South Florida
Extreme Weather and Weather Threats

Robert Molleda

Warning Coordination Meteorologist

National Weather Service

Miami/South Florida Weather Forecast Office

Robert.Molleda@noaa.gov

Miami-Dade County Healthcare Preparedness Coalition
2023 Annual Symposium
March 29th, 2023

Top Miami-Dade Hazard Based on FEMA NRI ?

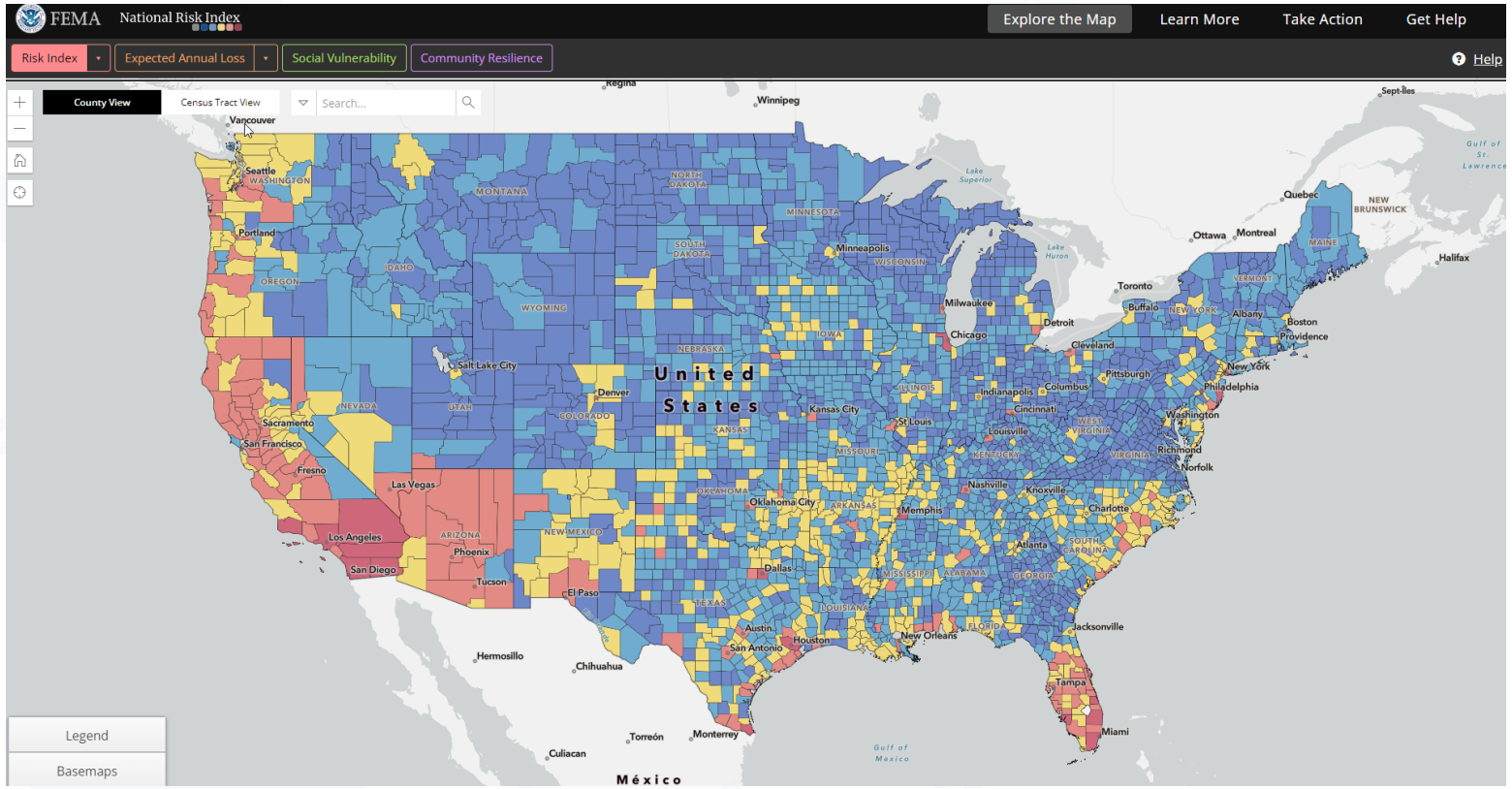
Miami
WEATHER FORECAST OFFICE

Which weather hazard is most concerning to you?

a. Tornadoes
b. Lightning
c. Hurricanes
d. Flooding
e. Heat
f. Other

FEMA National Risk Index (NRI)

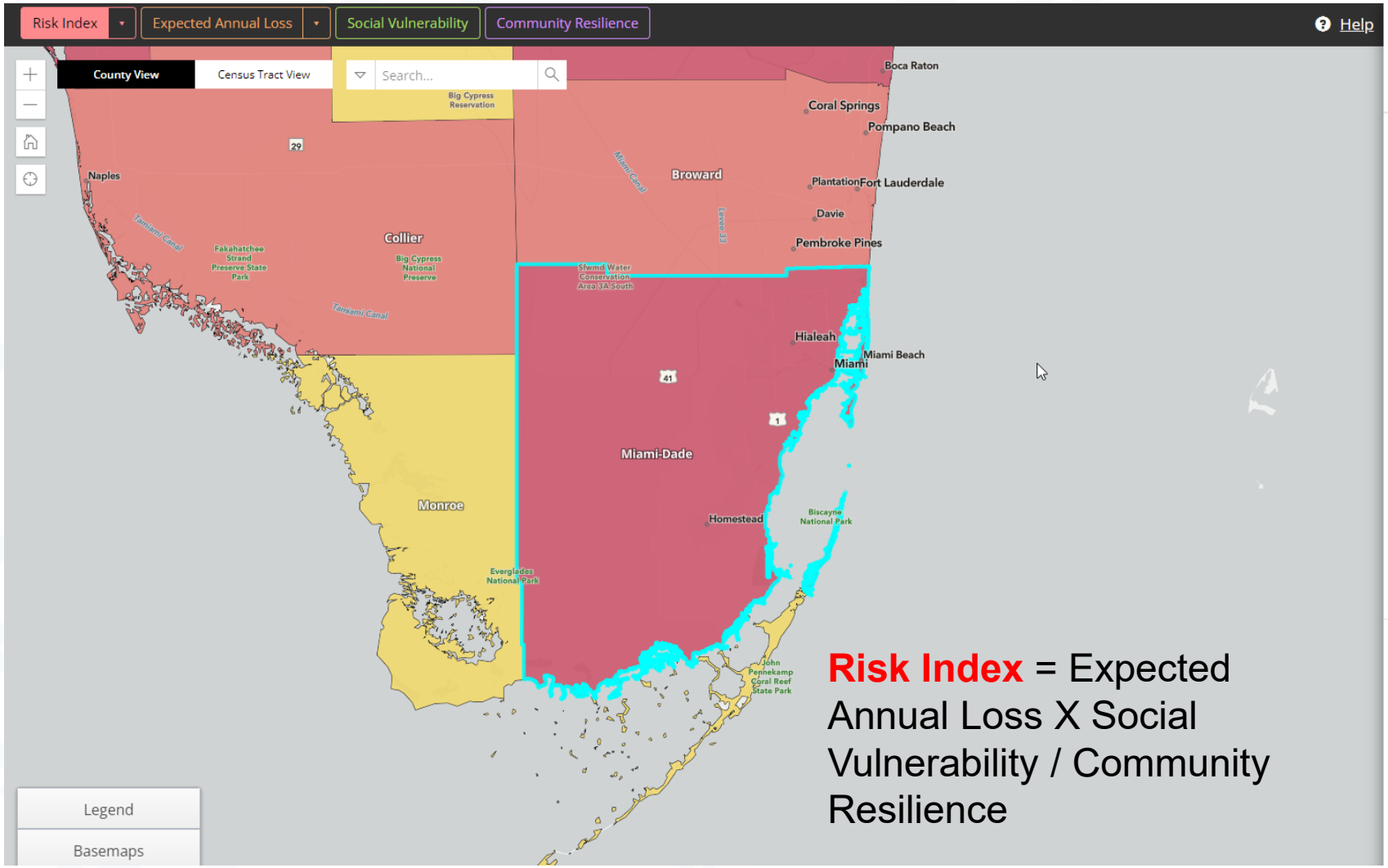
Miami
WEATHER FORECAST OFFICE



https://hazards.fema.gov/nri/map

FEMA National Risk Index

Miami
WEATHER FORECAST OFFICE



Risk Index = Expected Annual Loss X Social Vulnerability / Community Resilience

Miami-Dade County
Florida

Risk Index

Risk Index is Very High

Score	63.93

Miami-Dade County, FL: 63.93
Florida Average: 19.65
National Average: 10.60
0 — 100

The Risk Index rating is **Very High** for **Miami-Dade County, FL** when compared to the rest of the U.S.

99.9% of U.S. counties have a lower Risk Index

100.0% of counties in Florida have a lower Risk Index

Risk Index Overview

Compared to the rest of the U.S., **Miami-Dade County, FL's** Risk Index components are:

Expected Annual Loss	**Very High**
Social Vulnerability	**Very High**
Community Resilience	**Relatively Moderate**

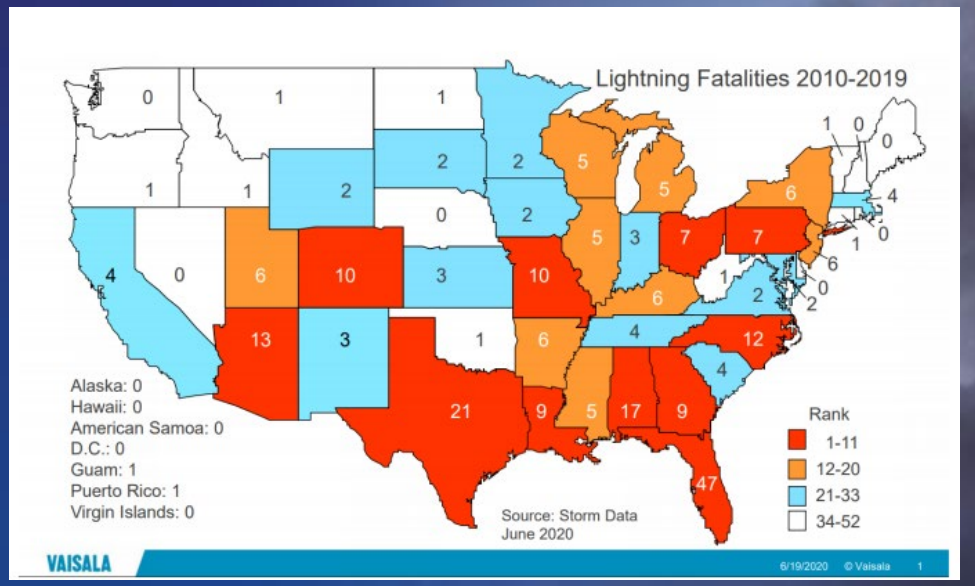
Which hazard has the highest NRI score in Miami-Dade County?

a. Tornadoes
b. Lightning
c. Hurricanes
d. Flooding

Top Miami-Dade Hazards Based on FEMA NRI

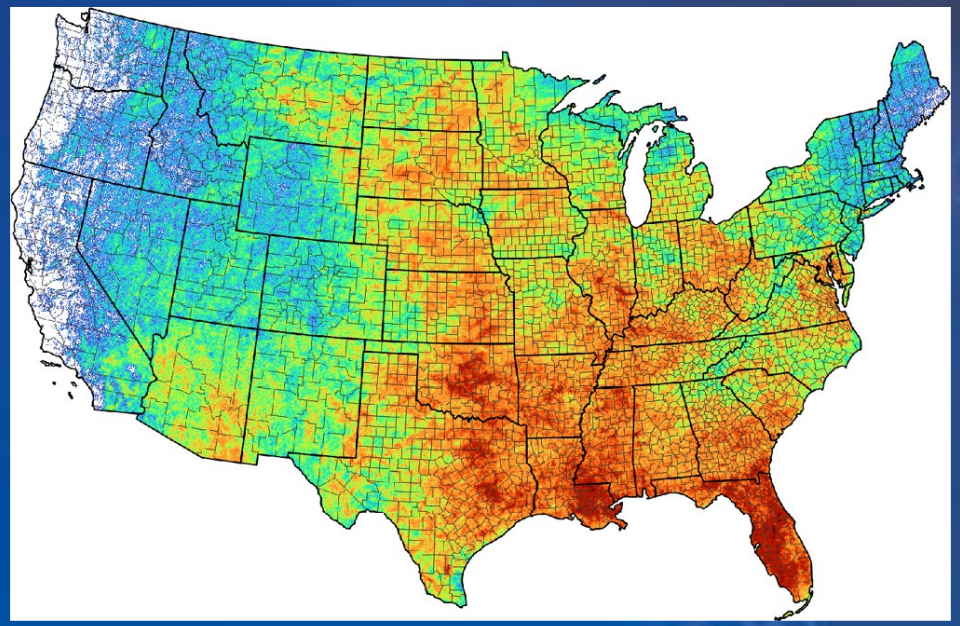
Miami
WEATHER FORECAST OFFICE

1. Lightning
2. Coastal Flooding (includes storm surge)
3. Tornadoes
4. Riverine Flooding
5. Cold Wave
6. Hurricanes (wind only?)



When Thunder Roars, Go Indoors
See a Flash, Dash Inside

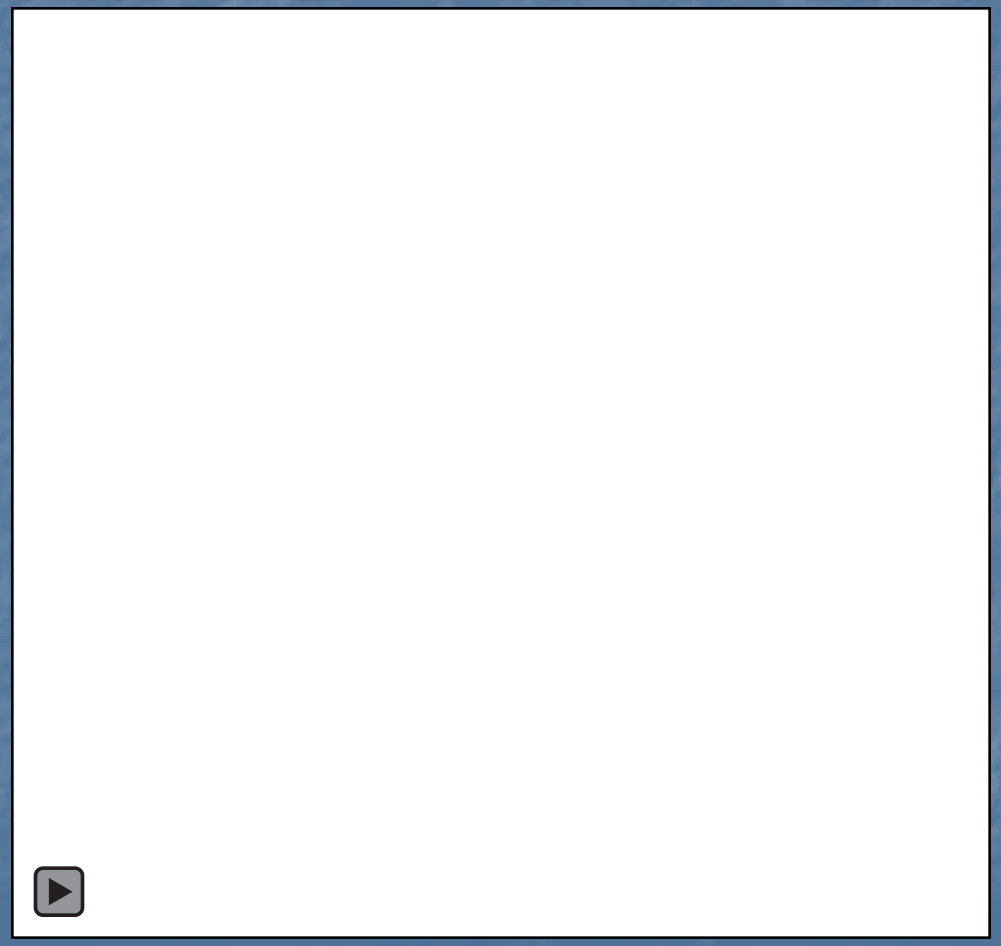
18 average lightning events per square mile per year in Miami-Dade County (2016-2022)



Tornadoes

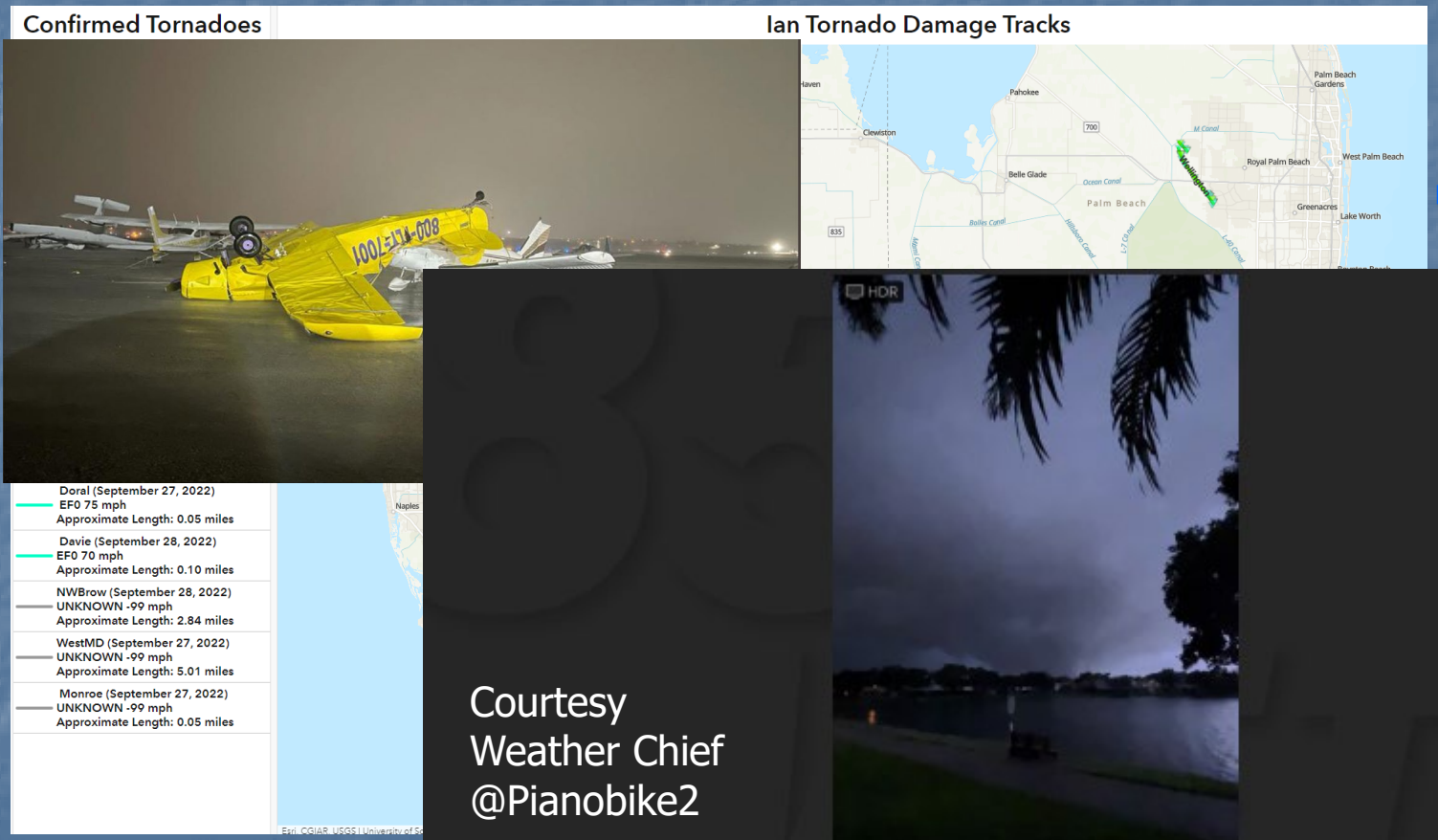
- *145 reported tornadoes in Miami-Dade County since 1950*
- *77% EF-0*
- *1 death (2003)*
- *Most tornadoes in Miami-Dade County are small in size and brief duration*
- *May-October, but have occurred in every month*

Tropical Cyclones and Tornadoes



- Tropical Cyclones often create an environment for mesocyclone formation (ample moisture, instability and wind shear).
- Favorable front right side of cyclone in outer bands 100-200 miles from center, NOT near the center. Must be careful to not focus too much on the center location.
- ANY tropical system can spawn tornadoes, even weak and disorganized ones!

Hurricane Ian Tornado Statistics



Courtesy
Weather Chief
@Pianobike2

- 13 confirmed tornadoes in Florida

Are Tornadoes Increasing in Frequency?

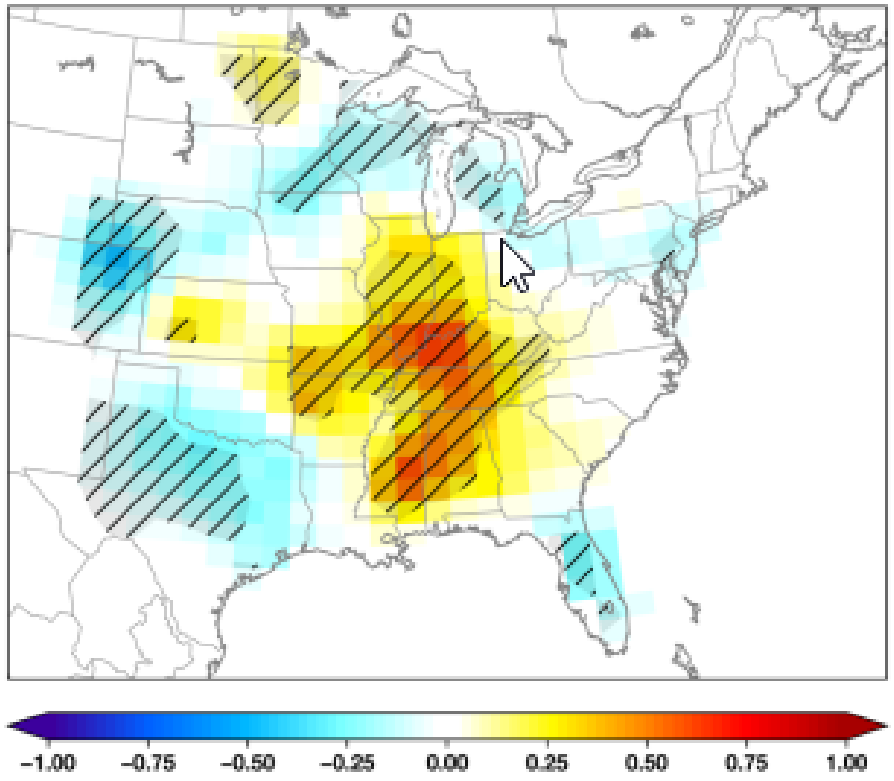


Fig. 5 Theil-Sen slope analysis of 1979–2017 annual gridded tornado reports. *p* values are hatched at values ≤ 0.05 significance using Kendall's τ statistic. Slope units are reports per year * 10^{-1}

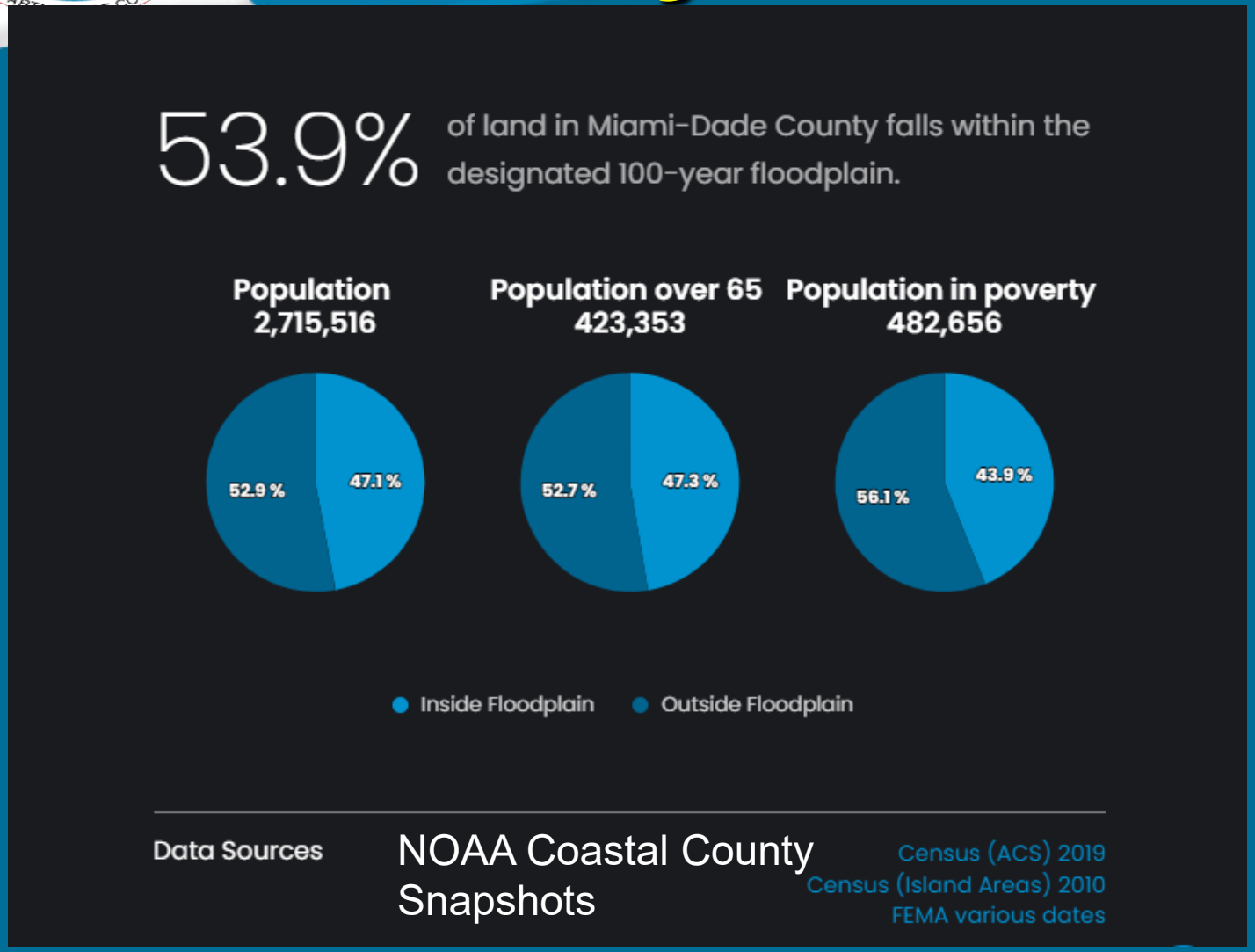
From article *"Spatial trends in United States tornado frequency"* (Gensini & Brooks, October 2018). Published in *npj Climate and Atmospheric Science*

- ***Slight decrease in tornado frequency in South Florida 1979-2017***

Rainfall Flooding

- *53 Flash Flood Events in Miami-Dade County since 1997 (average 2 per year)*
- *32 in past 10 years (3.2 per year)*
- *Increasing trend in flash flooding*

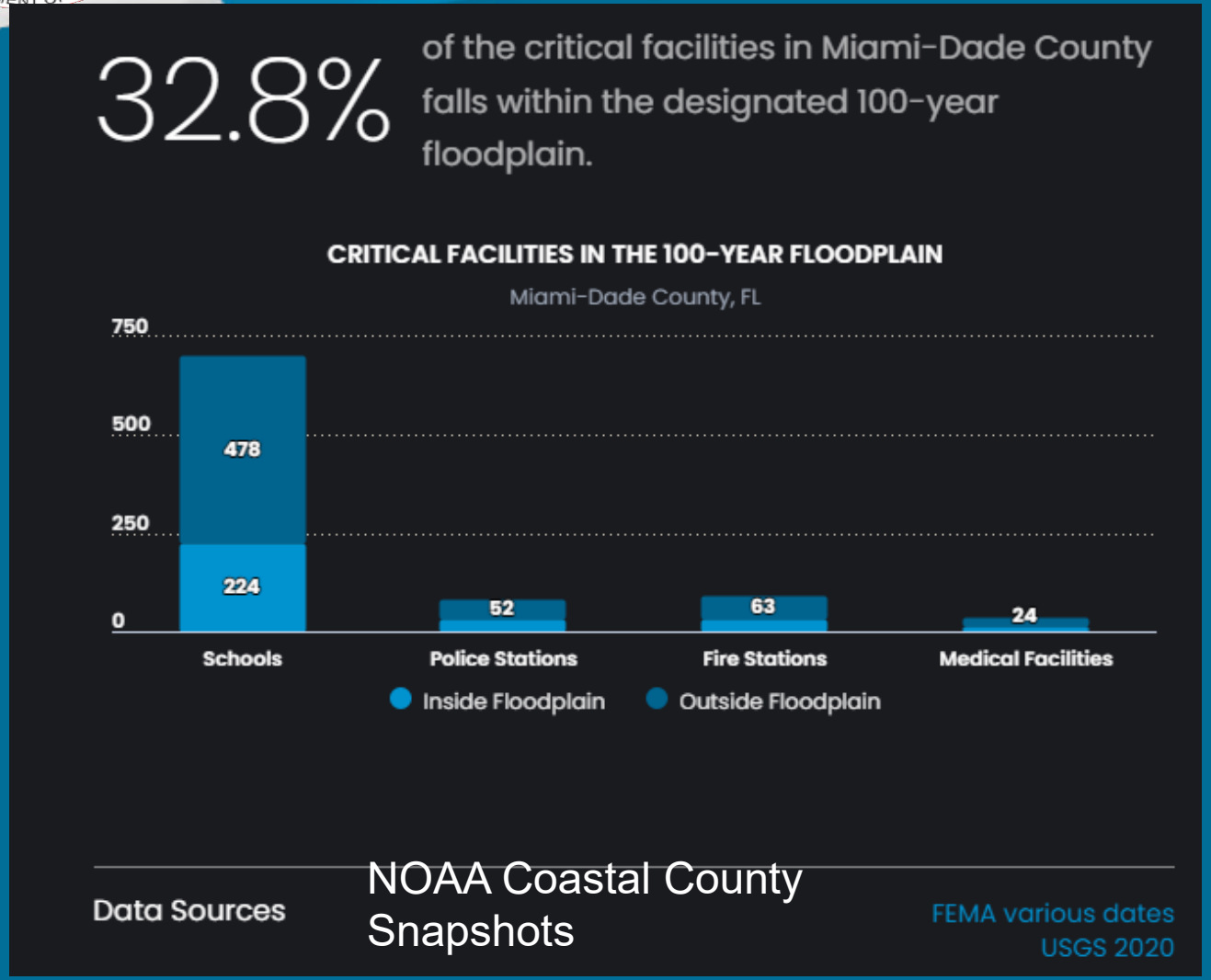
Rainfall Flooding



Link

100-year floodplain: areas with a 1% chance of flooding each year. Average depth 1-3 feet

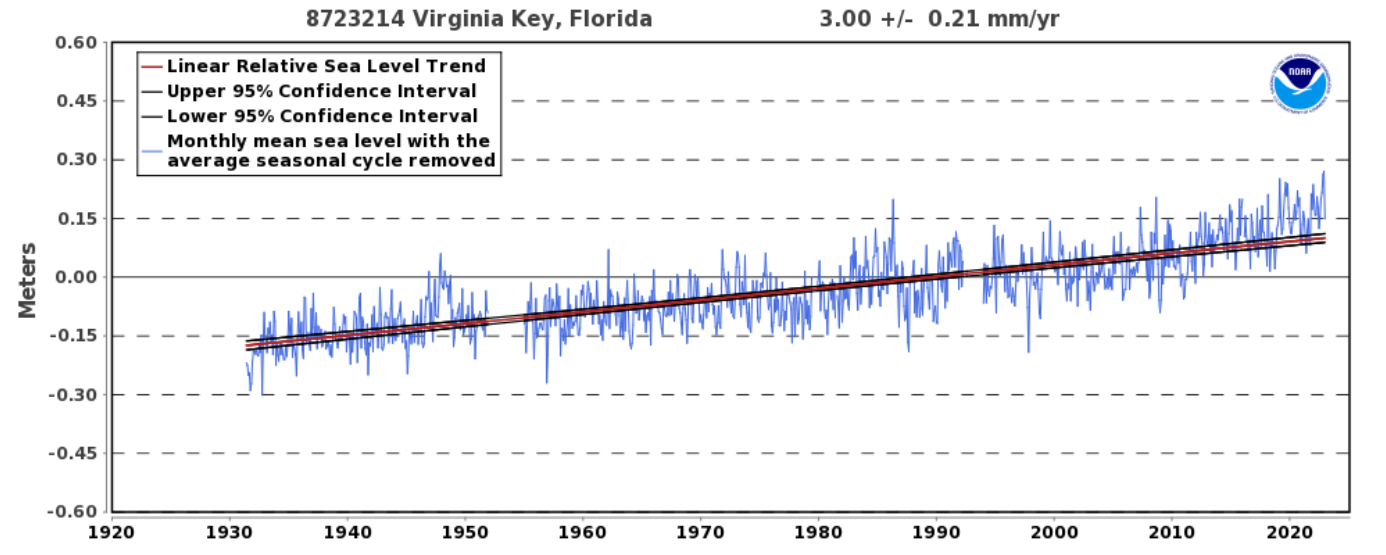
Rainfall Flooding



Link

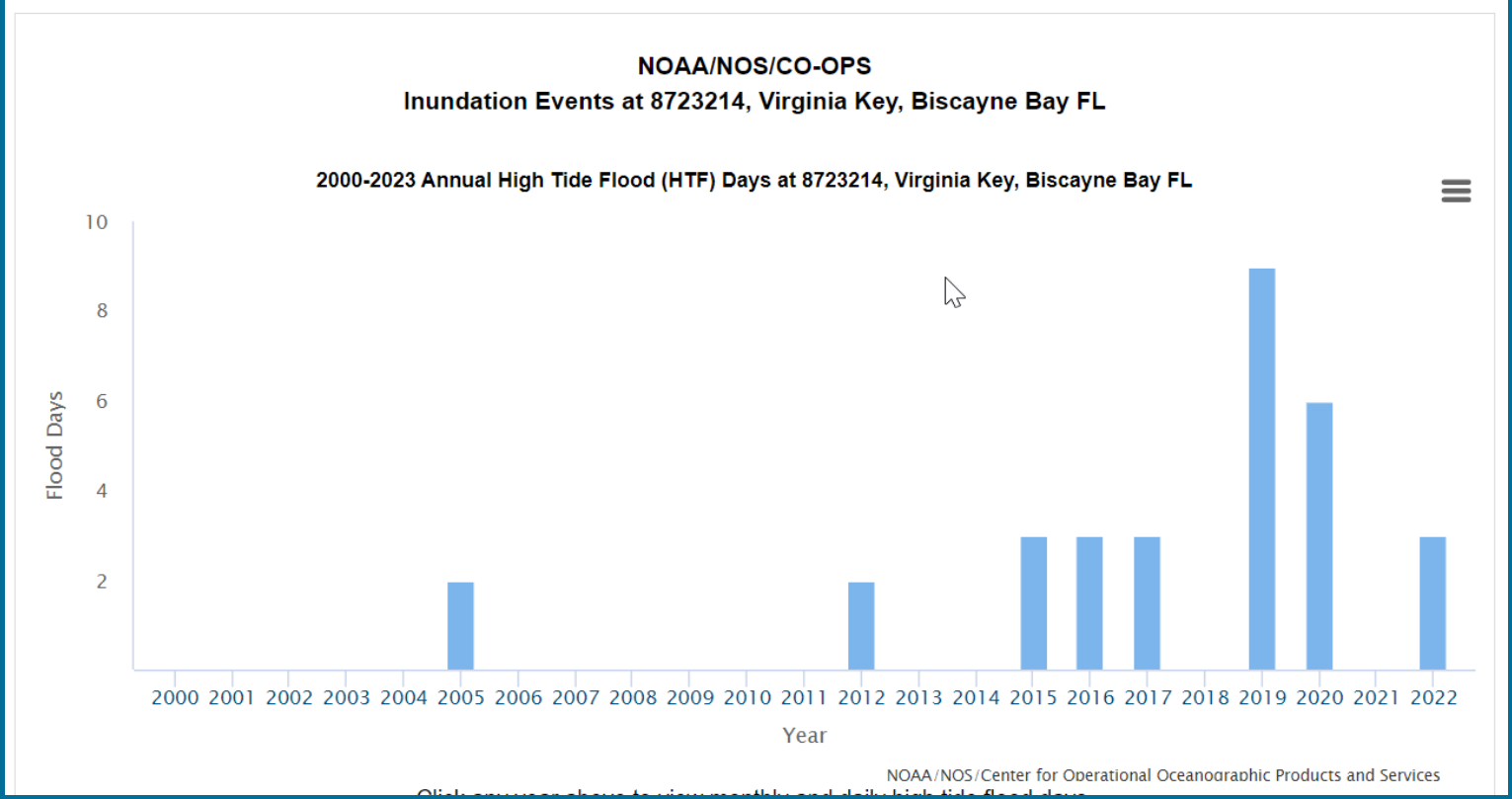
100-year floodplain: areas with a 1% chance of flooding each year. Average depth 1-3 feet

Coastal Flooding



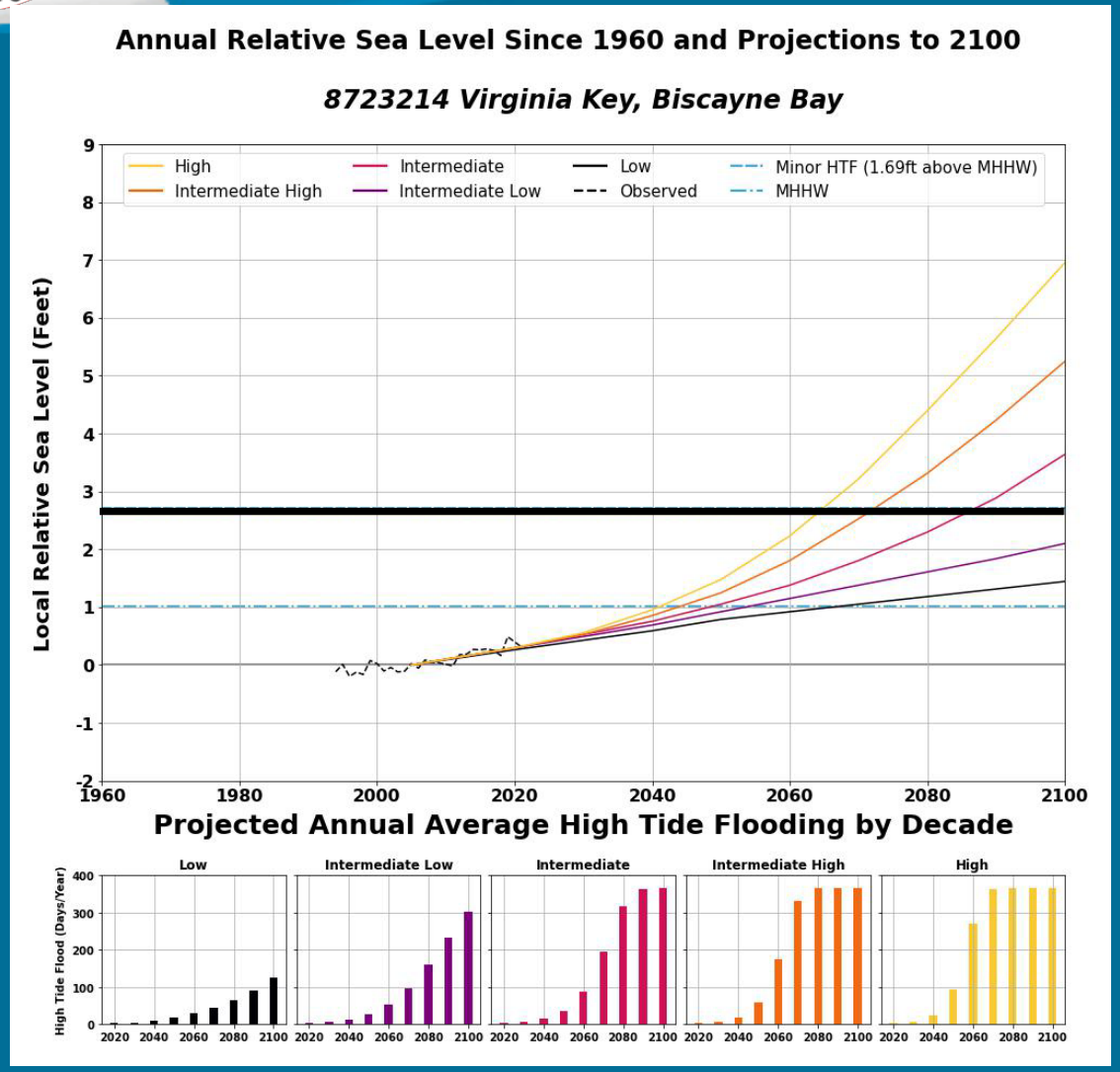
- *Storm Surge*
- *King Tide ("sunny day")*
- *Rate of sea level increase at Virginia Key tide gauge is 1 ft/100 yr*

Coastal Flooding



- *Therefore, the number of annual high tide flood days has increased*
- *Number of high tide flood days can vary significantly from year to year (hurricanes, other weather events, astronomical cycles)*

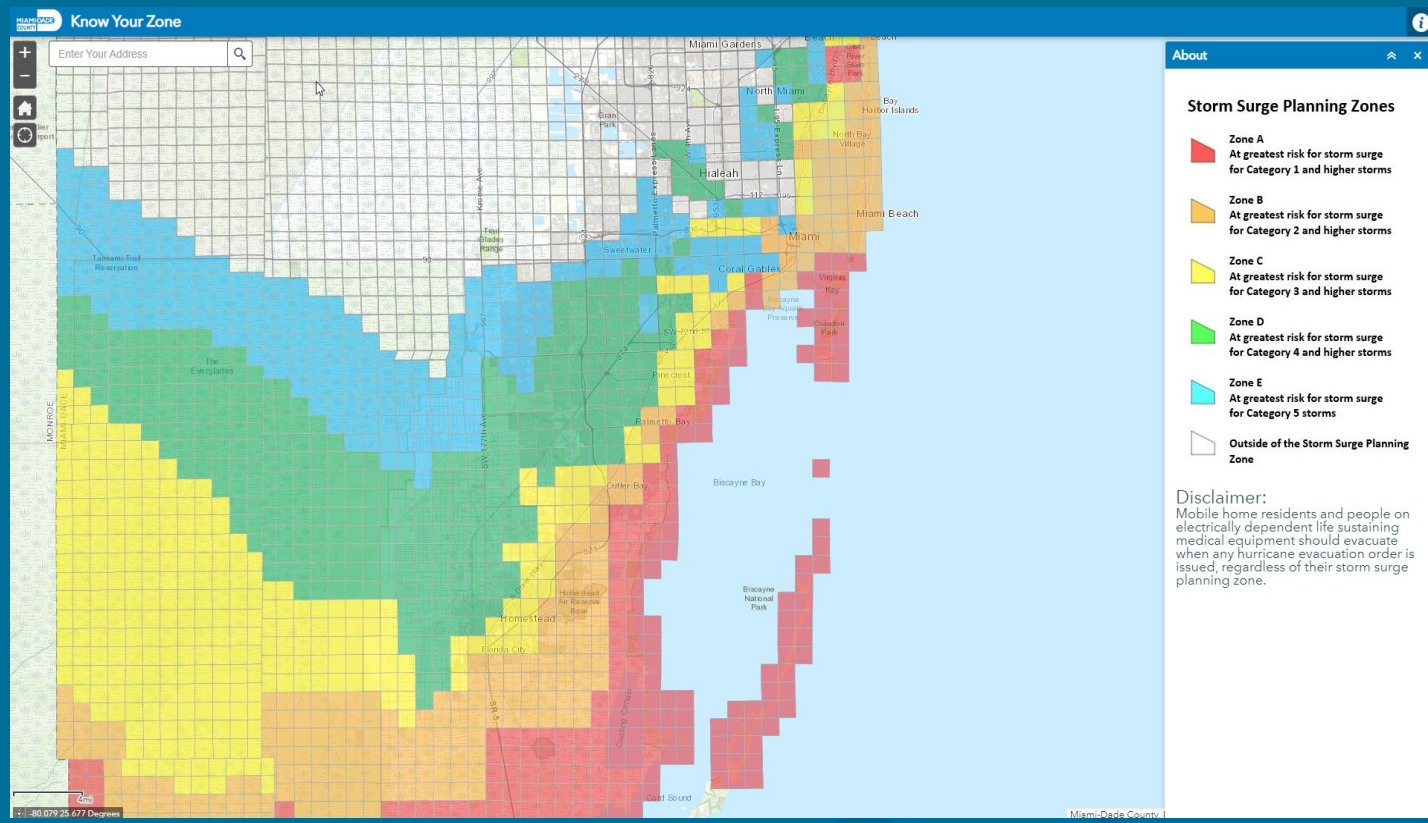
Coastal Flooding



- *Based on sea level reaching established threshold for minor to moderate salt water flooding*

Storm Surge Flooding

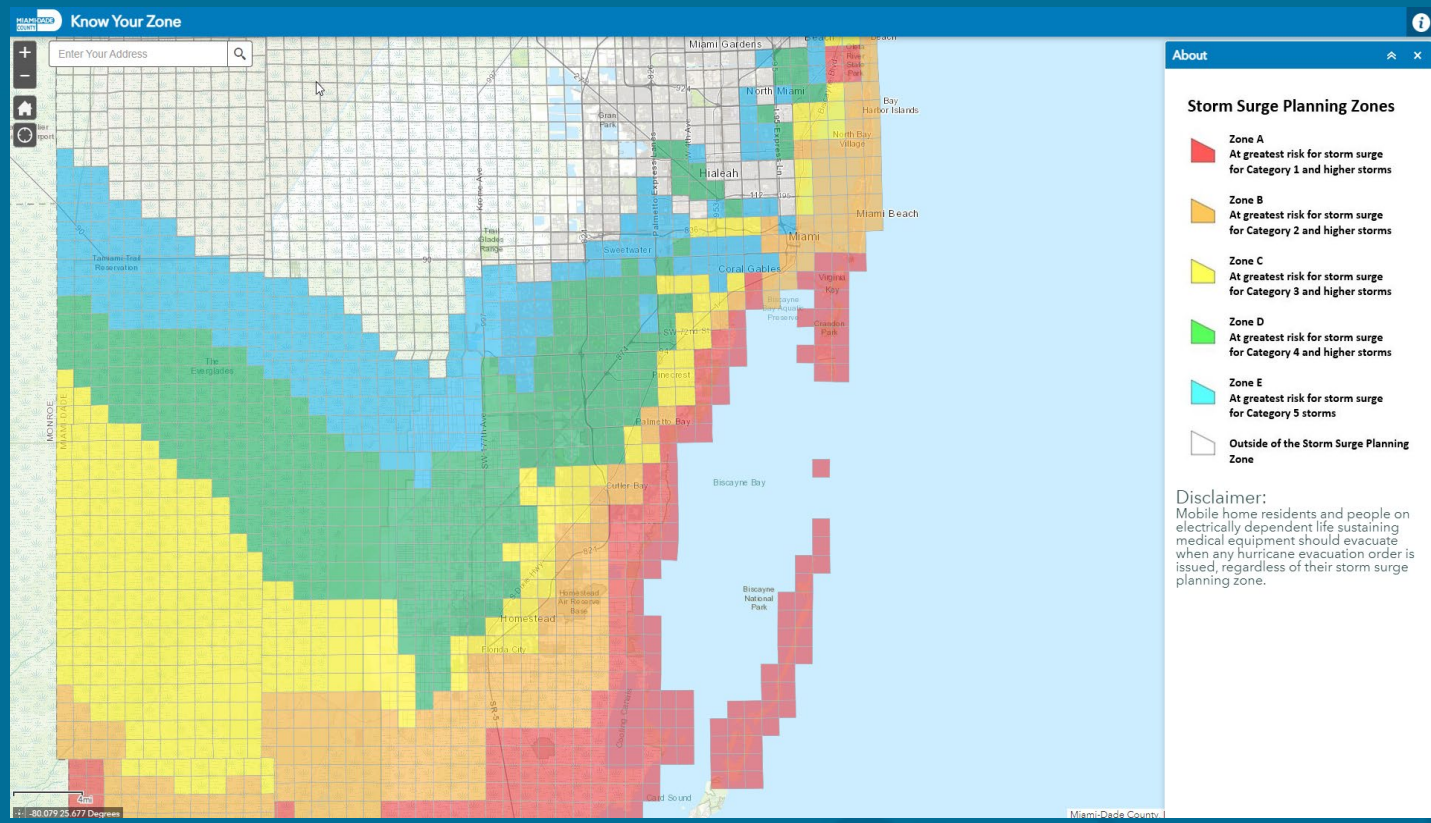
Brickell during Hurricane Irma. Courtesy Miami Herald



Miami-Dade County Storm Surge Planning Zones

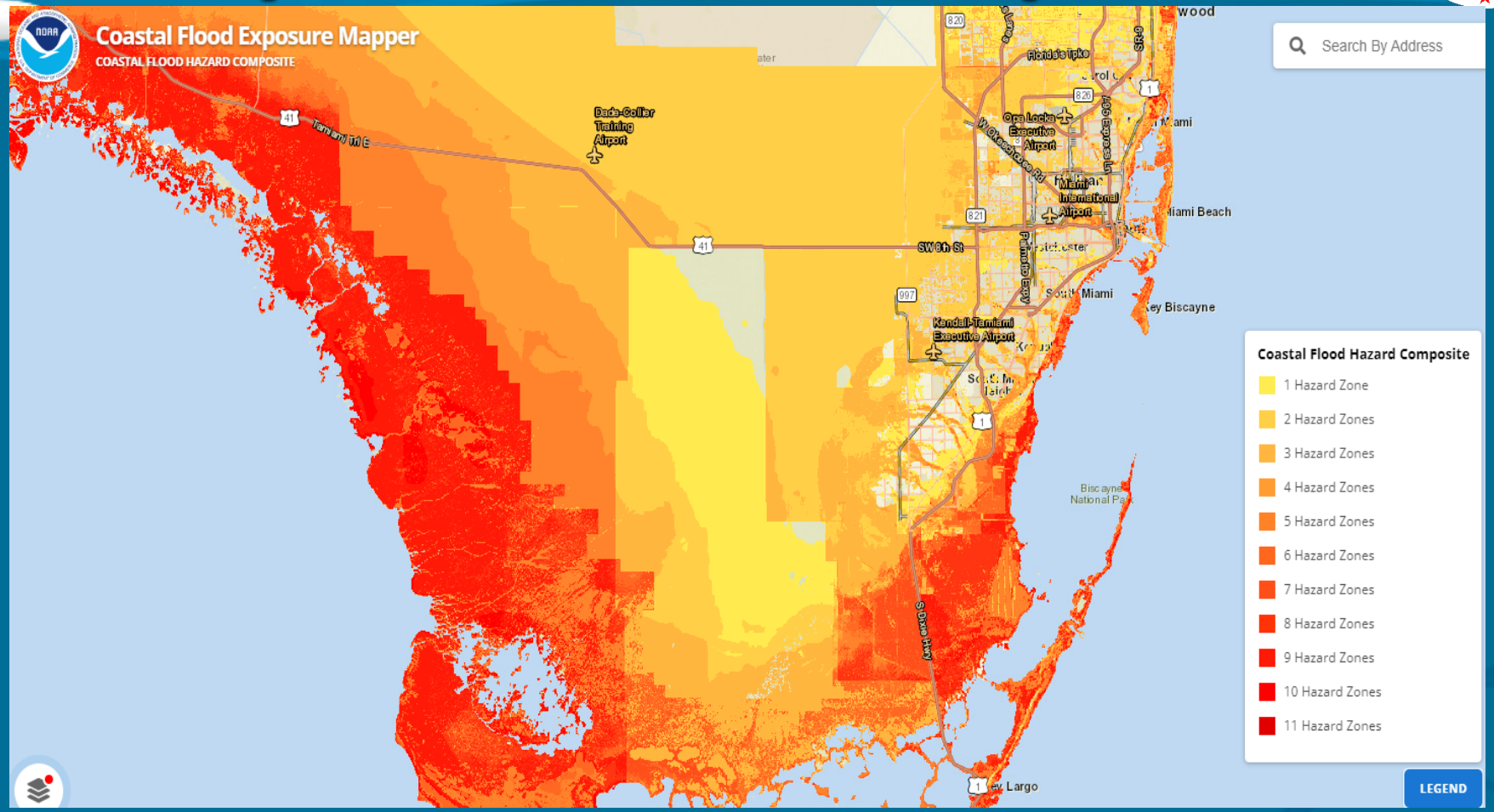
Storm Surge Flooding

- ***Storm surge events are relatively rare and HIGHLY dependent on exact storm track/size/intensity***
- ***Increasing sea levels could make future storm surge events more severe and/or cover larger areas***



Miami-Dade County Storm Surge Planning Zones – based on NOAA SLOSH model data

Composite Flood Exposure

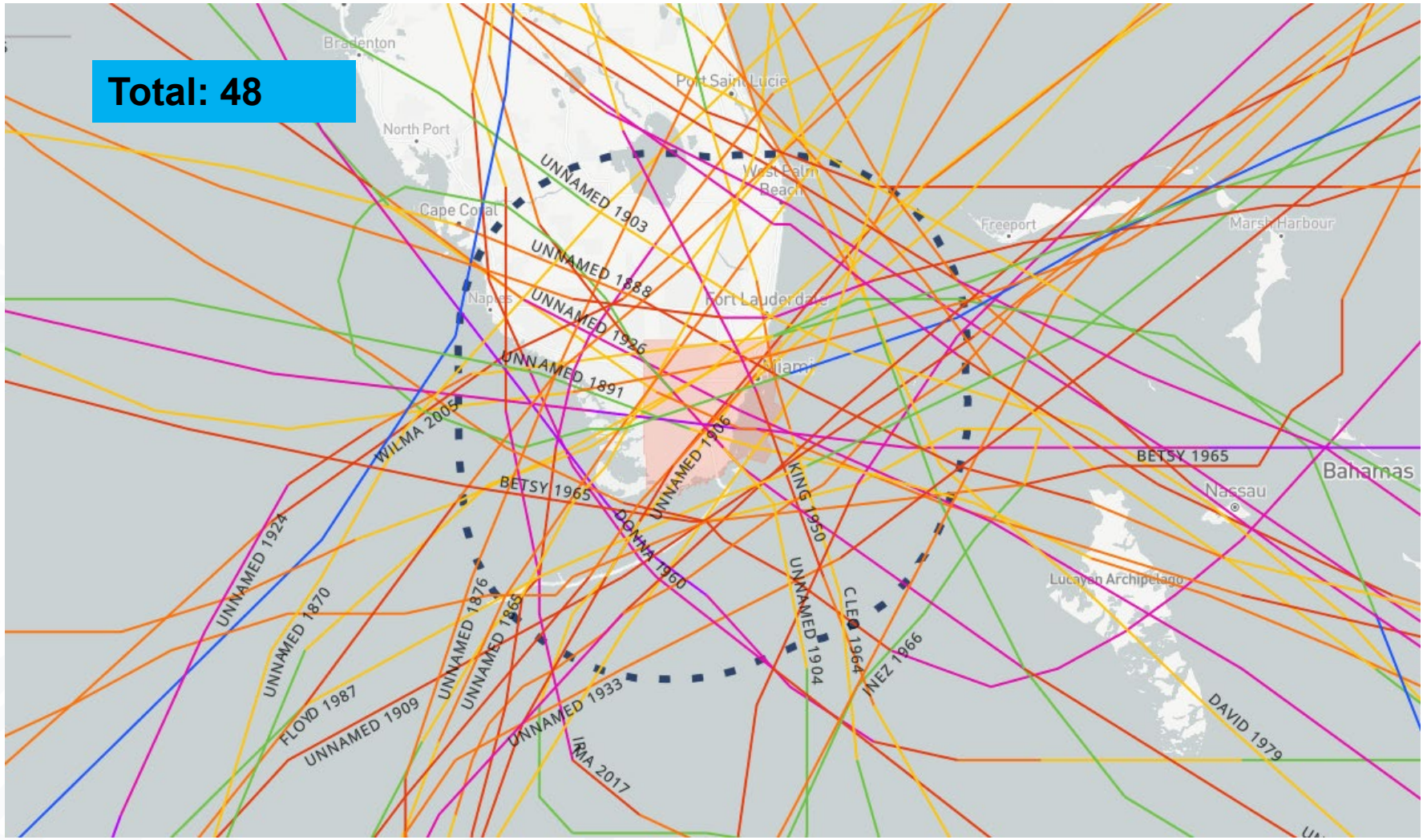


NOAA Coastal Flood Exposure
Mapper: coast.noaa.gov/floodexposure

South Florida is Hurricane Country!

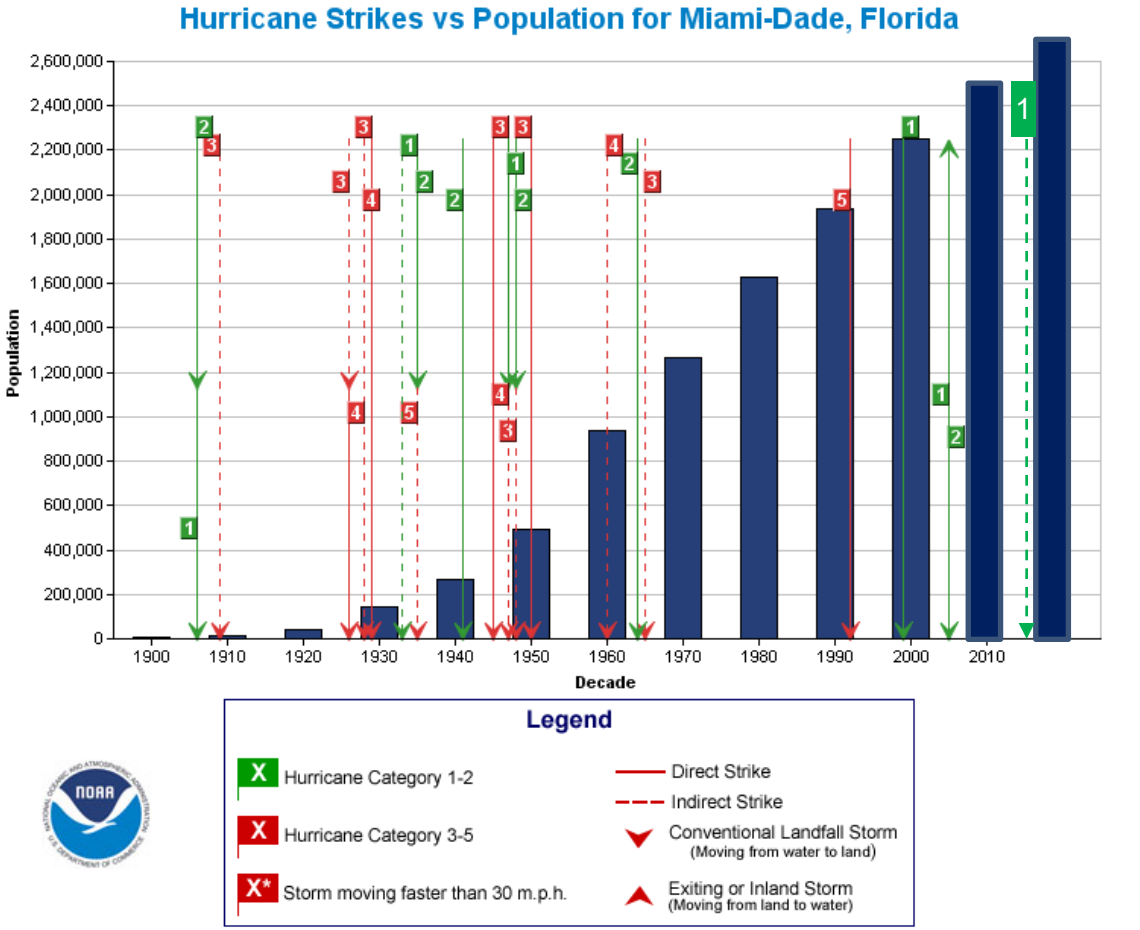
Tracks of Center of Hurricanes Passing Within60 Miles of Miami Since 1865

Miami
WEATHER FORECAST OFFICE



Hurricane Strikes vs Population

Miami
WEATHER FORECAST OFFICE



Hurricane Strike Data: National Hurricane Center
Population Data: U.S. Census Bureau
NOTE: Population values may be missing in some counties, particularly for earlier periods. This is most often attributable to the fact that the county had not yet been established.
NOTE: There may be discrepancies between the strike data shown in this chart and the HURDAT strike data used in the Historical Hurricanes Tracks Tool. The National Hurricane Center is currently updating the strike data used for these charts. For more information visit http://www.aoml.noaa.gov/hrd/data_sub/re_anal.html
NOTE: Population data is current as of 2000 U.S. Census. X-axis on graphs depict years through 2010 to illustrate storms that have occurred from 2000-2006.

Miami-Dade County:

- Highest historical frequency of major hurricanes (Category 3 or higher) of any U.S. coastal county

Hurricane Rapid Intensification (RI)

Miami
WEATHER FORECAST OFFICE

- **Ten storms in 2020 had sustained winds increase by 35 mph or more within 24 hours or less, and 5 in 2021. Hurricane Ian (2022) was another example**
- **In 2020, Eta and Iota broke records with 80 mph increases as they neared landfall on the coast of Nicaragua**
- **Number of RI storms have increased, and some believe this will continue to be the trend in the future**
- **Forecasting RI storms improving**

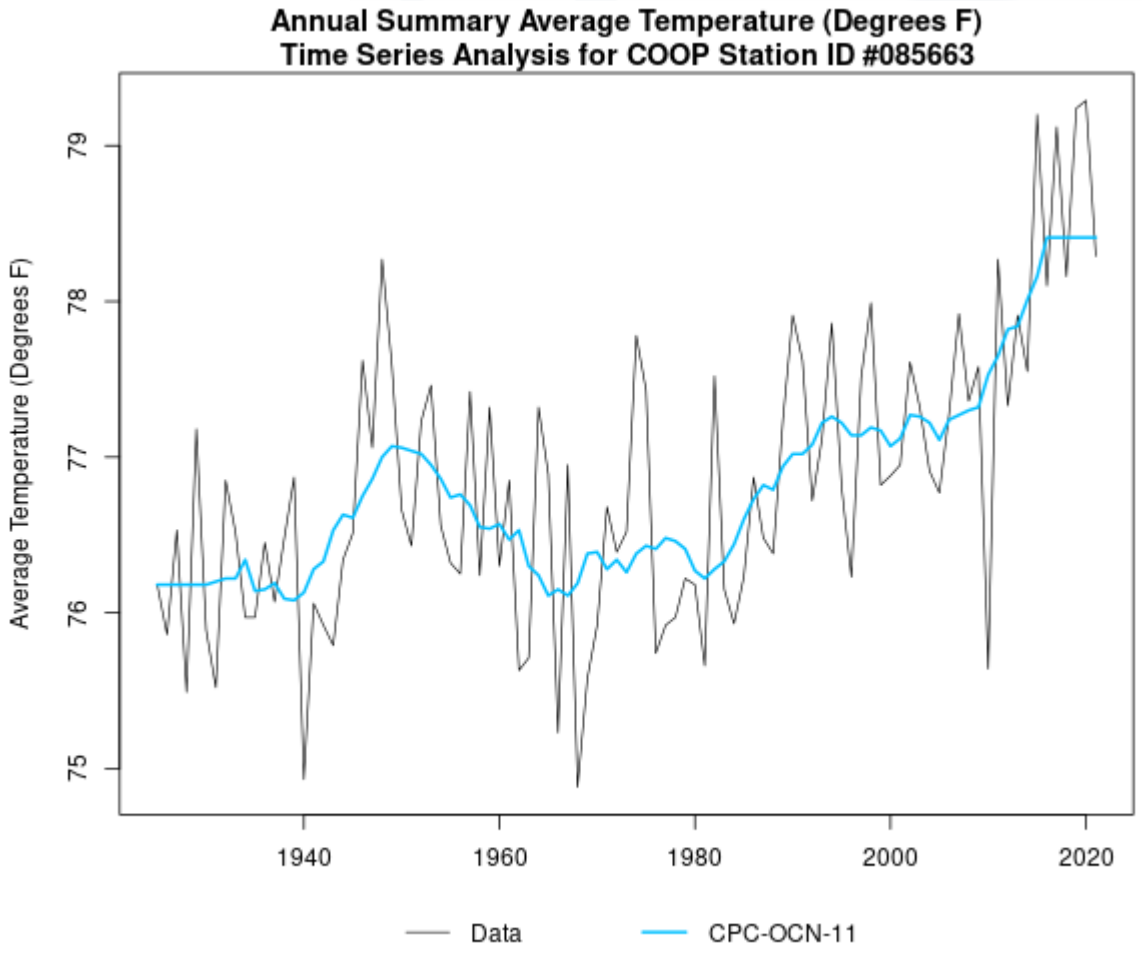
Not Every Storm Will Give Us Several Days or a Week to Track Before Affecting South Florida!!

4 hurricanes (Michael, Andrew, Camille, Labor Day 1935) have made landfall in the U.S. as a Category 5

ALL 4 were tropical storms 72 hours before landfall!!

Heat

Miami
WEATHER FORECAST OFFICE

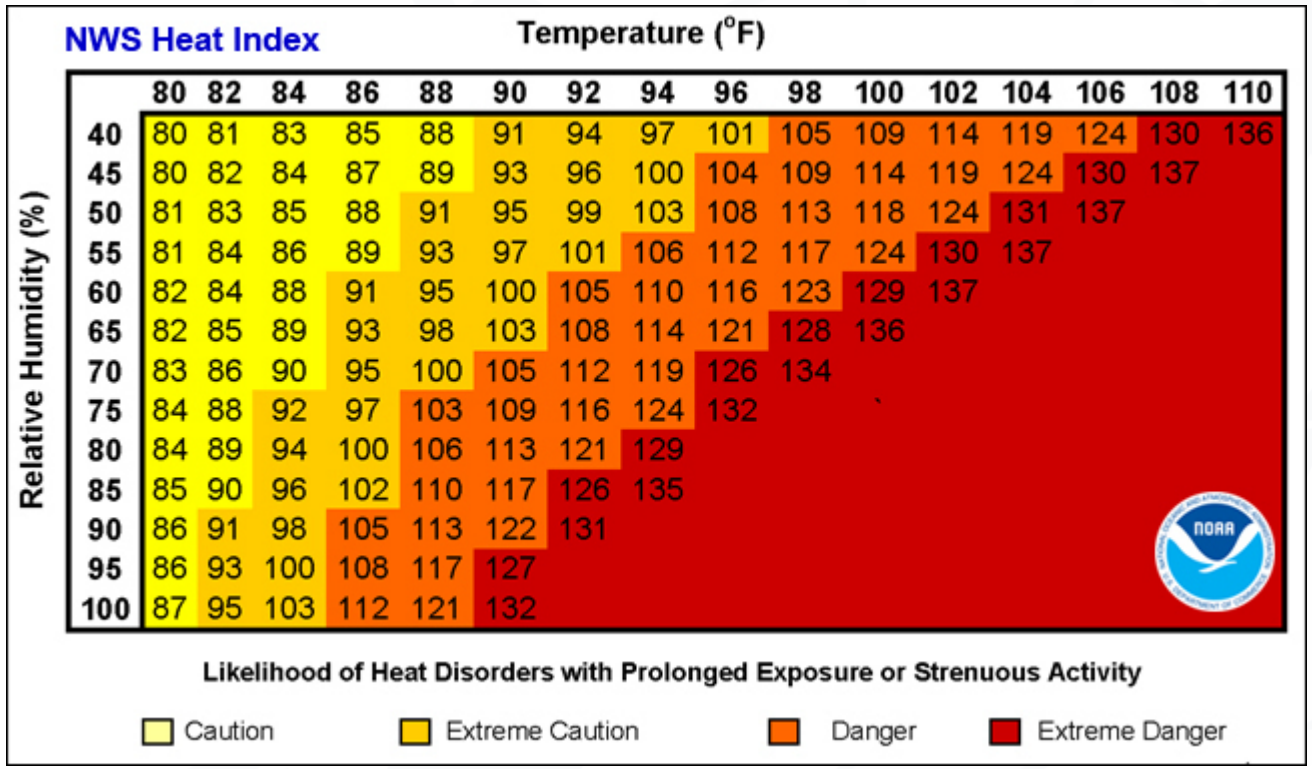


Miami is part of a general global trend of increasing temperatures (about 2F on average since 1980)

Urban Heat Island effect is a contributing factor

Heat

Miami
WEATHER FORECAST OFFICE

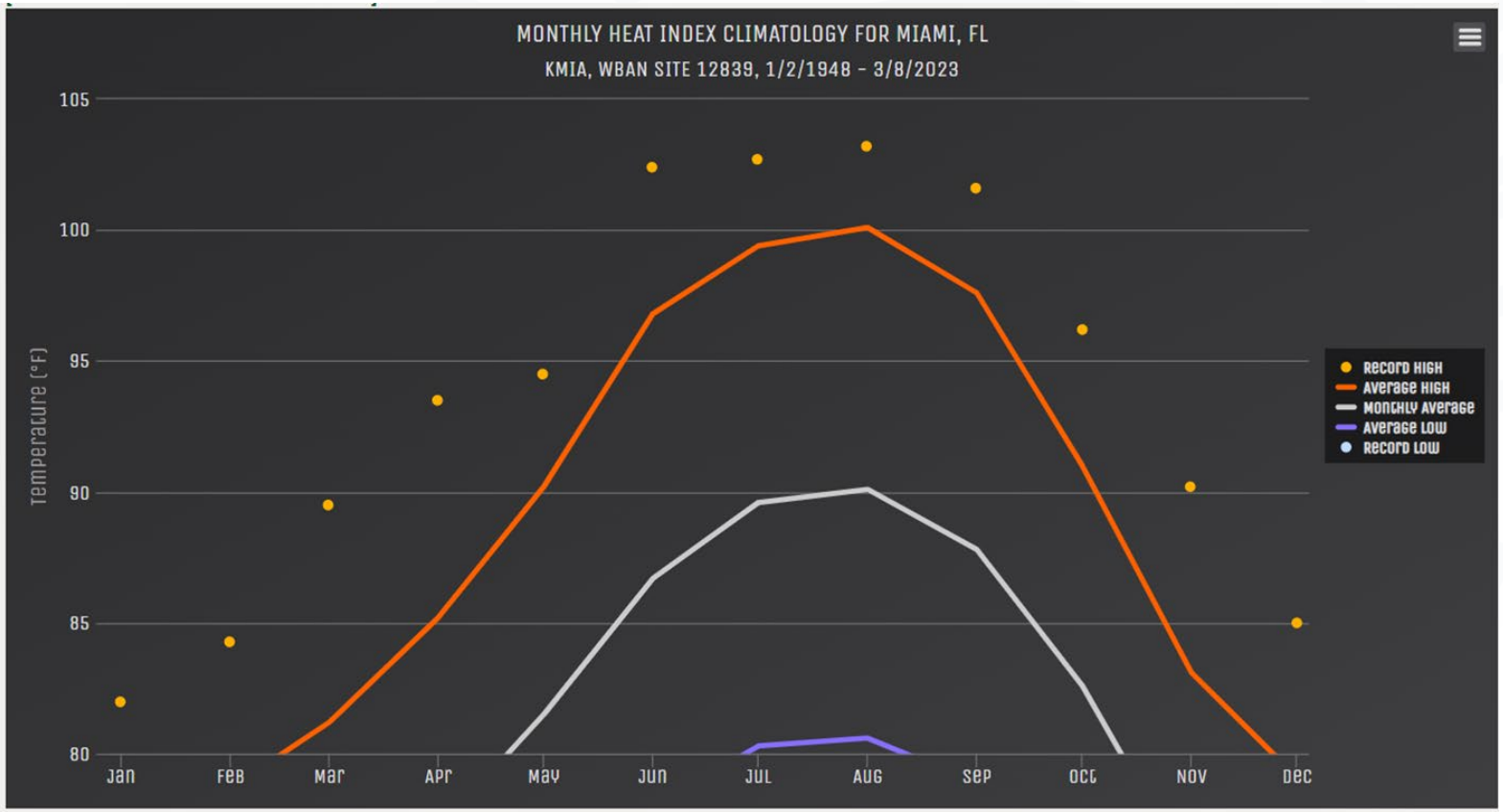


Heat is the #1 weather killer in the U.S.

Undercounted heat impacts in Miami

Heat

Miami
WEATHER FORECAST OFFICE



- Average Miami heat index is at dangerous levels from May until October
- Urban areas have higher heat index values
- Vulnerable populations especially at risk

Top Miami-Dade Hazard Based on FEMA NRI ?

Miami
WEATHER FORECAST OFFICE

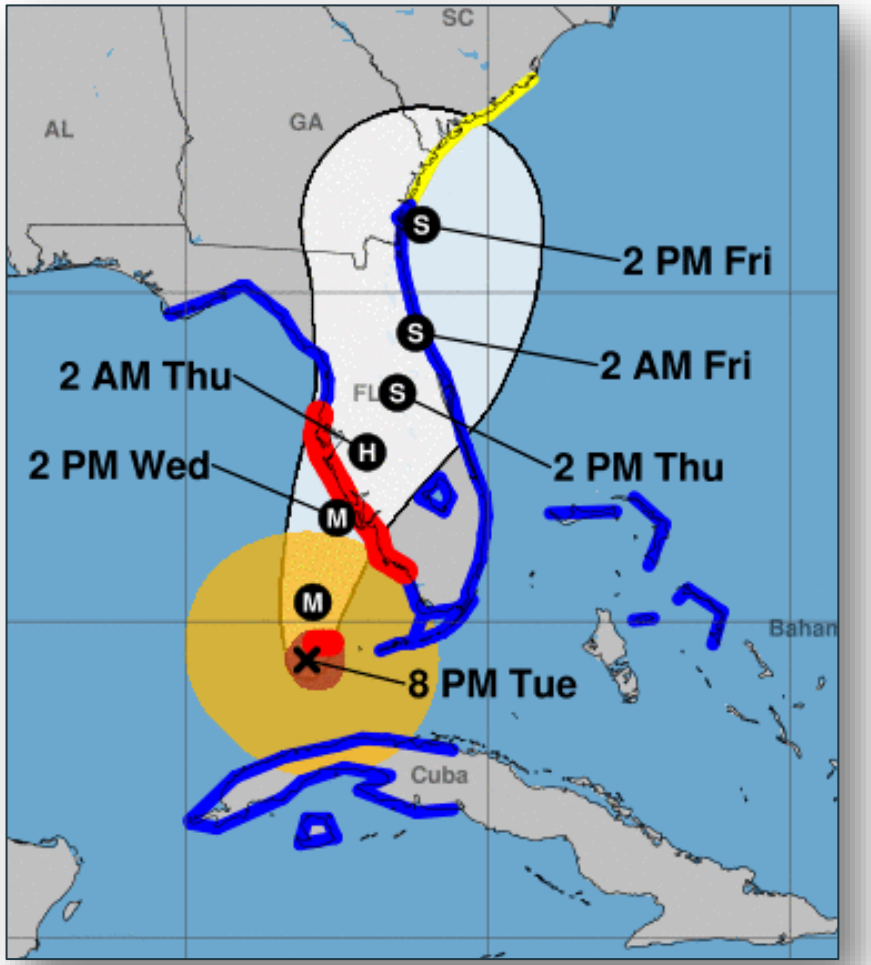
Which weather hazard is most concerning to you?

a. Tornadoes
b. Lightning
c. Hurricanes
d. Flooding
e. Heat
f. Other

Important: Focus on Potential Impacts

- A typical weather forecast only contains expected weather (temperature, wind, rain chances, storm track)
- Although these forecasts take into consideration different scenarios, they only depict what is most likely to occur.
- What if the most likely event does NOT occur (hint: this happens often)?
- Consider potential impacts based on alternate scenarios which have a realistic chance of occurring

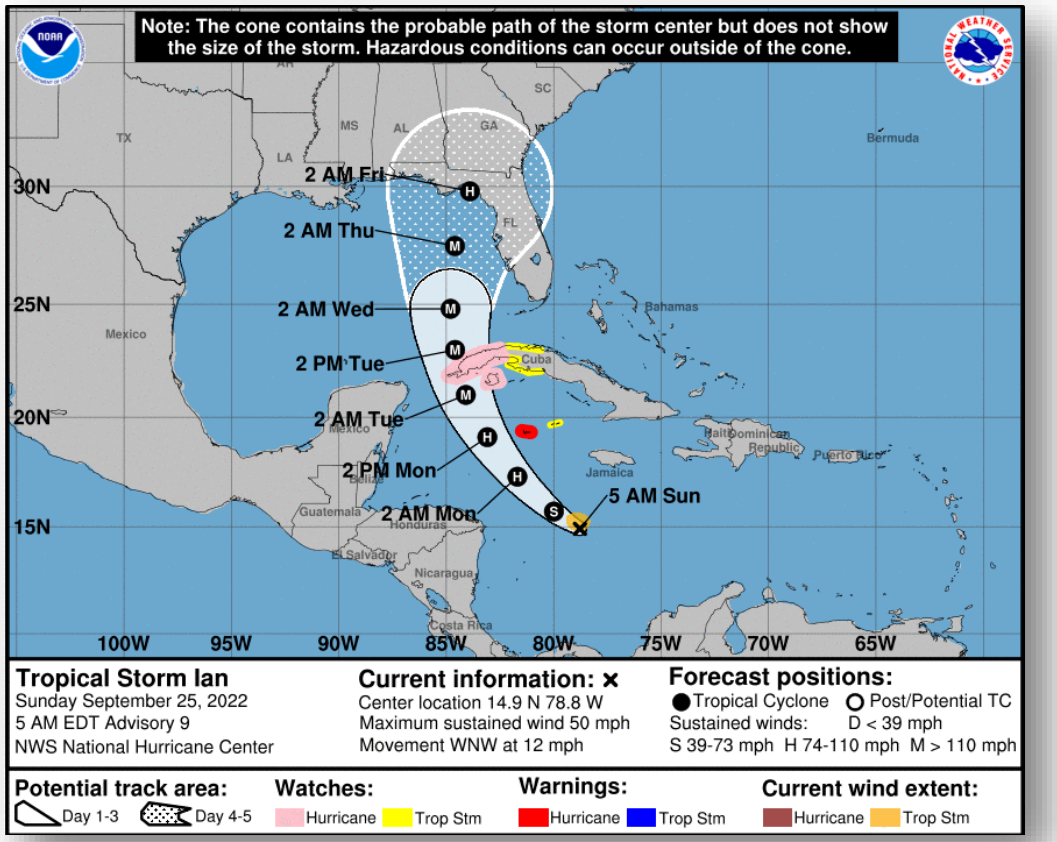
Be Careful with the Forecast Cone vs Impacts

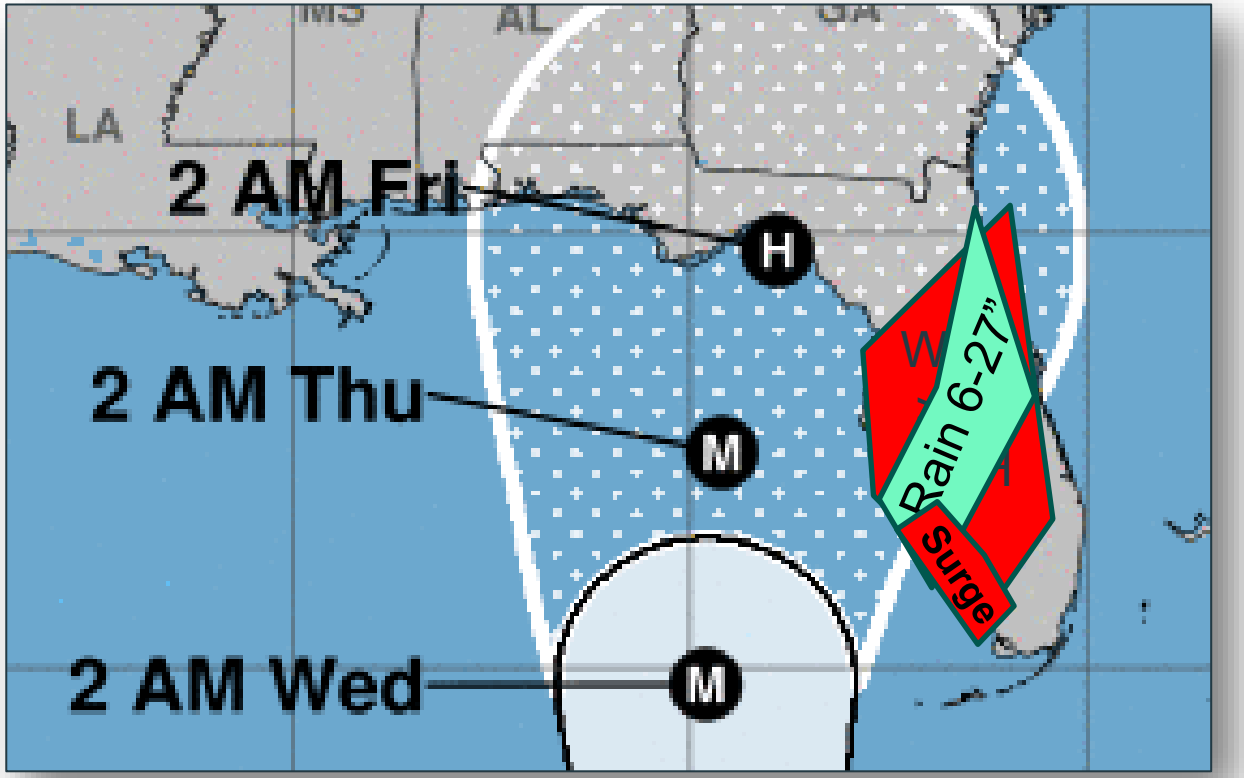


Look how much bigger Ian's wind field was when compared to the cone

If you use the cone, explain that life threatening impacts can occur outside the cone

Be Careful with the Forecast Cone vs Impacts





A Hurricane Forecast Depicts the Most Likely Scenario...

Not the ONLY Possible Scenario!

Miami
WEATHER FORECAST OFFICE

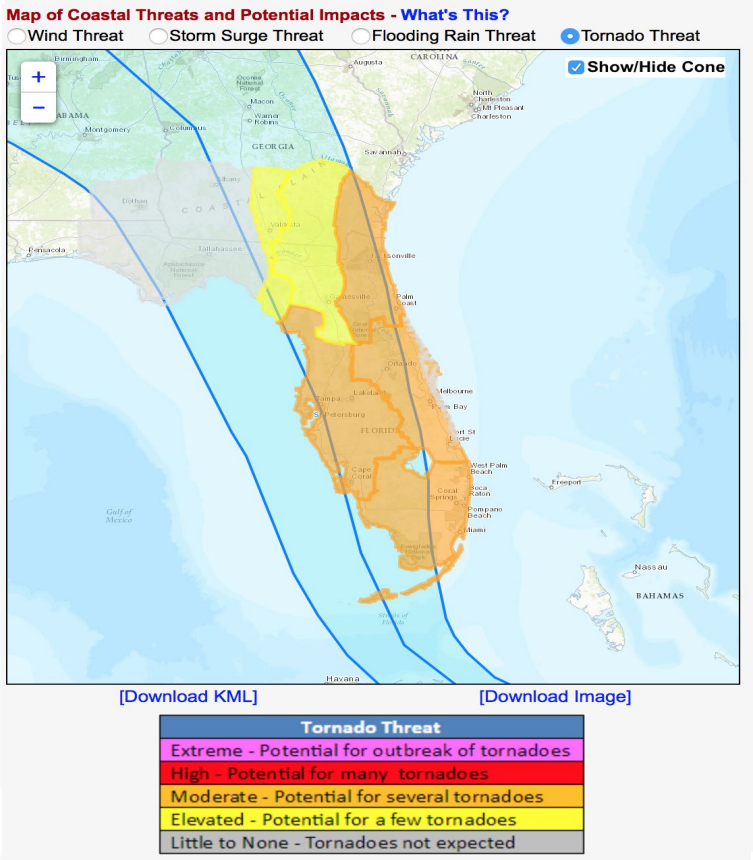
There are multiple alternate scenarios which must be considered in **EVERY** hurricane forecast

Taking this into consideration is crucial for **making responsible decisions that lead to actions proportional to the threat**

Hurricane Threats and Impacts

Local Threat and Impact Information

Miami
WEATHER FORECAST OFFICE

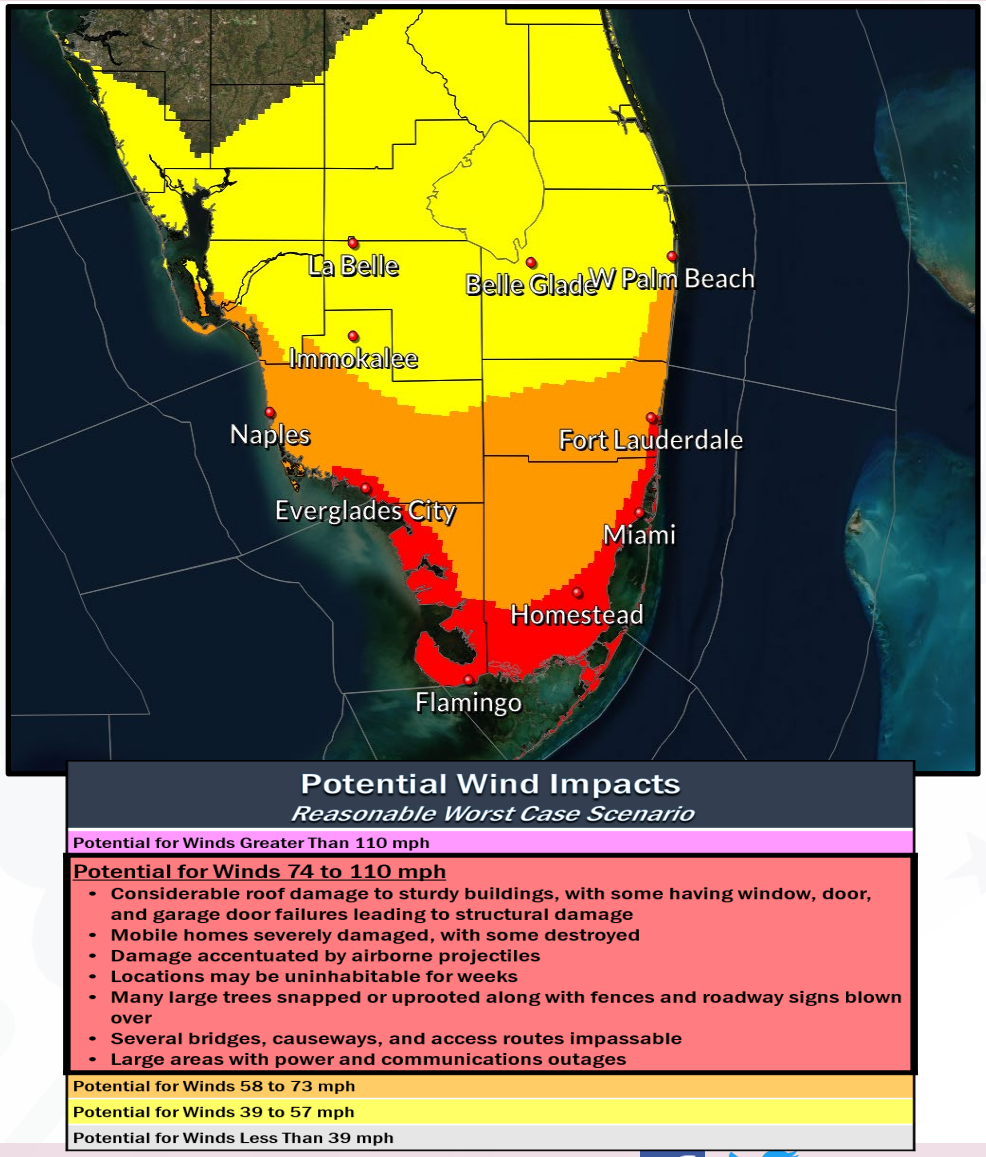


- **Hurricane Threats and Impacts graphics** show the potential level of impact **AND** geographical extent for each of the storm's four primary hazards
- **Provides a whole picture of the potential hazard threat levels**
- Describes potential threats/impacts to plan/prepare for, **based on a reasonable worst case scenario**

Hurricane Threats and Impacts

Local Threat and Impact Information

Miami
WEATHER FORECAST OFFICE

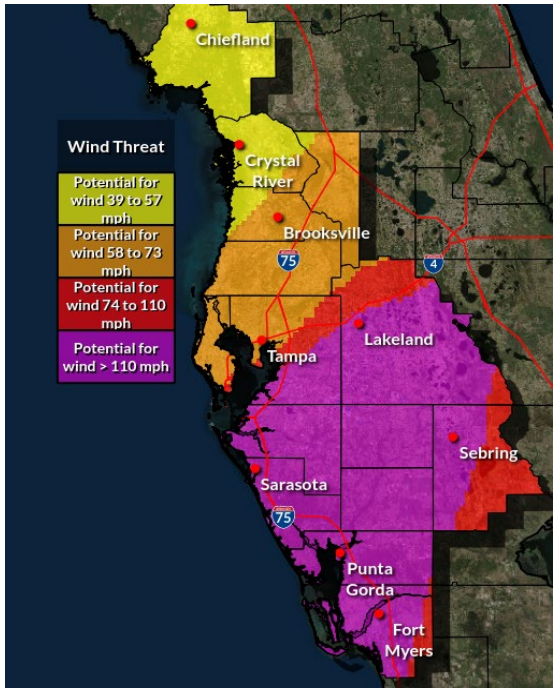


- Hurricane Threats and Impacts graphics show the potential level of impact **AND** geographical extent for each of the storm's four primary hazards, based on a ***reasonable worst case scenario***
- Provides a **whole picture of the potential threat levels for each hazard with any given storm**
- Based on a range of possible scenarios, not only the official forecast

Hurricane Ian – Potential Impacts

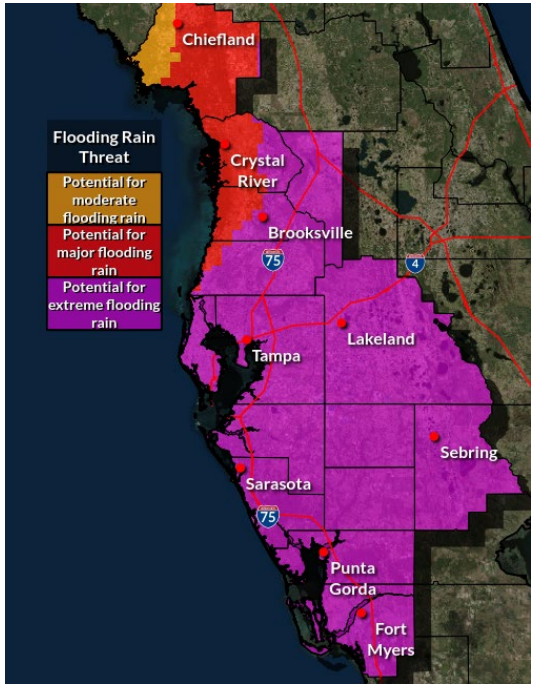
National Weather Service – Tampa Bay (Ruskin) – Impacts will continue through Thursday

Wind



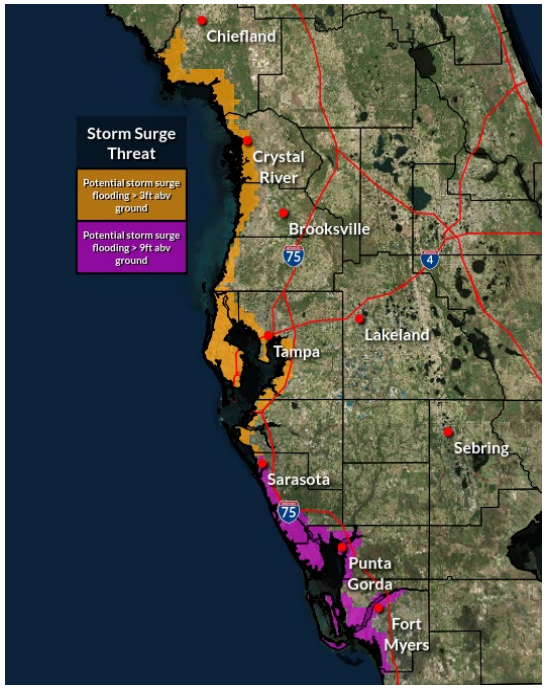
- Potential 110 mph or greater max winds.
- Wall and roof failure to some buildings.
- Destruction of mobile homes.
- Numerous trees down and debris blocking roads and bridges.
- Widespread power outage.

Flooding Rain



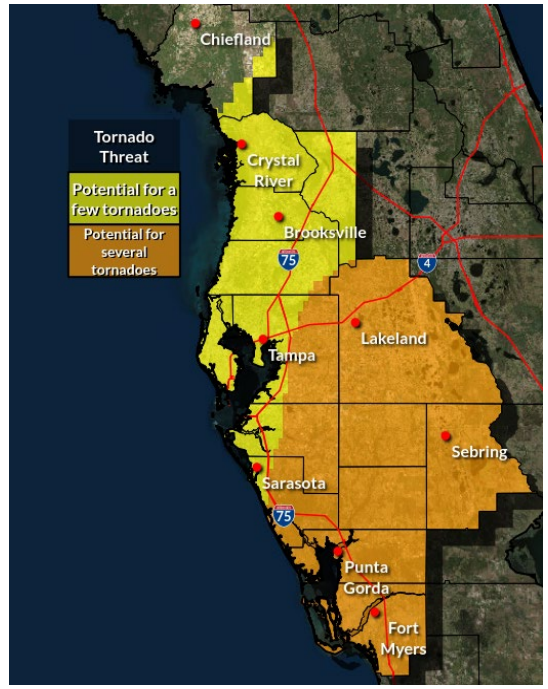
- Widespread 10”- 15”, potential isolated totals greater than 20”.
- Major flooding at or near historic levels.
- Widespread inundation covering roads.
- Storm drains/retention ponds overflow.
- Flood waters will affect buildings and homes and may prompt evacuations.
- Rescues may be necessary.

Surge

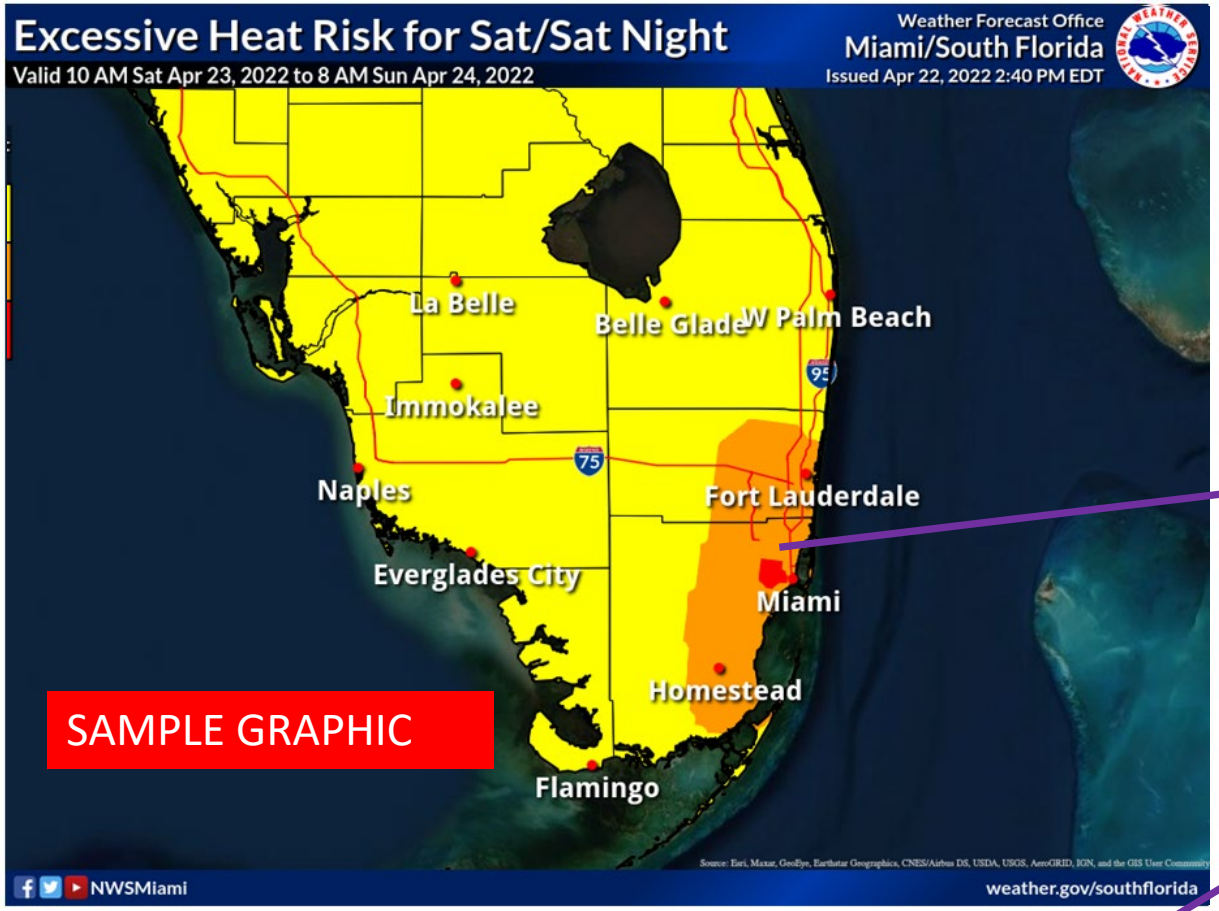


- 5 – 10 ft with low-lying escape routes severely flooded. Water possibly reaching several miles inland. Extreme beach erosion.
- Many large sections of near-shore roads washed out.
- Extensive damage to marinas, docks, and piers.

Tornado



- Isolated tornadoes and waterspouts.
- A few locations could see roofs peeled off buildings, mobile homes pushed off foundations, and large tree tops and branches snapped off.
- Isolated power and communication disruptions.



Public | Marine

24 Hr Hazard Risks	Today	Sat	Sun	Mon	Tue	Wed	Thu
Severe Thunderstorm							
Tornado							
Thunderstorm Wind							
Hail							
Lightning							
Excessive Rainfall							
Excessive Heat							
Wind							
Frost/Freeze							
Fog							
Fire Weather							
Excessive Cold							
Waterspout							

Risk Level	Category	Definition
	None	No Excessive Heat Risk.
	Limited	Limited Excessive Heat Risk. Heat index 98-102 degrees. Heat exhaustion possible with prolonged exposure.
	Elevated	Elevated Excessive Heat Risk. Heat index 103-107 degrees. Heat exhaustion likely with prolonged exposure.
	Significant	Significant Excessive Heat Risk. Heat index 108-112 degrees. Dangerous and potentially deadly heat stroke likely with prolonged exposure.
	Extreme	Extreme Excessive Heat Risk. Heat index 113 degrees or higher. Dangerous and potentially deadly heat stroke likely with limited exposure.

weather.gov/miami

Comments/Questions?

Robert Molleda
Warning Coordination Meteorologist
Weather Forecast Office, Miami, FL
Robert.Molleda@noaa.gov (305) 229-4520