Coastal Inlets Research Program

Coastal Community of Practice Meeting

17 May 2006

CIRP Technology-Transfer Workshop
Sarasota, FL, 30 Jan – 1 Feb 2006

Coastal Inlet Navigation Channel O&M

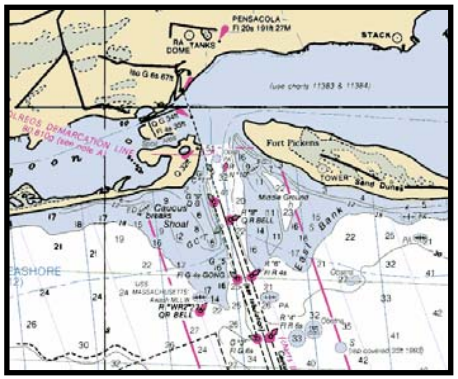
The Corps moves
250-350 Million cu yd of sediment annually

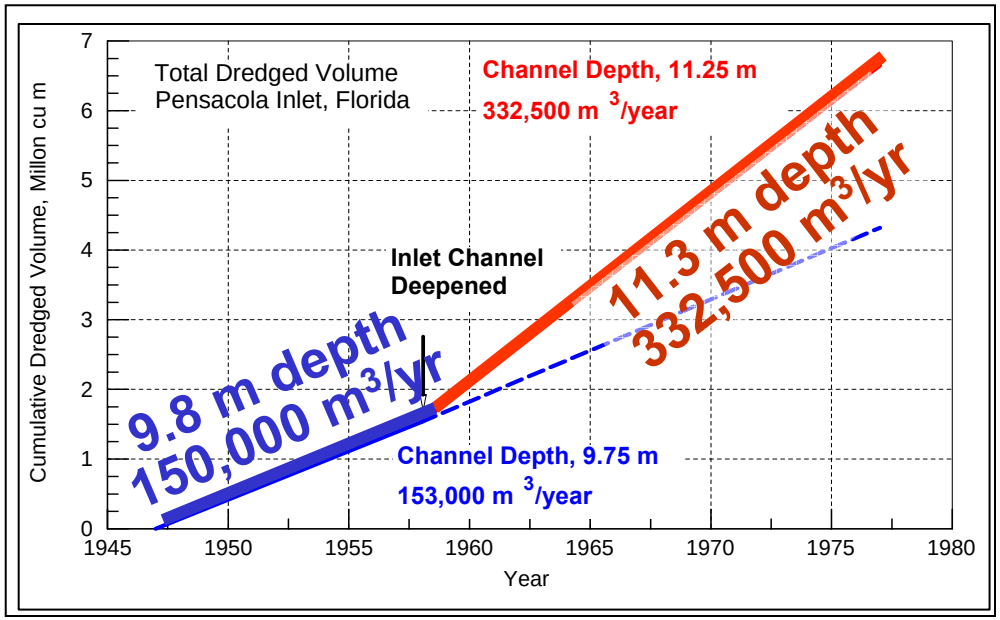
O&M Cost > $900 Million per year

CIRP

Objectives

- **Conduct R&D to reduce O&M costs at inlet navigation projects.**
- **Treat inlet channels & adjacent beaches as a system.**
- **Transfer technology.**





Federal Coastal Inlets

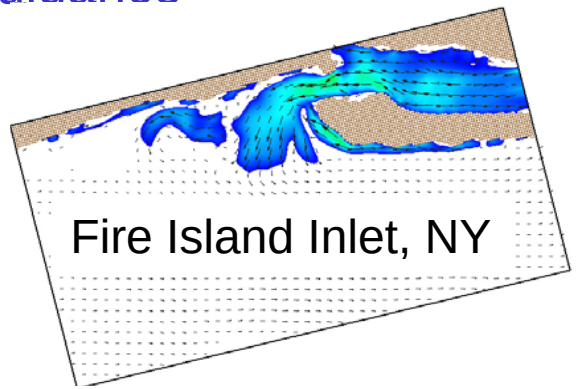
~ 150 major inlets

~ 500 total inlet & harbor channels

CIRP

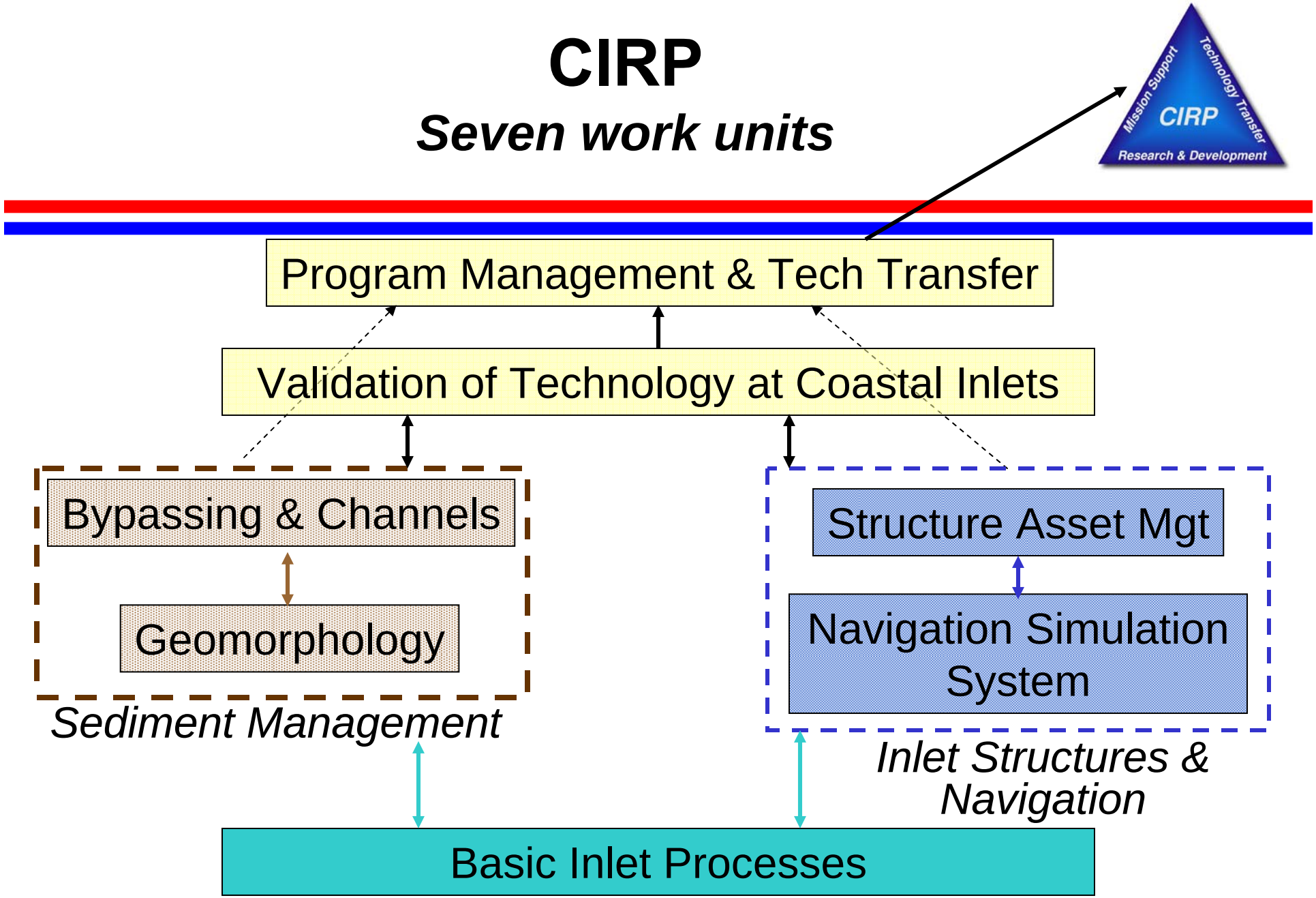
Vision

- District engineers & scientists run CIRP desk-top models
  - Reconnaissance, feasibility, and design O&M projects
  - Inlet channels, shoals, structures, and adjacent beaches
  - Short-term (storm cycles) to long-term (project life) analyses
- Advance predictive technology for inlets, structures, & adjacent beaches
- Web-based databases, tools, & downloads
  - Rapid access to integrated knowledge and guidance



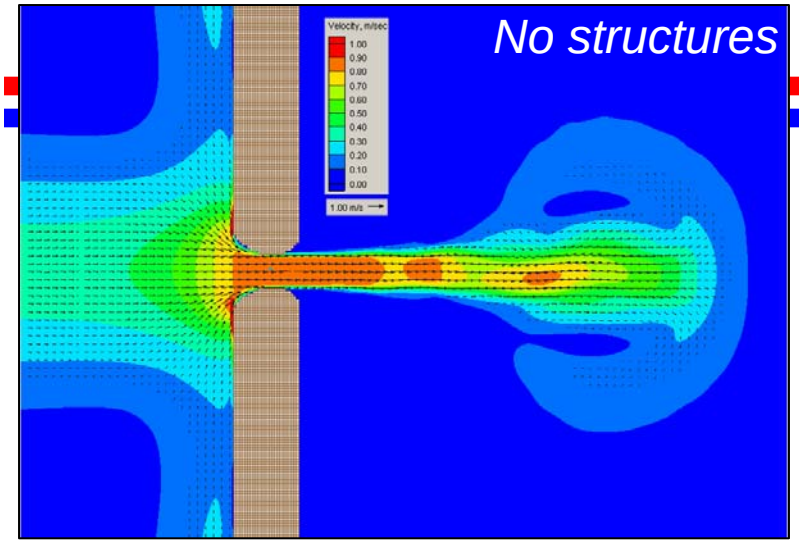
CIRP

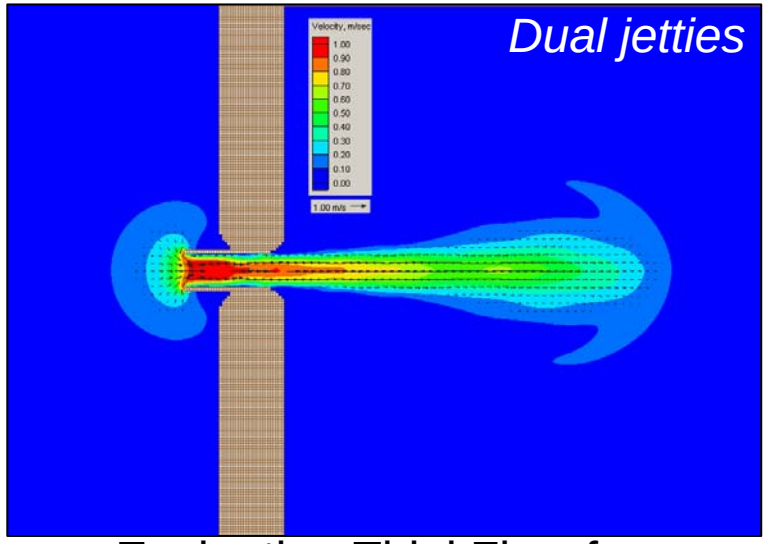
Seven work units



WU 1. Basic Inlet Processes

Lihwa Lin





Evaluating Tidal Flow for Unstructured and Jettied Inlets

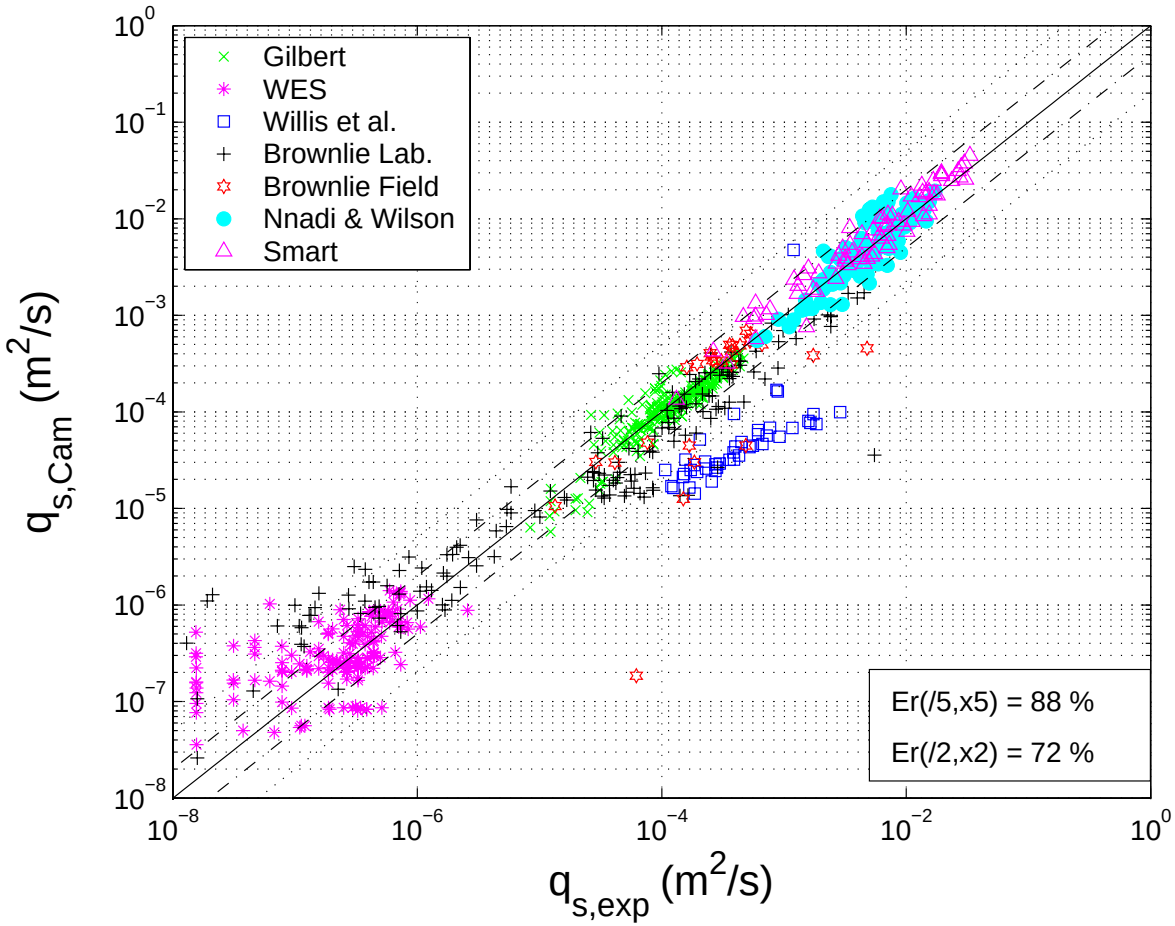
Need: Improved mathematical description of processes central to modeling waves, currents, and sediment transport at inlets.

Approach: Develop, improve individual algorithms

- Wave diffraction (WABED) – new wave model for inlet applications.
- Sediment transport at inlets.
- Advanced numerical solutions.

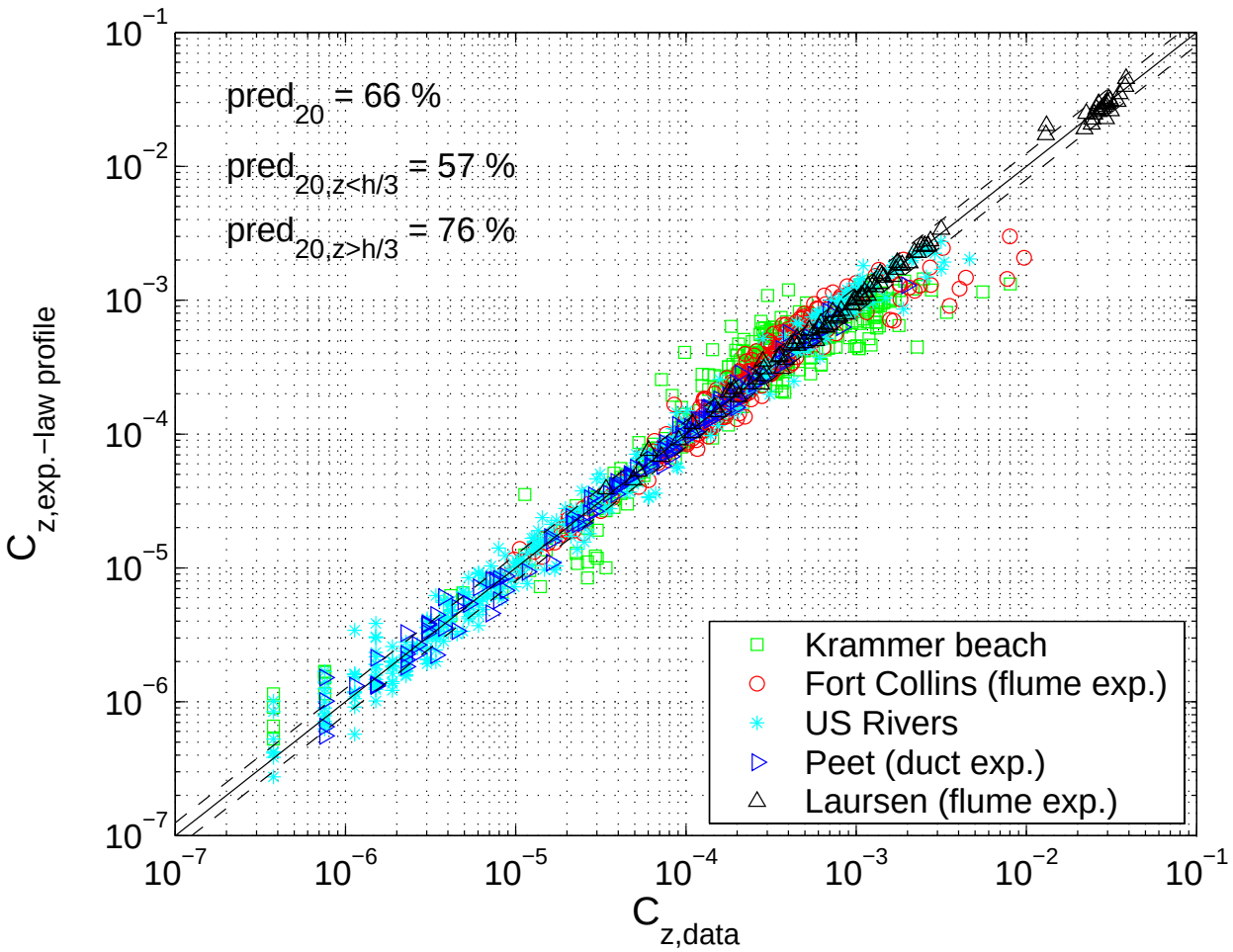
Lund-CIRP Sediment Formula Validation

Bed load under current



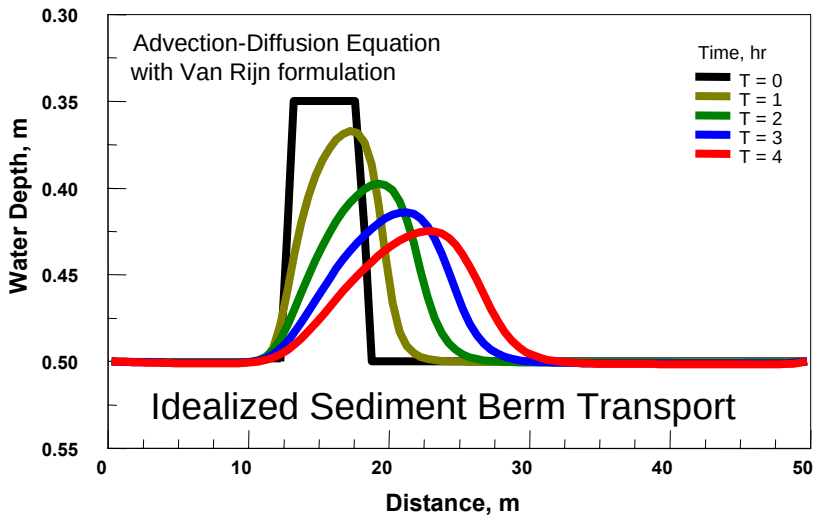
Lund-CIRP Sediment Formula Validation

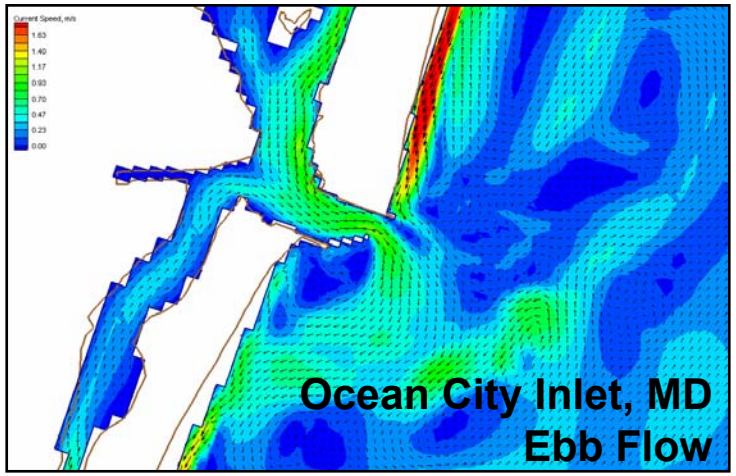
Concentration profile under current



WU 2. Inlet Bypassing & Nearshore Berms

Ken Connell





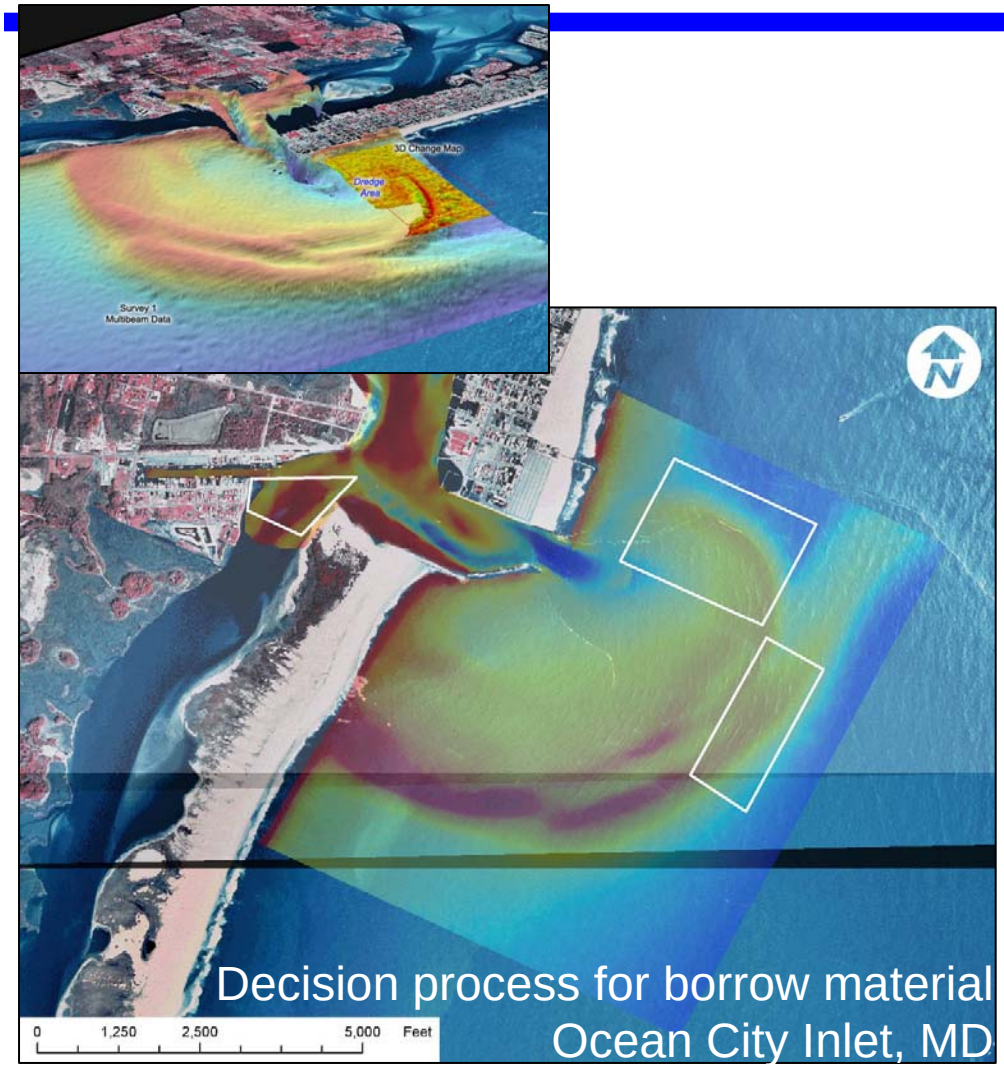
Need: Predictive technology to treat inlets & adjacent beaches as sand-sharing system.

Approach: Develop **Coastal Modeling System (CMS):**

- Channel infilling & design.
- Bypassing.
- Nearshore berm performance as a disposal option.
- Integrated inlet processes.

WU 3. Inlet Geomorphic Evolution

Nick Kraus



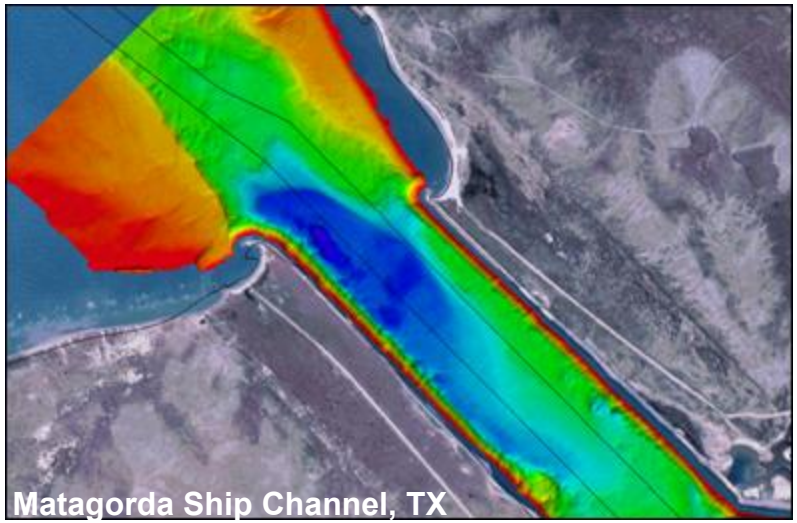
Decision process for borrow material
Ocean City Inlet, MD

Need: Many Federal inlets > 100 years old; morphology has greatly changed. Inlet modifications permanently change morphology, & O&M will be carried out with that morphology.

Approach: Develop tools and guidance to predict coastal morphologic evolution at inlets over long temporal and spatial scales.

WU 4. Coastal Structure Asset Management

Steve Hughes, Jeff Melby



Need: Procedures to objectively evaluate and prioritize O&M funding for repair, rehab, and maint of critical coastal navigation infrastructure.

Approach: Update coastal structure design guidance and develop new procedures for using the guidance within the Asset Management Decision Tool (AMDT) framework.

Coastal Structure Asset Management

Critical Components for Evaluating Structures

- Estimate the repair cost and **repercussions** associated with a damaged or failed structure (both to the Corps and to local/regional/national economies)
- Determine the **risk of additional damage** and the associated repercussions if repair is postponed (urgency of repair factor)
- Provide some indicator of **confidence level** in the estimates
  - **Low:** Based on minimal quantitative information
  - **Medium:** Some quantitative estimates and some approximate guesses
  - **High:** Based on detailed studies and analyses
- Need proper **weighting** when summing all the diverse elements for assessing risks and consequences arising from a damaged structure

WU 5. Navigation Simulation System

Zeki Demirbilek

Need: Lack information required for accurate prediction of wave-structure and wave-ship interactions.

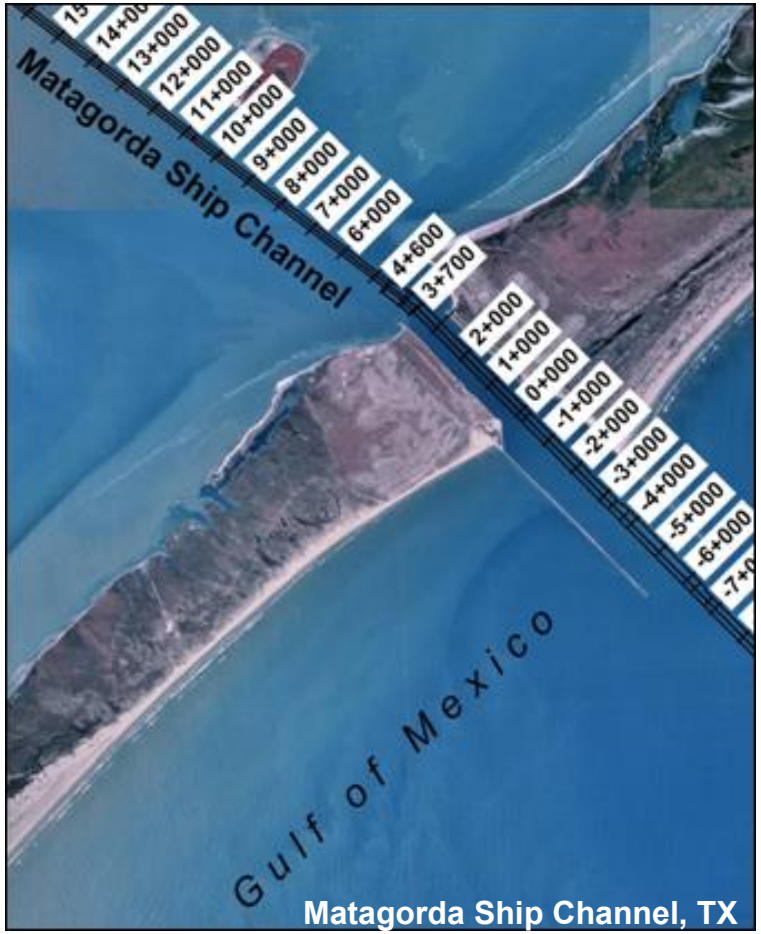
Global Explorer inbound on Columbia River

Approach: Boussinesq Model:

- Detailed wave transformation at inlets.
- Wave, current, & structure interaction.
- Wave runup & overtopping of coastal structures.
- Vessel-induced wakes & currents.
- Vessel & channel interaction.

WU 6. Validation of Predictive Technology

Julie Rosati



Matagorda Ship Channel, TX

Need: Validate CIRP models and tools at recon, feasibility, and design levels. Solve O&M problems common to Corps projects.

Approach:

- Test CIRP's emerging technology at sites with critical District O&M concerns of broad applicability.
- Propose and evaluate solutions.
- Develop web-based decision-support tools for O&M actions and anticipated response.

WU 7. Program Management and Technology-Transfer

Nick Kraus, Janie Daughtry

Need: Meet CIRP Objectives.

Approach: R&D products to the field.

- Assess applicability of research for O&M goals.
- Desktop-based modeling tools.
- Workshops, guidance documents, and training.
- Web-based resources.

Tech Director: Jim Clausner
Prog Manager: Nick Kraus

CIRP

Example Accomplishments

- Coastal Modeling System (CMS) – available via SMS
- Sediment Budget Analysis System (SBAS) jointly funded with SWWRP
- Inlet Reservoir Model for Sediment Bypassing
- Particle Tracking Model (PTM) – jointly funded with DOER
- Field data sets and laboratory data sets for validating technology
- Breaching model – breaching near inlet jetties
- Fundamental advances in understanding inlet stability,
  scour at jetties, coastal structure design
- More than 20 technology-transfer workshops
- Applications in support of difficult District problems
- CIRP website, online tools, and guidance, downloads

CIRP
Website

http://cirp.wes.army.mil/cirp/

Website Objectives:

- Information about CIRP
- Technology Transfer
- Simple Online Tools
- Easy Site Navigation

Information:

- CIRP Research
- Upcoming Events
- Past Presentations
- Photo Collections

Publications:

- CHETNs
- Technical Reports
- Journal Articles
- Conference Papers

Test of CIRP Technology

Wave Modeling at Mouth of Columbia River

WABED (WU 1)

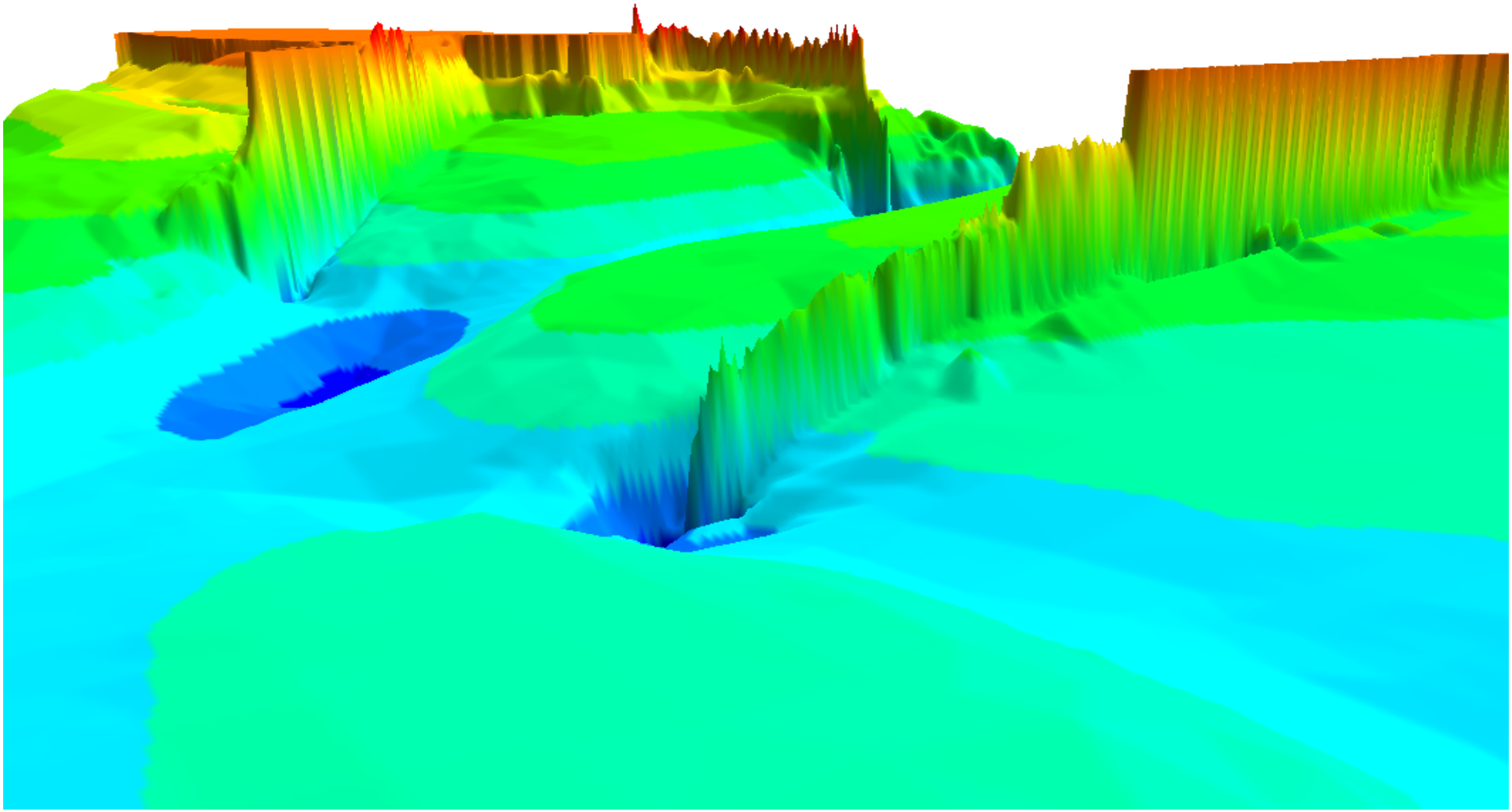
- Large-domain modeling
- Wave diffraction and reflection
- Wave-current interaction
- Coupled simulations for nearshore circulation models

BOUSS-2D (WU 5)

- Detailed combined wave and circulation model
- Wave transmission, diffraction, and reflection
- Non-linear terms included
- Computation intensive

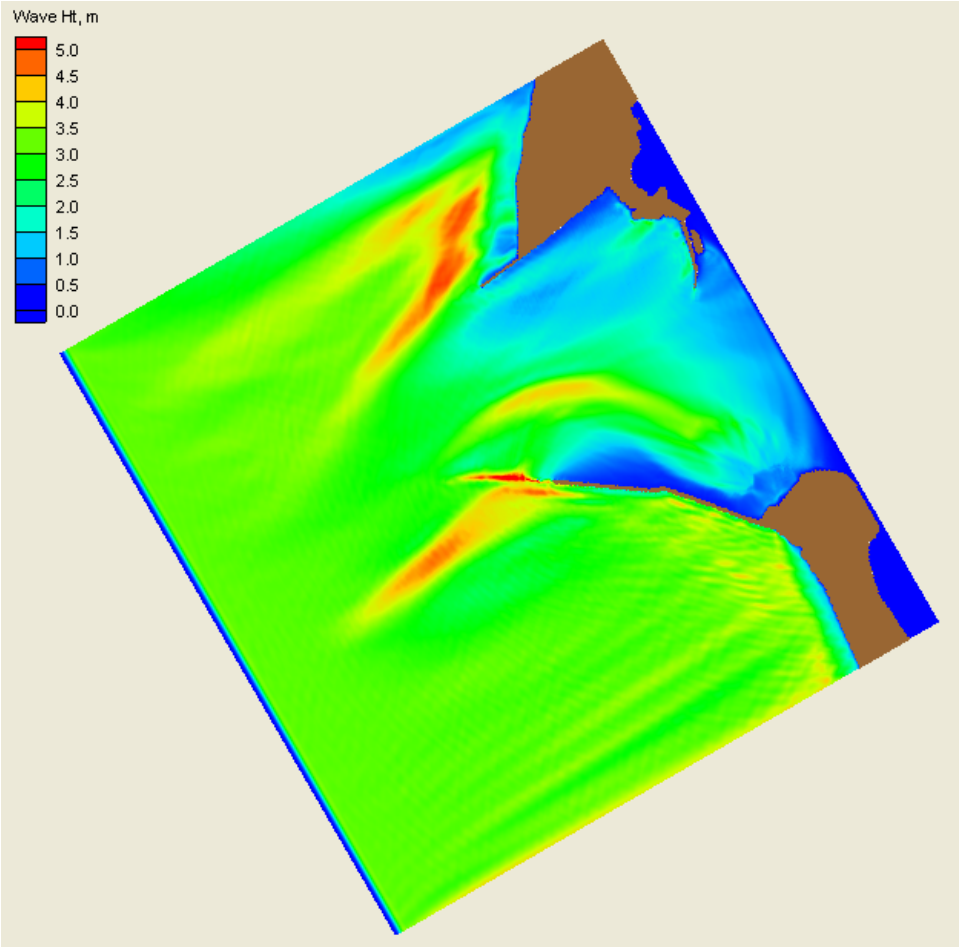
Mouth of Columbia River

Existing Bathymetry

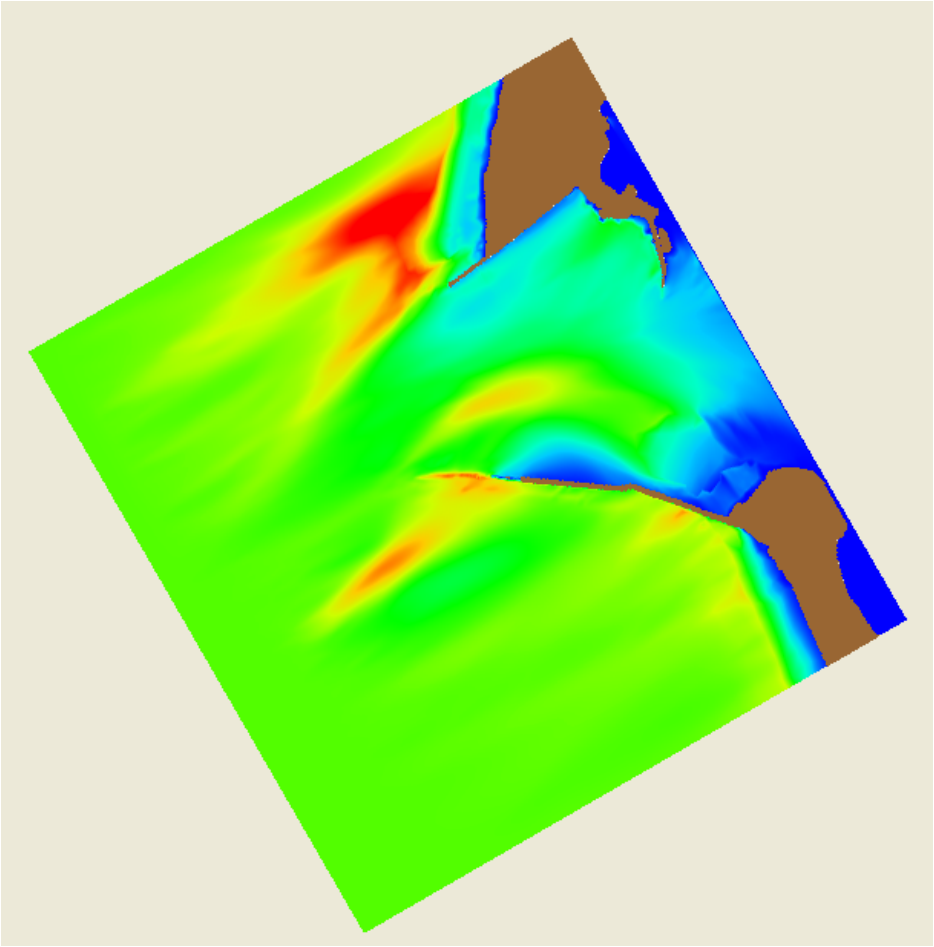


Wave Field Comparison – Existing Condition

H=3 m, T=12.5 sec, SW direction



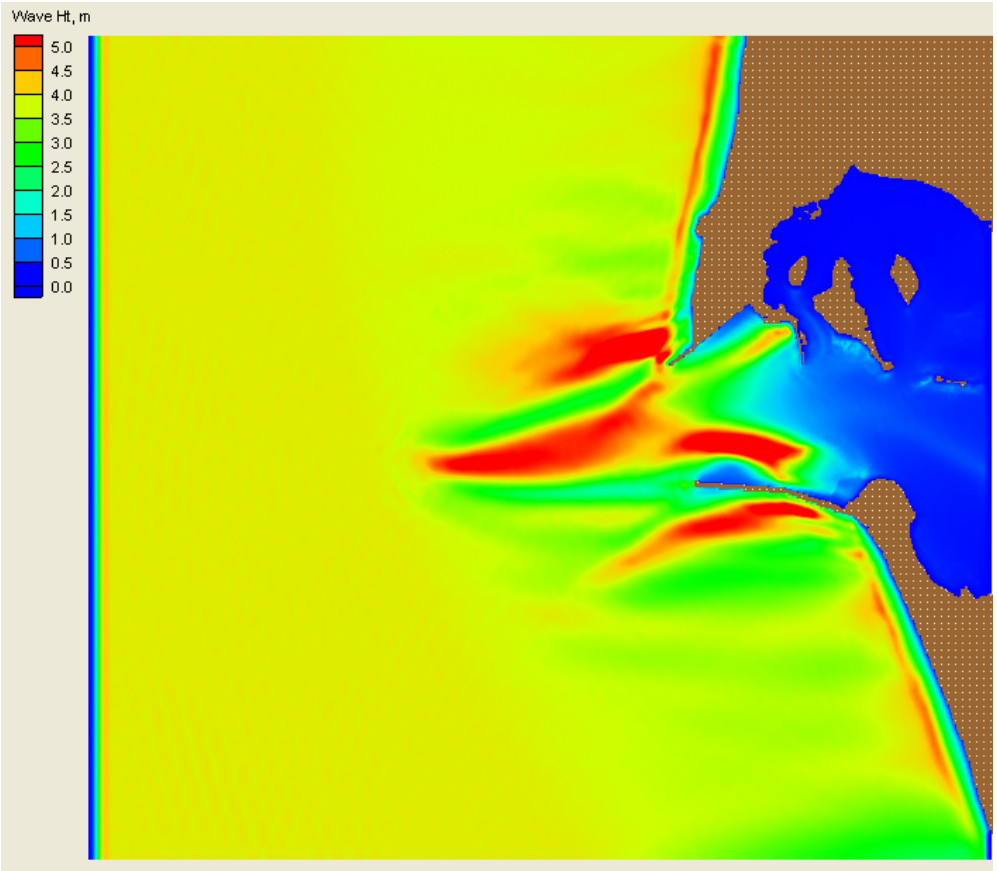
Bouss2D



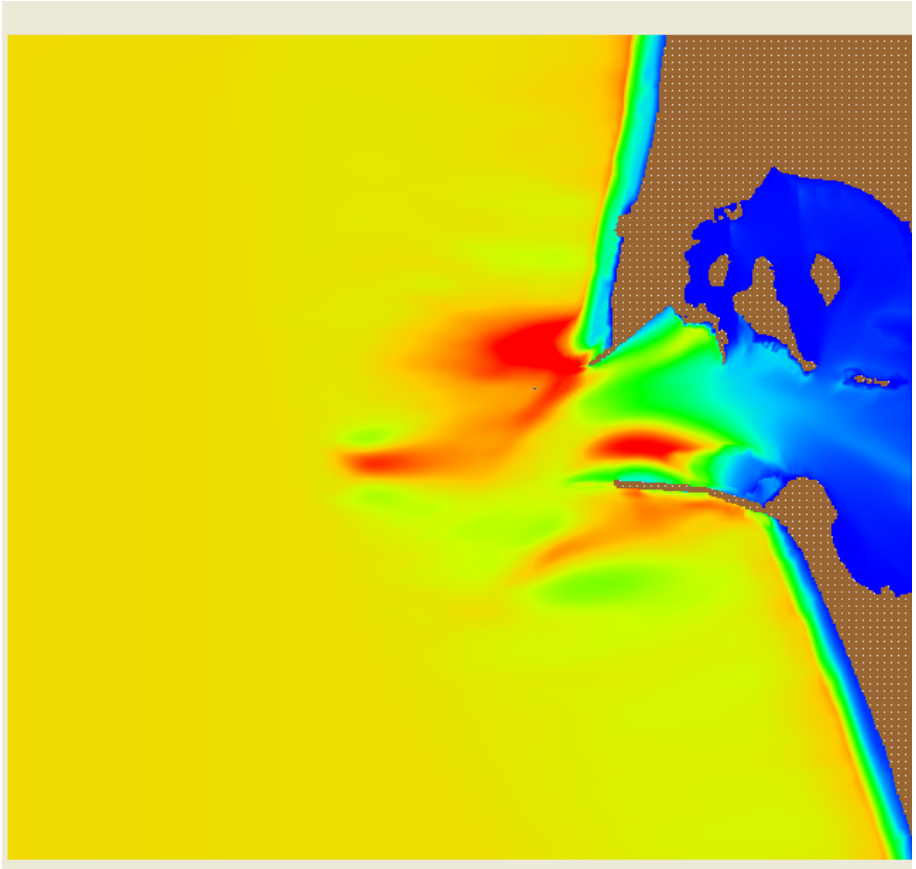
WABED

Wave Field Comparison – Existing Condition

H=4 m, T=12 sec, W direction



Bouss2D

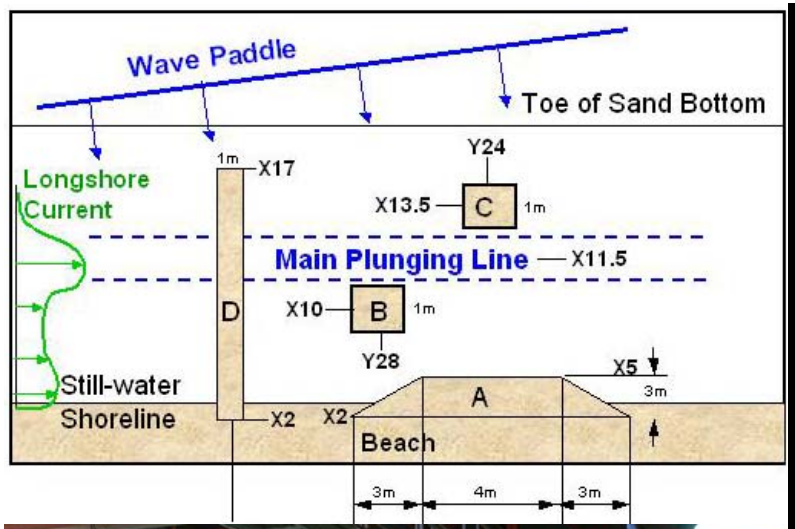


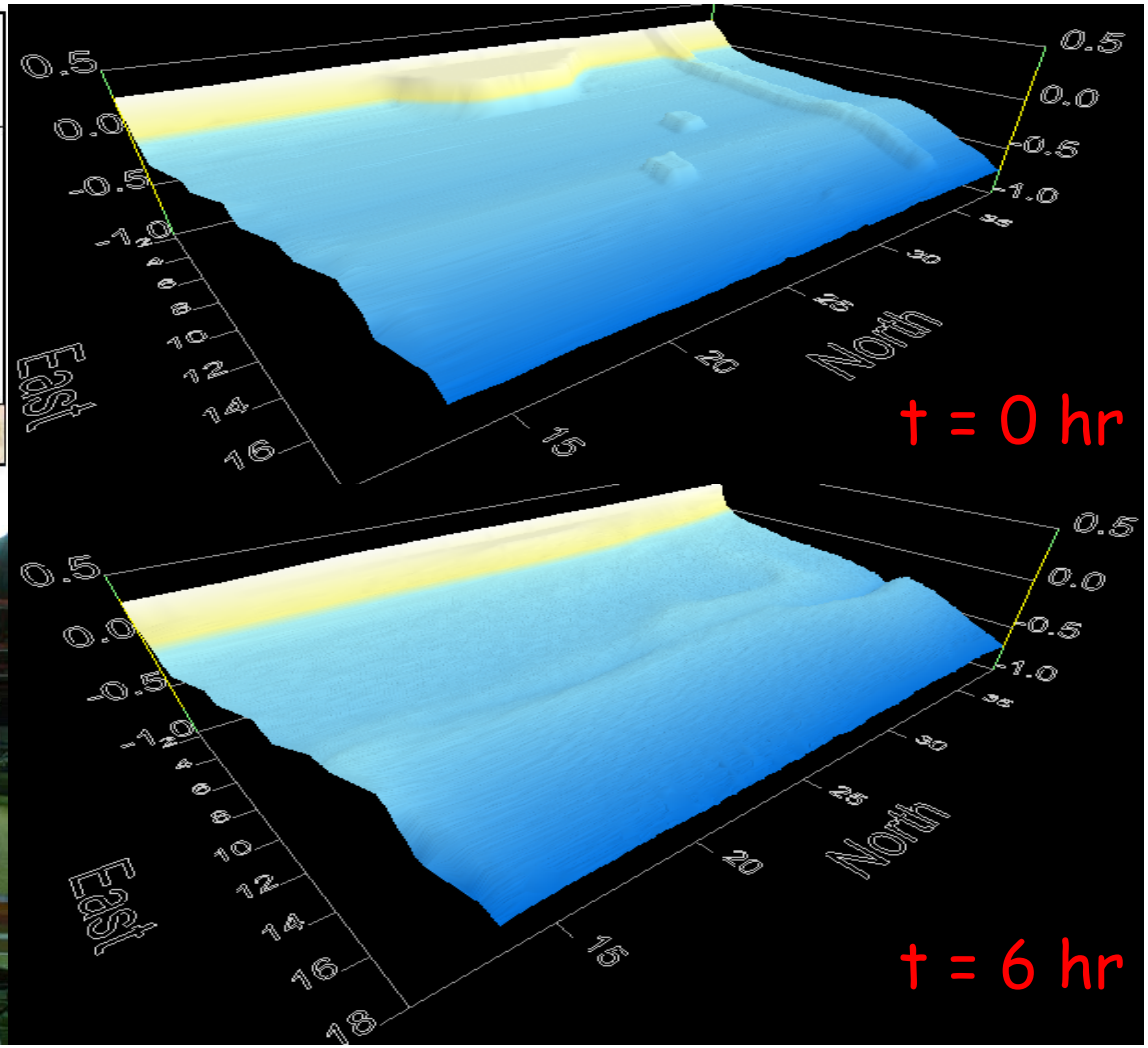
WABED

Validation of CIRP Predictive Technology

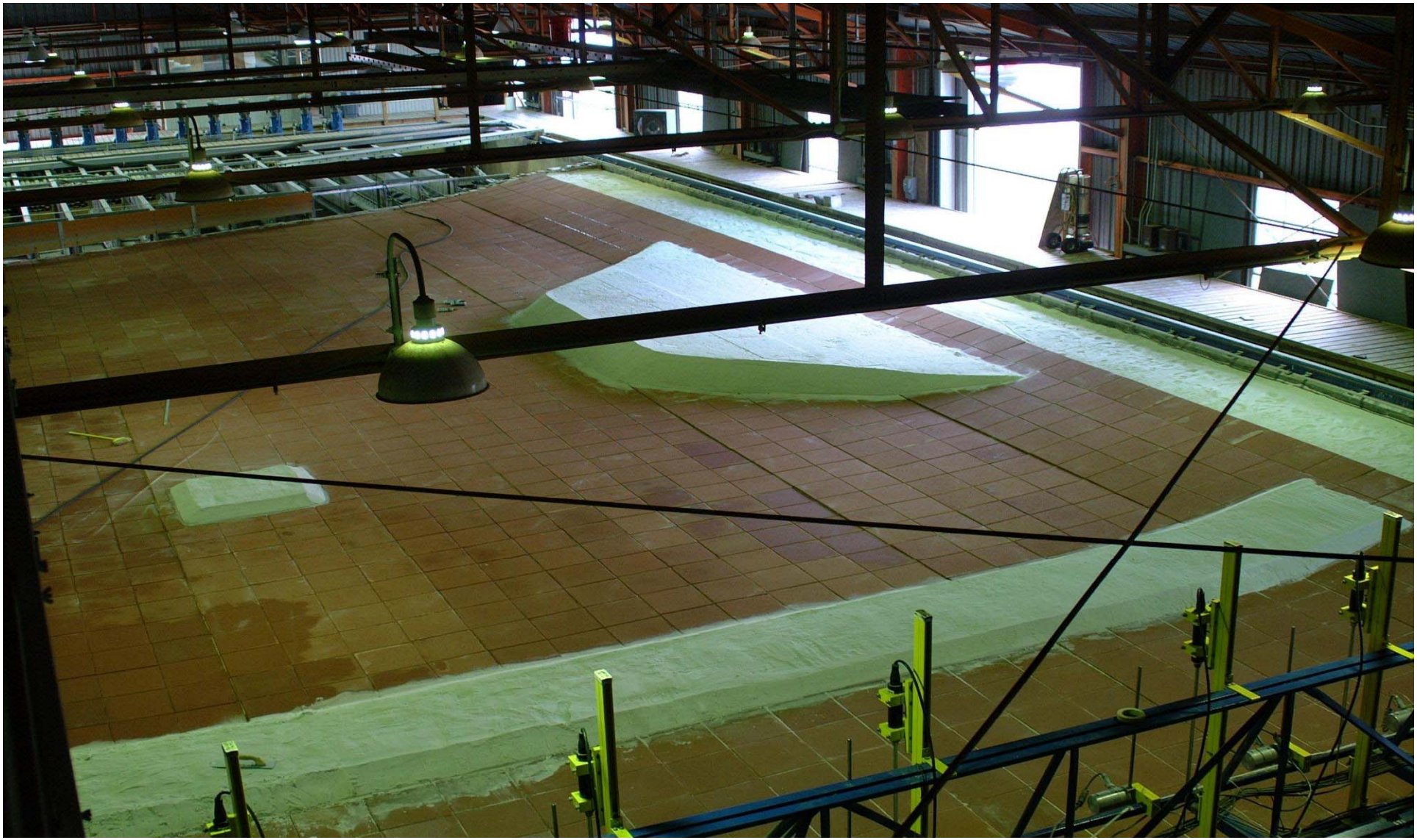
Hard-bottom Physical Model Tests

Validation Data for CMS & Other Morphology Change Models





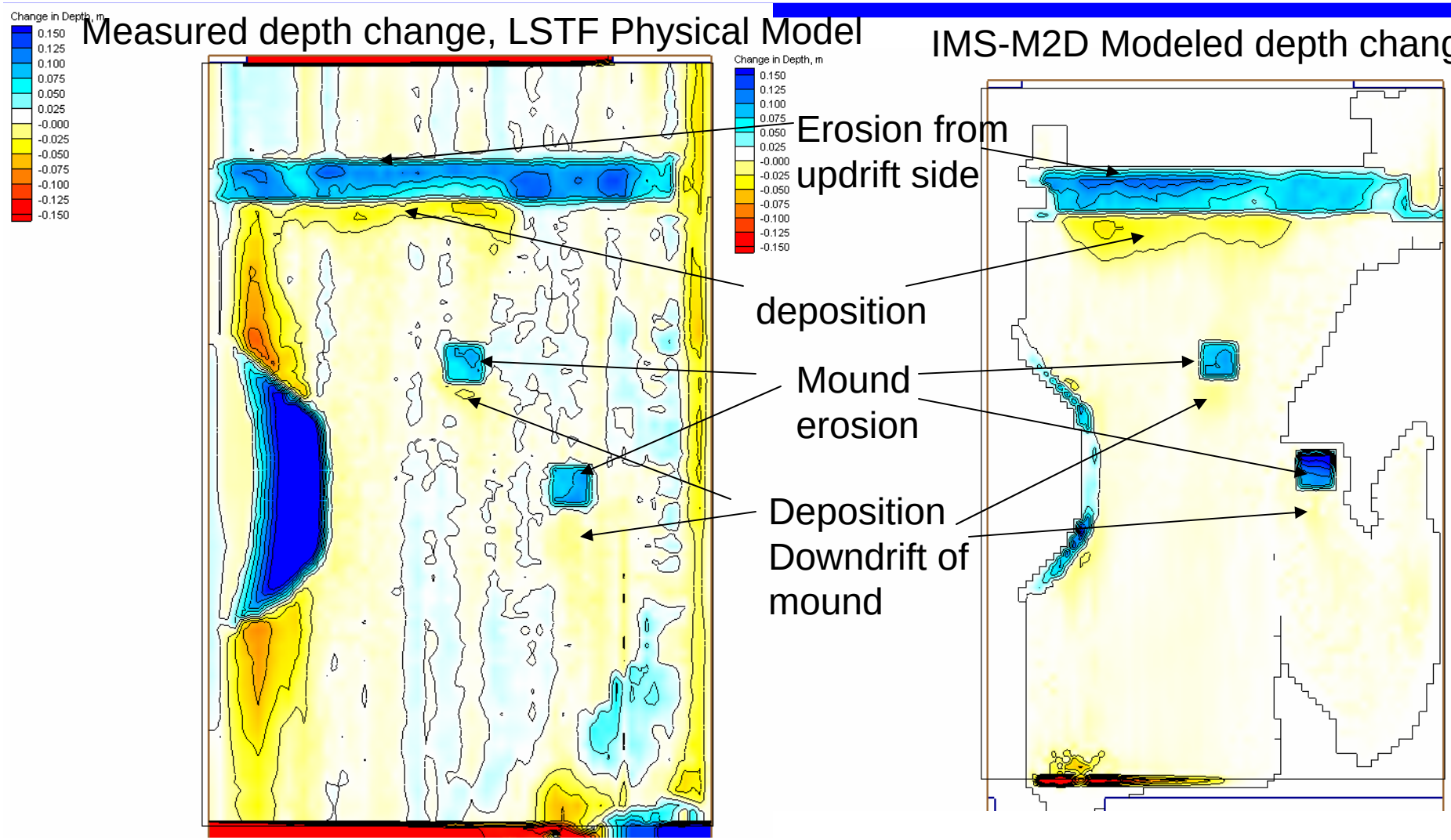
Large-scale Sediment Transport Facility (LSTF)
CIRP Hard-bottom Tests for CMS Validation



Comparison of LSTF Hard-Bottom Physical Model to CMS-M2D Hard-Bottom Algorithm, after 0.5 hr

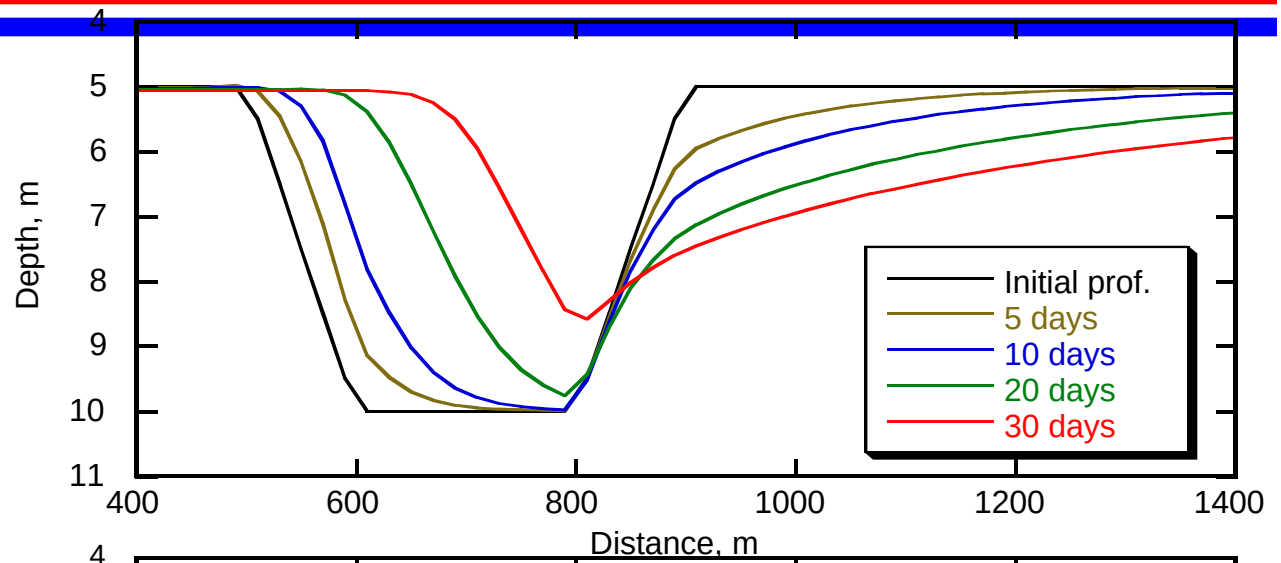
Measured depth change, LSTF Physical Model

IMS-M2D Modeled depth change



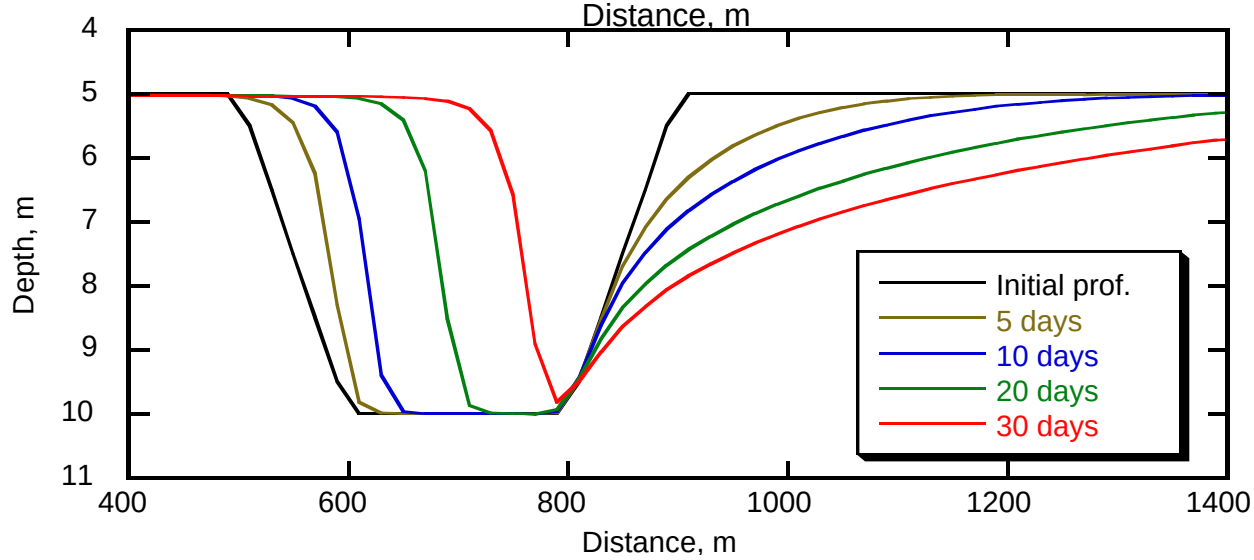
CMS-M2D Channel Infilling Test
A-D and TL (Lund-CIRP)

Advection-Diffusion Transport



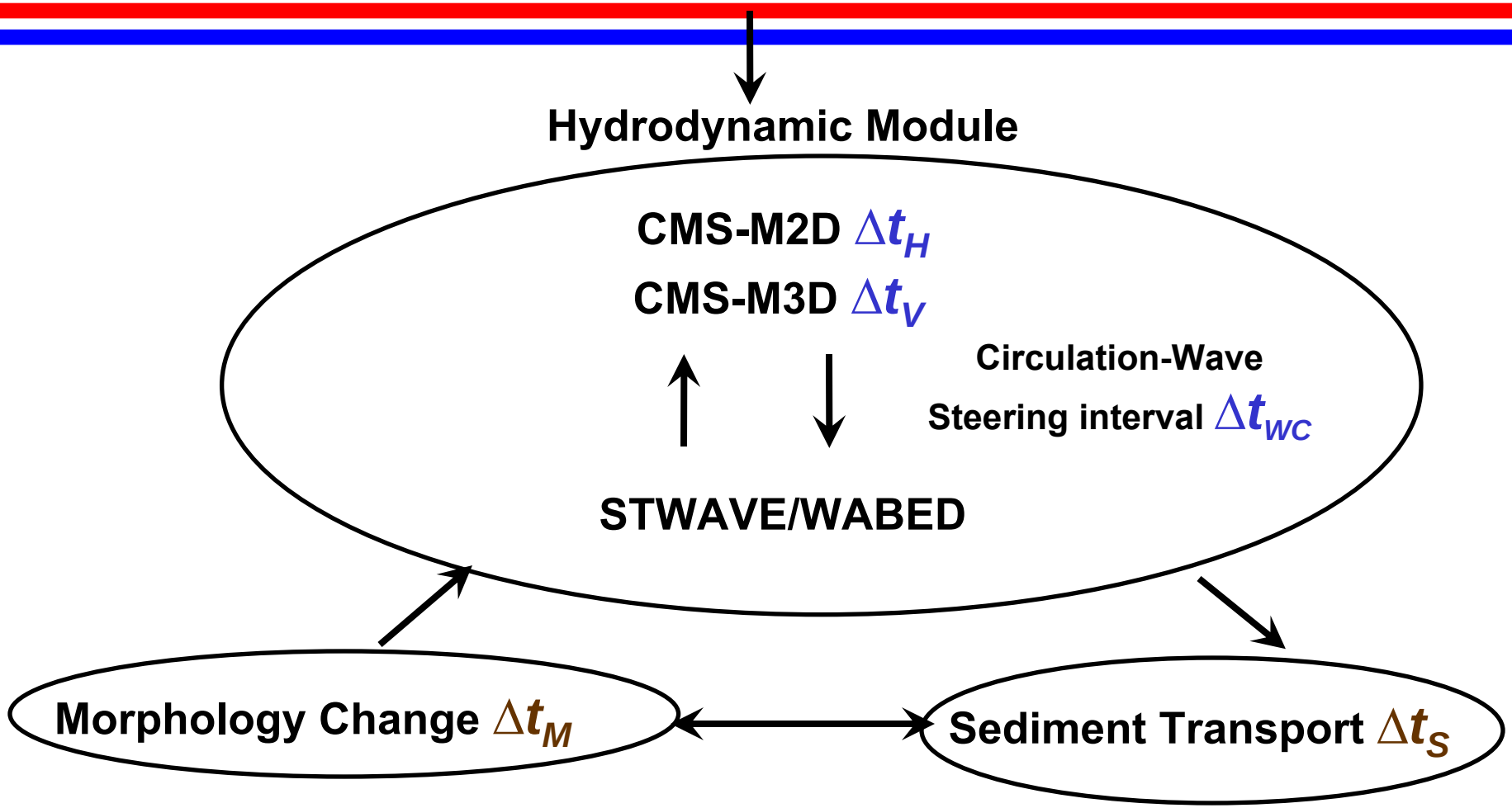
Grain size = 0.2 mm

Total Load Transport



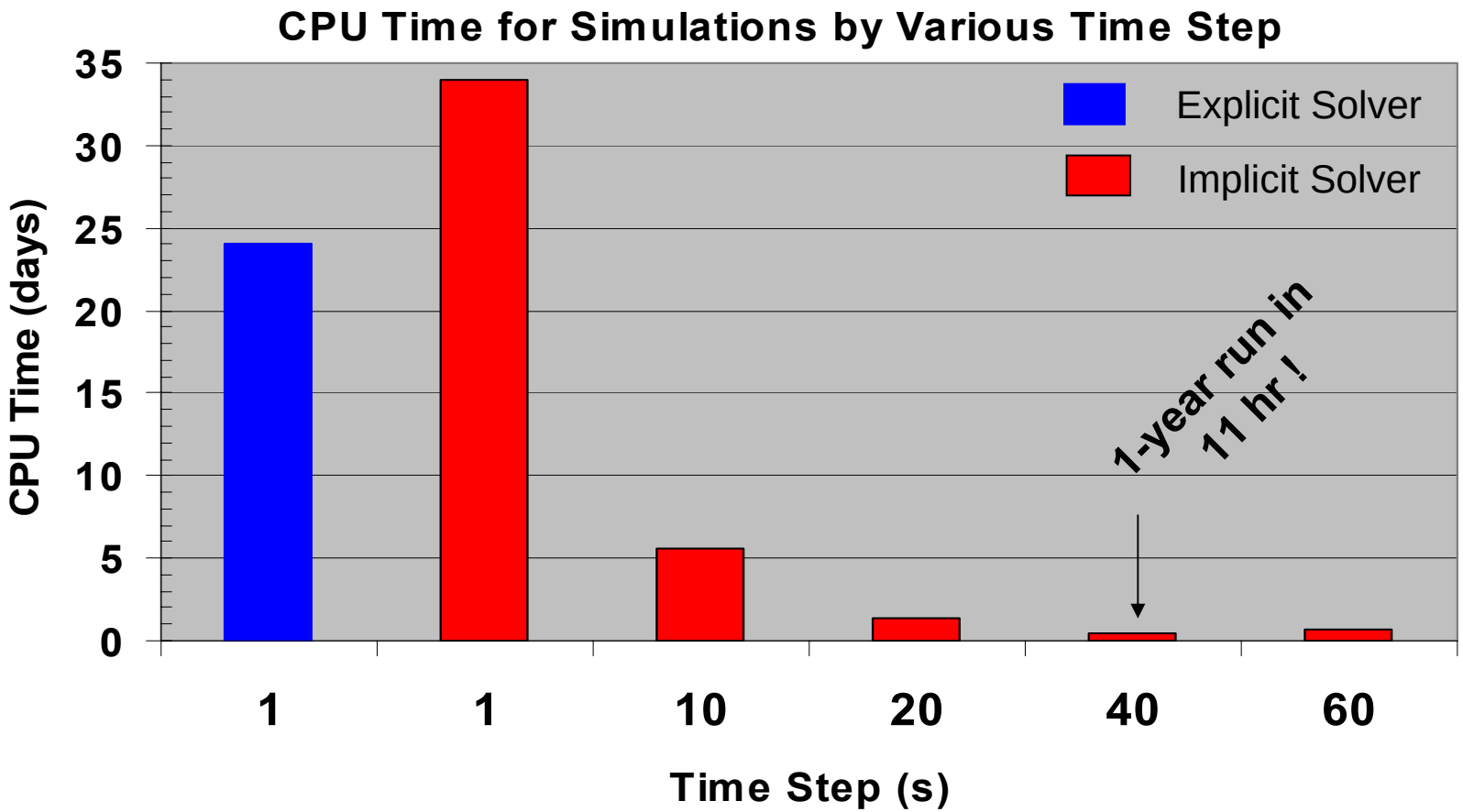
Coastal Modeling System (CMS)

Forcing by: Tide, waves, wind, river discharges



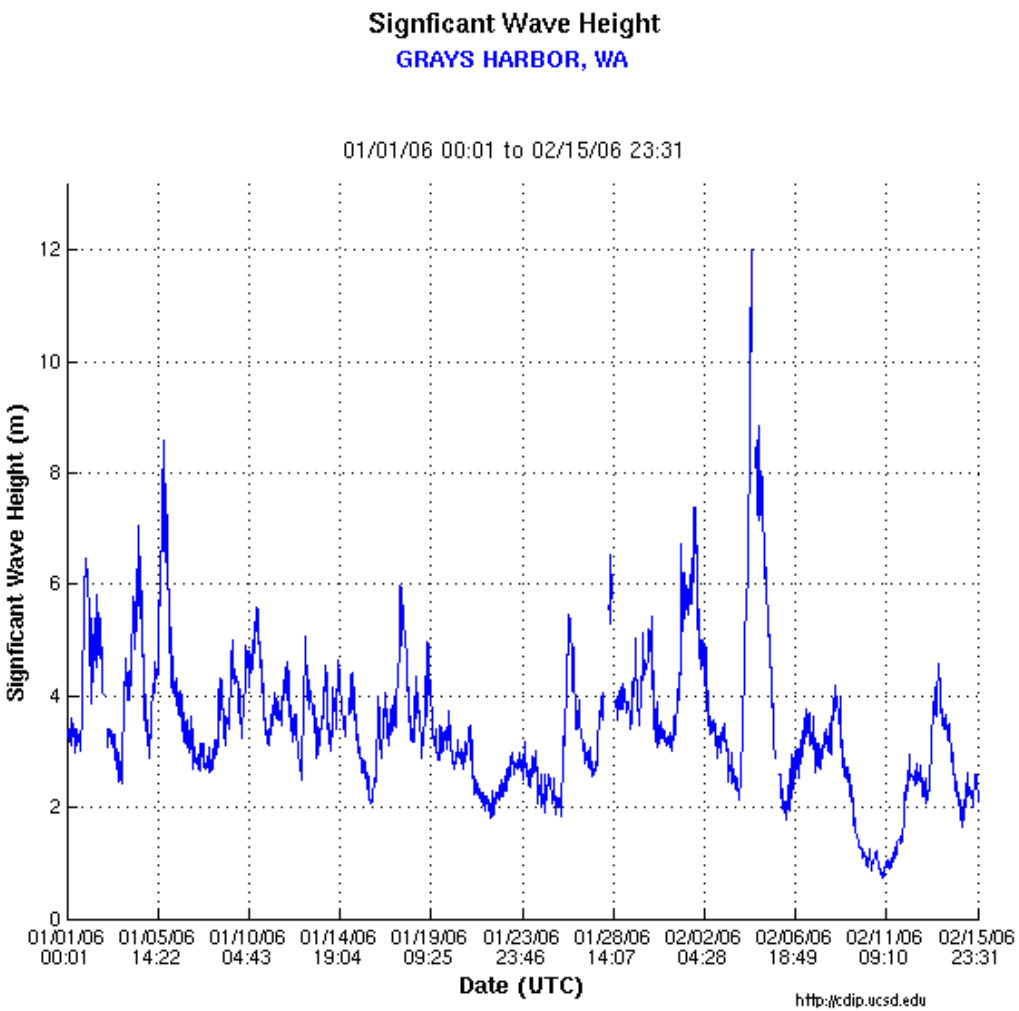
PC CPU Time
New M2D Implicit Solver

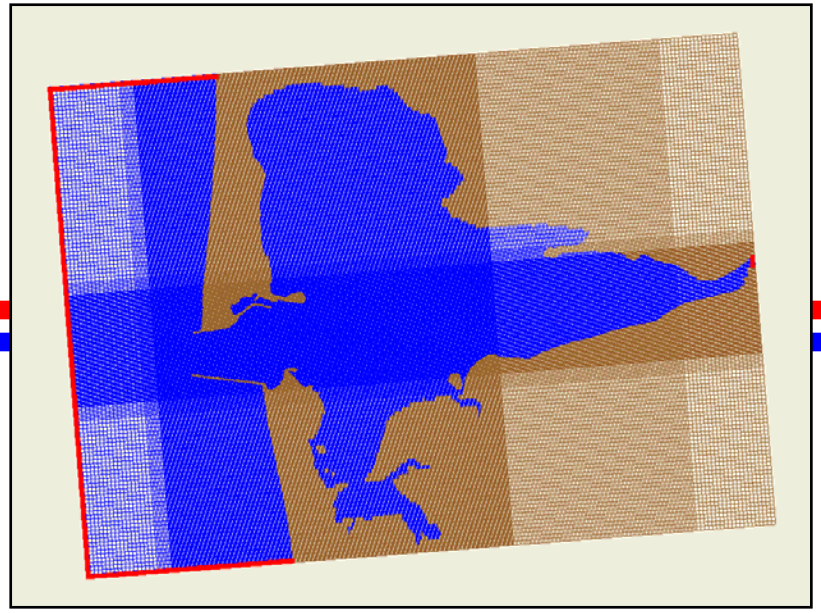
Tidal Circulation: Simulation Period = 1 year

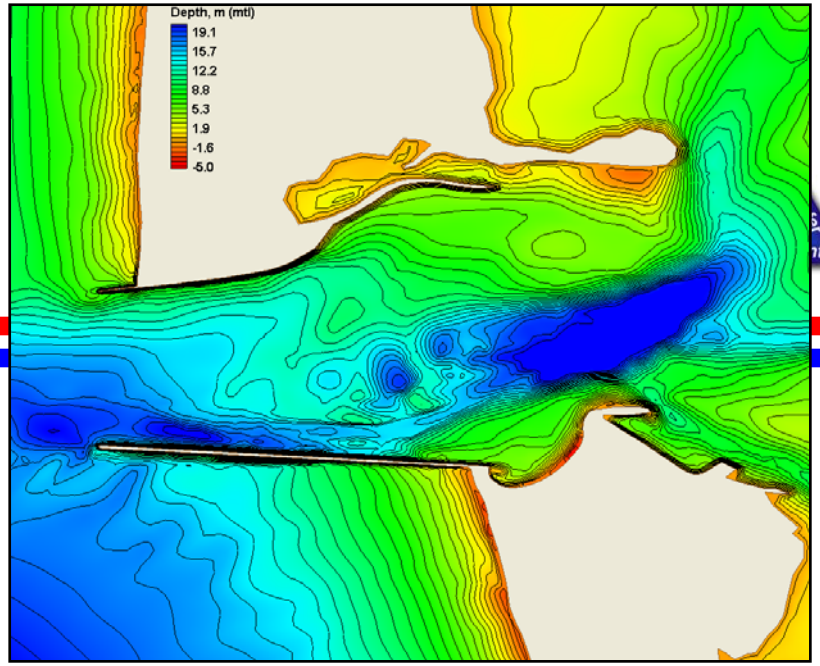


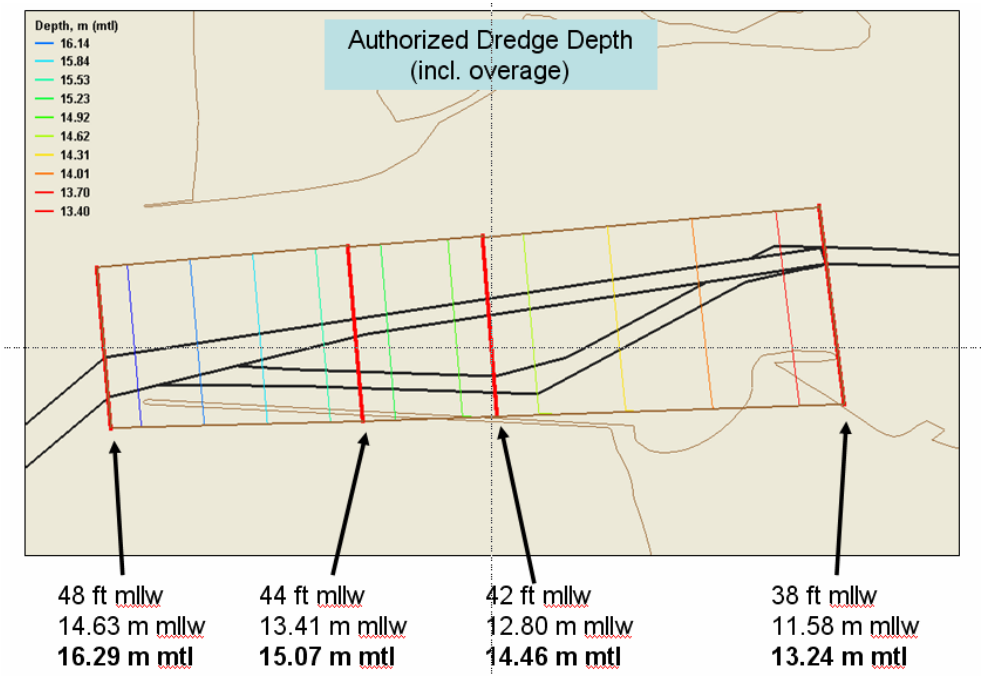
CMS-M2D Implicit Simulation

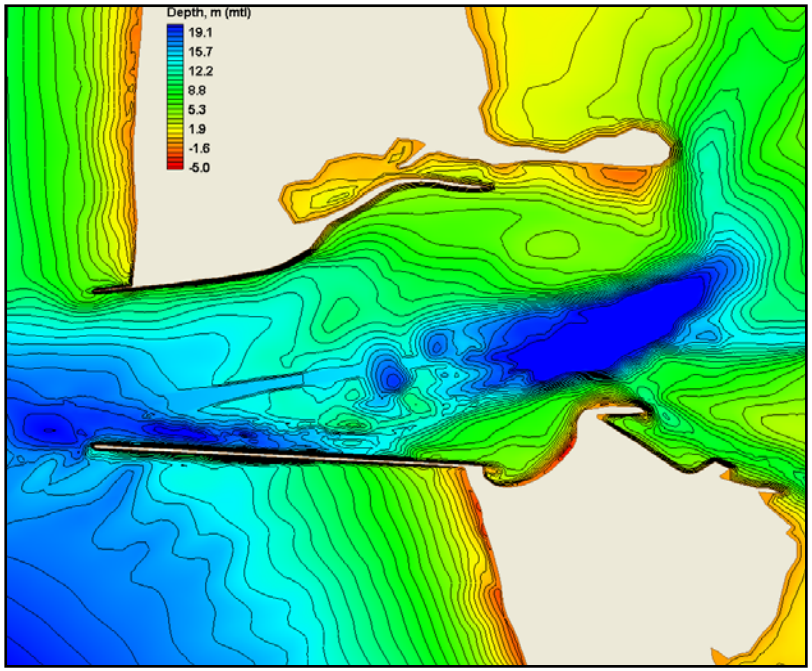
Grays Harbor, WA, Extreme Storm Case



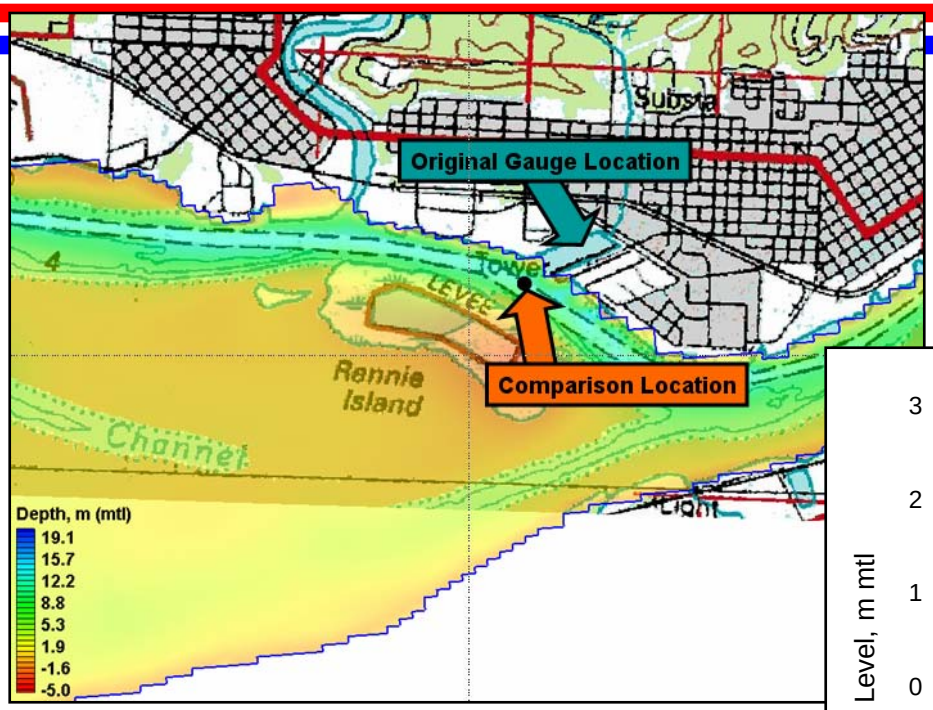


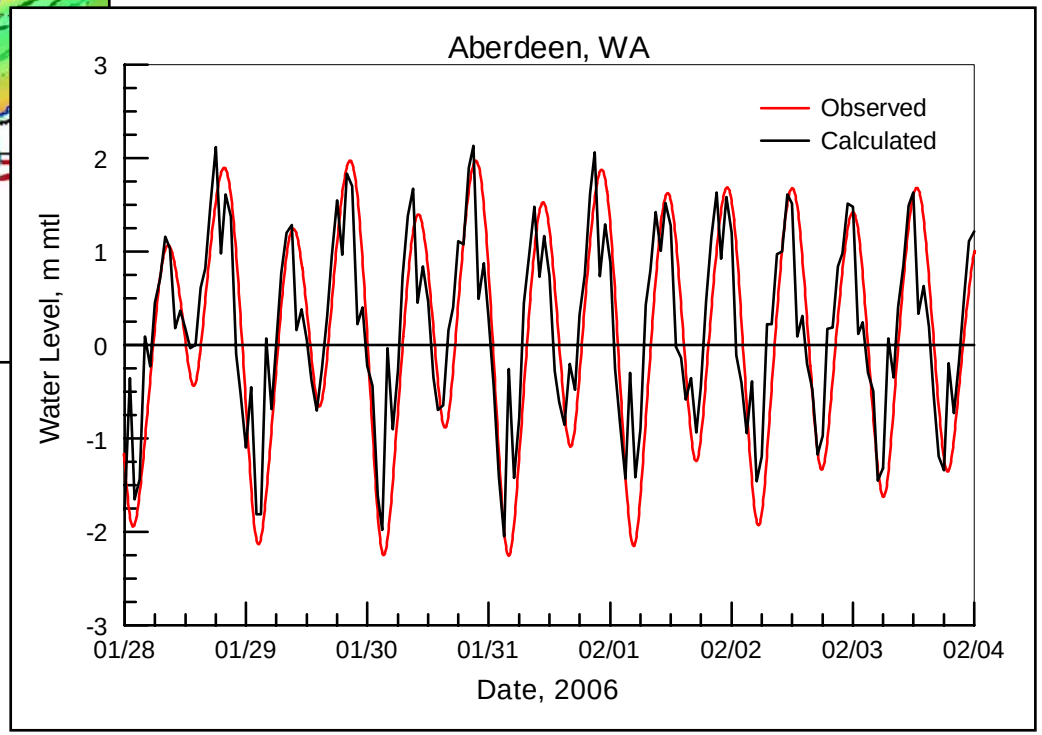

Depth, m (mtl)
19.1
15.7
12.2
8.8
5.3
1.9
-1.6
-5.0


Depth, m (mtl)
16.14
15.84
15.53
15.23
14.92
14.62
14.31
14.01
13.70
13.40
Authorized Dredge Depth
(incl. overage)
48 ft mllw
14.63 m mllw
16.29 m mtl
44 ft mllw
13.41 m mllw
15.07 m mtl
42 ft mllw
12.80 m mllw
14.46 m mtl
38 ft mllw
11.58 m mllw
13.24 m mtl

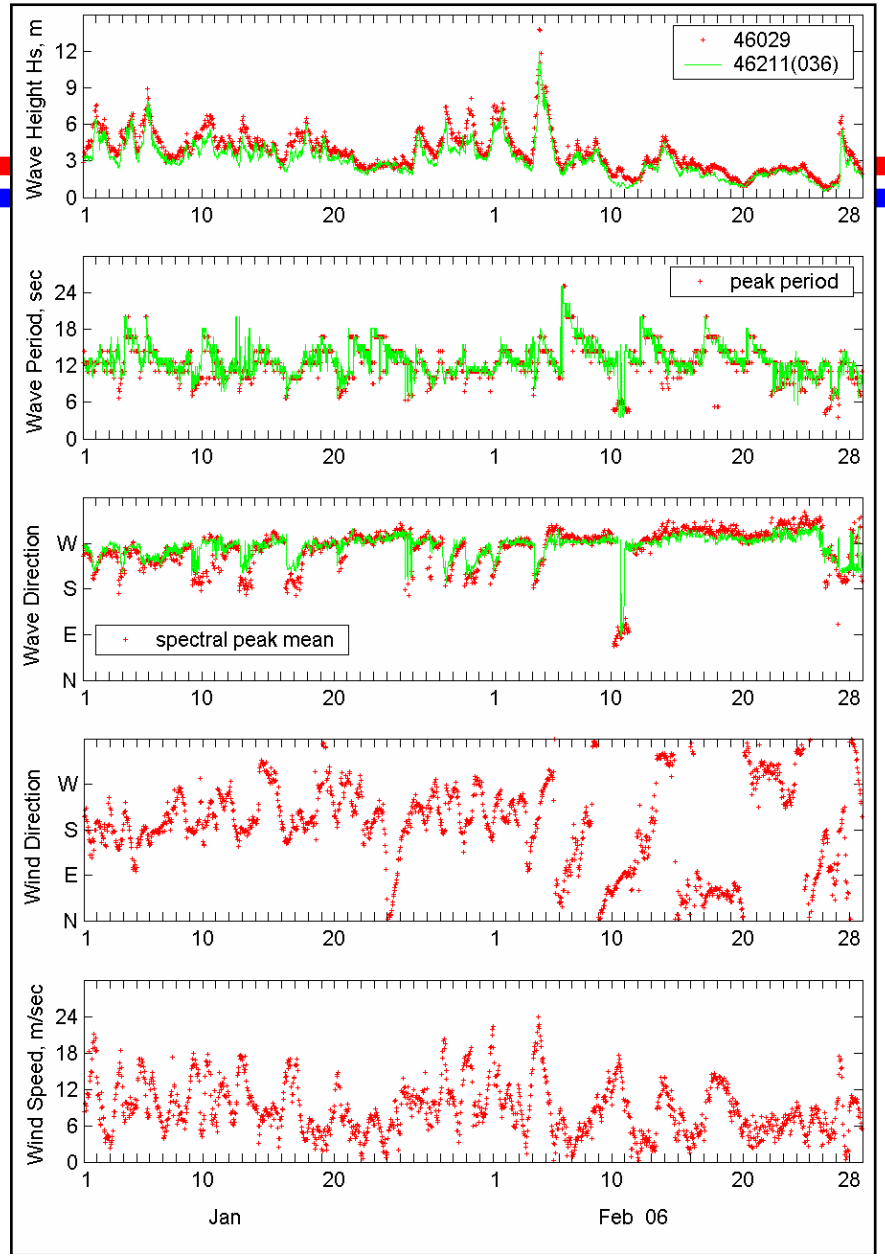

Depth, m (mtl)
19.1
15.7
12.2
8.8
5.3
1.9
-1.6
-5.0

Comparison of Existing Condition with Water Level Measurements, Aberdeen, WA

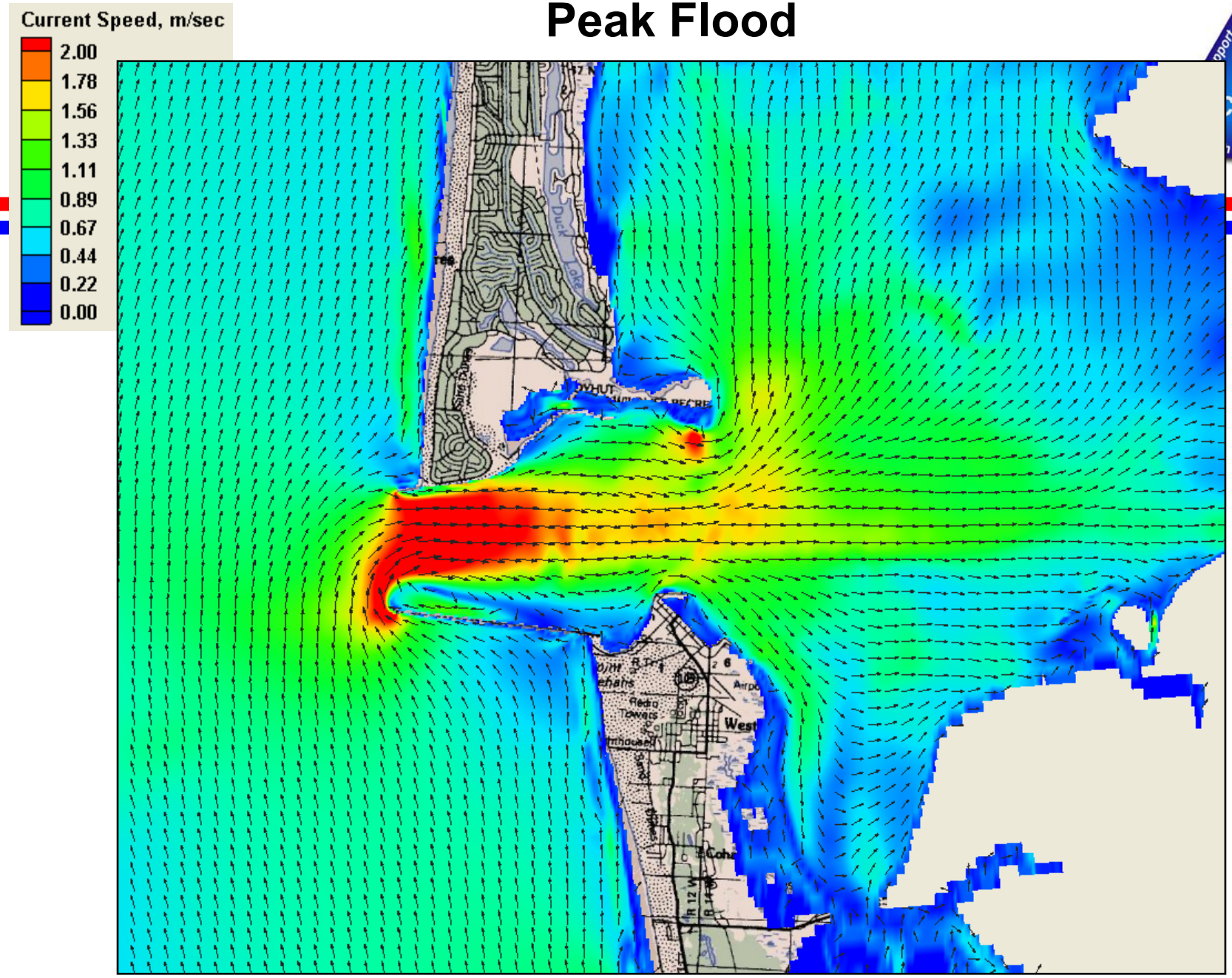




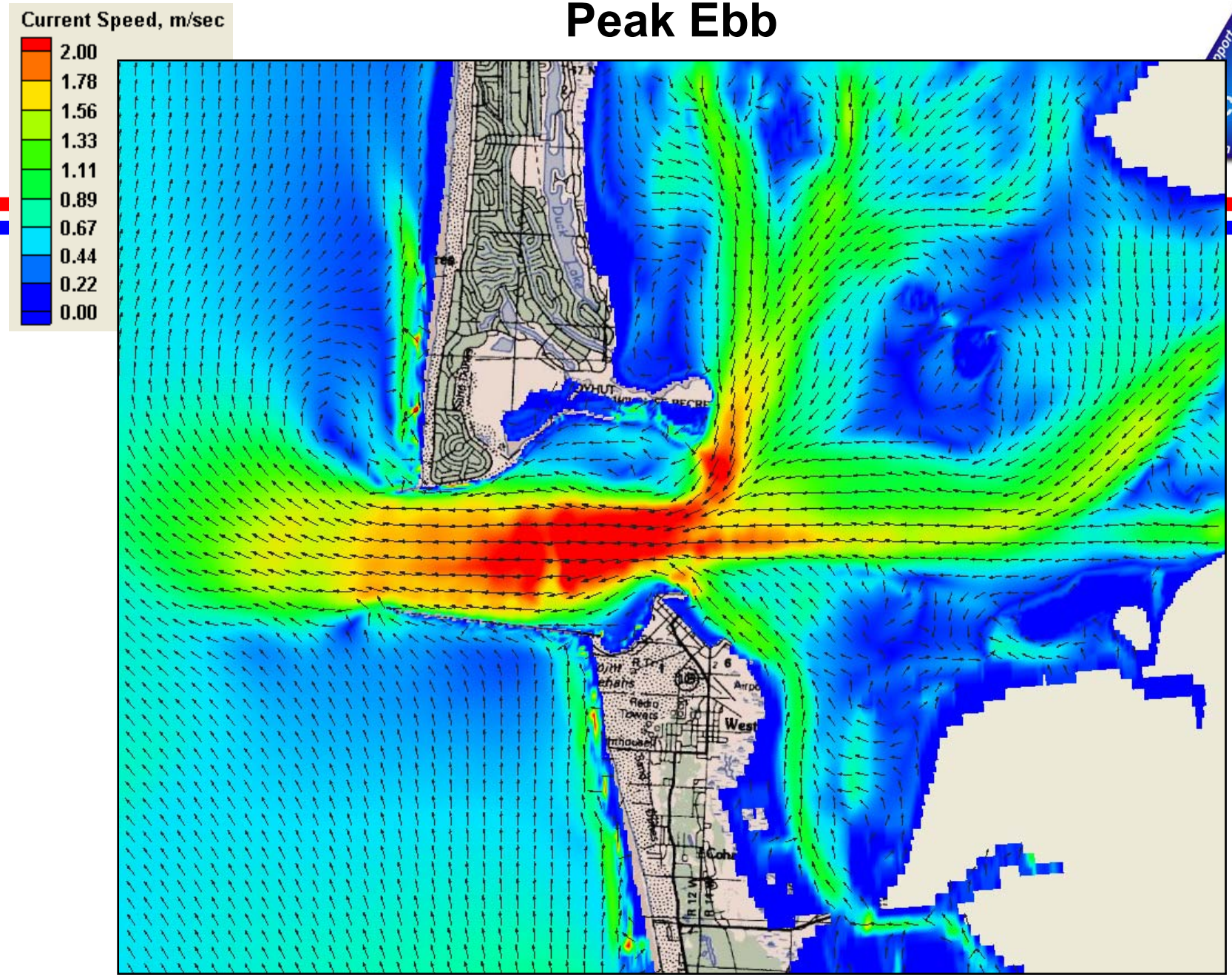
Wind and Wave Conditions for Extreme Event



Peak Flood



Peak Ebb

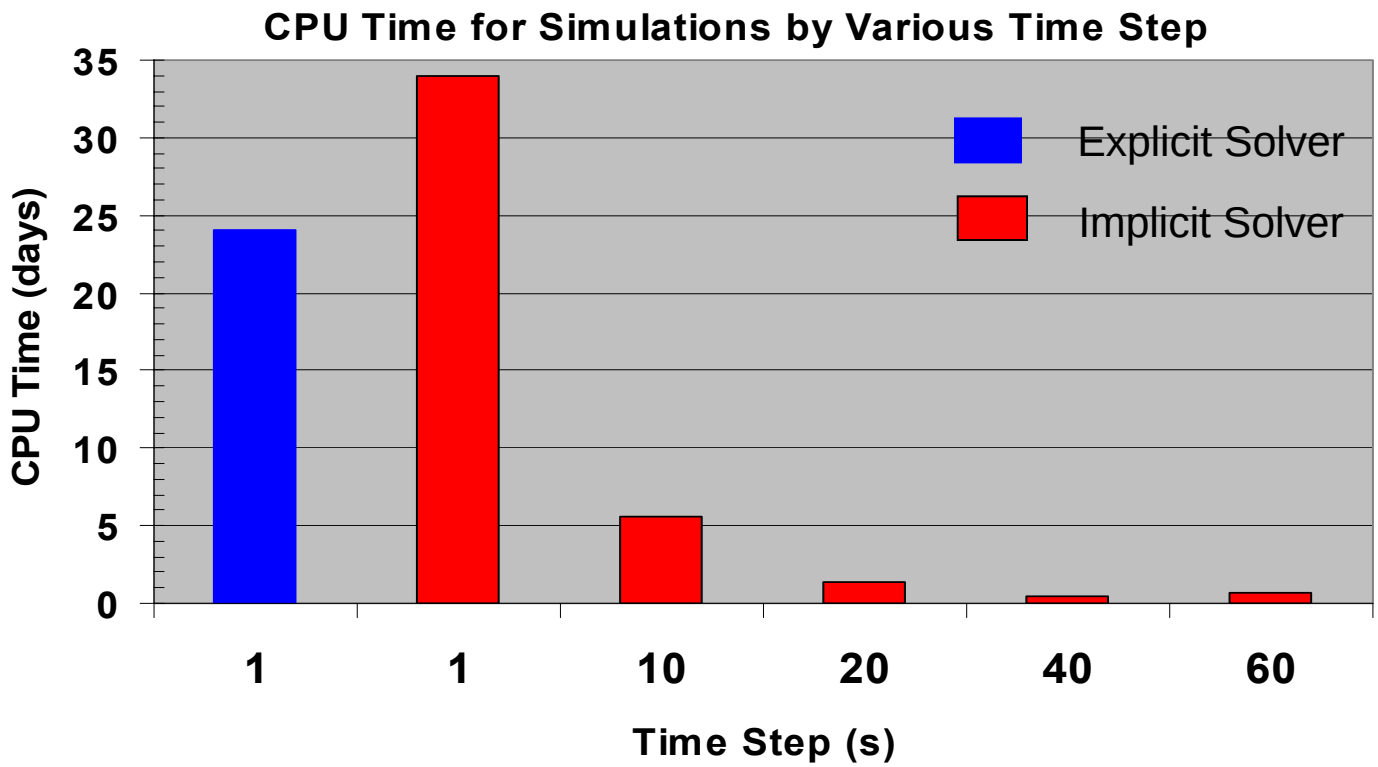


Grays Harbor, WA

Extreme Event Simulation of Circulation by Tide, Waves, and Wind – Model Comparison

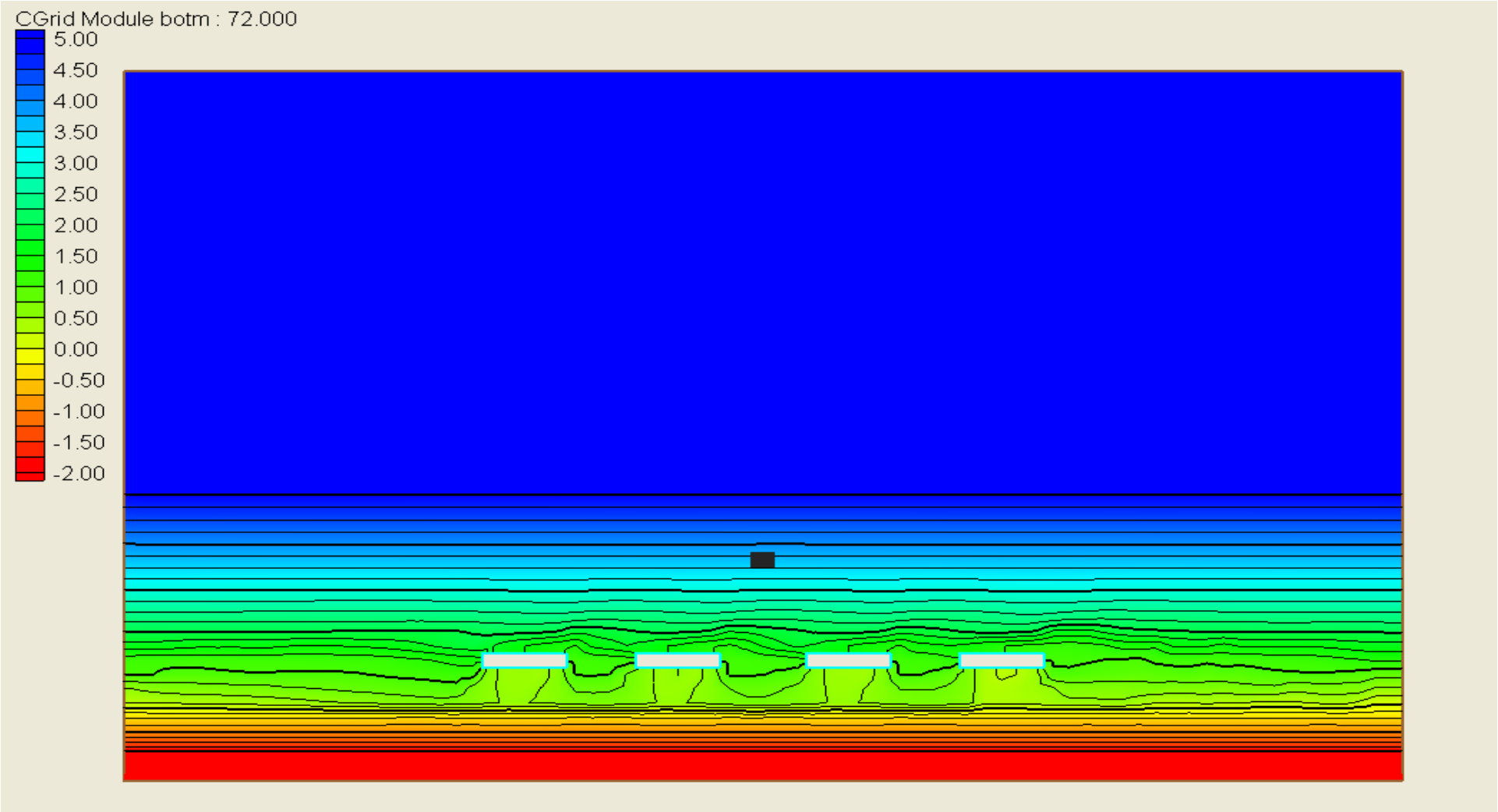
CMS- ADCIRC Δt_H <= 0.1 sec, failed before major storm

CMS-M2D Implicit Δt_H = 45 sec



45/0.1 = **450**

CMS-M2D Implicit 450 times faster than CMS-ADCIRC for intense forcing?

Morphology Change, CMS-M2D

Detached Breakwater Field; working on shoreline change – next year!