Coastal Inlets Research Program

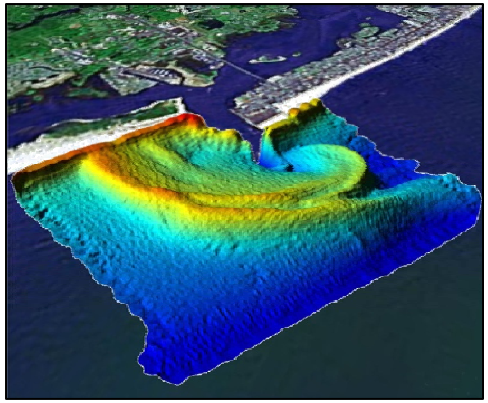
…advancing inlet engineering and science

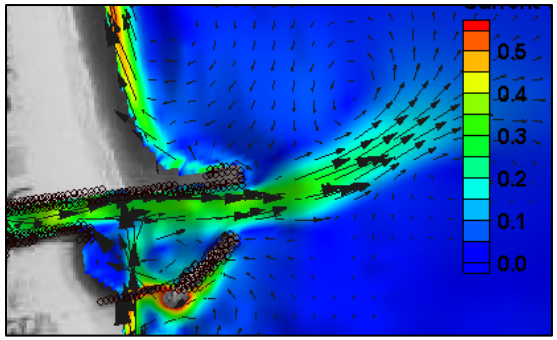
HQ Technical Monitor: Jim Walker

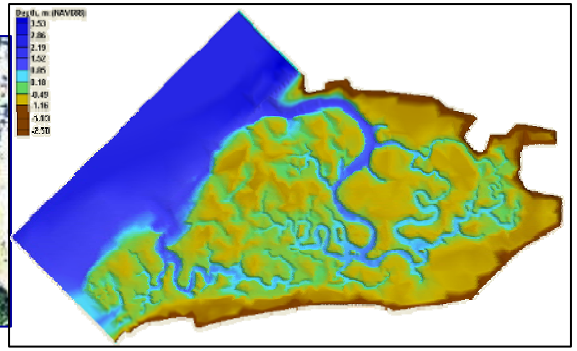
ERDC Tech Director: Jeff Lillycrop

CIRP Program Manager: Nick Kraus

Assistant Program Mgr.: Julie Rosati





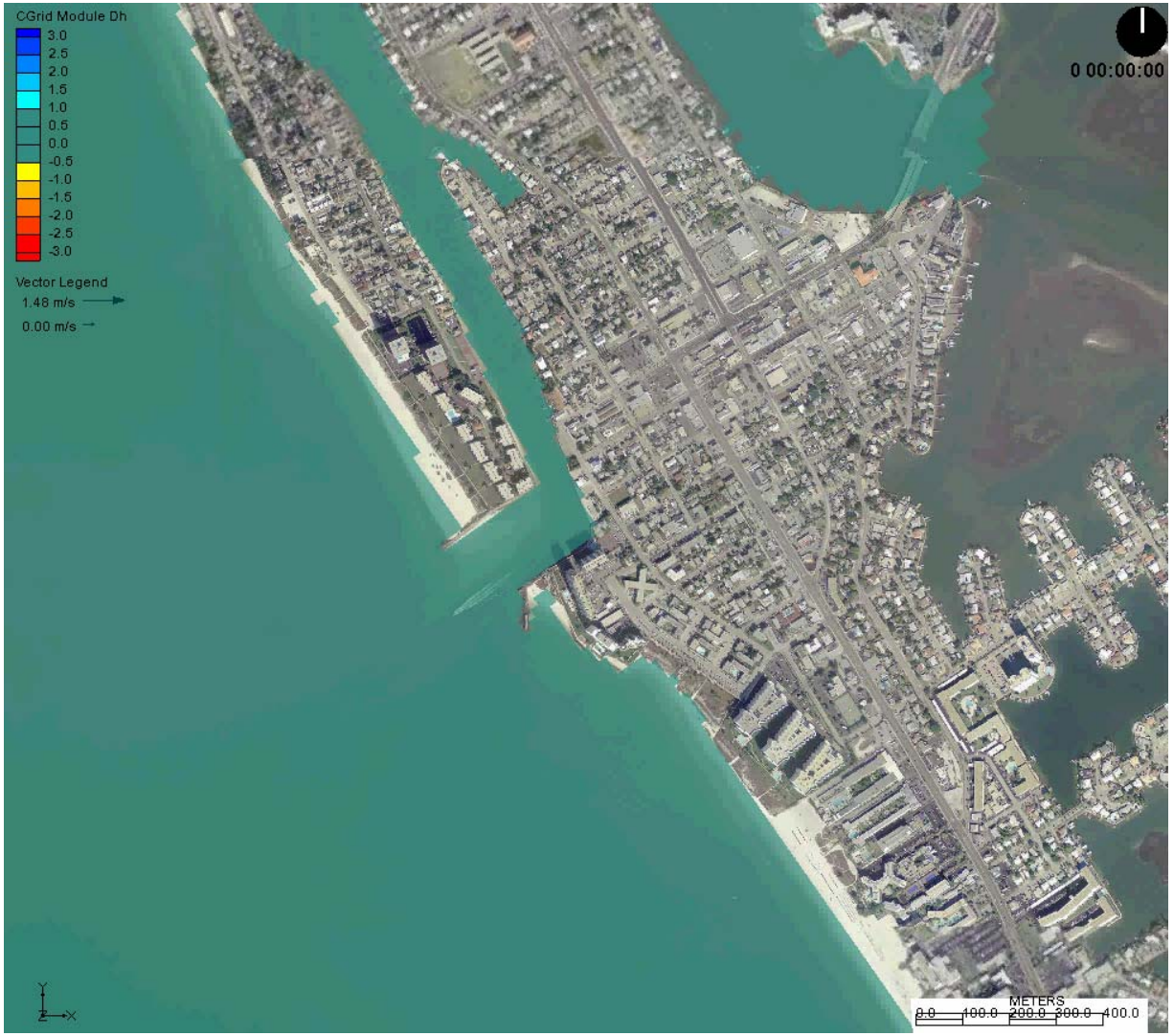


Nearshore placement, Assateague Island bypassing

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/

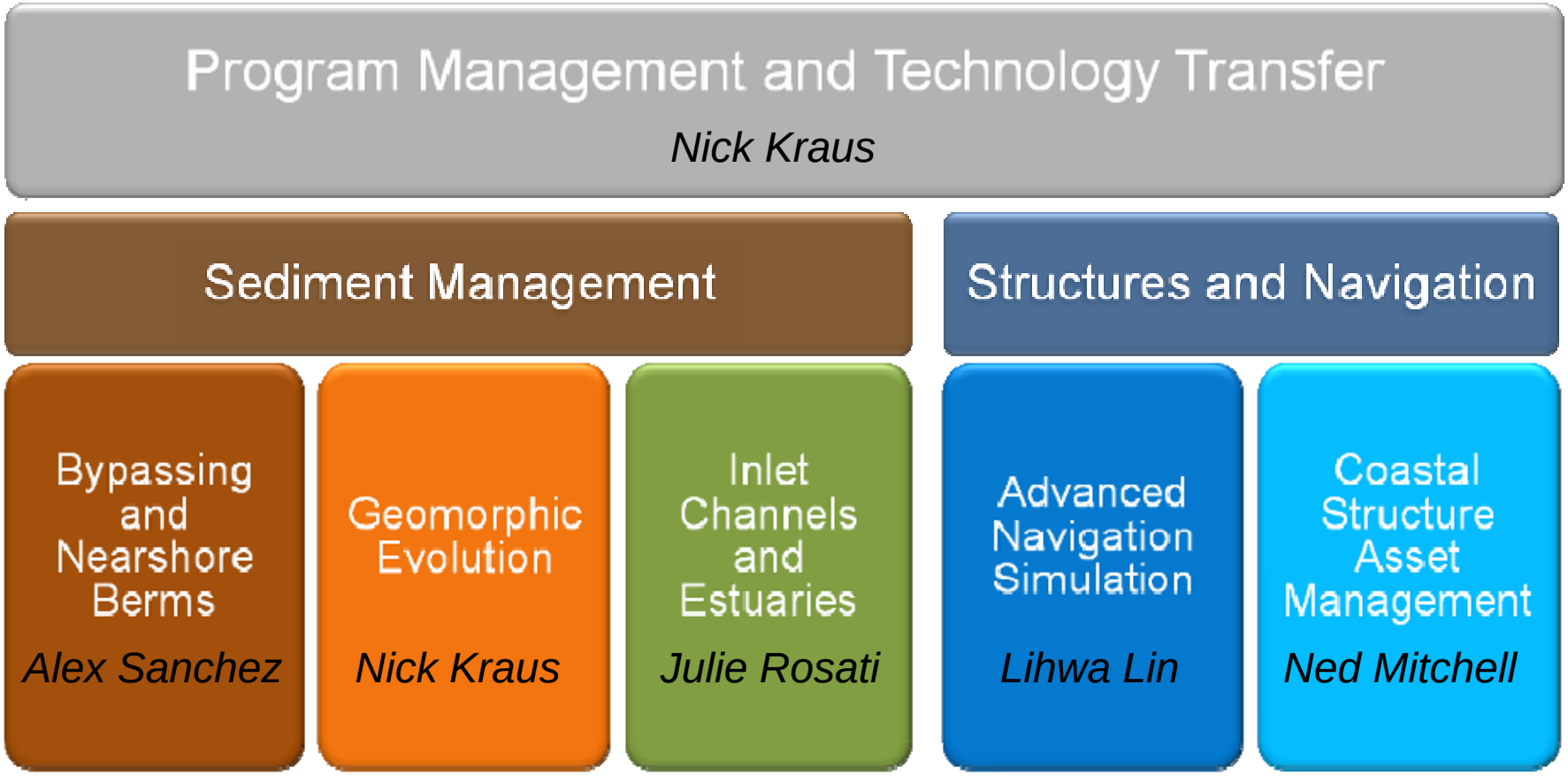
Features

- 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

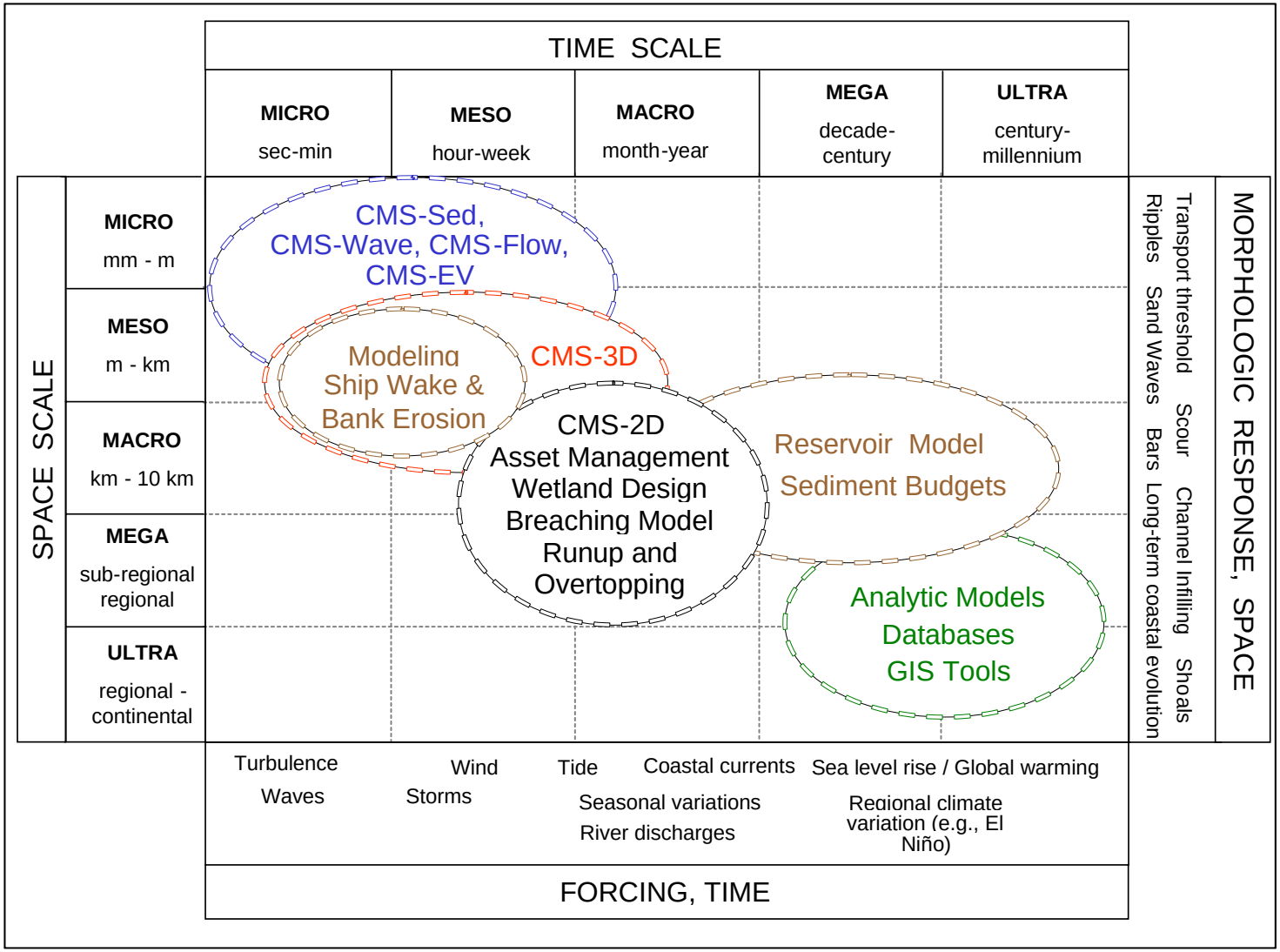
Benefits

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

CIRP – Two Focus Areas, 5-7 Work Units

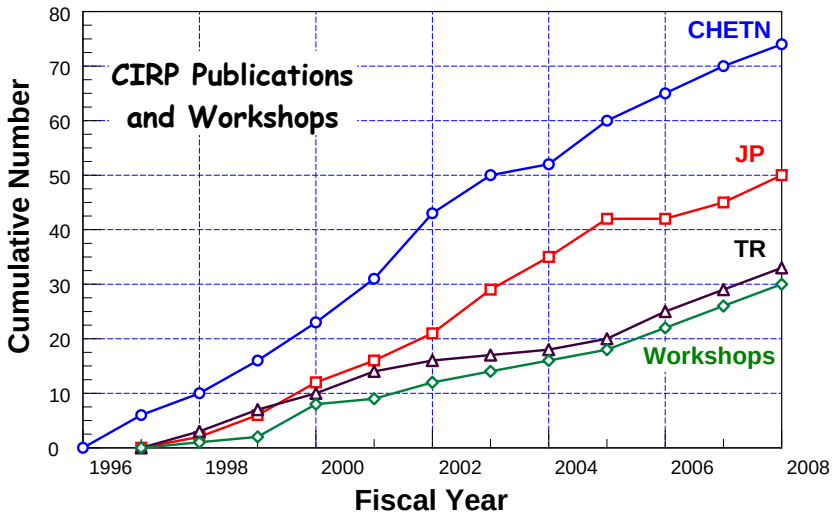


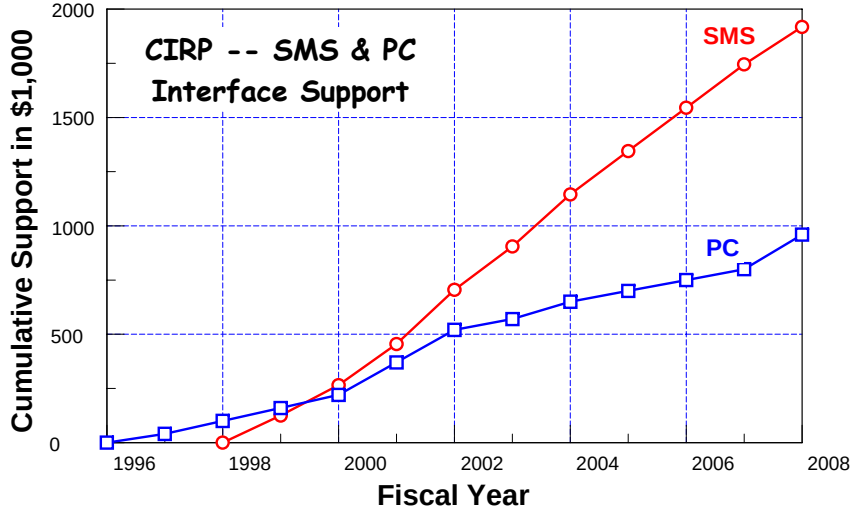
CIRP – Scales of R&D Coverage

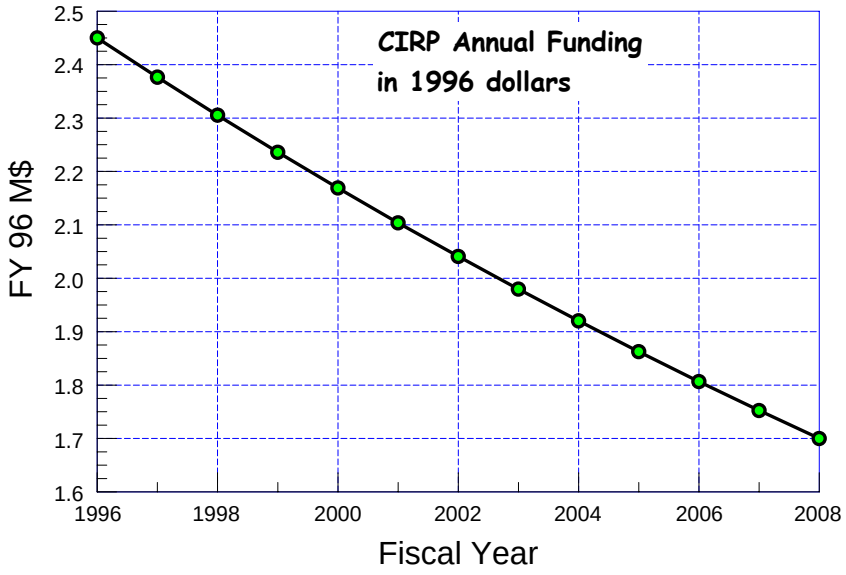


Quantitative Measures of Productivity

Metrics







Progression of Major (Selected) CIRP Technology-Transfer Workshops

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

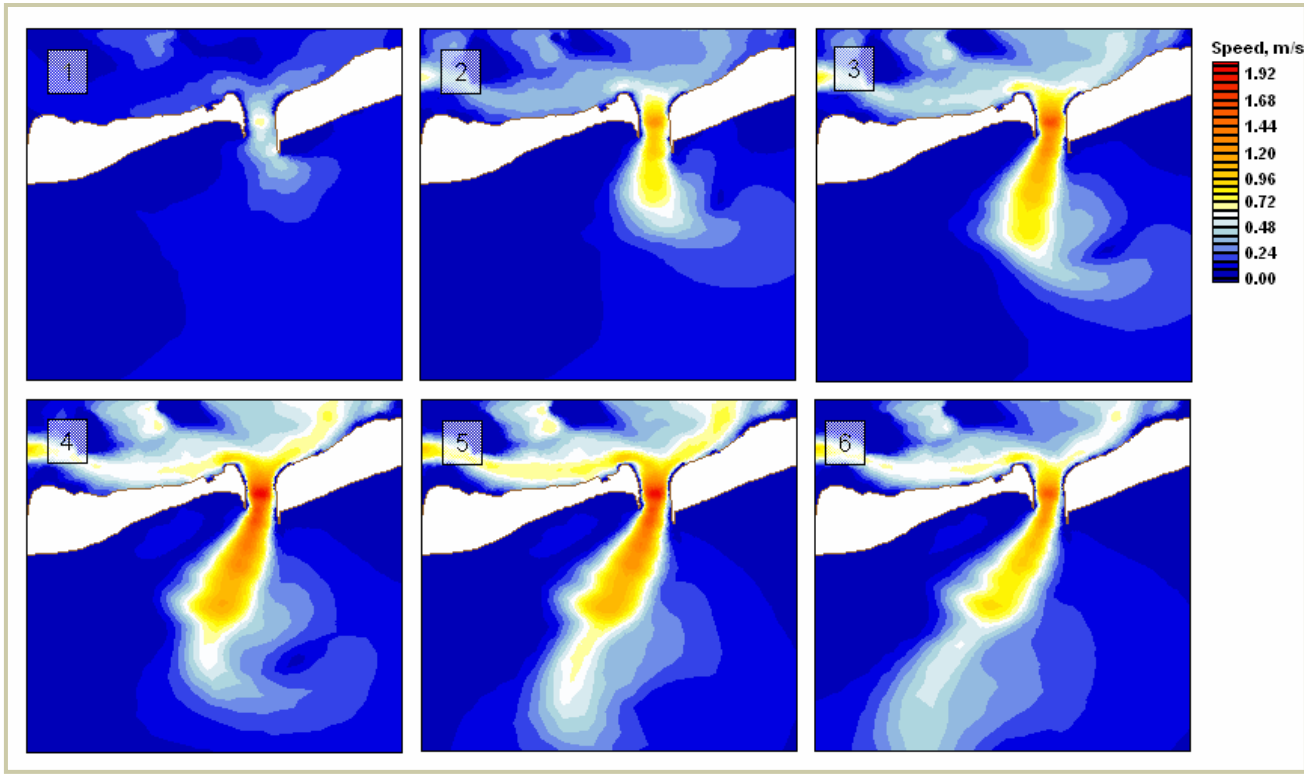
SAW: Cape Fear#, NC

NAO: Rudee Inlet, VA

# denotes deep-draft channel

Collaborative monitoring with Districts

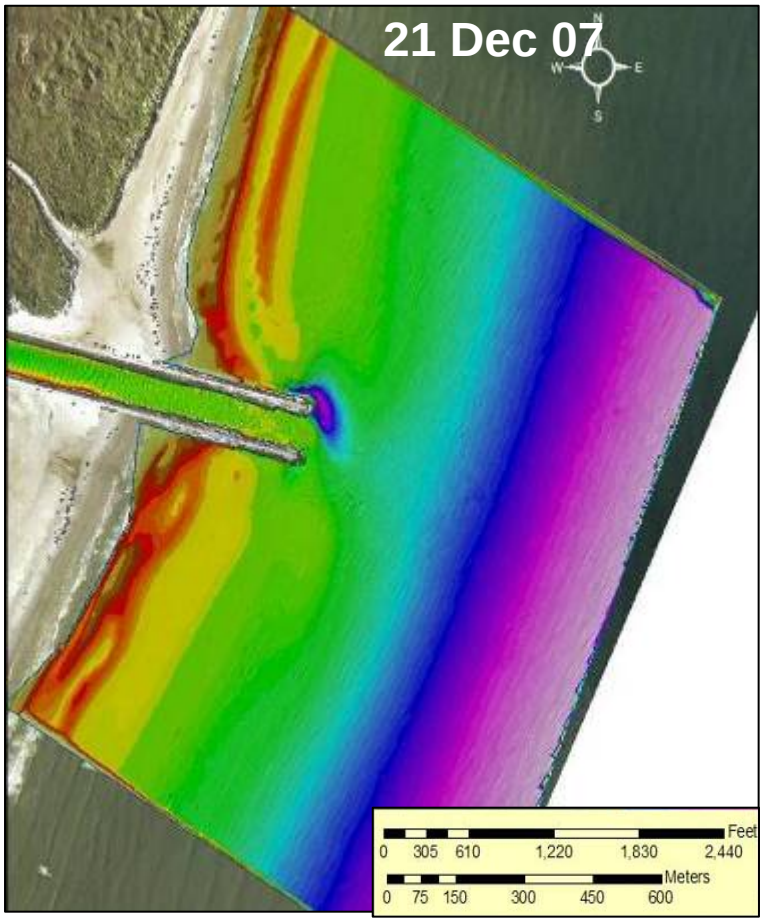
- Ebb jet migrates
- Navigation channel follows jet location
- Control migration by jetty configuration
- Reduce dredging by maintaining channel position
- **Partner: NAN**

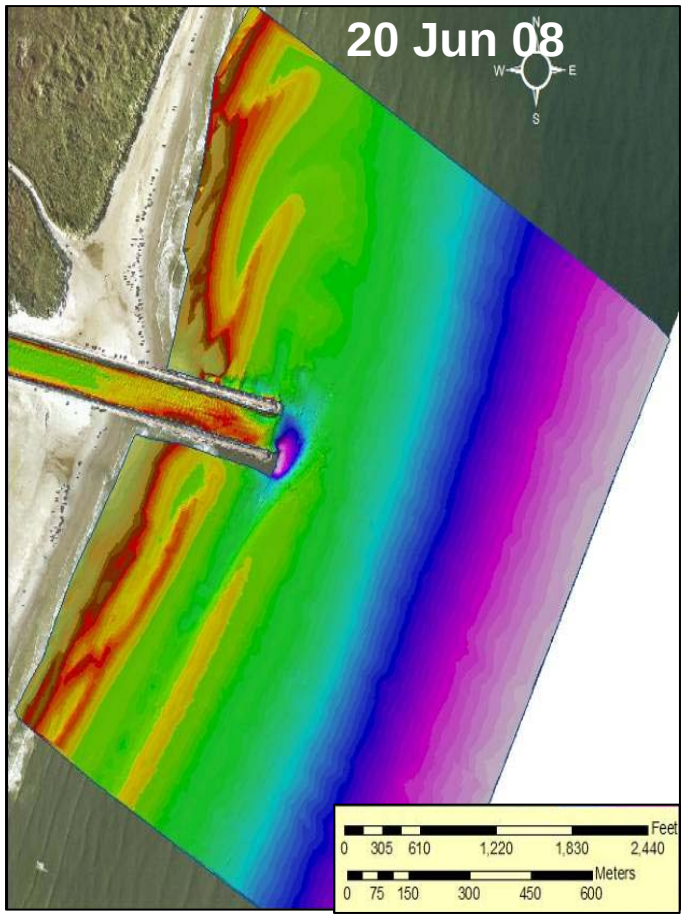


Shinnecock Inlet –Current at 1-hr intervals

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**

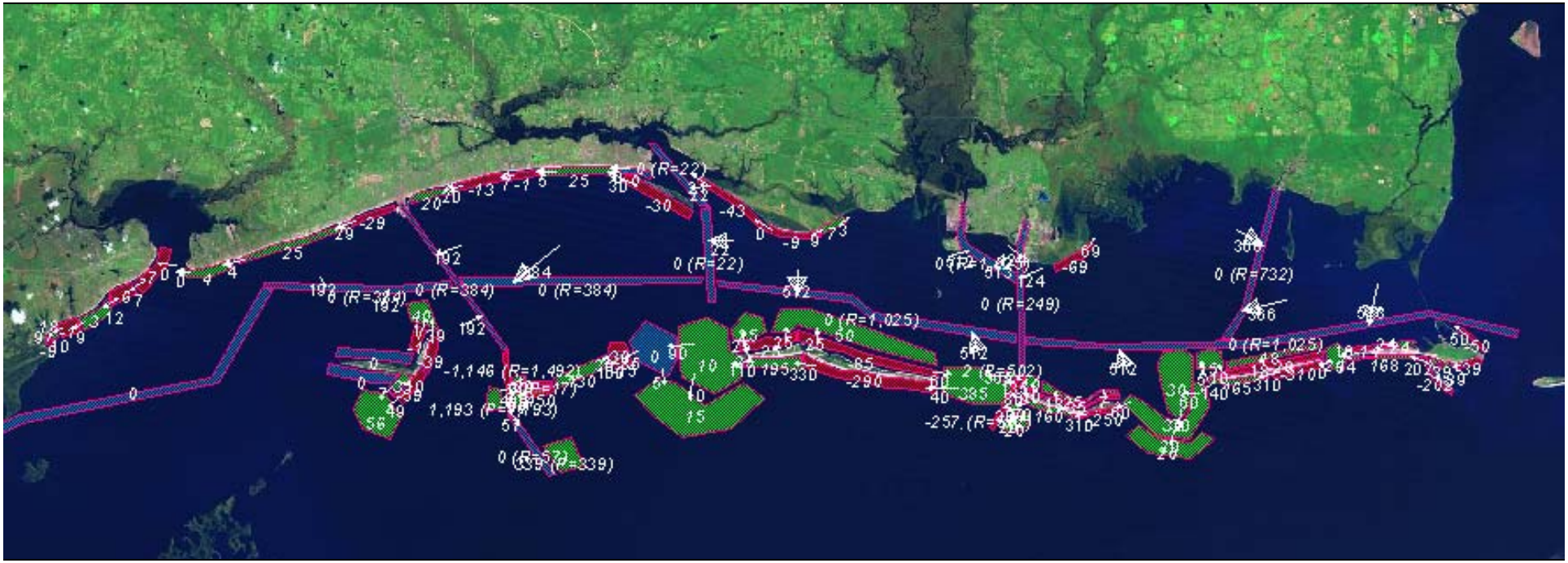




Depth, ft (MSL)

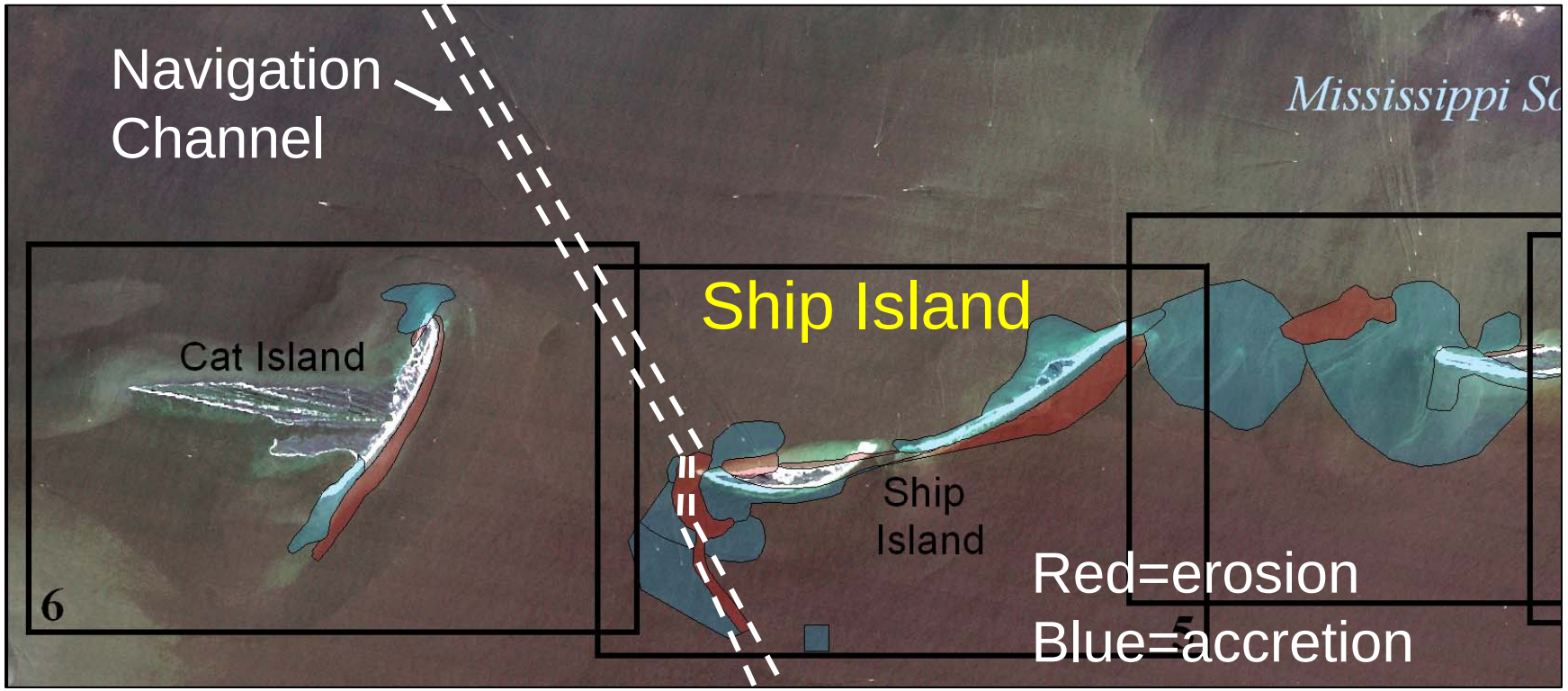
Sediment Budget Analysis System (SBAS)

- 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/



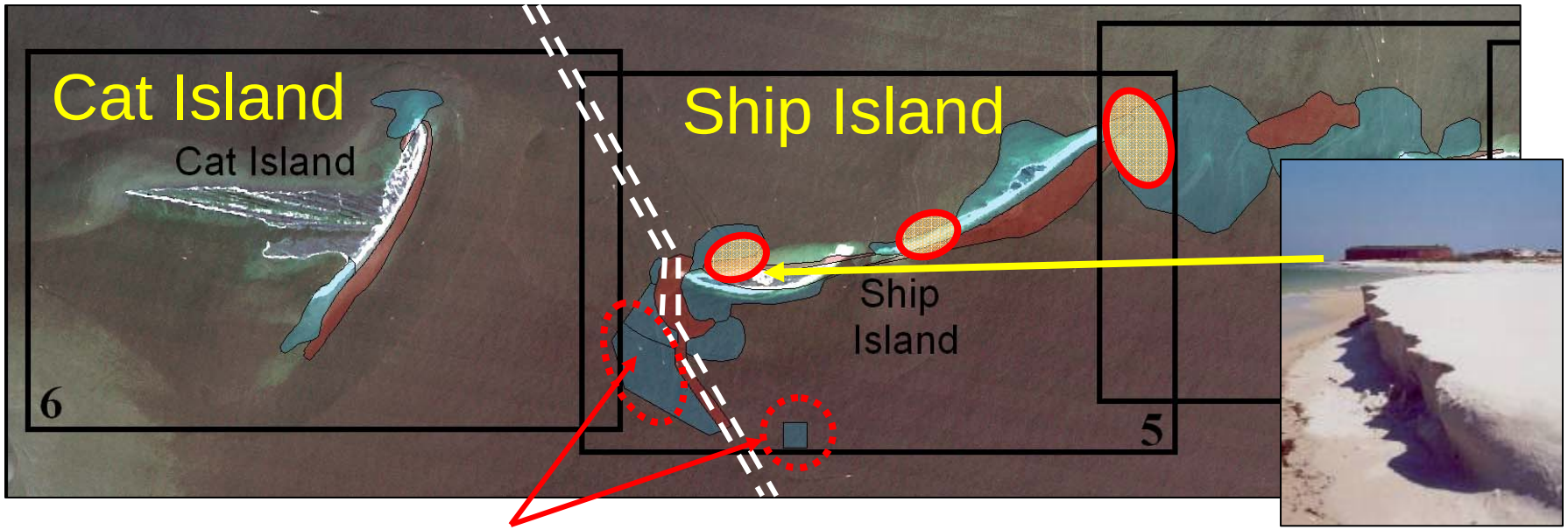
Sediment Budget Analysis System (SBAS)

- 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.

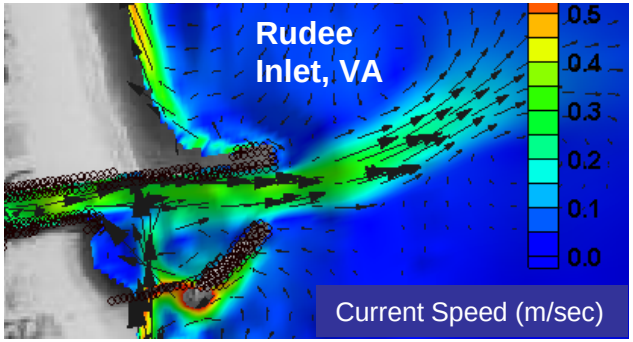
Coastal Modeling System (CMS)

CMS is a CIRP flagship product

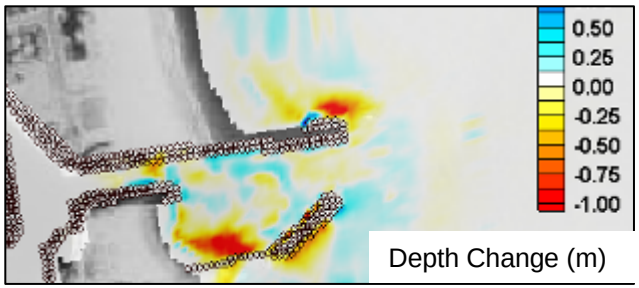
- **Interactive calculation of waves, current, sediment transport, and morphology change (shore term – storms, and long term – decades).**
- **Channels and jetties represented.**
- **2D version – Non-Equilib sediment Transport (NET), Rapid Assessment of Morphology (RAM).**
- **Represents sediment motion 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.***

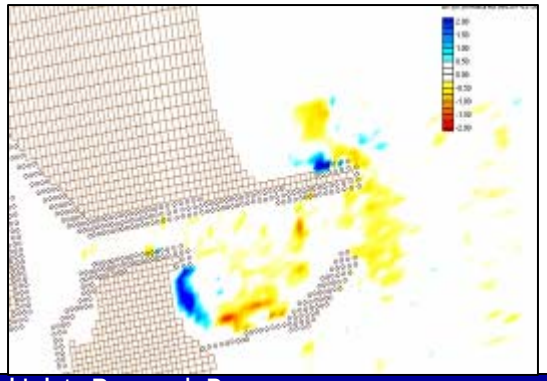
Sampling of CMS Applications & Partnerships

Wave & Tide-driven current

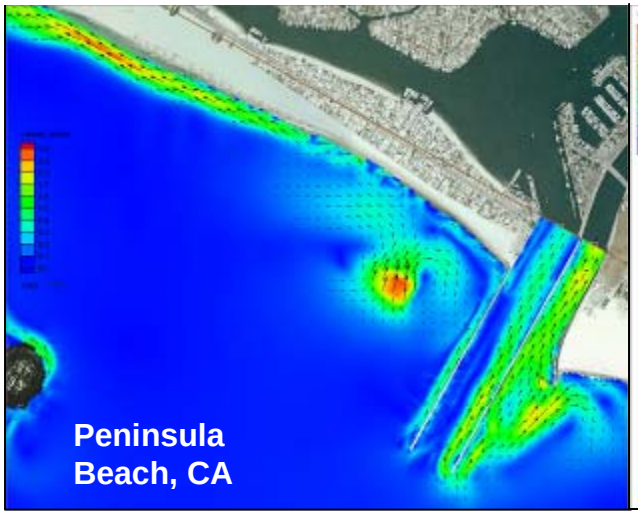


Morphology Change

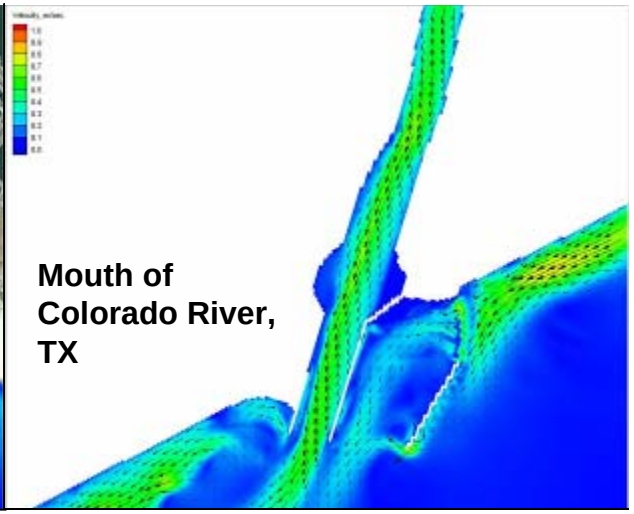


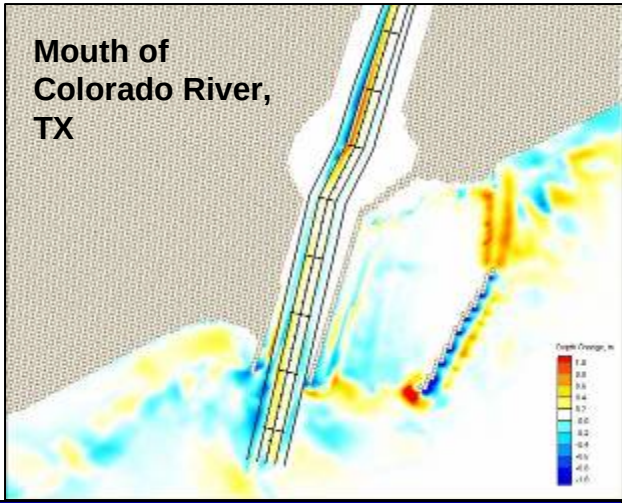


Wave-driven current



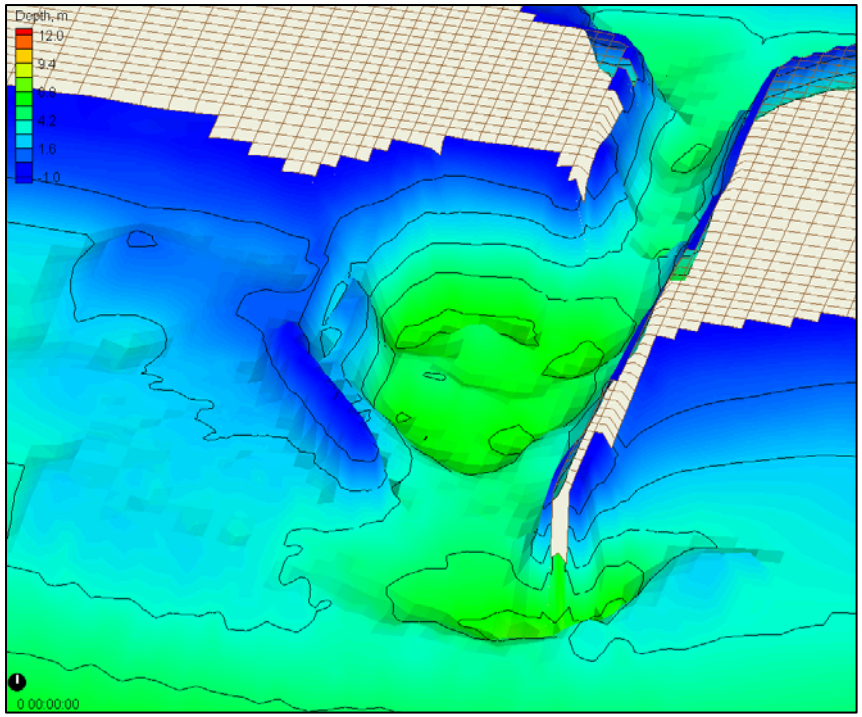
Wave & Tide-driven current





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).

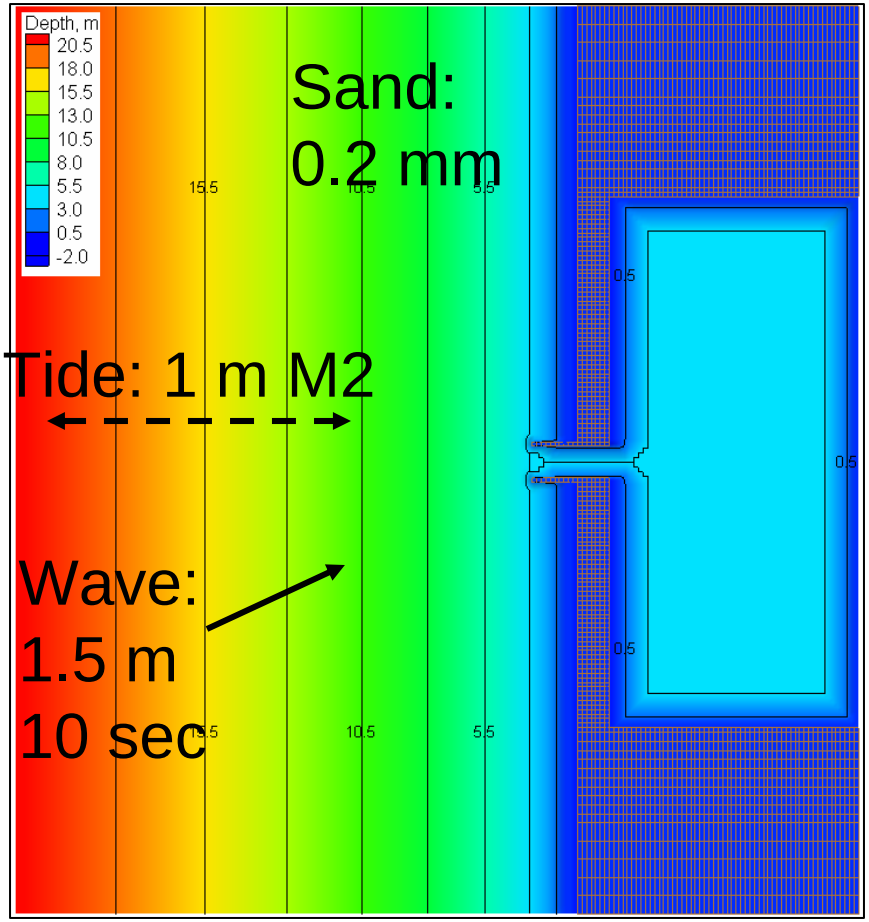


Rudee Inlet, VA, weir jetty (on south/left)

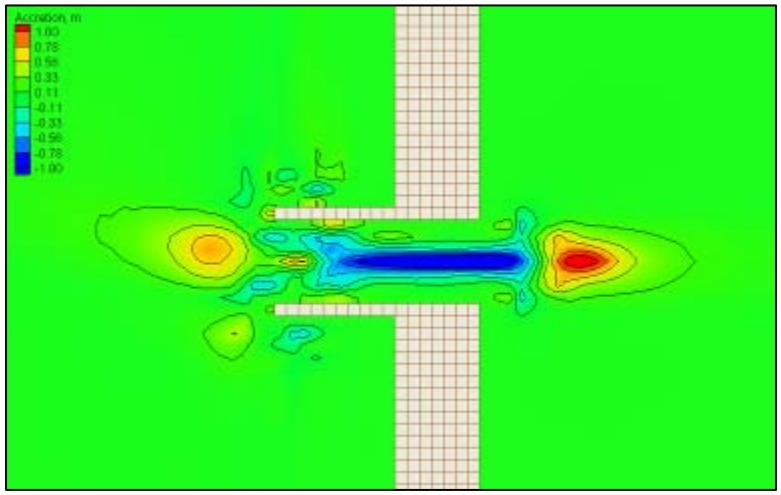
Morphology Change

NET removes unnatural extremes

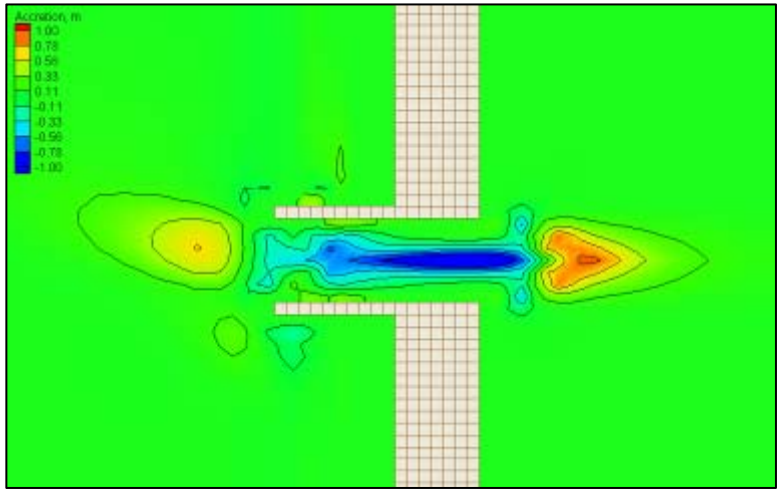
Idealized Inlet Grid



Equilibrium transport, 6 days

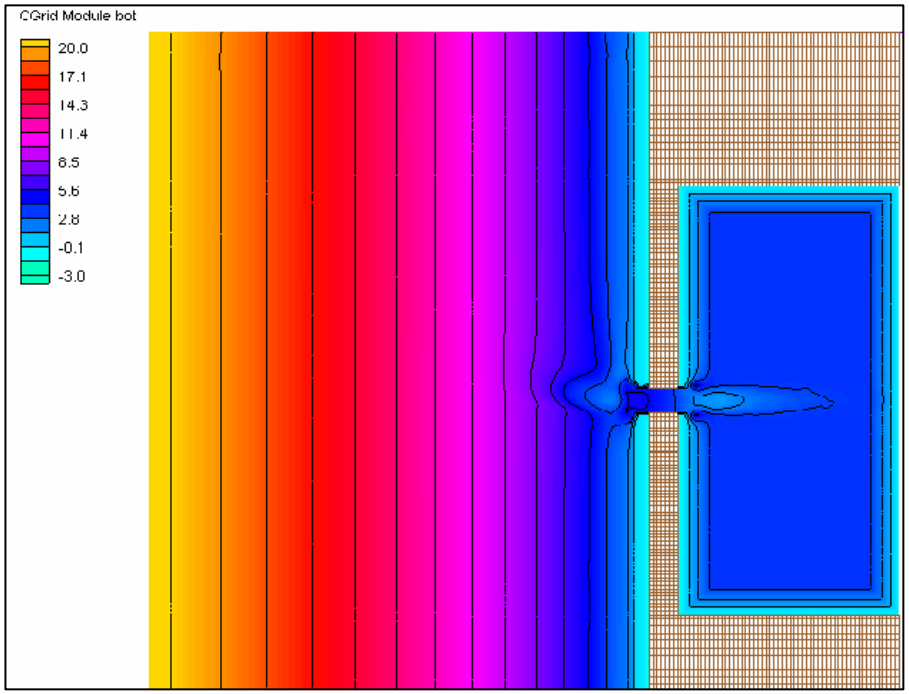


NET, 6 days



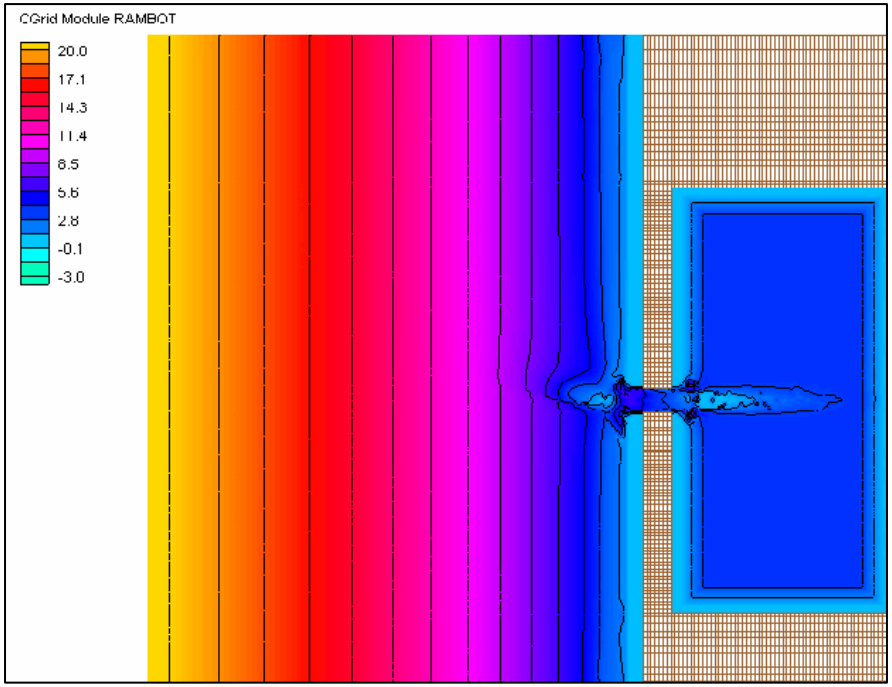
Rapid Assessment of Morphology
RAM Test

CMS, 60 Days



3 Days CPU time

CMS-RAM, 60 Days

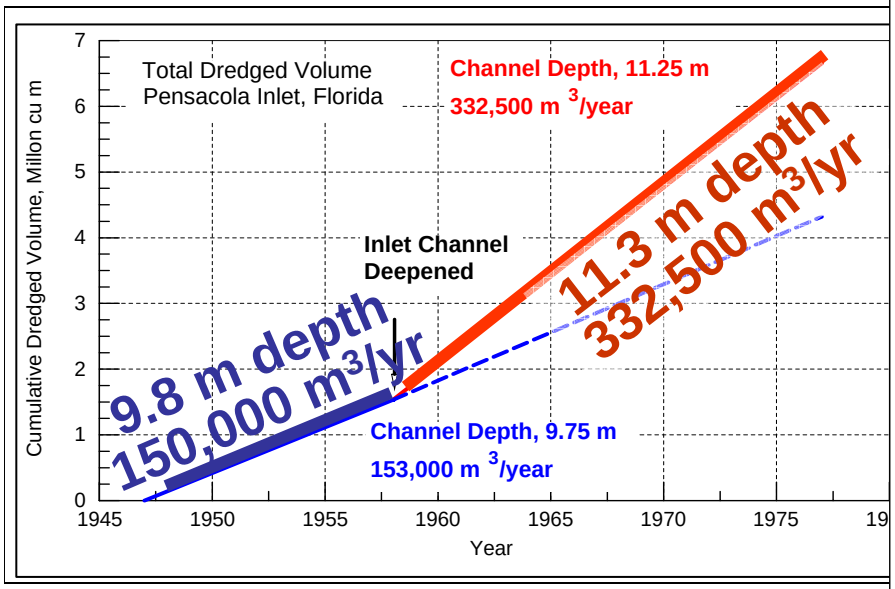


1 minute CPU time

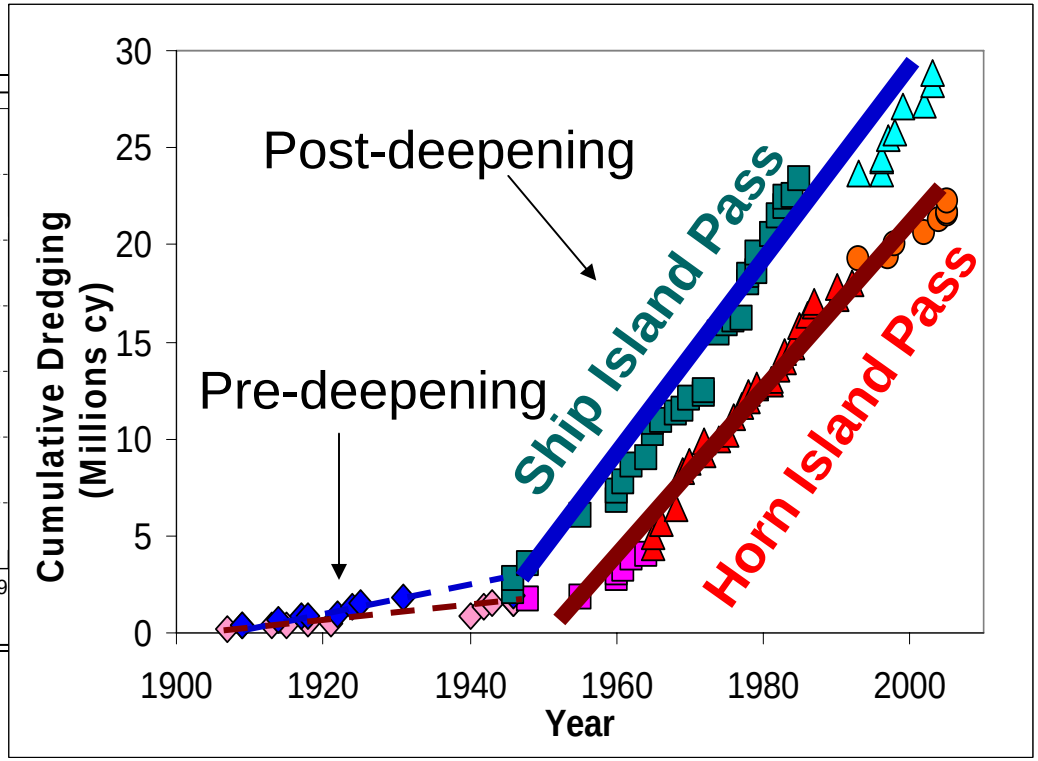
Channel Infilling

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

Pensacola Pass, FL

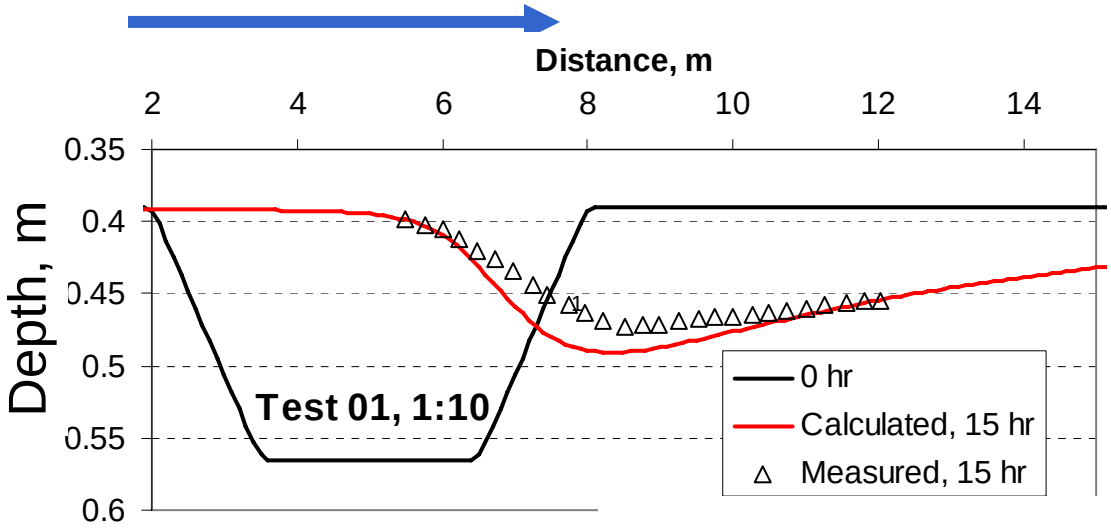


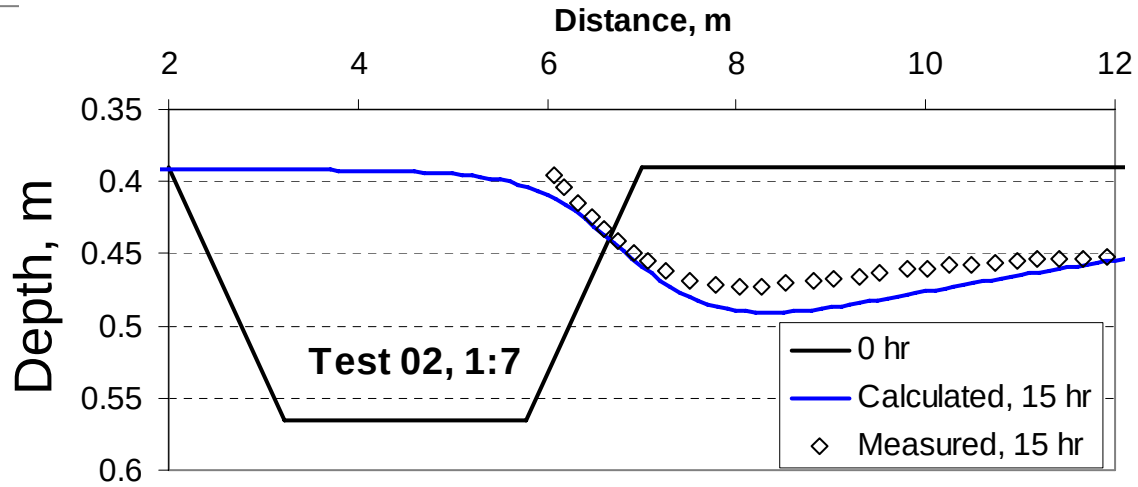
Ship and Horn Island Pass, MS



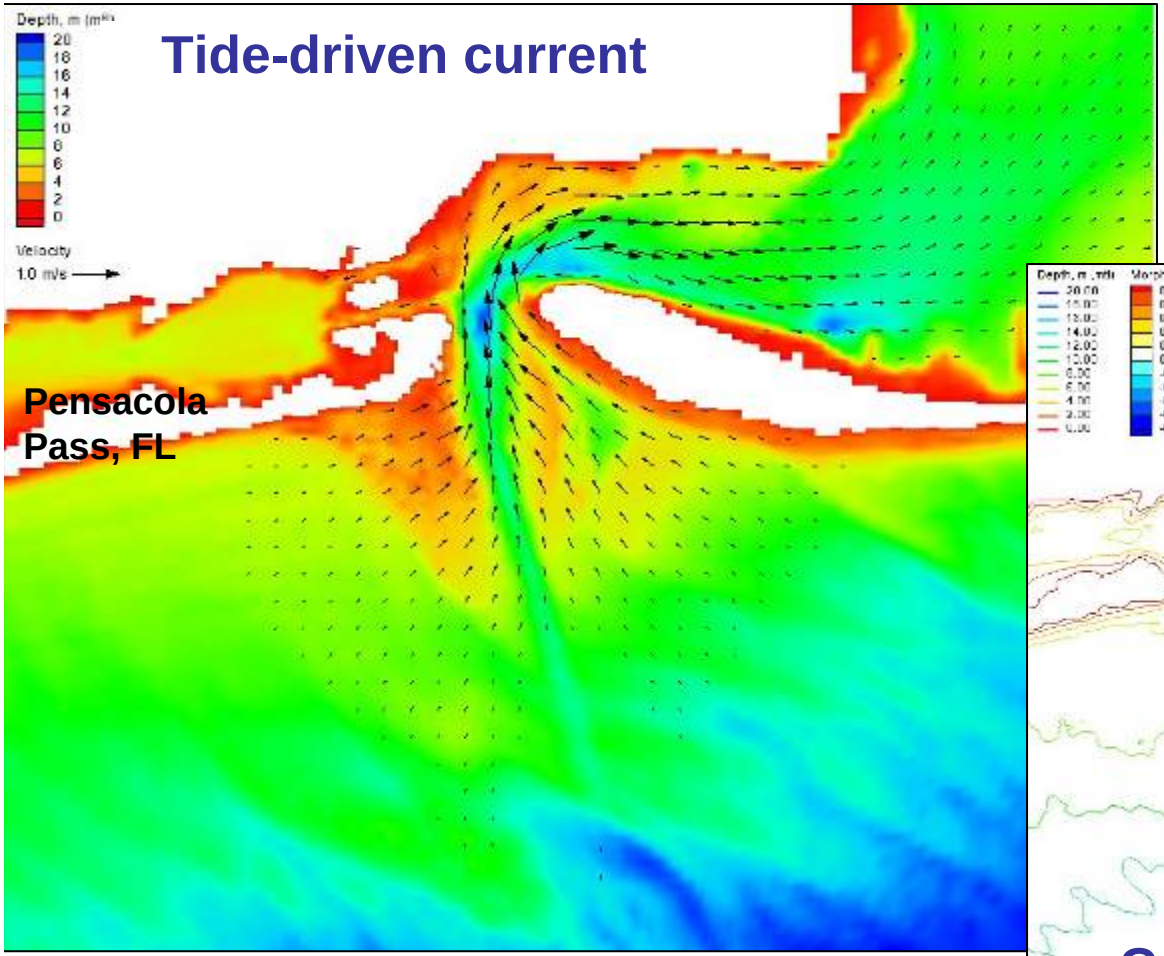
Channel Infilling
CMS Comparison with Laboratory Data

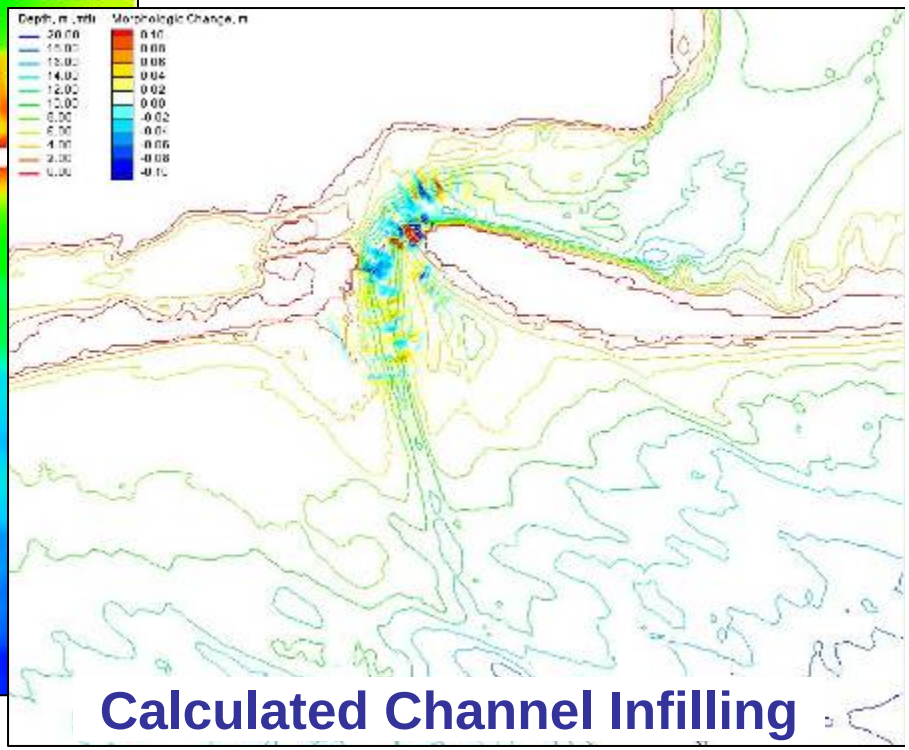
Extreme Longshore Current (for lab), 0.5 m/sec



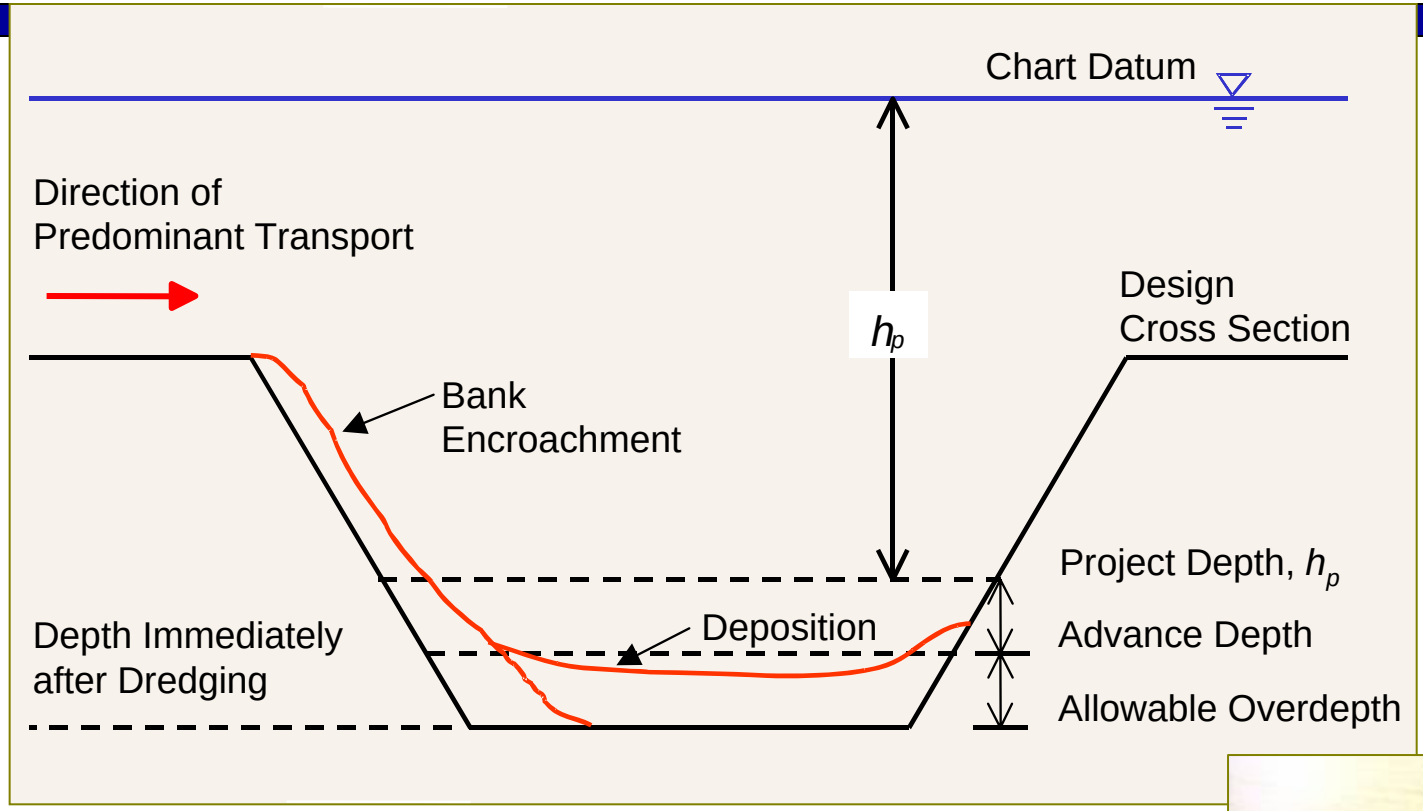


Channel Infilling
CMS Application to Pensacola Pass





Analytical Method for Channel Infilling

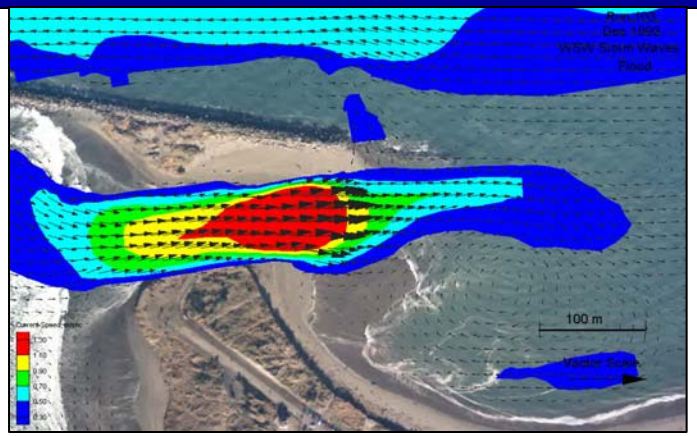


Barrier Island Breaching and Jetty Breaching

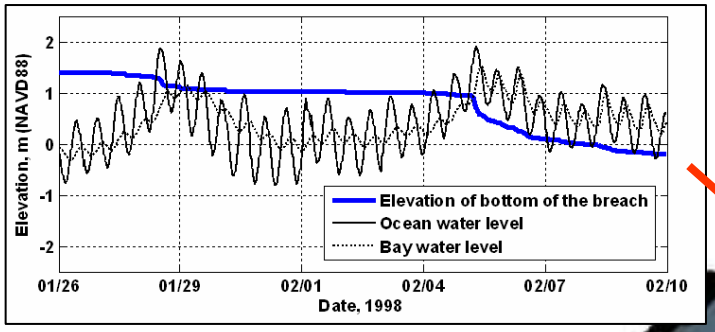
- Breaching near and at jetties is increasing with length of service of inlets
- Breaching has occurred at Grays Harbor, Coos Bay, Matagorda Ship Channel, and Moriches Inlet, and it threatens other locations

Barrier Island Breaching

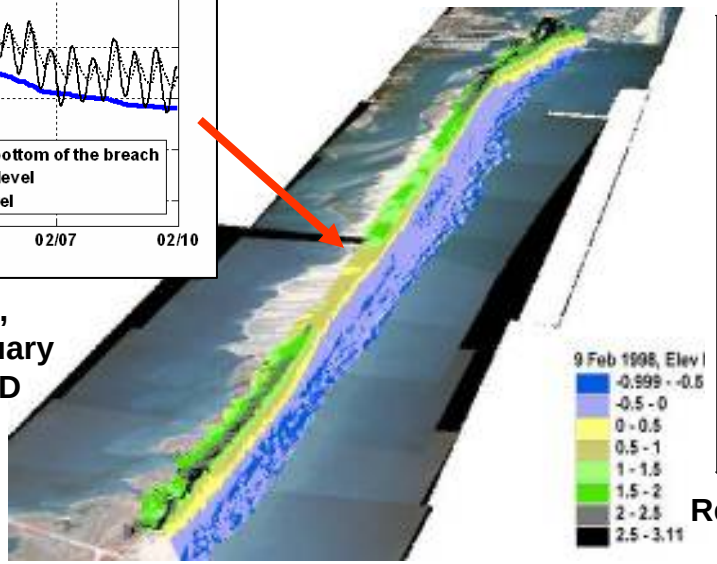
- CIRP is developing two different technologies to quantify breaching
  - One-Dimensional Regional Breaching Model (with SWWRP)
  - Two-Dimensional meso-scale module incorporated into CMS

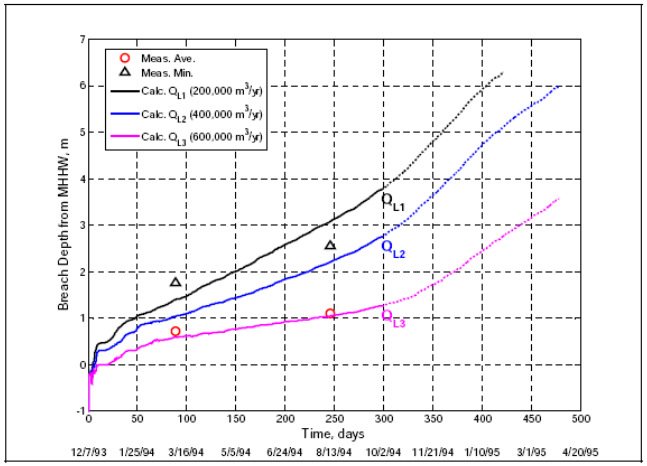


CMS, Calculated current velocity in breach of Dec 1993, Grays Harbor, WA



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

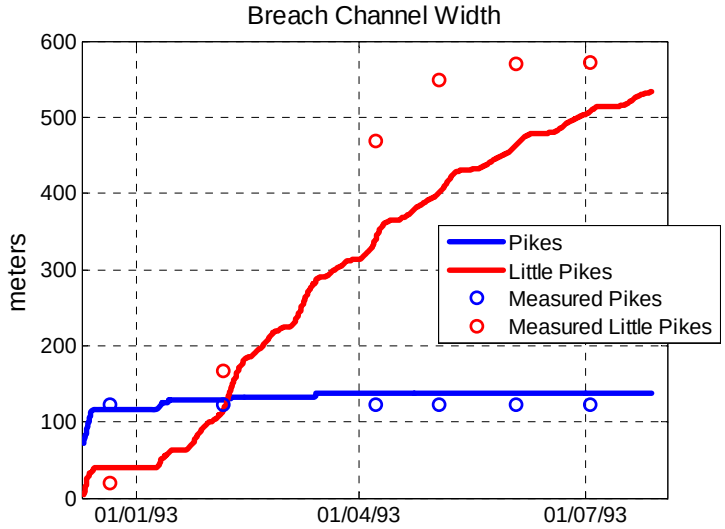




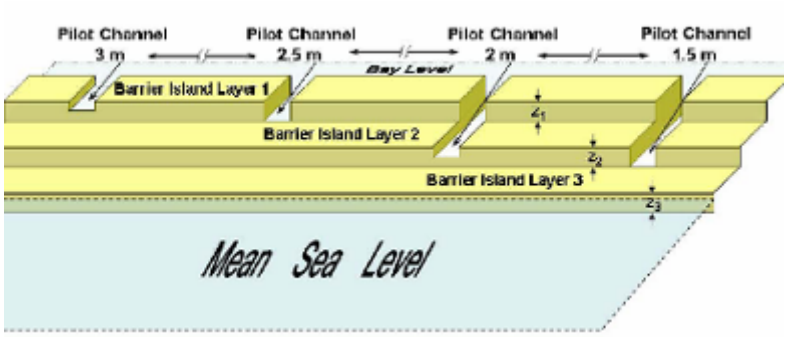
Regional Breaching Model, Calculated breach depth and observation, Grays Harbor, WA

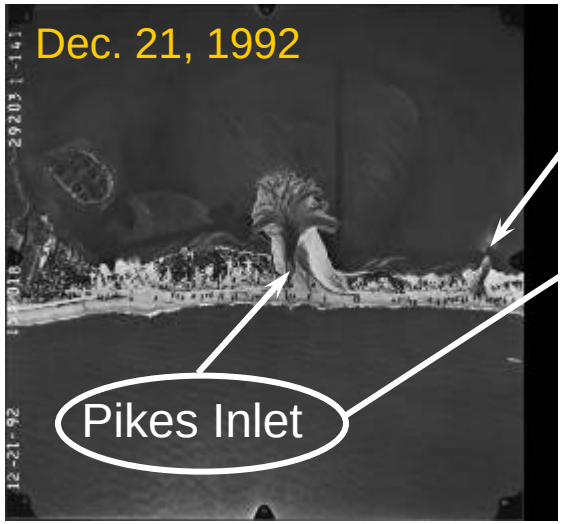
Regional Breaching Model

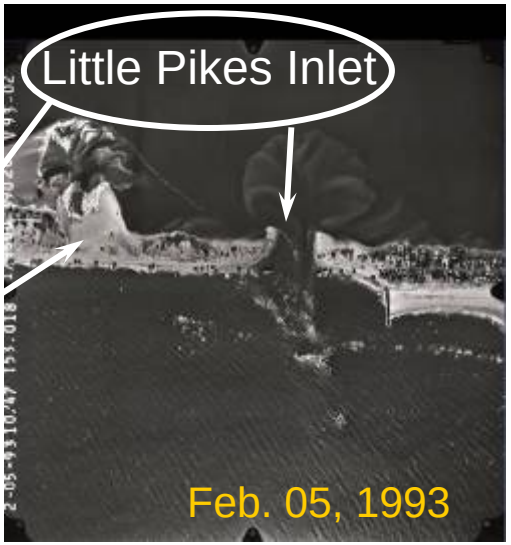
- Quantitative prediction of breach width and depth.
  - Incorporate our expertise with inlets. Most breach widening occurs after storms during normal tidal flow.
  - Include channel infilling by longshore transport, wave-current interaction in the channel and overwash prior to breaching.



2.5 mile East of Moriches Inlet



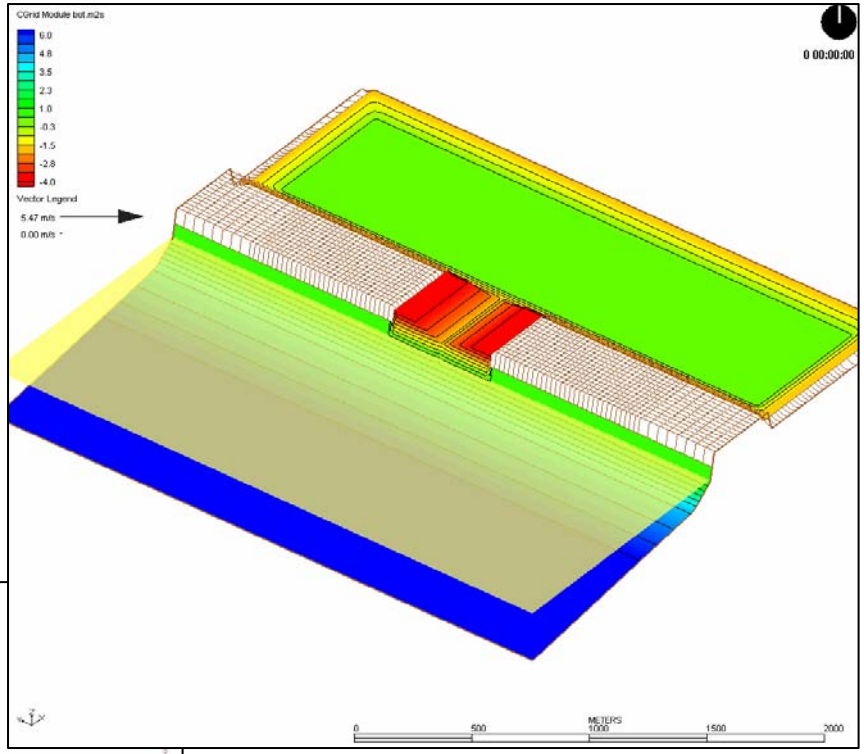


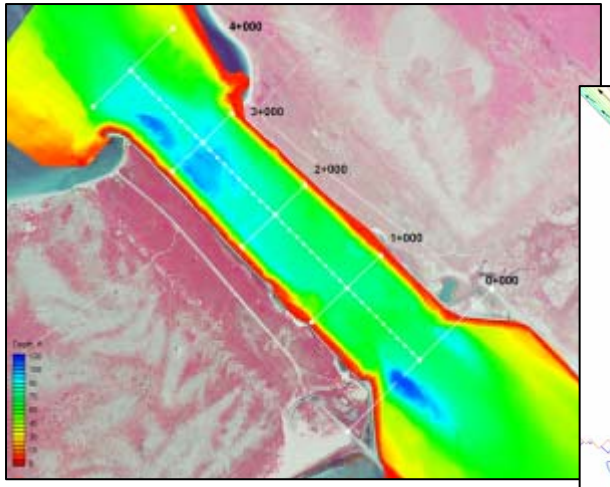


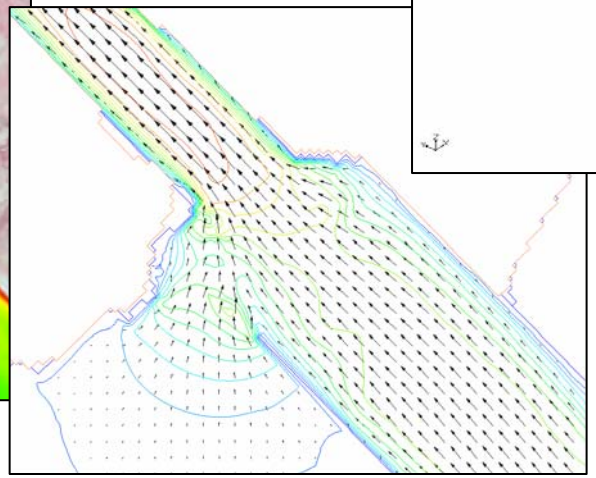
Breaching Module in CMS

- 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





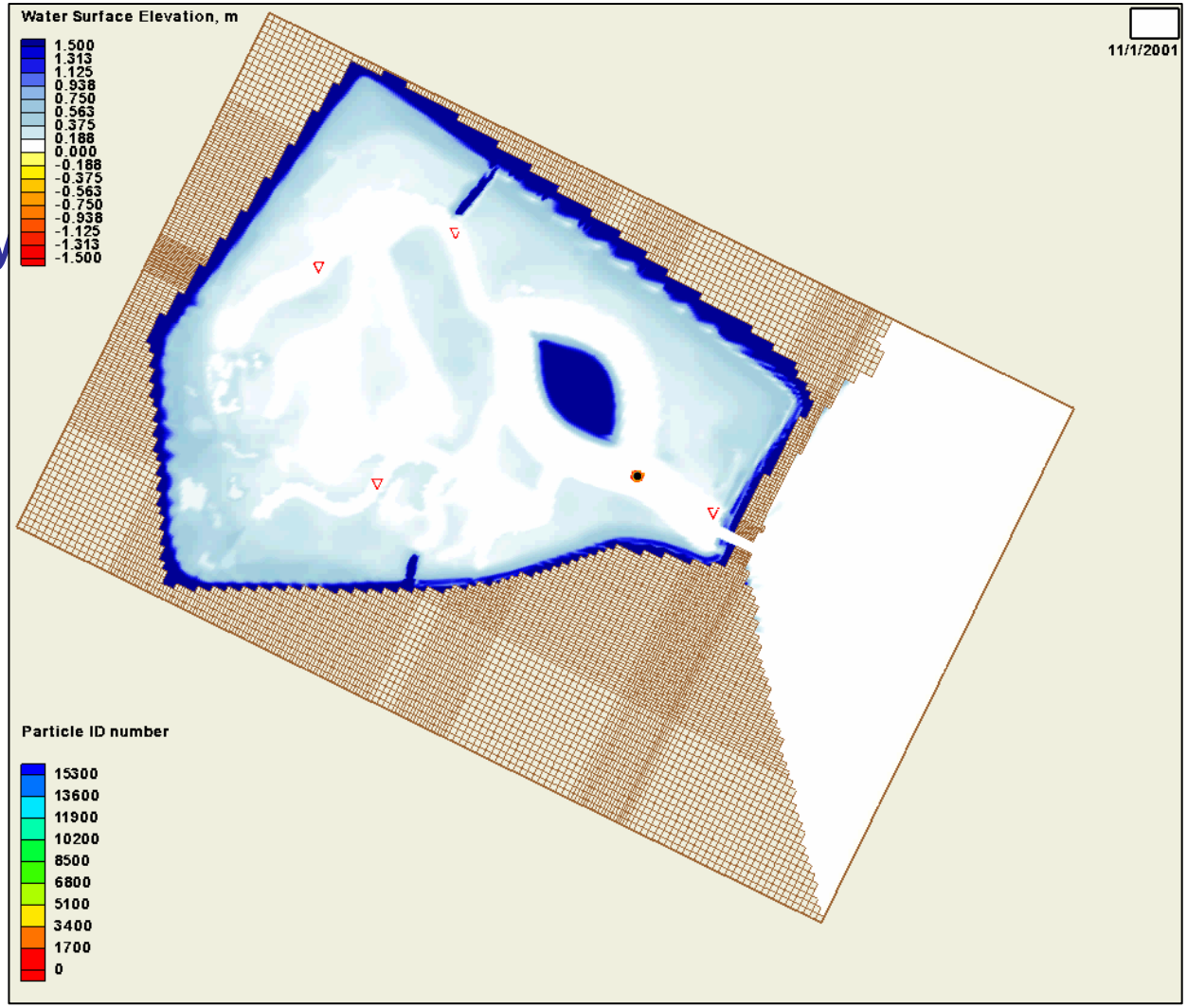


Matagorda Ship Channel Entrance, TX

Particle Tracking Model (CMS-PTM)

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

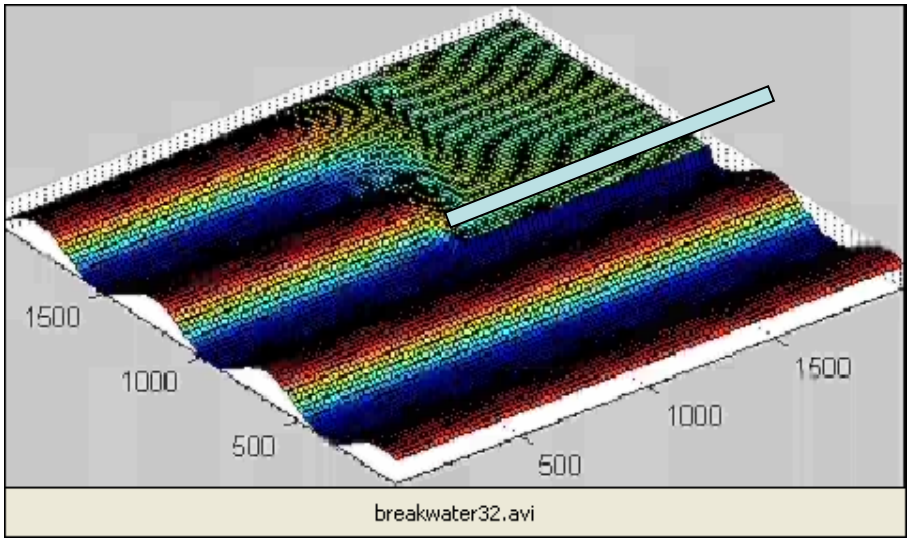
Animation: ~ 2,600 particles injected at 12-hr intervals. Particle color goes from red to blue depending on the its number (at time of release).

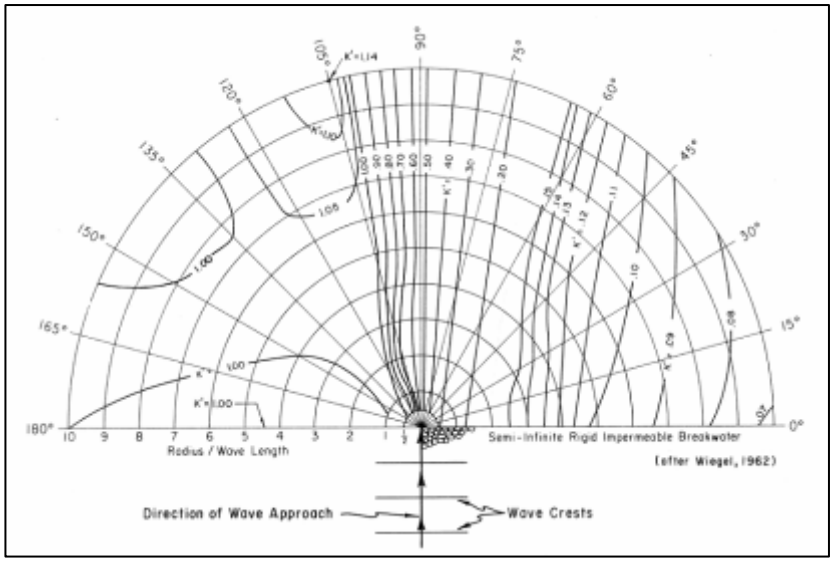


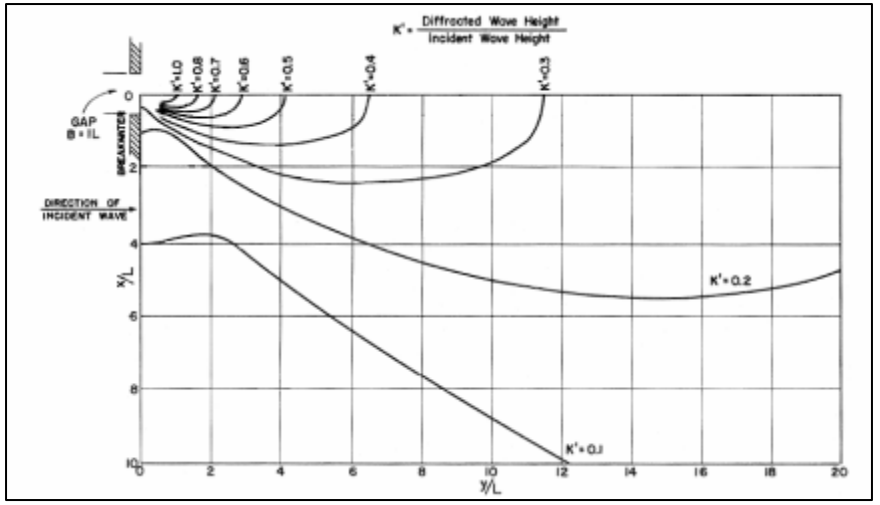
Animation of CMS-PTM to Poplar Island, MD – 3 days

Jetty and Breakwater Wave Modeling – *Diffraction*

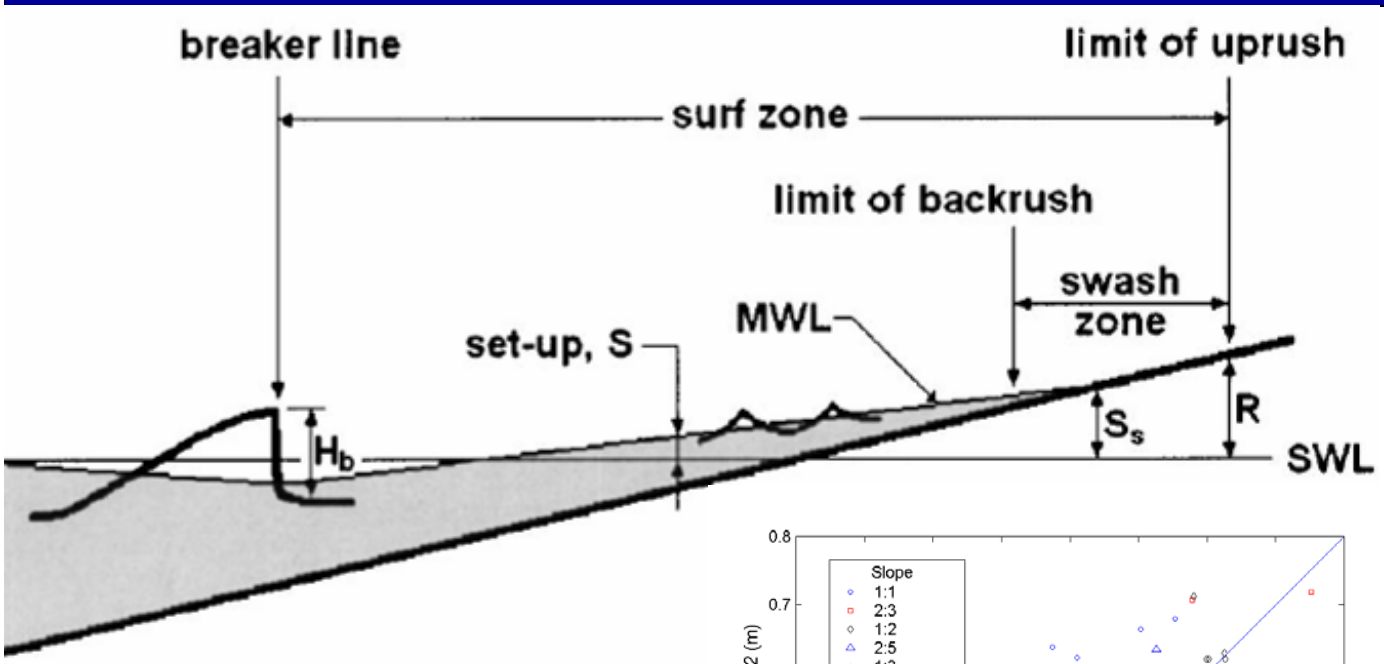
Humboldt Bay, CA



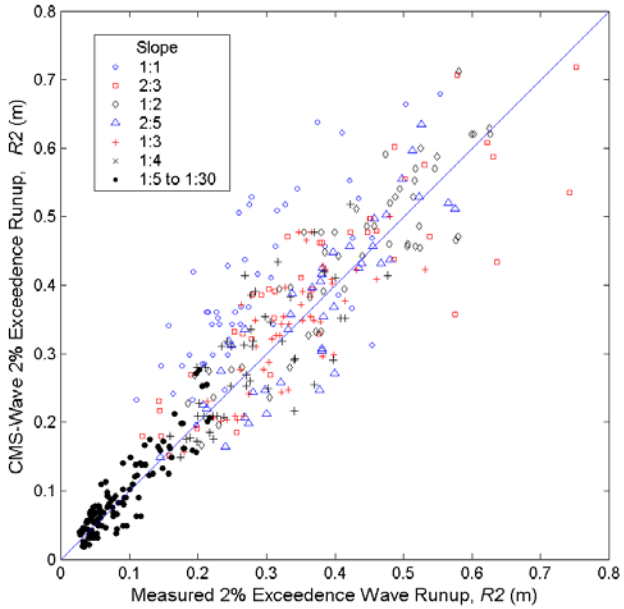


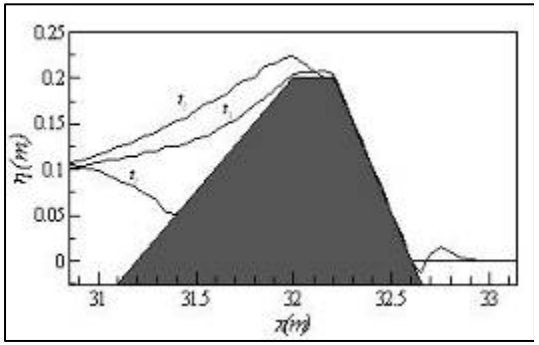


Jetty and Breakwater Wave Modeling
Run-up on Structures & Beaches



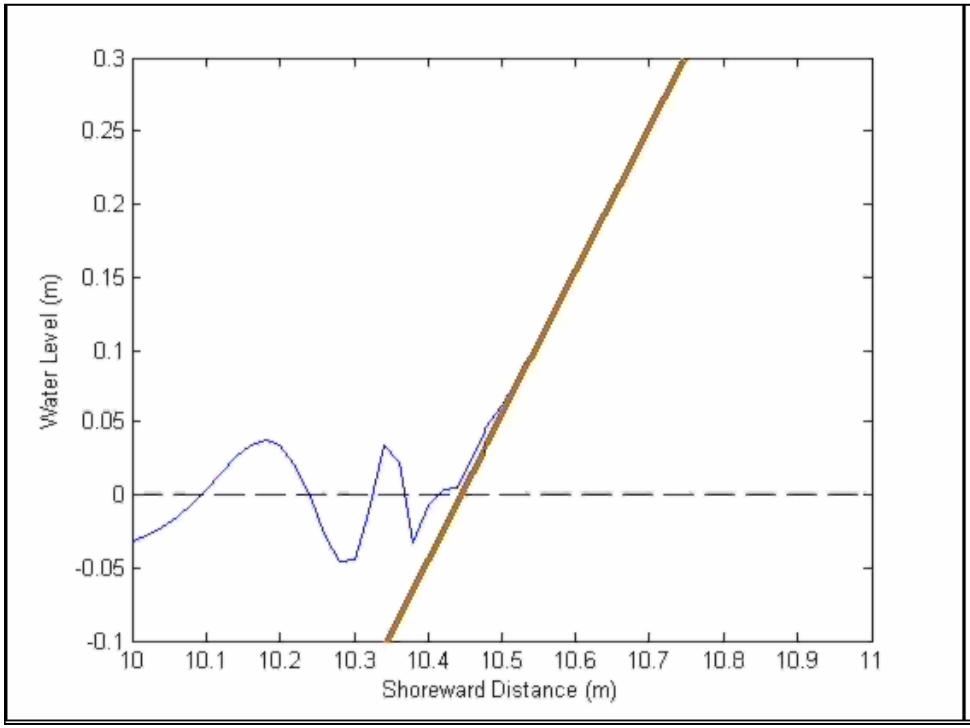
- Wave run-up
- Wave overtopping
- Wave transmission



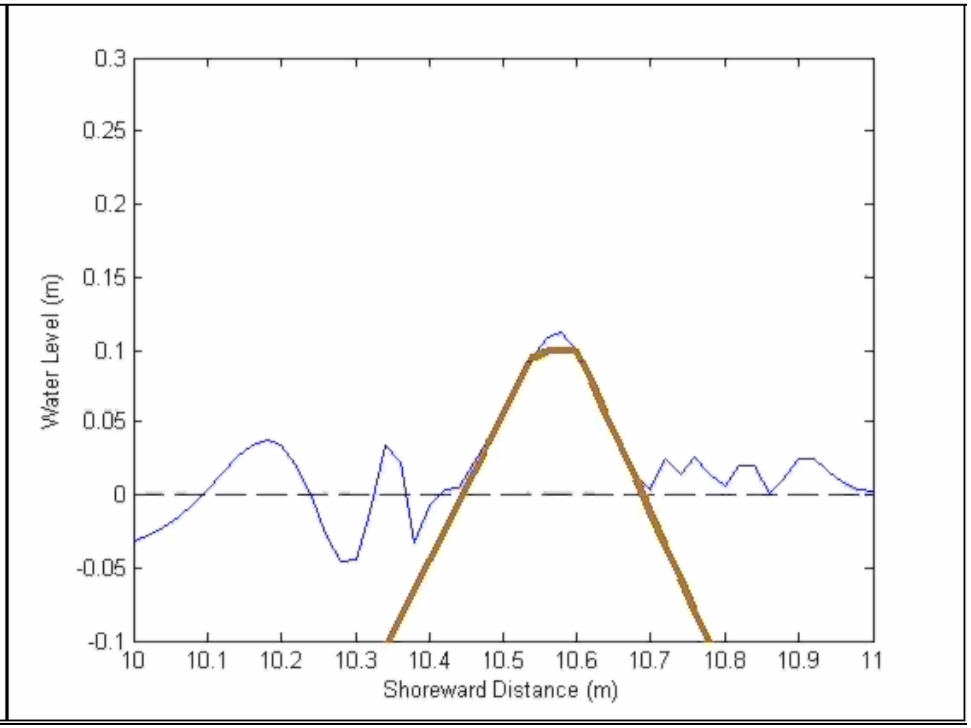


Calculated Run-up and Overtopping

Run-up



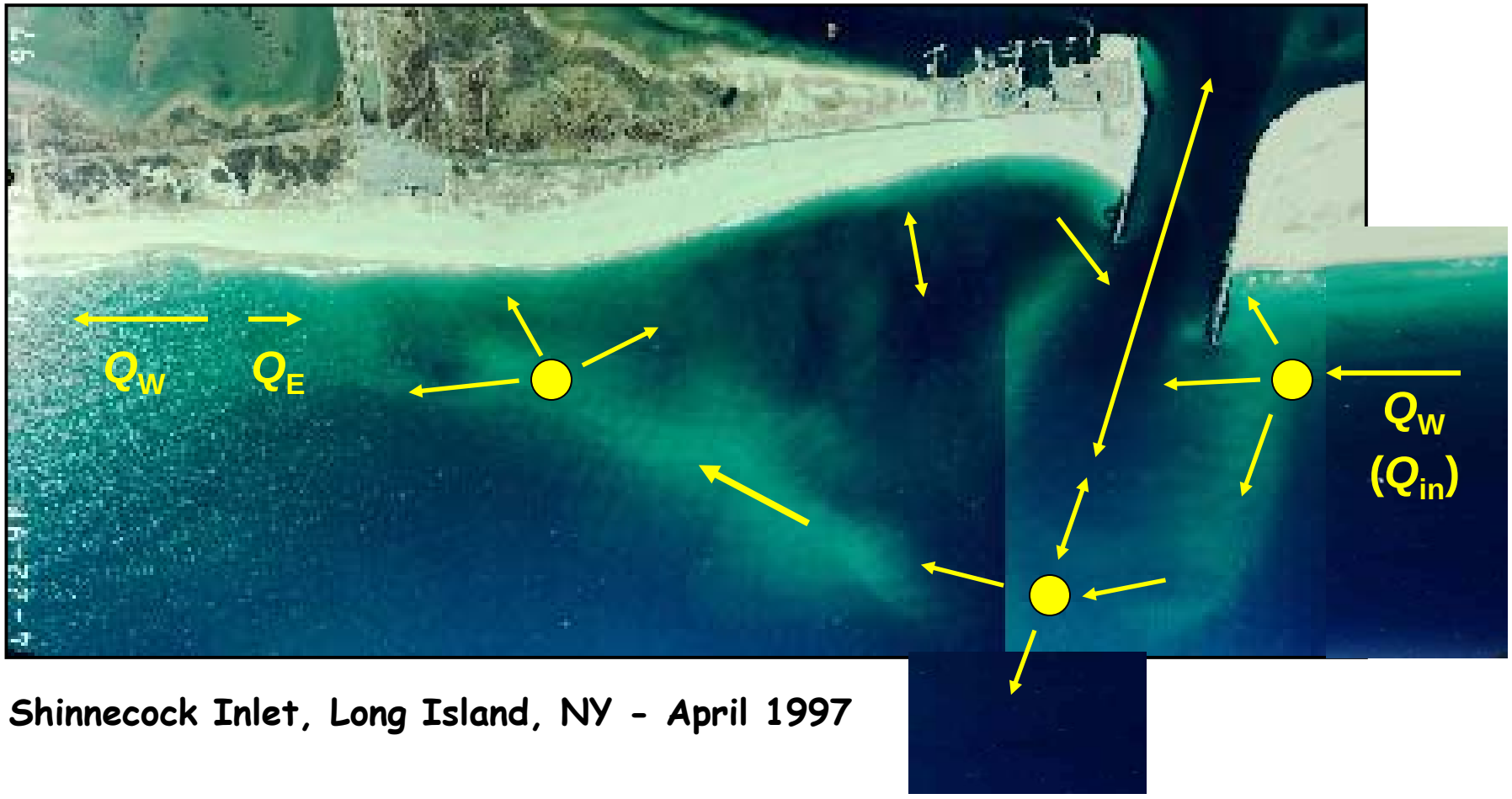
Overtopping



Inlet Reservoir Model
(long-term morphology change)

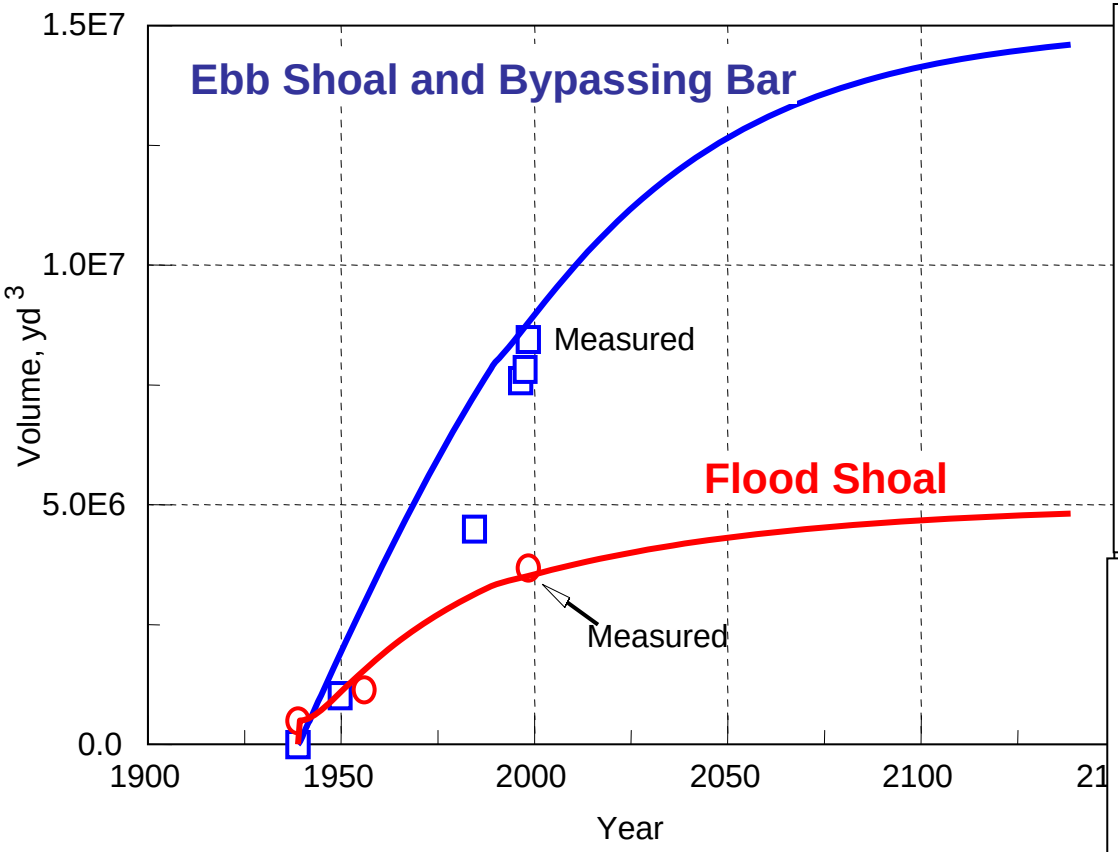
- Means of calculating natural sand bypassing, consequences of accessing ebb & flood shoals as borrow sites, recovery of shoals, and similar.
- Tool for evaluating engineering consequences from decades to centuries.
- Widely used – required by State of Florida for new inlet management plans; applied 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.

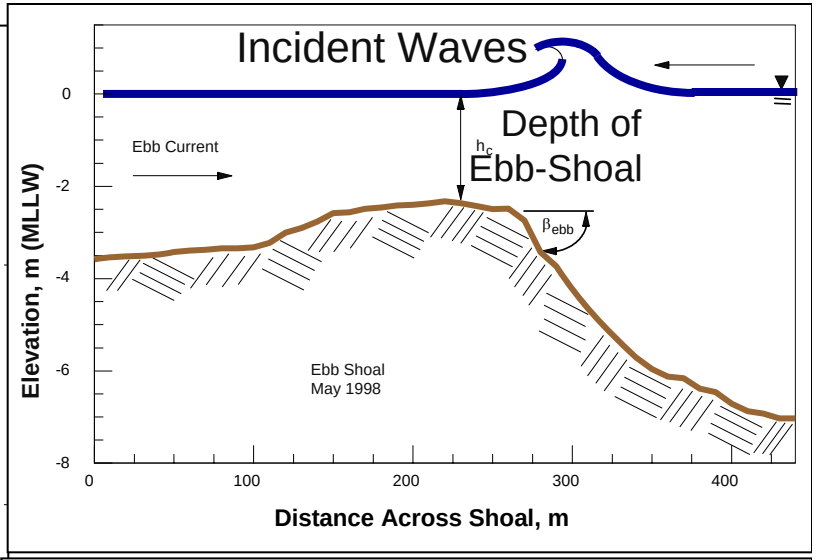
Inlet Reservoir Model: Long-term Bypassing and Shoal Development

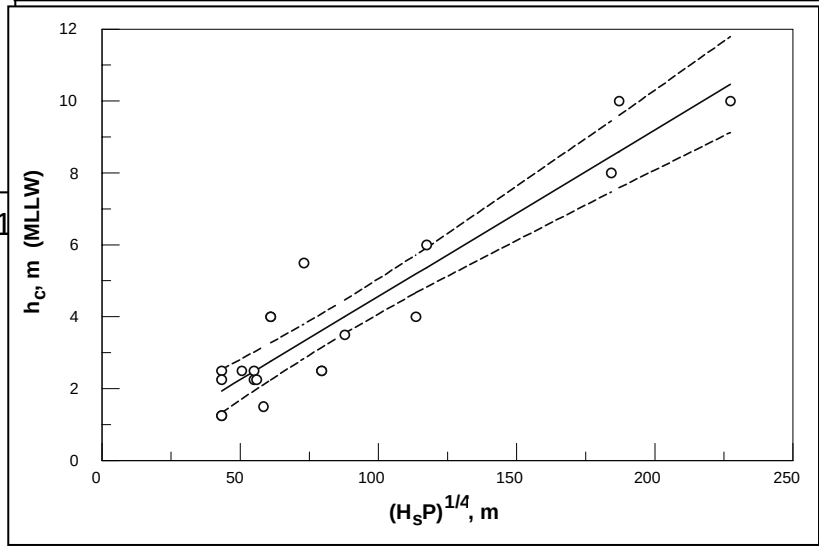


Shinnecock Inlet, Long Island, NY - April 1997

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)**

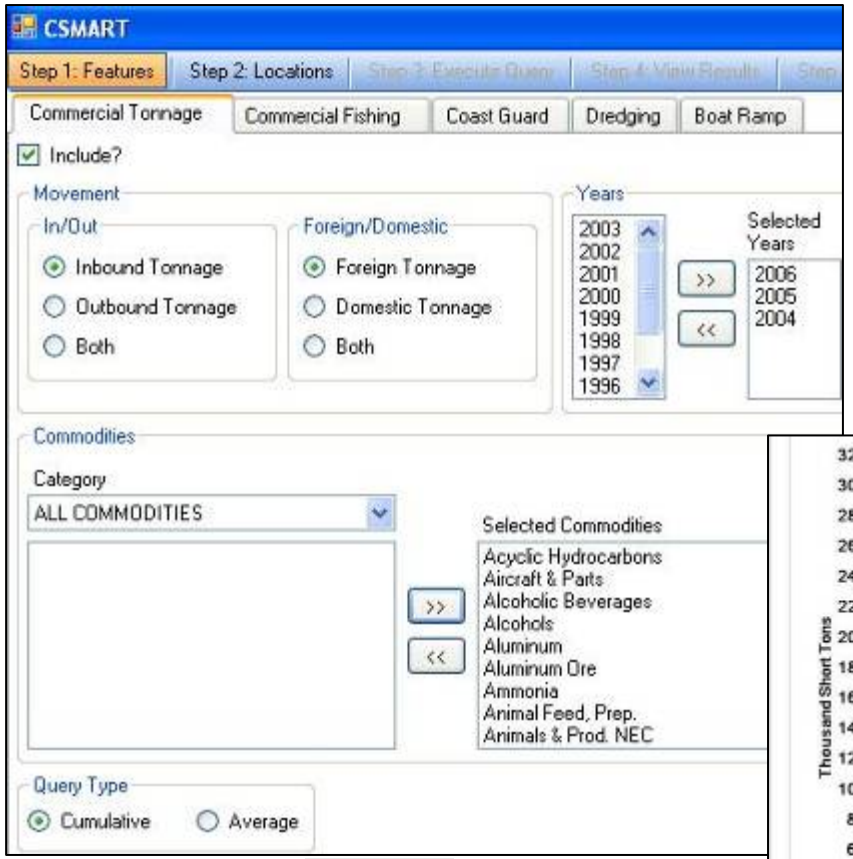
- **Project cost history:**
  - **USACE dredging records (NDC)**

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

- **Environmental metrics TBD**

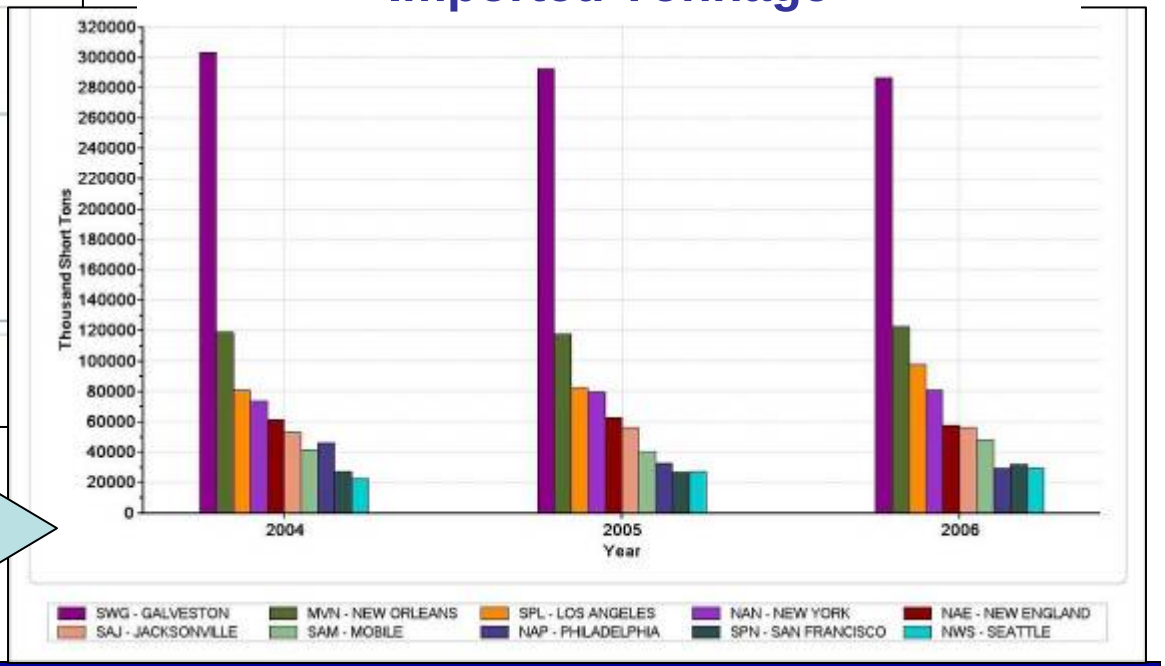
CSMART Example –Tonnage Supported

CSMART User Interface



- **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



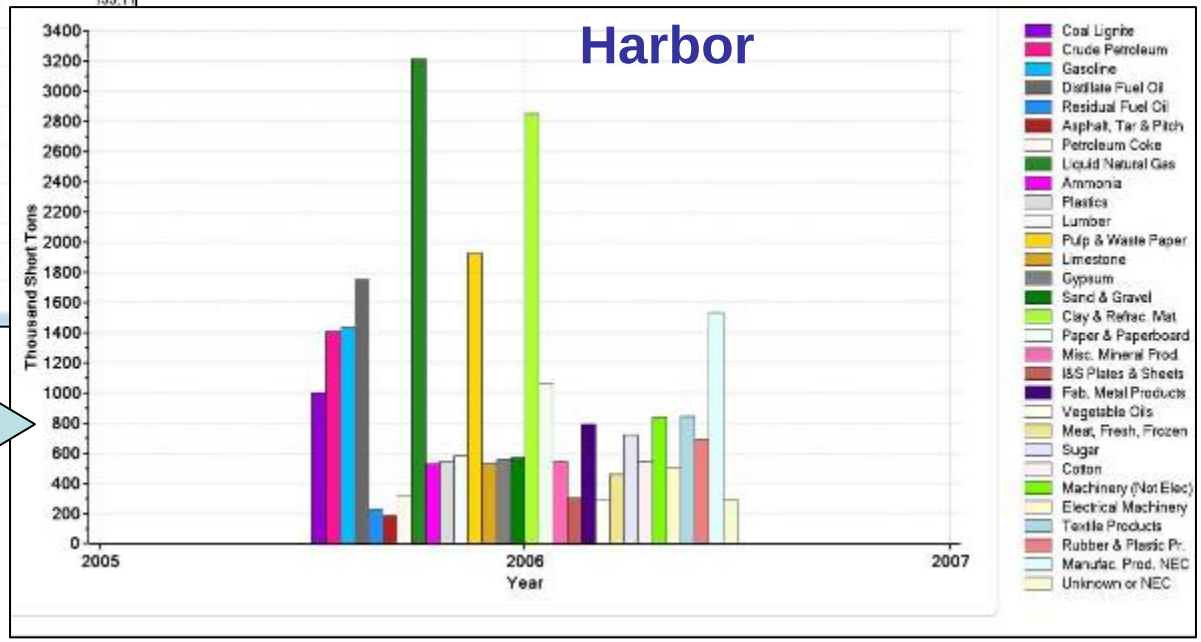
CSMART Example – Tonnage Breakdowns

CSMART User Interface

State		Project	Structure	Thousand Short Tons
LOUISIANA	1	SOUTHWEST PASS	SOUTHWEST PASS EAST JETTY	1,037.25
			SOUTHWEST PASS WEST JETTY	
TEXAS	2	GALVESTON ENTRANCE	GALVESTON HARBOR NORTH JETTY	998.55
			GALVESTON HARBOR SOUTH JETTY	
CALIFORNIA	3	LA-LB HARBORS	LA-LB HARBORS LONG BEACH BREAKWATE	646.47
			LA-LB HARBORS MIDDLE BREAKWATER	
			LA-LB HARBORS SAN PEDRO BREAKWATER	
TEXAS	4	SABINE PASS	SABINE PASS EAST JETTY	439.18
			SABINE PASS WEST JETTY	
	5	ARANSAS PASS	ARANAS PASS NORTH JETTY	306.32
			ARANAS PASS SOUTH JETTY	
MINNESOTA	6	DULUTH SUPERIOR HARBO	DULUTH SUPERIOR HARBOR (DULUTH SHIP	219.24
			DULUTH SUPERIOR HARBOR (DULUTH SHIP	
MINNESOTA AND WISCO			DULUTH SUPERIOR HARBOR (SUPERIOR EN	
			DULUTH SUPERIOR HARBOR (SUPERIOR EN	
LOUISIANA	7	CALCASIEU RIVER AND PA	CALCASIEU PASS EAST JETTY	181.17
			CALCASIEU PASS WEST JETTY	
OREGON AND WASHIN	8	COLUMBIA RIVER AT MOU	COLUMBIA RIVER AT MOUTH JETTY A	155.11
			COLUMBIA RIVER AT MOUTH NORTH JETTY	
			COLUMBIA RIVER AT MOUTH SOUTH JETTY	
MAINE	9	PORTLAND HARBOR	PORTLAND HARBOR NORTH (INNER HARBO	
			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	
	12	CHARLESTON HARBOR	CHARLESTON HARBOR NORTH JETTY	
			CHARLESTON HARBOR SOUTH JETTY	
FLORIDA	13	PORT EVERGLADES HARB	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	

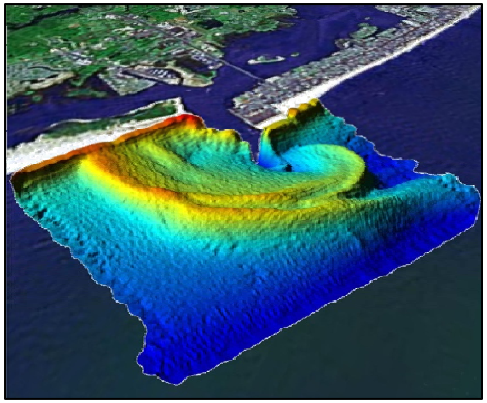
- **Project rankings, with individual structures listed separately, show relative significance of locations.**
- **For tonnage results, commodity breakdowns provide additional details.**

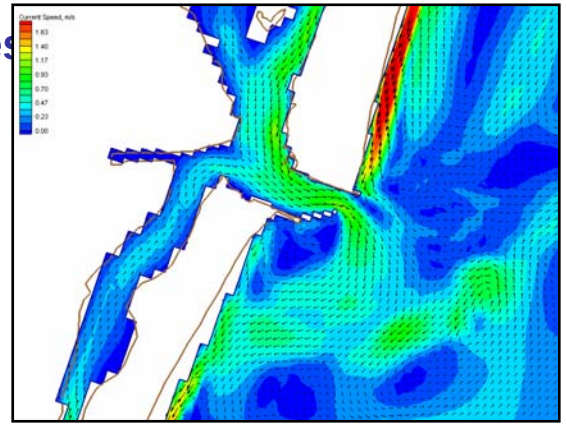
Commodities Breakdown for Savannah Harbor



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!