Modeling, Visualizing, & Communicating Nor'easter and Hurricane Threats with Sea-level Rise to Support Coastal Management within New England

Project Kickoff Meeting
May 10, 2022

On behalf of the University of Rhode Island and the project team, I acknowledge that we surrounded by the traditional lands of the Wamponoag Tribe of Gay Head-Aquinnah and Mashpee Wampanoag Tribal nations. We honor and respect the enduring and continuing relationship between the Indigenous people and this land by teaching and learning more about their history and present-day communities, and by becoming stewards of the land and sea we, now too, inhabit.

Introductions

- Name
- Organization
- Issue or opportunity -

a word or phrase related to modeling, visualizing, communicating storm/SLR

to support coastal management

Meeting Agenda

- Project Overview
- Discussion – what keeps you up at night?
- Interpretation and Communications - Overview and Discussion
- Next Steps

Goals, Objectives, and "Why?"

Promote informed management actions and wise expenditure of resources to improve coastal resilience and protect communities (people, infrastructure) and their ecosystems (habitats, resources, services) by investigating the combined impacts from storms –Nor'easters, hurricanes– and sea level rise (SLR)

Model – Simulate impacts of future extreme storms combined with SLR-with/without management actions

Inform – Provide stakeholders with data, visualizations, and other tools to build awareness and capacity for making informed decisions

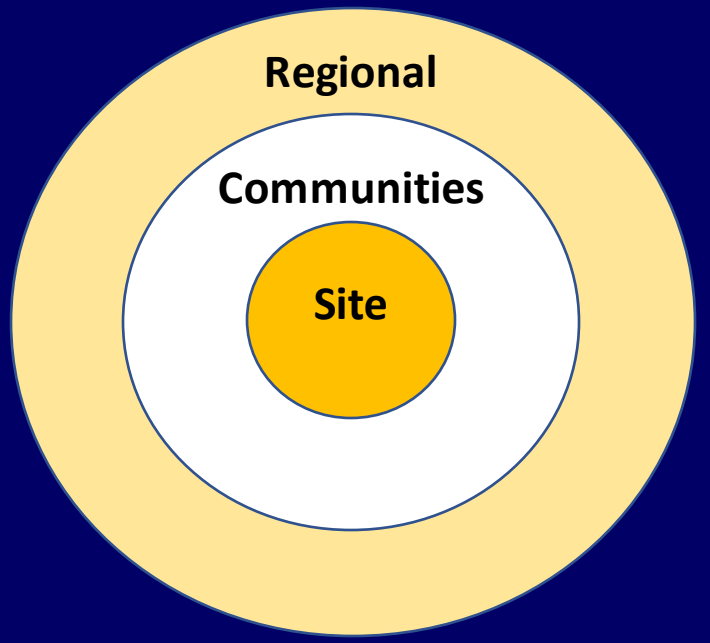
Communicate – Promote scientist-stakeholder dialog to build awareness and enhance understanding and application of project outputs

Tailor - Tailor project (modeling, visualizations, deliverables) to the extent possible to address site-specific needs and enhance/expand on existing efforts

Adaptation actions, infrastructure planning, emergency response, safe public access, natural resources and ecosystem protection and restoration

Engagement!

- Key component of project and commitment from project team
- Engage key stakeholders across the community
- Tailored to your needs



Scientists and stakeholders learn from one another

More effective and usable deliverables

Promotes science-based and effective management actions

Meet the Team

Isaac Ginis
URI Research

JP Walsh
URI Research

Stephan Grilli
URI Modeling

Annette Grilli
URI Modeling

Pam Rubinoff
URI Engagement

URI Graduate Assistants

Deb Crowley
Isabel Whaling
Elin Schuh
Alexa Leone
Felix Groetsch

Amanda Babson
NPS Engagement

Monique LaFrance Bartley
NPS Engagement

Catherine Schmitt
Schoodic Institute
Engagement

Peter Stempel
PSU
Visualizations

Roland Duhaime
URI Data

Chris Damon
URI Data

Why our team and this project?

Unique, advanced modeling tool supports coastal decision making

Complements and builds upon existing work

Ability to examine and visualize impacts to support modeling

- Better input data for today and future climate change scenarios
- Simulate modified coastal system

Model localized mitigation scenarios to support future decisions

Communication lessons learned and best practices contributes to interpretation and communication on the topic/issues

Sea-Level Rise Amplifies Impacts of Extreme Storms

+

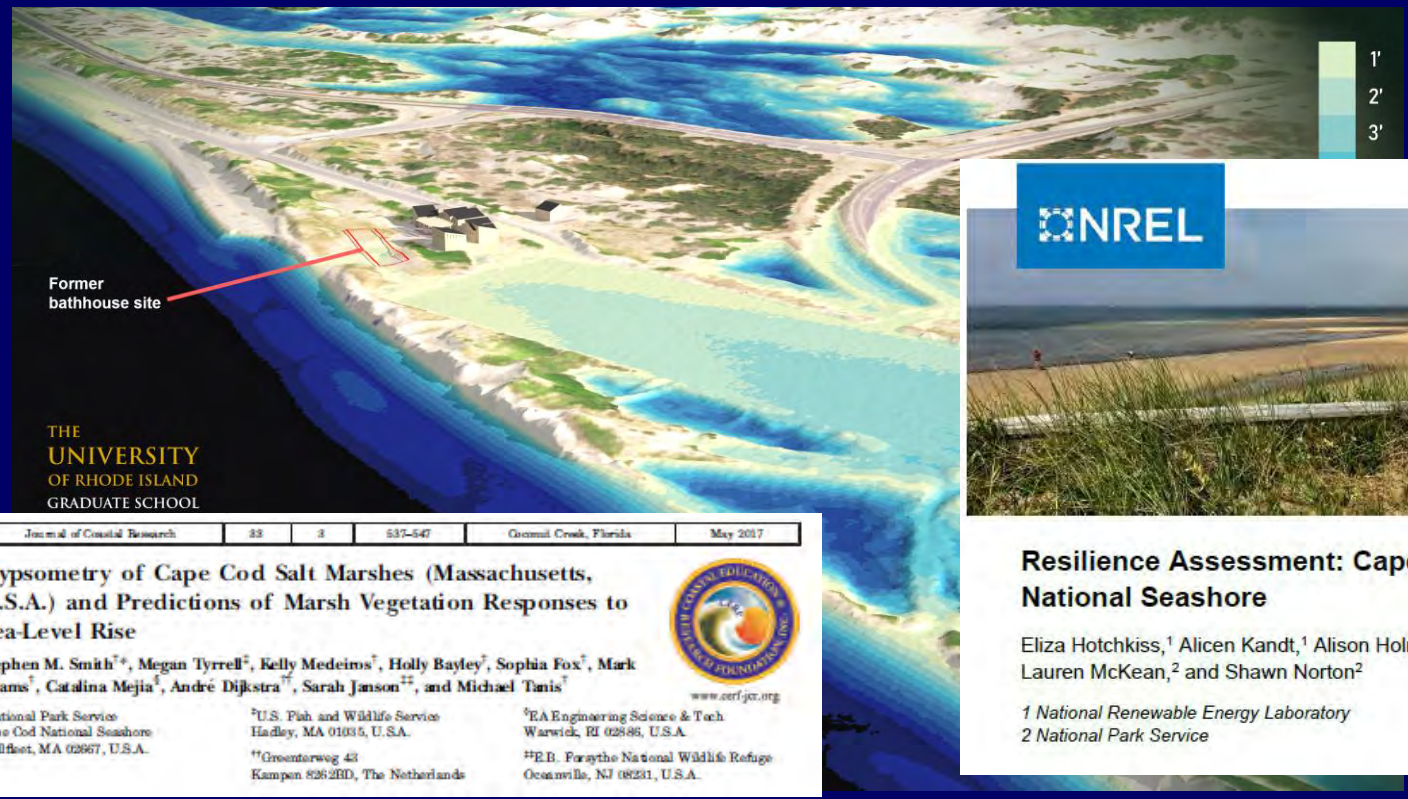
=

Informed Management Actions

Improved modeling including management actions

Building On Earlier Work – NPS & CCNS studies

- Modeling sea level rise effects on coastal inundation from Nor'easters in New England (URI led, NPS funded)
  - Understand how climate change affects Nor'easters and the associated hazards for three New England parks using advanced coastal ocean circulation/storm surge and wave models.
  - Incorporate improved storm vulnerability information into planning processes and decision making.
  - Communicate role of Nor'easters, changes in storms, and other research insights.
- Resilience Assessment (NREL)
- Coastal Facilities Vulnerability Assessment (WCU, in progress)
- Vulnerability assessment of Cape Cod National Seashore's coastal wetlands to sea level rise and other anthropogenic stressors (CCNS)



Journal of Coastal Research	33	3	537–547	Coconut Creek, Florida	May 2017

Hypsometry of Cape Cod Salt Marshes (Massachusetts, U.S.A.) and Predictions of Marsh Vegetation Responses to Sea-Level Rise

Stephen M. Smith[†*], Megan Tyrrell[‡], Kelly Medeiros[†], Holly Bayley[†], Sophia Fox[†], Mark Adams[†], Catalina Mejia[§], André Dijkstra[††], Sarah Janson[‡‡], and Michael Tanis[†]

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www.cerf-jcr.org

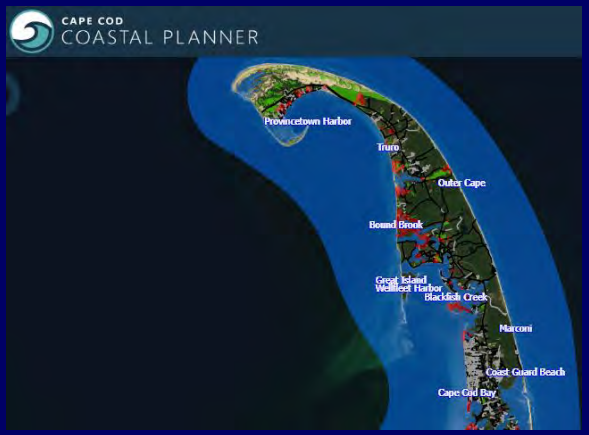
Resilience Assessment: Cape Cod National Seashore

Eliza Hotchkiss,[1] Alicen Kandt,[1] Alison Holm,[1] Lauren McKean,[2] and Shawn Norton[2]

1 National Renewable Energy Laboratory
2 National Park Service

Building On Earlier Work – Community Efforts

- Barnstable Cty, e.g., Cape Cod Coastal Planner
- Increasing Coastal Resiliency Through Intermunicipal Shoreline Management
- Hazard Mitigation Plans, Studies
- Municipal Vulnerability Preparedness
- State efforts, e.g., SLAMM Modeling
- Intermunicipal Shoreline Mgmt Geodatabase - Center for Coastal Studies
- USGS investigations including vulnerability, camera, CVI to Coastal Change Likelihood
- NOAA Digital Coast
- Extensive related literature



CENTER FOR COASTAL STUDIES
PROVINCETOWN

NOAA Office for Coastal Management
DIGITALCOAST

USGS
science for a changing world

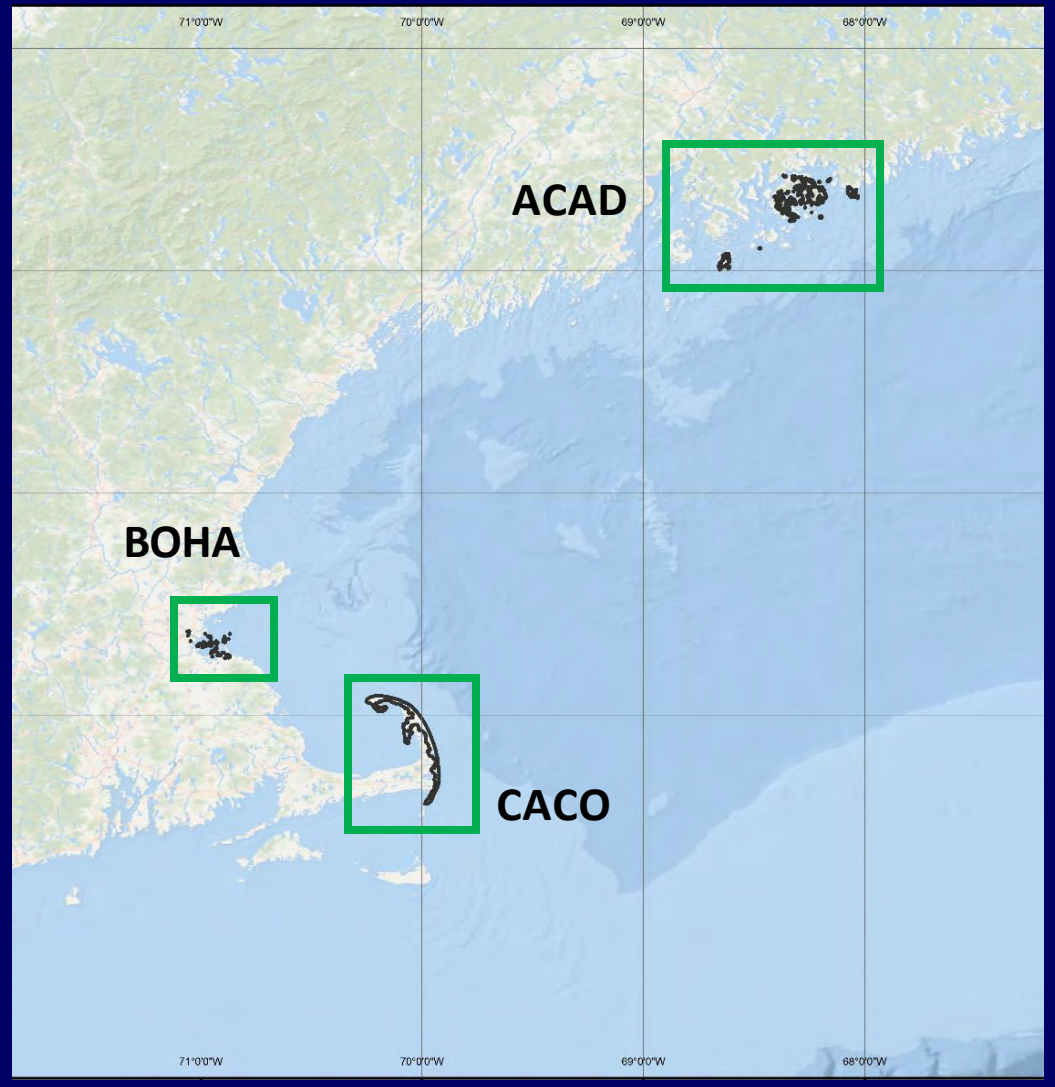
Past Experience: NPS Nor'easters Project Overview

Amanda Babson – NPS | Isaac Gins –URI GSO | Deb Crowley - URI GSO |Peter Stempel – Penn State

Climate change impacts on Nor'easter vulnerability for three New England Parks

- Study Area: Boston Harbor, Cape Cod & Acadia

- Scope: Numerical modeling and analysis
  - Coupled hydrodynamic (ADCIRC) and wave (SWAN)
  - Refined mesh
  - Model validation
  - Simulations of Nor'easters with present sea level and up to 1m SLR
    - March 2018 Nor'easter
    - January 2018 Nor'easter
    - Groundhog Gale 1976
    - April 2007 Nor'easter (In Progress)



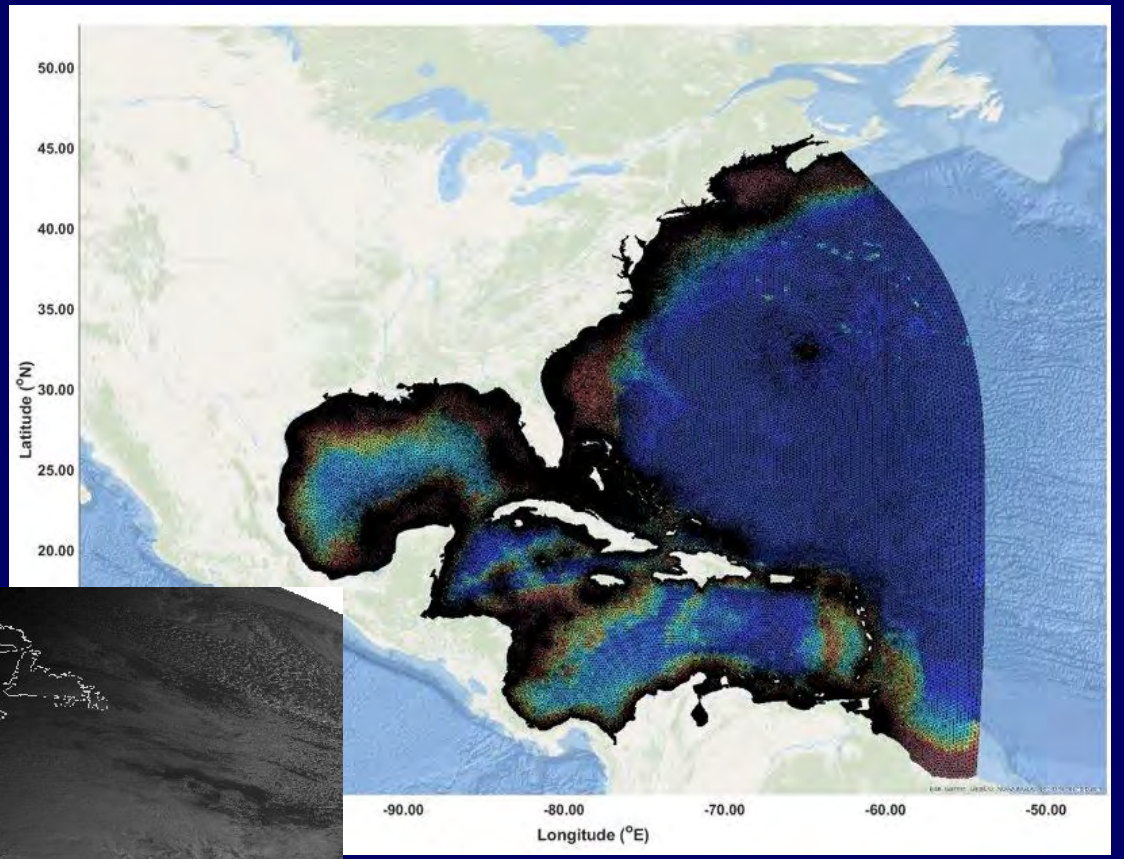
ADCIRC-SWAN Modeling

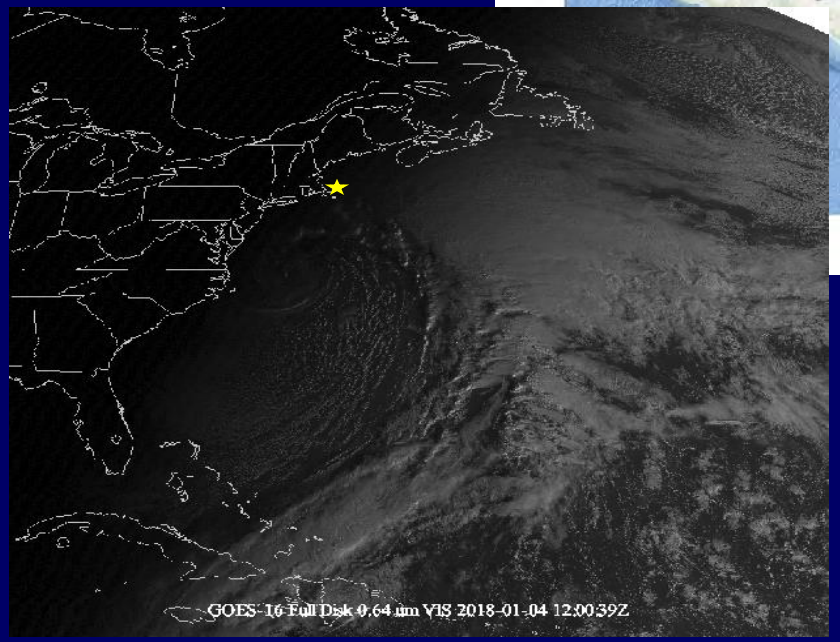
Domain

- Basin wide for capturing storm
- Includes all project areas
- Computational mesh extends over land

Model Output

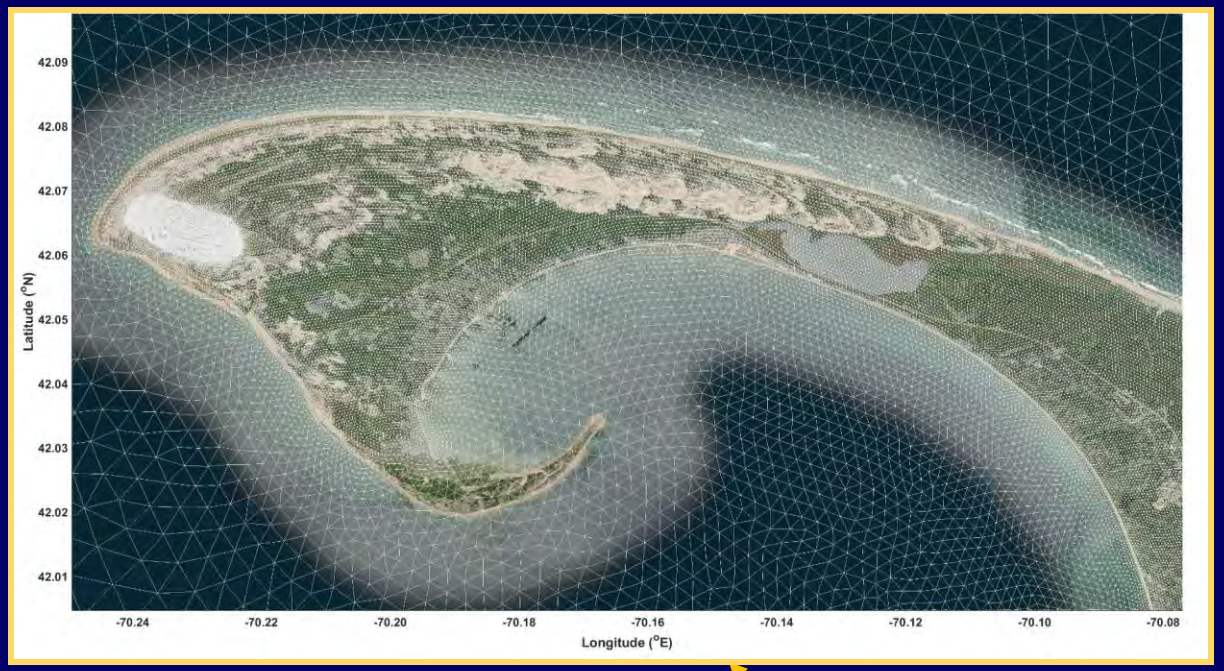
- Water levels
- Inundation depths
- Significant wave heights

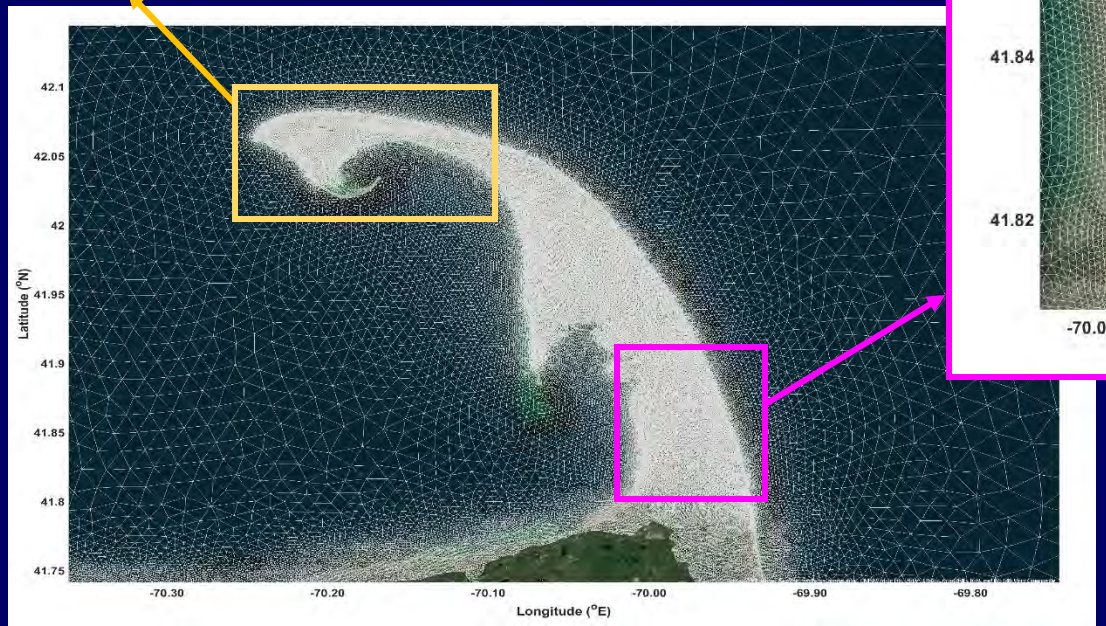


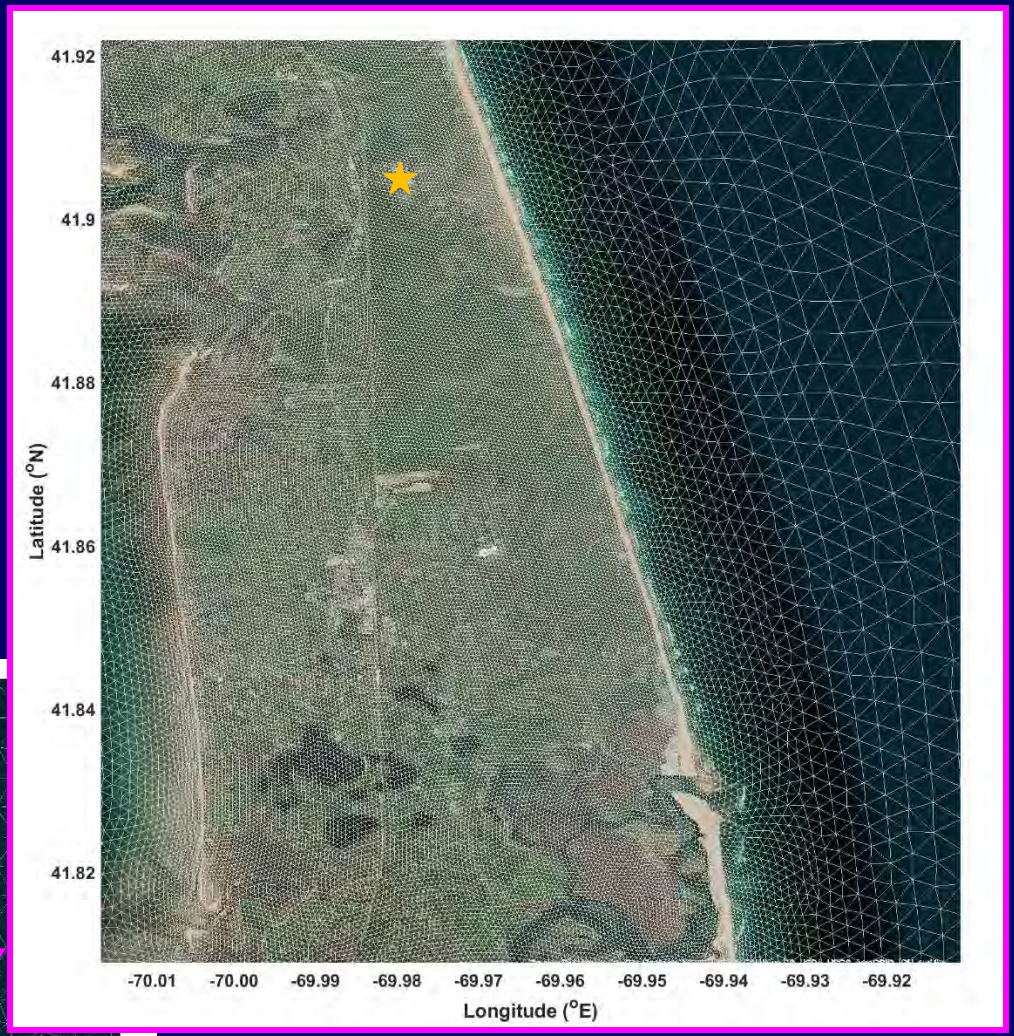


January 2018 Nor'easter

ADCIRC-SWAN Computational Mesh in Cape Cod

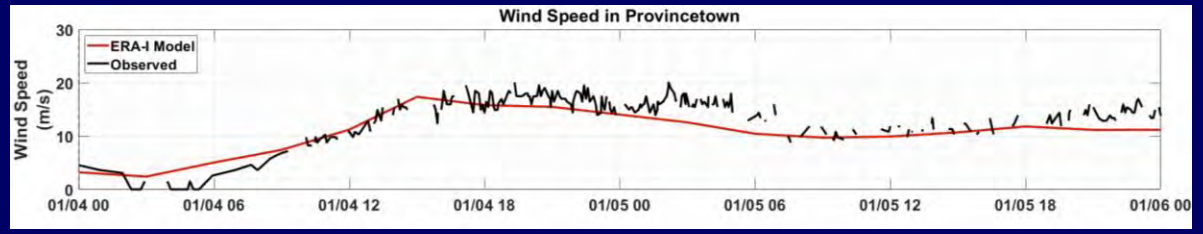


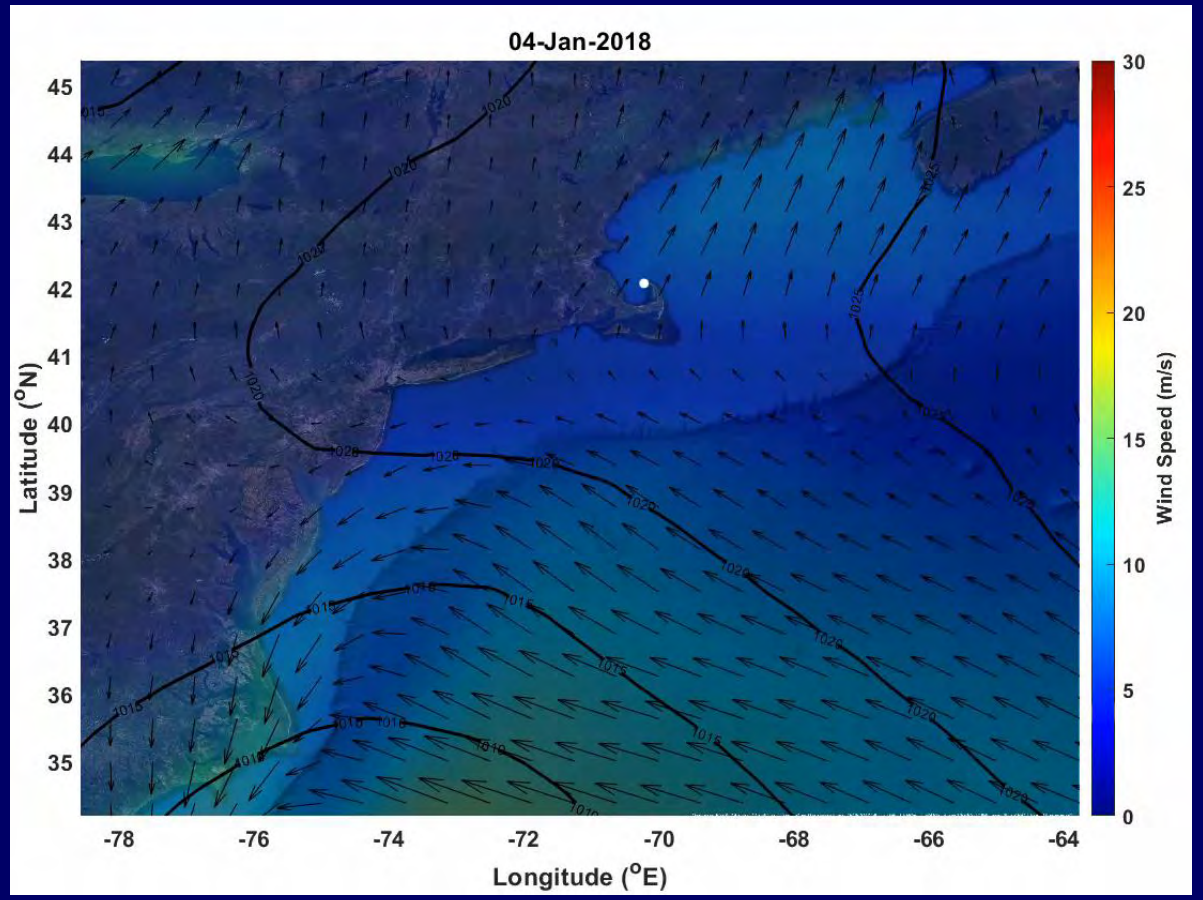




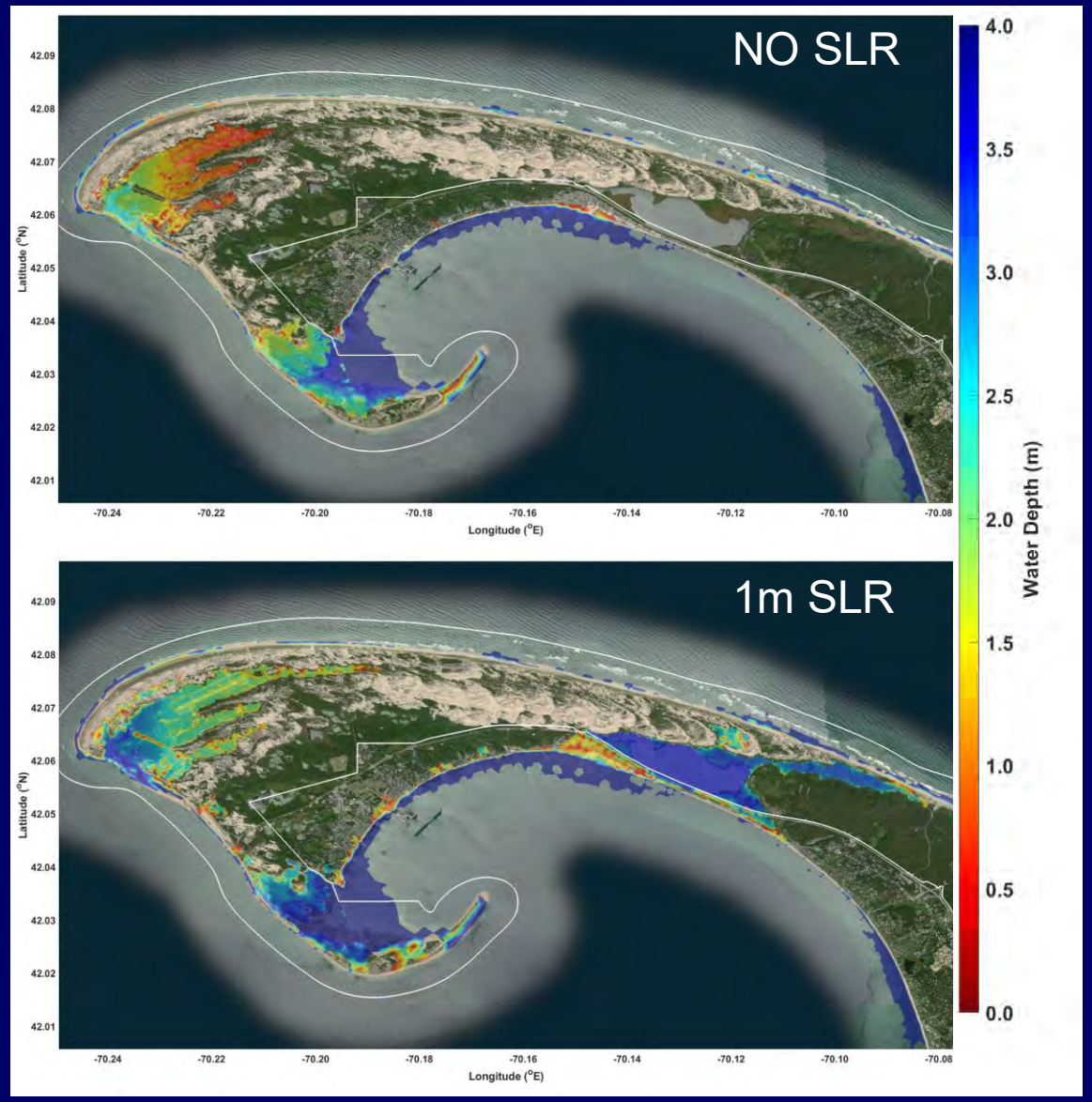
Simulation of January 2018 Nor’easter

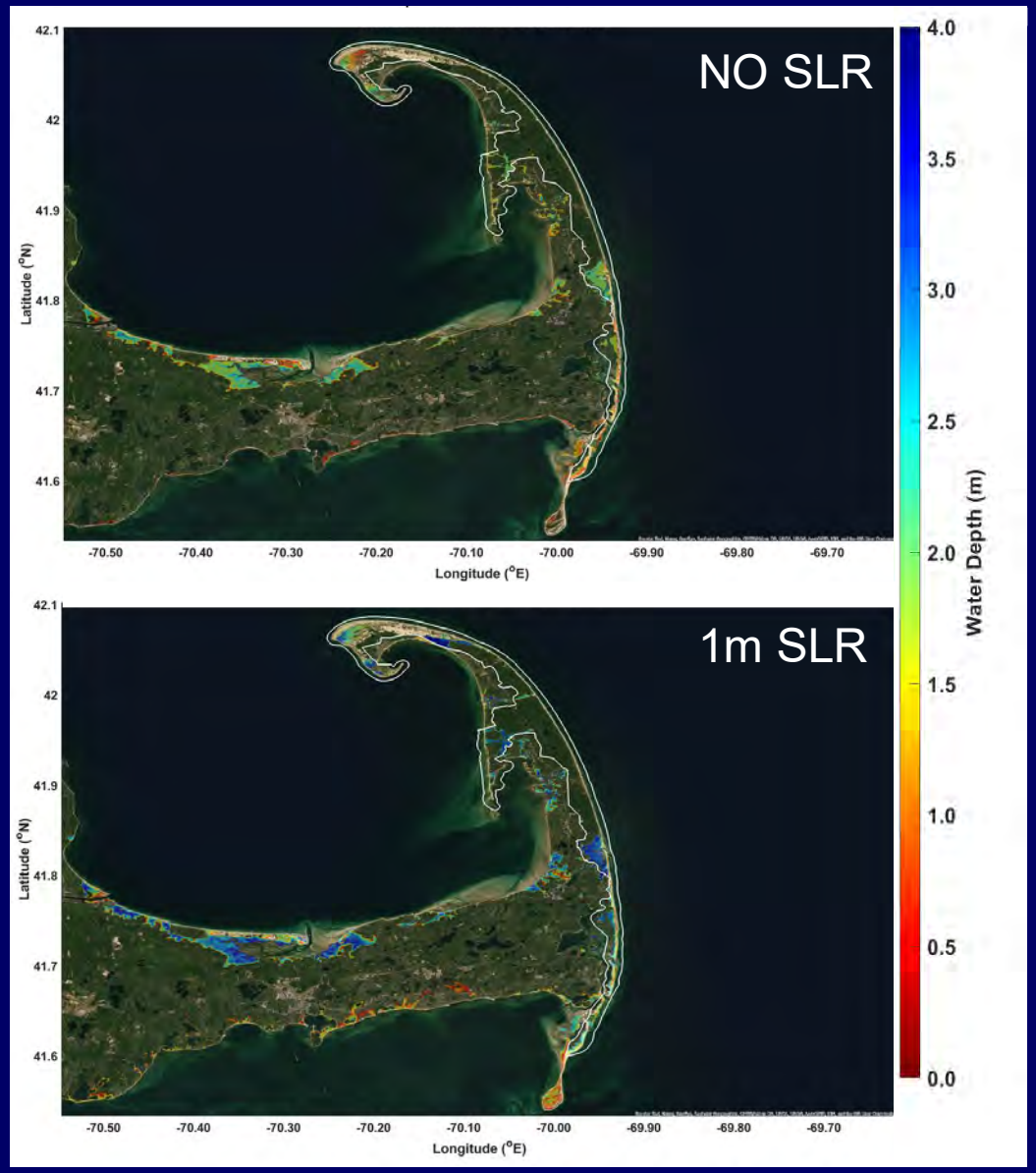
- Meteorological forcing
  - ECMWF ERA-Interim
  - 0.125° resolution
  - 3-hr timestep



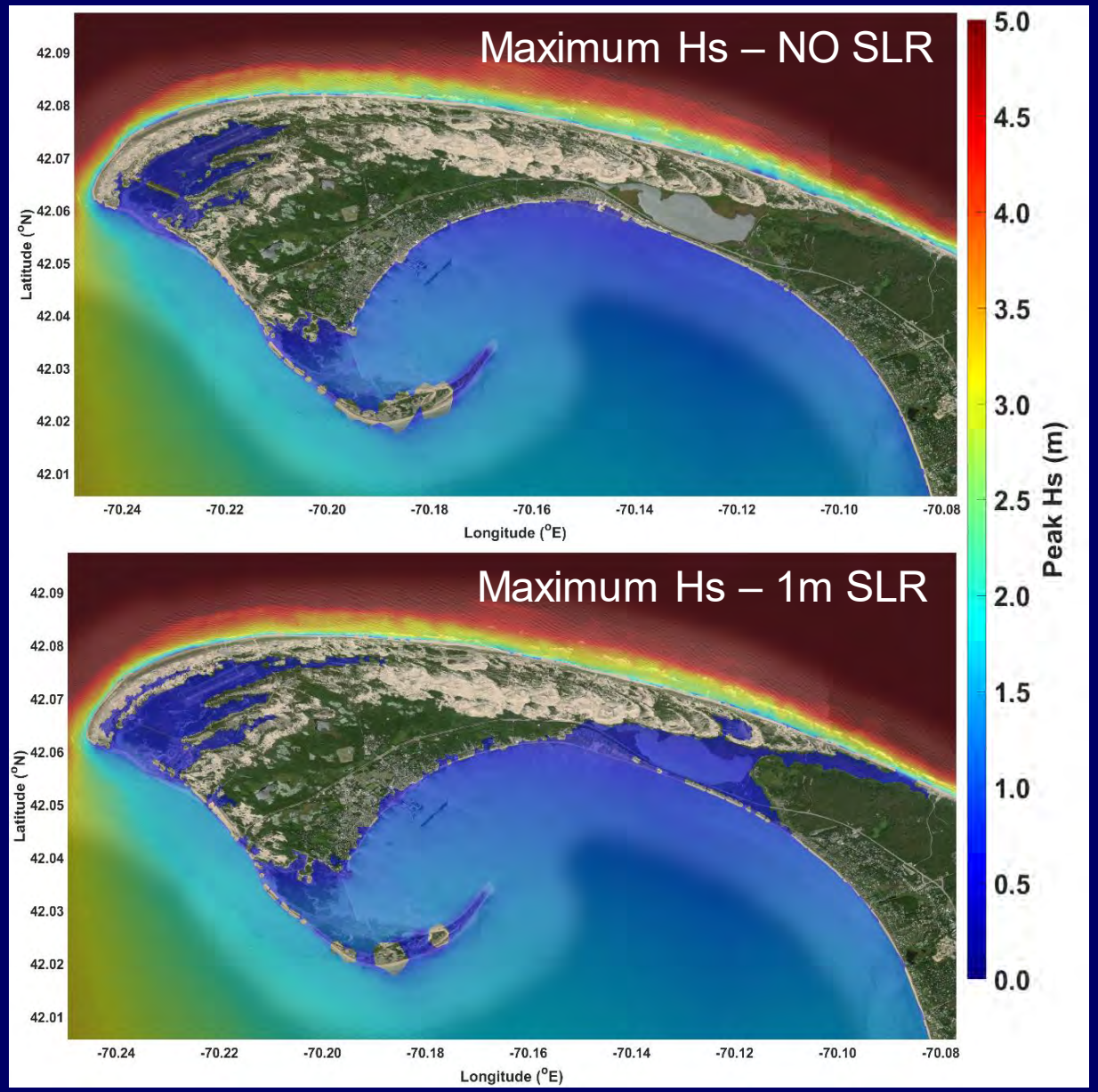


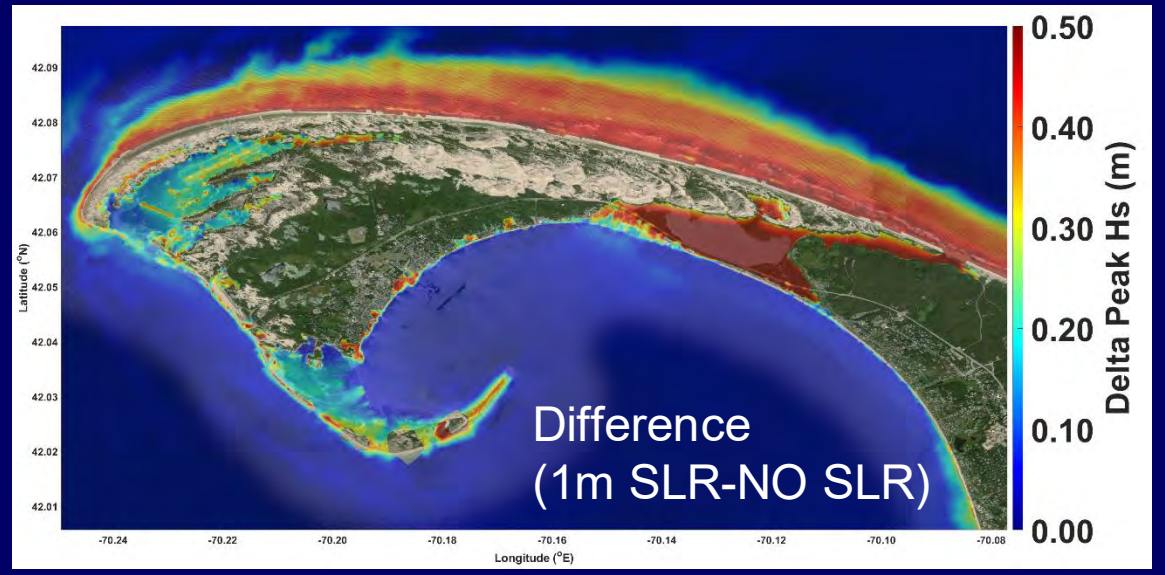
January 2018 Nor'easter – Maximum Inundation

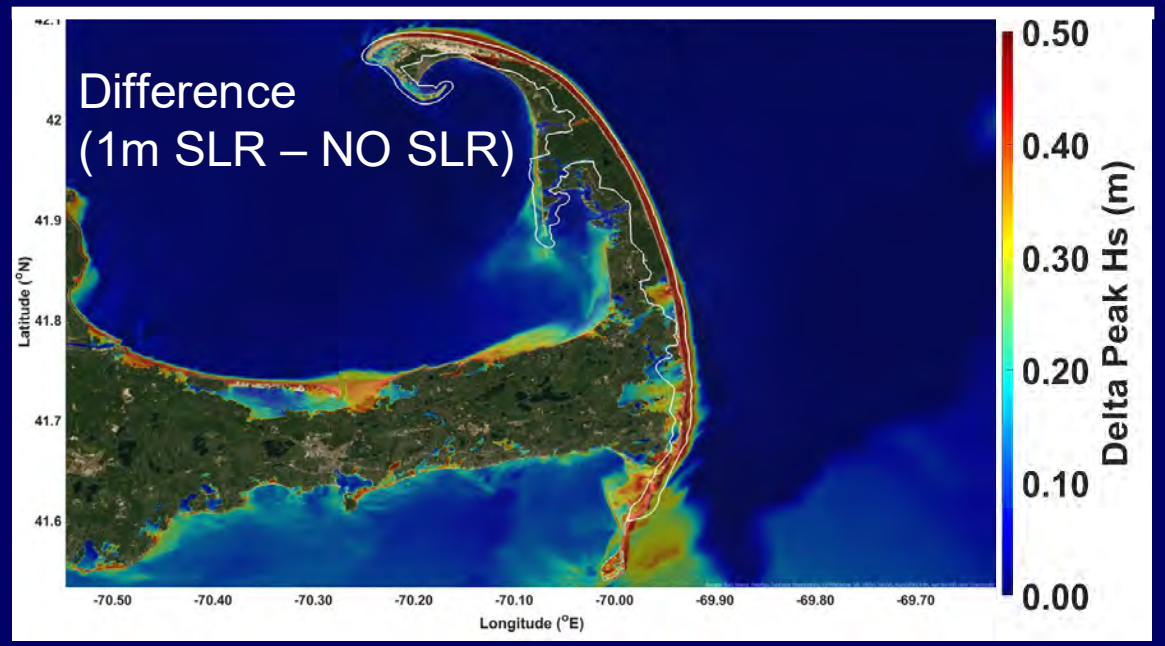




January 2018 Nor'easter – Significant Wave Height (Hs)





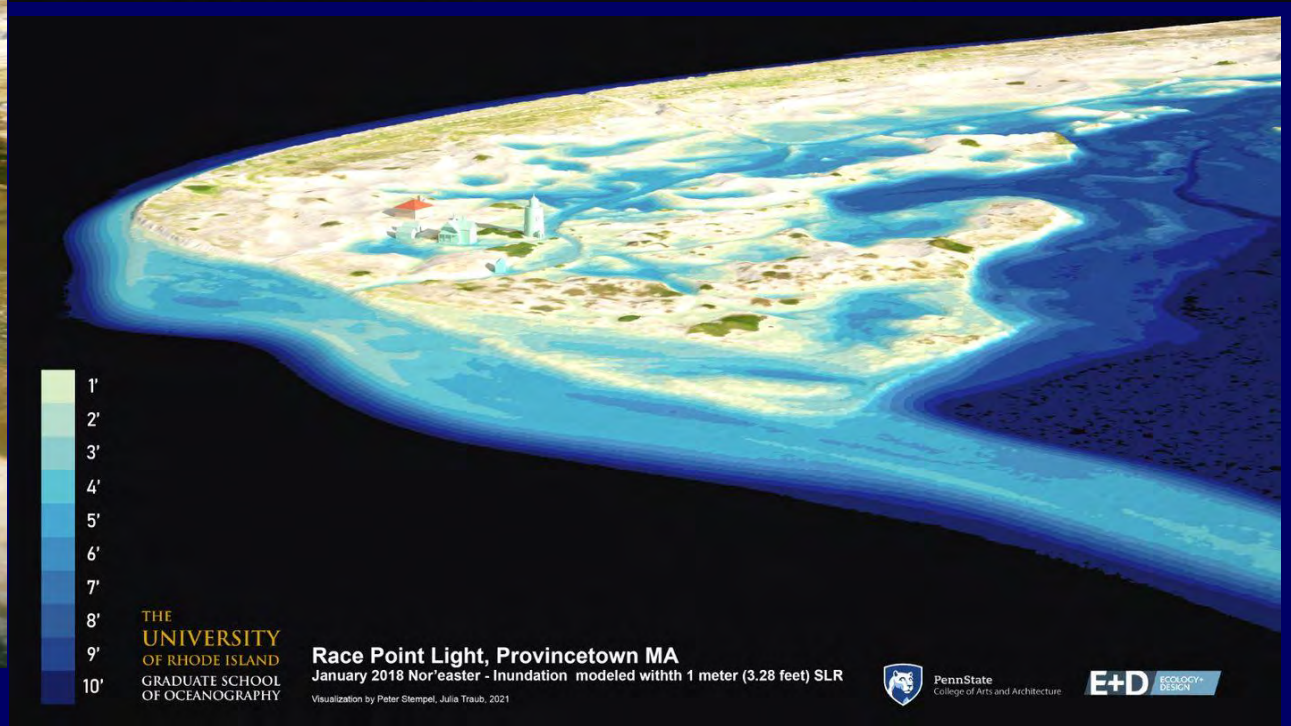


Advanced 3-D Visualization Tools

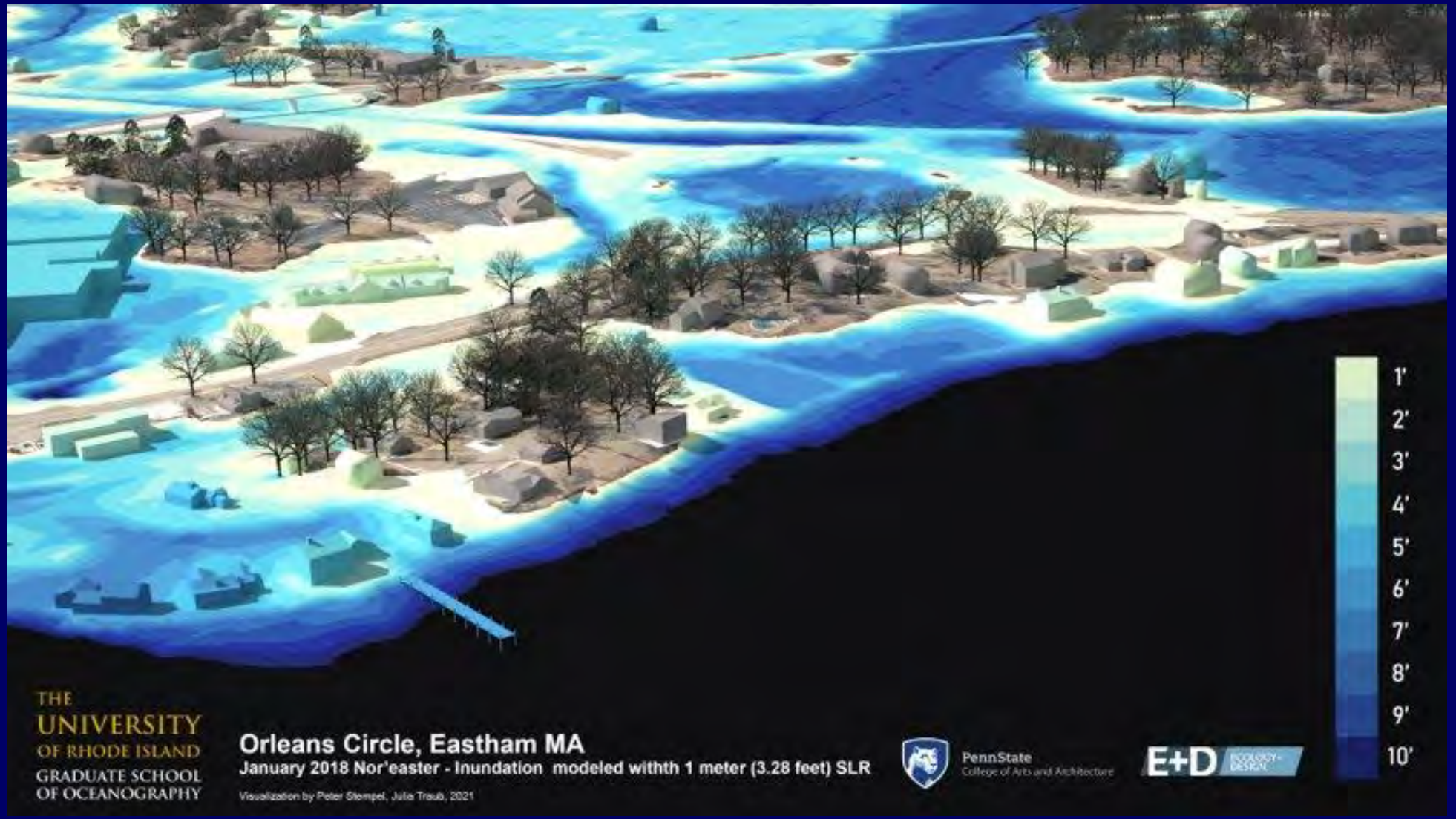
Bottom: Existing conditions

Top right: January 2018 Nor'easter

Bottom right: Nor'easter +1m SLR



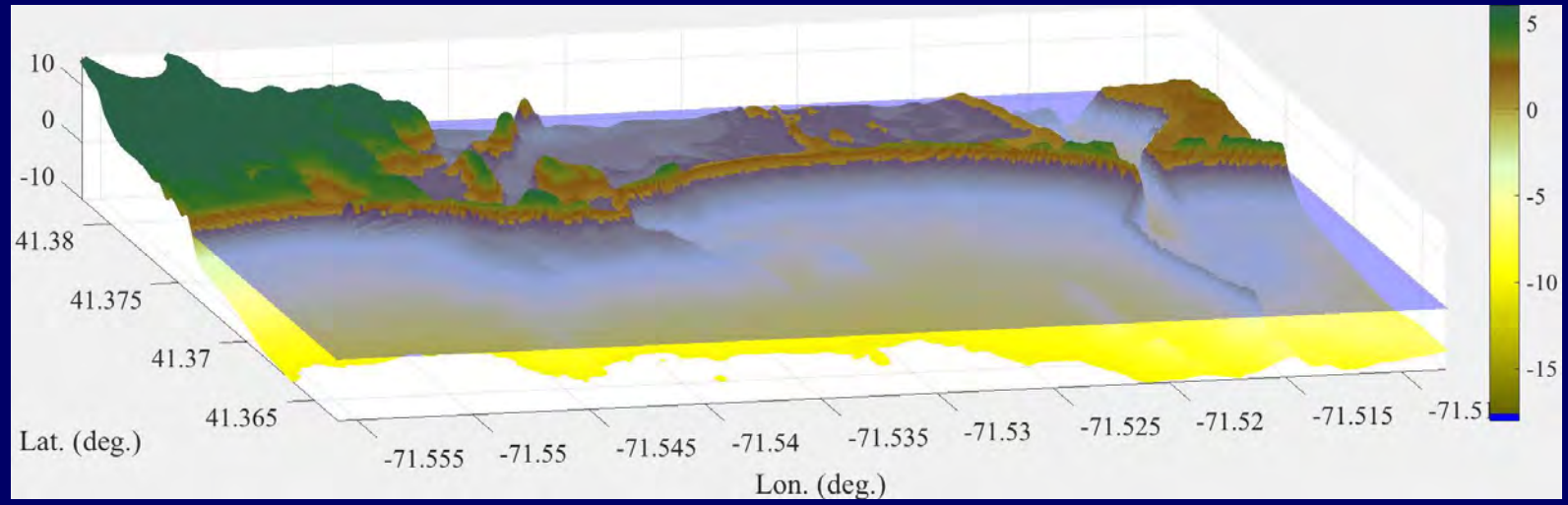
Working with stakeholders, these can be validated



Coastal Modeling: Beach and Dune Erosion

ASSESS AND PREDICT

- Beach and dune erosion during storm events
- Breaching and changes in coastal morphology
- Flooding



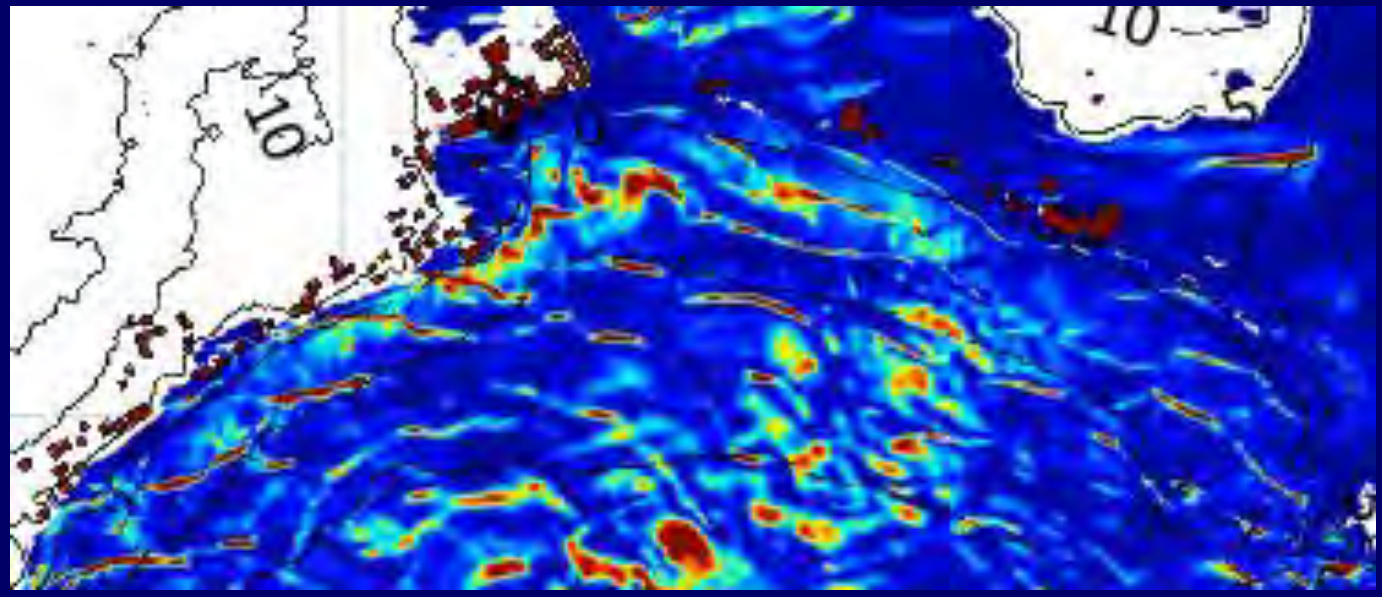
Grilli et al., 2020

Modeling tool: Morpho-dynamic model, XBeach

Coastal Modeling: Waves and Momentum Force

ASSESS AND PREDICT

- Runup
- Forces on structures
- Flooding



Grilli et al., 2020

Modeling tool: Phase resolving wave model, FUNWAVE

Coastal Modeling: Natural and Nature-based Features (NNBF) Mitigation Solutions

Beach Nourishment

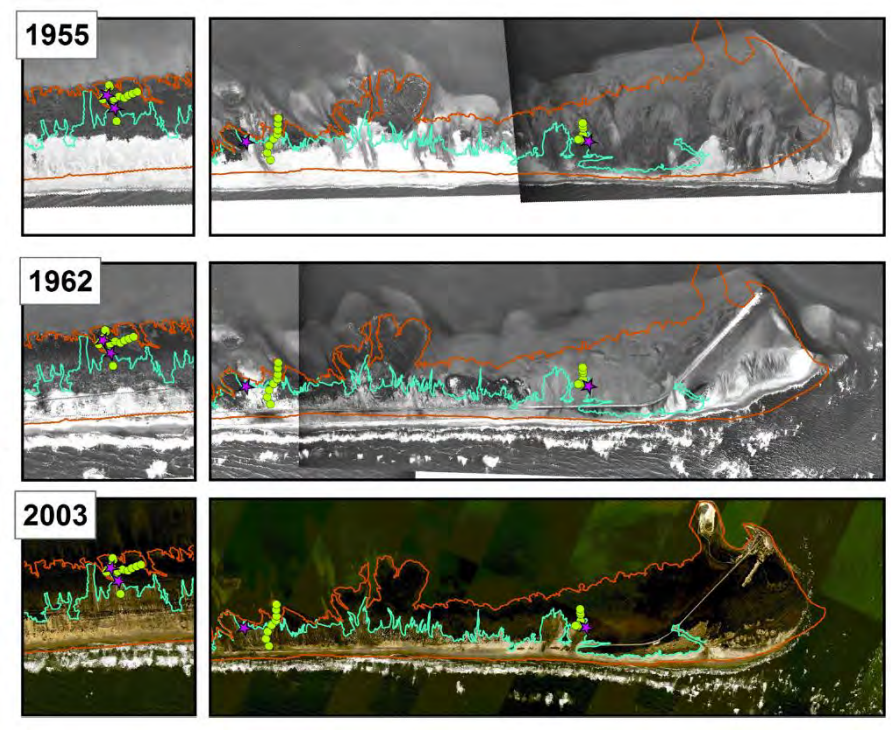
Dune reinforcement

Enhanced Vegetation

Using Historical & New Data to Inform Future Changes

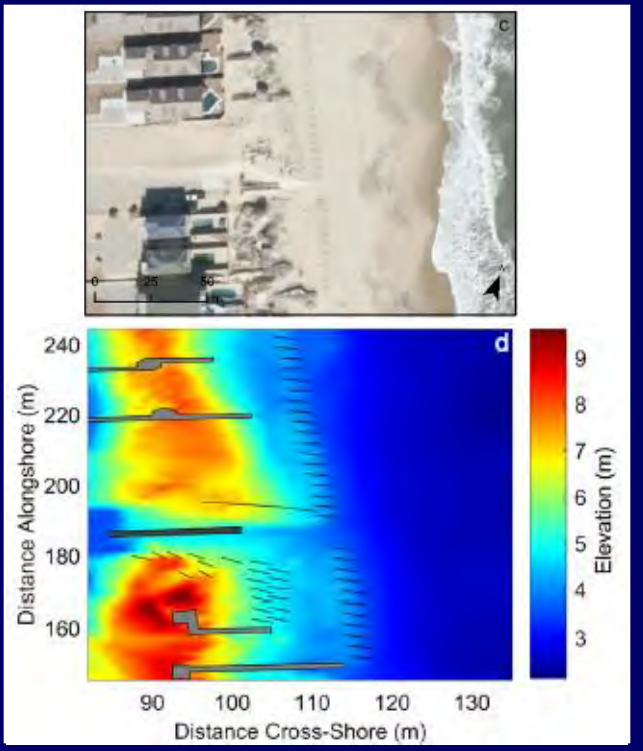
- An overall goal is to understand risk today and in the future.
- Additional field and GIS data analysis will measure past and recent changes.
- Use existing data and analyses to inform modeling. New data as needed.

Aerial Photographic Analysis



Field Surveying and Sampling

3D Change Mapping



Project Sites

- 5 National Parks
  - Acadia
  - Boston Harbor Islands
  - Cape Cod
  - New Bedford Whaling
  - Roger Williams Memorial
- 2 National Wildlife Refuges
  - Ninigret
  - Trustom Pond
- Tailored to meet site-specific needs
  - Management
  - Model and data availability
  - Existing planning efforts

Three-tiered stakeholder-driven approach

Tier	Community education and outreach	Hydrodynamic modeling	Development of 3D visualization tools	Hazard impact and coastal vulnerability assessment	Mitigation strategies implementation	Sustained Involvement
Tier 1 (CACO, NITR)	✓	✓	✓	✓	✓	✓
Tier 2 (ACAD)	✓	✓	✓			
Tier 3 (NEBE, BOHA, ROWI)	✓	✓	✓			

Timeline of Activities

YEAR 1

- Kickoff site teams and site visits
- Modeling, asset exposure and vulnerability; visualizations
- Data portal development
- Penn State student project
- MTAG meetings

YEAR 2

- Engagement – sites and MTAG
- Continue visualizations, vulnerability assessments, and modelling
- Finalize vulnerability assessments

YEAR 3

- Engagement – sites and MTAG
- Mitigation scenario modeling

YEAR 4

- Engagement – sites and MTAG
- Complete deliverables and user interface
- Transition to end users


QUESTION
ANSWER

Role of the working group

- Conduit to the larger community of stakeholders.
- Share issues and concerns, ensure that the project is applicable to the needs, discuss appropriate management options
- Identify common areas of concern
- Provide a forum to discuss options, and applications for research & models

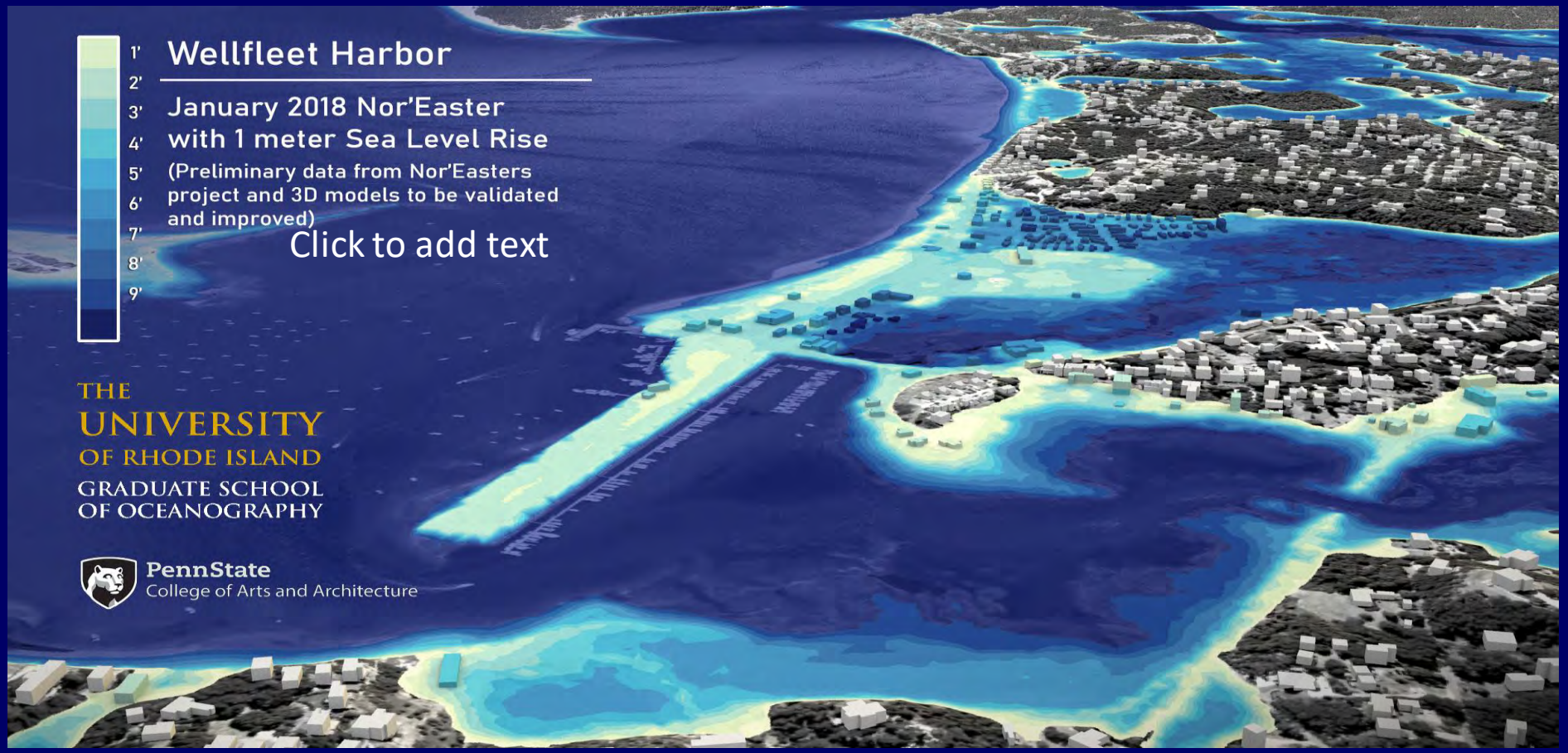
What are the issues and specific places of concern?

What keeps you awake at night?

Are there specific areas of concern to the community at risk from storms and flooding?

Issues: A quick look at the Municipal Vulnerability Program Results

- U.S. Route 6
- Truro – Truro Center, Beach Point area, Ballston Beach
- Wellfleet - Mayo beach, East Commercial Street
- Eastham - Eastham/Orleans rotary; Bridge Road, Town Cove area
- Provincetown – Bradford, Commerical Street



Interpretation & Communication Efforts

Catherine Schmitt
Science Communication Specialist
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Hannah Webber
Marine Ecology Director
hwebber@schoodicinstitute.org

SCHOODIC INSTITUTE
AT ACADIA NATIONAL PARK

Schoodic Institute is a nonprofit partner of the National Park Service and a center for inspiring science, learning, and community for a changing world.

My connection to Cape Cod

Nor’easters and their Impacts in Three New England Parks: Interpretation

- Enhance public understanding, awareness of storms and their impacts.
- Communicate science as a way of knowing.
- Encourage public engagement in science.

- Learning modules
- Visualization library
- Video -->

Nor’easters and their Impacts in Three New England Parks: Communication

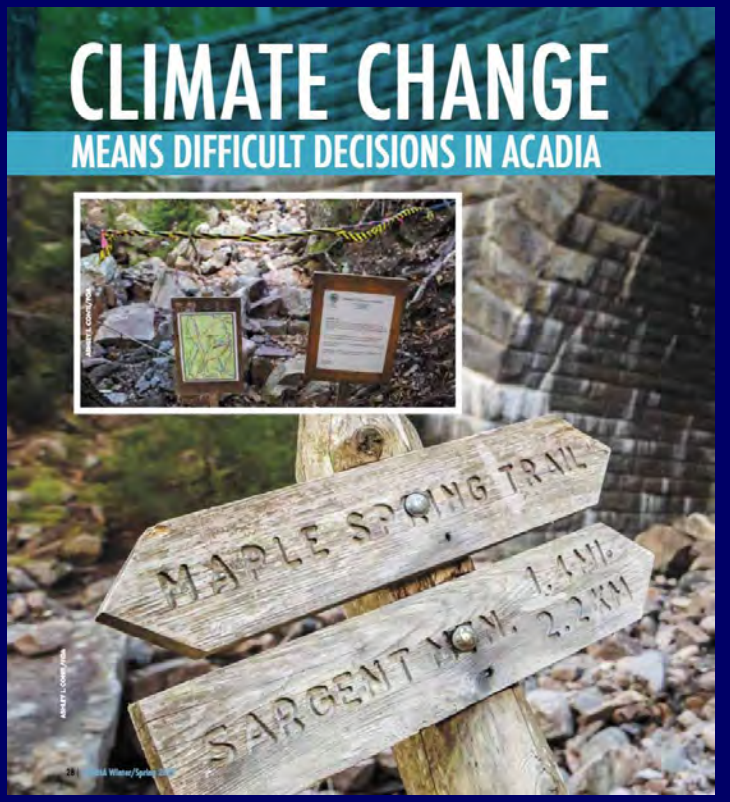
- Leverage National Park System networks to develop regional strategy and coastal climate change communications guidance document.

- Foster regional identity, collaboration.

- Nor’easters as “our own special kind of storm.”

NOAA Effects of Sea Level Rise

- Develop stories that both document the project and communicate results to stakeholders.
- Assist partners with products and programs to enhance understanding of storm surge and coastal flooding.
- Update and revise communications guidance document.
- Facilitate meetings for feedback on research results, science communication training.



Questions for you:

How has public understanding or discussion changed?

What communication has worked? What has not worked?

What are your communication challenges?

What stories aren't being told?

What's Next?

- Field visit
- Coordinate on existing work and ongoing efforts
- Technical modeling and field work scoping
- Information gathering – models, data, reports
- Permits, based on input and work
- Identify others to engage as appropriate
- Next meeting

Modeling, Visualizing, & Communicating Nor'easter and Hurricane Threats with Sea-level Rise to Support Coastal Management within New England

For more information
Pam Rubinoff, URI Coastal Resources Center, Rubinoff@uri.edu

Extra slides

What building blocks can this effort leverage and compliment?

Models, Data

- Salt marsh modeling
- Ocean shoreline change research
- Intermunicipal Shoreline Mgmt Geodatabase
- Towns, NPS and EDC data
- ?
- ?

Plans, initiatives

- Community resilience building workshops
- Cape Cod Coastal Planner
- Resilience assessments
- Adaptation strategy matrix
- Local Comprehensive Plan
- Hazard mitigation plan

Management Challenges Identified

ALL
- Resiliency (community, ecosystem)
- Adaptation strategies
- Results of taking management actions vs not
- Cultural resources

Cape Cod, MA
- Inundation of emergency access routes, local airport, vulnerable historic structures
- Safe public access
- Salt marsh restoration

New Bedford, MA; Providence, RI
- Infrastructure vulnerability and management options
- Engaging less-represented comm-unities in outreach and planning
- Ecosystem restoration

Acadia, ME
- Roads
- Access
- Emergency preparedness
- Park infrastructure
- Salt marsh restoration

Boston Harbor, MA
- Coordination with Climate Ready Boston
- Erosion of cultural resources

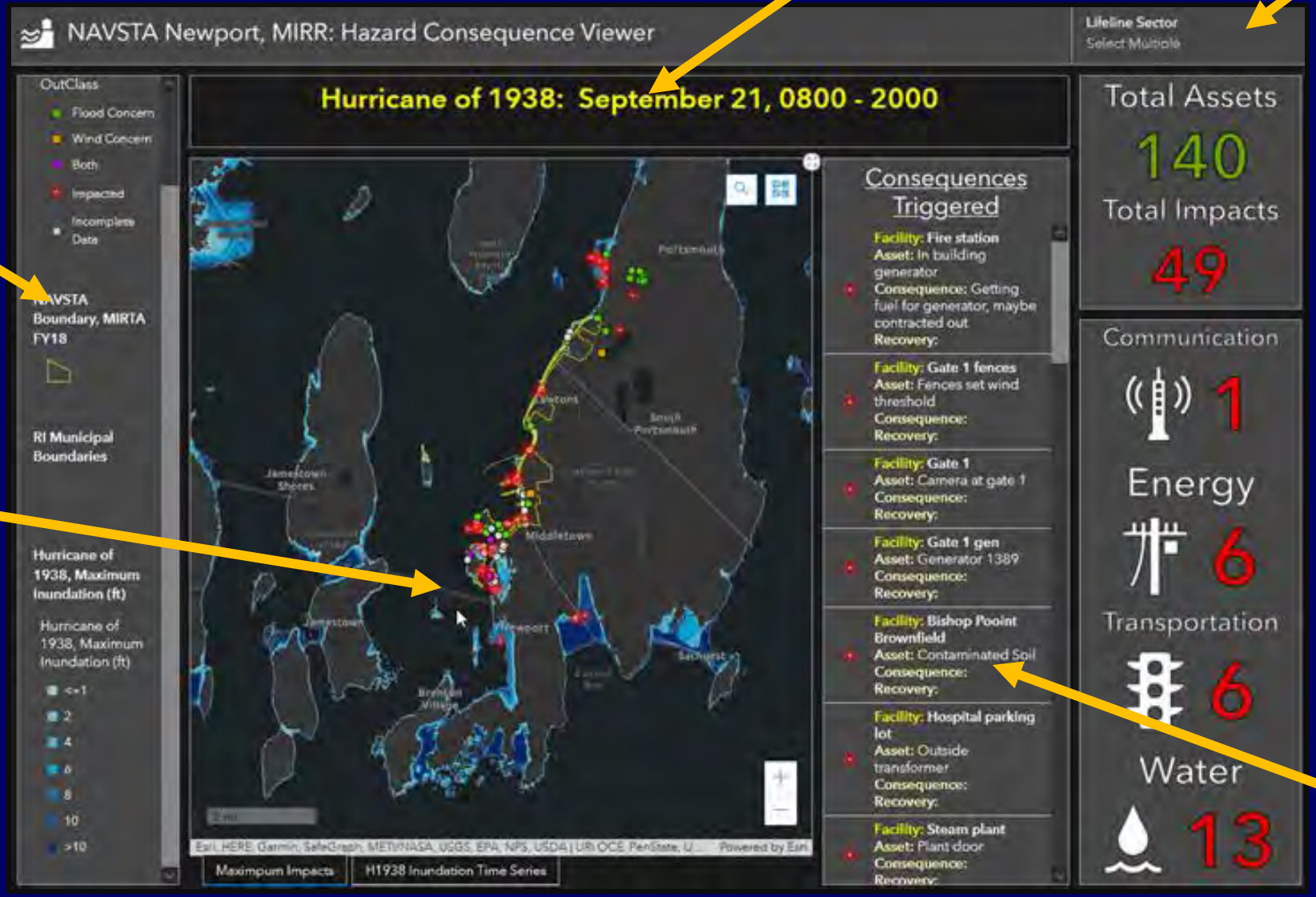
Charlestown/S. Kingstown, RI
- Estuarine habitat vulnerability
- Adaptive capacity of ecosystem
- Blue economy

Interactive Dashboard

Modeling Scenario

Data Filters (map and metrics)

Map Legend



Interactive Map :

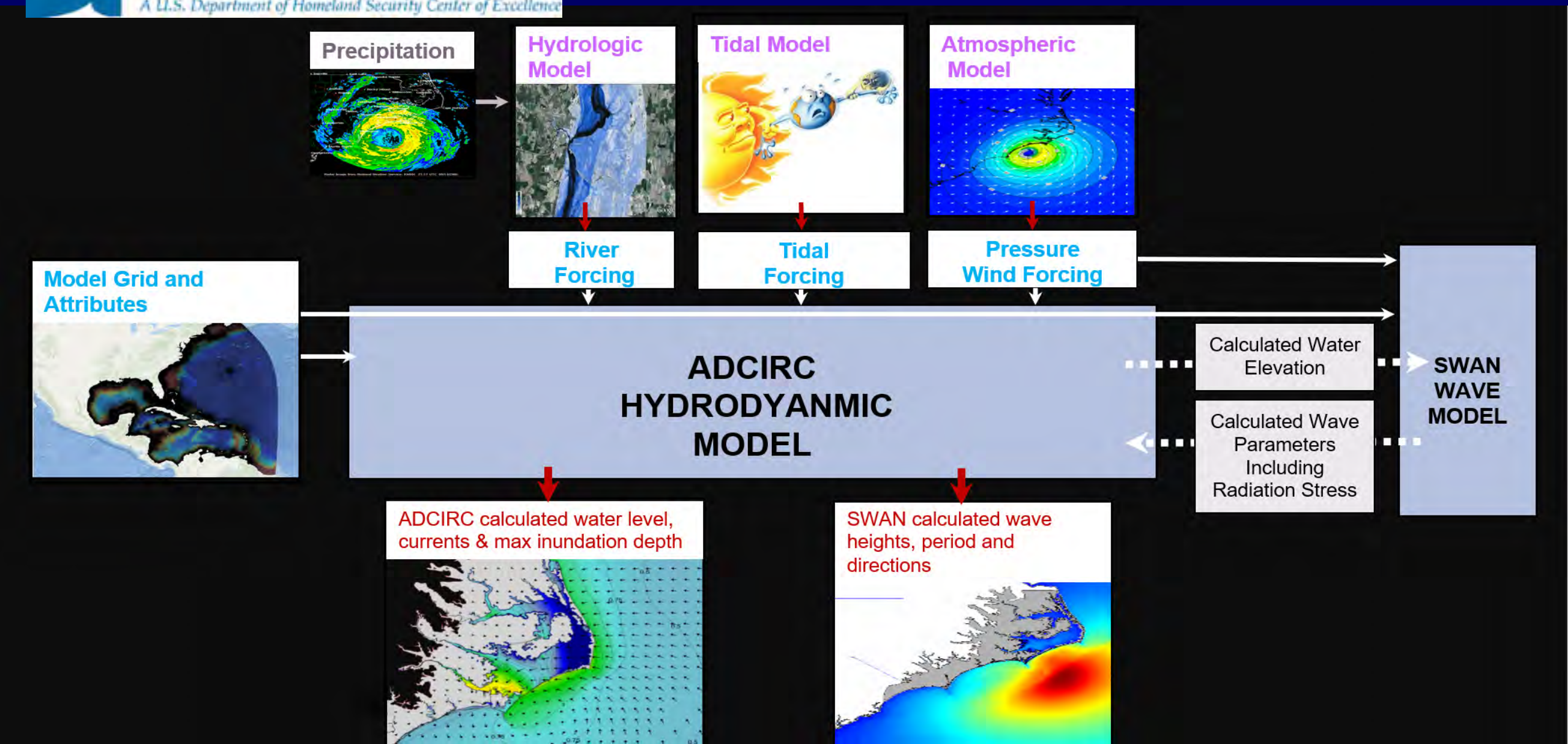
- Extent of flooding
- Depth of flooding
- Assets affected

Quantitative Summary of Impacts

Specific Asset Information

ADvanced CIRCulation (ADCIRC) Model for Flood Predictions

COASTAL RESILIENCE CENTER
A U.S. Department of Homeland Security Center of Excellence



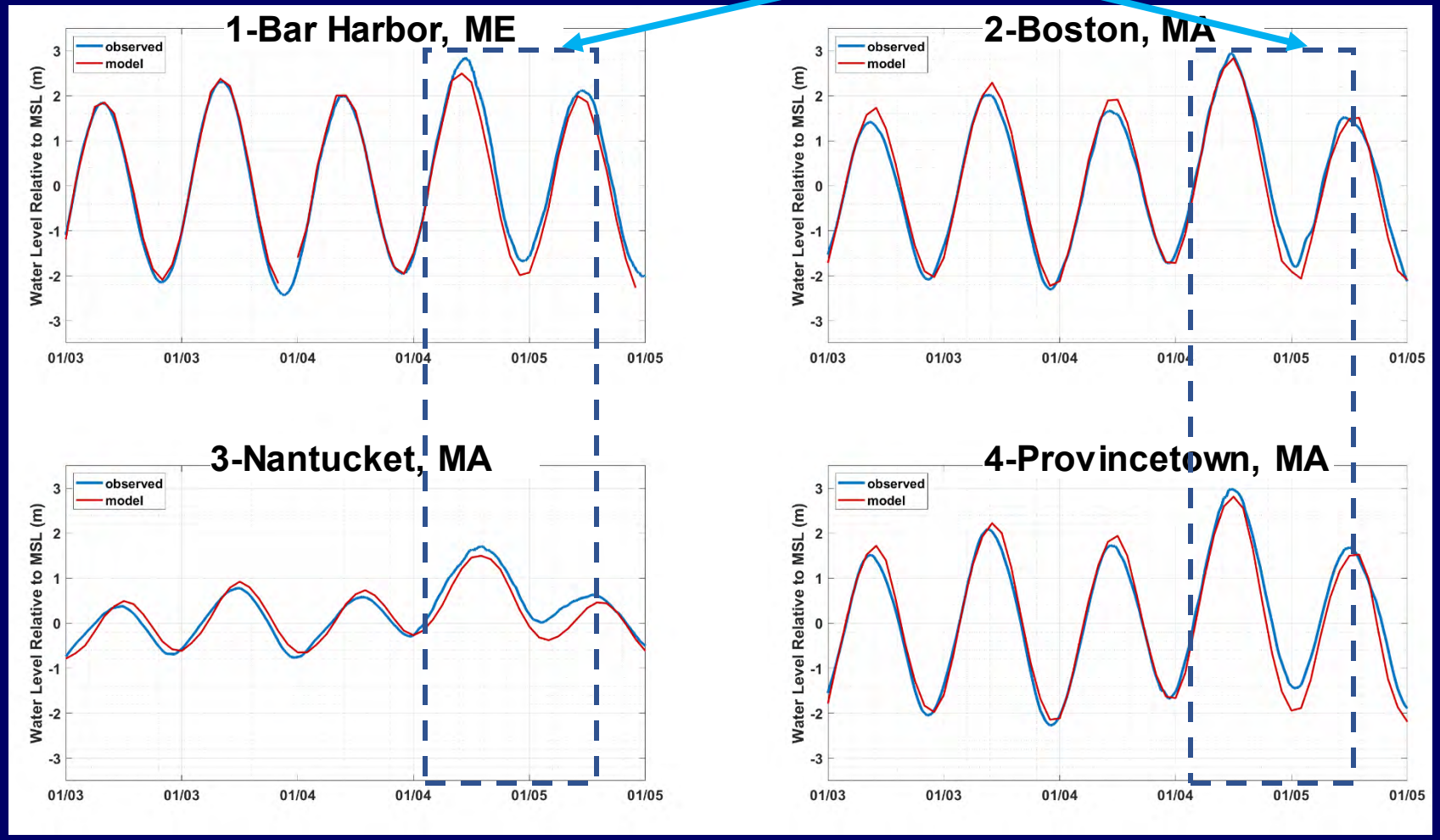
ADCIRC Model Storms

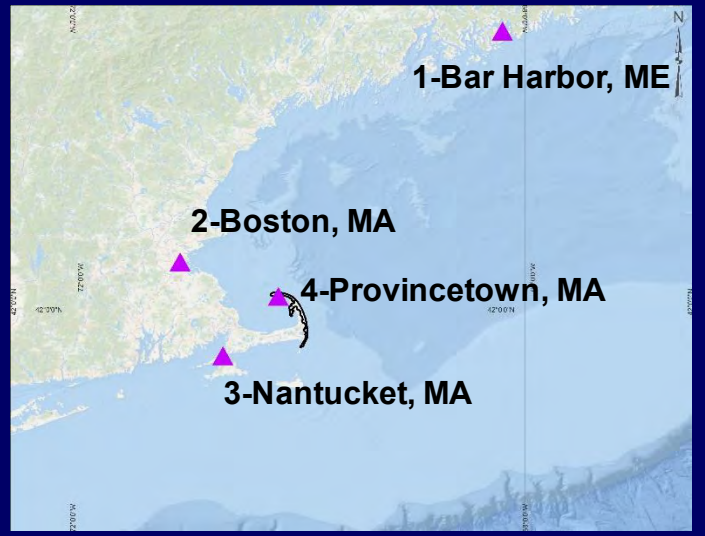
Storm	Mean Sea Level Conditions Modeled					Met Forcing
	Present MSL	0.3048m (1ft)	0.9144m (3ft)	1 m (3.2808 ft)	1.5240 (5ft)	
March 2018 Nor'easter	X			X		ERA-I
January 2018 Nor'easter	X			X		ERA-I
February 1976 Gale	X			X		ERA-5
Sandy (October 2021)	X	X	X		X	HWRF, ERA5, ERA-I
Hurricane 1938 (September 1938)	X					Best Track, Parametric Model
Modified Hurricane 1938	X	X	X		X	Shifted Worst Case Track, Parametric Model
Theoretical Storms Rhody and Ram	X					Best Track, Parametric Model
Tropical Storm Henri (August 2021)	X					Best Track - HBL, Best Track - Parametric, ERA5 Reanalysis
October 2021 Nor'easter	In Progress					GFS

ADCIRC Model Validation

Observed
ADCIRC -model predicted

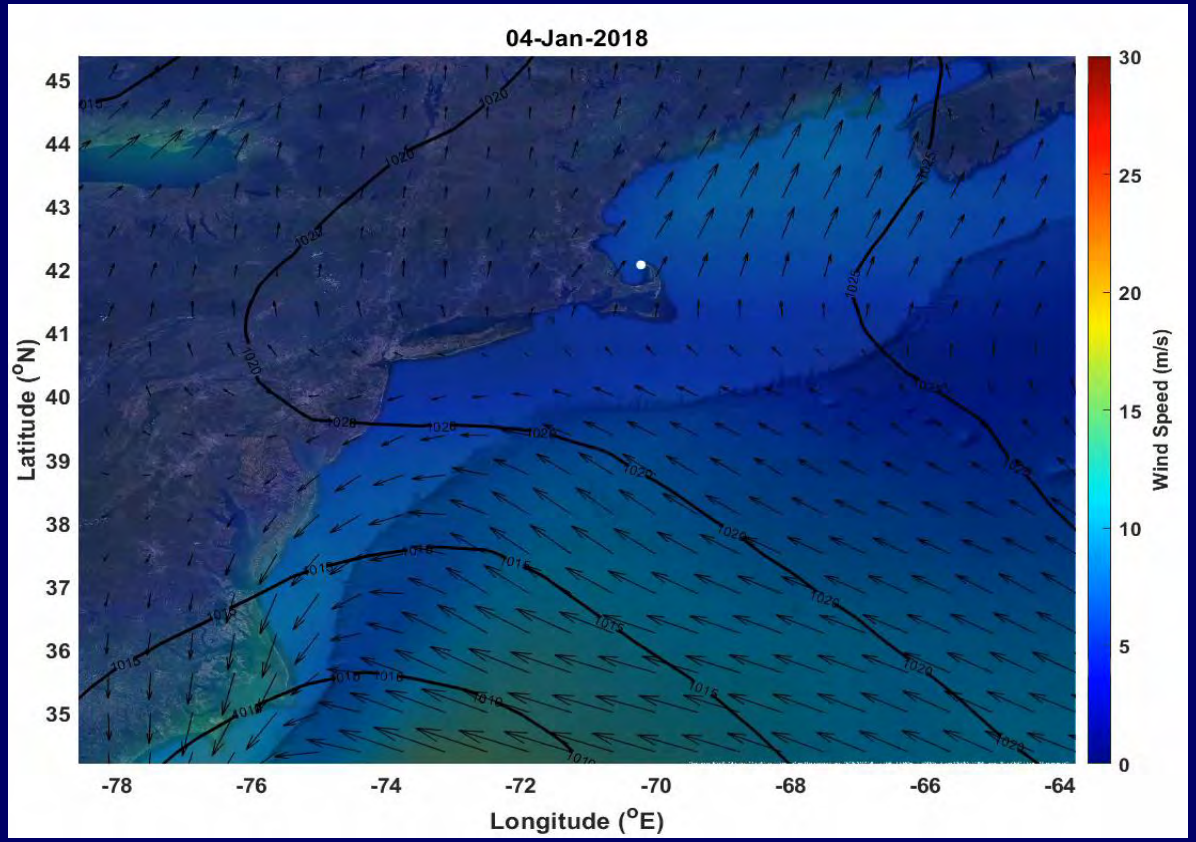
Storm Period





Simulation of January 2018 Nor'easter

- Meteorological forcing
  - ECMWF ERA-Interim
  - 0.125° resolution
  - 3-hr timestep



ACTIVITIES	Sites/ Tiers for Engagement & Research					
	CACO Tier 1	NITR Tier 1	ACAD Tier 2	BOHA Tier 3	ROWI Tier 3	NEBE Tier 3
Outreach & Engagement						
- MTAG Regional Meetings	**Y1 - Y4**					
- Kickoff workshops; site visit/scoping	**Y1**	**Y1**	**Y1**	**Y2**	**Y2**	**Y2**
- Validate models; review mgmt applications	**Y1-Y3**	**Y1-Y3**	**Y1-Y3**	**Y2-Y4**	**Y2-Y4**	**Y2-Y4**
- Transition to end-users	**Y4**					
Hydrodynamic Modeling						
- Storm surge and waves /SLR scenarios	**E, Y1, Y2**	**E, Y1, Y2**	**E, Y1, Y2**	**E, Y1, Y2**	**Y1, Y2**	**Y1, Y2**
- Mitigation scenario modeling	**Y3, Y4**	**Y3, Y4**				
Geomorphic Dynamic Modeling/Analysis						
- Long-term & event-based modeling	**Y1-Y4**	**E, Y1-Y4**				
- Mitigation scenario modeling	**Y3, Y4**	**E, Y3-Y4**				
- Geodata analysis barrier & estuarine	**E, Y1-Y4**	**E, Y1-Y4**				
- Focused field study barrier & estuarine	**E, Y1-Y4**	**E, Y1-Y4**				
Vulnerability Assessment						
- Exposure	**E,Y1-Y4**	**E, Y1-Y4**	**E, Y1, Y2**	**E, Y1, Y2**	**Y1, Y2**	**Y1, Y2**
- Sensitivity	**Y2, Y4**	**E, Y2-Y4**				
- Adaptive Capacity	**Y3-Y4**	**E, Y3-Y4**				
Visualizations						
- Assets and inundation	**E, Y1-Y4**	**E, Y1-Y4**	**E, Y1-Y4**	**E, Y1-Y4**	**E, Y1-Y4**	**Y2-Y4**
- Landform change	**Y2-Y4**	**Y2-Y4**				
- Waves impact	**Y2-Y4**	**Y2-Y4**				
User Interface						
- Data/map portal WWW	Y1 - Y4					

	Activity	Time
Outreach & Engagement	- MTAG Regional Meetings	**Y1 - Y4**
	- Kickoff workshops; site visit/scoping	**Y1**
	- Validate models; review mgmt applications	**Y1-Y3**
	- Transition to end-users	**Y4**
Hydrodynamic Modeling	- Storm surge and waves /SLR scenarios	**E, Y1, Y2**
	- Mitigation scenario modeling	**Y3, Y4**
Geomorphic Dynamic Modeling & Analysis	- Long-term & event-based modeling	**E, Y1-Y4**
	- Mitigation scenario modeling	**E, Y3-Y4**
	- Geodata analysis barrier & estuarine	**E, Y1-Y4**
	- Focused field study barrier & estuarine	**E, Y1-Y4**
Vulnerability Assessment	- Exposure	**E, Y1-Y4**
	- Sensitivity	**E, Y2-Y4**
	- Adaptive Capacity	**E, Y3-Y4**
Visualizations	- Assets and inundation	**E, Y1-Y4**
	- Landform change	**Y2-Y4**
	- Waves impact	
User Interface	- Data/map portal WWW	**Y1-Y4**

Role of the

- Conduit to the larger community of s
- Share issues and concerns, ensure th
  discuss appropriate management op
- Identify common areas of concern
- Provide a forum to discuss options, a