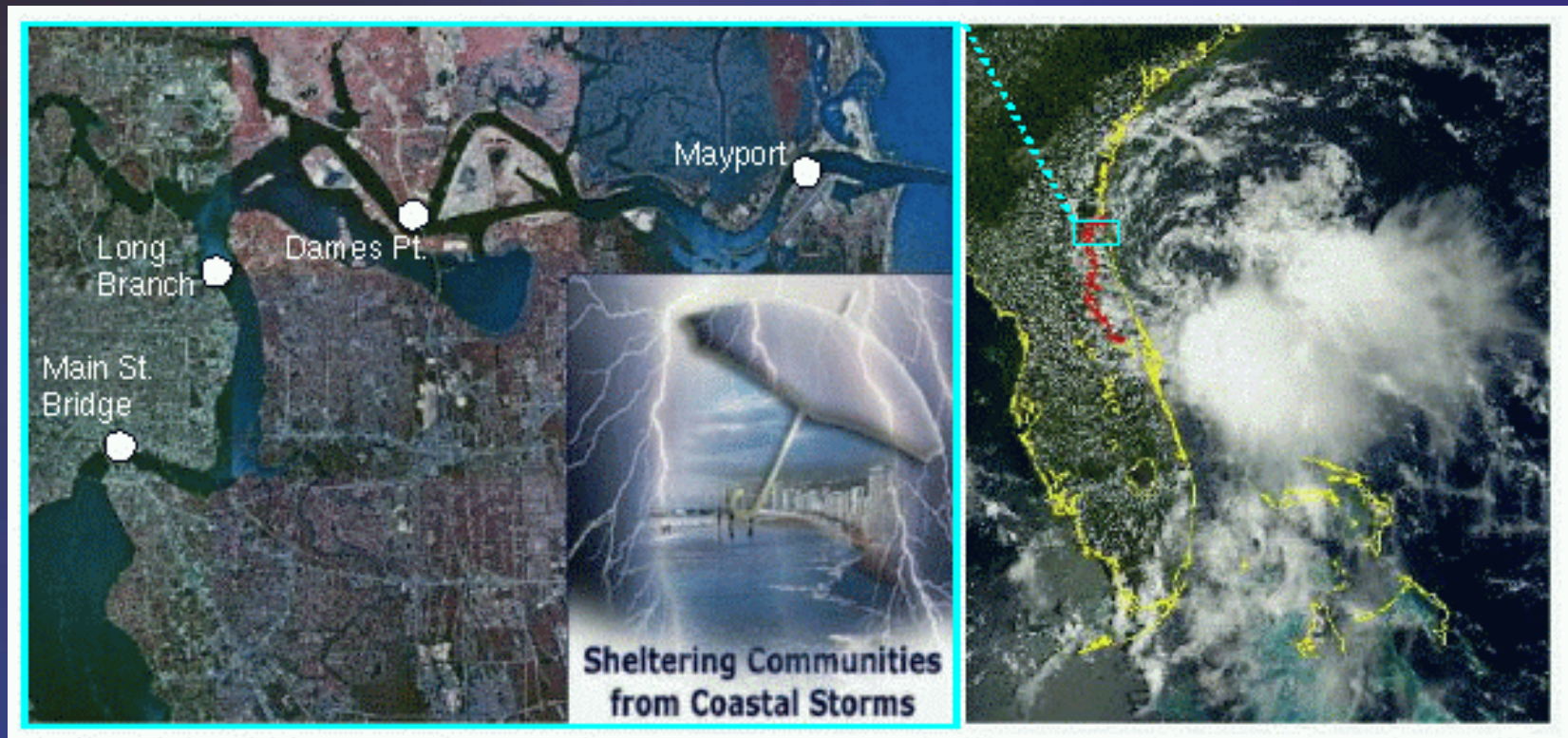# Using ELCIRC in NOAA's Coastal Storms Initiative

Ed Myers, Frank Aikman and Aijun Zhang
**Coast Survey Development Laboratory, National Ocean Service**

Coastal Storms Initiative Pilot Study, NE Florida

Coastal Storms Initiative

The Coastal Storms Initiative (CSI) is a nationwide effort led by the National Oceanic and Atmospheric Administration (NOAA) to lessen the impacts to coastal communities from storms. To accomplish this goal, local, state, and federal organizations are working together to develop a large suite of new and improved tools, data, information, forecast models, and training for coastal communities. This effort will help coastal communities plan for, respond to, and recover from coastal storms.
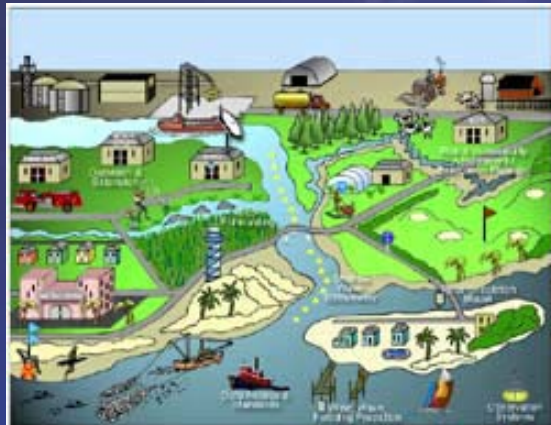
CSI Pilot Study Area: St. Johns River Watershed

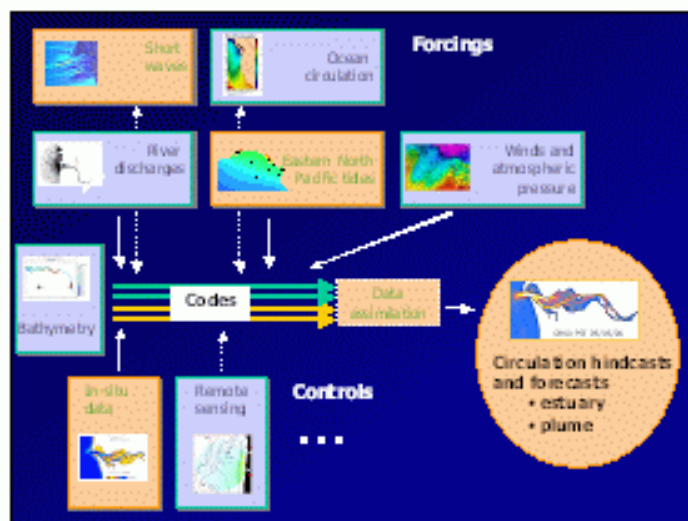# Second CSI Project Area: Pacific Northwest

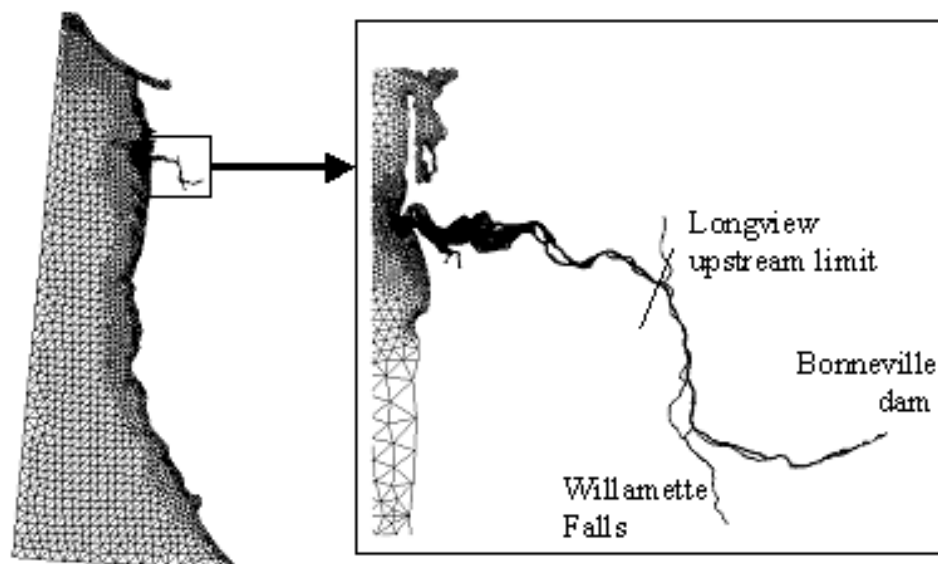Fig. 1: Components of the CORIE modeling system

Fig. 2: CORIE domain

The Need to Mitigate Impacts of Coastal Storms: NE Florida Pilot

Hurricane DORA
Maximum sustained winds 130 mph
Minimum central pressure 942 mb
8/28 – 9/16 1964

Storm Category
- Tropical Depression
- Tropical Storm
- 1 (74 - 95 mph)
- 2 (96 - 110 mph)
- 3 (111 - 130 mph)
- 4 (131 - 155 mph)
- 5 (> 155 mph)
- □ 00 GMT positions

- **Flooding due to Storm Surge**

- **Wave Action on the Coast**

- **Adverse Weather**
  - ° **Wind**
  - ° **Precipitation**
  - ° **Thunderstorms**
  - ° **Marine Visibility**

- **Navigation Hazards**
  - ° **Water Levels and Under Keel Clearance**
  - ° **Currents for HAZMAT, Search and Rescue, Homeland Security**

- **Resource Management**
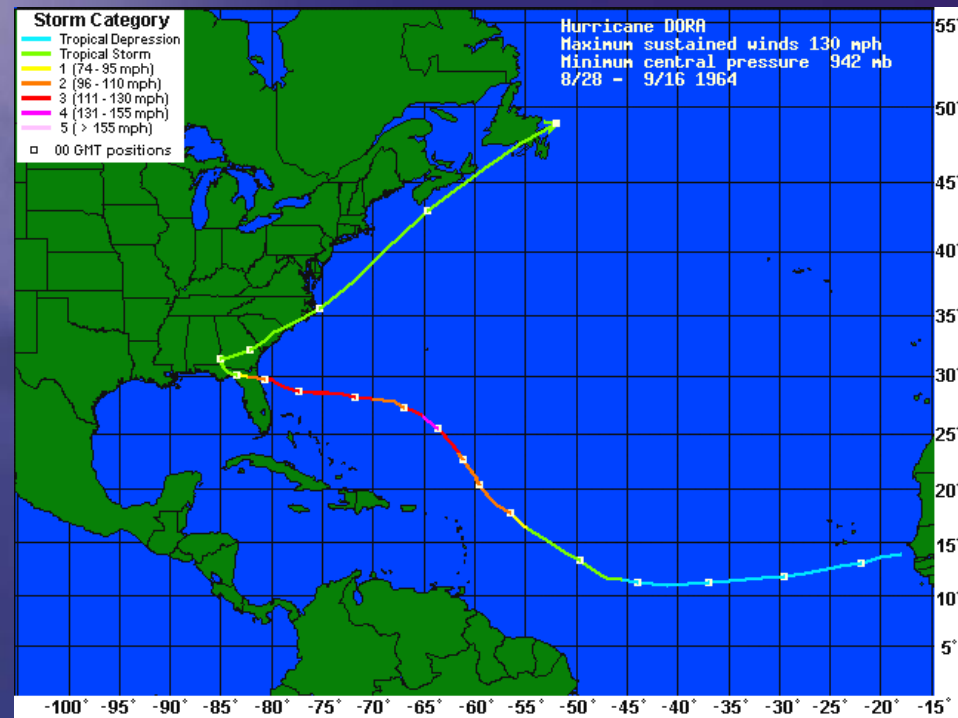
St. Johns River Circulation Model

- **EFDC (Environmental Fluid Dynamics Code) application developed by the St. Johns River Water Management District.**

- **NOS implemented a real-time experimental version:**
  - **° hourly nowcasts**
  - **° 36-hour forecasts four times a day**

- **Webpage with water levels, currents, salinity and temperature from both model and data.**
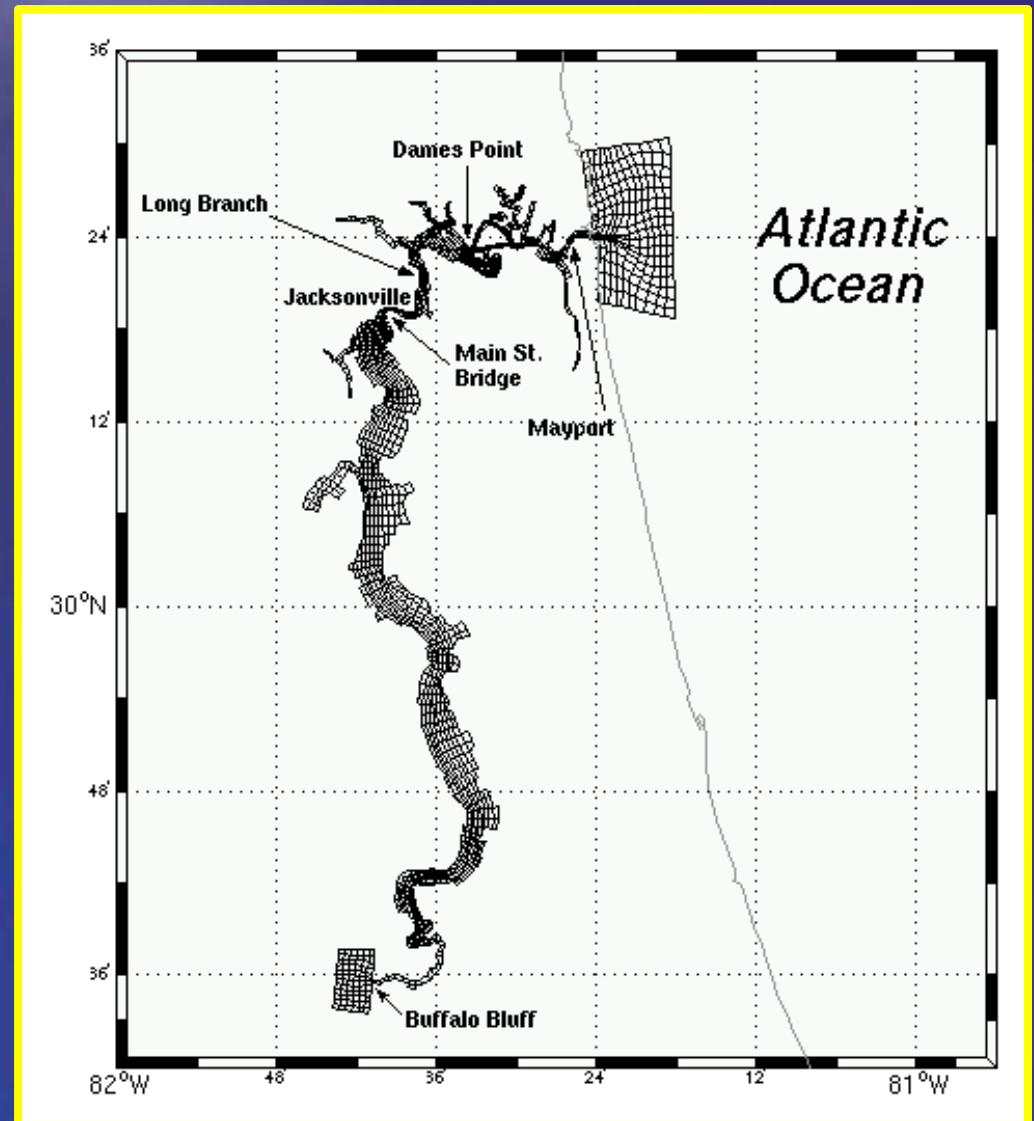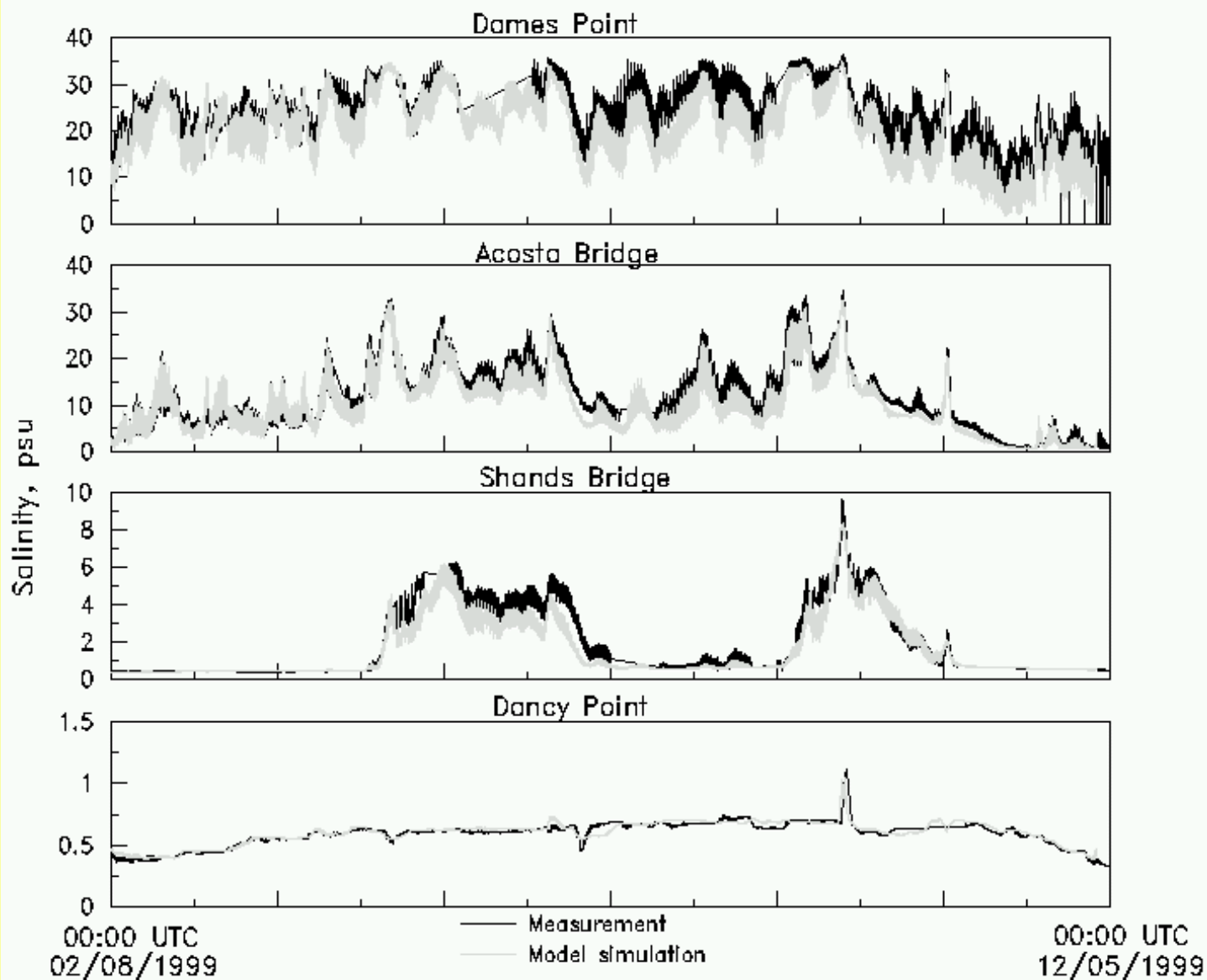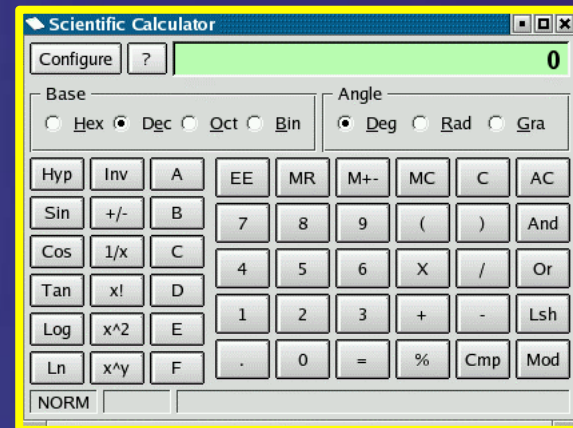
Hindcast Velocities: 1995-1998
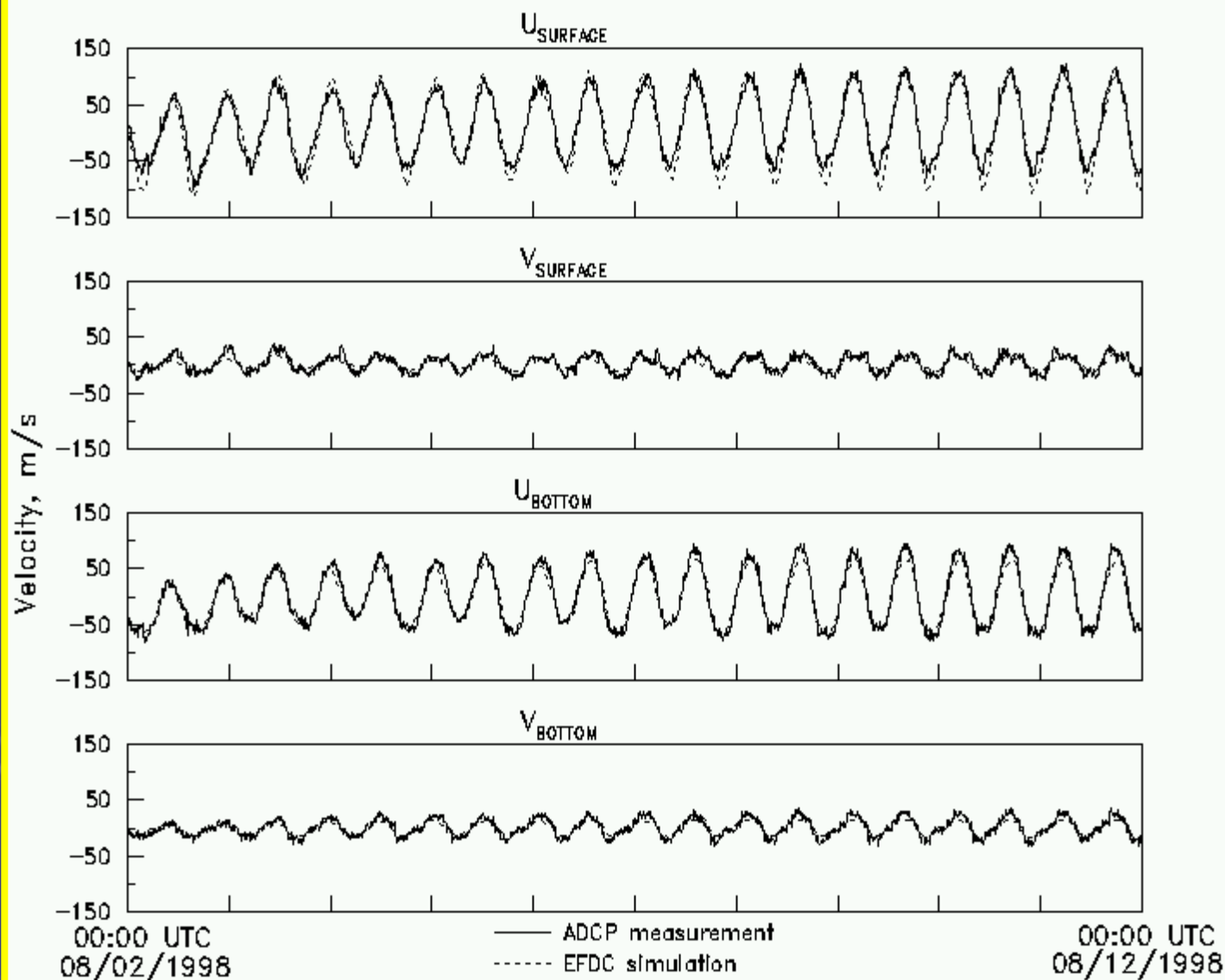
Hindcast Salinity: 1995-1998

Accuracy of the Hindcast Simulation

- Percent errors in the M_2 amplitude at 26 locations ranged from 0.6-14%, with an average error of 5.6%.

- The maximum and average M2 phase errors were 6 degrees and 2.8 degrees, respectively.

- Tidal velocities were reproduced to within 10% of the observed velocities at four ADCP NOAA deployments in the lower estuary.

- RMS errors in subtidal water levels ranged from 2.8-5.6 cm and correlation coefficients with the data were all above 0.94.

- RMS salinity errors were 0.02-2.4 psu (tidally-averaged), 0.1-1.7 psu (monthly-averaged), and less than 0.2 psu (long-term averaged).
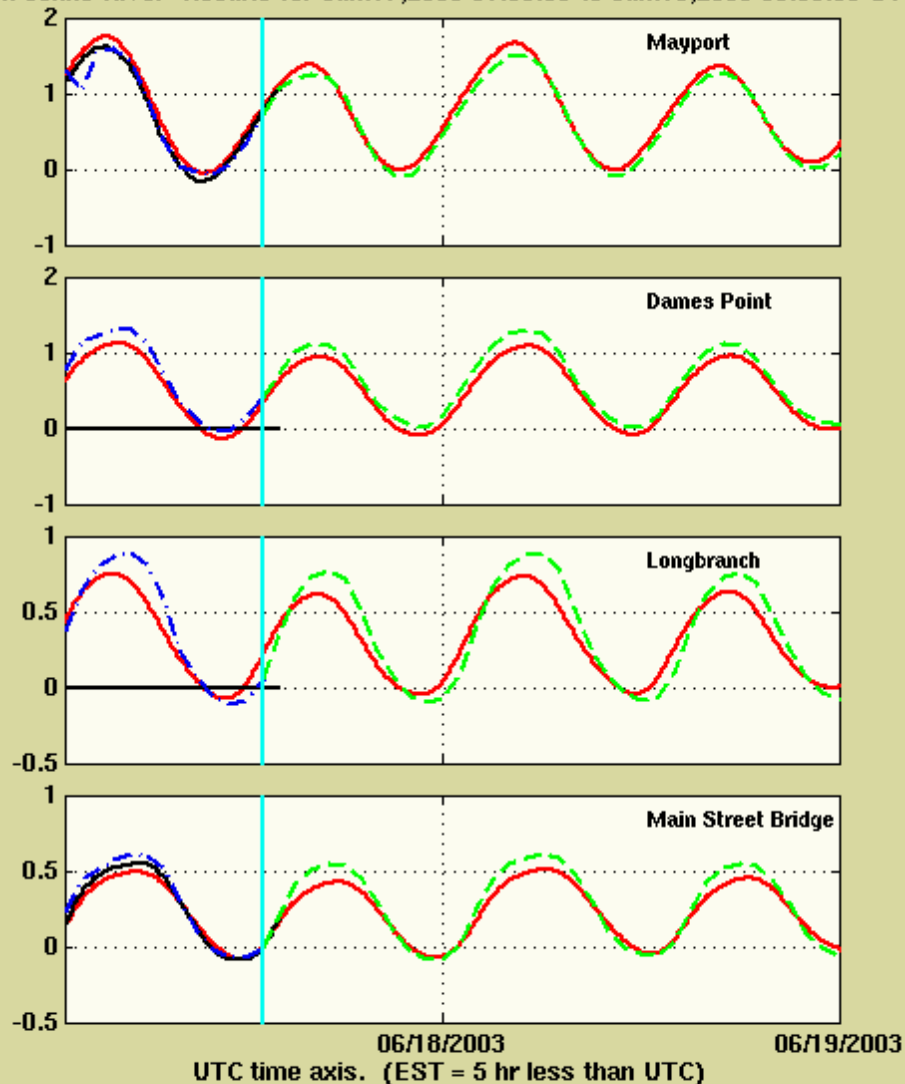
Real-Time Water Levels

Legend: Tide Prediction, Observation, Nowcast, Forecast, Nowcast Limit

- **For the nowcasts, the model uses water levels from Mayport as an open ocean boundary condition.**
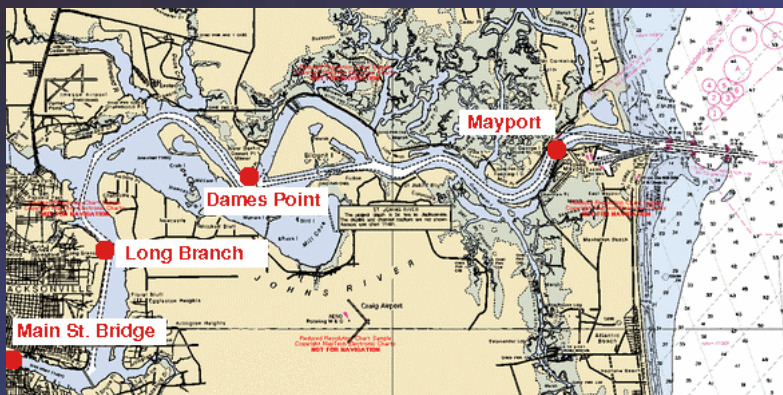
- **For the forecasts, tide predictions from Mayport are added to forecasts of nontidal water levels made by NWS' Extratropical Storm Surge model.**

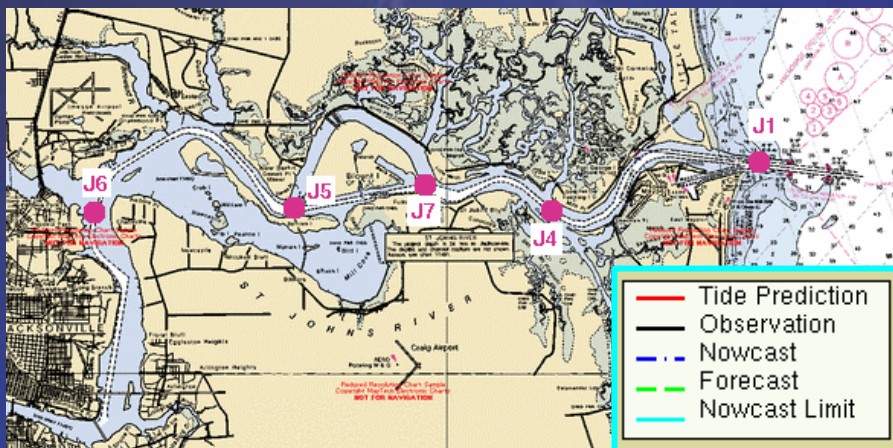St. Johns River Results for Jun.17,2003 01:00:00 to Jun.19,2003 00:00:00 UTC

Mayport, Dames Point, Longbranch, Main Street Bridge

06/18/2003   06/19/2003
UTC time axis. (EST = 5 hr less than UTC)

Real-Time Currents

Along-Channel currents are compared with tidal predictions computed from historical current meter measurements.

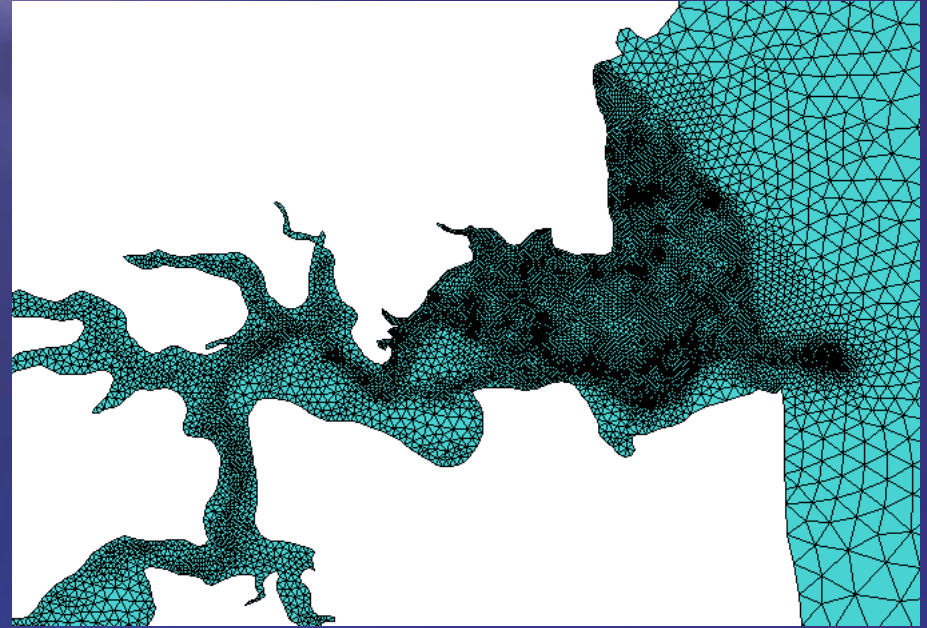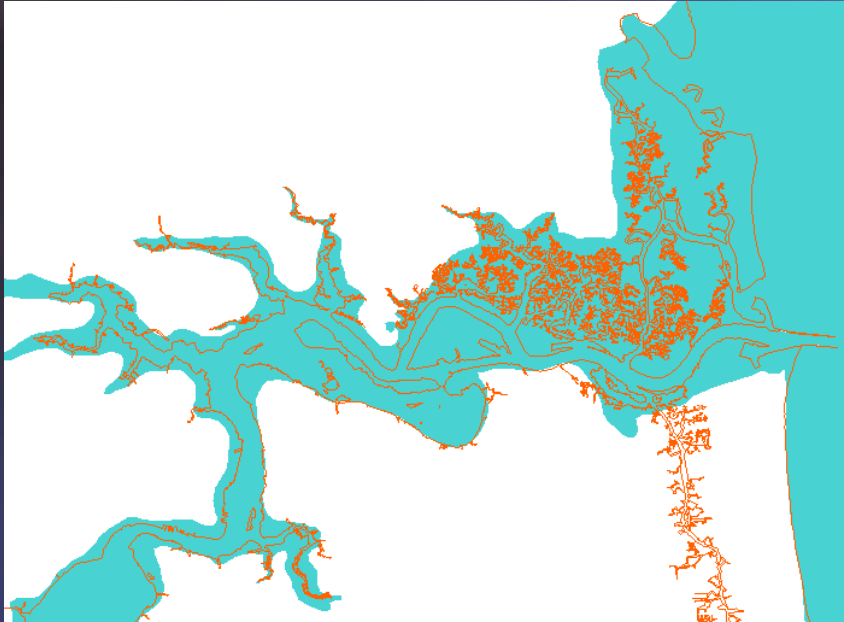**New current measurements will enable updated model evaluations and comparisons.**

St. Johns River Results for Jun.17,2003 01:00:00 to Jun.19,2003 00:00:00 UTC
Along-Channel Velocity (knots)

Tide Prediction
Observation
Nowcast
Forecast
Nowcast Limit

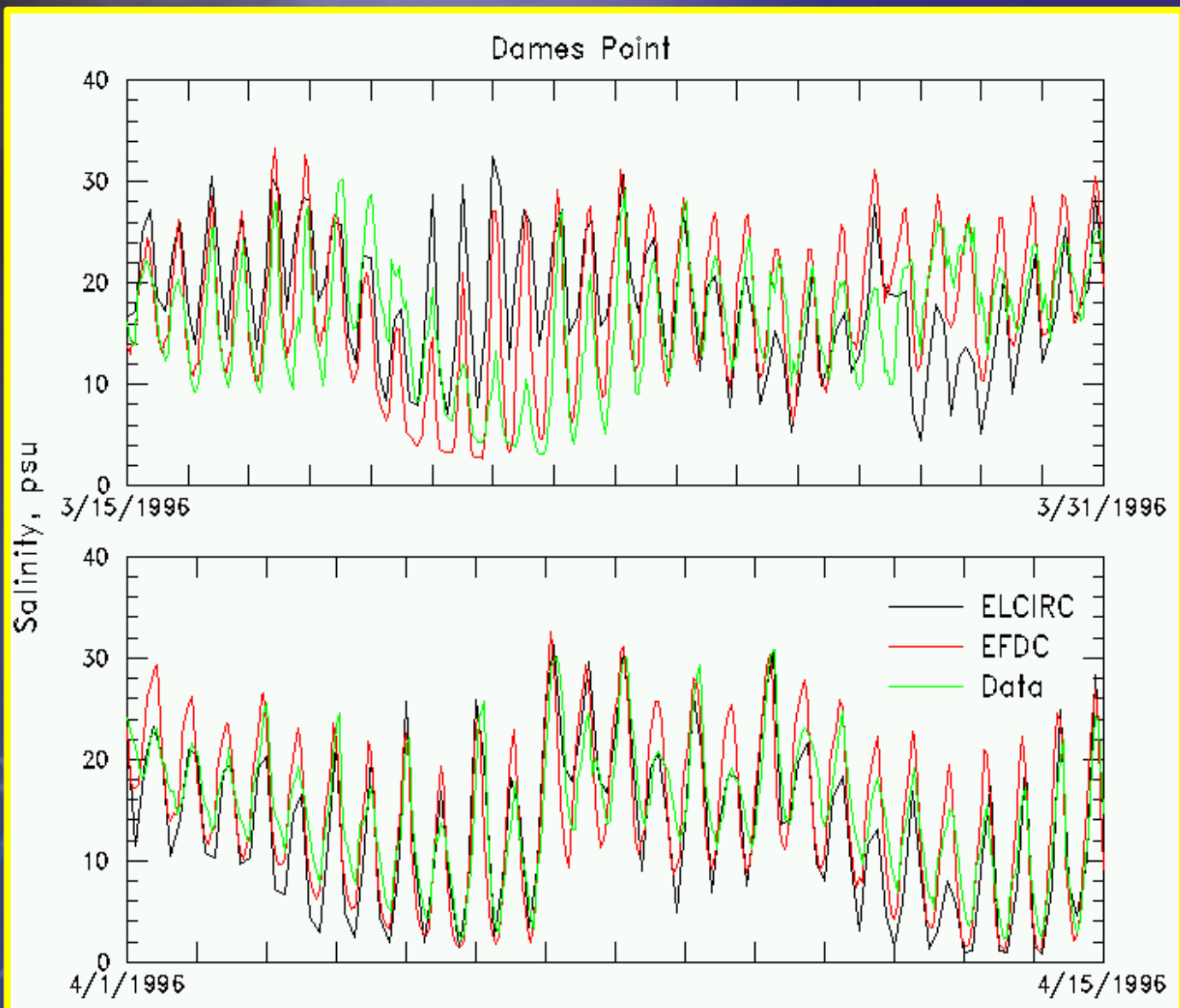UTC time axis. (EST = 5 hr less than UTC)
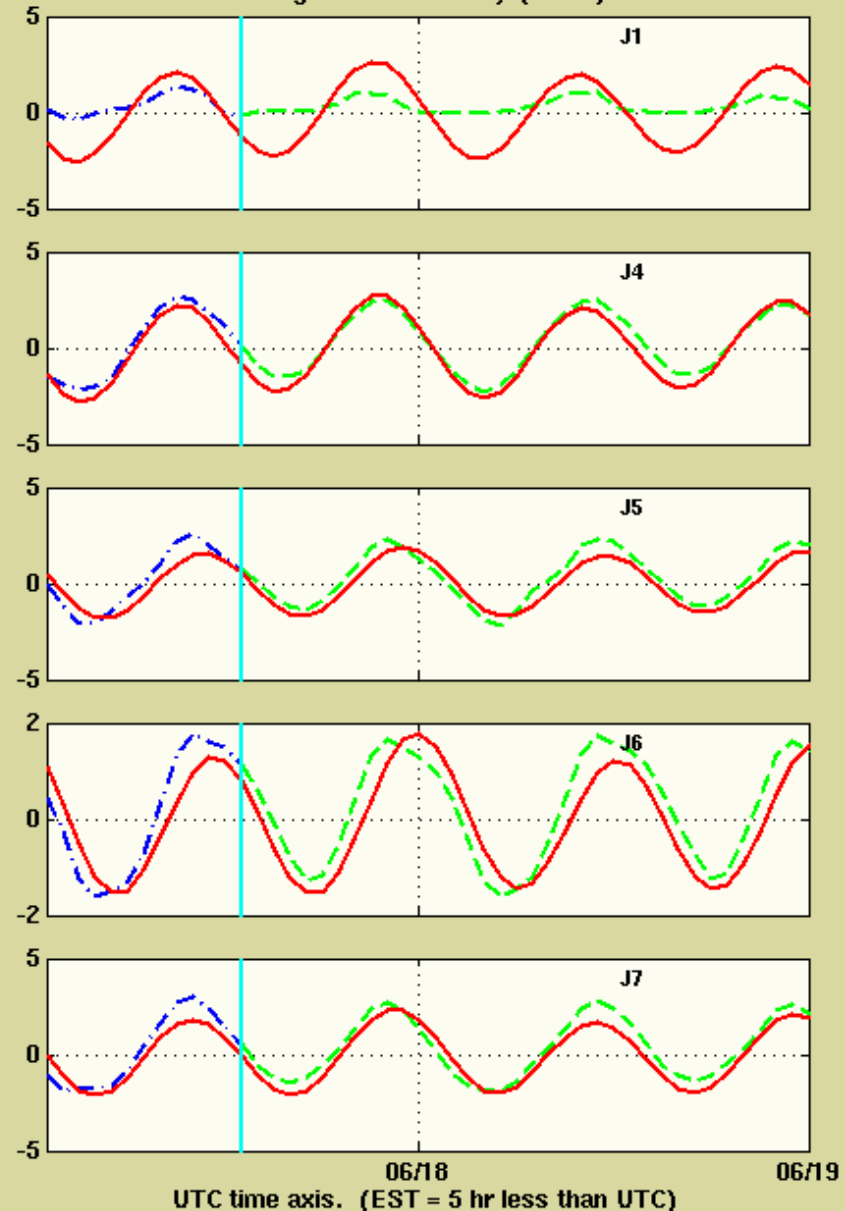
Applying ELCIRC in the St. Johns River

- 3D Baroclinic Model; Finite Difference/Finite Volume
- Natural treatment of wetting and drying
- Unstructured grids with triangles and quadrangles
- Z-Coordinate vertical resolution
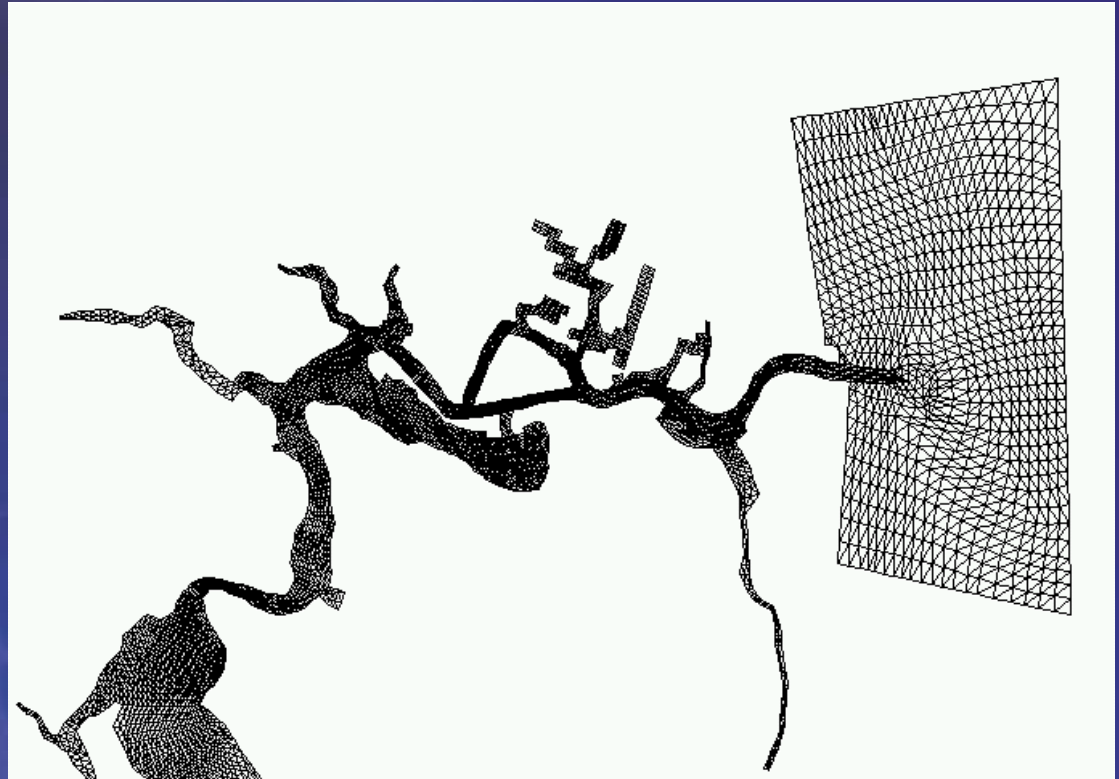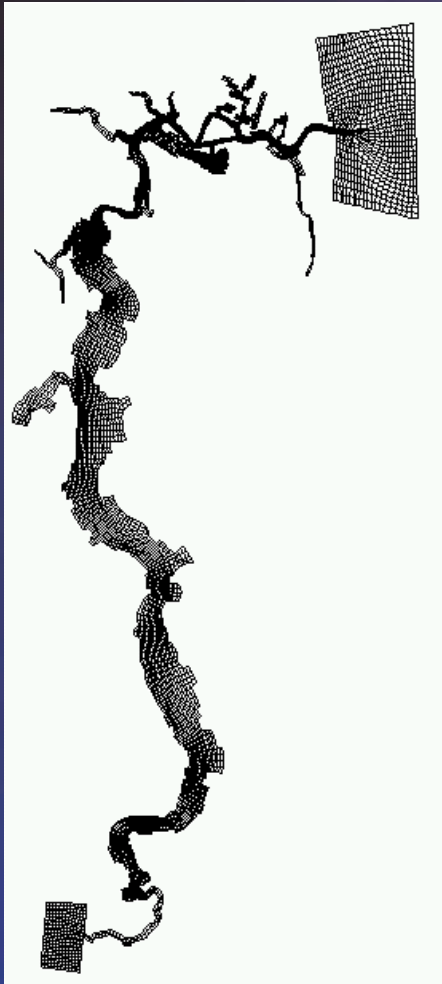- Lagrangian treatment of advection, thus larger time steps
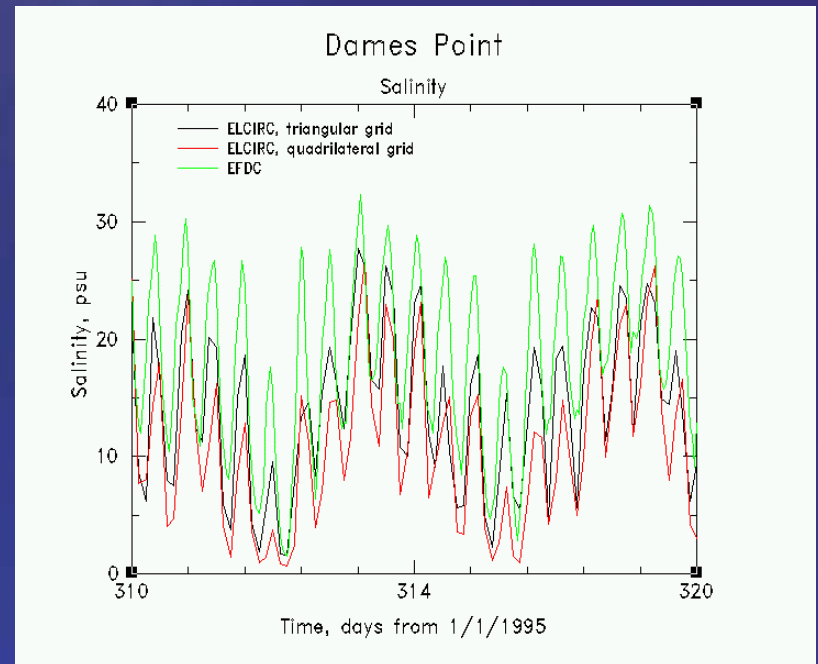
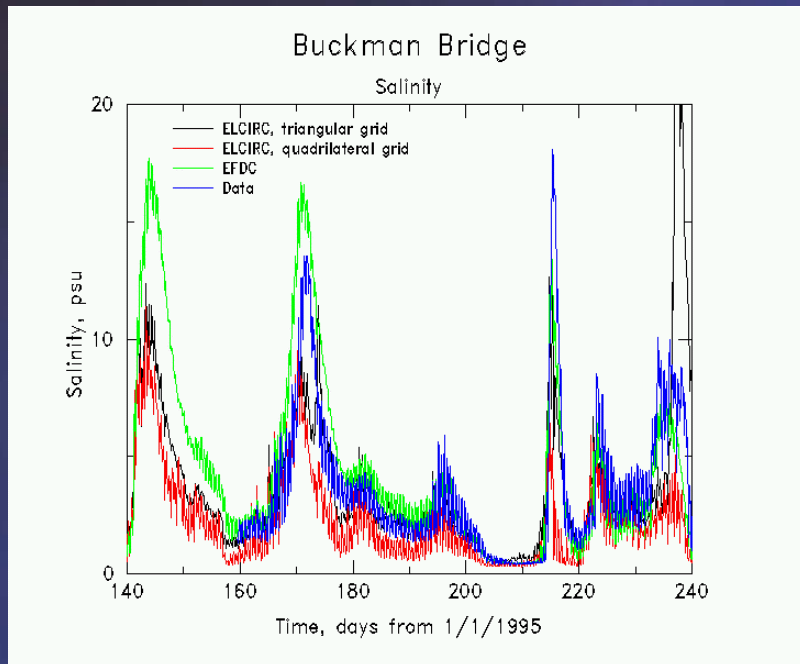# Comparisons of Simulated Salinity

Triangular vs. Quadrilateral Grids: the issue of orthogonality

Less Salinity Intrusion with Quadrilateral Grid

Assessing the Model Performance
NOS Skill Assessment Standards

NOS skill assessment standards will be evaluated for the following model run scenarios in the St. Johns River and the Columbia River :

- Astronomical Tide Only
- Hindcast
- Test Forecast
- Semioperational Nowcast
- Semioperational Forecast

Performance statistics will be computed for variables such as water level, times and amplitudes of high and low water, speed and direction of the currents, times and amplitudes of the maximum flood and ebb currents, start/end times of slack water, and water density effects on buoyancy. :

Flood Forecasting

- **National Weather Service (NWS) working with National Ocean Service (NOS) to:**
  - **Create 6 new forecast points on the St. Johns**
    - **Part of NWS Advanced Hydrologic Prediction Service (AHPS)**
    - **Will provide inputs to NOS estuary model**
  - **Develop real-time flood mapping capability**
  - **Integrate output from NOS estuary model with NWS models (inland river, storm surge) into a single product.**
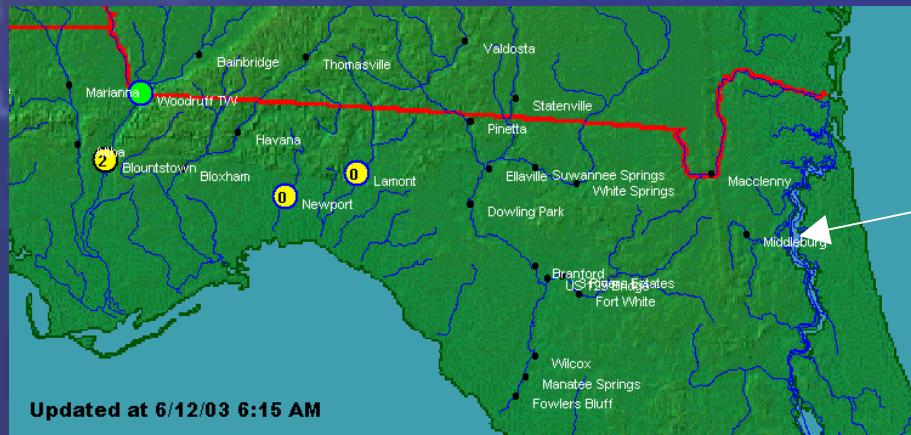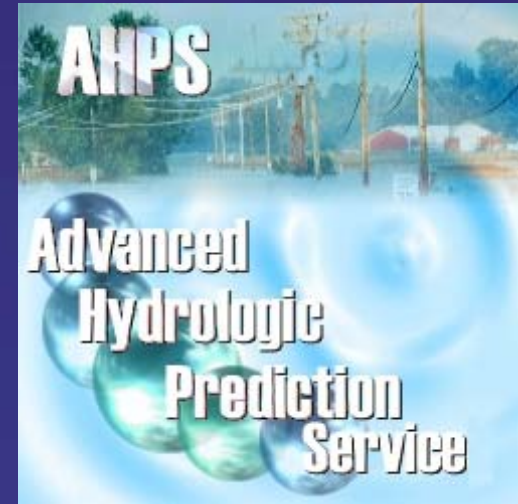
Currently no river forecast points

Integrating the Model into COMFS

Data Grabbing: A series of programs which pull the necessary external data off the various databases and makes it available to the model.

Reformatter: A series of programs specific to the model code which will reformat the standard data into the specific formats necessary for the model code.

Model Run: The specific model code, (POM, ROMS, Quoddy, Elcirc, etc.) is run. An alteration to the specific model code will be the use of our standardized output methods to create the CSDL NetCDF files.

Plotting: Standardized plotting programs will run on the standard CSDL NetCDF output files to create graphics which will be sent to standardized web pages for display by CO-OPS.

Archiving: The primary archive products are the CSDL NetCDF output files.

Summary

- **The EFDC application developed by the SJRWMD was transferred to NOS is currently being used in nowcast/forecast simulations.**

- **Development of an ELCIRC application in the St. Johns River is planned to replace the current EFDC nowcasts/forecasts.**

- **The grid is being adjusted to accomodate wetting/drying, and orthogonality is enforced as much as possible.**

- **NOS skill assessment will be used to assess the quality of the ELCIRC results, both in the St. Johns River and the Columbia River.**

- **NOS and NWS are working together to integrate their models into consolidated CSI products for NE Florida and the Pacific Northwest.**