

Webinar on PTM with CMS



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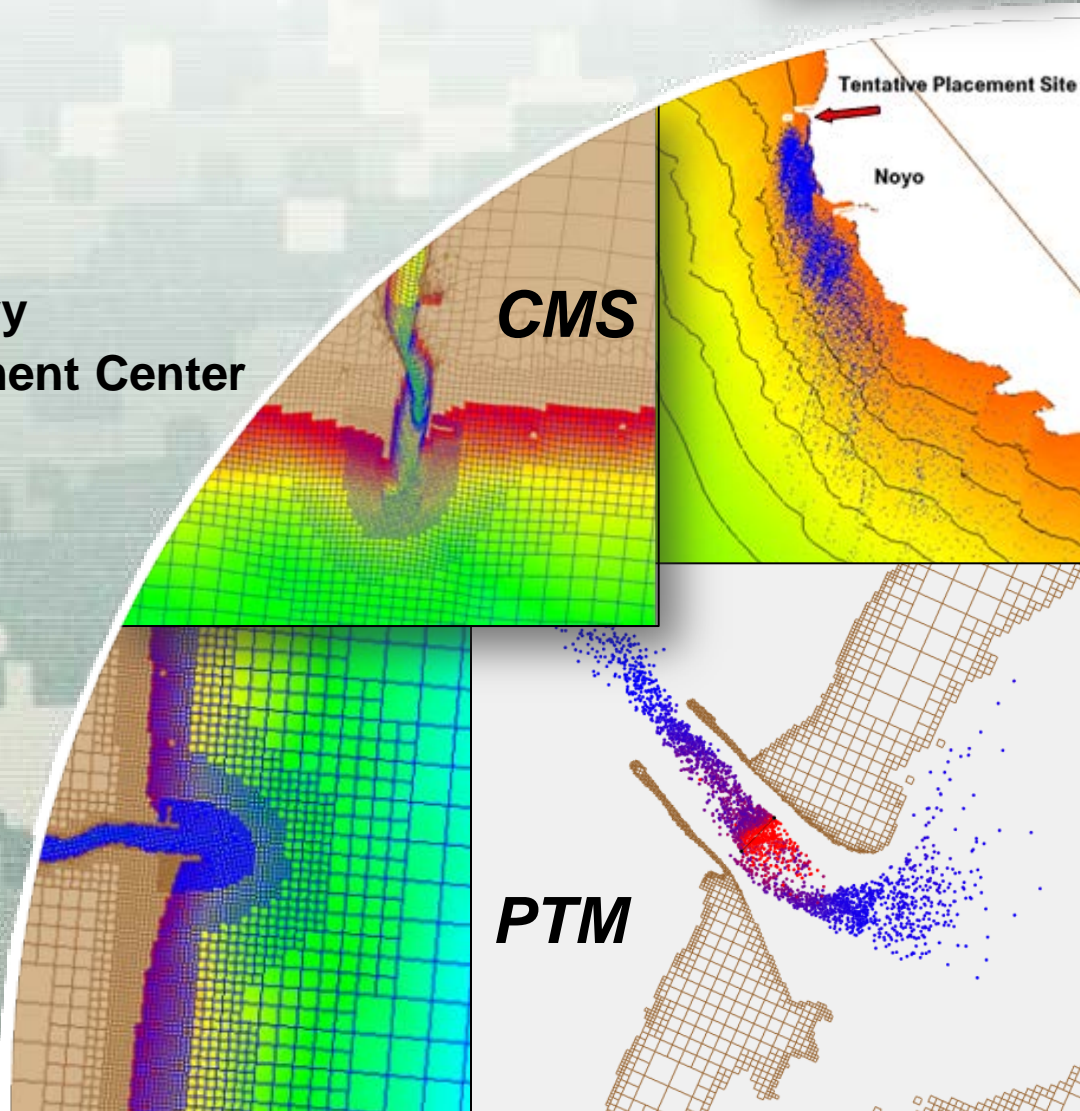
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**Coastal and Hydraulics Laboratory
Engineer Research and Development Center**

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US Army Corps of Engineers
BUILDING STRONG



Report Documentation Page

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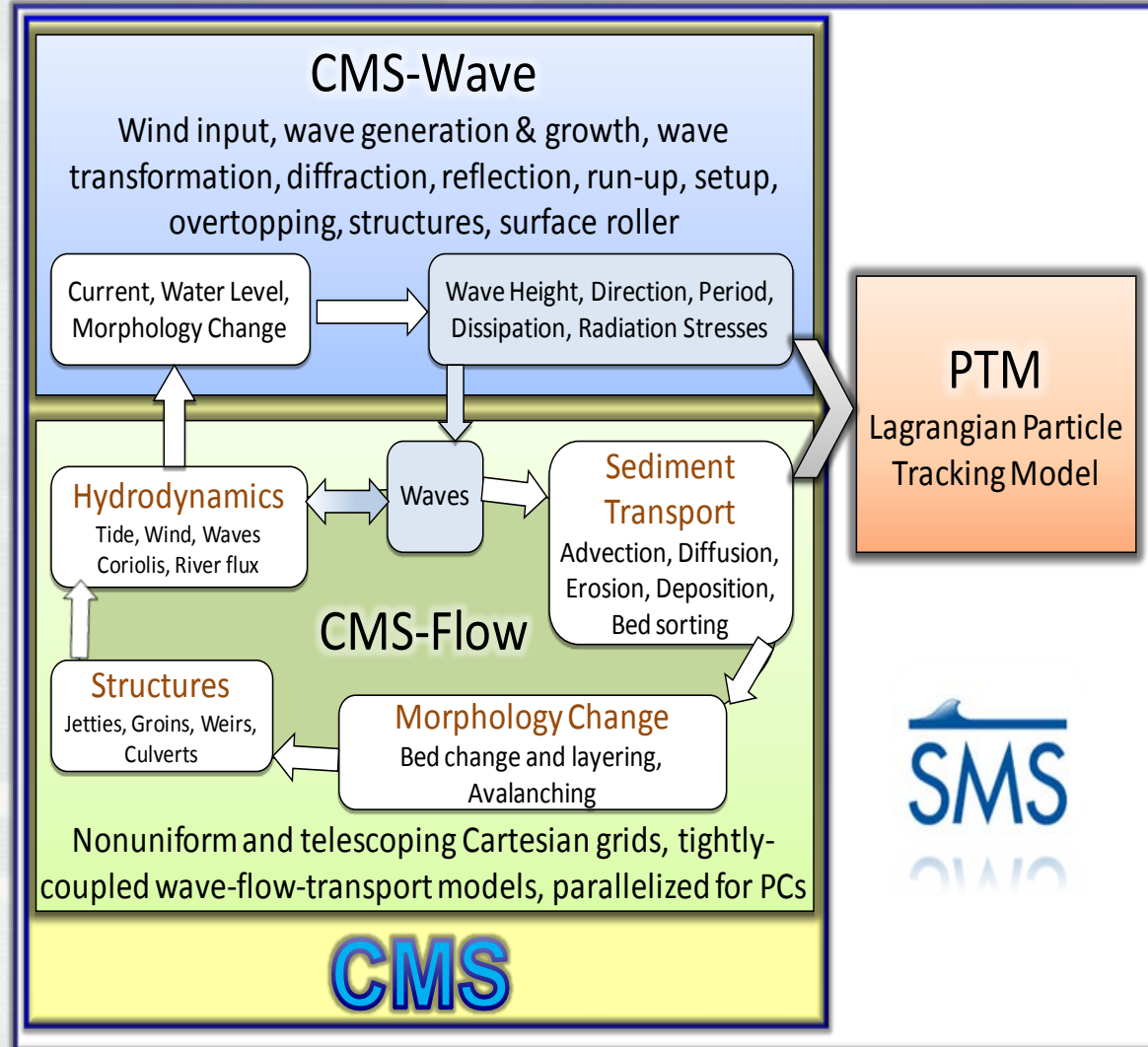
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Introduction to CMS

Integrated waves, current, and sediment transport model in the Surface-water Modeling System (SMS)

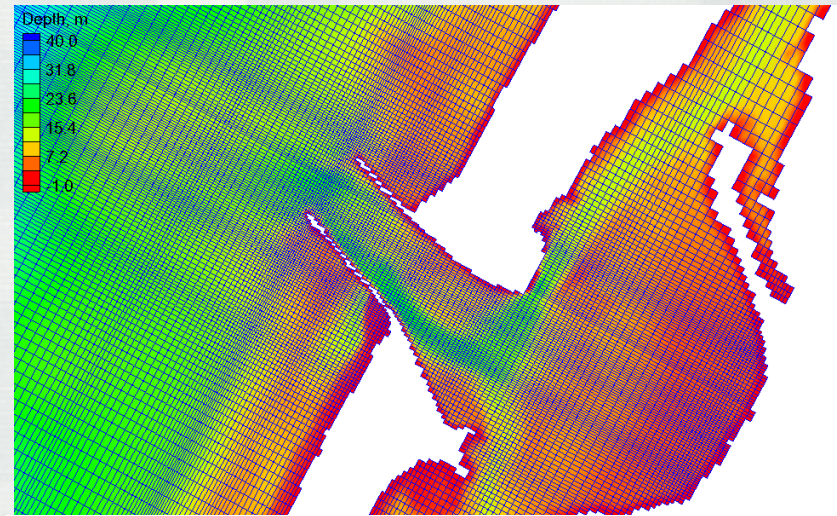
CMS-Flow and CMS-Wave

Coupled with Particle Tracking Model (PTM)

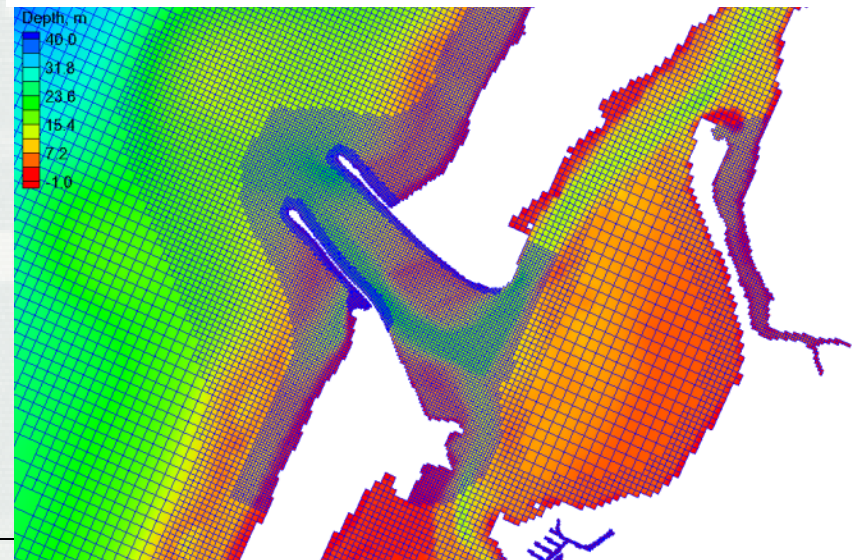


- Deliver to engineers' desktops advanced models that can be used as practical tools for coastal inlets, coastal navigation channel, and adjacent beach studies.
 - Models efficiently coupled to simulate relevant physical processes
 - PC-based, user-friendly interface, fast, robust and accurate
 - Manuals, tech reports, journal papers, Wiki, workshops, phone help, etc.

- Grid options
 - Non-uniform Cartesian grid: Easy to setup
 - Quadtree (telescoping) grid: Efficient, flexible (presently, only available for Implicit model)
- Solver options
 - Implicit: Tidal flow, long-term morphology change, parallel processing.
 - ~5 - 30 minute time step
 - Explicit: Flooding, breaching, super-critical flow. ~1 second time step, parallel processing

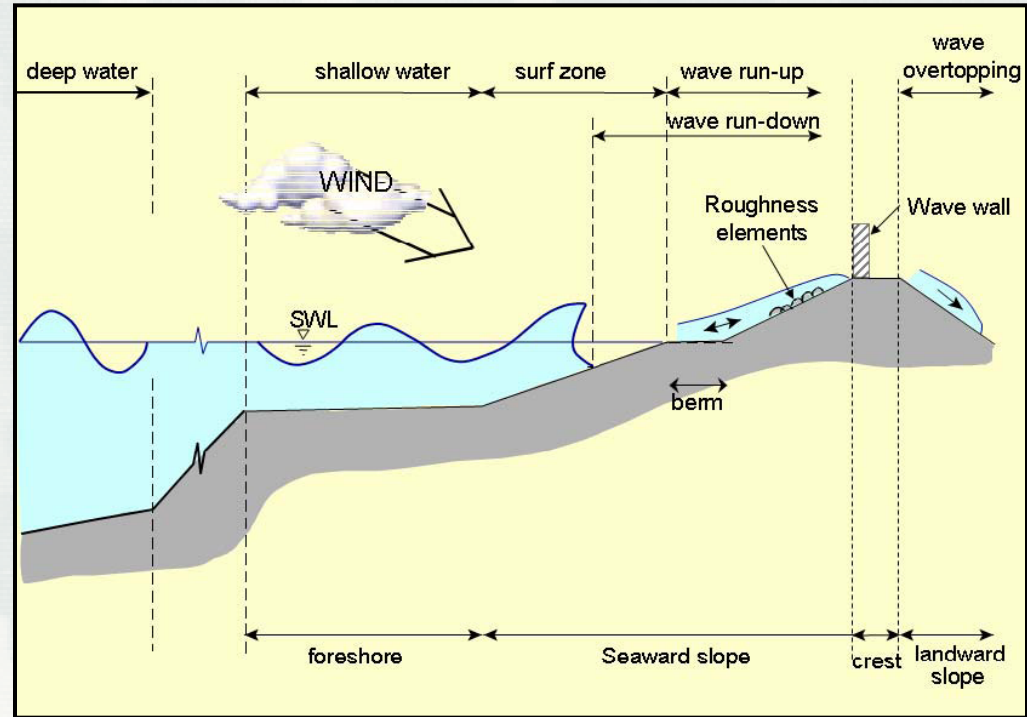


Non-uniform Cartesian grid (Variable spacing)

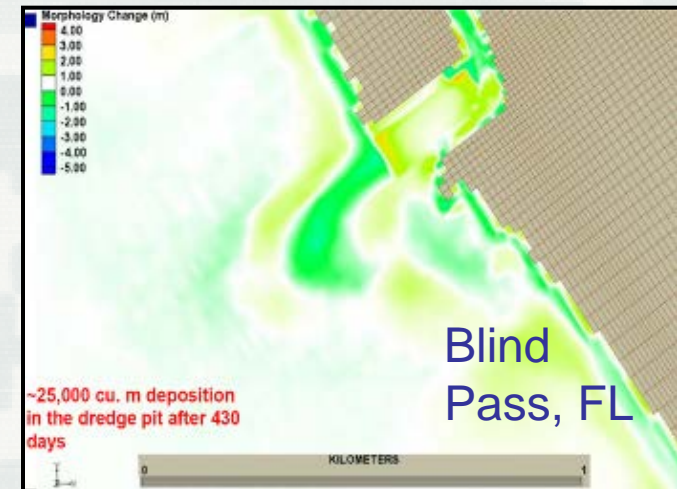
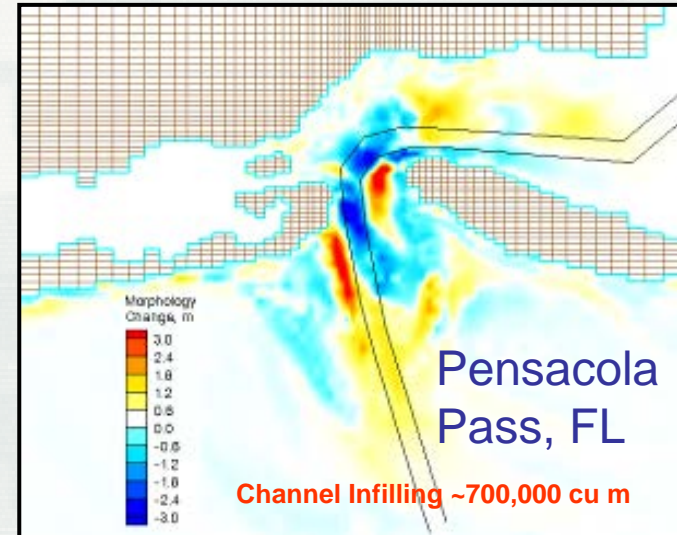


Quadtree grid (Telescoping)

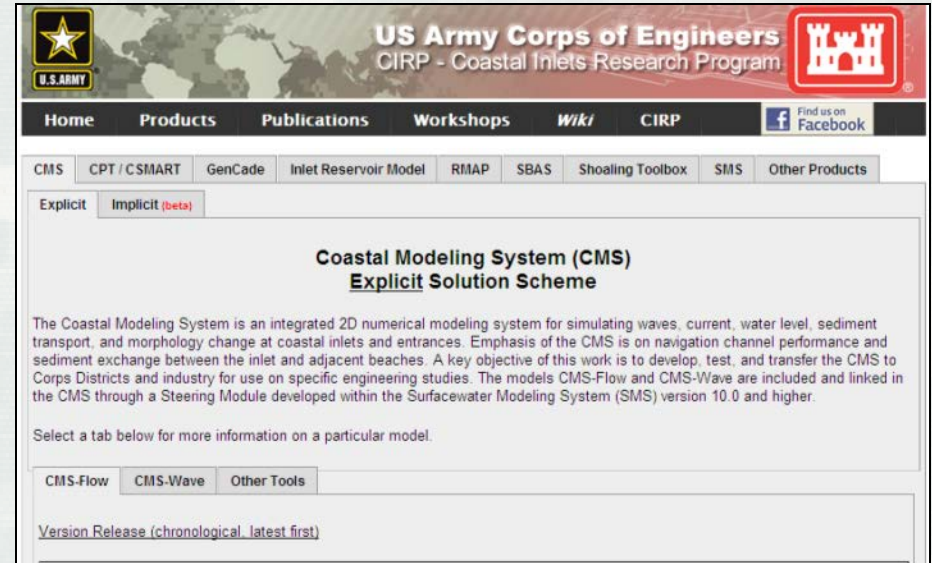
- Shoaling, refraction, diffraction, reflection
- Bottom friction
- White capping
- Wave breaking (4 options)
- Wind generation
- Wave-current, and wave-wave interactions
- Transmission, runup and overtopping
- Muddy bottom
- Automatic grid rotation
- Non-uniform Cartesian grid with nesting capability
- “Fast Mode”



- Sediment transport models
 - Equilibrium Total Load (Exner equation)
 - Eq. Bed Load + Advection-Diffusion (AD) Suspended Load
 - Non-Eq. (AD Total Load)
- Sediment transport formulas
 - Lund-CIRP
 - Van Rijn
 - Watanabe
 - Soulsby
- Hard-bottom
- Avalanching
- Bed slope influence on bed load
- Multiple-sized sed. transport (**NEW**)



- Products
 - CMS
 - GenCade
 - Others
- Publications
 - Technical Reports
 - CHETNS
 - Journal Articles
 - Others
- Tech Transfer
 - Upcoming
 - Recent



CIRP website

<http://cirp.usace.army.mil/>

CIRP wiki

<http://cirp.usace.army.mil/wiki/>

Introduction to PTM

Particle Tracking Model

PTM is a Lagrangian particle tracker that models transport processes (advection, diffusion, deposition, etc) of representative parcels to determine constituent (sediment, contaminants, biologicals, etc) fate.

Input Requirements

- Grid/Bathymetry Data
- Hydrodynamic and/or Wave Data
 - ADH
 - ADCIRC
 - EFDC
 - CH3D
 - CMS
- Native Sediment Data
- User Defined Source
 - Dredging
 - Placement
 - CSOs

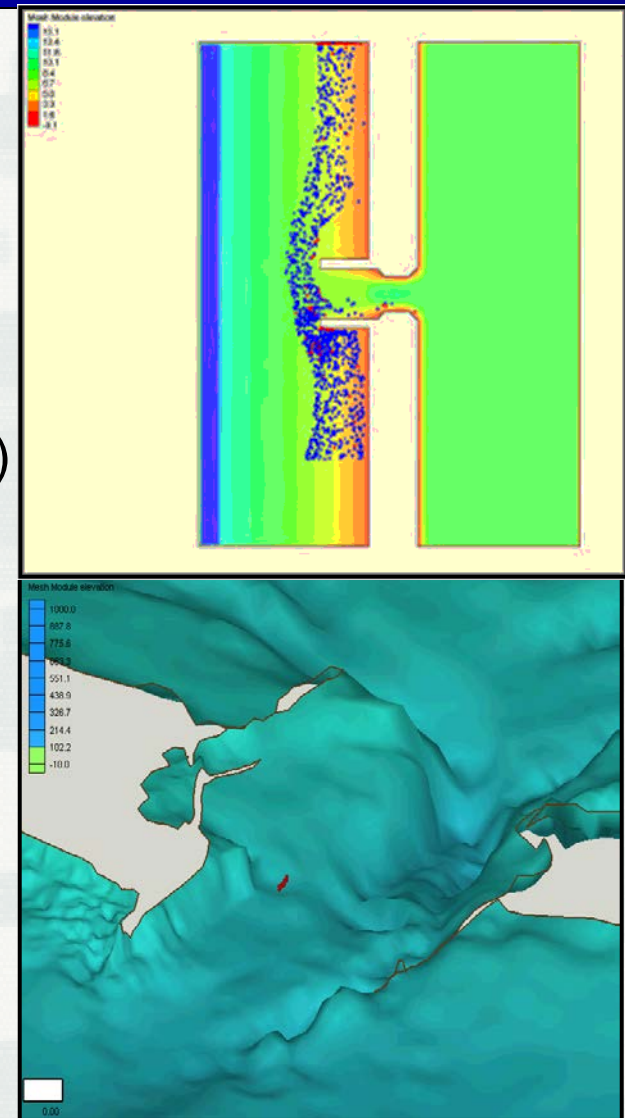
PTM

Time-dependent
Particle Positions
 $P(t,X,Y,Z)$

PTM/Surface-water Modeling System (SMS) Data Analysis Tools

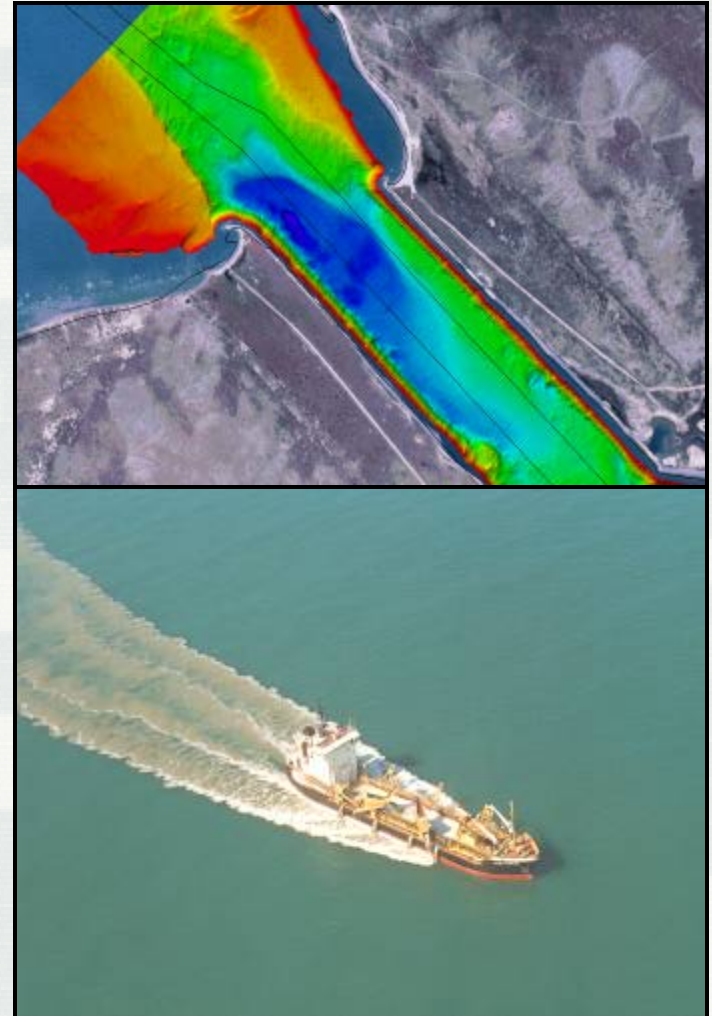
- Deposition
- Concentration
- Dose
- Exposure
- Accumulation
- Pathways

- Combined wave-current sediment mobility (Soulsby & Whitehouse) and bottom shear stresses (O'Connor & Yoo, van Rijn)
- Temporally and spatially varying bedforms (Mogridge et al.) and variable bed roughness for growth/decay of bedforms
- Suspended sediment transport (Rouse, van Rijn)
- Bed load transport (van Rijn)
- Settling and entrainment algorithms (Soulsby)
- Hiding and exposure function (Egiazaroff, Kleinhans & van Rijn)
- Influence of bed slope on transport
- Mixed sand-silt-clay sediment transport algorithms
- Fully-3D transport of particles
- Neutrally-buoyant particles

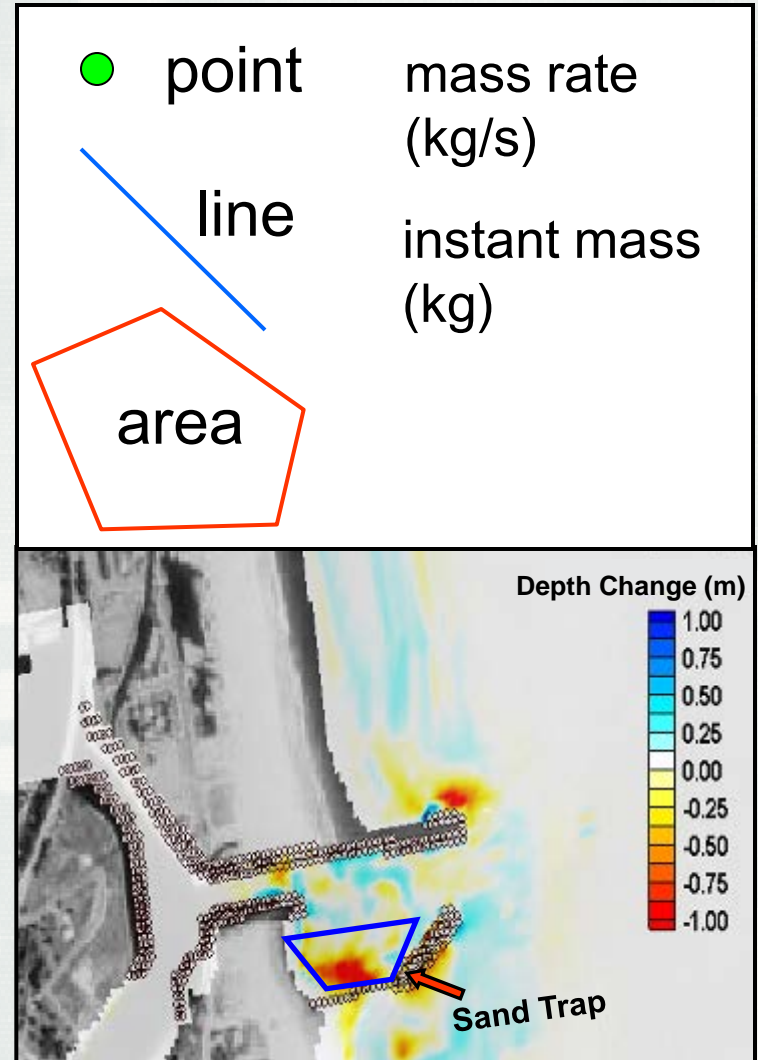


PTM Capabilities

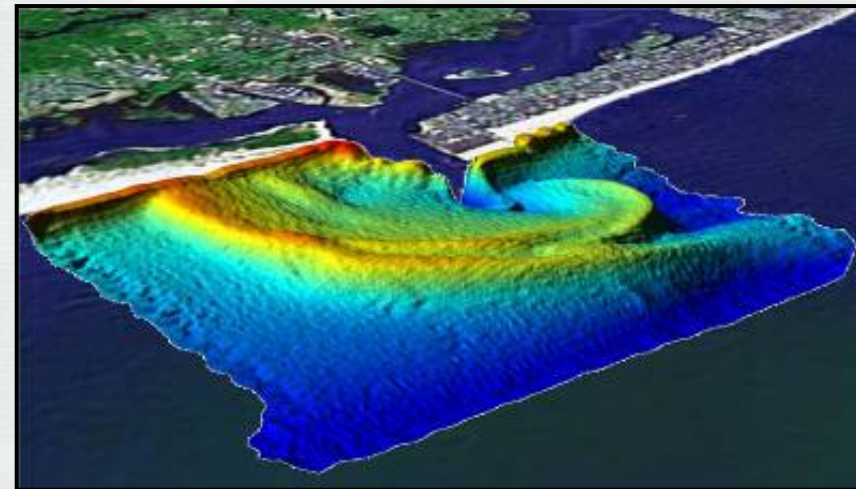
- Visualize particle pathways and fate
- Calculate residence time
- Monitor specific sources of sediment transported to inlets and navigation channels
- Monitor dispersion of sediment from dredged material placement sites
- Predict accretion and erosion zones
- Forecast potential increase in turbidity and deposition
- Isolate and track particles from other sources, such as outfalls, propeller-induced suspension ...



- User-specified particle sources
 - Temporally- and spatially-varying point, line, or area sources
 - Mimic complicated dredging operations
- Particle traps
 - Used to monitor (count/collect) particles
 - Trap types may be defined as a line or area (zone or region)
- Residence time and spatial maps of particle transport parameters
 - Mobility, shear stress, and bedform
 - Pathways



- Sediment transport around inlets, shoals, structures, and adjacent beaches
- Sediment transport related to channel design, infilling, and bypassing projects
- Sediment transport from channel dredge and material placement
- Erosional Transport
- Larval fish, fish egg, and water particulate transport

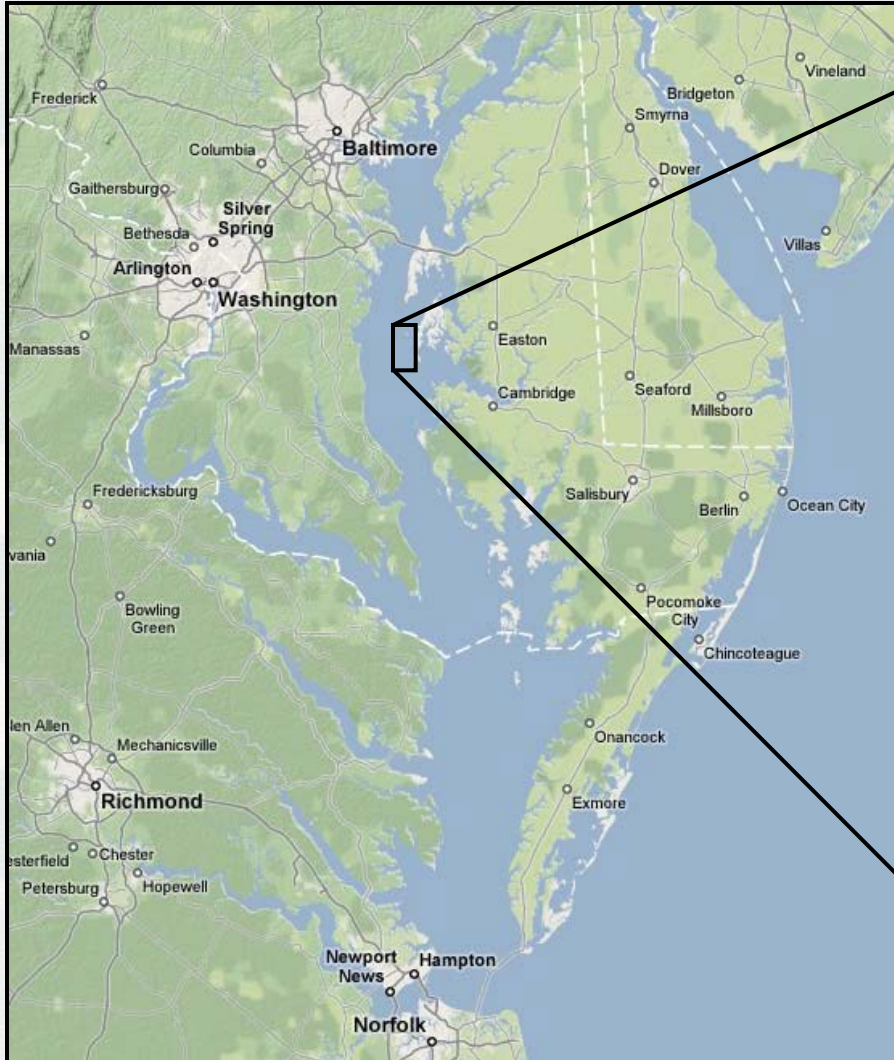


PTM Applications

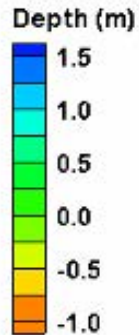


Poplar Island, MD

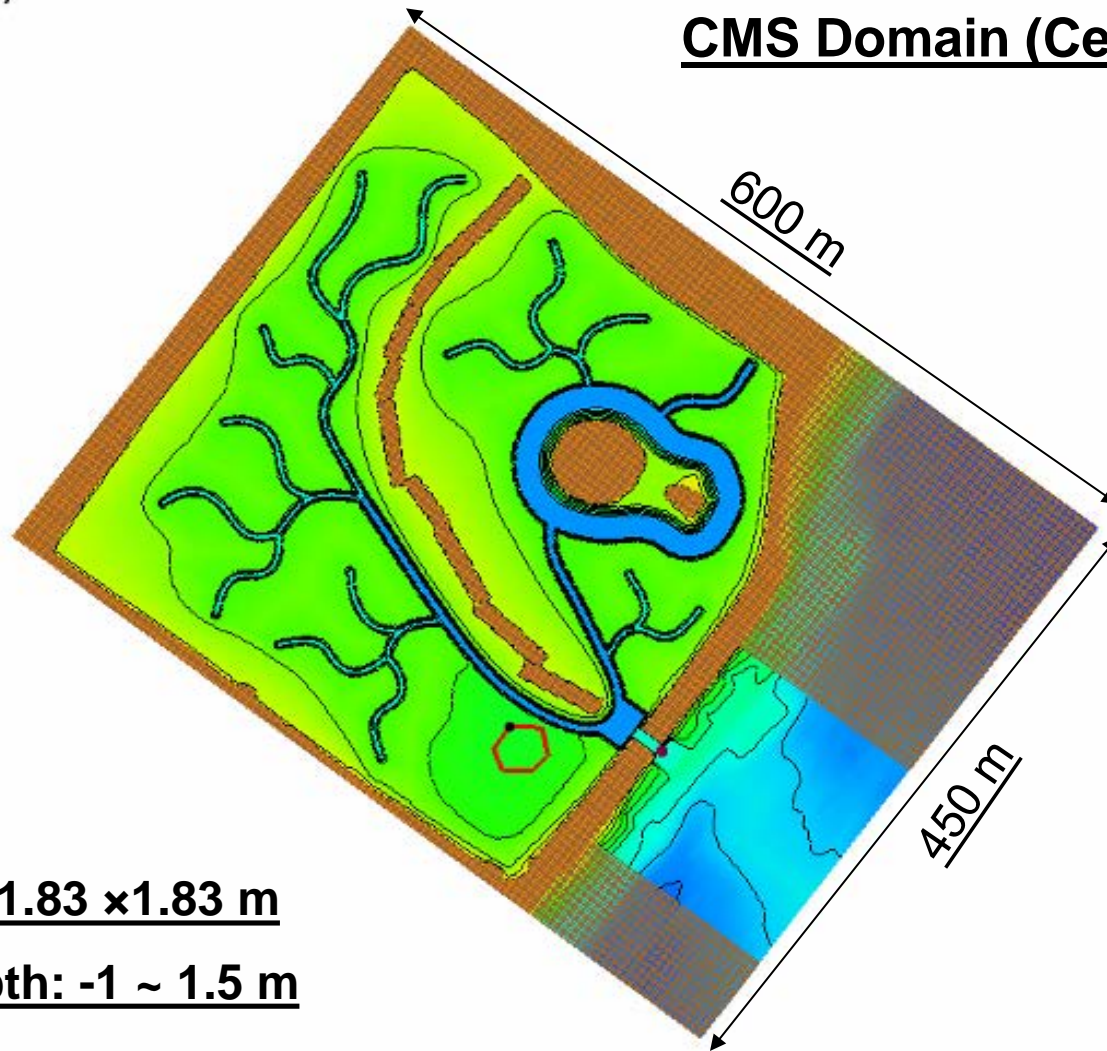
Beneficial Use of Sediment Dredged from Navigation Channel



Poplar Island, MD



CMS Domain (Cell-1A)



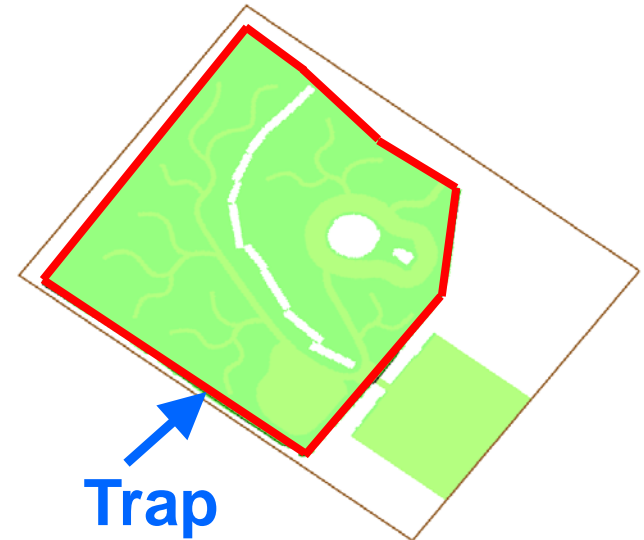
Cell Size: 1.83 x 1.83 m

Water Depth: -1 ~ 1.5 m

Residence Time:

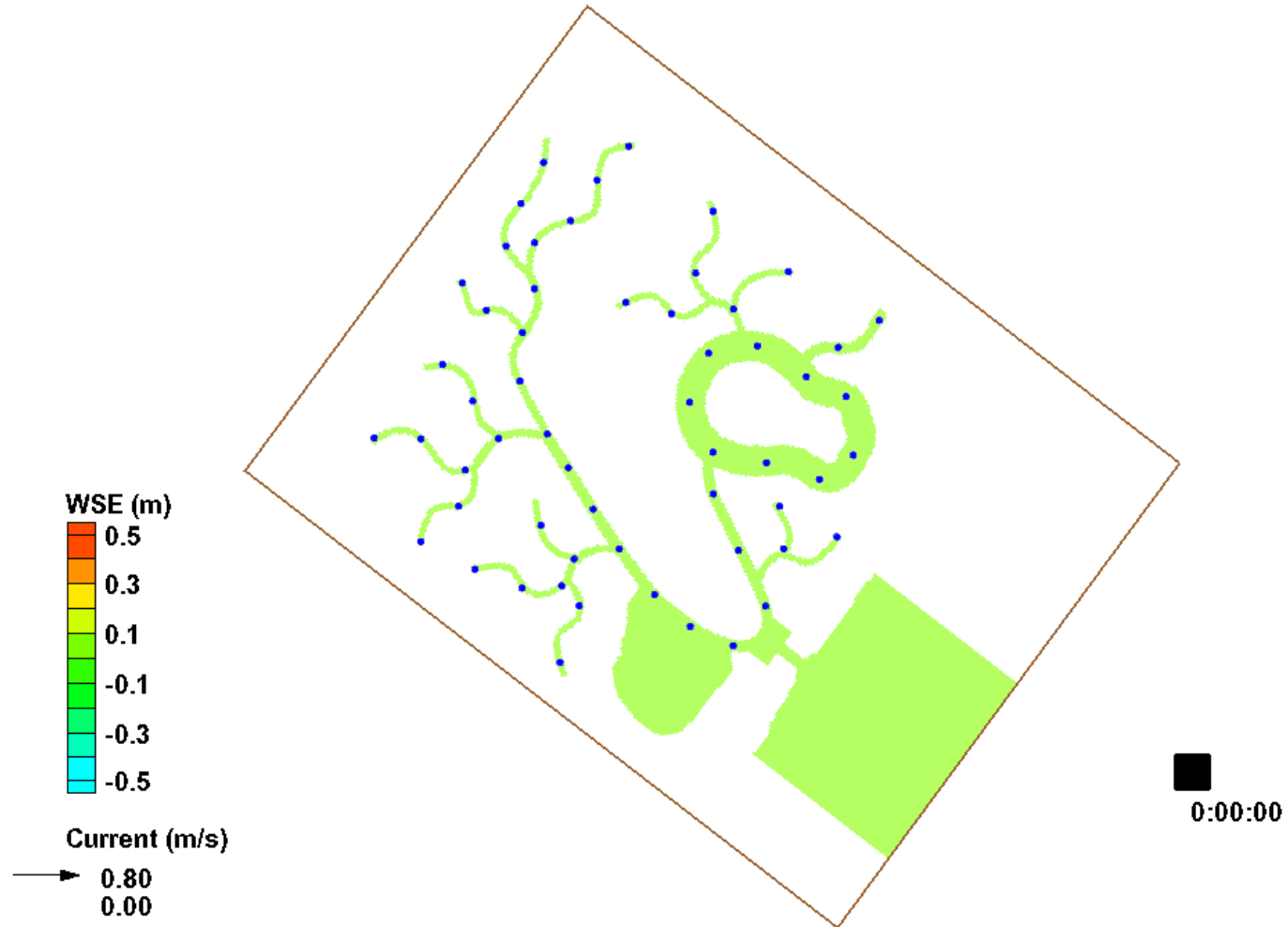
Time Particles Exit Trap – Time Particles Enter Trap
(TIME OUT) (TIME IN)

- 57 particle point sources
Instant mass release
- Space Distance
~30 m
- Time interval of release
1 hour
- Release duration
12 hours (1 tidal cycle)



Sources of Particle Release

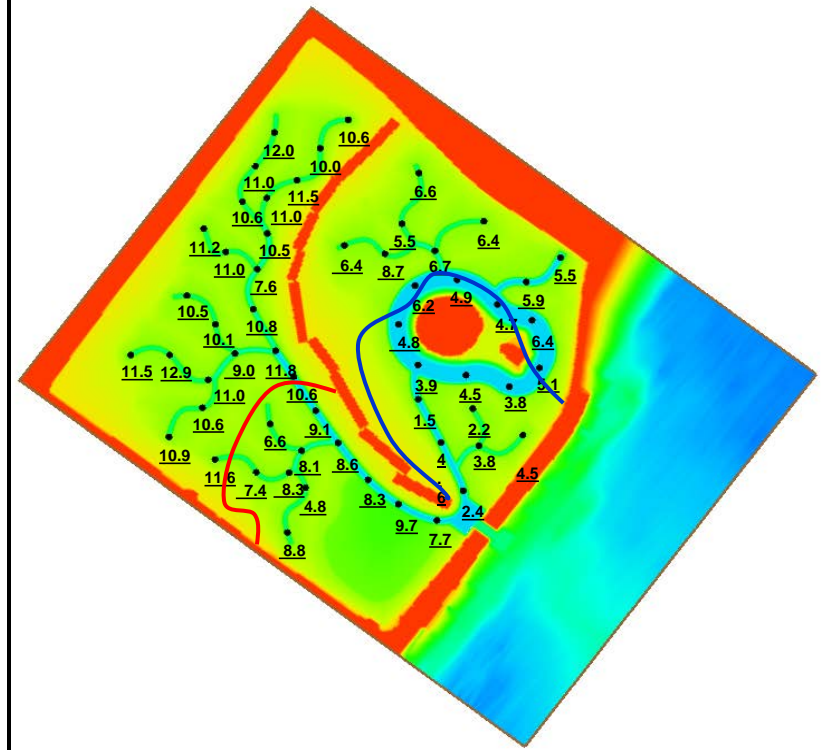
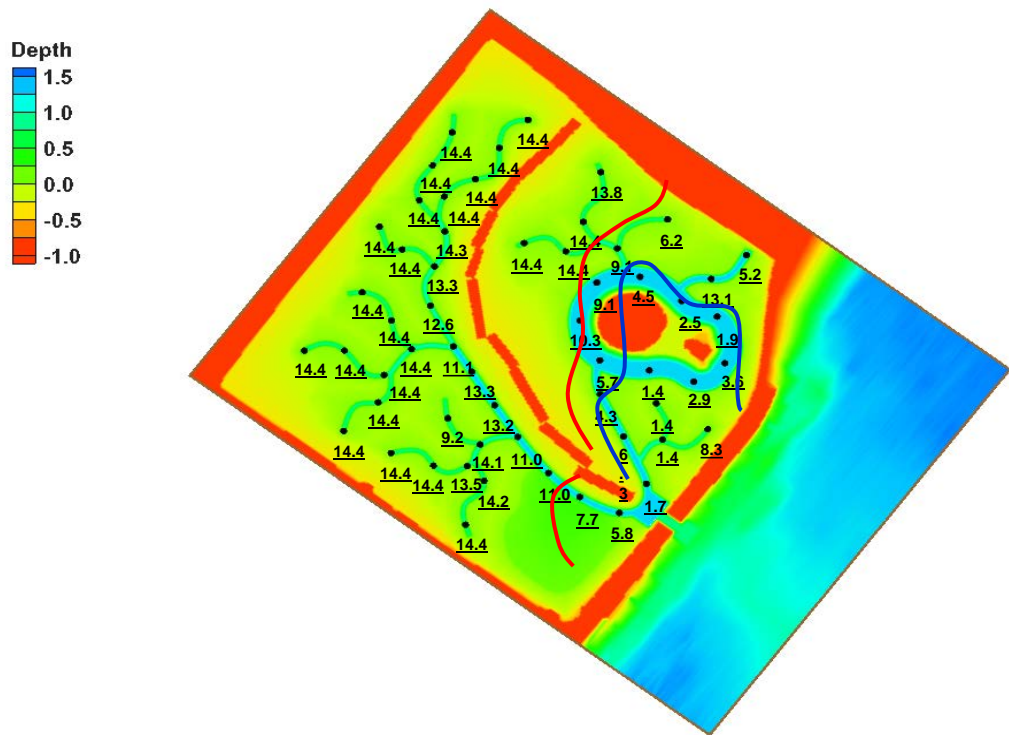
Residence Time

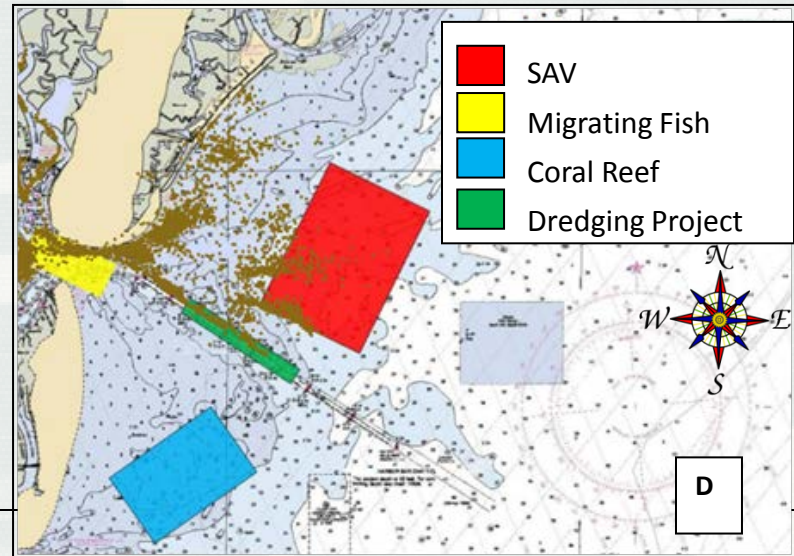
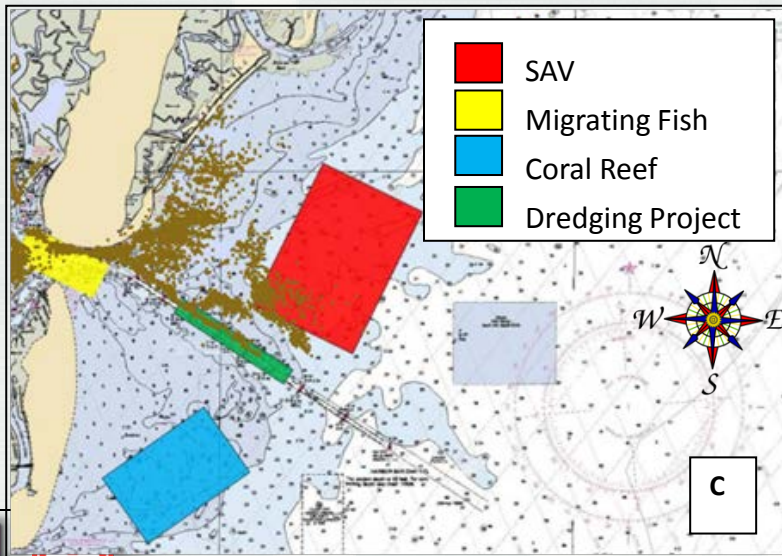
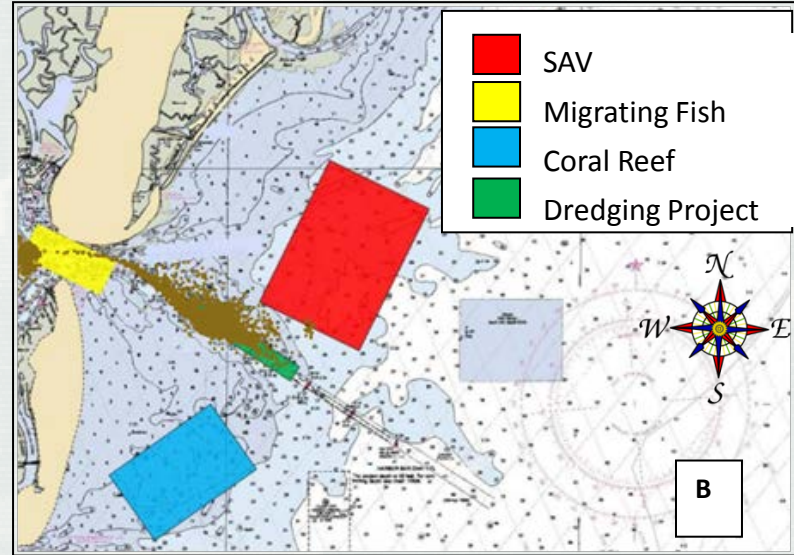
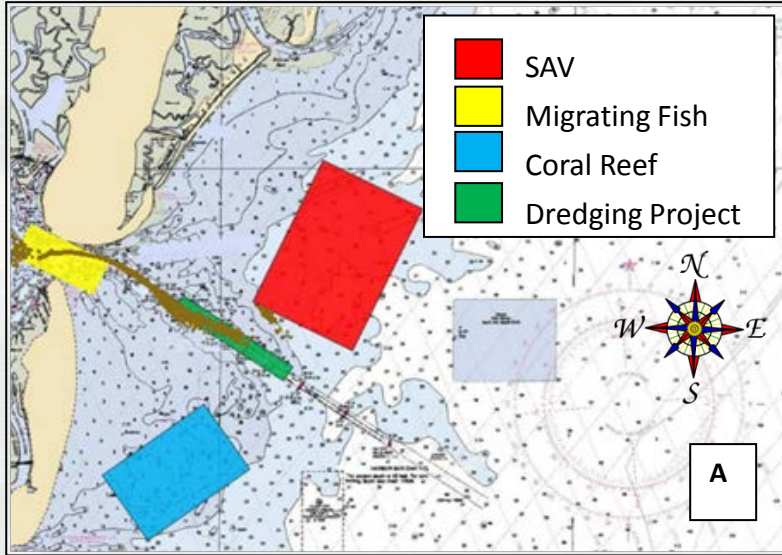


Neutrally Buoyant Particles

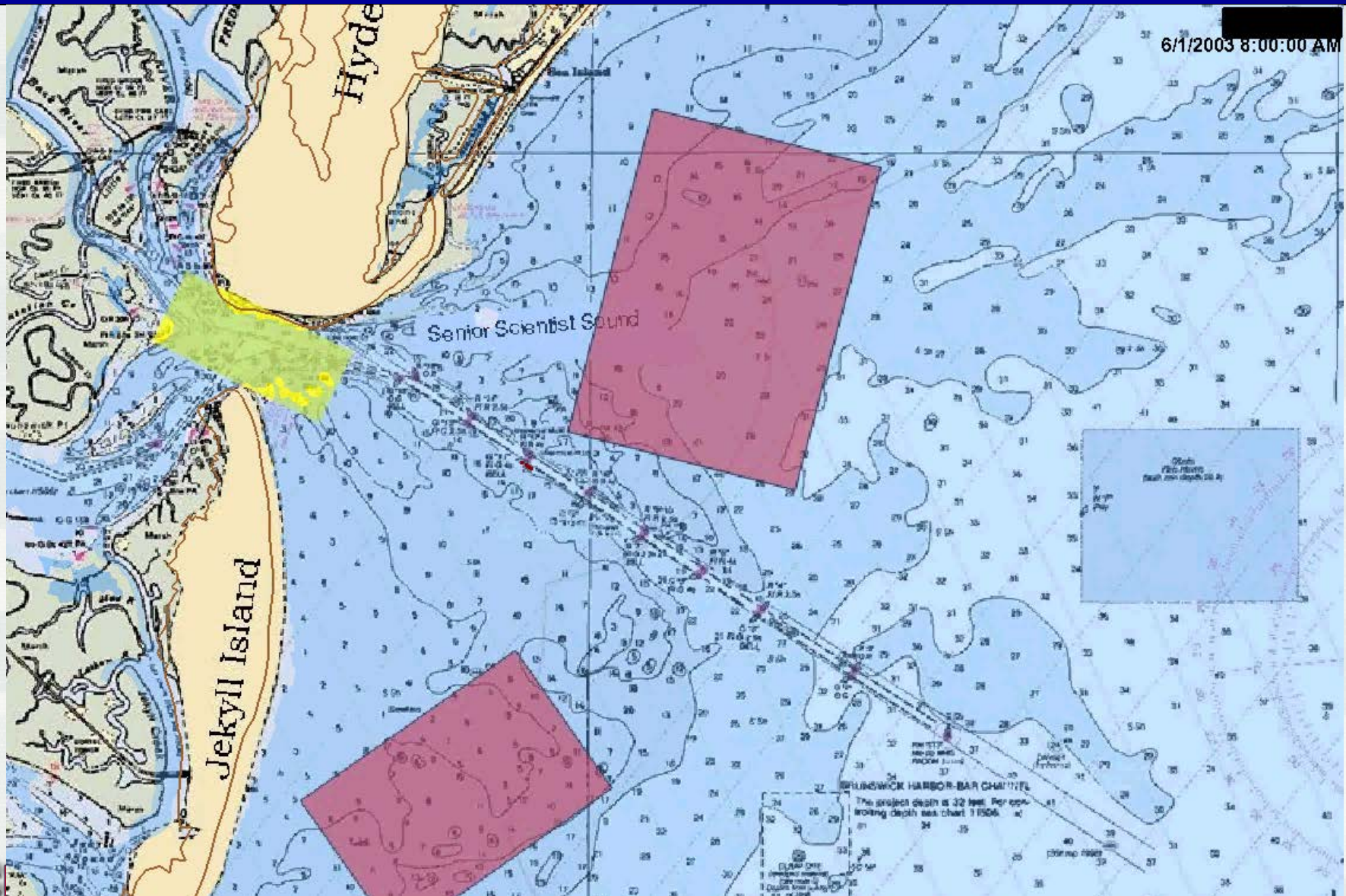
July 07-21, 2007

October 21-November 04, 2007

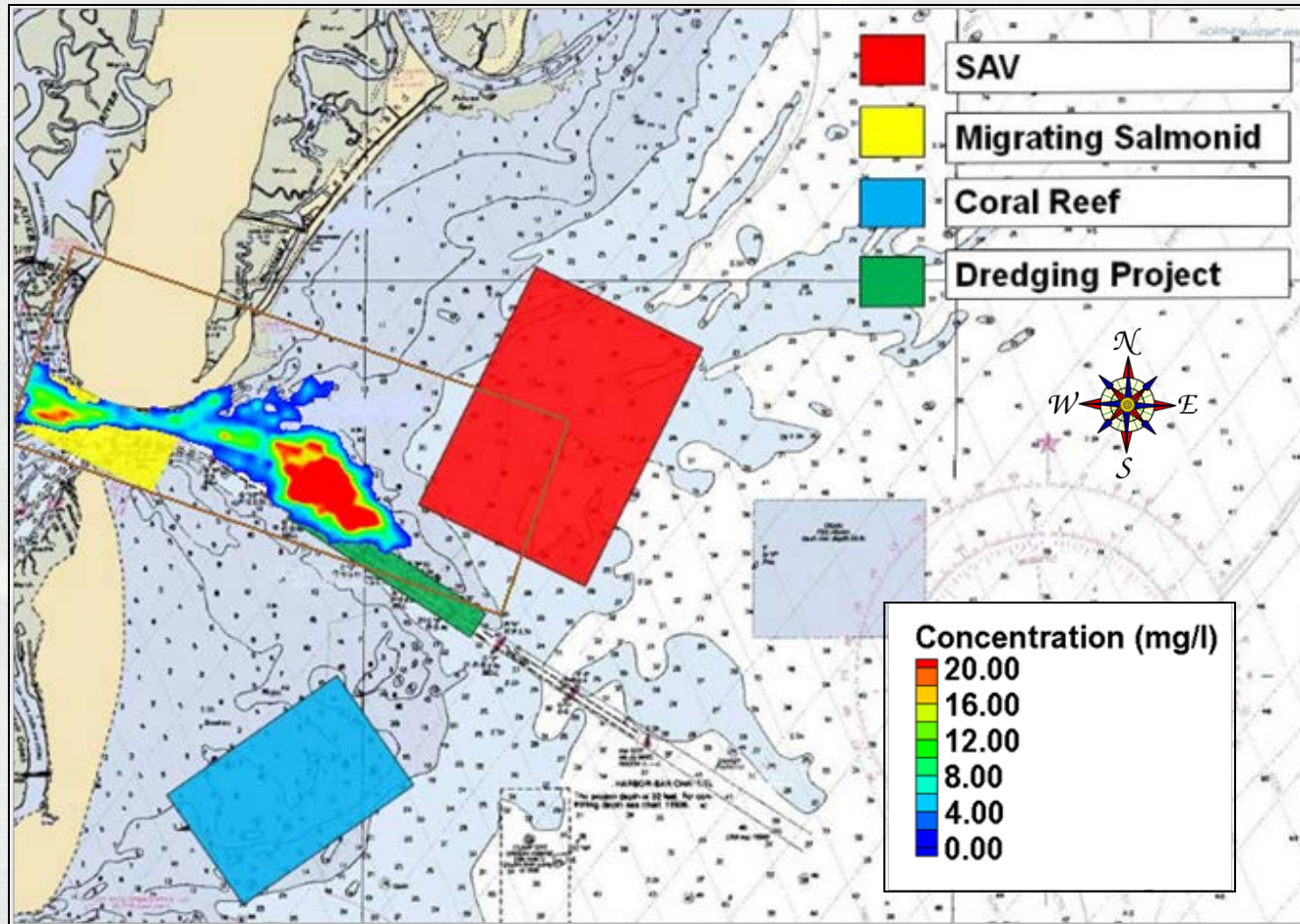




Dredging Materials and Management



Suspended Sediment Concentration (Particle Density)



- Demirbilek, Z., K. J. Connell, and N. MacDonald (2008). **Particle Tracking Model (PTM) in the SMS 10: IV. Link to Coastal Modeling System**, ERDC TN-IV-71, <http://cirp.usace.army.mil/pubs/chetns/CHETN-IV-71.pdf>.
- MacDonald, N., M. Davies, A. Zundel, J. Howlett, Z. Demirbilek, J. Gailani, T. Lackey, and J. Smith (2006). **PTM: Particle Tracking Model, Report 1. Model Theory, Implementation, and Example Applications**, ERDC/CHL TR-06-21, <http://cirp.usace.army.mil/pubs/pdf/TR-06-20.pdf>.
- Li, H., and N. J. MacDonald. 2012. Use of the PTM with CMS Quadtree Grids. Coastal and Hydraulics Engineering Technical Note CHETN IV-82. Vicksburg, MS: U.S. Army Engineer Research and Development Center, <http://cirp.usace.army.mil/pubs/chetns.php>.

Determine Sources of Sediment Responsible for Channel Infilling at Port Orford Port for Different Breakwater Configurations

CMS Grid and Setting

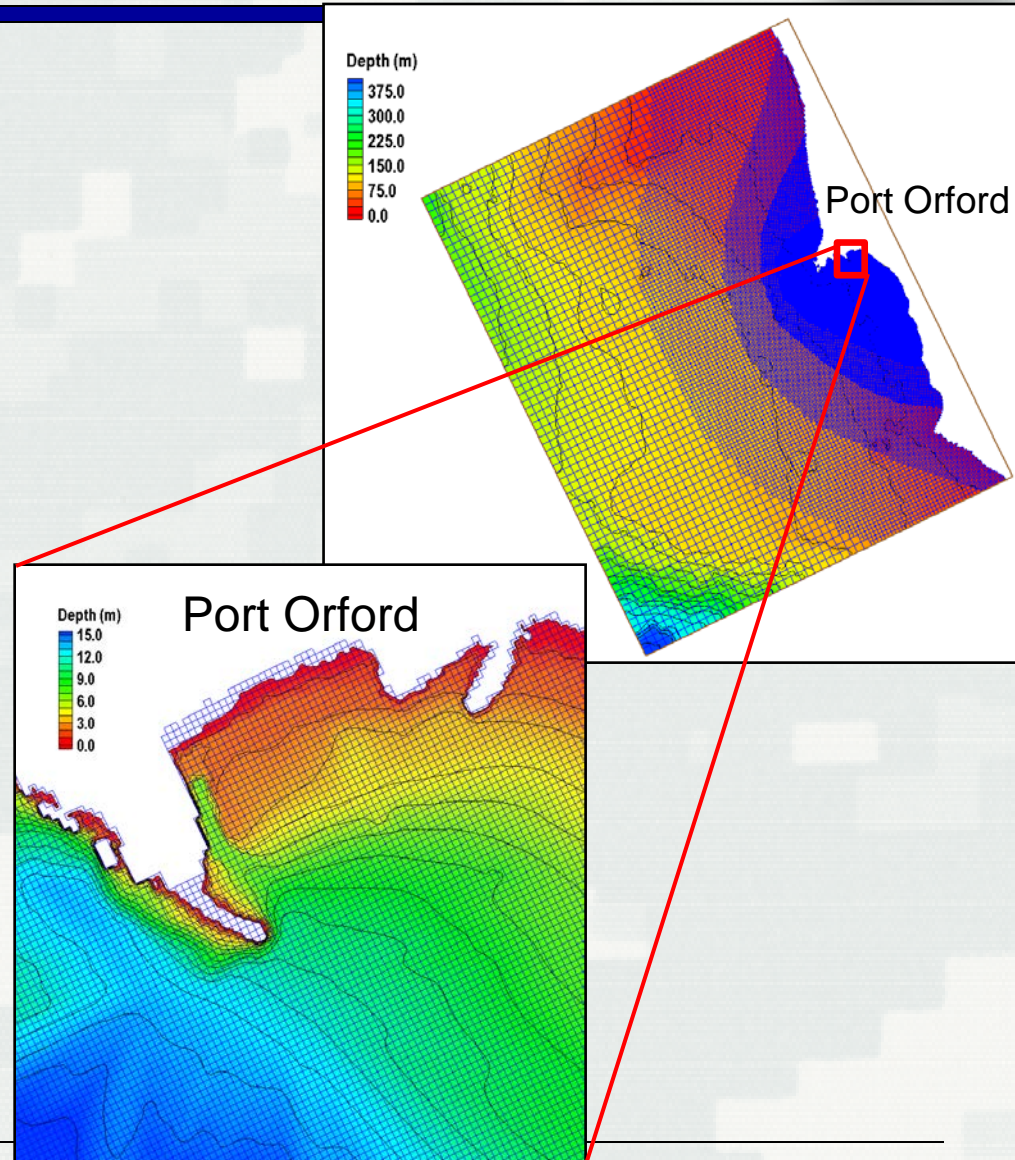
CMS-Flow:

Telescoping

Domain Size: 21 x 16 km

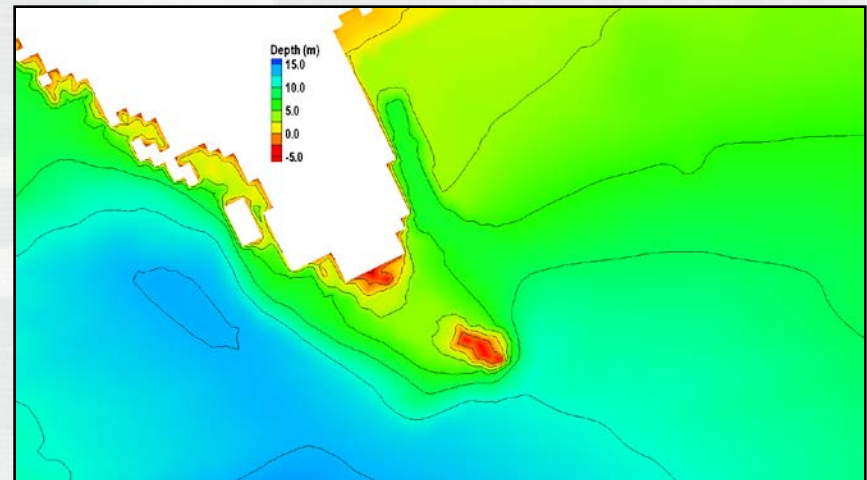
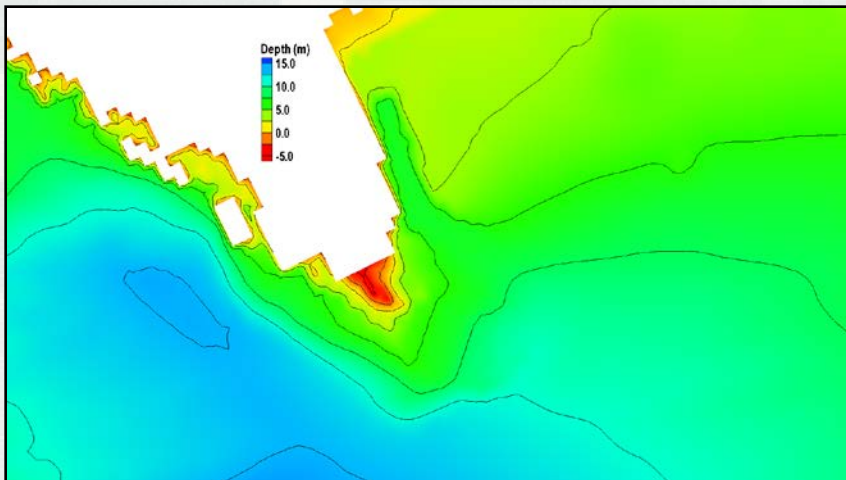
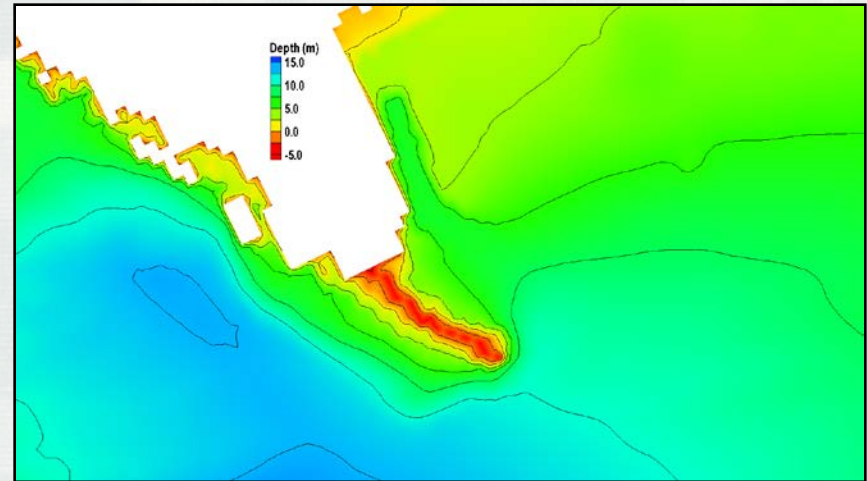
Cell Size: 10 to 3200 m

Water Depth: 0 to 400 m



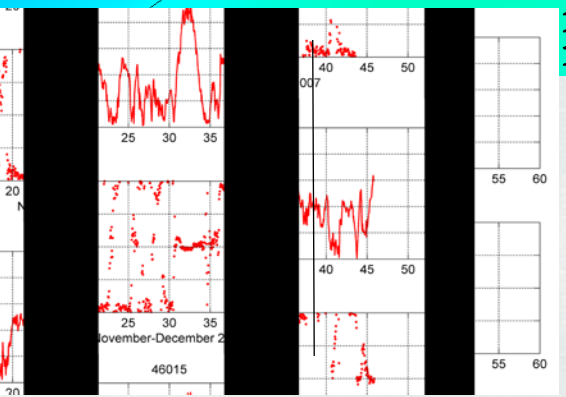
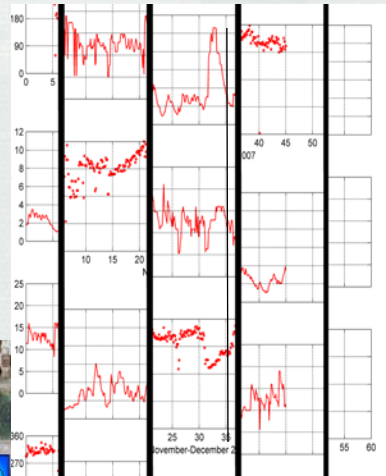
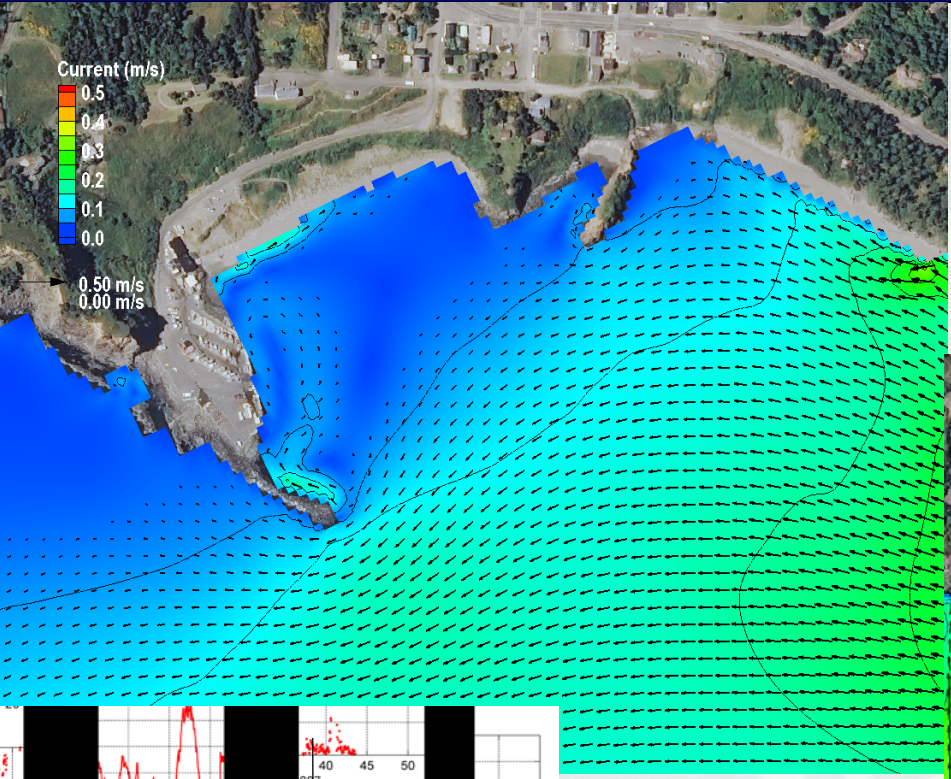
Breakwater Configuration

- Restore breakwater
 - Crest elevation: 16.1 ft above MSL
- Open mid-section notch
 - Length: 250 ft
 - Crest elevation: 8.9 ft above MSL
- Remove breakwater



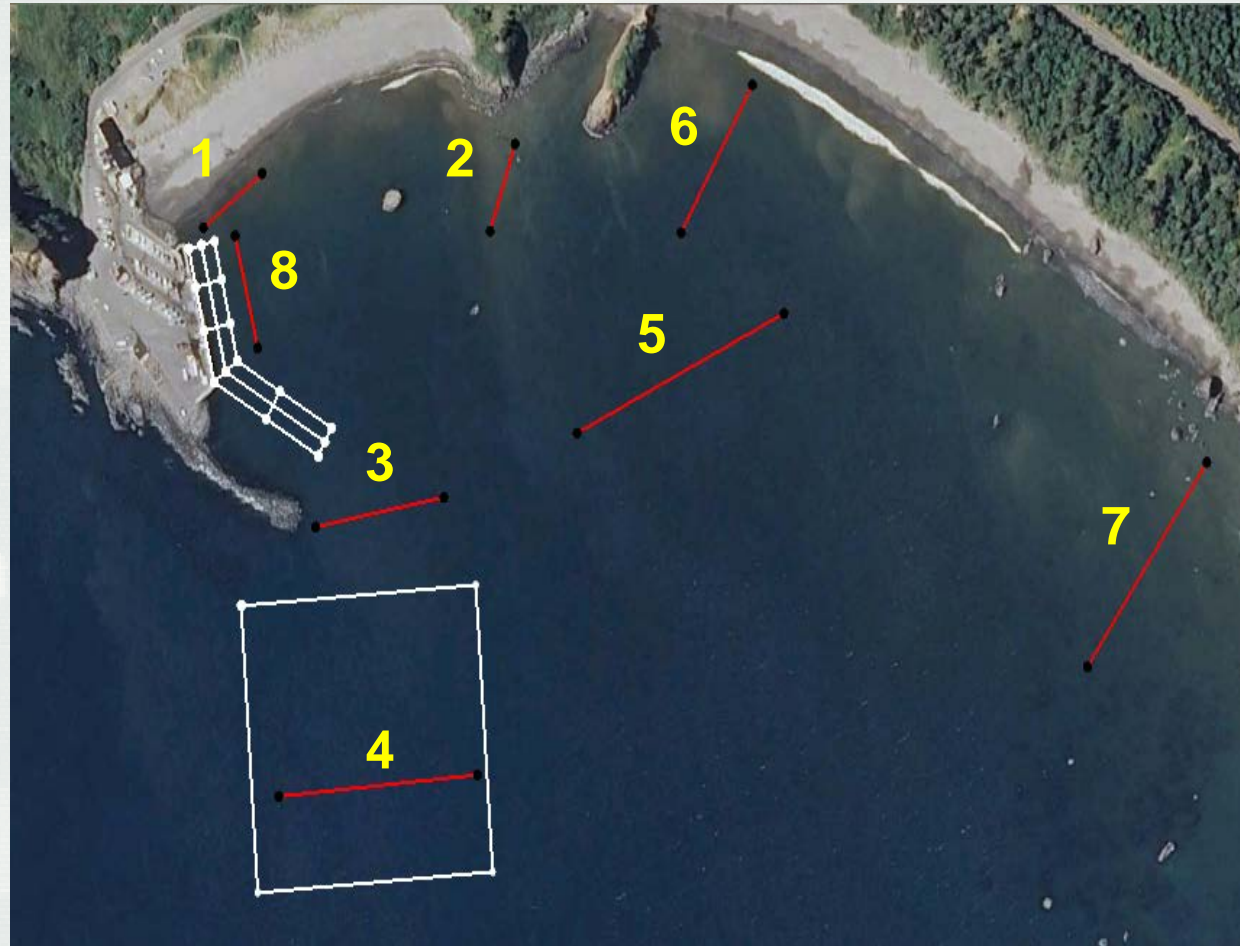
Current and Waves

(Extreme Winter Storm, 3 December, 2007)

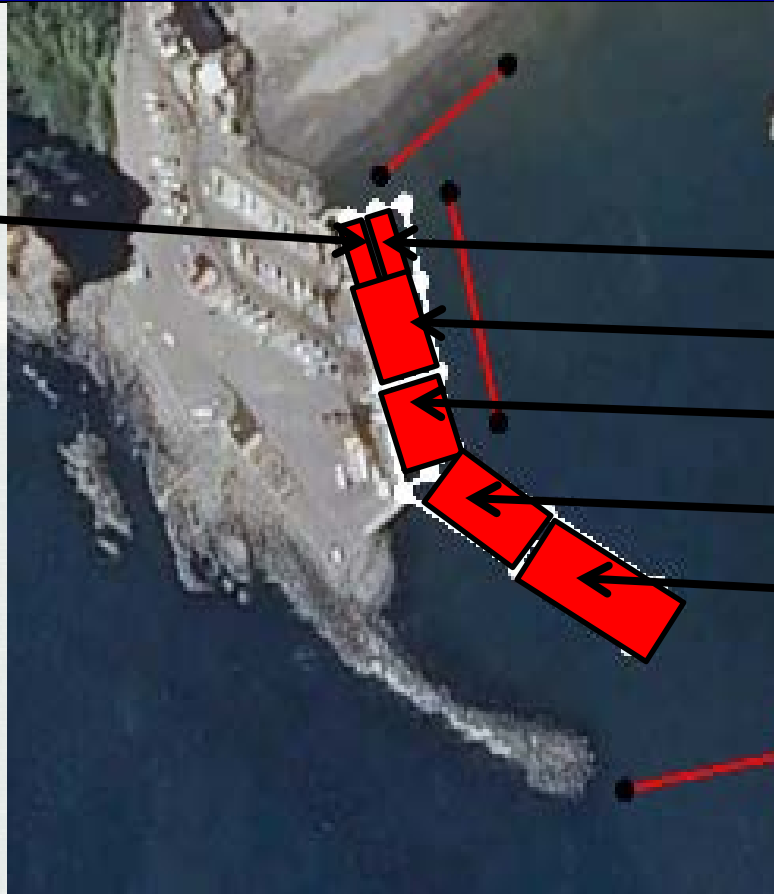


Source Locations

- Sediment sources locations were determined through consultation by:
 - ERDC Team
 - Portland District
 - Port of Port Orford
- Sources are erosion sources (particles are initially at the bed)

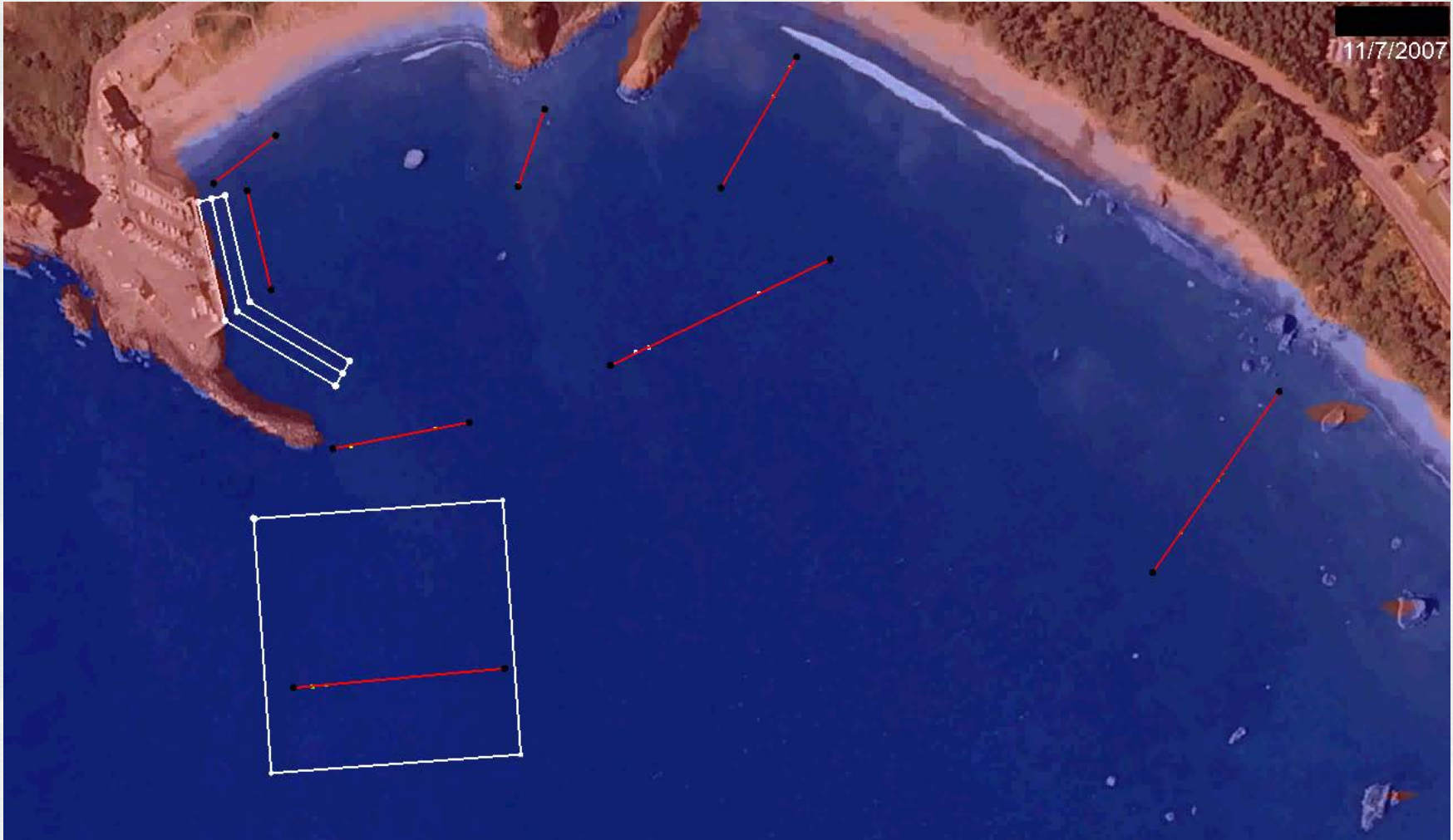


Analysis Traps



- A series of traps were developed for analysis purposes.
- Trap height is approximately half the depth.
- Traps are designed as closed traps (when a particle enters trap, it is counted and transport calculations for the particle ceases)

Modified Breakwater



Comparison (Nov/Dec)

