ADAPTATION PATHWAY FOR A BARRIER ISLAND TO FUTURE HURRICANES

Abstract No. 1553

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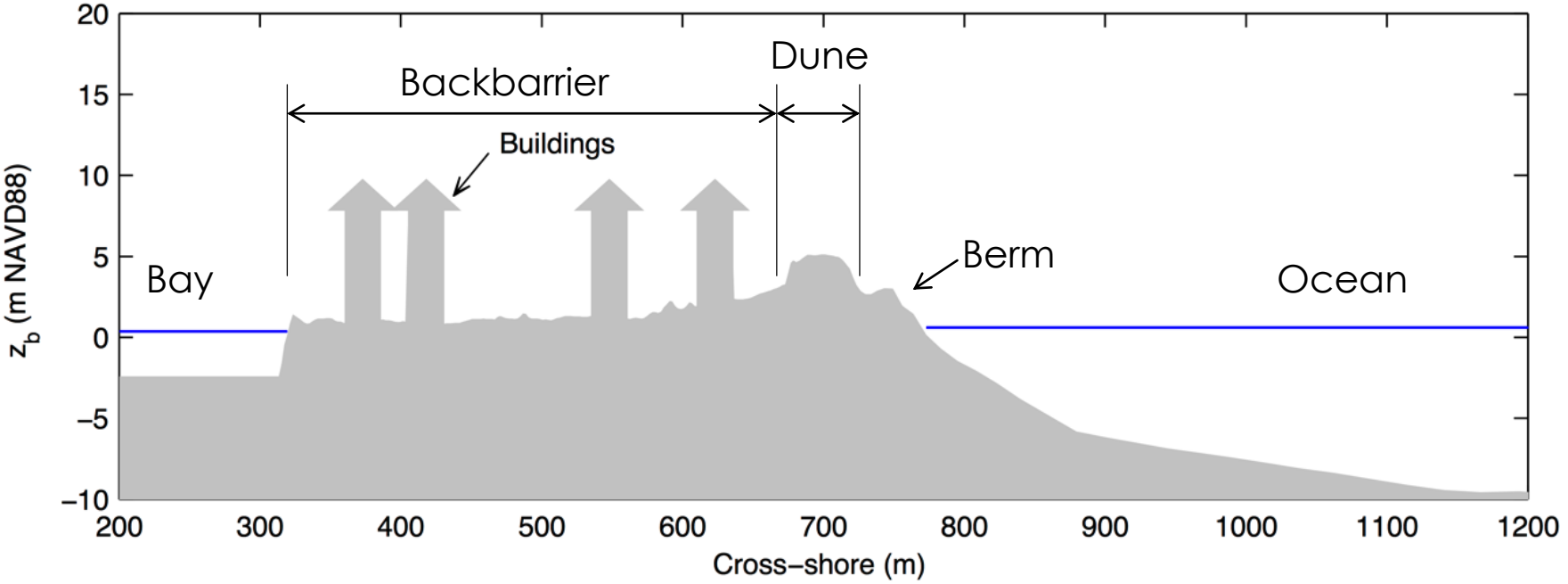
Introduction

- 6.5% of coastlines are barrier islands
- Protects mainland from storm impacts
- Vary by several island characteristics and regional hydrodynamics



Objectives

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- Create a simple pathway for coastal managers to use as a decision making guide

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- Determine impacts of storm surge + waves and sea level rise on a developed barrier island
- Create a simple pathway for coastal managers to use as a decision making guide
- Establish an appropriate, meaningful level of accuracy
  - Location specific
  - Include SLR scenarios by observed levels, not by a timeline
  - Consider realistic storms and their impacts
  - Implement realistic strategies

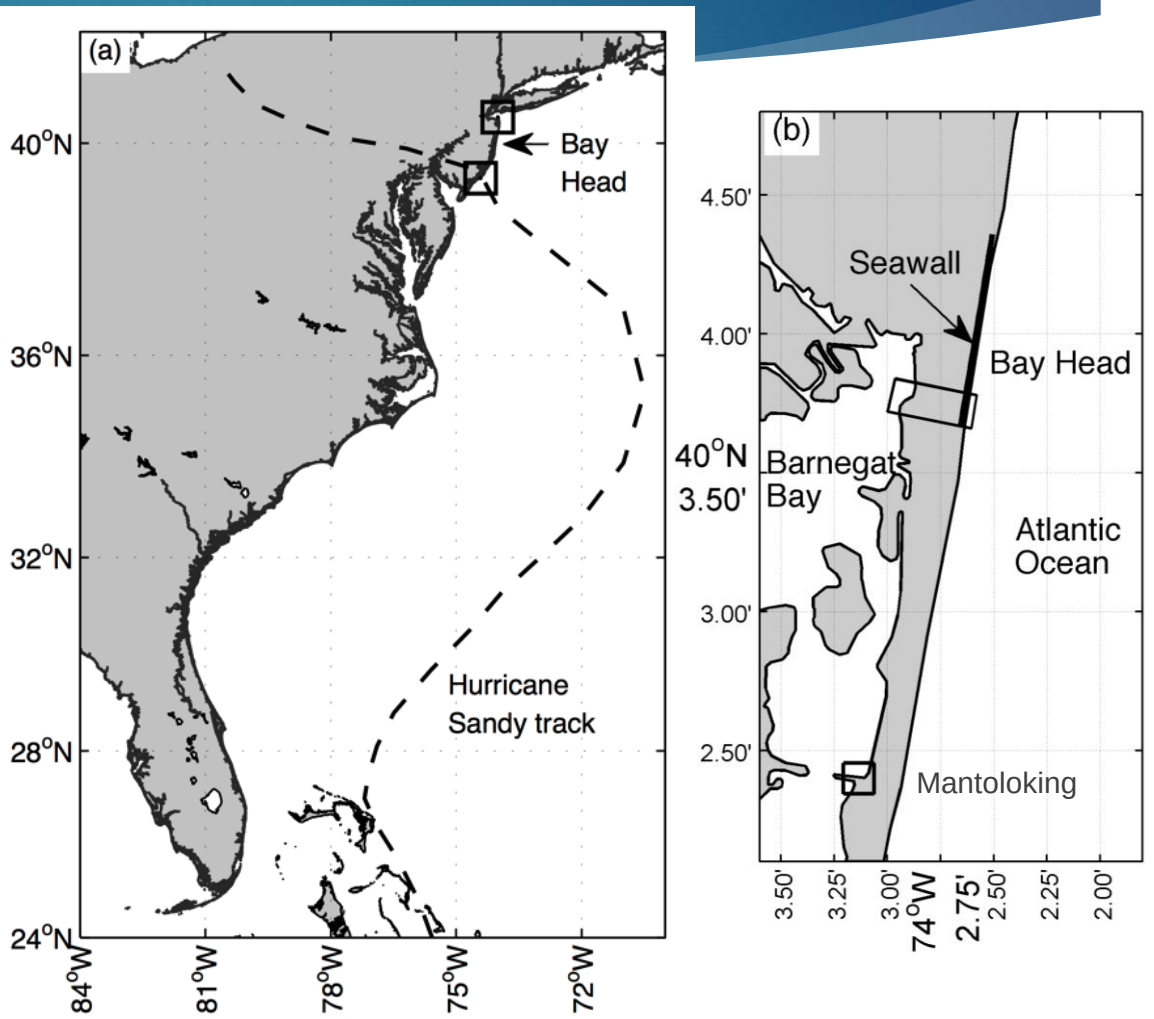
Hurricane Sandy (2012)

- Landfall: 29 October 2012 at 2330 GMT
- Hybrid hurricane + Nor'easter
- 280 km radius
- 130 km/h maximum sustained winds
- 945 mb minimum pressure
- 159 fatalities
- $71 billion in damages

Gutro (2013)

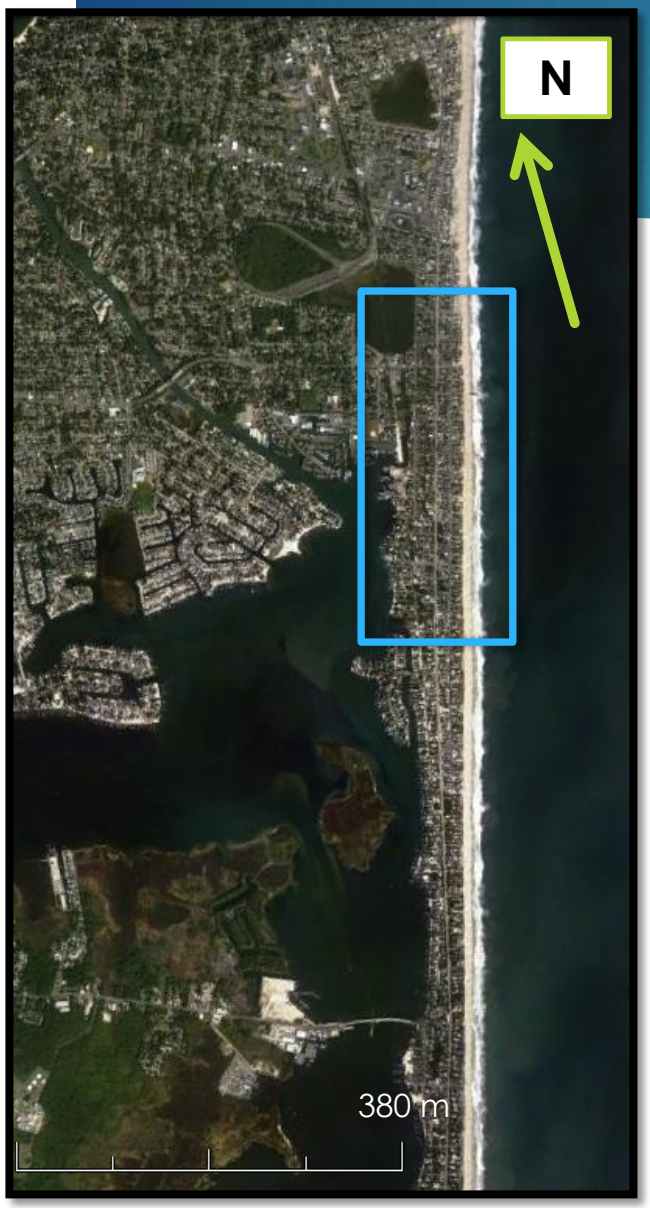
Study Area

- Bay Head, NJ
- 1260 m rock seawall buried beneath dunes
- Seawall often exposed during storms

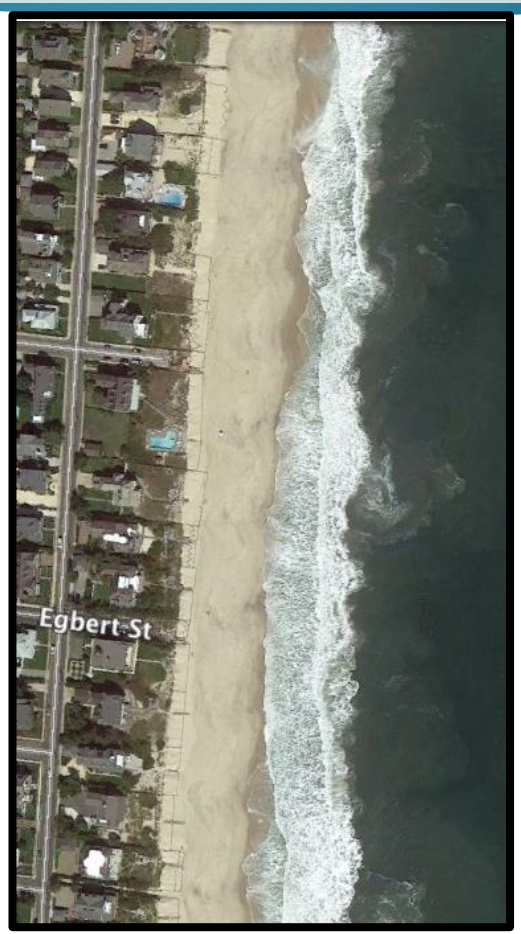


From Smallegan et al. 2016 (*Coastal Eng.*)

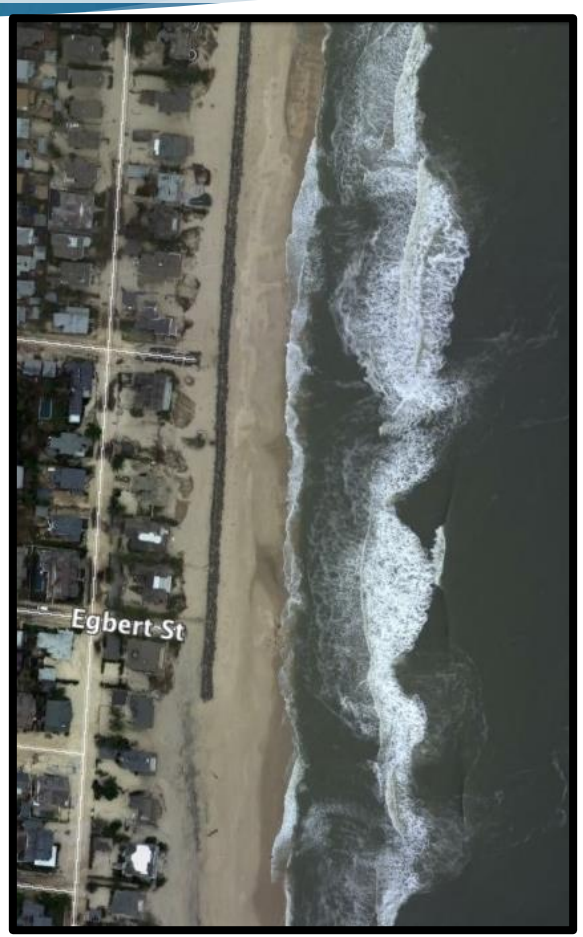
Bay Head, NJ



Pre-Hurricane Sandy



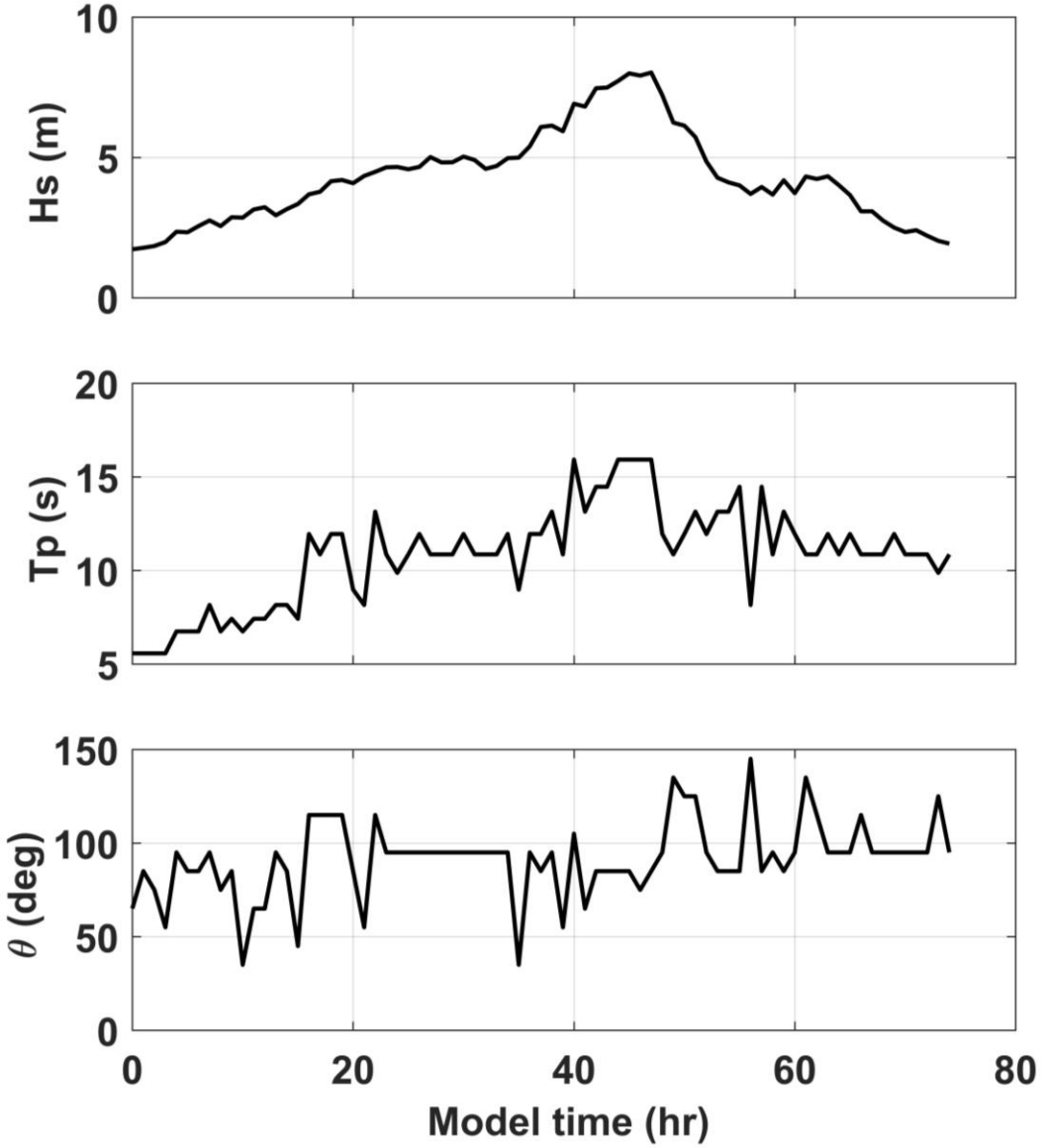
Post-Hurricane Sandy



Images from Google Earth (2018)

Model Setup

- Hurricane Sandy
- 74-hour storm
- At storm peak:
  - H_s = 8.0 m
  - T_p = 16 s
  - θ = 85° (approx. shore normal)



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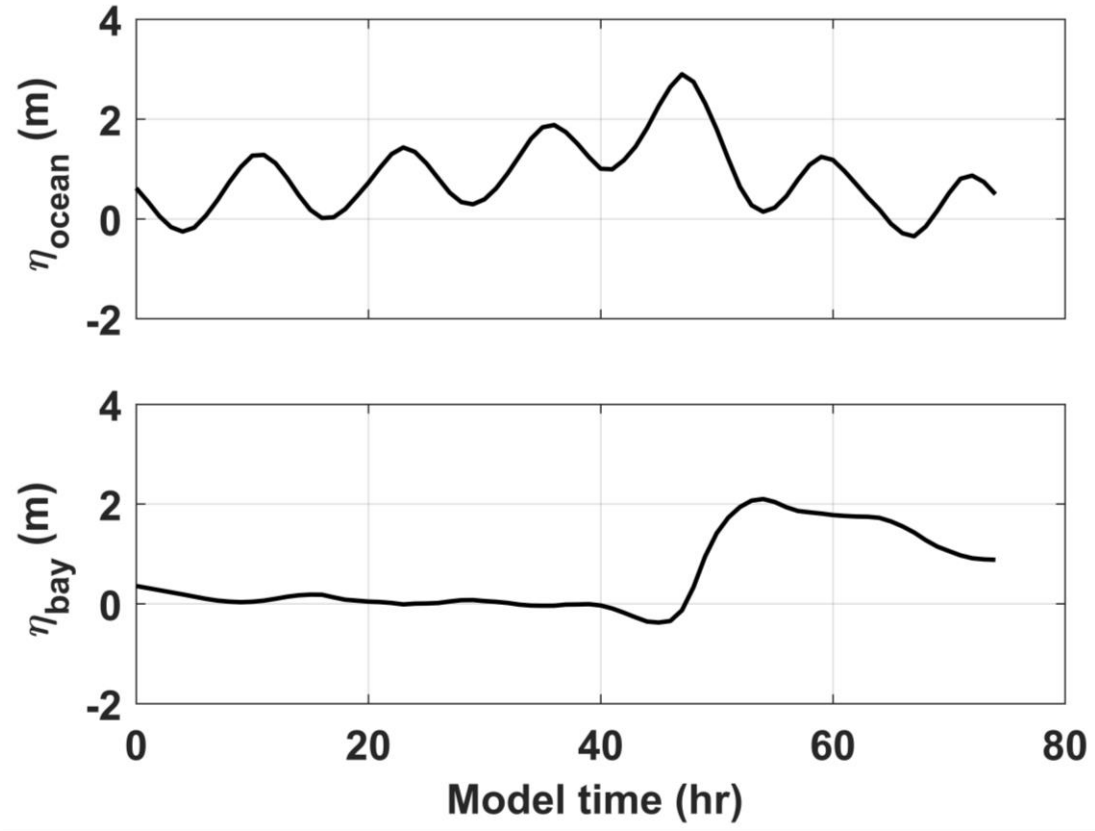
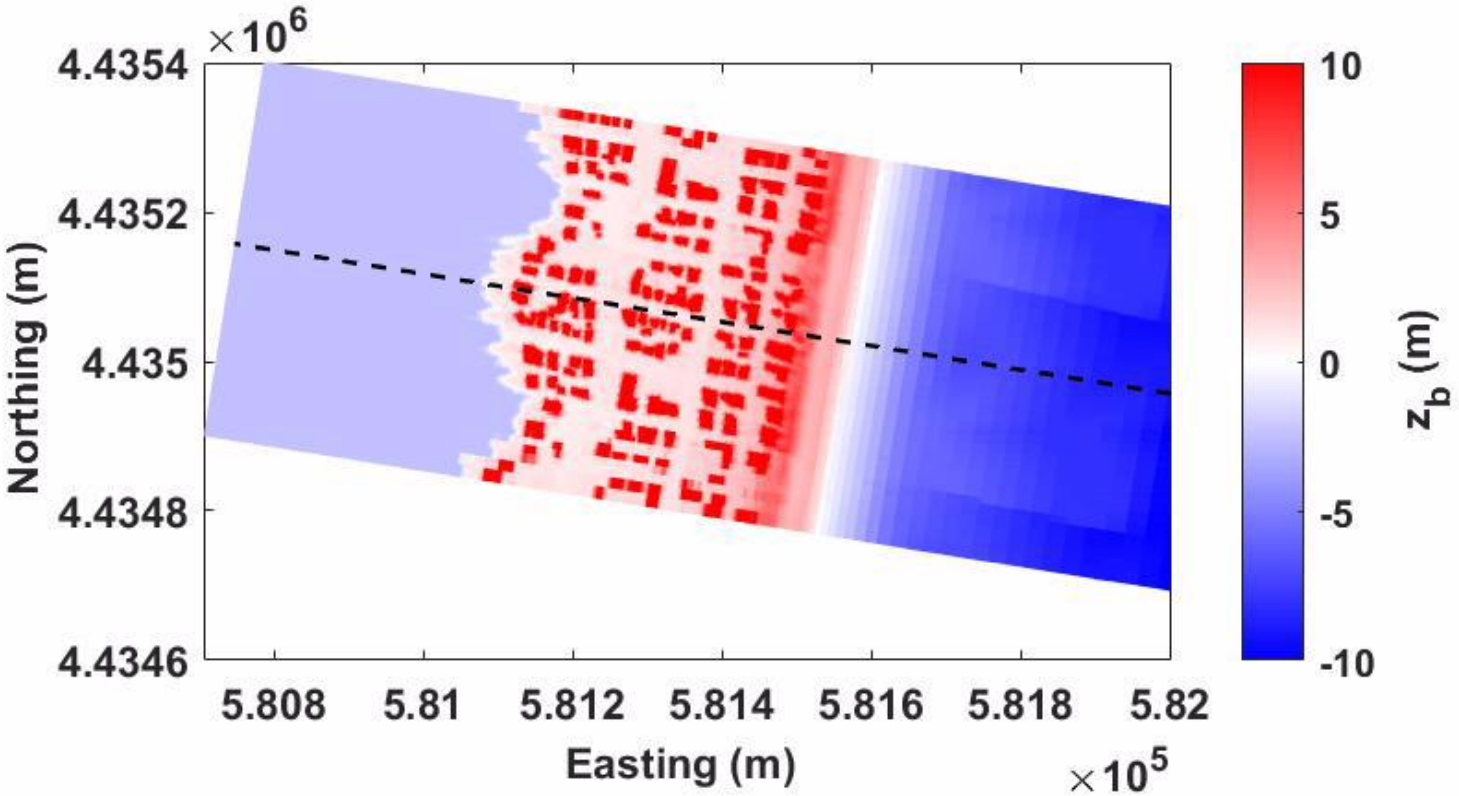
Model Setup

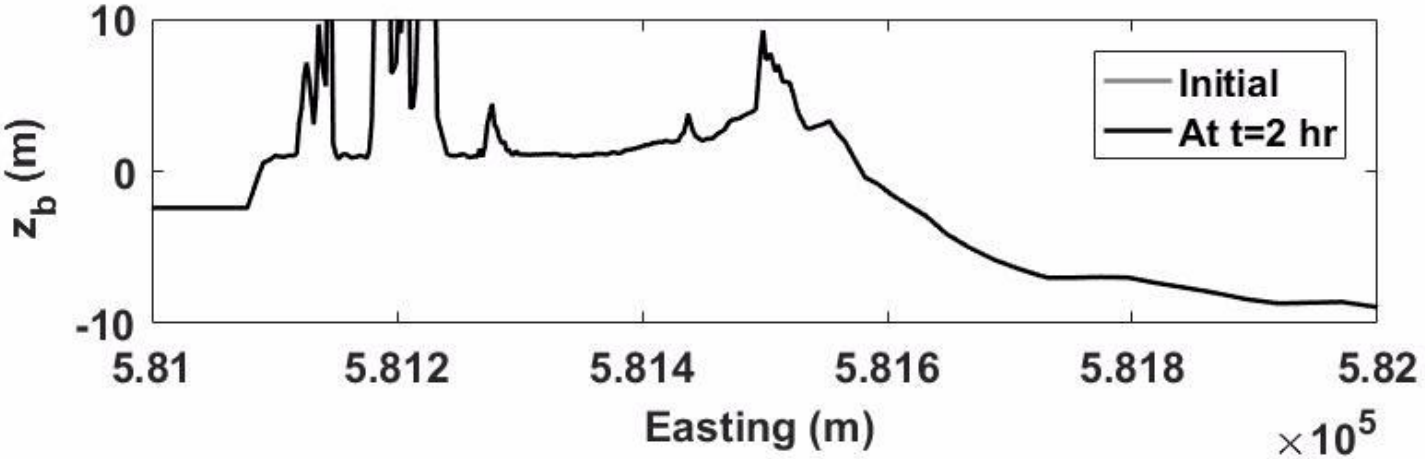
- Present day: SLR = 0 m
  - Hurricane Sandy surge unchanged



Model Setup

- **Morphological change simulated with XBeach** (Roelvink et al., 2009)
- Hard structures are indestructible
- Validation published in Smallegan et al. (2016)


×10^6
4.4354
4.4352
4.435
4.4348
4.4346
Northing (m)
5.808
5.81
5.812
5.814
5.816
5.818
5.82
Easting (m)
×10^5
10
5
0
-5
-10
z_b (m)


10
0
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z_b (m)
Initial
At t=2 hr
5.81
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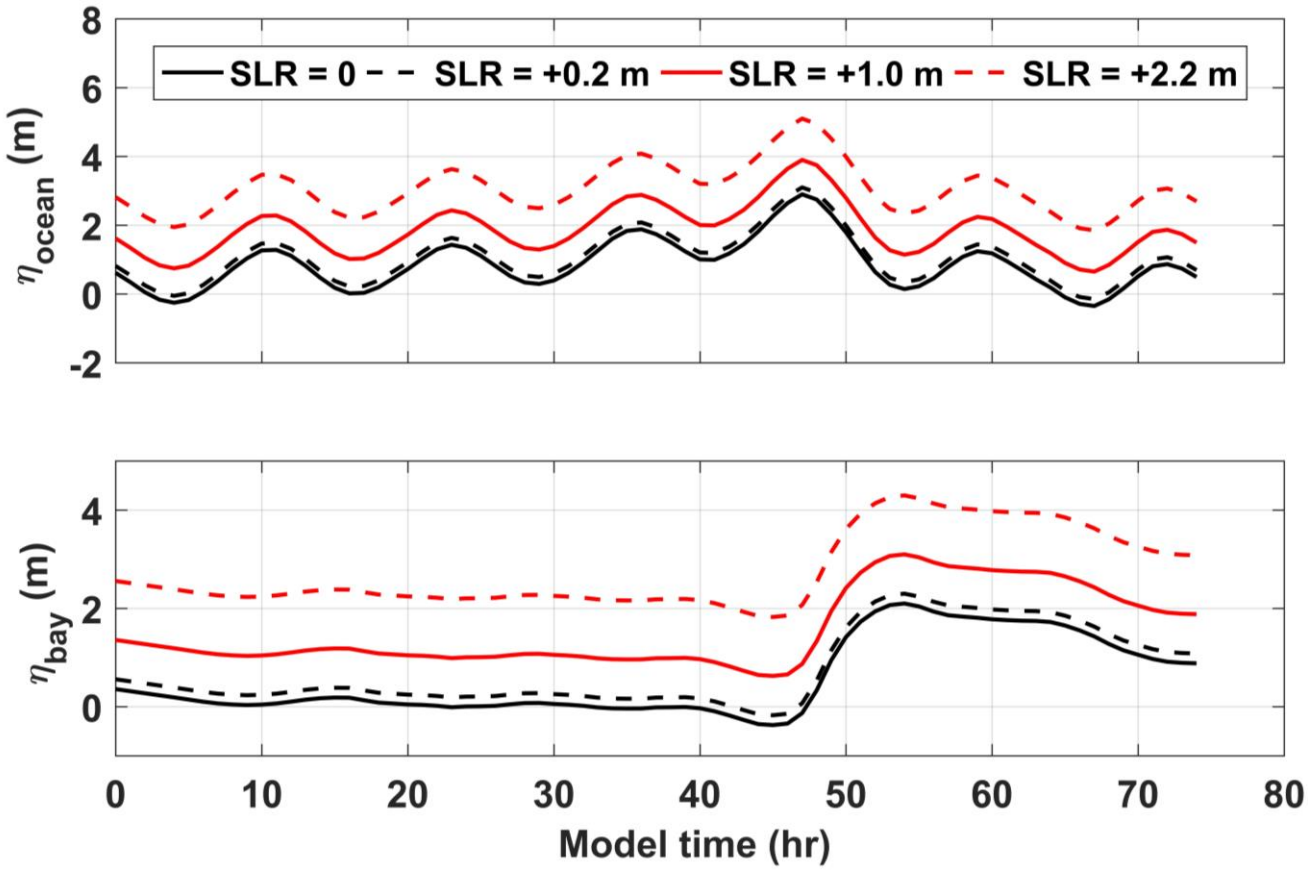
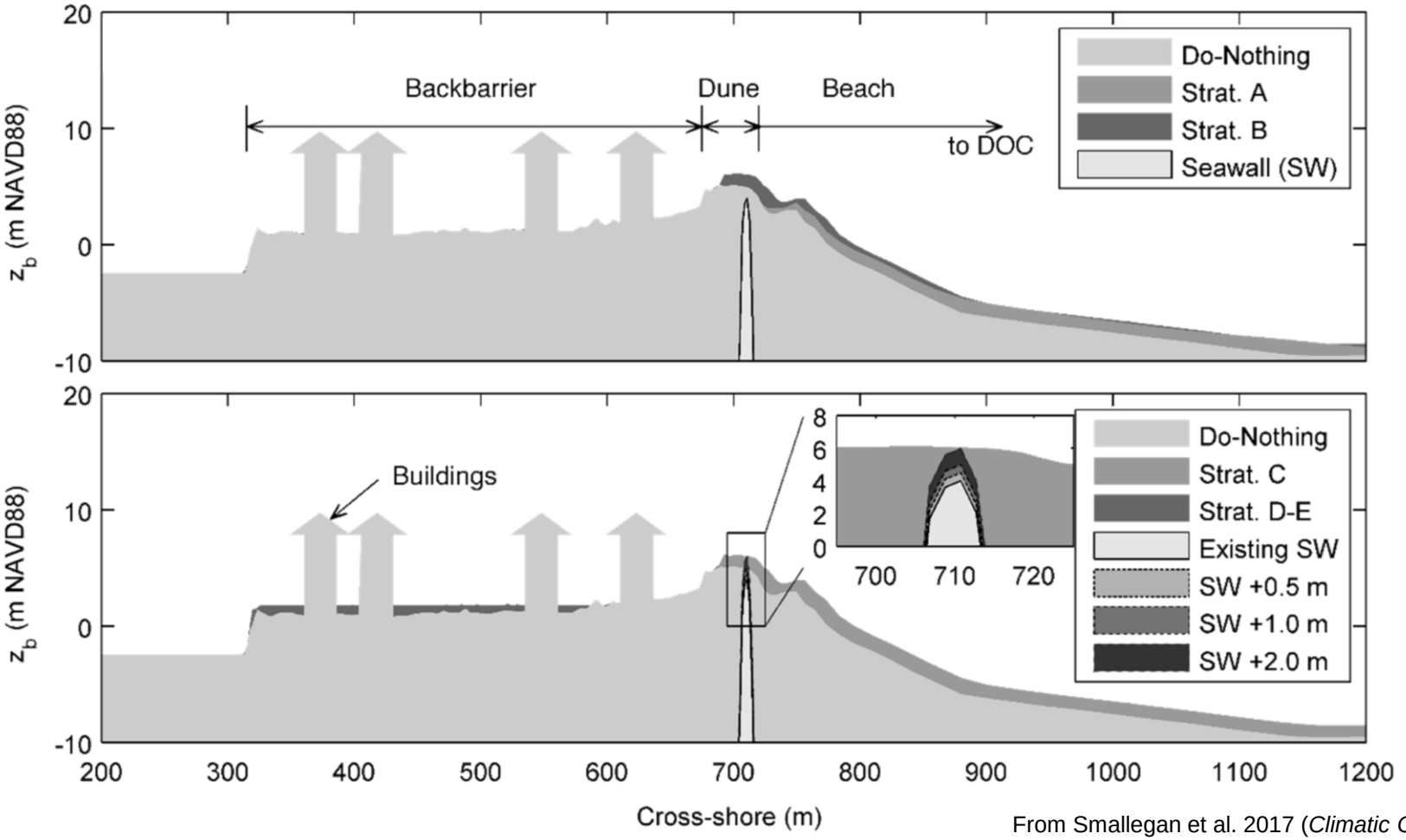
Easting (m)
×10^5

Sea Level Rise (SLR)

- Present day: SLR = 0 m
  - Hurricane Sandy surge unchanged
- Future:
  - SLR = +0.2 m, +1.0 m, +2.2 m
  - Both ocean and bay surge raised



Adaptation Strategies



From Smallegan et al. 2017 (*Climatic Change*)

Adaptation Strategies

- A: Raise beach
- B: Raise dune + beach
- C: Raise seawall
- D: Raise island
- E: Raise island + seawall

Strategy (sediment volume added, m^3)	Beach raised by SLR	Dune raised by SLR	Seawall raised by			Back barrier raised to minimum elevation
			0.5 m	1.0 m	2.0 m	
EC						
A (8,32,71)	X					
B (11, 68, 145)	X	X				
C (11, 68, 145)	X	X	X			
C1.0 (10, 67, 144)	X	X		X		
C2.0 (7, 64, 141)	X	X			X	
D (13, 128, 322)	X	X				X
E (13, 128, 322)	X	X	X			X
E1.0 (12, 127, 321)	X	X		X		X
E2.0 (9, 124, 318)	X	X			X	X

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Adaptation Strategies

- A: Raise beach
- B: Raise dune + beach
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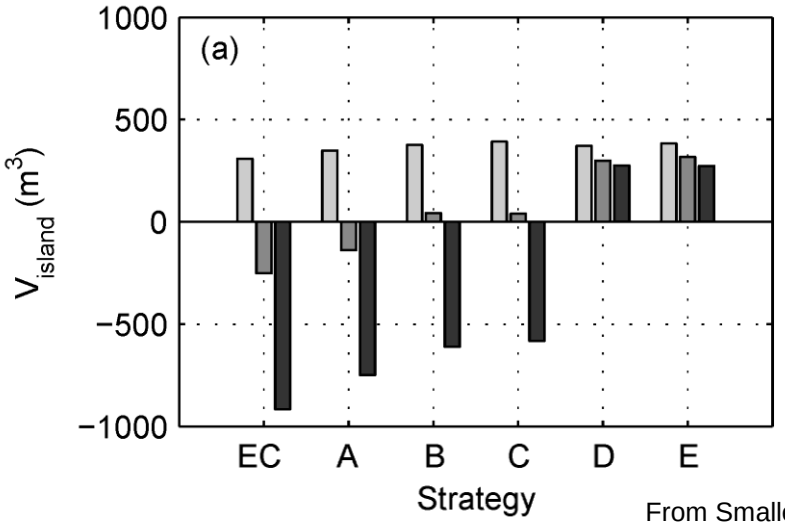
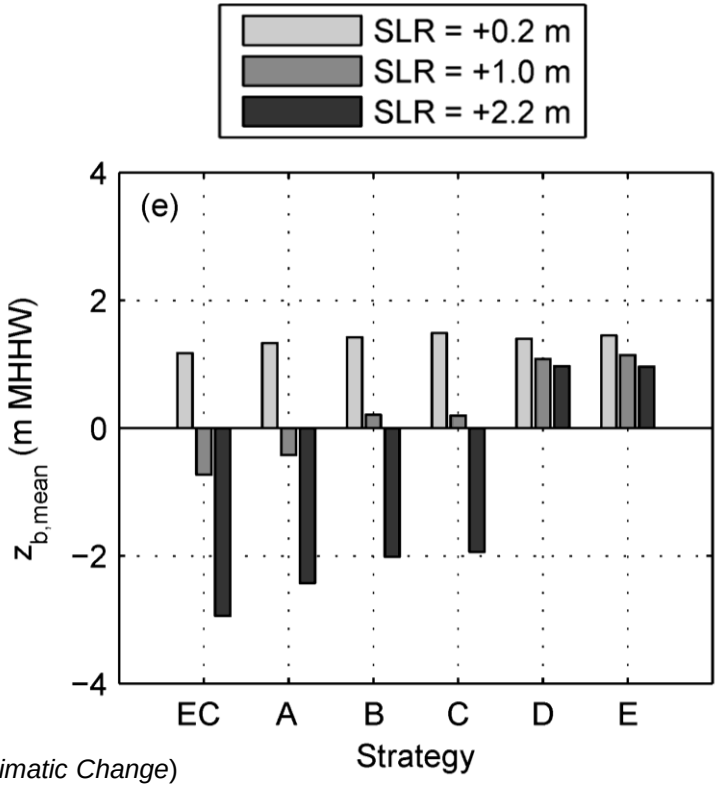
- Remaining sediment volume:

$$V\left(m^3\right) = \int_{y_1}^{y_2}\int_{x_1}^{x_2} z_{bf}\, dx\, dy$$





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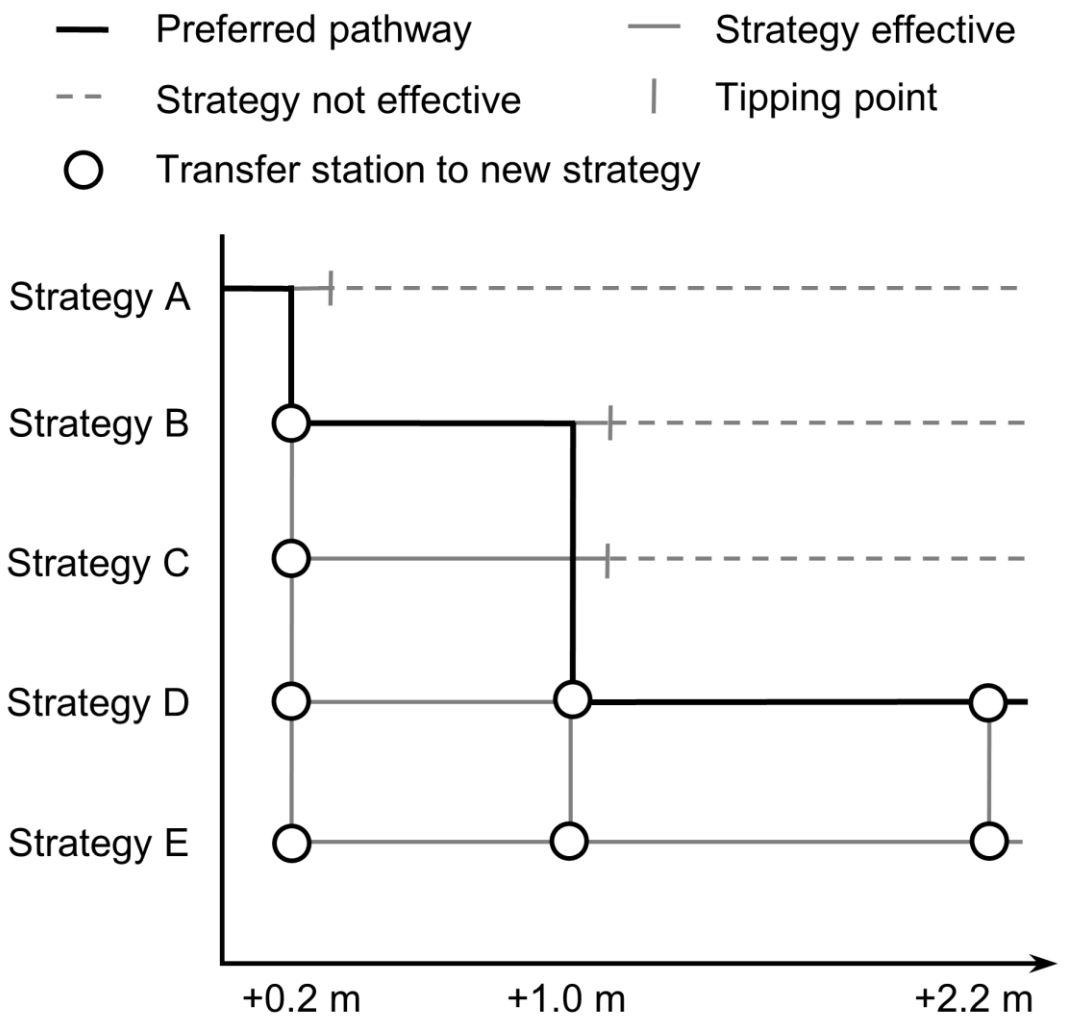
Adaptation Pathway

- Create pathway using strategies A – E
  - Function of SLR
  - No timeline associated with pathway



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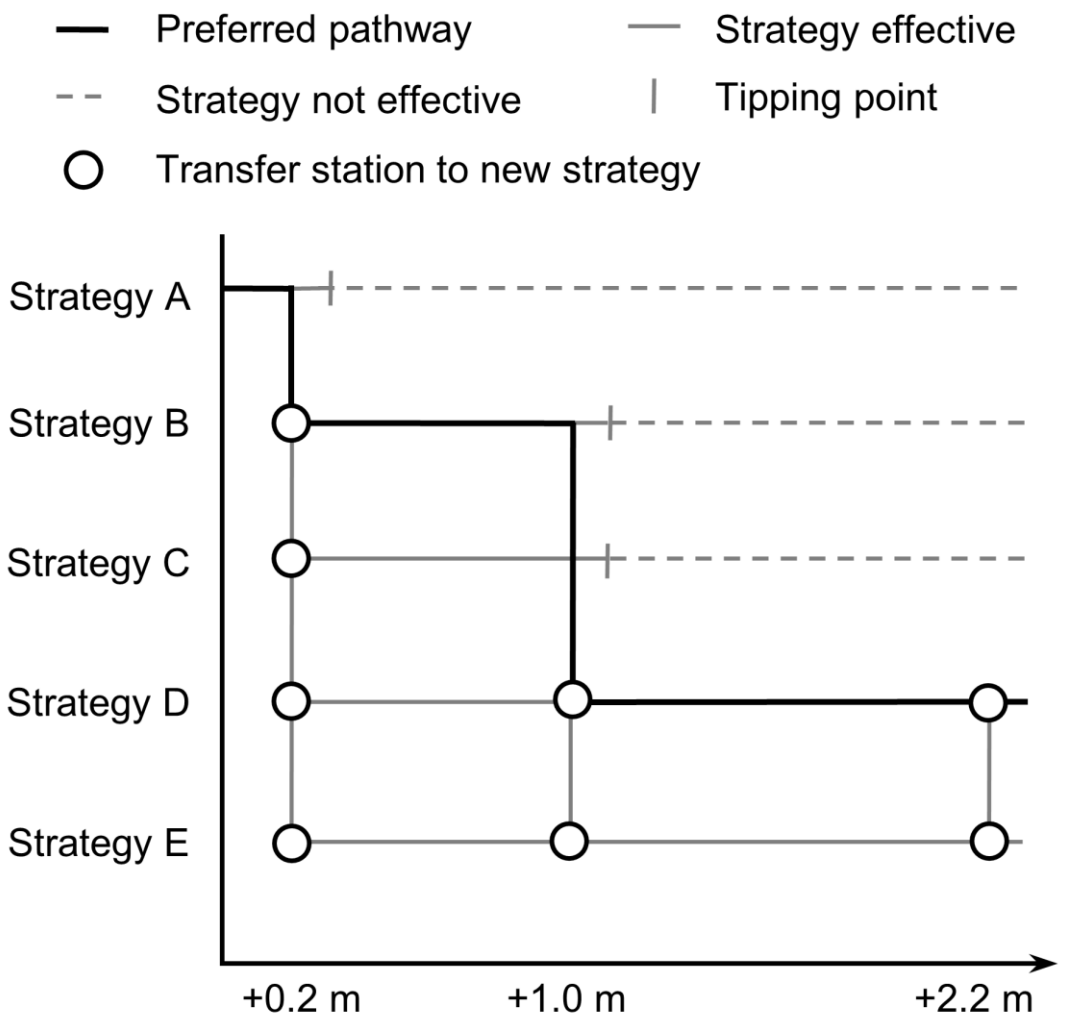
But this is designed with only one storm…



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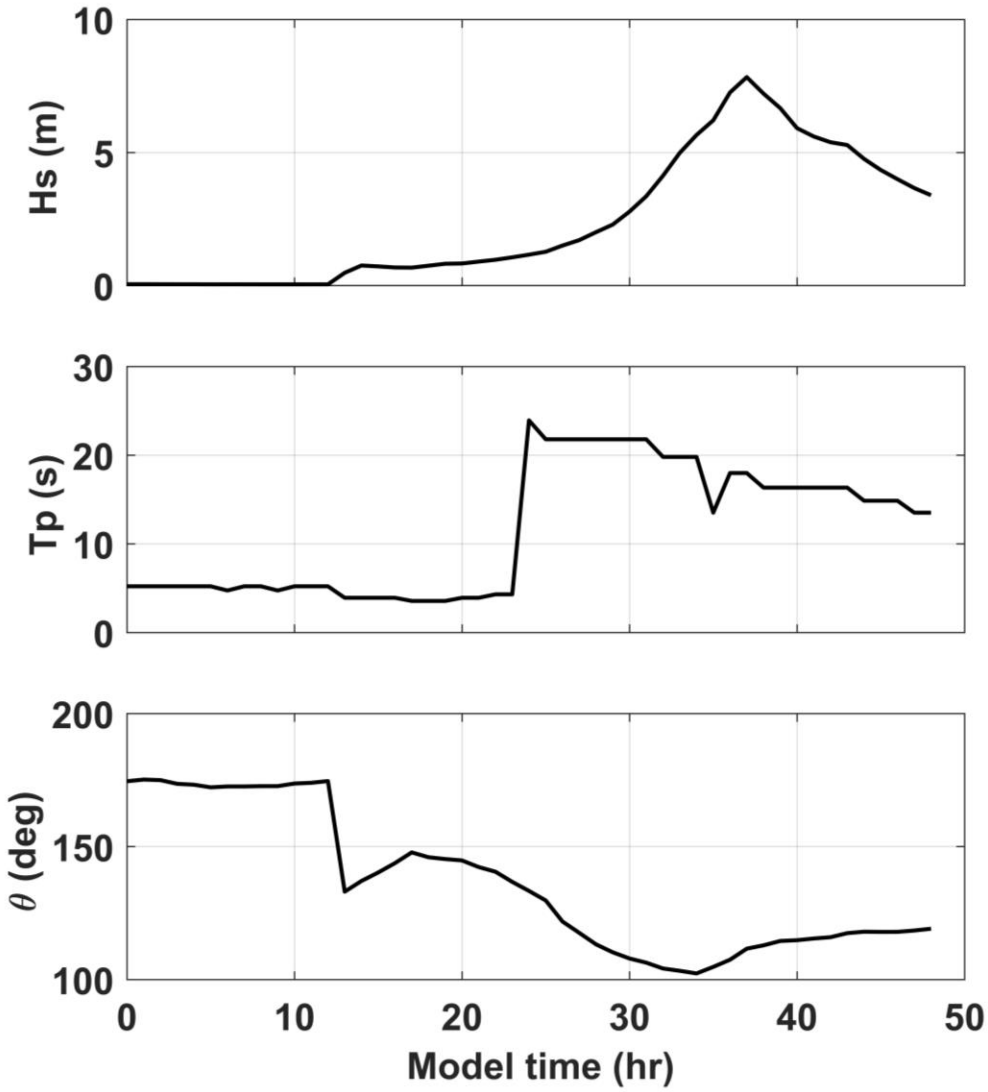
Expanding the Analysis

- NACCS: North Atlantic Coast Comprehensive Study (Cialone et al., 2015)
  - Statistically-comprehensive set of storms that could practically occur
  - Accessed through the Coastal Hazards System (Melby et al., 2015)
- 1050 storms * 3 SLR scenarios * 5 strategies = >15k simulations!
  - Not feasible…
- Subset of storms based on hydrodynamics

Model Setup

- NACCS Storm 391
- 48-hour storm
- At storm peak:
  - H_s = 7.8 m
  - T_p = 18 s
  - Θ = 110° (approx. shore normal)



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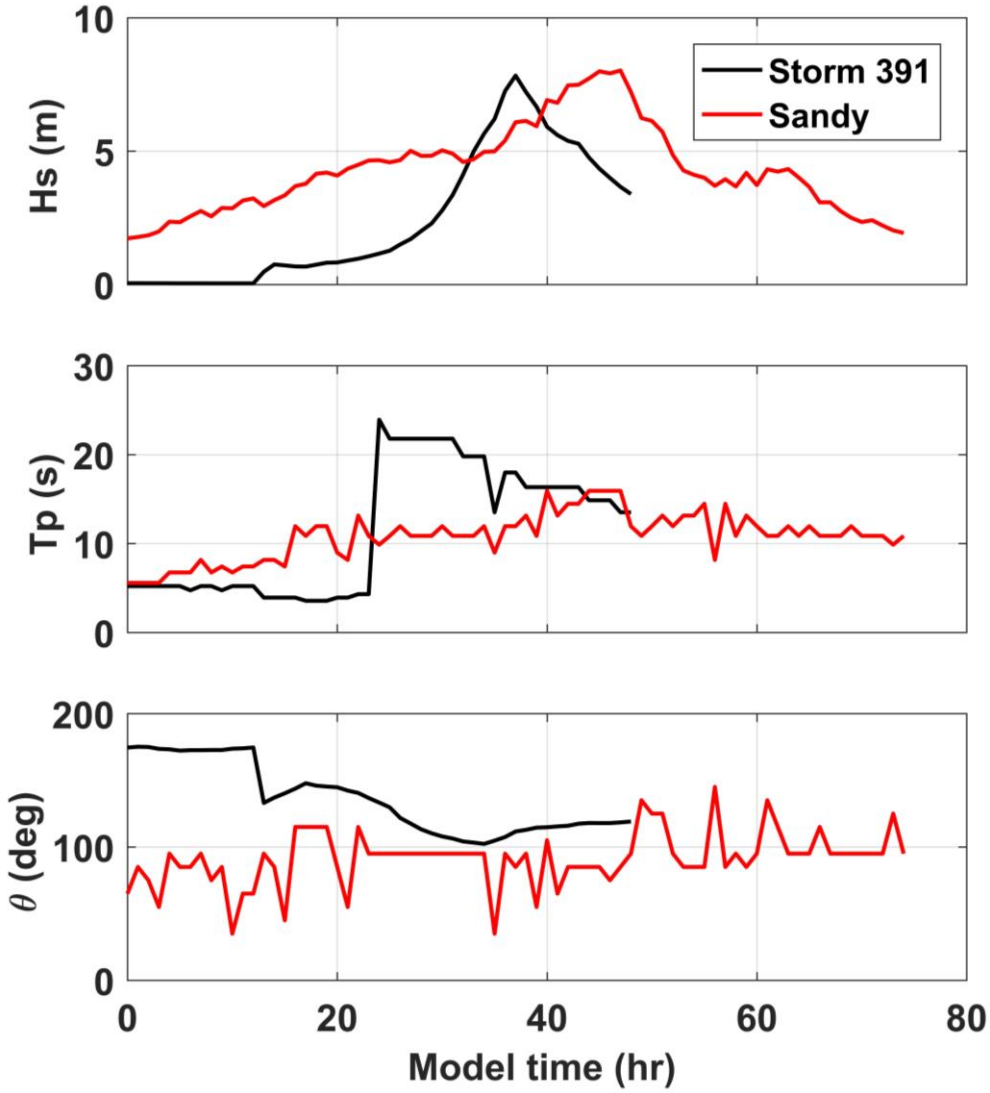

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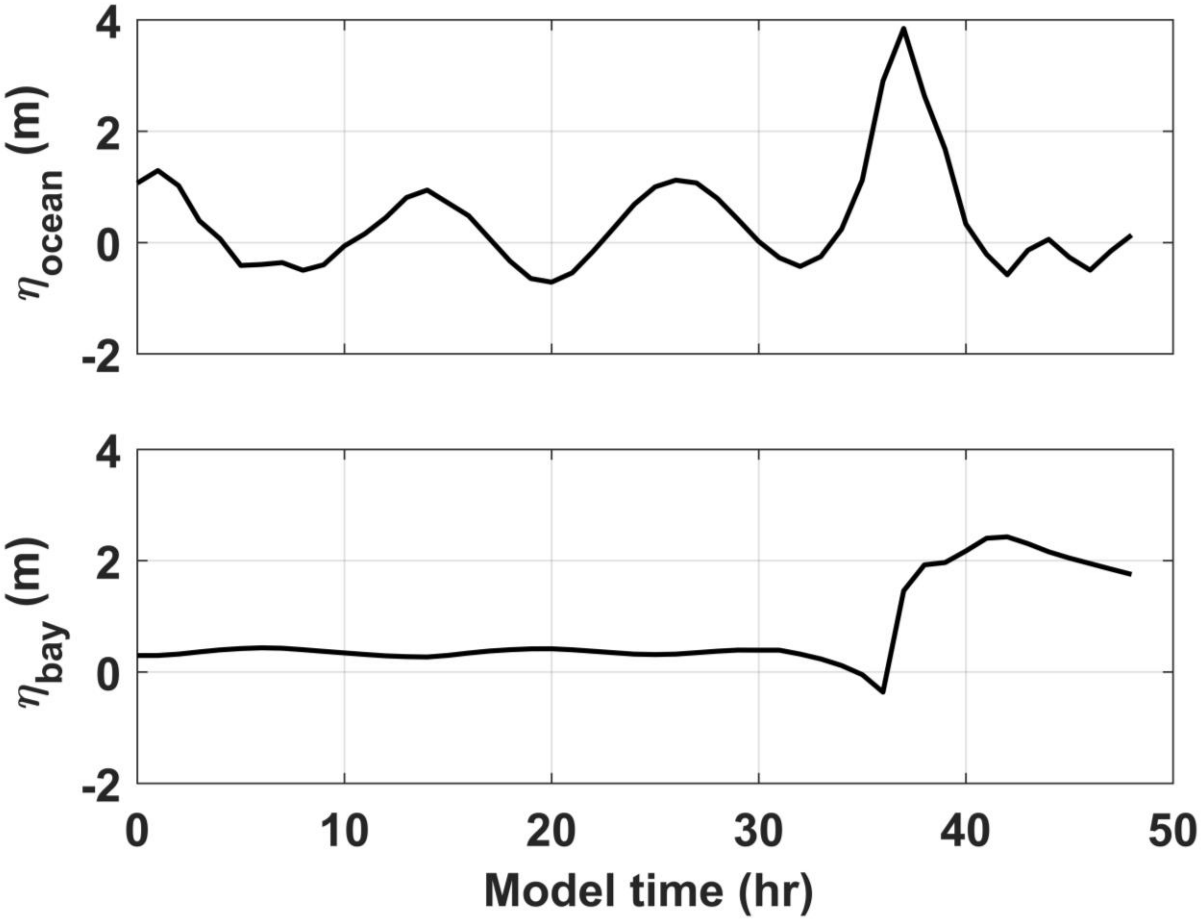

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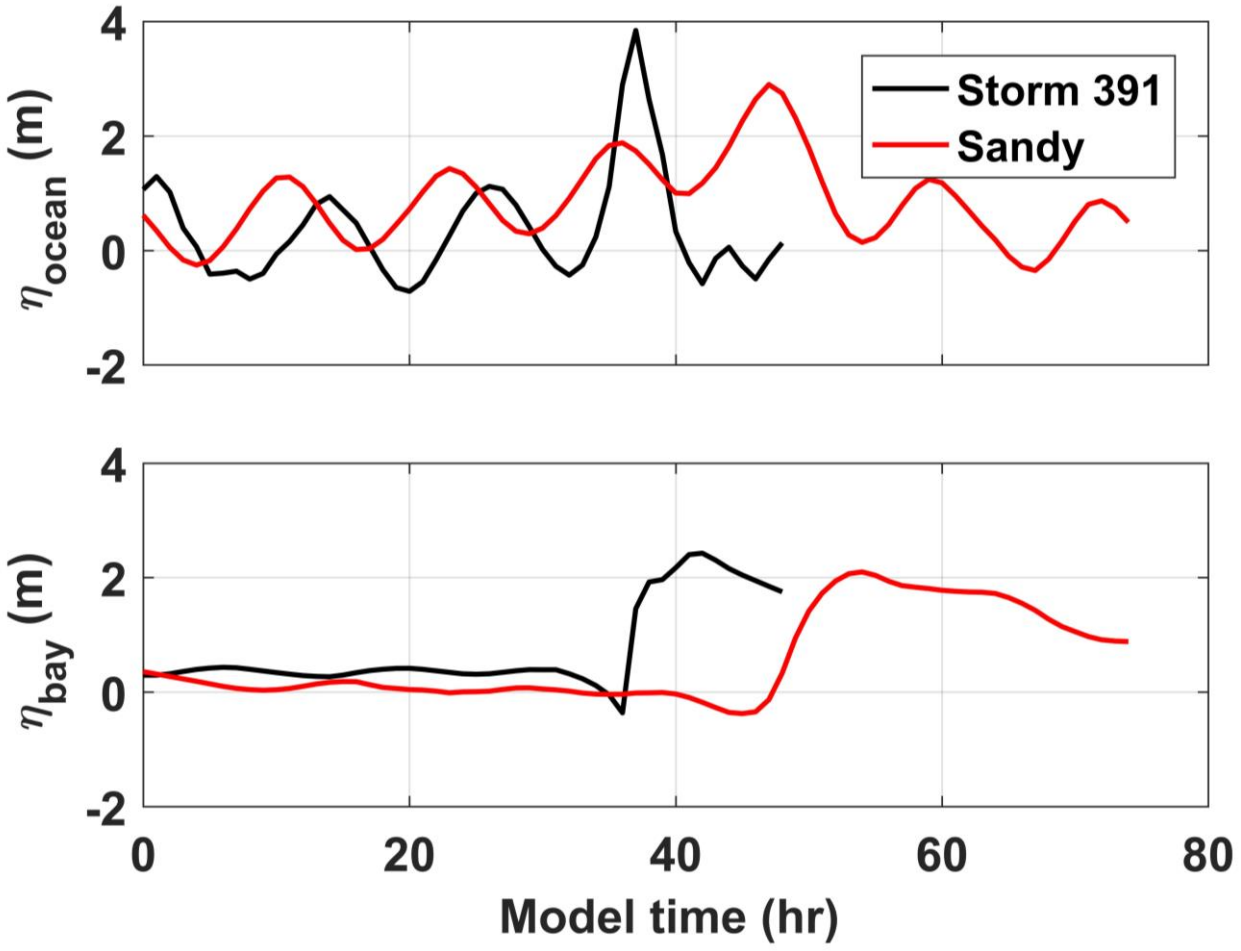

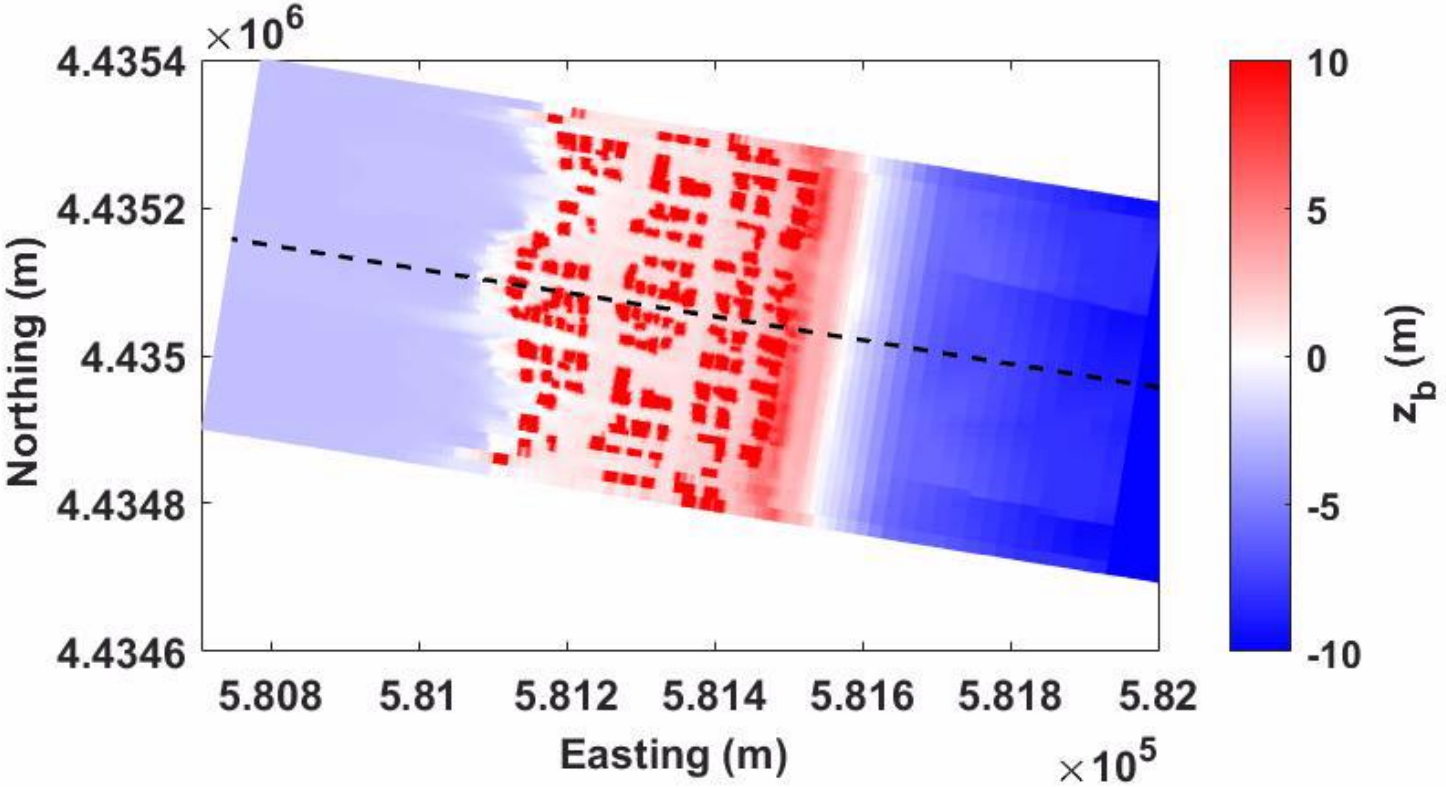
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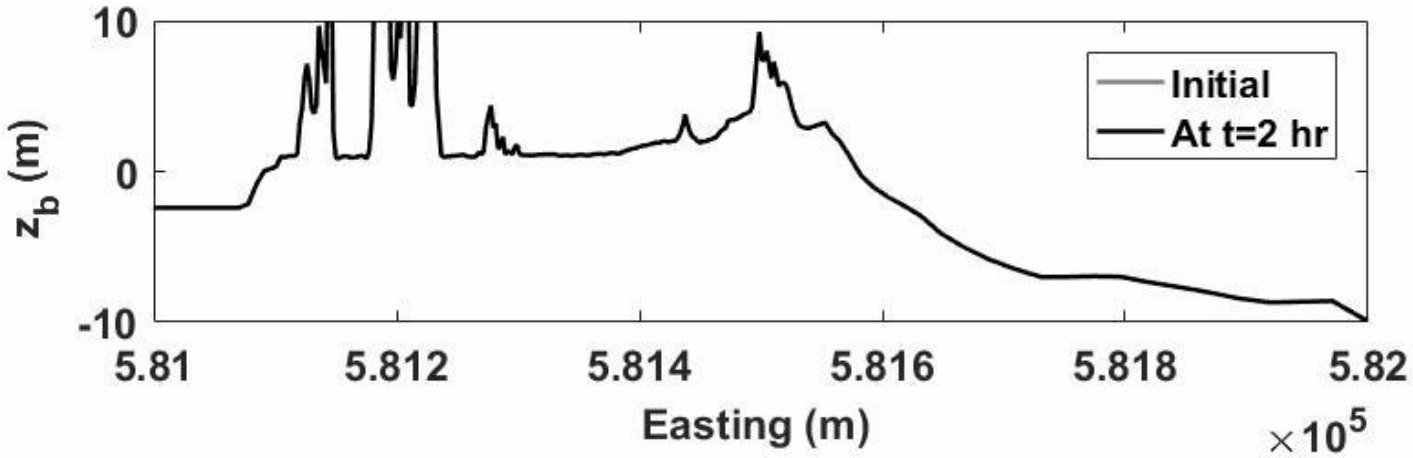
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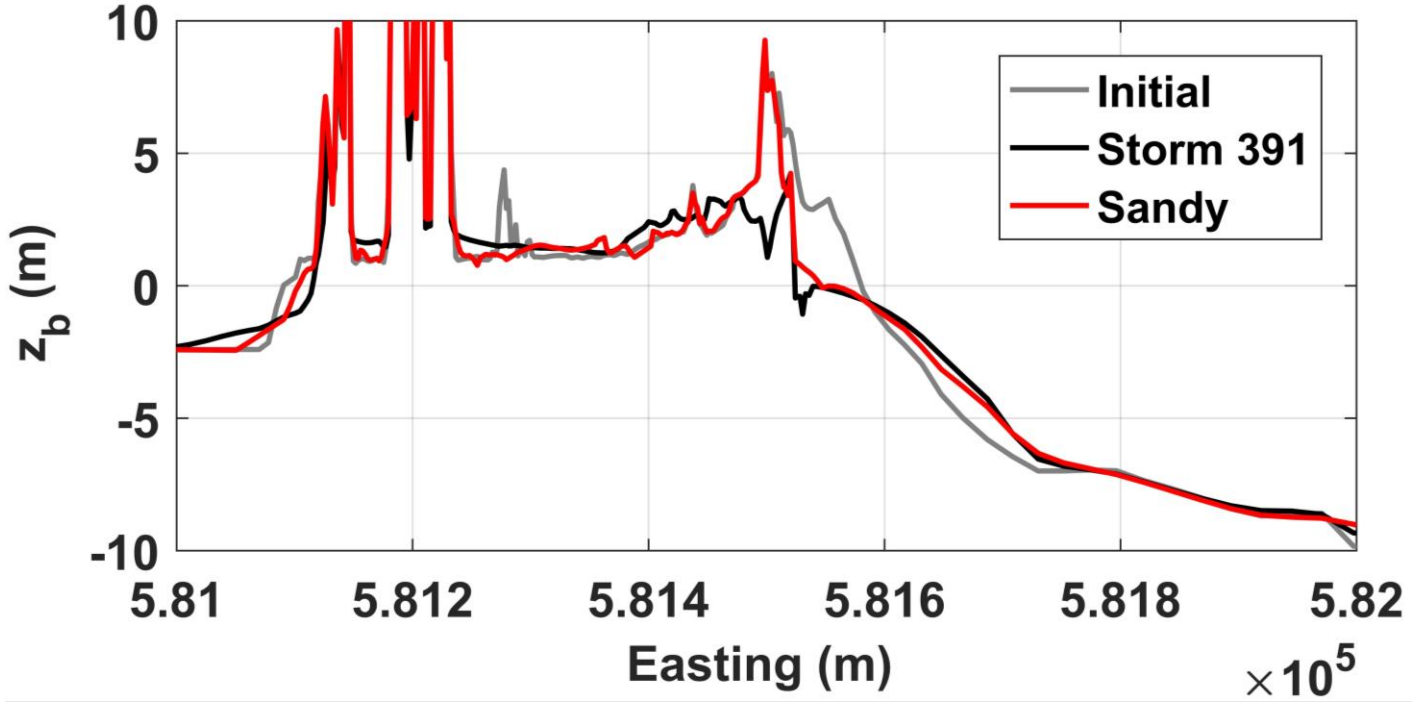
At t=2 hr

Sandy vs Storm 391

- Storm 391 resulted in more erosion



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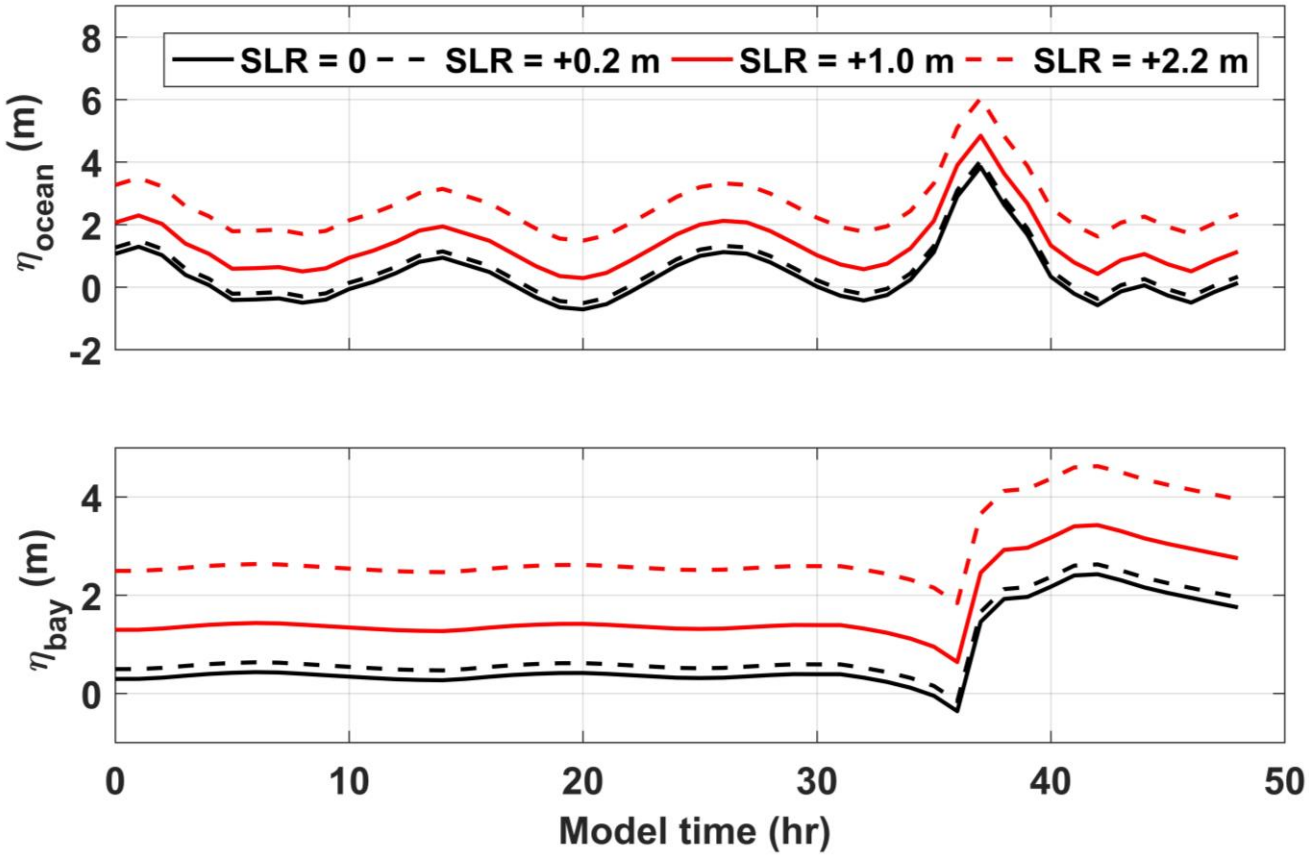
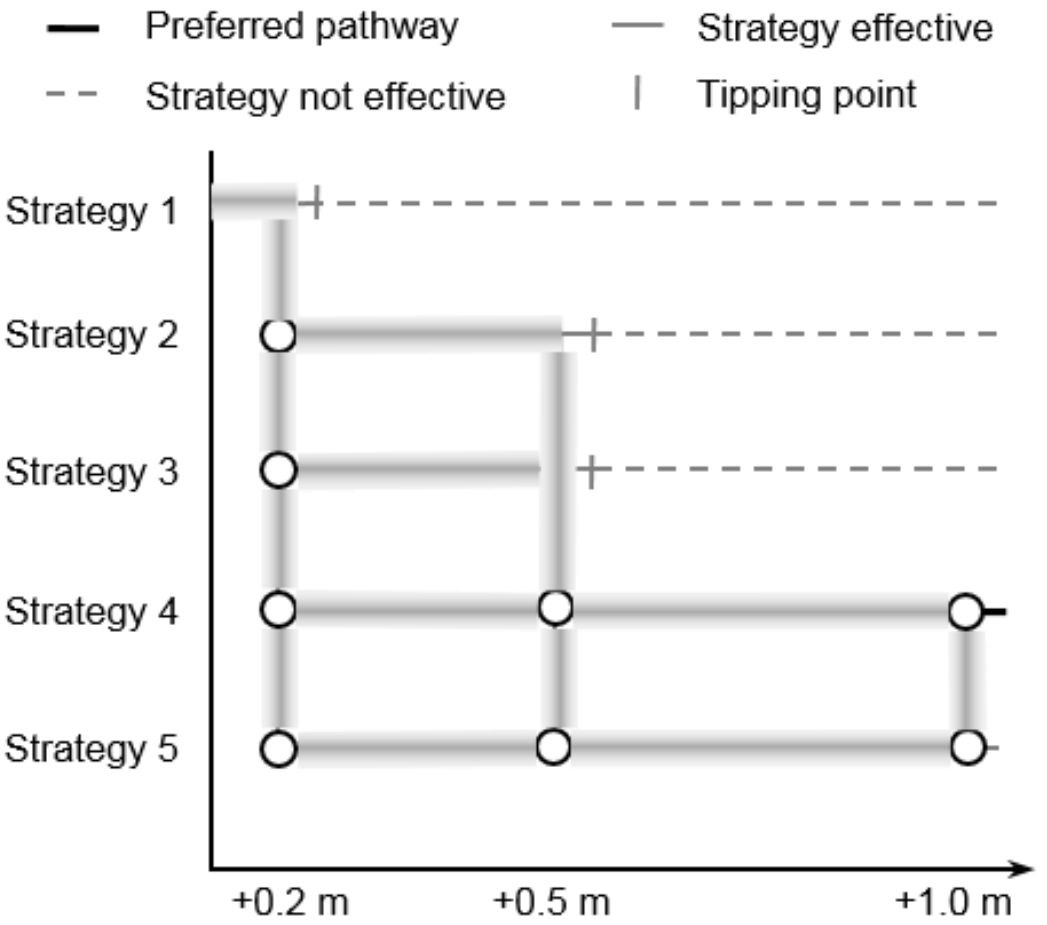


Present/Future Work

- Clear lines on the pathway
- Include life cycle cost analyses
- Create pathway for Dauphin Island, AL



Questions

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