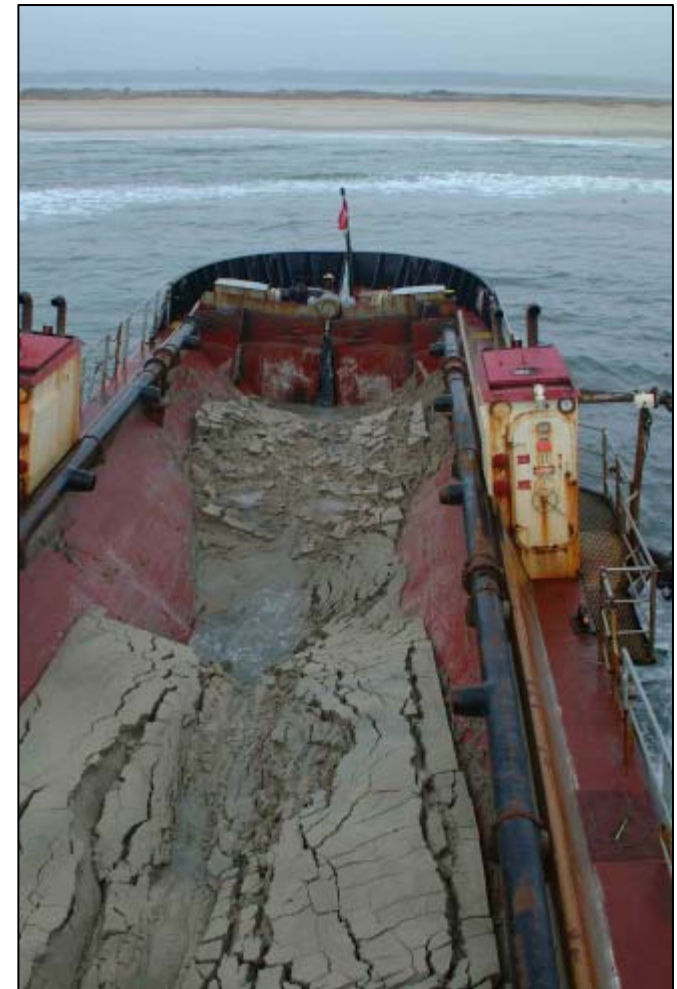
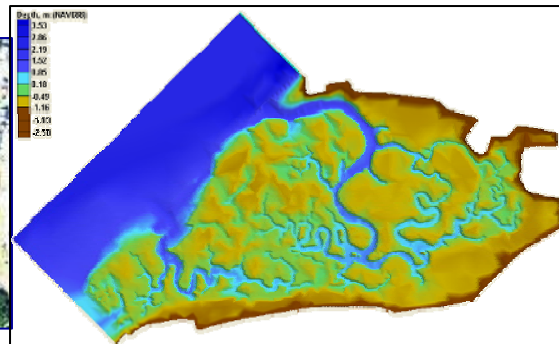
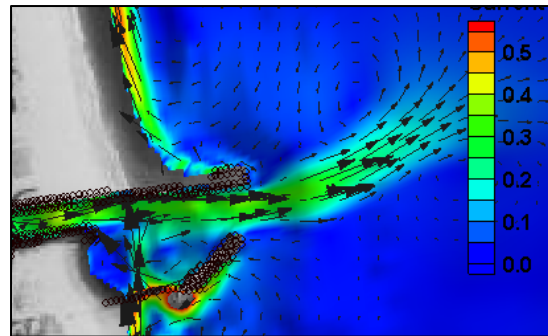
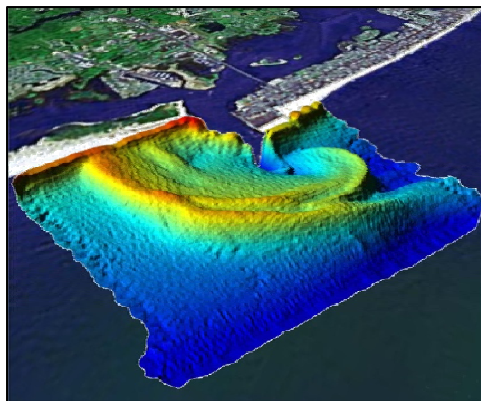


Coastal Inlets Research Program

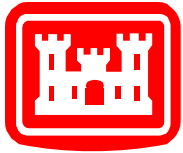
...advancing inlet engineering and science



HQ Technical Monitor: Jim Walker
ERDC Tech Director: Jeff Lillycrop
CIRP Program Manager: Nick Kraus
Assistant Program Mgr.: Julie Rosati



Nearshore placement,
Assateague Island bypassing



Prediction of *Long-term* Morphology Change at Coastal Inlets

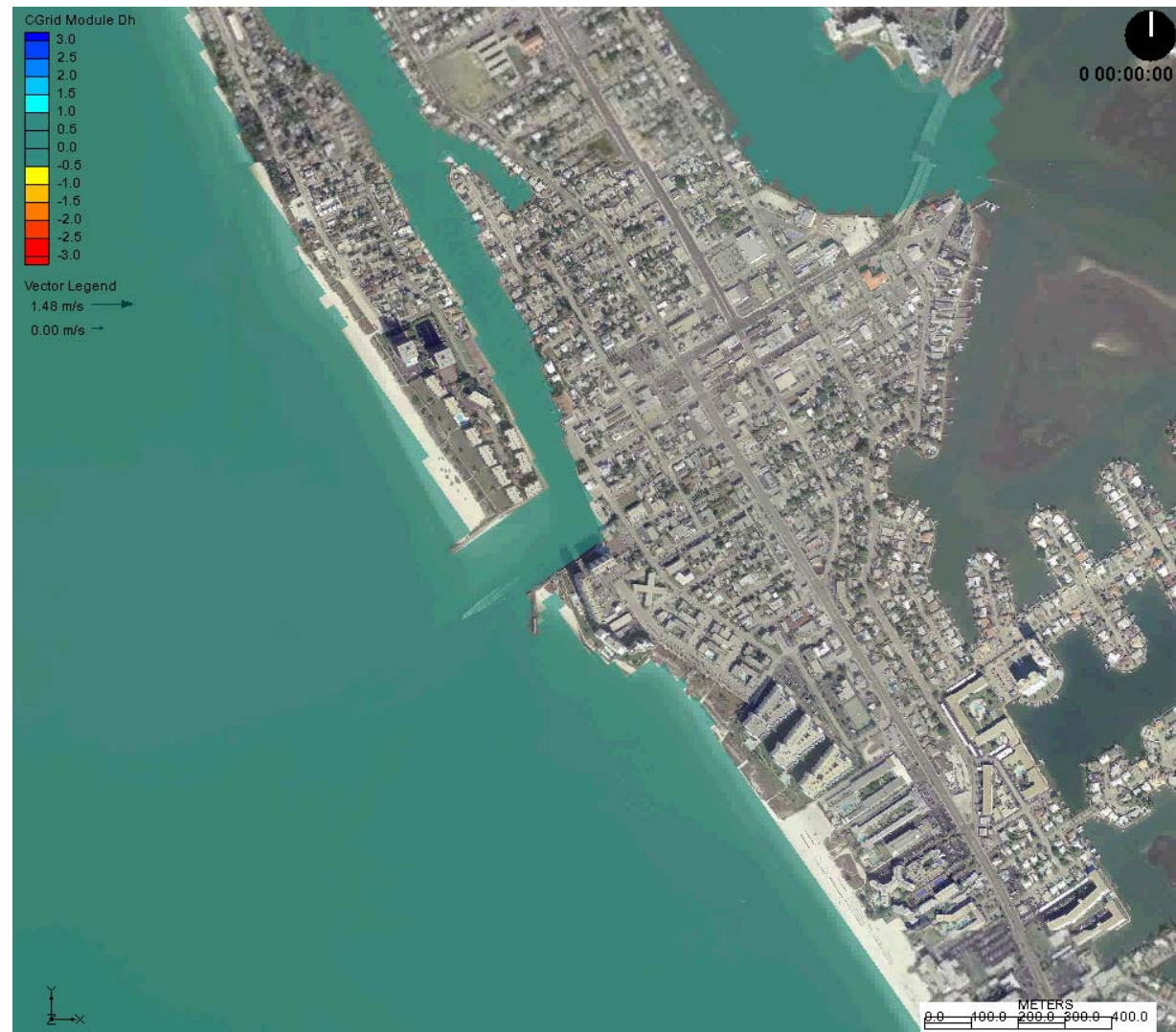


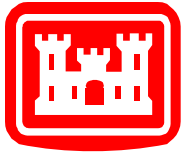
After a decade of R&D, CIRP is achieving long-term simulation capability through the CMS – on a PC.

Long-term predictions being done – In an incremental improvement process.

Districts running the Coastal Modeling System (CMS) on desktops.

7-month animation of sediment transport & morphology change at Blind Pass, FL





Coastal Inlets Research Program



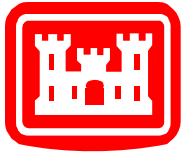
CIRP Mission

Reduce the cost of O&M at Federal coastal Inlet navigation projects.

- *Mission accomplished by taking multiple approaches, from empirical to process based, for the inlet, adjacent beaches, and estuary as a sediment-sharing system.*
- *CIRP R&D advances knowledge of basic physical processes and delivers, to District desk tops, reliable predictive procedures and guidance defining the state of the art.*

Overview of Presentation

1. CIRP Administration and Tech Transfer
 - WU's and PI's
 - Productivity metrics
 - Web site
2. Technical Presentation -- selected R&D & products
3. CIRP & RARG



Coastal Inlets Research Program

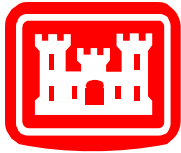
Background



CIRP Logo



- Formulated at all-Corps meeting, 1991
- Began 1994
- Nick as PM 1997
- Julie Rosati, Assistant PM 2008
- Typically 5-7 WU's, 2 FA's
- Flat funded since 1997 @ ~\$2.45M
- Program responsive and evolves to fit identified field needs
- CIRP motto "Product oriented, incremental progress, products to field"
- Considerable spin-off
- Collaborative efforts emphasized (intra-CIRP, w/Districts, w/consultants)
- CIA (Coastal Inlets advisors) or PDT, Apr 2008



CIRP Web Site – industrial strength

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



Features

- Database: US inlets & structures
- Publications / CHETN's/ Archive of high-impact Corps reports
- CIRP Forums for interaction
- On-line calculators & models
- News and calendar of events

Benefits

- Technology transfer
- Program monitoring
- District feedback
- Internal communication
- Public awareness of CIRP

CIRP Links

Home
Event Calendar
Newsletters
Product Forum

Databases
FAQs
Inlets Online
Online Presentations
Photo Collections
Products and Tools
Publications
Related Internet Links
Technical Staff
Work Units

Latest

Visitor Info

Web Masters



CIRP

Coastal Inlets Research Program

[!!Warning!!](#)

Coastal Inlets and the U.S. Army Corps of Engineers

The United States, through the U.S. Army Corps of Engineers, has national interest in the stability and evolution of coastal inlets. Almost \$1 billion is expended annually to operate and maintain federal coastal inlet navigation projects including the inlet channel, associated jetties and breakwaters, and adjacent inland waterways. The physical processes of coastal inlets span the navigation, shore protection, and coastal environmental missions of the Corps.

Coastal Inlets are:

- Vital commercial and military navigation links
- Closely connected to beach stability and estuary health, locally and regionally.
- Central for exchange of water, sediment, and nutrients between estuaries and seas
- Recreational opportunities for the nation and assets for the economic strength of coastal communities.

The Coastal Inlets Research Program (CIRP)

Because of the multiple interacting forces and the numerous scales of geomorphic change ranging in time from days of a storm to centuries for long-term adjustment, the physical processes of inlets are poorly understood. Little quantitative information is available to predict infilling of navigation channels, long-term change in the nearshore – affecting channel and jetty stability, short- and long-term migration trends and cycles of inlets, and the interactions among inlets, adjacent beaches, and estuary.

The Coastal Inlets Research Program, or CIRP, advances the state of knowledge and develops engineering technology for predicting the waves, current, sediment transport, and morphology change at and around inlets. Products of the CIRP improve management and design of coastal inlets through increased reliability of actions and reduction in operation and maintenance costs. The CIRP takes a variety of approaches, including developing concepts and theory for all relevant time scales, numerical simulation, field data collection, and laboratory experimentation. Reports and peer-reviewed articles as found on this web site provide the information gained from the CIRP to the Corps, scientific community, and public.

| |
|--|
| HQ USACE Oversight Navigation Business Line Manager James E. Walker |
| Technical Director for the Navigation Systems Program Jeff Lillycrop, CHL |
| Program Manager <mailto:Nicholas.C.Kraus@usace.army.mil> : Dr. Nicholas C. Kraus, CHL |
| Assistant Program Manager <mailto:Julie.D.Rosati@usace.army.mil> : Julie Dean Rosati, CHL |

**RELEVANT
READY
RESPONSIVE
RELIABLE**

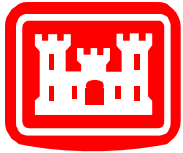
Proudly serving the Armed Forces and the Nation now and in the future.



Matagorda Ship Channel entrance, TX, April 2008 (Click to expand)



Ebb shoal at Ocean City Inlet, MD, January 2004 (Click to expand)



CIRP – Two Focus Areas, 5-7 Work Units



Program Management and Technology Transfer

Nick Kraus

Sediment Management

Structures and Navigation

Bypassing
and
Nearshore
Berms

Alex Sanchez

Geomorphic
Evolution

Nick Kraus

Inlet
Channels
and
Estuaries

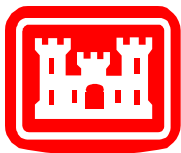
Julie Rosati

Advanced
Navigation
Simulation

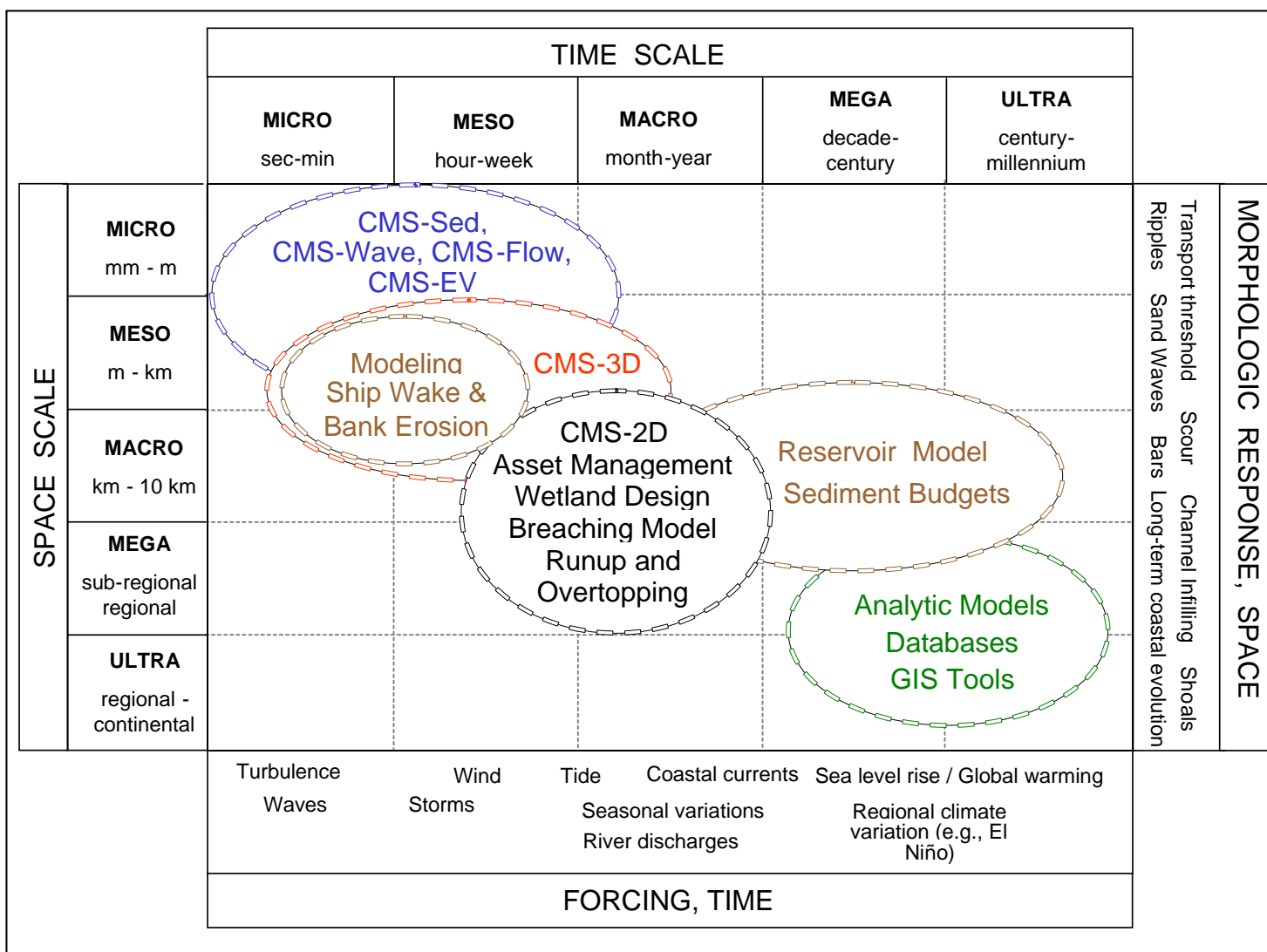
Lihwa Lin

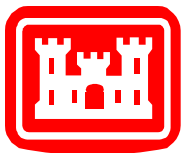
Coastal
Structure
Asset
Management

Ned Mitchell

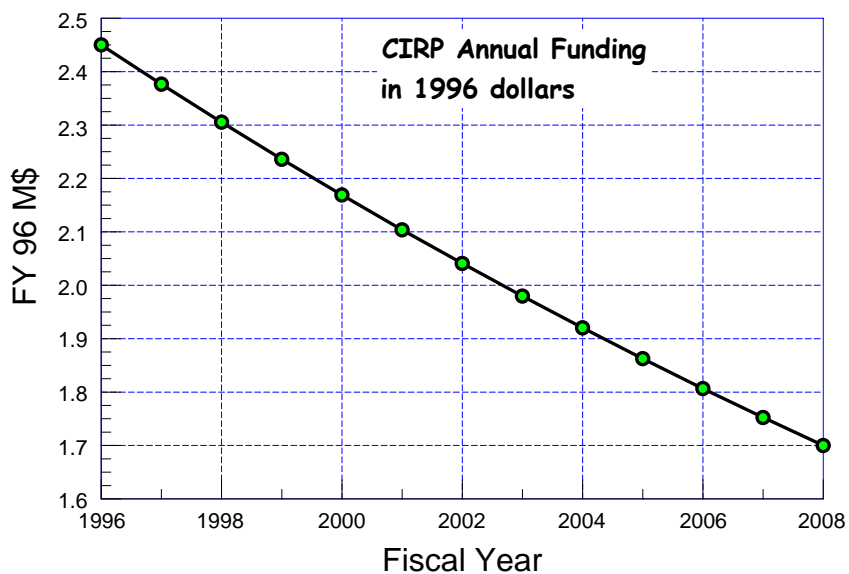
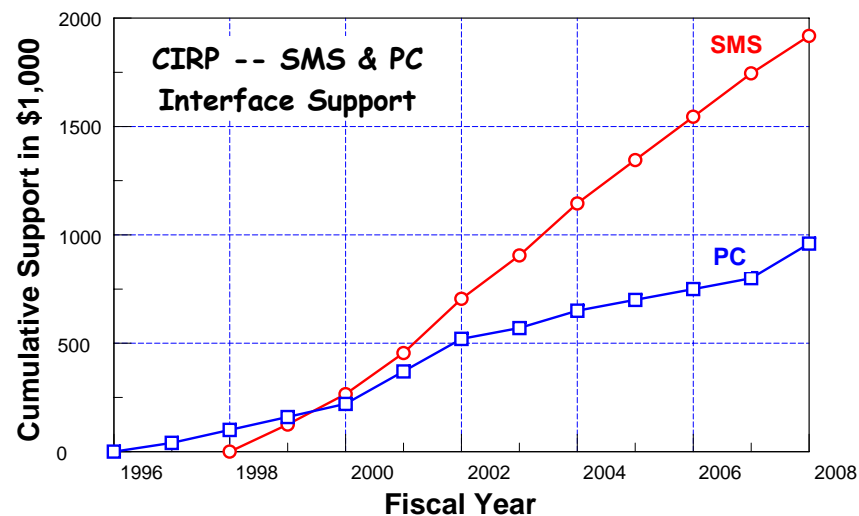
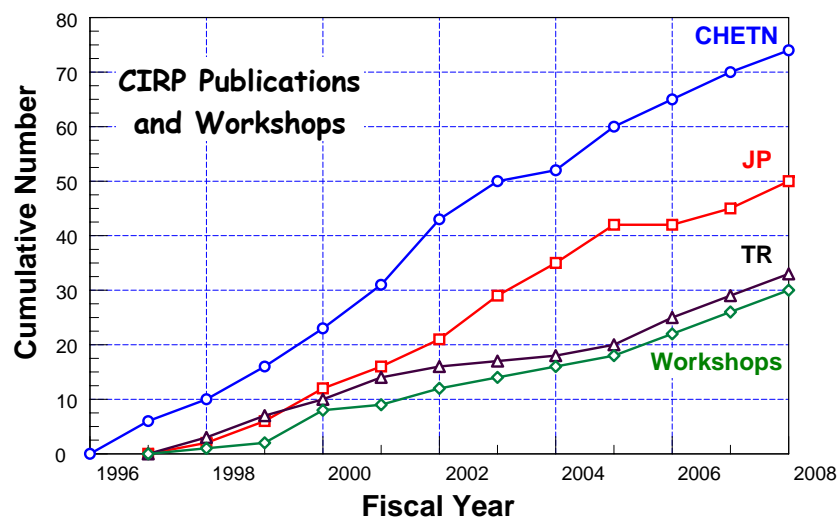


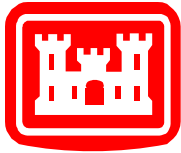
CIRP – Scales of R&D Coverage





Quantitative Measures of Productivity Metrics

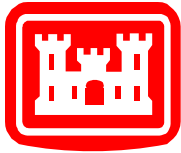




Progression of Major (Selected) CIRP Technology-Transfer Workshops

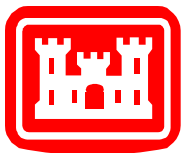


| | E. & W. Coasts | Avalon, NJ | |
|---|-----------------------------|--------------------|---|
| N | Feb 2005 #6 – FSBPA | Destin, FL | Modeling sediment transport and morphology change, channel infilling (Lund-CIRP; Watanabe) |
| F | Aug 2005 | Baltimore, MD | Inlet Modeling System technology transfer workshop (SMS 9.0 new features, STWAVE, ADCIRC, IMS-M2D) |
| J | Jan-Feb 2006 #7 -- FSBPA | Sarasota, FL | 2D and 3D modeling of waves, circulation, sediment transport, and morphology change at coastal inlets |
| J | Dec 2006 | Vicksburg, MS | Surface Water Modeling System (SMS) Workshop |
| F | Jan 2008 | Ft. Lauderdale, FL | Empirical and Numerical Techniques for Analyzing Wave Processes |
| M | Jan 2008 #9 – FSBPA | Sarasota, FL | Estuarine Design and Research Needs |
| F | Jun 2008 | Chicago, IL | Coastal Structure Asset Management Workshop |
| A | Jun 2008 | Vicksburg, MS | Advanced Coastal Modeling System Workshop |
| | Jan-Feb 2009 #10-- FSBPA | Sarasota, FL | 10 th Annual FSBPA-CIRP workshop |



Typical Annual CIRP Tech-Transfer Workshop

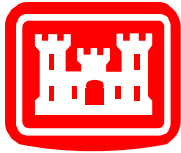




Spin-off & Collaboration



1. SBAS to **RSM Program** for eCoastal implementation.
2. Cascade to **SWWRP**.
3. ADCIRC – CIRP regional model; advances all applications.
4. Consistent SMS support by CIRP lifts interface capabilities for **all ERDC models**.
5. PTM developed jointly with **DOER** Program.
6. Breaching research conducted jointly with **SWWRP** (SWWRP – regional; CIRP – project oriented).
7. Models tested and advanced with collaboration of Corps CWG, academia, & consultants.



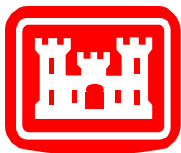
District Partnerships (selected)

Ground-truthing by District problems & field data collection



- SAJ: Ponce De Leon Inlet, Johns Pass, FL
 - NAN: Shinnecock Inlet, NY
 - SPL: Ventura Harbor, CA
 - NWS: Grays Harbor[#], Willapa Bay, Bay Center, WA
 - NWP: Mouth of Columbia River[#], WA/OR
 - SWG: Matagorda Bay[#], Mouth of Colorado R., San Bernard River Mouth, Packery Channel, TX
 - SPN: Humboldt Bay[#], CA
 - POA: Anchorage Harbor, [#] AK
 - NAB: Ocean City Inlet, MD
 - SAW: Cape Fear[#], NC
 - NAO: Rudee Inlet, VA
- [#] denotes deep-draft channel

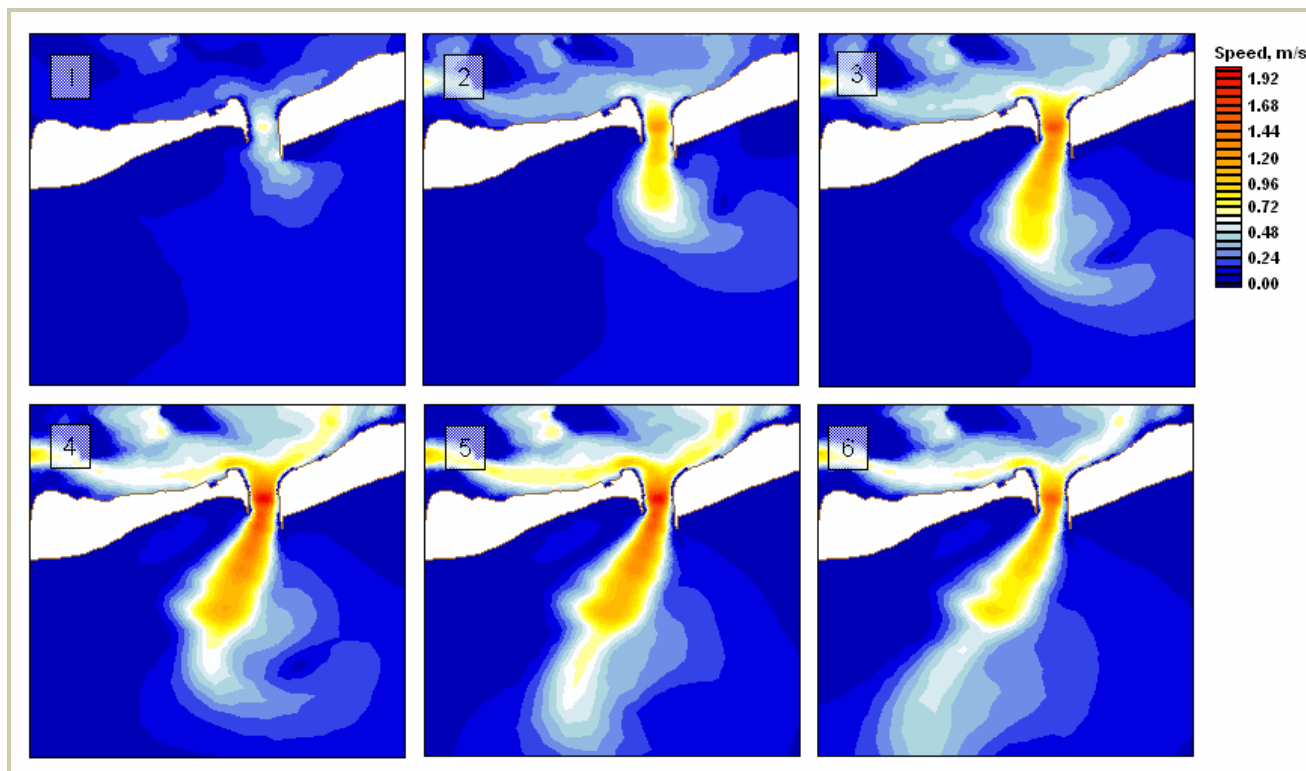




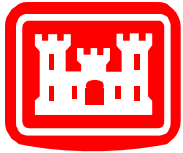
Collaborative monitoring with Districts



- Ebb jet migrates
- Navigation channel follows jet location
- Control migration by jetty configuration
- Reduce dredging by maintaining channel position
- **Partner: NAN**



Shinnecock Inlet –Current at 1-hr intervals

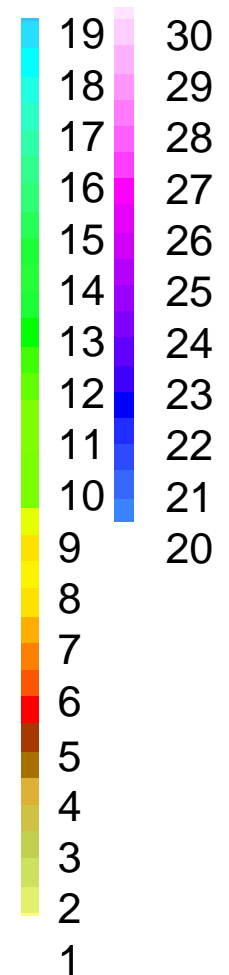
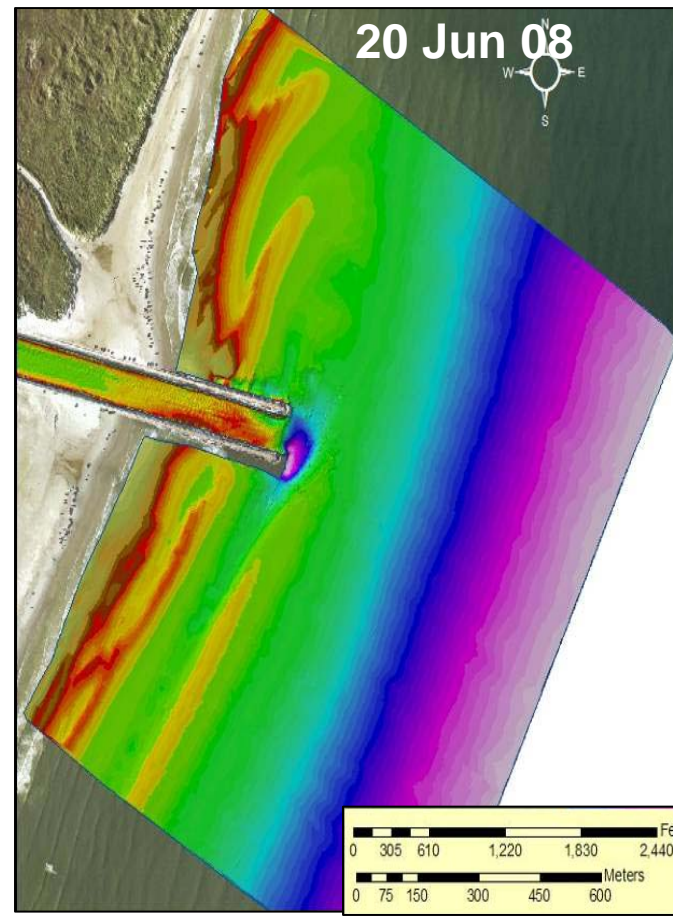
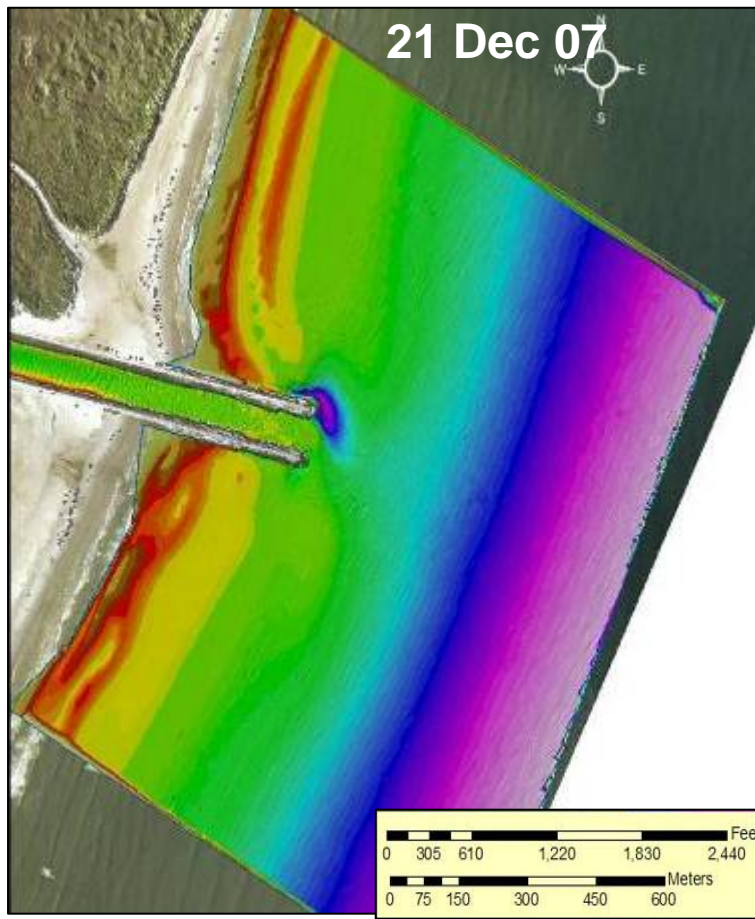


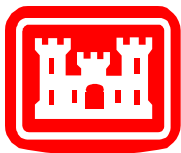
Packery Channel (new inlet) SWG, Monitoring by HBCU/MI



- Monitoring from 2003 (pre-construct) with SWG, Texas A&M-Corpus Christi
- Documents seasonal & rapid morphology change; connection with forcing

Depth, ft
(MSL)

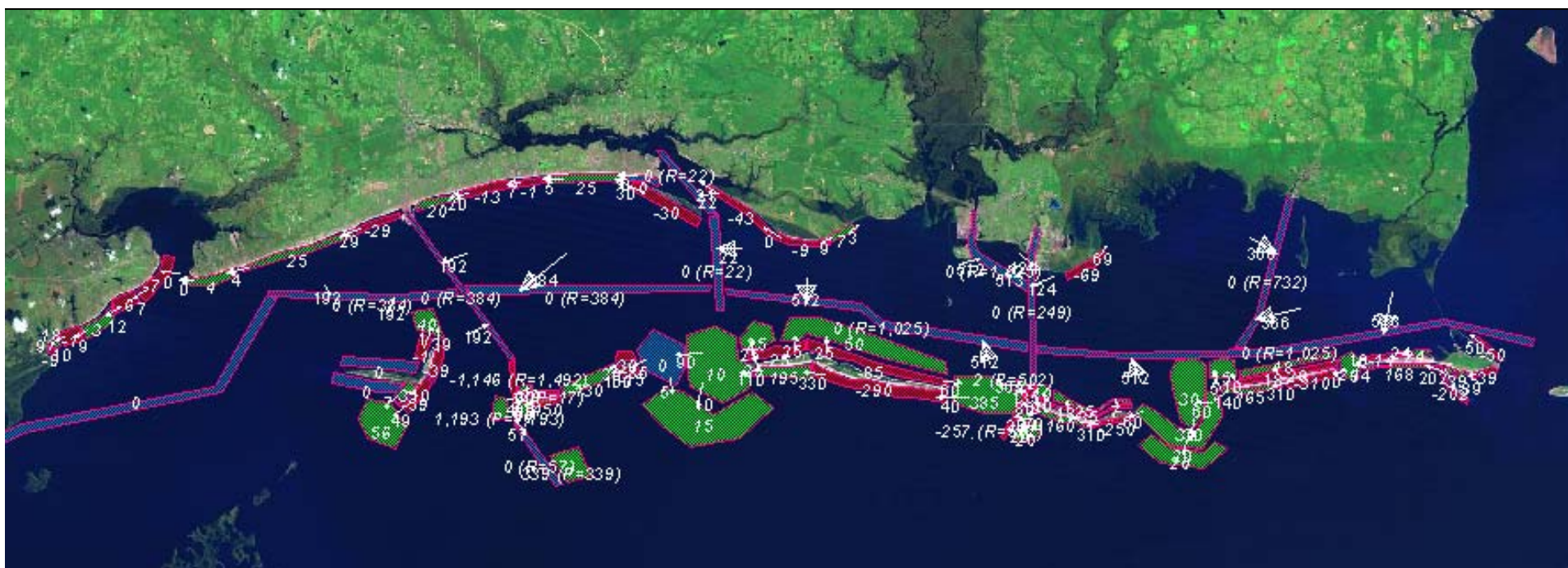


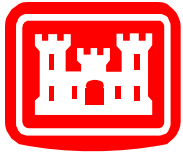


Sediment Budget Analysis System (SBAS)



- Regional Sediment Budget for Mississippi Sound using PC-SBAS
- Early collaboration ported SBAS calculation engine to RSM GIS (ArcView[©])
- Much-used program in academia (teaching), consulting companies, Corps
- Can be easily downloaded from <http://cirp.wes.army.mil/cirp/>

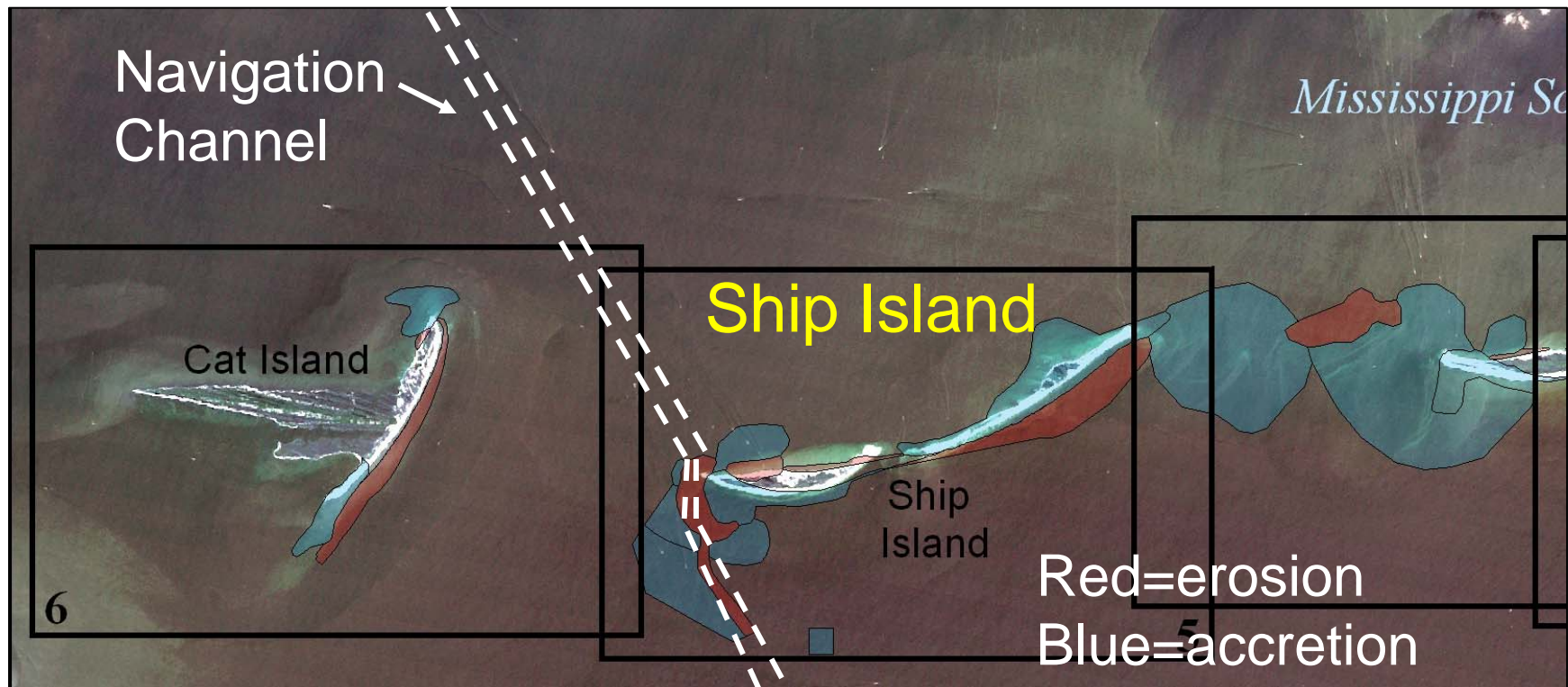


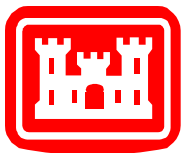


Sediment Budget Analysis System (SBAS)



- Local Sediment Budget for Ship Island Pass, SBAS-ArcView[®]
- Can have detailed budgets at inlets, then “collapse” them for regional view
- SBAS is a convenient way of producing sediment budgets, and transferring archiving, and updating sediment budget information

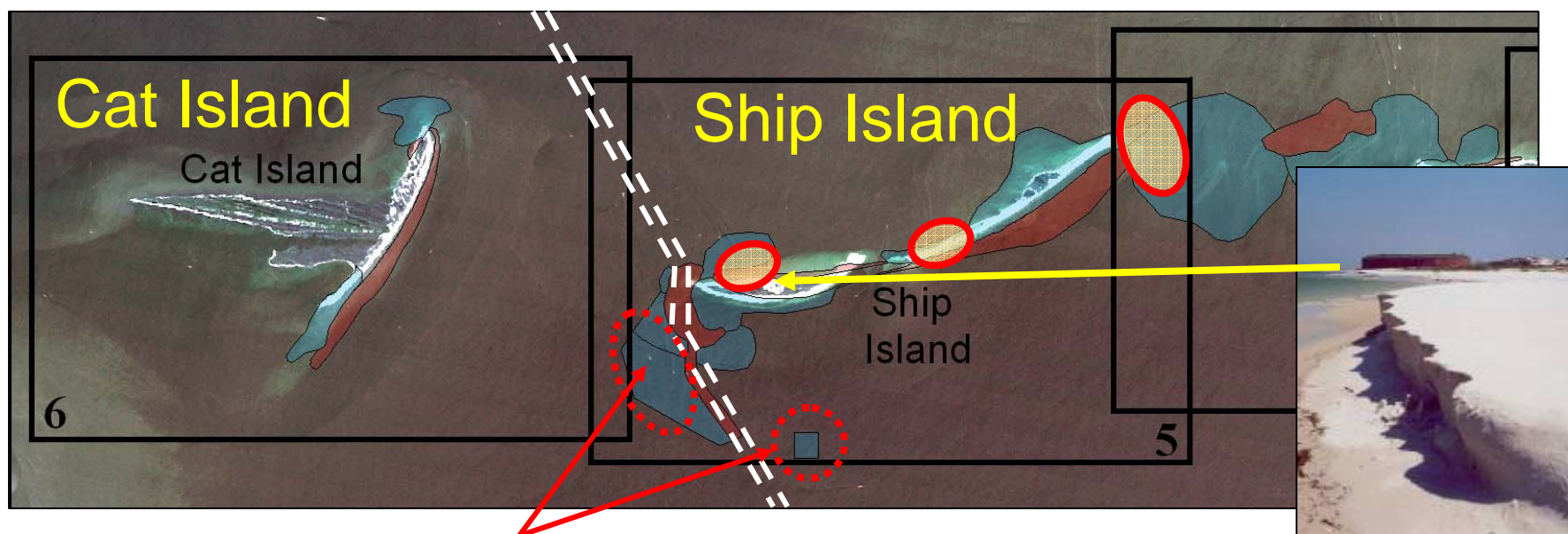




Sediment Budget Analysis System (SBAS)

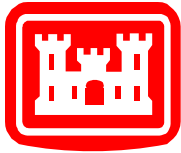


Local Sediment Budget Applied to Scope Out O&M Alternatives



Present placement sites do not nourish Cat or Ship Islands

Placement sites are not contributing to regional budget.
Alternative sites will protect cultural resources as well as
provide sand to nourish Ship Island.

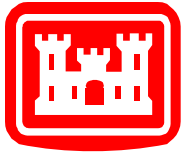


Coastal Modeling System (CMS)



CMS is a CIRP flagship product

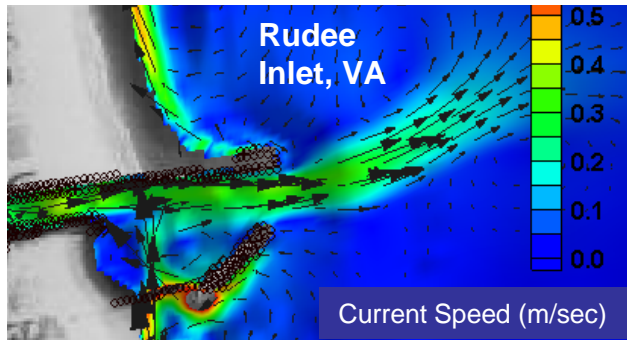
- Interactive calculation of waves, current, sediment transport, and morphology change (shore term – storms, and long term – decades).
- Channels and jetties represented.
- 2D version – Non-Equilib sediment Transport (NET), Rapid Assessment of Morphology (RAM).
- Represents sediment motion by waves and horizontal gradients in current – **vertical structure starting in FY10 – needed for berm processes.**
- Shoreline change & breach representation (as near jetties) underway.
- Channel and wetland module underway.
- Long been fully integrated in the SMS.
- *Scores of person-years at CHL, at SMS developers, and by academia and consultants.*



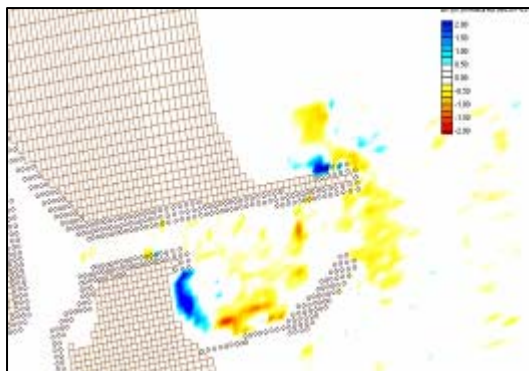
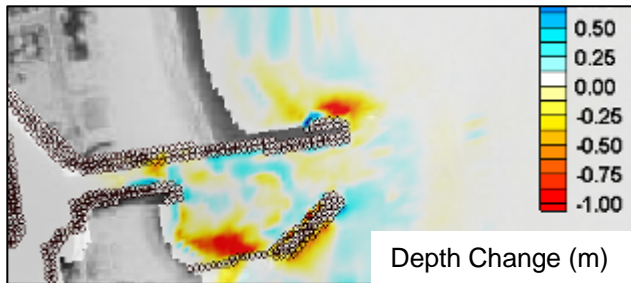
Sampling of CMS Applications & Partnerships



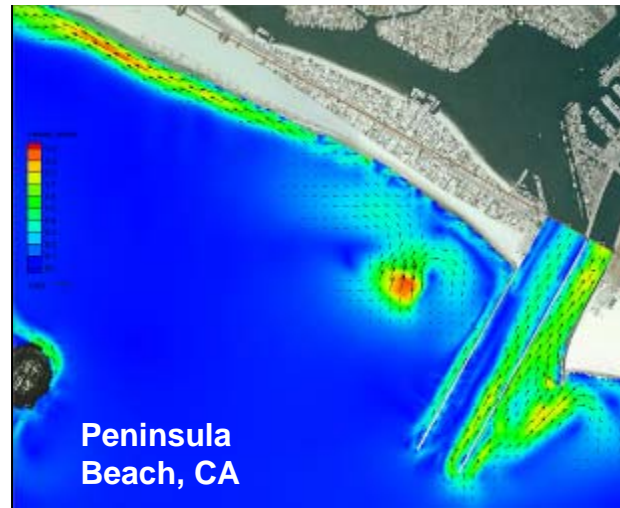
Wave & Tide-driven current



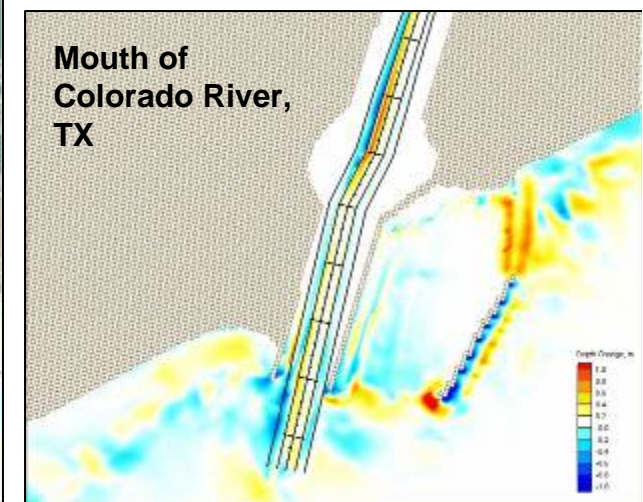
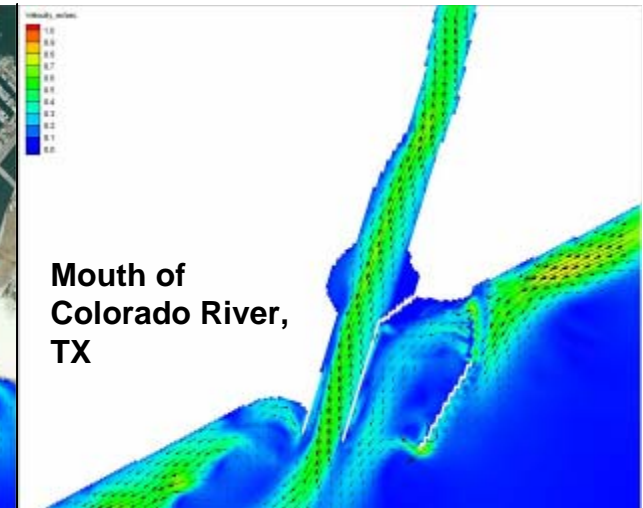
Morphology Change

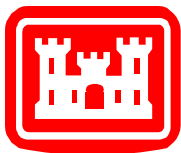


Wave-driven current



Wave & Tide-driven current

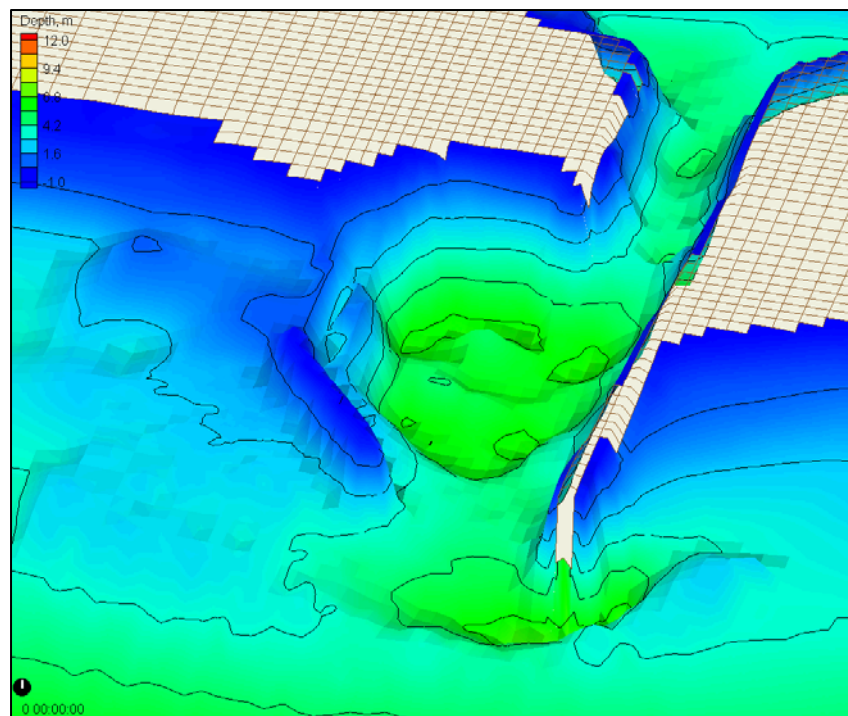




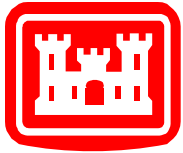
Non-Equilibrium Sediment Transport (NET)



- Accounts for temporal and spatial lags between flow and sediment transport.
- Represents nature.
- Improves model stability.
- Represents suspended and bed load separately or combined as bed-material or total load; hard bottom automatically represented (simplification of CMS code).



Rudee Inlet, VA, weir jetty (on south/left)

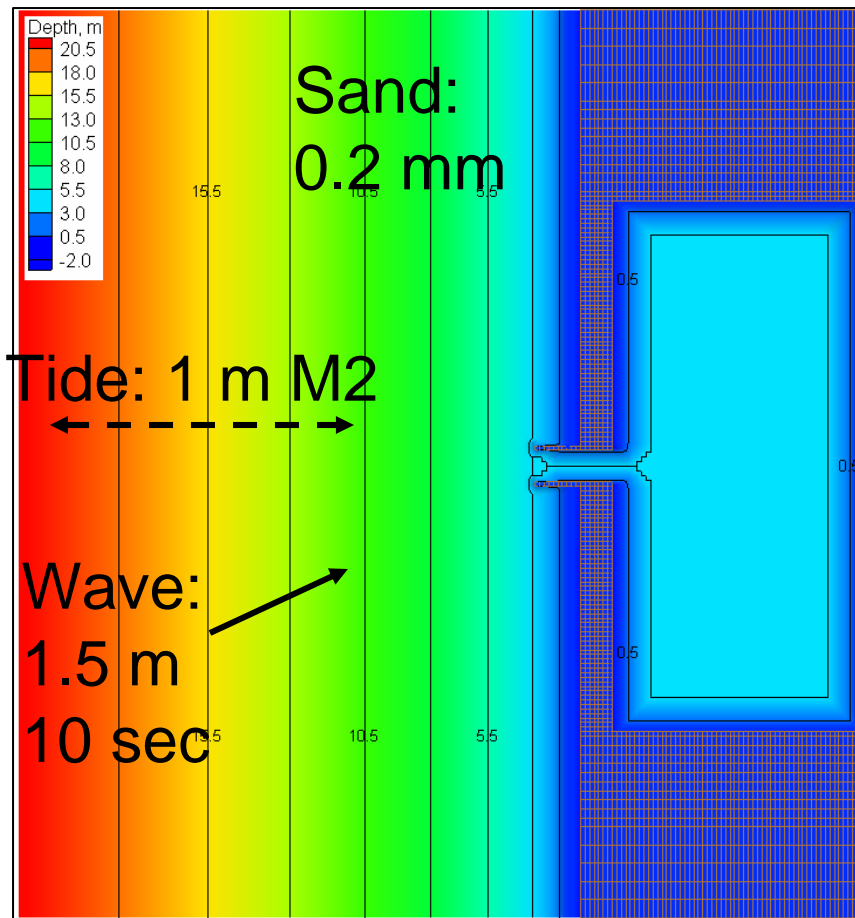


Morphology Change

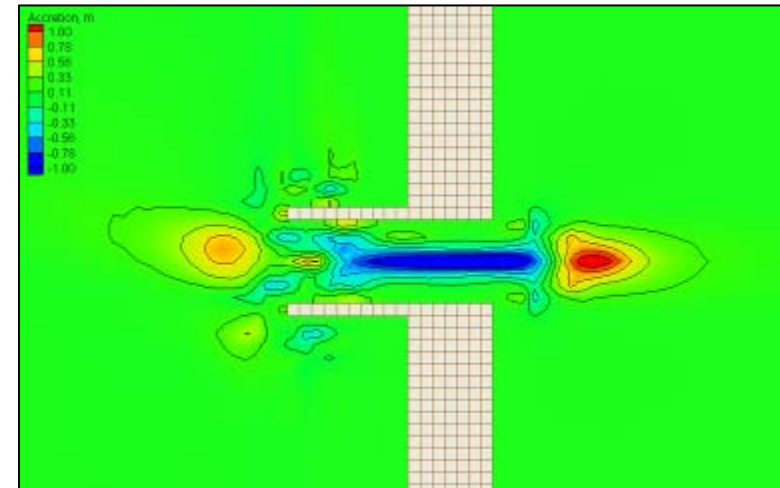
NET removes unnatural extremes



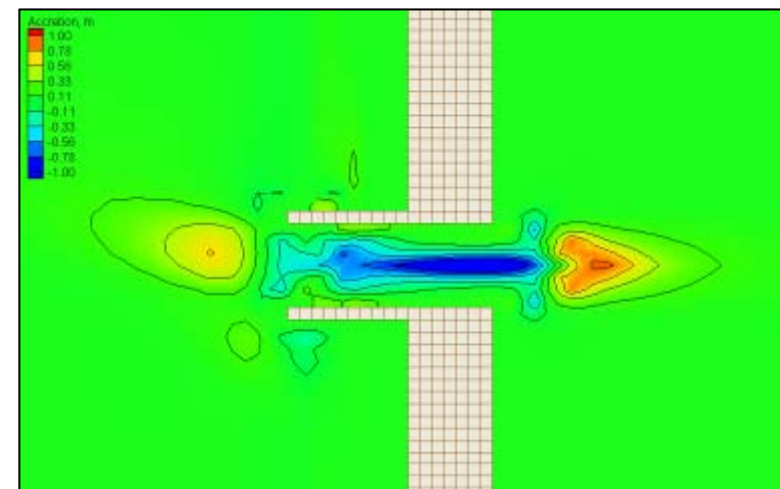
Idealized Inlet Grid

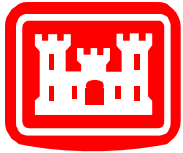


Equilibrium transport, 6 days



NET, 6 days

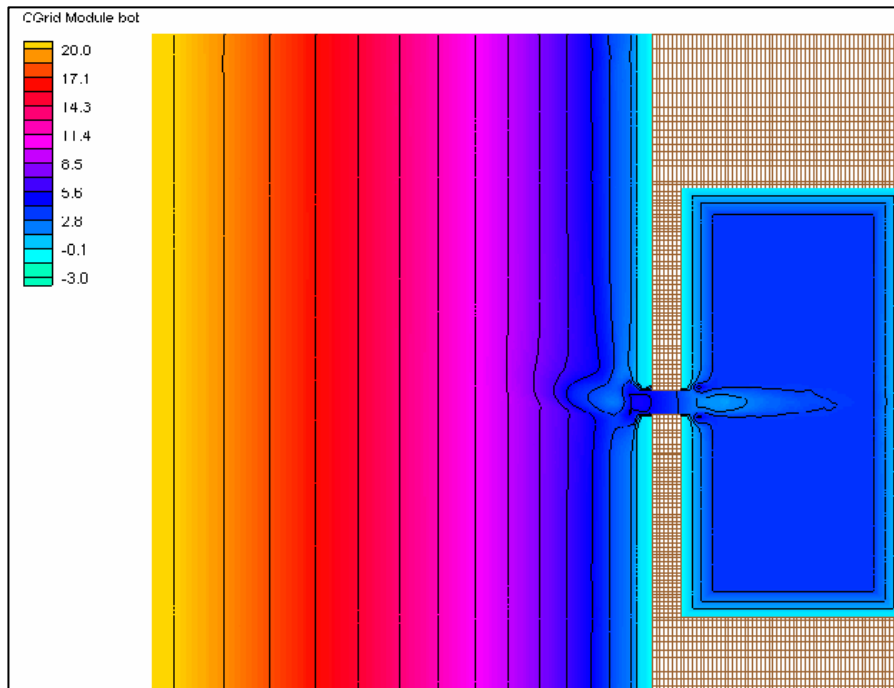




Rapid Assessment of Morphology RAM Test

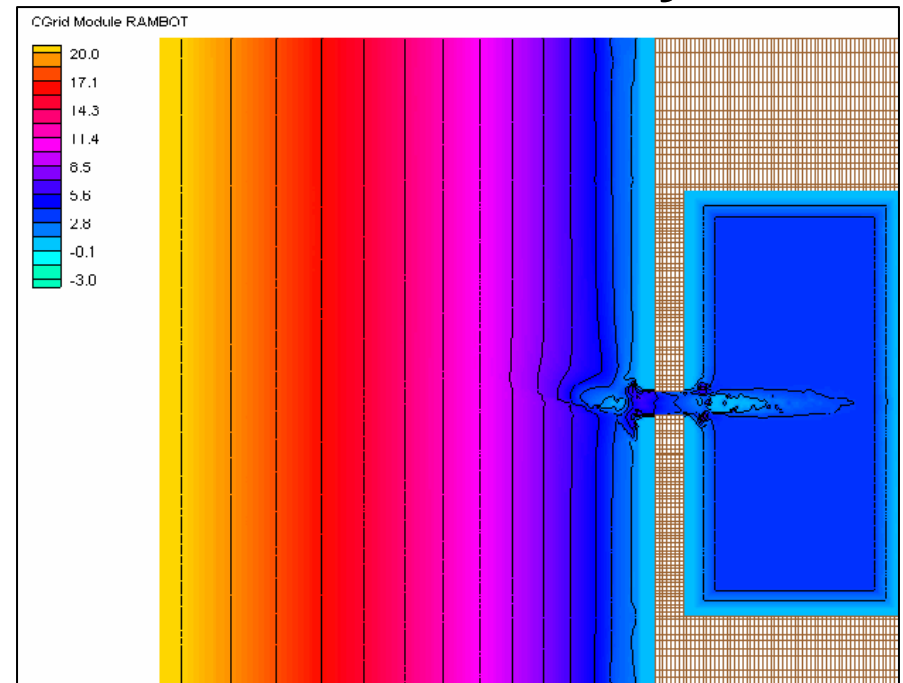


CMS, 60 Days

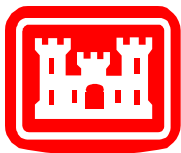


3 Days CPU time

CMS-RAM, 60 Days



1 minute CPU time

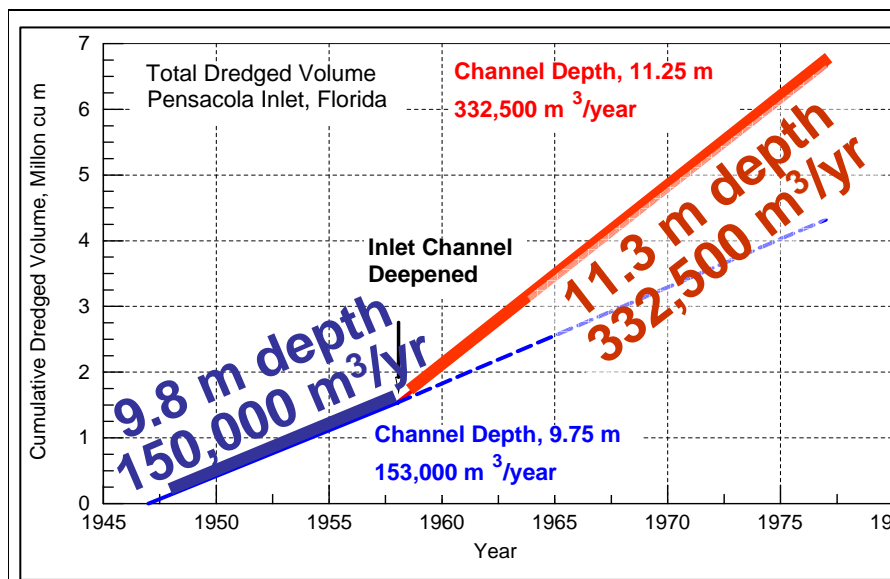


Channel Infilling

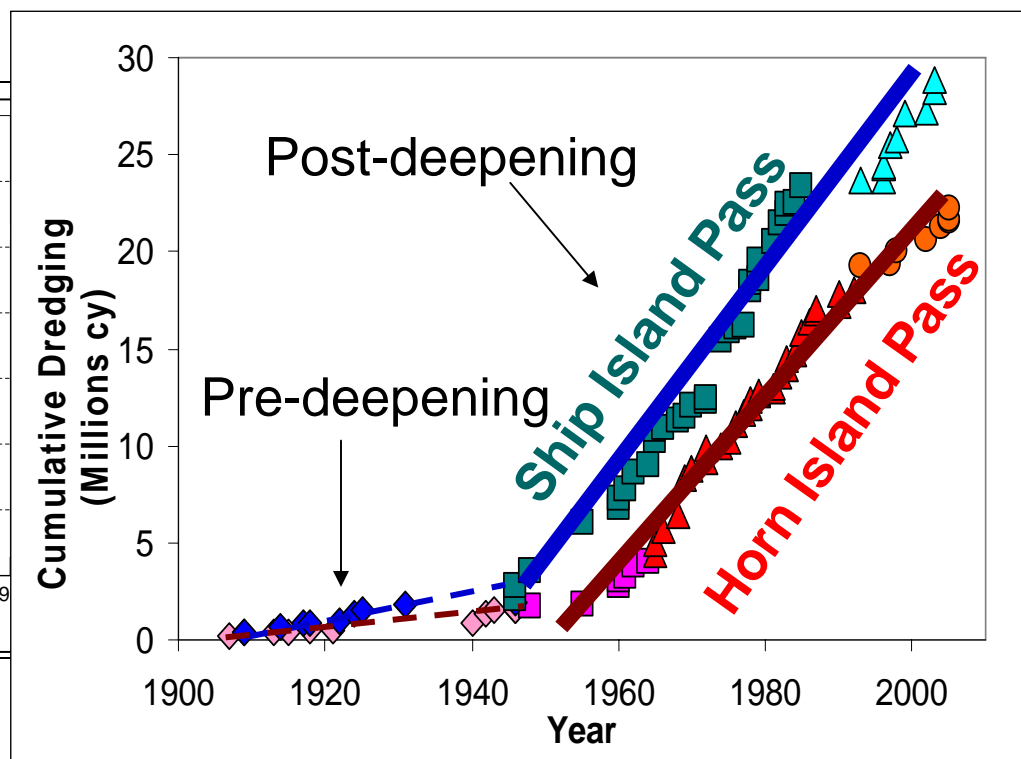


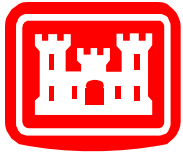
Channel shoaling increases with increasing channel depth
Channels are longer to provide navigability for increased depth

Pensacola Pass, FL



Ship and Horn Island Pass, MS



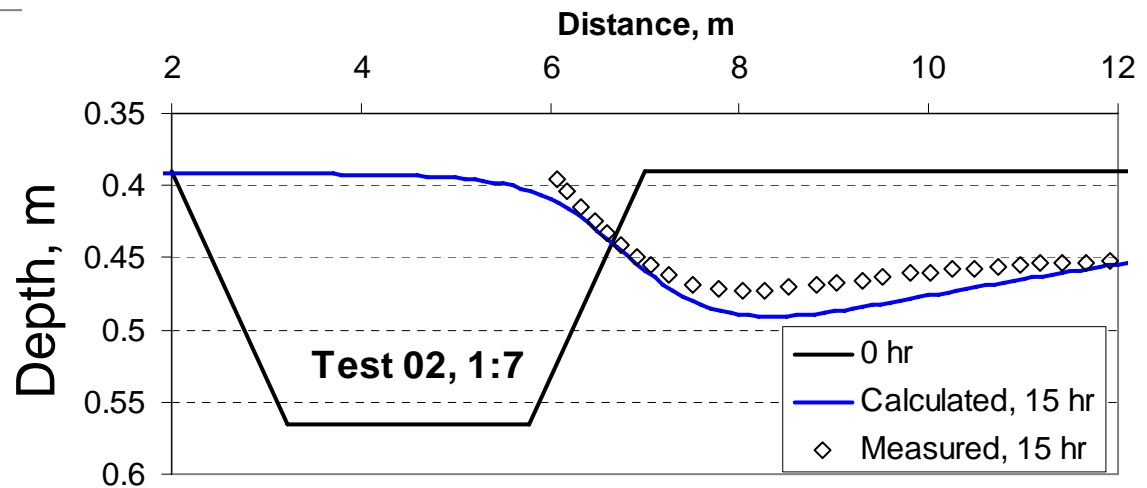
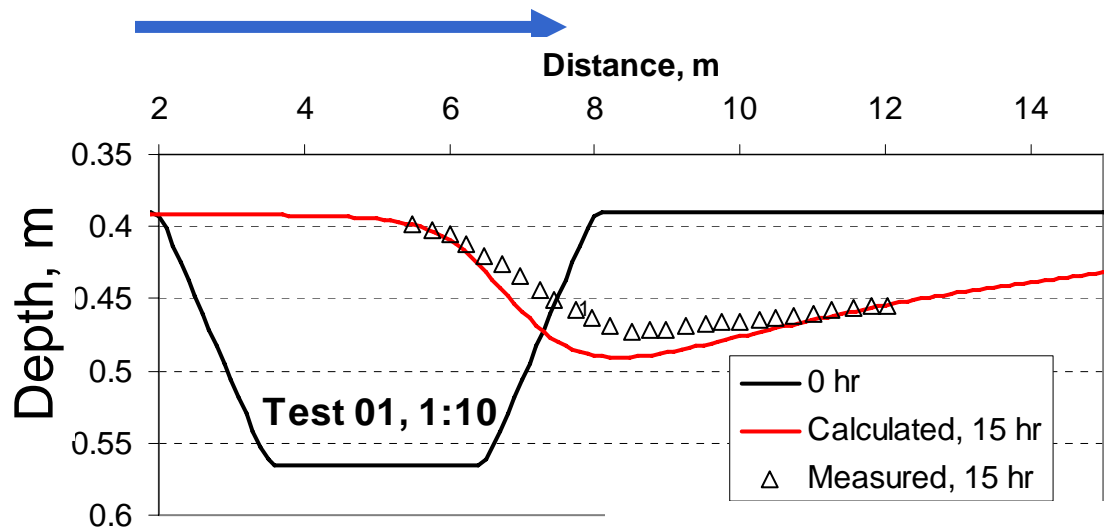


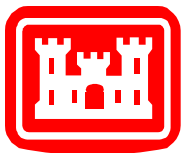
Channel Infilling

CMS Comparison with Laboratory Data



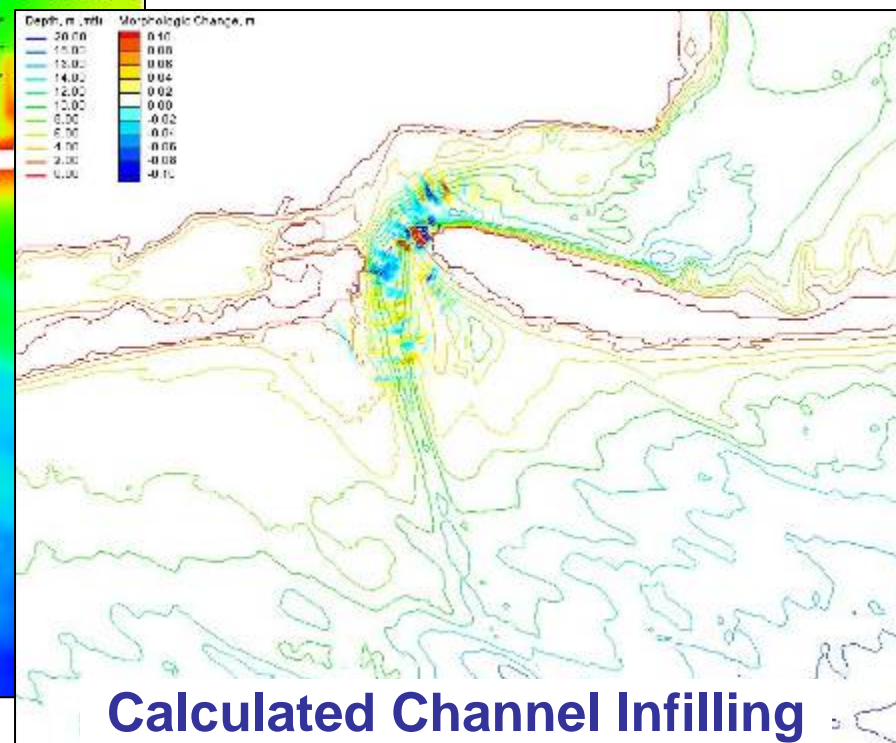
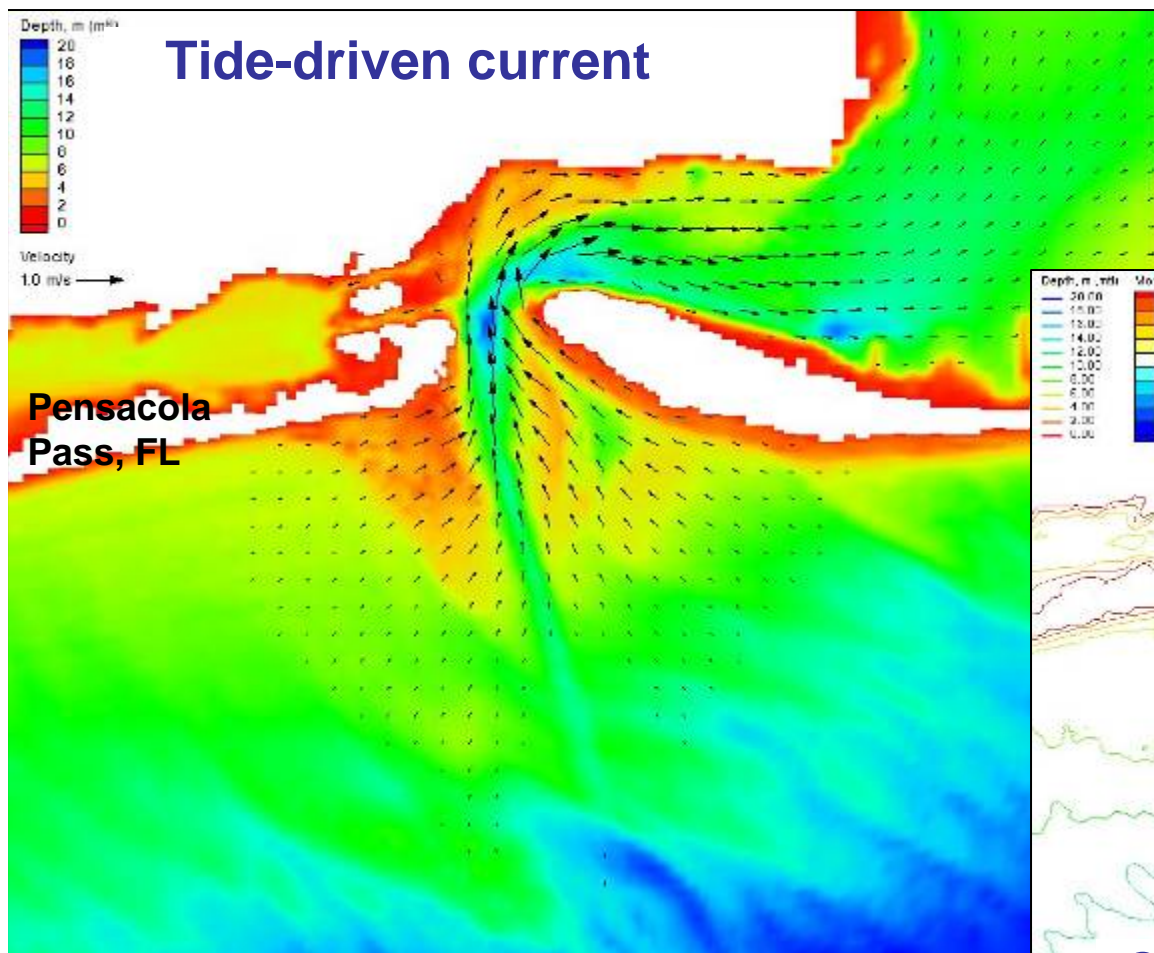
Extreme Longshore Current (for lab), 0.5 m/sec

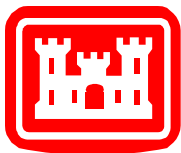




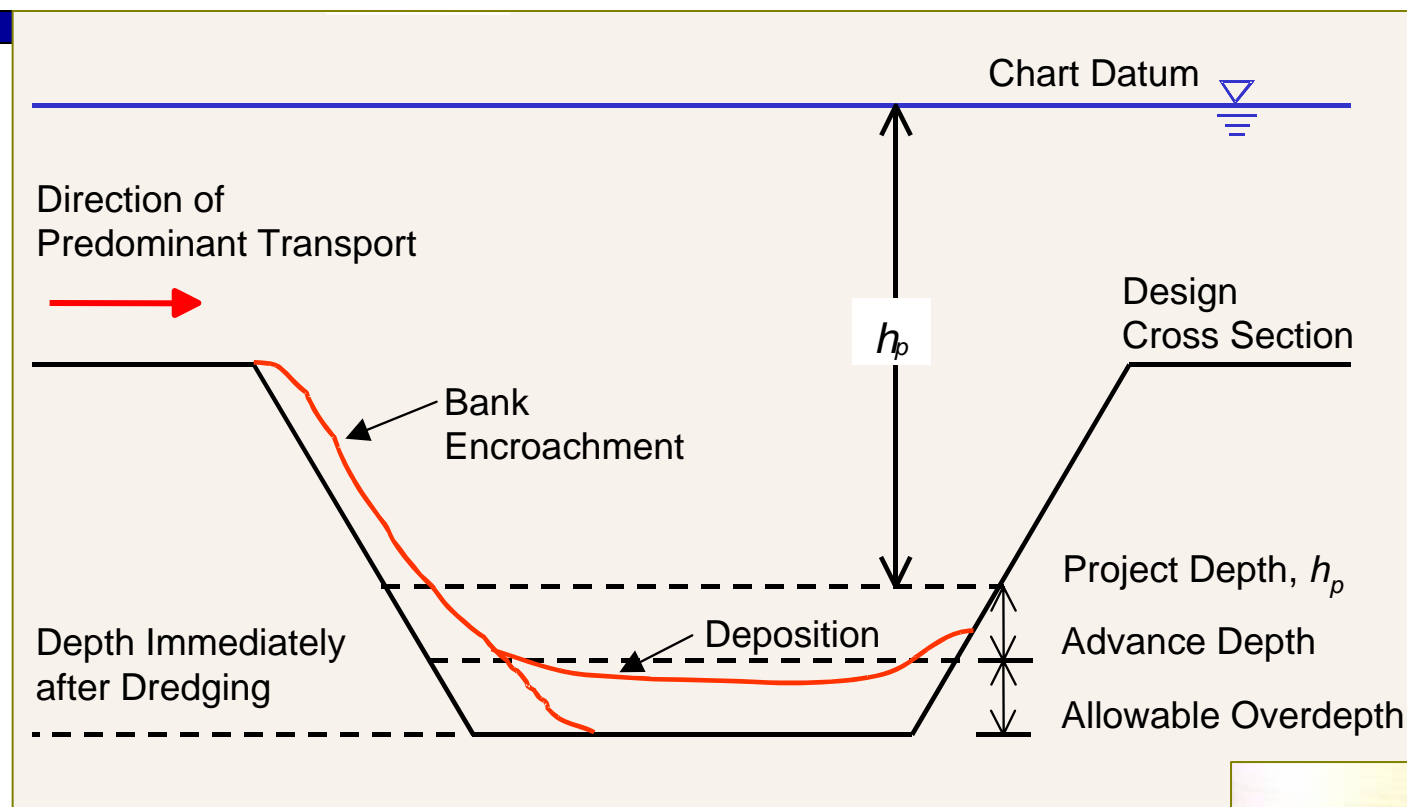
Channel Infilling

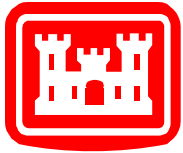
CMS Application to Pensacola Pass





Analytical Method for Channel Infilling



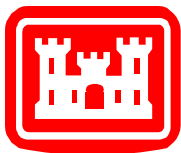


Barrier Island Breaching and Jetty Breaching



Breaching near and at jetties is increasing with length of service of inlets

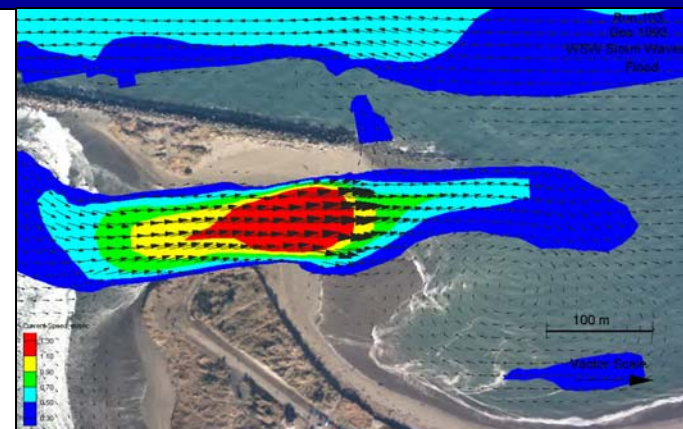
Breaching has occurred at Grays Harbor, Coos Bay, Matagorda Ship Channel, and Moriches Inlet, and it threatens other locations



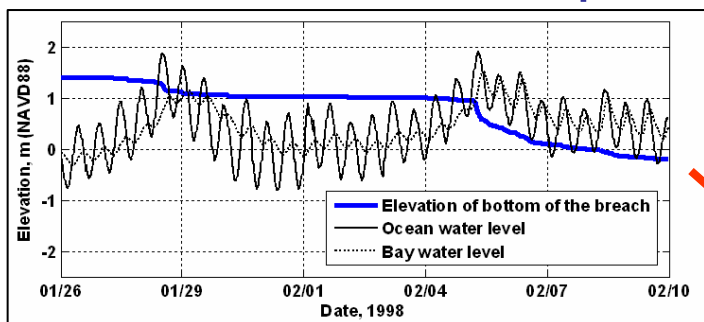
Barrier Island Breaching



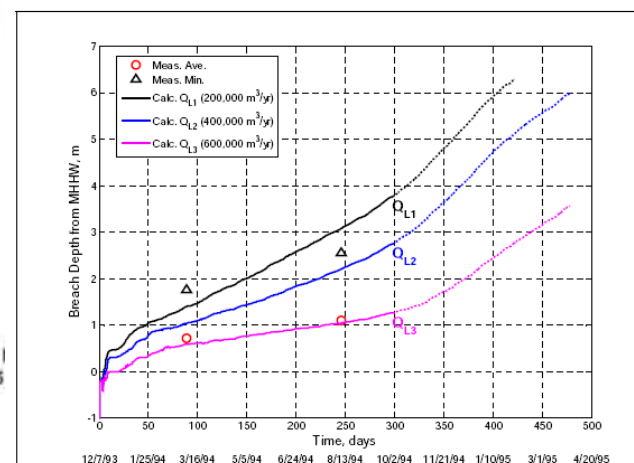
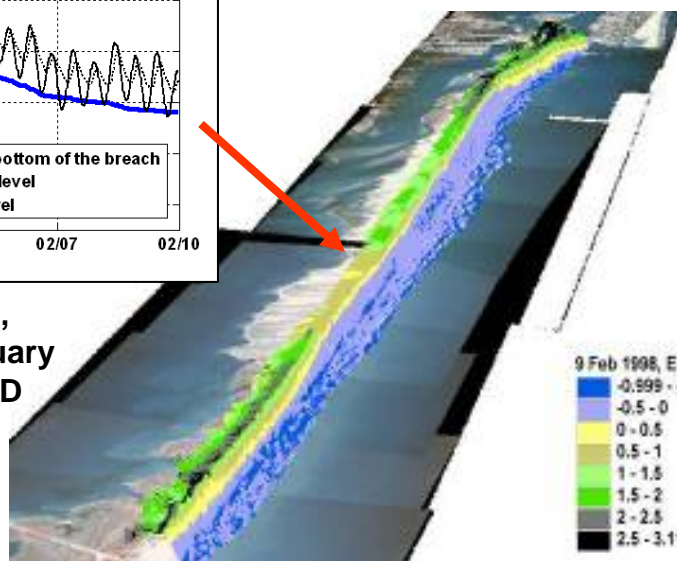
- CIRP is developing two different technologies to quantify breaching
 - One-Dimensional Regional Breaching Model (with SWWRP)
 - Two-Dimensional meso-scale module incorporated into CMS



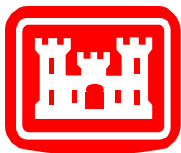
CMS, Calculated current velocity in breach of Dec 1993, Grays Harbor, WA



Regional Breaching Model, Calculated breach depth January 1998, Assateague Island, MD



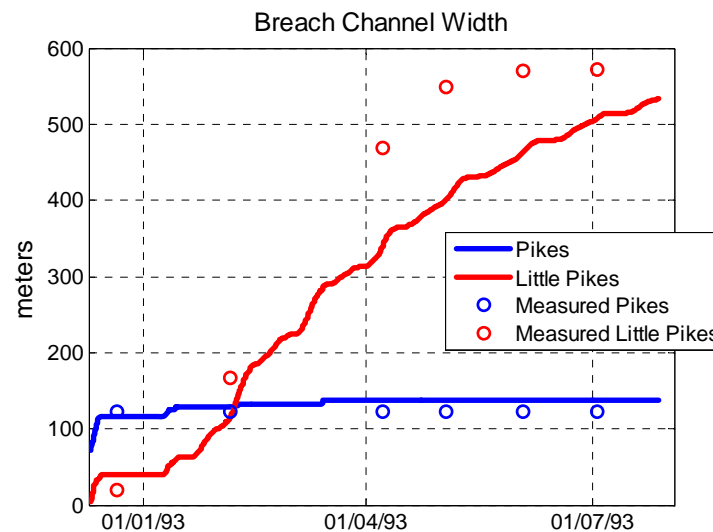
Regional Breaching Model, Calculated breach depth and observation, Grays Harbor, WA



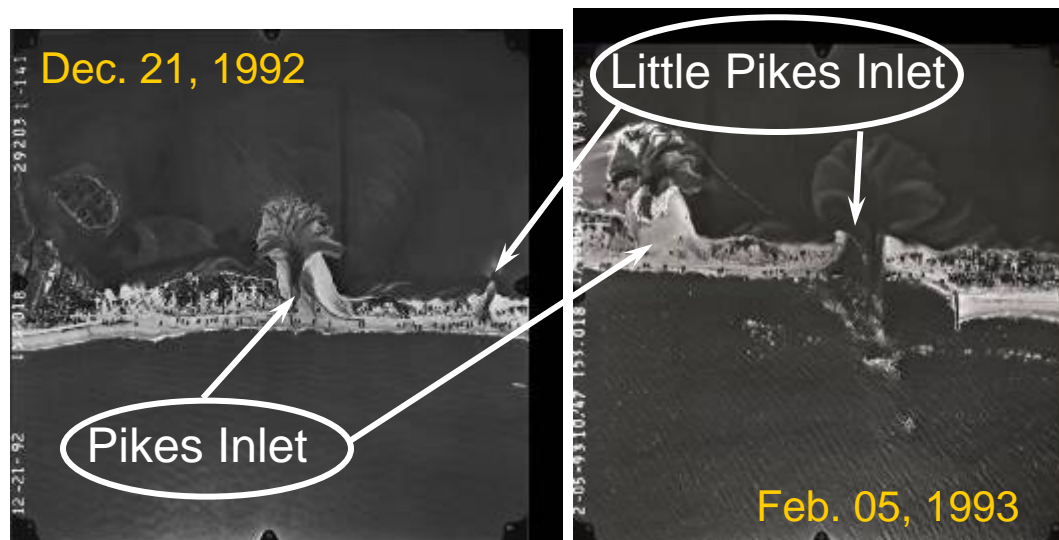
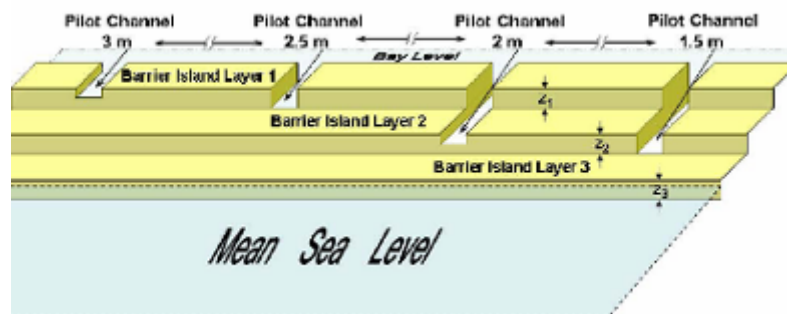
Regional Breaching Model

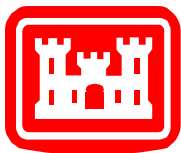


- Quantitative prediction of breach width and depth.
 - Incorporate our expertise with inlets. Most breach widening occurs after storms during normal tidal flow.
 - Include channel infilling by longshore transport, wave-current interaction in the channel and overwash prior to breaching.



2.5 mile East of Moriches Inlet



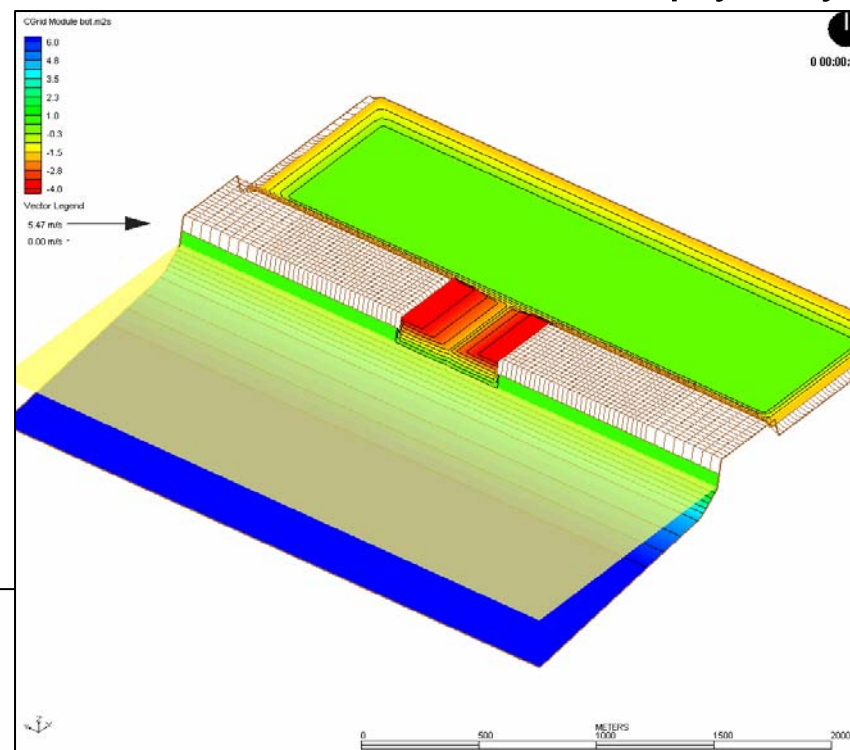


Breaching Module in CMS

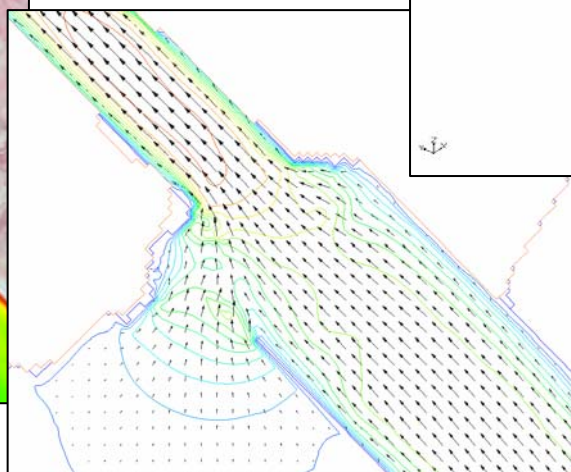
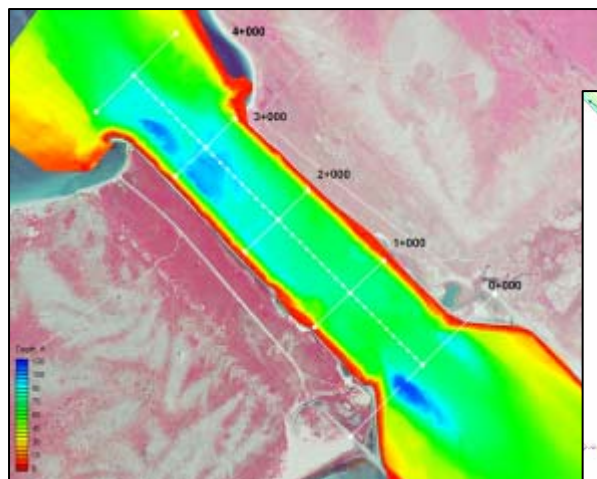


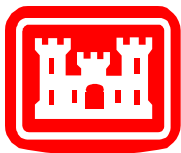
- Two-Dimensional physics-based module for the CMS.
 - Resolve waves, runup, flow, and morphology change for complex bathymetry.
 - Provides morphological responses of adjacent inlet

Animation of Breach to Empty Bay



Matagorda Ship Channel Entrance, TX



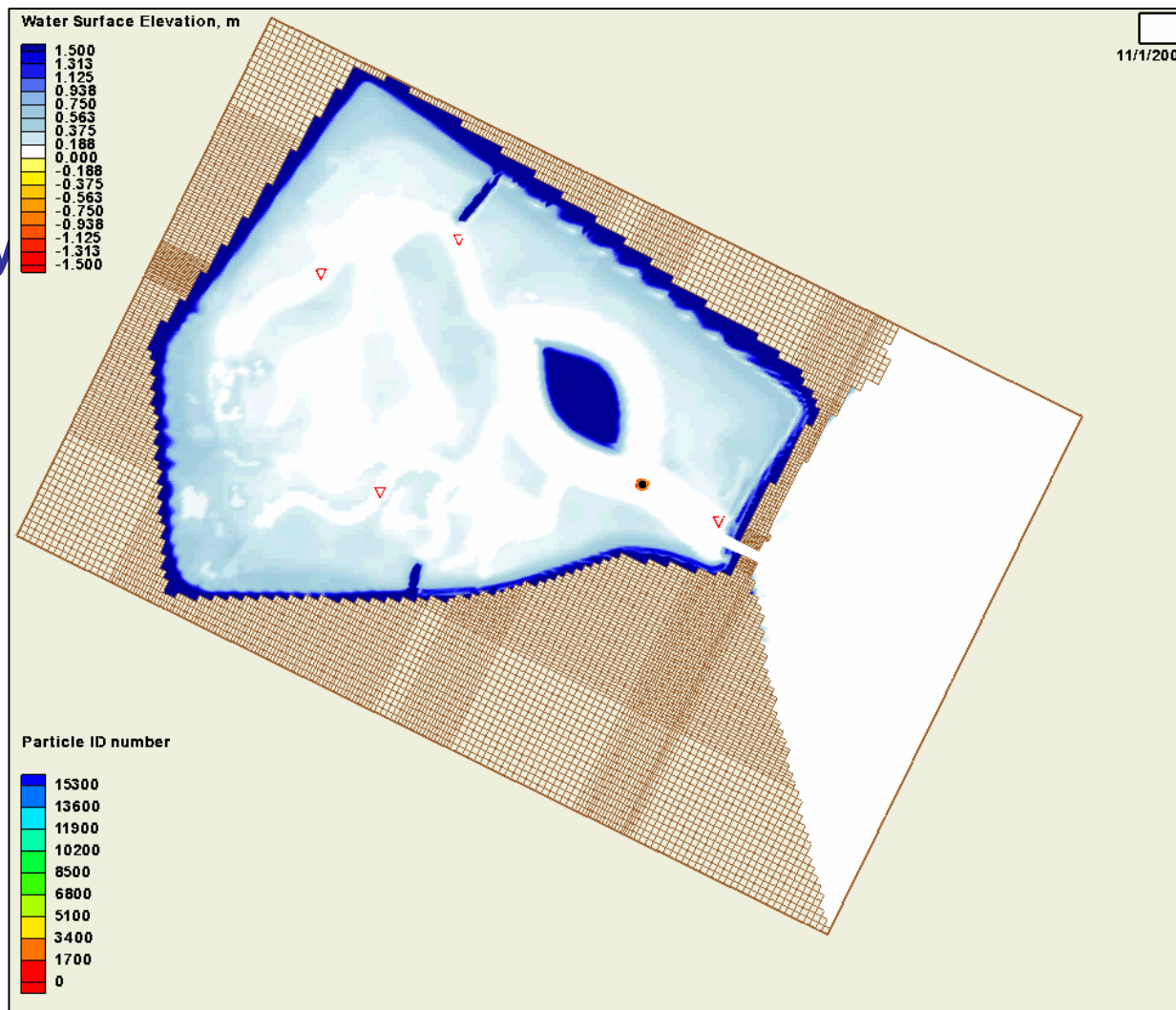


Particle Tracking Model (CMS-PTM)

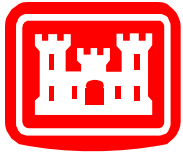


- Compelling visualization
- Retention time (salinity fine-grain sediment)
- Test-bed for sediment transport physics
- Jointly developed with DOER

Animation: ~ 2,600 particles injected at 12-hr intervals. Particle color goes from red to blue depending on the its number (at time of release).



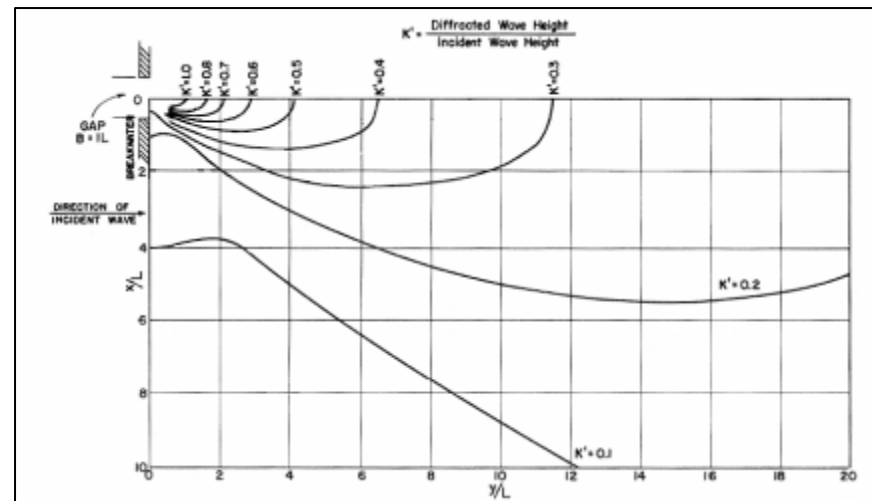
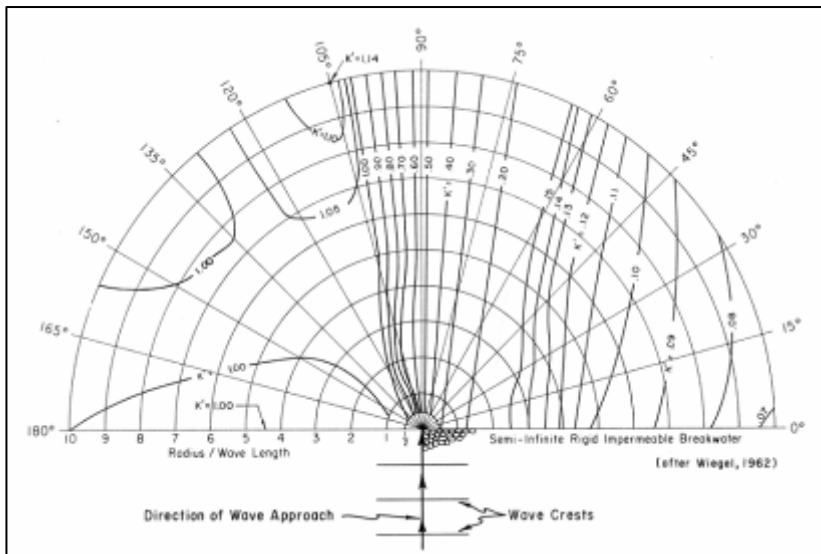
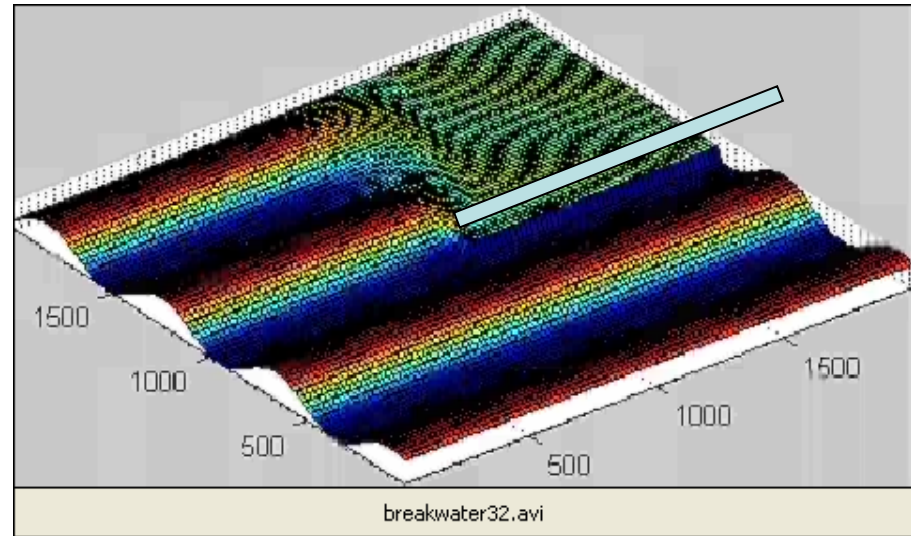
Animation of CMS-PTM to Poplar Island, MD – 3 days

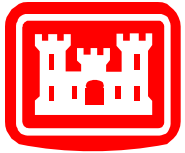


Jetty and Breakwater Wave Modeling – Diffraction



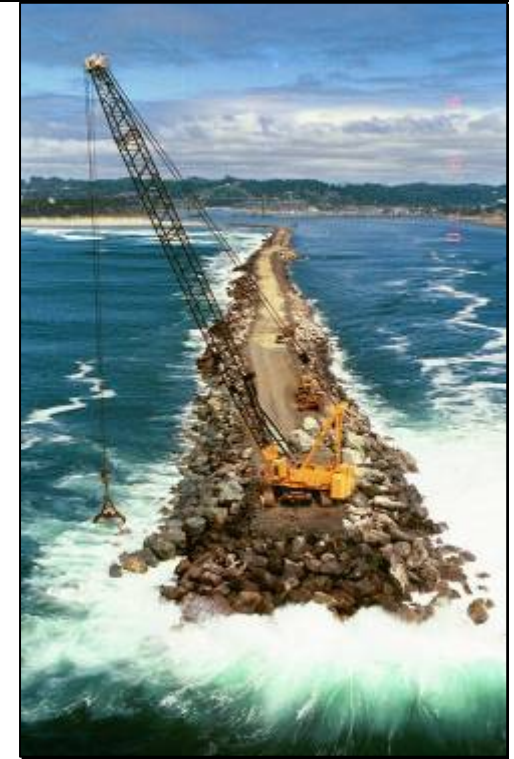
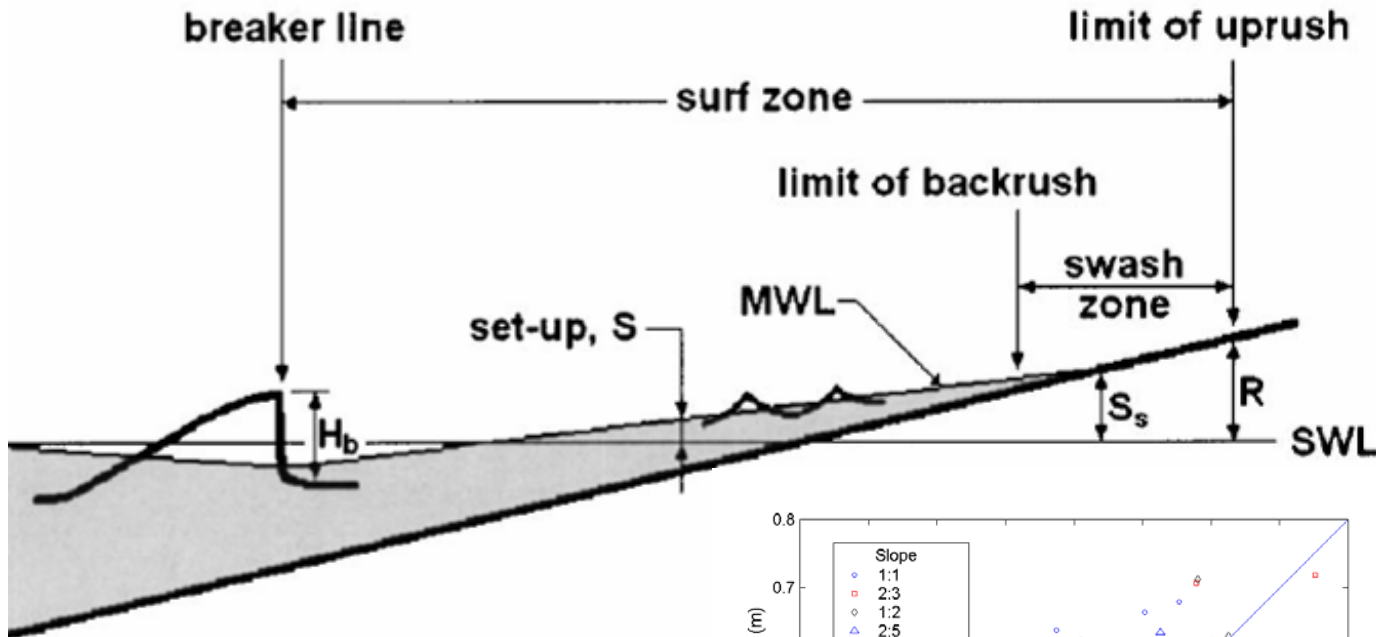
Humboldt Bay, CA



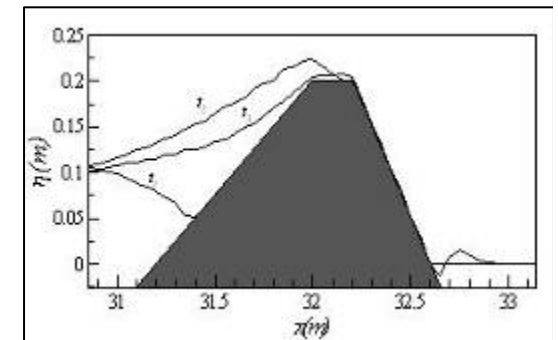
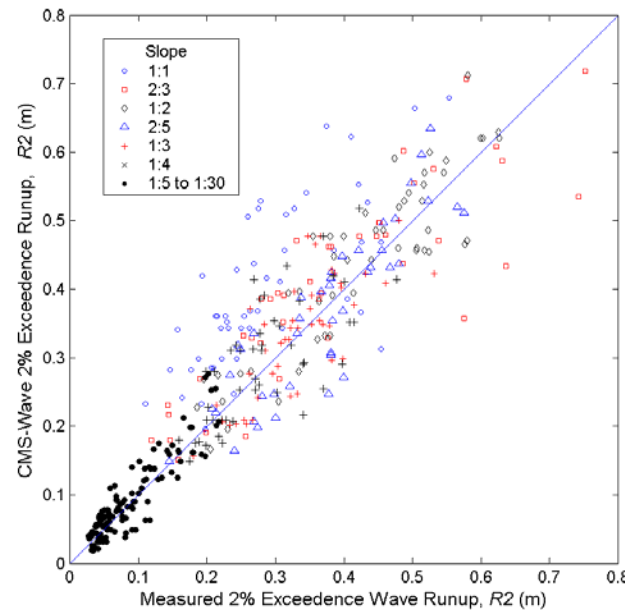


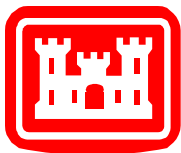
Jetty and Breakwater Wave Modeling

Run-up on Structures & Beaches



- Wave run-up
- Wave overtopping
- Wave transmission

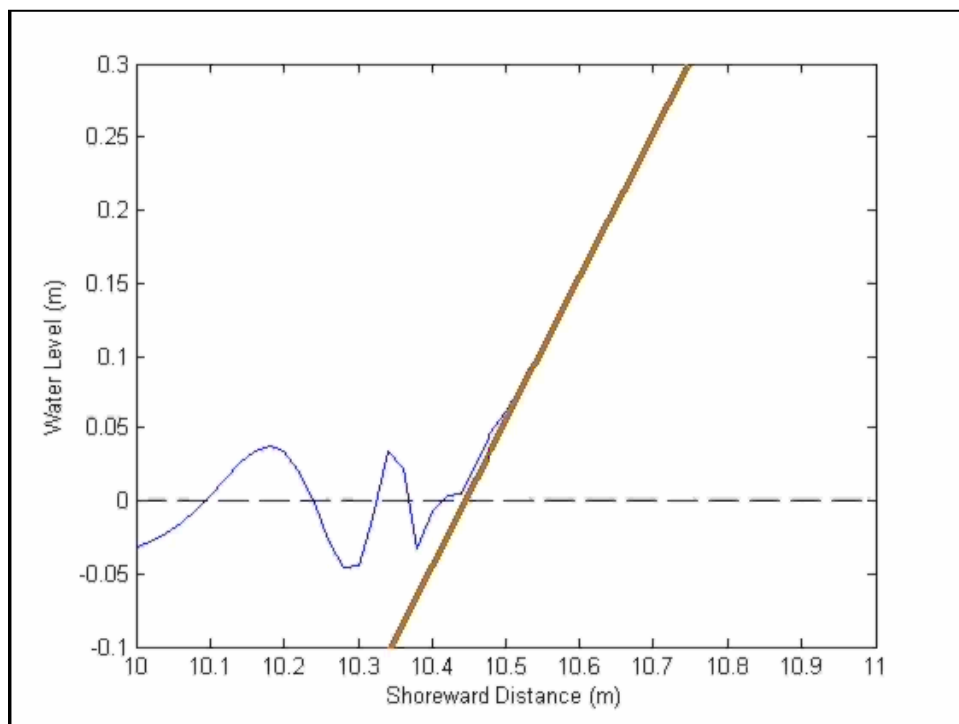




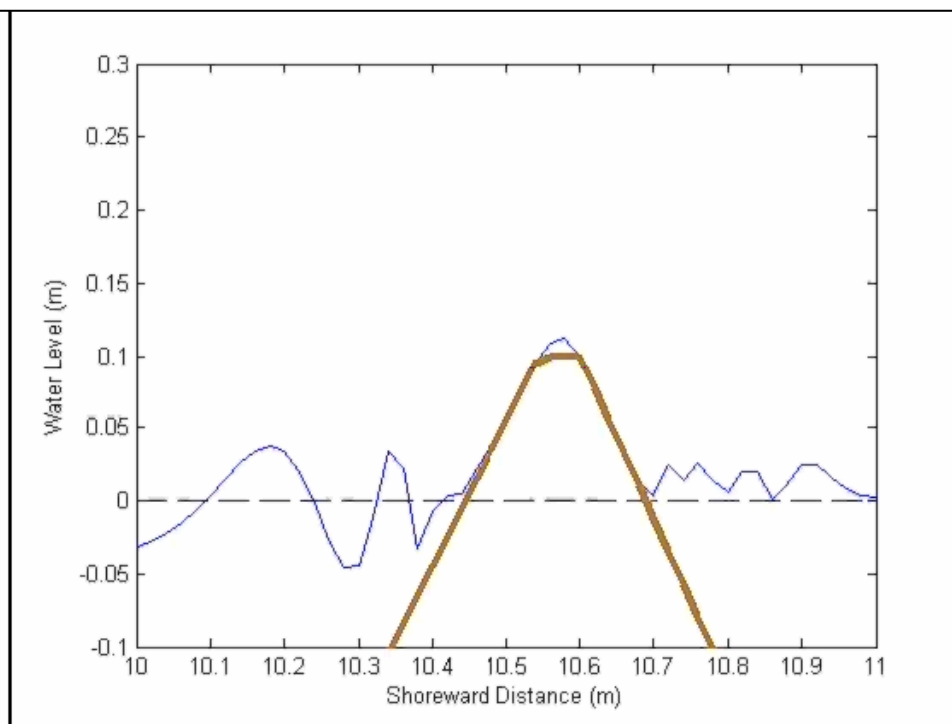
Calculated Run-up and Overtopping

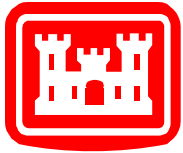


Run-up



Overtopping

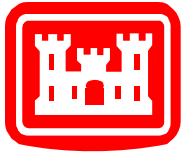




Inlet Reservoir Model (long-term morphology change)



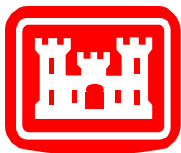
- Means of calculating natural sand bypassing, consequences of accessing ebb & flood shoals as borrow sites, recovery of shoals, and similar.
- Tool for evaluating engineering consequences from decades to centuries.
- Widely used – required by State of Florida for new inlet management plans; applied for NAN at Shinnecock Inlet, NY; for NAB at Ocean City Inlet, etc.
- Will be released in a coastal inlet engineering toolbox and/or Section 111 Toolbox.



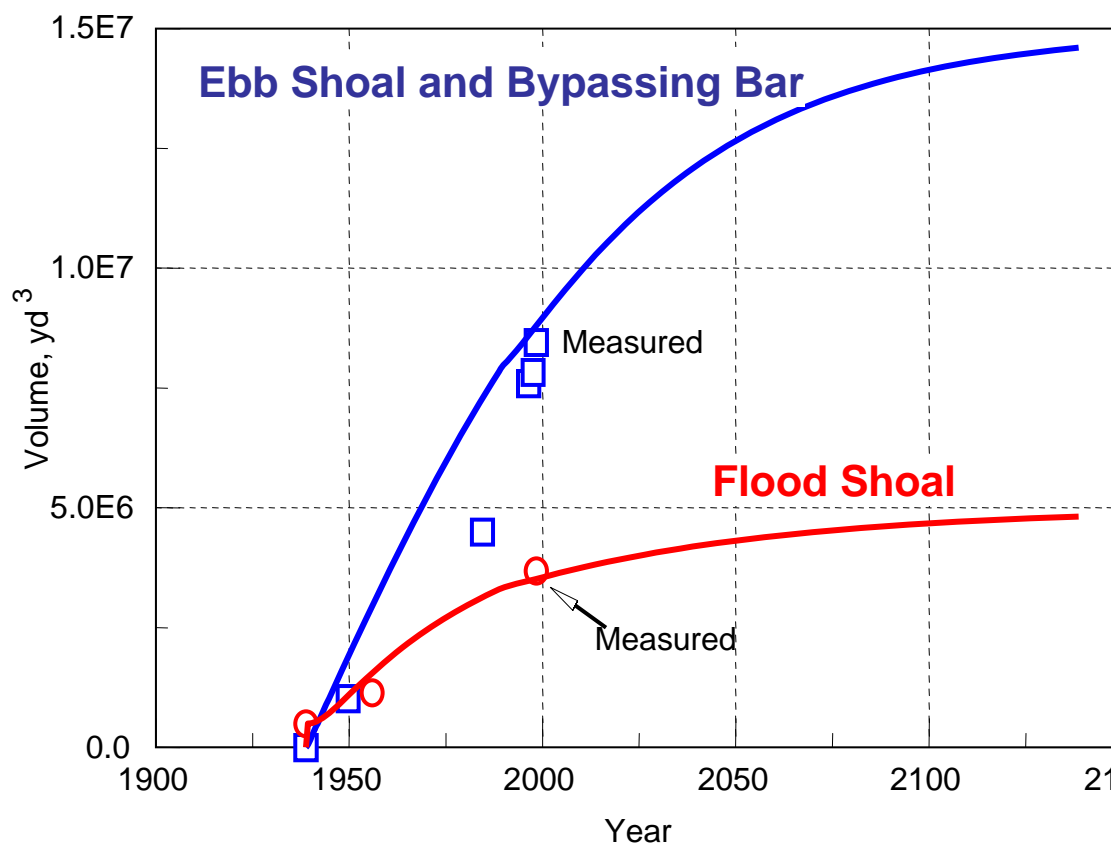
Inlet Reservoir Model: Long-term Bypassing and Shoal Development



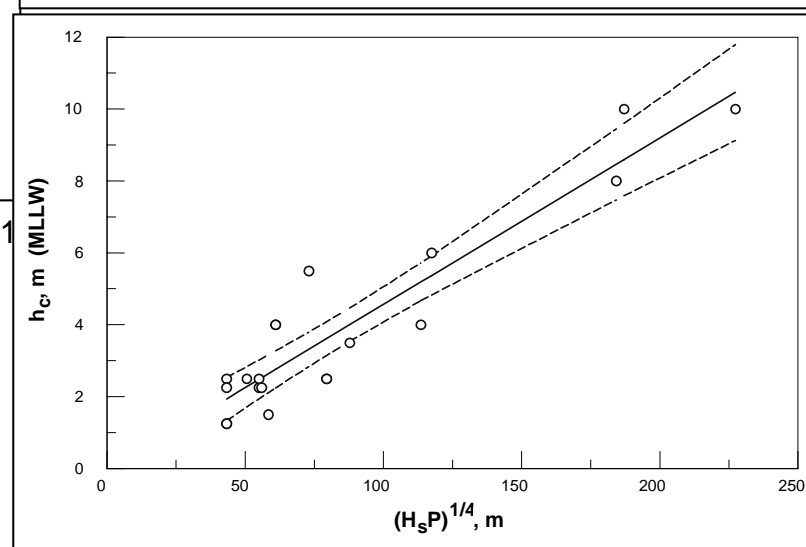
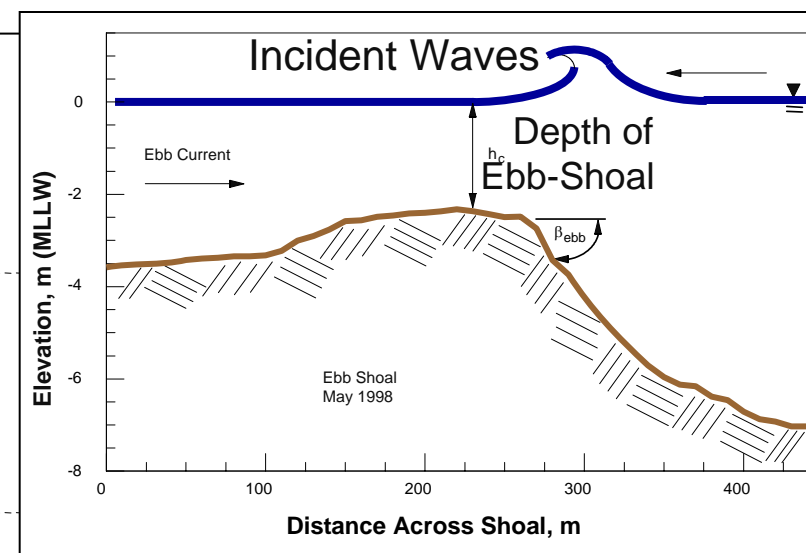
Shinnecock Inlet, Long Island, NY - April 1997

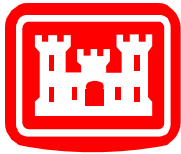


Quantitative Geomorphology Inlet Reservoir Model; Depth over Entrance Bar



Shinnecock Inlet
(engineering on scale of century)

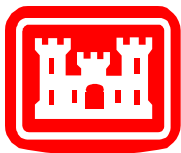




Coastal Structures Asset Management



- Districts, Divisions, and HQ need rational and consistent methods for managing O&M expenditures on critical coastal infrastructure.
- High-level, portfolio-wide rankings of structures requires a methodology & tool for collating and analyzing large amounts of data.
- Multiple measures of coastal structures significance:
 - Supported economic activity (tonnage, fishing, recreation, etc.)
 - Life safety & storm protection
 - Military and national security value
 - Environmental benefits
- Portfolio-wide AM demands *surrogate metrics* that *correlate* with the true significance, but can be collected, updated, and tabulated quickly.



Coastal Structures Asset Management



- **Economic metrics from existing sources:**
 - Commercial tonnage (IWR-NDC)
 - Commercial fish landings (NOAA-NMFS)
 - Cruise and ferry statistics (USDOT)



- **Life safety metric:**
 - Maritime casualties and vessel incidents (USCG)

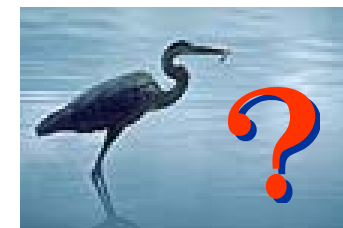


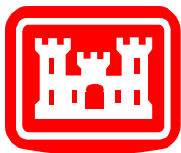
- **Project cost history:**
 - USACE dredging records (NDC)

- **Potential recreation-economics metric:**
 - Boat ramp and pier datasets (private sector)



- **Environmental metrics TBD**





CSMART Example –Tonnage Supported



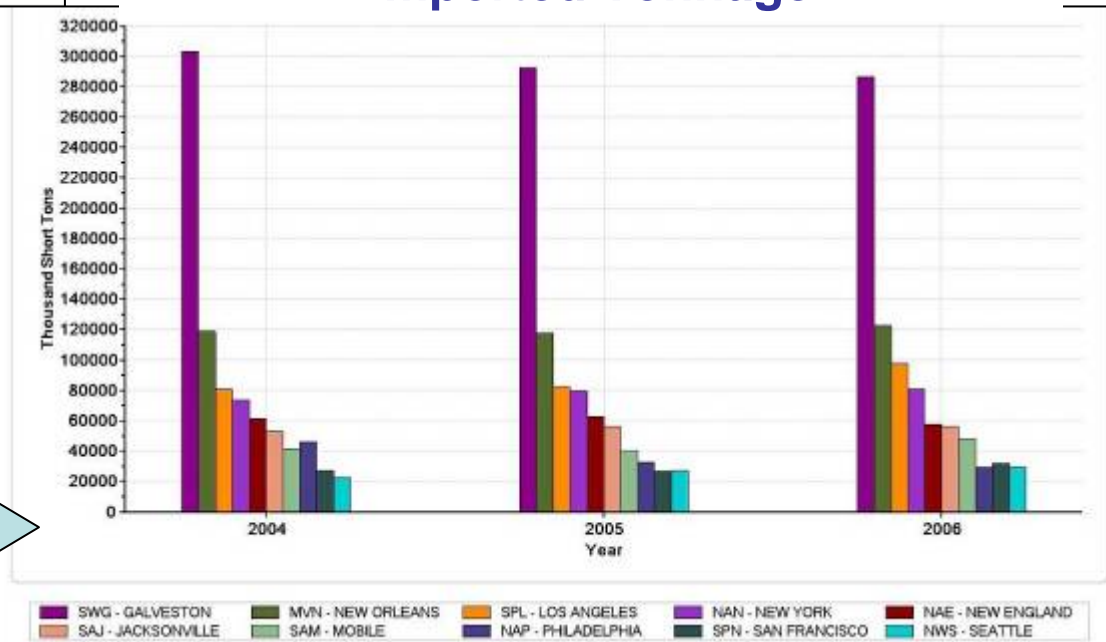
CSMART User Interface

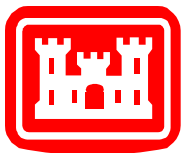
The screenshot shows the CSMART interface with the following settings:

- Step 1: Features (selected)
- Commercial Tonnage (selected)
- Include? (checked)
- Movement: In/Out (Inbound Tonnage selected)
- Foreign/Domestic: Foreign Tonnage (selected)
- Years: 2003-2006 (Selected Years: 2006, 2005, 2004)
- Commodities: ALL COMMODITIES (Selected Commodities list includes Acyclic Hydrocarbons, Aircraft & Parts, etc.)
- Query Type: Cumulative (selected)

- User interface allows for rankings to be produced according to a variety of criteria.
- Charting feature provides report-ready visualizations of ranked items and temporal trends.

Top 10 Districts Ranked by Foreign Imported Tonnage





CSMART Example – Tonnage Breakdowns

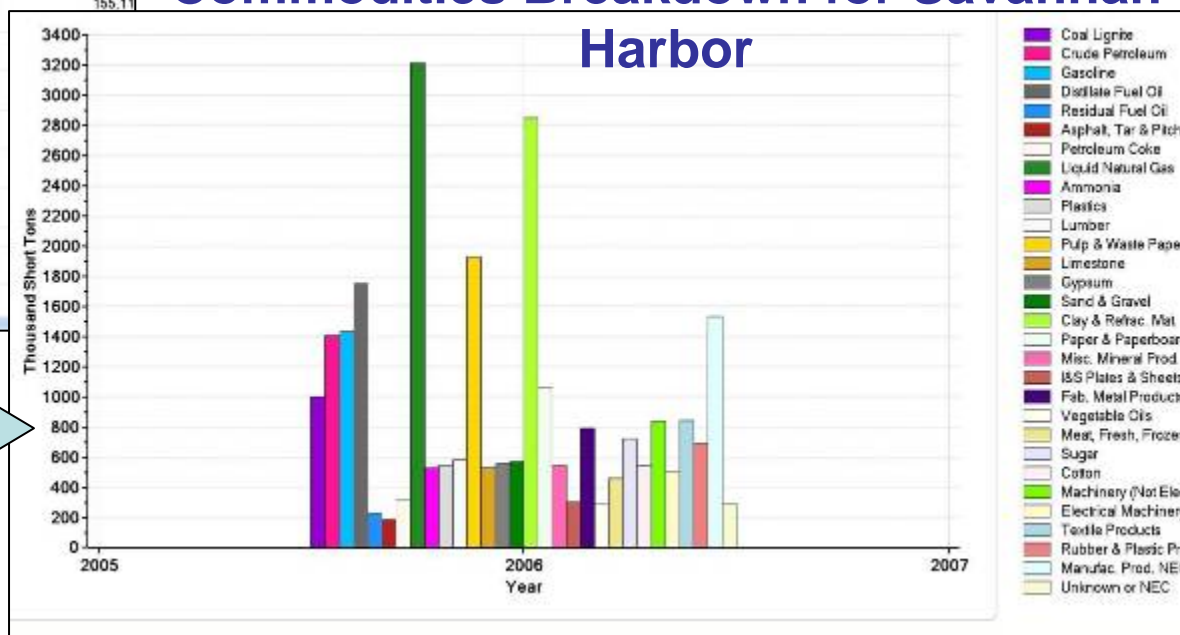


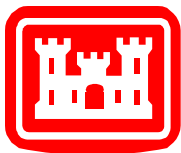
CSMART User Interface

| State | Project | Structure | Thousand Short Tons |
|-------------------------|----------------------------|---|---------------------|
| LOUISIANA | 1 SOUTHWEST PASS | SOUTHWEST PASS EAST JETTY SOUTHWEST PASS WEST JETTY | 1,037.29 |
| TEXAS | 2 GALVESTON ENTRANCE | GALVESTON HARBOR NORTH JETTY GALVESTON HARBOR SOUTH JETTY LA-LB HARBORS LONG BEACH BREAKWATER | 998.56 |
| CALIFORNIA | 3 LA-LB HARBORS | LA-LB HARBORS MIDDLE BREAKWATER LA-LB HARBORS SAN PEDRO BREAKWATER | 646.47 |
| TEXAS | 4 SABINE PASS | SABINE PASS EAST JETTY SABINE PASS WEST JETTY | 439.18 |
| TEXAS | 5 ARANAS PASS | ARANAS PASS NORTH JETTY ARANAS PASS SOUTH JETTY | 306.32 |
| MINNESOTA | 6 DULUTH SUPERIOR HARBOR | DULUTH SUPERIOR HARBOR (DULUTH SHIP DULUTH SUPERIOR HARBOR (DULUTH SHIP DULUTH SUPERIOR HARBOR (SUPERIOR EN | 219.24 |
| MINNESOTA AND WISCONSIN | 6 DULUTH SUPERIOR HARBOR | DULUTH SUPERIOR HARBOR (SUPERIOR EN | |
| LOUISIANA | 7 CALCASIEU RIVER AND PASS | CALCASIEU PASS EAST JETTY CALCASIEU PASS WEST JETTY | 181.17 |
| OREGON AND WASHINGTON | 8 COLUMBIA RIVER AT MOUTH | COLUMBIA RIVER AT MOUTH JETTY A COLUMBIA RIVER AT MOUTH NORTH JETTY COLUMBIA RIVER AT MOUTH SOUTH JETTY | 155.11 |
| MAINE | 9 PORTLAND HARBOR | PORTLAND HARBOR NORTH (INNER HARBOR) PORTLAND HARBOR SOUTH (SPRING POINT) | |
| TEXAS | 10 FREEPORT HARBOR | FREEPORT HARBOR NORTH JETTY FREEPORT HARBOR SOUTH JETTY | |
| SOUTH CAROLINA | 11 SAVANNAH HARBOR | SAVANNAH HARBOR COCKSPUR JETTY SAVANNAH HARBOR OYSTER BED JETTY | |
| SOUTH CAROLINA | 12 CHARLESTON HARBOR | CHARLESTON HARBOR NORTH JETTY CHARLESTON HARBOR SOUTH JETTY | |
| FLORIDA | 13 PORT EVERGLADES HARBOR | PORT EVERGLADES HARBOR NORTH JETTY PORT EVERGLADES HARBOR SOUTH JETTY | |
| CALIFORNIA | 14 RICHMOND HARBOR | RICHMOND HARBOR BREAKWATER | |
| FLORIDA | 15 JACKSONVILLE HARBOR | JACKSONVILLE HARBOR NORTH JETTY JACKSONVILLE HARBOR SOUTH JETTY | |
| CALIFORNIA | 16 OAKLAND HARBOR | OAKLAND HARBOR NORTH JETTY OAKLAND HARBOR SOUTH JETTY | |

- Project rankings, with individual structures listed separately, show relative significance of locations.
- For tonnage results, commodity breakdowns provide additional details.

Commodities Breakdown for Savannah Harbor





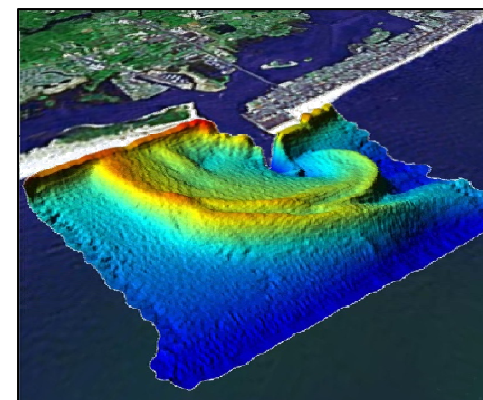
CIRP – Exciting Future



- CSMART
 - Release to Corps (coastal structures)
 - Continue methodology to inlet-related navigation channels?

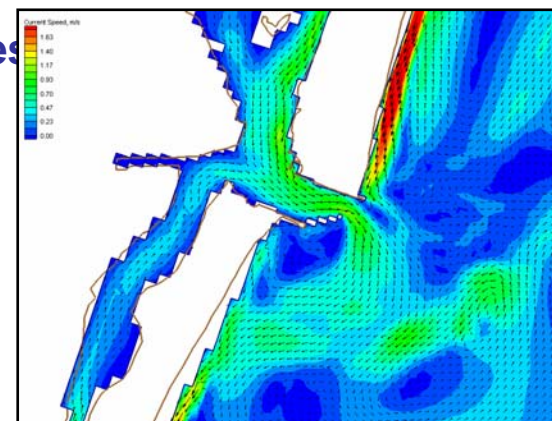


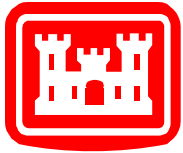
- CMS
 - Efficient, long-term simulation capability deployed to Districts
 - RAM (Rapid Analysis of Morphology Change) deployed
 - NET (Non-Equilibrium Transport) deployed
 - PC multi-processor on PCs deployed
 - Channel & wetland module; weirs, culverts
 - CMS-ShipSed (channel infilling contrib. by ship passage)
 - Nearshore berm design and fate
 - Prediction of breaching at jetties & evaluation of alternatives



- Toolboxes
 - Lidar analysis, aerial photograph analysis (collab. R&D)
 - Tidal Inlet Engineering
 - Section 111 Analysis
 - Tidal Signal Analysis

Ocean City Inlet, MD
NAB long-term partner





Thank you!

