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Resources Program

National, operational forecasts of shoreline total water levels and coastal change

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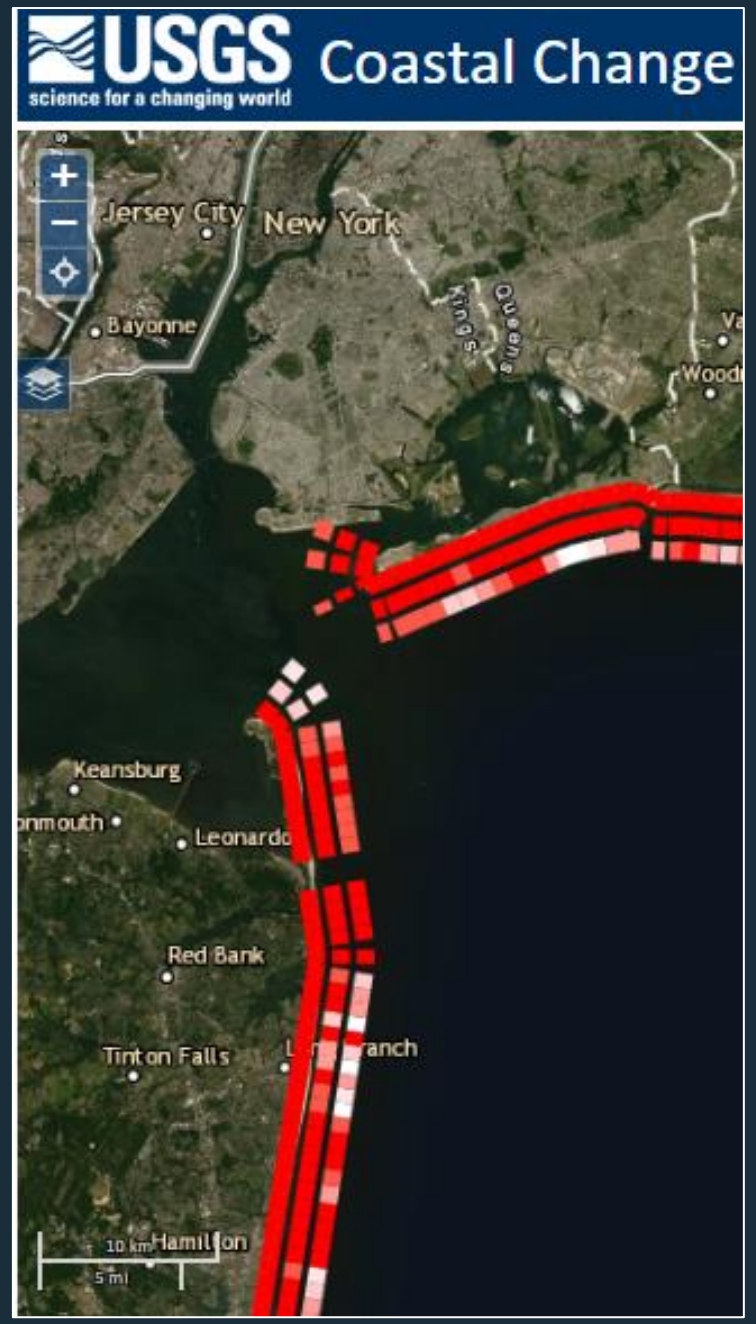

Hurricane Sandy

Rockaway Beach, NY

November 2012

FIRE DEPARTMENT
CITY OF NEW YORK

Sandy leveled the dunes. Another storm's on the way. I know it will be bad. But how bad?

~ FDNY Captain

Science for Decision-makers

- **Clear, compelling need.** "How will the coast change and when?" (Days to weeks; decades to centuries)
- **Science and research.** What is already known? What else do we need to know?
- **Data, data, data.** Extensive collections of water level and elevation data for model development, input, and validation.
- **Tested models.** Numerical and empirical models used to create a broadly applicable model.
- **Meaningful collaborations**. Complex problems of national scope require teams – federal and academic.

National, operational model for forecasting shoreline water levels and coastal change hazards

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Clear Need

Local **NWS Weather Forecasting offices** came to USGS **seeking guidance on wave-induced coastal erosion and flooding.**

“We had an idea of what the waves were going to be, [but] we really couldn’t accurately forecast the wave run-up component at the coast and get a good assessment of where the worst erosion and inundation was going to be.”

~ Rich Bandy, NOAA NWS

Early investment of ideas and commitment from NOAA:

*Mark Willis (Outer Banks NC)
*Tony Mignone (Caribou ME)
*Greg Dusek (Silver Springs MD)

Finding: NWS lacks sufficient forecast guidance on inundation associated with wave run-up and coastal rivers making it difficult to forecast impacts from coastal storms

Recommendation: NWS should develop guidance for inundation in coastal rivers and for wave run-up on U.S. coasts for *all* wind-forced surge and inundation events

Seaside Heights, NJ after Hurricane Sandy (2012)

Photo credit: Mario Tama

Sullivan & Uccellini 2013;
NOAA Hurricane Sandy Service Assessment

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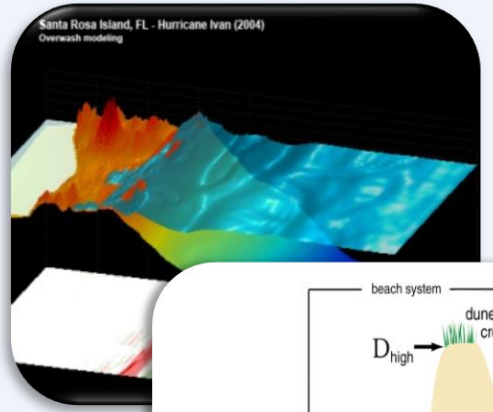
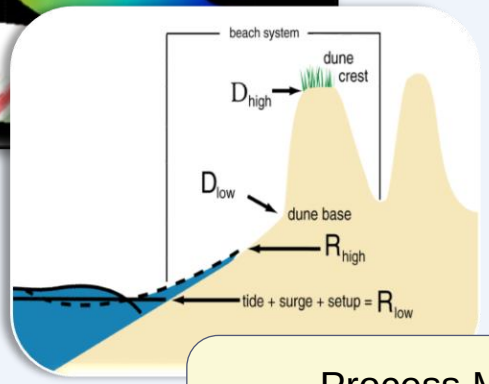
Forecasting Coastal Change Hazards

Models describing the interactions between coastal processes, morphologic evolution, and ecosystem change (USGS, NOAA) are used with high-resolution observations of water levels, waves, elevation, and land cover (USGS, NOAA, USACE) to understand and forecast how coastal environments will respond to future storm conditions and provide stakeholders with actionable information at a national scale

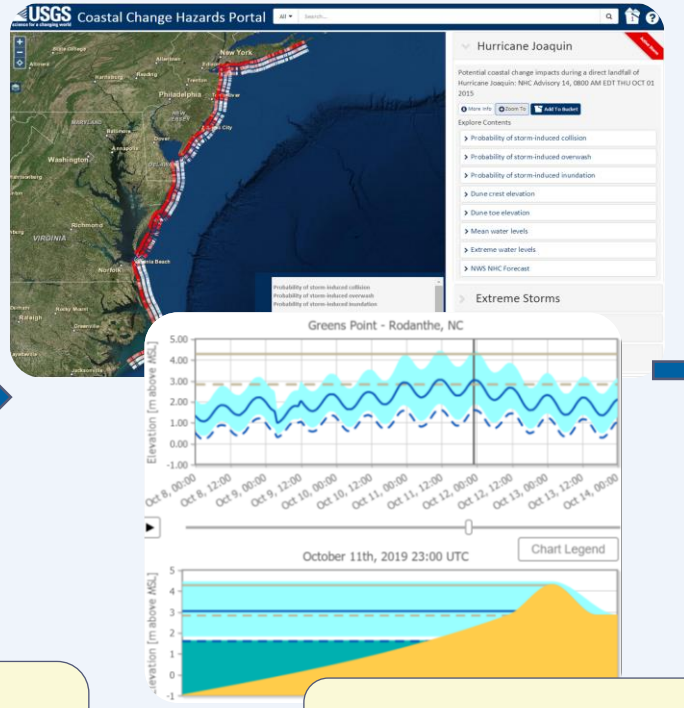
Oceanographic Observations/Models

Coastal Elevations and Land Cover





Process Models (waves, surge; coastal change; feedbacks)



Coastal Change Hazards Assessments

Actionable Information for Stakeholders

Probability of coastal change for hurricanes

INPUT:

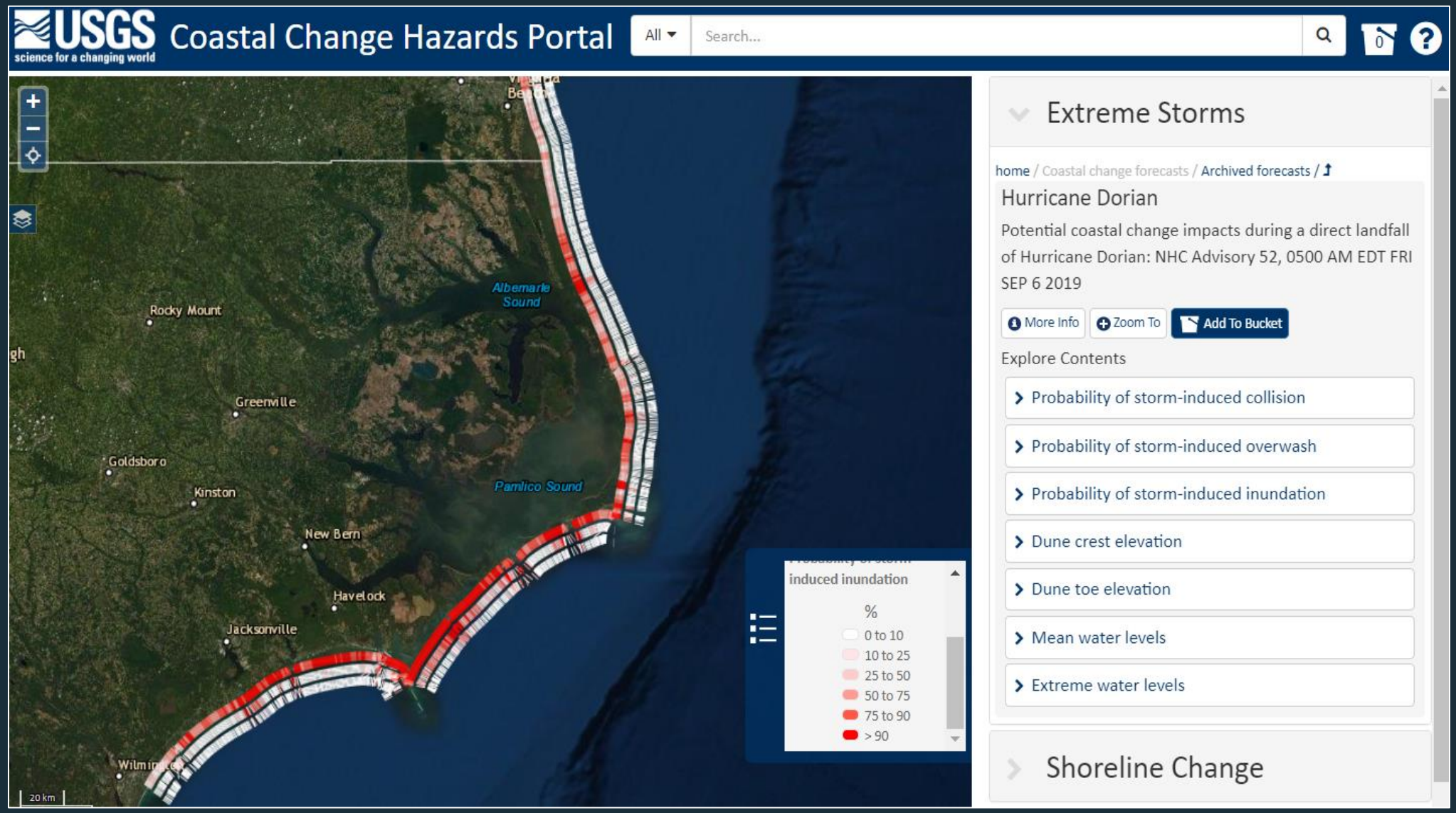
Lidar-based morphology (USGS, USACE, NOAA0

Wave and surge forecasts (NOAA NHC)

OUTPUT:

Modeled for total water level and coastal change (USGS)

- Updated with NHC advisories
- Online and interactive
- Downloadable data and mapping services



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But then this happened.

Operational models forecasting TWL and coastal change for…

- ***All wave/weather conditions***,
- ***Everywhere***,
- Addressing ***local concerns*** and triggering local warnings.

Forecasts would include ***magnitude, timing, and duration*** of water level impacts.

Tool/service had to be

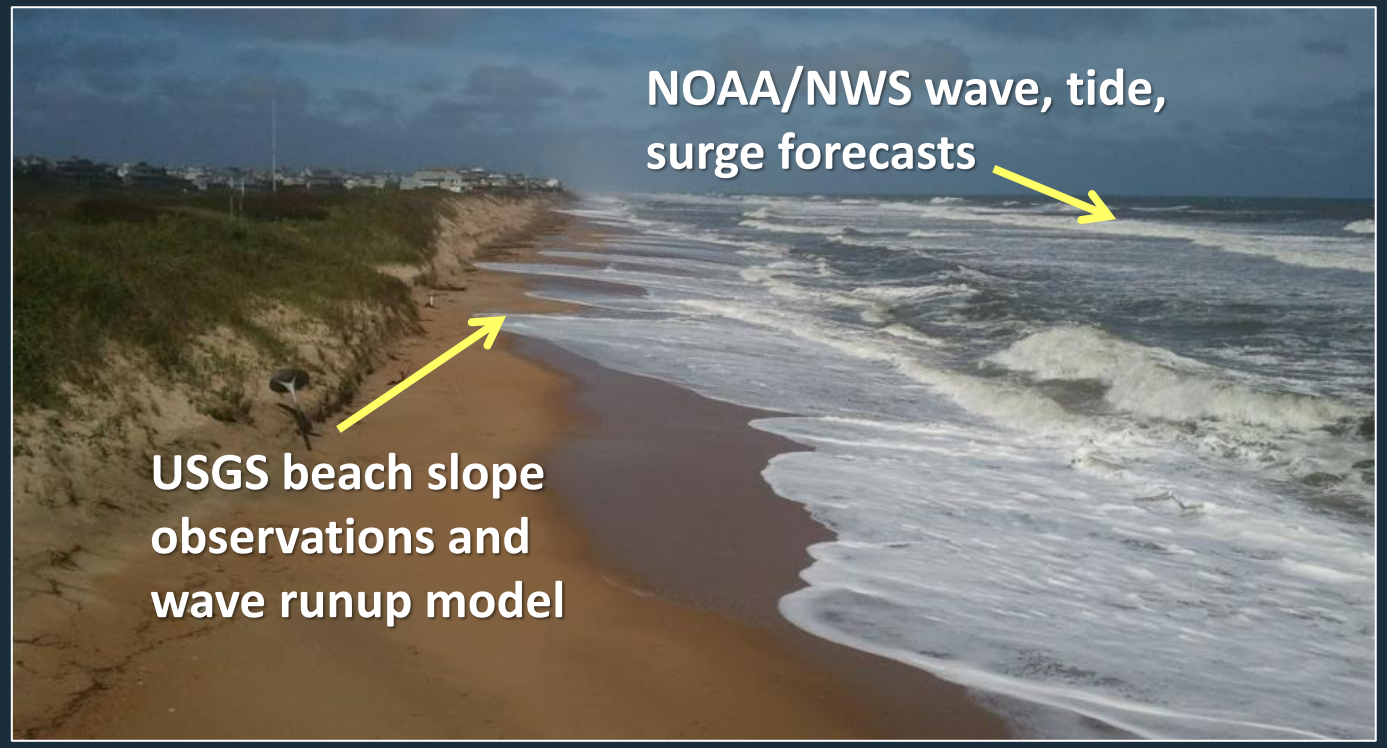
- reliable,
- sustained,
- understandable, and
- accurate.

AND, it needed to fill a need.

Operational Model for Total Water Levels (USGS/NWS)

Strong collaborations

Develop and validate an operational forecast system for total water levels along the coast that includes tides, wind surge, and wave runup.



- Process-based wave runup models
- Observations of topography, beach slope, slope variability
- Expertise to observe and study wave runup and coastal erosion

- Development of NWPS and centralized computing infrastructure
- Operational forecasts and observations of waves, tides, surge
- Connection to local emergency managers

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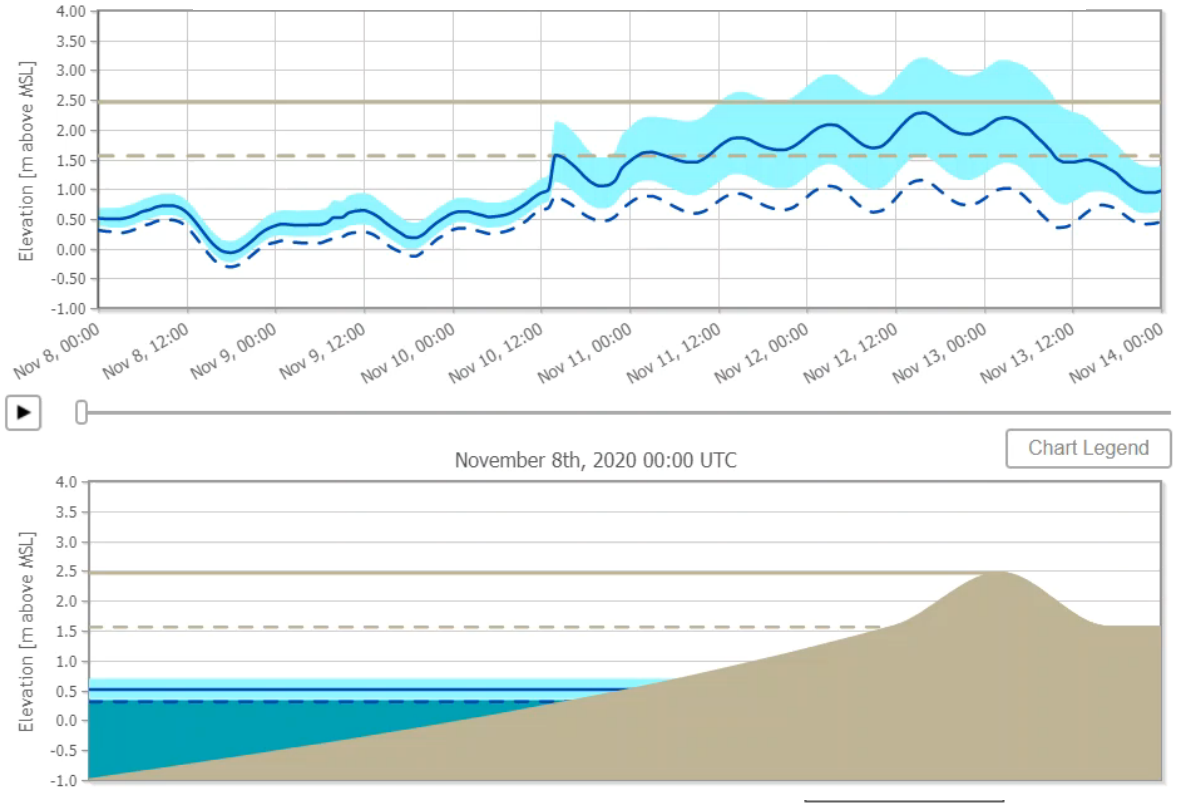
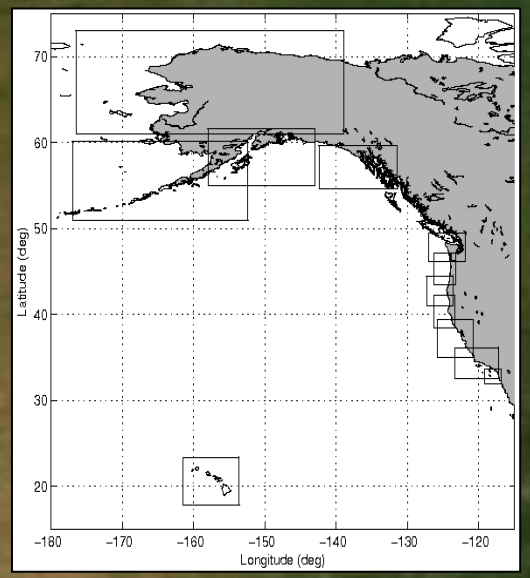


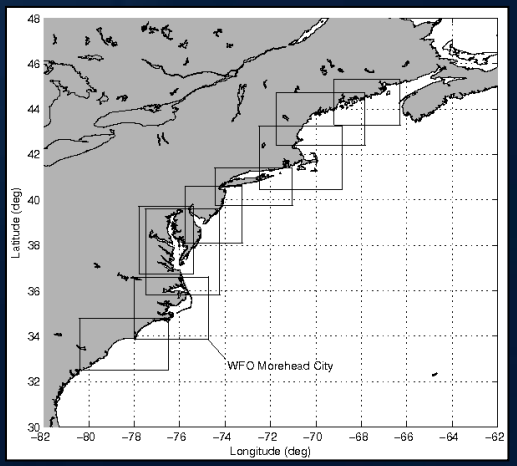
USGS/NOAA/NWS Wave Runup Forecasts

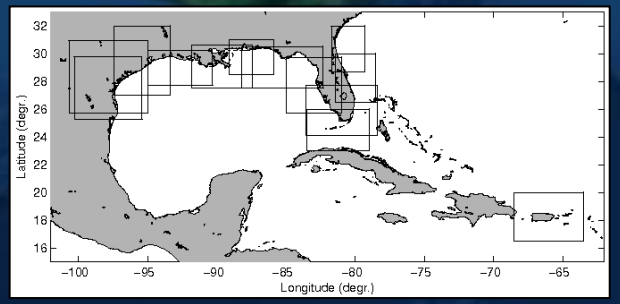
- Interagency effort providing forecasts every 300-500 meters along the coast, hourly for a 6-day period.
- Forecasts include combination of tides, wind surge, and ***wave runup***.
- Predicts the ***magnitude***, ***timing***, and ***duration*** of water level impacts
- Provides ***operational*** predictions that can trigger local coastal change warnings for all storm events (tropical and extratropical storms)

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



NOAA Nearshore Wave Prediction System, including USGS TWL and coastal change forecasts, is being ***implemented nationally***.
Currently operational on the sandy coasts of the US Gulf and Atlantic.
Pacific coast grids are under development.





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How high will the water be? What will happen on land?

Clear need. Quality research. Loads of data. Solid models.
Strong collaborations. Brave moves. Information provided.

National model for operational forecasts of shoreline water levels and coastal change hazards

MOVING AHEAD

NOAA:

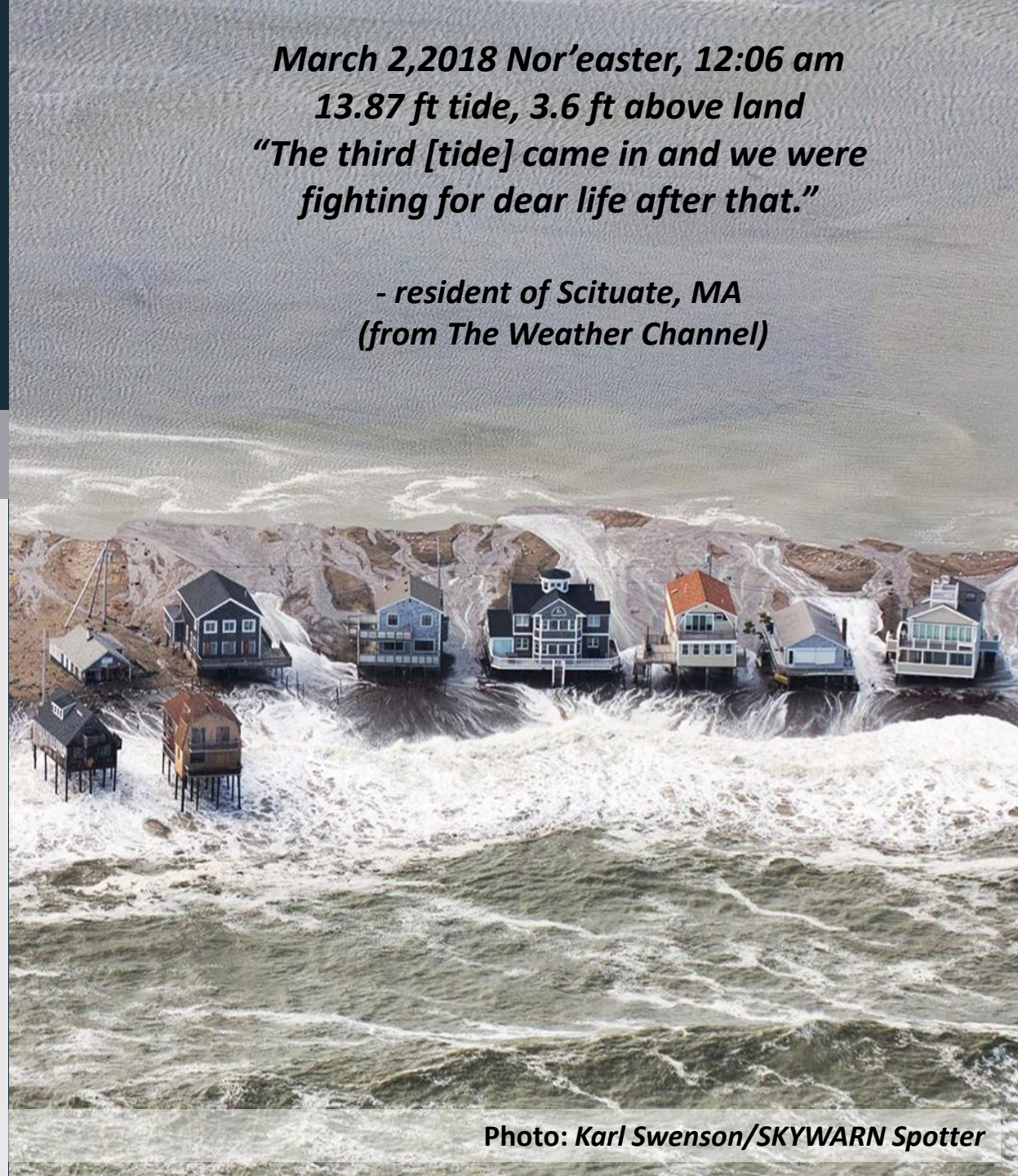
- model implementation
- guidance on hazardous conditions
- delivery, products, and user interface

USGS:

- model development and validation
- research aimed towards improved models, broader applicability

BOTH:

- well-supported, sustained observational systems (water levels; coastal elevations)
- continued connection with users



Operational Total Water Level and Coastal Change Forecasts:
https://coastal.er.usgs.gov/hurricanes/research/twlviewer/

Nearshore Wave Prediction Center:
https://polar.ncep.noaa.gov/nwps/

USGS: Hilary Stockdon, Meg Palmsten, Kara Doran, Joe Long, Richard Snell, Justin Birchler, Jenna Brown, Alfredo Arextabaleta, Li Erikson

NOAA NCEP: Andre Van der Westhuysen

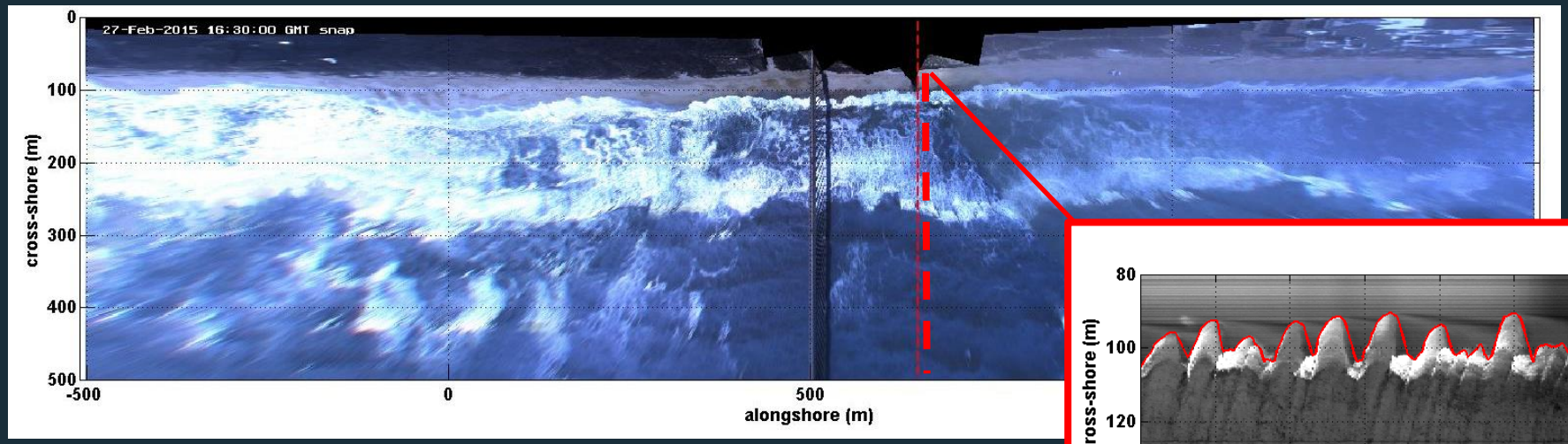
NOAA NWS: Rich Bandy, Pablo Santos, Mark Willis, Tony Mignone, John Cannon, Robert Thompson, Alex Gibbs, Donnie King, Greg Dusek

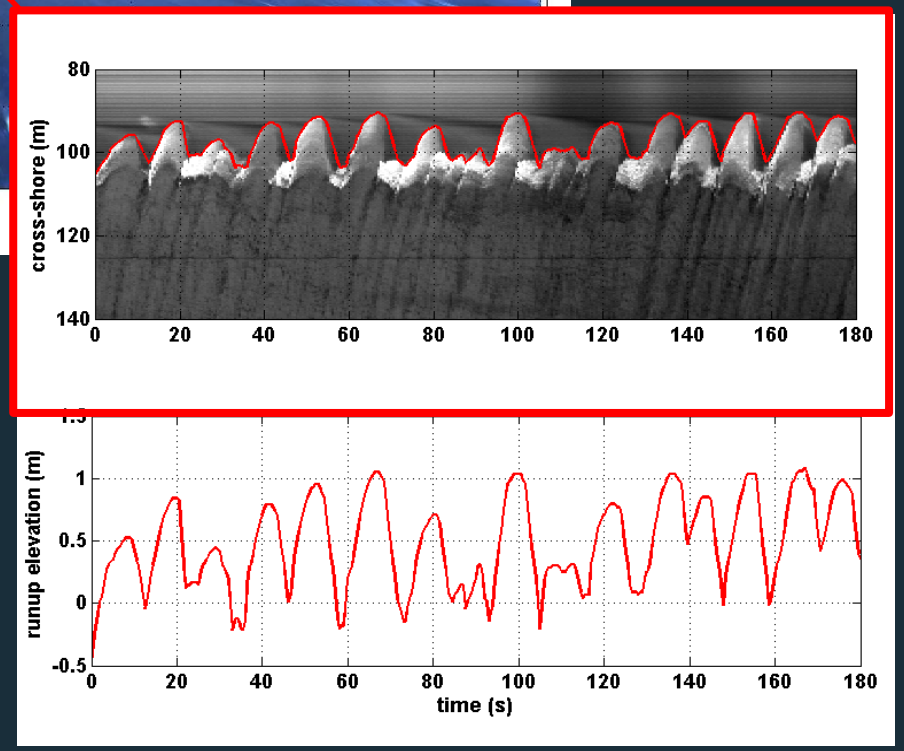
National, operational forecasts of shoreline total water levels and coastal change

Validating Total Water Level Forecasts

Research

- Using elevated and ground-based sensors to measure water levels on hourly timescales
- Collaborative work between USGS, USACE, NOAA, and academics





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