

CIRP
Research & Development

COASTAL & HYDRAULICS LABORATORY
ERDC
Engineer Research and Development Center

Inlet Engineering Toolbox

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US Army Corps of Engineers

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Inlet Engineering Toolbox

Focus: develop desktop PC and web-based tools to aid in studies of the consequences of engineering actions at coastal inlets


- **Statements of Need addressed**
 - ▶ **GenCade**
 - 2017-N-67: Guidance for Numerical Modeling of Inlet Ebb Shoal and Navigation Mining Studies
 - 2017-N-71: Modeling Effects of Sea Level Change at Tidal Inlets
 - ▶ **Modeling and Monitoring of Coastal Foredunes**
 - 2015-N-11: Resilience Guidance
 - 2014-N-10: Update of engineering guidance for the development and maintenance of coastal dune systems
 - 2017-N-72: Improved Simulation of Dune Morphological Response at Short & Long Time-scales
 - ▶ **Vessel Wake Effects**
 - 2017-N-01: Testing and evaluating USACE coastal numerical models.
 - 2017-N-09: Shoreline sediment resuspension and wave energy dissipation due to vessel wake

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Overview of FY18 Products




- **TRs**
 - ✓ Styles, R. and M. Hartman. Wave characteristics and sediment resuspension by recreational vessels in coastal plain saltmarshes. US Army Engineer Research and Development Center, ERDC/CHL 2018-TR-05
- **TNs**
 - ✓ Townsend, K, R. Thomas, E. A. Frey, D. King, J. Rosati, S. Kim, R. Styles, Y. Ding, and R. Permenter (2018). Comparison of GenCade, Pelnard-Considere, and LITPACK.
 - ✓ Hartman, M. and R. Styles, Vessel wake prediction tool. (In management review)
 - ✓ Kim, S., R. Styles, Y. Ding, R. Permenter, and A. Frey, Cross-shore transport in GenCade
 - ✓ Munger, S. and A. Frey, Computer-based calibration and uncertainty analysis of GenCade: Description and proof of concept (In management review)
- **Workshop/Webinar/Conference**
 - ✓ Conery, I. High-resolution lidar scanning of developed and natural beach-dune systems on the Outer Banks, NC Ocean Sciences
 - ✓ Brodie, K., Terrestrial Lidar Observations of Coastal Morphodynamics in Duck, NC, Ocean Sciences
 - ✓ Brodie, K., Observations of Dune Morphological Evolution in Duck, NC, Over Monthly and Decadal Time-Scales ASBPA
 - ✓ Palmsten, M., High temporal Resolution Observations and Modeling of Dune Erosion in the Collision Regime ASBPA




Conery, I., "High-Resolution LiDAR Observations of Developed and Natural Beach-Dune Systems on the Outer Banks, NC" ASBPA





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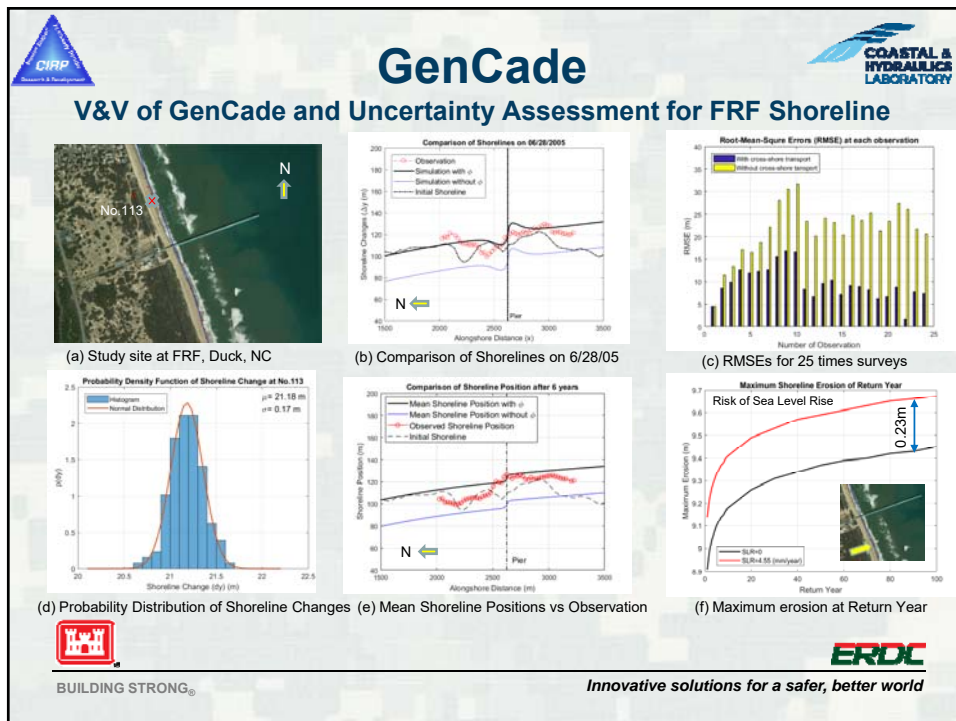
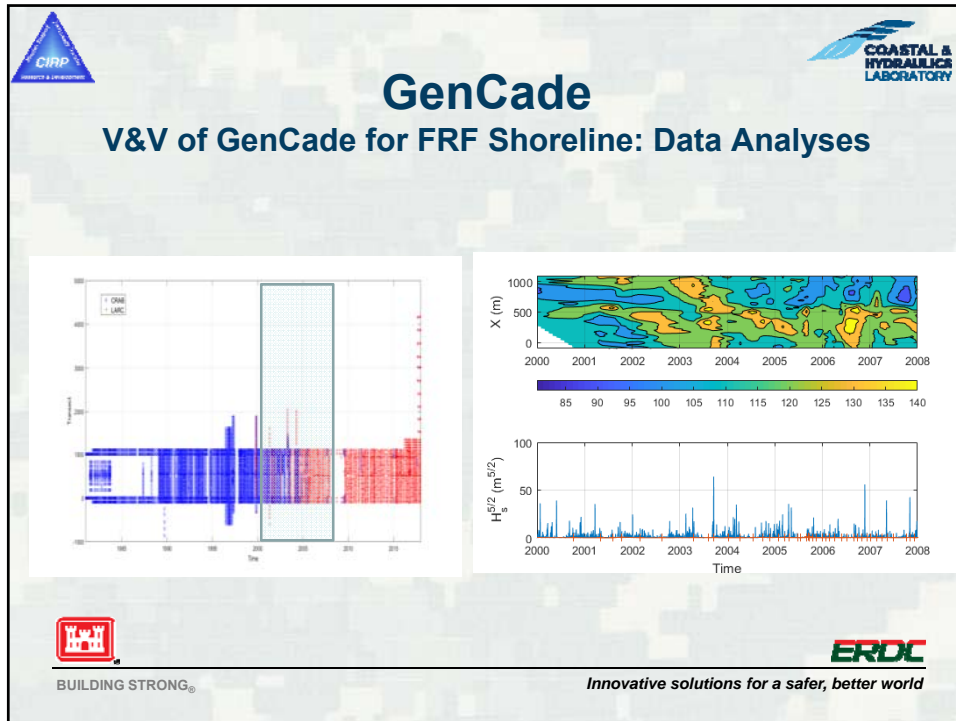
Overview of FY18 Products

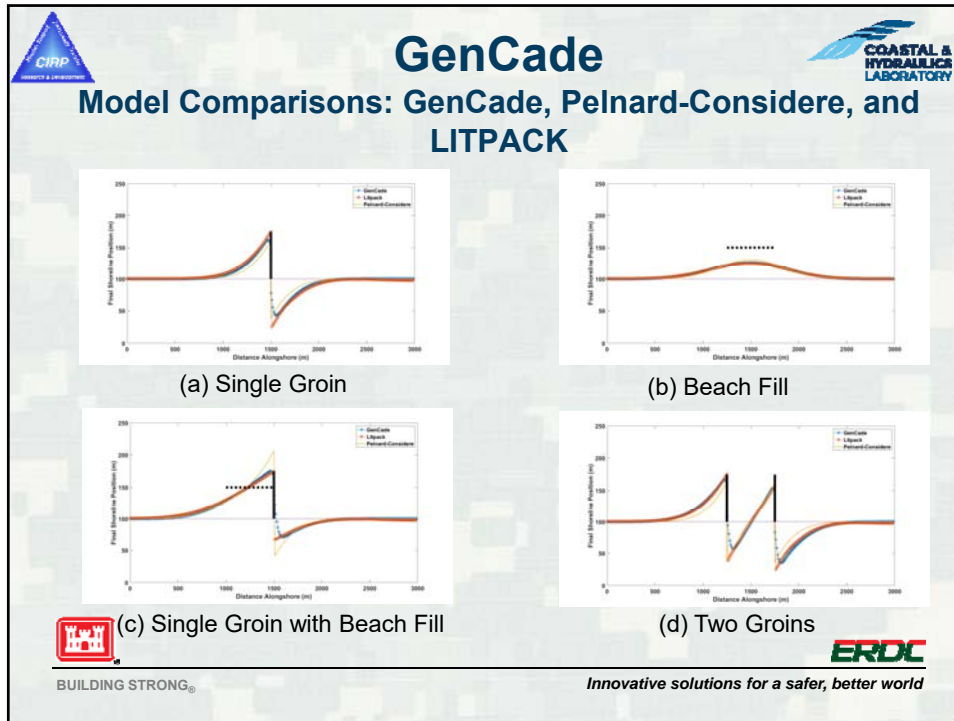



- **Workshops/Webinar/Conference (cont.)**
 - ✓ Ding, Y., S. Kim, and E. A. Frey (2018). Probabilistic Shoreline Evolution Modeling in Response to Sea Level Changes, In: Proc. of ASCE-EWRI 2018 Congress, June 3-8, 2018, Minneapolis, MN, pp197-209.
 - ✓ Ding, Y., S. Kim, E. A. Frey, R. Permenter, and R. Styles (2018). . Probabilistic Modeling of Long-term Shoreline Changes in Response to Sea Level Rise and Waves, to be published in Proc. of Int. Conf. on Erosion and Scouring 2018, Nov. 5-8, 2018, Taipei, Taiwan, 8p.
 - ✓ Ding, Y., S. Kim, E.A. Frey, Sleath, and R. Permenter (2017). GenCade for Modeling Shoreline Change, Presented in USACE-ERDC's CHL Symposium 2017, Nov. 1, 2017, Vicksburg, MS.
 - ✓ Ding, Y., S. Kim, and E.A. Frey (2017). Probabilistic Shoreline Change Modeling, Presented in USACE-ERDC's CHL Symposium 2017, Nov. 1, 2017, Vicksburg, MS
 - ✓ Ding, Kim, Frey, and Permenter (2018). Probabilistic Shoreline Change Modeling, Presented in RD18-ERDC R&D Workshop, May 1-2, 2018, Vicksburg, MS.
 - ✓ Ding (2018). Integrated Coastal Process Modeling and Applications in Coasts and Estuaries, Presented in the ASCE-EWRI 2018 Congress, June 3-7, 2018, Minneapolis, NM.
 - ✓ Ding, Kim, Frey, & Permenter (2018). Probabilistic Shoreline Change Modeling and Risk Estimation of Erosion, Presented in 36th ICCE, Baltimore, MD, 7/29-8/3/2018.
 - ✓ Permenter (2017) GenCade: Current Status and Future Work/ Presented at Coastal Working Group Meeting, November 15, 2017
 - ✓ Styles, R Vessel wake prediction tool. CERF, Rhode Island




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Vessel Wake



Vessel wake prediction tool


- Matlab program for rapid assessment of potential vessel effects
- Wake height from 7 wake models (barges, container ships, small vessels)
- Computes wake parameters (height, period, bottom stress, critical stress, celerity, energy, energy flux)

Features

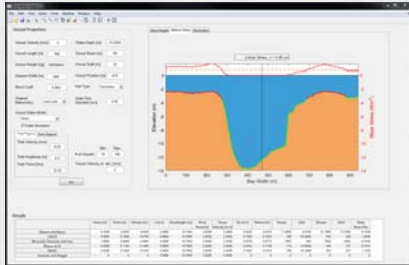
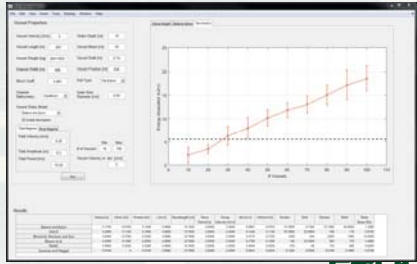
- Input vessel information (speed, beam, draft, length)
- Constant/equilibrium bathymetry profile or read in bathymetry file

Vessel Stochastics


- Computes total wake energy as a function of # of vessels
- Computes tidal energy
- Computes river energy



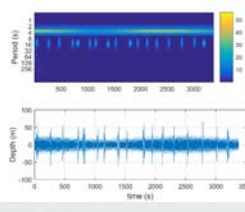
TN - user guide
TR - bank erosion

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Vessel Wake

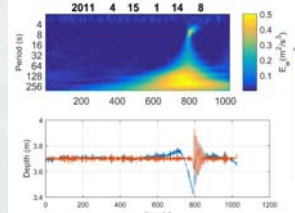


FY18 Products (Wake Extraction Algorithm)

- New extreme analysis algorithm
- ID vessel information (AVIS)
- ID vessel position from AISAP
- Vessel wake ID software implemented (Charleston Post 45)


Tech Transfer
 TR (Vessel Effects in Wetlands)
 New collaborations: SAG/Texas A&M, US Naval Academy
 BBLM – CIRP website


Stoltaguila – Tanker 13.1 knt




Vessel Wake Detection Efficacy

Period \ Amplitude	Short	Medium	Long
Small	High	High	Medium
Medium	Medium	High	Low
Large	Low	Low	Low







Inlet Engineering Toolbox Coastal Foredunes




► **Modeling and Monitoring of Coastal Foredunes:**


- Goal: Improved understanding and predictive capabilities of dune dynamics in natural and managed systems at time-scales important for project lifetimes and event-relevant management decisions
- SoNs addressed in FY18:
 - ▷ 2017-N-72 Improved Simulation of Dune Morphological Response at Short & Long Time-scales
- PDT: Kate Brodie, Meg Palmsten (NRL), Matthew Geheran, Ian Conery (Pathways Intern)
 →New FY19 PDT Member: Nick Cohn



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Coastal Foredunes FY18 Products




- Completed prototype web-tool for the Dune Erosion Planning Tool
- Completed testing and evaluation of web-tool for Hurricane Joaquin dataset at the FRF; JP in-prep → FY19 Deliverable.
- Completed initial setup of Aeolis (dune growth tool) at developed dune site
- **2 Presentations at Ocean Sciences 2018 Meeting:**
 - (1) High-resolution lidar scanning of developed and natural beach-dune systems on the Outer Banks, NC – Ian Conery (**50% CIRP**; 50% F&C)
 - (2) Terrestrial Lidar Observations of Coastal Morphodynamics in Duck, NC – Katherine Brodie (**33% CIRP**; 33% F&C; 33% CFDC)
- **3 Presentations at ASBPA 2017 Meeting:**
 - “Observations of Dune Morphological Evolution in Duck, NC, Over Monthly and Decadal Time-Scales” — Katherine Brodie (**40% CIRP**; 40% F&C; 20% CFDC)
 - “High temporal Resolution Observations and Modeling of Dune Erosion in the Collision Regime” — Margaret Palmsten (**80% CIRP**; 20% CFDC)
 - “High-Resolution LiDAR Observations of Developed and Natural Beach-Dune Systems on the Outer Banks, NC” — Ian Conery (**50% CIRP**; 50% F&C)

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Dune Erosion Planning Tool



(Palmsten & Holman 2011)

Hindcast Mode

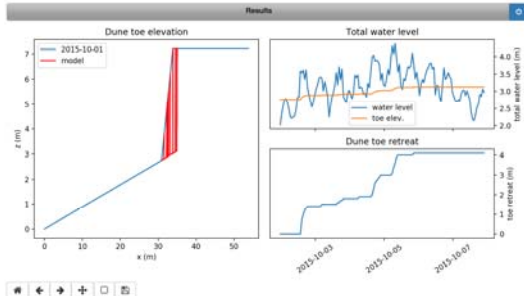
- Wave data from NDBC and CDIP historical buoy data.
- Water level data from NOAA water level stations (sparse coverage).

Forecast Mode – designed off the USGS Coastal Change Hazards Portal

- Wave data from WaveWatch III.
- Water level from NOAA ESTOFS.


→ Could tie in with CHS in the future once data is available for whole U.S. East Coasts



Assumption: all wave impacts lead to dune erosion.



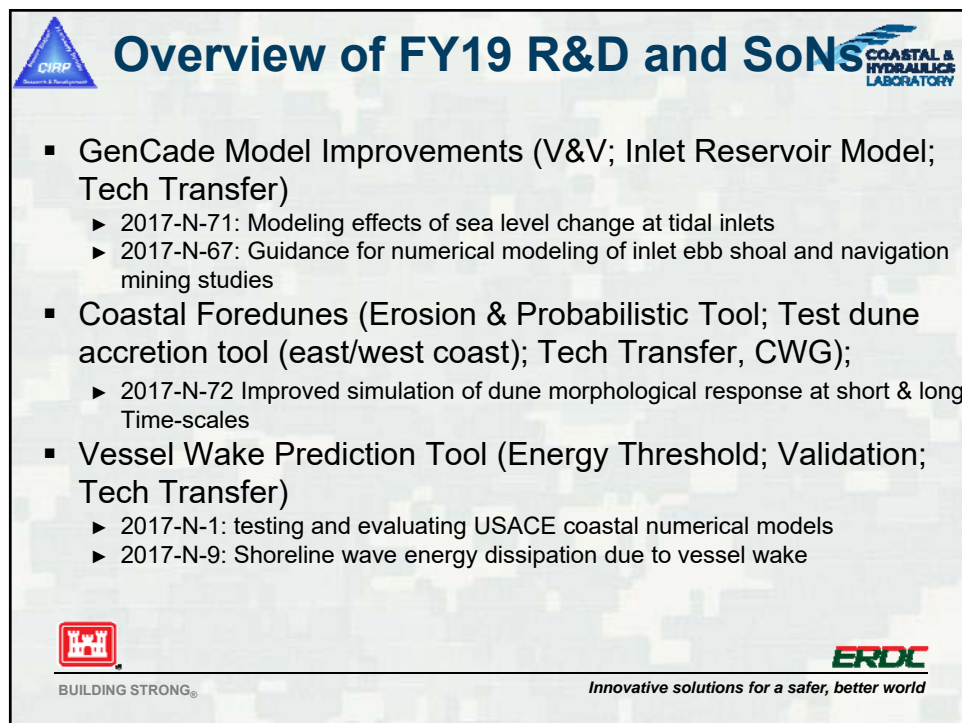
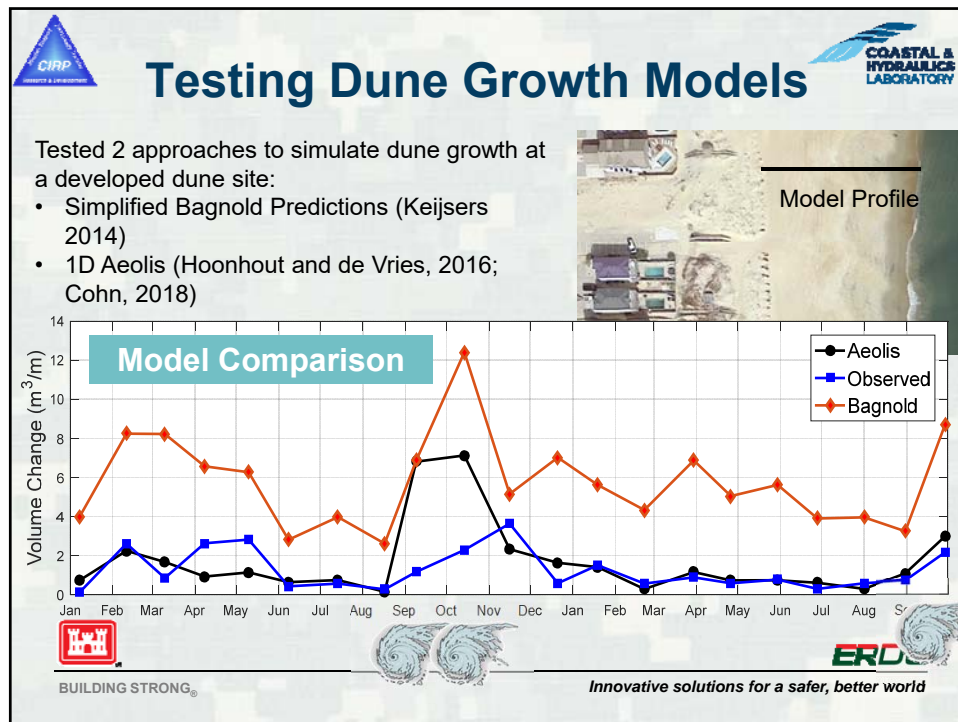
User inputs: idealized dune profile;


Output: dune toe retreat & timing through storm for collision regime events




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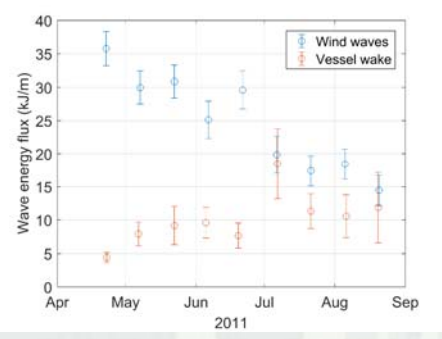


FY19 R&D

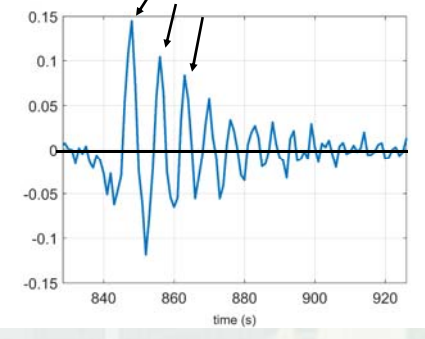
Vessel Wake Energy Analysis




- Compute wave energy and power from wave height measurements
- Relate power to energy dissipated at shore
- Develop energy threshold requirements for wake energy comparison
- Test algorithms for maximum stress and run-up (Pujara et al. 2015; Si-yu et al. 2017)
- JP – wake extraction methods




$$E_i = \frac{1}{8} \rho g H_i^2 \quad P_i = \frac{1}{8} \rho g H_i^2 C_g$$


$$E_D = \sum_{i=1}^N P_i T_i$$




Coastal Foredunes FY19 R&D





- Test Aeolis at a west coast prograding beach adjacent to a navigation structure
- Improve incorporation of vegetation and structure feedbacks within Aeolis modeling framework
- Use Aeolis to evaluate sediment fluxes into the dune and adjacent inlet between 2014 to 2018 and to explore implications of management actions (e.g. dune grass planting, sand fencing, etc.) at reducing input to the inlet





➔

Active collaboration with OSU (Dr. Peter Ruggiero) and NWP (Rod Moritz, Kate Groth, Jarod Norton) on this project






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Reimbursable Studies

- NAP – 20+ years validation data for GenCade, external review (Jeff Gilbert, Rob Hampson)
- SAM – datasets for validation
- SAG – Field support, measurements, and sediment analysis (Texas A&M); outside review for GenCade (P. Hamilton)
- SAC – Harbor deepening project, validation data, test vessel extraction algorithm (H. Carpenter)
- NWP – Dune transport model west coast dune system






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Collaborations


- Academic:
 - ▶ Drs. JP Walsh & Reide Corbett, East Carolina University, Coastal Studies Institute
 - ▶ Dr. Kristen Splinter, University of New South Wales
 - ▶ Dr. Peter Ruggiero, OSU
 - ▶ Drs. Britt Raubenheimer & Steve Elgar, WHOI
 - ▶ Dr. Jens Figlus, Will Fuller, Texas A&M
 - ▶ Dr. Anna Wargula, US Naval Academy
- Federal:
 - ▶ USGS, NOAA, NRL through Nearshore Collaboration Effort
- Other R&D Programs
 - ▶ RSM, DOER, F&C, FRF
- Non-governmental:
 - ▶ ASBPA



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Conclusion



- FY18 major advances
 - ▶ V&V for FRF coast (cross-shore transport as a critical process)
 - ▶ Monte-Carlos Method for Probability Shoreline Modeling and Uncertainty Assessment of Shoreline Change
 - ▶ Model comparisons (Verified against Pelnard-Considere analytical solutions; GenCade comparable to LITPACK)
 - ▶ Tool/App to simulate dune erosion planning
 - ▶ Initial setup of dune growth tool
 - ▶ Implementation (operational) vessel wake extraction
- FY19 key products/advances
 - ▶ V&V for DE Coast (focus on beach nourishment and inlet bypassing)
 - ▶ JP - V&V of GenCade (combining FRF and DE coast V&V)
 - ▶ Transition dune erosion tool to operations
 - ▶ Evaluate 1- and 2-D aeolian transport tool (dune growth)
 - ▶ Wake height extraction validation with 2-D model (JP)



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