



U.S. ARMY

GENCADE MODEL IMPROVEMENT AND DOCUMENTATION

INLET ENGINEERING TOOLBOX

PI Yan Ding
Mitchell Brown

District PDT Members

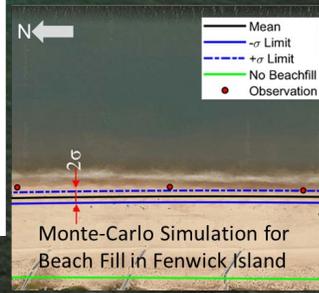
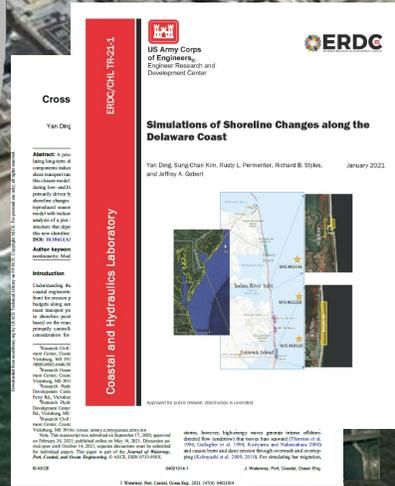
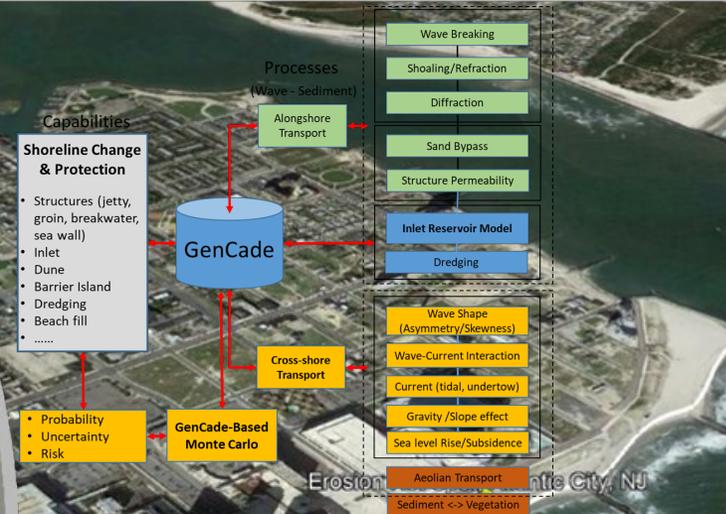
Robert Hampson, Keith Watson, Harry Friebe (NAP),
Richard Allen (SAM), Matthew Wesley (SPL)

COASTAL INLETS RESEARCH PROGRAM

FY21 IN PROGRESS REVIEW

Tiffany Burroughs
HQ Navigation
Business Line
Manager

Eddie Wiggins
Technical Director, Navigation
Morgan Johnston
Acting Associate Technical Director,
Navigation



US Army Corps of Engineers



ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

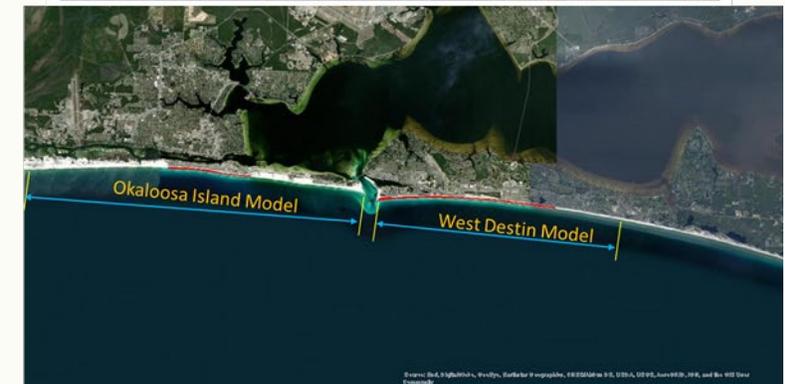
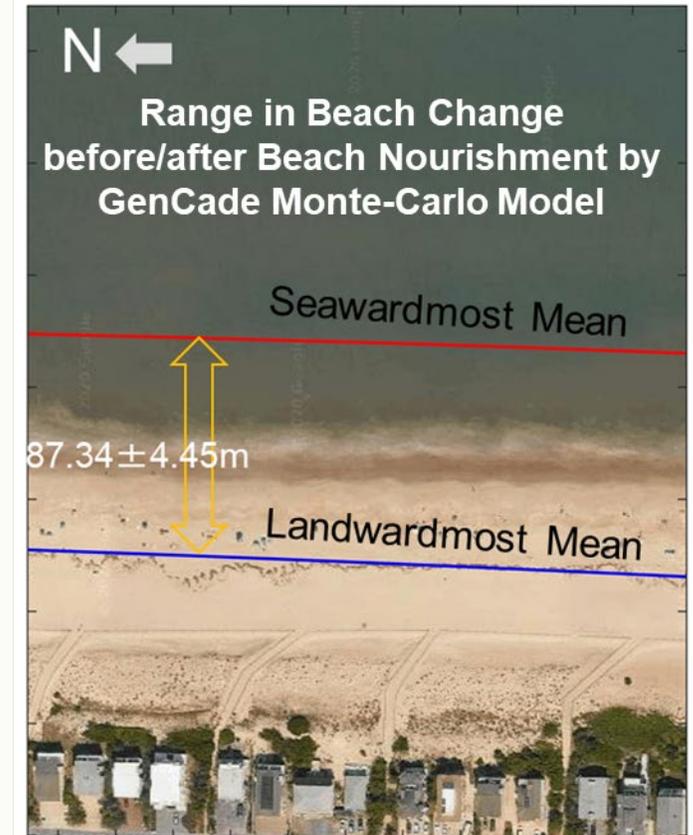
Problem Statement

- Prediction of long-term (decadal) and regional ($10^1 \sim 10^2$ km) shoreline changes is a key task in regional coastal management practices.
- A range of methods including beach fills/nourishment, sand bypassing and structures have been utilized to mitigate coastal erosion. The Regional benefits and interactions of these methods are difficult to quantify along this regional-scale coastline.
- Quantifying erosion risk and uncertainty in simulating long-term shoreline changes is essential for risk-based coastal management practice.
- GenCade provides various capabilities for predicting long-term and regional shoreline evolution driven by longshore and cross-shore transport and coastal protection measures. The model has to be validated by applying to engineering practices.

Strategic R&D: Innovation in Sediment Management (Shoreline Erosion)

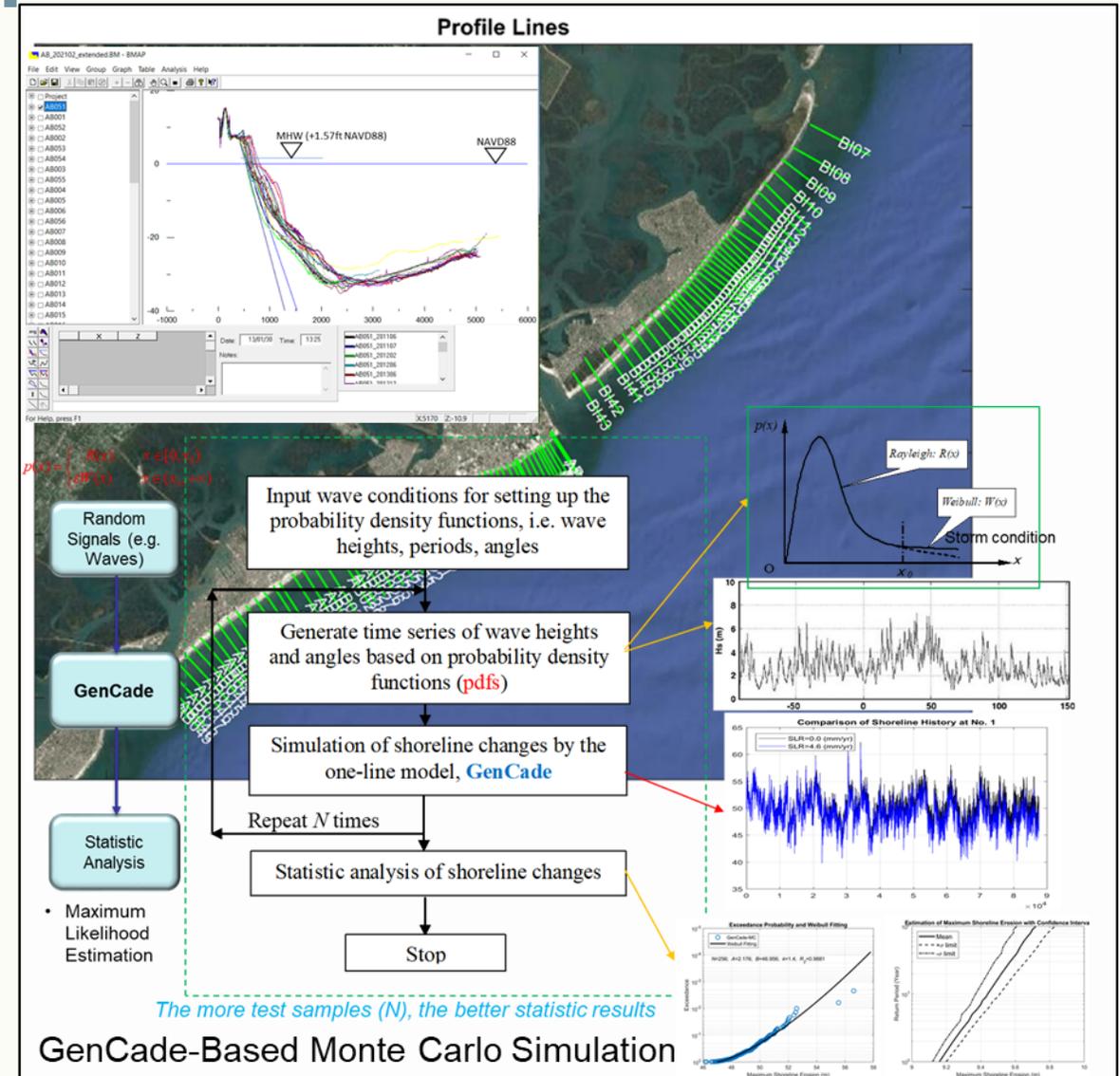
SoN-NAV-1726 (Nearshore Nourishment Best Management Practices)

SoN-1386 (Strategic Nearshore Placement of Dredged Material to Sustain Coastal Beach & Dune Resilience)



Capability and Strategic Impact Statement

- V&V: Quantify and control model errors by extensive model validation using various types of field survey data (transect survey, hydro survey) for long-term and regional scale simulation.
- GenCade-based Monte-Carlo Simulation: Provide probabilistic shoreline changes solutions driven by physical processes (wave, currents, sediment transport)
- Quantitative long-term (>life cycle) impact assessment of coastal protection measures (i.e. structures (groins, jetties, breakwater, seawall), beach fills, nourishment, etc), including inlets
- Has a potential to provide risk-based erosion prediction for planning and management.



GenCade – SMS 13.2+ interface (DMI and others)

Phase 1 – Recreate all feature arc types with more user-friendly look and feel.

(Complete)

Phase 2 – Use DMI to generate a 1-d grid.

(Nearing completion)

Phase 3 – Model Control and Post Processing improvements.

Phase 4 – Add Cross-shore

(DMI design completed, Nearing completion)

Phase 5 – Add Monte Carlo

(Same as Phase 4)

The screenshot displays the GenCade software interface. On the left, the 'Arc Options' dialog box is open, showing a list of arc types such as Breakwater, Regional Contour, and Inlet. A green box labeled 'New Interface' is overlaid on this dialog. In the center, a 'GenCade Control File' window is open, displaying a list of parameters and their values, including WAVE PDF, SLR_RATE, and SUBSIDENCE_RATE. A green arrow points from this window towards the right. On the right side, the 'DMI' (Data Management Interface) dialog box is open, showing various input fields for parameters like Regional SLC, Beach Slope, and Monte Carlo simulation options. A green box labeled 'DMI' is overlaid on the top right of this dialog. The background shows a 3D model of a coastal structure with a grid overlay.

GenCade: Technical Transfer (1/2)

- GenCade and SBAS Webinar in CWG 2020
- A presentation in vICCE2020 (a 14-min pre-recorded video)
- An iPoster presented in AGU Fall Meeting 2020
- A presentation in 2021 ASCE EWRI, June 7-11, 2021 (a 15-min pre-recorded video)
- A presentation in Next Generation Coastal Planning Model Meeting, July 14, 2021

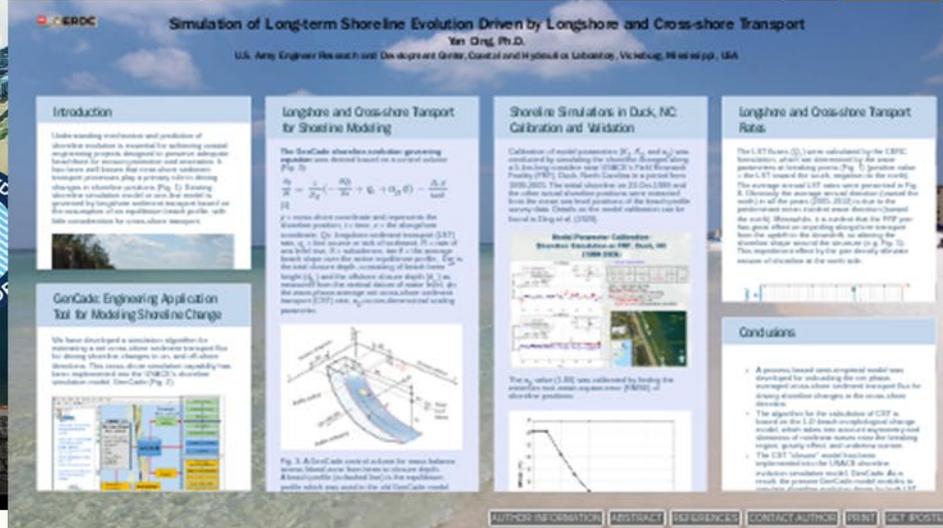
Simulation of Long-Term Shoreline Change Driven by Longshore and Cross-shore Sediment Transport

Yan Ding, Ph.D. Research Civil Engineer
Sung-Chan Kim, Richard B. Styles, and Rusty L. Permenter

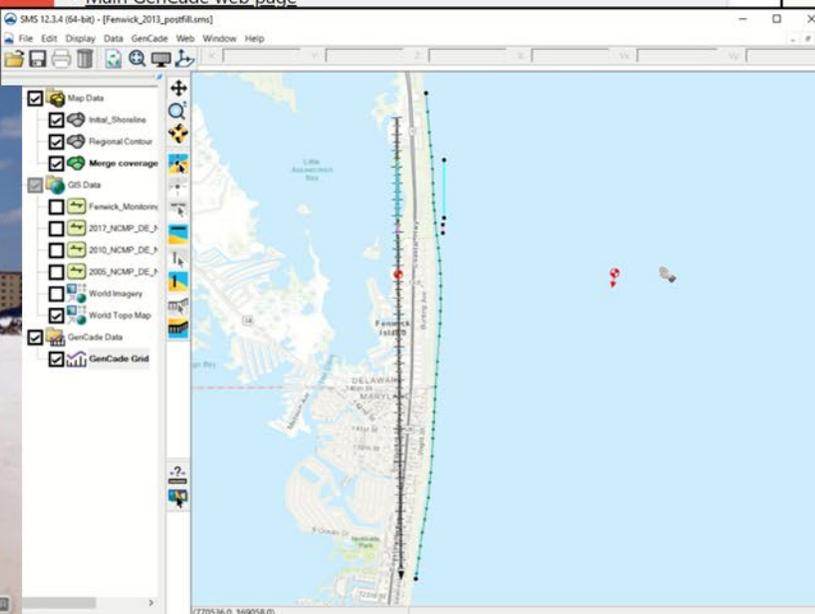
U.S. Army Engineer Research and Development Center (ERDC), Coastal and Hydraulics Laboratory (CHL)

Presented in vICCE 2020, Oct. 7, 2020









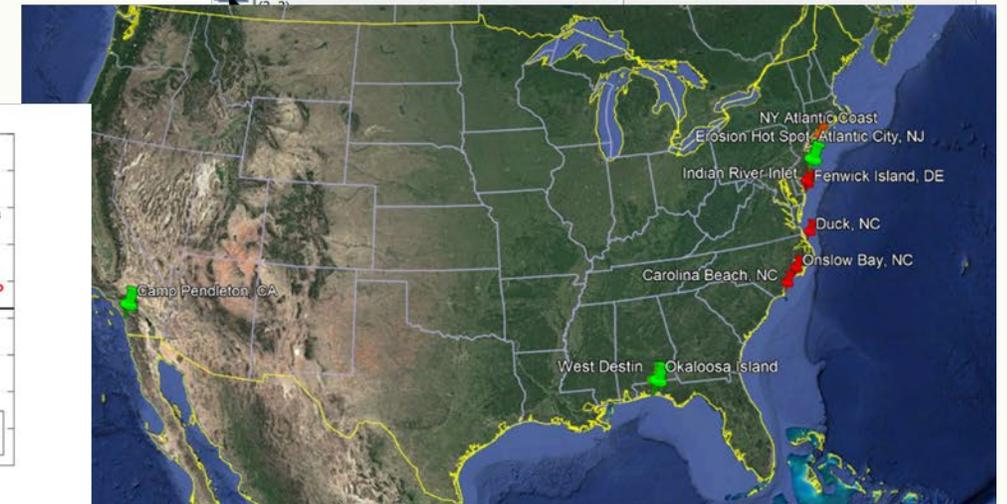
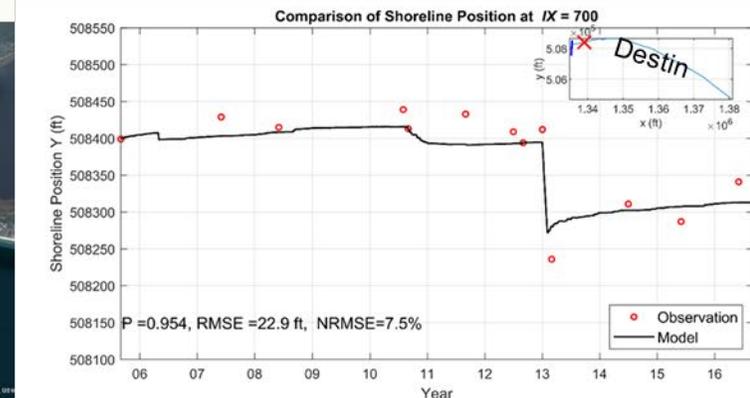
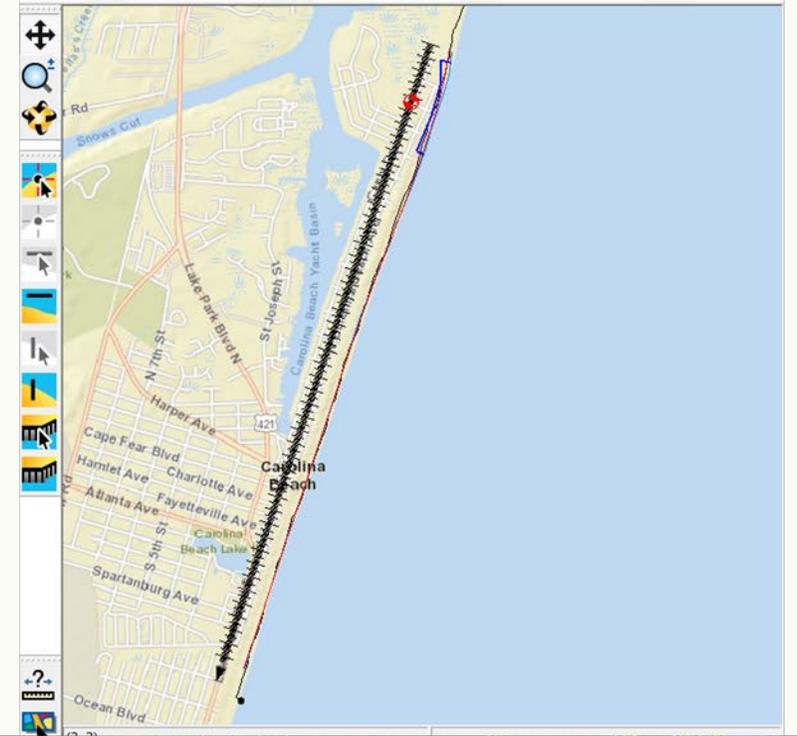
GenCade: Technical Transfer (2/2)

DOTS project

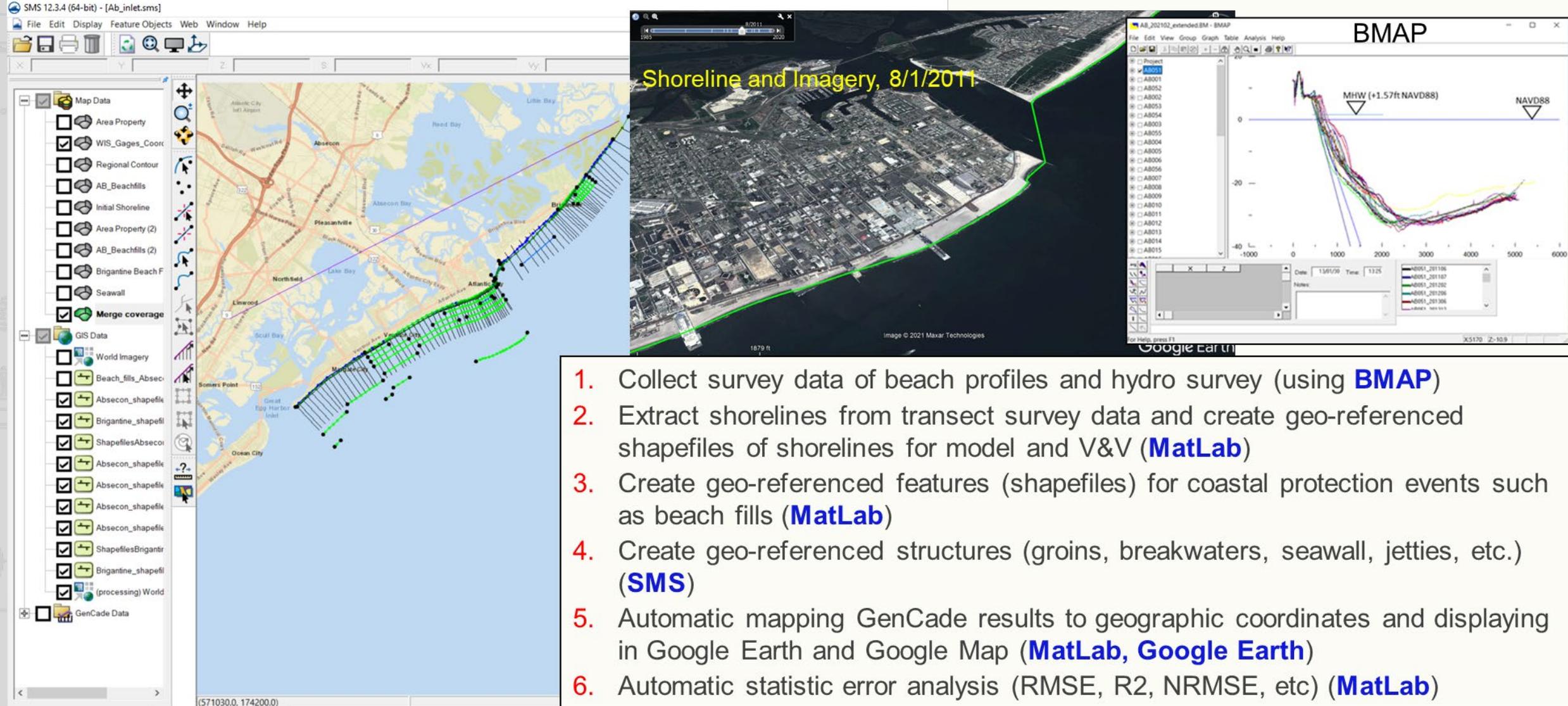
- GenCade Training for Shoreline Simulation on Carolina Beach, NC (USACE-SAW)

Reimbursable Projects

- Determining Shoreline Response to Beach Fill Templates for CSRSM study in Okaloosa County, Florida (USACE-SAM)
- Study of Atlantic City North End Erosion Using GenCade Shoreline Simulations (USACE-NAP)
- Onofre Creek and Beach Study, Camp Pendleton, CA (USACE-SPL).

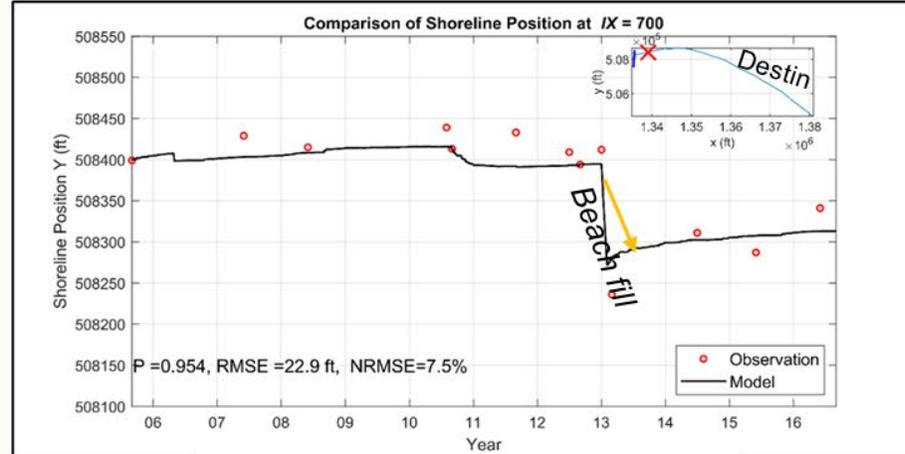


Develop a Regional Scale GenCade Model using GIS & Others

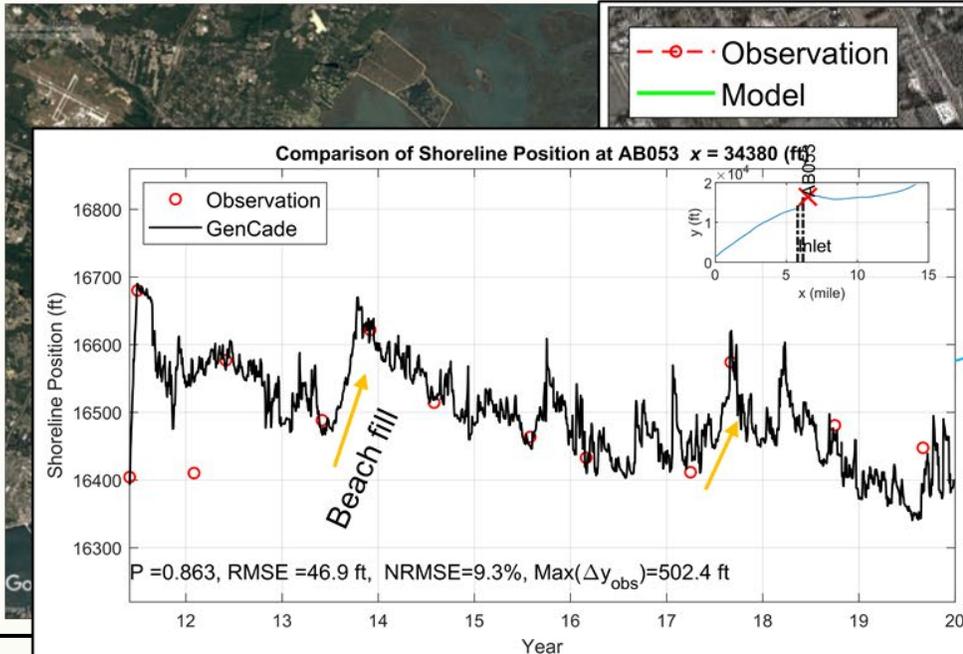


Regional-Scale Shoreline Evolution Simulations (FY21 Reimbursable Projects)

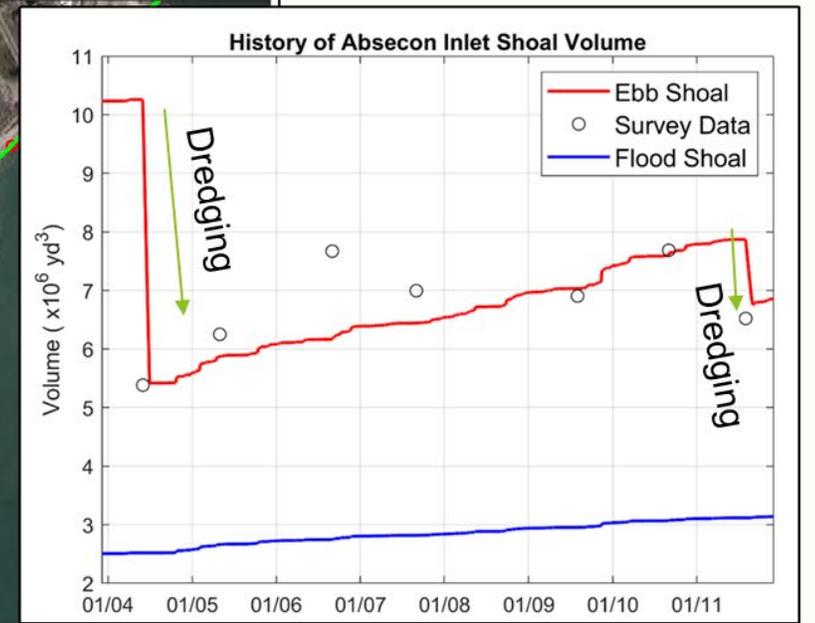
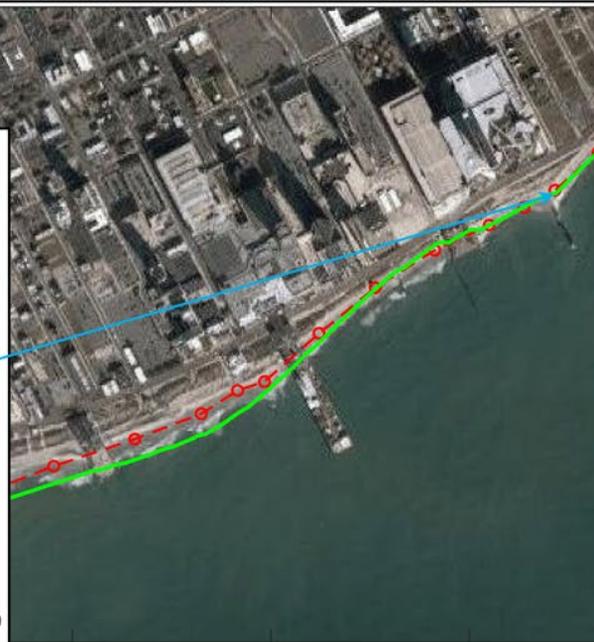
- Okaloosa Island CSRM (SAM)



- Atlantic City Erosion Hot Spot (NAP)

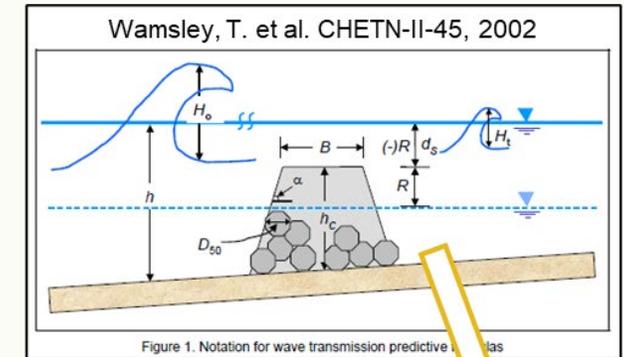


Shoreline Positions on 04/01/2017



GenCade: Code Management and Accessory Tool Development

- Develop a new version (v2p0) by merging the version with cross-shore and Monte-Carlo into the released version V1r8. The DMI in SMS 13.1 will be available for it.
- Debugging, testing, and V&V about modeling structures:
 - Fixed major bugs in wave diffracting calculation, seawall module, and buried structures
 - Increased simulation efficiency (> 4 times faster by a release mode)
 - Types of structures: Groin, Jetty, Detached Breakwater, T-Groin, Seawall, and combinations of Groin and DB.
- Code release (v1r8)
- Develop a suite of tools (Matlab and Fortran) for statistic error analysis for
 - (1) Quantifying model skill performance (model skill assessment metrics)
 - (2) Monte-Carlo result analysis (including maximum likelihood analysis for extreme shoreline changes, uncertainty estimation, erosion estimation in return periods)
 - (3) Spectral analysis of waves to determine random wave conditions
- Develop a suite of tools (Matlab) for visualization:
 - (1) Analyzing and Displaying GIS shapefiles of historical data (shoreline, beach fill, Beach-fx reaches).
 - (2) Displaying in Google Earth (comparing with historical images)
- Update GenCade web site



SMS 12.3

Breakwater Attributes

Freeboard to MSL (m)	3.0
Width (m)	3.0
Seaward Side Slope	0.333
Shoreward Side Slope	0.53
D50 of armor stone (m)	0.9

Help... OK Cancel

Detached Breakwaters

	Start Cell	Y1 (m)	Depth 1 (m)	End Cell	Y2 (m)	Depth 2 (m)	Transmission	Coeff/Perm/Atts
1	146	200.0	5.0	155	200.0	5.0	Ahren's	Atts...
2								



Summary

FY21 Major Advances in Capability

- Release GenCade v1r8
- Upgraded GenCade to include Monte-Carlo and Cross-Shore transport
- Develop DMI GenCade Interface (near completion)
- Debug and optimize codes
- Reimbursable projects (test capabilities)
- Publications and technical transfer

FY21 Major Products & Collaborations

- 1 TR: *ERDC/CHL TR-21-1 published*,
- 1 TR GenCade Monte-Carlo simulation, *TR-xx-DRAFT, in preparation*
- 1 JA: DOI: 10.1061/(ASCE)WW.1943-5460.0000644
- 1 Webinars (CWG 2020): *GenCade and SBAS*
- 4 Oral Presentations in conferences
- 1 DOTS project (SAW)
- 3 Reimbursable Projects (SAM, NAP, SPL)
- Leveraging to other Programs: SBAS

Planned Outyear Products/Advances

- Release GenCade V.2.0 (Cross-shore + Monte-Carlo), publish TR, and technical transfer
- Continue working with Aquaveo to complete DMI development
- Cross-shore Transport for beach fill / nourishment and nearshore placement: for predicting effect of beach fill by better quantifying variations of shoreline and volume (native and placed).
- Data assimilation for predicting long-term and regional shoreline evolution
- Couple GenCade with multi-dimensional coastal morphological model
- Aeolian transport for change of berm and dune