Application of GenCade DE & MD Coasts

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CIRP
Mission Support
Technology Transfer
Research & Development

US Army Corps of Engineers ®

COASTAL AND HYDRAULICS LABORATORY

U.S. Survey Feet
0   2500   5000   7500

Outline

- What is GenCade?
- GenCade capabilities
- MC GenCade
- Delaware/Maryland Study
- Future Development

GENESIS + Cascade → GenCade
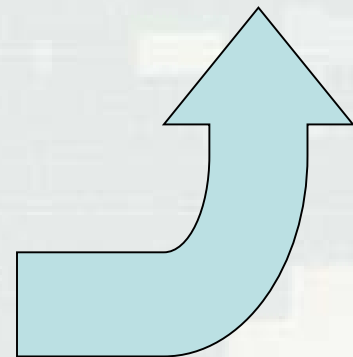
Cascade (top to bottom)

- **Planning tool (RSM Support)**
- **Time scales: months to centuries**
- **Multiple inlets, shoals, and barrier islands; cumulative impacts; retains curvature of regional geomorphology**
- **Fast**
- **Typical grid resolution ~ 500 m**
- **Cross-shore processes in future**
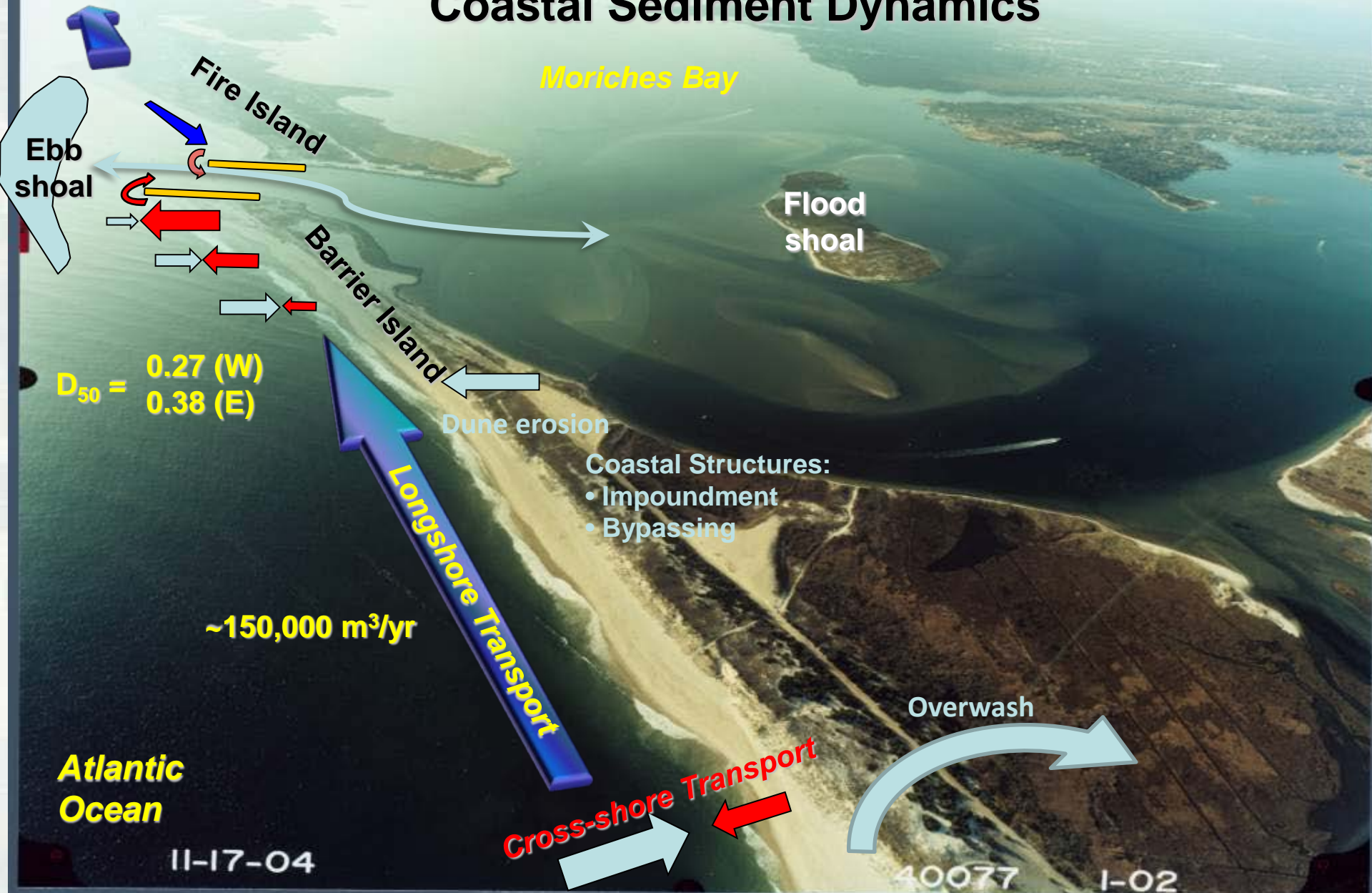
GENESIS (bottom to top)

- **Engineering design tool**
- **Can represent all engineering details – structures, etc.**
- **Mature technology – big payback by updating**
- **Typical grid resolution ~ 25 m**
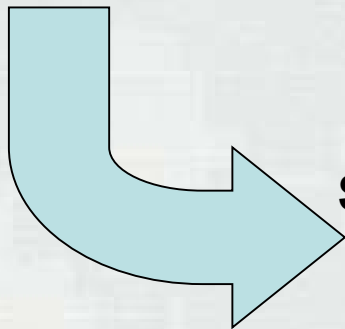
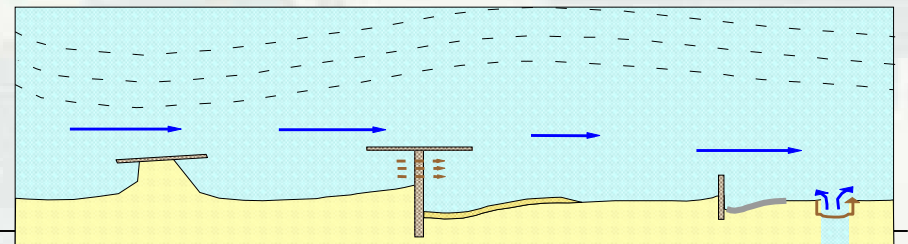**Strategy**: Add Cascade capabilities to GENESIS to automatically include all GENESIS features

Gencade Conceptual Processes: Coastal Sediment Dynamics

Fire Island

Moriches Bay

Ebb shoal

Flood shoal

Barrier Island

$D_{50} =$ 0.27 (W) 0.38 (E)

Dune erosion

Coastal Structures:
- Impoundment
- Bypassing

Longshore Transport

~150,000 m³/yr

Overwash

Atlantic Ocean

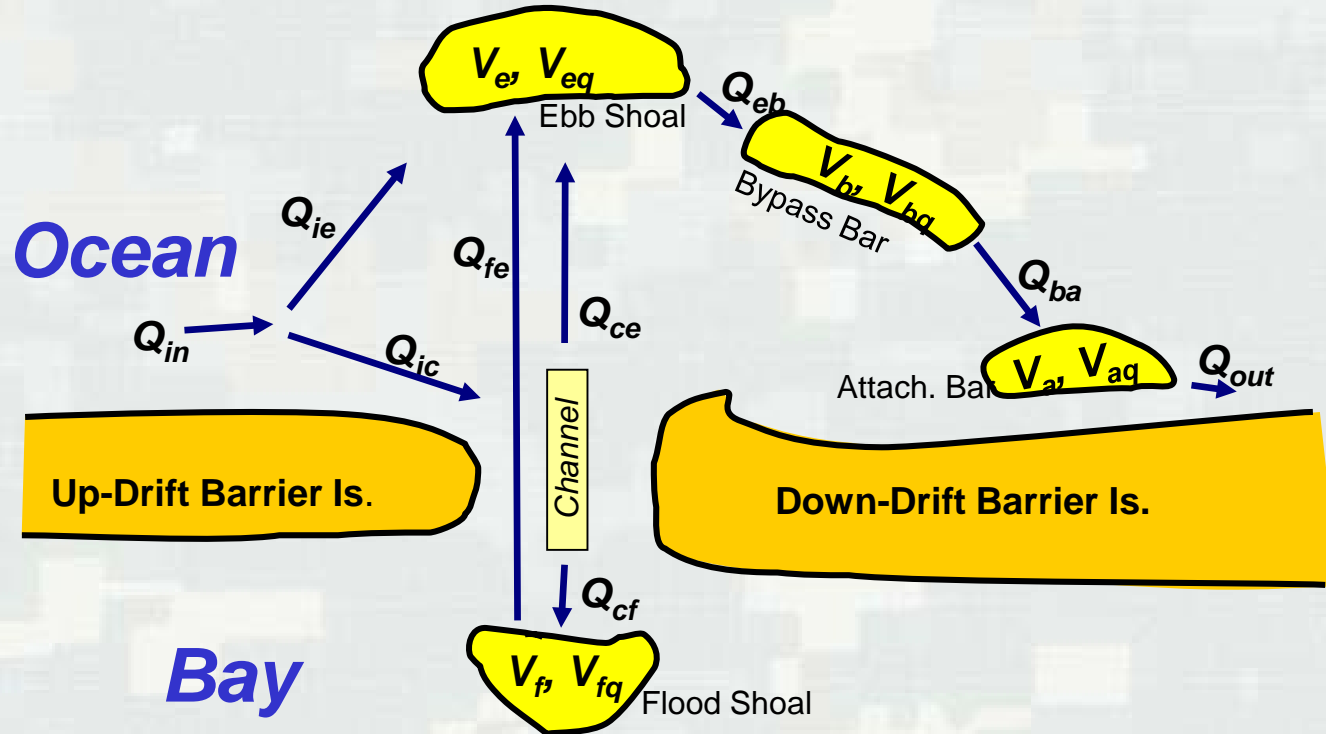Cross-shore Transport

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Model Functionality and Capabilities

- Variable resolution grids

- Inlet bypassing

- Inlet Reservoir Model for calculation of shoal and inlet feature sediment balance

- Representation of regional morphologic trends

- Multiple wave input forcing locations

- Representation of coastal structures: groins, jetties, seawalls, t-head groins, breakwaters, etc.

- Calculation of salients and tombolos behind breakwaters

- Time-dependent detached breakwater transmission

- Efficient calculation of breaking wave properties in internal wave model

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Inlet Reservoir Model
Inlet bypassing and evolution of inlet deltas

V_e, V_{eq} — Ebb Shoal

Q_{eb}

V_b, V_{bq} — Bypass Bar

Q_{ba}

Q_{ie}

Ocean

Q_{fe}

Q_{ce}

V_a, V_{aq} — Attach. Bar

Q_{out}

Q_{in}

Q_{ic}

Channel

Up-Drift Barrier Is.

Down-Drift Barrier Is.

Q_{cf}

Bay

V_f, V_{fq} — Flood Shoal

$$Q_{ie} = \delta Q_{in}$$
$$Q_{ic} = (1 - \delta) Q_{in}$$
$$Q_{ce} = \beta Q_{ic} = \beta(1 - \delta) Q_{in}$$
$$Q_{cf} = (1 - \beta) Q_{ic} = (1 - \beta)(1 - \delta) Q_{in}$$
$$Q_{fe} = (V_f - V_{fq}) / dt, \ V_f > V_{fq}$$

$$Q_{eb} = \frac{V_e}{V_{eq}} (Q_{ie} + Q_{fe} + Q_{ce})$$
$$Q_{ba} = \frac{V_b}{V_{bq}} Q_{eb}$$
$$Q_{out} = \frac{V_a}{V_{aq}} Q_{ba}$$
$$\delta = (V_e + V_f) / (V_{eq} + V_{fq})$$
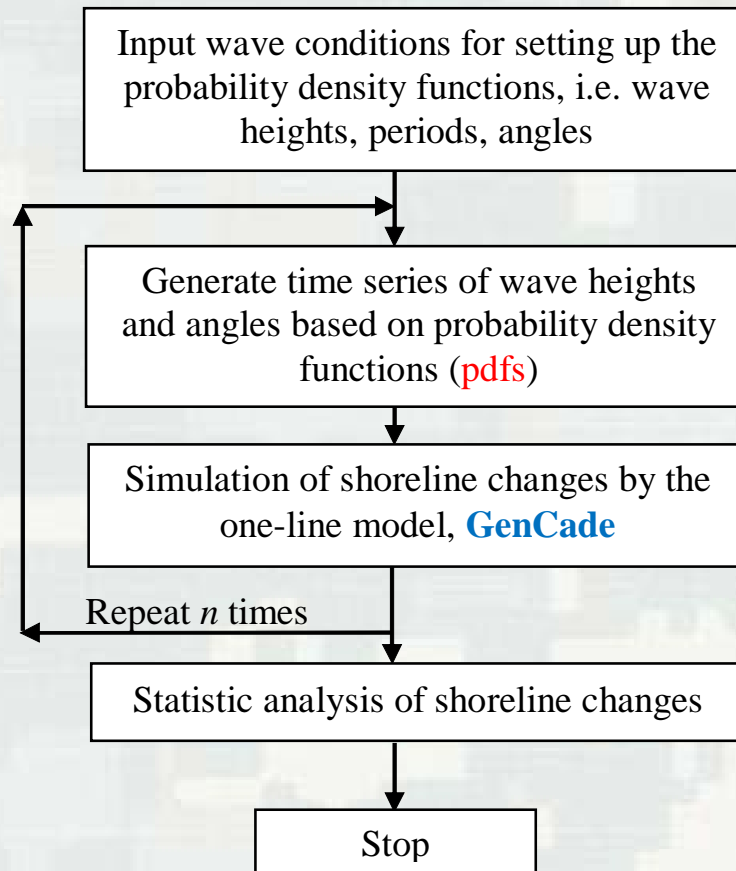
$$dV_e = (Q_{ie} + Q_{fe} + Q_{ce} - Q_{eb}) dt$$
$$dV_f = (Q_{cf} - Q_{fe}) dt$$
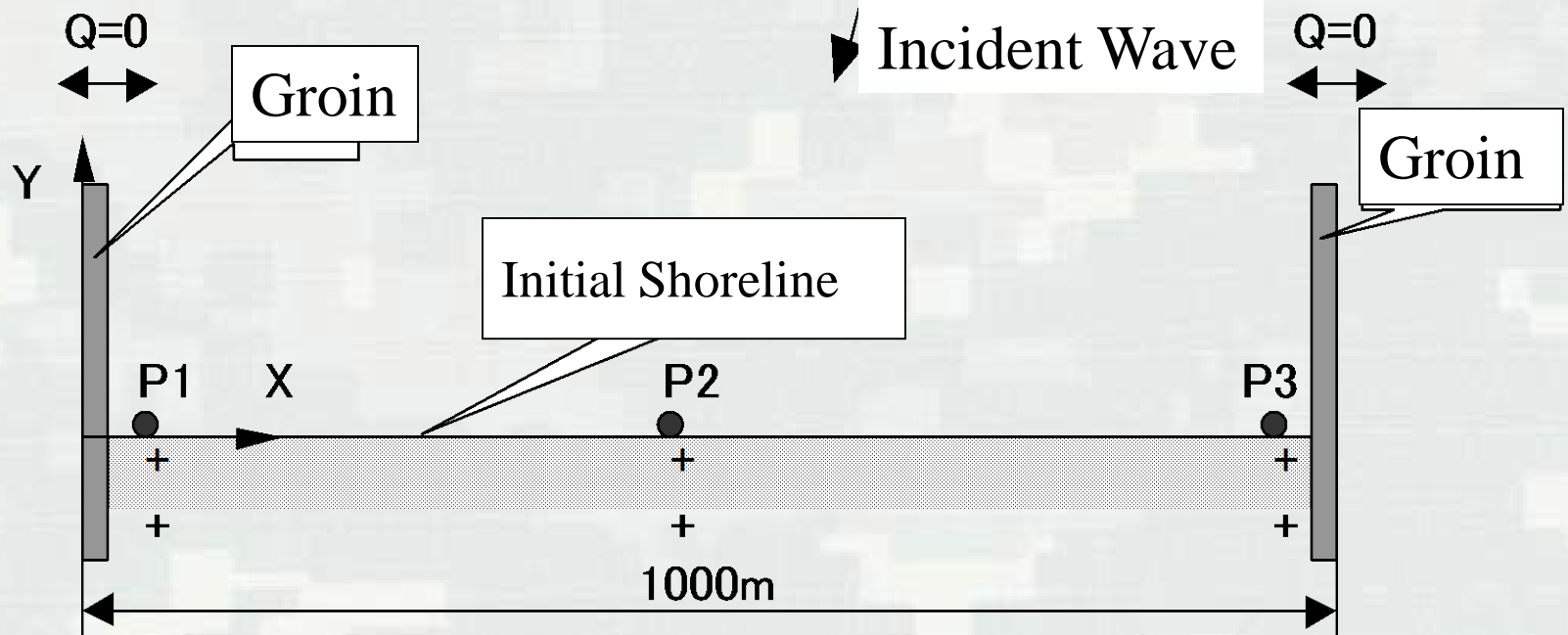$$dV_b = (Q_{eb} - Q_{ba}) dt$$
$$dV_a = (Q_{ba} - Q_{out}) dt$$
$$\beta = (1 - V_e / V_{eq}) / (2 - V_e / V_{eq} - V_f / V_{fq})$$

Flow chart of shoreline change simulation by Monte Carlo Method

Input wave conditions for setting up the probability density functions, i.e. wave heights, periods, angles

Generate time series of wave heights and angles based on probability density functions (pdfs)

Simulation of shoreline changes by the one-line model, **GenCade**

Repeat *n* times

Statistic analysis of shoreline changes

Stop

The more test samples (n), the better statistic results
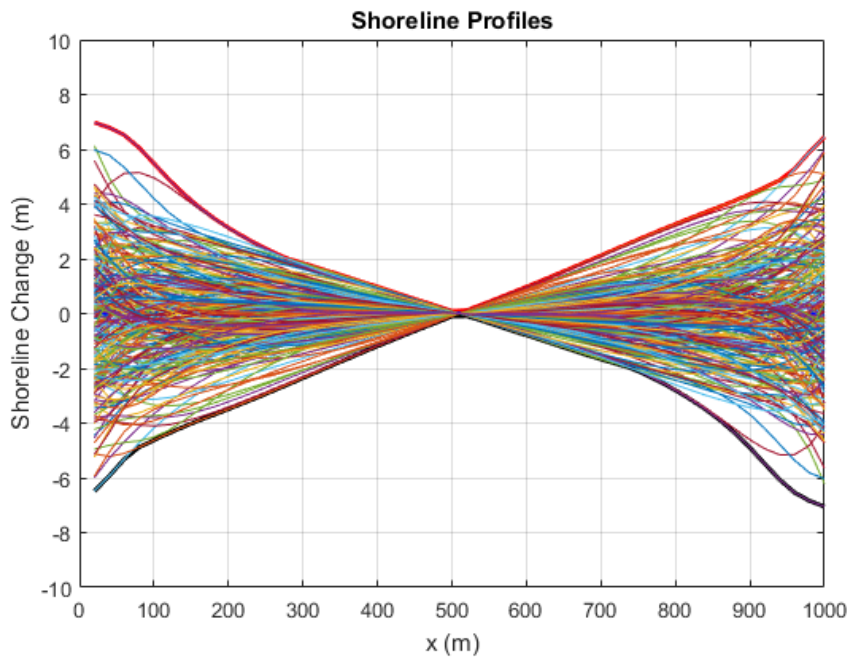
Study Case

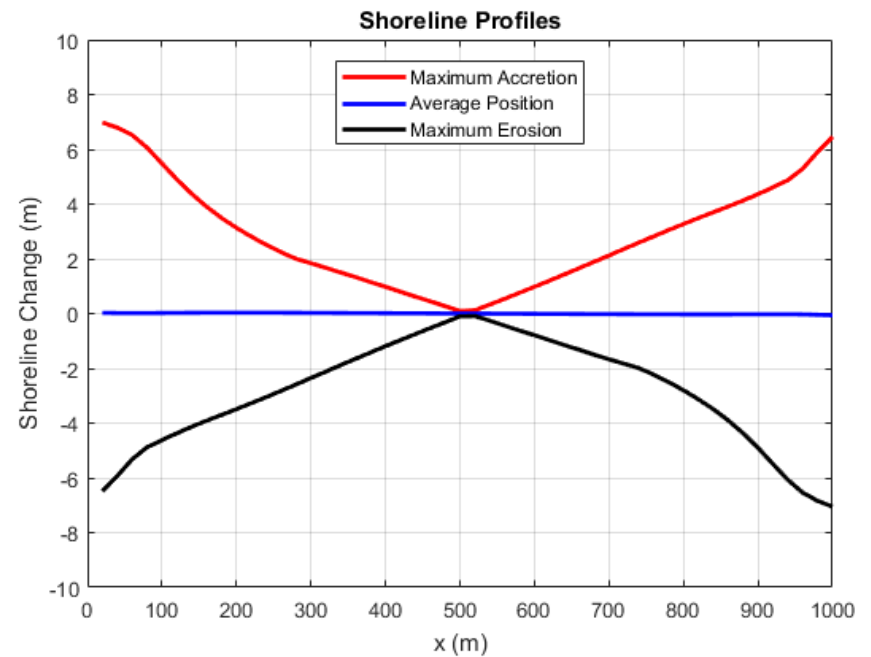Stochastic Variables: wave height and direction
Computational Period: 10years
Numerical experiments: 256

Shoreline Profiles after 10 years
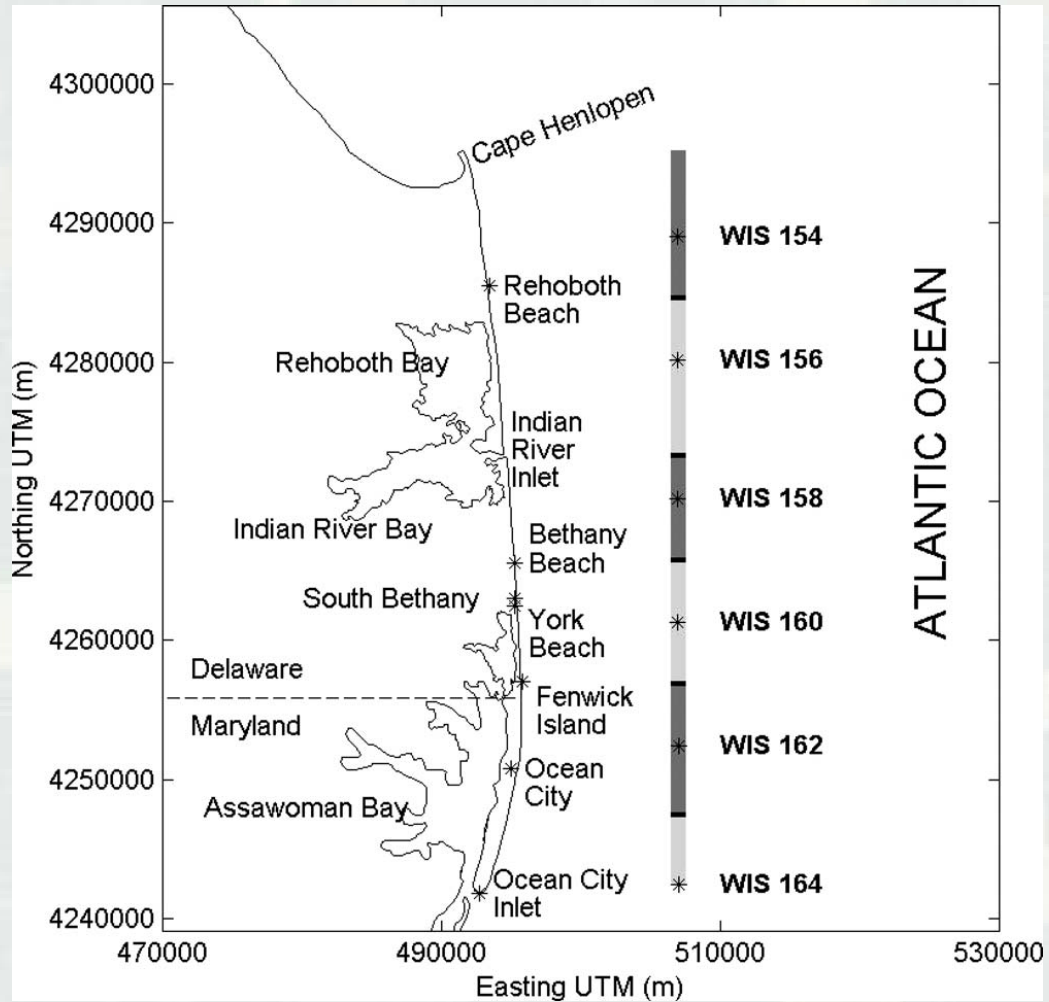

(a) All 256 shorelines

(b) Max., average, and min positions

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Delaware and Maryland Coast

- Evaluate bypassing alternatives around Indian River Inlet
  - ► Currently bypassing around 100,000 cy/yr sediment around the inlet
- Modeling will directly output sediment budget for input into SBAS
- Can also calculate nodal zone using MC GenCade
- Leverages current sediment budget work in CIRP with NAP

Study Area

Puleo (2010)

Bethany Beach Survey Data

Discussion

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