### **COASTAL MODELING SYSTEM (CMS)** *DEVELOPMENT, V&V, TECH TRANSFER, AND USER SUPPORT*

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ERDC

CIRP

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19 April 2024

**U.S. ARMY** 

**COASTAL INLETS RESEARCH PROGRAM** FY23 IN PROGRESS REVIEW

**US Armv Corps** 

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Salinity/Temperature







### **PROBLEM STATEMENT**



Users rely heavily on the calculations of waves, hydrodynamics, sediment transport, and morphodynamics to address problems related to channel shoaling, dredging, and coastal structure modifications. Systematic quality assurance and quality control processes are necessary because the CMS evolves continually, and different versions and updates often produce different solutions.

Statement of Need: 2018-N-1356: Long-term Modeling of Barrier Island Tidal Inlets 2019-N-1509: Morphodynamic Modeling of Navigation Designs 2021-N-1538: Nearshore Processes Research and Development 2022-N-1726: Nearshore Nourishment Best Management Practices



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# **CAPABILITY AND STRATEGIC IMPACT**



The CMS gives users the capability to perform 2D simulations of project alternatives using advanced, integrated models complete with coastal hydrodynamic, wave, sediment transport, and morphodynamic process, including surf zone processes.

User-friendly, computationally inexpensive framework has enabled hundreds of projects by Districts, ERDC, and consultants, along the East, Gulf, Great Lakes, and West Coasts of the United States as well as other international locations.





# **TECHNICAL APPLICATIONS**



### Scopes of Work (SOWs)

- SWG USCG Station Waterfront Facility
- NAN Stony Creek Marsh Island Ecosystem Restoration Project
- MVN Shoaling Rate Comparison for Alternative vs. Tentative Plan
- NAP CMS and GenCade evaluation of coastal structure performance and impacts at Indian River Inlet, DE
- POH Study Pohoiki Bay hydrodynamic analysis, sediment budget and CMS modeling

### Reports

- NAN Cupsogue Beach County Park, New York
- MVN Shoaling Rate for Baptiste Collette Bayou
- SAS Nearshore BUDM at Jekyll Island, Georgia
- NAO Milford Haven
- NAO Hampton Roads
- SAW Sediment tracer study for Cape Fear Inlet
- SAW Sediment tracer study for Beaufort Inlet

### Transferability/transparency

- CMS OpenSource GitHub release (Jan 2024)
- CMS User's Guide TR published (Apr 2024)











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## **TECHNICAL ADVANCEMENTS**



 $-H_s$ 

 $-average(E_f)$ 

500

600

- - Ef

1.8

1.6

1.4

0.8

0.4

0

0

 $[m]^{1.2}$ 

ERROF

100

200

300

x[m]

400



- Wave energy flux at boundary (Johnson), shown right
- Dynamic model interface (DMI) for sea level rise curve and permeable structures (Li)
- Wave file export and convergence (Li)

Improvements to Rubble Mound Structure DMI (Brown) allowing for either constant forcing or from a dataset:

	S Rubble Mound Jetty Attributes		
	Name:	South Breakwater	
	Rock diameter type:	Dataset V	
	Select	Project/UGrid Data/UGrid/ROCK_D	
	Porosity type:	Constant ~	
	Porosity:	0.4	
	Base depth type:	Dataset ~	
	Select	Project/UGrid Data/UGrid/BASE_D	
	Calculation method:	Kadlec and Knight (1996) 🗸 🗸	
		OK Cancel Help	



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### TECHNICAL ADVANCEMENTS (cont.)



				G Tidal Constituents X
SMS Reintroduction of	Source: ADCIRC2015 V			
with undate to <b>newest</b>	ADCIRC 20	15 databases (Brown)		Reference time: 10/1/2023 12:00 AM 🐳
with update to newest		15 databases (blowit)		Constituents
Added the CMS-Wave • Presently works for WIS	model input S Stations only	tool on the WIS Data Por	rtal (Brown)	2MK3       2N2       2Q1       2SM2         J1       K1       K2       L2         LAMBDA2       M1       M2       M3         M4       M6       M8       MF         MK3       MM       MN4       MS4
<ul> <li>EV21 work will extend t</li> </ul>	the canability t	o work with NDBC and MEDS	Shuove	MSF NU2 NU2
	ine capability i		5 buoys.	01 🗹 001 🗌 P1 🗌 Q1 🗹
	CT70007 - 00 0000 00 0 000 / 0000		×	R2 🗌 RHO1 🗌 S1 🗌 S2 🗹
	ST73337 @ 28.00°N, 93.9 °W / 1980-0	01-01T01:00:002 - 2023-01-01T00:00:002		S4 S6 SA SSA
WIS Data Portal	Overview	CMS-Wave (beta)		T2
	Data Export	This tool obtains information from 2d Spectra for a particular station and transforms that information to the specified depth for a CMS-Wave grid domain.		Select All Clear All Select Minor Select Major
Q ;; Data Layers Stations Legends Backgrounds () Q Filter data layers	Generic Export 2D Spectra Time Series (ONELINES) Mean-Max Summary Tables	sending back the files needed for CMS-Wave forcing. A maximum of one year is allowed due to file sizes. Preset Dates Custom Dates	~ -	OK Cancel Help
	Extremes Analysis Table	Select 2022 V All Months V		
WIS Stations ✓ Q Alaska	Wave Percent Occurrence		a218_2022-01-01_2022-01-31.eng ⊠	
<ul> <li>♀ Atlantic</li> <li>♀ Great Lakes</li> </ul>	Wind Percent Occurrence	gridOrientation 1	2 0.03500 0.03850 0.04240 0 3 0.09080 0.09990 0.10980 0	0.04660 0.05120 0.05640 0.06200 0.06820 0.07500 0.08250 0.12080 0.13290 0.14620 0.16080 0.17650 0.19460 0.21410
<ul> <li>♀ Gulf Of Mexico</li> <li>♀ Pacific</li> </ul>	Plots		4 0.23550 0.25900 0.28490 0 5 202201010100 4.8 358.0	0.31340 0.34470 0.37520 0.41710 0.45880 0.50470
Buoys	Wind Rose	Add to Export Group Download	6         0.00000         0.00000           7         0.00000         0.00000	0.00000 0.00000 0.00000 0.00000 0.00000
MEDS (Canada)     VDBC	Wave Rose		8 0.00000 0.00000 9 0.00000 0.00000	0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
	Duration		10 0.00000 0.00000 11 0.00000 0.00000	0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
	Wave Height Duration Distribution		12 0.00000 0.00000 13 0.00000 0.00000	0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
	Yearly Wave Height Time Series		14 0.00000 0.00000 15 0.00000 0.00000	0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
a contraction of the second	Extremes Analysis Plot		16 0.00000 0.00000 17 0.00000 0.00000	0.00000 0.00000 0.00000 0.00000 0.00000
	Input for Models			0.00000 0.00000 0.00000 0.00000 0.00000
	CMS-Wave (beta)		20 0.00000 0.00000	0.00000 0.00000 0.00000 0.00000 0.00000
				0.00000 0.00000 0.00000 0.00000 0.00000
	5		23         0.00200         0.00200           24         0.00000         0.00000	0.00100 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
CIRP		UNCLASSIFIED	25         0.00000         0.00000           26         0.00000         0.00000	0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000



## SUMMARY



FY23 Major Advancements in Capability	FY23 Major Products & Collaborations
<ul> <li>Dynamic model interface (DMI) for rubble mound structures and others</li> <li>Addition of CMS-Wave tool within the WIS Data Portal</li> <li>Code debugging and feature testing</li> <li>Sediment Transport V&amp;V test cases prepared</li> </ul>	<ul> <li>Release CMS version 5.3.8 [Jan 24], Push code to Open Source (GitHub)</li> <li>Publish CMS User's Guide</li> <li>User Training and Support to USACE Districts, Workshop @ SPL</li> <li>Interactivity between CMS and WIS teams</li> <li>Coordination with NMM and WW3 teams</li> <li>1 journal paper, 6 conf. presentations; several Letter Reports</li> <li>2 USACE Poster Sessions (CWG &amp; RD24)</li> </ul>

#### FY24 Products & Advancements

- Implementation of Continuous Integration (CI) QAQC framework to Git version control
- DMIs for three additional structure types (i.e., weirs, tide gates, culverts), Aeolis, sediment mapping, and hard bottom features
- Adding toolboxes to SMS to rapidly calculate meaningful hydro/morpho statistics of interest
- Review of implicit and explicit codes to streamline, standardize nomenclature, and carefully merge
- Update WIS Portal API to allow better access for users and through SMS
- Continue yearly workshops for USACE District staff and their consultants
- Documentation of various features and improvements and various tech transfer activities (i.e., training, web dev, conferences, pubs)
- Continue to investigate and implement fixes for known code issues
- Continue tech transfer through Workshop/Webinar & DOTS requests.

1 BAA (Clarkson University), Task Orders for Aquaveo and RPS/TetraTech contracts, 1 Task Order for CHL IDIQ (Reed)



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