An Operational Forecast Model for Coastal Water Levels

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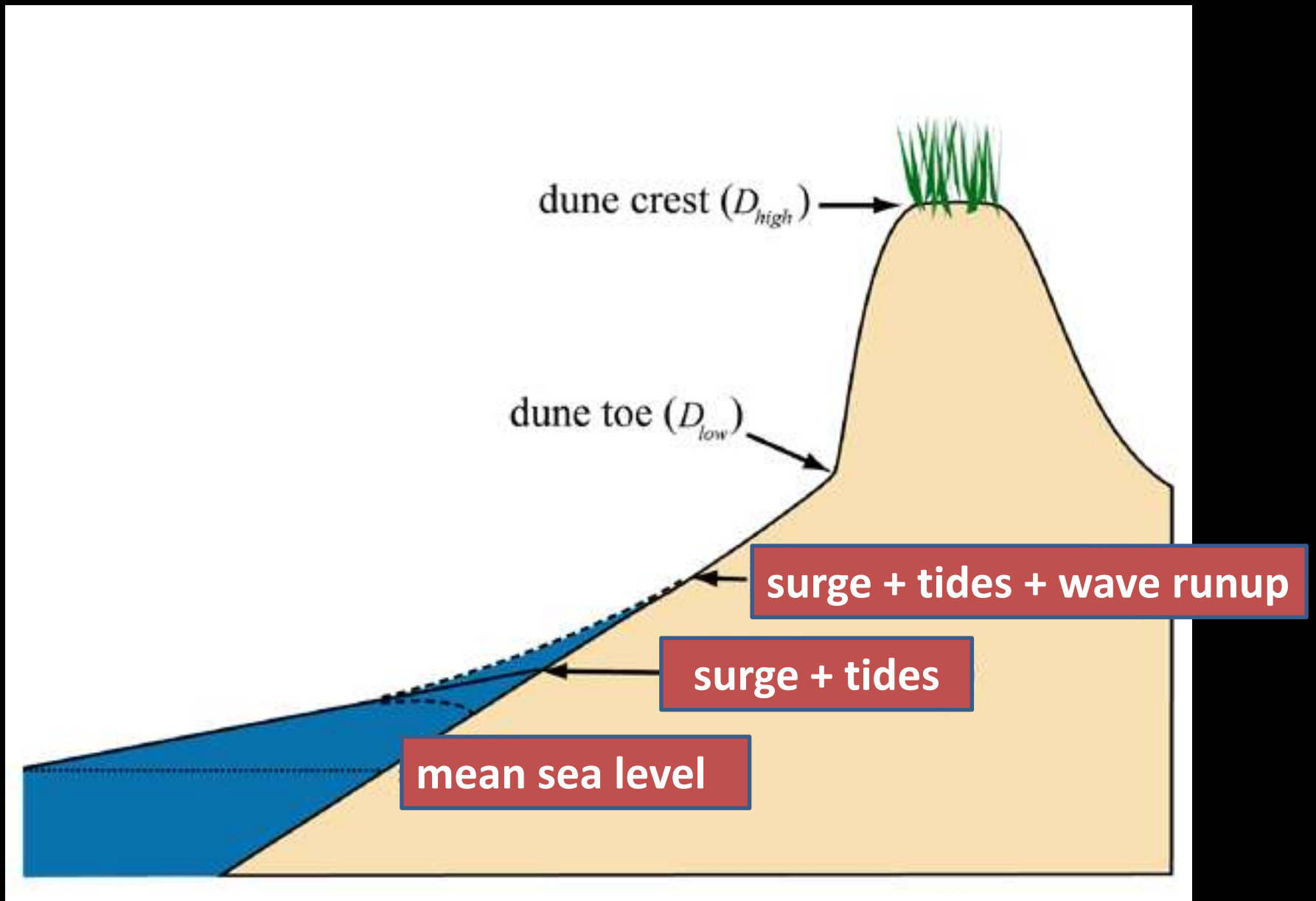
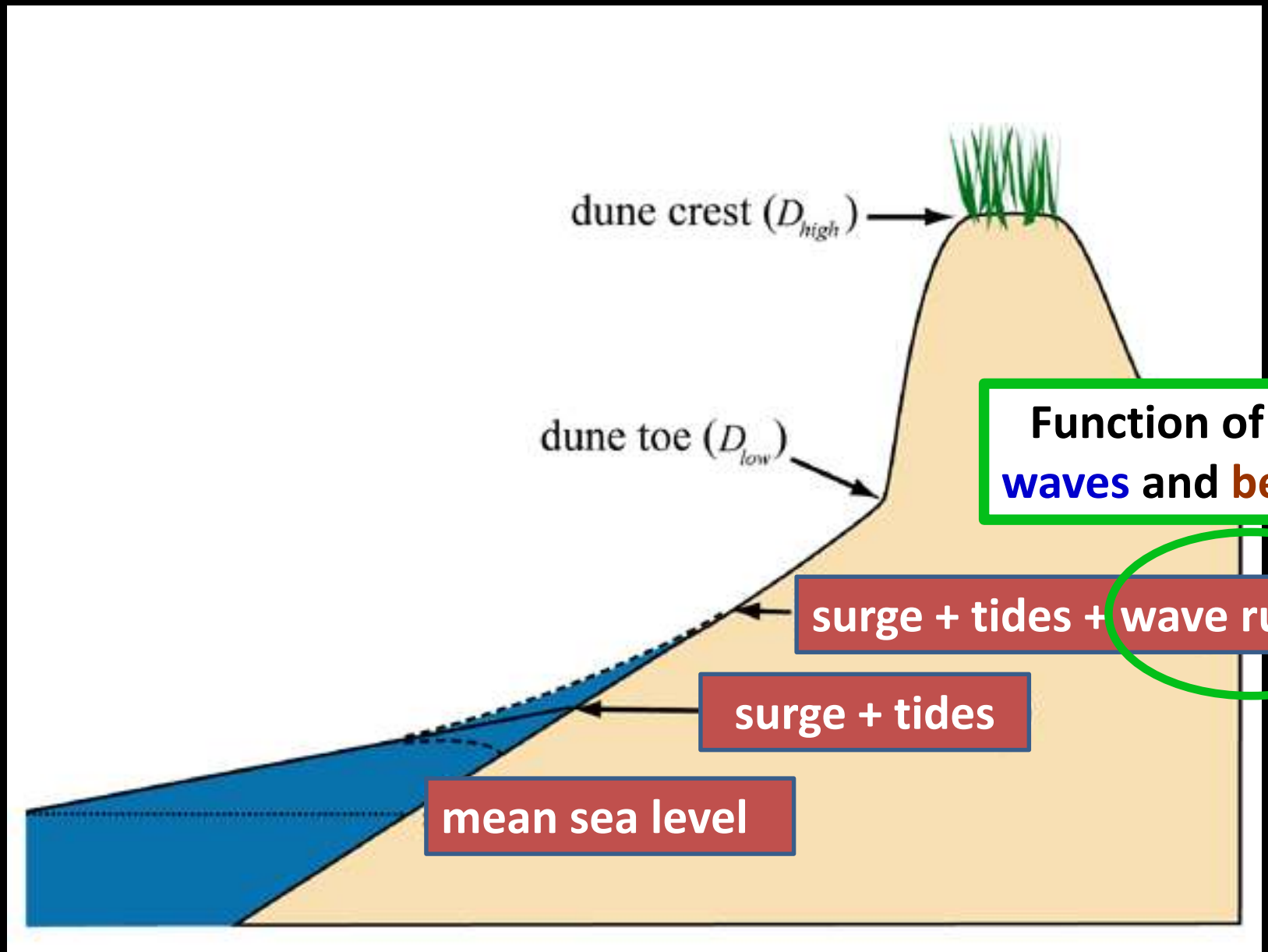
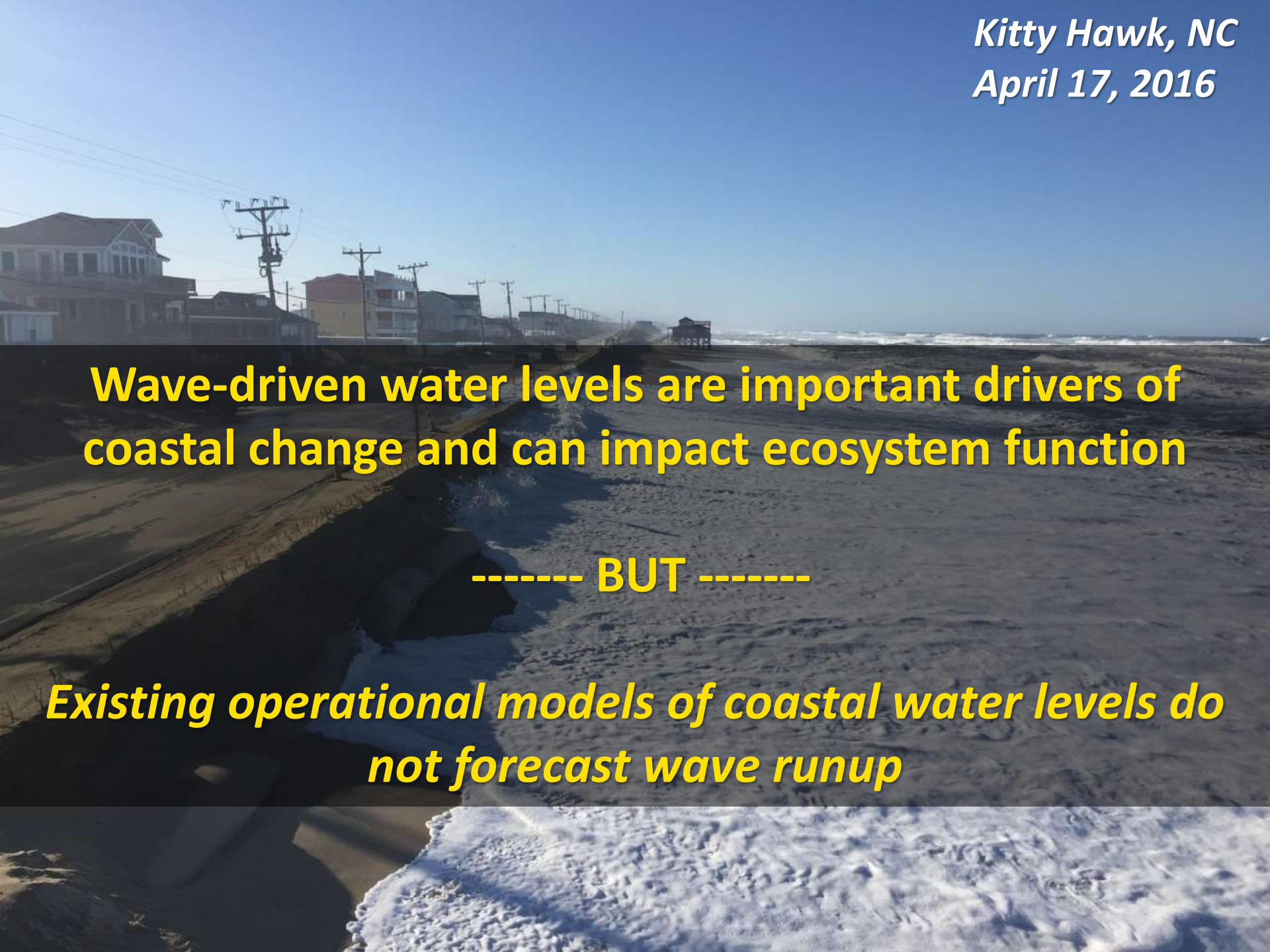
Components of Coastal Water Levels



Components of Coastal Water Levels




Kitty Hawk, NC
April 17, 2016
surge + tides + wave runup

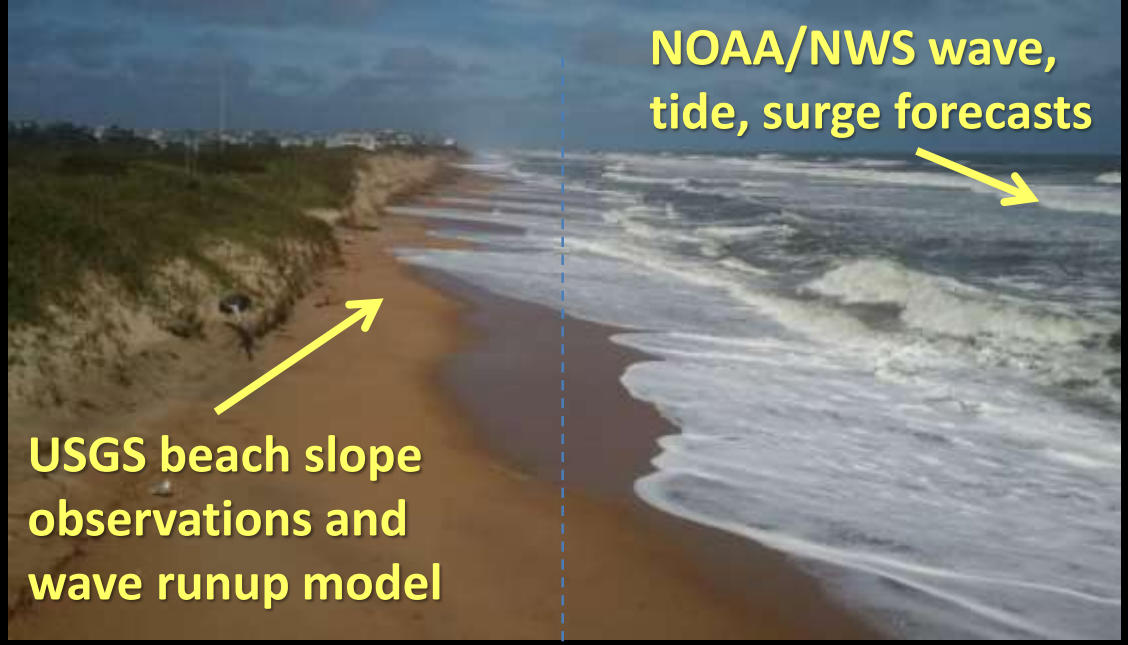

Kitty Hawk, NC
April 17, 2016
Wave-driven water levels are important drivers of coastal change and can impact ecosystem function
-------- BUT --------
Existing operational models of coastal water levels do not forecast wave runup

Objective

Combine capabilities and expertise of USGS and NOAA/NWS/NCEP to develop an operational forecast for total water levels along the coast.

Outcomes/Benefits:

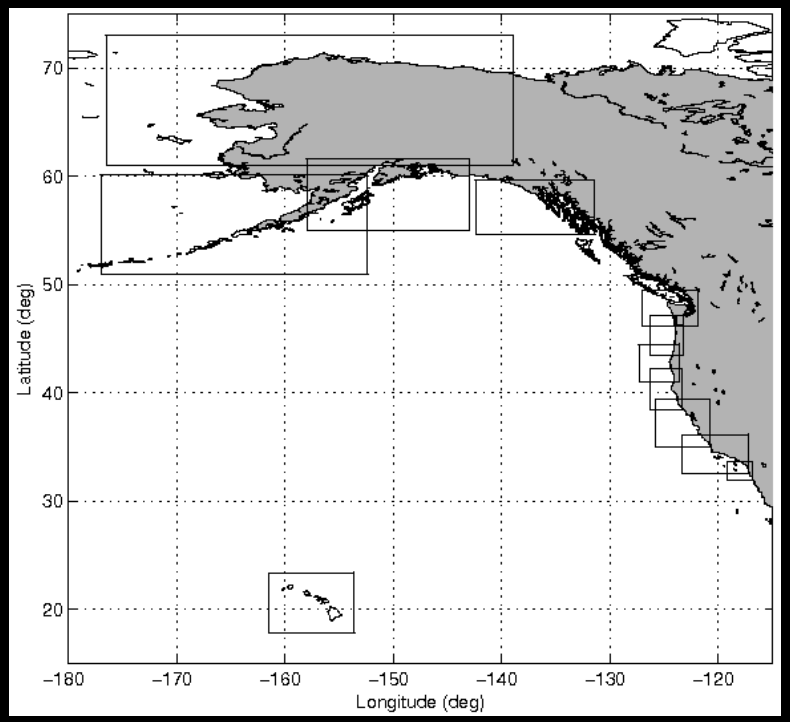
- Increase reliability of coastal hazard forecasts
- Predict the *magnitude and timing* of tides, surge, and wave runup
- Provide operational guidance that includes extratropical and tropical events

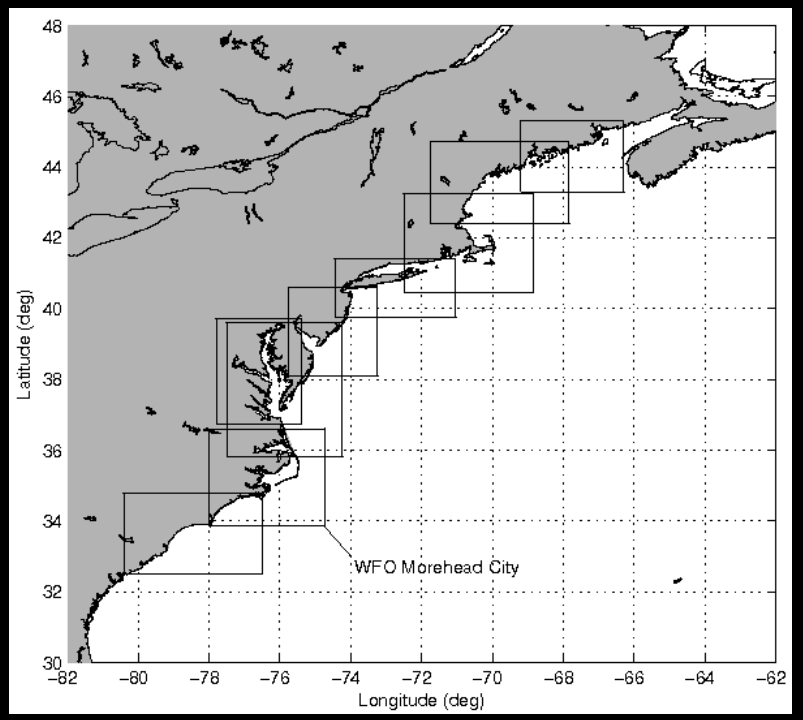


- Process-based & parameterized wave runup models
- Observations of beach slope, slope variability, topographic features
- Remote sensing expertise to measure wave runup

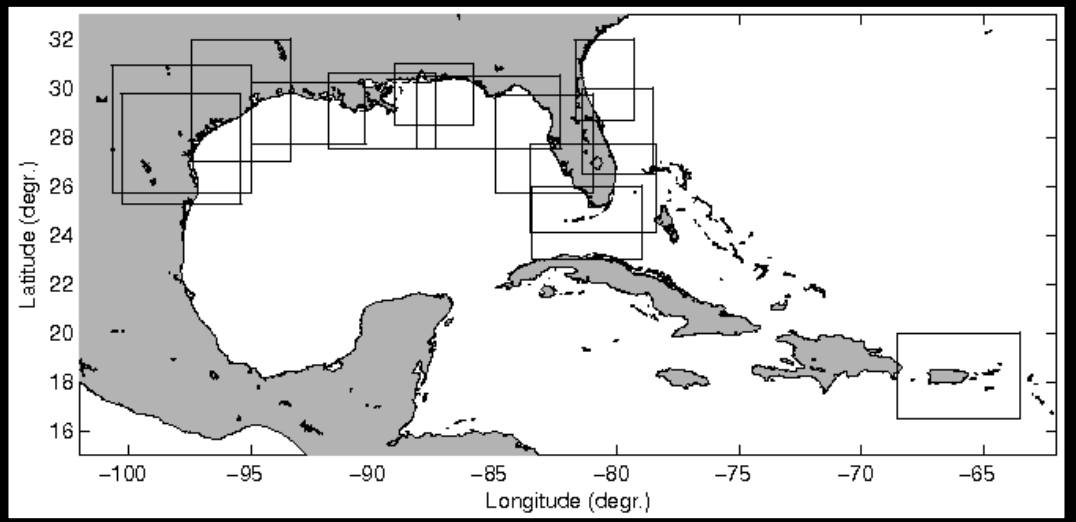
- Development of Nearshore Wave Prediction System and centralized computing infrastructure
- Operational forecasts and observations of waves, tides, surge
- Lines of communication with local emergency managers

Local Knowledge, Better Forecasts



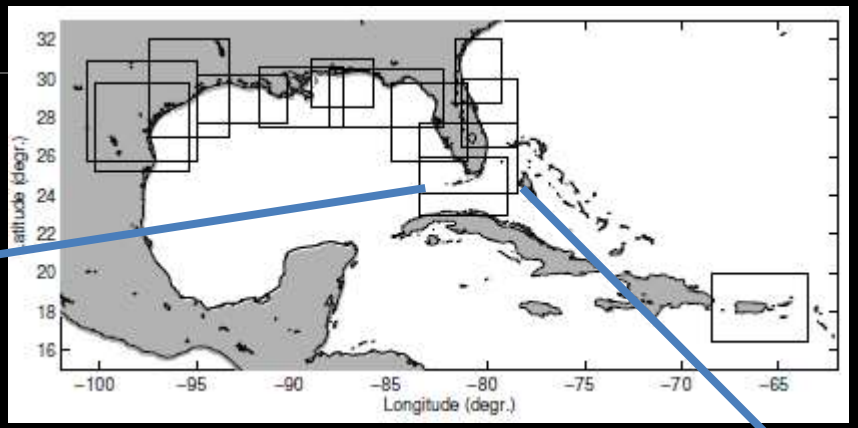


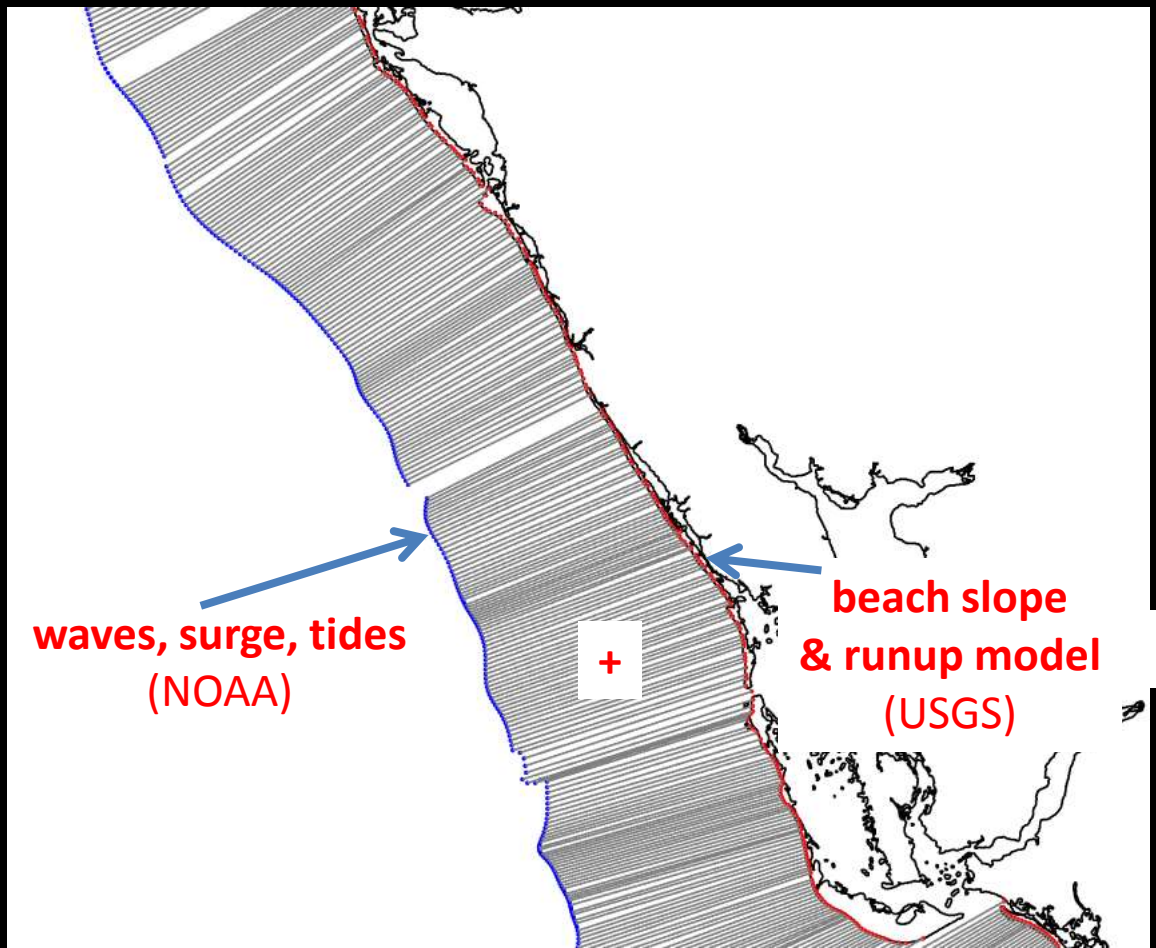
- 36 coastal Weather Forecast Offices (WFO).
- Meteorologists in each WFO prepare wave & surge model inputs - submit to centralized computer.



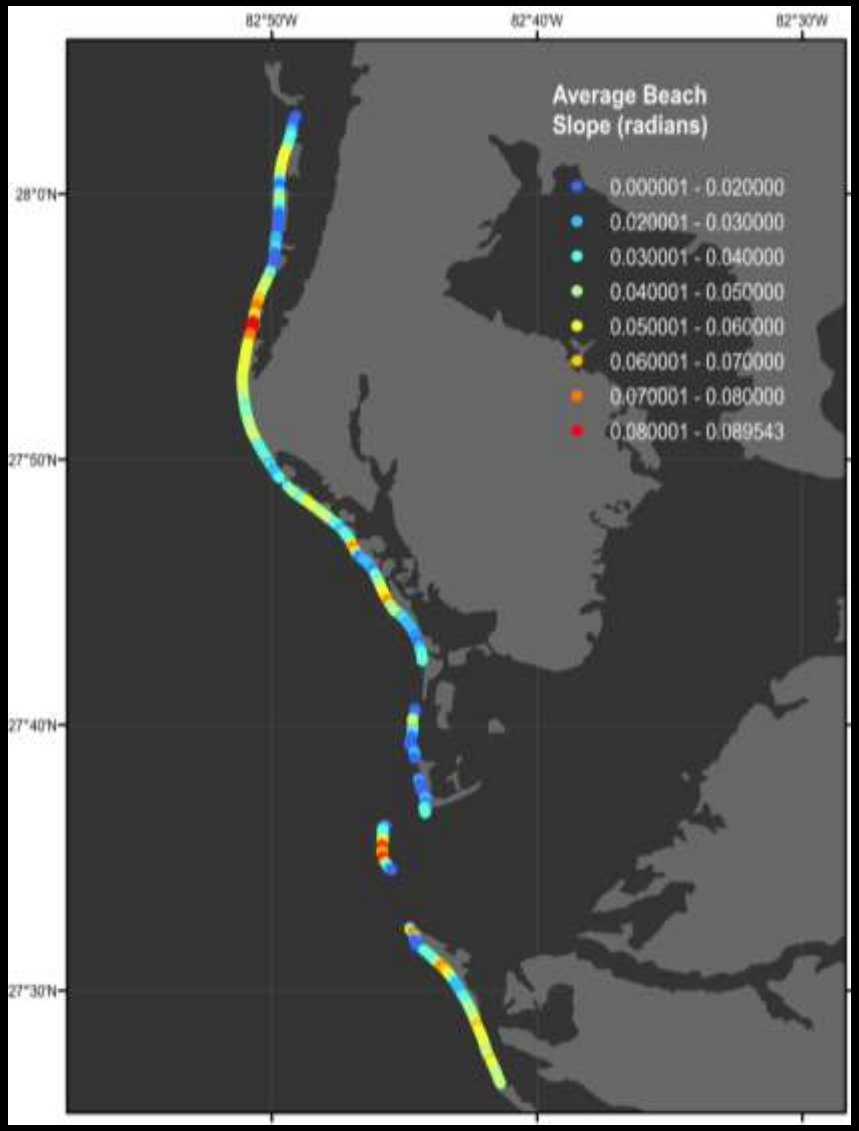
Automated Approach

- Wave runup model & beach slope data is housed on the NWS centralized computing infrastructure

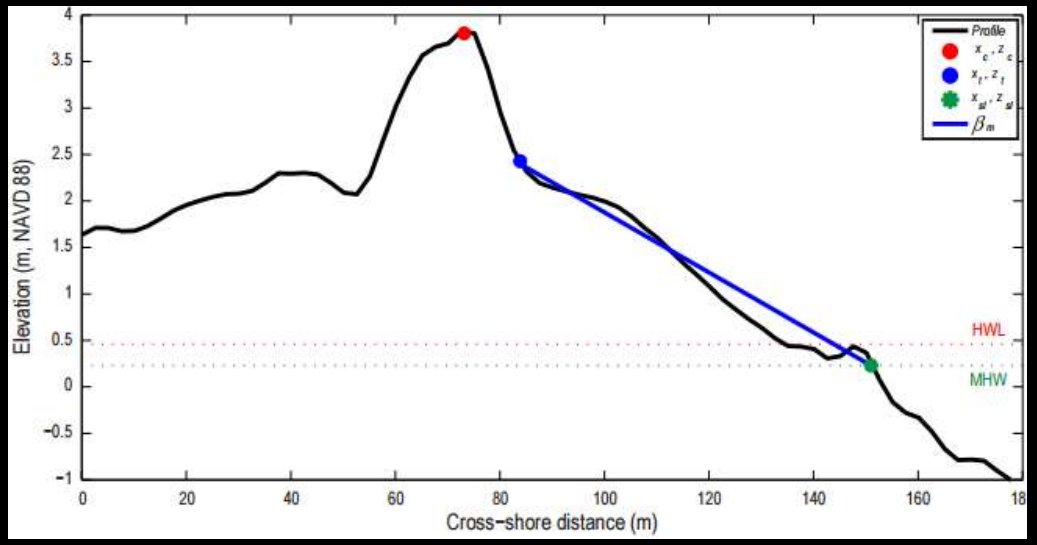




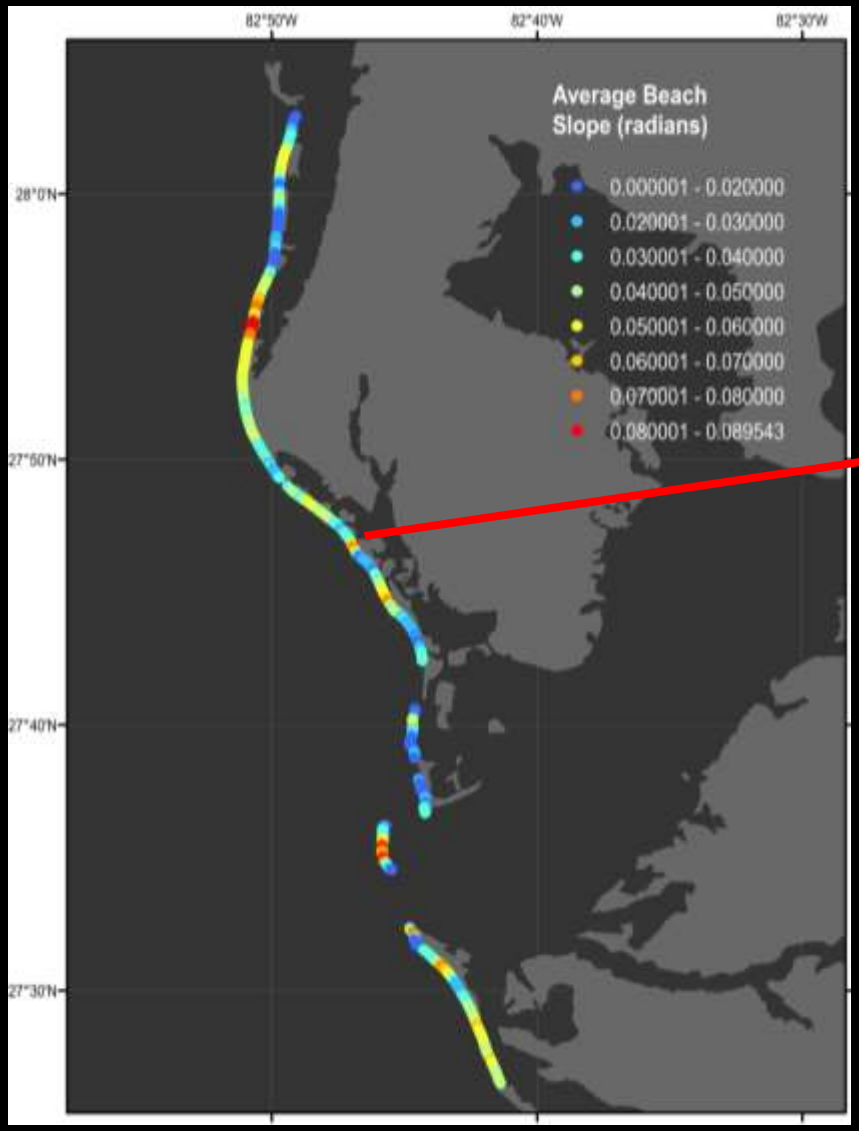
Beach slope input:

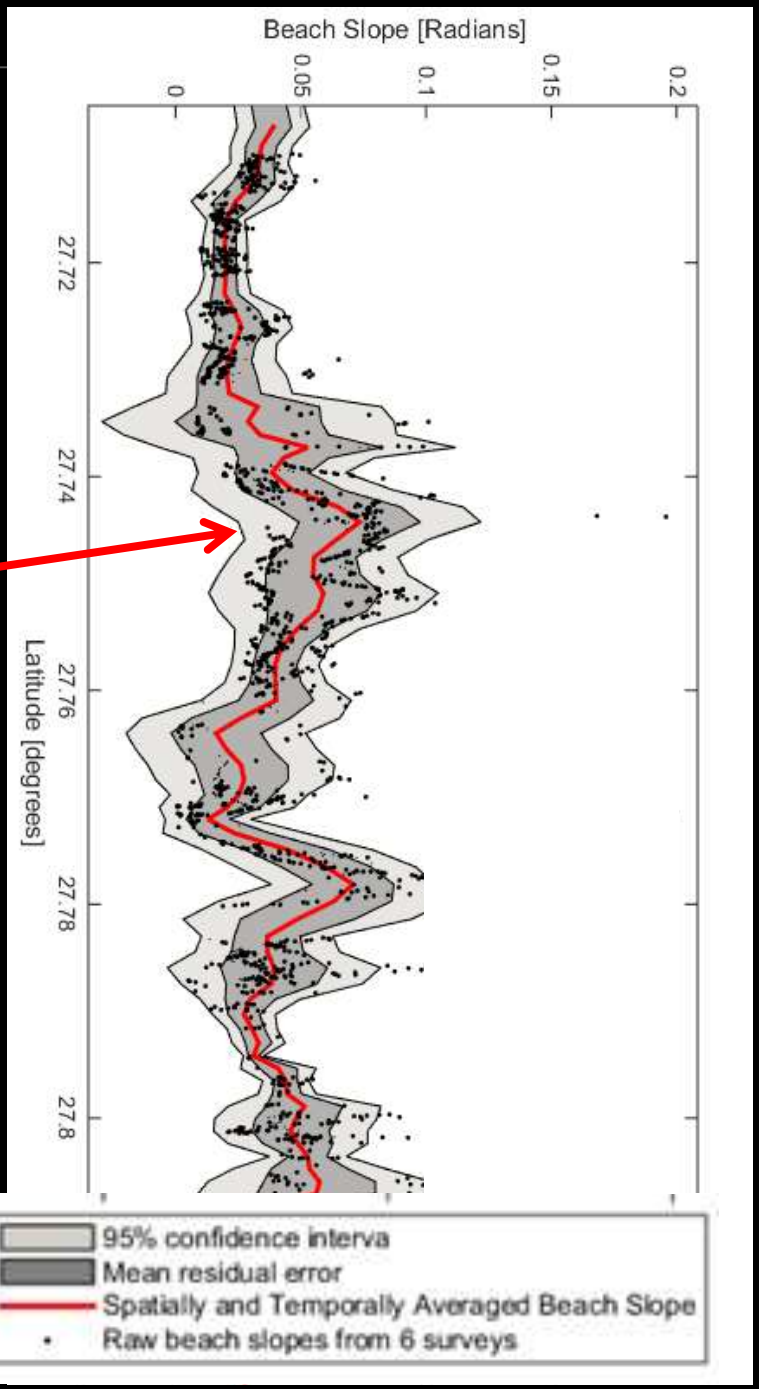


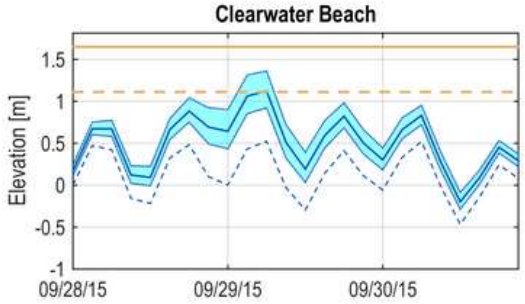
- Define a mean beach slope based on historical surveys
- Quantify spatial and temporal variability

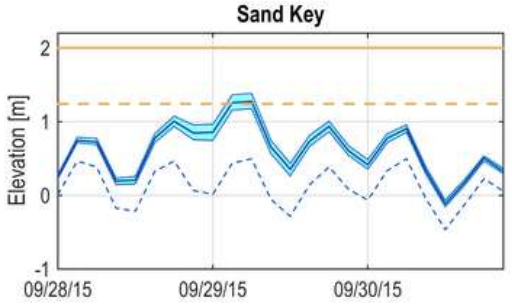


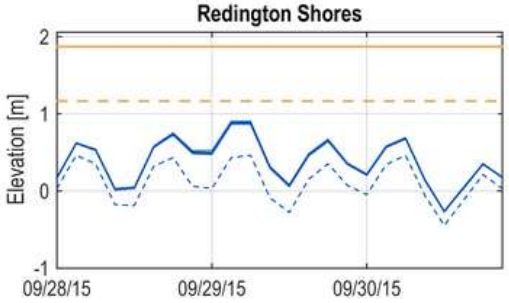
Spatial and Temporal Variability:

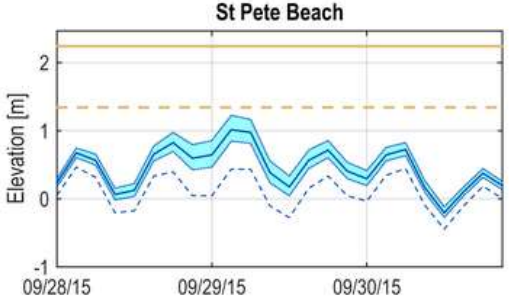


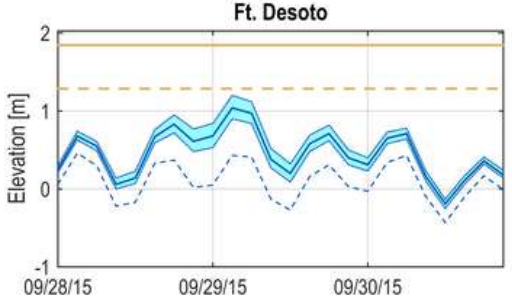


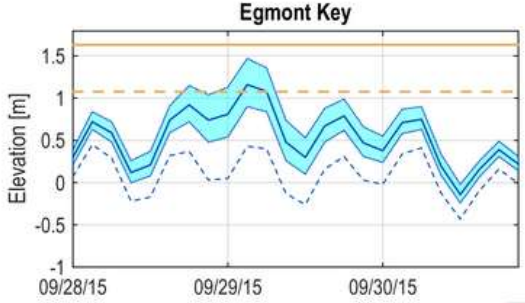


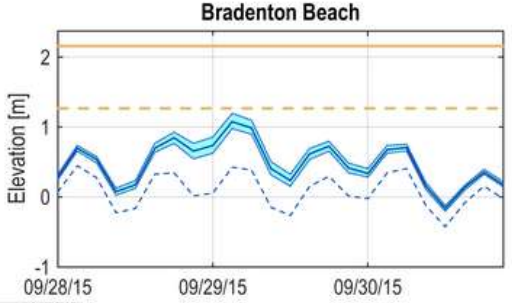


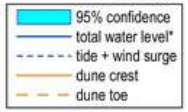










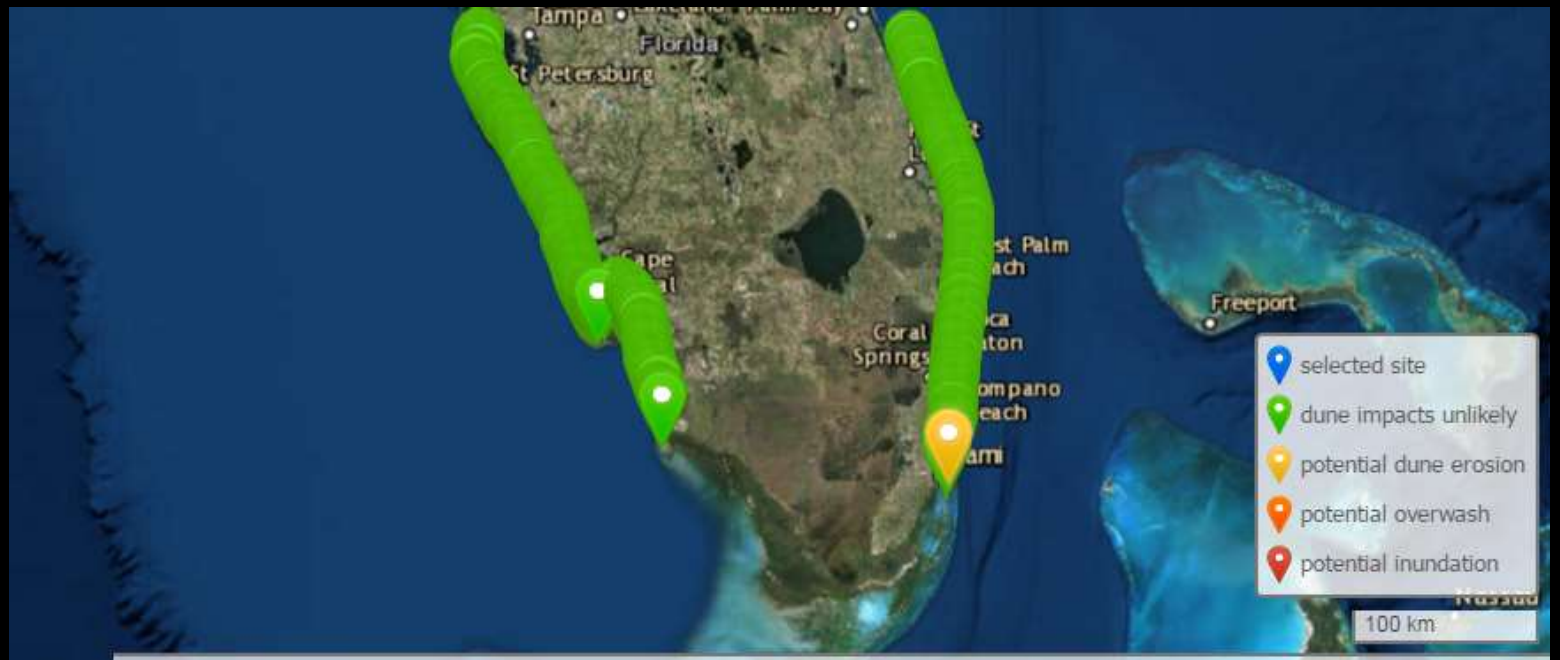


*includes tides, wind surge, and wave runup

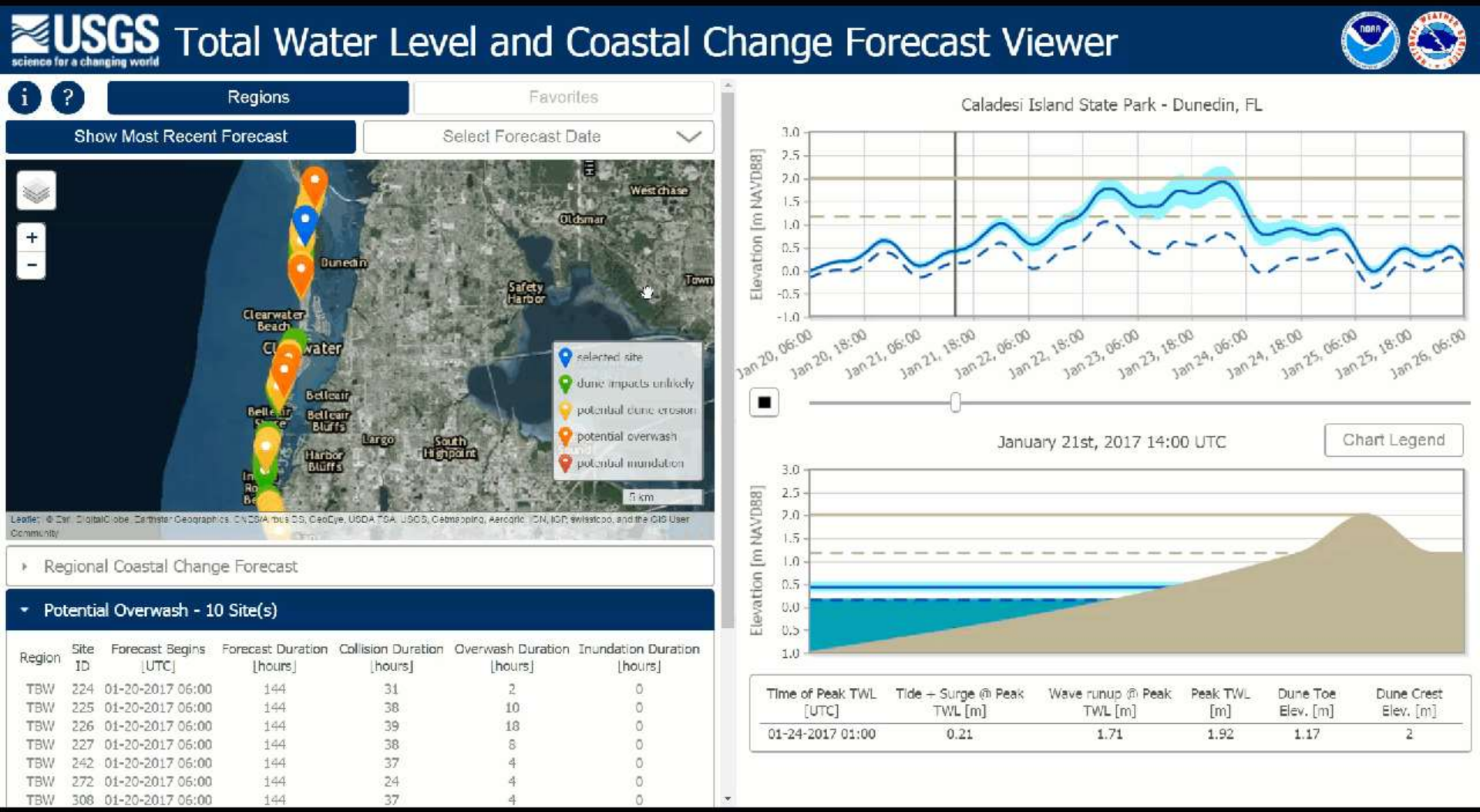
Forecast Dissemination:

- Forecasts are available on internal NWS systems and integrated into local warnings, watches, and advisories

- USGS public-facing viewer that provides:
  - Visualization of forecasts
  - Timing and magnitude of peak water levels
  - Time and duration of coastal change hazards (dune erosion, overwash)



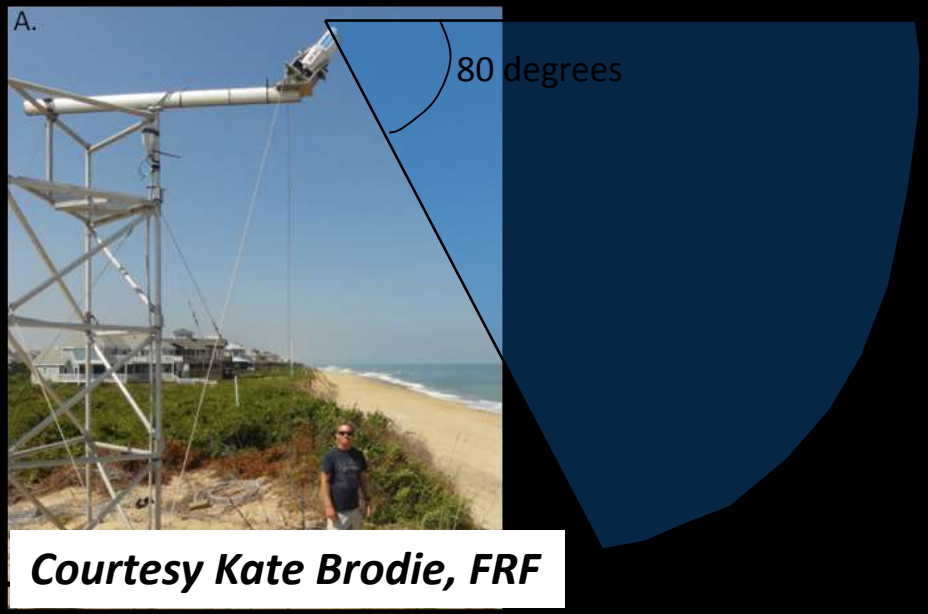
Forecast Dissemination:



https://coastal.er.usgs.gov/hurricanes/research/twlviewer/

Is the forecast any good?

Validating Total Water Level Forecasts:



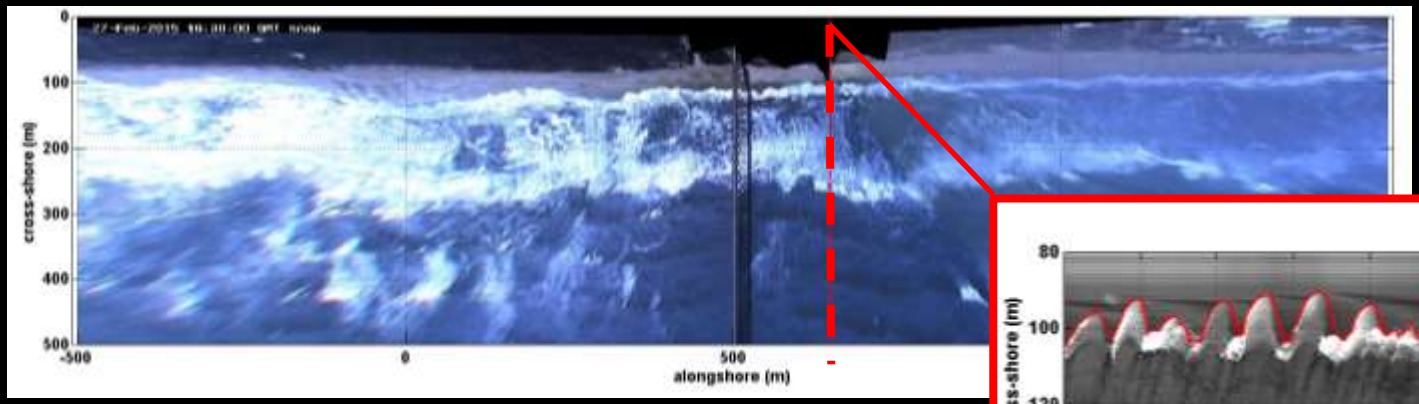
Courtesy Kate Brodie, FRF

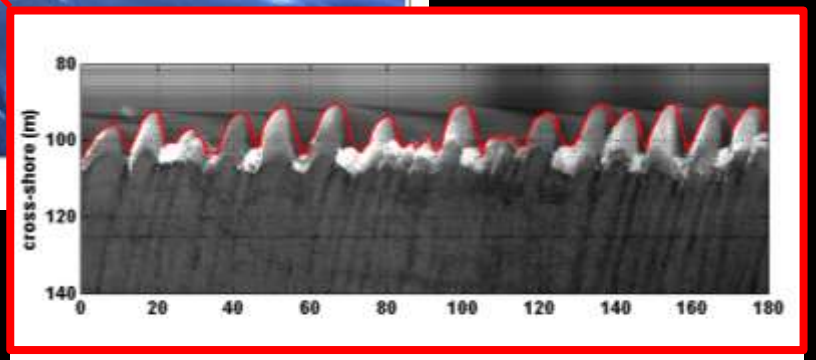
Video and lidar-based remote sensing provide spatially and temporally robust measurements of where water levels intersect the coast.

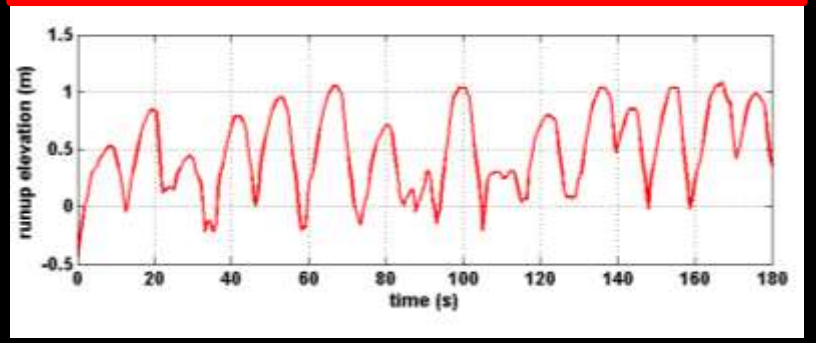
Validating Total Water Level Forecasts:

- Using elevated and ground-based sensors to track water levels on hourly timescales.

US Army Corps of Engineers®

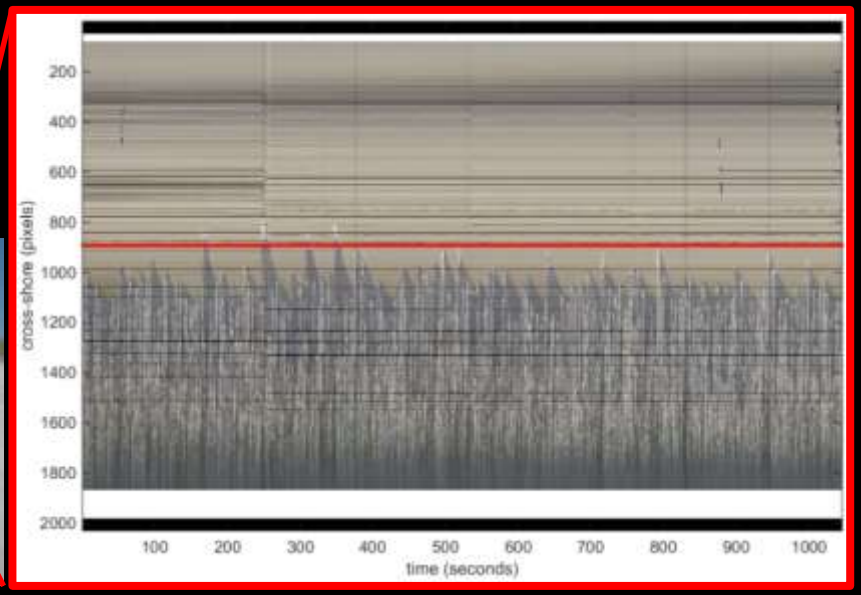






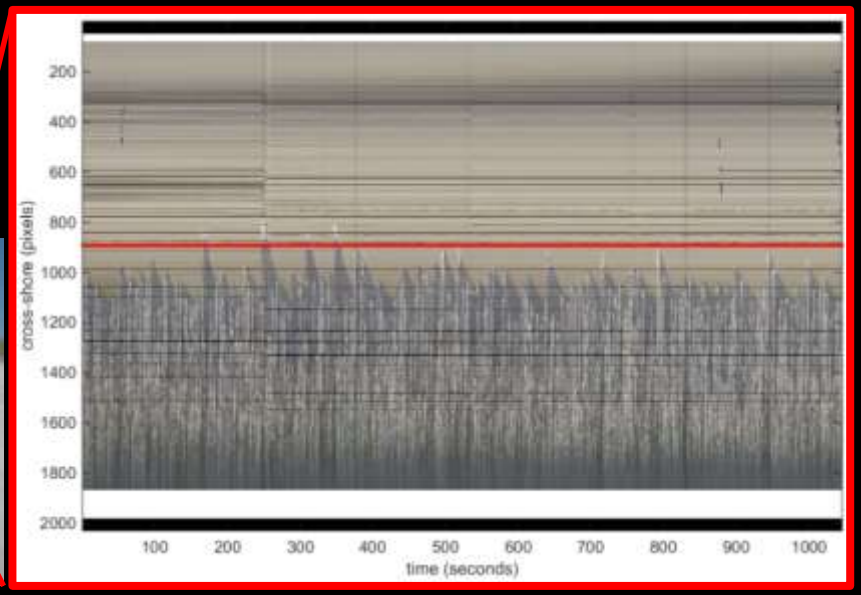
Validating Total Water Level Forecasts:

- Using elevated and ground-based sensors to track water levels on hourly timescales.
- Using both permanent and rapid/temporary sensors.

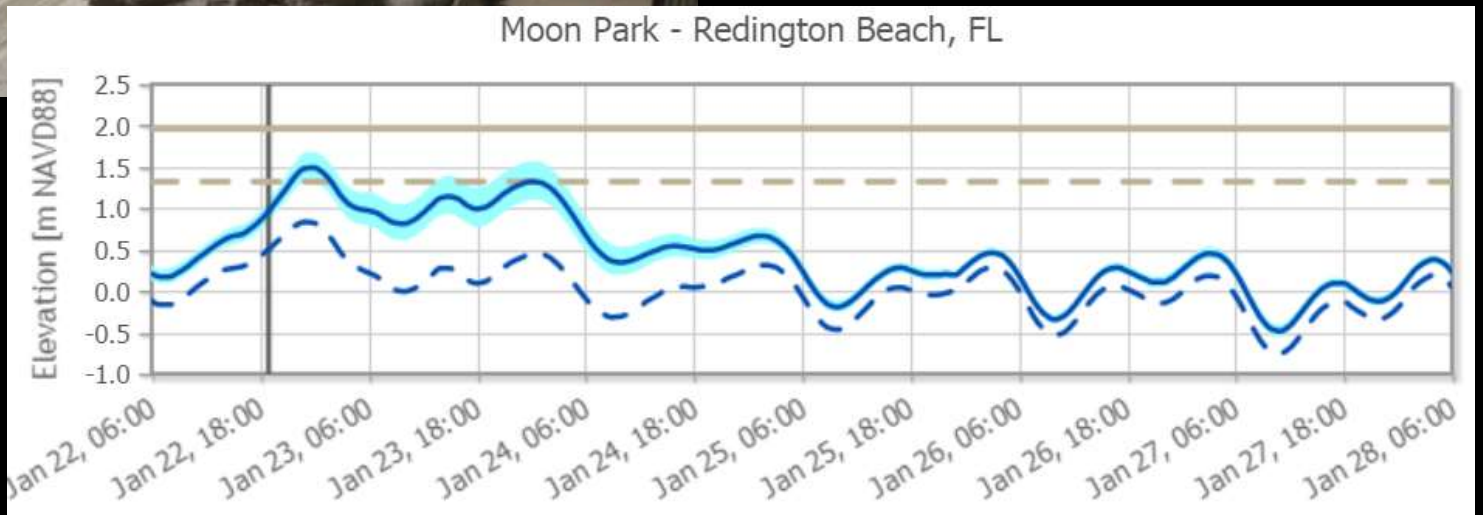


Validating Total Water Level Forecasts:

- Using elevated and ground-based sensors to track water levels on hourly timescales.
- Using both permanent and rapid/temporary sensors.
- Currently evaluating 2 locations in Outer Banks, North Carolina and 2 locations in Tampa Bay, Florida

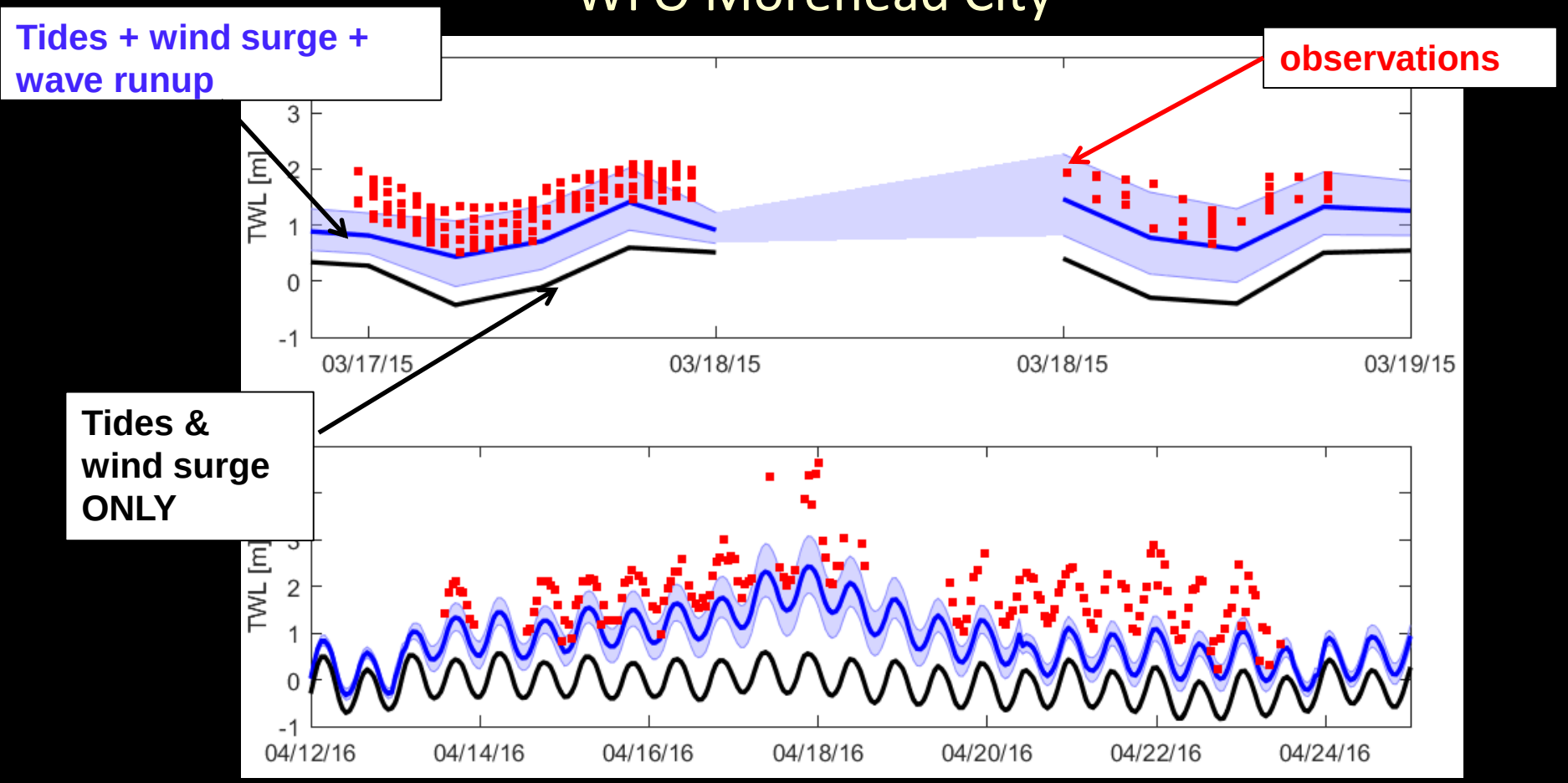


Example Tampa Bay Video Data:



Preliminary Validation:

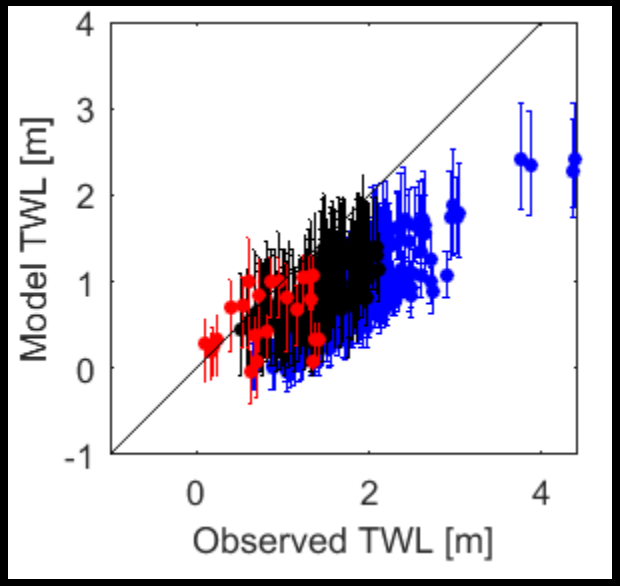
WFO Morehead City



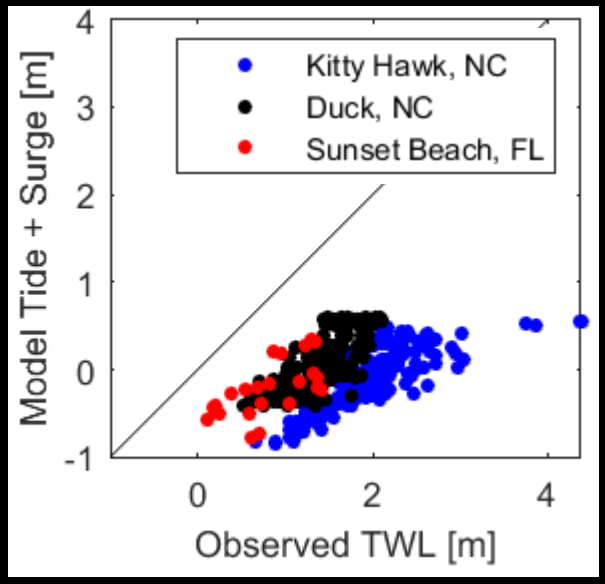
- Can now use these observations to investigate model errors and improvement.
- Total water level predictions at the shoreline improve with the addition of wave runup.

Preliminary Validation:

Tides + surge + wave runup

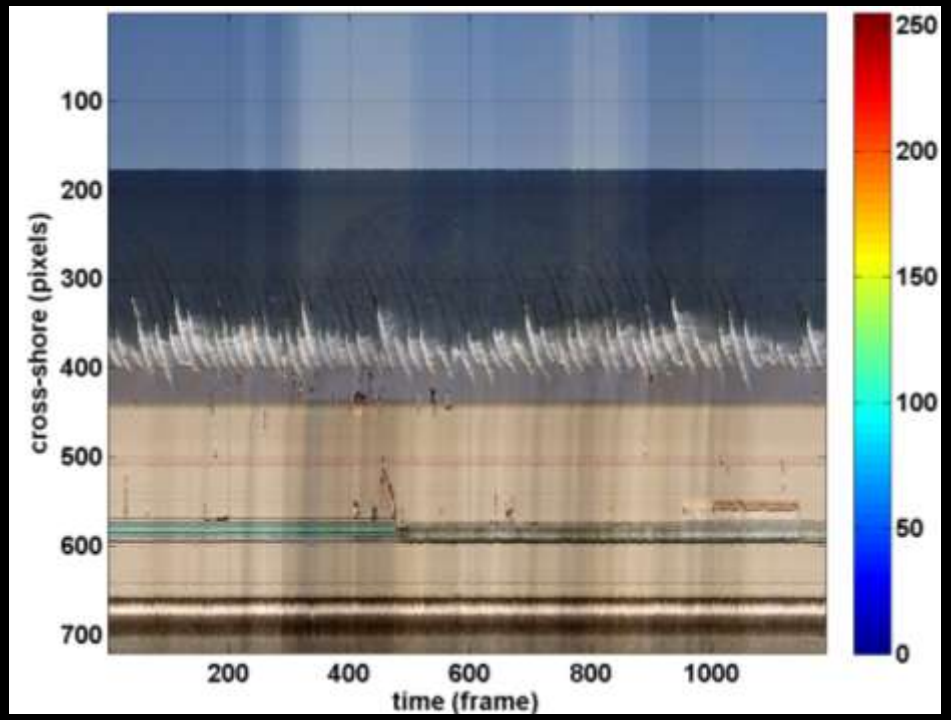


Tides + surge



- Data collected for over 300 hours in 3 different locations.
- In general, the model shows a bias towards underprediction of total water level.
- Total water level predictions based only on tides and surge have significant errors at the coast.

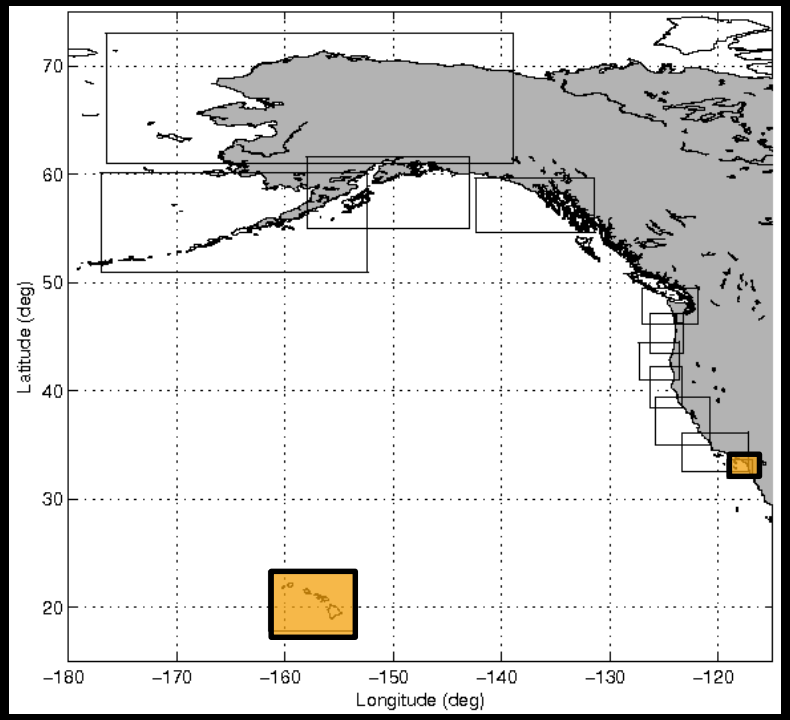
Expanded Validation Sites:

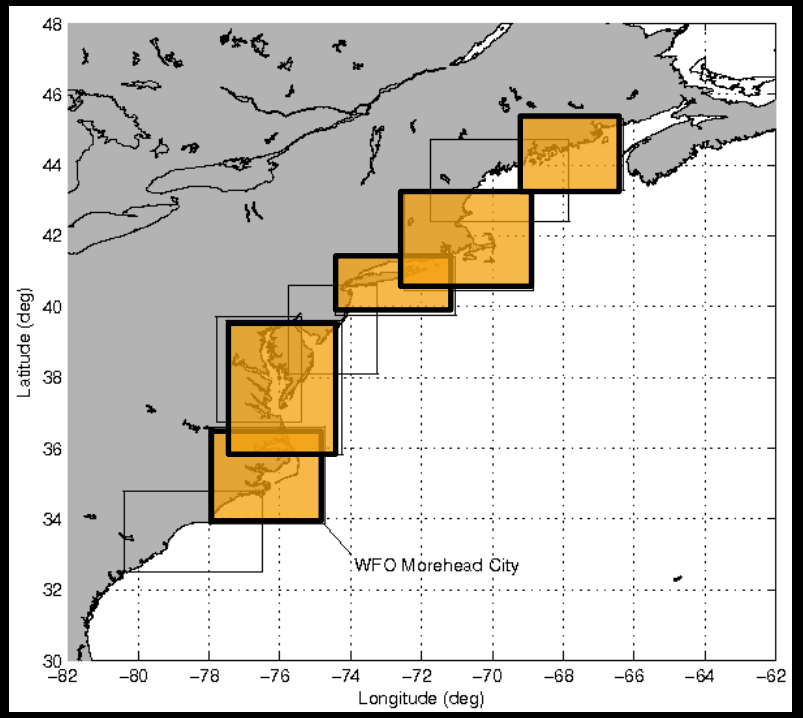


Example analysis of Surfline video data; Mantoloking, NJ

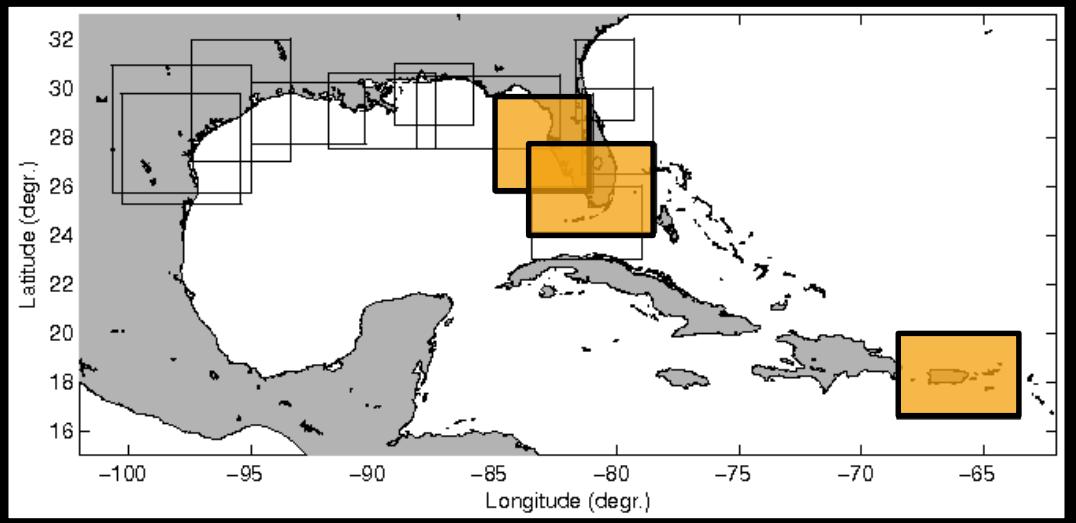
- Recently established a partnership between Surfline and the USGS to use video data collected by existing camera network.
- Will increase the number of validation sites using ‘cameras of opportunity’ that are already imaging the coast!

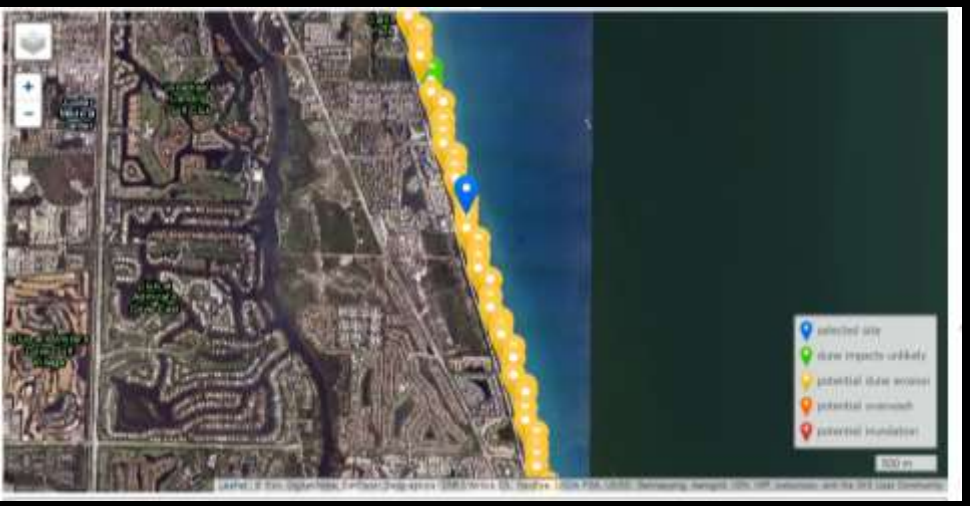
Expansion of Forecast Sites:

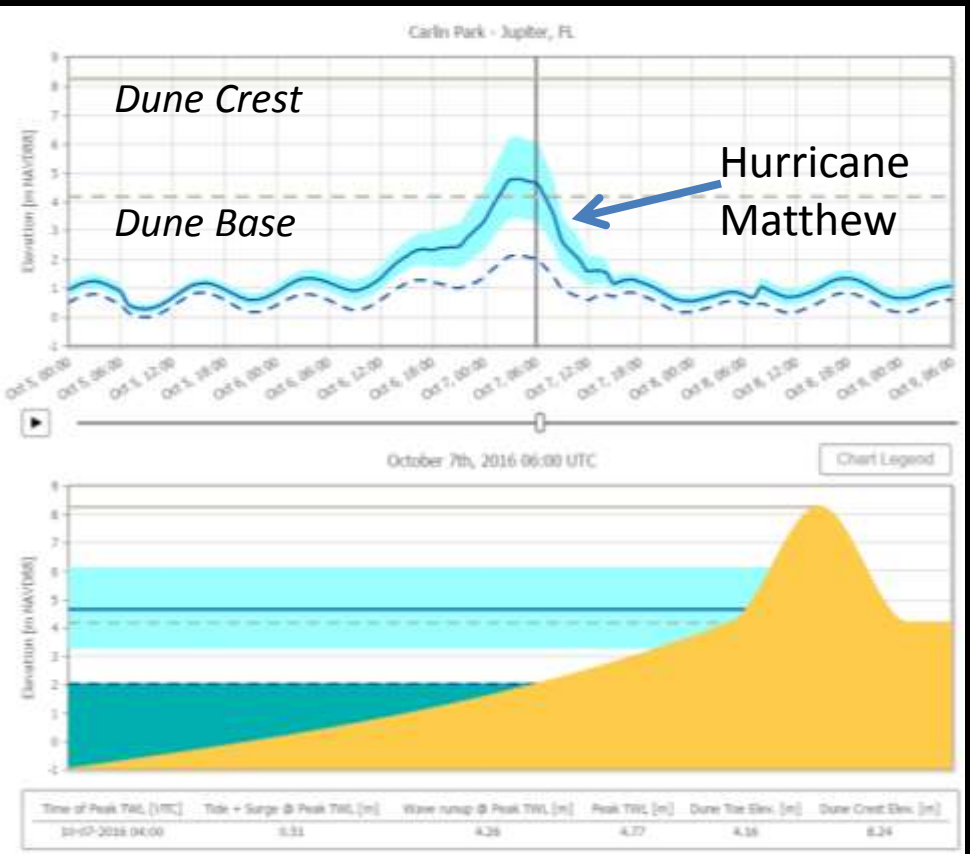




- Started at 5 pilot sites; expansion to 10 of 36 coastal WFOs.
- Use of unstructured grids.
- Incorporating additional wave runup formulations



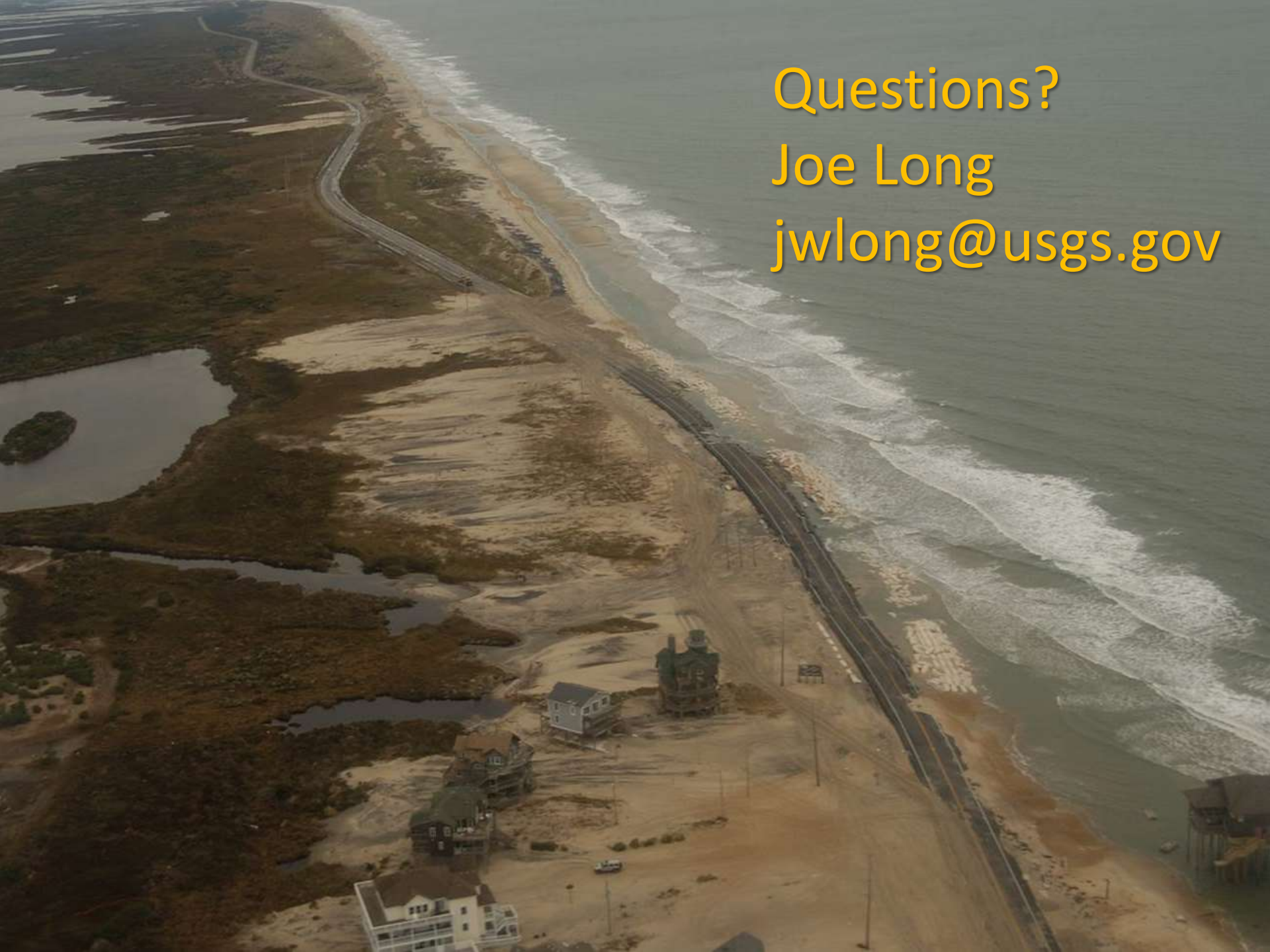




USGS/NOAA/NWS Wave Runup Forecasts

- Interagency effort providing forecasts every ~1km along the coast.
- Forecasts include combination of tides, wind surge, and ***wave runup***.
- Predicts the ***magnitude***, ***timing***, and ***duration*** of potenital water level impacts
- Provides ***operational*** predictions that can trigger local coastal change warnings for all storm events (tropical , extratropical storms, high tide flooding)
- Fully operational at five pilot sites; methodology designed to ***scale nationally***

coastal.er.usgs.gov/hurricanes/research/twlviewer


Questions?
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