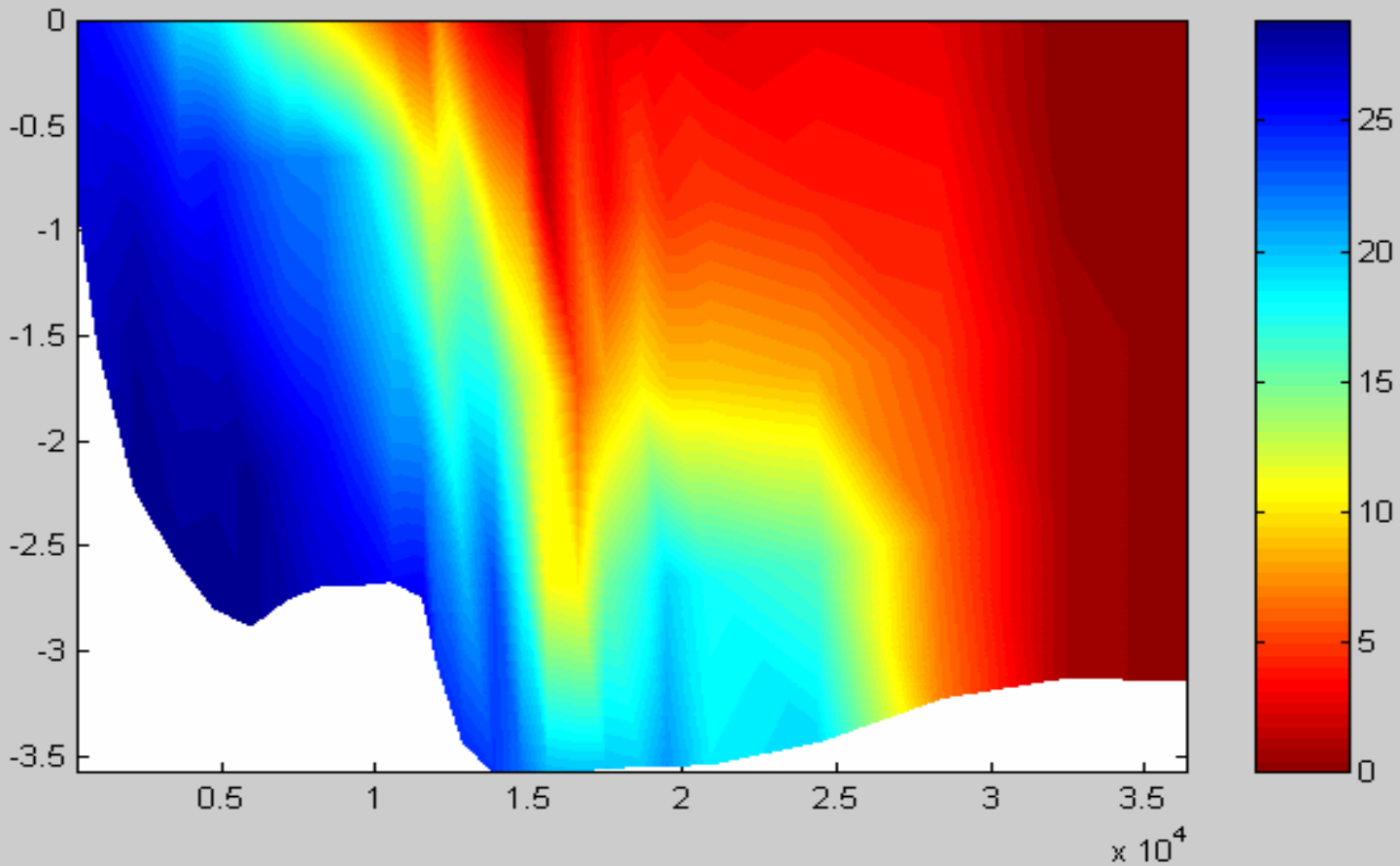
Time = 24 hr, flood tide, surface salinity



Vertical Salinity Stratification: Cross Section from Western to Eastern Apalachicola Bay



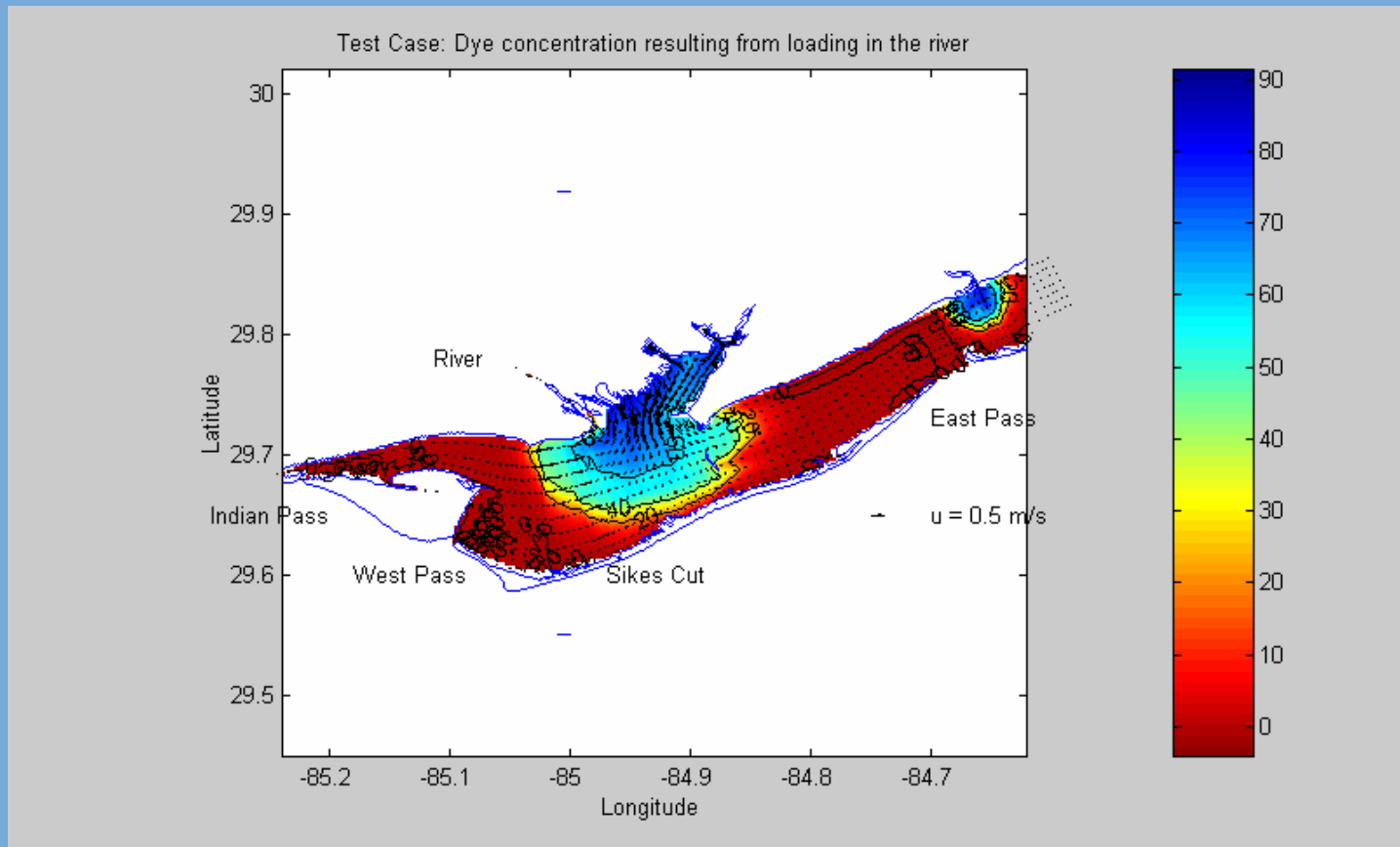
Vertical Salinity Stratification: Apalachicola Bay(left) to Apalachicola River (right)



3-2. Linkage between POM and WASP

1. Apalachicola POM converted to EFDC format that can be linked directly to WASP;
2. Model test simulations for dye concentration and sediment transport.

Model Test for Constant Dye Released from Apalachicola River



Model Test for Sediment Re-suspension

