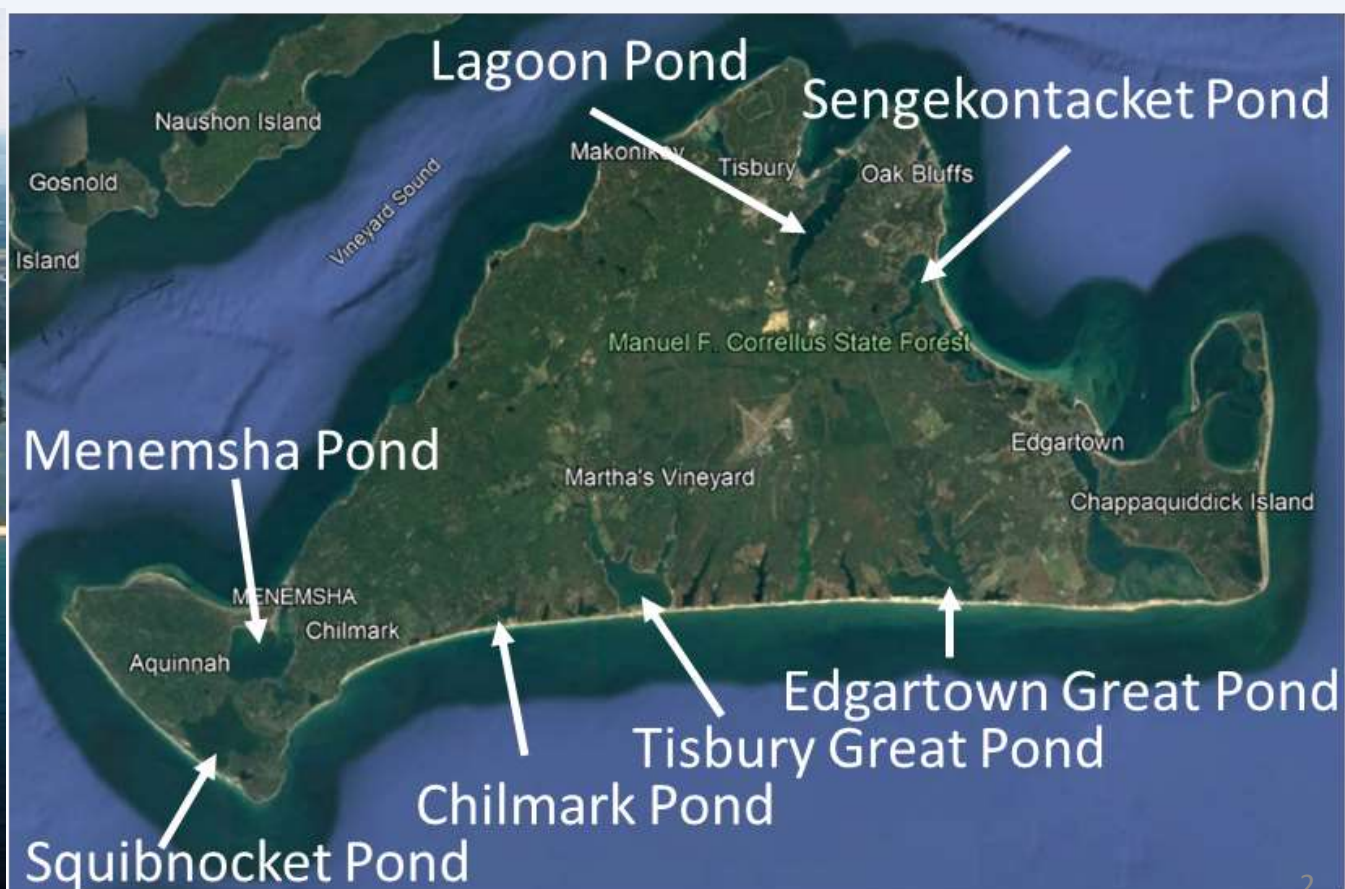


Shoreline Resilience and Inlet Management

Paige Hovenga, Steve Elgar, Britt Raubenheimer, Levi Gorrell

Coastal Ponds

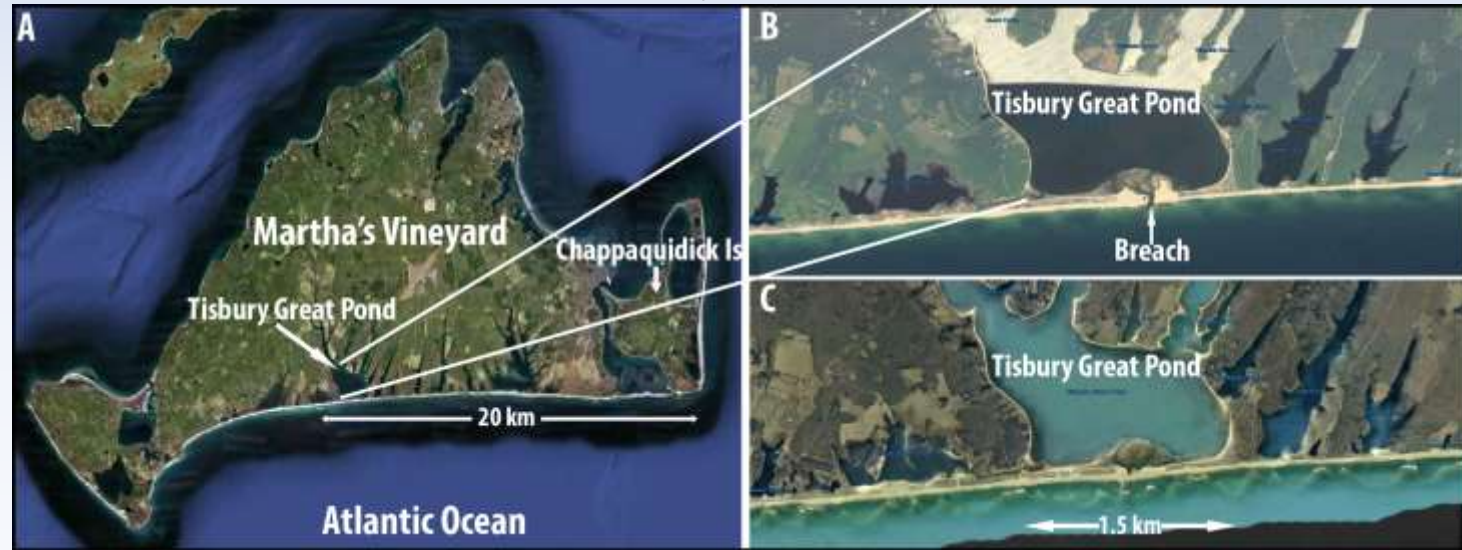
- Saltwater or brackish ponds typically separated from the ocean by a narrow, barrier beach
- Cape Cod, Martha's Vineyard, Nantucket, and mainland Massachusetts shorelines
- Provide many ecosystem services including habitat, recreation, support of local economy



Background

- Flood mitigation – neighboring properties
 - Due to rainfall, groundwater levels, overwash surges, snowmelt
- Environmental – improve water quality
 - Tidal flushing of the pond to increase salinity and reduce nitrogen
 - E.g., shellfish populations
- Facilitate migration of marine species
 - Diadromous fish
 - E.g., herring to spawn

Tisbury Great Pond



Sesachacha Pond



Background

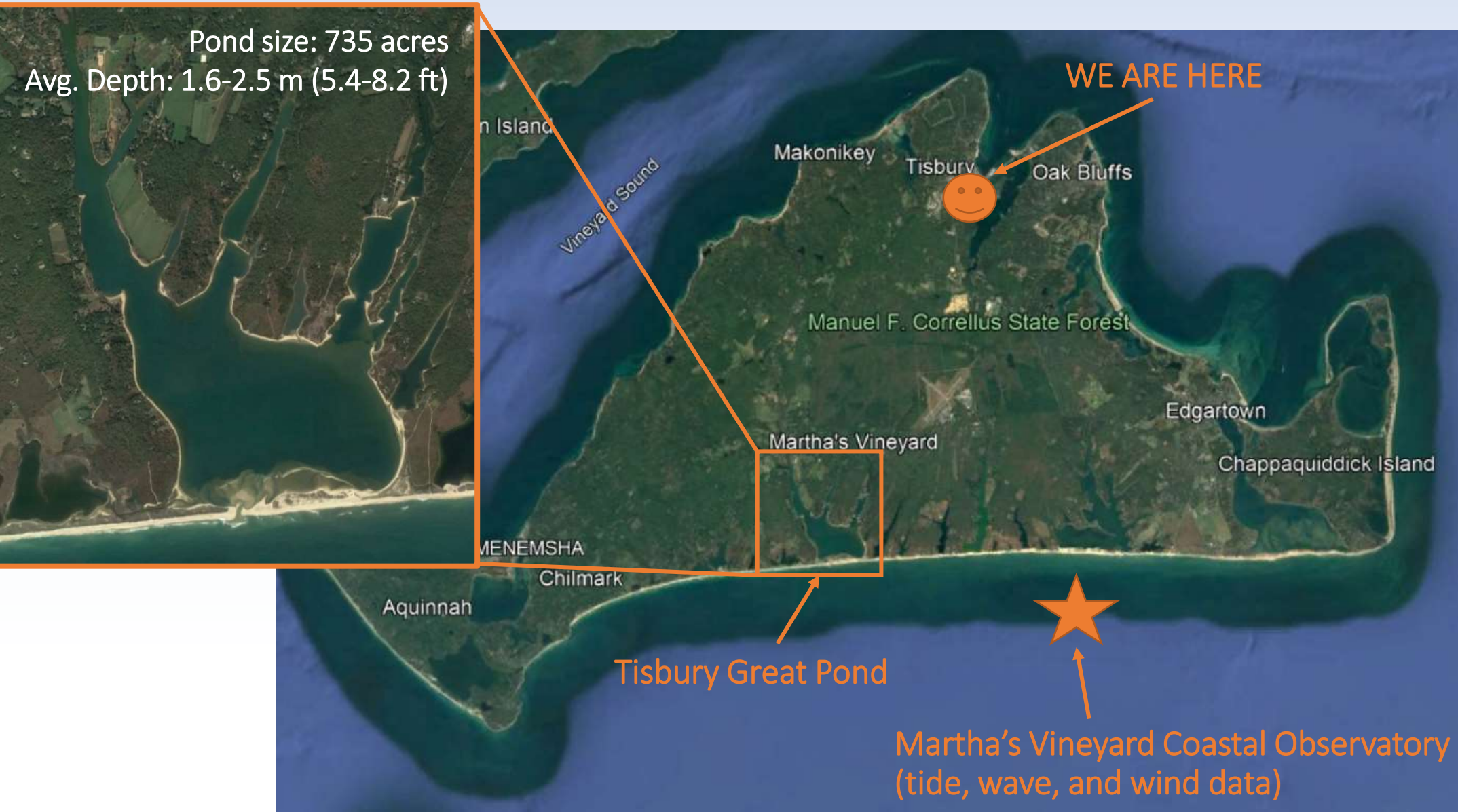


Sesachacha Pond Fall 2021 Opening and Closure



- 1) Understand the physical processes that result in beach recovery after machine-made or natural breaching
- 2) Determine breaching strategies that optimize exchange between coastal ponds and the ocean
 - inlet cut geometries and environmental conditions

Tisbury Great Pond (TGP) on Martha's Vineyard

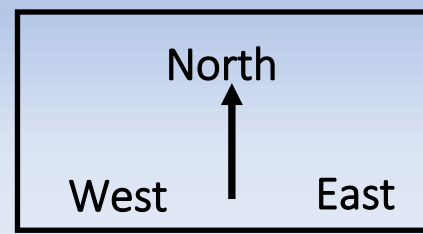


Tisbury Great Pond (TGP) on Martha's Vineyard

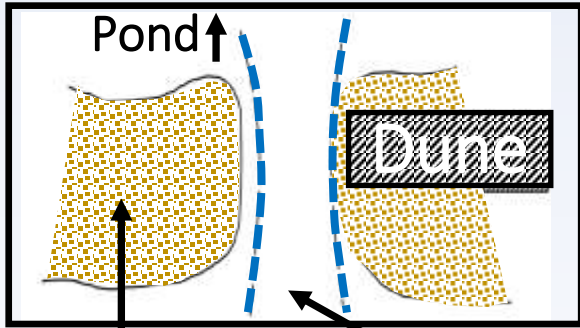
- First recorded opening in the early 1700's
- Barrier beach is intentionally opened ~4 times a year when pond is around 1m above sea level



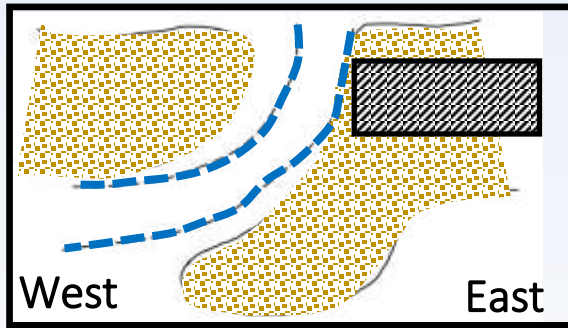
Observations at Tisbury Great Pond, MV (2018)



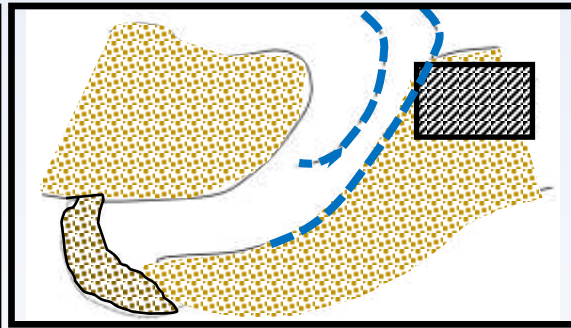
Breached Mar 23



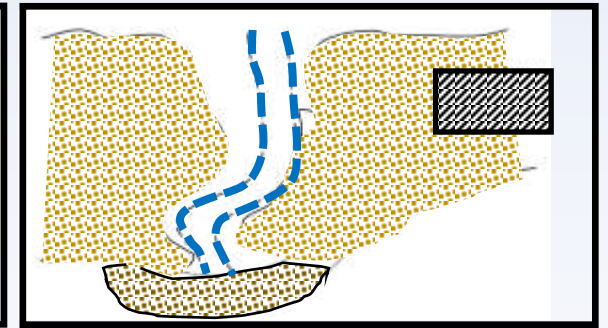
Mar 29



Apr 23



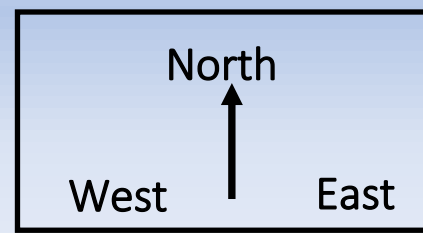
May 1



Beach
Ocean
Breach



Observations at Tisbury Great Pond, MV (2018)

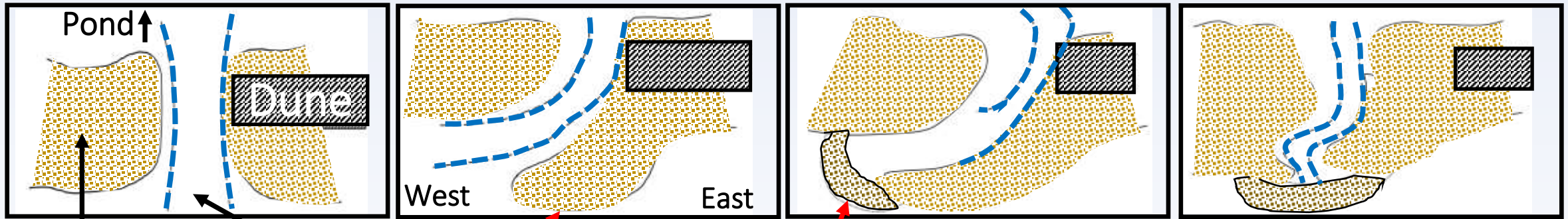


Breached Mar 23

Mar 29

Apr 23

May 1



Pond ↑
Beach ↑
Ocean ↓
Breach ↓

West

East

Direction (deg)

West

East

West

Mar 23

Mar 29

Apr 23

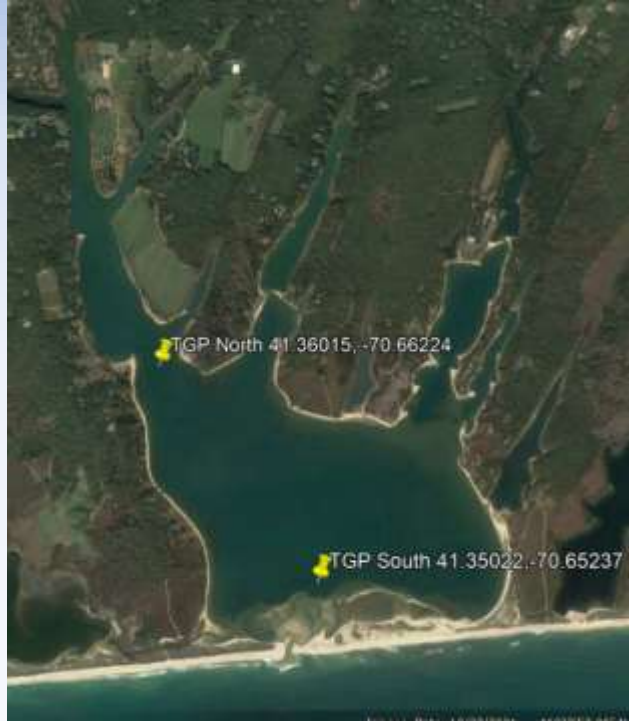
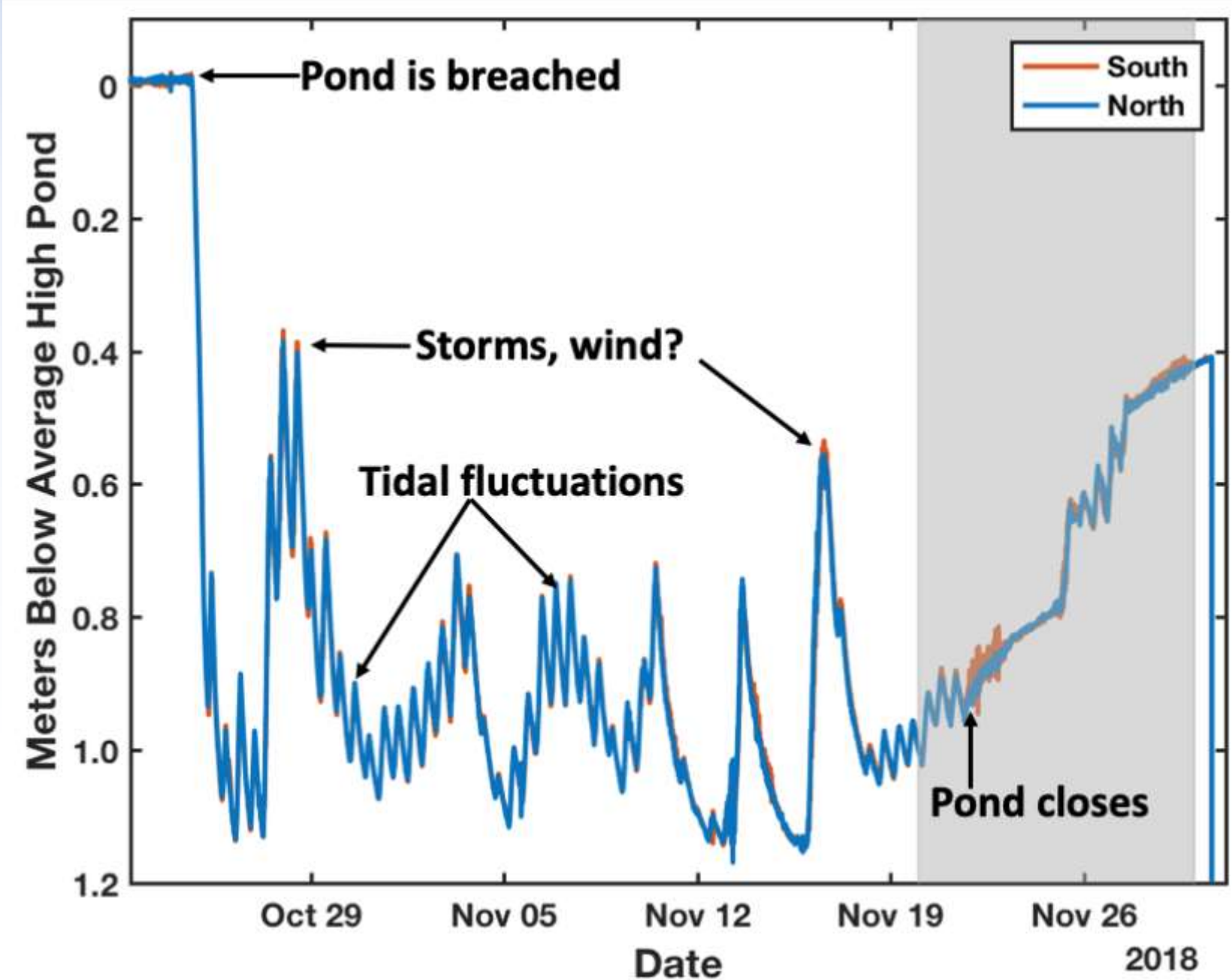
May 1

Waves from east,
spit grows to west

Waves from west,
spit grows to east

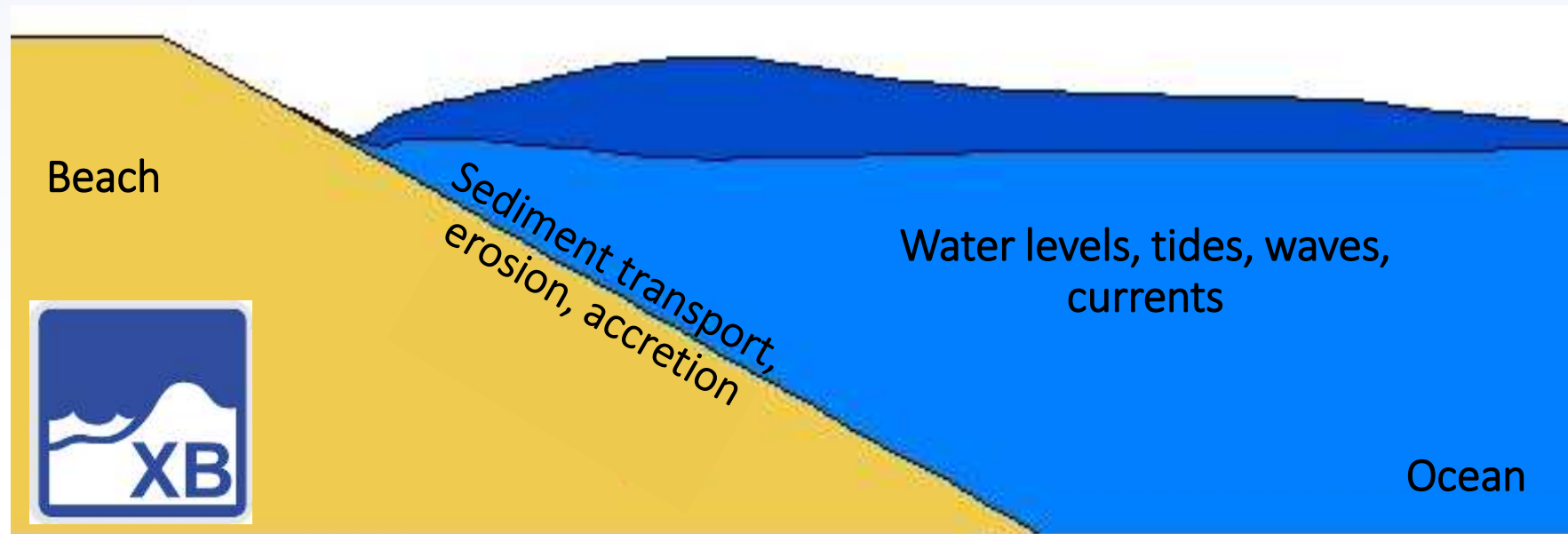
Shore normal waves,
sand moves onshore,
breach closes

Water Levels in Tisbury Great Pond (2018)

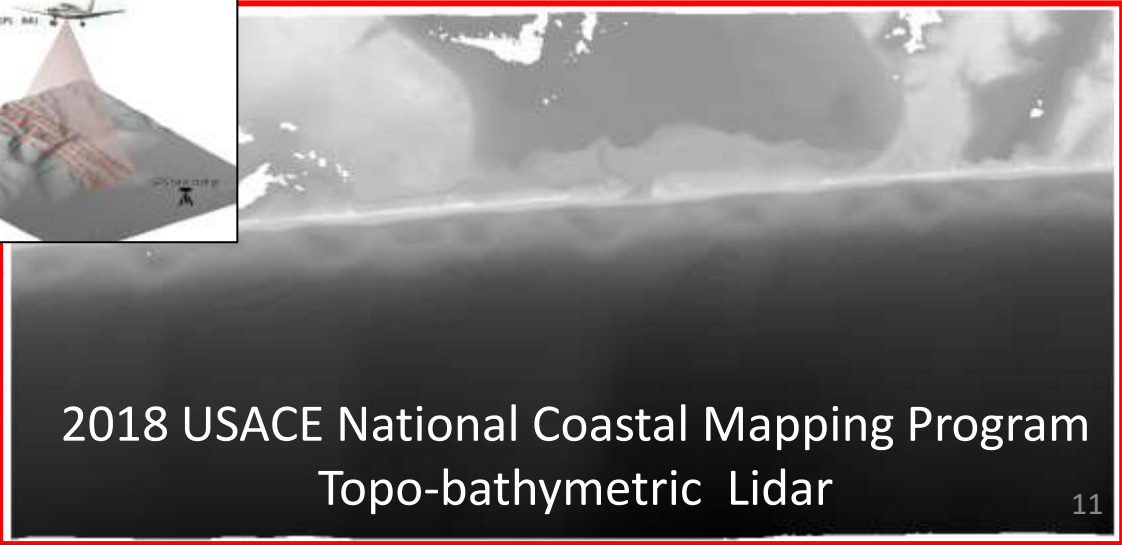
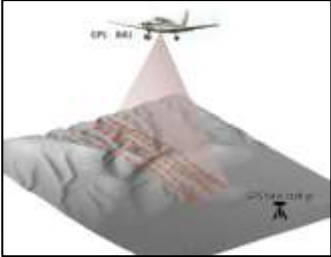
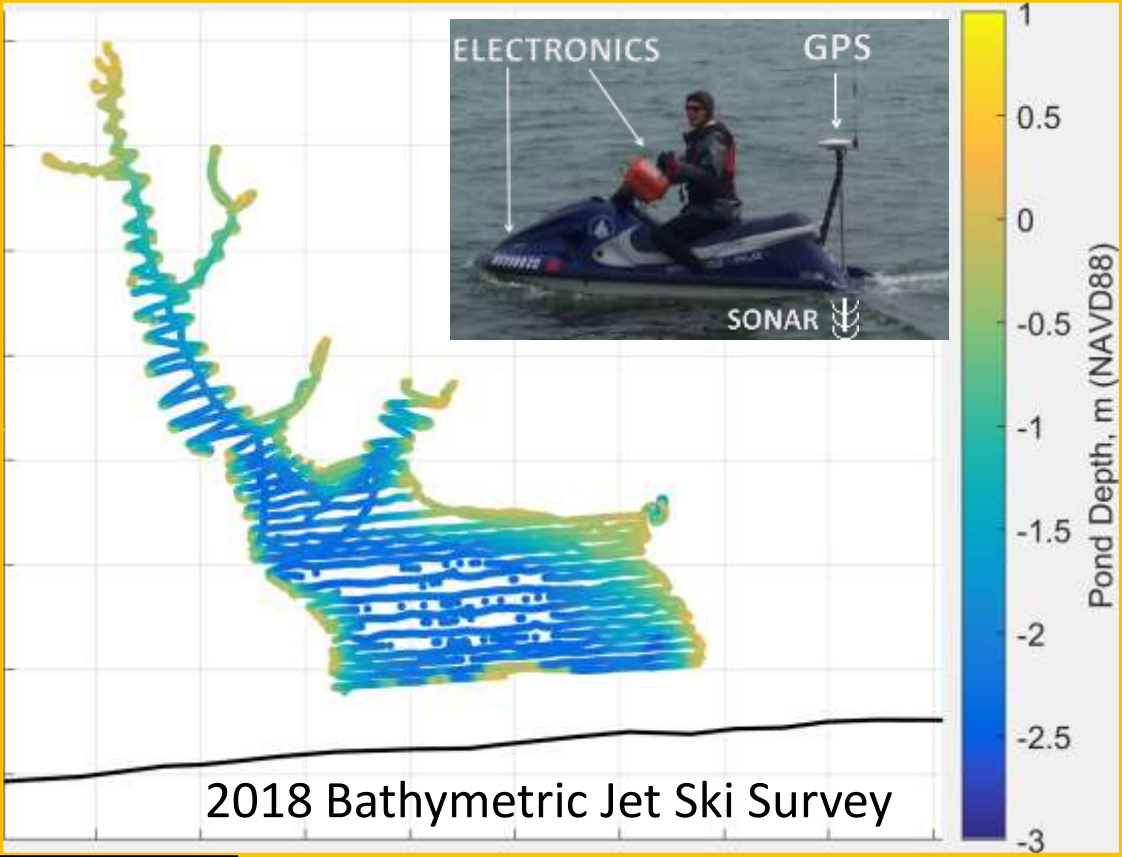


XBeach (Roelvink et al., 2019)

- Numerical model that simulates hydrodynamic and morphodynamic processes
- Develop an XBeach model to test a variety of....
 - Environmental conditions (water levels, tides, waves)
 - Inlet cut geometries (cut width, depth, angle relative to the shoreline)

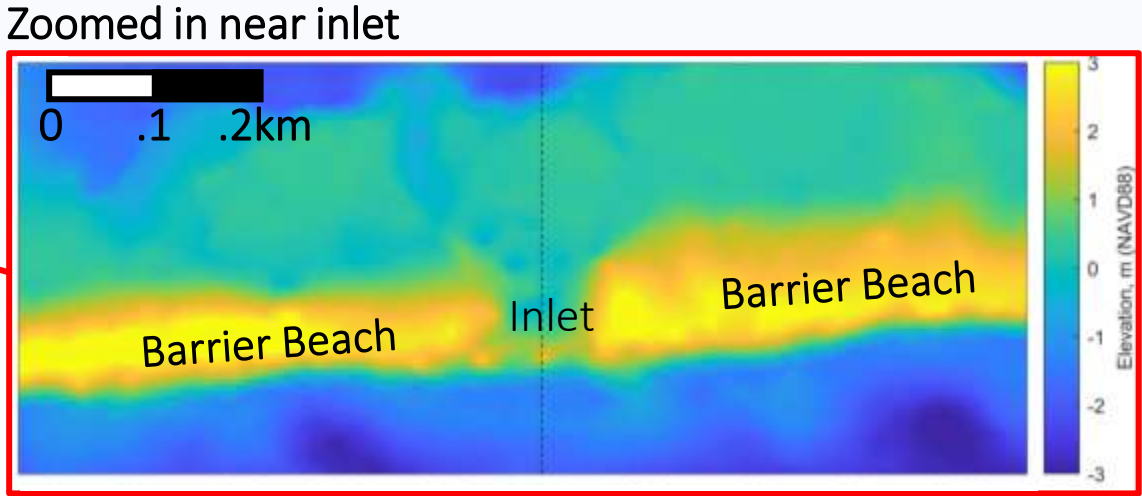
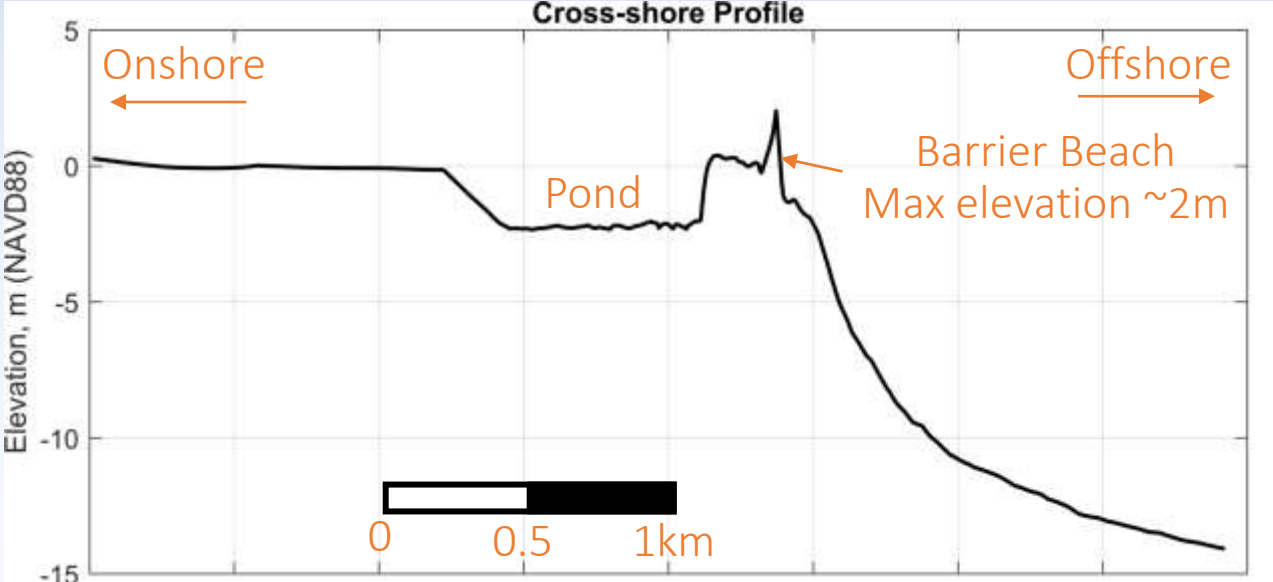
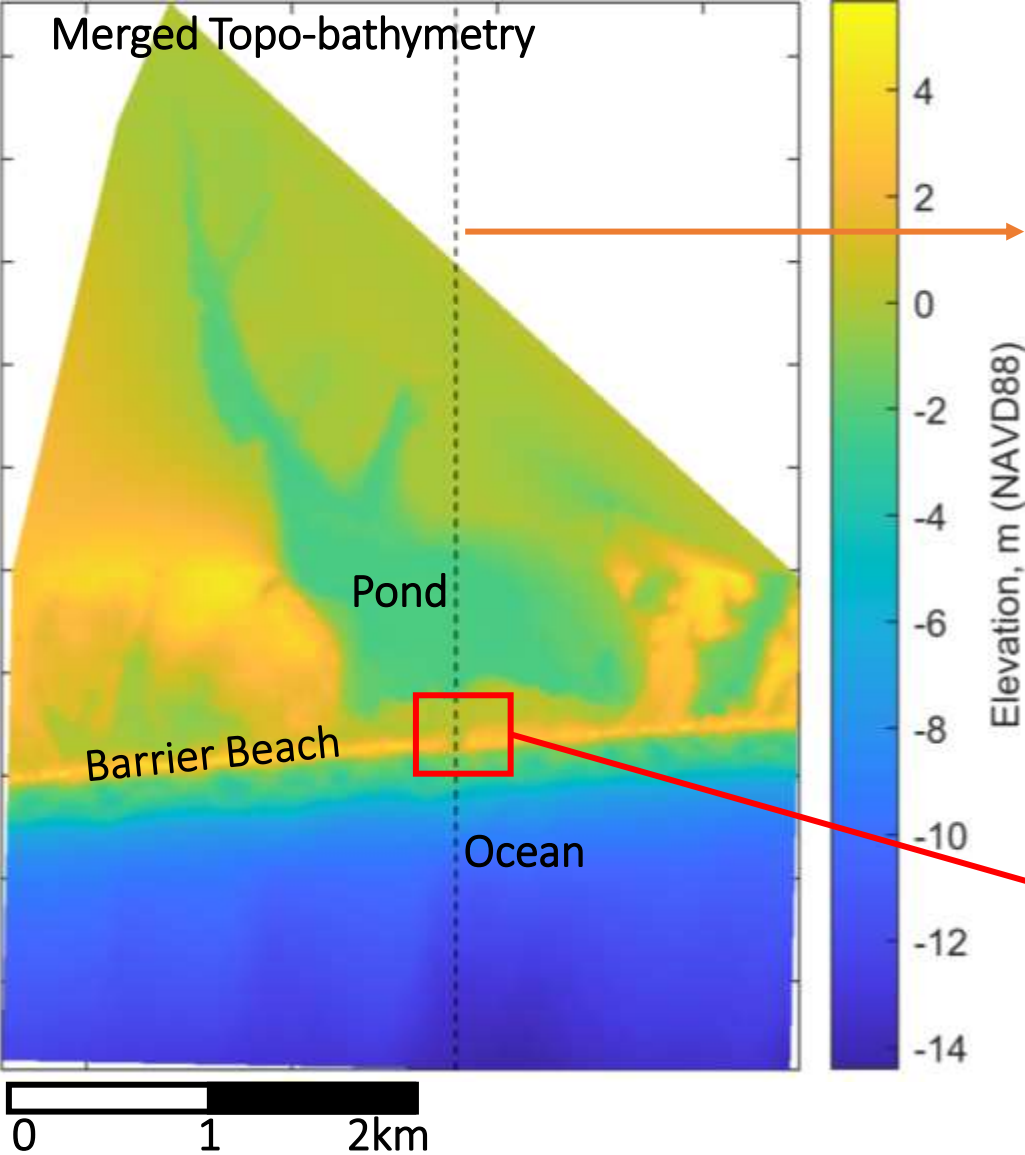


Tisbury Great Pond Depth

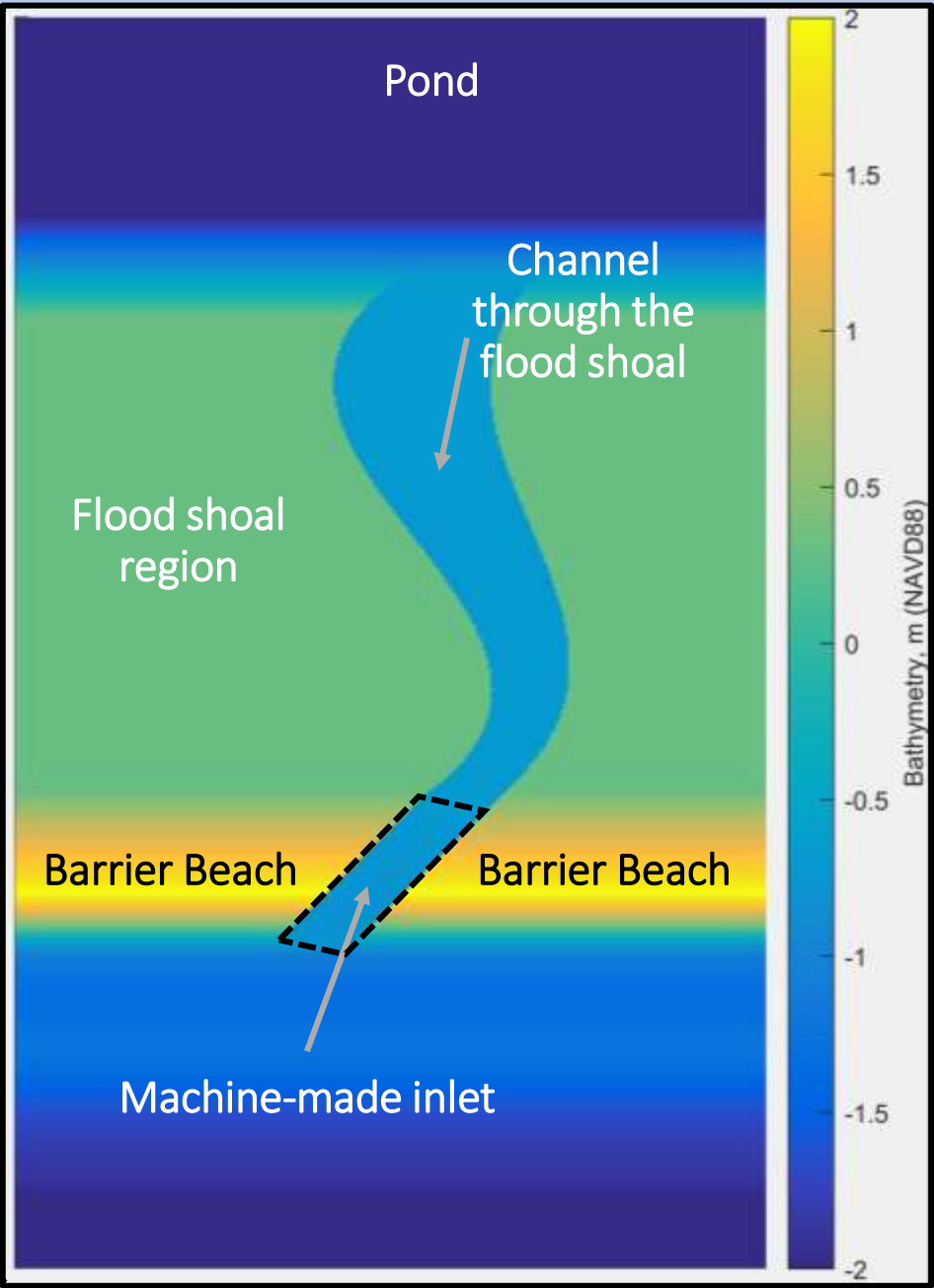
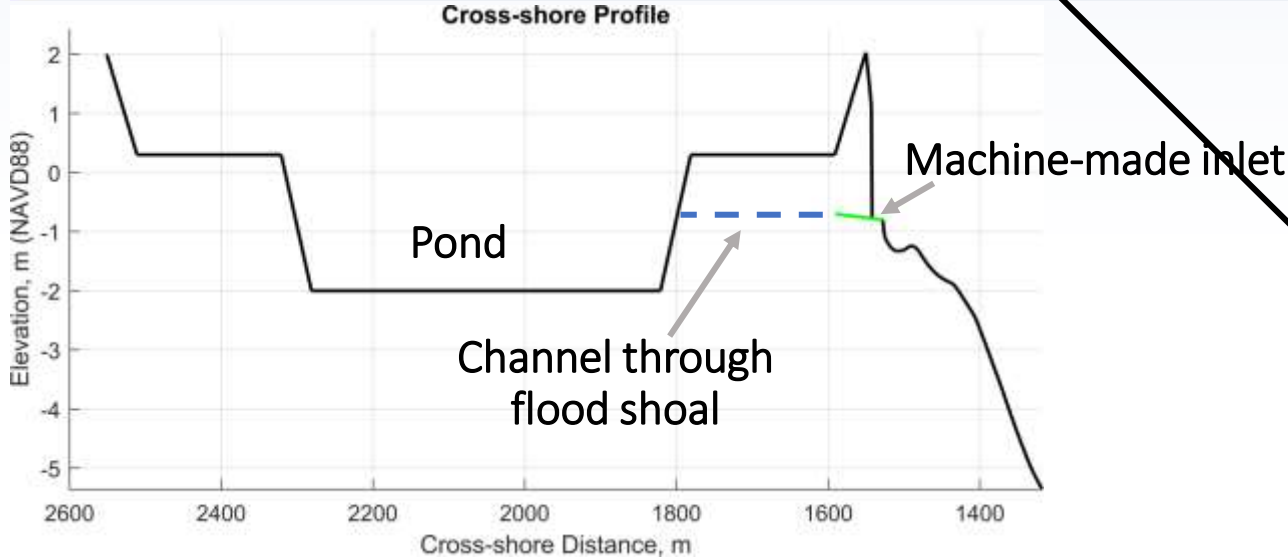
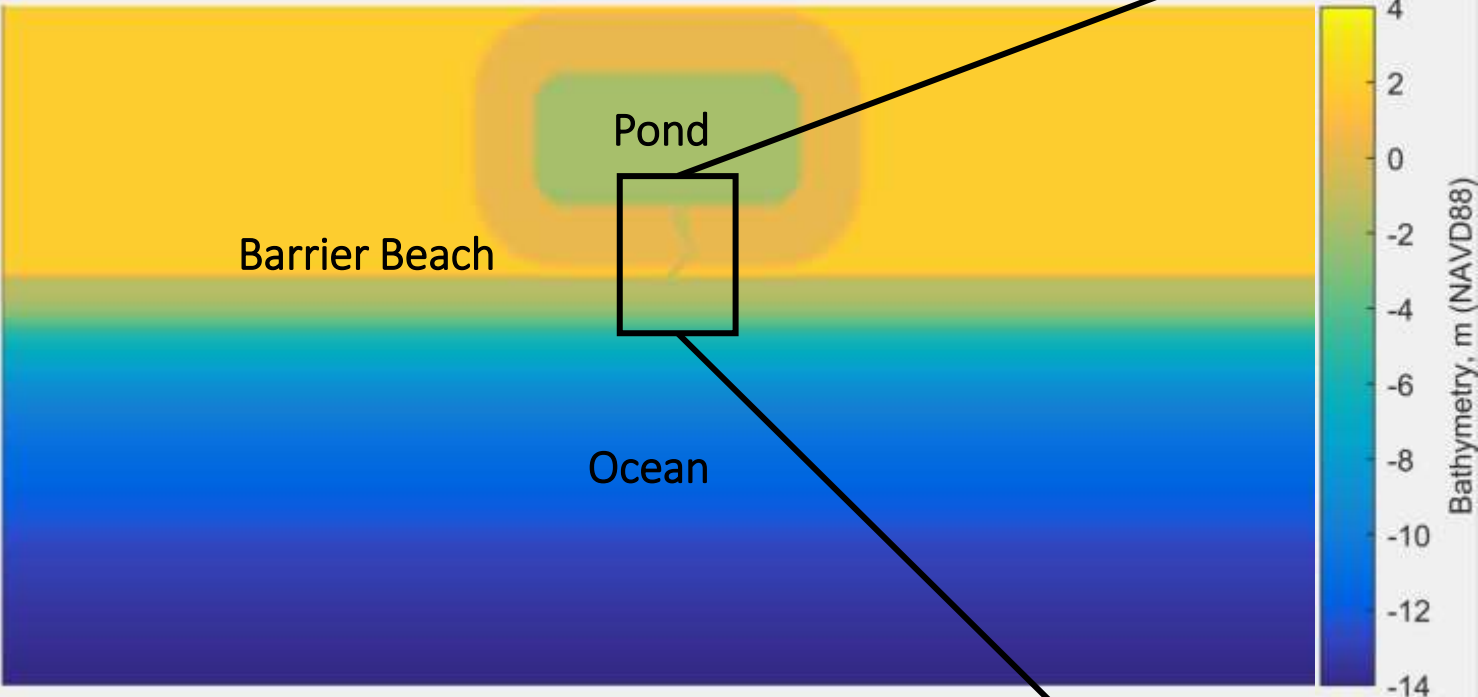


2018 USACE National Coastal Mapping Program
Topo-bathymetric Lidar

Tisbury Great Pond Bathymetry



Schematized XBeach Model Domain



Environmental Conditions for XBeach Modeling

Water Levels

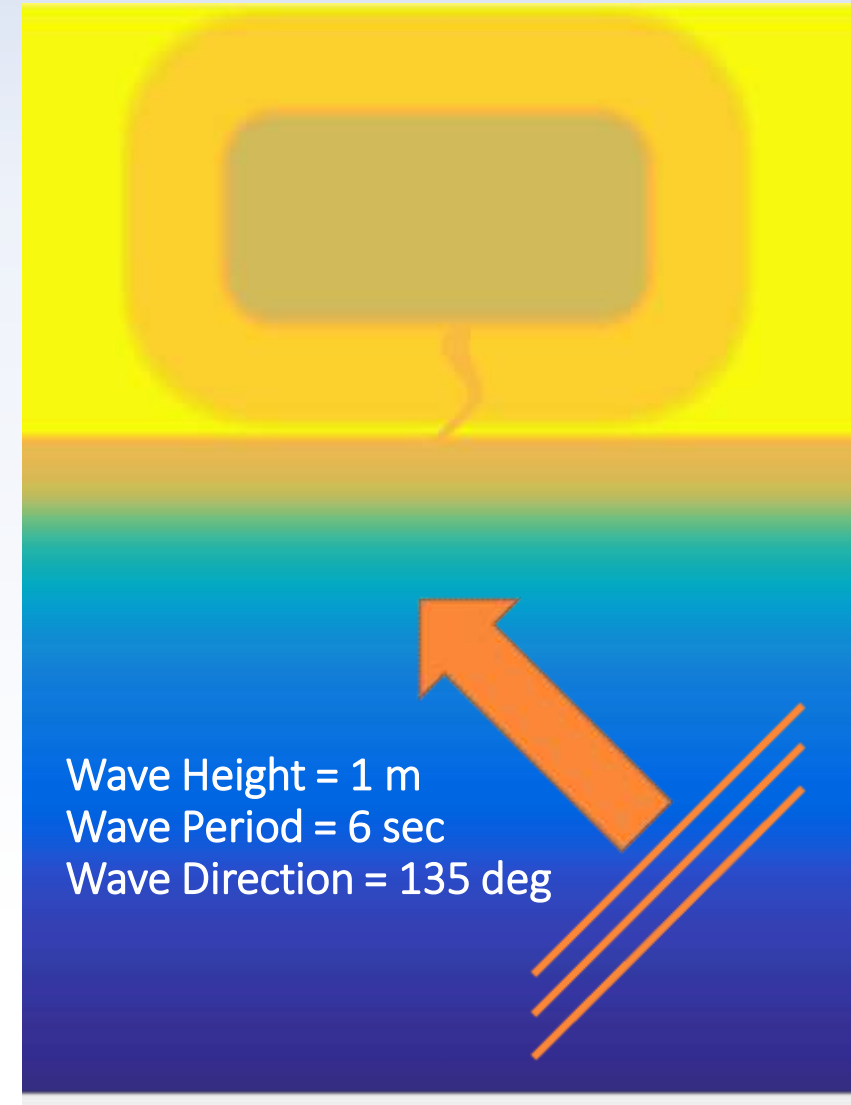
- Measured tides (start at low tide)

Waves

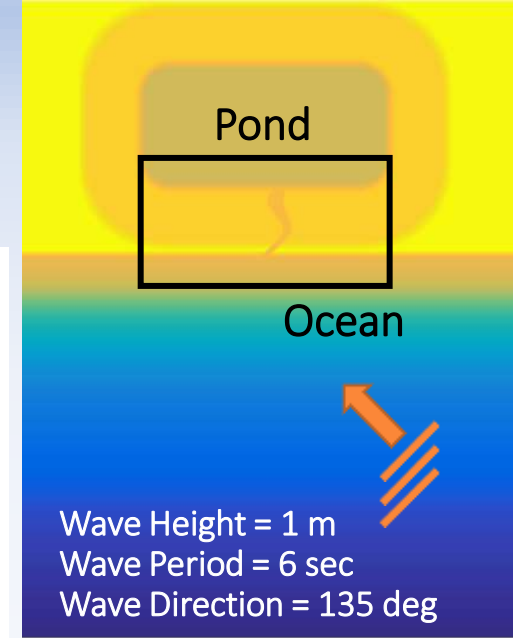
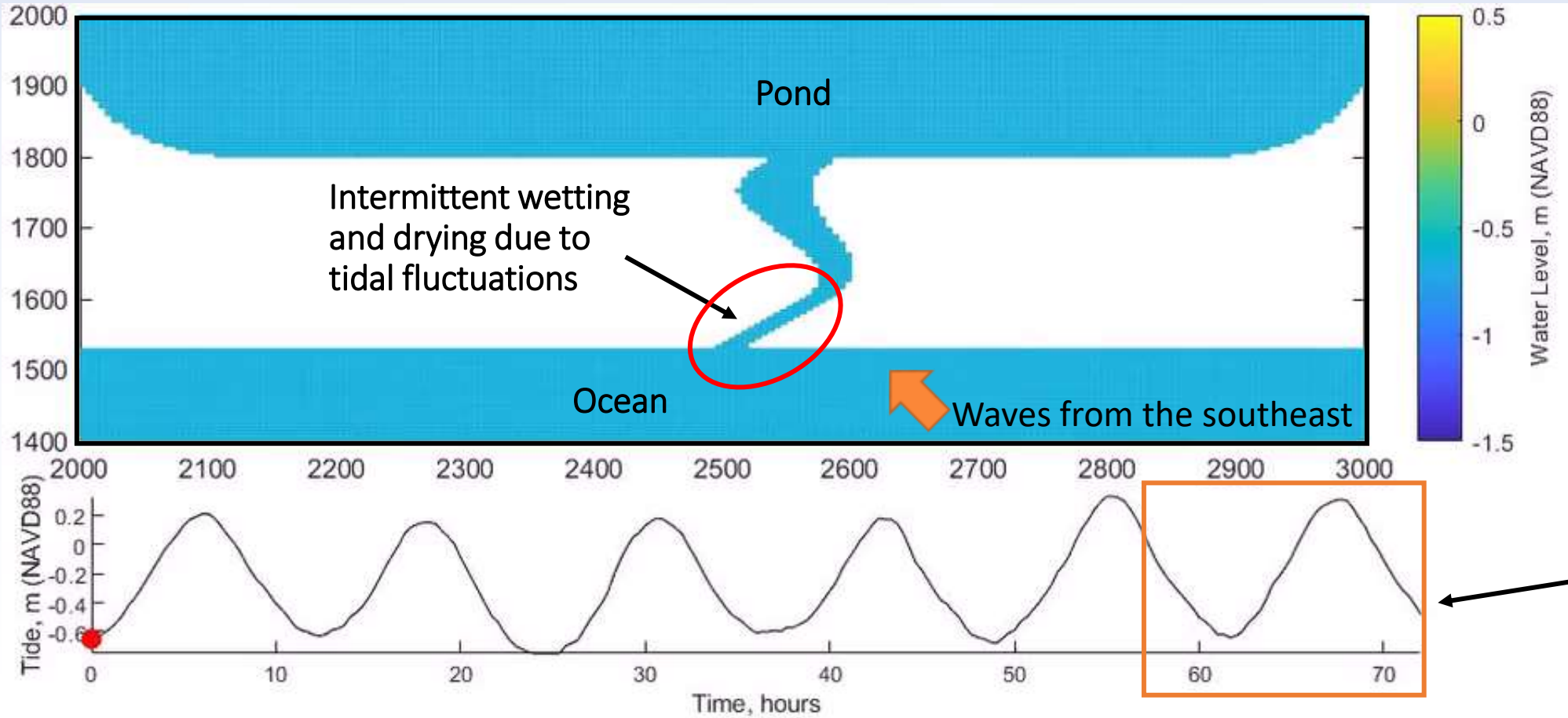
- Wave height = 1 meter (~3 foot)
- Wave period = 6 seconds
- Wave direction = 135 deg (oblique waves from the southeast)

Simulation Run Time = 72 hours

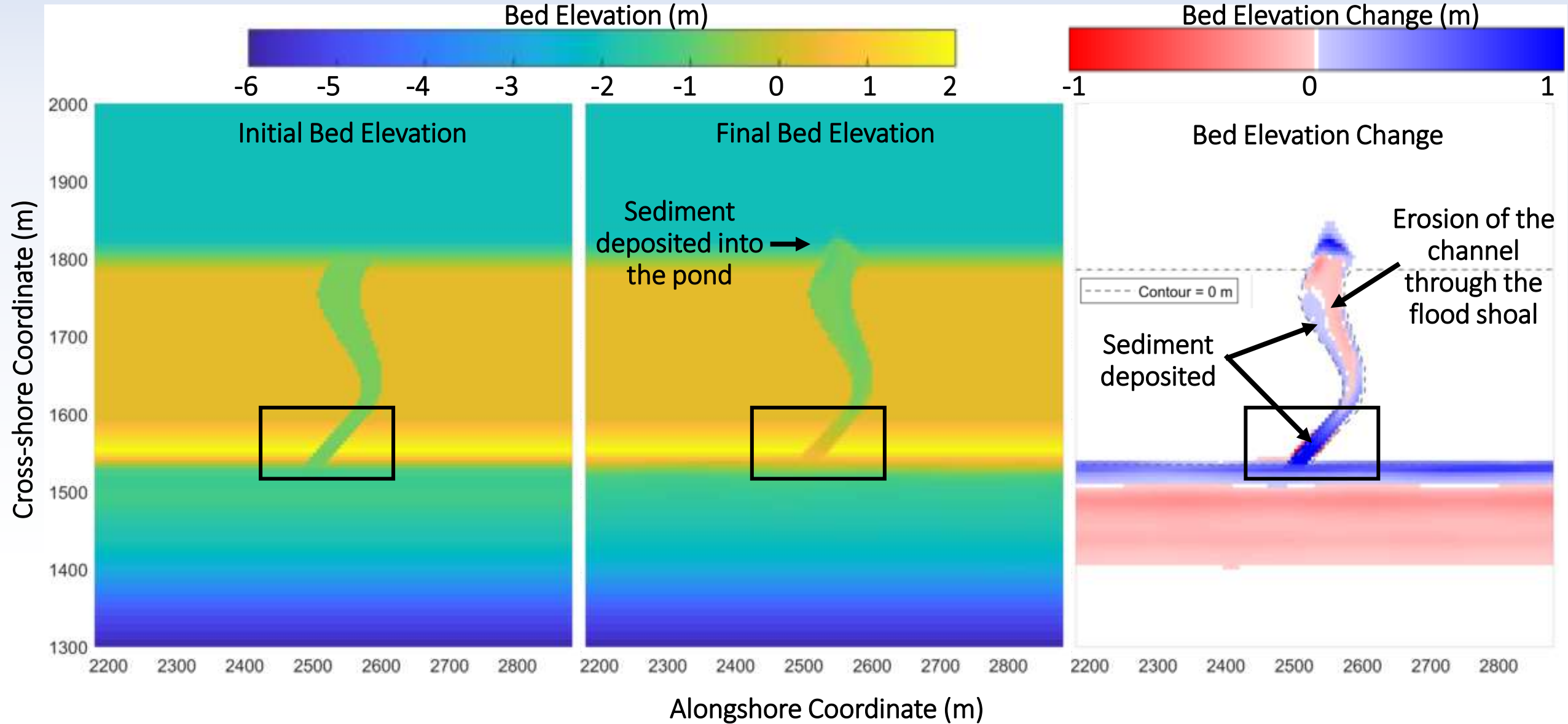
Look for closure of the inlet....



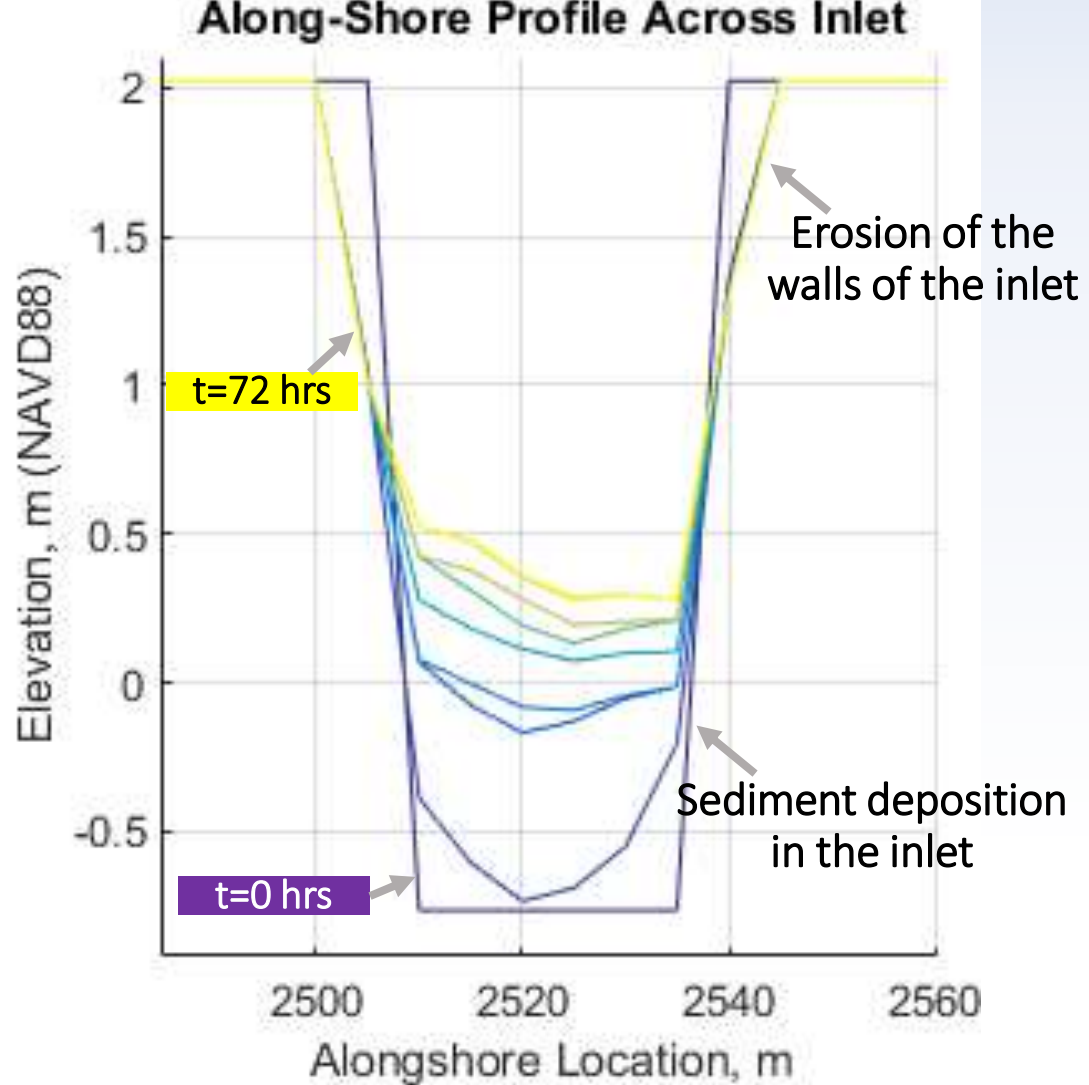
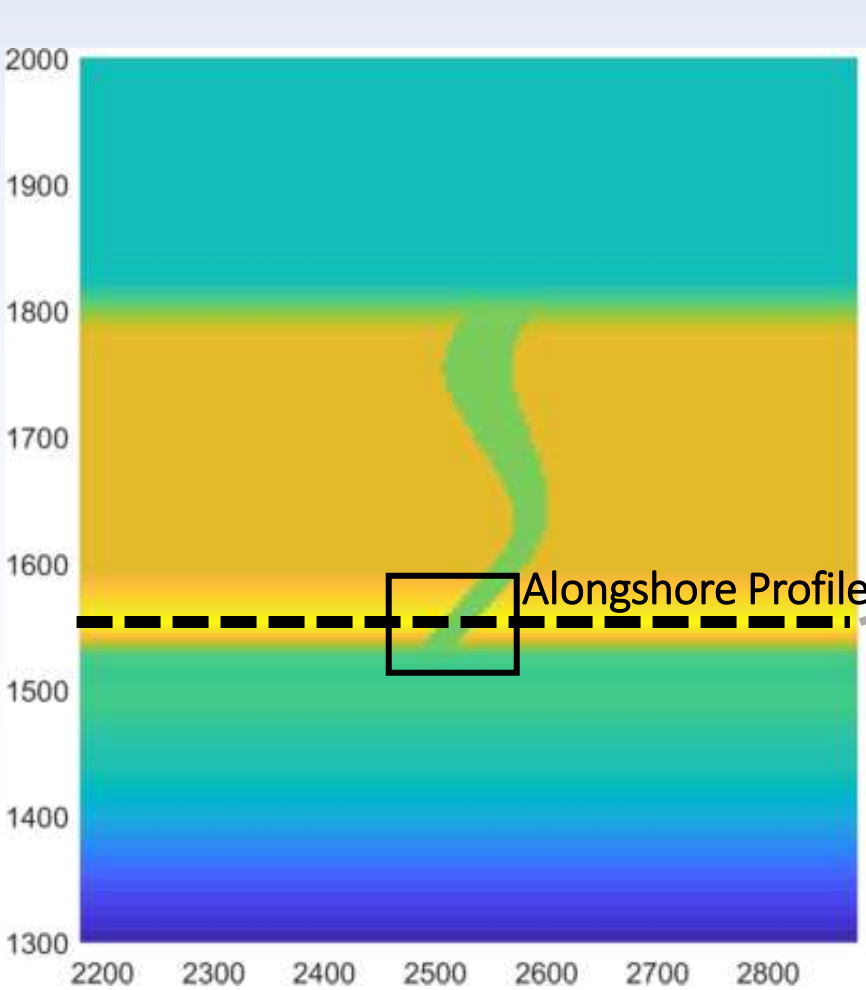
Water Level Fluctuations Near the Inlet



Modeled Bed Elevation Change



Sediment Erosion and Deposition in the Inlet



Preliminary Results

- Moderate waves lead to faster closure
 - Wave Heights = 0.3, 1, and 3 m
- Channel infilling is sensitive to the channel length and curvature
 - Presence of the flood shoal
- Ongoing work to test a range of...

Environmental conditions	<ul style="list-style-type: none">• Wave height, period, direction• Tide range (spring or neap)• Starting tide level (rising or falling)• Water levels• Wind speed and direction
Inlet cut geometries	<ul style="list-style-type: none">• Cut width, depth, and angle
Morphologies	<ul style="list-style-type: none">• Pond length, width, contour depth• Offshore bathymetry• Features (flood and ebb shoals, sand bars)



Photography by Melissa Knowles, Joshua Robinson-White, Reece Robinson, Maria Thibodeau, and Eli Dagostino.

Supplementary Slides

Tisbury Great Pond



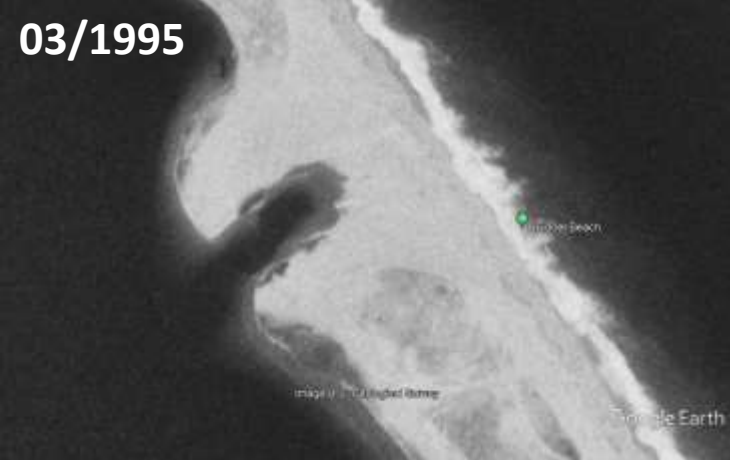
Same opening



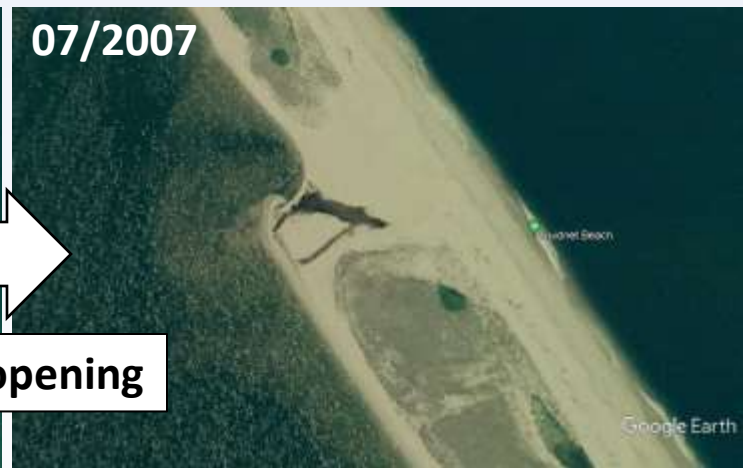
Cut further west



Sesachacha Pond



Less of a flood shoal



Same opening

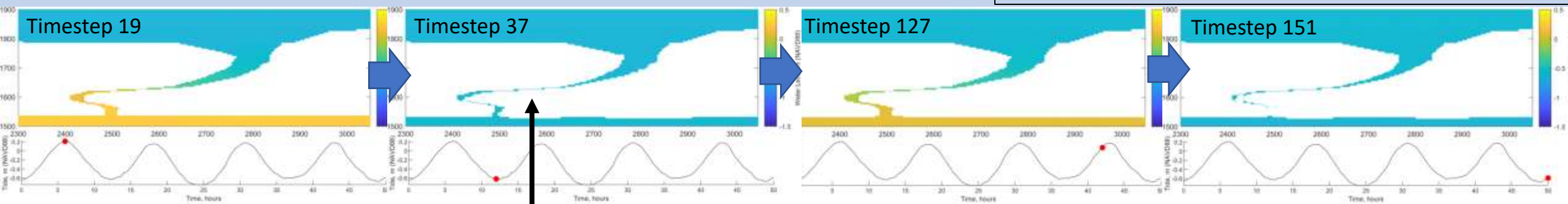


Cut is longer than TGP



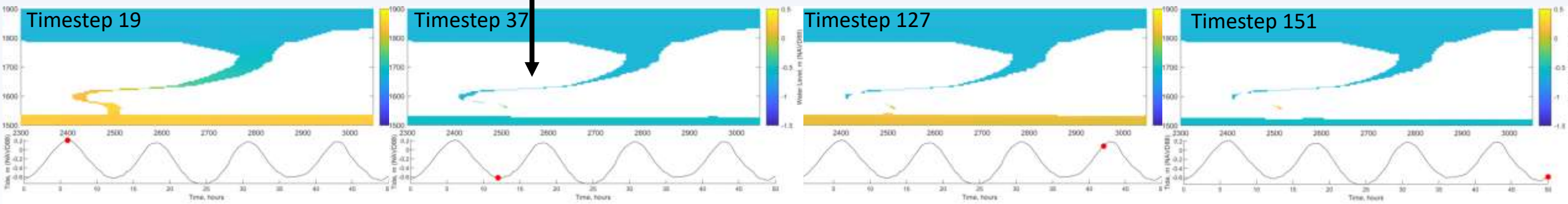
Test 109; **H=0.3 m** and Tides=measured

Instantaneous Water Levels at Different Timesteps



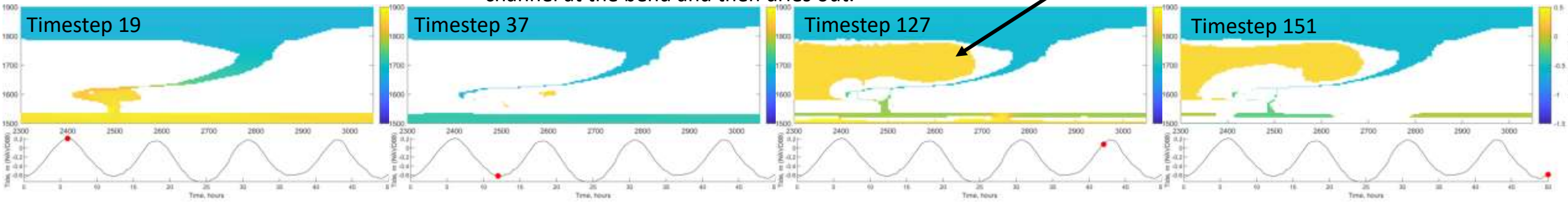
More drying when H=1 m compared to H=0.3
 More sediment is pushed onshore with H=1m, which fills the inlet faster

Test 107; **H=1 m** and Tides=measured

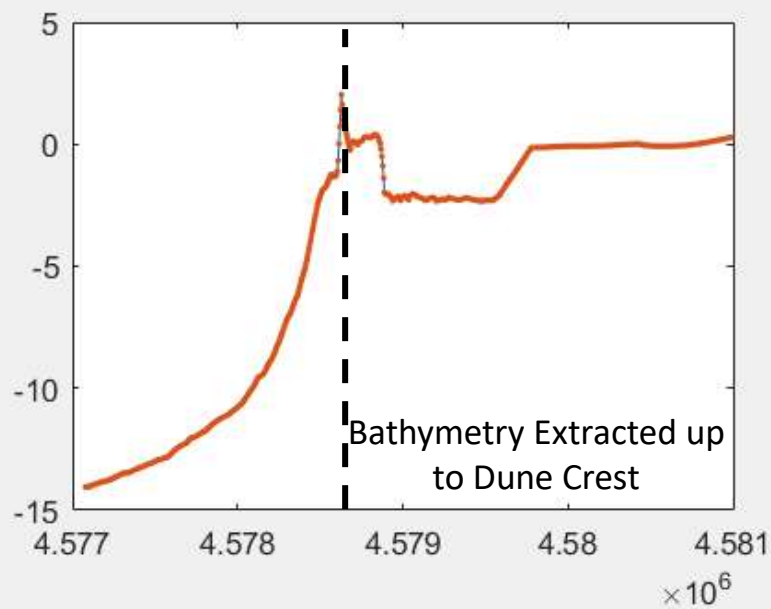
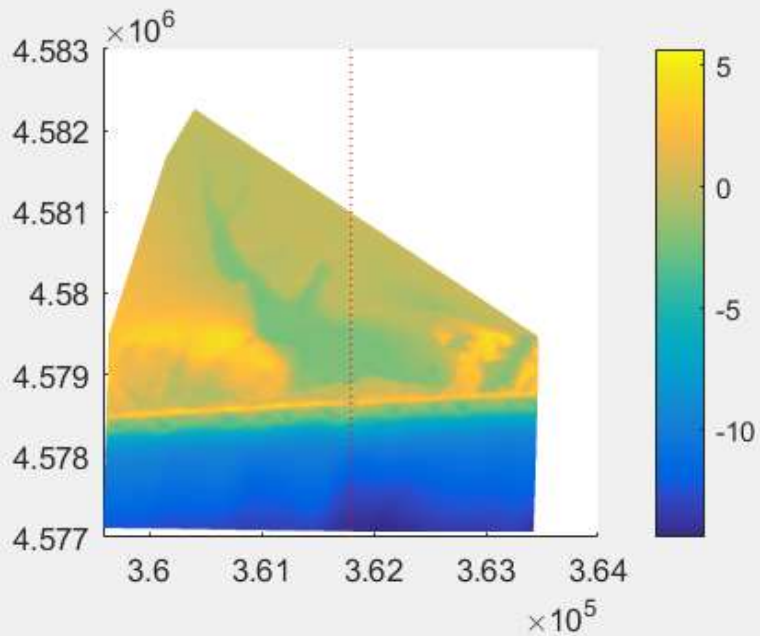


Flooding in the surrounding areas outside the shoal inlet. This occurs during all the high tides, especially hour 30
 There are a few areas where the dune is being breached. But this large, flooded area has spilled over from the channel at the bend and then dries out.

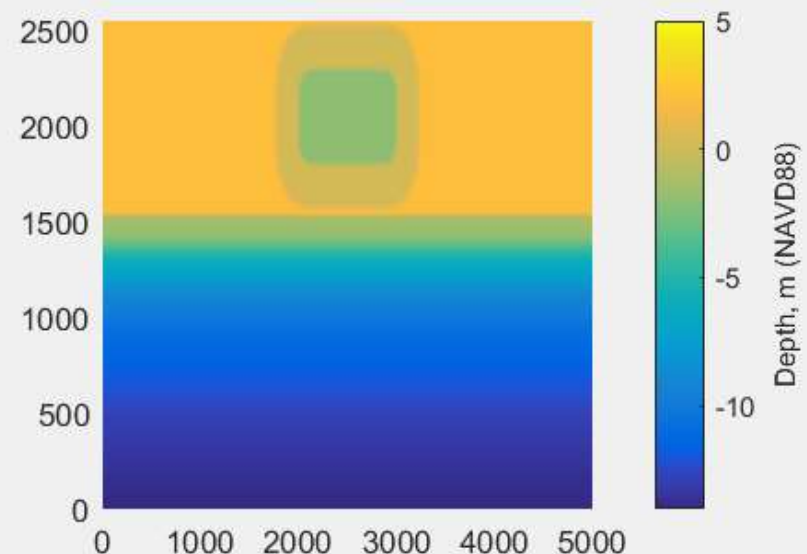
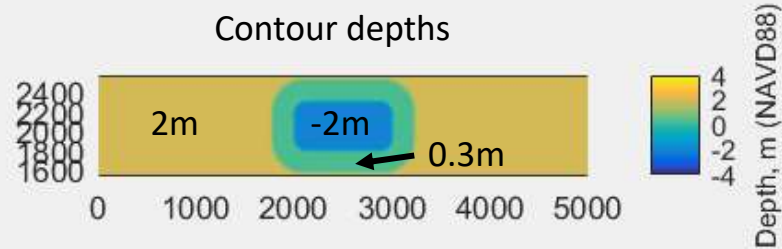
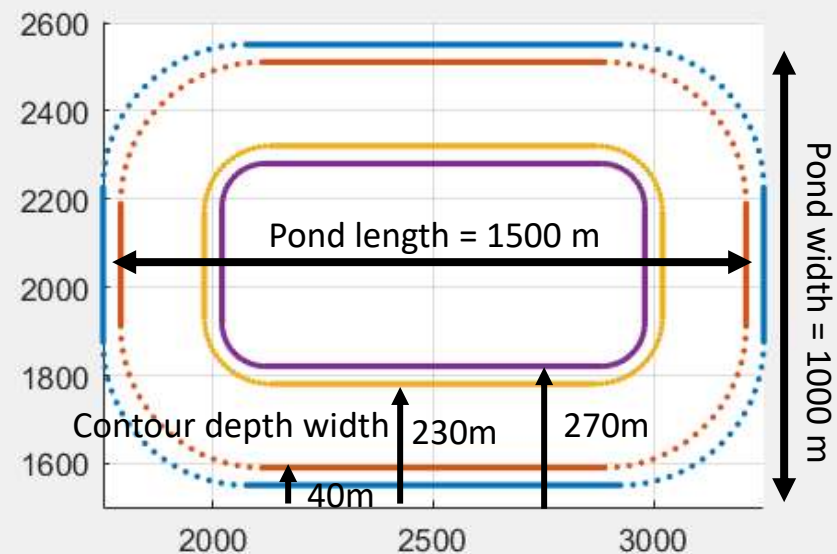
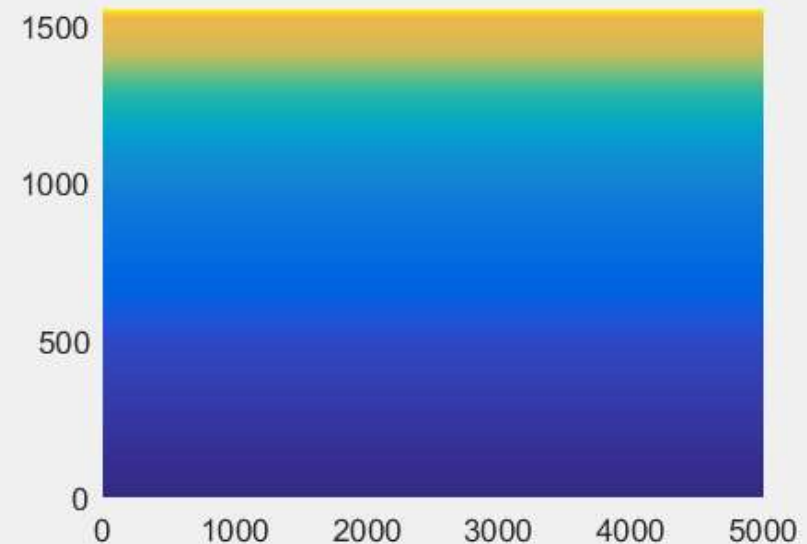
Test 108; **H=3 m** and Tides=measured



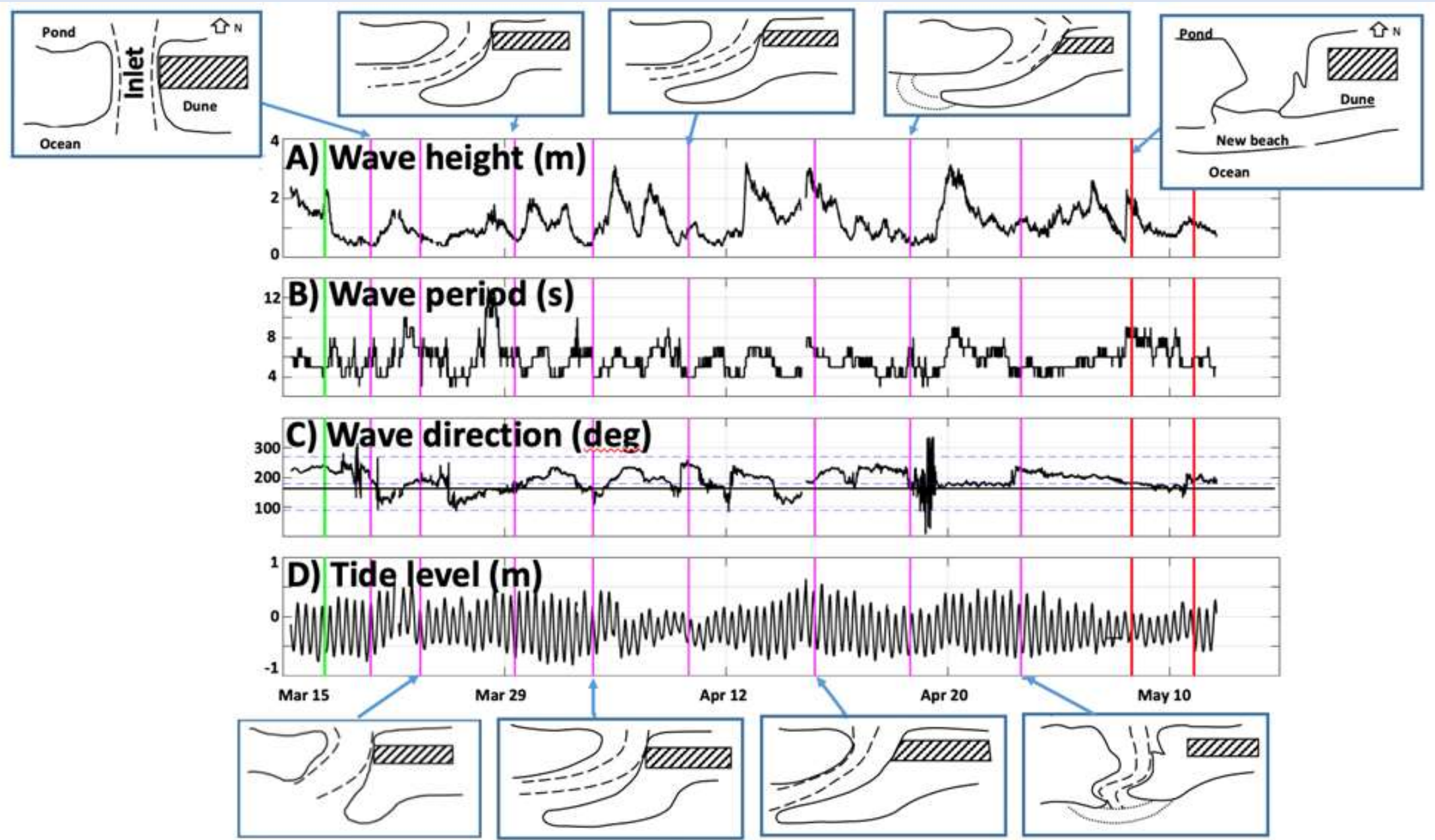
Schematized XBeach Model Domain

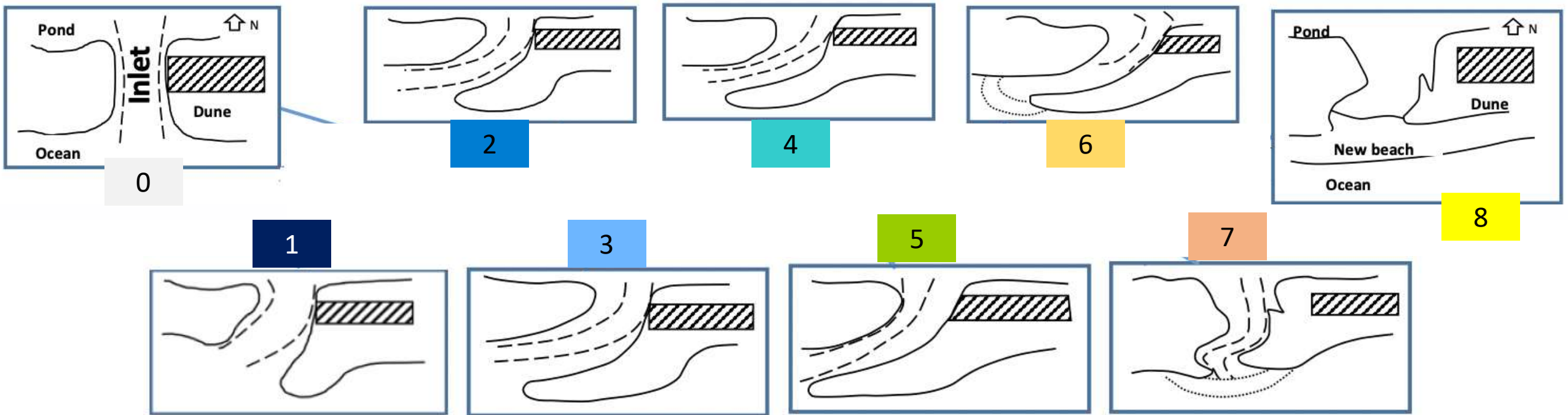
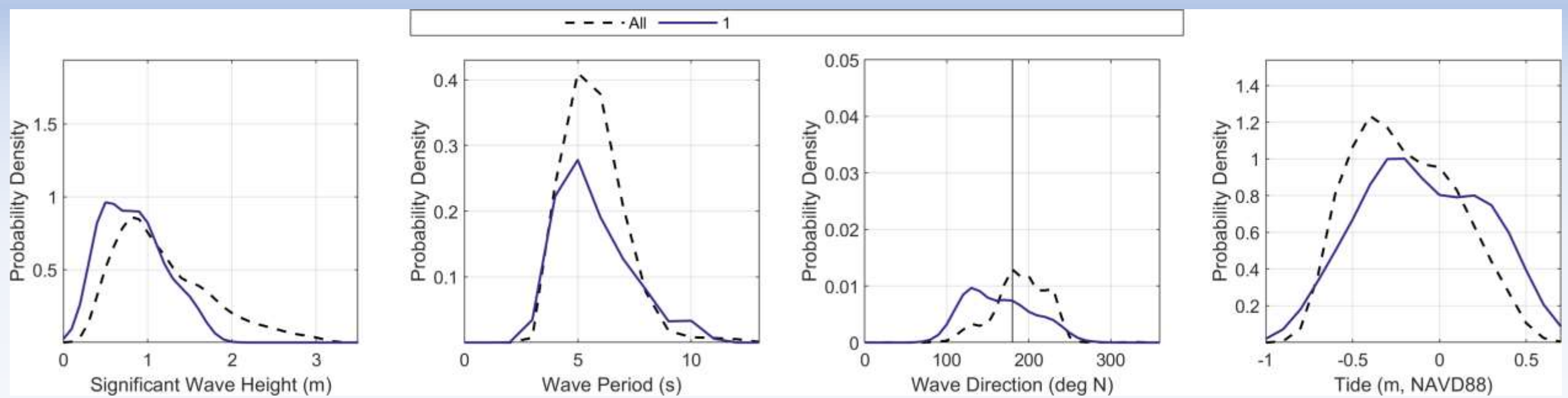


Extracted Offshore Bathymetry
Parallel Contours



Observations at Tisbury Great Pond, MV (2018)





Water Level Fluctuations Near the Inlet

