New Storm Surge Products at the National Hurricane Center

Robbie Berg

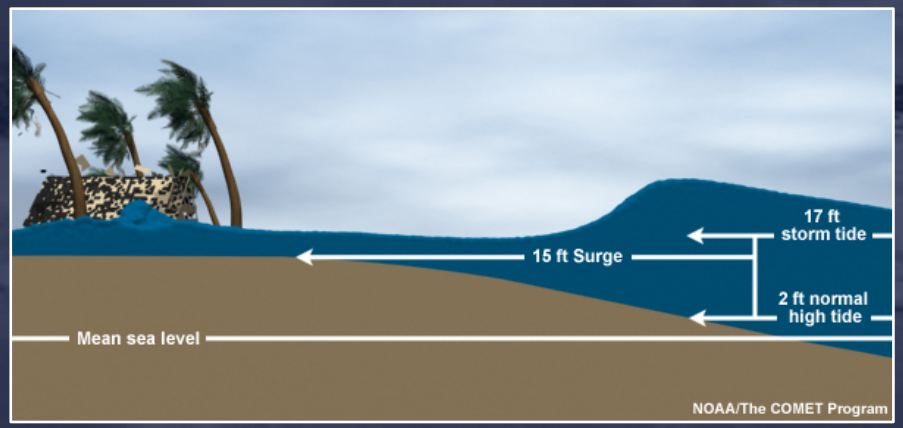
National Hurricane Center

SECART Webinar

13 May 2014

SLOSH

- Sea, Lake, and Overland Surges from Hurricanes
- A computerized numerical model developed by the National Weather Service (NWS) to estimate storm surge heights (and winds) resulting from historical, hypothetical, or predicted hurricanes

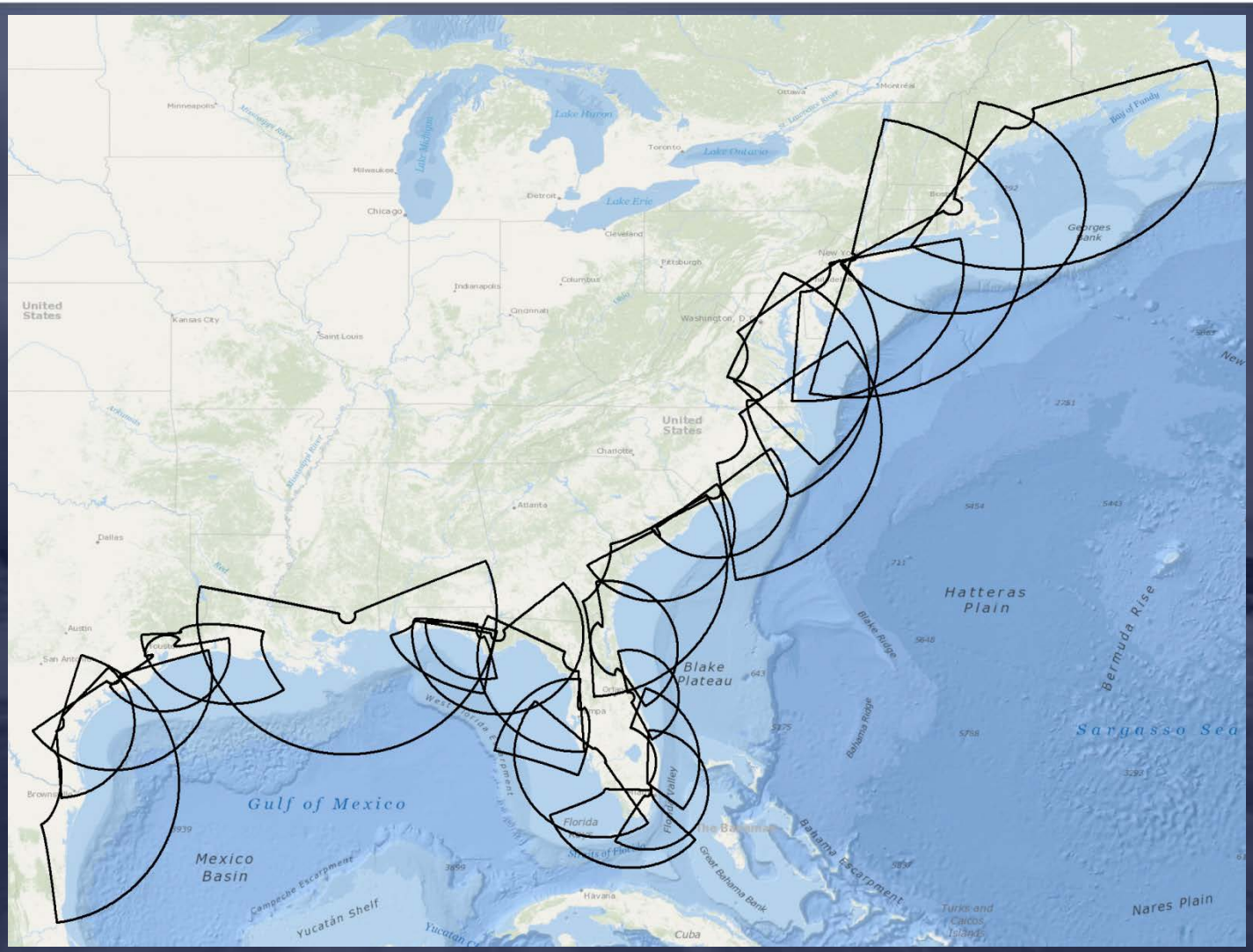


SLOSH
Strengths and Limitations

- SLOSH does include:
  - Flow through barriers/gaps/passes
  - Deep passes between bodies of water
  - Inland inundation (wet/dry cell)
  - Overtopping of barrier systems, levees, and roads
  - Coastal reflection (coastally trapped Kelvin waves)
  - Astronomical tides

- SLOSH does not include:
  - Breaking waves/wave run-up
  - Normal river flow and rain

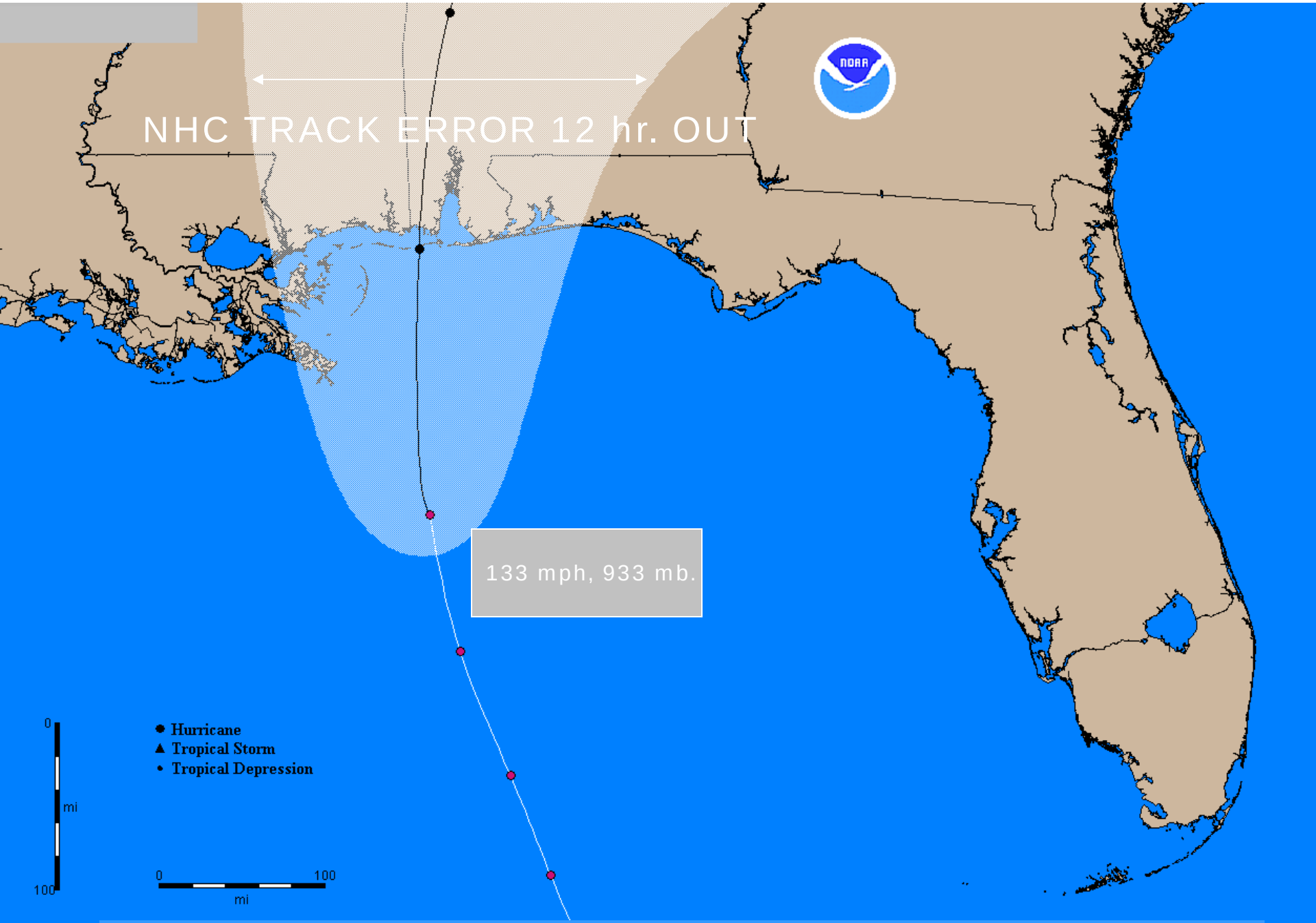
SLOSH Grids


Minneapolis
Milwaukee
Chicago
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
Toronto
Ottawa
Montreal
Detroit
Cleveland
Pittsburgh
Columbus
Indianapolis
Cincinnati
Washington, D.C.
Kansas City
Saint Louis
United States
Charlotte
Atlanta
Dallas
Austin
San Antonio
Brownsville
Gulf of Mexico
Mexico Basin
Campeche Escarpment
Yucatán Shelf
Florida
Florida Valley
Havana
Cuba
Great Bahama Bank
Bahama Escarpment
Blake Plateau
Blake Ridge
Bahama Ridge
Hatteras Plain
Bermuda Rise
Sargasso Sea
Georges Bank
Bay of Fundy
Nares Plain
Turks and Caicos Islands

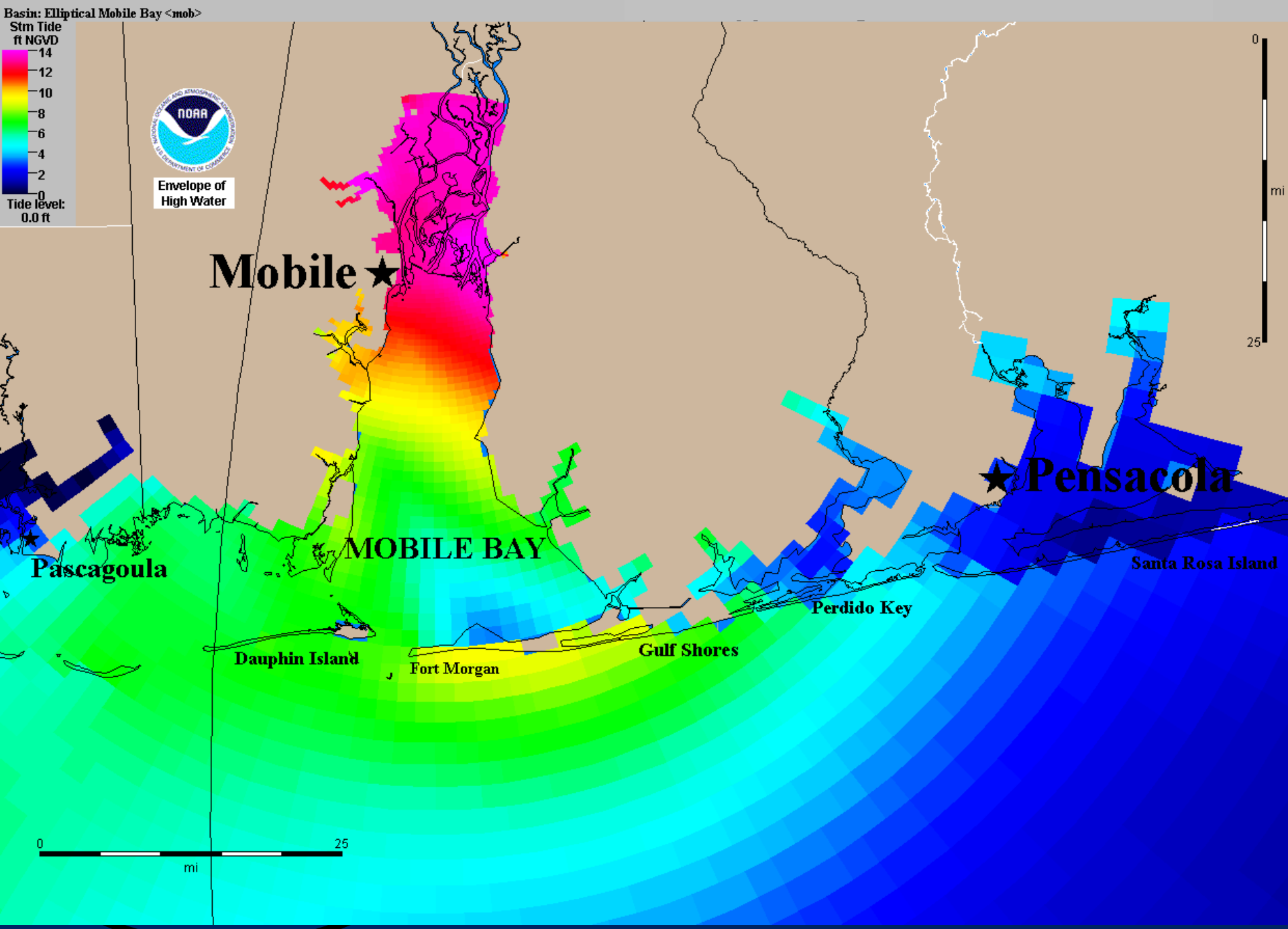
Forecasting Storm Surge

- All storm surge models are STRONGLY dependent on the accuracy of the meteorological input
- Meteorological uncertainty will dominate over storm surge model specifications (physics, resolution, etc)
- Different vertical datums/reference levels
- Storm surge is only one component in the real water level rise

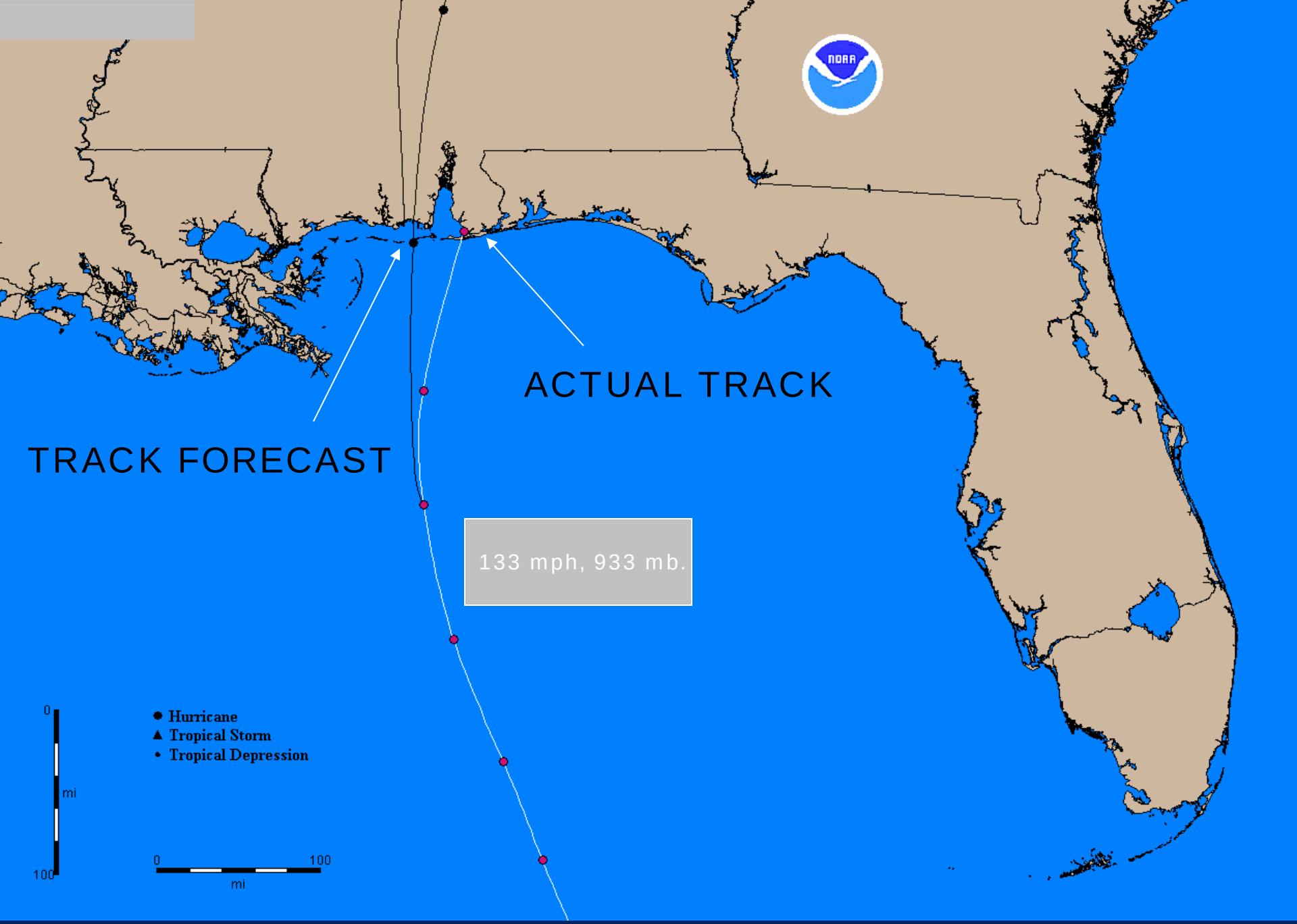
Total water rise = surge + tides + waves + freshwater flow



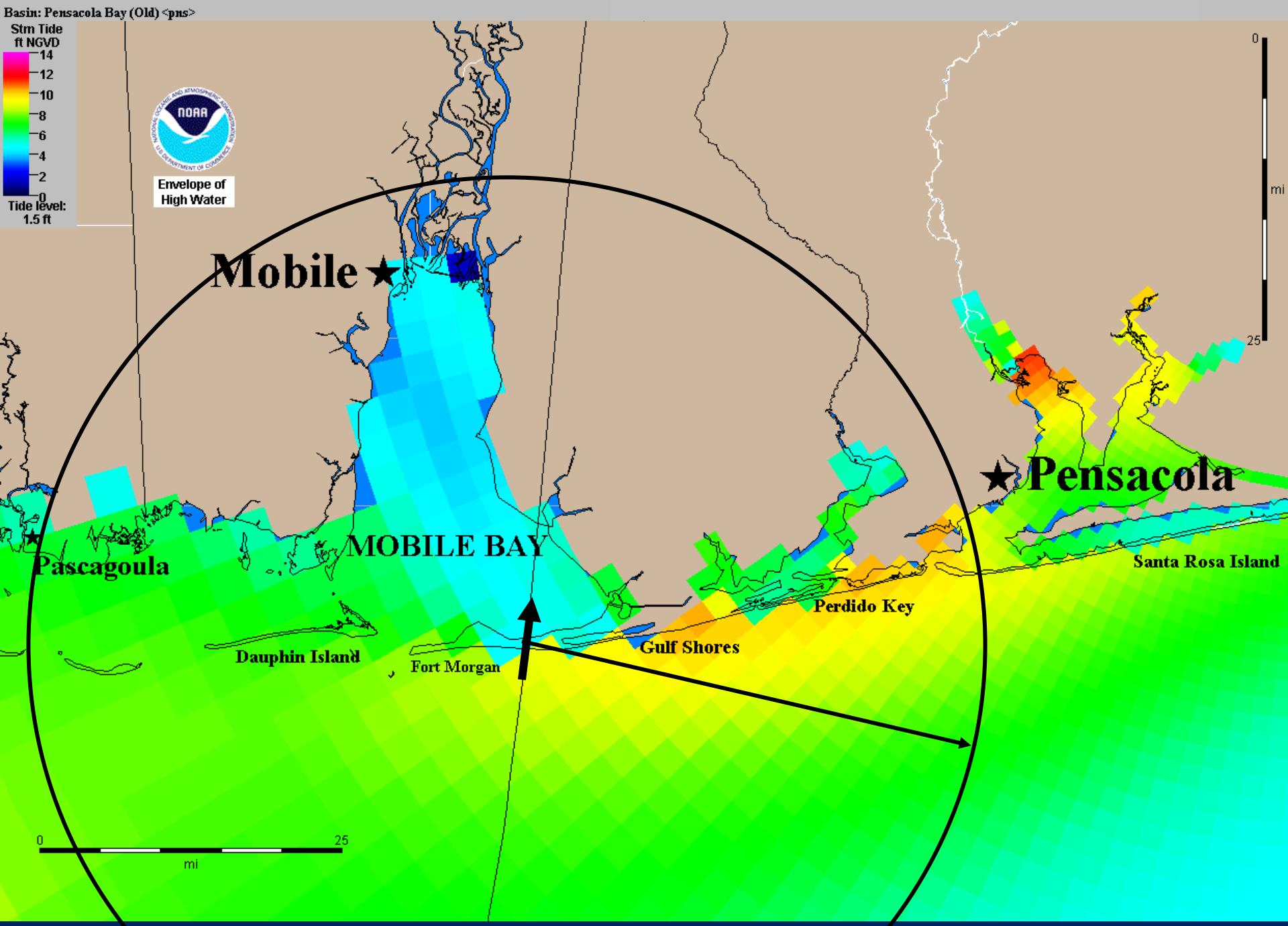
Hurricane Advisory - Approximately 12 hr. before landfall



Surge Based on NHC -12 hr. Advisory



Actual Hurricane Track 30 mi. E of -12 hr. Advisory Forecast Track



Surge Based on NHC Storm Best Track

The Perils of Not Accounting for Uncertainty

Must use ensemble approaches

Don’t put all your eggs in one basket!

Ensemble Guidance

Pre-Computed Storm Surge Simulations

MEOWs

Maximum Envelopes Of Water

MOMs

Maximum Of the MEOWs

Real-Time Storm Surge Simulations

P-Surge

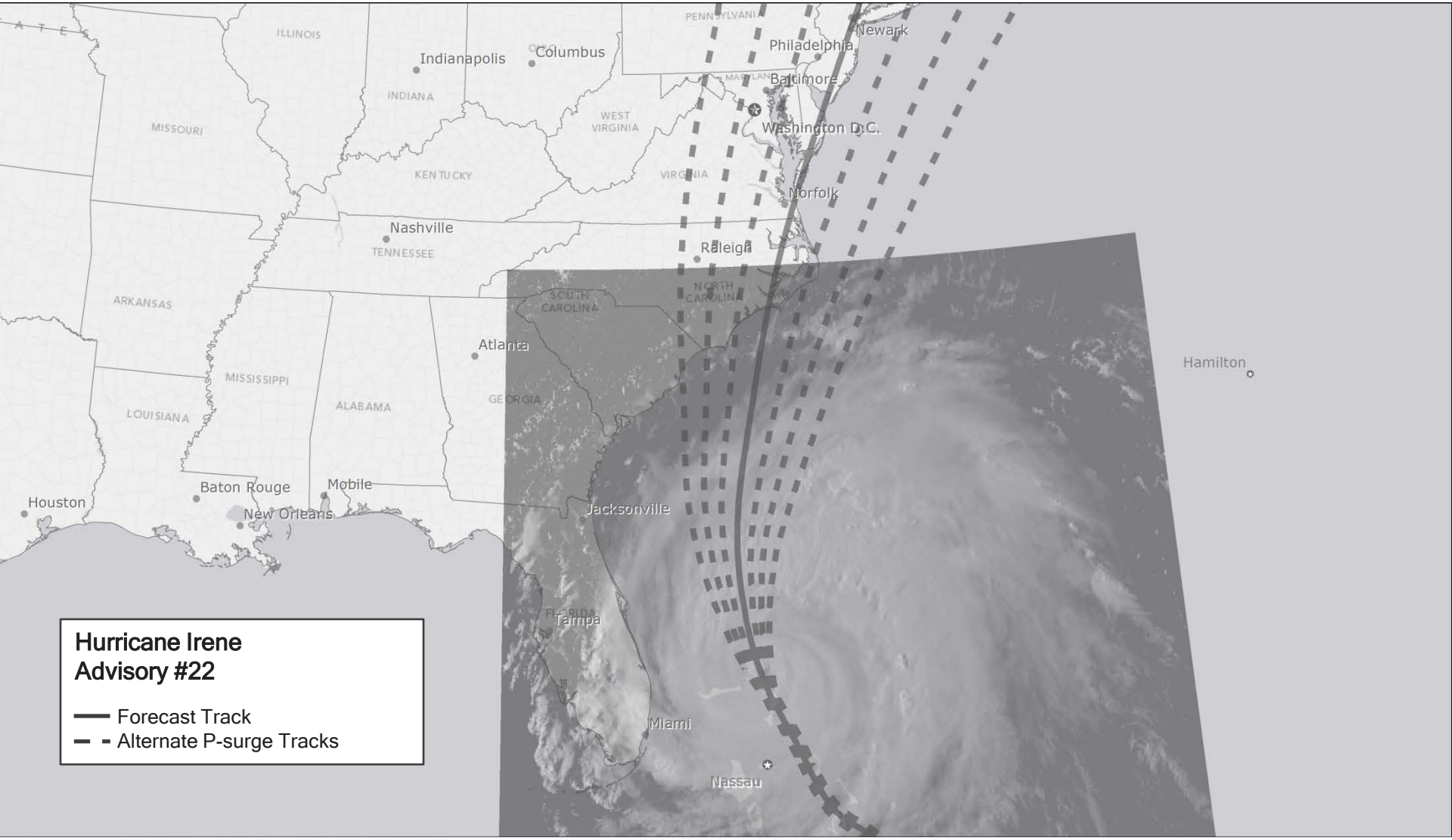
Probabilistic Storm Surge

P-surge
Probabilistic Storm Surge

Probabilistic Storm Surge (P-Surge)

- Storm surge probabilities based on NHC official advisory
- Available roughly 48 hours prior to arrival of TS winds
- Accounts for meteorological uncertainty in:
  - Track / landfall location
  - Size
  - Forward speed
  - Intensity
- Uncertainties based on historical errors
- Version 2.0 (2014) also accounts for the tide and is above ground level

Probabilistic Storm Surge (P-surge) Multiple Tracks and Landfall Locations



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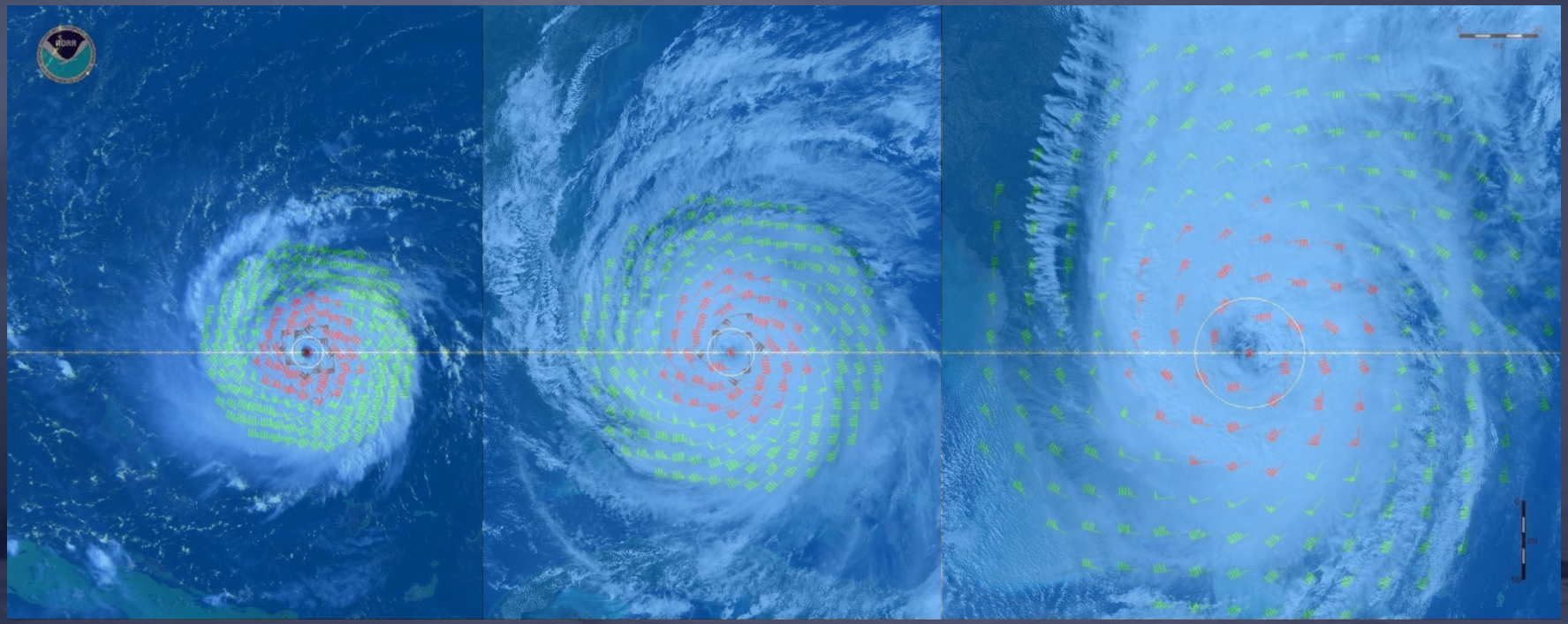
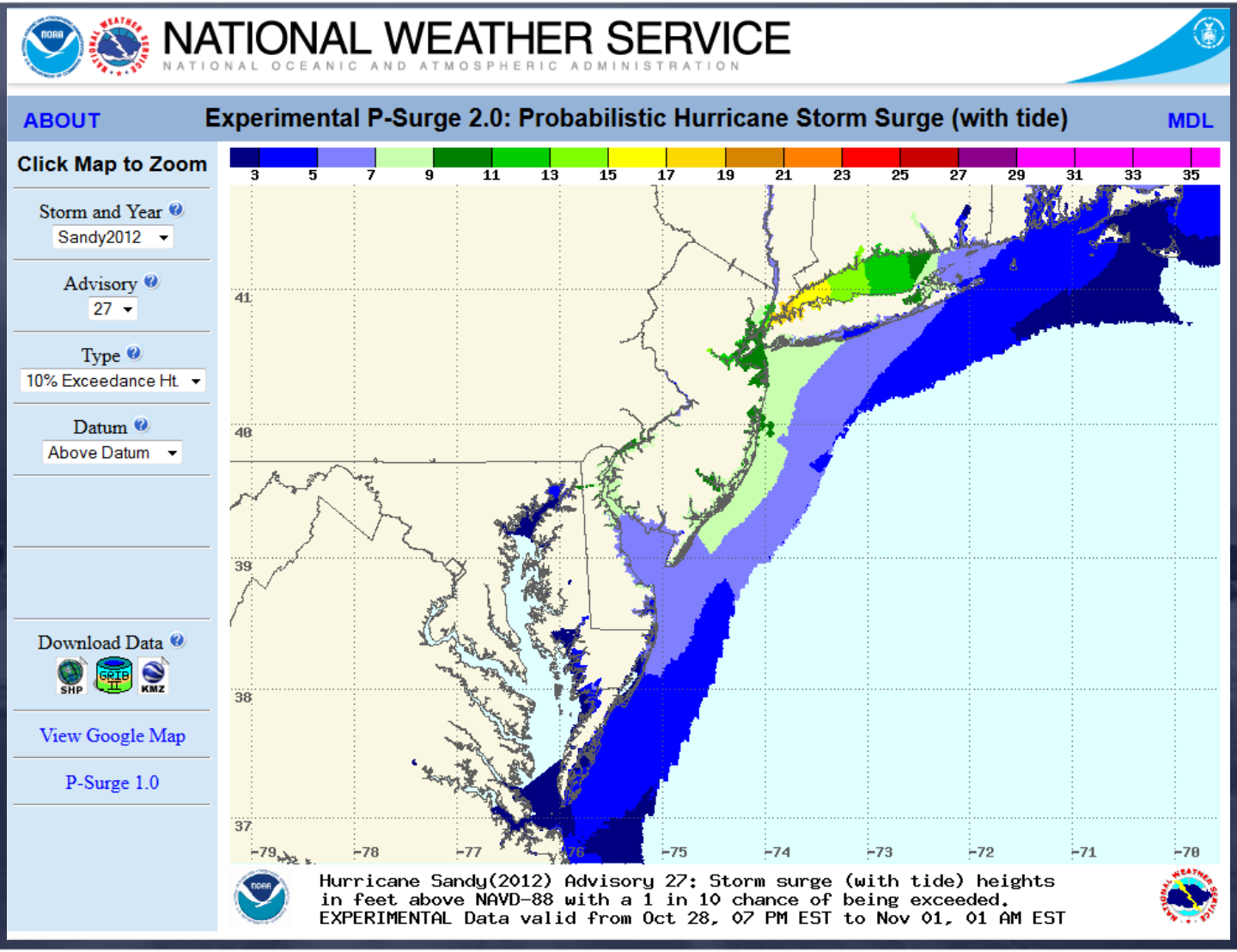


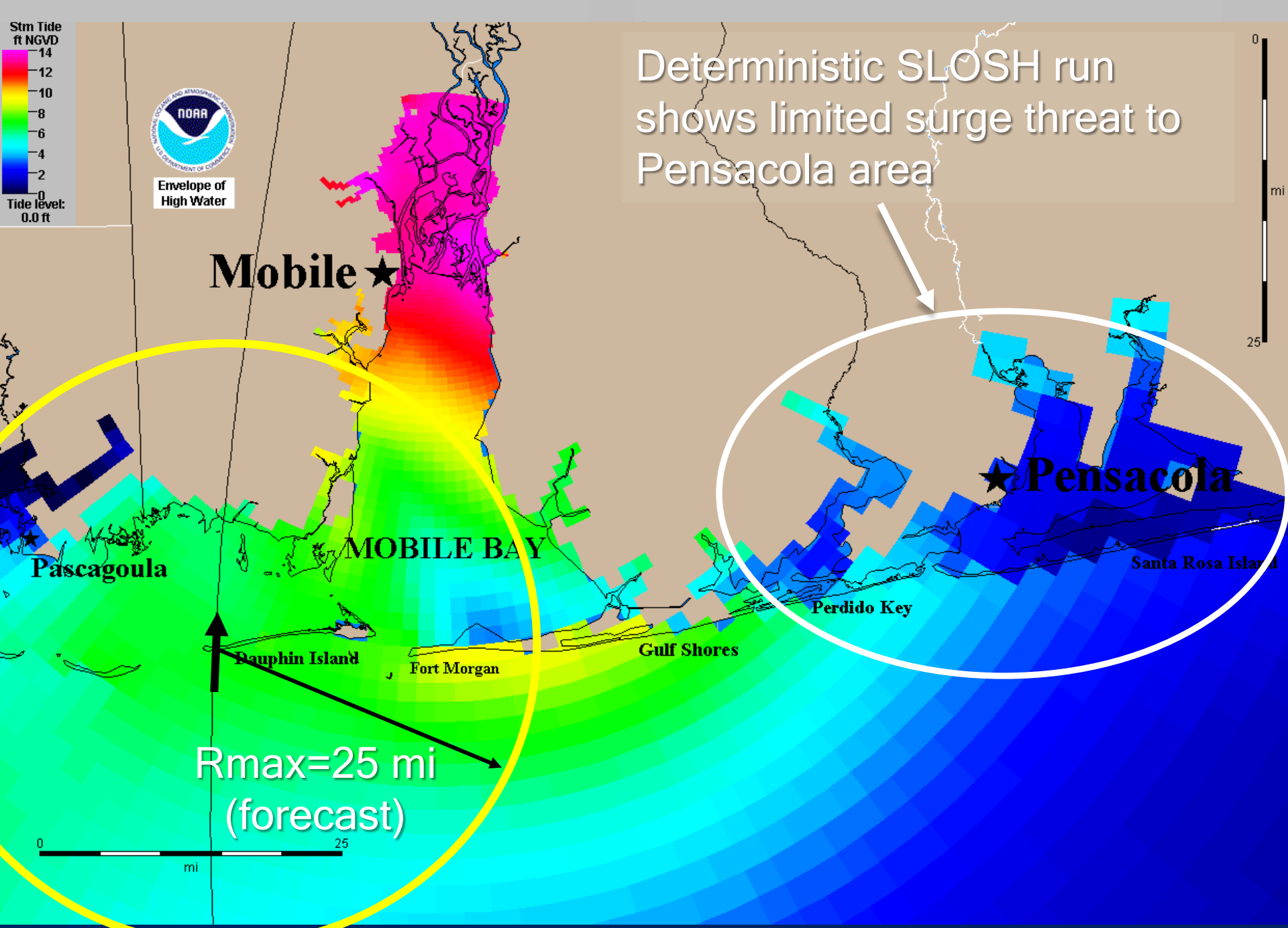
Size: Small, Medium, Large

Forward Speed: Fast, Medium, Slow

Intensity: Strong, Medium, Weak

Psurge2.0

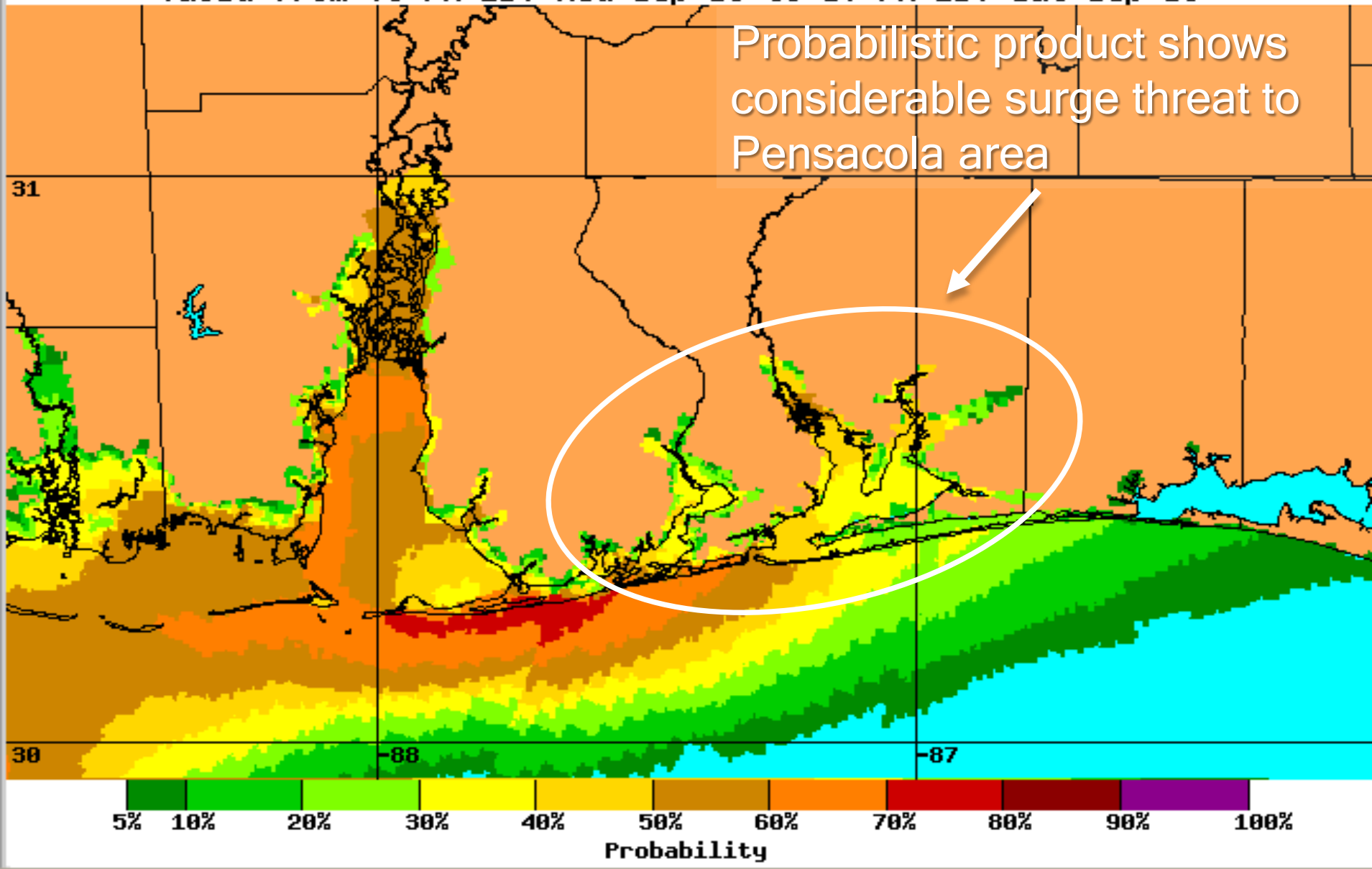

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ABOUT
Experimental P-Surge 2.0: Probabilistic Hurricane Storm Surge (with tide)
MDL
Click Map to Zoom
Storm and Year
Sandy2012
Advisory
27
Type
10% Exceedance Ht.
Datum
Above Datum
Download Data
View Google Map
P-Surge 1.0
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35
41
40
39
38
37
-79 -78 -77 -76 -75 -74 -73 -72 -71 -70
Hurricane Sandy(2012) Advisory 27: Storm surge (with tide) heights
in feet above NAVD-88 with a 1 in 10 chance of being exceeded.
EXPERIMENTAL Data valid from Oct 28, 07 PM EST to Nov 01, 01 AM EST

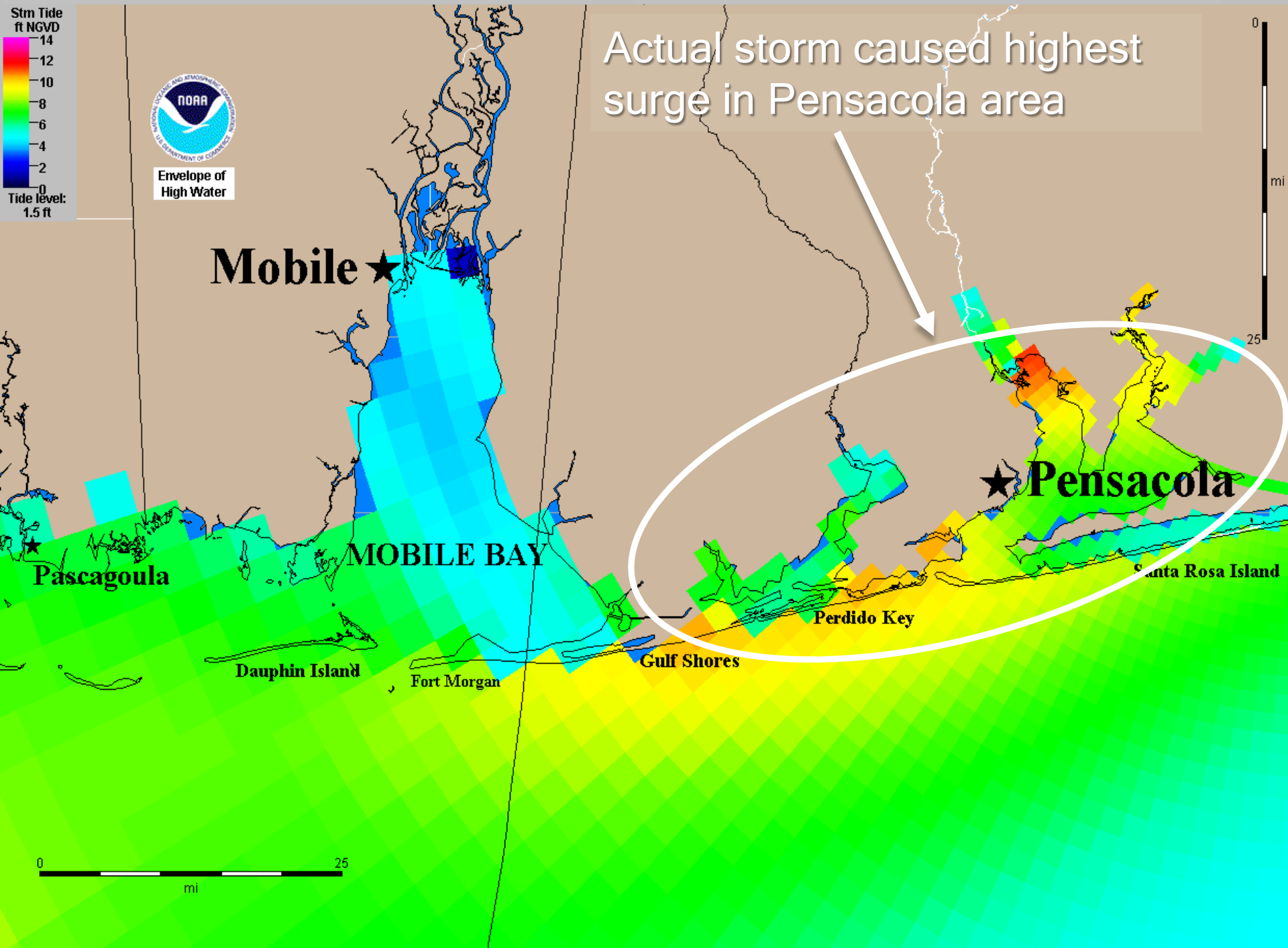


Surge Based on NHC -12 hr. Advisory

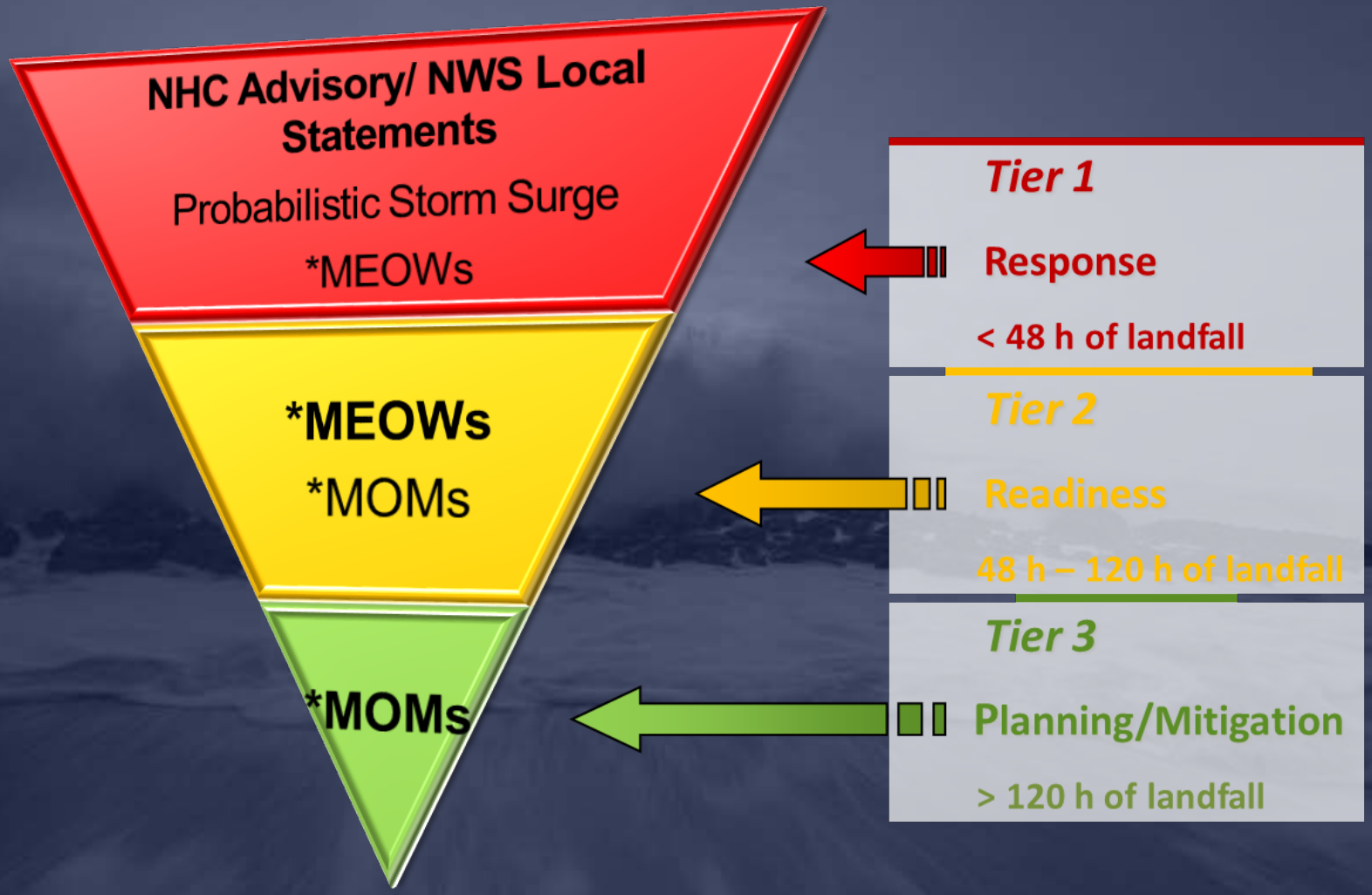
Storm: Ivan2004 Adv54 Type: Prob. of surge > 8 feet Zoom Level: Full

Experimental Tropical Cyclone Storm Surge Probabilities
Chance of Storm Surge >= 8 feet at Individual Locations
Hurricane Ivan (2004) Advisory 54
Valid from 05 PM EDT Wed Sep 15 to 10 PM EDT Sat Sep 18



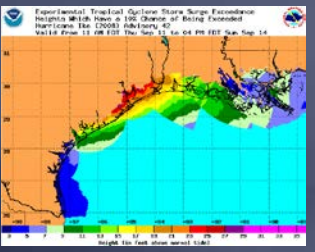

Actual storm caused highest surge in Pensacola area
Stm Tide ft NGVD
14
12
10
8
6
4
2
0
Tide level: 1.5 ft
Envelope of High Water
Mobile
MOBILE BAY
Pascagoula
Dauphin Island
Fort Morgan
Gulf Shores
Perdido Key
Pensacola
Santa Rosa Island
0
25
mi

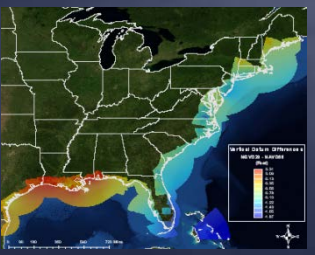
Storm Surge Decision Support Wedge

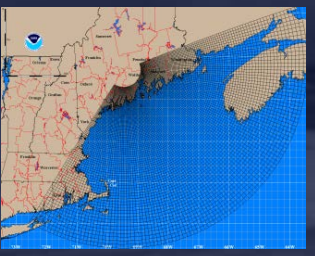


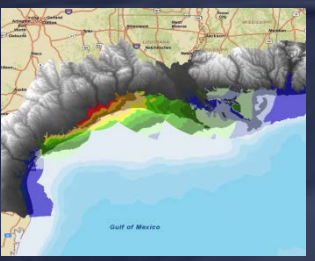
Experimental Potential Storm Surge Flooding Map

NHC Experimental Inundation Graphic



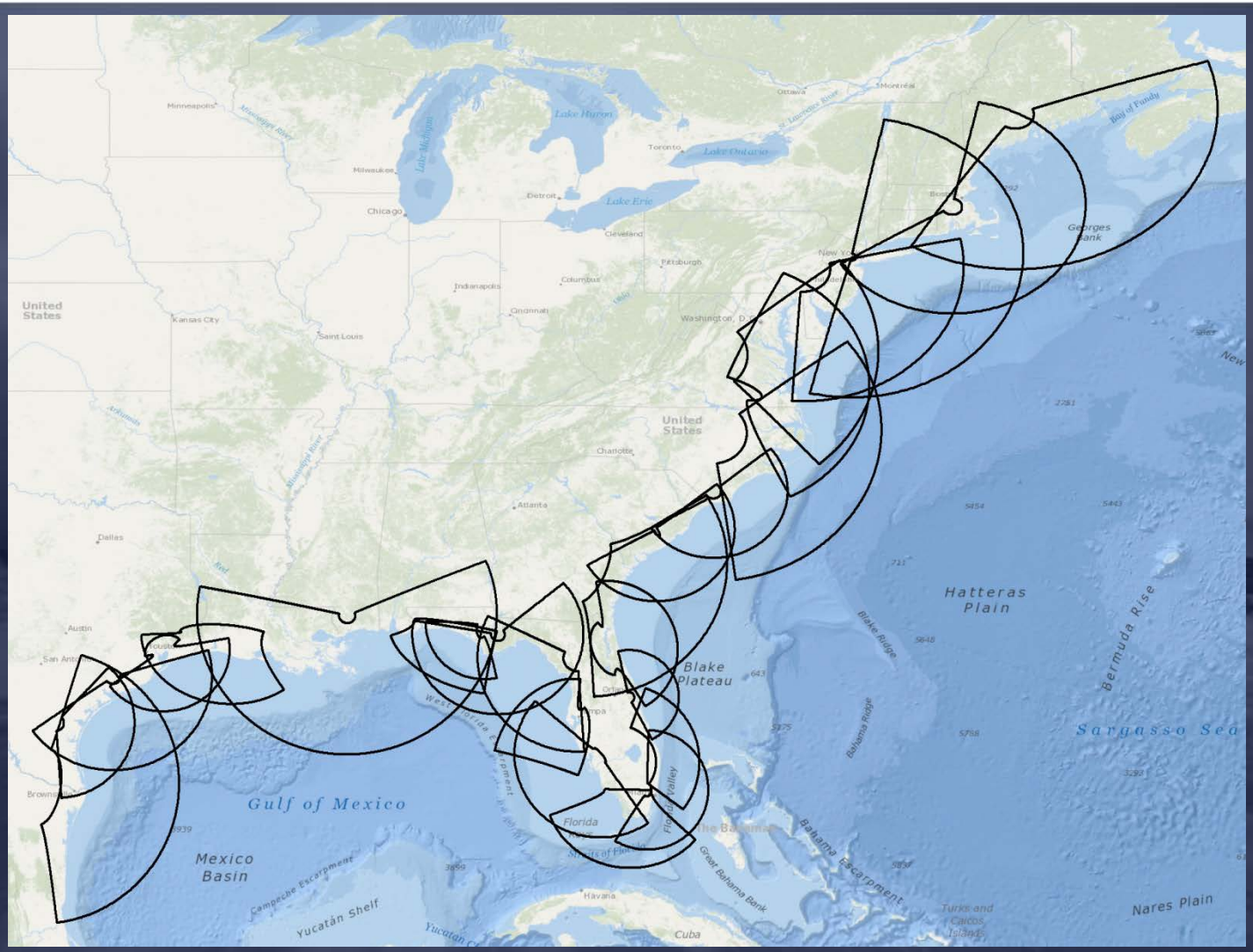






- Which product will drive inundation
  - Experimental psurge2.0 (includes tides)
  - 10% Exceedance
- Grids
  - Latest SLOSH basins updated to NAVD88
- Topography/DEMs
  - NOAA CSC Sea-level rise DEM
    - Resampled to smoother resolution
  - Augmented with USGS NED
- Processing
  - Locally using ArcGIS for Server and Desktop
  - Working toward leveraging NWS integrated dissemination program (IDP) for 2015 season

SLOSH Grids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Montreal
Detroit
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Indianapolis
Cincinnati
Washington, D.C.
Kansas City
Saint Louis
United States
Charlotte
Atlanta
Dallas
Austin
San Antonio
Brownsville
Gulf of Mexico
Mexico Basin
Campeche Escarpment
Yucatán Shelf
Florida
Florida Valley
Havana
Cuba
Great Bahama Bank
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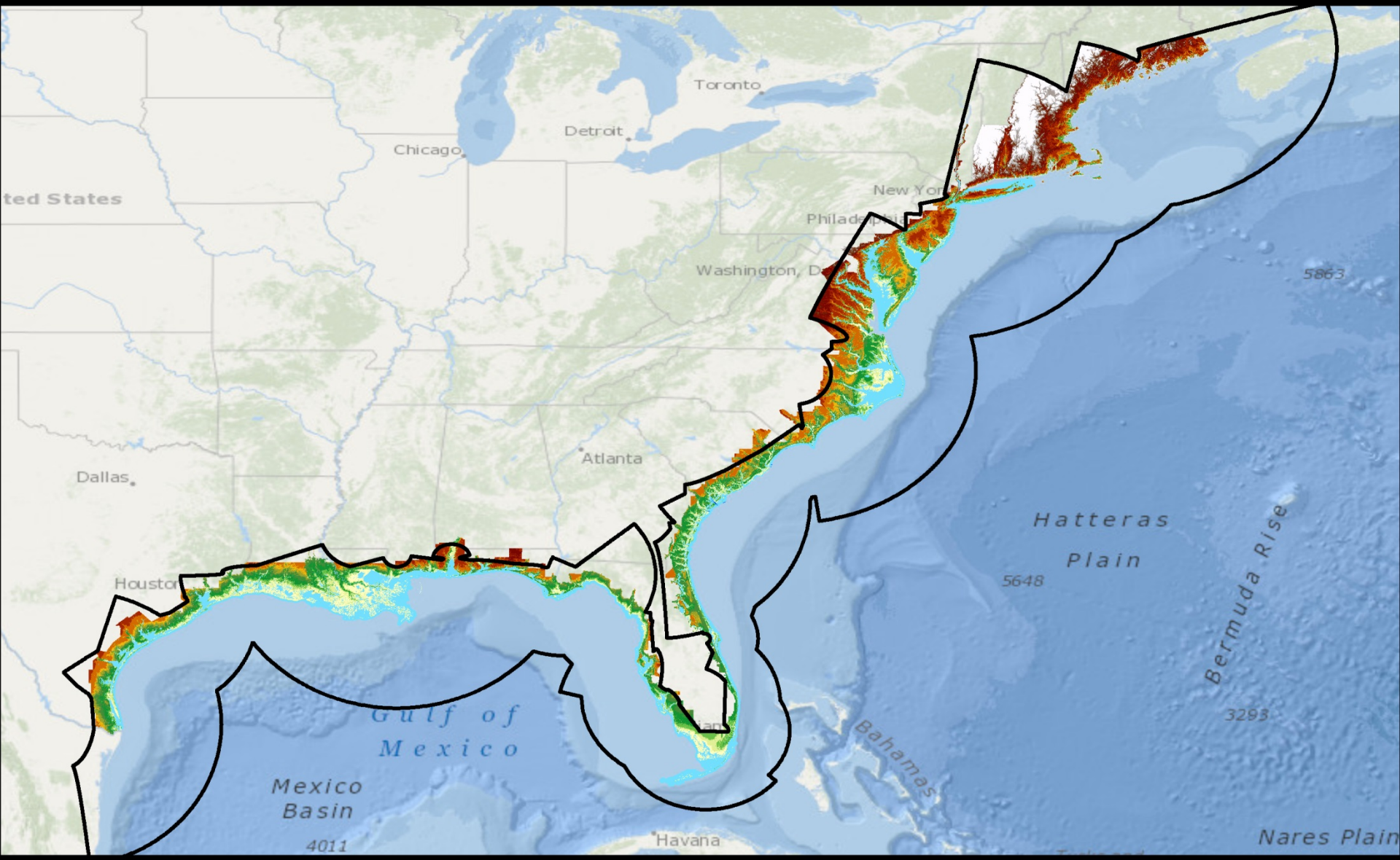
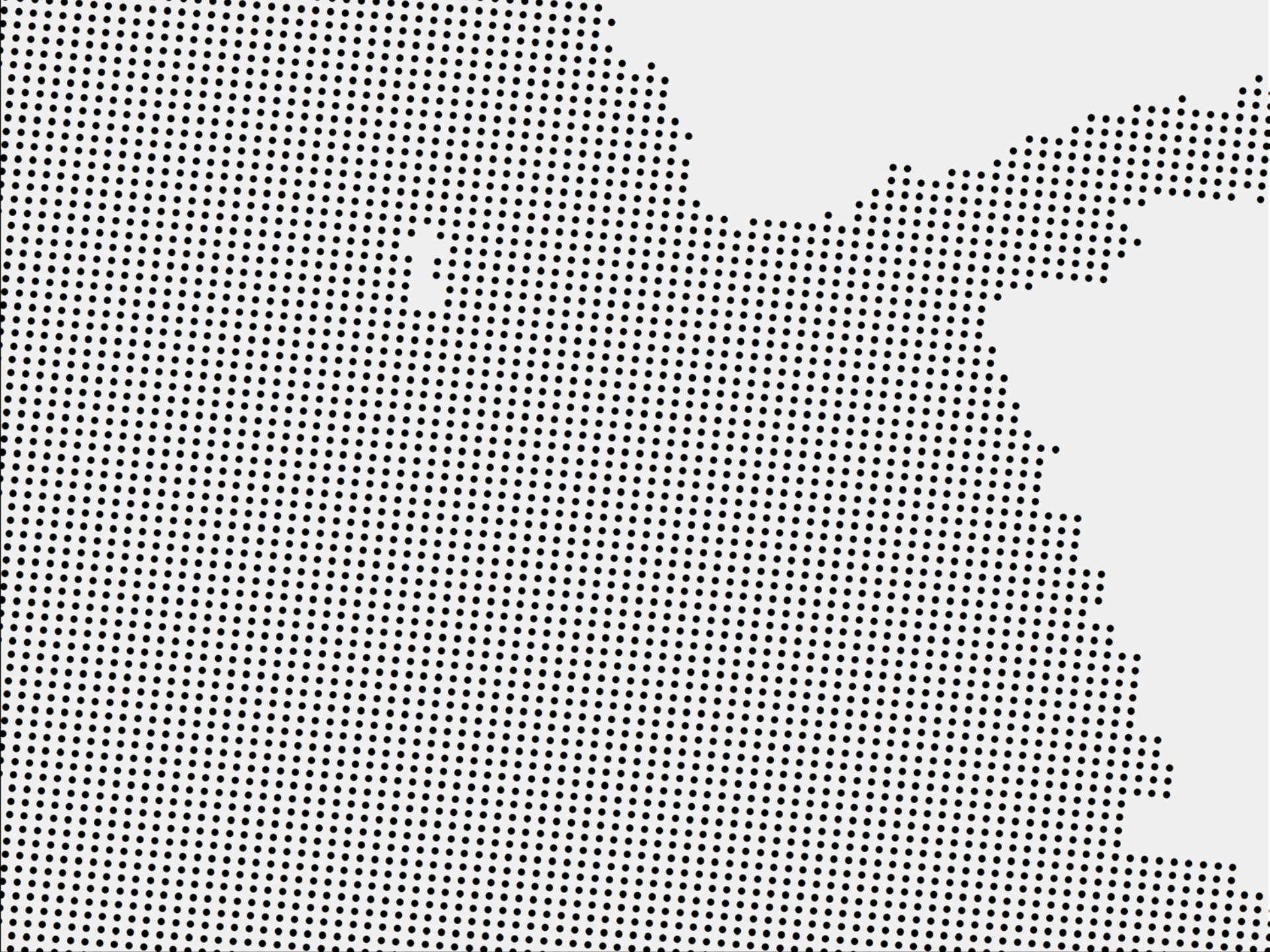
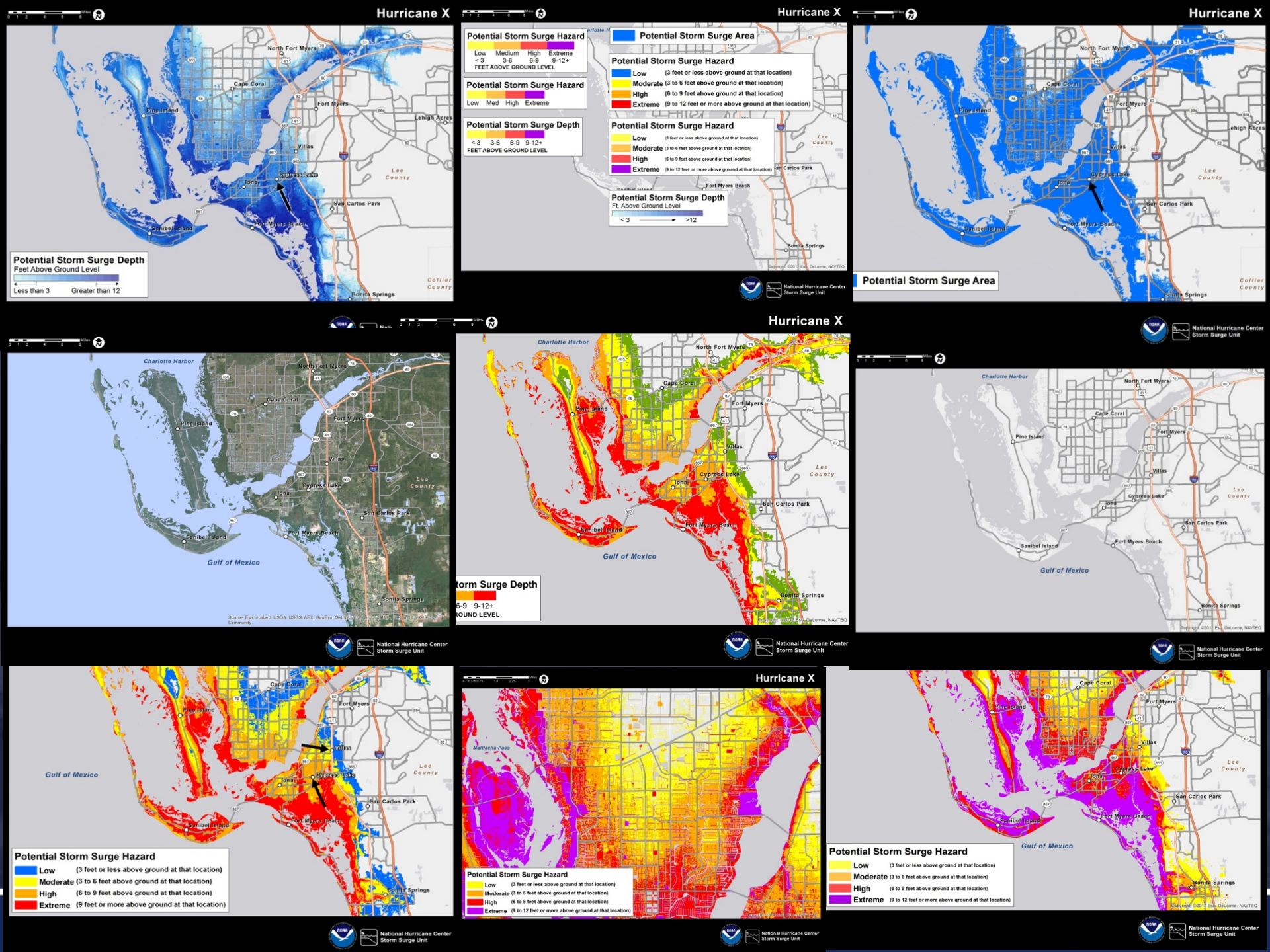
Bay of Fundy
Nares Plain
Turks and Caicos Islands

SLOSH Basins and DEMs



National Hurricane Center
Storm Surge Unit




Hurricane X
Potential Storm Surge Depth
Feet Above Ground Level
Less than 3
Greater than 12
Potential Storm Surge Hazard
Low Medium High Extreme
< 3 3-6 6-9 9-12+
FEET ABOVE GROUND LEVEL
Potential Storm Surge Hazard
Low Med High Extreme
Potential Storm Surge Depth
< 3 3-6 6-9 9-12+
FEET ABOVE GROUND LEVEL
Potential Storm Surge Area
Potential Storm Surge Hazard
Low (3 feet or less above ground at that location)
Moderate (3 to 6 feet above ground at that location)
High (6 to 9 feet above ground at that location)
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Ft. Above Ground Level
< 3
>12
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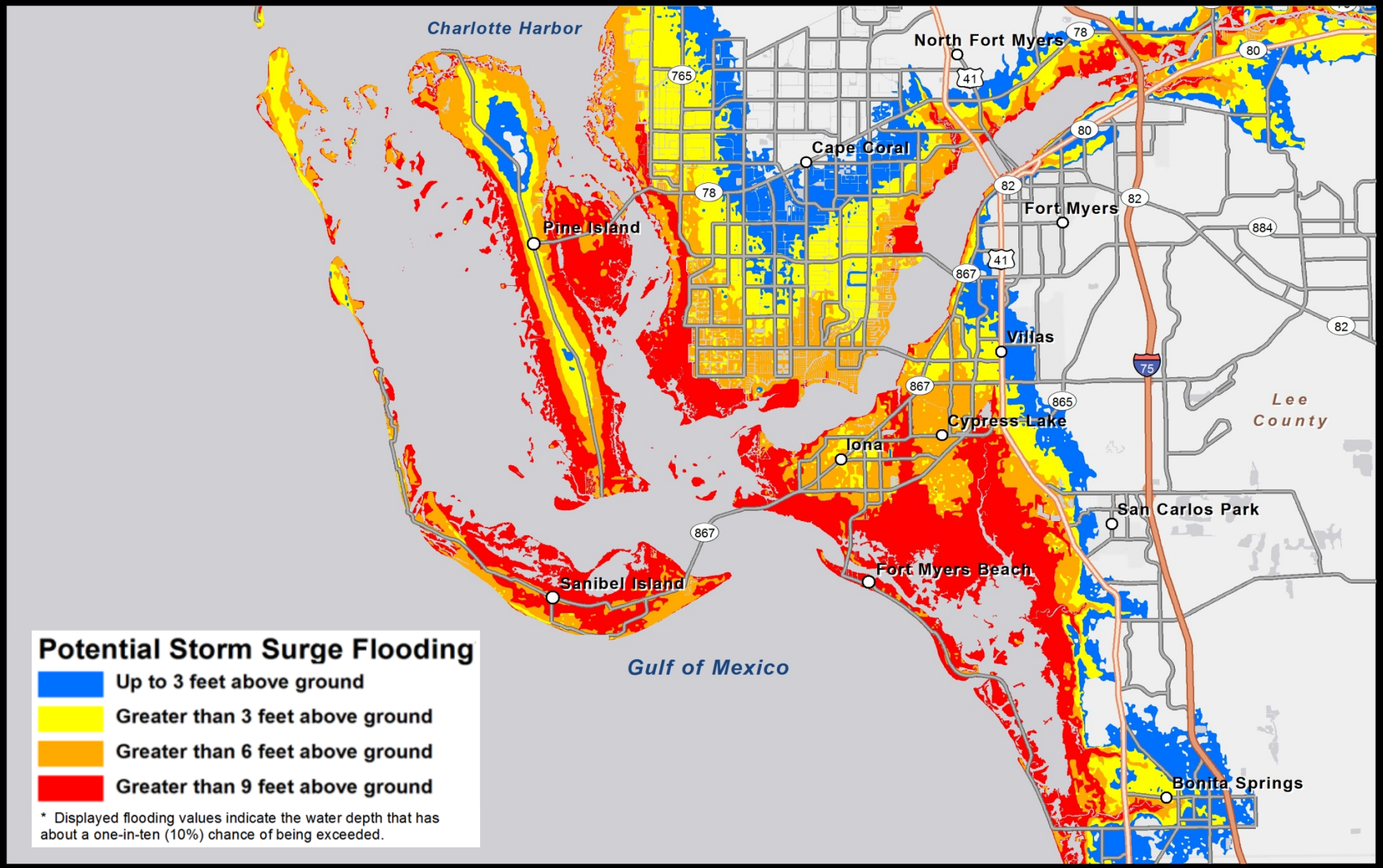
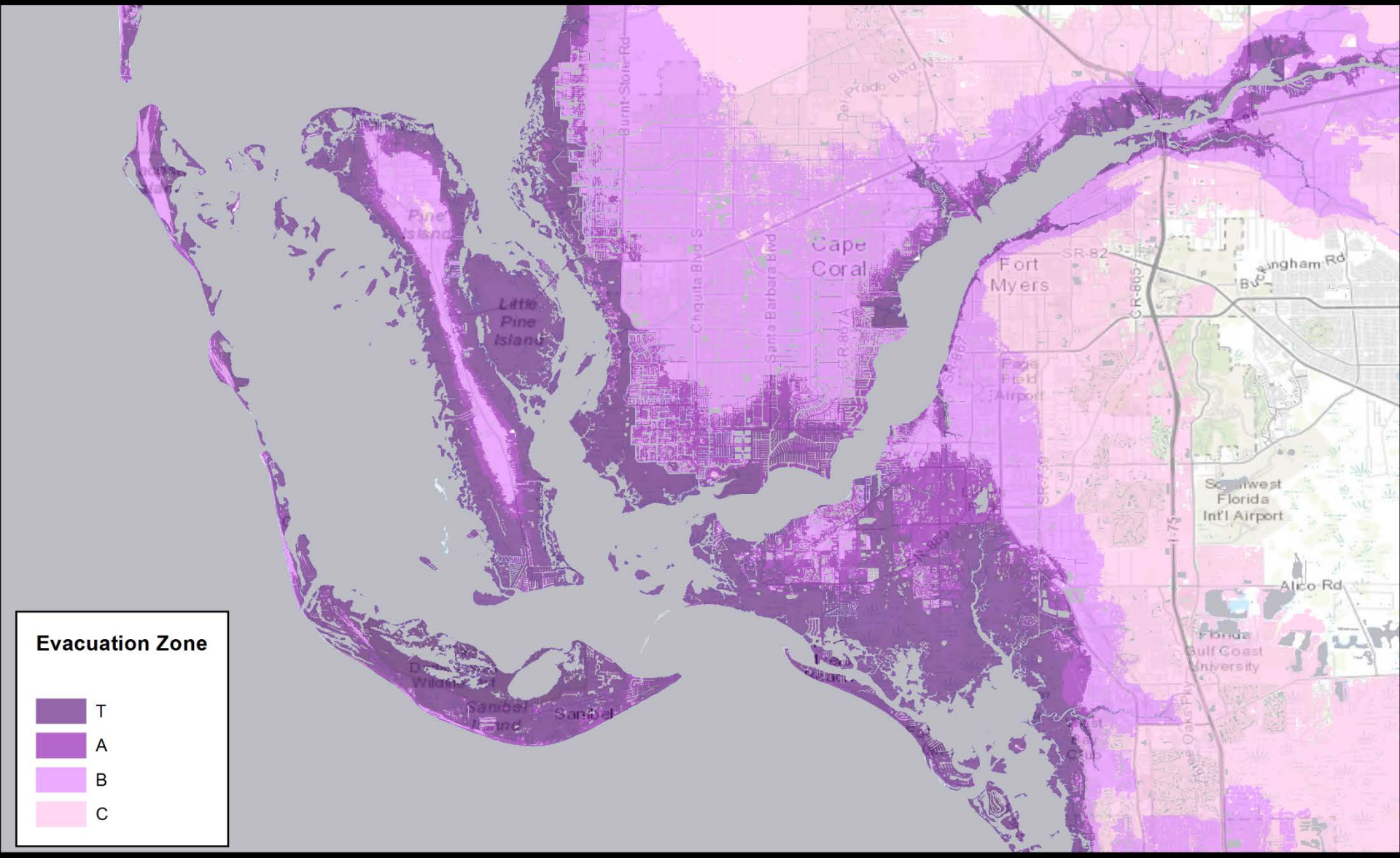
National Hurricane Center
Storm Surge Unit

Hurricane X



National Hurricane Center
Storm Surge Unit

Southwest Florida Evacuation Zones - T, A, B, C



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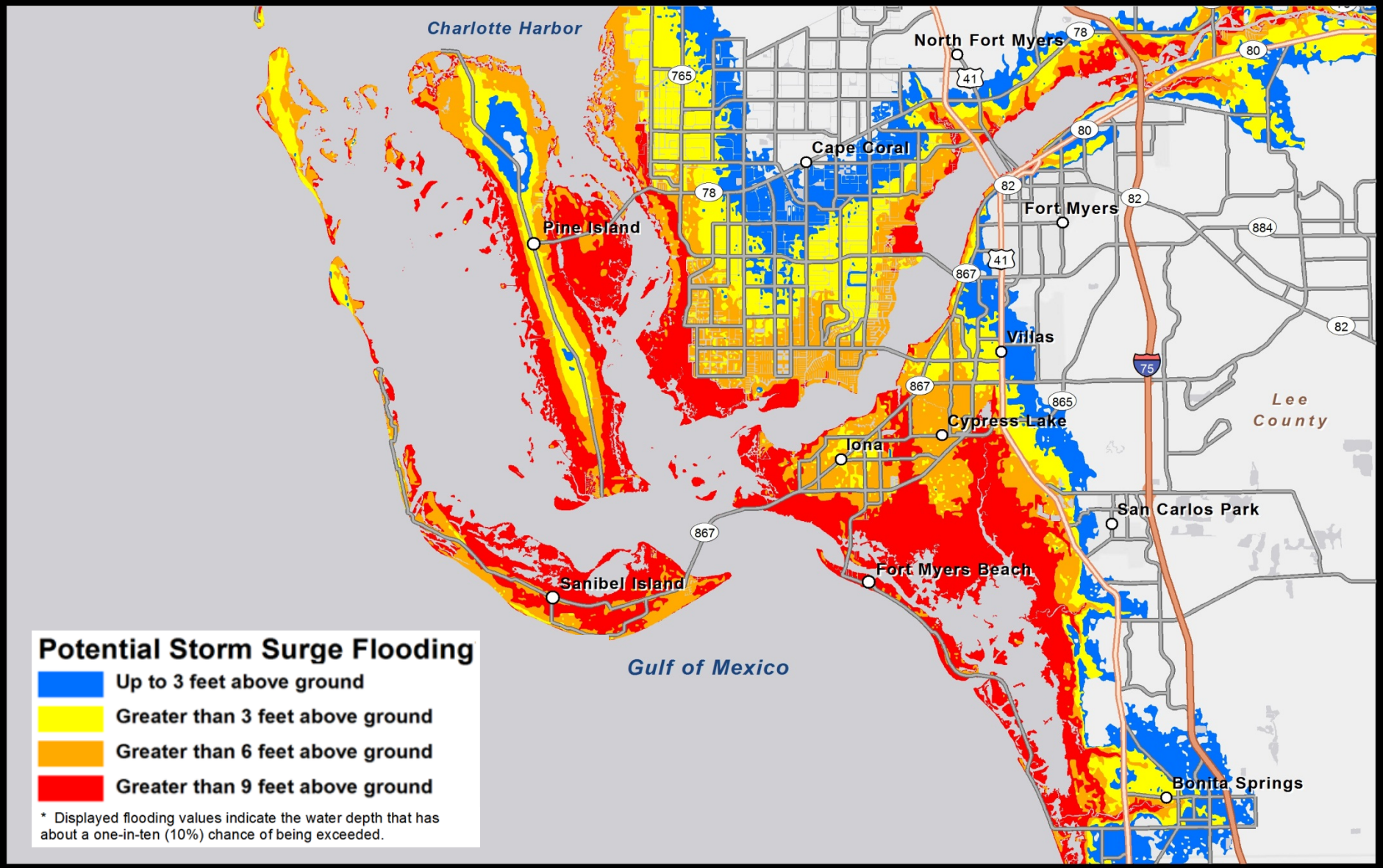

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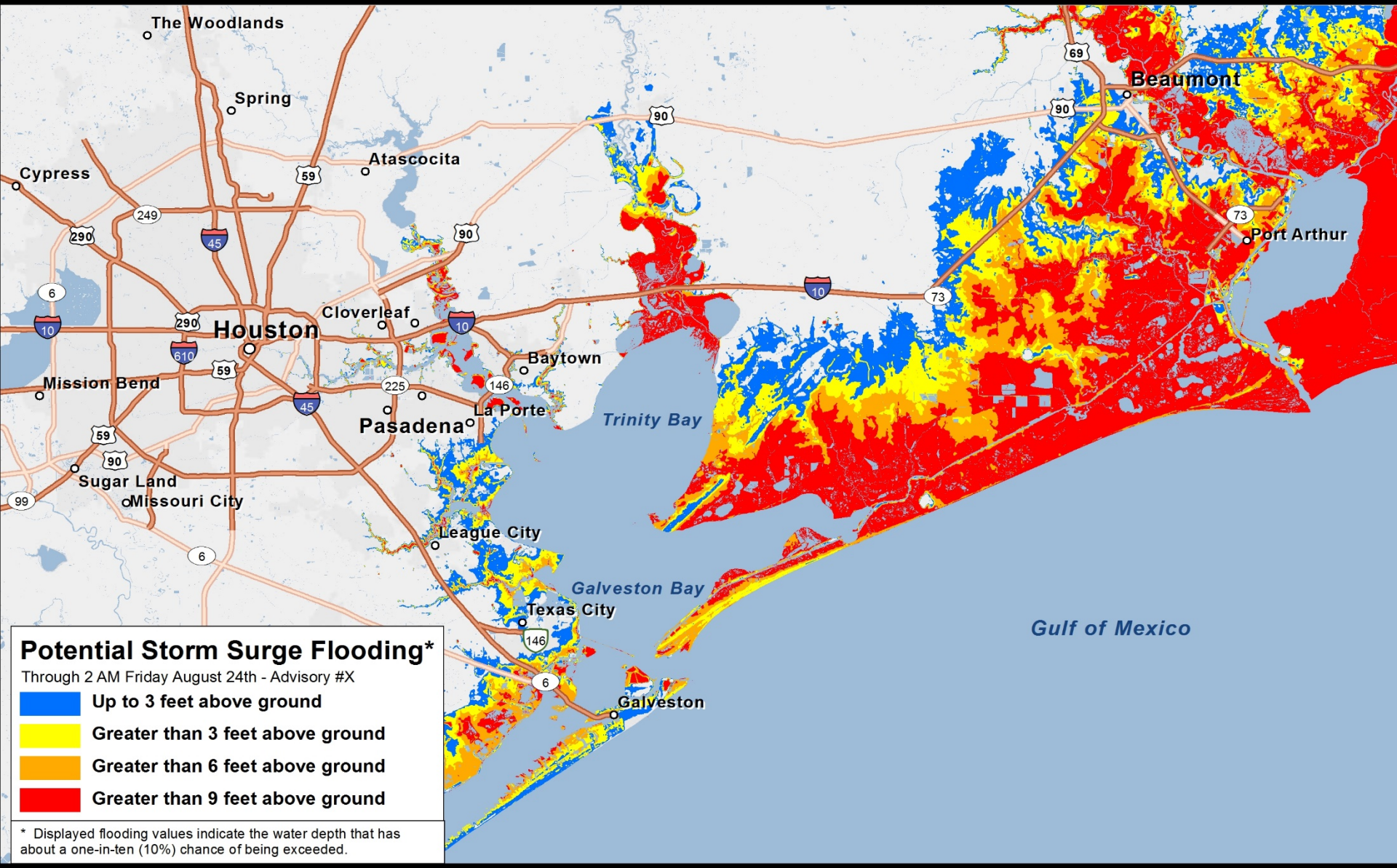

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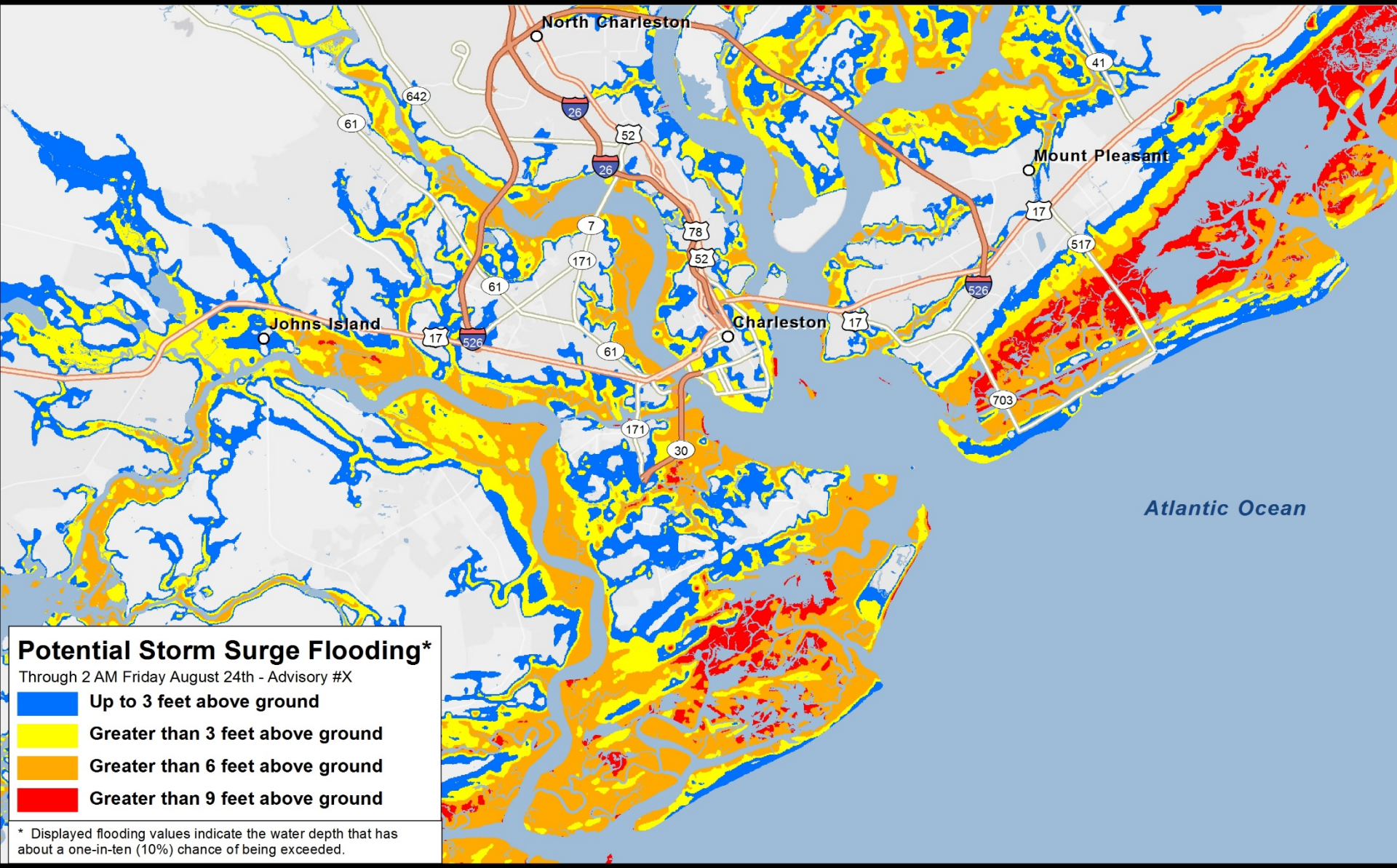

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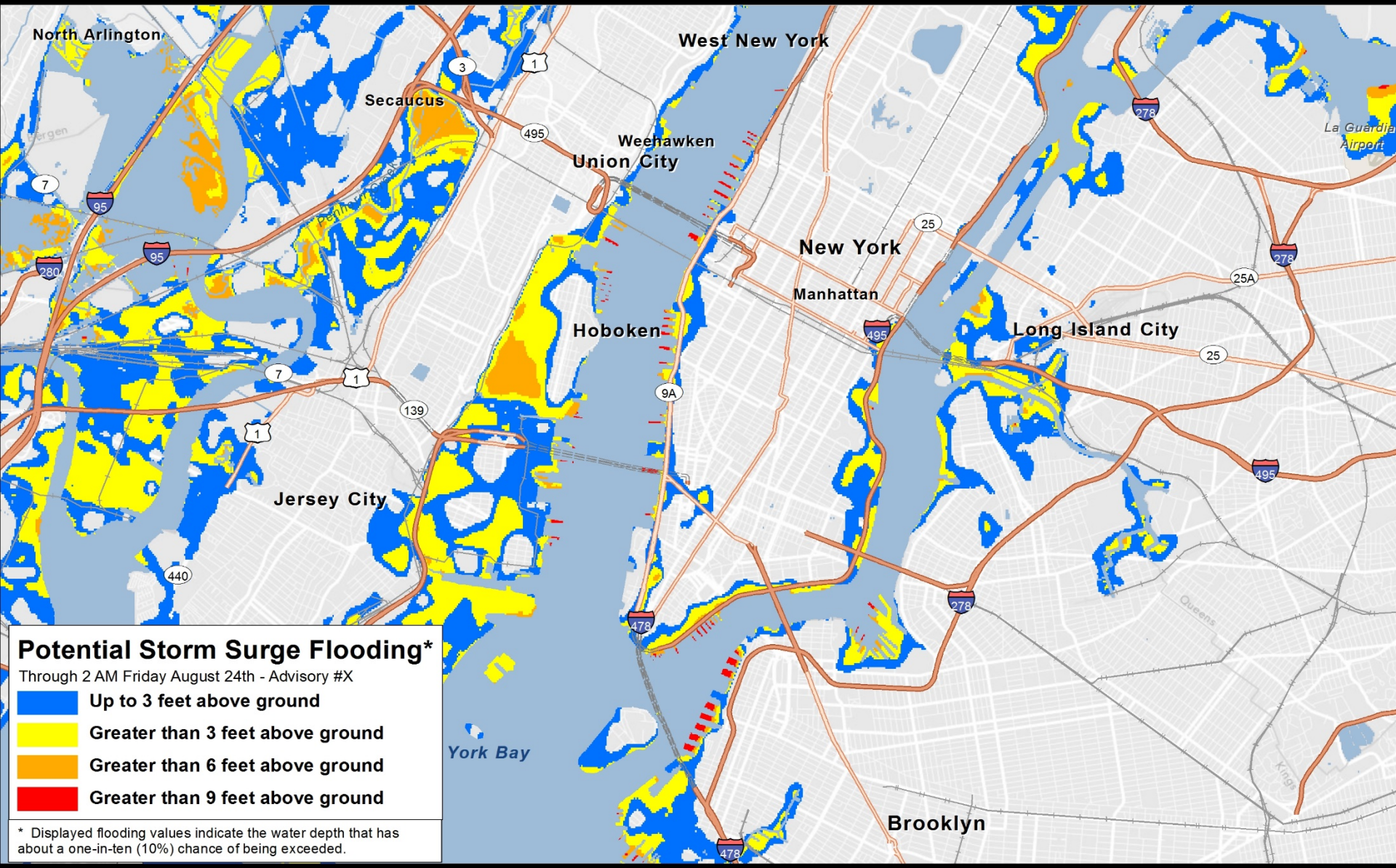

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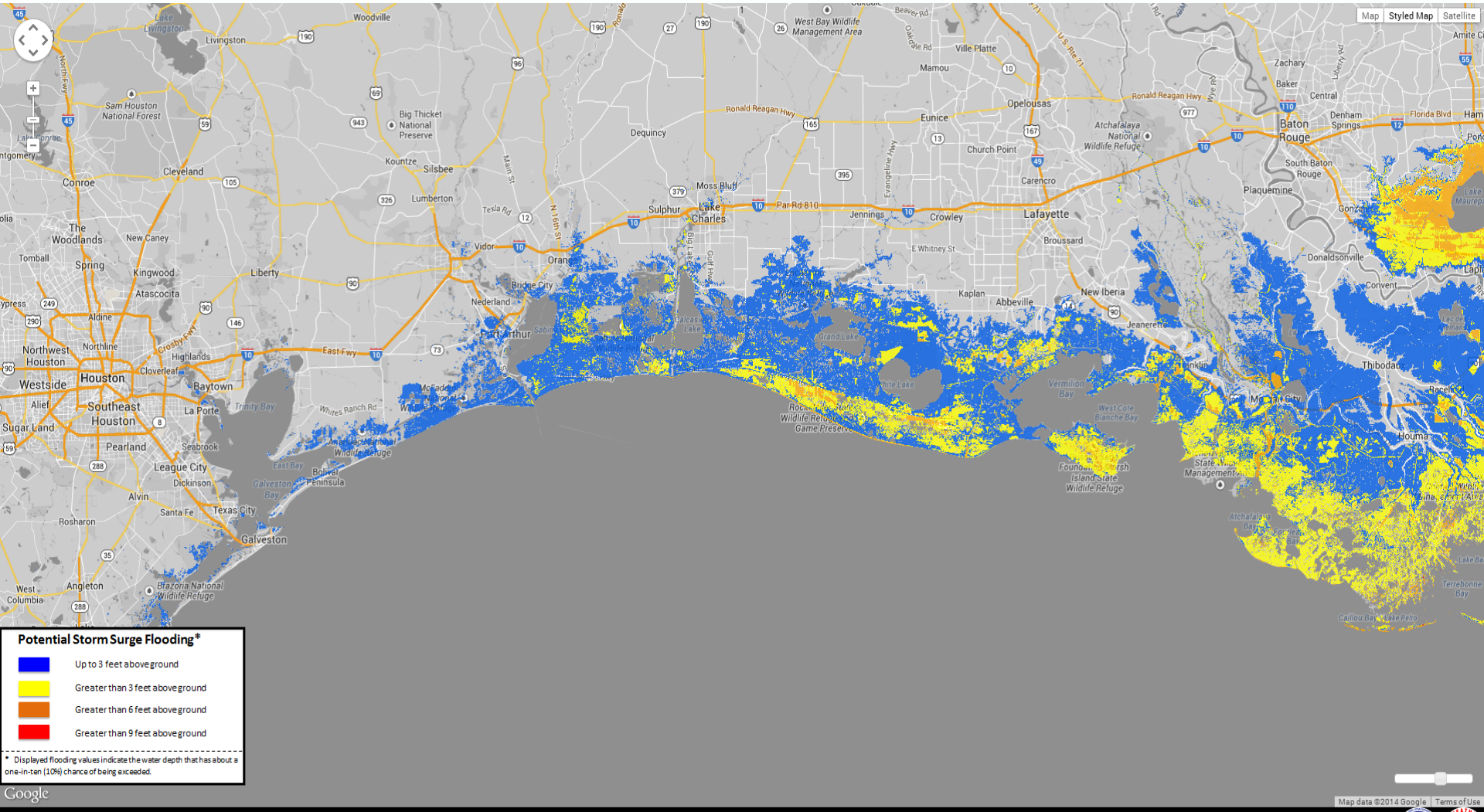
Storm Surge Unit

Viewable in Google Map Interface



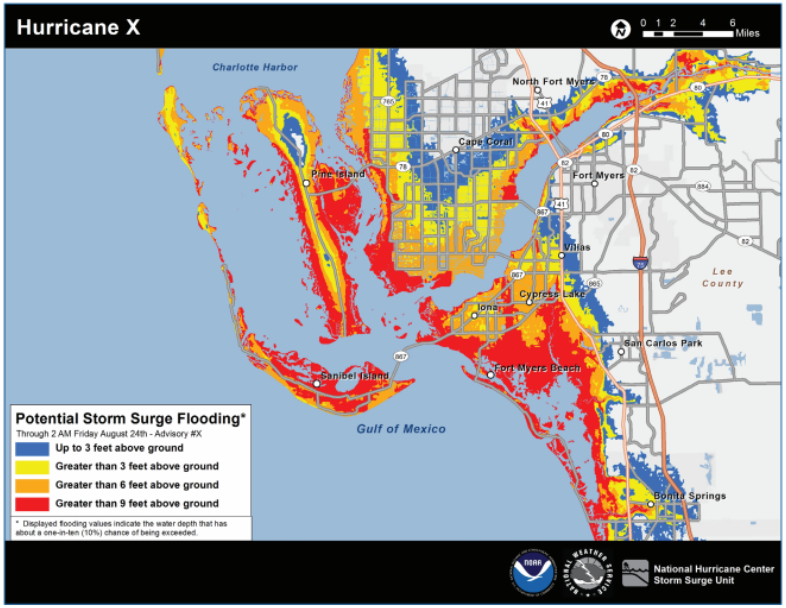
Takeaways

- Available during the 2014 hurricane season *experimentally* via the NHC website
  - No data dissemination during experimental phase (no shapefiles)
- Interactive map with zoom capability that is available roughly 20-30 min after P-Surge 2.0
- SLOSH P-Surge 2.0 post-processed to produce a user-friendly graphic of potential storm surge depth
- Marketing/outreach efforts underway
  - Fact sheets, examples, website, video, etc.

New Storm Surge Fact Sheets are Available for Outreach

When a storm is threatening your area, always follow the instructions of local officials

1. Storm surge is often the greatest threat to life and property from a hurricane. It poses a significant threat for drowning. A mere **six inches** of fast-moving flood water can knock over an adult. It takes only **two feet** of rushing water to carry away most vehicles—including pickups and SUVs.
2. Storm surge can cause water levels to rise quickly and flood large areas—sometimes in just minutes, and you could be left with no time to take action if you haven't already evacuated as instructed.
3. Storm surge values do not correspond well to the hurricane wind categories (of the Saffir-Simpson Hurricane Wind Scale) that range from 1 to 5. These categories are based only on winds and do **not** account for storm surge.
4. Tropical storms, category 1 or 2 hurricanes, major (category 3 to 5) hurricanes, and post-tropical cyclones can **all** cause life-threatening storm surge.
5. Storm surge can also occur with non-tropical storms like Nor'easters and other winter storms.
6. Many U.S. Gulf and East Coast areas are vulnerable to storm surge, including areas up to several miles inland from the coastline. **Find out today, well before a hurricane ever approaches, if you live in a storm surge evacuation zone.**
7. Storm surge can occur before, during, or after the center of a storm passes through an area. Storm surge can sometimes cut off evacuation routes, so do not delay leaving if an evacuation is ordered for your area.



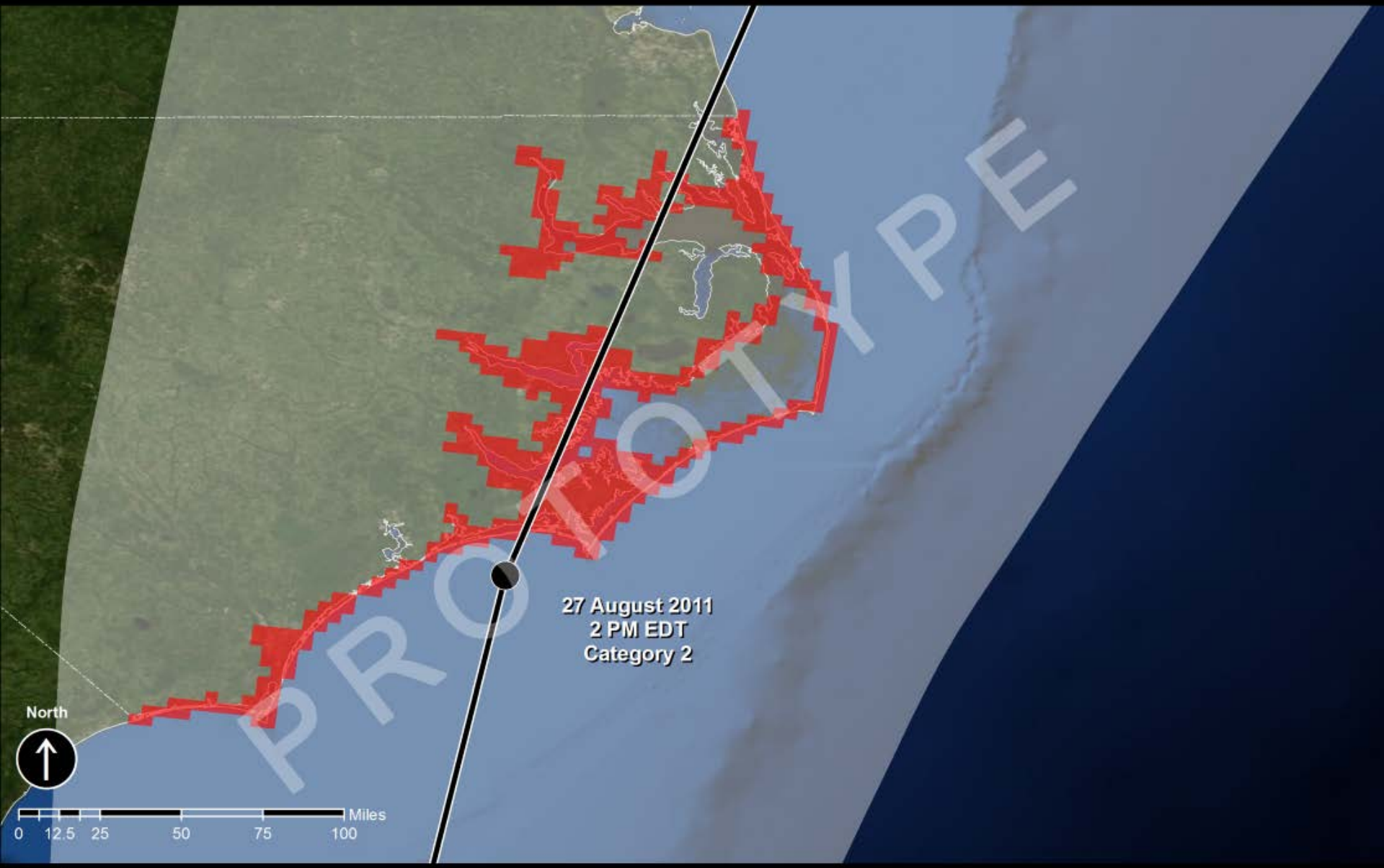
If a tropical storm or hurricane is threatening your community, go to www.nhc.noaa.gov to see a map like this, which will show potential storm surge flooding for your area

8. During the peak of a storm surge event, it is unlikely that emergency responders will be able to reach you if you are in danger.
9. Even if your community is not directly affected by storm surge, it could experience other hazards from the storm and face dangerous conditions such as **impassable roads, water and sewage problems, and power outages**. If power remains on, downed electrical wires can pose an **electrocution risk**.
10. Weather conditions and the forecast can change. Local officials could issue evacuation or other instructions for many reasons. **Always follow the instructions of local officials**.

Two public fact sheets are available, also one for emergency managers and for media professionals. Available at: www.nhc.noaa.gov/surge/resources.php

Hurricane Irene, Advisory #22

Storm Surge Warning PROTOTYPE



National Hurricane Center
Storm Surge Unit

Hurricane Irene Adv #22 Forecast Track

NWS/NHC Storm Surge Warning