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
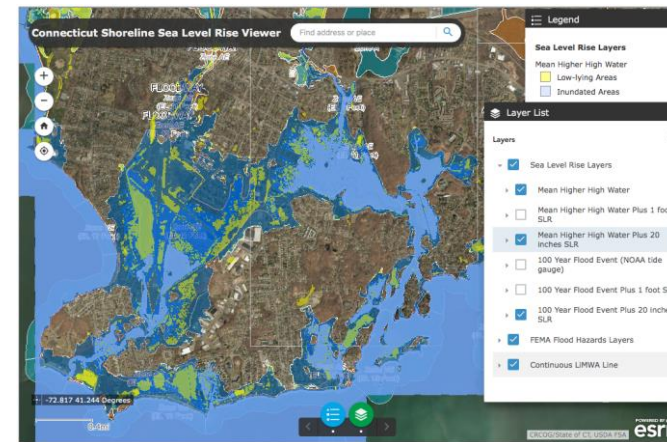 - 4) not considering sea-level rise

Existing Flood Map Products
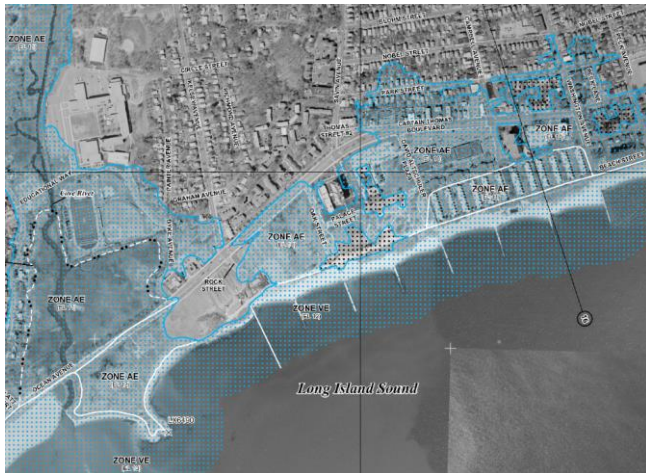
FEMA Flood Insurance Map
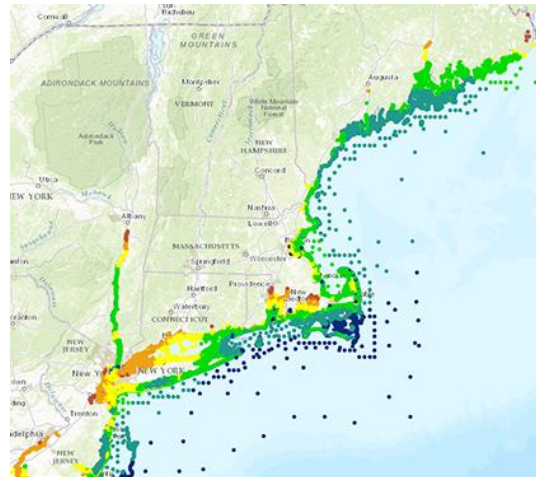
North Atlantic Coast Comprehensive Study (NACCS)

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
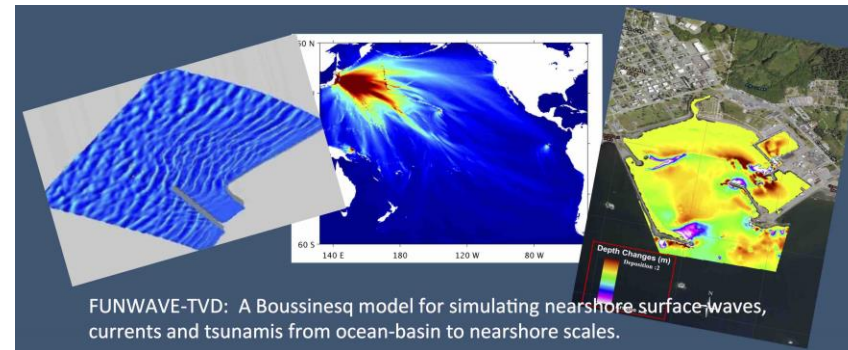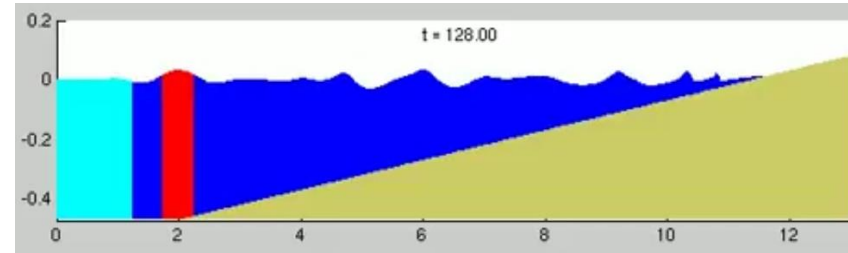
Study Area
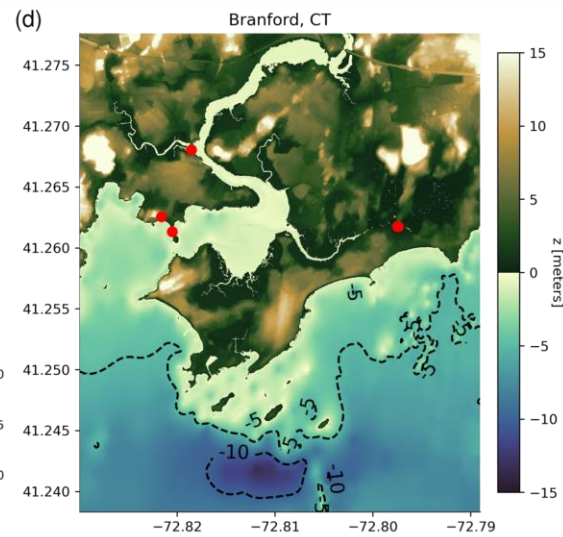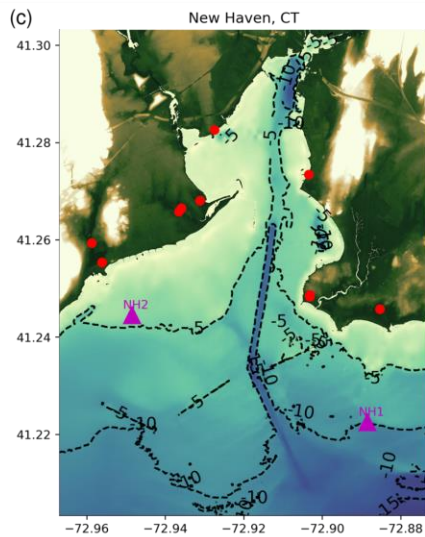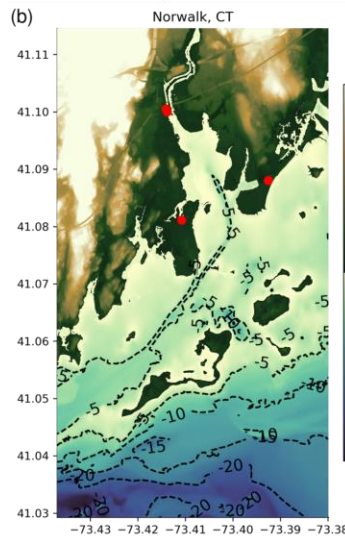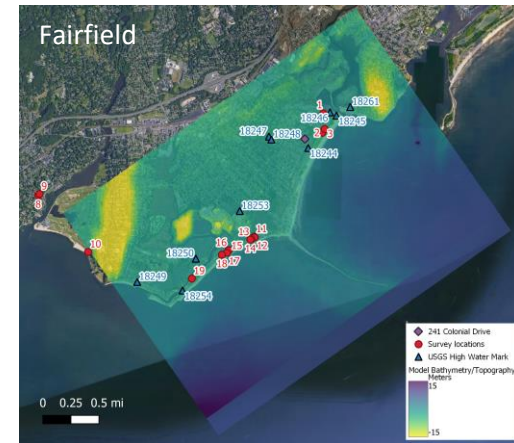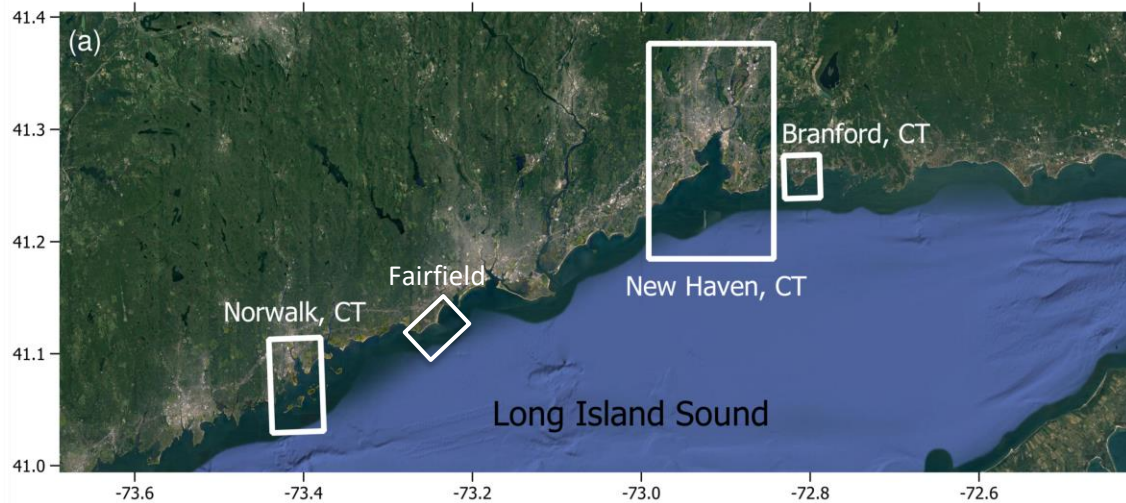
Model Setup

- 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

FUNWAVE-TVD: A Boussinesq model for simulating nearshore surface waves, currents and tsunamis from ocean-basin to nearshore scales.

fengyanshi.github.io

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Validation: High Water Level

- Compare with observed high water during super storm Sandy

- Modeled values are close to observations

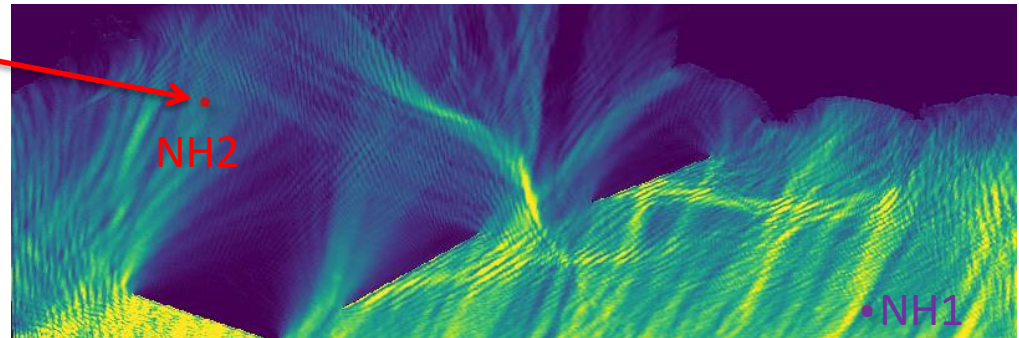RMSE: 0.25 m

Fairfield
RMSE: 0.38 m
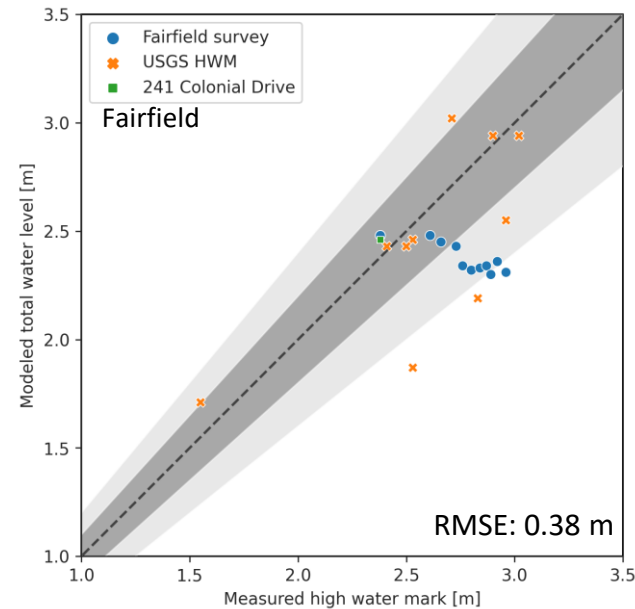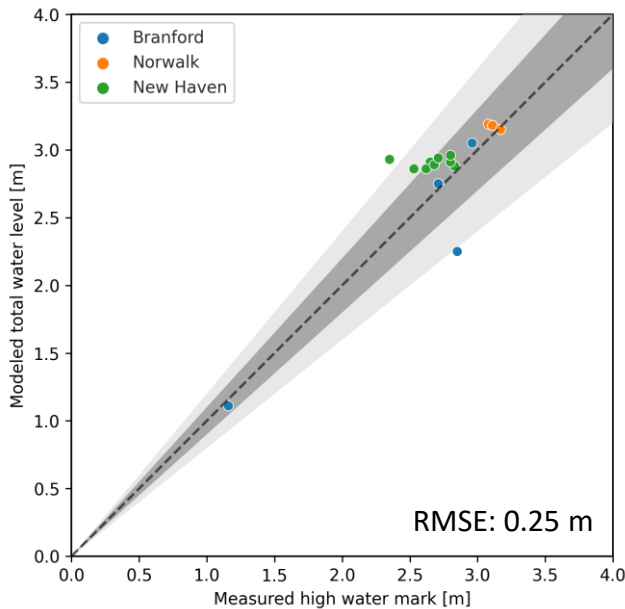
Validation: Wave Height

- 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
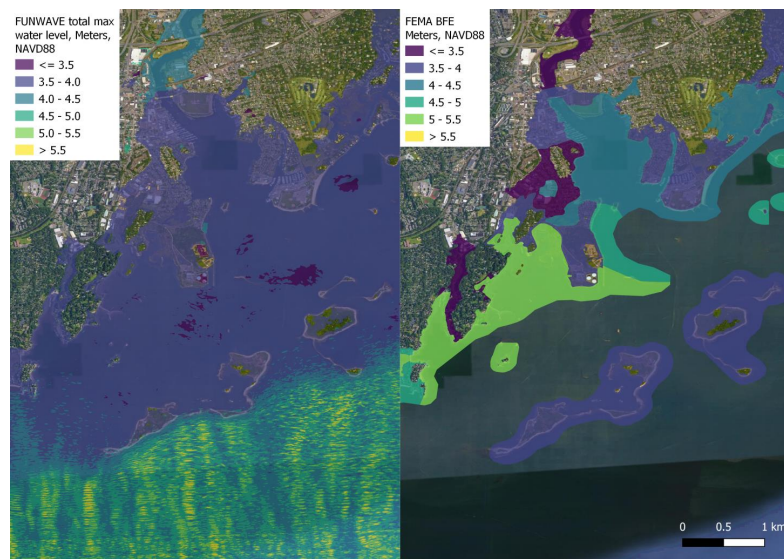
Significant Wave Height at NH2 (meters)

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

NH2

NH1

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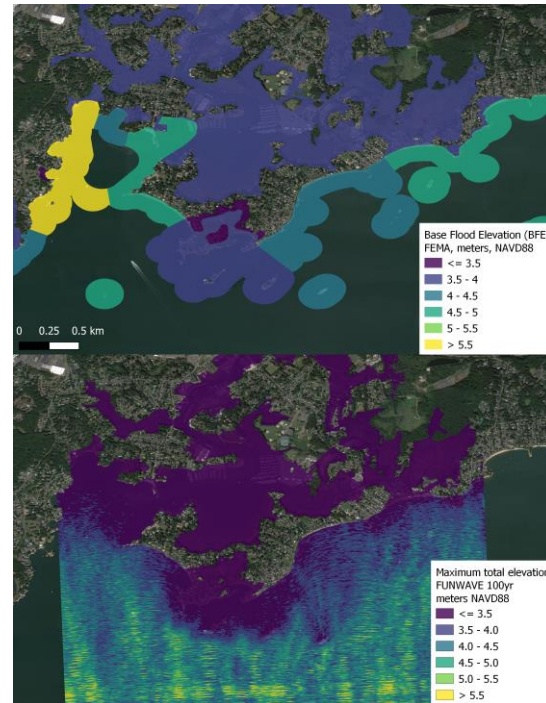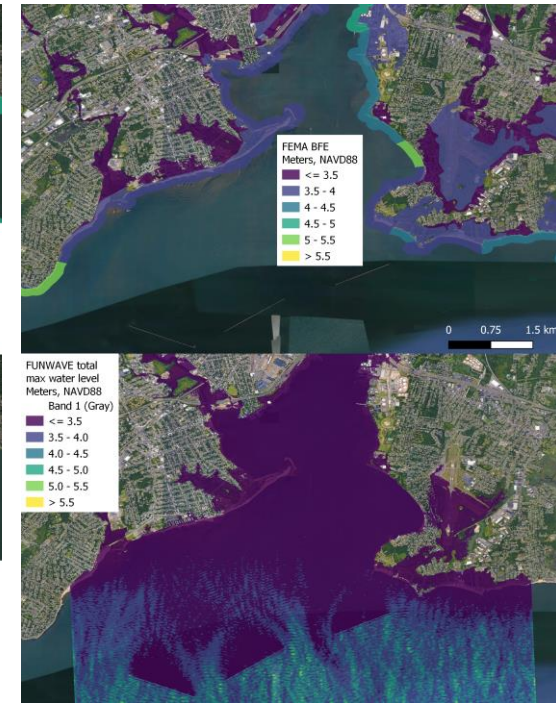
Comparison with FEMA (100-year)

Norwalk
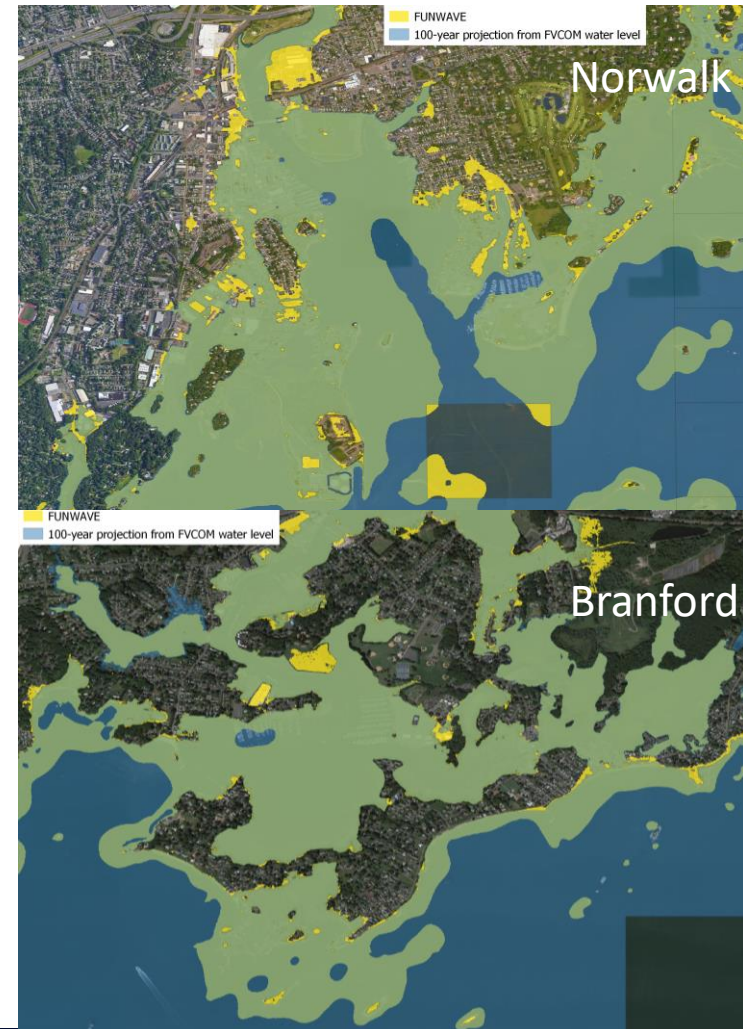
Branford

New Haven

Comparison with FEMA (100-year)
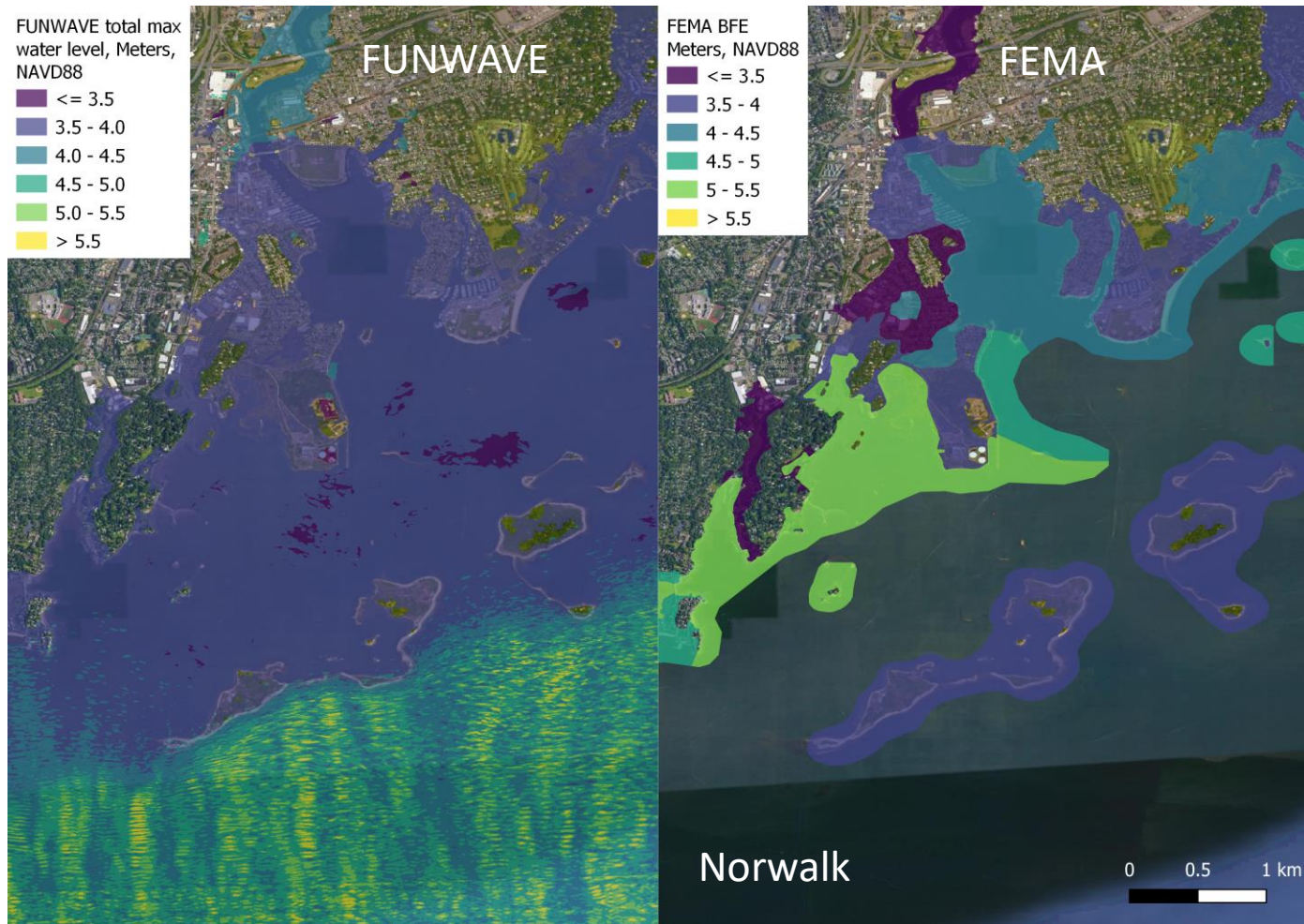
Comparison with NACCS (100-year)
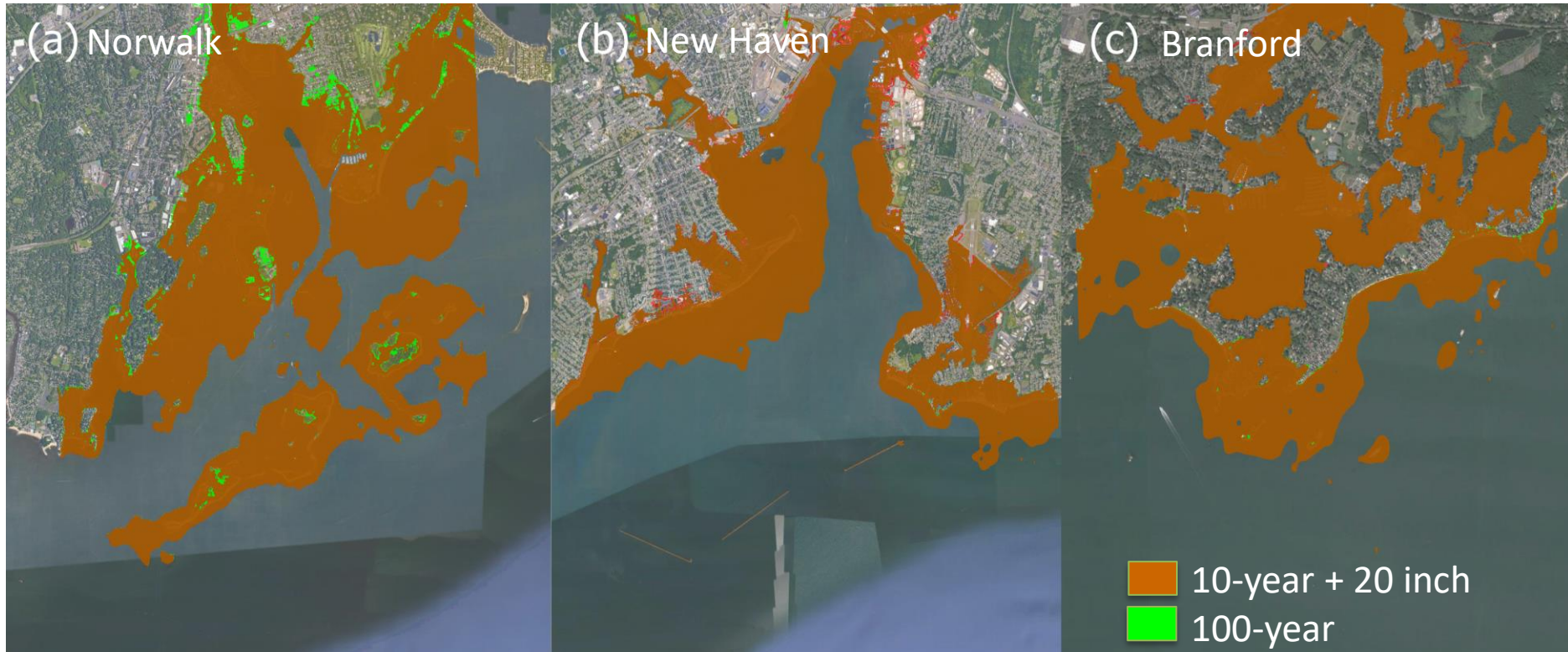

New Haven

Norwalk

Branford

FUNWAVE

NACCS 100-year water level

Comparison with FVCOM-SWAVE

10-yr with sea-level rise

(a) Norwalk (b) New Haven (c) Branford

10-year + 20 inch
100-year

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?