Hurricane Forecasting and Impact Decision Support Information

2017 National Conference on Beach Preservation Technology

Stuart, FL

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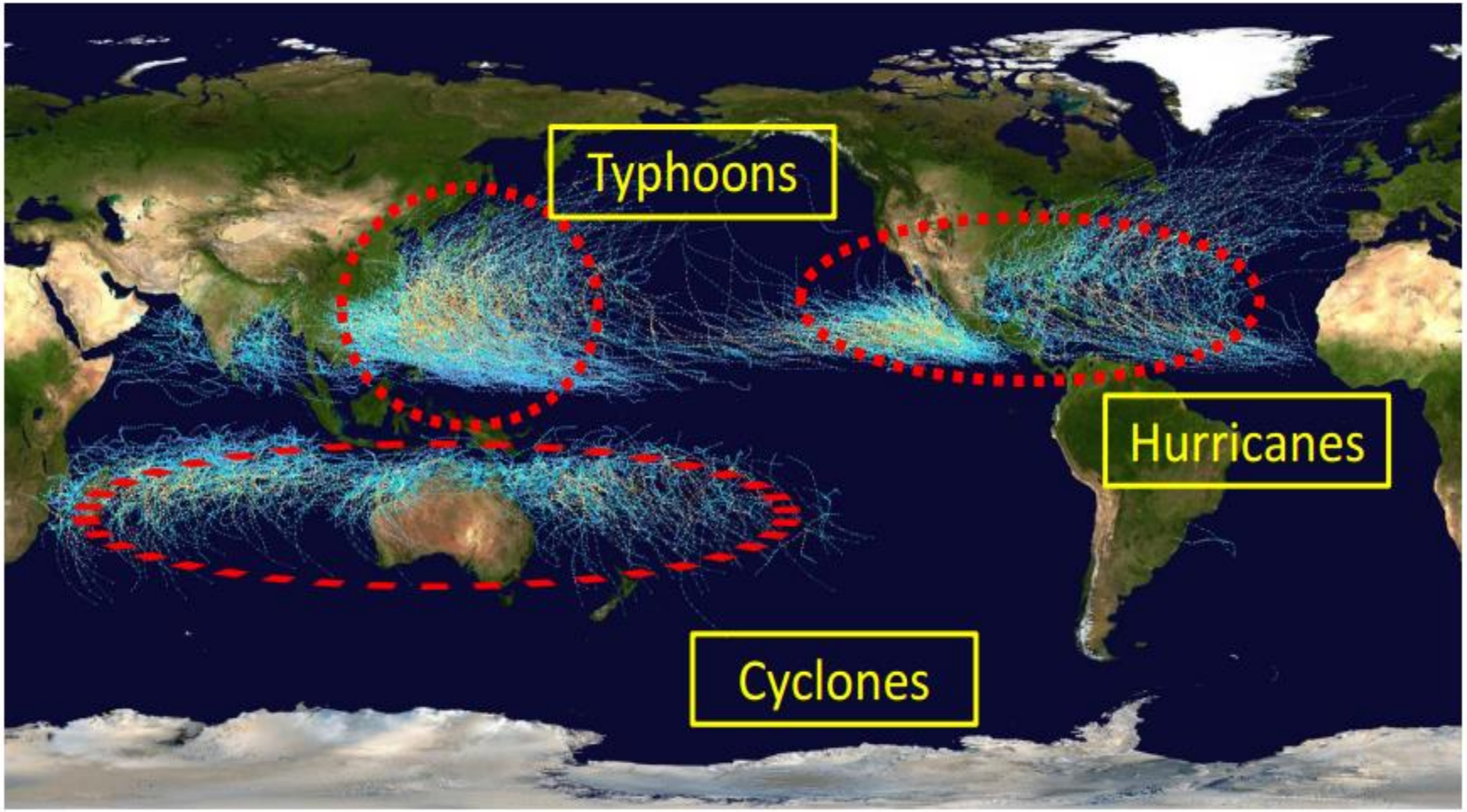
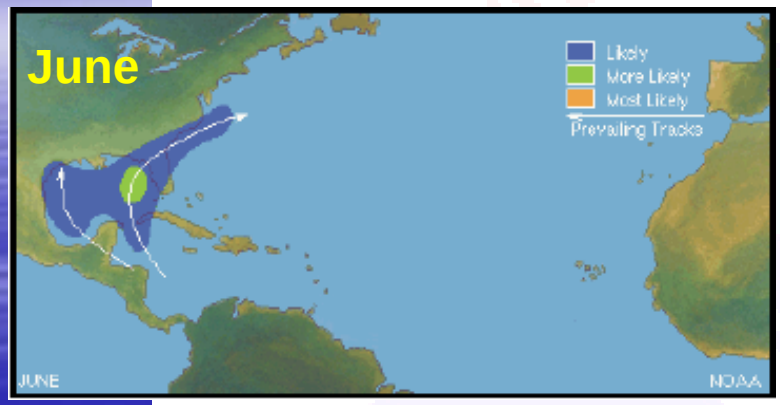
National Weather Service

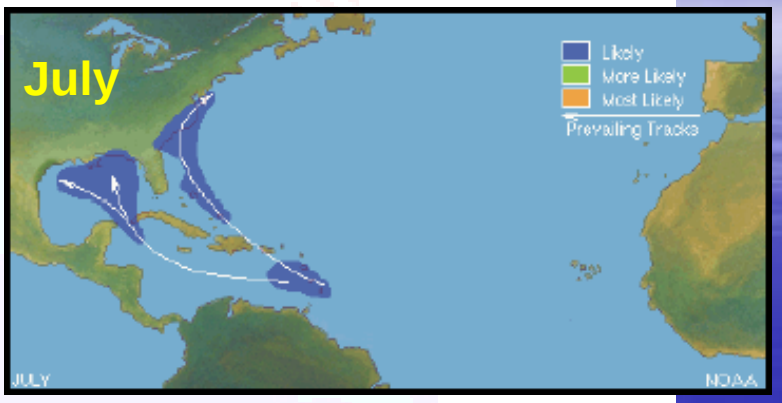
Miami-South Florida Forecast Office

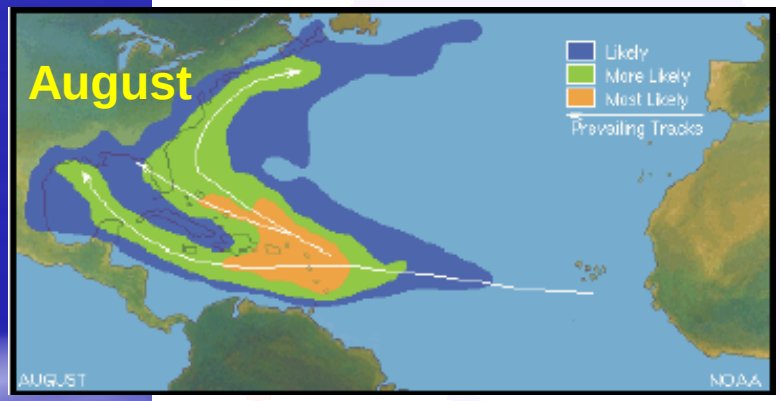
Tropical Cyclone Tracks

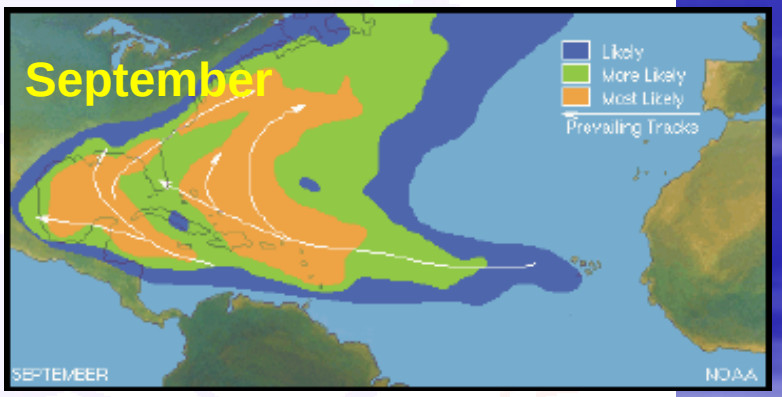


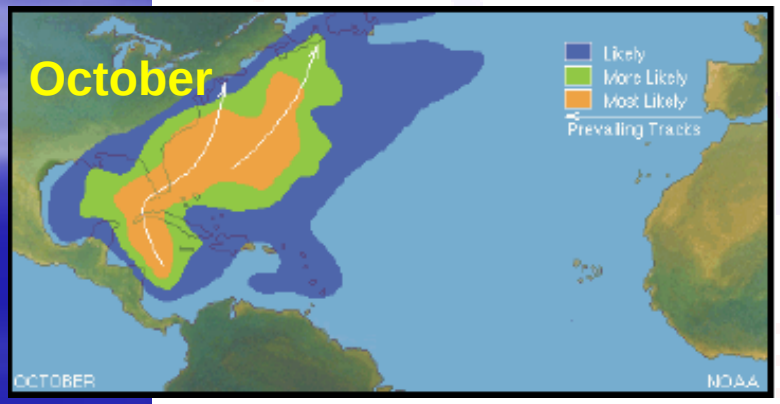
TS/Hurricane Formation Areas by Month

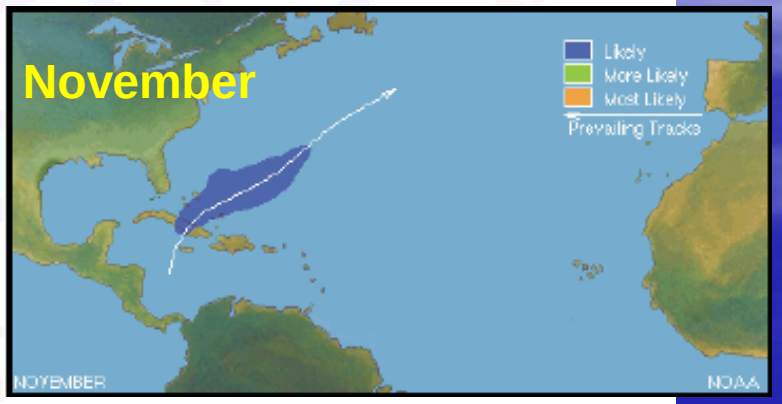












1) Making Measurements

Variety of instruments define initial conditions (starting point for forecasts)

2) Model Predictions

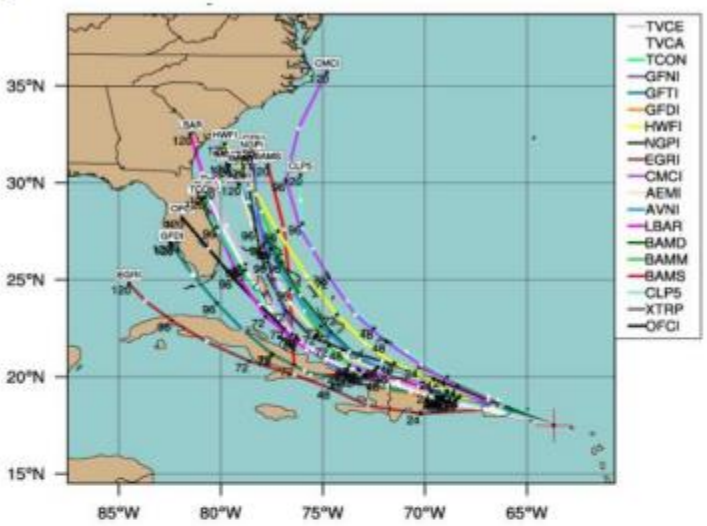
Weather models on the world's fastest super computers predict the future state of the weather based on current information and approximate equations

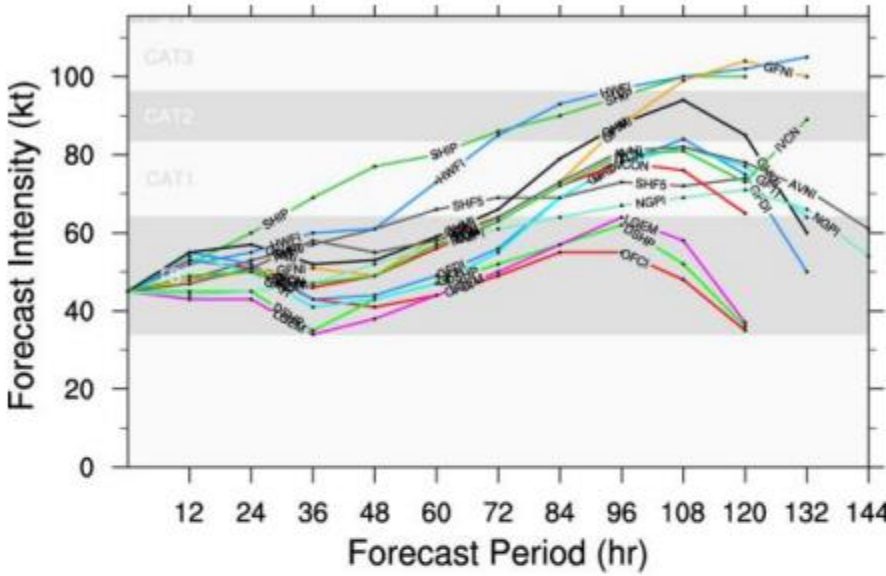
$$u\frac{\partial u}{r\partial\theta}+v\left(\frac{\partial u}{\partial r}+\frac{u}{r}+f\right)+\omega\frac{\partial u}{\partial p}$$
$$=-\frac{\partial}{\partial r}\left[\nu\left(\frac{\partial u}{\partial r}+\frac{u}{r}\right)\right]+\frac{\partial}{r\partial\theta}\left[\nu\left(\frac{\partial u}{r\partial\theta}\right)\right]$$
$$+\frac{\partial}{\partial p}\left[\kappa\left(\frac{\partial u}{\partial p}\right)\right],$$

$$u\frac{\partial v}{r\partial\theta}+v\frac{\partial v}{\partial r}-u\left(\frac{u}{r}+f\right)+\omega\frac{\partial v}{\partial p}$$
$$=-g\frac{\partial z}{\partial r}+\frac{\partial}{\partial r}\left[\nu\left(\frac{\partial v}{\partial r}+\frac{v}{r}\right)\right]+\frac{\partial}{r\partial\theta}\left[\nu\left(\frac{\partial v}{r\partial\theta}\right)\right]$$
$$+\frac{\partial}{\partial p}\left[\kappa\left(\frac{\partial v}{\partial p}\right)\right]-\frac{2}{r^2}\frac{\partial(uv)}{\partial\theta},$$

3) "Ensemble" of Forecasts

Different equations, initial conditions, and modelling techniques lead to a variety of predictions

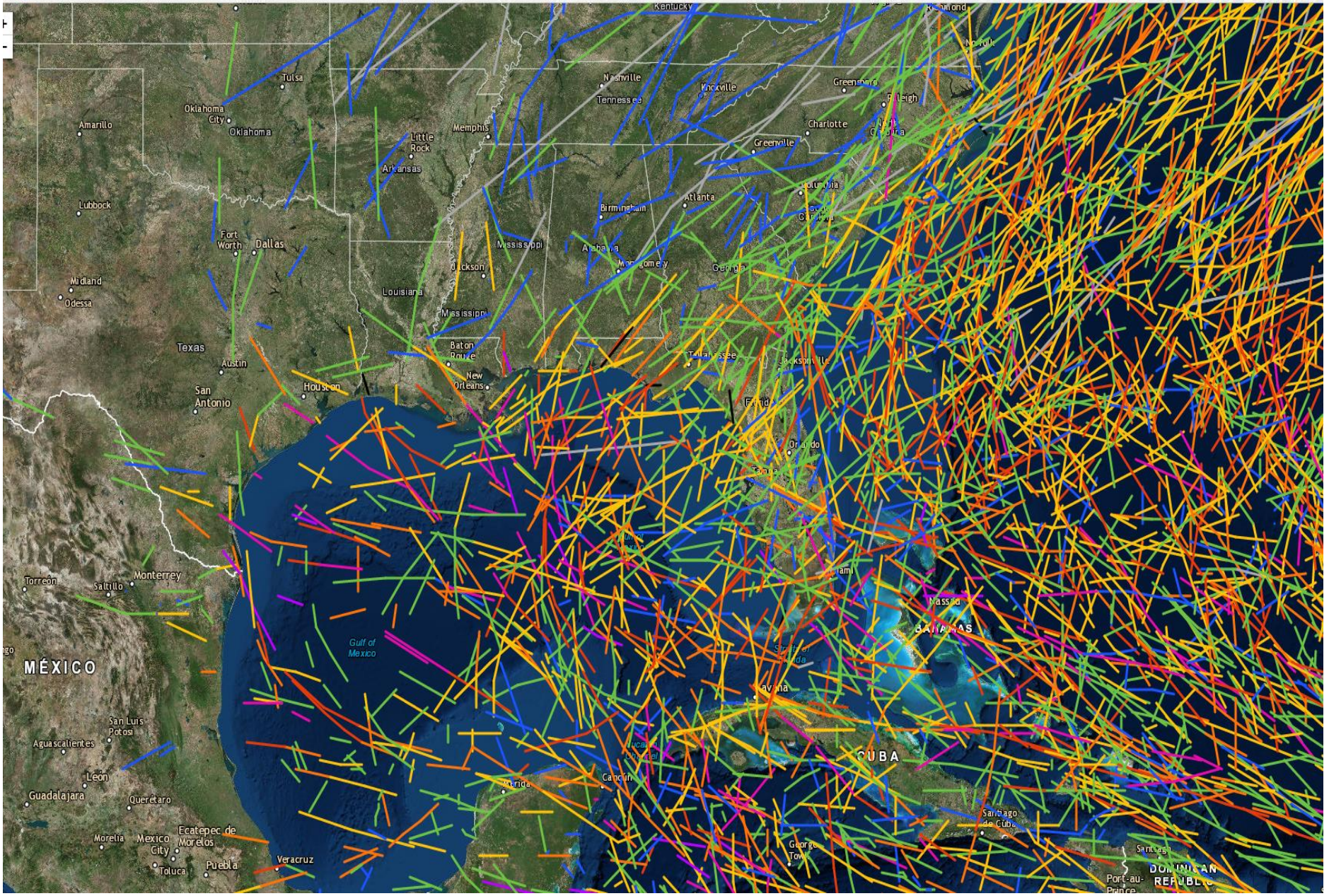




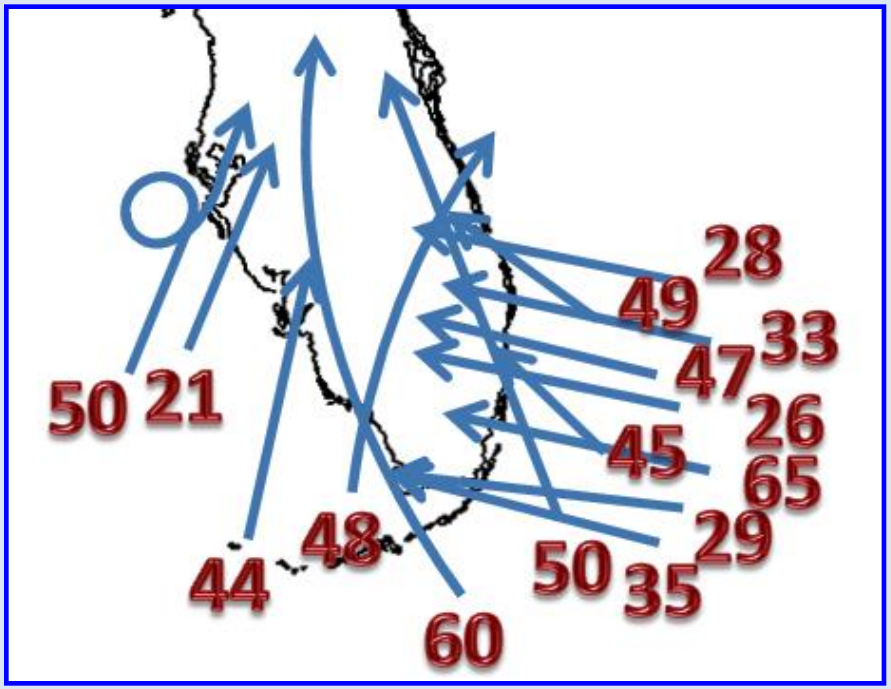
4) The Official Forecast

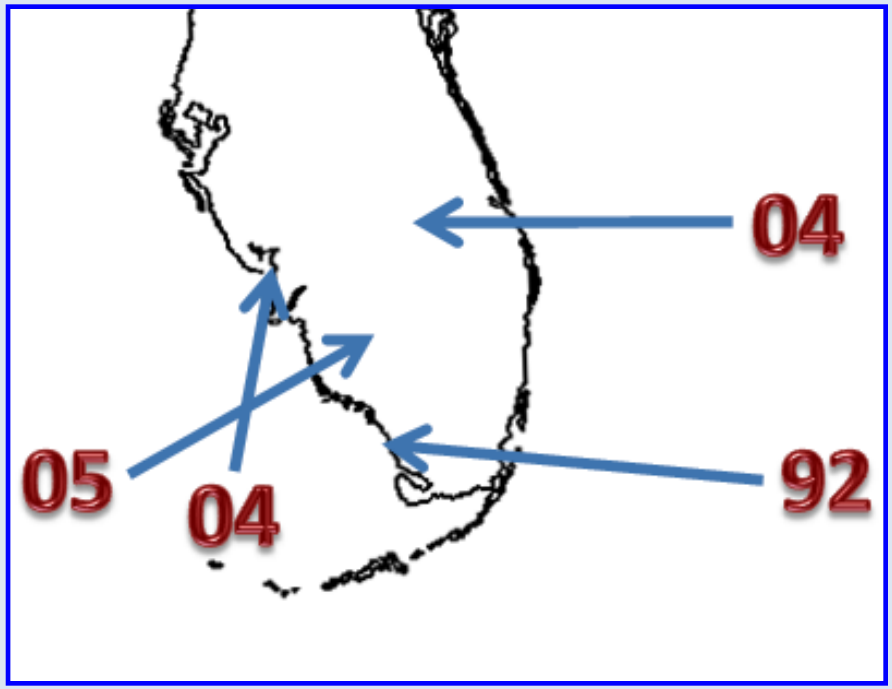
Forecasters at the National Hurricane Center examine computer model forecasts and issue the official forecast based on what they deem as the most likely scenario

Historical Hurricane Tracks



Major Hurricane Landfalls





1920-1965:

15

– averages 1 strike every 3 years!

1966-2016:

4

(Last 50 years)

Tropical Cyclones are multi-hazard IMPACT events!

What to Expect During a Hurricane Landfall

- Storm Surge
- Wind
- Rain
- Tornadoes
- Waves/Rip Currents

The Saffir-Simpson Intensity Scale

Category	Maximum Sustained Winds	Description
Tropical Depression	< 40 mph	Tie down your trash can and outdoor furniture.
Tropical Storm	40-73 mph	**Dangerous winds**: Tree branches and loose objects can cause isolated damage to houses and people.
Category 1 Hurricane	74-95 mph	***Very dangerous winds will produce some damage***: Roof damage, large tree branches, many power lines down leading to power outages.
Category 2 Hurricane	96-110 mph	***Extremely dangerous winds will cause extensive damage***: Roof and siding damage, some trees uprooted. Extended power loss and road blockages likely.
Category 3 Hurricane	111-130 mph	***Devastating damage will occur***: Significant home damage, road blockage, extended electricity AND water outages.
Category 4 Hurricane	131-155 mph	***Catastrophic damage will occur***: Major home damage or destruction, road blockages, power and water outages could last up to months.
Category 5 Hurricane	> 155 mph	***Catastrophic damage will occur***: Most homes/trees/etc. destroyed. Affected area uninhabitable for weeks or months.

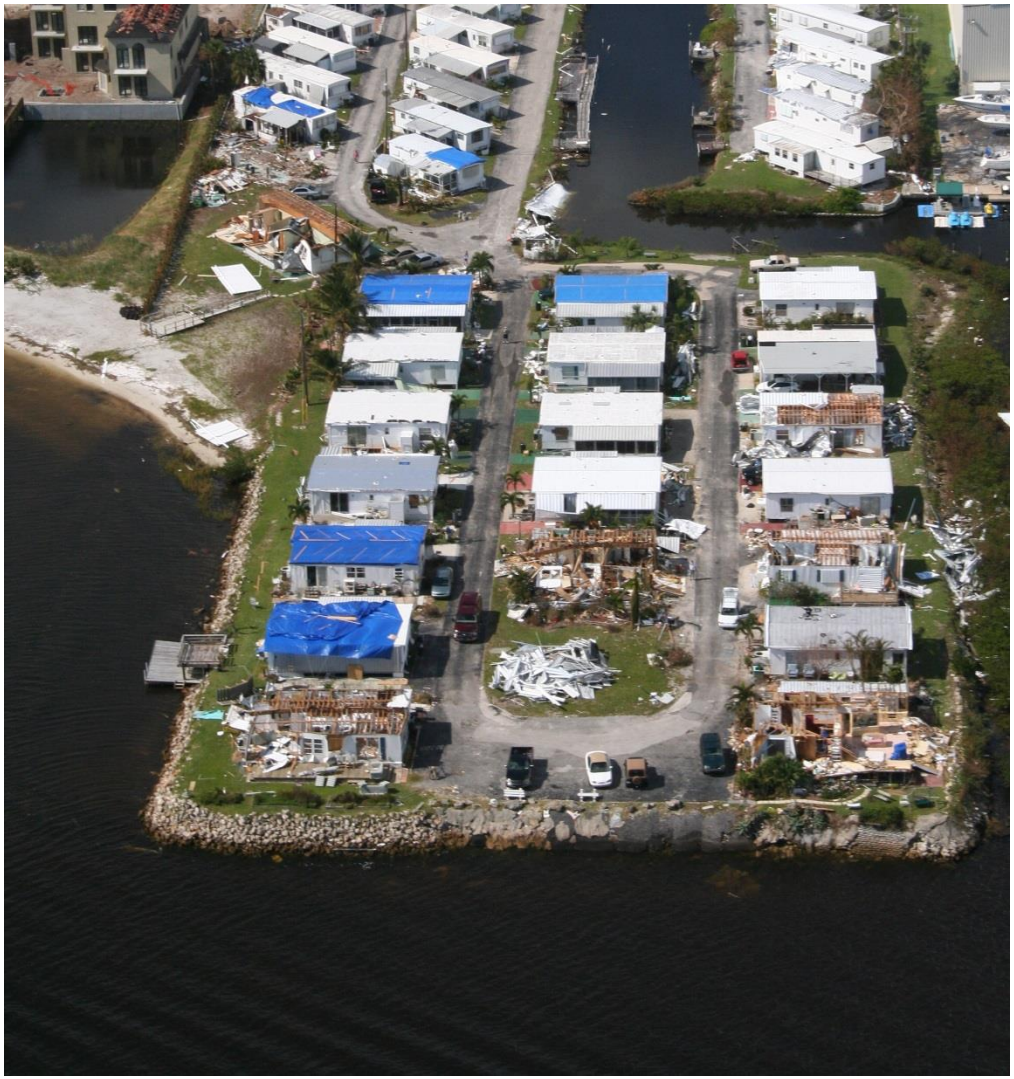
What Category Hurricane Caused This?

Category 4/5: Hurricane Andrew 1992

What Category Hurricane Caused This?

Category 2: Hurricane Wilma 2005

What Category Hurricane Caused This?



Category 2: Hurricane Wilma 2005

Hurricane Matthew: Melbourne Beach

Hurricane Matthew: Ormond Beach

Hurricane Matthew: Ormond Beach

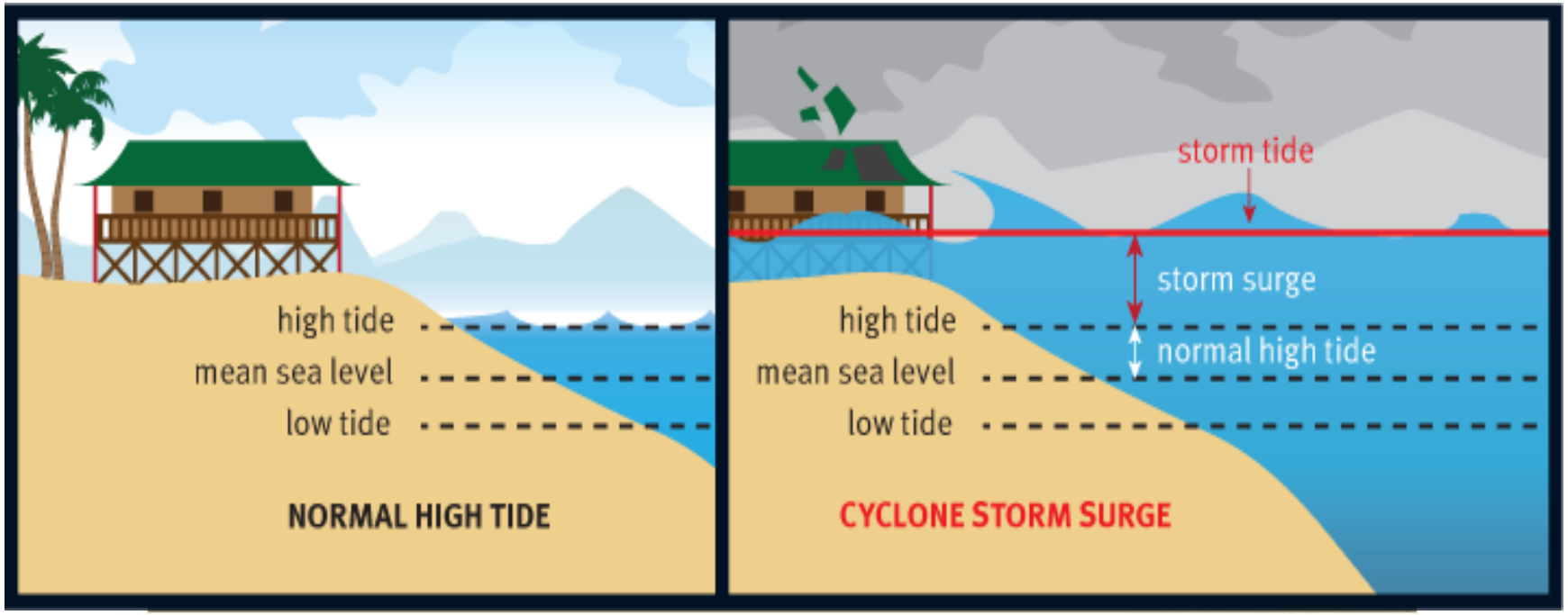
More Than Just Wind

- **Wind gets the headlines and other impacts sometimes get "lost in the shuffle**".
- However, the "other" impacts are often the ones that impact us the most.
- Flooding and tornadoes a potential problem with ANY tropical system.
- For coastal areas, storm surge/tide threat must be taken seriously (low probability, HIGH impact event.

Storm Surge: Wind Pushing Water

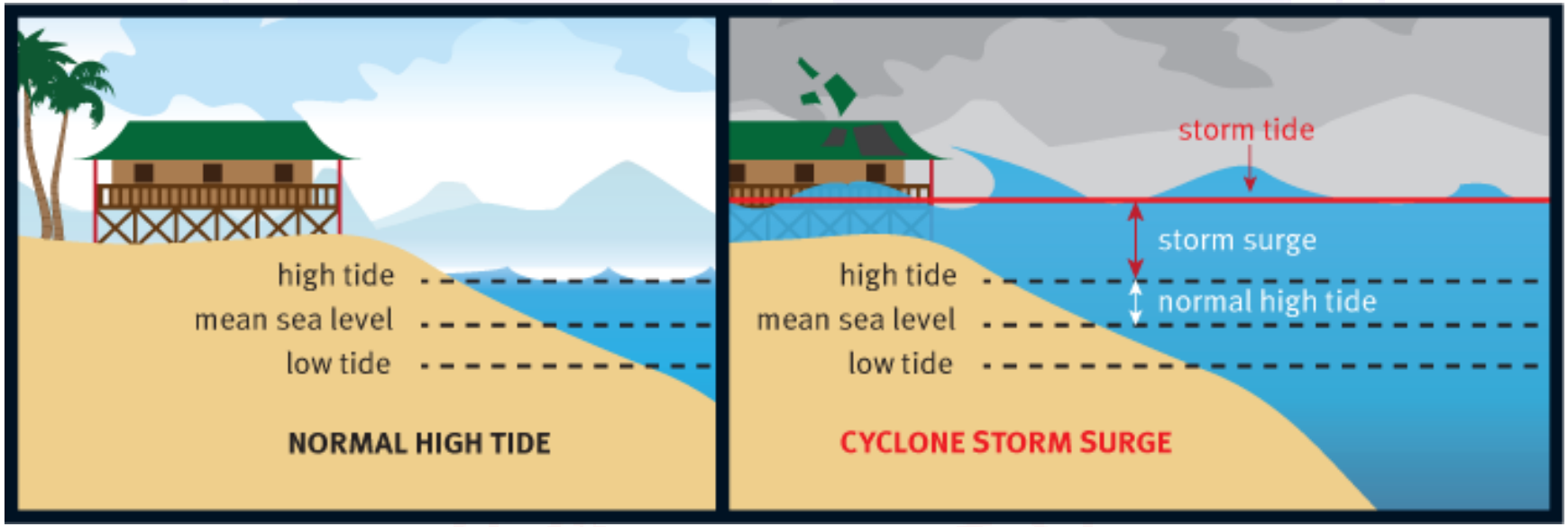
- The #1 cause of deaths in hurricanes

- Storm surge is produced by water being pushed toward the shore by the storm winds

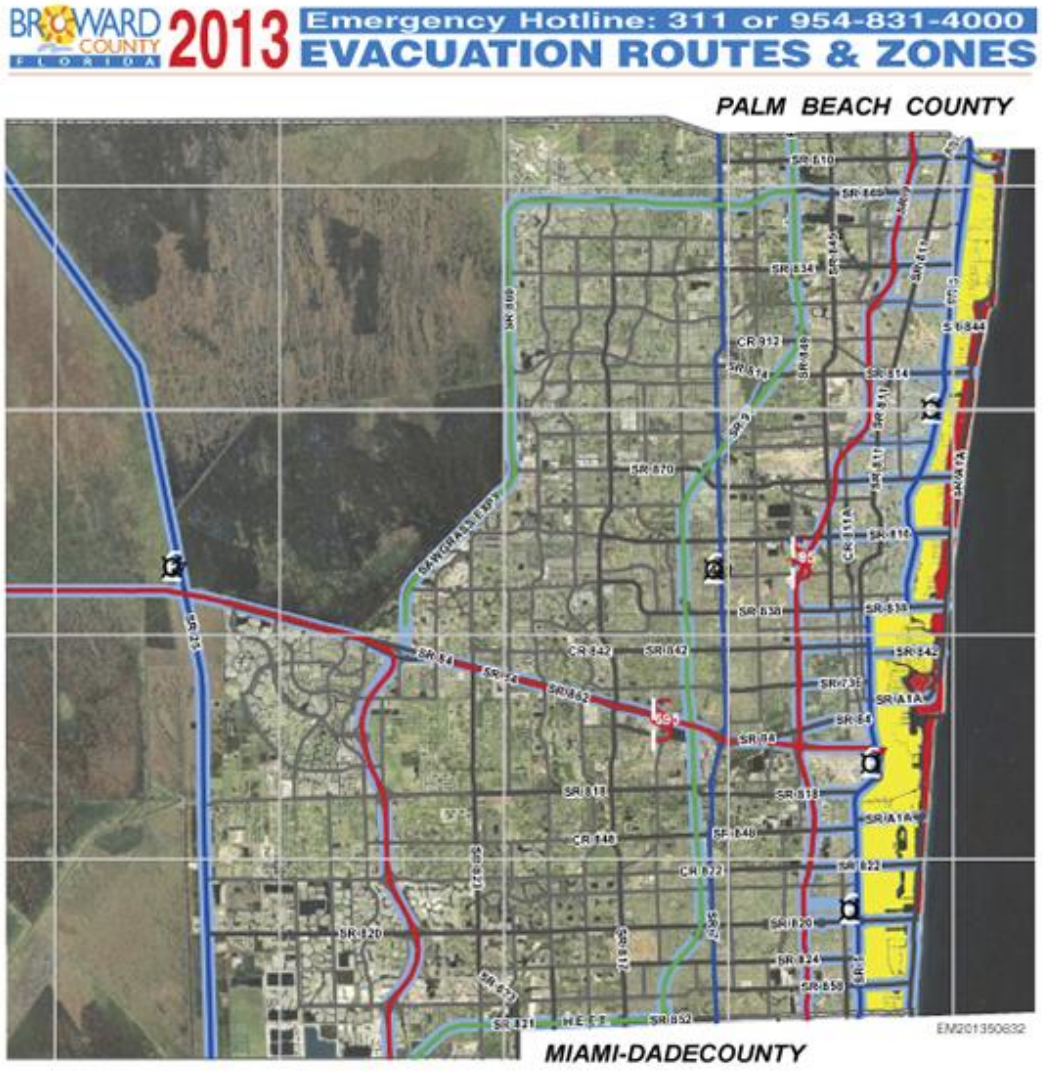


What is Storm Surge?

"An abnormal rise of water, generated by a storm's winds, pushed onshore near a landfalling tropical cyclone, **over and above** the astronomical tide."



Know Your Evacuation Zones

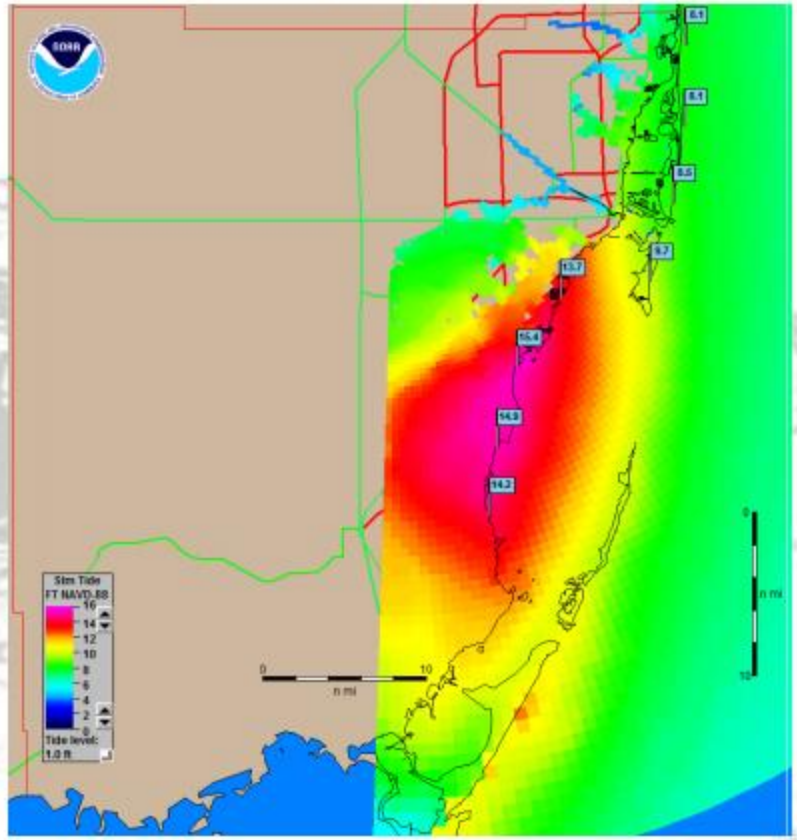


- Based on storm surge models and detailed elevation studies (LIDAR)

- Storm surge not always dependent on hurricane category (remember that the Saffir-Simpson Scale is a WIND scale only)

Concave and Convex Coast and Shallow Water VS. Deep Water

Biscayne Bay VS. South Beach



Bathymetric Map

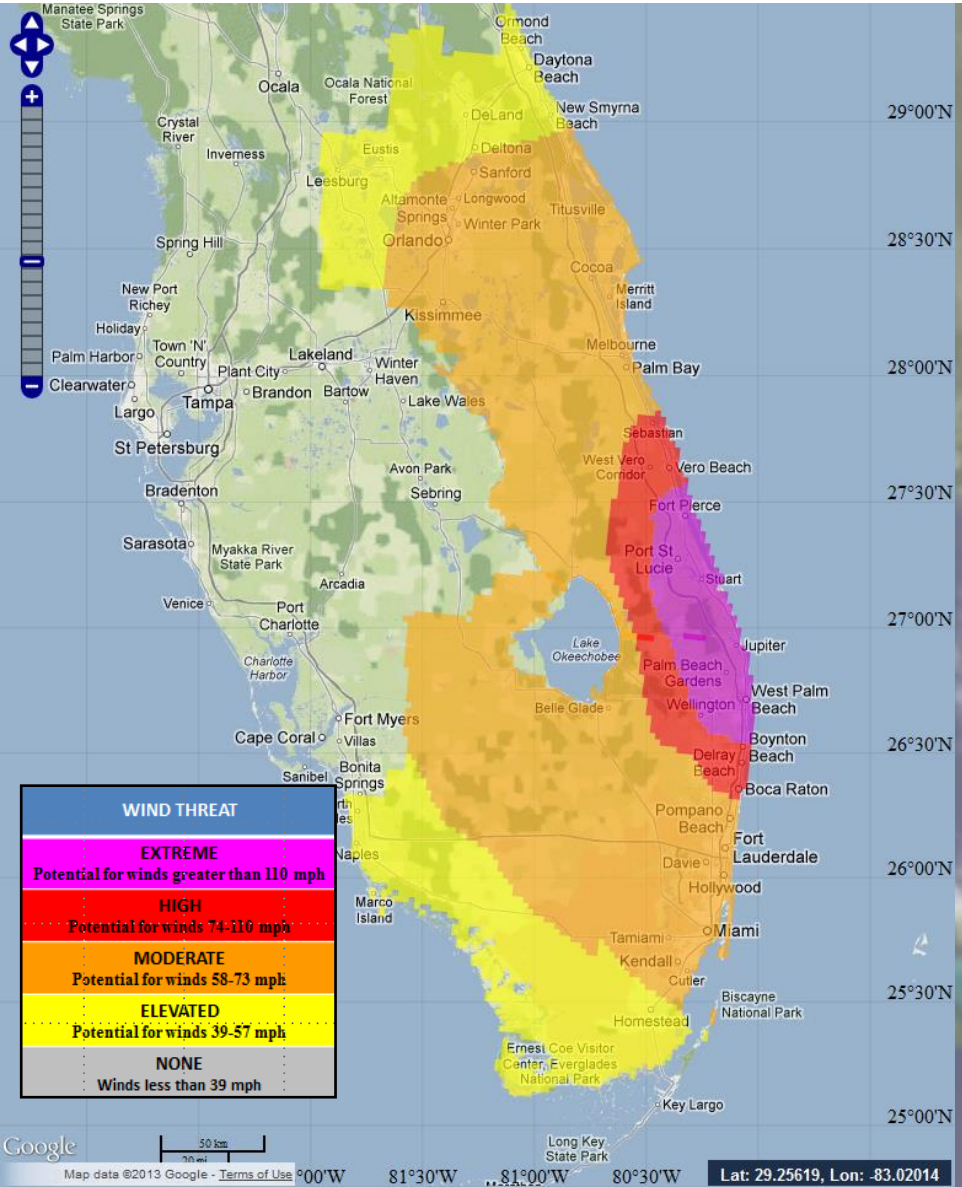
Focusing Forecasts on IMPACTS for Decision Support

- Using hurricanes as an example, the National Weather Service provides a series of graphics depicting the potential THREAT and associated IMPACT from each of the hurricane's hazards (wind/rainfall flooding/storm surge/tornadoes)

- These impacts are derived from an assessment of the different potential scenarios with each forecast, then a impact level is determined which depicts the **REASONABLE WORST CASE** scenario at that particular point in time

Hurricane Threats & Impacts

"A Picture is Worth a Thousand Words"



HTI

- Colorized threat maps with locally-defined potential impacts statements for each hazard
- Available in KML or PNG formats
- Available during Watch/ Warning period; valid from issuance until end of event

Hurricane Threats & Impacts

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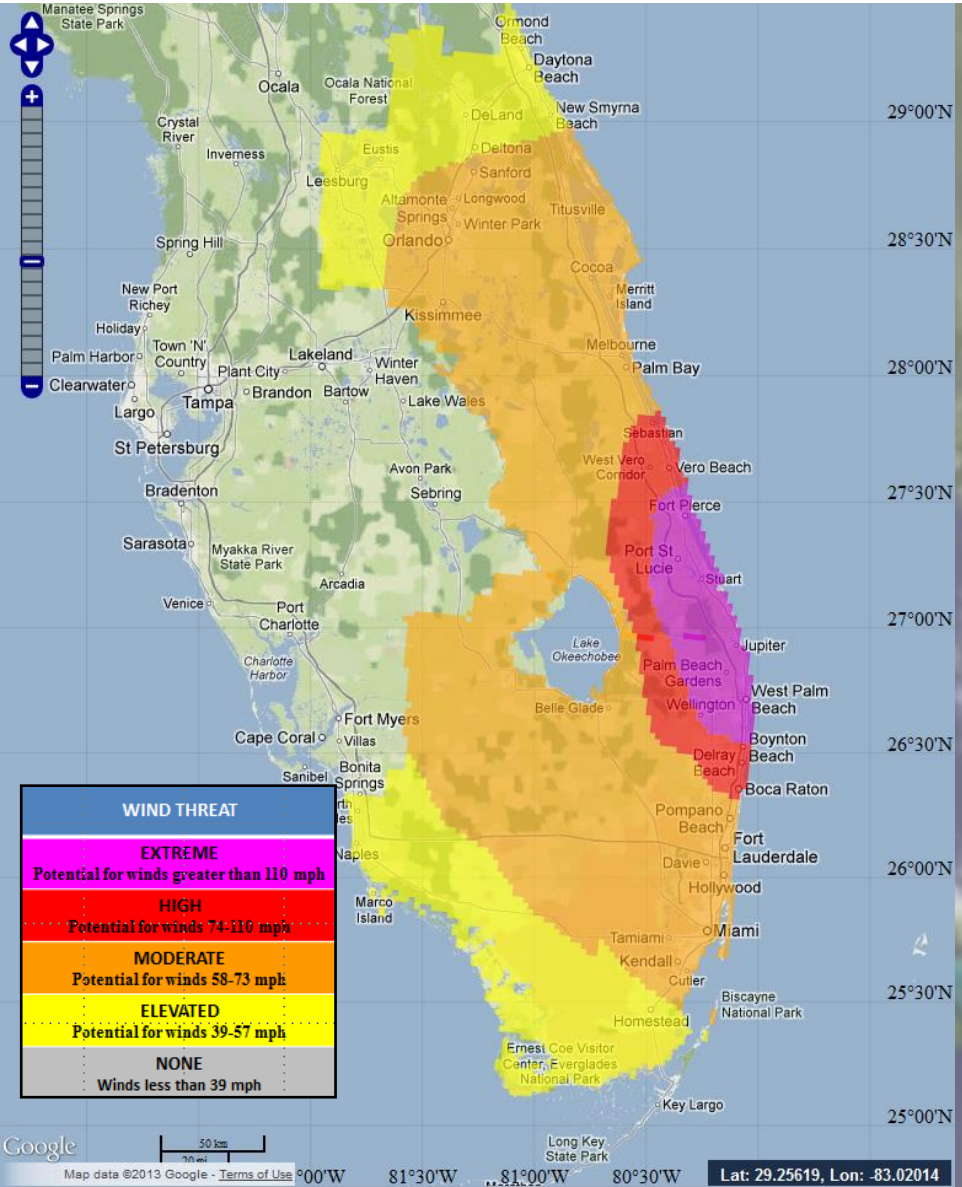
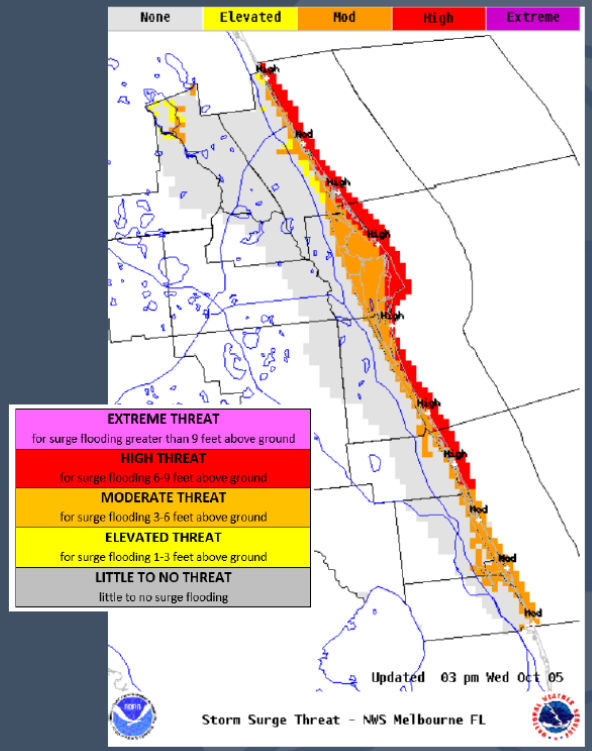


Wind Threat	Potential Wind Impacts
EXTREME Threat for wind greater than 110 mph	**DEVASTATING TO CATASTROPHIC** To be safe, aggressively prepare for the potential of devastating to catastrophic wind impacts from major hurricane force wind of equivalent Category 3 intensity or higher.
HIGH Threat for wind 74-110 mph	**EXTENSIVE** To be safe, aggressively prepare for the potential of extensive wind impacts from hurricane force wind of equivalent Category 1 or 2 intensity.
MODERATE Threat for wind 58-73 mph	**SIGNIFICANT** To be safe, earnestly prepare for the potential of significant wind impacts from strong tropical storm force wind.
ELEVATED Threat for wind 39-57 mph	**LIMITED** To be safe, prepare for the potential of limited wind impacts from tropical storm force wind.
LITTLE TO NONE Wind less than 39 mph	**LITTLE TO NONE** No immediate preparations needed; little to no wind impacts.

Focusing Forecasts on IMPACTS for Decision Support

Storm Surge Flooding Threat

East Central Florida & Adjacent Coastal Waters



- The threat of storm surge flooding has increased with locations possibly receiving 5-8 feet of surge inundation.
- Over wider areas, 2 to 4 feet of surge inundation is possible.
- This includes significant wind piling and surging of water within the intra-coastal waterways, lagoons, and inlets.
  - Particular concerns are for the south end of Mosquito Lagoon, the areas the Indian River Lagoon south of Sebastian Inlet, and at the base of all causeways.

Melbourne
WEATHER FORECAST OFFICE

http://www.weather.gov/melbourne
facebook.com/NWSMelbourne @NWSMelbourne

October 5, 2016

Focusing Forecasts on IMPACTS for Decision Support

Storm Surge Flooding Threat

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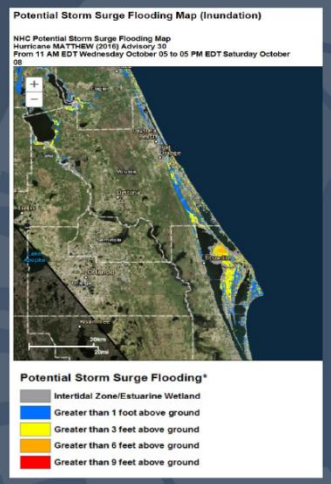
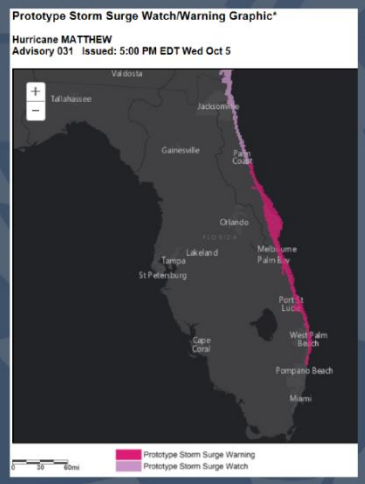




An interactive High-Resolution Potential Storm Surge Inundation Graphic is available on NHC's Website. An experimental Storm Surge Watch/Warning product places a Storm Surge Warning from south of West Palm Beach to Flagler Beach, which includes the entire coastline of East Central Florida. The warning indicates a potential for life-threatening storm surge.

Melbourne http://www.weather.gov/melbourne facebook.com/NWSMelbourne @NWSMelbourne October 5, 2016

Storm Surge Threat	Potential Surge Impacts
EXTREME Threat for surge flooding greater than 9 feet above ground	**DEVASTATING TO CATASTROPHIC** To be safe, aggressively prepare for the potential of devastating to catastrophic life threatening surge impacts.
HIGH Threat for surge flooding 6-9 feet above ground	**EXTENSIVE** To be safe, aggressively prepare for the potential of extensive and life threatening surge impacts.
MODERATE Threat for surge flooding 3-6 feet above ground	**SIGNIFICANT** To be safe, earnestly prepare for the potential of significant and life threatening surge impacts.
ELEVATED Threat for surge flooding 1-3 feet above ground	**LIMITED** To be safe, prepare for the potential of limited surge impacts.
LITTLE TO NONE Little (less than 1 foot) to No surge flooding	**LITTLE TO NONE** No immediate preparations needed; little to no surge impacts.

Focusing Forecasts on IMPACTS for Decision Support

PROTECT AGAINST LIFE-THREATENING SURGE HAVING POSSIBLE SIGNIFICANT IMPACTS ACROSS THE IMMEDIATE BEACH FRONT AREAS OF PALM BEACH COUNTY.

POTENTIAL IMPACTS IN THIS AREA INCLUDE:

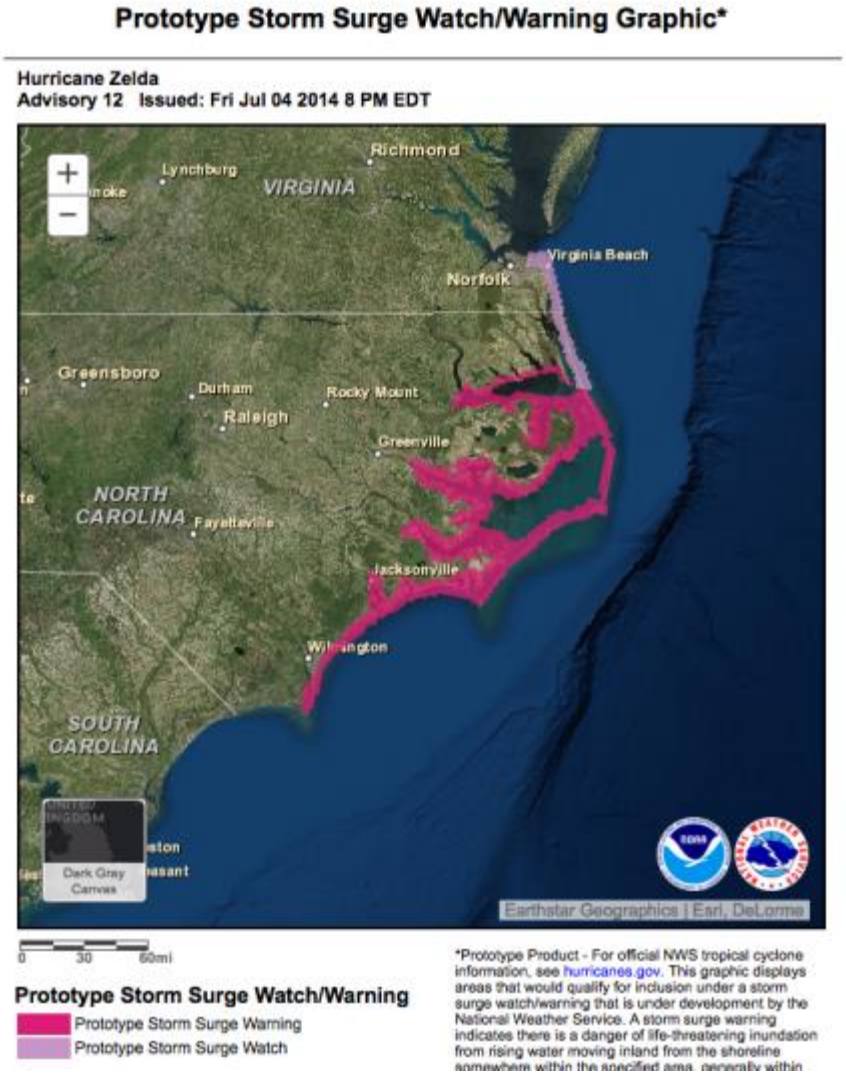
- AREAS OF INUNDATION WITH STORM SURGE FLOODING ACCENTUATED BY WAVES. DAMAGE TO SEVERAL BUILDINGS, MAINLY NEAR THE COAST

- SECTIONS OF NEAR-SHORE ESCAPE ROUTES AND SECONDARY ROADS BECOME WEAKENED OR WASHED OUT, ESPECIALLY IN USUALLY VULNERABLE LOW SPOTS.

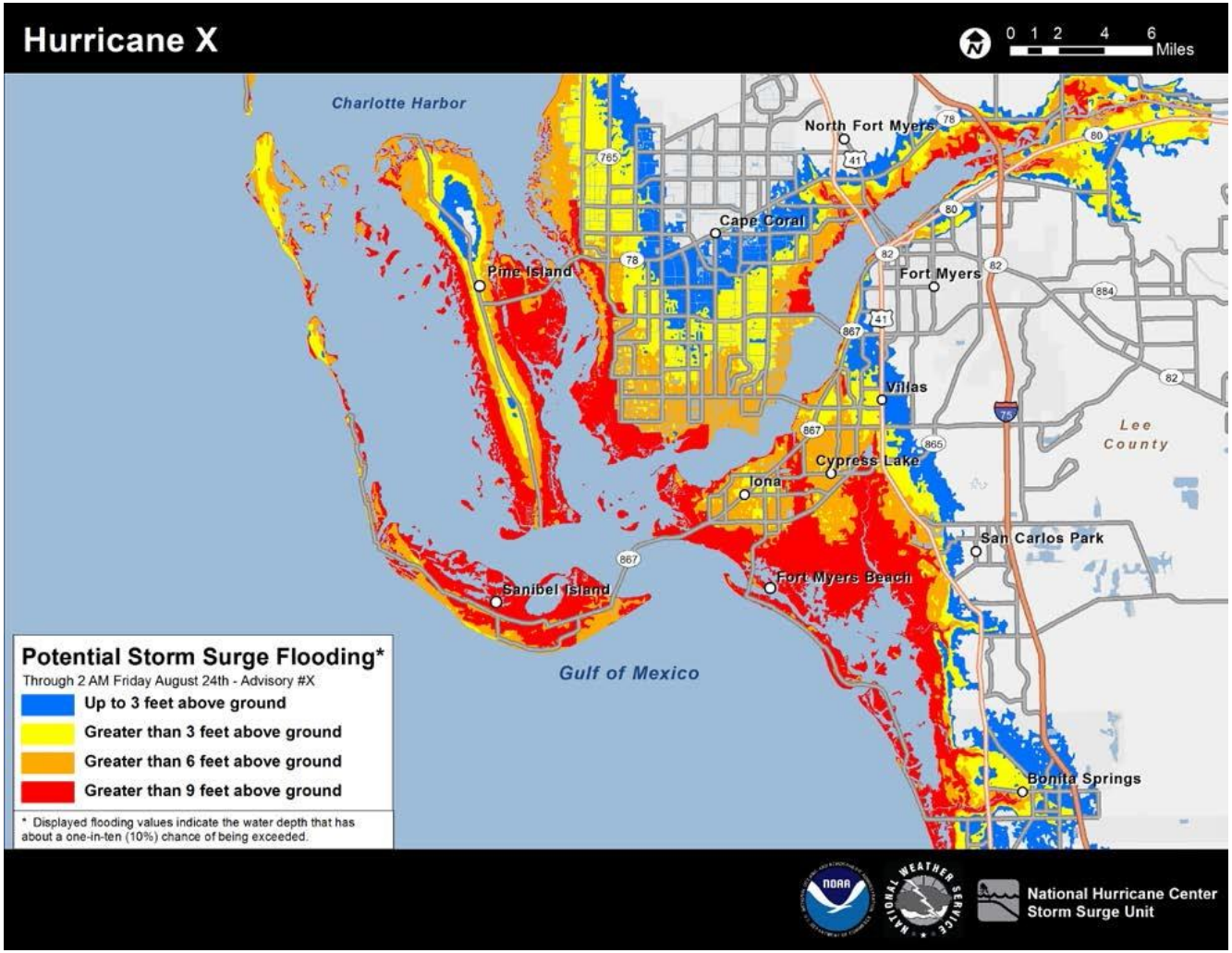
- MAJOR BEACH EROSION WITH HEAVY SURF BREACHING DUNES. STRONG AND NUMEROUS RIP CURRENTS.

- MODERATE DAMAGE TO MARINAS, DOCKS, BOARDWALKS, AND PIERS. SEVERAL SMALL CRAFT BROKEN AWAY FROM MOORINGS, ESPECIALLY IN UNPROTECTED ANCHORAGES.

Storm Surge Watch/Warning Official in 2017



Potential Storm Surge Flooding Map



- Official in 2016
- Uses latest storm surge model and LIDAR data
- Depicts areas of storm surge threat
- NOT a forecast of total area inundation

Visit Hurricanes.gov for More Information

Focusing Forecasts on IMPACTS for Decision Support

- This information is intended to convey potential threats and associated impacts based on the latest information and state of the science

- This information is intended to go beyond the routine forecasts and provide decision makers with tools that facilitate planning, and ultimately decisions to protect life and property

Threats -----> Potential Impacts

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