

Comparing GenCade and ShorelineS: Evaluating One-Line Shoreline Change Models on Florida and North Carolina Coasts

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Research Questions

- Where do one-line models fit within coastal modeling and engineering analyses?
- How well do different one-line models reproduce observed shoreline change?
- What are the practical differences between two one-line model softwares, GenCade and ShorelineS?
- How do these differences influence future model selection for engineering applications?

Research Overview

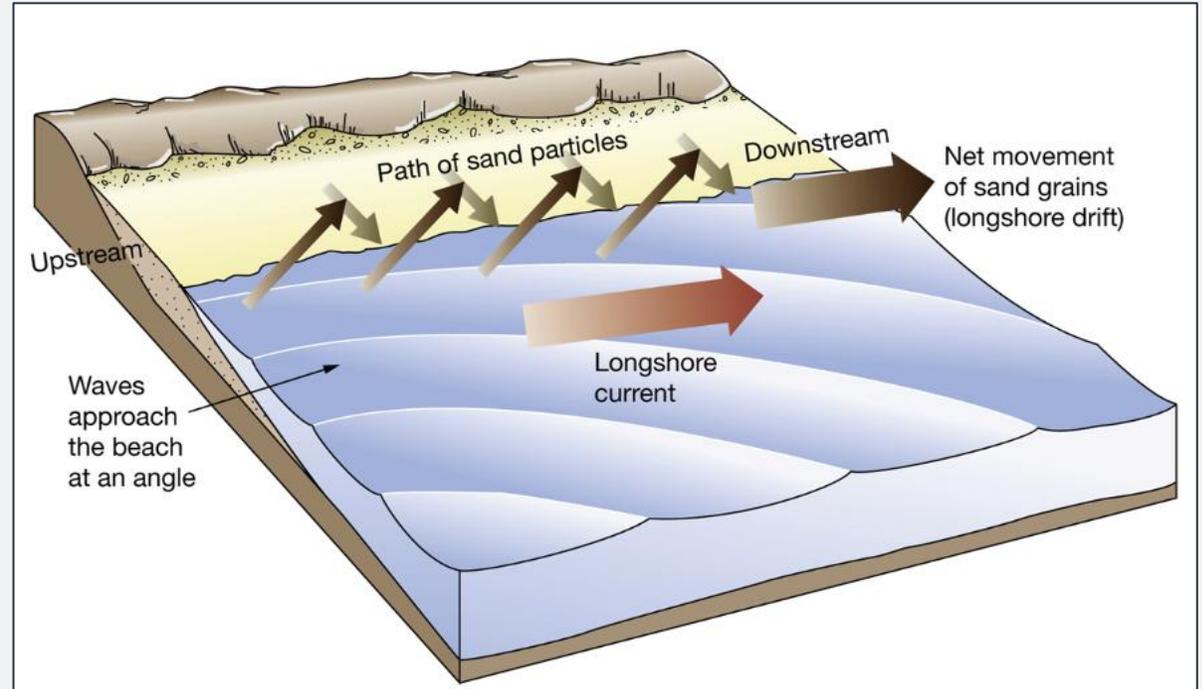
- One-Line Purpose
- GenCade and ShorelineS
 - Software Overview
 - Application
 - Okaloosa, FL
 - Duck, NC
 - Pros/Cons
- Conclusions

Source: Wikimedia Commons



One-Line Shoreline Change Models

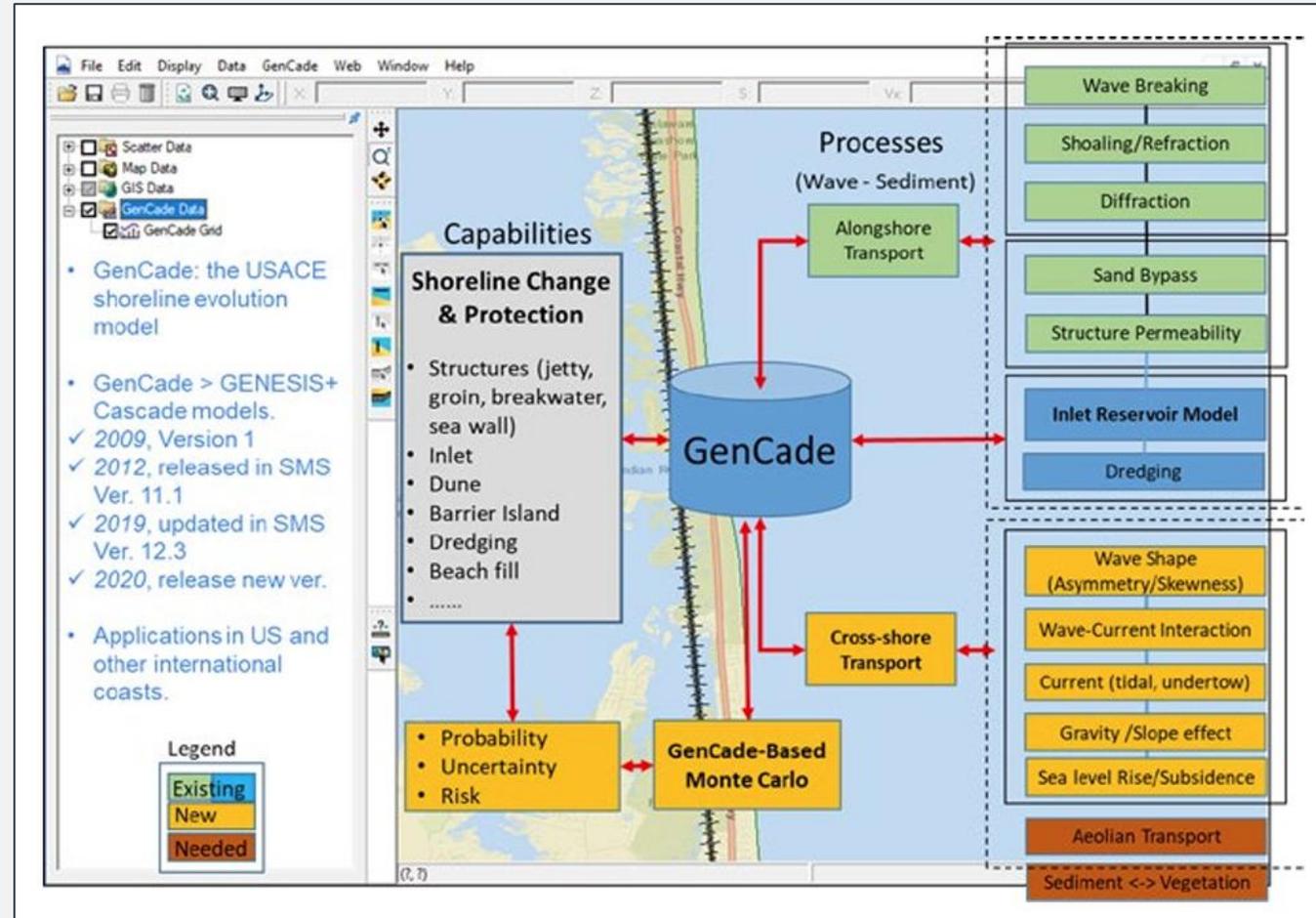
- Simulate shoreline position over time based on wave-driven alongshore sediment transport gradients
 - Assumes a representative cross-shore profile
- Widely applied in beach nourishment planning, inlet management, and sediment budget assessments
- Well suited for long-term, regional-scale assessments due to their computational efficiency and modest data requirements



Source: Save Our Beaches SC

GenCade Overview

- **Developer:** USACE Coastal Inlets Research Program (CIRP)
- **Operating System:** Surface Water Modeling System (SMS)
- **Strengths:** Integrates GENESIS shoreline change modeling with Cascade sediment budget concepts
- **Transport Formulas:** CERC
- **Primary Use:** U.S. engineering design projects

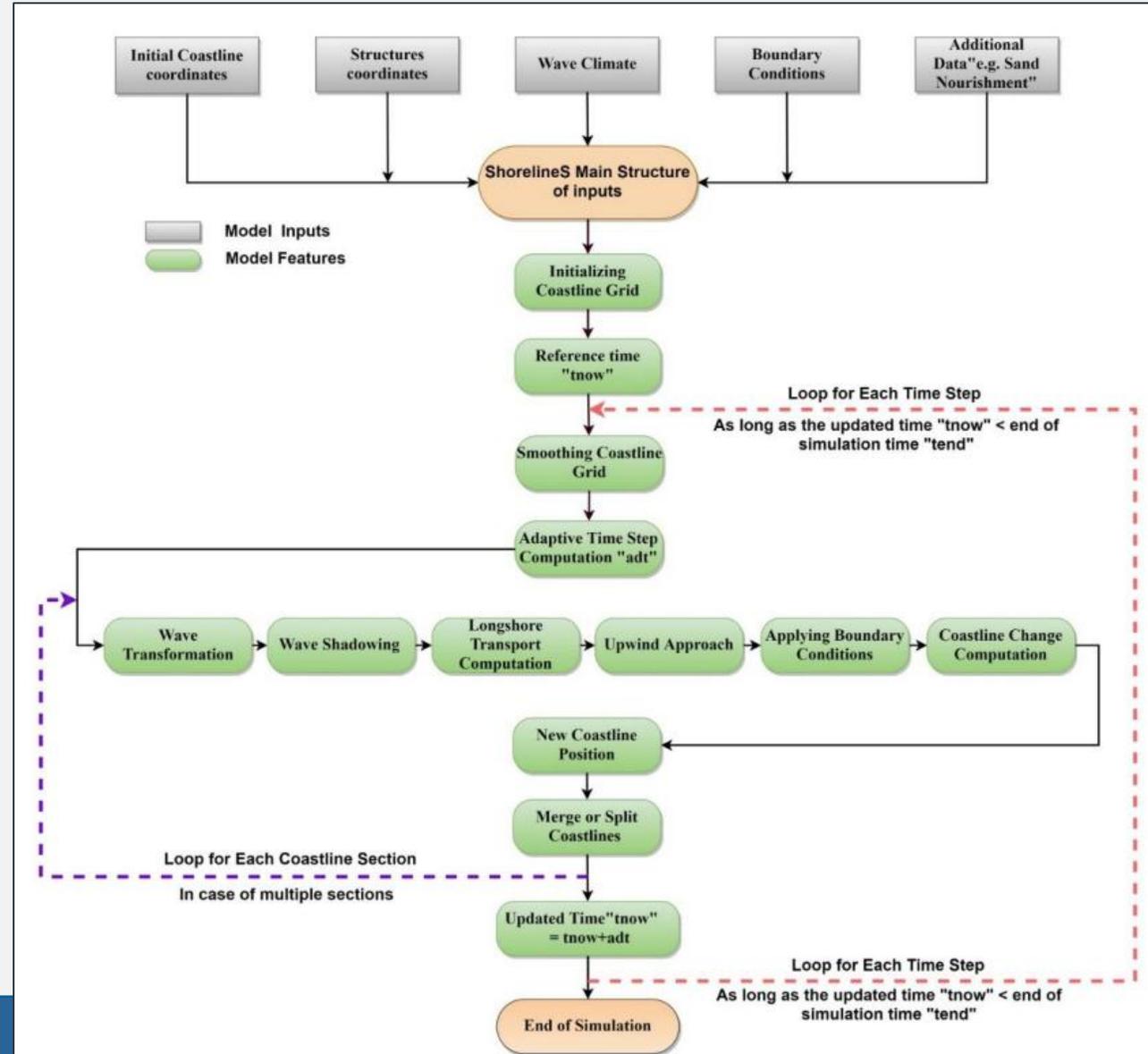


Source: USACE CIRP, GenCade Fact Sheet

ShorelineS Overview

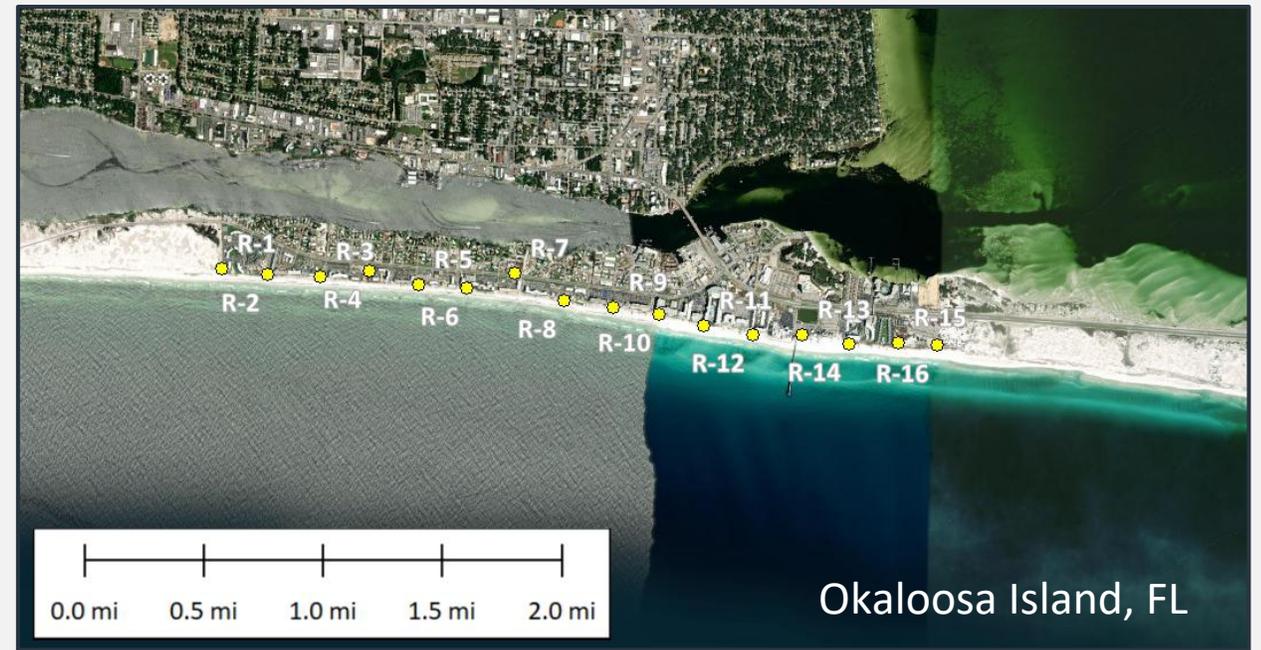
- **Developer:** Deltares/IHE Delft
- **Operating System:** Open source and script-based model implemented in MATLAB
- **Strengths:** Free-form grid allows for elongated spit features to grow unconstrained and handle high-angle wave coastline instabilities
- **Transport Formulas:** CERC, Kamphius (1991), Mil-Homens (2013), Van Rijn (2015)
- **Primary Use:** International engineering design and research projects

Source: ShorelineS User Manual v1.0



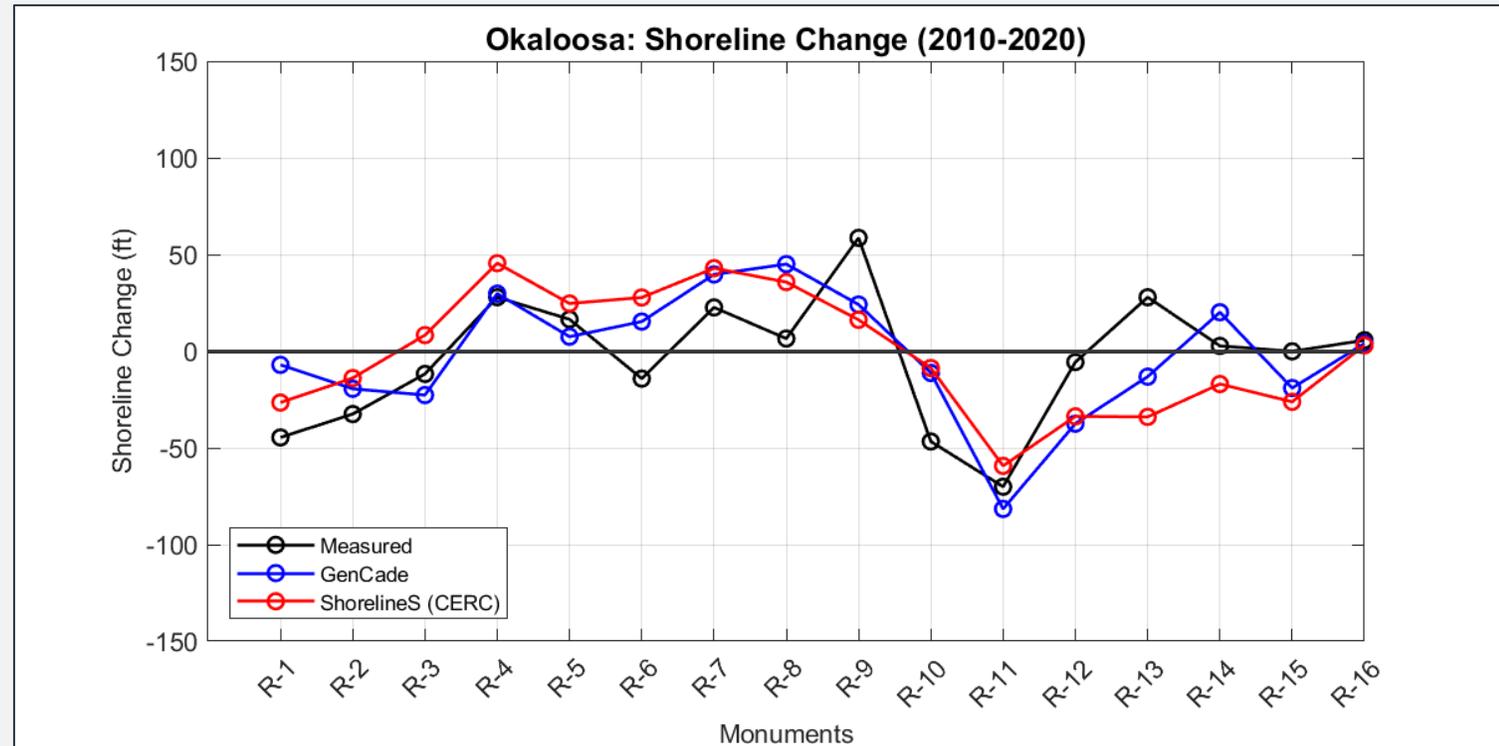
Study Sites

- **Objective:** Compare simulated shoreline behavior between GenCade and ShorelineS
- **Application:** Apply both models over the same time period at two locations
- **Okaloosa Island, FL (2010-2020)**
 - Parallel offshore contours
- **Duck, NC (2019-2025)**
 - Parallel offshore contours
 - Beach fill (575,000 CY)



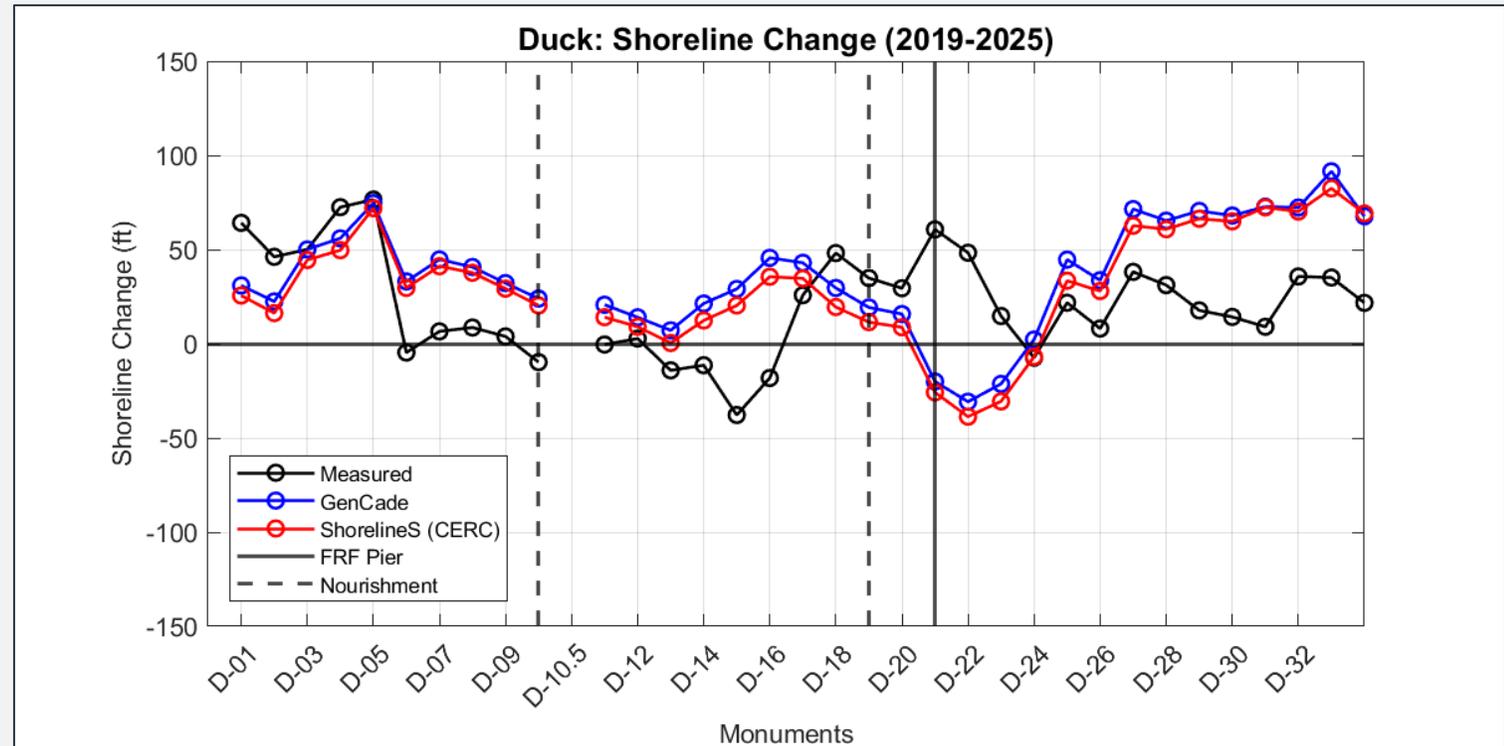
Okaloosa Island, FL

- Using the same input data:
 - Initial shoreline
 - Wave Climate
 - CERC Sediment Transport Formula
- **The models behave nearly identical**
- Both models accurately capture measured regional trends of accretion and erosion

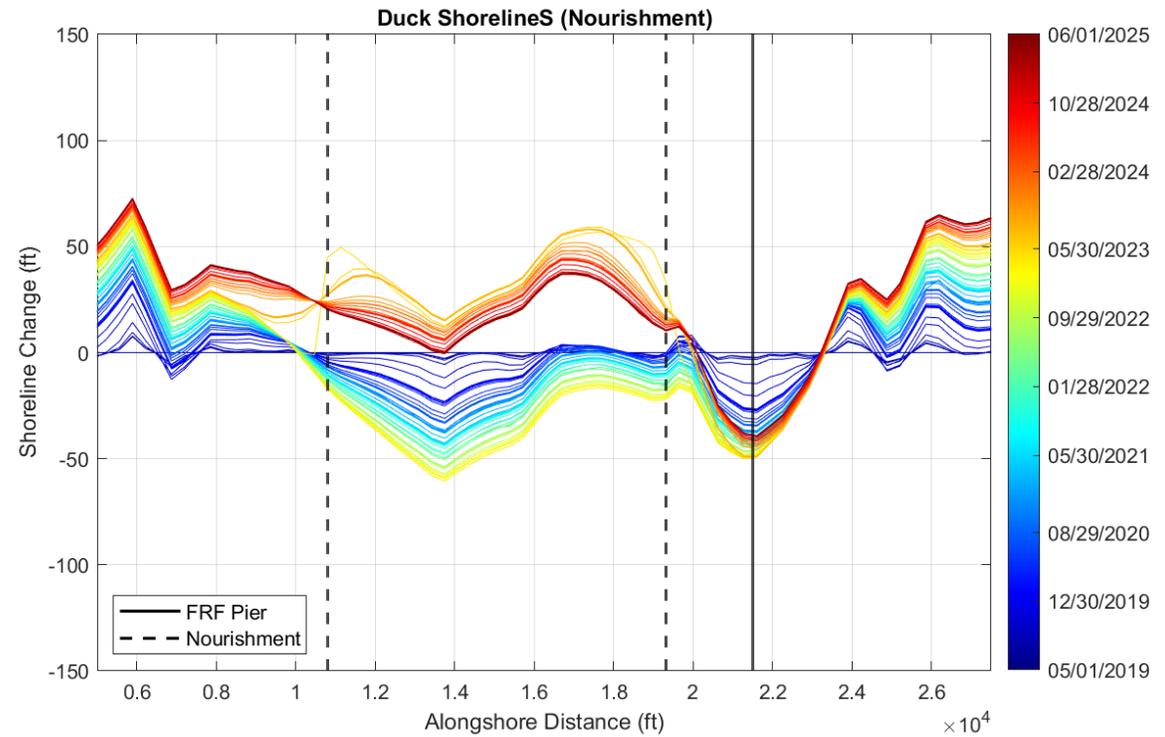
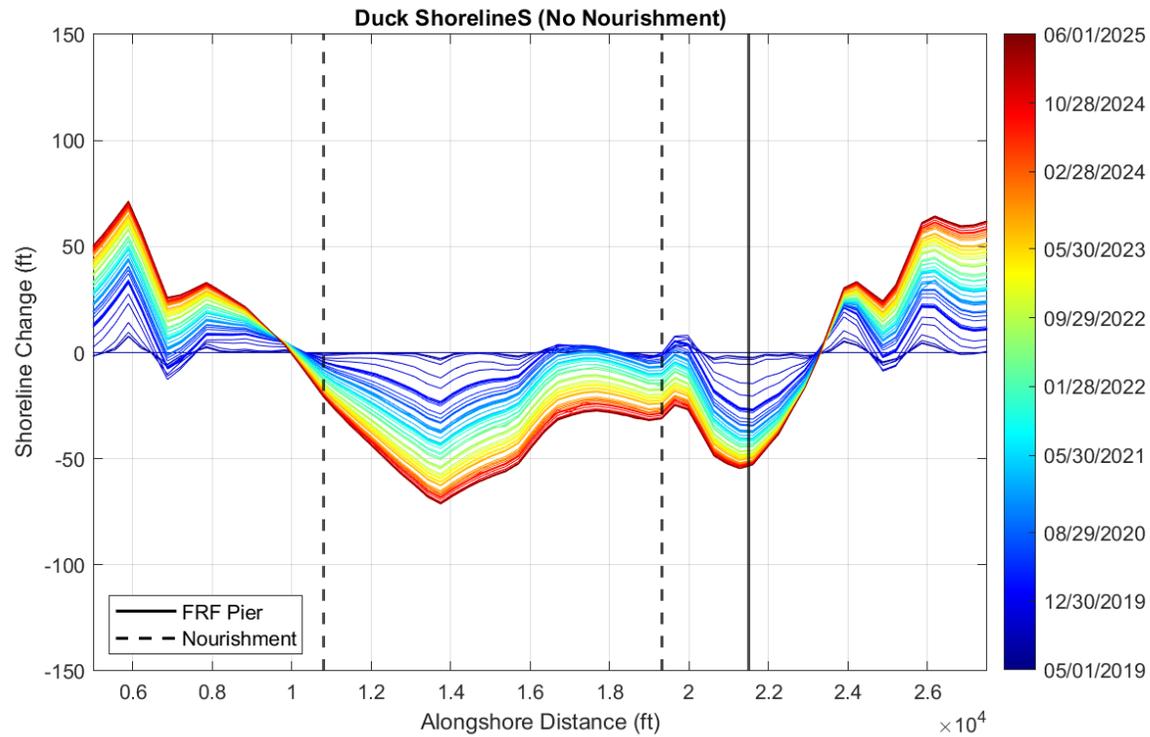


Duck, NC

- Using the same input data:
 - Initial shoreline
 - Wave Climate
 - CERC Sediment Transport Formula
- **The models behave nearly identical**
- Both models accurately capture measured regional trends of accretion and erosion

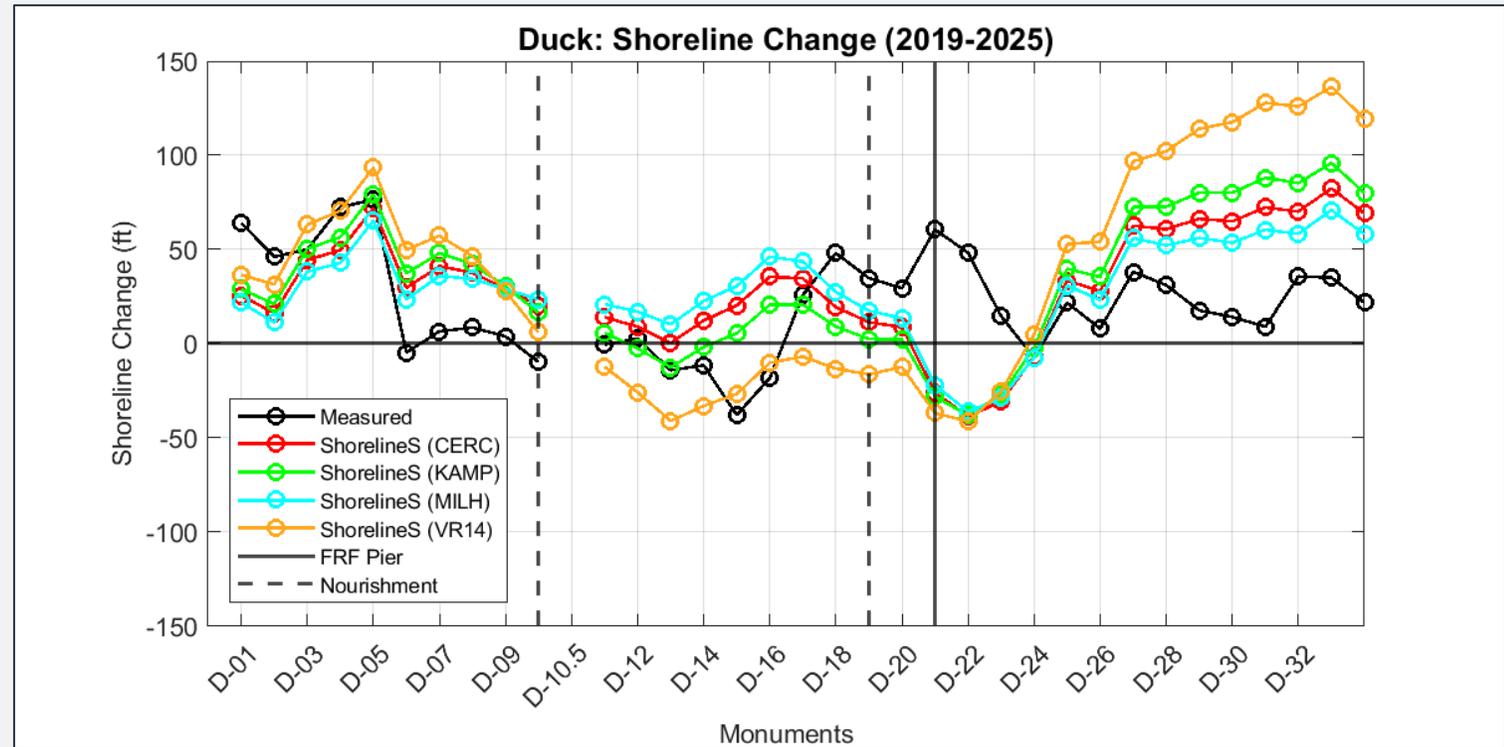


One-line Beach Nourishments



One-line Sediment Transport Formulas

- What if further model improvement is desired?
 - Limited options for modifying sediment transport behavior available in GenCade
 - Additional sediment transport formulas available in ShorelineS:
 - Kamphius (1991)
 - Mil-Homens (2013)
 - Van Rijn (2015)



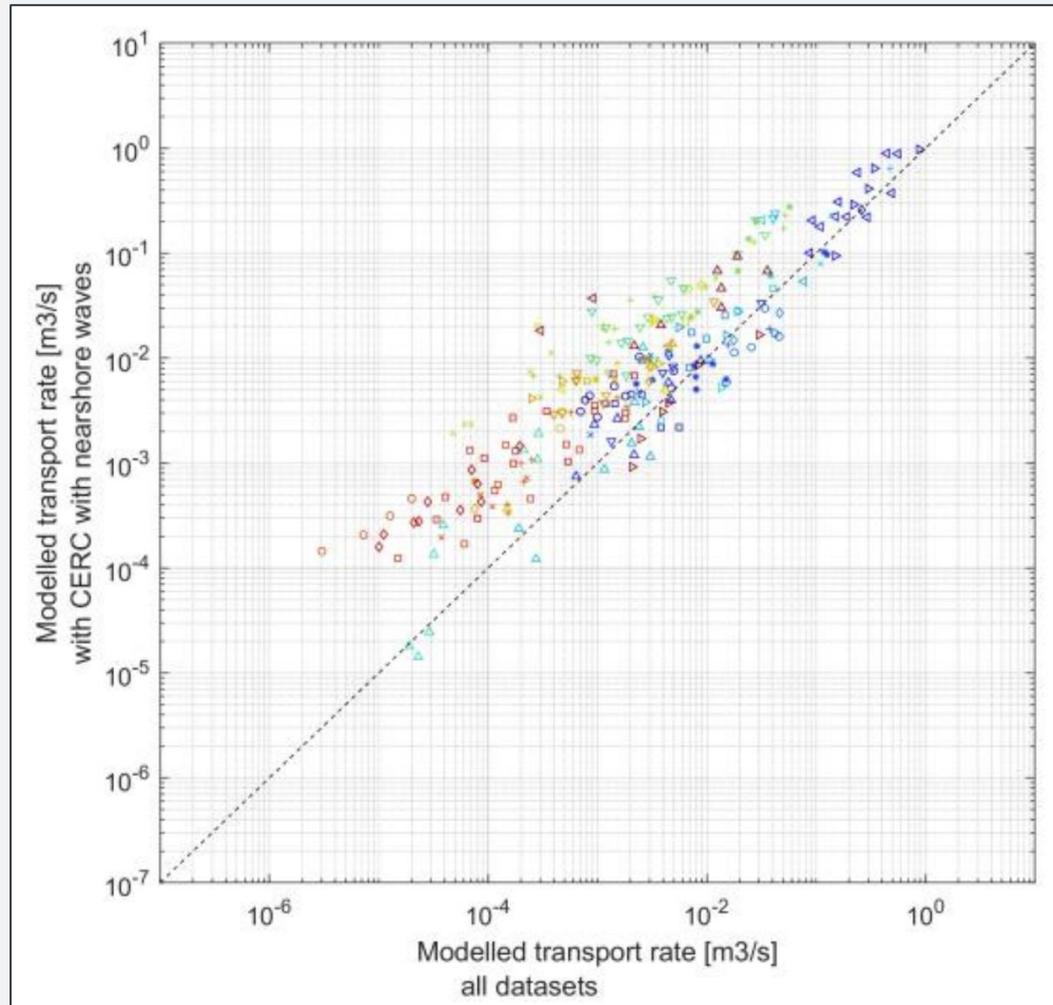
One-line Sediment Transport Formulas

- More advanced formulas have the potential to reveal differences not captured by simpler models
 - Allowing for more detailed calibration through additional input options
- **An ongoing, unpublished study by Huisman et al. highlights this potential for improvement**
 - Comparison of measured and simulated transports in a large range of field and laboratory datasets...

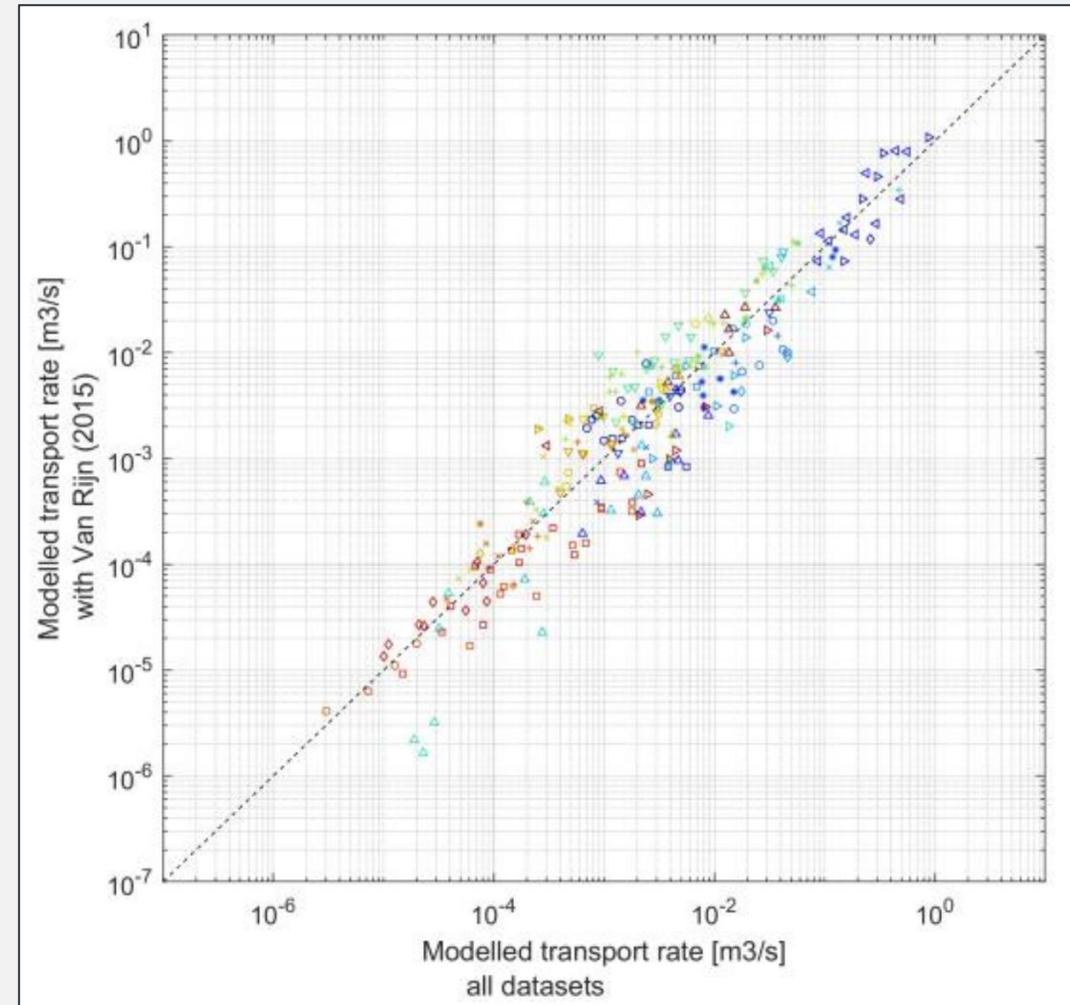
○ Duck (Kraus et al., 1986)	• Kinburn (Voitsekhovich, 1986)
□ Duck (Bodge, 1986)	• Shoreham (Chadwick, 1989)
◇ Duck (Kana & Ward, 1980)	○ Aveiro (Castanho, 1966)
▷ Duck (Miller, 1998)	□ Lobito (Castanho, 1966)
◁ Duck (Miller, 1999)	◇ Emerald Isle (Wang et al., 1988)
△ El Moreno (Komar & Inman, 1970)	▷ Onslow Beach (Wang et al., 1988)
▽ Silver strand (Komar & Inman, 1970)	◁ Myrtle Beach (Wang et al., 1988)
• Leadbetter (Gable, 1981)	△ Jekyll Island (Wang et al., 1988)
+ Torrey Pines (Inman et al., 1980)	▽ Anastacia Beach (Wang et al., 1988)
× Lake Worth (Watts, 1953)	• N. Mantazas Beach (Wang et al., 1988)
○ Channel Islands (Bruno et al., 1961)	• Canaveral Seashore (Wang et al., 1988)
□ Price Inlet (Kana, 1977)	• Canaveral Beach (Wang et al., 1988)
◇ Pointe Sapin (Kooistra & Kamphuis, 1984)	○ Melbourne Beach (Wang et al., 1988)
▷ Anaheim Bay (Caldwell, 1956)	□ Beverly Beach (Wang et al., 1988)
◁ Pt. Mugu (Duane & James, 1980)	◇ Lido Key Beach (Wang et al., 1988)
△ Lake Michigan (Lee, 1975)	▷ St. George Island (Wang et al., 1988)
▽ Cape Thompson (Moore & Cole, 1960)	◁ St. Joseph Island (Wang et al., 1988)
• Cotonou, Benin (Sireyjol, 1964)	△ Grayton Beach (Wang et al., 1988)
+ Safi, Maroc (Delorme, 1981)	▽ Redington Beach (Wang et al., 1988)
× Agadir, Maroc (Delorme, 1981)	• Indian Shores (Wang et al., 1988)
○ Pointe-Noire, Congo (Delorme, 1981)	+ Indian Rocks Beach (Wang et al., 1988)
□ Lome, Benin (Delorme, 1981)	× LSTF (Smith et al., 2003)
◇ Ventnor (Fairchild, 1977)	○ LSTF (Burcharth & Frigaard, 1998)
▷ Nags Head (Fairchild, 1977)	□ Delft Hydraulics (1977)
◁ Abidjan, Ivory Coast (Bijker, 1968)	◇ Delft Hydraulics (1981)
△ Miyazu (Adachi et al., 1959)	▷ El Moreno (Komar, 1969)
▽ Rosseika (Voitsekhovich, 1986)	◁ Hurst castle spit (Nicholls & Wright, 1991)
• Primorskoe (Voitsekhovich, 1986)	△ Leontyev (1989)

Source: Huisman et al., unpublished

One-line Sediment Transport Formulas



Source: Huisman et al., unpublished



Source: Huisman et al., unpublished

Takeaway Comparison

GenCade

■ Pros

- Reliable replication of shoreline behavior
- Widely trusted in U.S. industry for regional planning, nourishment design, and inlet management

■ Cons

- Less flexible for testing alternative sediment transport formulas
- Limited stable replication for complex coastal features
- Setup and modifications can be slower due to SMS-based implementation

ShoreLineS

■ Pros

- Reliable replication of shoreline behavior
- Allows testing of multiple sediment transport formulas
- Free-form grid enables more accurate modeling of complex coastal features
- Open-source implementation allowing for quick setup and modifications
- Ongoing research and development for continued improvement

■ Cons

- Less established in U.S. industry
- GUI still in development

Conclusions

- Both GenCade and ShorelineS are effective one-line shoreline models
- GenCade remains the U.S. industry standard for one-line analysis
- ShorelineS represents a promising, research-driven alternative with expanded calibration capabilities
 - Ongoing joint venture involving over 20 research institutes and multiple European dredging and beach nourishment companies
- Understanding the strengths and limitations of both established and emerging models supports informed coastal management decisions and improved project outcomes for the future

Thank you!
Questions?



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