



COASTAL MODELING SYSTEM

CMS DEVELOPMENT, V&V, TECH TRANSFER,
AND USER SUPPORT

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COASTAL INLETS RESEARCH PROGRAM

FY22 IN PROGRESS REVIEW

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Coastal Modeling System Annual Report
Brown Lihwa Lin, Yan Ding, Tanya M. Beck,
Ming Wu, Christopher Reed, and Alan Zundel
April 2023

CMS-Wave
Reflection, Run-up, Setup, Overtopping,
Wave Generation, Structures,
Nestled Grids
Wave Height, Period, Direction, Dispersion,
Radiation Stress

CMS-Flow
Hydrodynamics
Circulation, Tide, Wind, River
Sediment Transport
CMS/C2SHORE
Mixed Grain Sizes
Sediment Mapping
Salinity/Temperature

SMS

Water Level (m)
0.0014
0.0008
0.0003
-0.0003
-0.0008
-0.0014
Velocity
5.00 m/s
0.50 m/s



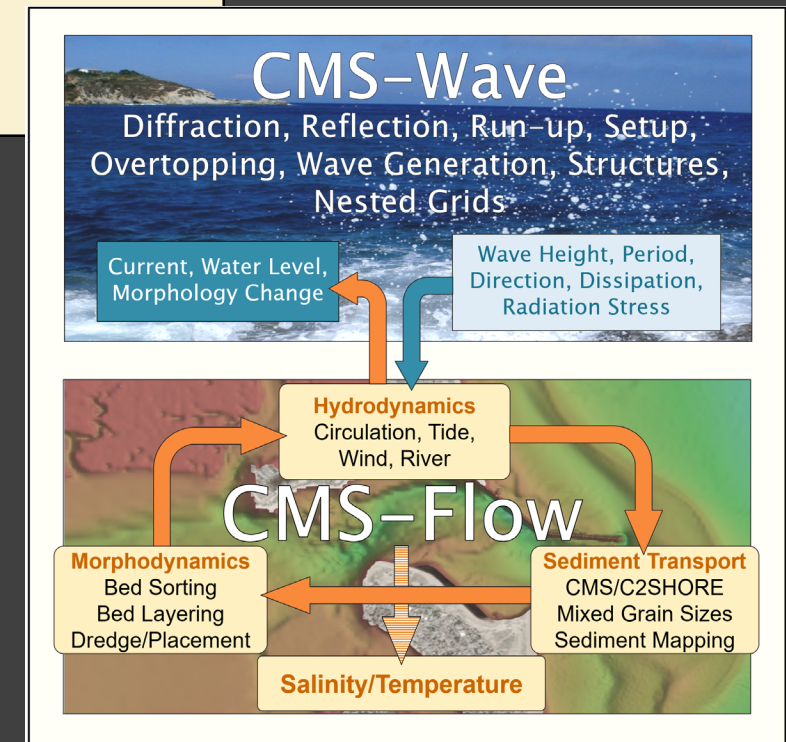
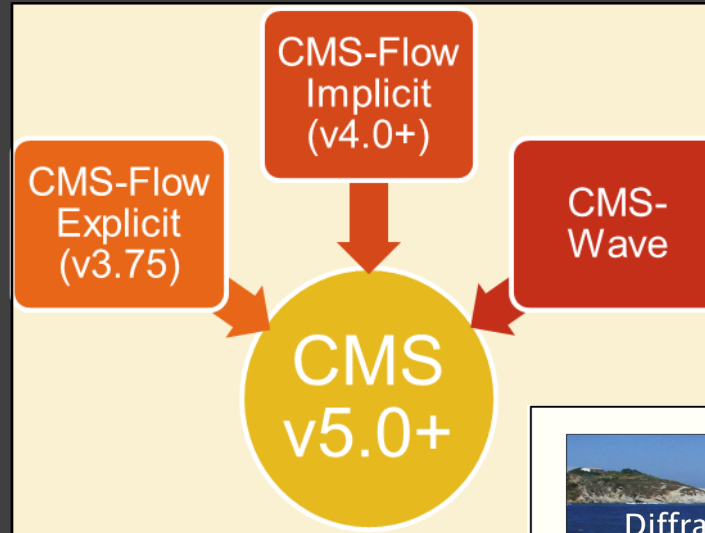
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Problem Statement

- The Coastal Modeling System has evolved from three separate models into one merged code (presently CMS 5.3):
 - A model user guide is necessary for USACE-wide tech transfer and user support.
 - Merged Code debugging, testing, and streamlining
 - GUI releases – SMS 11.x to SMS 13.2 (dynamic interface)
 - Training via workshops/webinars.



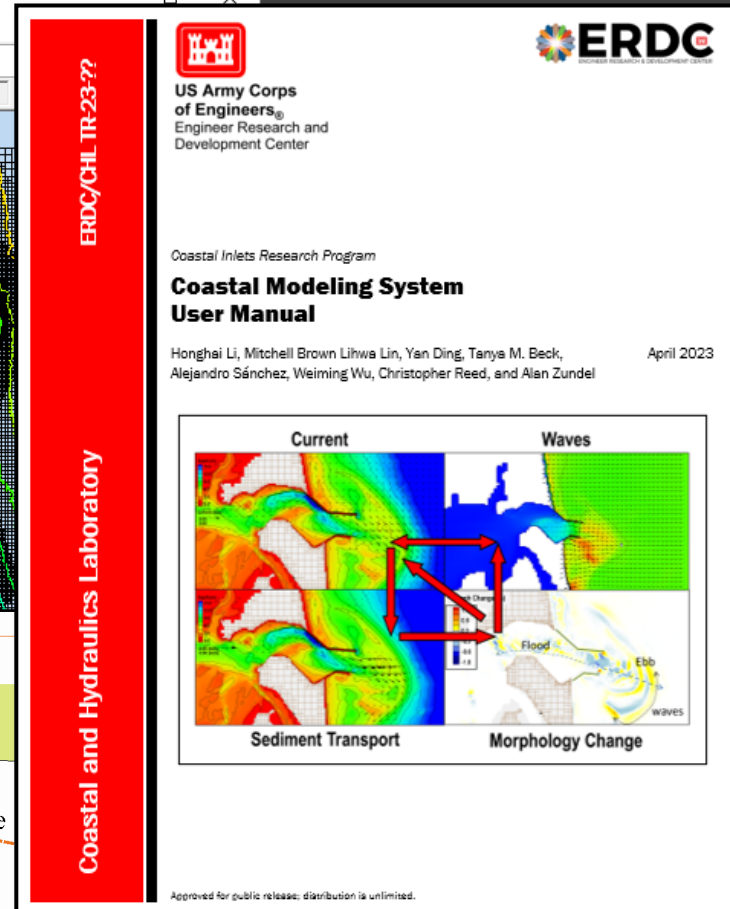
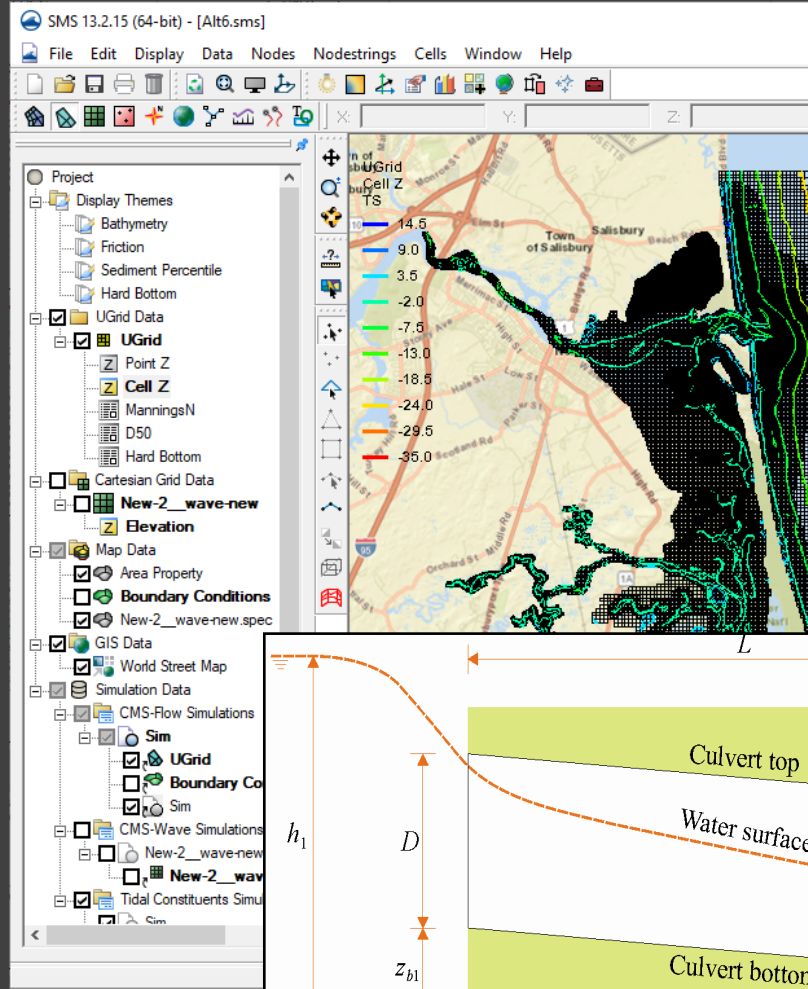
CMS Framework

Navigation Statements of Need

- 2019-N-1370: Testing and Evaluation of USACE Coastal Numerical Models.

CMS User Guide

- Hydrodynamics, wave transformation, sediment transport and bed changes
- Governing equations and numerical methods
- Graphical user interface for model setup and result post-processing with SMS 13.2
- Features
 - Surf zone process (longshore, cross-shore sediment transport)
 - Salinity/temperature calculations
 - Coastal structures (rubble mound, culvert, weir, tidal gate)
 - Sediment mapping (Eulerian sediment tracer simulation)
 - Sea level change
 - Dredge/placement module



$$\begin{aligned}
 \text{Approx} \frac{\partial(hV_i)}{\partial t} + \frac{\partial(hV_j V_i)}{\partial x_j} - \varepsilon_{ij} f_c h V_j &= -gh \frac{\partial \bar{\eta}}{\partial x_i} - \frac{h}{\rho} \frac{\partial p_a}{\partial x_i} \\
 + \frac{\partial}{\partial x_j} \left(v_t h \frac{\partial V_i}{\partial x_j} \right) - \frac{1}{\rho} \frac{\partial}{\partial x_j} (S_{ij} + R_{ij} - \rho h U_{wi} U_{wj}) &+ \frac{\tau_{si}}{\rho} - m_b \frac{\tau_{bi}}{\rho}
 \end{aligned}$$

CMS: Coding changes

- Release of CMS v5.3 for working with SMS 13.2 interface.
- Numerous edits for bug-fixes or improved features (Brown, Li)
- Bug fixes relating to the explicit solution scheme (Reed)
- Integrated C2Shore sediment algorithms into master CMS code (Johnson)
- Major change for inline steering correcting behavior of the wave model integration (Lin)
- Maintain CMS code in Git repository for accessing and interacting within and coworkers outside the group

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== Version 5.3.3 (04/07/2023) ==
* Split third-party code (spatial transformations) out as separate
* Implemented two new ADCIRC tidal databases (EC2015 and ENPAC2015)

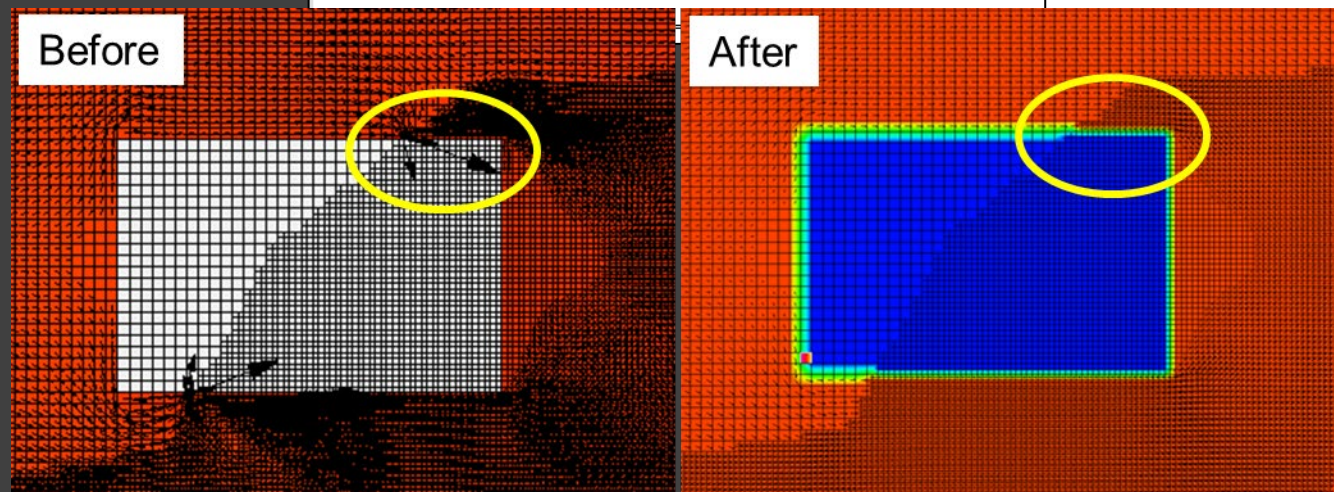
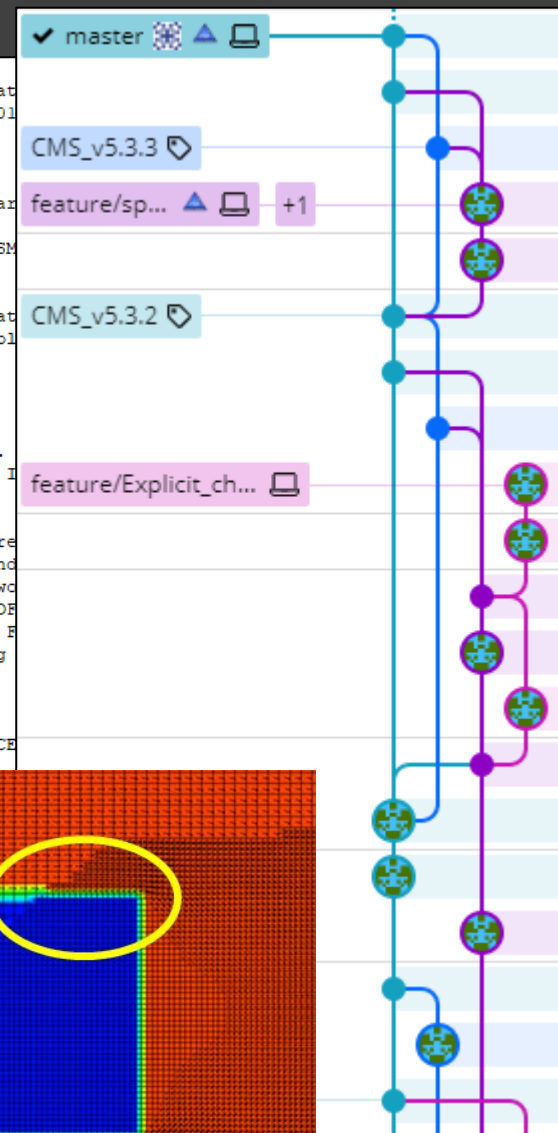
== Version 5.3.2 (08/11/2022) ==
* Minor change to reading parameter file for Explicit scheme.
* Bug fix when choosing multi-sediment with D35,D50,D90. Fixed array
* Bug fix in one lookup-table, 'bs_init' routine.
* Bug fix in Tools (Option 4) when merging datasets written by SMS

== Version 5.3.1 (07/07/2022) ==
* Minor change to Weir Structure specification cards for integration
** Add option to specify Cell IDs in the same manner as for Rubble
* Updated the array upper limit for several CMS-Wave variables.

== Version 5.3.0 (05/16/2022) ==
* Initial version of CMS to be released with SMS version 13.2
* Change cardnames and documentation from 'CSHORE' to 'C2SHORE'.
** C2SHORE is a new option for Cross-shore sediment transport.

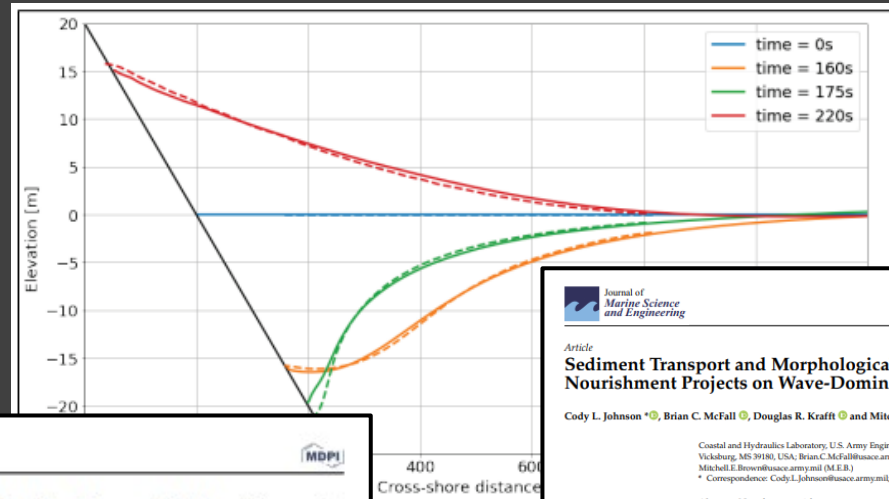
== Version 5.2.18 (04/29/2022) ==
* Bug fix for DREDGE_RATE card in the dredging module. Was not re
* Bug fix for divide by zero in WVBK_Inline - rewrote using cond
* Bug fix for using Initial Condition file outside the current wo
* New card 'EXTEND_DURATION_RUN_FOR_HOTSTART' with value 'ON'|'OFF
* Minor - force user to associate datasets with their choice of E
* Minor - added better diagnostic output for Dredge Rate showing

== Version 5.2.17 (03/29/2022) ==
* Bug fix for Wave structures
* Bug fix for Dredge/Placement where no cards exist between PLACE
  
```



CMS: Tech Transfer

- Assist USACE users in CMS applications
- Support districts in projects on sediment management, dredge/placement operations, beach nourishment, coastal structure design (NAE, NAN, NAP, NAB, NAO, SAW, SAJ, NWS, SPN, SWG, LRB, LRE)
- Start migration of WaveNet tools to the WIS Portal
- Updated several key CIRP Wiki pages with latest information
- Documentation (tech reports, tech note, letter report, JP, SOWs)



Journal of Marine Science and Engineering MDEPI

Article
Feedback between Basin Morphology and Sediment Transport at Tidal Inlets: Implications for Channel Shoaling
 Douglas K. Krafft, Richard Styles, and Mitchell E. Brown

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 * Correspondence: douglas_krafft@erdc.usace.army.mil

Abstract: Increasing societal pressures (e.g., population growth and urbanization) change practices in coastal areas that could potentially alter the hydrodynamic transport patterns near coastal inlets in ways that might exacerbate existing or investigate the potential impact of coastal development, a numerical model in an inlet evolution of an idealized lagoonal-type barrier island inlet under fixed inlet conditions that transferred from net sediment import to net sediment export, designed to address the potential effect of inter-tidal placement and land use transport and the resulting deposition/erosion patterns. Estimates that were an extensive tidal flat tended to promote sediment import and had a greater pro-channel shoaling. Simulations that were characteristic of inter-tidal placement set the likelihood of channel shoaling was increased because some of the net tidal flats was deposited in the deeper channels as opposed to being eroded. Alternatively, it was found that regions in which the intertidal area was restricted in the tidal flats, which also showed a net export, produced greater sediment area that tended to bypass the deeper sections, reducing the likelihood of channel shoaling.

Keywords: hydrodynamic modeling; tidal inlets; long-term morphological change; morphodynamics; modeling; coastal inlet evolution; hypothesis

1. Introduction
 Increasing societal pressures (e.g., population growth and urbanization) change practices in coastal areas. In response to the greater engineering activities, such as armoring, sediment diversions, dune stabilization, and other coastal protection, these modifications can alter flow, or decrease fetch and average water depth, and change tidal propagation. The long-term effect of anthropogenic modifications to coastal inlets is sea level change, which itself can affect sediment distribution patterns. Urbanization and changes in land use practices could have various sediment transport and channel-shoaling patterns, thereby exacerbating through increased dredging requirements and associated costs.

Numerical modeling can be used to explore the dynamic feedback between the hydrodynamics and the morphology. Long-term simulation of coastal shifts in the large-scale sediment transport patterns that affect the sediment supply. The initial sediment distribution (hydrodynamics) can explore the role of sediment placement to control the dominant sediment import vs. export. Configurations that favor sediment import and loss of channel shoaling can be categorized in terms of morphology (land to water), sediment supply, or new sediment placement. Developing a geomorphology...

J. Mar. Sci. Eng. 2022, 10, 422. <https://doi.org/10.3390/jmse1004422>

Journal of Marine Science and Engineering MDEPI

Article
Sediment Transport and Morphological Response to Nearshore Nourishment Projects on Wave-Dominated Coasts
 Cody L. Johnson, Brian C. McFall, Douglas R. Krafft, and Mitchell E. Brown

Coastal and Hydraulics Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS 39180, USA; Brian.C.McFall@erdc.usace.army.mil (B.C.M.); Douglas.R.Krafft@erdc.usace.army.mil (D.R.K.); Mitchell.E.Brown@erdc.usace.army.mil (M.E.B.)
 * Correspondence: Cody.L.Johnson@erdc.usace.army.mil; Tel.: +1-601-634-2522

Abstract: Nearshore nourishments are constructed for shoreline protection from waves, to provide sediment nourishment to the beach profile, and to beneficially use dredged sediment from navigation channel maintenance. However, it is poorly understood how placement morphology and depth influence nearshore processes operated on wave-dominated coasts. This study investigates the wave fields, sediment transport, and morphological response to three common nearshore nourishment shapes, nearshore berm (elongated bar), undulated nearshore berm, and small discrete mounds, with the use of the Coastal Modeling System. The nourishments are placed in three distinct coastal settings with a volume of approximately 100,000 m³ and between 400 m and 600 m from the shoreline. Numerical simulations are carried out in three distinct coastal settings and geomorphology. Simulation results indicate that shallower, more diffuse placements receive the most wave energy, while deeper, more discrete placements receive the least wave energy. The results from this study improve the understanding of nearshore nourishment structures and their morphological response to wave-dominated coasts. The most appropriate construction technique for nearshore nourishment projects is identified based on the results of the simulation. The results of this study indicate that nearshore nourishment projects can be constructed by beneficially using dredged sediment from navigation channel maintenance. However, it is poorly understood how placement morphology and depth influence nearshore processes operated on wave-dominated coasts. This study investigates the wave fields, sediment transport, and morphological response to three common nearshore nourishment shapes, nearshore berm (elongated bar), undulated nearshore berm, and small discrete mounds, with the use of the Coastal Modeling System. The nourishments are placed in three distinct coastal settings with a volume of approximately 100,000 m³ and between 400 m and 600 m from the shoreline. Numerical simulations are carried out in three distinct coastal settings and geomorphology. Simulation results indicate that shallower, more diffuse placements receive the most wave energy, while deeper, more discrete placements receive the least wave energy. The results from this study improve the understanding of nearshore nourishment structures and their morphological response to wave-dominated coasts. The most appropriate construction technique for nearshore nourishment projects is identified based on the results of the simulation.

Keywords: nearshore nourishment; wave-dominated coasts; sediment transport; coastal hydrodynamics; wave dissipation; nearshore sediment transport; coastal hydrodynamics

https://www.mdpi.com/journal/jmse

ERDC/CHL TR-22-18
Coastal and Hydraulics Laboratory

US Army Corps of Engineers
 Engineer Research and Development Center

Coastal Inlets Research Program
A Revisit and Update on the Verification and Validation of the Coastal Modeling System (CMS)
 Report 1—Hydrodynamics and Waves

Honghai Li, Lihua Lin, Cody L. Johnson, Yan Ding, Mitchell E. Brown, Taryn M. Beck, Alejandro Sánchez, and Weiming Wu
 September 2022

Approved for public release; distribution is unlimited.

CMS: Tech Transfer

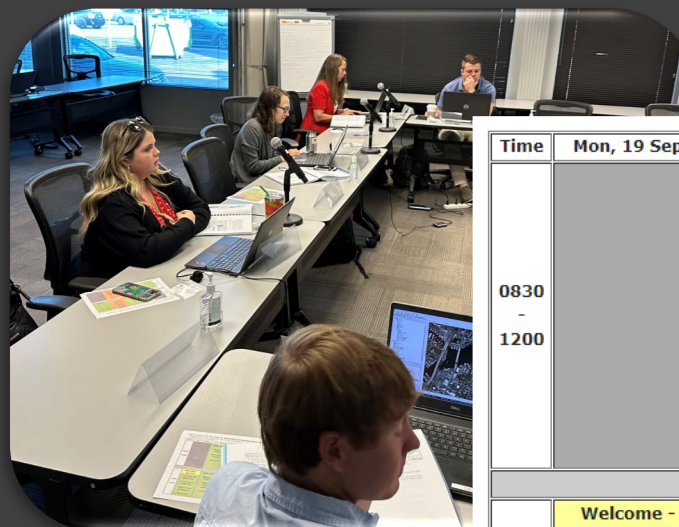
CIRP Technology-Transfer Workshop

CMS/GenCade Workshop

USACE Mobile District, Mobile, AL

19-23 September, 2022

- Leveraged SAD/CIRP funds for the 5-day hands-on workshop
- Gives training for those working on new and existing Coastal Storm Risk Management (CSRM) and Navigation (NAV) projects.
- 16 USACE attendees from SAM, NAE, SAJ, SWG, and ERDC (5 in-person, 11 virtual)



Time	Mon, 19 Sep	Tue, 20 Sep	Wed, 21 Sep	Thu, 22 Sep	Fri, 23 Sep	
0830 - 1200		CMS (v5.2) Flow grid creation Flow model control hands-on	CMS (v5.2) Steering Post-processing Hydro-validation hands-on	GenCade (v1.1.8) Introduction to GenCade Simple Example Walk-Thru hands-on	CMS (v5.2) Multiple Sediment Grain Sizes Advanced Topics SMS 13.2 demo Final Questions Workshop Concludes	
	Lunch on your own					
	1300 - 1700	Welcome - Agenda	CMS (v5.2) Wave grid creation	CMS (v5.2) Sediment Transport	GenCade (v1.1.8) hands-on	
		Overview of SMS 13.1	Wave model control	Morphology Change	New topics: Cross-shore Monte Carlo	
Overview of CMS 5.2		hands-on	hands-on			
Bathymetry & Datums hands-on				Q&A session		



Summary

- FY22 Major Advances in Capability
 - Several improvements to CMS code (better results from inline wave model and explicit solution scheme)
 - CMS User Guide updated for SMS 13.2 interface and new features
 - Tech transfer for CMS/GenCade for East Coast/Gulf Districts in Mobile, AL

- Coming in FY23

- Initial efforts by summer student to prepare for VVUQ Part II: Sediment Transport and Morphology Change in FY24
- Publish final version of CMS User Guide
- Additional CMS review/enhancements (investigate tidal boundary conditions, add tide potential terms, and more)
- WaveNet tool availability within WIS Portal
- 5-day workshop on CMS/GenCade for West Coast and Pacific Districts

- FY22 Major Products & Collaborations

- Journal Pubs (JMSE)
- Tech reports
- SOWs
- EWN Toolkit

The collage consists of three main components:

- WIS Data Portal Map:** A satellite-style map of a coastal region with numerous yellow and red location pins along the shoreline.
- Coastal Modeling System User Manual:** The cover of a manual from the US Army Corps of Engineers, ERDC. It features the ERDC logo and the title "Coastal Modeling System User Manual" under the "Coastal Inlets Research Program". The authors listed are Honghai Li, Mitchell Brown, Lihwa Lin, Yan Ding, Tanya M. Beck, Alejandro Sánchez, Weiming Wu, Christopher Reed, and Alan Zundel. The cover includes a grid-based map with color-coded areas for "Current", "Waves", "Sediment Transport", and "Morphology Change".
- WIS Data Portal Screenshot:** A screenshot of the WIS Data Portal interface for a specific location (ST73345 @ 28.45°N, 89.9°W). It shows a "Data Export" section with options for "Generic Export", "Time Series (ONELINES)", "2D Spectra", "Mean-Max Summary Tables", "Extremes Analysis Table", "Wave Percent Occurrence", and "Wind Percent Occurrence". There are also "Preset Dates" and "Custom Dates" options, a "Select" dropdown set to "2021", and "All Months" selected. Buttons for "Add to Export Group" and "Download" are visible.