Coastal Inlets Research Program

ERDC
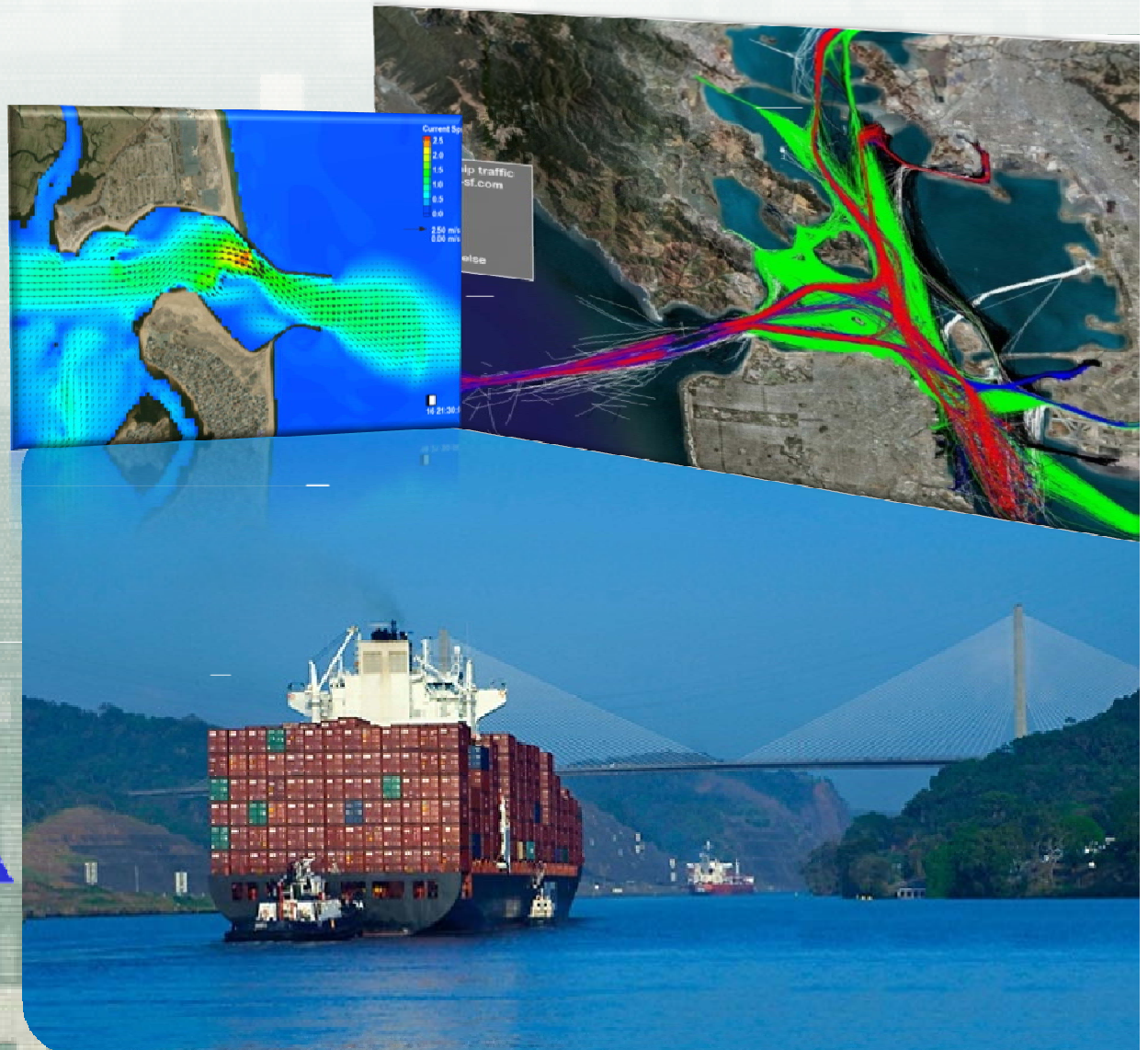Engineer Research & Development Center

Julie Dean Rosati
Program Manager

Jeff McKee
HQ Navigation
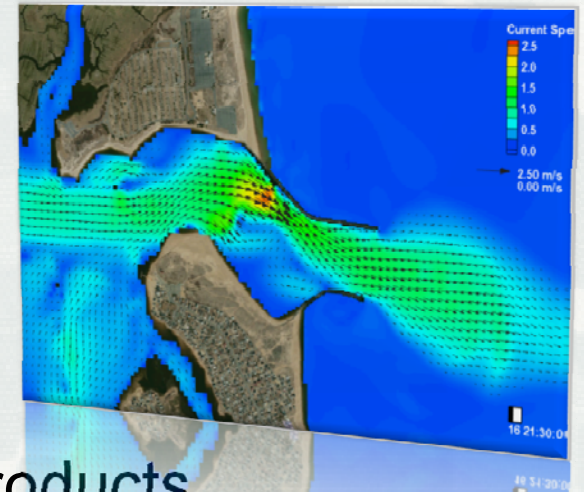Business Line Manager

Jeff Lillycrop
Technical Director

Eddie Wiggins
Associate Technical Director

CIRP
Mission Support
Technology Transfer
Research & Development

US Army Corps of Engineers
BUILDING STRONG®

CIRP Mission

- Conduct R&D to reduce O&M costs at coastal navigation projects
  - Include inlets, entrances, ports, marinas, harbors, navigation structures, channels and adjacent beaches.

- Develop tools to support O&M practice
  - Provide Districts tools for PCs to evaluate inlets, channels, structures, adjacent beaches, dredging and placement within regional systems.

  - Transfer technology and products

software, Web portals, Mobile device apps, video clips.

CIRP

Research & Development

CHL
Coastal and Hydraulics Laboratory

Program Management and Technology Transfer

Julie Rosati, Mitch Brown

Coastal

System

Honghai Li

Research & Development

Navigation Structures

Zeki Demirbilek

Geomorphic Evolution

Tanya Beck

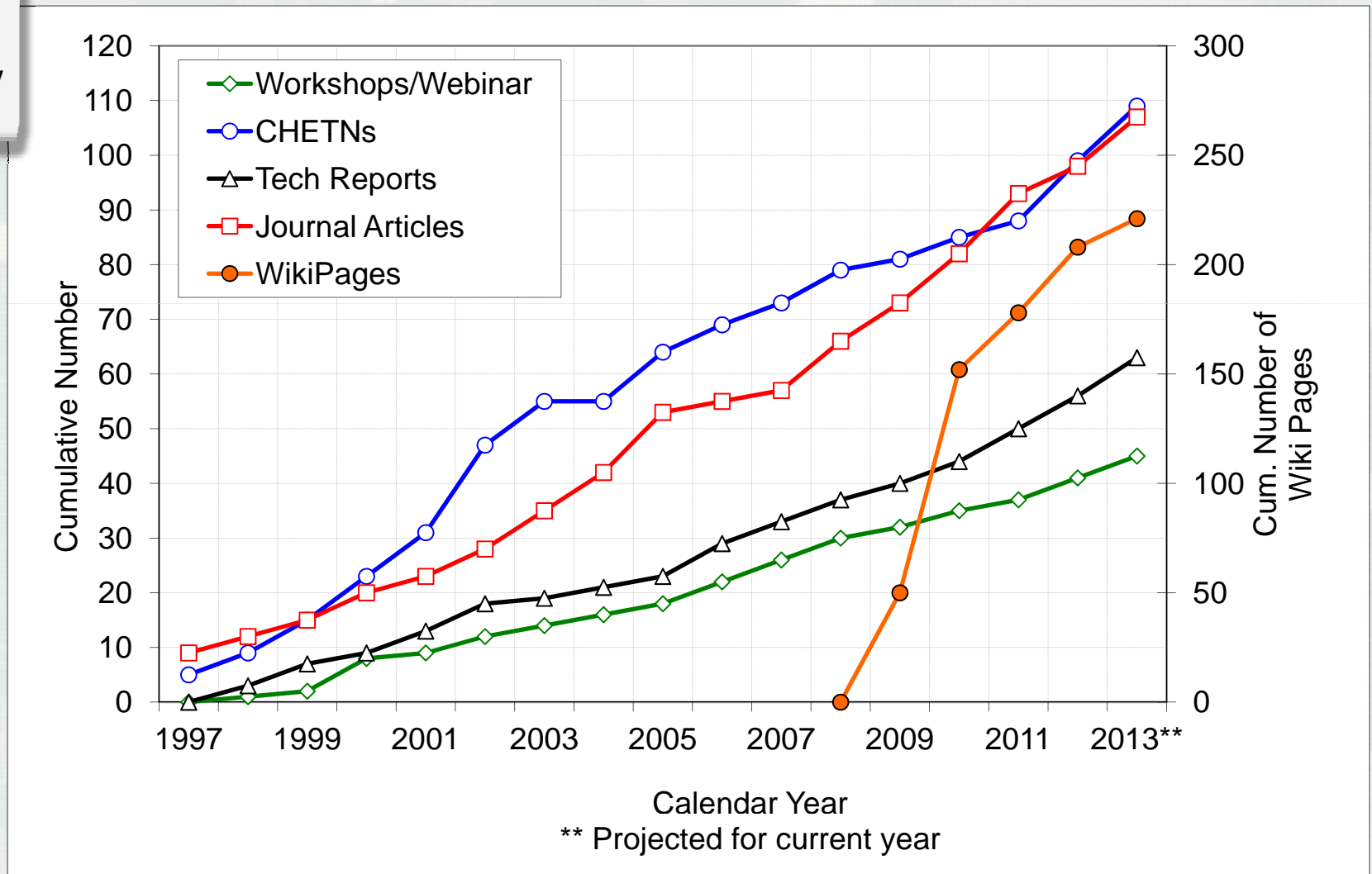**Inlet Engineering Toolbox**

Ashley Frey
Julie Rosati

Coastal Navigation Portfolio Management

Ned Mitchell

Coastal and Hydraulics Laboratory
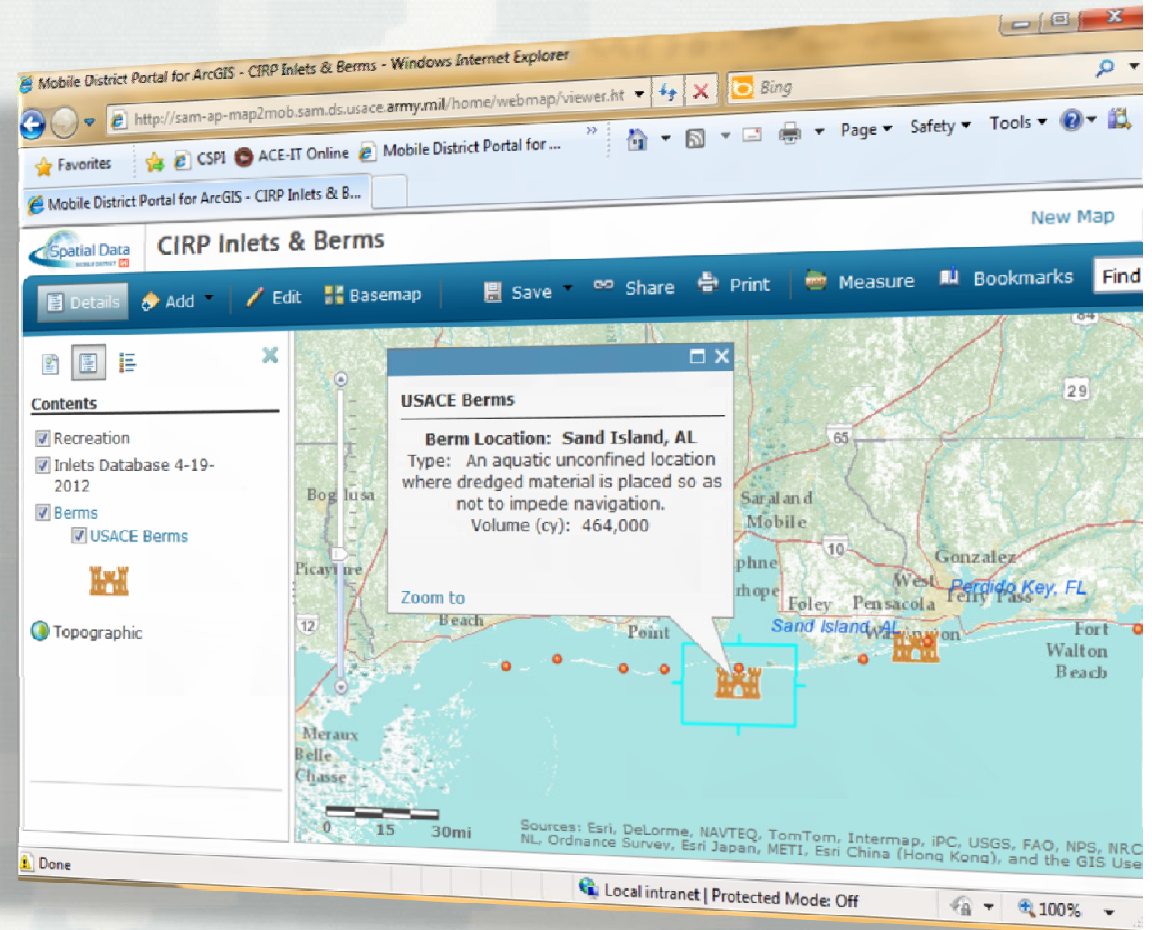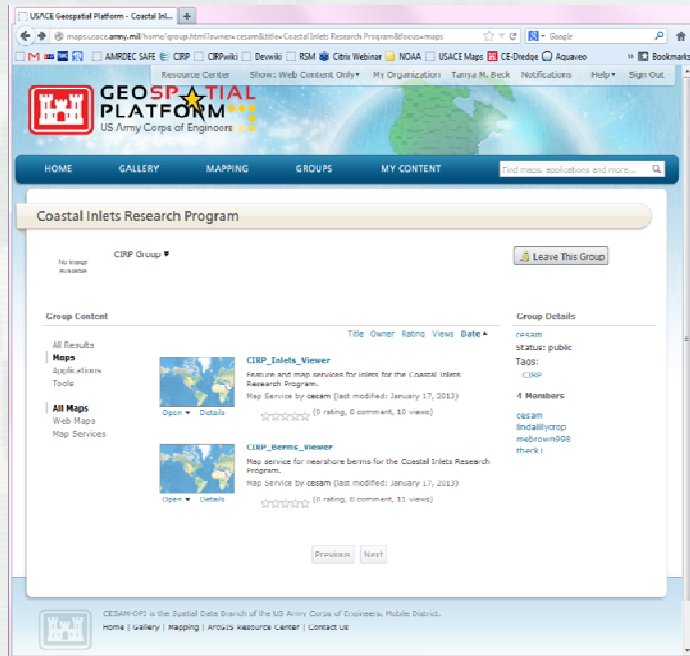
Program Management and Technology Transfer

New CIRP Inlets Portal and Interactive Map of CIRP Projects

Program Management and Technology Transfer

Geomorphic Evolution

Tools are linked to National Coastal Data Bank (NCDB) and other data resources

ERDC Engineer Research

CIRP

Program Management and Technology Transfer

E & W Coasts, Nov 1998	Avalon, NJ/Redondo Beach, CA	Recent developments in CIRP: ADCIRC & STWAVE
#1 – FSBPA, Feb 2000	Melbourne, FL	Waves, tidal hydrodynamics, tidal inlet circulation
PA, Feb 2001	Orlando, FL	ADCIRC, STWAVE, & ADCIRC/STWAVE linkages
PA, Jan 2002	Biloxi, MS	GIS for coastal and navigation projects
	Vicksburg, MS	SMS Steering Module Workshop
PA, Feb 2003	Ponte Vedra Beach, FL	Hydro Steering Module and sediment transport/ morphology change
May 2003	Clearwater Beach, FL	CS03 Modeling Tidal Inlets
#5 – FSBPA, Feb 2004		
Aug 2004	New York, NY	Calculating sediment transport/morphology change
#6 – FSBPA, Feb 2005	Destin, FL	Modeling sediment transport and morphology change, channel infilling
Aug 2005	Bar...	...ing Modeling System technology transfer workshop
#7 – FSBPA, Jan/Feb 2006	Sarasota, FL	Modeling of waves, circulation, sediment transp, and morph. change
Dec 20...	V...	...Modeling System (SMS) ...
Jan ...	Ft. Lauderdale, FL	Empirical and Numerical Techniques for Analyzing Wave Processes
#9 – FS...	Sarasota, FL	Estuarine Design and Research Needs
Jun 2008	...nge...	...bruary Assessment Workshop
Jun 2008	Vicksburg, MS	Advanced Coastal Modeling System Workshop
#10 – FSBPA, Jan/Feb 2009	Sarasota, FL	...th Annual FSBPA CIRP Workshop
#11 Annual, Dec 200...	S...	Integrated Coastal and Simulation with Application...
May 2010	New Orleans District, LA	Advances in Decision-Support: CMS and CPT
#12 FSBPA, Feb 2011	...	...for Coastal Inlet...
Aug 2011	San Diego, CA	CMS&GenCade for Regional Sediment Management
#13 NAP, Mar 2012	Philadelphia, PA	Technology Transfer Workshop/Webinar
Jun (2)	Webinars	Two CMS Webinars
Oct 2012	Webinar	GenCade Webinar

13 Years of Annual Workshops
40 Cumulative Workshops
DOTS one-on-one at NAB in Apr13
DOTS one-on-one at NAO FY13
WOTS (wetland) for LRB in FY13
2 Webinars (2 more planned) in FY13

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CIRP Work Units

Program Management and Technology Transfer

Julie Rosati, Mitch Brown

Coastal

System

Honghai Li

Research & Development

Navigation Structures

Zeki Demirbilek

Geomorphic Evolution

Tanya Beck

Inlet Engineering Toolbox

Ashley Frey
Julie Rosati

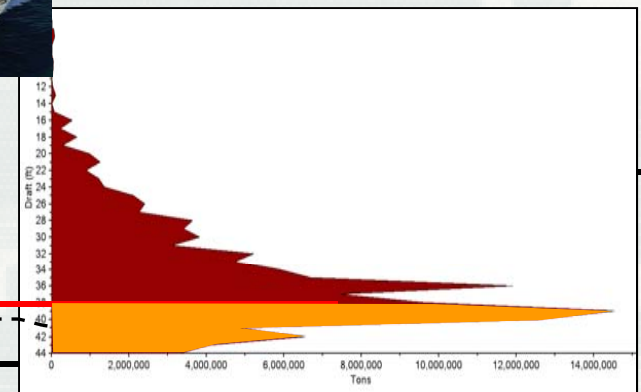**Coastal Navigation Portfolio Management**

Ned Mitchell

Coastal Navigation Portfolio Management

Coastal Navigation Portfolio Management

Focus: develop decision-support tools that provide the USACE with objective, consistent performance metrics for inventory of coastal channels, structures, and other navigation assets.

Channel Portfolio Tool (CPT):

Web-based application that relates navigable depths to cargo most vulnerable to shoaling. Allows for detailed, reach-level analysis as well as regional and national summaries of the waterborne transportation systems supported by Corps navigation projects.

https://cpt.usace.army.mil

Coastal Structures Management, Analysis, and Ranking Tool (CSMART):

Web-based application that prioritizes coastal structures according to user-specified criteria and weightings on metrics such as condition rating, commercial tonnage, fish landings, and cruise and ferry passengers. Allows local, regional, and national queries and comparisons.   https://itlgis01.usace.army.mil/CPT/Silverlight/CSMART

Statements of Need

Improved Justification for and Prioritization of Annual Maintenance Dredging Investments
Tracking Number 2009-N-8

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Coastal Navigation Portfolio Management

Channel Portfolio Tool (CPT):

- Aligned project inventory with official CWIS codes for future merging with navigation budget data (ongoing in FY13)
- Developed CPT Optimization add-on
  - Extract waterway freight corridor information
  - Develop systems-based strategies for O&M dredge budgeting
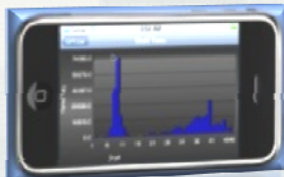
CPT-LITE

Coastal Structures Management, Analysis, and Ranking Tool (CSMART):

- Supported Corps Asset Management (AM) initiative and Low-Use Navigation Project PDT
- Matched AM inventory of coastal structures to Project CWIS codes
- Adapted CSMART to include physical condition ratings submitted via AM effort

Coastal Navigation Portfolio Management

CPT:

- Integration with 3D Channel Framework (finally!) and Hydro Survey Tool
- Interactive charts within CPT interface

• Paper on systems-based O&M optimization to appear in *Transportation Research Record* (Mitchell, Wang, and Khodakarami; 2013)

CSMART:

- Merging CPT and CSMART
- Interface upgrades and various functionality improvements

New! **Navigation Project Performance via AIS data archive (SON 2012-N-5)**

- Paper: *AIS History and Future Improvements in Waterway Management* (Scully and Mitchell, 2013)
- Investigating new R&D applications of AIS archive as a remote sensing technology; can be cross-correlated with other data archives (tides, waves, env. monitoring, etc.)
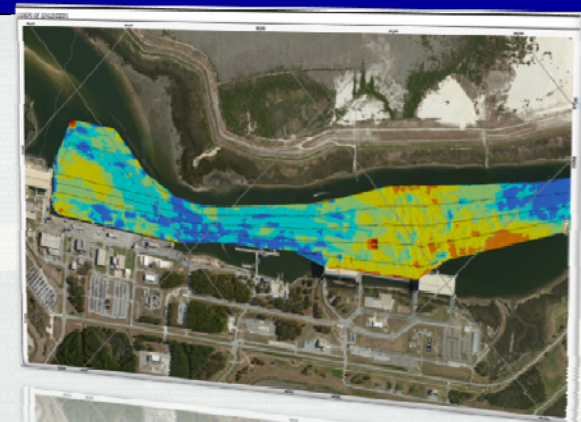
Statements of Need

Automatic Identification System (AIS) data use in Navigation operations and engineering. Tracking Number 2012-N-5

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CIRP Work Units

Program Management and Technology Transfer
Julie Rosati, Mitch Brown

Coastal – System

Honghai Li

Research & Development

Navigation Structures

Zeki Demirbilek

Geomorphic Evolution

Tanya Beck

Inlet Engineering Toolbox

*Ashley Frey
Julie Rosati*

Coastal Navigation Portfolio Management

Ned Mitchell

Coastal and Hydraulics Laboratory

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Coastal Modeling System

Focus: Develop, advance, and transfer an integrated wave, current, and sediment transport model for District use in O&M applications

Coastal Modeling System:

- PC-based

- Verified and validated with hydrodynamic (20 cases) and sediment transport (10 cases) tests

- Focus on channel shoaling, inlet short- and mid-term morphology change

- Operational at 17 Districts*

Statements of Need

Need long-term morphologic evolution predictors
Tracking Number 2008-N-6

*NAN, NAE, NAP, NAB, SAJ, SAS, SAM, SWG, SPL, SPN, NWS, NWP, POA, POH, LRB, LRE, LRC

Coastal and Hydraulics Laboratory

Coastal Modeling System
FY12 Accomplishments
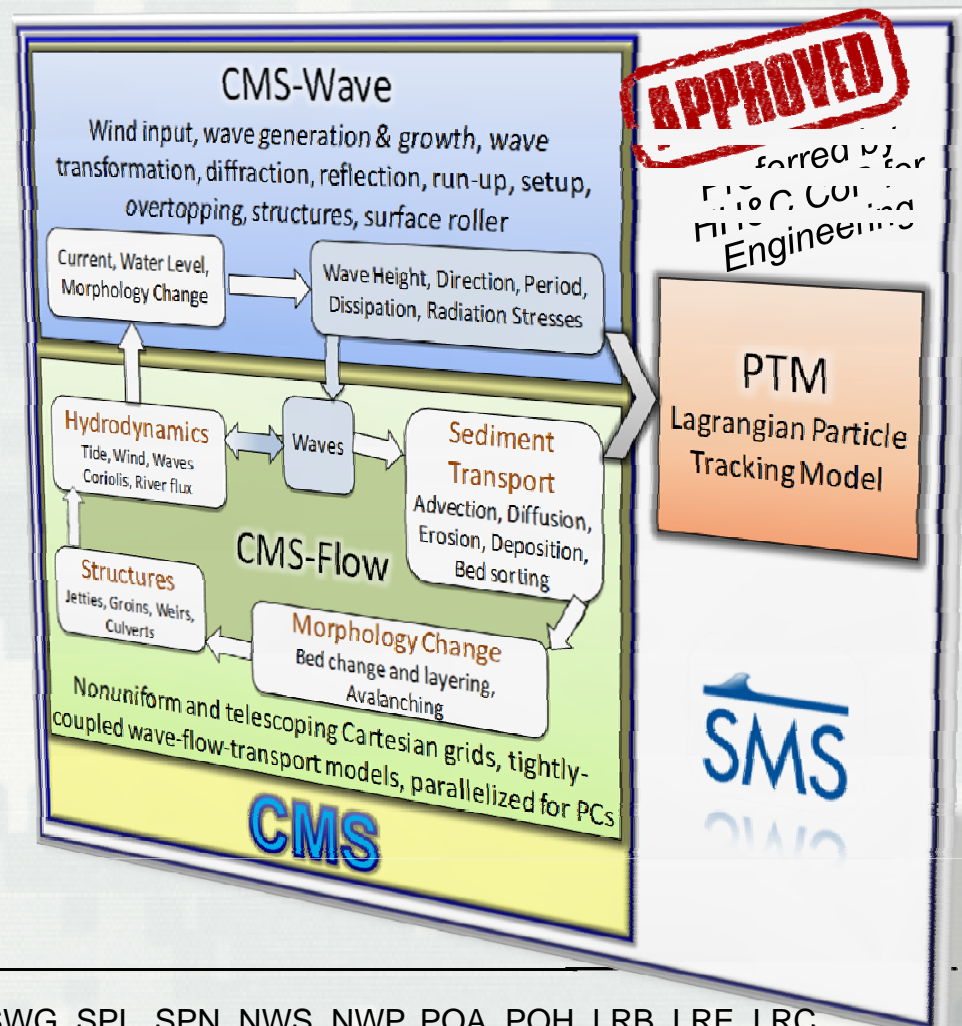
Coastal Modeling System

New! **Structures in CMS**

Culverts

Tidal gates

Permeable rubble mound breakwaters and jetties
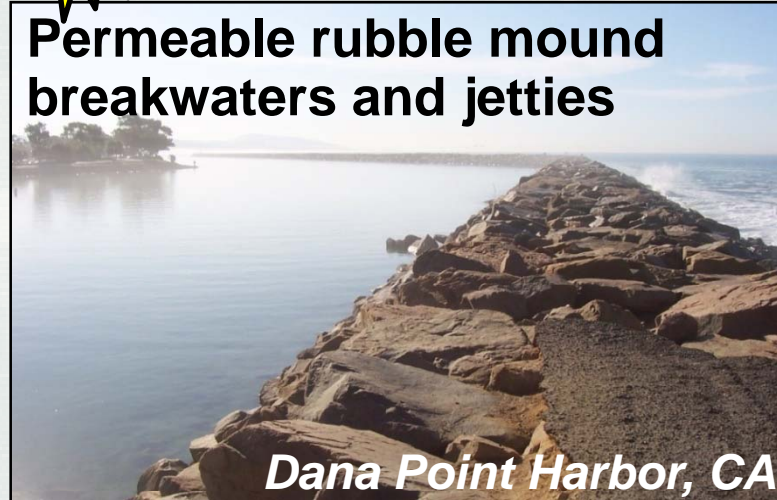
Dana Point Harbor, CA

Low-crested weirs

← **Weir Jetty**

Rudee Inlet, VA

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13

Coastal Modeling System

- Multiple-sized sediment transport and bed layering
- Quasi-3D wave-averaged formulation
  - *Better representation of cross-shore momentum and sediment dispersion, especially significant for nearshore*
- Automated Nesting Boundary Extraction
- Automated Tidal Database Boundary
- Horizontal Coordinate Projection Conversions

Coastal and Hydraulics Laboratory
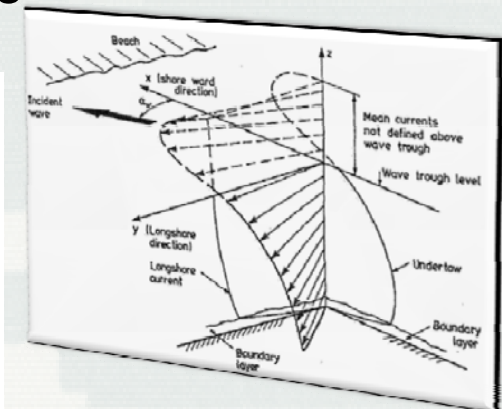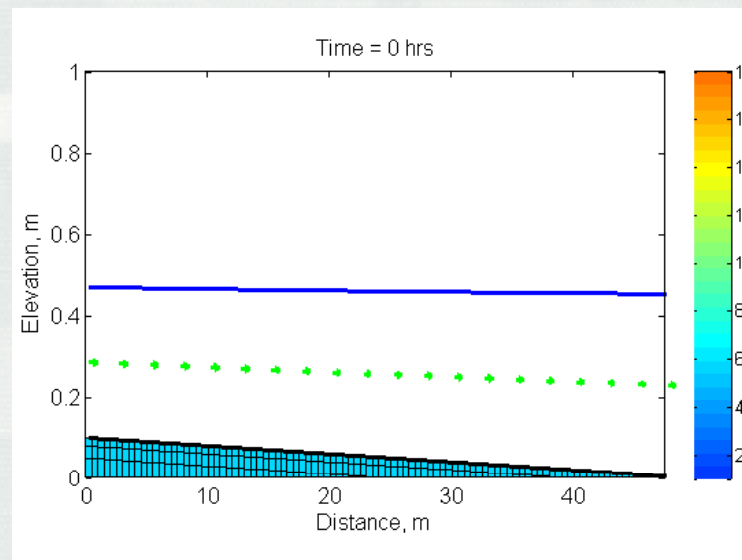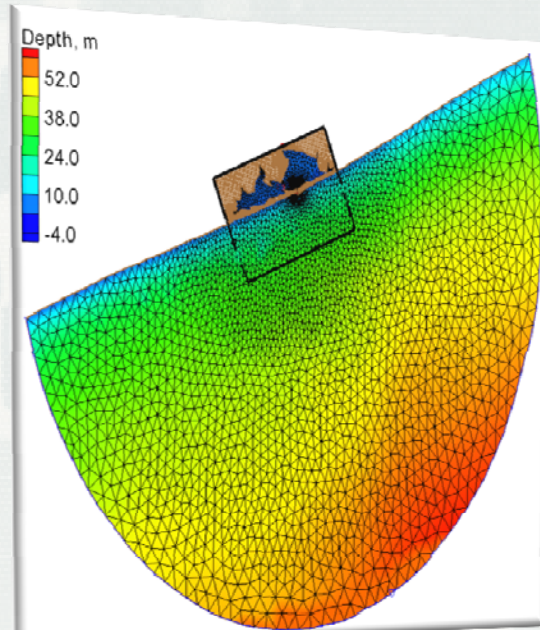
Coastal Modeling System

- Largest source of error in modeling
- Existing formula designed for
  - Graded sediments under currents only (e.g. Wu et al. 2000) or
  - Sorted sediments under waves and currents (e.g. Lund-CIRP)

- Database being compiled
- Lab experiments
- Work benefits CIRP, DOER, RSM, +
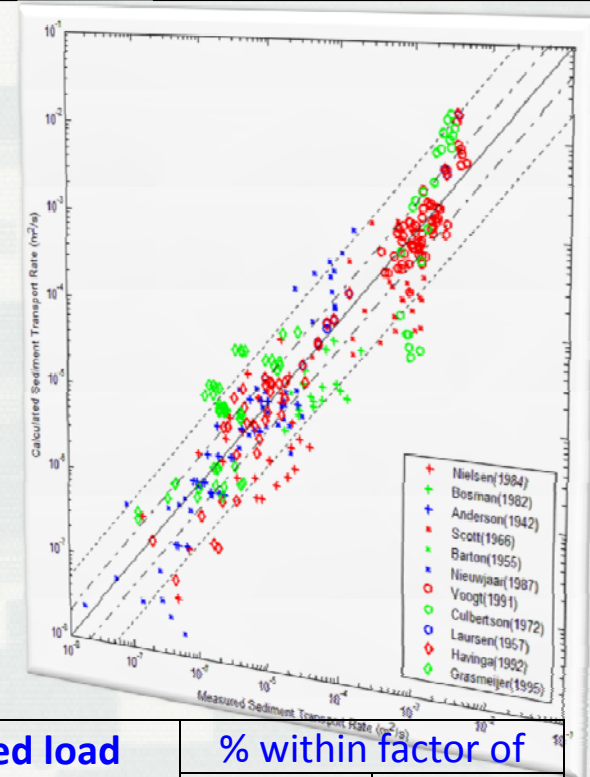
Bed load	% within factor of	
Transport Formula	2	5
Bailard and Inman (1981)	47	70
Dibajnia and Watanabe (1992)	41	72
Ribberink (1998)	32	52
Lund-CIRP (2007)	46	74
Wu et al. (2011)	**55**	**86**

Suspended load	% within factor of	
Transport Formula	2	5
Bijker (1968)	23	52
Bailard (1968)	30	65
van Rijn (1989)	32	52
Lund-CIRP (2007)	33	65
Wu et al. (2011)	**48**	**83**

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- ## 2 Webinars
  - Beginners (10 hrs)
  - Advanced (5 hrs)
- ## 1 Journal paper
  - (Norfolk, VA)
- ## 2 Book Chapters
  - Sediment transport theory, and applications
- ## 5 Conference papers
- ## 2 V&V TR's
- ## 5 CHETN's
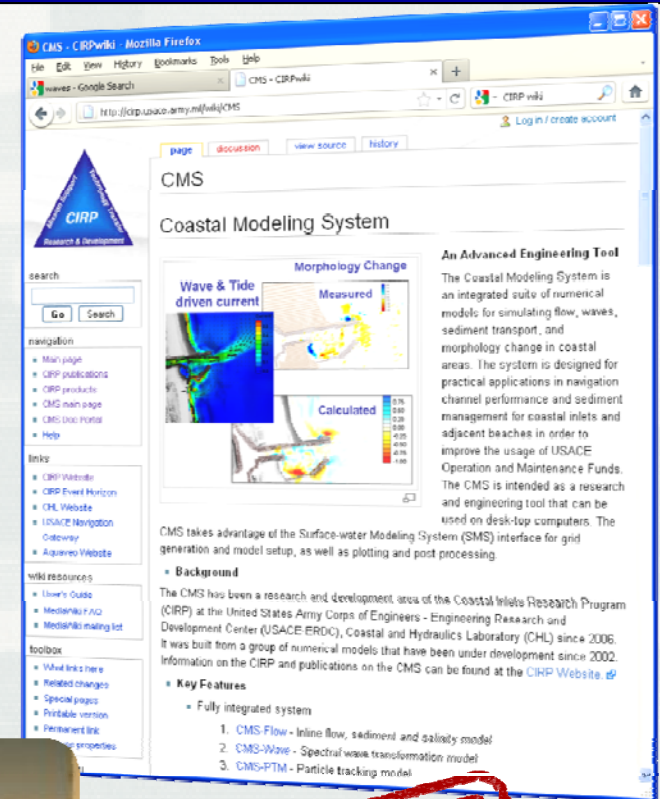
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Preferred by HH&C CoP for Engineering

CMS features/updates

- Sediment Mapping
- Dredging events
- Explicit telescoping grid
- Parallelization for HPC
- Tidal potentials
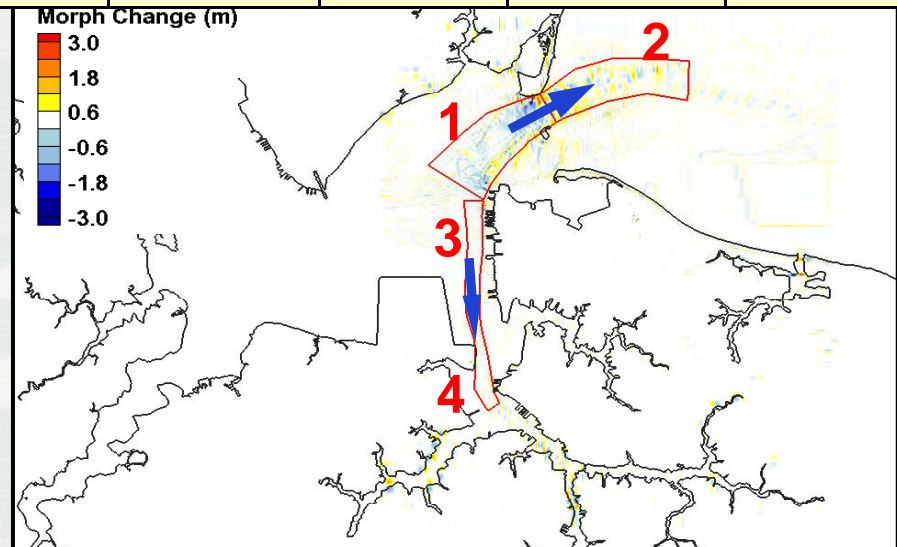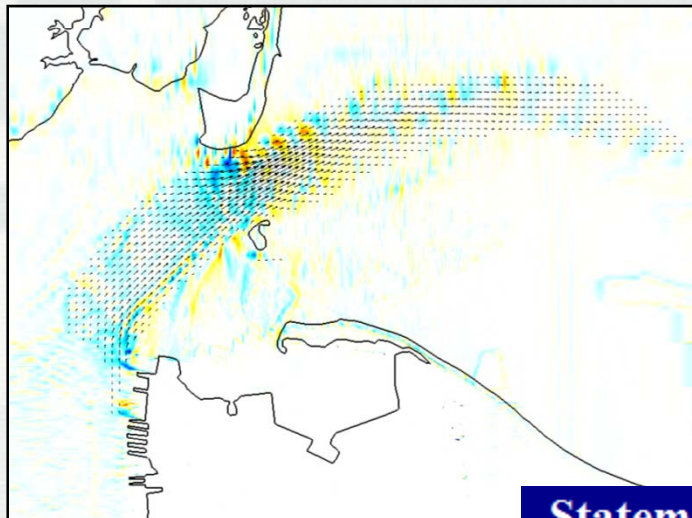- Improved Open BC's, etc
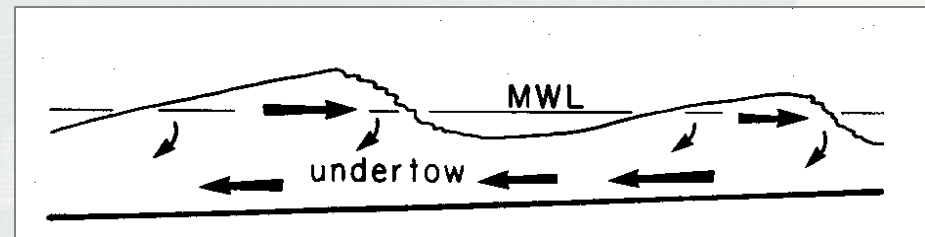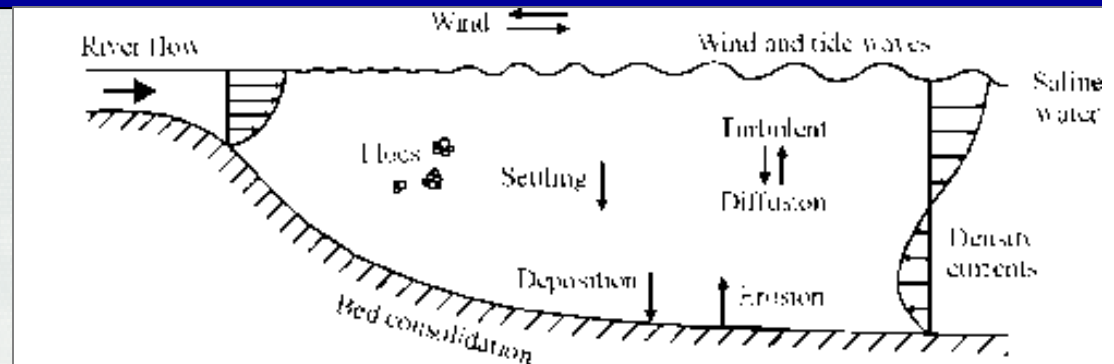
R&D

- V&V of Quasi3D
- Swash zone
- V&V of mixed sediments

Coastal Modeling System

Coastal Modeling System

Ongoing Application: Sea Level Change Impacts to Navigation
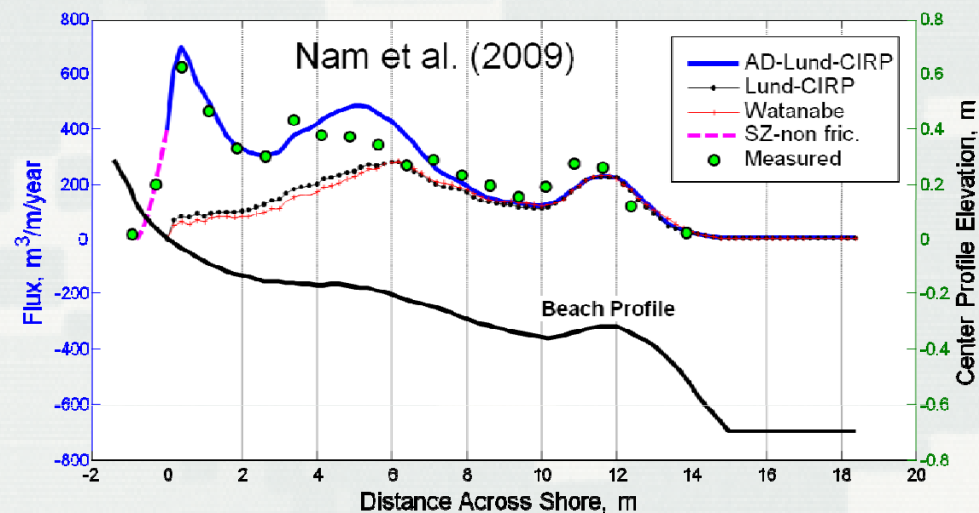
100-year return synthetic storm and sea level rise scenarios

Average sediment transport, channel volume and bed changes in Hampton Roads, near Norfolk, VA

→ **Increased SLR increases response (either more erosion or accretion)**

Region	SLR = 0 m		SLR = 2 m	
	Volume Change (m^3)	Bed Change (m/m^2)	Volume Change (m^3)	Bed Change (m/m^2)
1	6,800	**0.003**	26,000	**0.01**
2	-18,800	**-0.01**	-51,000	**-0.02**
3	-940,000	**-0.10**	-1,569,000	**-0.17**
4	566,000	**0.06**	894,000	**0.10**

Morph Change (m)
3.0 / 1.8 / 0.6 / -0.6 / -1.8 / -3.0

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Concerns:
- Erosion of downdrift beach
- Reduced navigability of inlet

Watch:
- Currents up to 2.5 m/sec in inlet
- 2.6-m tidal range
- Island appearing in middle of channel
- Currents thru degraded jetties may exacerbate downdrift erosion
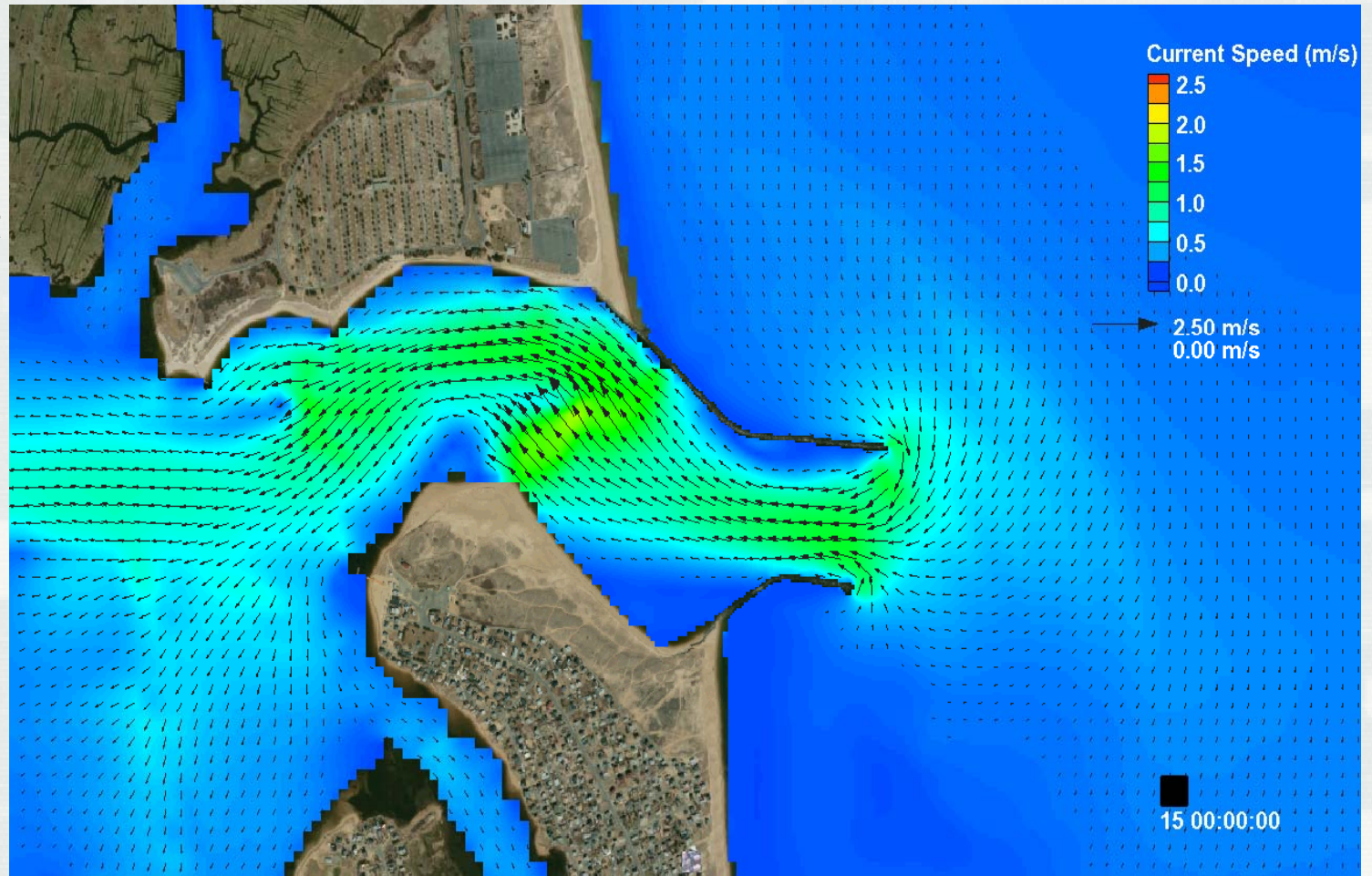
Examining 19 Alternatives including mining ebb/flood shoal, jetty modifications, detached breakwaters

Program Management and Technology Transfer

Julie Rosati, Mitch Brown

Coastal System

Honghai Li

Research & Development

Navigation Structures

Zeki Demirbilek

Geomorphic Evolution

Tanya Beck

Inlet Engineering Toolbox

Ashley Frey
Julie Rosati

Coastal Navigation Portfolio Management

Ned Mitchell

Coastal and Hydraulics Laboratory

Waves at Navigation Structures

Focus: to advance wave predictive capability in support of USACE missions for coastal navigation, structures, ports/harbors/marinas, and adjacent beaches, reefs and wetlands.

CMS-Wave:

Advanced spectral wave propagation model including diffraction, reflection, run-up, setup, overtopping, wave generation, structures (breakwaters, jetties, groins, etc.), nested grids; integrated with CMS-Flow

14 Verification & Validation Cases

Report 2 - Waves
- Basic Verification for Idealized Problems
  - Ex 1 - Wave generation and growth in limited fetch (~800 KB)
  - Ex 2 - Nonlinear wave-wave interactions (~800 KB)
  - Ex 3 - Wave diffraction at breakwater gap (~1 MB)
- Laboratory Studies
  - Ex 1 - CHL Idealized inlet experiments (~8 MB)
  - Ex 2 - Wave breaking experiments on a planar beach (~2 MB)
  - Ex 3 - Wave runup on impermeable uniform slope (~12 MB)
  - Ex 4 - Experiments for Cleveland Harbor, Ohio
- Field Studies
  - Ex 1 - Matagorda Bay, Texas (~110 MB)
  - Ex 2 - Grays Harbor, Washington (~41 MB)
  - Ex 3 - Mouth of Columbia River, WA/OR (~34 MB)
  - Ex 4 - Southeast Oahu Coast, Hawaii (~7 MB)
  - Ex 5 - Field Research Facility, Duck, NC (~48 MB)
  - Ex 6 - Mississippi Coastal Improvement Program (~117 MB)
  - Ex 7 - Waves over a submerged rock reef, Indian River County, FL (~18 MB)

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Preferred by HH&C CoP for Engineering

Bouss-2D:

Advanced phase-resolving wave propagation and transformation model.

Coastal and Hydraulics Laboratory

Waves at Navigation Structures

WaveNet: Web-based interactive GUI with Google Map

- Purpose: Provides data for projects and models

- Data Sources: NOAA, USGS, USACE, NAVY

- Actions: Access, process, plot, and analyze data

- Data Types: Waves, Winds, Water levels, Currents

- Future Additions: Bathymetry and Shoreline
  Inlet Structures
  Navigation Channels
  Ports/Harbors/Marinas
  Tidal Databases

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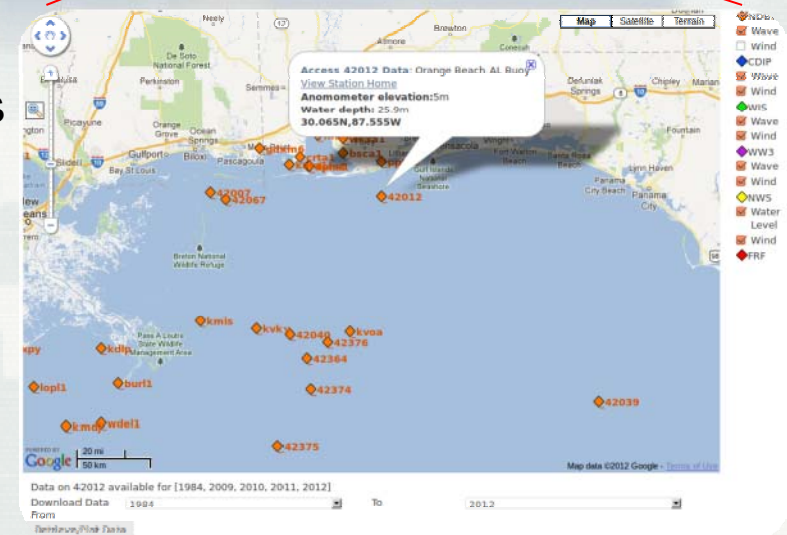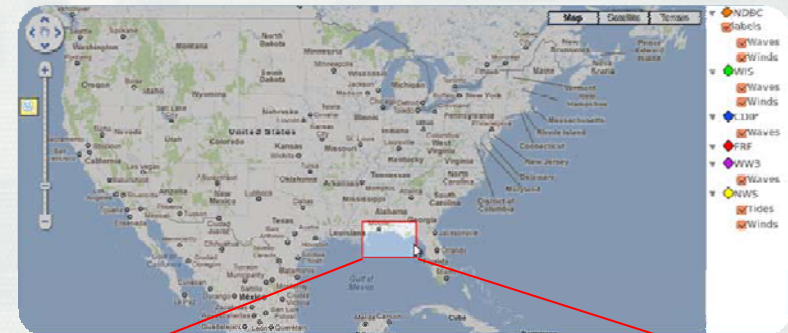
Waves at Navigation Structures
FY12 Project Applications/Reimbursables

Waves at Navigation Structures

- NWS: Grays Harbor, WA
- NWP: Tillamook Inlet, OR
- SPN: Ocean Beach San Francisco Bight, CA
         Noyo Bay, CA
         Half Moon Bay, CA
- SWG: Matagorda Ship Channel, TX
         Galveston Bay, TX   *MCNP*
         Sargent Beach, TX
- NAE: Point Judith Harbor, RI
         Merrimack Inlet, MA
- NAN: Ambrose Channel, NY
- SAJ: St. Johns River, FL
         St. Augustine Inlet, FL
- POH: North Kahola Harbor, HI
         Kikiaola Harbor, HI

Tillamook Inlet, OR

MCNP

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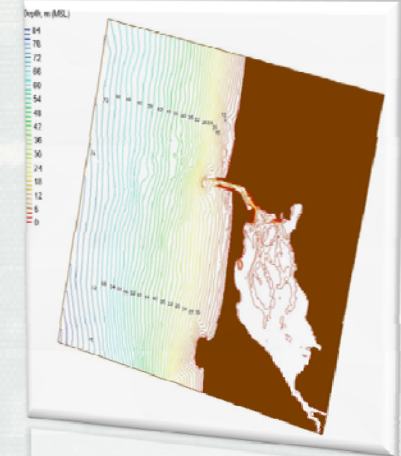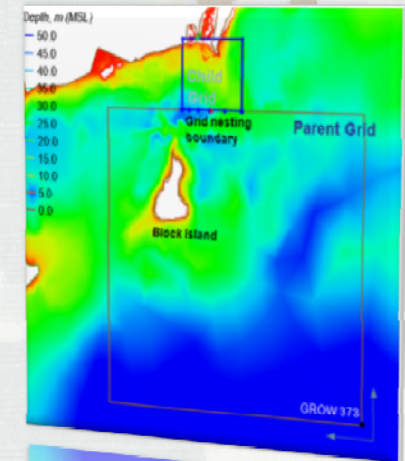
Waves at Navigation Structures

- TR: Regional and Nearshore Wave Modeling at Point Judith Harbor, RI
- CHETN: Advanced Numerical Wave Modeling for Reefs
- TR: Matagorda Bay Channel Shoaling Study, TX
- CP: Littoral Transport Modeling of Ocean Beach and San Francisco Bight, CA
- JP: Numerical Modeling of Coastal Inundation and Sedimentation by Storm Surge, Tides, and Waves at Norfork, Virginia, USA

- CHETN: WaveNet Part II: Other Data Sources
- CHETN: WaveNet and GenCade Coupling
- CHETN: Coupling of CMS-Wave to AIS
- TR: Wave, Circulation, and Sedimentation Study at Braddock Bay, NY
- TR: Storm Waves, Circulation, and Sedimentation Study at Dana Point Harbor, CA
- CP: Mixed Sediment Modeling for Matagorda Ship Channel, TX
- CP: Numerical Modeling of Coastal Dredged Material Placement Study at Noyo Harbor, CA
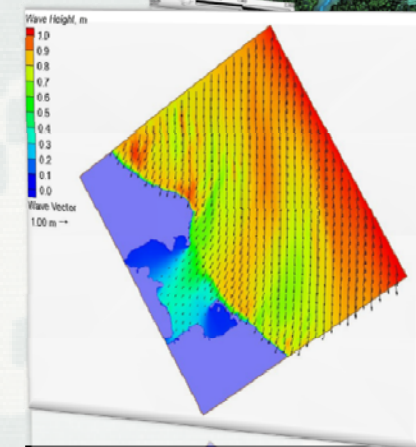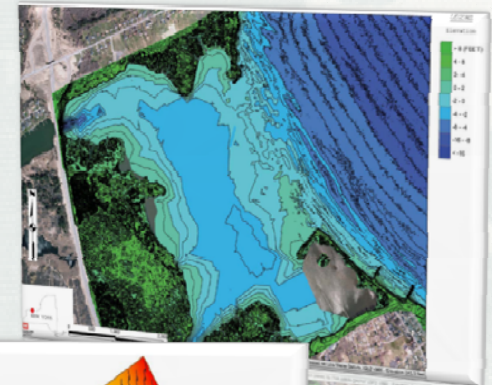
Waves at Navigation Structures

Purpose:
- Quantify hazard and risk levels for navigation
- Evaluate wave and current condition near degraded jetties

Conditions:
- Currents up to 6 kt in inlet
- 1.9-m tidal range
- High wave energy coast
- Seasonal migration of large ebb shoal
- Increased wave breaking and current flow at submerged relic jetty sections
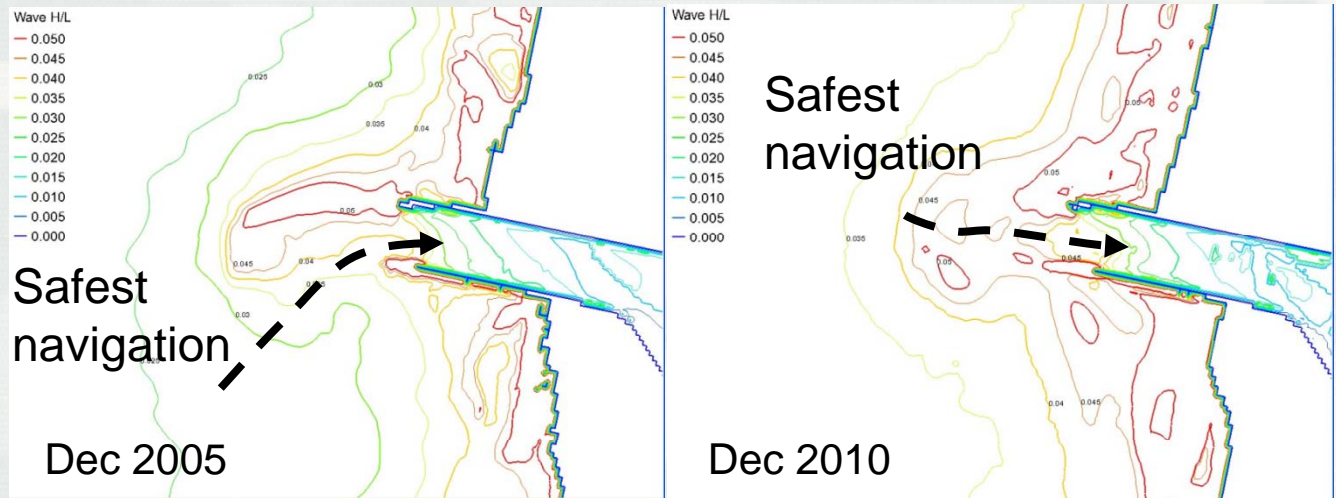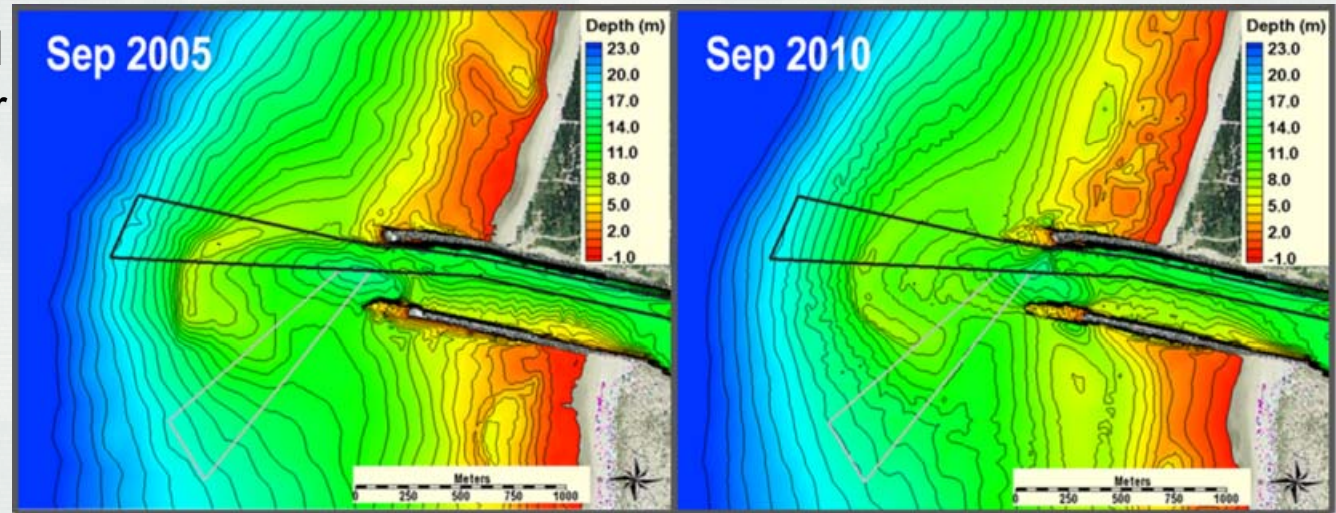
Sep 2005 — Depth (m): 23.0, 20.0, 17.0, 14.0, 11.0, 8.0, 5.0, 2.0, -1.0

Sep 2010 — Depth (m): 23.0, 20.0, 17.0, 14.0, 11.0, 8.0, 5.0, 2.0, -1.0

Wave H/L: 0.050, 0.045, 0.040, 0.035, 0.030, 0.025, 0.020, 0.015, 0.010, 0.005, 0.000

Safest navigation

Dec 2005

Safest navigation

Dec 2010

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CIRP Work Units

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Inlet Engineering Toolbox
FY12 Accomplishments

Inlet Engineering Toolbox

Focus: develop desktop PC and web-based tools to assess how engineering actions affect coastal inlets, navigation channels, and adjacent beaches

GenCade

- A 1-line model for shoreline change, sand transport, and inlet sand sharing
- Based on GENESIS (project scale) and Cascade (regional scale)
- GenCade Version 1 released in FY12
- GenCade available in SMS 11.1 Beta
- Published TR: Theory and Users Guide

GenCade at Sargent Beach, TX
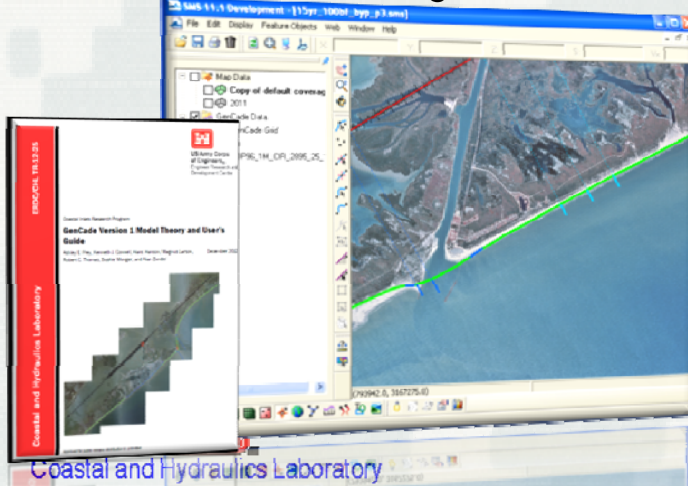
Inlet Reservoir Model

- PC-based, time-dependent sand sharing model for inlet morphologic evolution
- CHETN on PC interface
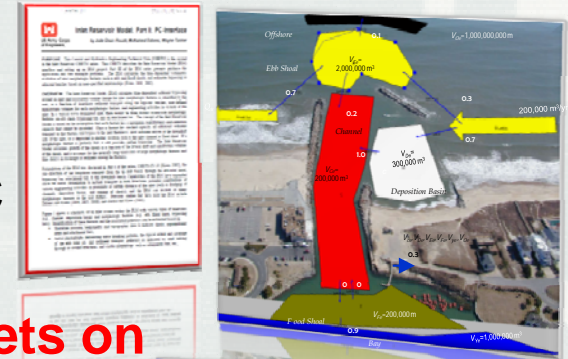
Impacts of Inlets on Adjacent Beaches (IIAB) application

- Calculates alongshore extent of inlet influence (CEM method) and total volumetric impact of inlet

Statements of Need

Need long-term morphologic evolution predictors
Tracking Number 2008-N-6

Coastal and Hydraulics Laboratory

GenCade

Completed GenCade studies at 3 sites:

St. Johns County, FL (TR-12-14: Report 3)

Onslow Bay, NC (CHETN-IV-85)

Sargent Beach and Matagorda Peninsula (TR in editing)

- Wiki documentation enhanced
- ...ivities

Inlet Engineering Toolbox

GenCade

Guidance Documentation

- Recommendations & requirements (TR, extension of Model Theory TR)
- Site-specific guidance
  - ✓ Definition of "region"
  - ✓ Pre-calibration assessment
  - ✓ Standard procedure for calibration
  - ✓ Purposes & goals of calibration & validation
  - ✓ Statistics
- Lateral boundary conditions (CHETN)

Wave Conversion Tool (2 CHETNs in review)

Variable alongshore parameters

Shore-Parallel Offshore Contour
Smoothed Offshore Contour
Groin
Shoreline
Berm Crest   Depth of closure

Variable structures in time

On 6/1/2002
Groin
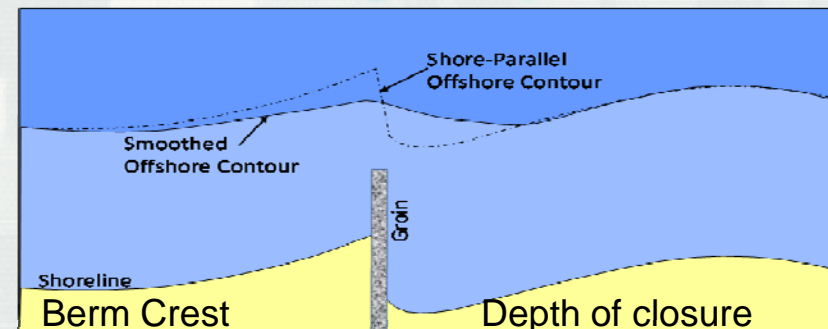On 1/1/2000
Shoreline

CMS-Wave

Wind input, wave generation & growth, wave transformation, diffraction, reflection, run-up, setup, overtopping, structures, surface roller
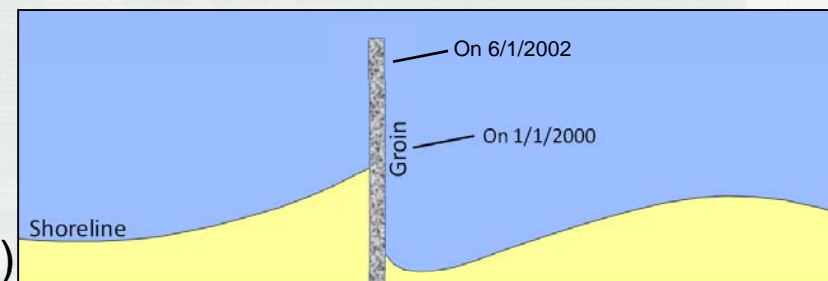
➡ **GenCade**

Option for GenCade to accept forcing from an external wave model
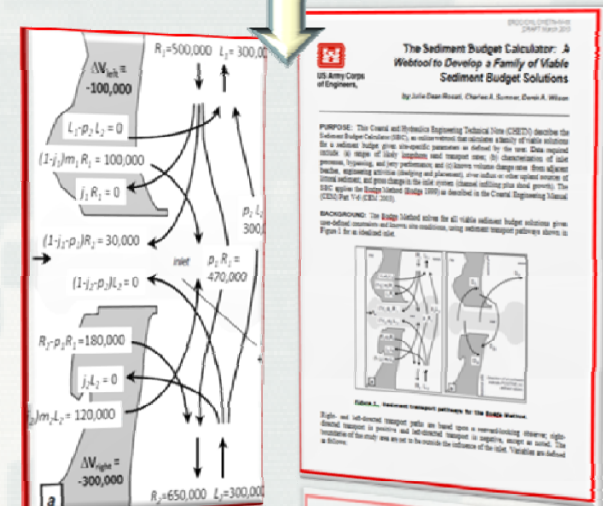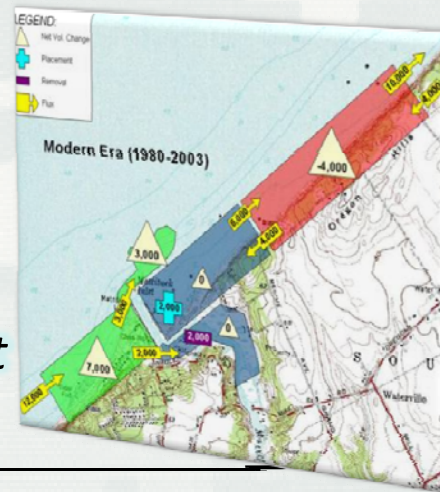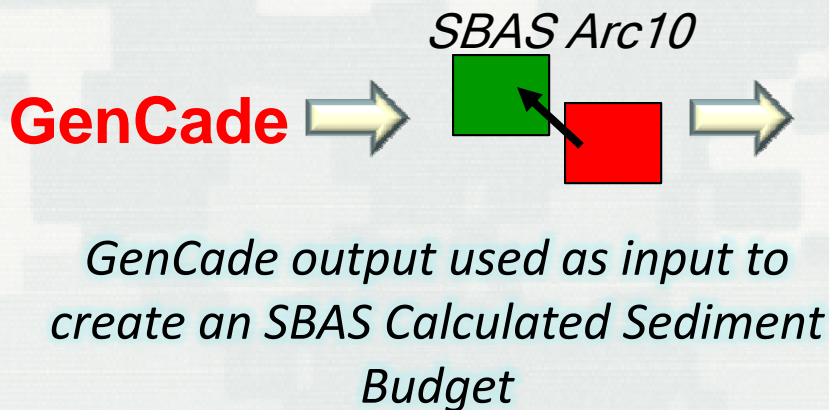
Inlet Engineering Toolbox

GenCade

Improve Inlet Reservoir Model in GenCade
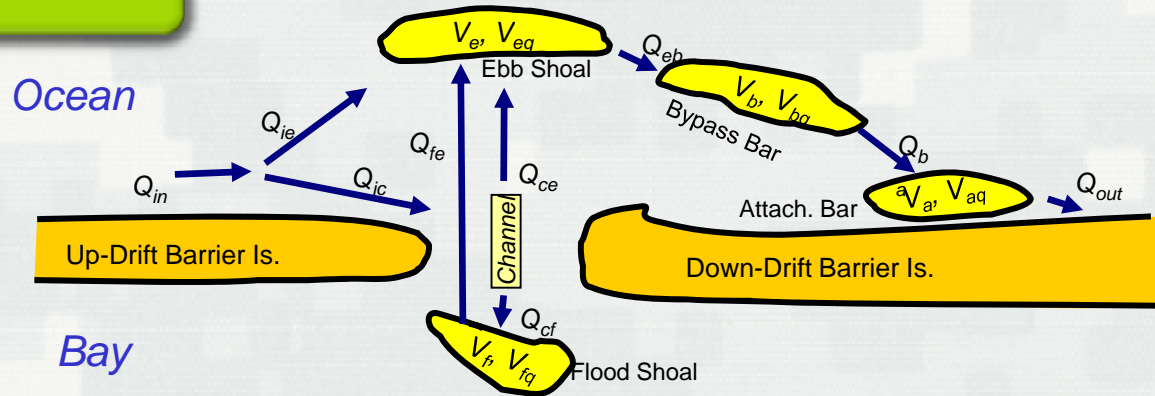
Sediment Budget Calculator

- CEM (Bodge) Method to develop Family of Solutions for sediment Budgets
- Web Tool and TN

Ocean

Q_{in}

Q_{ie}

Q_{ic}

Q_{fe}

Q_{ce}

Channel

V_e, V_{eq}

Ebb Shoal

Q_{eb}

V_b, V_{bq}

Bypass Bar

Q_b

$_aV_a, V_{aq}$

Attach. Bar

Q_{out}

Up-Drift Barrier Is.

Down-Drift Barrier Is.

Bay

Q_{cf}

V_f, V_{fq} Flood Shoal

GenCade

SBAS Arc10

GenCade output used as input to create an SBAS Calculated Sediment Budget

Modern Era (1980-2003)

CIRP Work Units

Program Management and Technology Transfer
Julie Rosati, Mitch Brown

Coastal System

Honghai Li

Navigation Structures

Zeki Demirbilek

Research & Development

Geomorphic Evolution

Tanya Beck

Inlet Engineering Toolbox

Ashley Frey Julie Rosati

Coastal Navigation Portfolio Management

Ned Mitchell

Coastal and Hydraulics Laboratory

Develops methods and context for studies on federal navigation and coastal projects over time scales much greater than dredging cycles, planning timelines, and the dimensions of the navigation channel.

Geomorphic Evolution

Products

Characterized Environments for Nearshore Berm Prediction

Documentation & Guidance

Numerical Modeling

Statements of Need

Design and Evaluation Tool for Nearshore Berm Placement of Non-Beach Compatible Material
Tracking Number 2011-N-15

Nearshore Placement of Dredged Sediment Assessment
Tracking Number 2011-N-19

...ediment

Statements of Need

Need long-term morphologic evolution predictors
Tracking Number 2008-N-6

Tools

Statements of Need

Identifying and Addressing Potential Sea Level Change Impacts to Navigation Projects
Tracking Number 2013-N-11

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Monitoring Nearshore Berms in Collaboration with SAJ & SAM

Egmont 2013

🟡 **Perdido Key:** Monitored since Jan 2012 Starting Jan 2013

🔵 **Egmont:** Starting Sep 2012

🟢 **New Smyrna Beach:** Started Aug 2012
(Complete)

🔴 **Ft. Myers Beach:** Monitored since May 2010
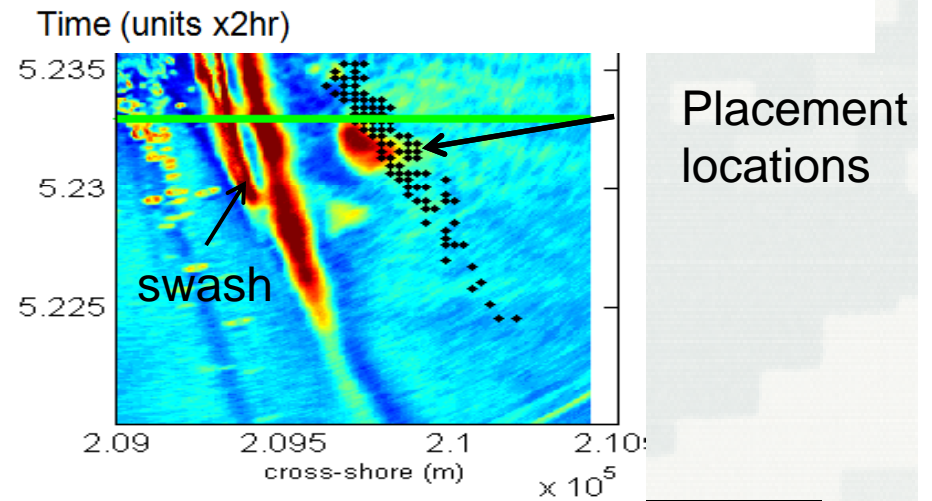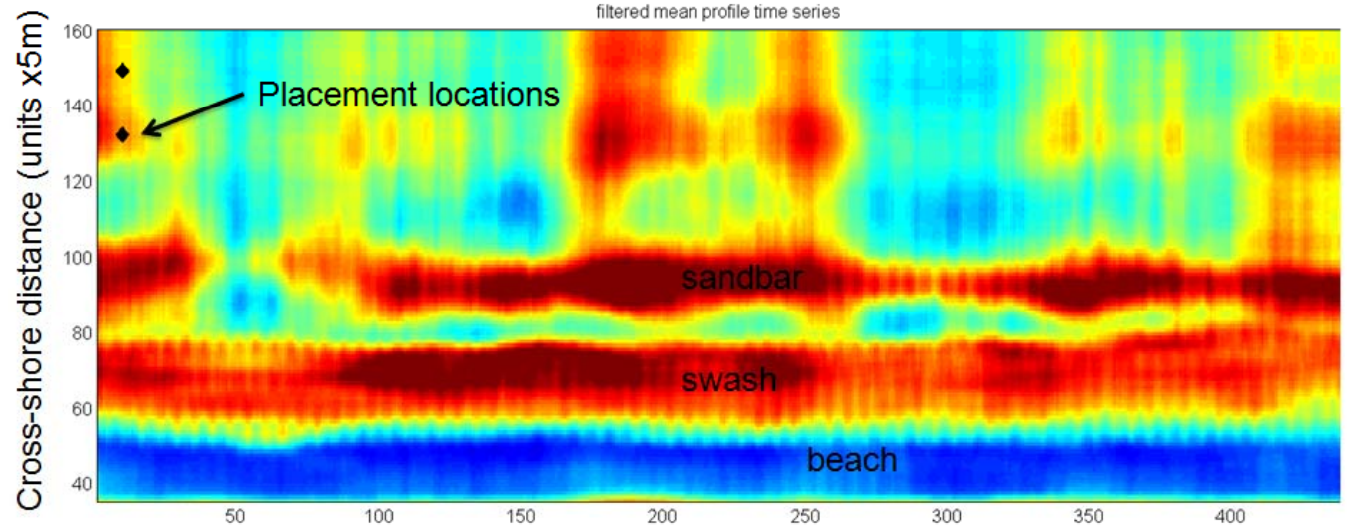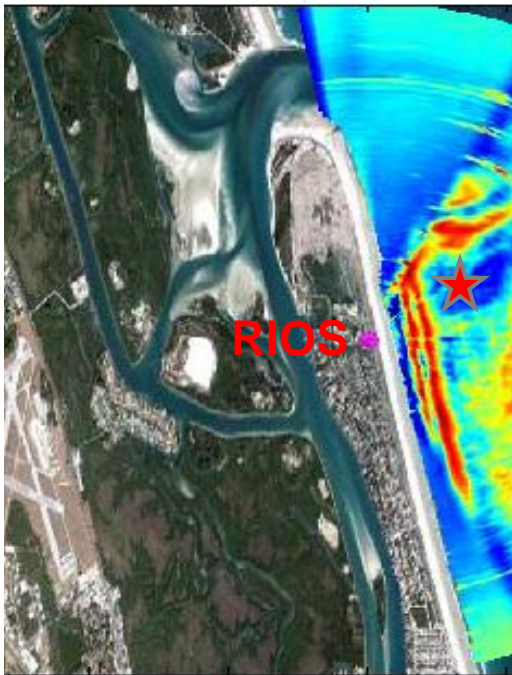(Complete; Starting Oct 2012)

Perdido Key, FL 2012

New Smyrna 2012

Field Research Facility

Ft. Myers 2009/12

Geomorphic Evolution
FY12 : New Smyrna Nearshore Placement (Aug 2012)

www.offshoreswell.com

o **Planning-Scoping Tool**

o **Estimates placement depth (based on wave-limited cross-shore transport)**

o **Calculates position and design from user-defined parameters and coastal engineering design practices**

o **Automated wave parameter extraction; user-defined beach profile; draft depth and placement limitations based on dredge**

Nearshore Berm Calculator

Home | Calculator | Background | Definitions | References | Contact | Login

Nearshore Berm Calculator

General | Beach | Waves | Dredging & Placement Type | Placement Depth | Placement Location

US

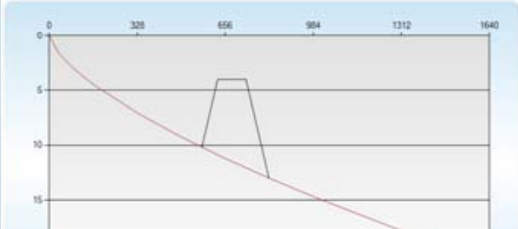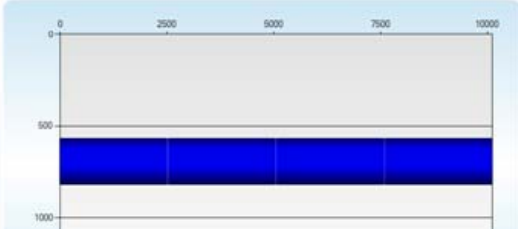|		
Estimate of Width	250	ft
Estimate of Area	1500	ft^2
Predicted Length of Given Crest Height	9000	ft
Suggested Length	2500	ft
Segmented Count	3	
Segmented Length (each)	3000	ft

Geomorphic Evolution
FY13: Field Monitoring Study of GIWW Dredging and Nearshore Placement at Egmont Key
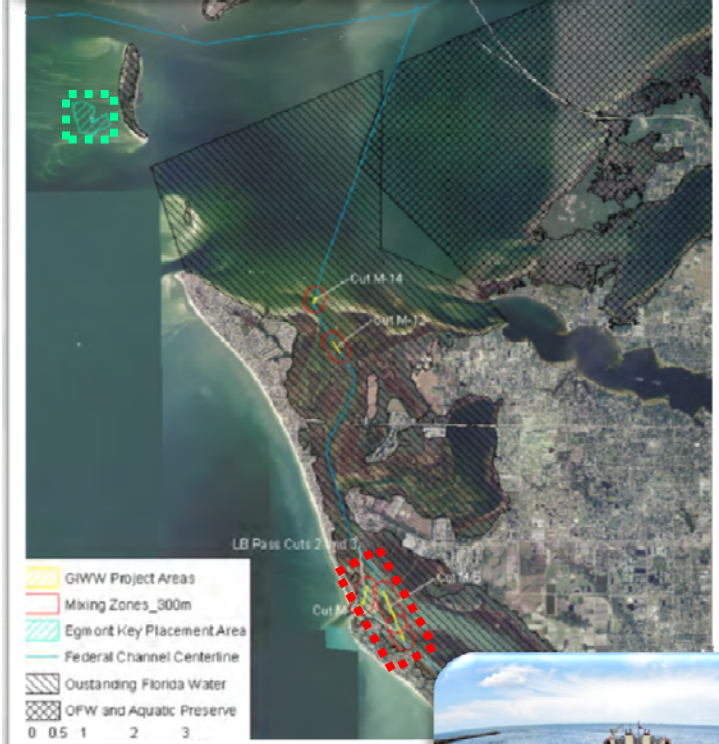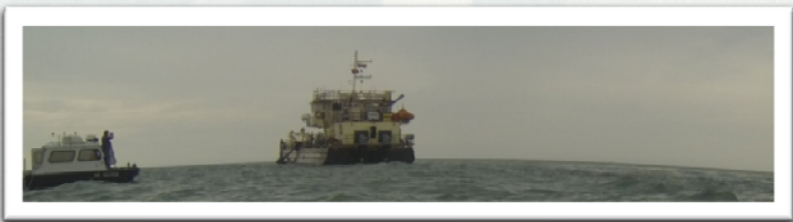
- **ADCP Currents**
- **ADCP Backscatter**
- **Total Suspended Solids**
- **Turbidity Sensor Array**
- **Wave Array**
- **Light Attenuation**
- **Surface Sediment**

GIWW Project Areas
Mixing Zones_300m
Egmont Key Placement Area
Federal Channel Centerline
Outstanding Florida Water
OFW and Aquatic Preserve

FY13 Plans: Release 3D Sediment Resource Tool
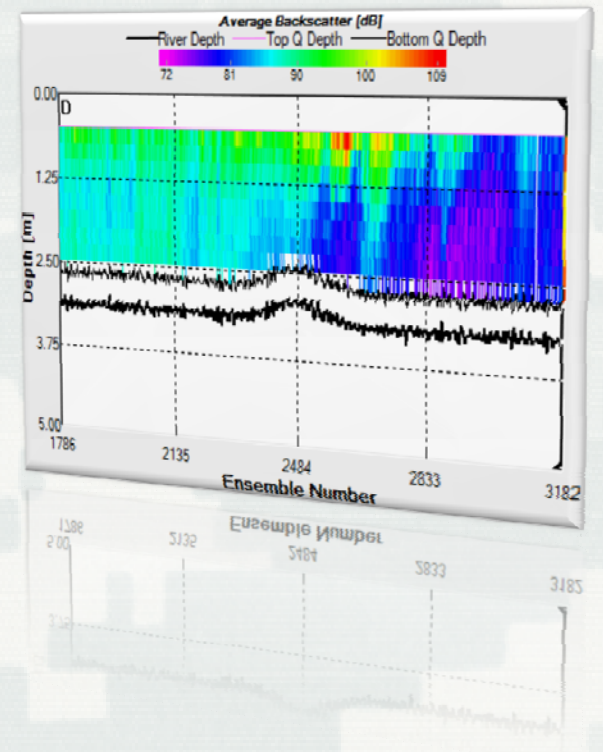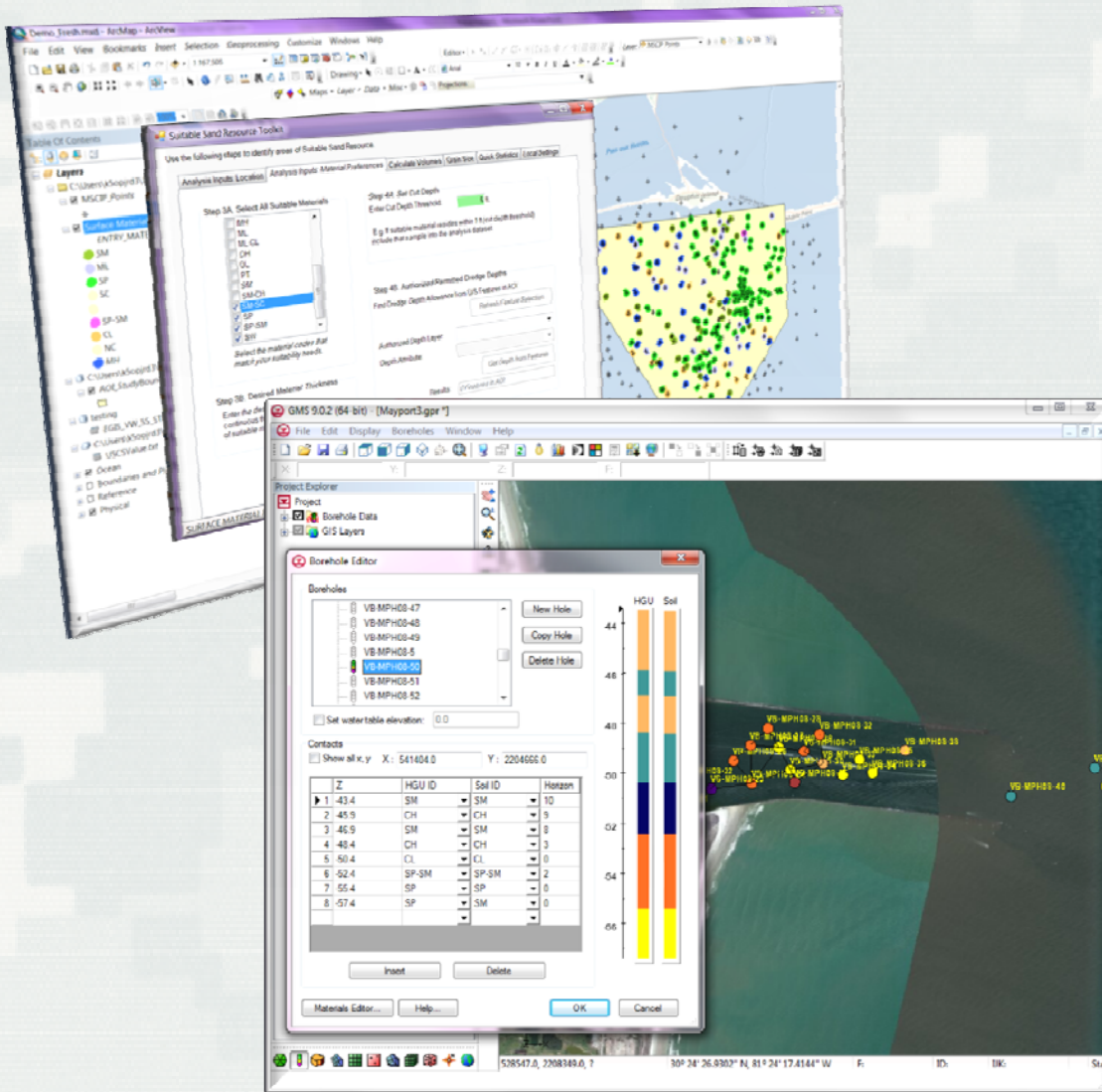
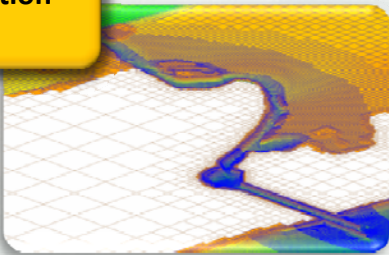- Develop a standard web-service linked to individual District Servers to serve out sediment data into a common format

- Web Application version of data submission form feeds directly to NCDB

- Integrated to GMS, and designed to provide 3D sedimentologic input for SMS numerical models

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Geomorphic Evolution

CMS

CShore

← **Validated 2DH Coastal Model that simulates vertical variation of horizontal velocities and includes mixed sands**
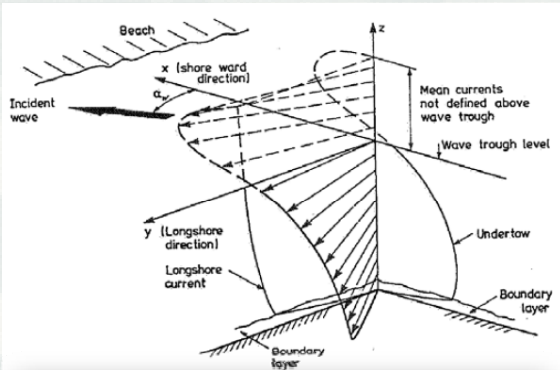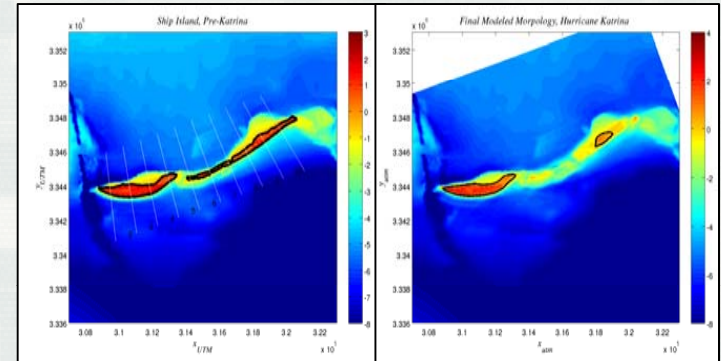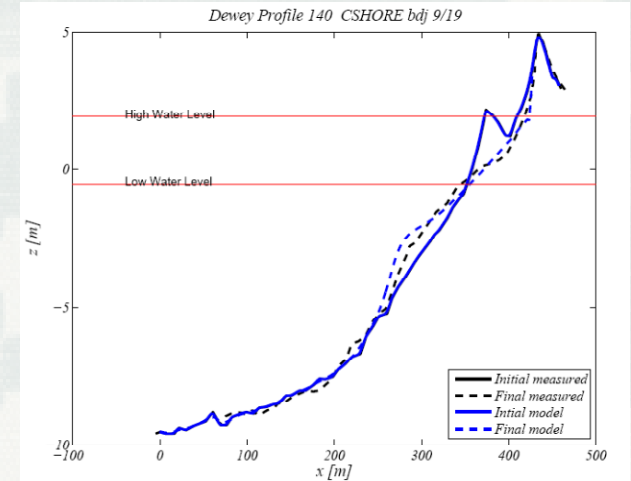

Surf Zone Processes in Both Models:
Undertow
Stokes Drift
Wave Asymmetry
Separated Bed and
Suspended Load
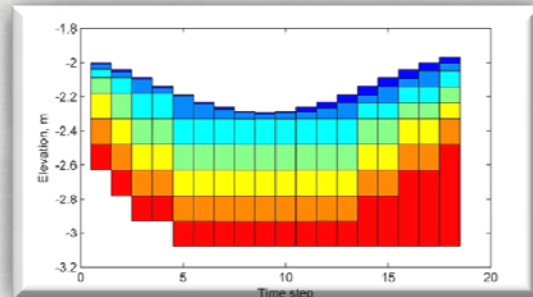
1D Coastal Model → validated for erosion/accretion in the cross-shore for both East and West Coast Applications

Dewey Profile 140 CSHORE bdj 9/19

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CIRP Summary

- All products & documentation available on website and wiki
- CIRP available to travel to your District and provide training on products
    - CIRP travel and labor free (until funding runs out)
- We invite suggestions for improvement, new methods for technology transfer, and challenging inlet applications

New Initiatives with CIRP assistance:

- Corps of Engineers Coastal Engineering Certificate Program
- FRF Field Experiment with Nearshore Berm

Corps of Engineers Coastal Engineering Certification (CECEC) Program

Home | Overview | Courses | Tutorials | Examples | Registration | FAQs

- Overview of CECEC
- Upcoming Courses
- Software Tutorials
- Examples of Special Projects

- Registration
- Download Information
- Computer Requirements
- FAQs

We anticipate launching the CECEC program in Spring 2014, but potential applicants are encouraged to email for more information and upload your registration at any time.

ERDC — Engineer Research and Development Center
US Army Corps of Engineers.
CHL — Coastal and Hydraulics Laboratory
asbpa

Target Date: Sep FY15- Sep FY17
- Coastal experiments on Atlantic
- Estuary experiments in Currituck Sound
- Overland environmental measurements
- Multi-R&D, multi-agency experiment

ERDC-EL

C2SHORE

Field Research Facility

Coastal and Hydraulics Laboratory

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