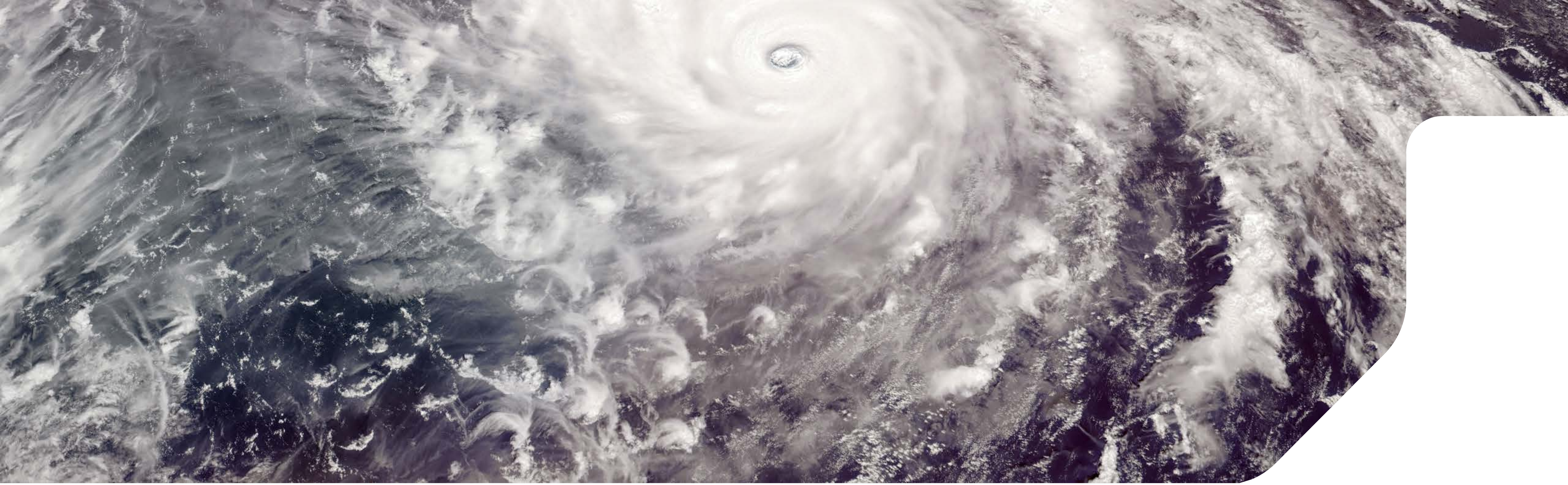


NORTH ATLANTIC COAST COMPREHENSIVE STUDY OVERVIEW - SESSION 1

INFORMING COASTAL DECISIONS IN THE NORTHEAST

Jamie Carter, NOAA

Dr. Tayebeh TajalliBakhsh, RPS

Oct. 2020

rpsgroup.com

MAKING COMPLEX EASY

NOAA Office for Coastal Management

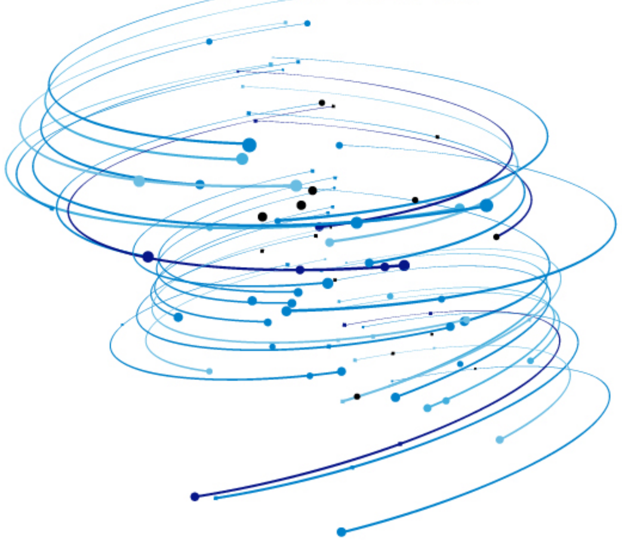
Federal lead for national coastal management efforts (CZMA)

Primary programs:

- Digital Coast
- National Coastal Zone Management Program
- National Estuarine Research Reserves
- Coral Reef Conservation Program

What is at Stake? What are the Costs?

Severe Weather Events



Source: NOAA National Centers for Environmental Information

Billion Dollar Disasters

Weather Disasters	(1980-2016)	(2017-2019)	(Totals)
Drought	24	2	26
Flooding	26	6	32
Freeze	7	2	9
Severe Storm	83	30	113
Tropical Cyclone	35	9	44
Wildfire	14	3	17
Winter Storm	14	3	17
Average Cost (billions)			
Drought	$9.3	$9.6	$249.7
Flooding	$4.3	$4.6	$146.5
Freeze	$3.6	$3.4	$30.5
Severe Storm	$2.2	$2.2	$247.8
Tropical Cyclone	$16	$21.5	$945.9
Wildfire	$2.4	$5.0	$84.9
Winter Storm	$3	$2.9	$49.3

America's Coasts

40% of the population, **10%** of the land mass
$7.9 trillion in goods and services
54.6 million employed
$3.2 trillion in wages

Coastal Management

"Balancing competing demands for coastal resources. This often involves property rights, economics, safety, and natural resources."

North Atlantic Coast Comprehensive Study

The U.S. Army Corps of Engineers produced North Atlantic Coast Comprehensive Study (NACCS) in 2015 to address coastal storm and flood risk in the North Atlantic region. The study was designed to:

- Help local communities better understand changing flood risks associated with climate change
- Provide tools to prepare for future flood risks that can be customized for any coastal watershed

The Northeast Regional Ocean Council (NROC) worked with RPS to extract key model data and statistics and develop tools and services to easily work with these data.

www.northeastoceancouncil.org/naccs

What to Expect

Session 1 - NACCS overview: Informing coastal decisions in the Northeast

- A high-level overview of the NACCS and how it can be applied to coastal management in the Northeast and Mid-Atlantic.

Session 2 - NACCS technical session: Understanding what’s under the hood

- Building on *Session 1- NACCS overview* offered on Oct. 21st, this more in-depth session will explore the technical components of NACCS.
- When? Session 2 will be offered twice to provide flexibility in scheduling:
  - October 27, 2020, Tuesday | 10am - 11:30am Eastern Time
  - October 29, 2020, Thursday | 10am - 11:30am Eastern Time

Outline

- Introduction
- Coastal flooding assessment and management
- Publicly available modeled datasets, useful for coastal planning

    -North Atlantic Coast Comprehensive Study (NACCS)

    -FIRM

    - Some regional and basin-wide models
- Example of NACCS uses

    - Dynamic modeling: Nonlinear interaction of tide, SLR and Storm Surge

Introduction

- Our story
- The goals of this session
    - A high-level overview of the NACCS (goals, approach, outputs, access points) to the coastal management professionals in the Northeast and Mid-Atlantic to inform their work.
    - Other datasets used for planning (<u>cannot</u> be compared or replaced by each other) and their strengths and limitations.
    - How NACCS can be used and applied locally

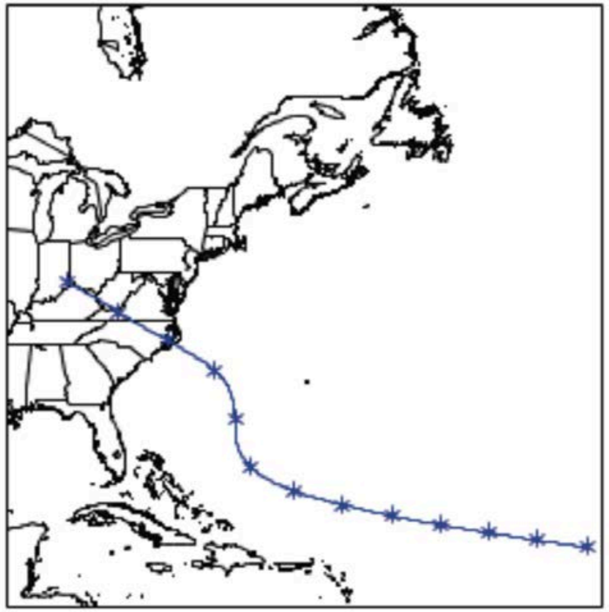
Coastal Flooding; Flood Risk Management

- Inundation of a coastal environment caused by a short-term increase in water level due to:
  - Storm surge
  - Extreme tides
  - Tsunamis
- Storm surge: The magnitude and extension depend on the coastal topography and broader bathymetry of the coastal area.
- Understanding the flood hazard:
  - Site specific flood elevations and its probability.
  - Assessment of the possible damages/cost of the flood

to support planning efforts and mitigating the risks.

Coastal Flood Assessment

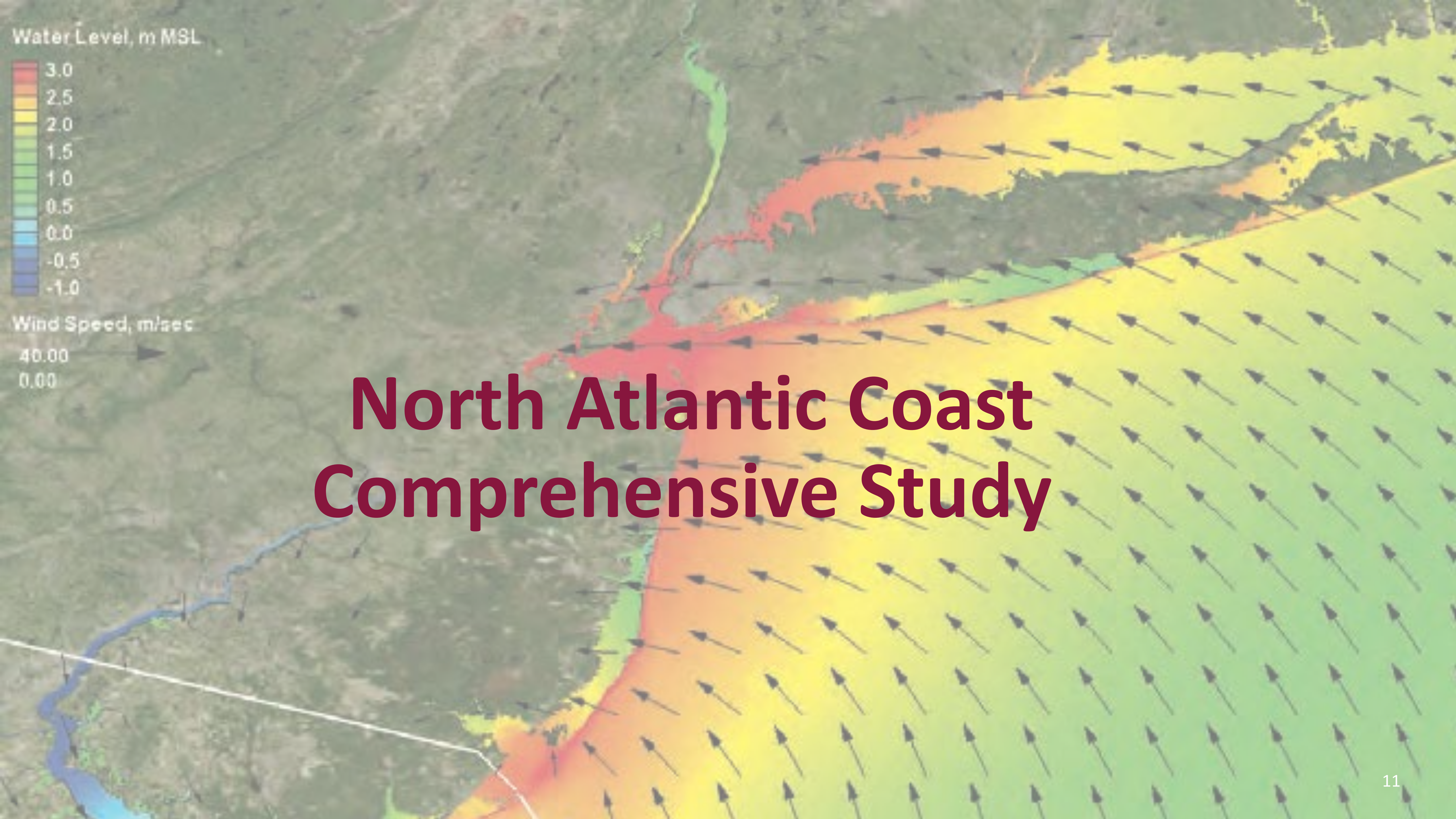
- **Probability-Based**
  - Based on a statistical combination of different storm scenarios
  - Floodplain management, permitting, construction standards, hazard mitigation planning and projects.
- **Event-Based**
  - Historic event
  - Advisory, public outreach/education purposes.
- **Scenario-Based**
  - Hypothetical event or composite of events
  - Used operationally to develop evacuation zones.



Studies and Datasets

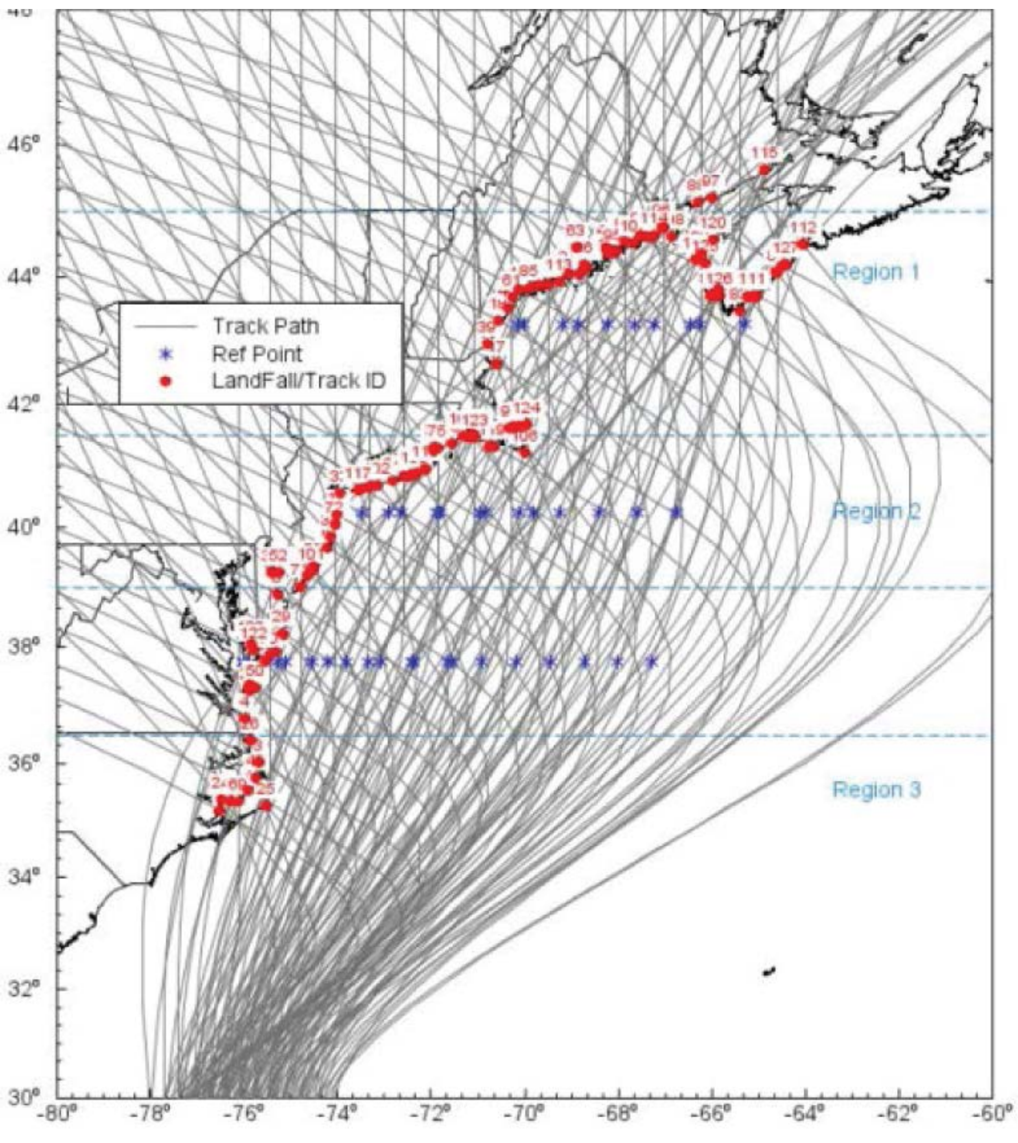
- Federal:
  - USACE NACCS
  - FEMA FIRM
- Non-profit:
  - First Street Foundation
- Some Regional/States:
  - Maine: Ransom
  - Massachusetts : WHG
  - Rhode Island: URI StormTools

North Atlantic Coast Comprehensive Study



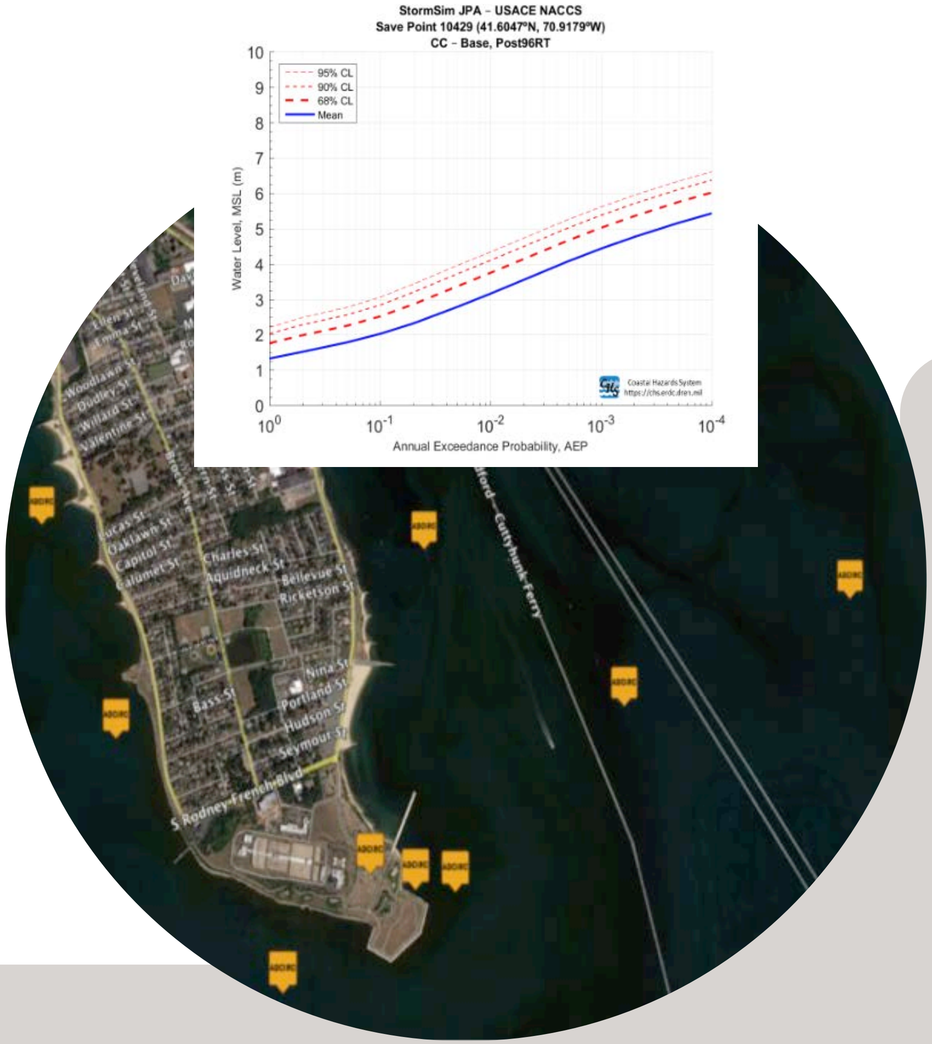
NACCS

- North Atlantic Coast Comprehensive Study (NACCS) , a two-year study by the USACE
- Included atmospheric, wave and storm surge modeling for the North Atlantic region, including coastal areas of all NROC member states.
- To provide critical information for effective flood risk management project planning, design, and performance evaluation, providing the joint probability of coastal storm environmental forcing parameters.
- To provide tools to better prepare for future flood risks.



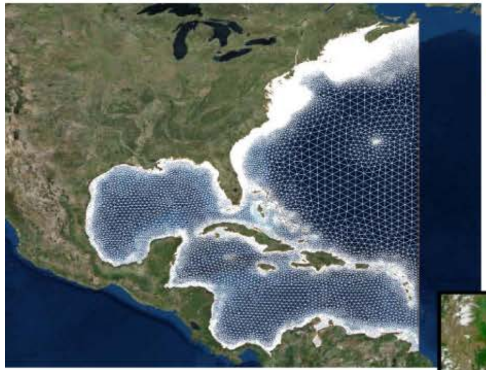
Goals of NACCS Modeling Effort

- Compute the joint probability of coastal storm forcing parameters for the North Atlantic Coast
- Simulate storm winds, waves, and water levels along the coast for both tropical and extratropical storms.
- To support coastal resilience initiatives by providing actionable information critical for effective flood risk management project planning, design, and performance evaluation to the planning and management communities.



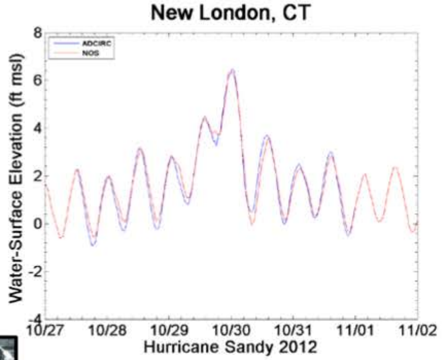
NACCS

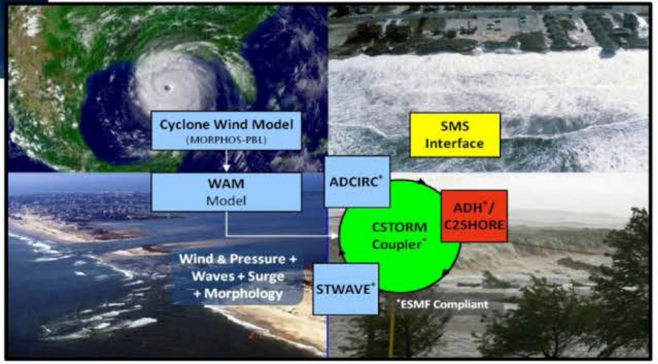
ADCIRC



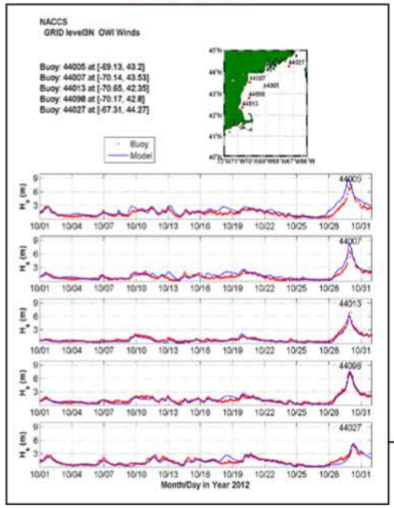
CSTORM-MS

High Fidelity Modeling





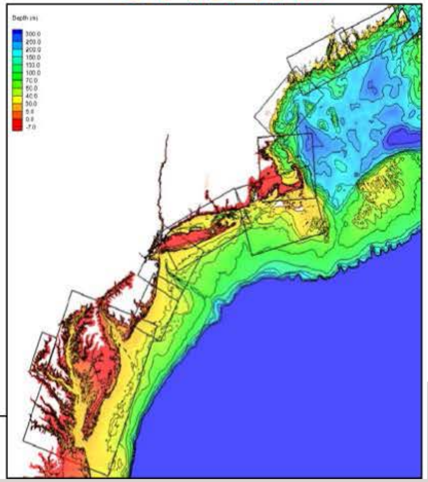
WAM

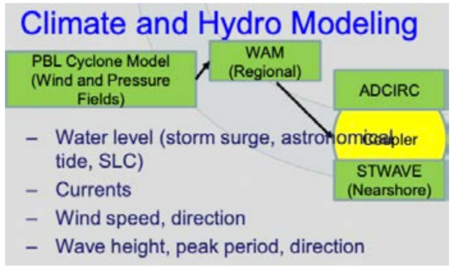


CSTORM-MS: Coastal STORM Modeling System

WAM: WAve Prediction Model
STWAVE: STeady-State Spectral WAVE model
ADCIRC: ADvance CIRCulation Model

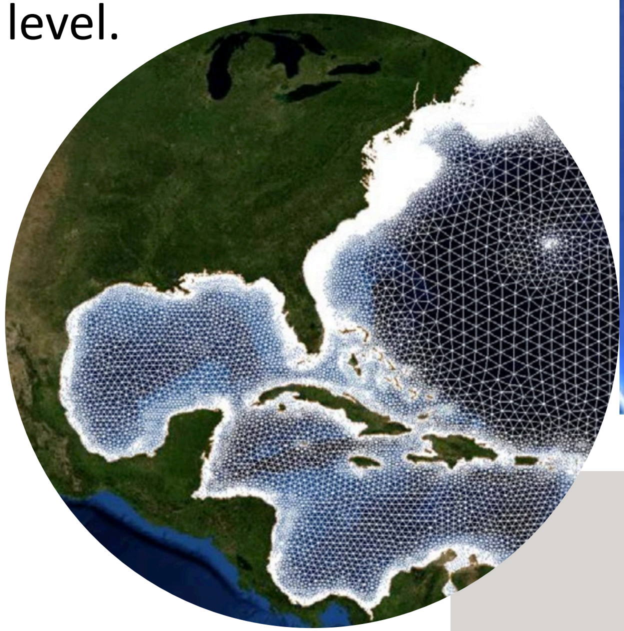
STWAVE

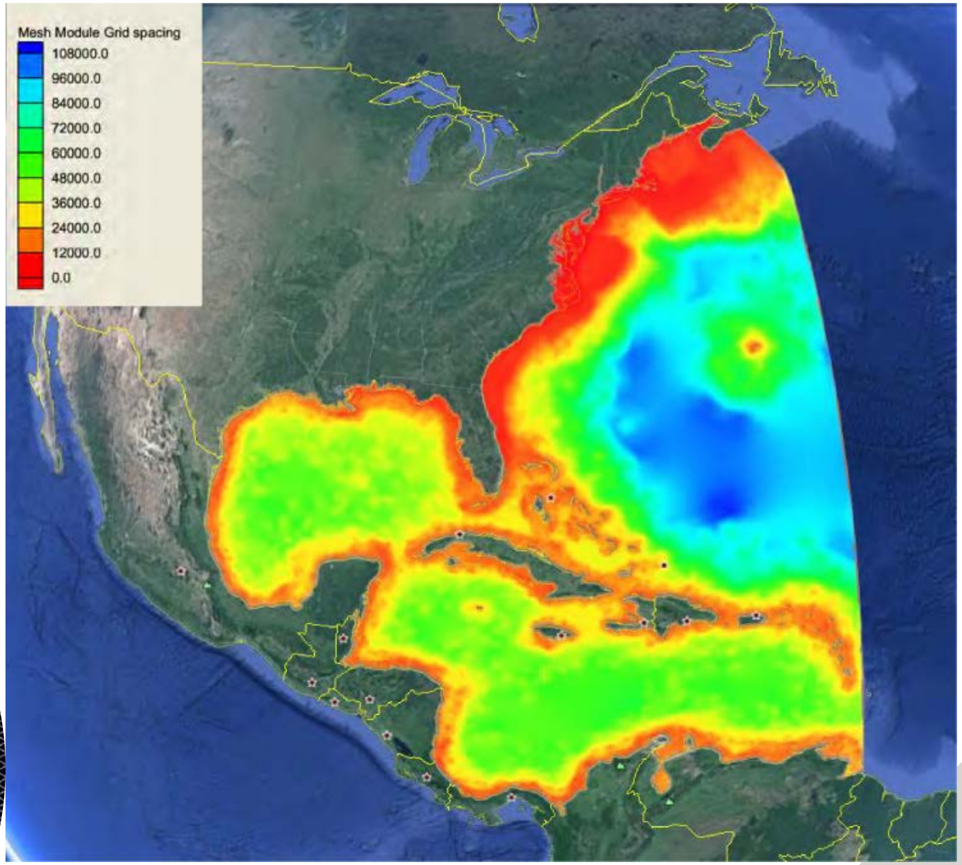




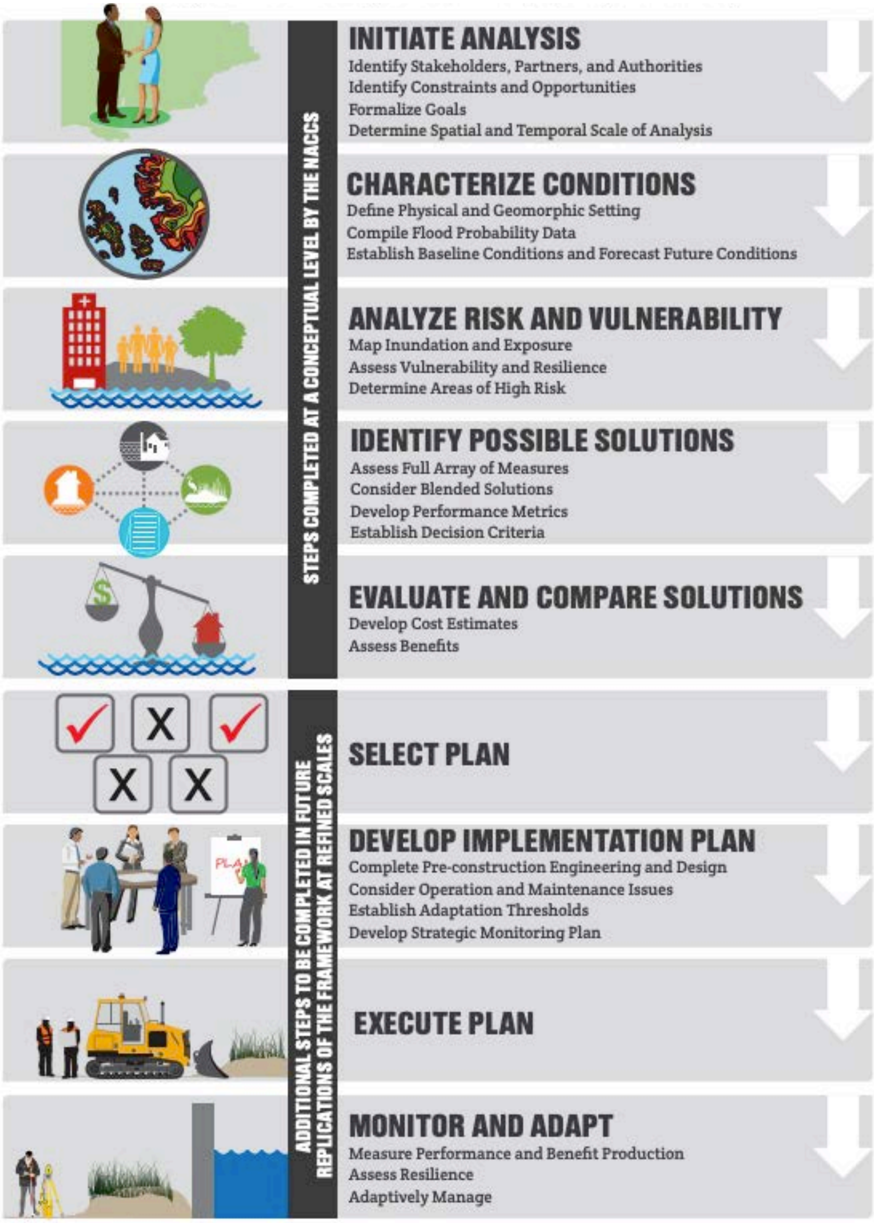
NACCS

- The result of this effort is a catalog of storm surge, wave heights, and extremal statistics derived from each model run and stored at high resolution stations along the coast.
- The database offers a new opportunity to extend high fidelity model data to studies at the regional and local level.



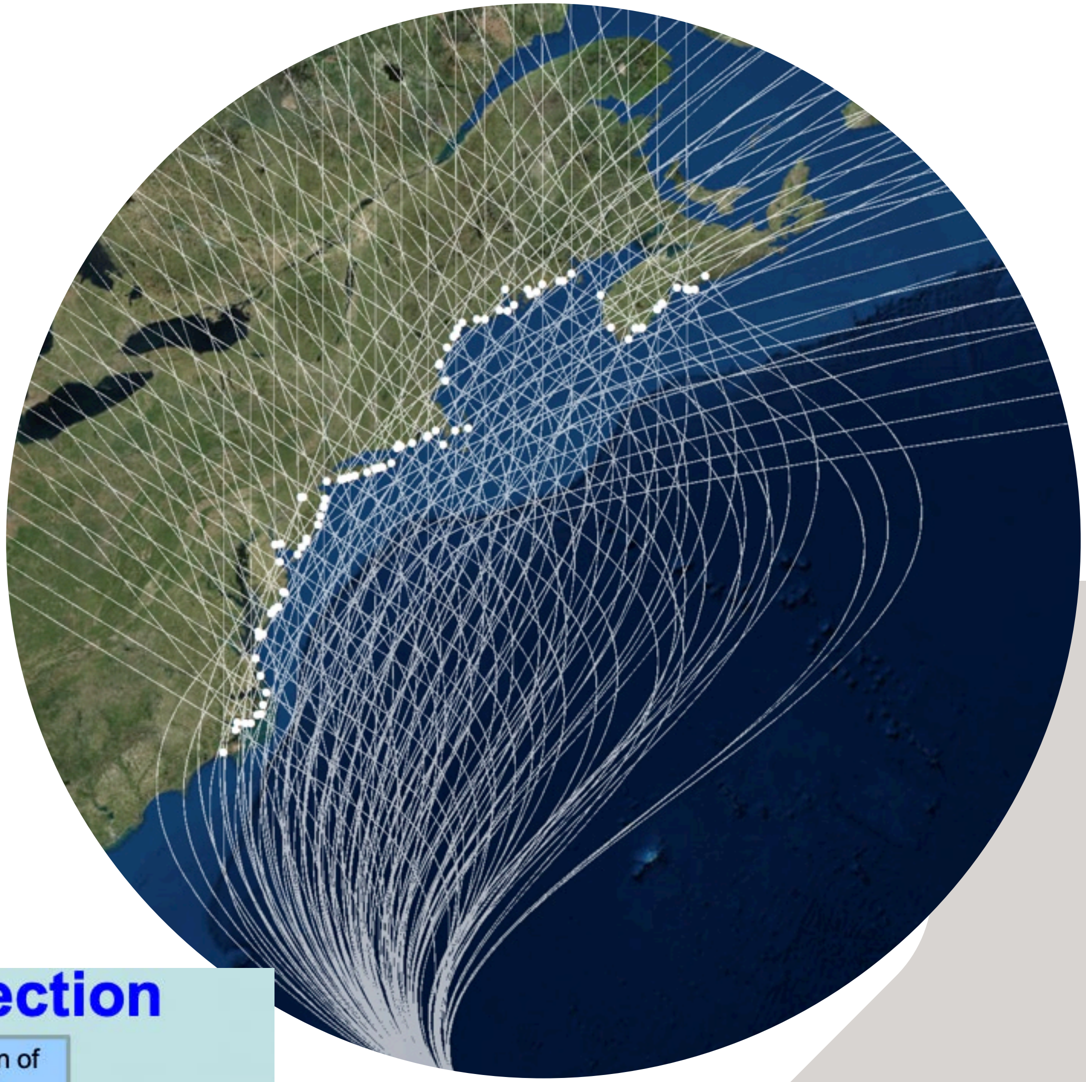


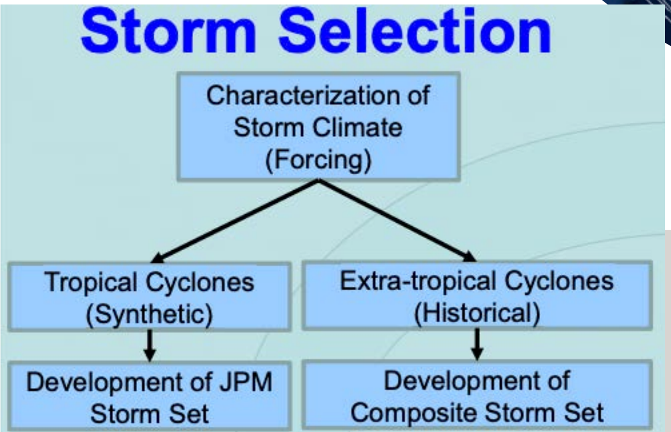
NACCS Coastal Storm Risk Management Framework



NACCS

- The storm set included:
  - 1050 synthetic tropical storms, joint probability method with optimized sampling
  - 100 historical extratropical storms strategically selected to characterize the regional storm hazard, peaks-over-threshold (POT)
- Extremal analysis techniques were applied to develop statistical wave and water level information (i.e. return periods) for the study area.





NACCS Outputs

- Compute probabilities of coastal storm parameters

Output

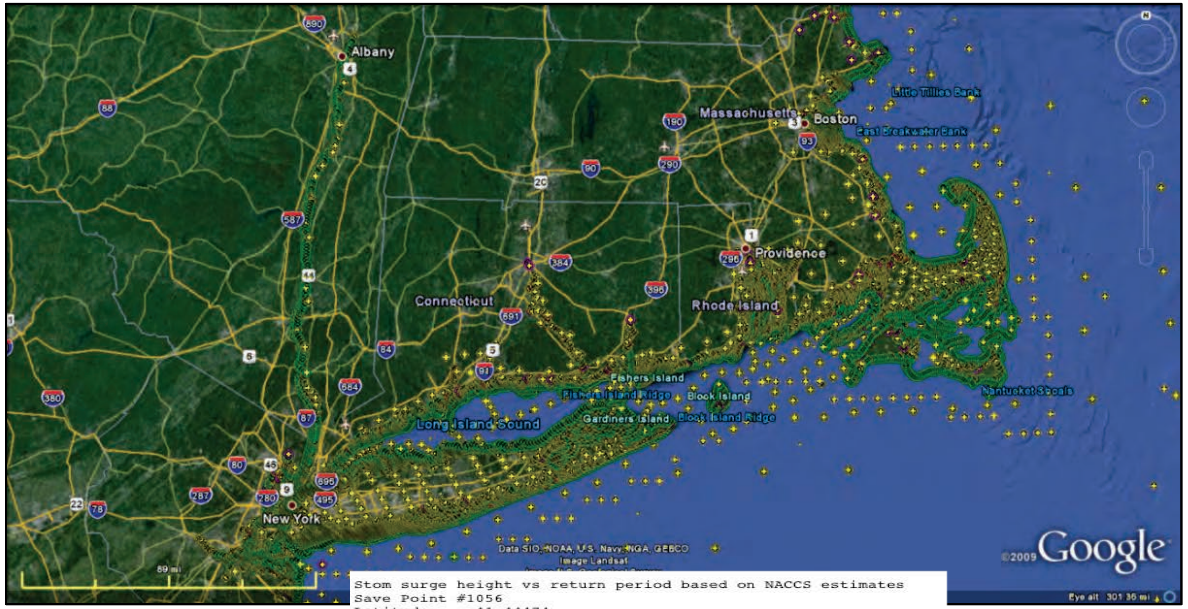
- Data at Save Points (not full grid)
- 1-10,000 year return periods:

ADCIRC model save points

- Storm recurrence rates
- Peak water levels from
  - 1050 Tropical Cyclone simulations (synthetic)
  - 100 Extra Tropical simulations (historical)
- Water level return periods with associated confidence intervals

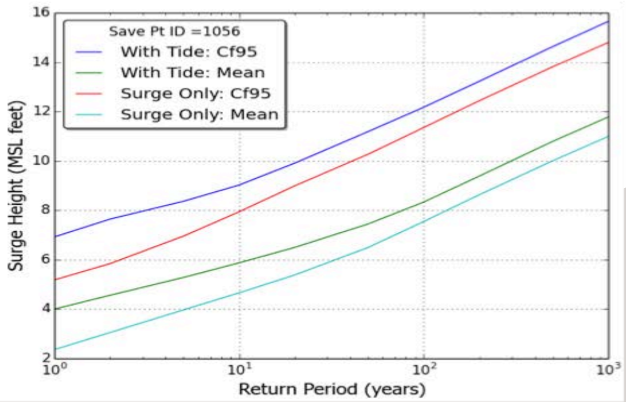
STWAVE model save points

- Peak wave heights from STWAVE

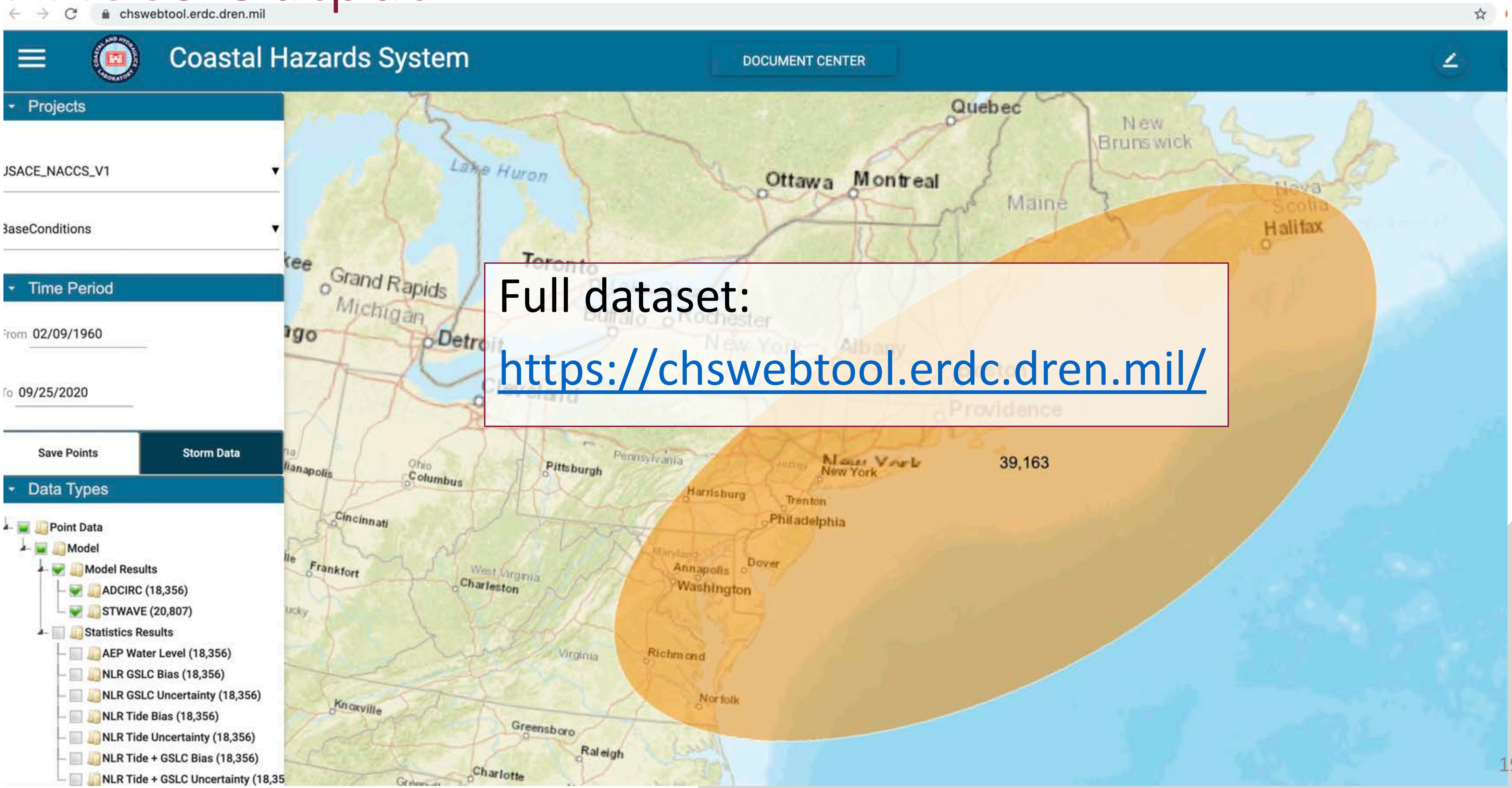


Stom surge height vs return period based on NACCS estimates
Save Point #1056
Latitude 41.44474
Longitude -71.34537

Return Period (yrs)	Surge Only Mean (m)	Surge Only Mean (ft)	Surge Only Upper 95% Confidence (m)	Surge Only Upper 95% Confidence (ft)	With Tide Mean (m)	With Tide Mean (ft)	With Tide Upper 95% Confidence (m)	With Tide Upper 95% Confidence (ft)
1	0.72	2.4	1.58	5.2	1.22	4.0	2.11	6.9
2	0.93	3.1	1.78	5.8	1.39	4.6	2.33	7.6
5	1.21	4.0	2.12	7.0	1.61	5.3	2.55	8.4
10	1.42	4.7	2.42	7.9	1.79	5.9	2.75	9.0
20	1.64	5.4	2.74	9.0	1.98	6.5	3.02	9.9
50	1.98	6.5	3.13	10.3	2.27	7.4	3.41	11.2
100	2.30	7.5	3.46	11.4	2.54	8.3	3.71	12.2
200	2.63	8.6	3.79	12.4	2.86	9.4	4.03	13.2
500	3.05	10.0	4.21	13.8	3.29	10.8	4.46	14.6
1000	3.35	11.0	4.51	14.8	3.59	11.8	4.77	15.6
2000	3.63	11.9	4.79	15.7	3.89	12.8	5.06	16.6
5000	3.96	13.0	5.12	16.8	4.24	13.9	5.42	17.8
10000	4.19	13.7	5.35	17.6	4.49	14.7	5.66	18.6

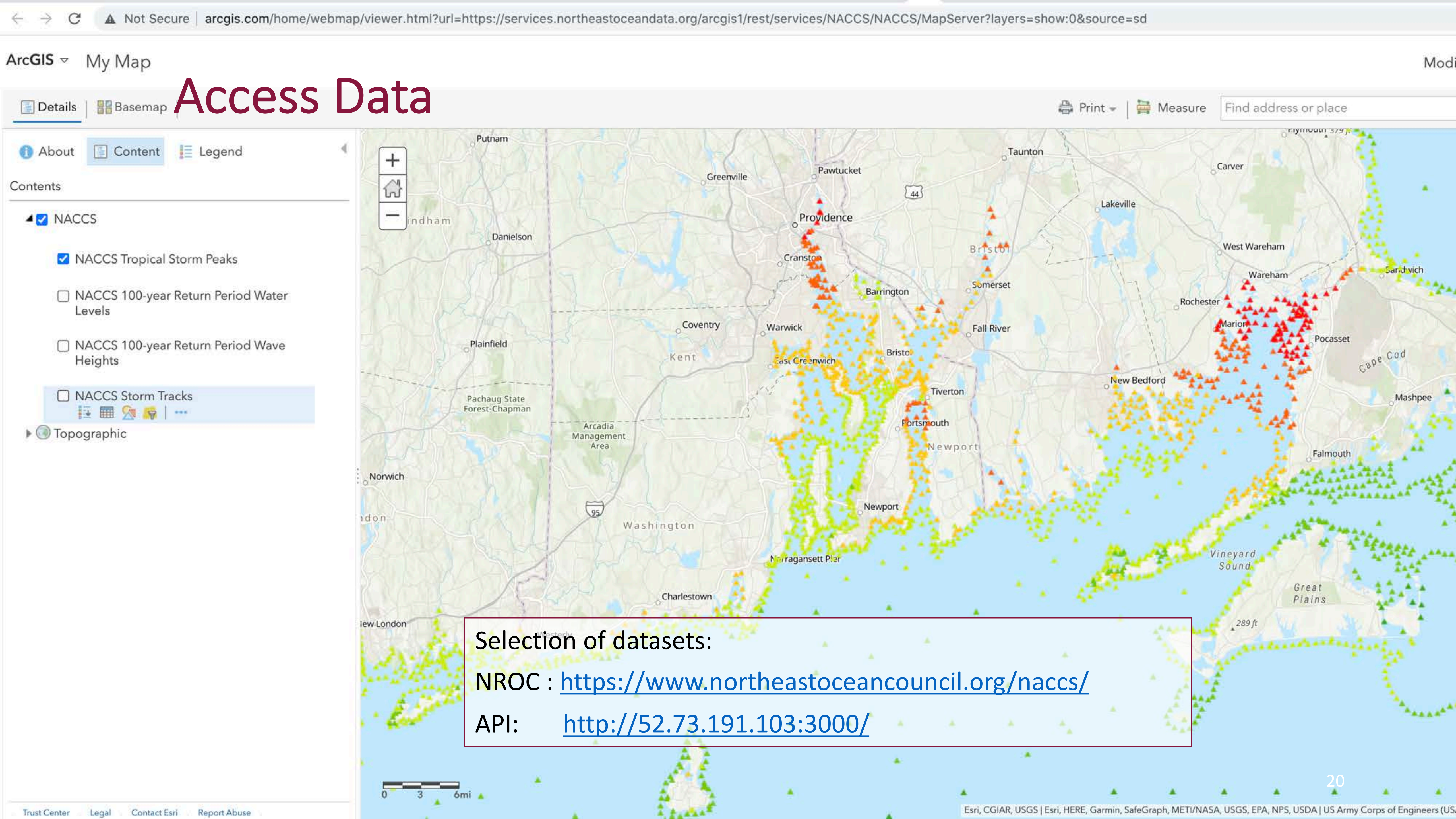


NACCS Output



Full dataset:
https://chswebtool.erdc.dren.mil/

Access Data

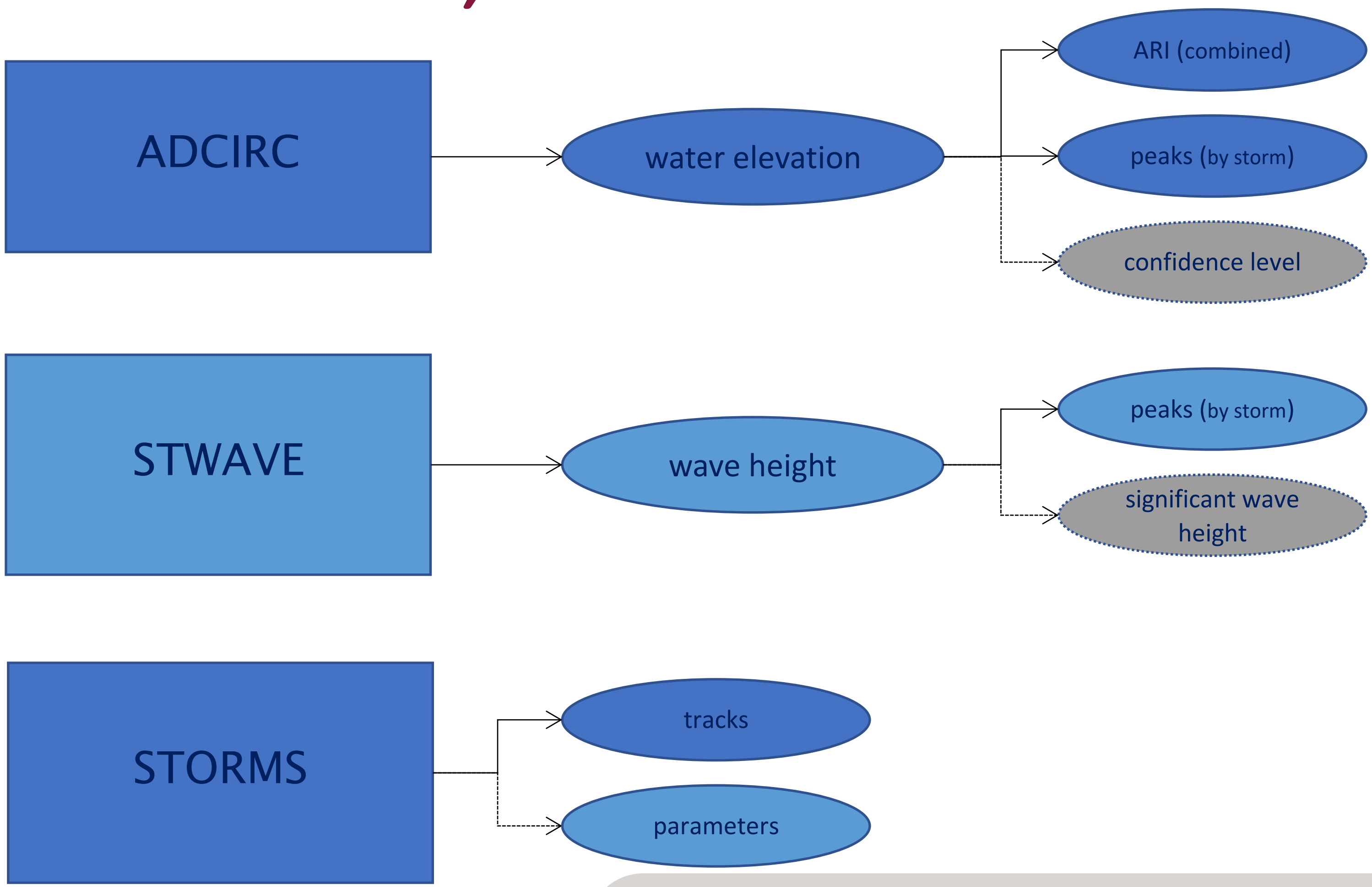


Selection of datasets:

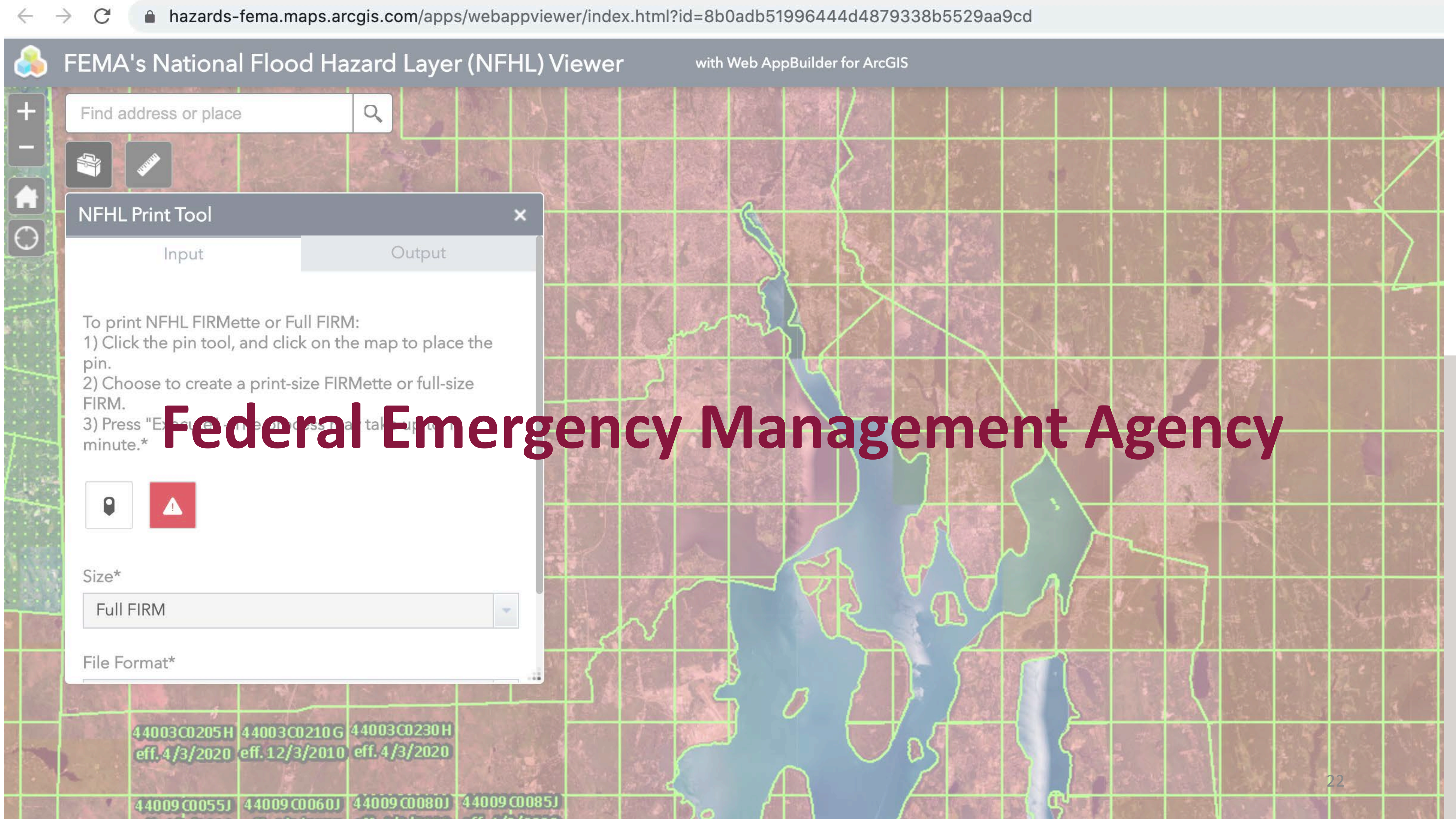
NROC : https://www.northeastoceancouncil.org/naccs/

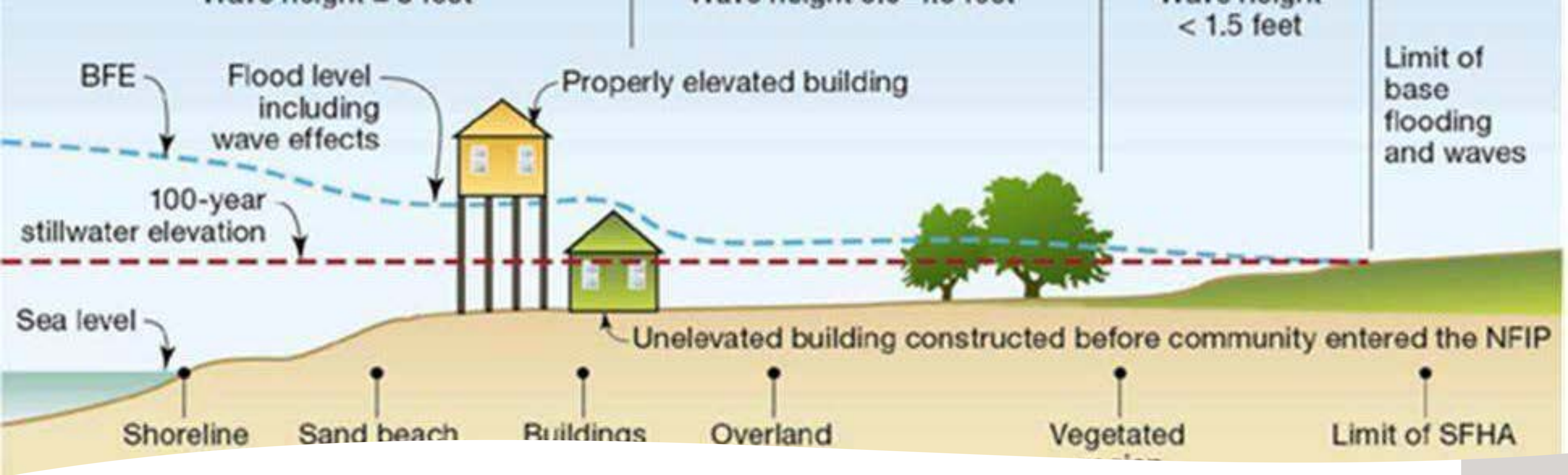
API: http://52.73.191.103:3000/

Database Contents, NROC



Federal Emergency Management Agency





FEMA

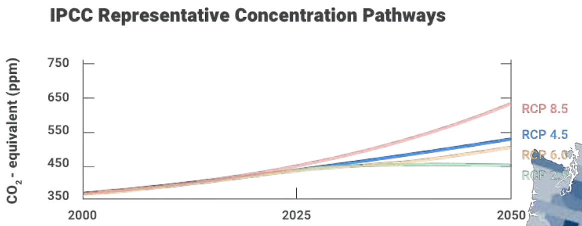
- Flood Insurance Rate Maps (FIRM).
- BFE: Base flood level associated with a single likelihood of occurrence of 100-year flood
- Also shows insurance zone designations, and floodplain boundaries.
- Useful for risk assessments that do not need to consider increasing risk due to climate change or sea level rise.
- Used in design and construction of new buildings, the improvement and repair of existing buildings, and additions to existing buildings.

FEMA

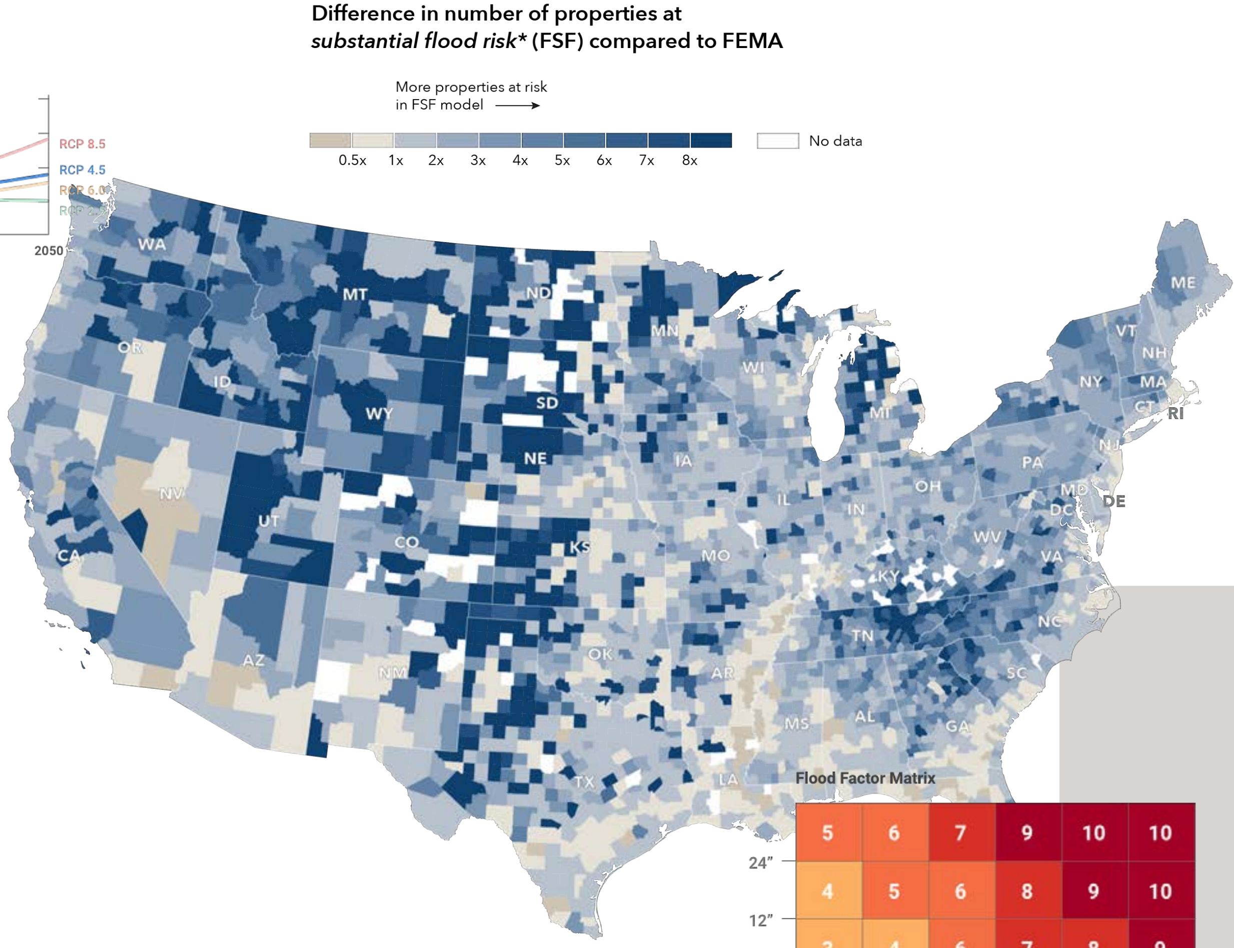
Readily available, baseline information for estimating risk, but FIRMs **<u>do not account</u>** for the following:

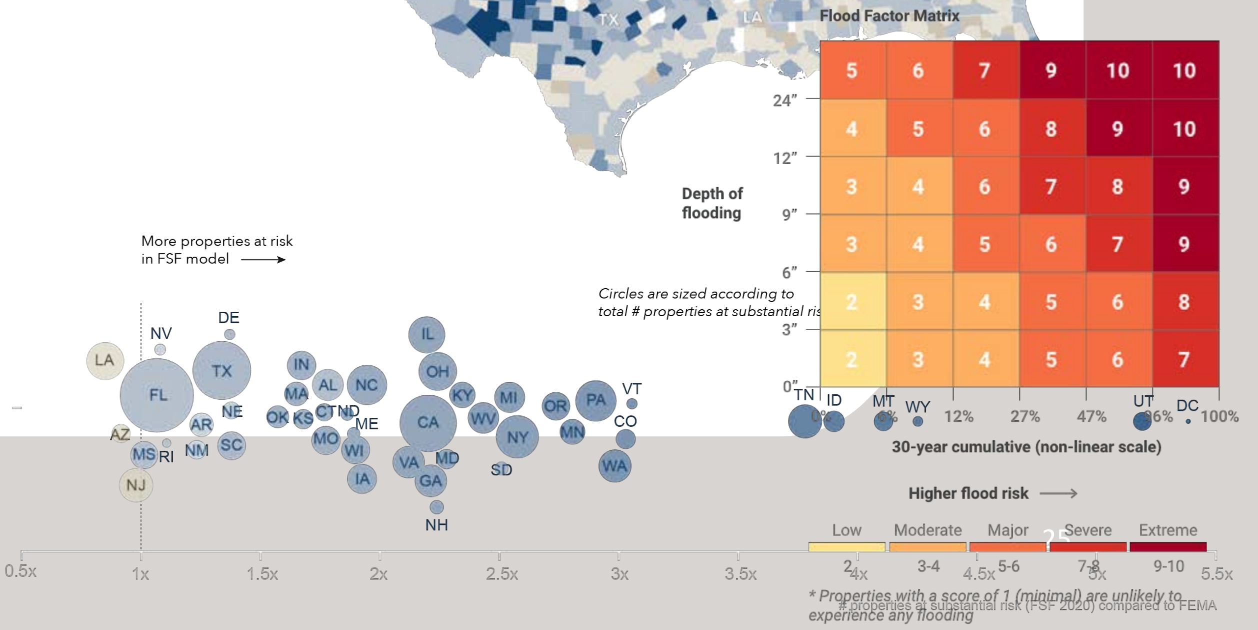
- Shoreline erosion, wetland loss, subsidence, and relative sea level rise
- Not showing worst-case scenarios: only the 100-year storm.
- Some engineering studies are decades old.
- Total Water Level as linear combination of the Still Water Level (SWL) and, the wave setup.
- Over/underestimation: Some coarse-scale studies interpolated or transect calculations for wave runup, and overtopping
- Missing changes in storm climatology (frequency and severity)

US : FSF



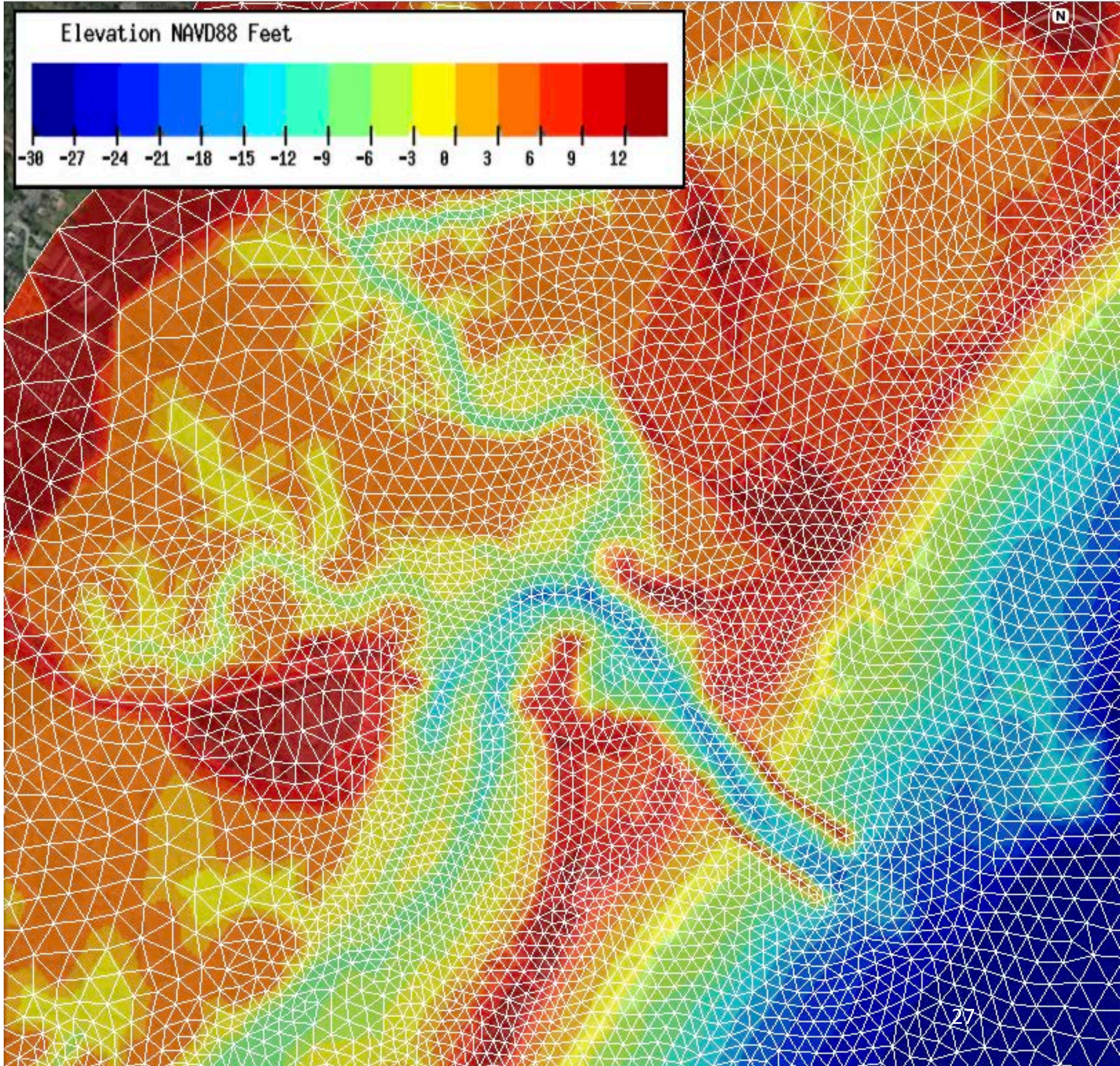
- First Street Foundation(FSF), a nonprofit research and technology group, https://firststreet.org/
- realtor.com® included [Flood Factor]™
- A Flood Factor™, a risk score ranging from 1 to 10, which reflects a property's risk of flooding over the course of a 30 year mortgage.
- Calculates the probabilistic future risk of flooding by incorporating the output of an ensemble 21 Global Climate Models (GCM) ; 0.2%, 1%, 10%, 20%, 50% "hazard layers"
- Most appropriately used for informational or awareness purposes
- Should not be used as the sole source for specific risk management decisions at the parcel level.





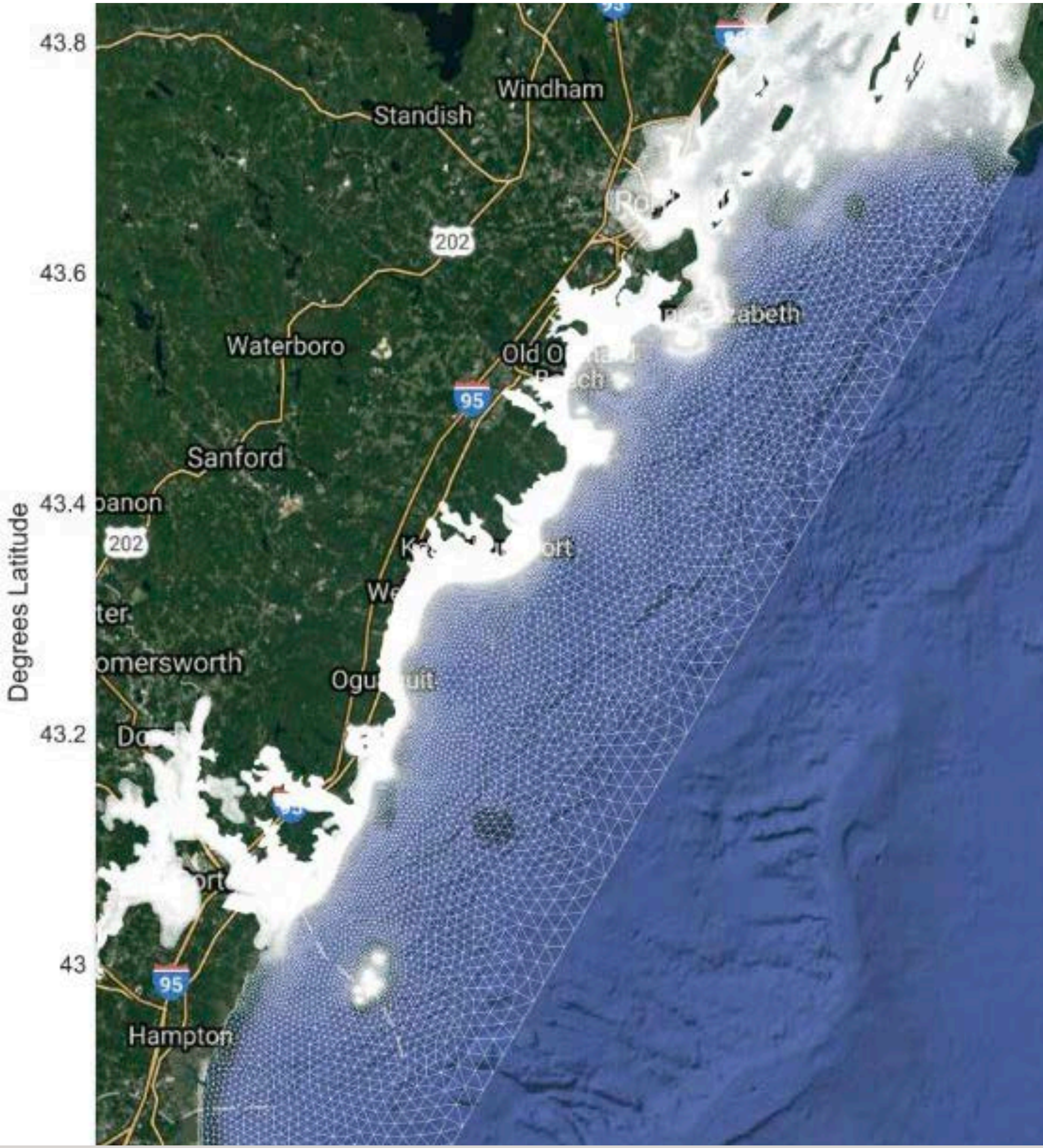
Examples of Regional Datasets

Maine



Maine, Ransom

- Extreme Storm Coastal Hydrology & Numerica Modeling, **York and Cumberland Counties, Maine.**
- Can be used in site-specific analyses to evaluate overland flooding, wave run-up and overtopping, and erosion hazards,
- Provides estimates of the water levels and associated wave conditions over a range of possible flood events from 10-year flood to 500-year flood.



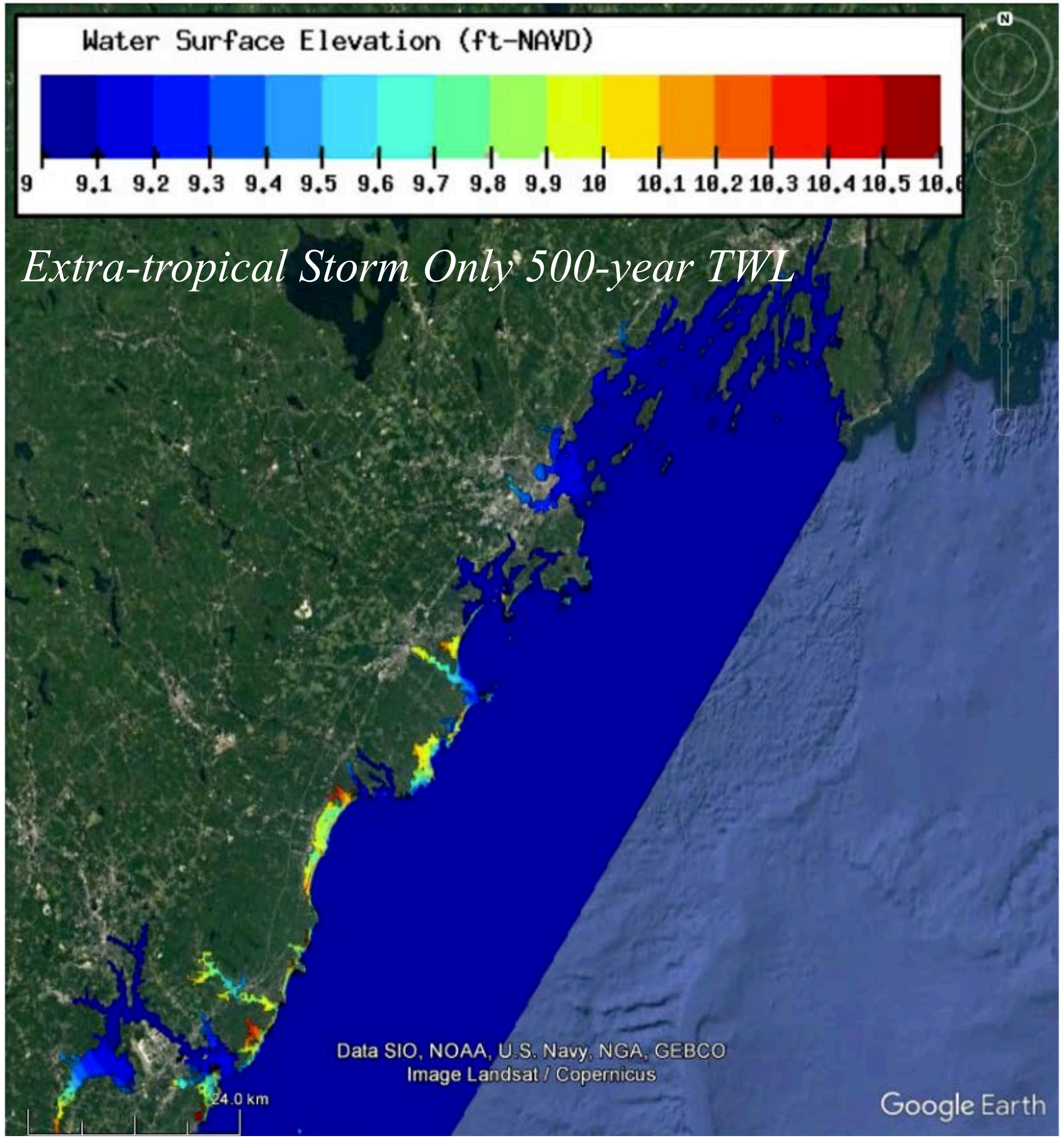
Maine, Ransom

- Storms producing a peak water level greater than the 50-year return period water level at save points.
- Using the same numerical modeling(ADCIRC+SWAN) and statistical analysis methods as NACCS and FEMA guidelines and specifications

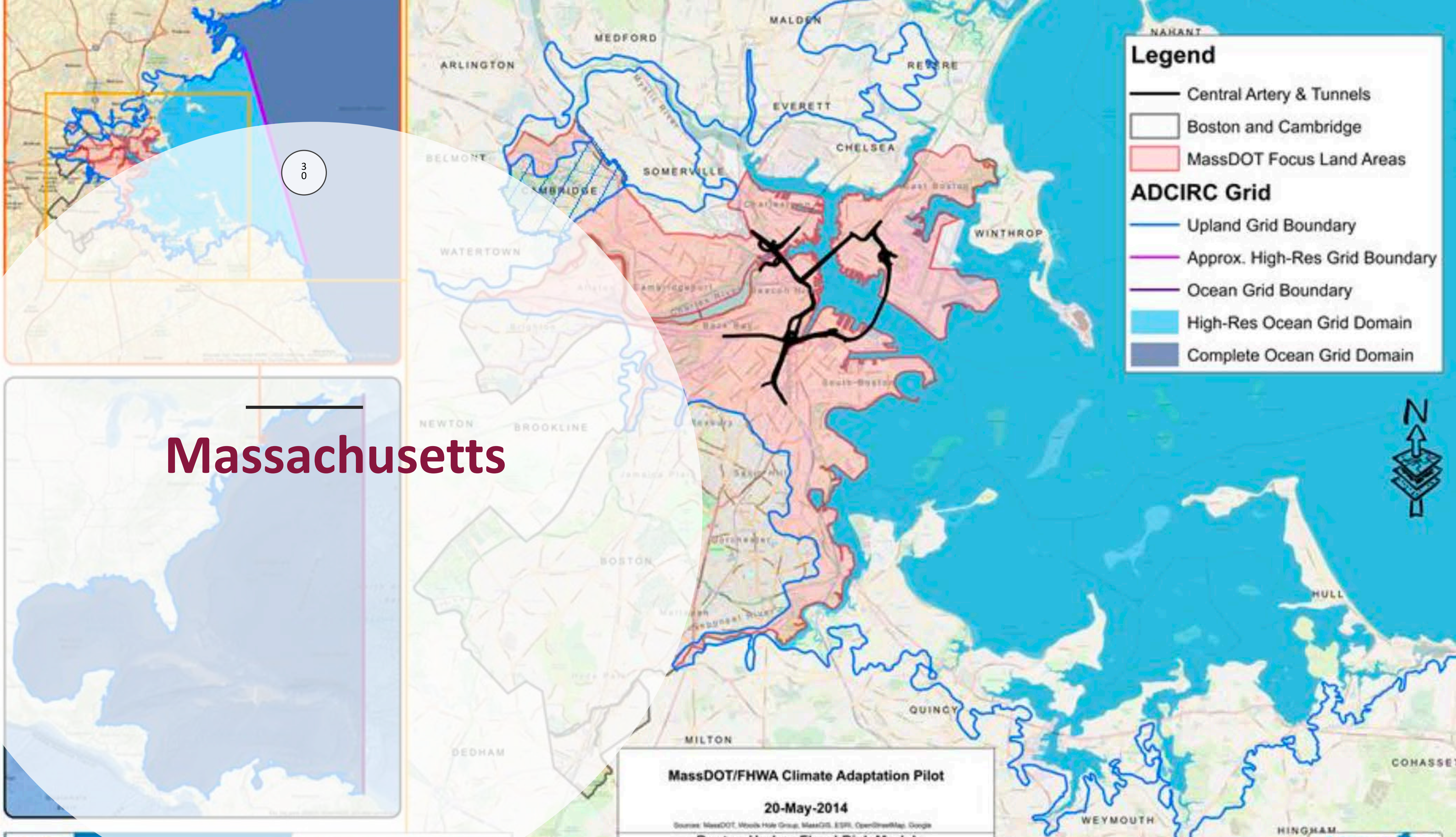
Limits:

- Considers the Total stillWater Level (TWL) and incident wave conditions that are needed to compute the coastal BFE, but it does not provide the BFE.
- Does not provide inland hydrologic information related to precipitation, rainfall runoff, or stream discharge; effect of climate change

https://ransomenv.sharefile.com/d-s477b8ab8aba4599a



Massachusetts



MCFRM, WHG

Massachusetts Coast Flood Risk Model (MCFRM)

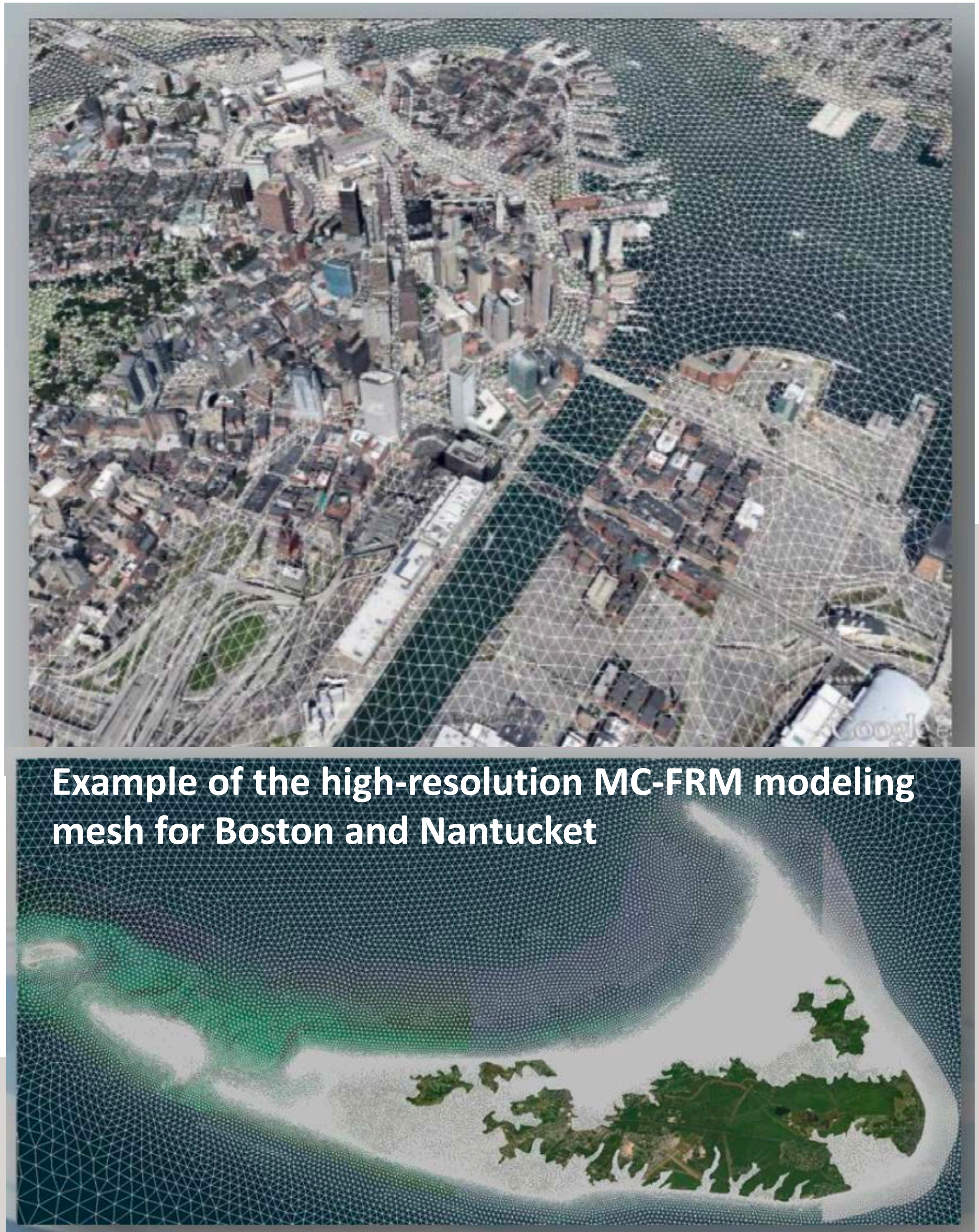
(1) dynamic model including (winds, waves, wave-setup, storm surge, wave run-up and overtopping,...)

(2) calibrated to historical storm events that impacted MA

(3) high resolution (flood pathways, complex topographies)

(4) includes effect of climate changes on hurricanes and nor'easters

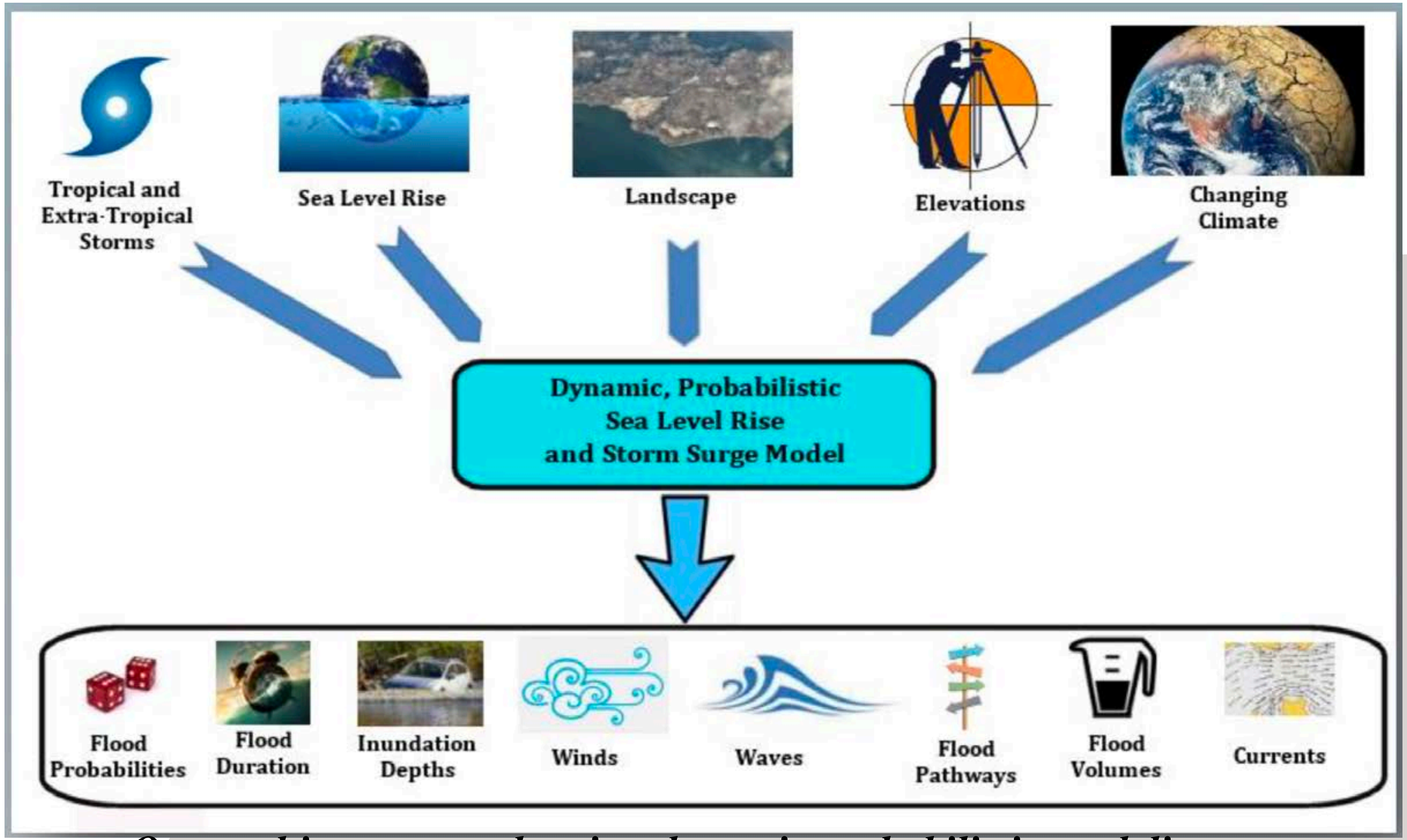
(5) captures effect of varying storm types, magnitudes, and frequencies.



Example of the high-resolution MC-FRM modeling mesh for Boston and Nantucket

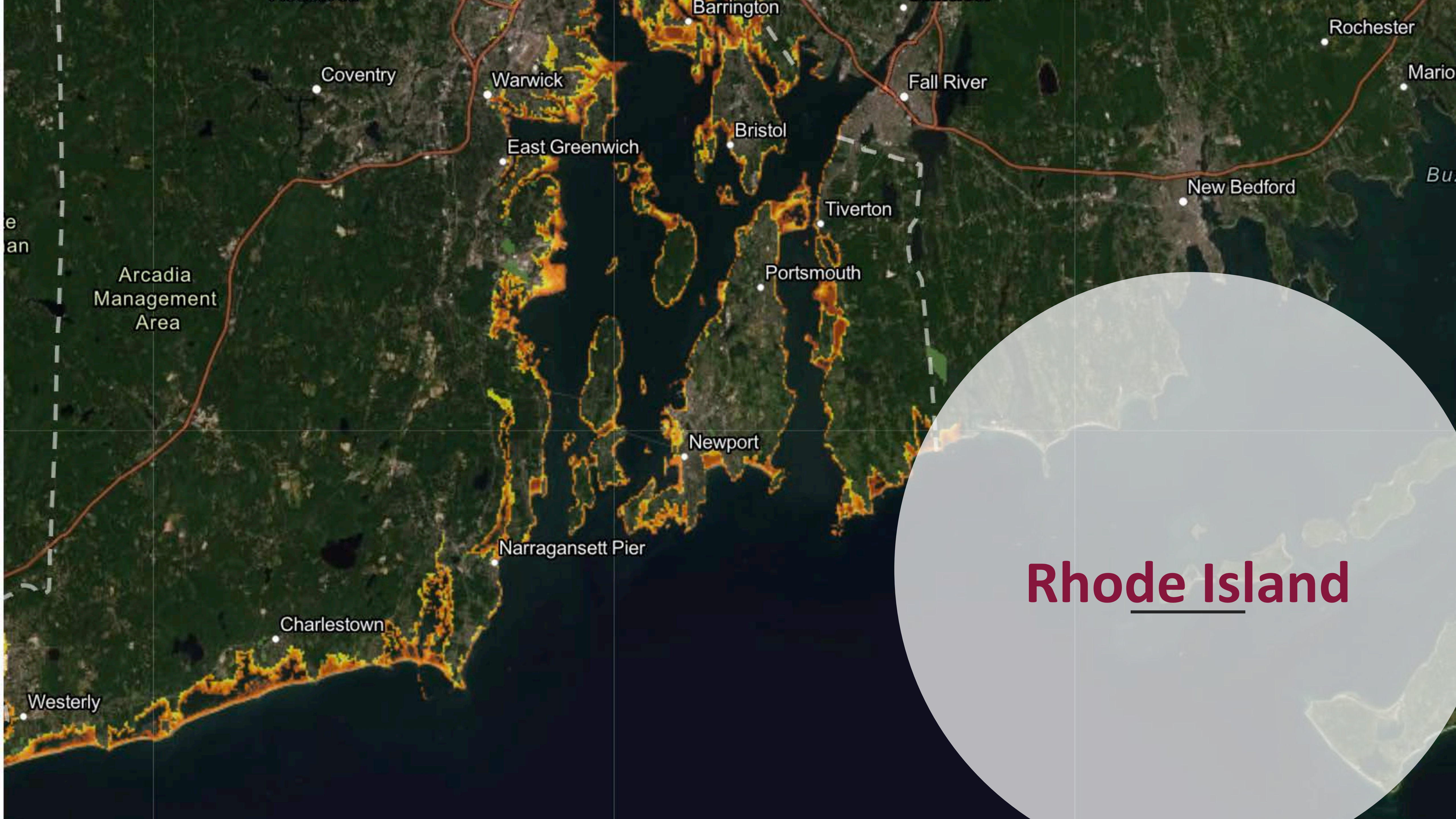
MCFRM: WHG

- Dynamically simulates hundreds to thousands of storms.
- Scenarios being simulated in the MC-FRM include present day, 2030, 2050, 2070, and 2100 climate conditions.
- The depth of flooding associated with the 100-year, 200-year, 1000- year annual exceedance probability levels.



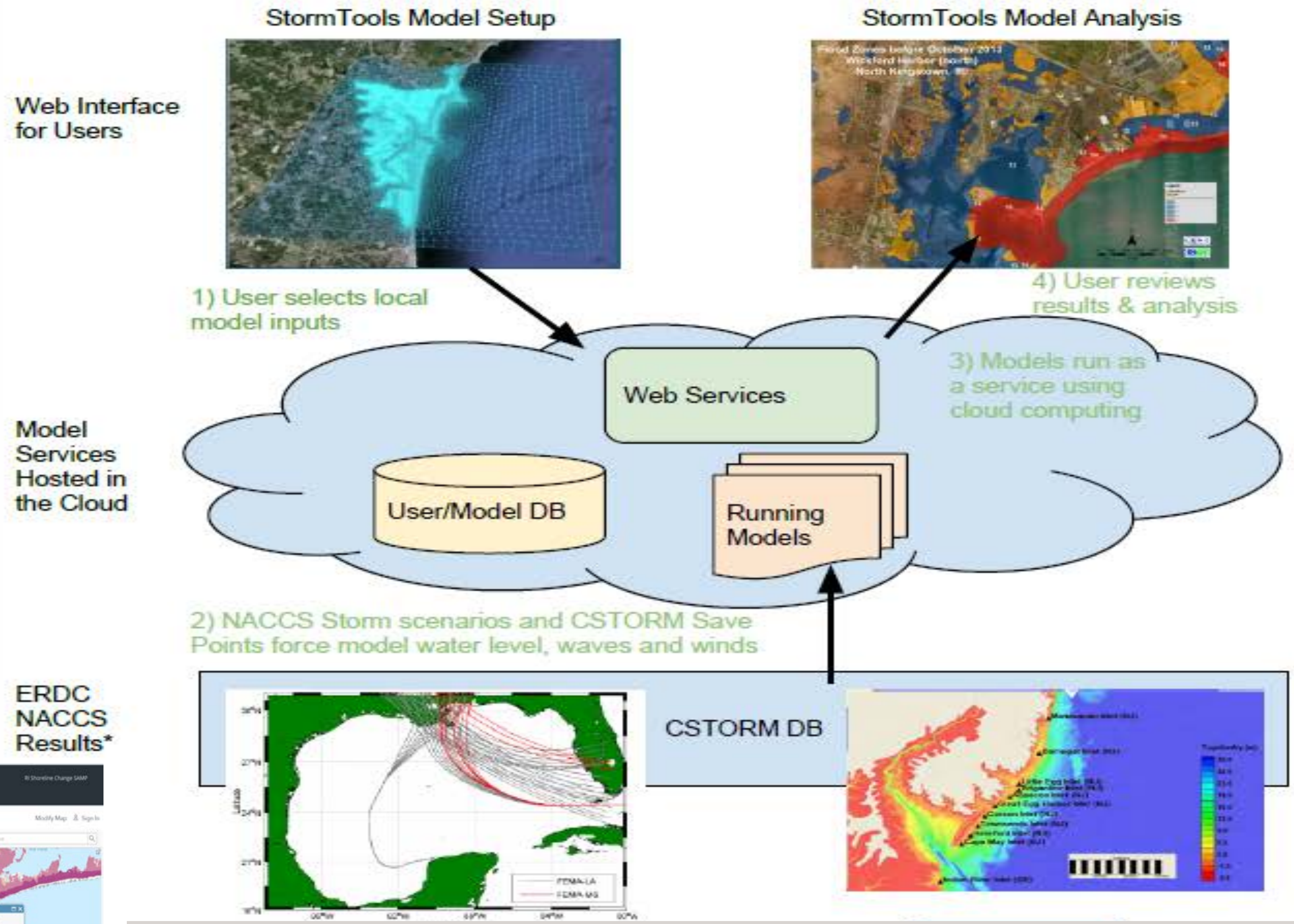
Overarching approach using dynamic probabilistic modeling.

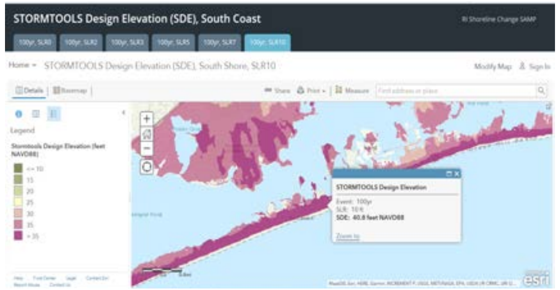
Rhode Island



StormTools RI, URI

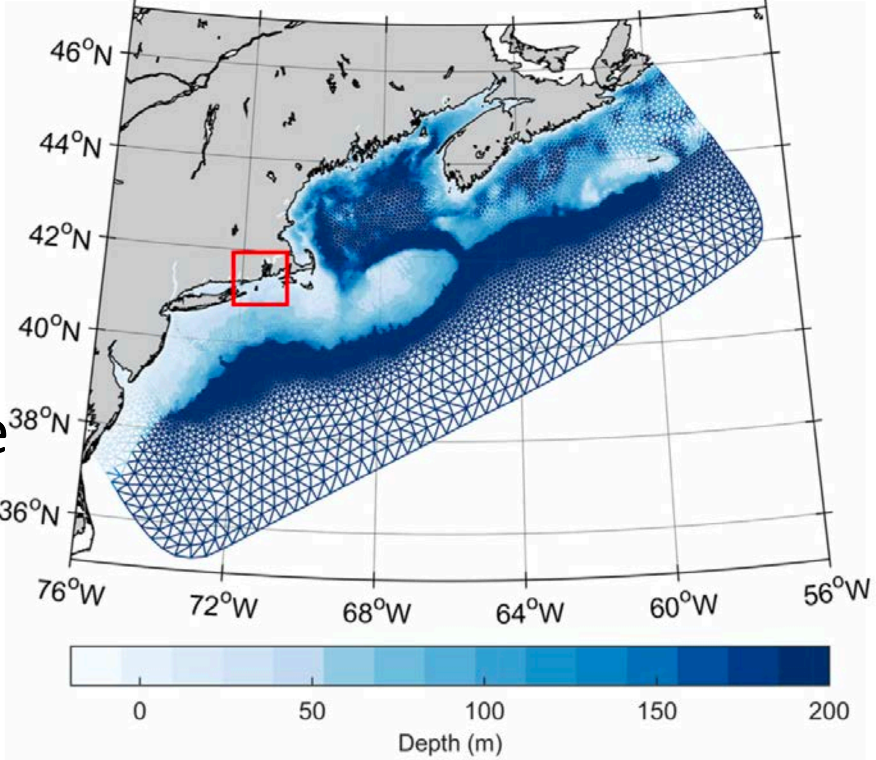
- Maps of flooding from sea level rise (0 to 12 ft);
- 25, 50, and 100 yr and 500 year storms;
- Nuisance flooding maps (1 ,2, 3, 5 and 10 yrs), at a 95% confidence interval
- Flooding from historical storms (1938, Carol- 1954, Bob- 1991, and Sandy- 2012)

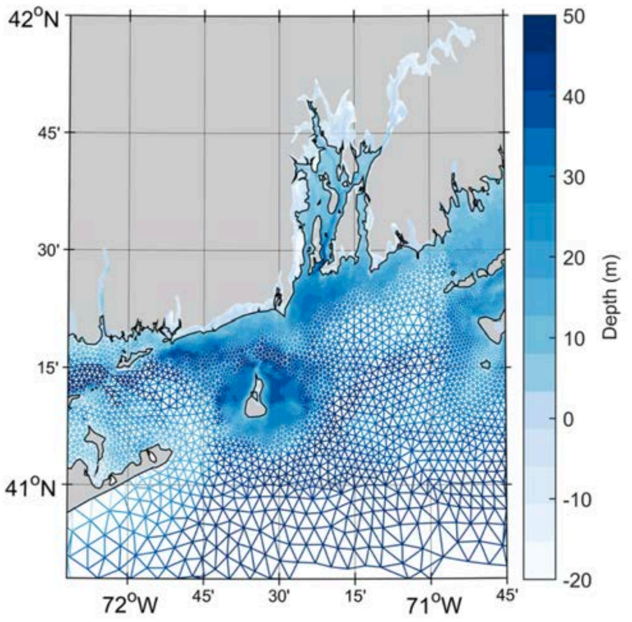




StormTools RI, URI

- ADCIRC, STWAVE , XBeach
- Predict storm surge and wave, combined with shoreline change maps (erosion), and damage functions to construct a Coastal Environmental Risk Index (CERI).
- Surge levels and associated offshore waves used to determine BFEs were obtained from the NACCS hydrodynamic and wave model predictions.
- Uses estimates of (BFE), explicitly including the effects of sea level rise (SLR); the structure types, first floor elevation (FFE); and damage curves from NACCS
- Determine the damages to structures for the study area.



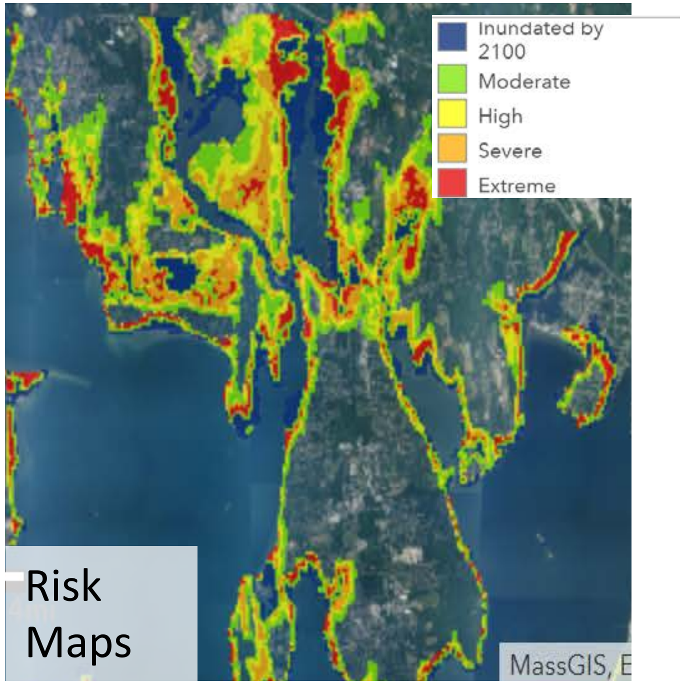


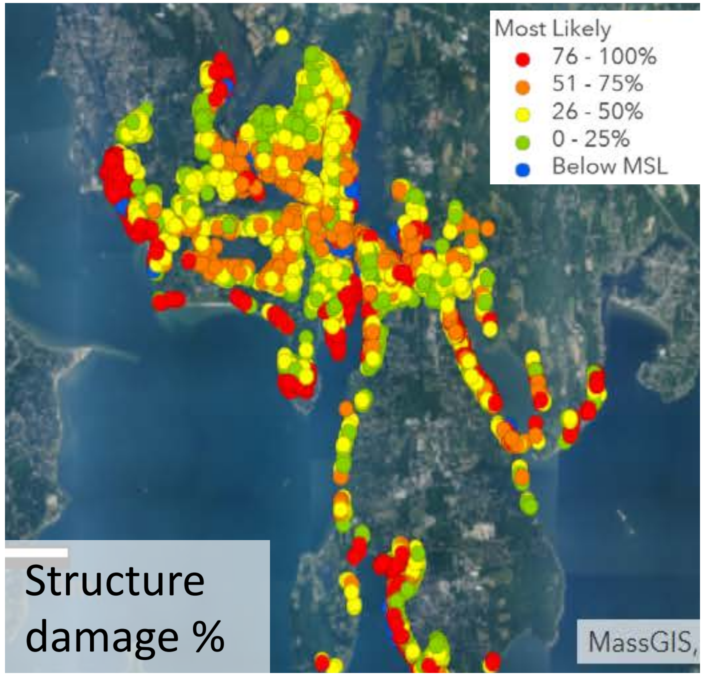
StormTools RI, URI

Limitations:

- No freshwater flooding from rainfall or rivers (except Pawtuxet river)
- Flooding through stormwater drains

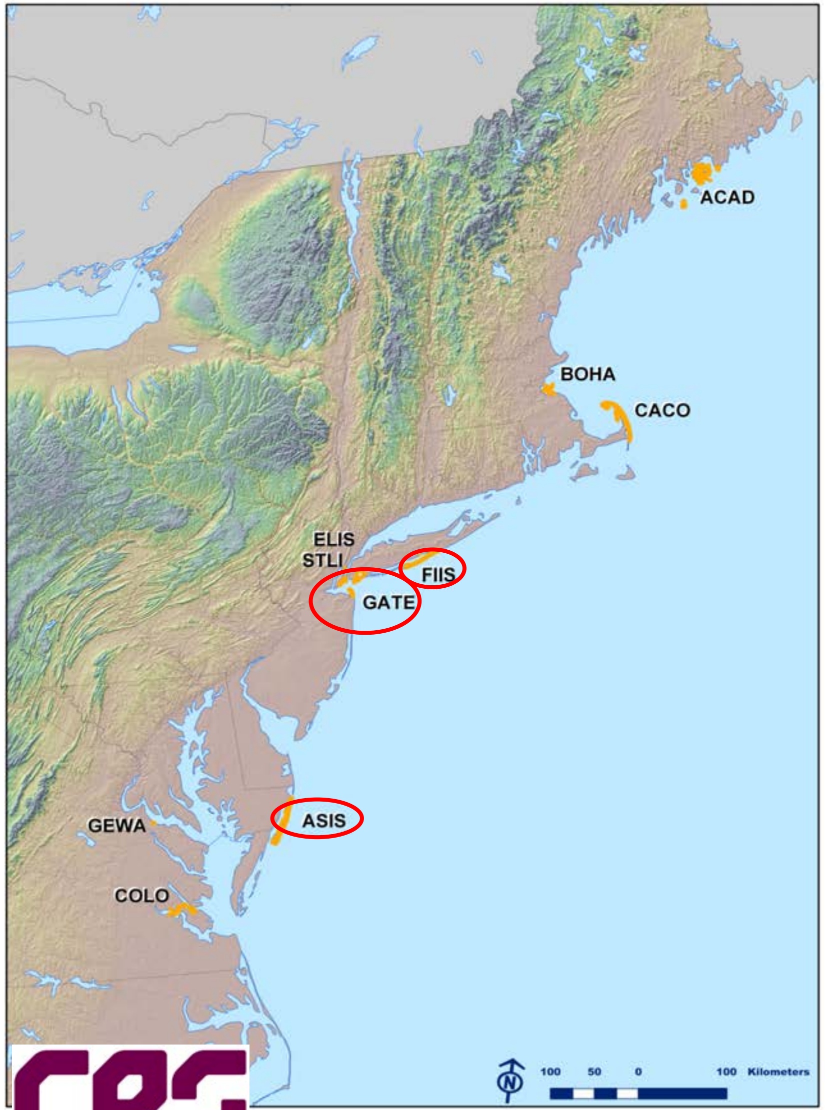
https://stormtools-mainpage-crc-uri.hub.arcgis.com/





NACCS Use Examples

Coastal Flooding of North East National Parks

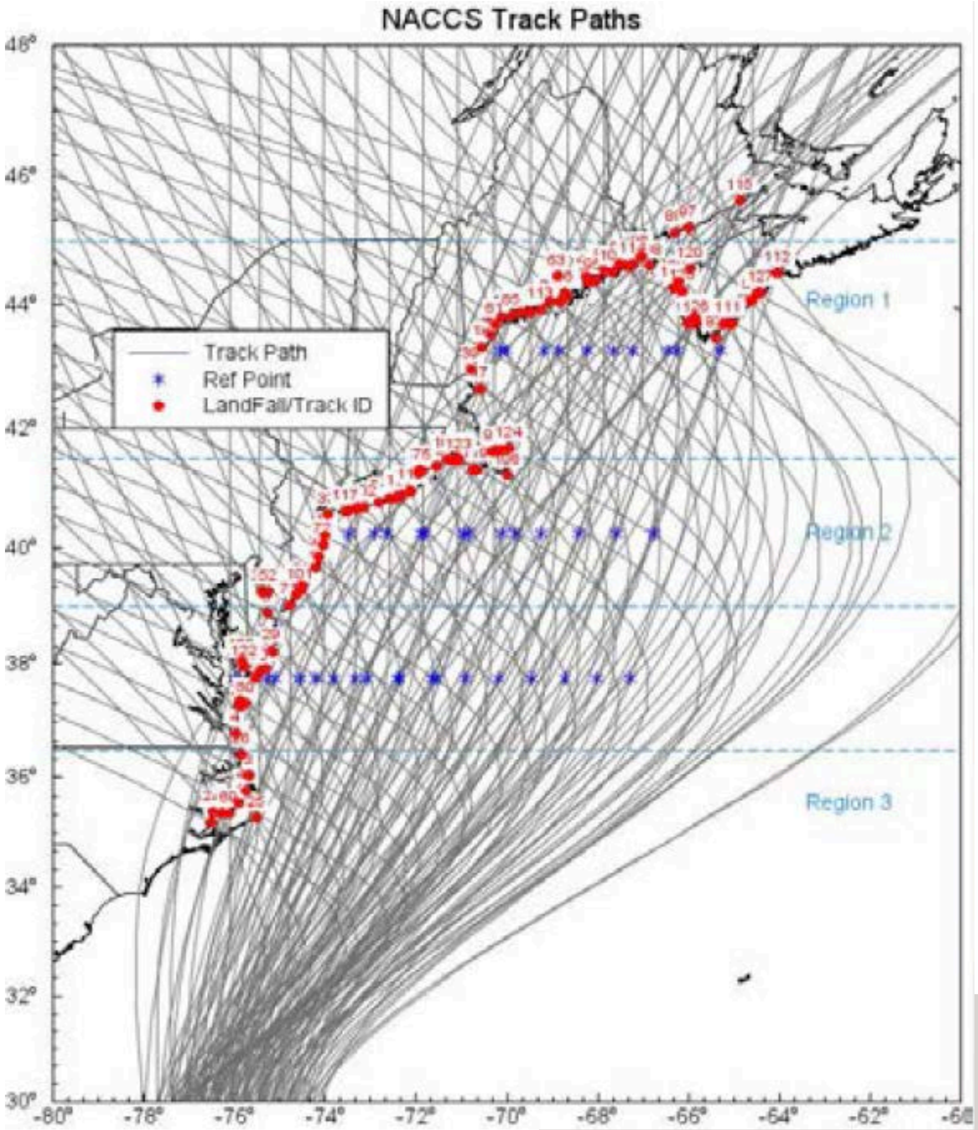


Statement of Purpose

- *Create the data infrastructure and technical procedures that will be used in preparing for and responding to storm events at three National Parks – Fire Island National Seashore (FIIS), Gateway National Recreational Area (GATE), and Assateague Island National Seashore (ASIS).*

1. Extension and enhancement of URI's "Monumentation" Project for the National Park Service
2. Enhance sentinel site database and network for FIIS and GATE.
3. Tide gauge infrastructure and gap analysis
4. Environmental Outreach
5. **Inundation Modeling**

Characterizing regional 100 year event



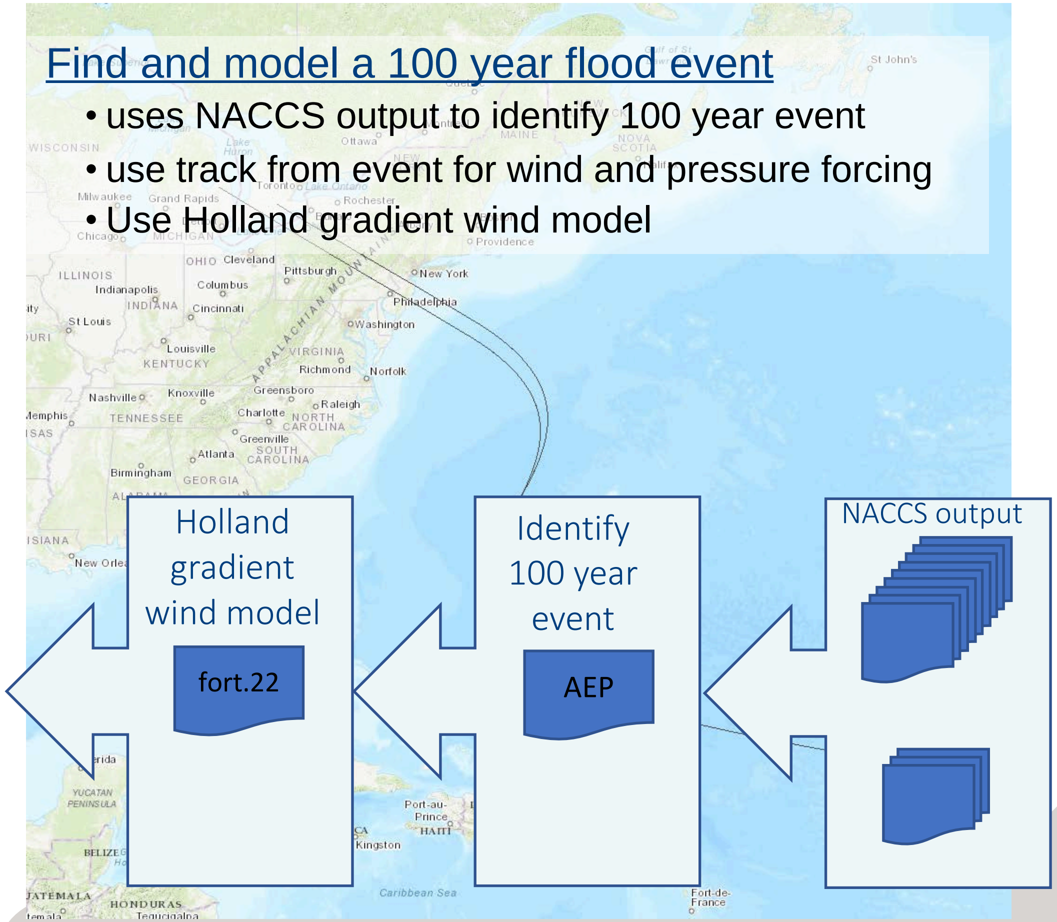
USACE,NACCS study

Atmospheric Forcing

NACCS Synthetic Tropical Storm Forcing

Find and model a 100 year flood event

- uses NACCS output to identify 100 year event
- use track from event for wind and pressure forcing
- Use Holland gradient wind model



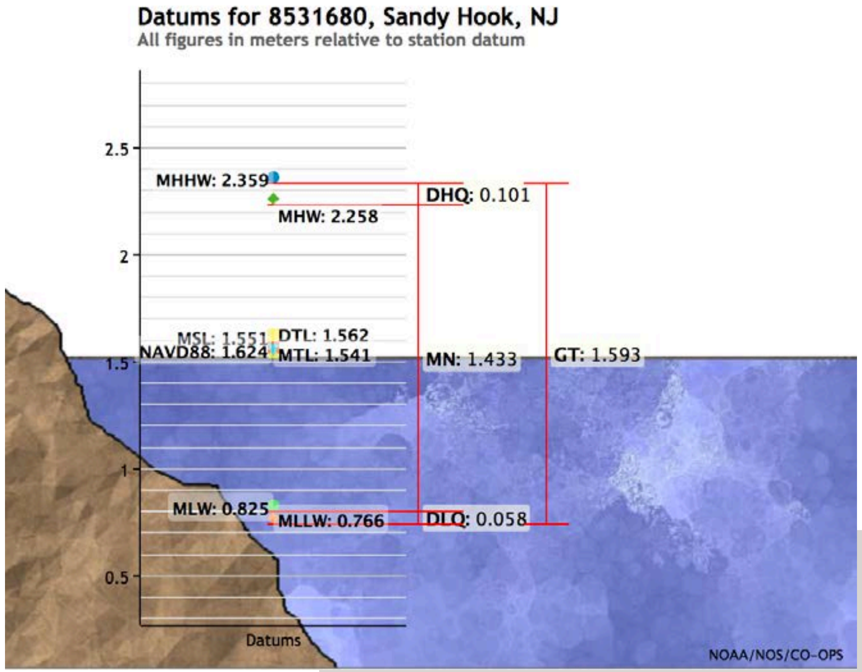
Park	NACCS ID	Subregion	Master Track	θ (deg)	ΔP (hPa)	Rmax (km)	Vf (km/h)
FIIS	355	2	10	-60	78	51	36
GATE	362	2	11	-60	68	61	26

40

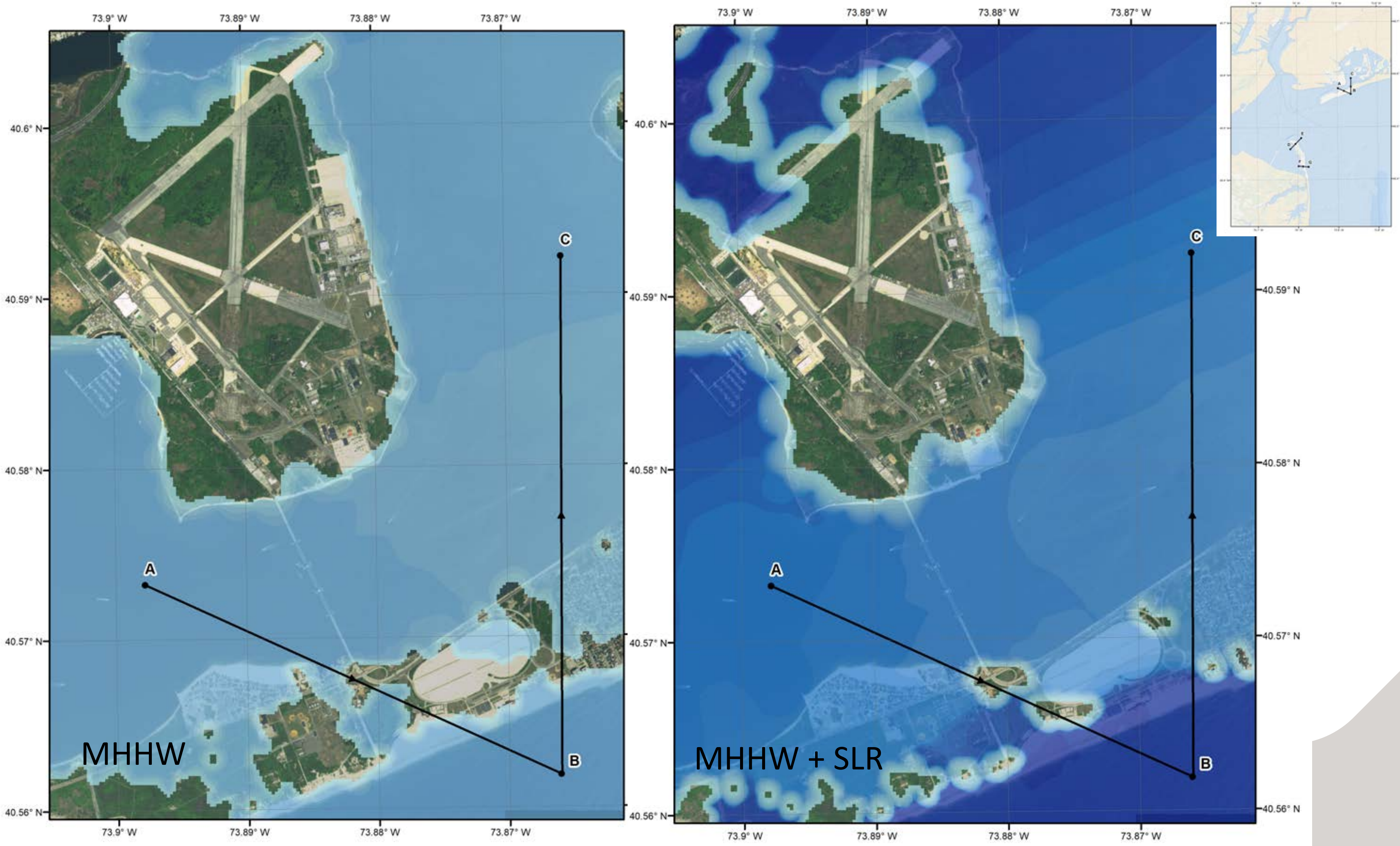
Water Levels

Sea Level Rise Scenario (2050) based on: The nonlinear interaction of Sea Level Rise and storm surge; without changes in vulnerability or storm pattern.
SLR at the site adopted from high emission scenario (2050) evaluated by corpsclimate

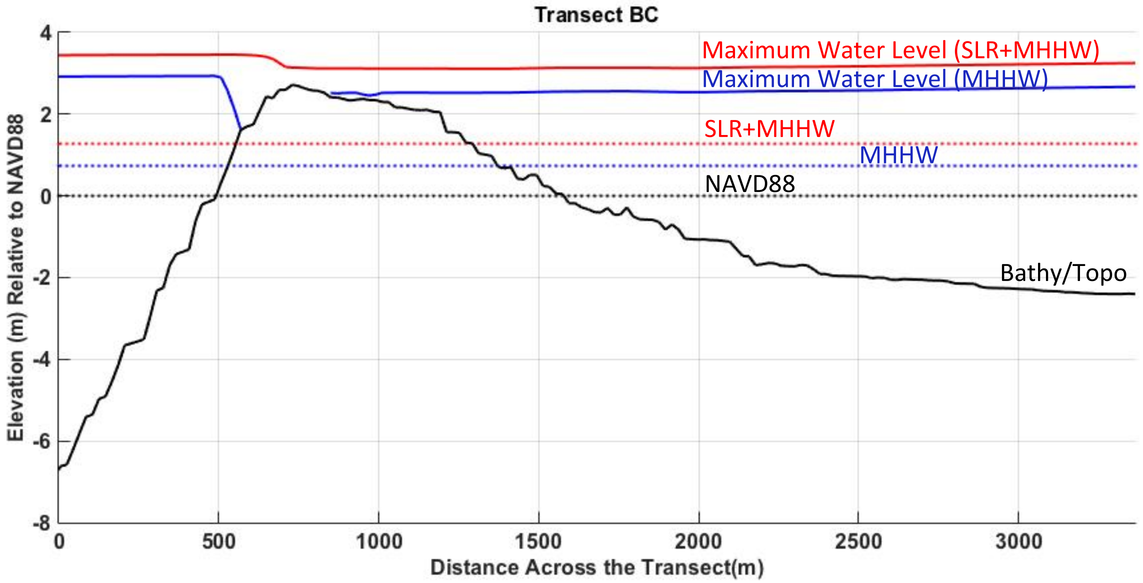
Site	Station	Station #	MHHW (m) relative to NAVD88	SLR(m) in 2050
FIIS/GATE	SandyHook, NJ	8531680	0.735m	0.54

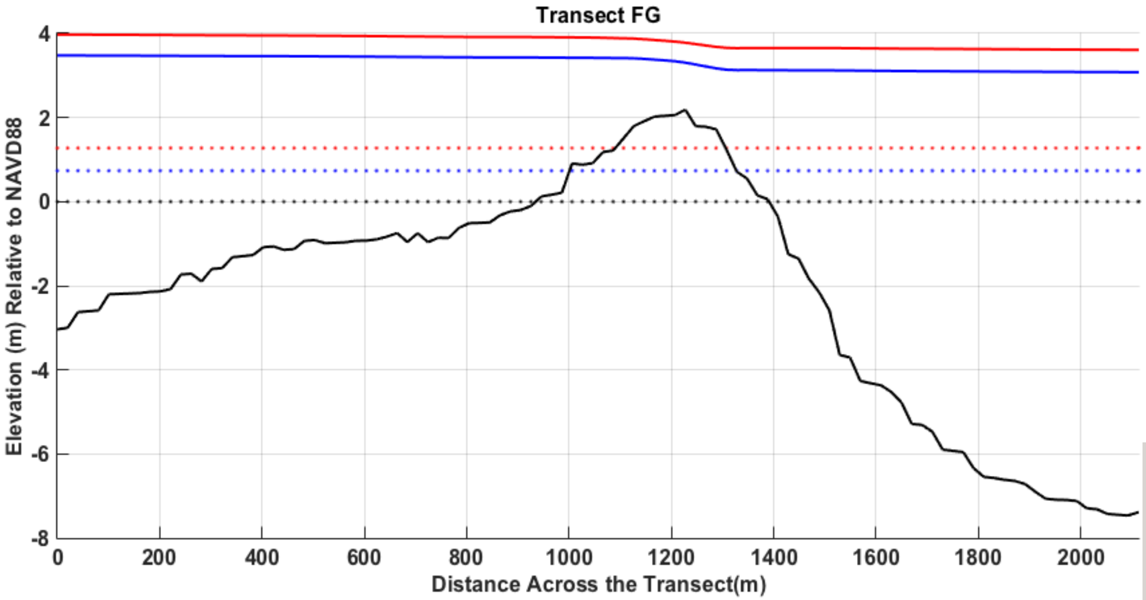


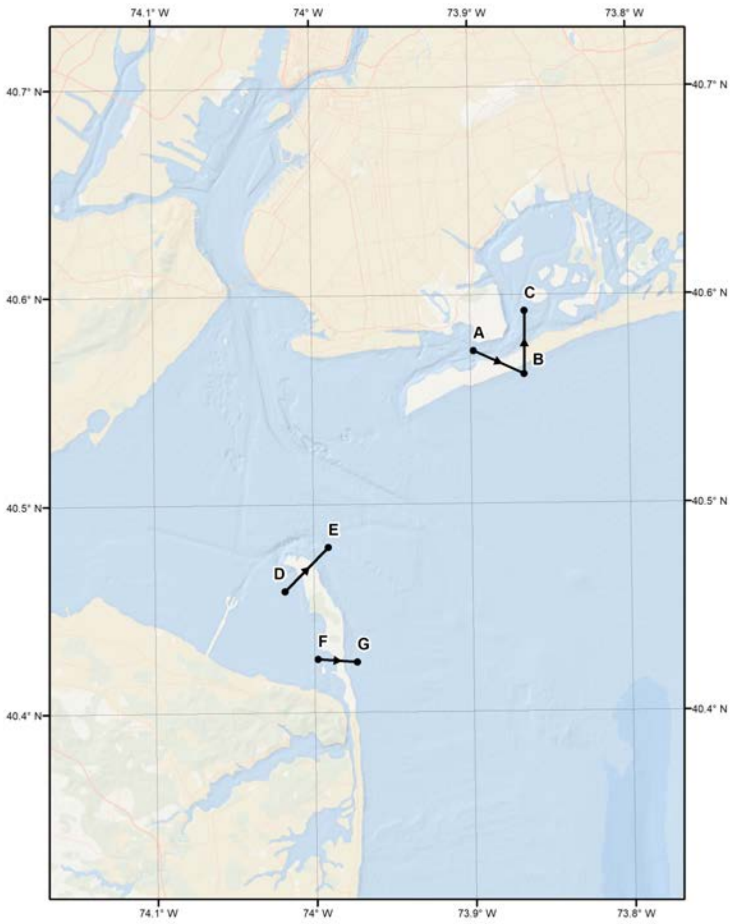
Maximum Inundation Envelope



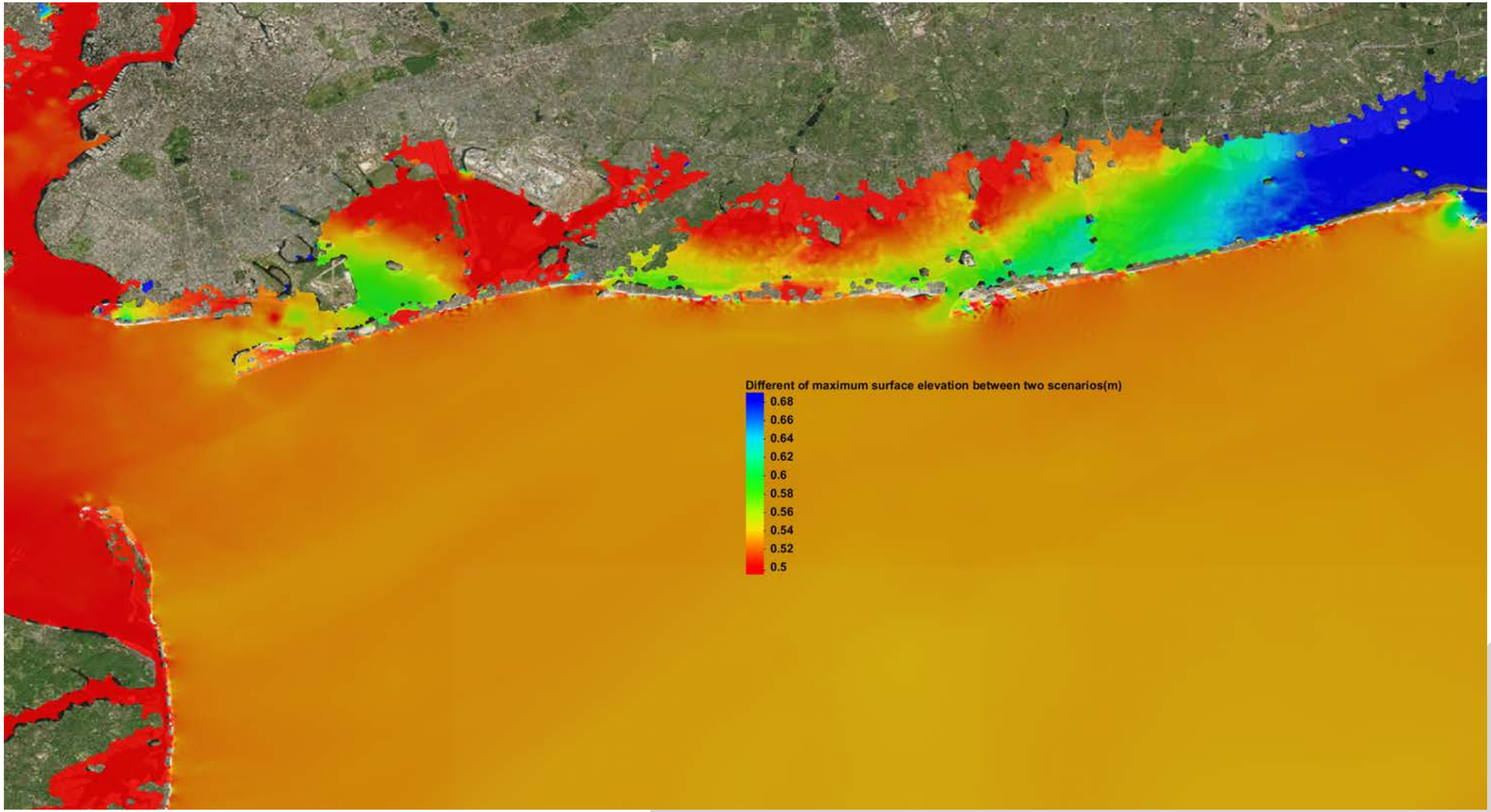
Maximum Inundation Envelope







Nonlinearity: Maximum Inundation Envelope



Final Note

Discussed:

- NACCS and other coastal flooding products
  - So many maps …. most appropriately for education/awareness purposes
  - Should not be used as the sole source for specific risk management decisions.
- Use case(s) of NACCS
  - Nonlinear interaction of tide, sea level rise and storm surge
  - Limitation of bathtub approach

Next session:

- NACCS modeling details
- How to access and analyze the NACCS from NROC (Demo)

THANK YOU!

Questions?

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