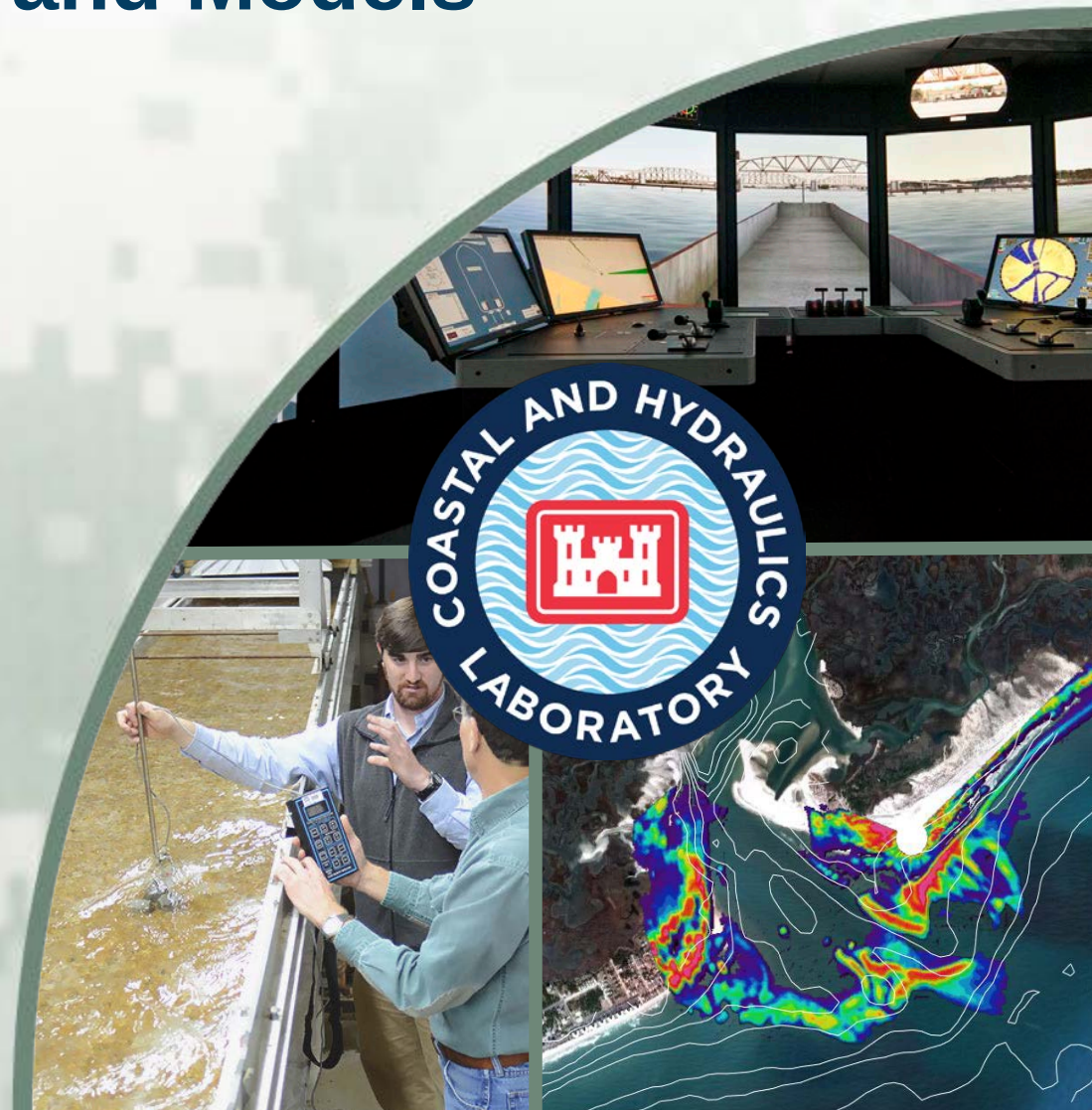
ERDC
Engineer Research and Development Center

Coastal Processes and Models

Katie Brutsché, PhD

Jane McKee Smith, PhD, PE
Senior Scientist



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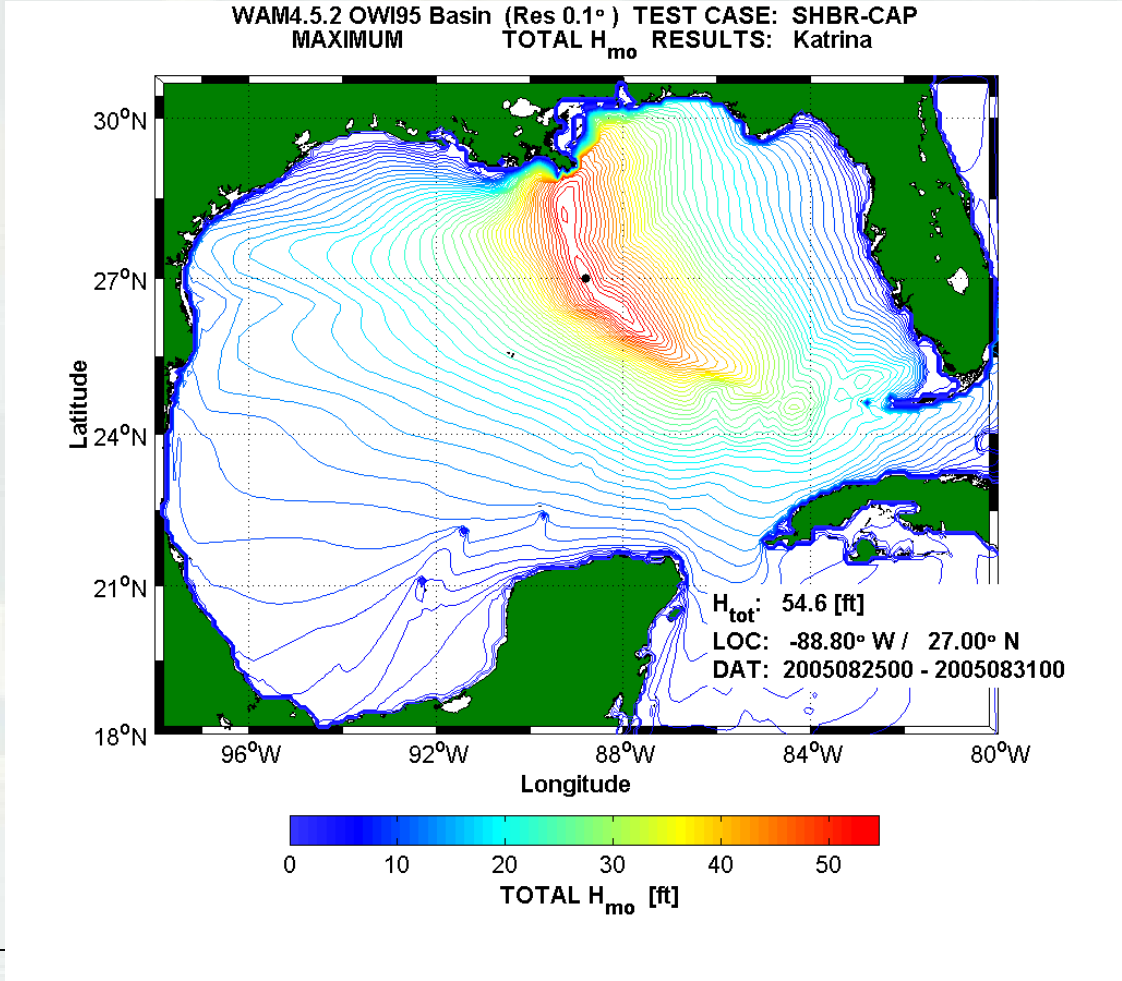
Categories of Models

- Waves
- Tides & Circulation
- Sediment Transport

Wave Generation Model (Hindcast & Forecast)

- **Large-scale Wave Generation**
  - **Wave Information Studies (wis.usace.army.mil)**
- **Uses:**
  - **Wave Climate for Projects**
  - **Input to nearshore models**
  - **Operations (forecast)**
- **Processes:**
  - **Wind Generation**
  - **Propagation**
  - **Sheltering**



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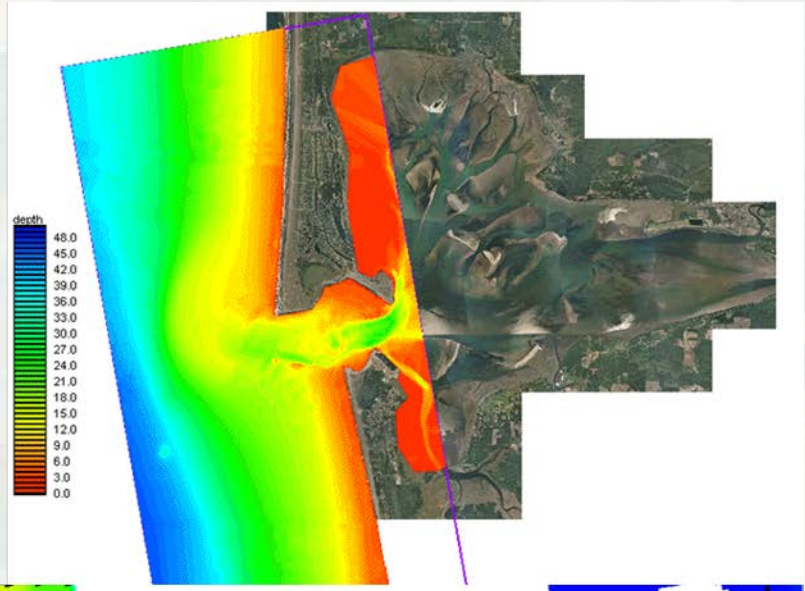
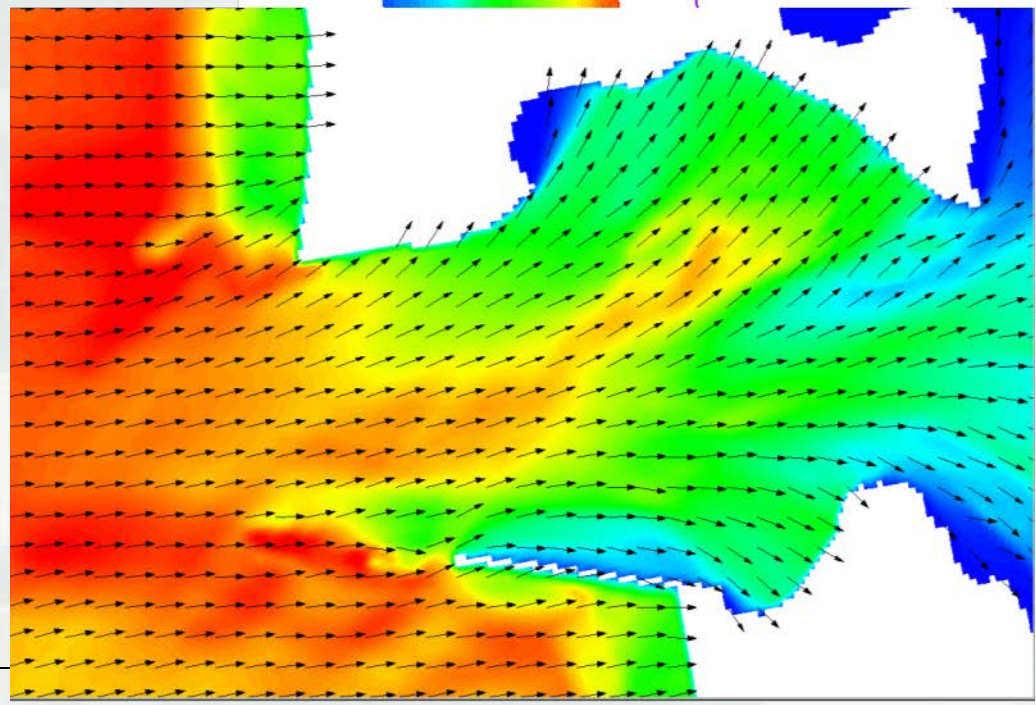
Wave Transformation Models

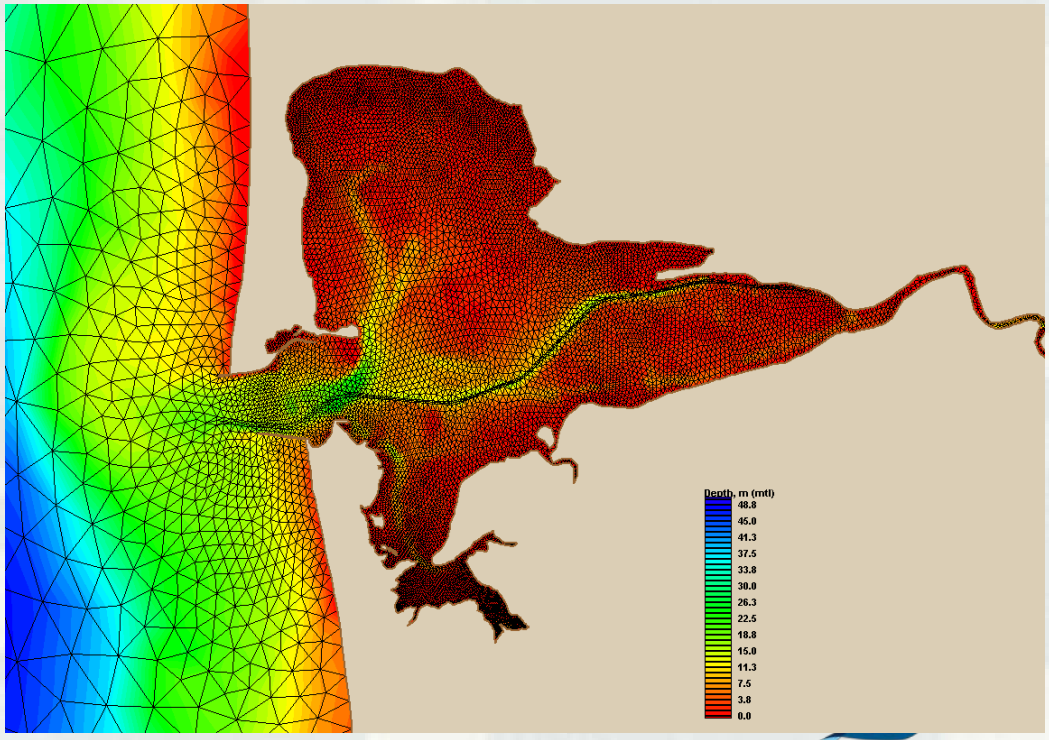
- STWAVE is Workhorse Corps Model
- Uses:
  - Sediment transport modeling
  - Structure design
  - Navigability
  - Shoal mining/bathymetry modifications
- Processes:
  - Refraction
  - Shoaling
  - Breaking
  - Wave-Current Interaction
  - Generation
- SWAN – Delft equivalent
- CMSWAVE -- CIRP





Circulation Models

- Time-Stepping Solution of Momentum and Continuity (2D & 3D)
- Models:
  - ADCIRC, CH3D, RMA Suite, ADH, CMSFLOW
- Uses:
  - Sediment transport
  - Tidal current
  - Storm surge
  - Water quality (?)
- Processes:
  - Tides
  - Wind-forcing
  - Coriolis
  - Wave-forcing
  - Wetting & Drying
  - Frictional Losses



Sediment Transport Models

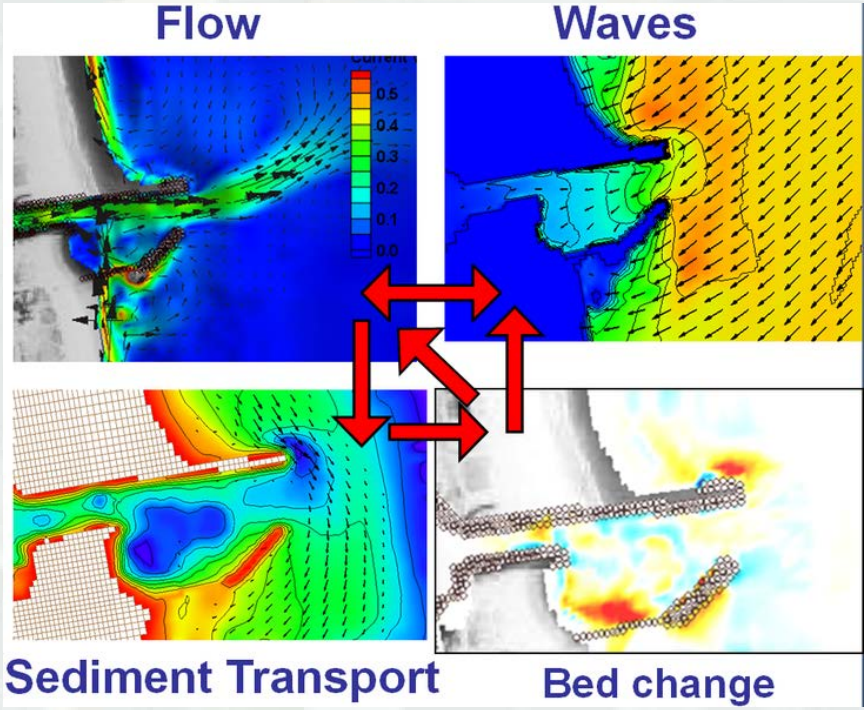
- Shoreline Change
- Profile Change
- Morphology Change
- Particle Tracking

Morphology Change Models

- Models:
  - Coastal Storm Modeling System (CSTORM)
  - Coastal Modeling System (CMS)
- Uses:
  - Short to mid-term bathymetry evolution
  - Beach fill
  - Inlet evolution
  - Storm response
- Processes:
  - Wave- and current-driven sediment transport
  - Physics based, but some empiricism; Models under development
  - Present weakness – shoreline processes (shoreline change, overwash, breaching, etc.)

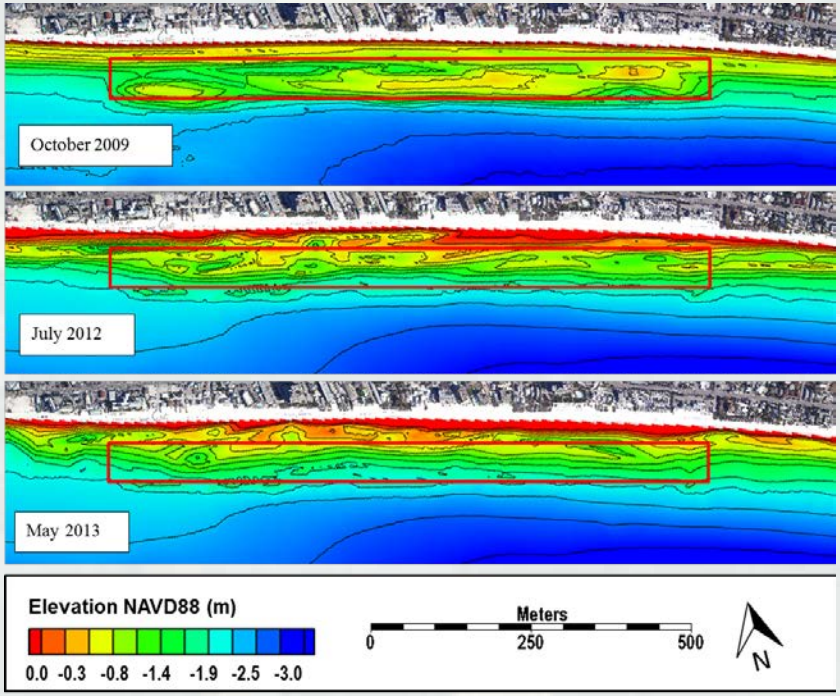
Coastal Modeling System

- **Coupled calculations of waves, currents, water levels, sediment transport and morphology change** in and around inlets
- **Short- (weeks) to mid-term (seasonal to multiple years) project scale** simulations
- **Representation of** wetting and drying, advection, turbulent mixing, tides, wind, atmospheric pressure, and waves; river flows, wave-current interaction, multiple-sized sediment transport, bed sorting, and morphology change



Coastal Modeling System

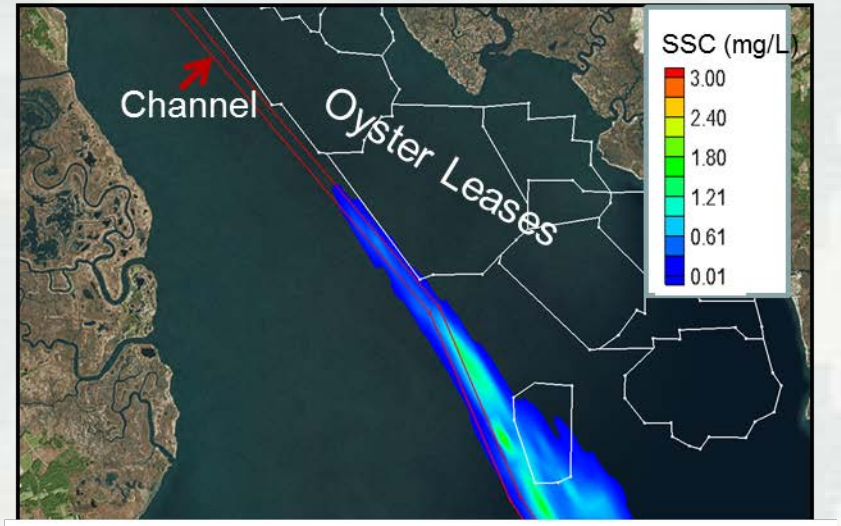
- Tool Input
  - Waves
  - Tides
  - Bathymetry
  - Grain size
- Tool Output
  - Currents
  - Waves
  - Water Levels
  - Morphology/Sed Transport
- How does the tool help the Districts?
  - Gives an idea of waves and currents at the placement site
  - Limited computation of sed transport & morphology change



The Particle Tracking Model

- **The Particle Tracking Model (PTM)** is a Lagrangian particle tracker that models transport processes (advection, diffusion, deposition, etc)
- PTM is designed to predict the fate of multiple constituents (sediment, chemicals, debris, biota, etc) released from local sources (dredges, placement sites, outfalls, propeller wash, etc) in complex hydrodynamic and wave environments.
- Motivation for model development is the need for accurate risk assessment for environmental receptors near local sources.
  - Total Suspended Solids (TSS) concentration (light attenuation, fish and larval migrations)
  - Contaminants
  - Sediment deposition (Egg burial, oyster lease, Coral reefs)

Environmental Concerns:



PTM Suspended Sediment Concentration modeling from Hopper Dredge Overflow near Oyster

Data Sources

- Waves
  - NDBC, WIS, WAVEWATCHIII, ADCPs, pressure gage
- Currents/tides
  - NDBC, ADCPs
- Bathymetry
  - JALBTCX, NOAA Digital Coast, Profile surveys
- Sediment
  - SAGA Tool, Geotechnical data, sediment samples