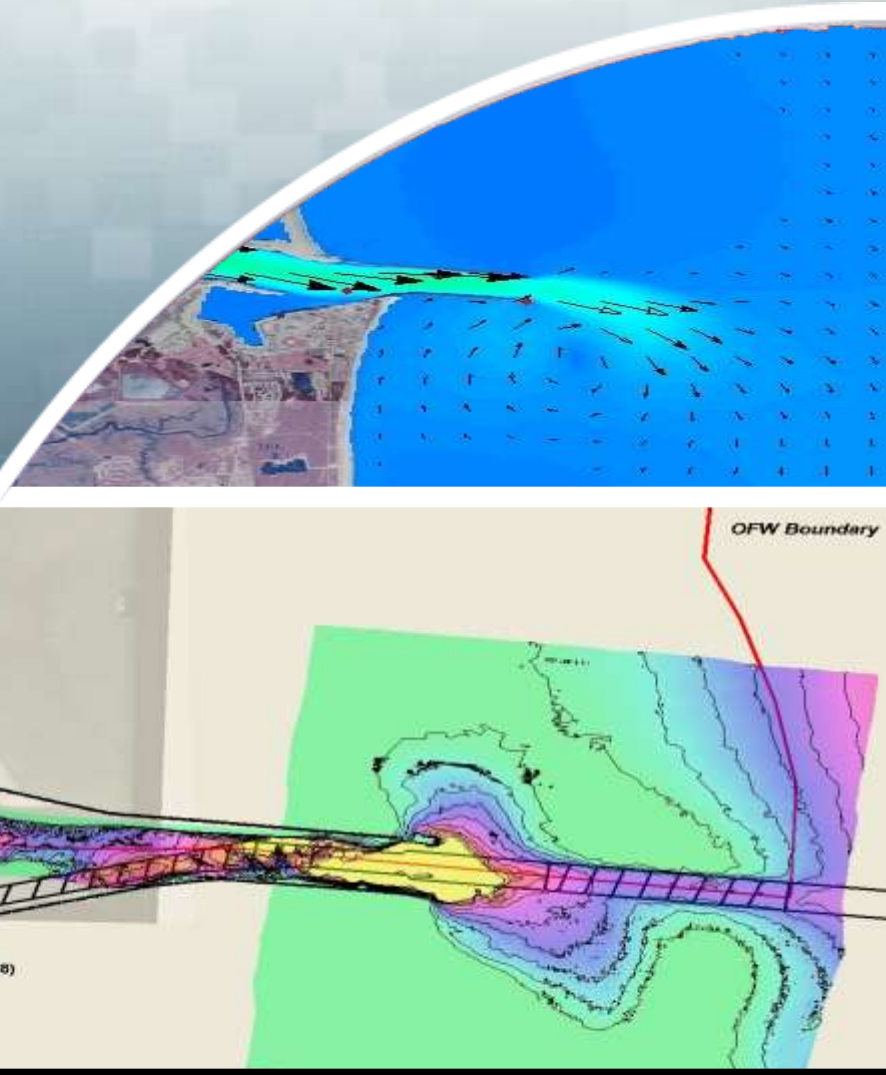
Regional Sediment Management – Application of a Coastal Model at the St. Johns River Entrance

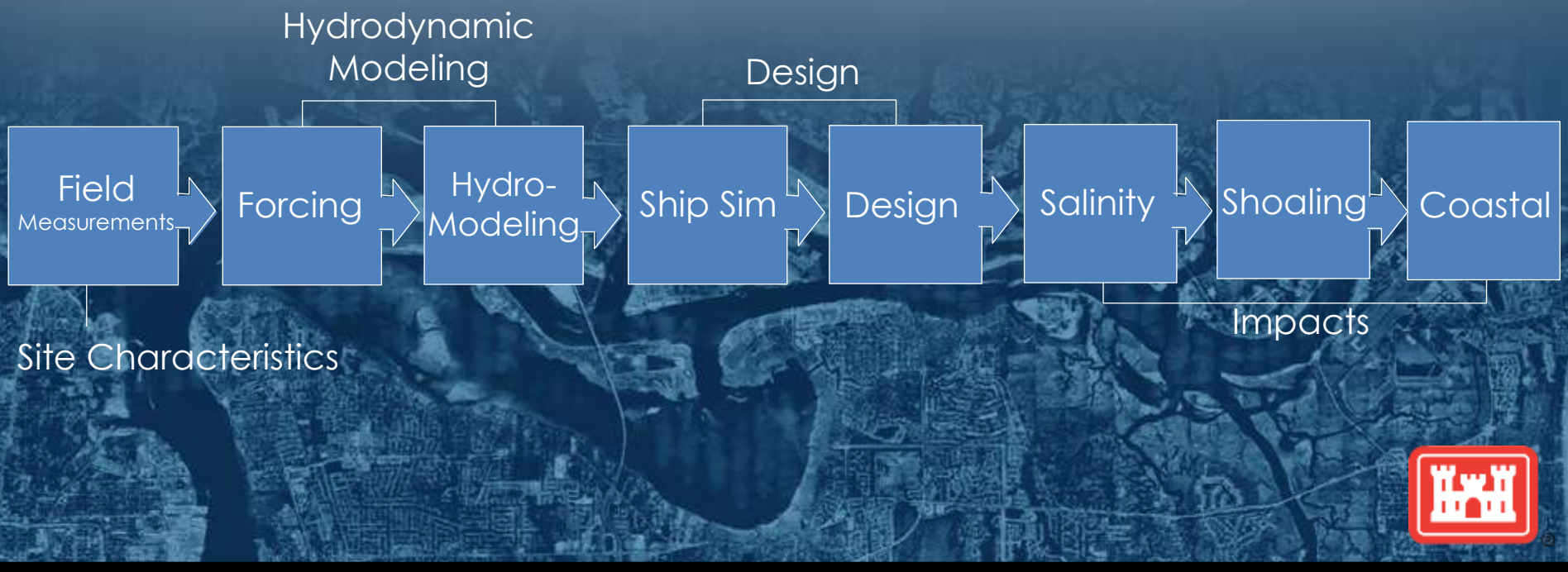
Steven Bratos
Senior Coastal Engineer
U.S. Army Corps of Engineers – Jacksonville District

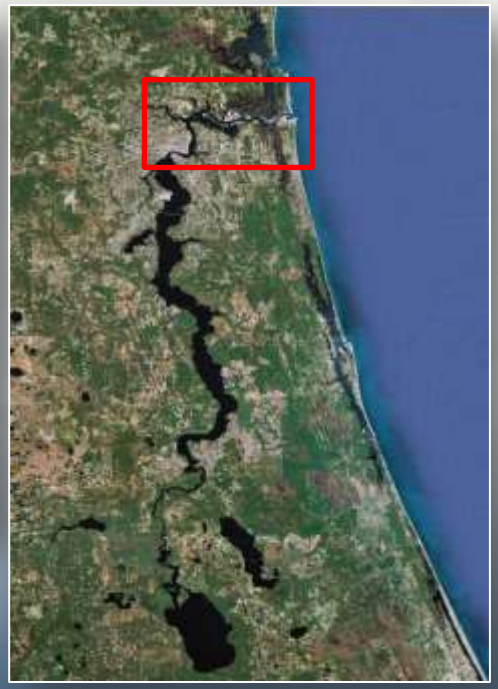
February 11, 2011



Presentation Outline

- Jacksonville Harbor Project Background
- Project vs Regional View
- Coastal System Approach
- Summary & Conclusion



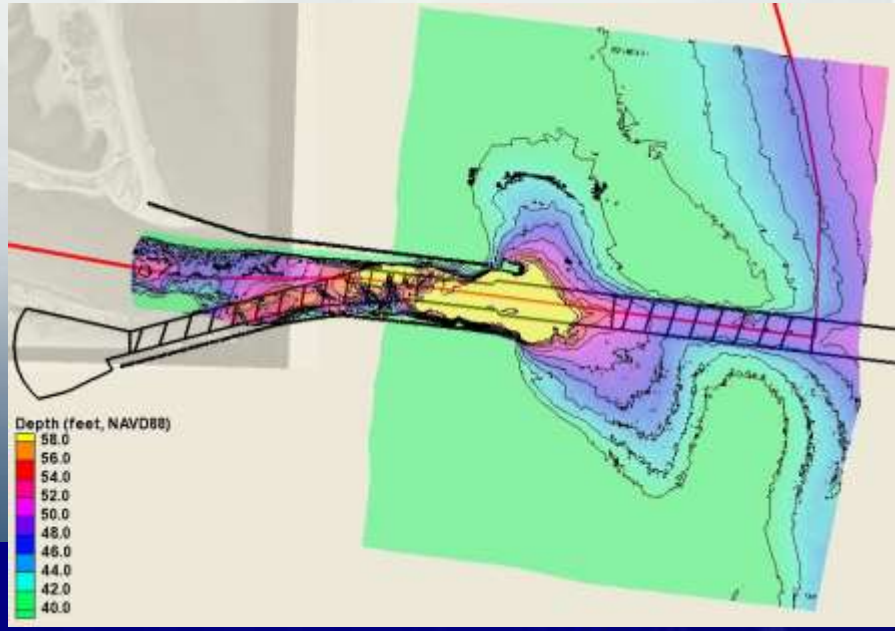


Project Location

Jacksonville Harbor Federal Channel

Jacksonville Harbor – Mayport NS

- Jacksonville Harbor Seg. 1&2
  (14 mi, 6 mi)
- Existing Project Depth – 40 ft, Proposed between 40 & 50 ft
- Mayport NS – Project Depth 50 ft (under constr)



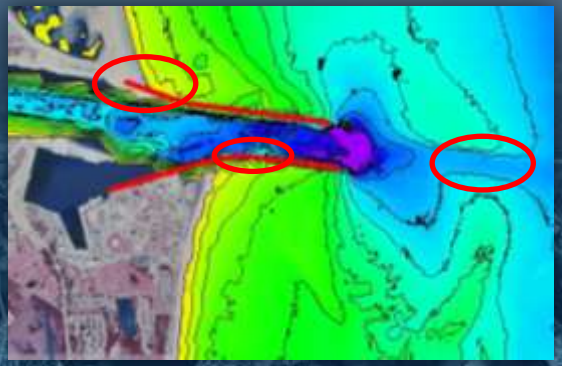
Project & Regional View

PROJECT SCALE

- Channel Shoaling
- Impacts – Adjacent Inlets & Beaches
- Miles
- Years

REGIONAL SCALE

- Manage Sediment per Littoral Processes
- Multi-Project
- 10s of miles
- Decades



Shoaling Rates 10 to 40 KCY/yr

Modeling | Design | Impacts

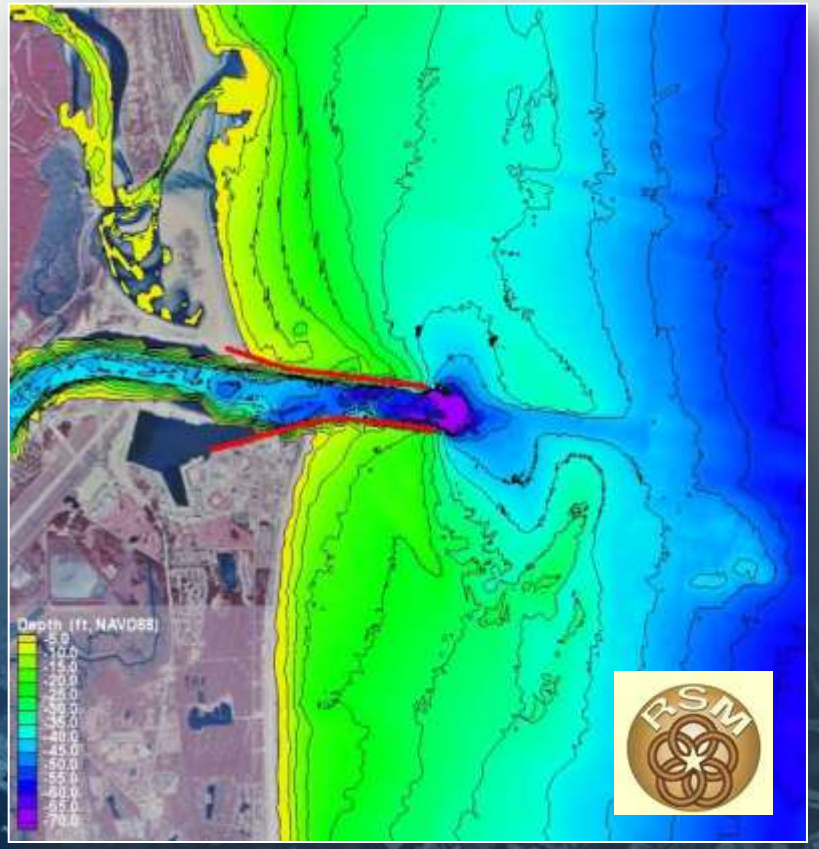
Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

Impacts to the Littoral Zone

Beaches and Inlets

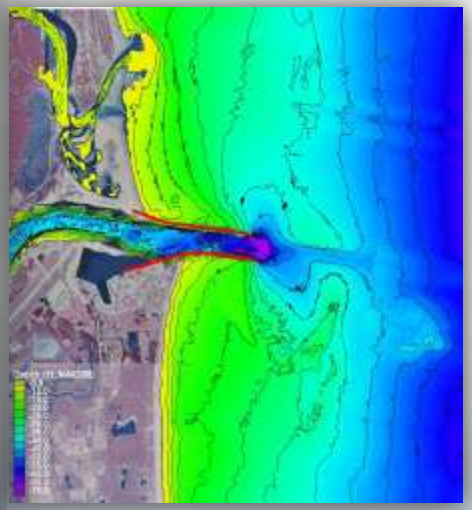
- Regional Sediment Management
- Sediment managed as valuable resource
- Regional – Multi project level
- Understand existing condition
- Inlet and adjacent beach morphology
- Regional effects of project modification

  - ➢ Sediment transport modeling
    - Deposition/erosion



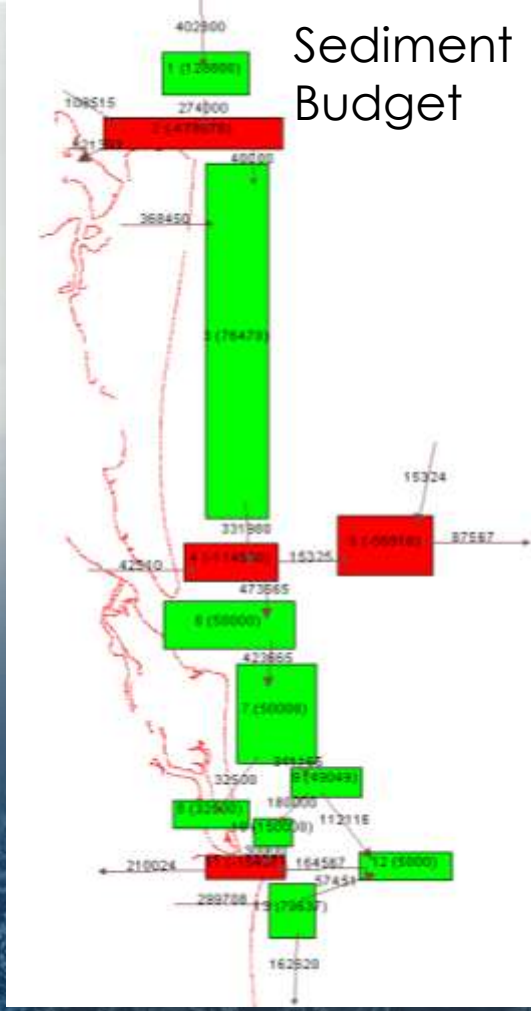
Modeling | Design | Impacts

Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal



Regional Sediment Management

- Mining Ft. George Flood Shoal and Wards Bank
- Improve Ft. George River Flow
- Back pass to Little Talbot
- Bypass to Duval County SPP
- Nearshore Placement Duval Co SPP



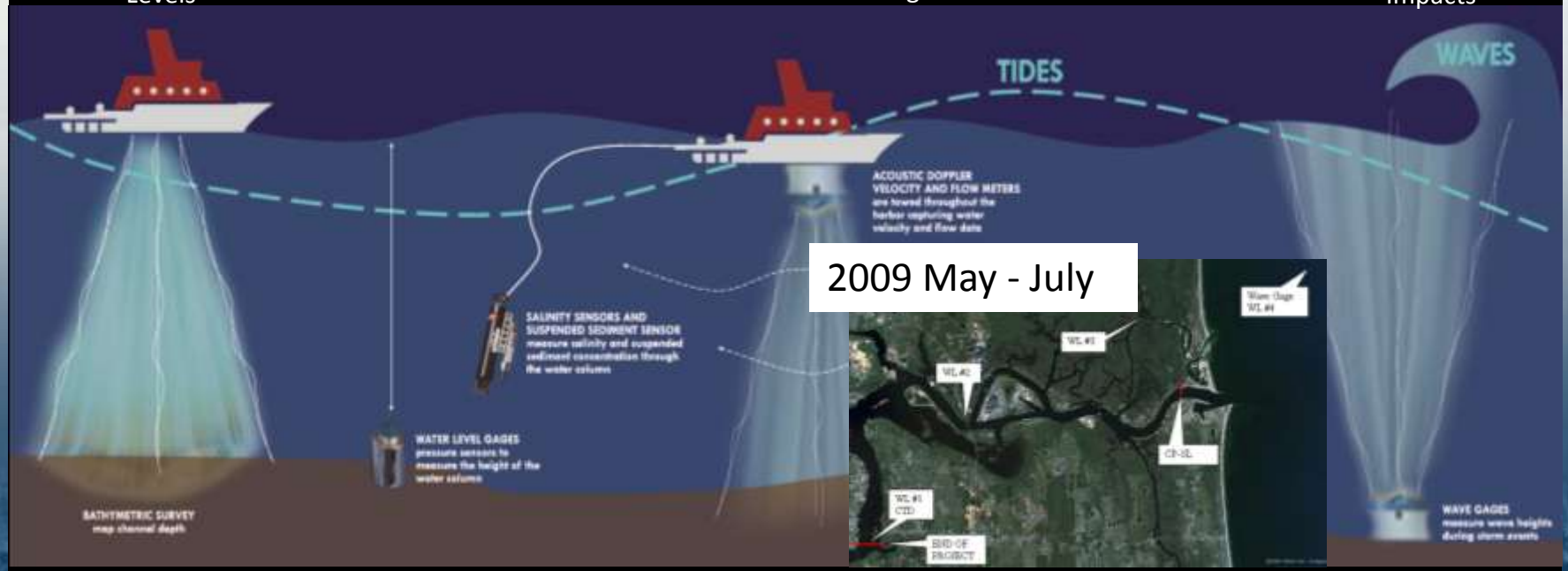
Modeling | Design | Impacts

Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

Field Measurements and Modeling

PHYSICAL CHARACTERISTICS

Water Levels | Velocities and Flows | Salinity | Channel Shoaling | Ship Wakes | Coastal Shoreline Impacts



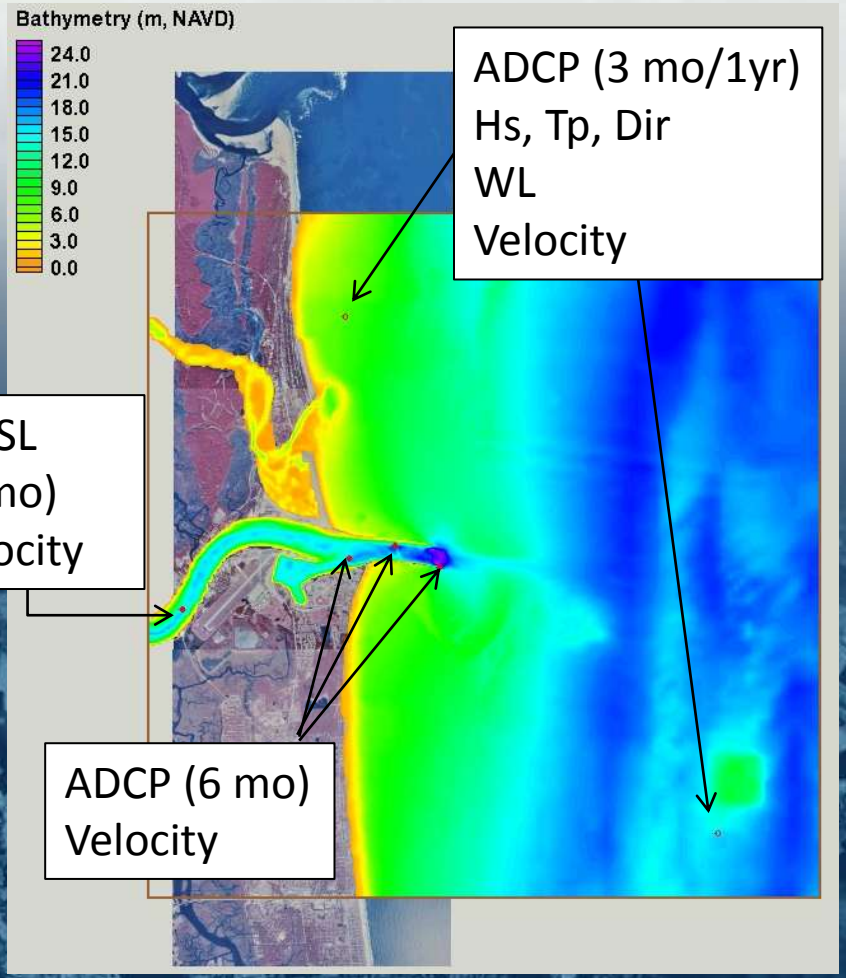
Bathymetric Survey | Water Level Gages | Salinity and Suspended Sediment Sensors | Acoustic Doppler Velocity and Flow Meters | Measurement Plan | Wave Gages

MEASUREMENTS

Modeling | Design | Impacts

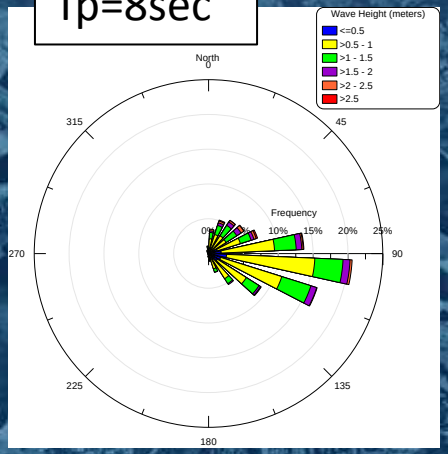
Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

CoastalMeasurements

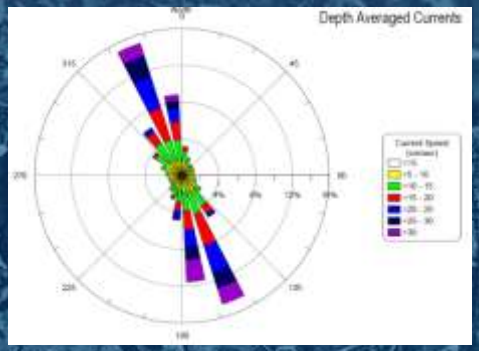


- Waves, WL, Currents
- Bathymetry (channel)
- Sediment (channel)

Waves
Hs=1m
Tp=8sec

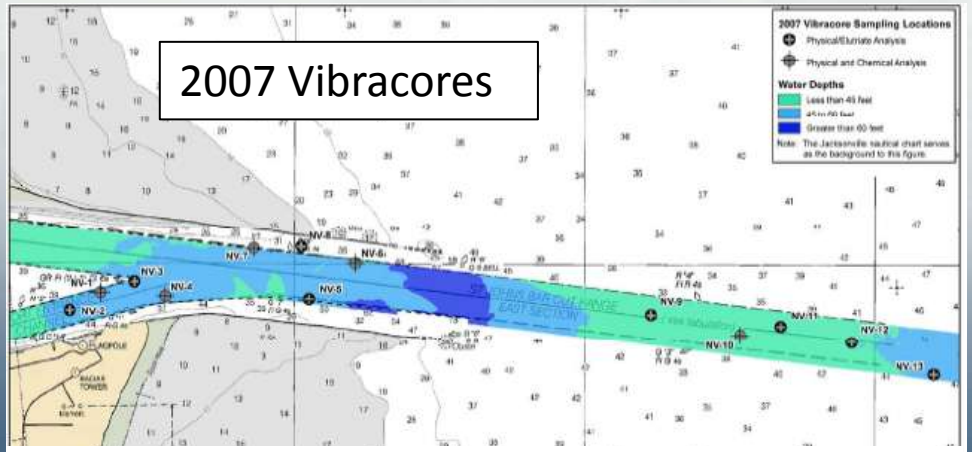


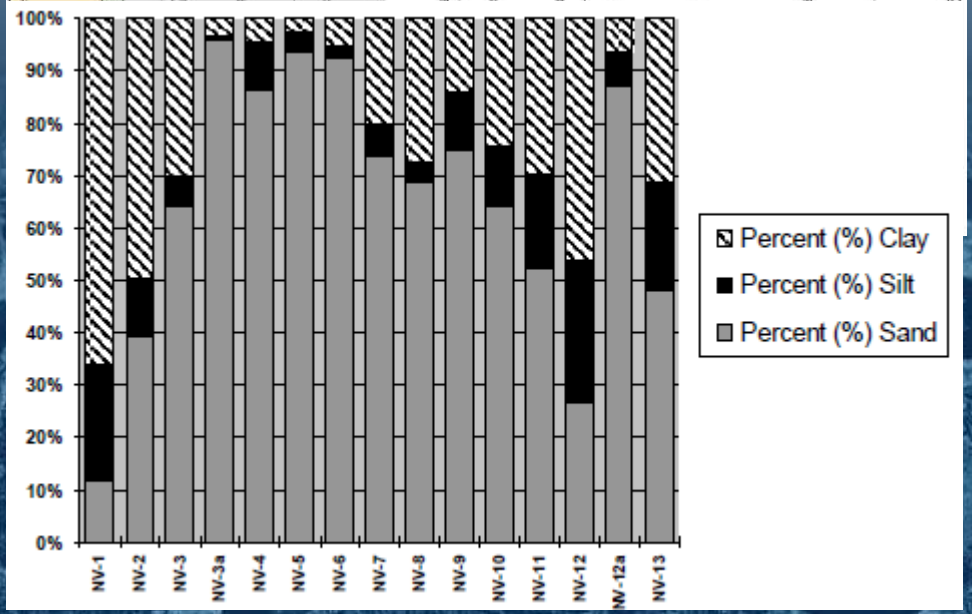
Currents



JAX ODMDS ADCP

Sediment Characteristics





Distribution (2010)

- 75 -60% fine sand
- 15 % med/cor
- 10 -25 % silt/clay

Ebb Shoal

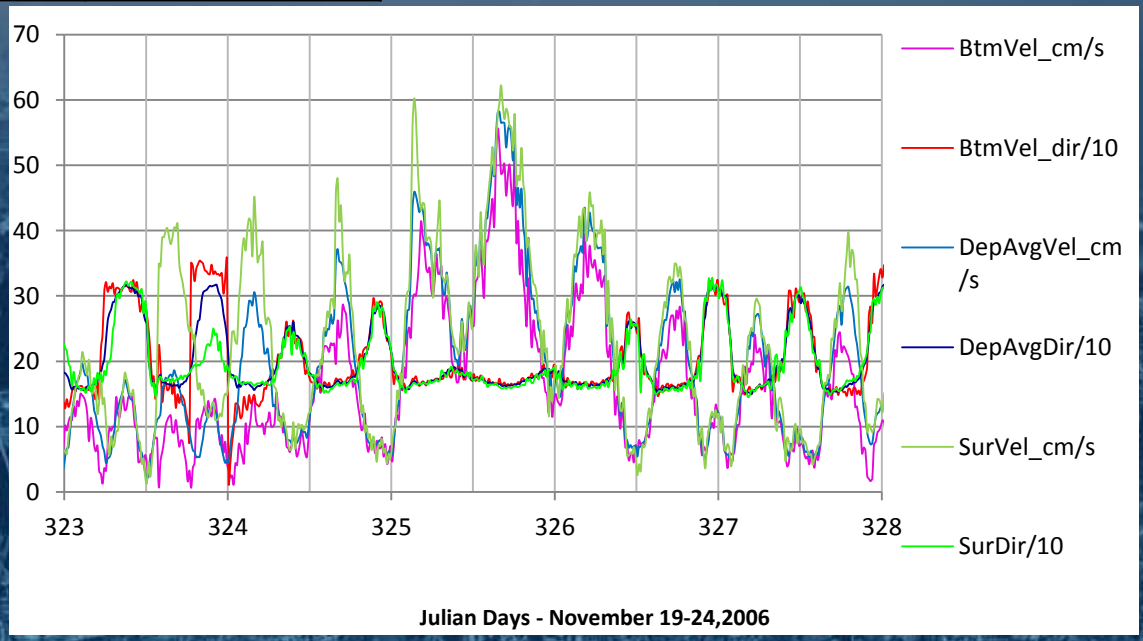
D_{50} 0.125 to 0.25 mm

Extratropical Storm Events

Storm Event	Date	Max Hs	Max Vbtm	Duration Max Vbtm above 35 cm/s
		(m)	(cm/s)	(days)
1	Sep, 10-15, 2006	**2.0**	35	0.5
2	Nov, 2-9, 2006	**2.8**	45	2.5
3	Nov, 18-25, 2006	**3.0**	45	1.5
4	Jan, 16-22, 2007	**2.8**	47	1.5
5	Mar 29-Apr 4, 2007	**2.3**	40	0.5
6	Apr 19-24, 2007	**2.7**	45	0.5
7	May 5-13, 2007	**3.0**	44	3.0
8	May 29-Jun 5, 2007	**3.6**	35	0

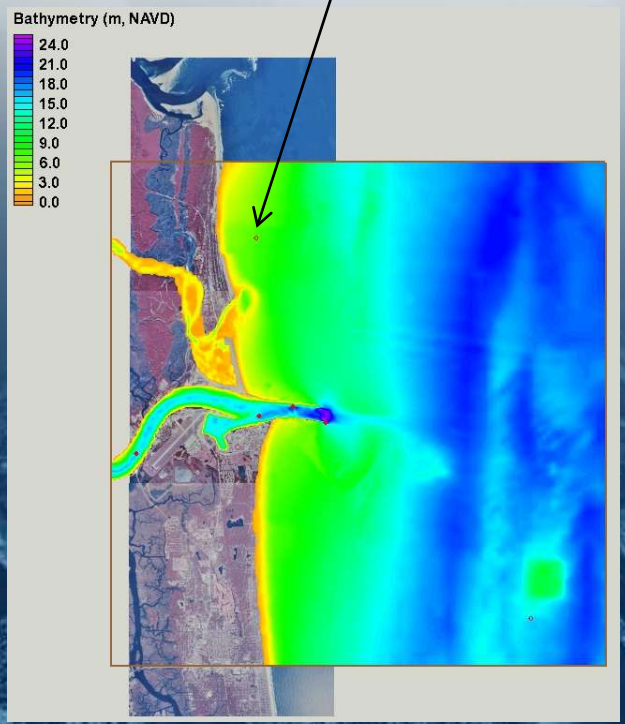
- ExtraTrop: 10-12/yr
- Tropical: 1 / 2yr

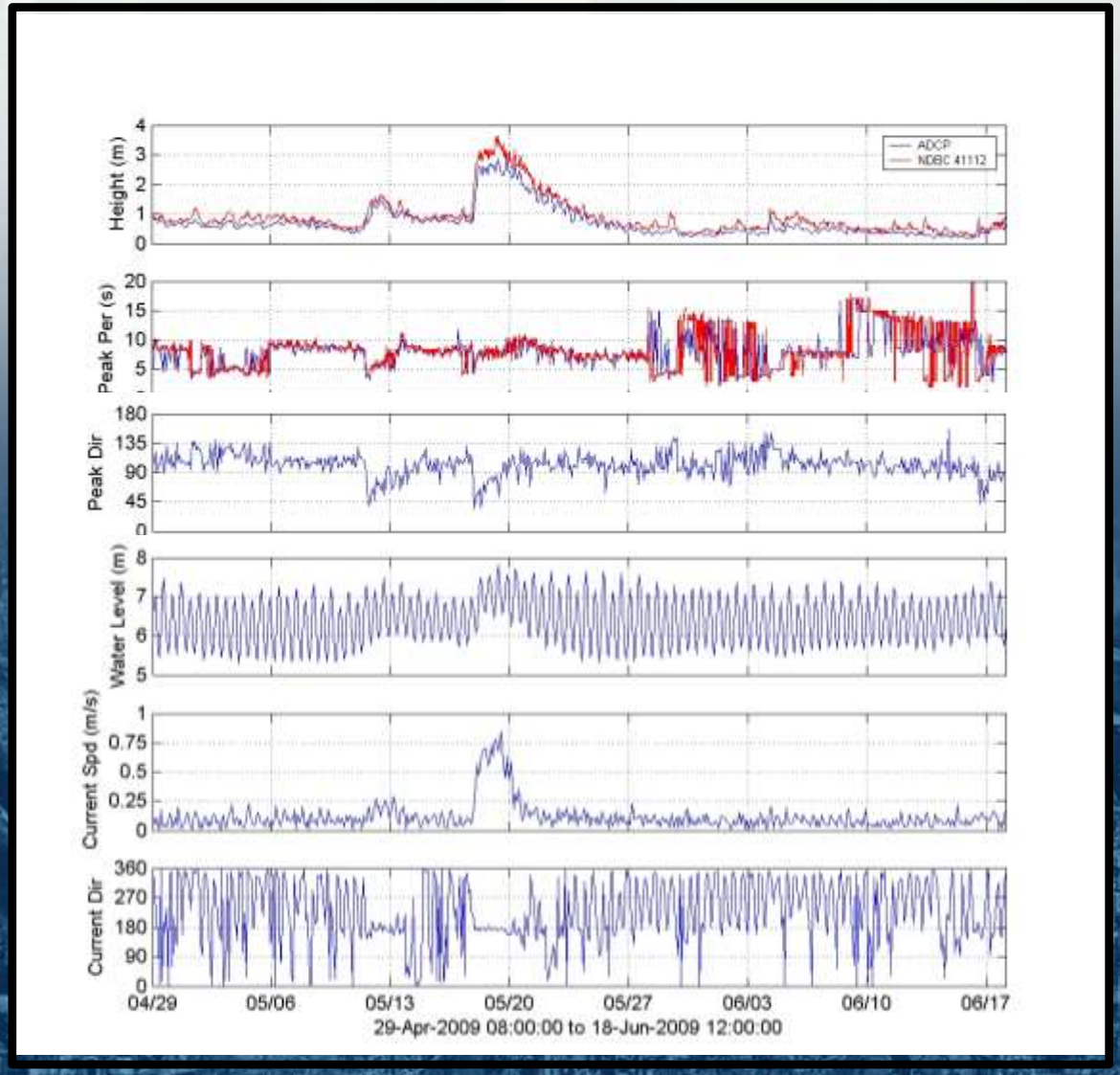
JAX ODMDS ADCP



JAX ADCP Wave – WL #4 (pressure)

JAX Gage (7m Depth)
Wave, Current, WL

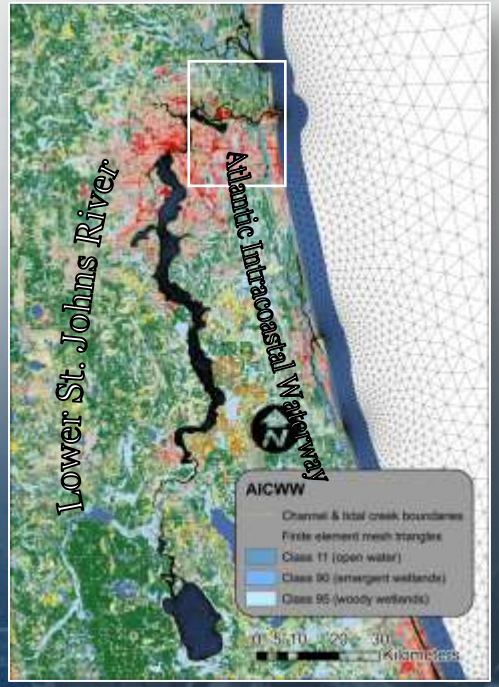




Modeling

- ADCIRC
  - Depth Averaged Water level & Current Boundary Conditions
  - Nov 2006, May – July 2009 (complete)
- Coastal Modeling System (CMS)
  - Channel Shoaling Rates *(Preliminary)*
  - Sediment budgets & sediment transport for coastal shoreline
- GenCade – Long Term Morphology (start 2011)

ADCIRC - Salt Marsh, Tidal Creeks & IWW



Advanced Circulation (ADCIRC) Models

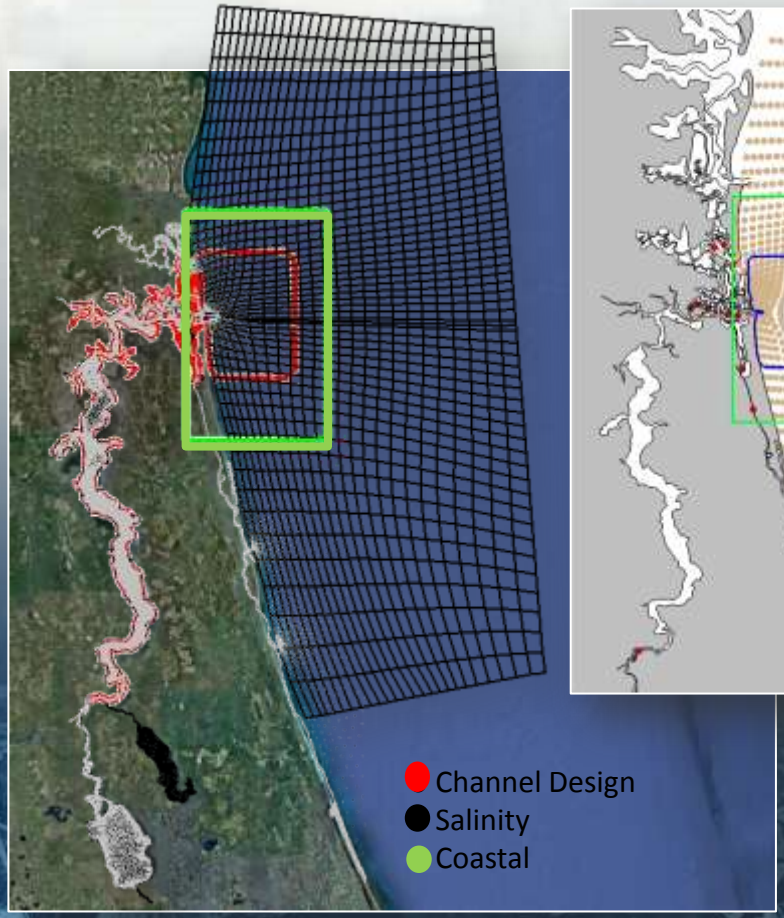
Coastal water levels and velocities

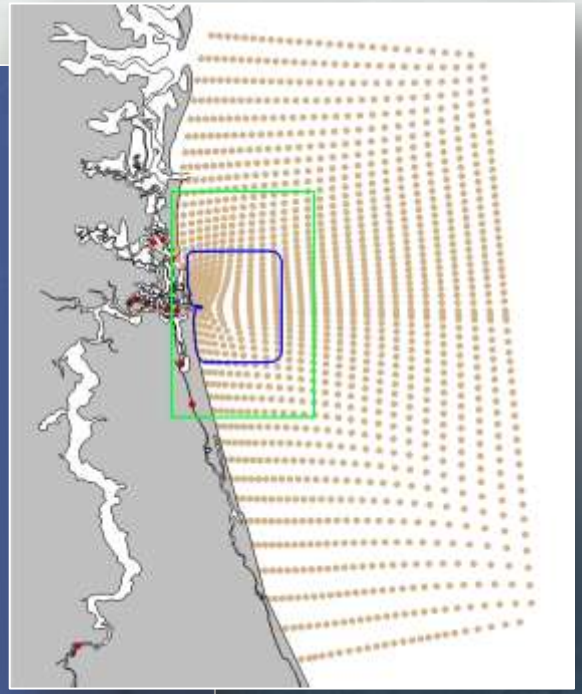
Modeling | Design | Impacts

Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

Local Model Applications - Regional ADCIRC Boundary Conditions

Tidal and Meteorologic



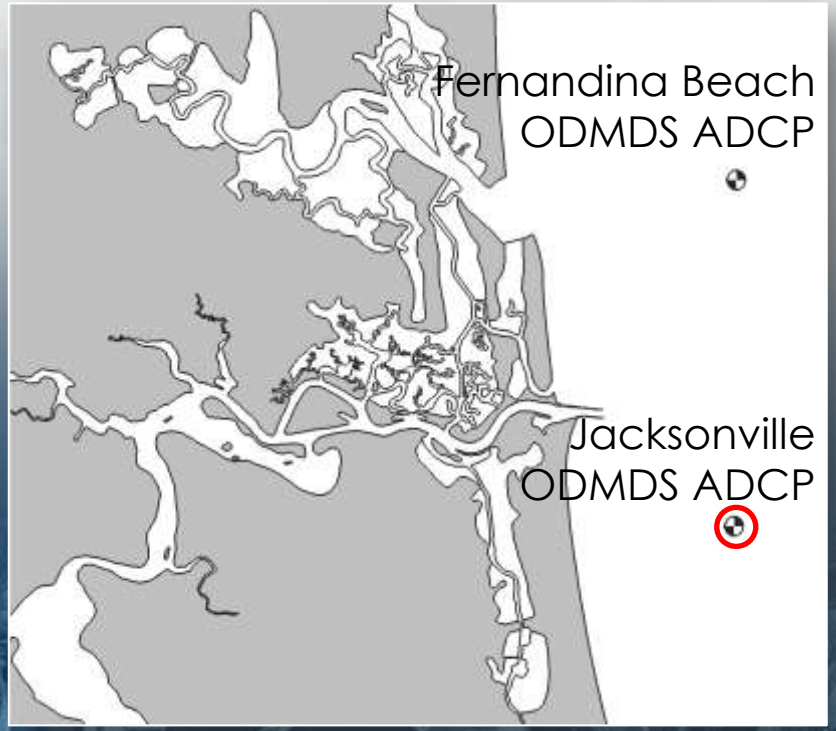


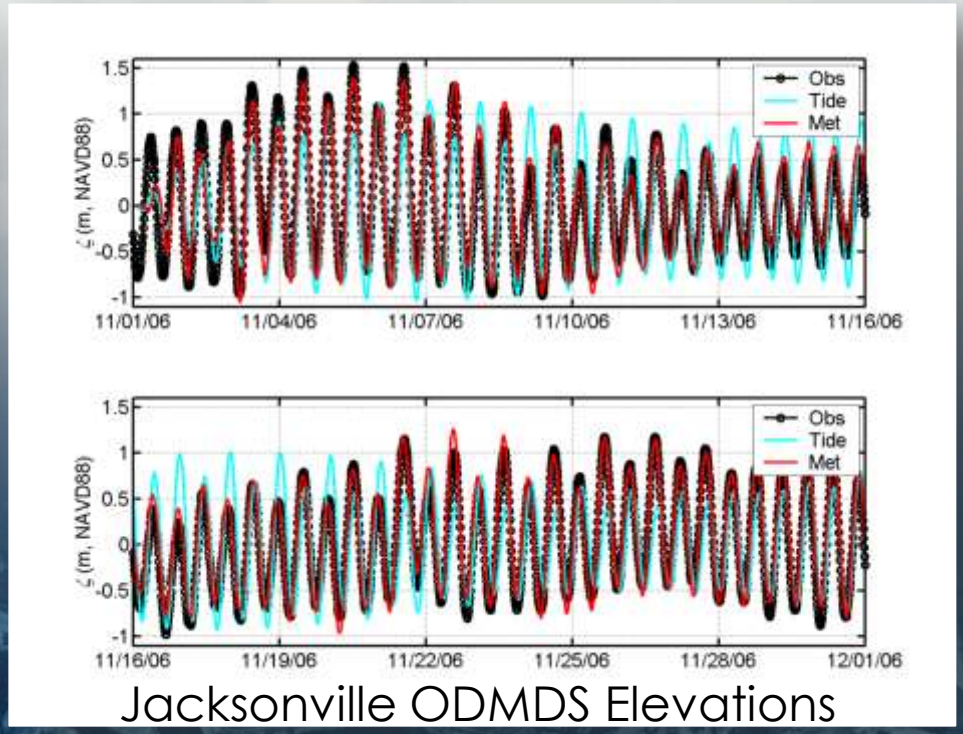
Modeling | Design | Impacts

Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

Time Series Validated

(in terms of elevations and velocities at two stations)





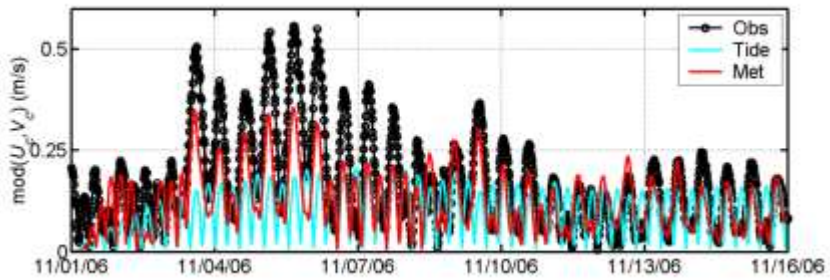
Jacksonville ODMDS Elevations

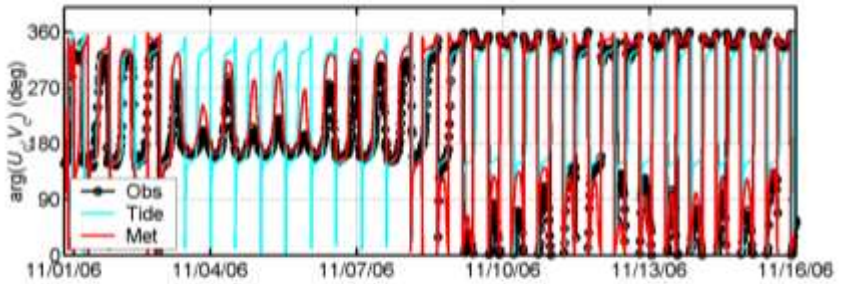
Modeling | Design | Impacts

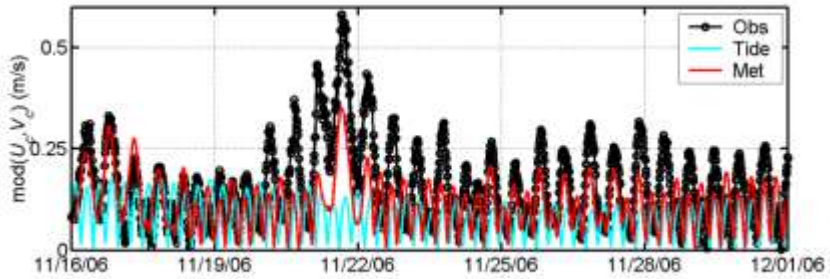
Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

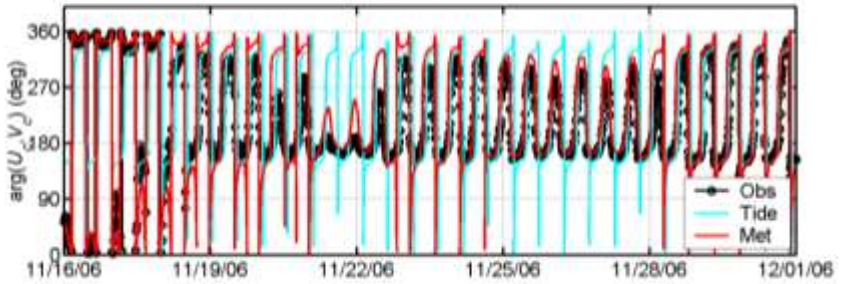
Jacksonville ODMDS

Velocity and Direction









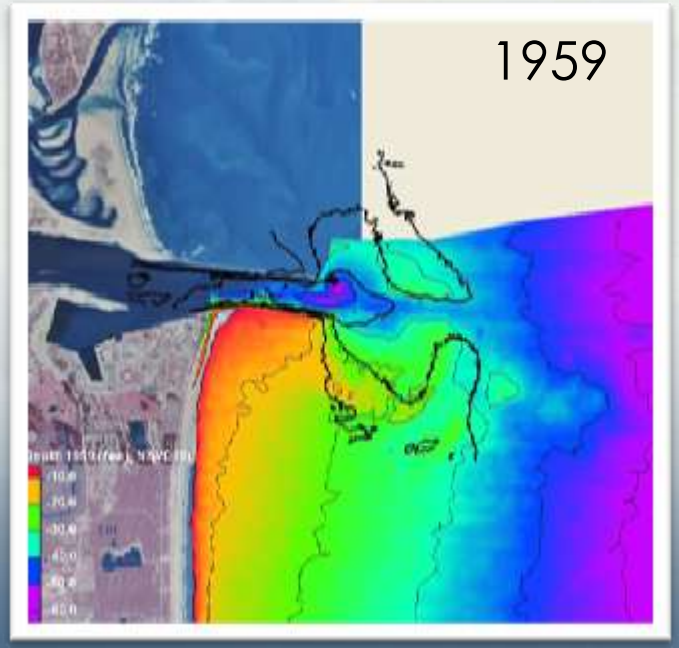
Modeling | Design | Impacts

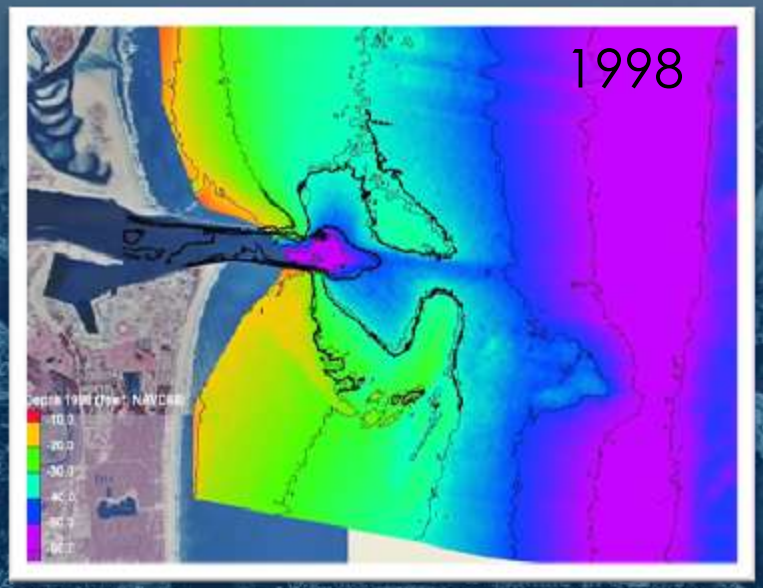
Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

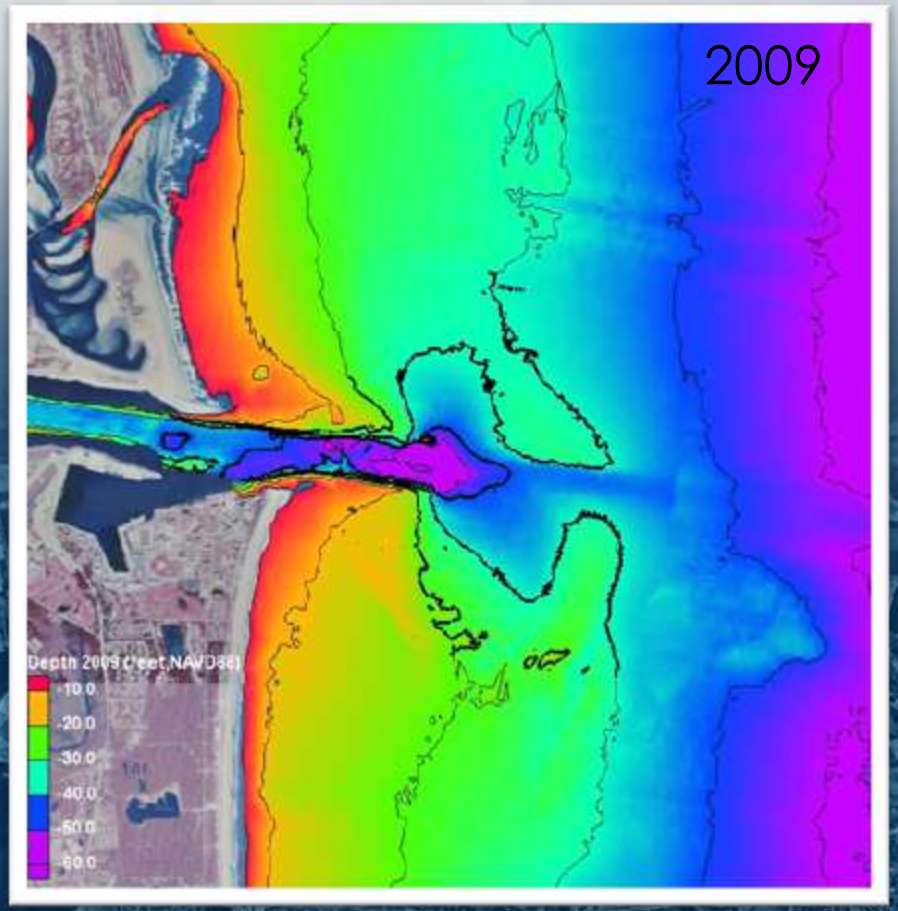
St. Johns Inlet Evolution

1856 chart of the St. Johns River entrance

St. Johns Inlet Evolution



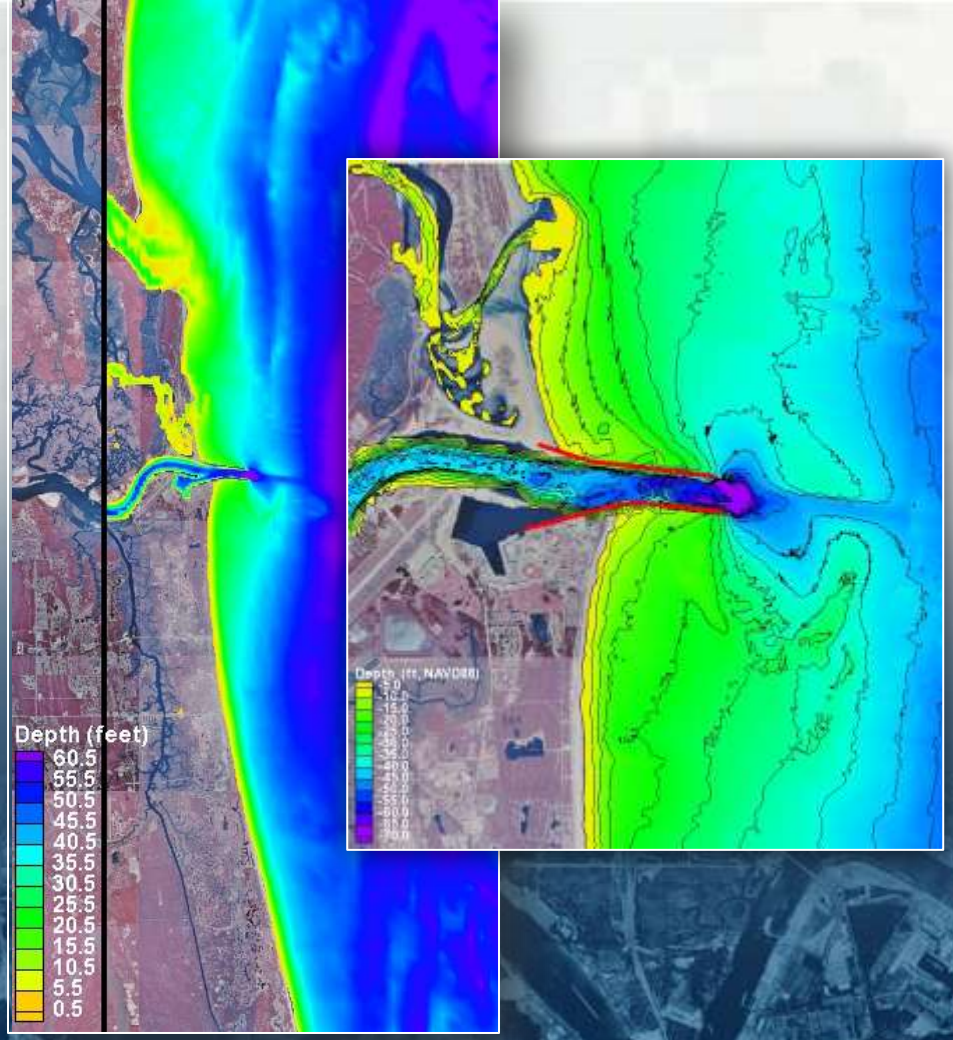


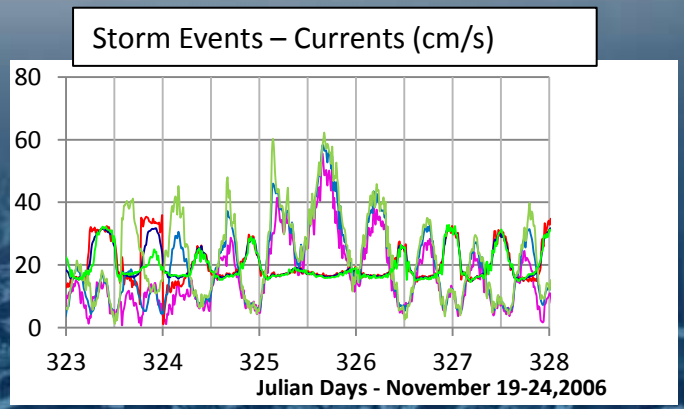


CMS Modeling

St. Johns River Inlet

- Coastal Modeling System
- Coupled wave, current, sediment transport and bottom change
- 2-D / 3-D



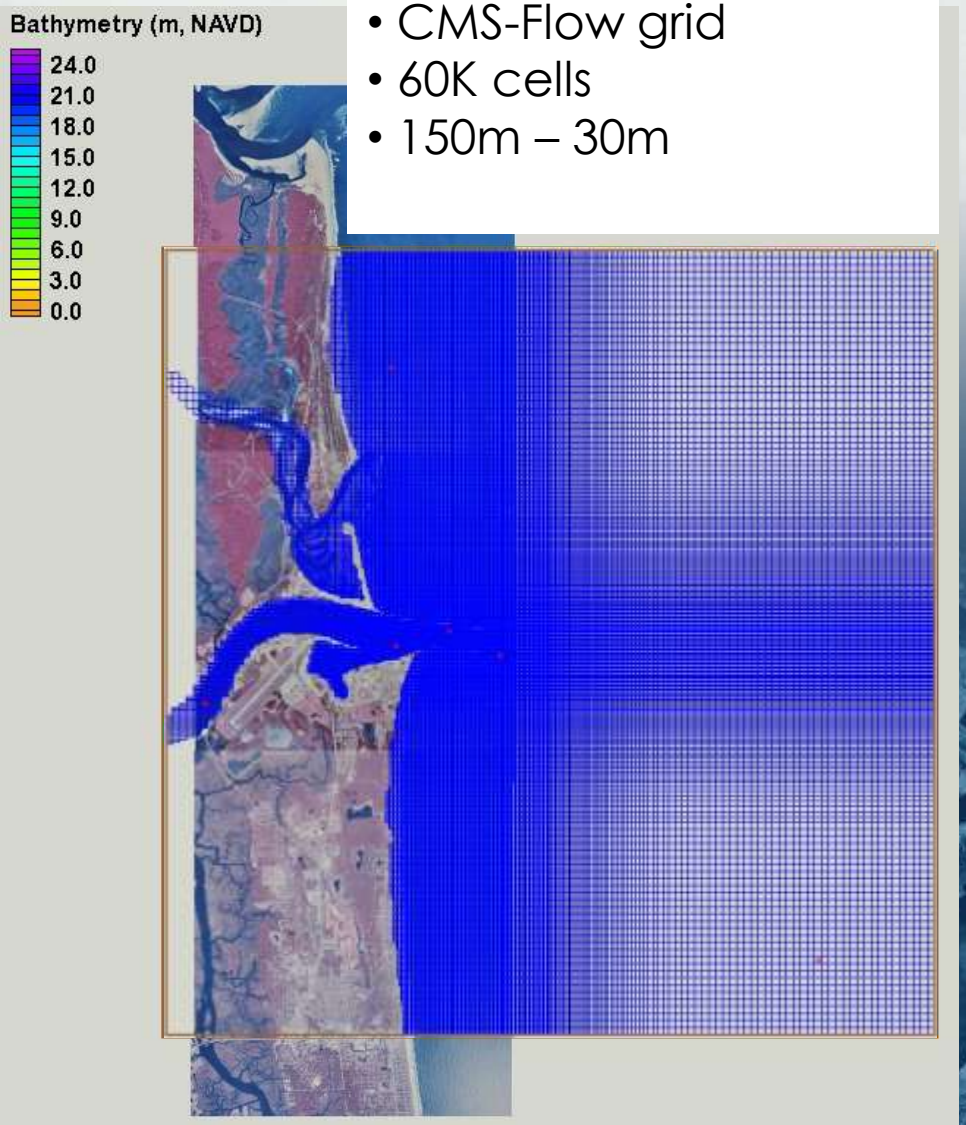


Modeling | Design | Impacts

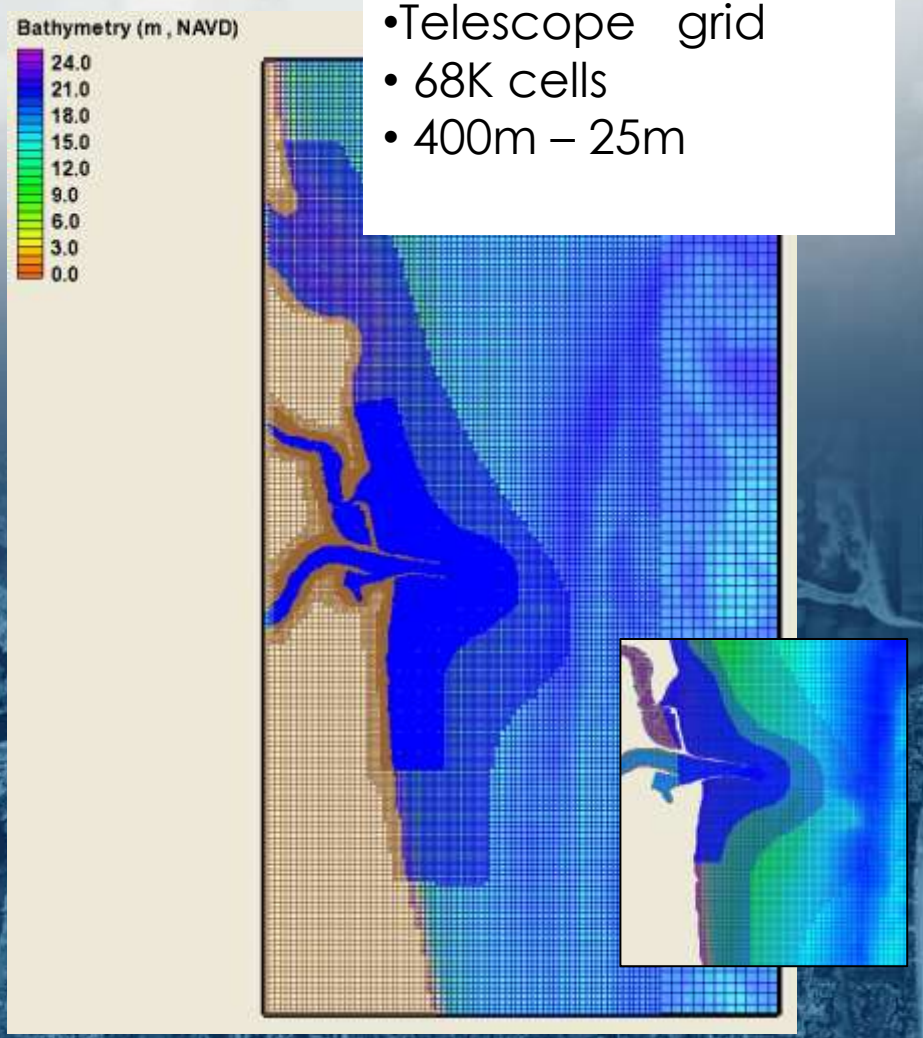
Field Measurements → Forcing → Hydro-Modeling → Ship Sim → Design → Salinity → Shoaling → Coastal

Project & Regional Scale CMS

- CMS-Flow grid
- 60K cells
- 150m – 30m

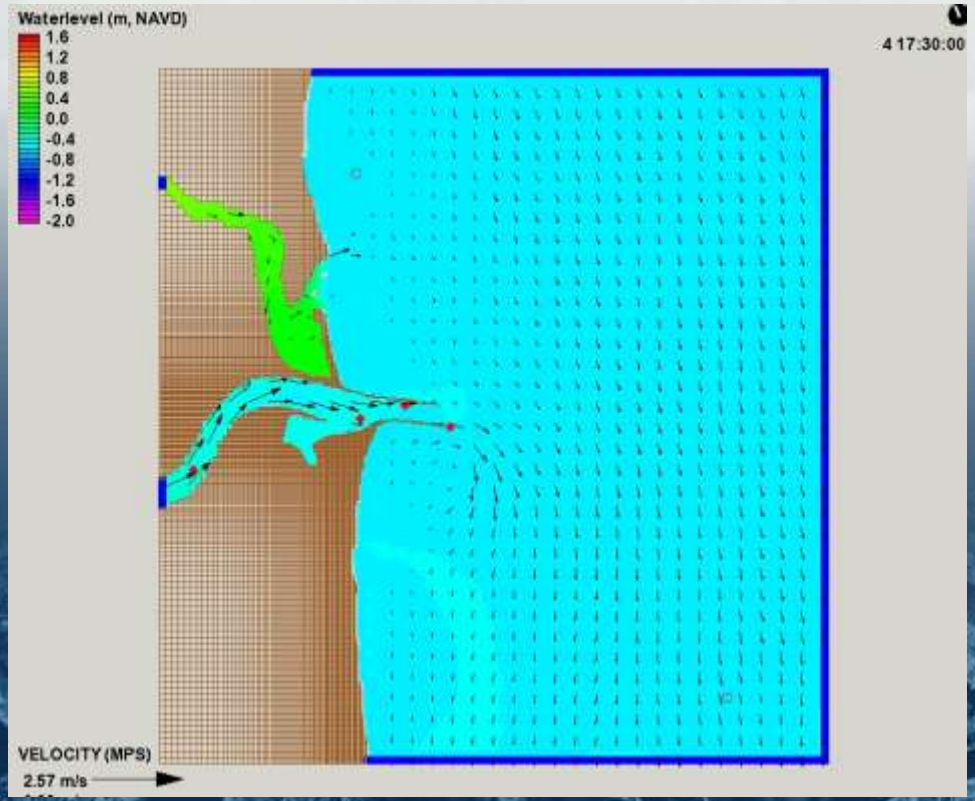


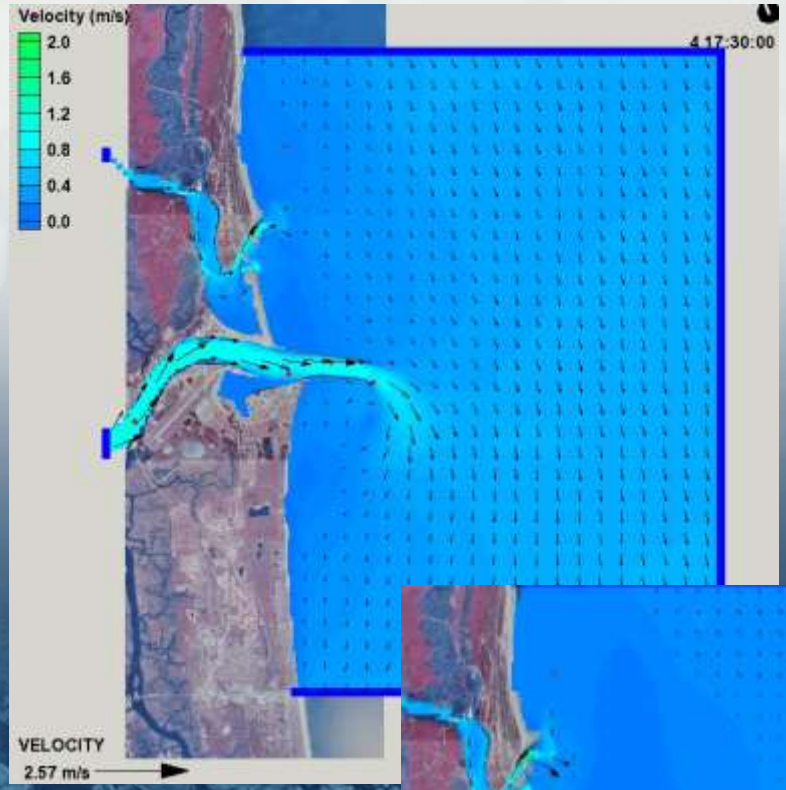
- CMS-Flow
- Telescope grid
- 68K cells
- 400m – 25m

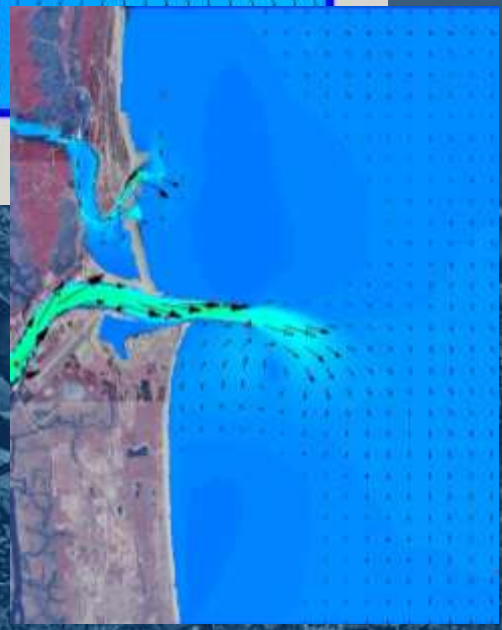


Project Level CMS-Flow Tides & Current

Falling Tide – Ebb Current







CMS Tasks

- Calibrate, & Verify
  - Hydrodynamics, Waves, Sediment Transport & Morphology
  - 2D-Depth Averaged or 3D ?
  - Simulate 1 year storm climate
- Define Sediment Transport Pathways
- Calculate Sediment Transport Rate
  - Channel Shoaling Rates
  - Sediment Budget

Regional Sediment Management Plan

- CMS - St. Augustine Inlet
- CMS - St. Johns River Inlet
- GenCade
  Long Term Morphology

Summary

- Jacksonville Harbor / Mayport Deepening Projects
- Project & Regional Sediment Management Perspectives
- Modeling Tools
  - ADCIRC
  - Coastal Modeling System (CMS)
  - GenCade

Thank You !