Modeling Nearshore Dynamics of Extreme Storms in Complex Environments of Connecticut

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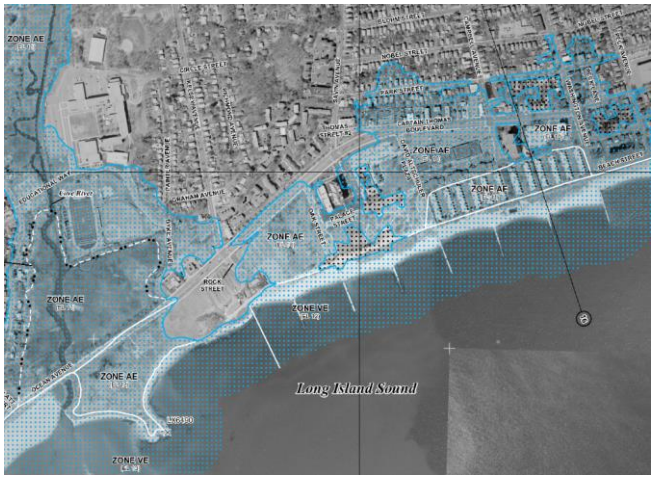
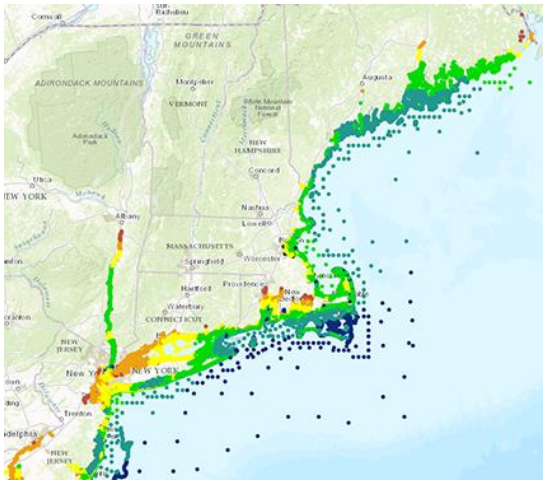
Background

- Flood hazard planning requires the accurate estimation of total water elevation.
- The coastal topography and nearshore circulation conditions impact the flood mapping in complex environments.
- Some conventional approaches are flawed in several ways:
  - 1) using bathtub approach,
  - 2) insufficient resolutions or model physics
  - 3) failing to calibrate and validate with real-time data, or
  - 4) not considering sea-level rise

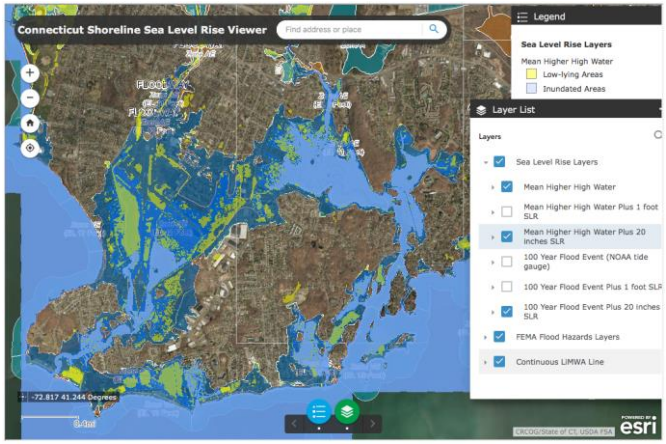
Existing Flood Map Products



FEMA Flood Insurance Map



North Atlantic Coast Comprehensive Study (NACCS)

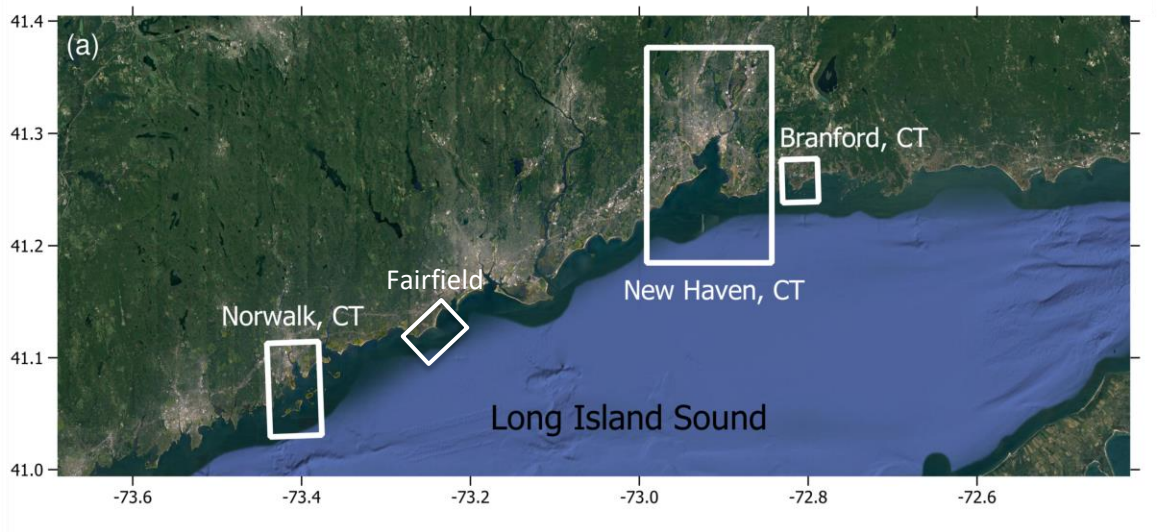


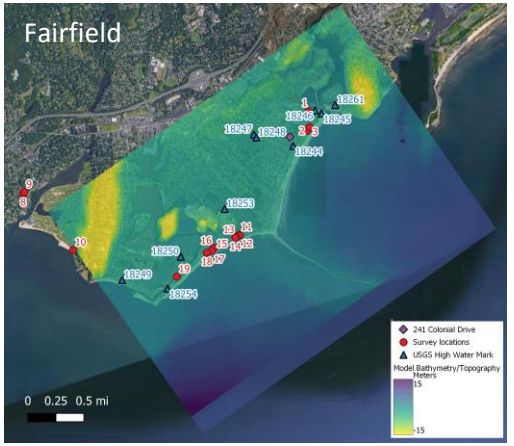
CIRCA FVCOM-SWAVE

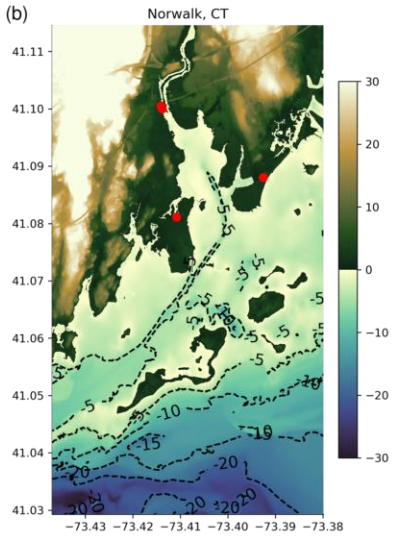
Objectives

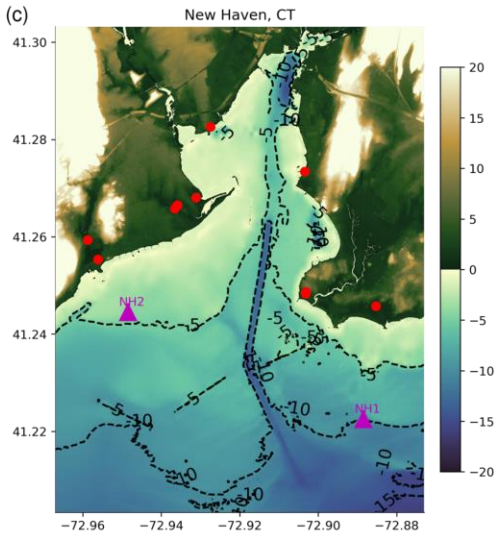
- Create accurate flood maps using a capable, high-resolution wave model to determine total water elevation on the shores
- Validate the models with observations
- Examine local sea-level rise predictions of storms with 1% (100-year) and 10% (10-year) annual exceedance probability by the year 2050 in Connecticut

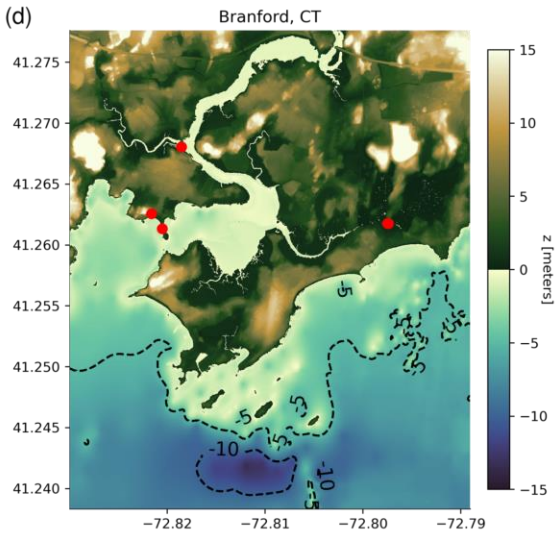
Study Area


(a)
Branford, CT
Fairfield
New Haven, CT
Norwalk, CT
Long Island Sound
41.4
41.3
41.2
41.1
41.0
-73.6
-73.4
-73.2
-73.0
-72.8
-72.6


Fairfield
241 Colonial Drive
Survey locations
USGS High Water Mark
Model Bathymetry/Topography
Meters
0 0.25 0.5 mi

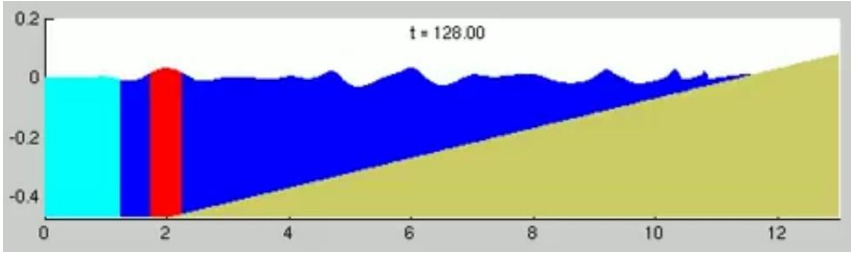

(b)
Norwalk, CT
41.11
41.10
41.09
41.08
41.07
41.06
41.05
41.04
41.03
-73.43 -73.42 -73.41 -73.40 -73.39 -73.38

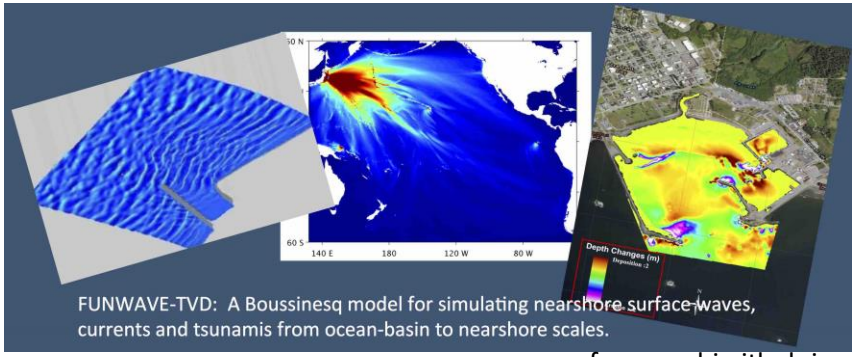

(c)
New Haven, CT
41.30
41.28
41.26
41.24
41.22
NH2
NH1
-72.96
-72.94
-72.92
-72.90
-72.88


(d)
Branford, CT
41.275
41.270
41.265
41.260
41.255
41.250
41.245
41.240
-72.82
-72.81
-72.80
-72.79
z [meters]

Model Setup

- FUNWAVE-TVD: phase-resolving wave model
- Wavemaker generates waves with specified wave height, frequency, and direction
- Grid resolution 2 m (6.5 ft)
- Simulate 1% (100-year) and 10% (10-year) annual exceedance probability

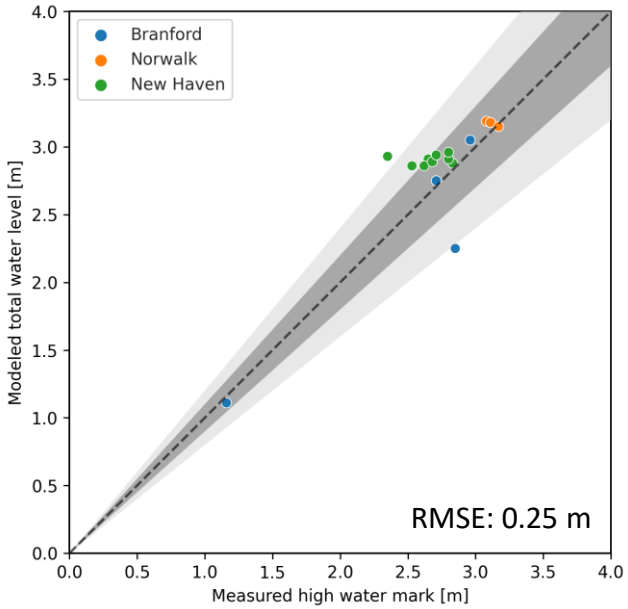


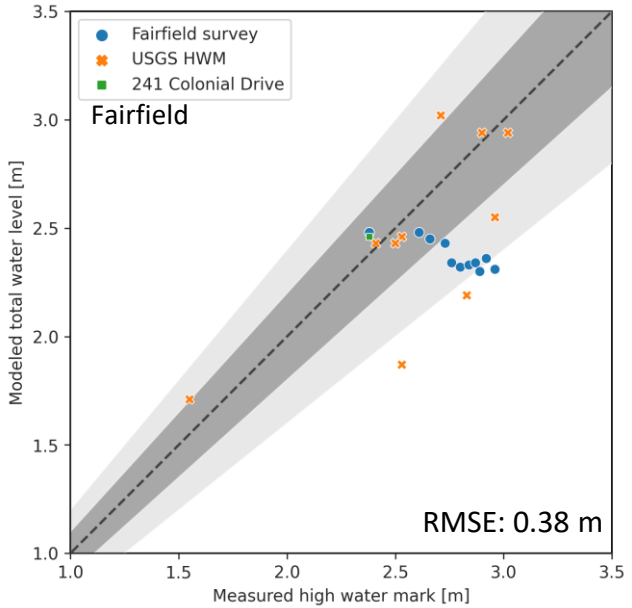


fengyanshi.github.io

Validation: High Water Level

- Compare with observed high water during super storm Sandy
- Modeled values are close to observations



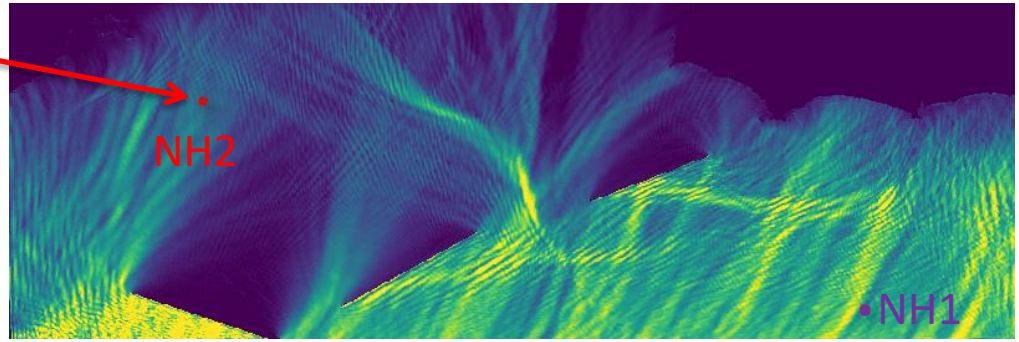


Validation: Wave Height

- Compare with observed wave height at stations near breakwaters in 2015
- Model forced with wave characteristics observed at NH1, compare modeled vs observed values at NH2

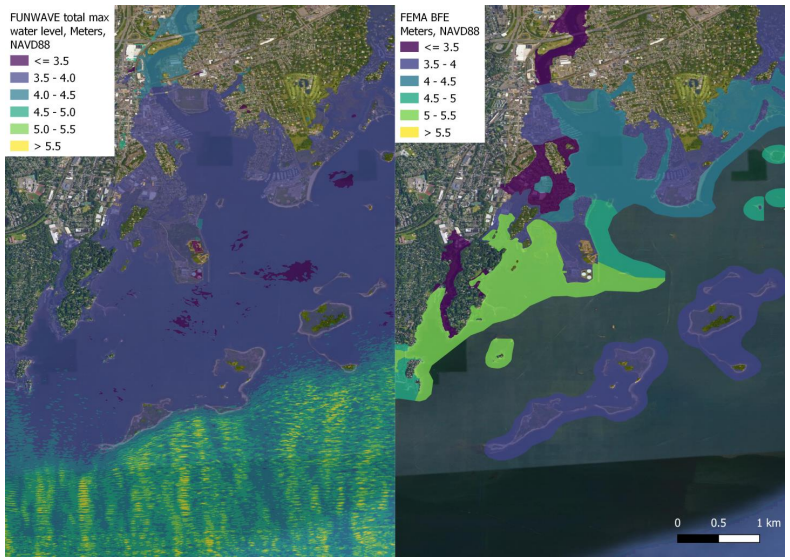
Significant Wave Height at NH2 (meters)

	01/25	02/02	03/26
Observed	0.69	0.59	0.44
FUNWAVE Modeled	0.56	0.47	0.37

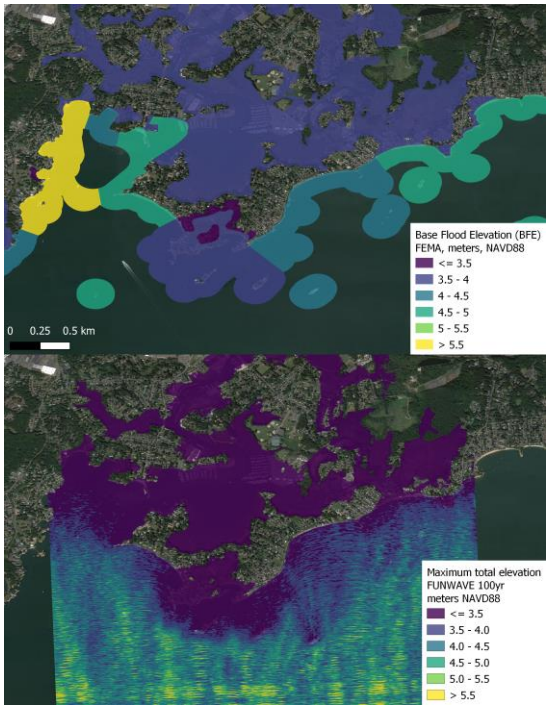


Comparison with FEMA (100-year)

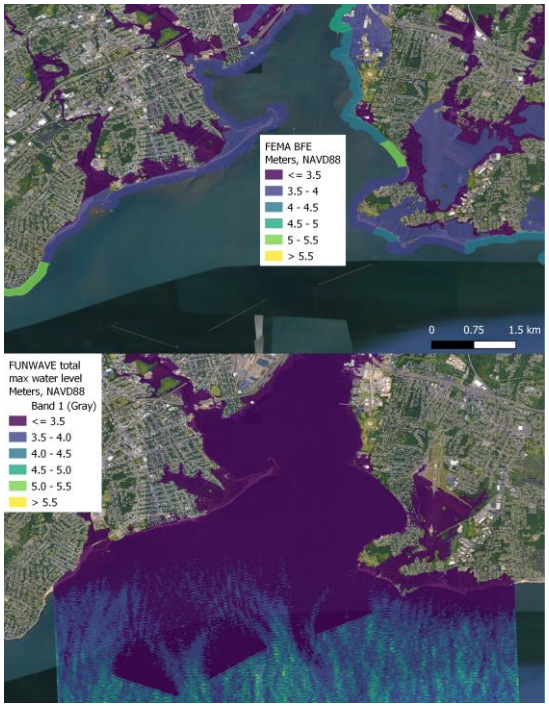
Norwalk



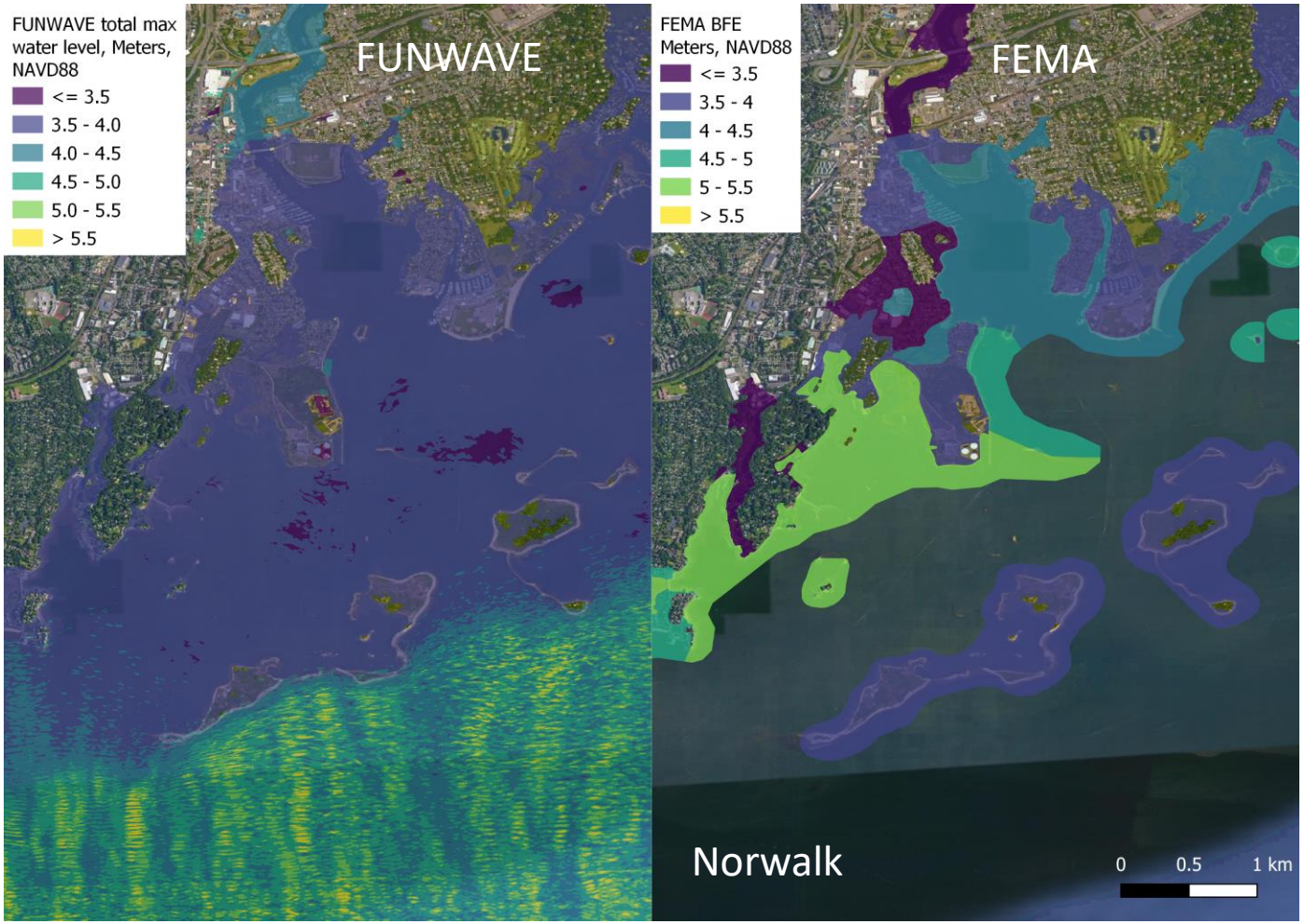
Branford



New Haven

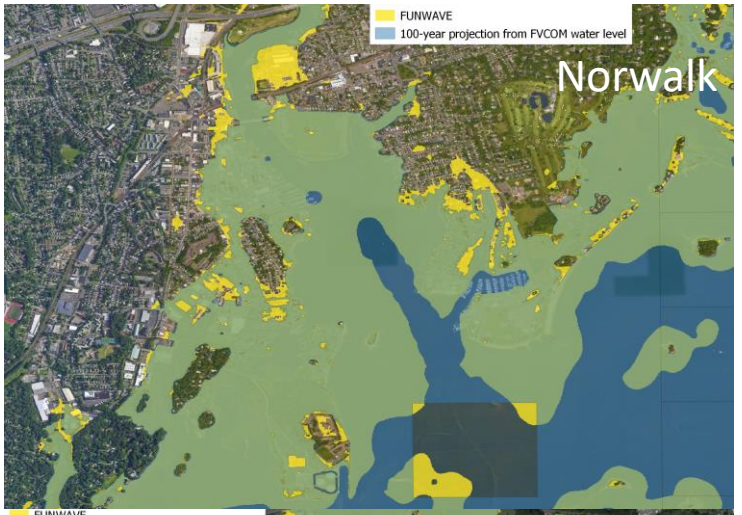


Comparison with FEMA (100-year)

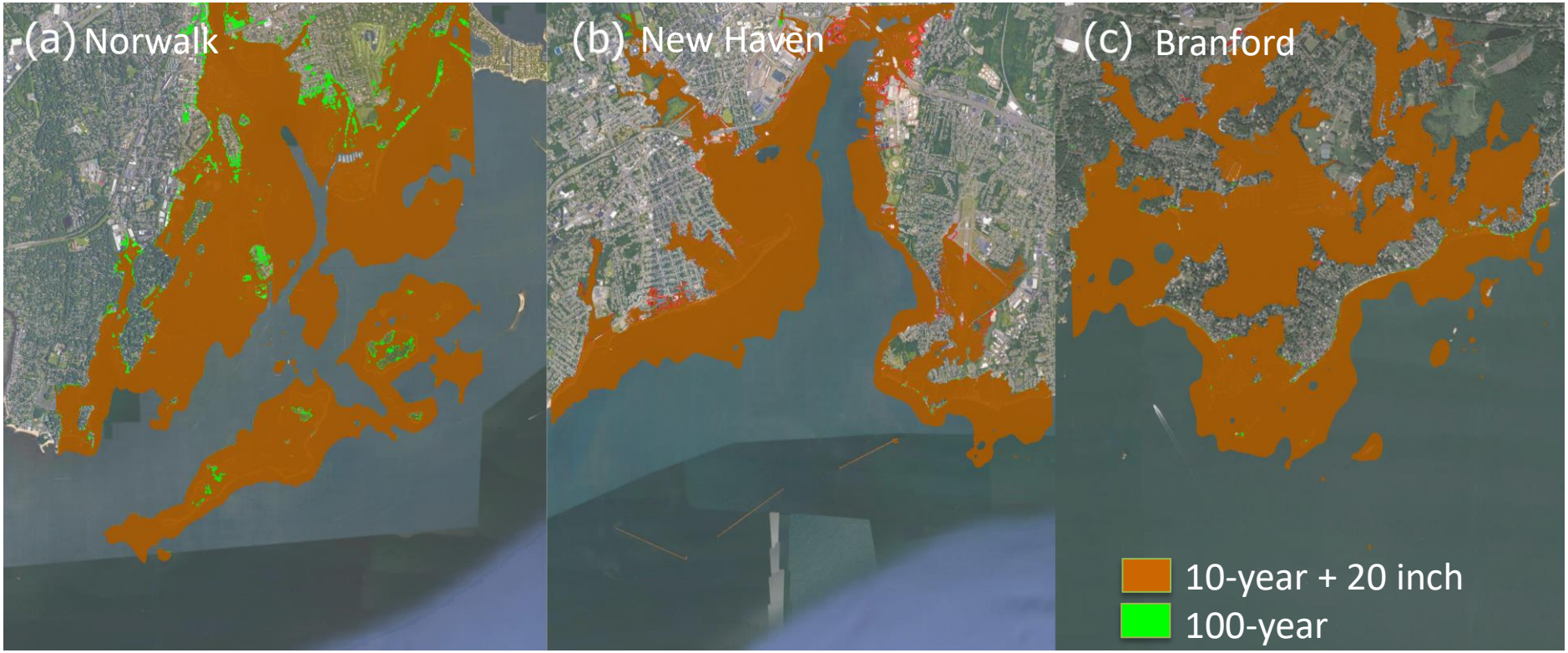


Comparison with NACCS (100-year)

Comparison with FVCOM-SWAVE



10-yr with sea-level rise



Summary

- The FUNWAVE-TVD model is found to model wave processes more accurately in shallow water regions compared to the empirical equation application of FEMA and coupled circulation-phase averaged model application of NACCS and FVCOM-SWAVE.
- We also examined local sea-level rise predictions of storms with 1% (100-year) and 10% (10-year) annual exceedance probability by the year 2050 in Connecticut and found that the flood extent of these two storms showed little to no difference due to the topographic conditions.
- We suggest the planning approaches consider the increase in the frequency of the storms in the predicted inundation zones due to sea-level rise.

THANK YOU

Questions?