


**CIRP**  
Research & Development



**COASTAL & HYDRAULICS LABORATORY**  
**ERDC**  
Engineer Research and Development Center


## Waves at Navigation Structures

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**US Army Corps of Engineers**




Coos Bay Inlet, Oregon



**CIRP**

## Waves at Navigation Structures

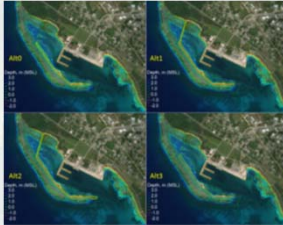


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- **Work Unit focus:**
  - ▶ Maintain and upgrade CIRP wave models
  - ▶ Support USACE and other users of models
  - ▶ Conduct & assist Districts in reimbursable studies
  - ▶ Develop & improve WaveNet/TideNet webtools
  - ▶ Improve inputs for coastal structure design and rehab methods in wave models

**Goal:** provide USACE community reliable wave models for performing its missions in projects at coastal inlets, navigation, structures, ports, harbors, marinas, adjacent beaches, reefs, and wetlands


- **FY18 Statements of Need addressed:**
  - ▶ SoN 17-N-01: Testing and evaluation of USACE coastal numerical models
  - ▶ SoN 16-N-14: Long-term modeling of coastal structure functionality



Tinian Harbor Modification



Lynnhaven Harbor Modification




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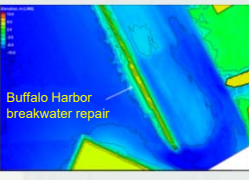
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## Overview of FY18 Products




- **Research Products**
  - 3TRs, 4TNs, 3CPs, 2JPs, 1 Book Chapter
  - CIRP trainings: NWP, NWS, SPL, POH, SWG, LRE, LRB (B2D, CMS, PTM, WaveNet/TideNet)
  - DOTS requests: (1) Swinomish Channel RSM project, and (2) Matagorda Bay modeling
  - Proposals: (1) ERDC Basic and Applied R&D Program and (2) USMC proposal for PACOM applications.
  - Updates: TideNet/Wavenet, CMS-Wave, SMS
- **SoNs supported by R&D advancement:**
  - SoN 2016-N-10: continue R&D to enhance swash zone & surf zone sediment transport processes
  - SoN 2016-N-4: quantify wave and current driven sediment transport at near-shore dredge disposal sites
  - SoN 2013-N-22: data integration framework – navigation portal





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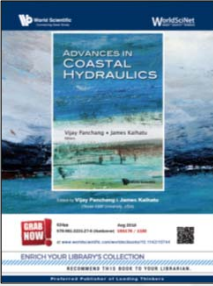


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## JPs & TNs




- Book Chapter – “Use of numerical modeling and field data for harbor infrastructure modifications” Demirebilek, Z., L. Lin, T.D. Smith and O.G. Nwogu. *Advances in Coastal Hydraulics*. World Scientific, London, 2018.
- JP – “LiDAR and multi-spectral imaging investigations in Lake Superior: migrating tailings threaten Buffalo Reef”. Kerfoot et al., *Limnology & Oceanography*, 2018.
- JP – “Interpolation method based on linear regression and Monte Carlo simulation for hurricane storm surge vulnerability of US Highway 90 along Mississippi Gulf coastline” Bu et al., *Journal of Operational Oceanography*, 2018.
- TN – “Understanding regional shoreline change and coastal processes at the Sunset Beach region, Oahu, Hawaii” Smith et al., ERDC/TN RSM-18-1, 2018.
- TN – “Hawaii RSM: West Maui Nearshore sedimentation at Honokowai Stream” Podoski et al., ERDC/TN RSM-18-xx.
- TN – “Alternatives to manage sediment at the intersection of the Gulf Intracoastal Waterway and the Corpus Christi Ship Channel” Hamilton et al., ERDC/TN RSM-18-xx.
- TN – “Evaluation of alternatives in navigation channel to Victoria for beneficial utilization and design consideration” Hamilton et al., ERDC/TN RSM-18-xx.





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## TRs & CPs



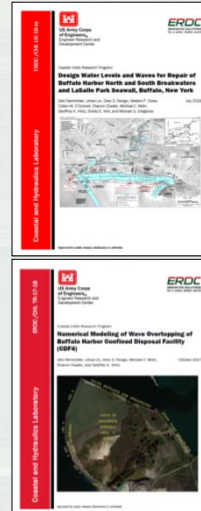
- TR – “Numerical modeling of wave overtopping of Buffalo Harbor Confined Disposal Facility (CDF4)” Demirbilek et al., ERDC/CHL TR-17-18, Oct. 2017.
- TR – “Design water levels and waves for repair of Buffalo Harbor North and South Breakwaters and LaSalle Park Seawall, Buffalo, New York” Demirbilek et al., ERDC/CHL TR-18-xx.
- TR – “Hydrodynamic and salinity modeling for Matagorda Ship Channel (MSC) improvement project” Lin et al., ERDC/CHL TR-18-xx.
- CP – “Wave and circulation numerical modeling for breakwater rehabilitation project at Tinian Harbor, Northern Marianna Islands” Lin, L., Z. Demirbilek, and J.H. Podoski. 28th International Symposium of Ocean & Polar Engineering, 2018.
- CP – “Coastal wave modeling for jetty rehabilitation at Coos Bay, Oregon” Lin, L. and Z. Demirbilek. 36th International Conference on Coastal Engineering, 2018.
- CP – “Numerical modeling of alternatives to reduce channel shoaling at Lynnhaven Inlet, Virginia Beach, USA” Lin, L. and Z. Demirbilek. 9th International Conference on Scour and Erosion, 2018.







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## MetOcean Webtools



### WaveNet & TideNet


- Web-based interactive GUIs using ESRI maps
- Availability: Districts access thru ACE-IT network
- Purpose: provide data for projects and numerical models
- Data sources: NDBC, USACE, CDIP, GLCFS, GLOS, WW3, ADCIRC, Le Provost, NWS, TPXO
- Data types: winds, waves, water levels
- Functions: access, process, plot, and analyze data






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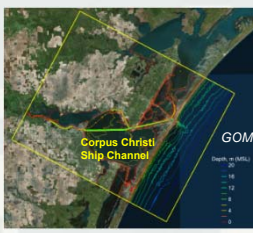
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## DOTS/CIRP/RSM Requests & Proposals




- **Requests**
  - NWS: Seattle Harbor, Swinomish Channel sediment modeling project (Oct 2017-Sep 2018)
  - NWP/NWS: U.S. Moorings project for Portland Harbor, OR (Feb-Sep 2018)
- **Proposals**
  - ERDC Basic and Applied R&D: Metocean metrics for port & harbor accessibility and usability
  - USMC: Identification of beach access points and harbors for military operations
  - LRB: Buffalo Harbor infrastructure repairs project
  - LRE: Wisconsin Pt beach nourishment project
  - LRE: Lexington Harbor sediment accretion study
  - SWG: Matagorda Ship Channel widening/ deepening and design placement area modeling
  - SWG: Corpus Christi Ship Channel improvement project





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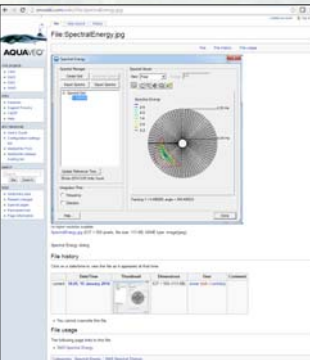
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## SMS & CIRP Website Updates



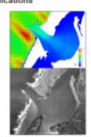
- **CMS-Wave interface in SMS**
  - Wave spectra source options:
    - 1) spatially varying
    - 2) nested grids (from parent grid)
  - Input spectra generation along open boundaries
  - Variable wind, water level, and current inputs
  - Coupled to CMS-Flow, GENCADE and BOUSS-2D
- **CIRP website**
  - Model upgrades and updates
  - SMS interface changes
  - CMS/B2D trainings for SPL, NWP, NWS, POH, SWG, and assistance to A/E firms, academia & others




**CMS-Wave: A Two-Dimensional Steady-State Spectral Wave Model for Coastal Inlet Applications**



**Description:**  
 An operator wave transformation model for regional and reservoir wave applications support USACE missions for military and civil works.  
 - CMS-Wave is part of the Coastal Modeling System (CMS). It is a PC-based software model, which serves as a coupled to hydro and sediment transport models.

**Model Overview:** CMS-Wave is part of the Surface Water Modeling System (SWMS) which is used for all USACE missions.  
<http://www.usace.army.mil/ERDC/COE/Products/Modeling/Modeling%20Systems/CMS/>  
[CMS-Development@usace.army.mil](mailto:CMS-Development@usace.army.mil)




Wave application in Humboldt Bay, CA







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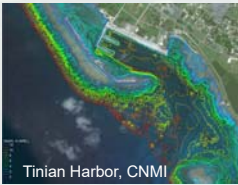
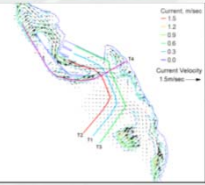
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## FY19 R&D and SoNs




- **WaveNet/TideNet Tools for Coastal MetOcean Data**
  - SoN 2013-N-22 “Data Integration Framework - Navigation Portal”
- **V&V and Benchmarking for the CMS Tech Transfer and User Support**
  - SoN 2017-N-01 “Testing and Evaluation of USACE Coastal Numerical Models”
- **Wave, Water Level, and Current Estimates for Navigation, Port Operations, and Structures**
  - SoN 2016-N-14 “Long-term modeling of coastal structure functionality”
- **Surface Wind Improvement for Coastal Zone Applications**
  - SoN 2017-N-01 “Testing and Evaluation of USACE Coastal Numerical Models”




Tinian Harbor, CNMI




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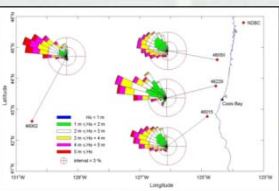
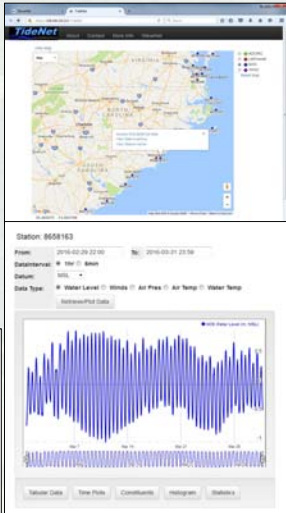
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## WaveNet/TideNet Tools for Coastal MetOcean Data (FY19)




- **Objective:** provide USACE community web-based metocean data access, processing, and analysis tools customized to support the USACE’s “3x3x3 planning paradigm” for a rapid assessment of coastal projects
- **Advancement:** incorporate 2D spectra, 2D current fields, 2D surface wind and pressure fields to support numerical models
- **Products:** provide user guides and conduct training webinars for final release.


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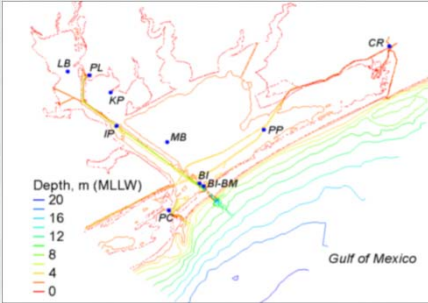
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## CMS V&V (FY19)



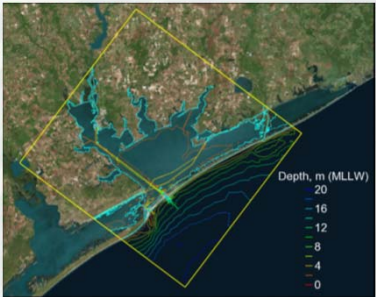
- **Objective:** assemble and re-evaluate the latest CMS using 2011 test cases
- **Advancement:** evaluate the latest CMS to identify I/O and bugs for next release
- **Products:** release the latest CMS with necessary documentation and user guide



Depth, m (MLLW)

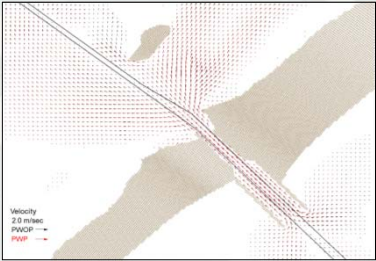
20  
16  
12  
8  
4  
0

Gulf of Mexico




Depth, m (MLLW)

20  
16  
12  
8  
4  
0



Velocity


2.0 m/sec  
PWOP  
PWP




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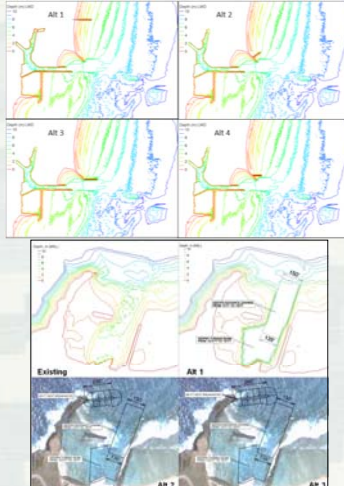
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## Wave, Water Level, and Current Estimates for Navigation, Port Operations, and Structures (FY19)




- **Objective:** implement capabilities in wave models to provide estimates of water levels and wave parameters for navigation and port operations, and for engineering design and rehab of navigation structures
- **Advancement:** provide USACE users water level, wave and current estimates for O&M planning and design studies, test and evaluate these using various methods, including the CEM, Eurotop and Japanese methods
- **Products:** add new capabilities to wave models for calculating structural design/rehab conditions; evaluate and demonstrate these in reimbursable studies, and document in a user guide



AR 1 AR 2  
AR 3 AR 4  
AR 5  
Existing AR 1  
AR 2 AR 3







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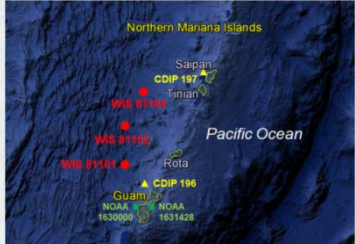
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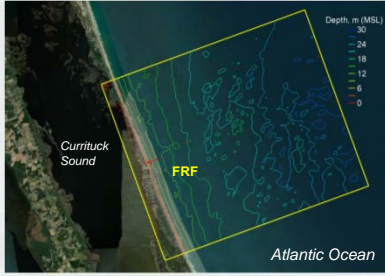


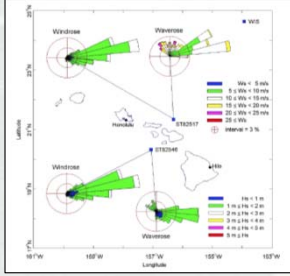
## Wind Input Improvement for Coastal Zone (FY19)




- **Objective:** improve wind input for open applications in coastal zone, bays and estuaries
- **Advancement:** provide USACE user community more reliable and accurate wind input for various applications
- **Products:** document research findings and provide a user guide on procedure for improved wind input











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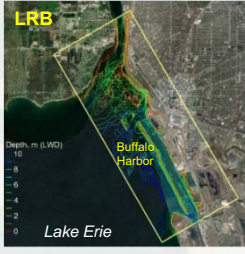



## Reimbursable Studies (FY18)



- Waukegan Harbor, IL: sponsors are LRC and IDNR; entrance channel shoaling and harbor access problems
- Buffalo Harbor, NY: LRB; breakwaters and a seawall repair projects
- Coos Bay, OR: NWS; channel and jetty rehab project
- Wisconsin Pt, WI: LRE and WDNR; beach nourishment and erosion control project
- Matagorda Ship Channel widening/deepening project, TX: SWG; waves-hydrodynamics-salinity modeling project
- Corpus Christi Ship Channel widening/deepening project, TX: SWG; waves-hydrodynamics modeling for placement areas
- Ship Channel to Victoria Harbor, TX: RSM; channel maintenance plan and beneficial use of dredged materials









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## Collaborators (FY18)

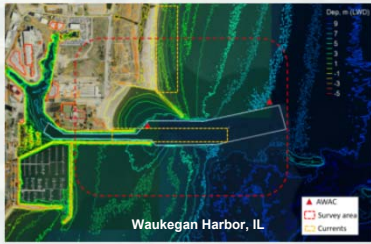


**Internal**

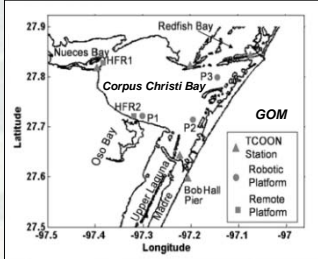
- DOTS
- RSM
- DOER

**External**



- HBCU-MI (JSU, Univ of Hawaii)
- USGS, EPA
- State agencies (HI, CA, FL, VA, MD)
- US universities  
(Univ of Wisconsin, Univ of Illinois Champaign-Urbana, OleMiss, TAMU, UMich, SIT, USF, UC Berkeley, UC Irvine)
- Private industry (USA, CANADA)
- International partners (UPRM, Tokyo Univ, Mansoura Univ, UTwente, UDelft, UHohai, UDundee, UHarbin, UKagoshima, ULund)




Waukegan Harbor, IL




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## Conclusions





- **FY18 major advances**
  - Several coupled studies of B2D and CMS-Wave in USACE projects (Buffalo Harbor, NY, Waukegan Harbor, IL, Lake Macatawa, MI; Portland Harbor, OR)
  - Successful implementation of short- and long-wave forcing capability in projects (Victoria Harbor, Matagorda Ship Channel, and Corpus Christi Ship Channel, TX)
  - Wave inputs for coastal structural studies (Coos Bay, Buffalo Harbor, Duluth Harbor, MN)
- **FY19 key products**
  - WaveNet/TideNet release #3 (final) of improved metocean data tools
  - Release #1 of wave, water level, and current input capability for navigation, port operations, and structures in wave models to support navigation projects
- **FY19 challenges**
  - A web programmer for web-based tools
  - Use Coos Bay lab and field data for V&V of CMS to investigate differences between structural design methods (USACE-Eurotop-others)
  - Prototype time series & 2D wind fields for CMS V&V and other apps


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 **Waves at Navigation Structures** 



**Questions?**

Waves on Tillamook Inlet Jetty



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

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