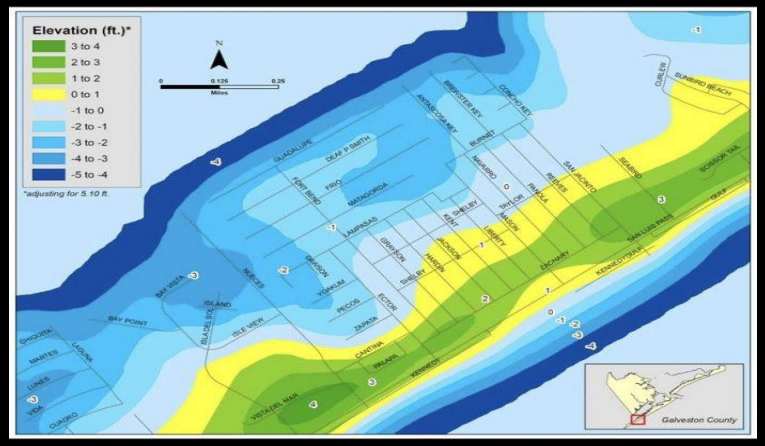
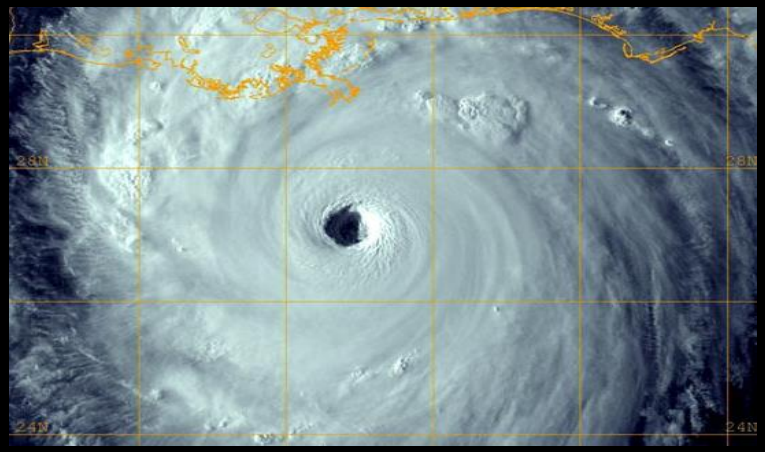
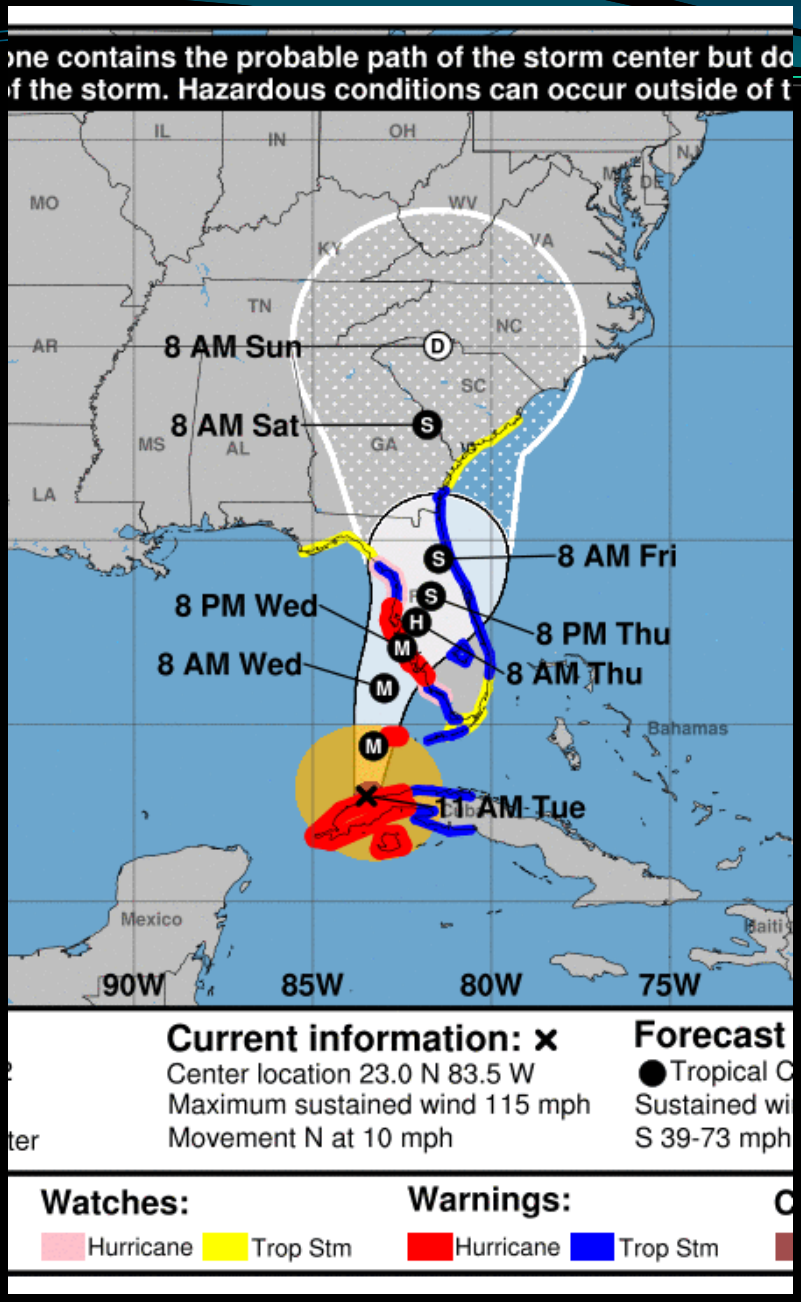
# Navigating Evolving Weather Patterns In a Rapidly Changing World




Hal Needham, Ph.D.

October 28, 2022


one contains the probable path of the storm center but do
f the storm. Hazardous conditions can occur outside of t
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MO
WV
KY
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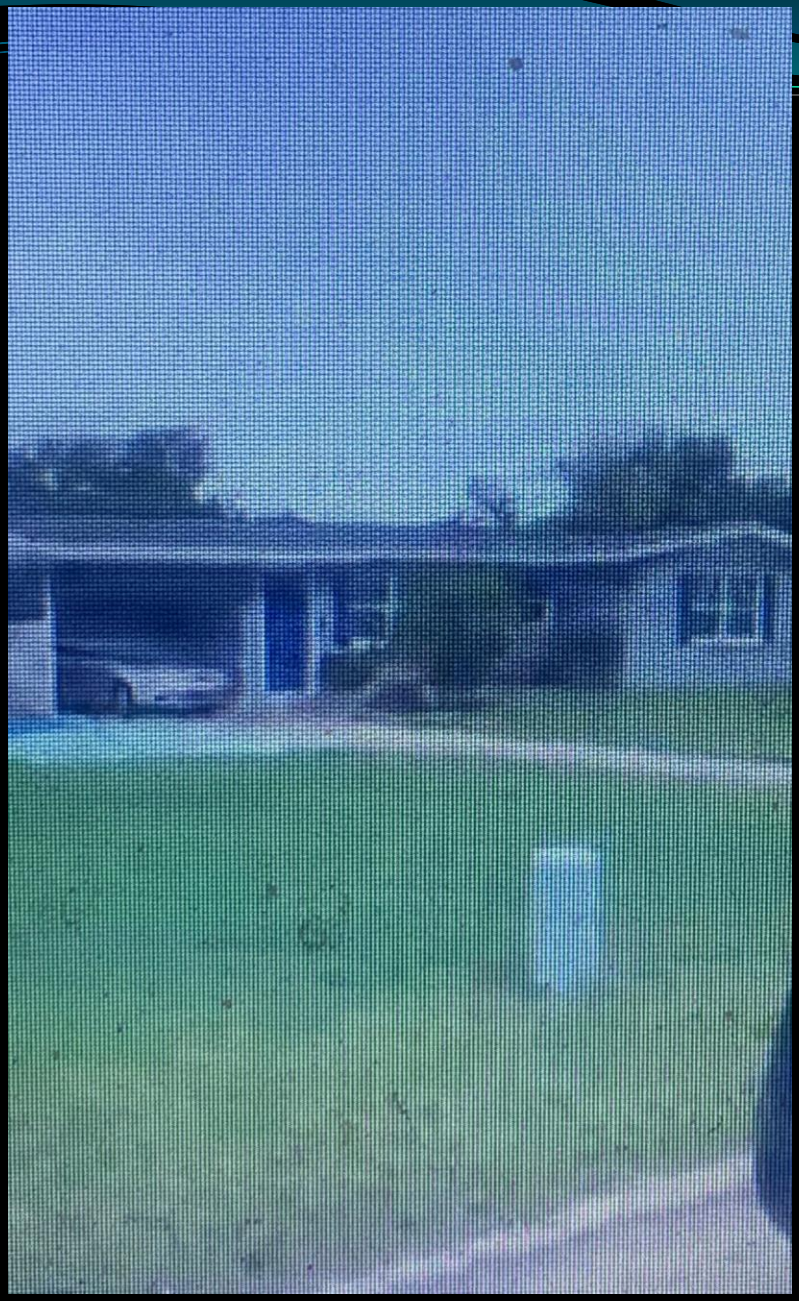
SC
MS
AL
GA
LA
8 AM Sun
8 AM Sat
8 AM Fri
8 PM Wed
8 PM Thu
8 AM Wed
8 AM Thu
Bahamas
AM Tue
Mexico
90W
85W
80W
75W
Current information:
Center location 23.0 N 83.5 W
Maximum sustained wind 115 mph
Movement N at 10 mph
Forecast
Tropical C
Sustained wi
S 39-73 mph
Watches:
Hurricane
Trop Stm
Warnings:
Hurricane
Trop Stm

# Storm Surge Forecast




ALIAN GRIL
OPEN

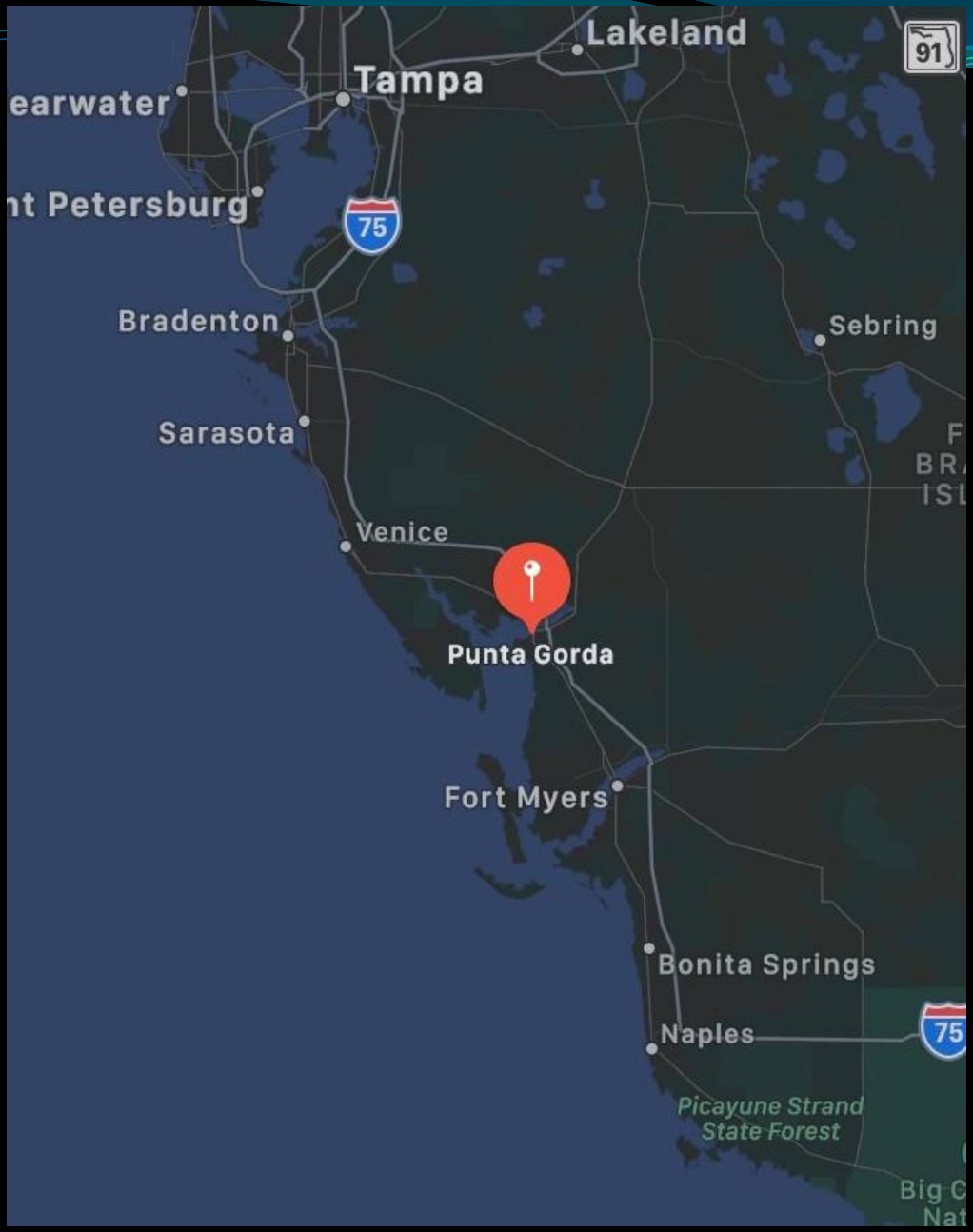

Top
NAILS


SPA
MASSAG

# Storm Surge Forecast


Marian Ave.
Taylor St.
F.M. DON'S
PROVISIONS
HOSPITALITY
201

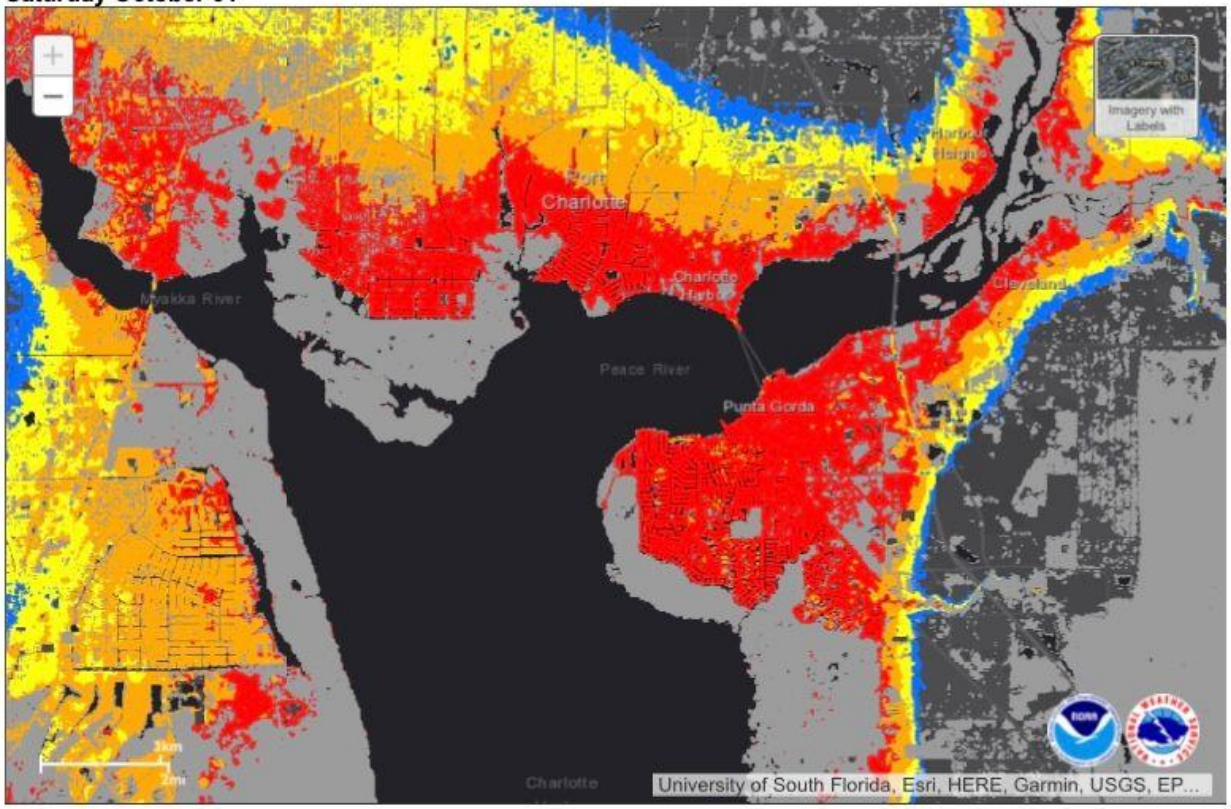

Marian Ave.
Taylor St.
F.M. DON'S
PROVISIONS
HOSPITALITY
201


Lakeland
91
Tampa
earwater
nt Petersburg
75
Bradenton
Sebring
Sarasota
Venice
Punta Gorda
Fort Myers
Bonita Springs
Naples
75
Picayune Strand
State Forest


HERALD
COURT CENTER
POLICE

# Potential Storm Surge Flooding Map (Inundation)

**NHC Potential Storm Surge Flooding Map**
**Hurricane IAN (2022) Advisory 18**
**From 11 AM EDT Tuesday September 27 to 02 PM EDT**
**Saturday October 01**




**Potential Storm Surge Flooding***

- Intertidal Zone/Estuarine Wetland
- Greater than 1 foot above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground

**Map Layer Options:**

Inundation Layer Only | Inundation with Intertidal Layer

Map Opacity Slider

| Download GIS data *(Instructions)* | Inundation Layer Only | Inundation with Intertidal Layer |
|---|---|---|


PORSCHE
911 Targa 4S
MYFLORIDA.COM
11-22
NMY T26
SUNSHINE STATE


Kestrel
BARO
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settings
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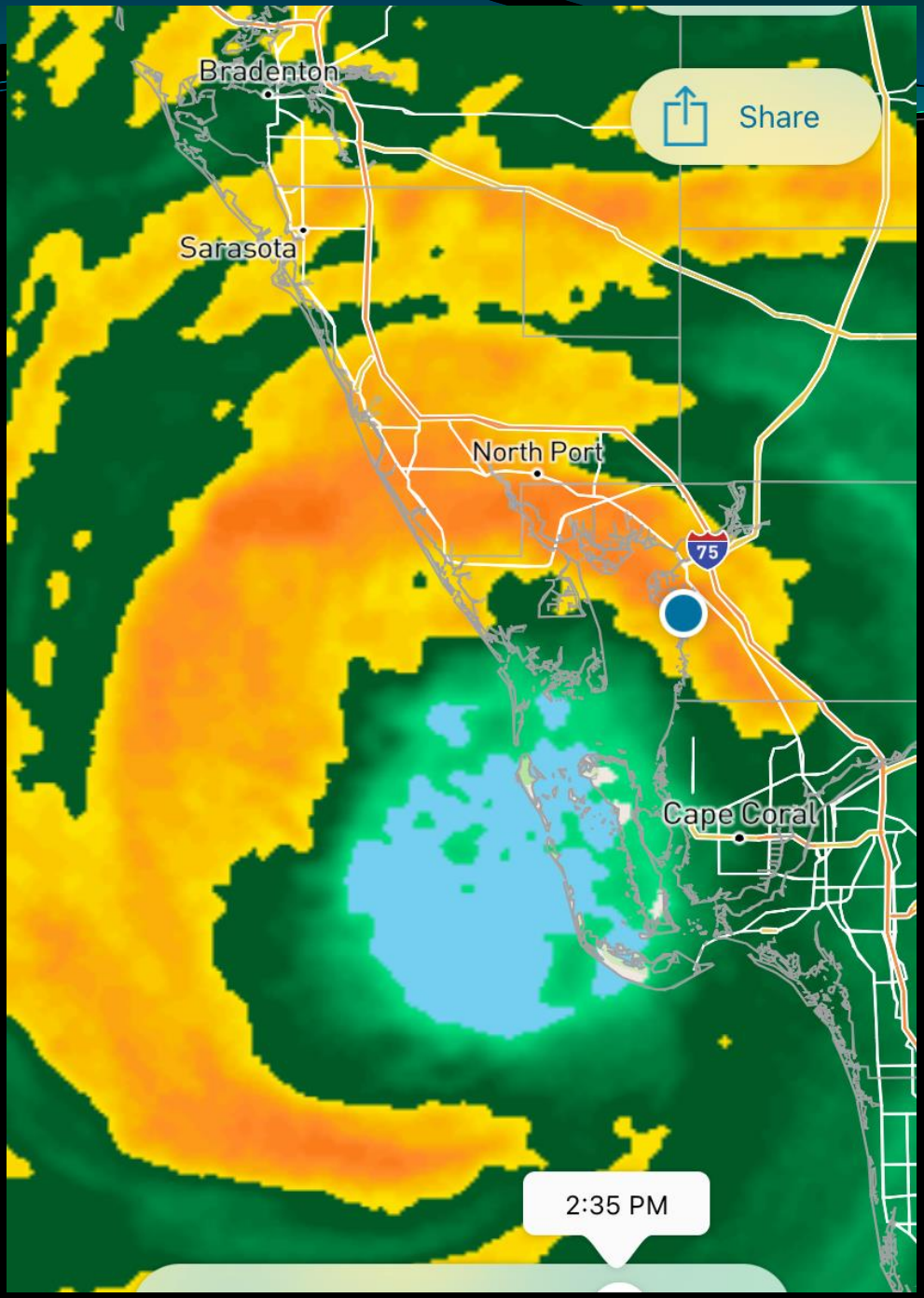
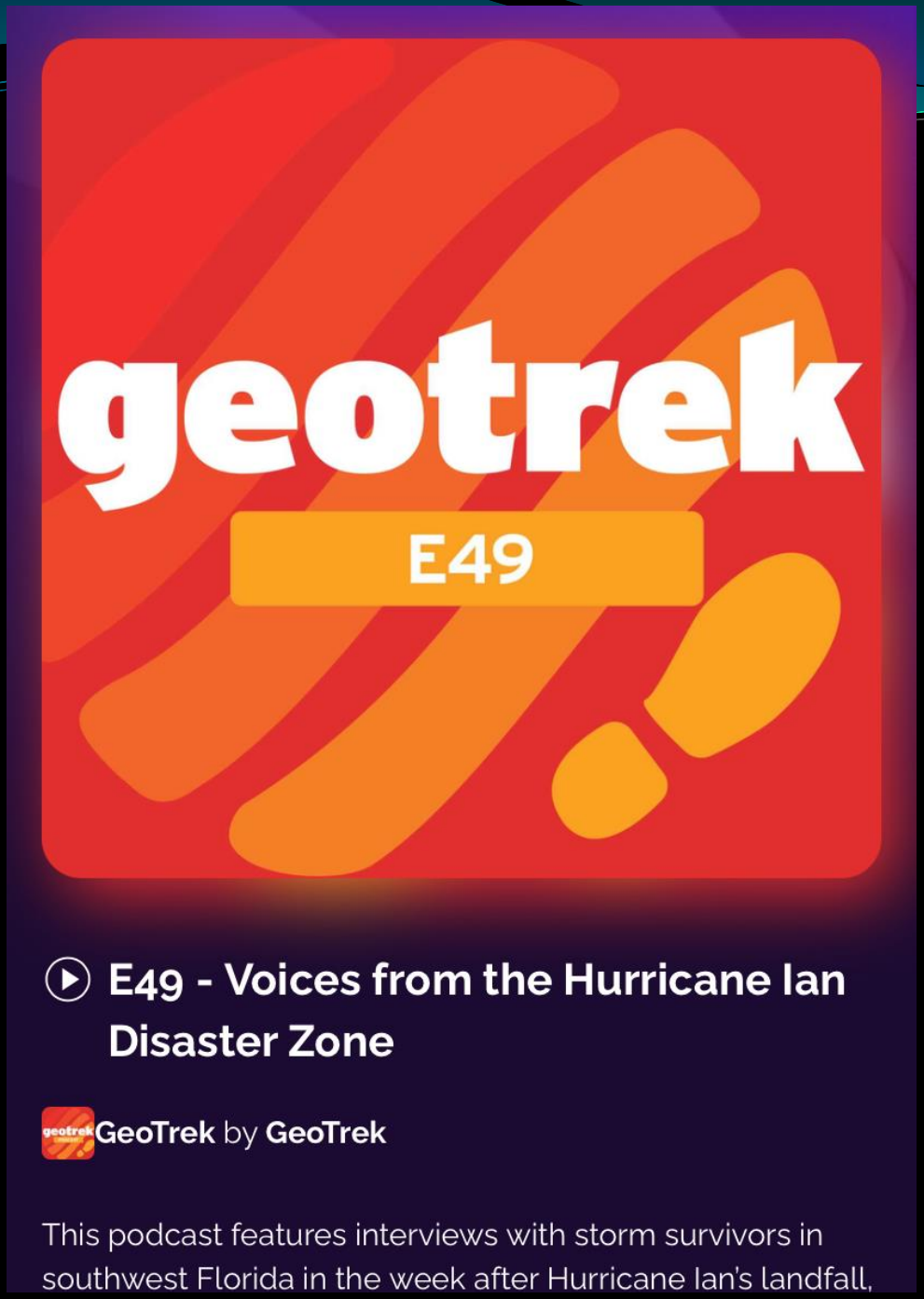

Bradenton
Share
Sarasota
North Port
75
Cape Coral
2:35 PM


PINE RIDGE


6:06
LTE
Search
Dudley's
BBQ
More
we're over on the Fort Myers side.
84
2
8
4
_geotrek · 2d ago
More voices of those affected by Hurricane Ian. Listen to our full podcast at th... See more
original sound - _geotrek


geotrek
E49
E49 - Voices from the Hurricane Ian Disaster Zone
GeoTrek by GeoTrek
This podcast features interviews with storm survivors in southwest Florida in the week after Hurricane Ian's landfall,

Key to Disaster Resiliency:

Key to Disaster Resiliency:

1. Know your regional disaster history

AND

2. Build in a buffer for future storms

AND

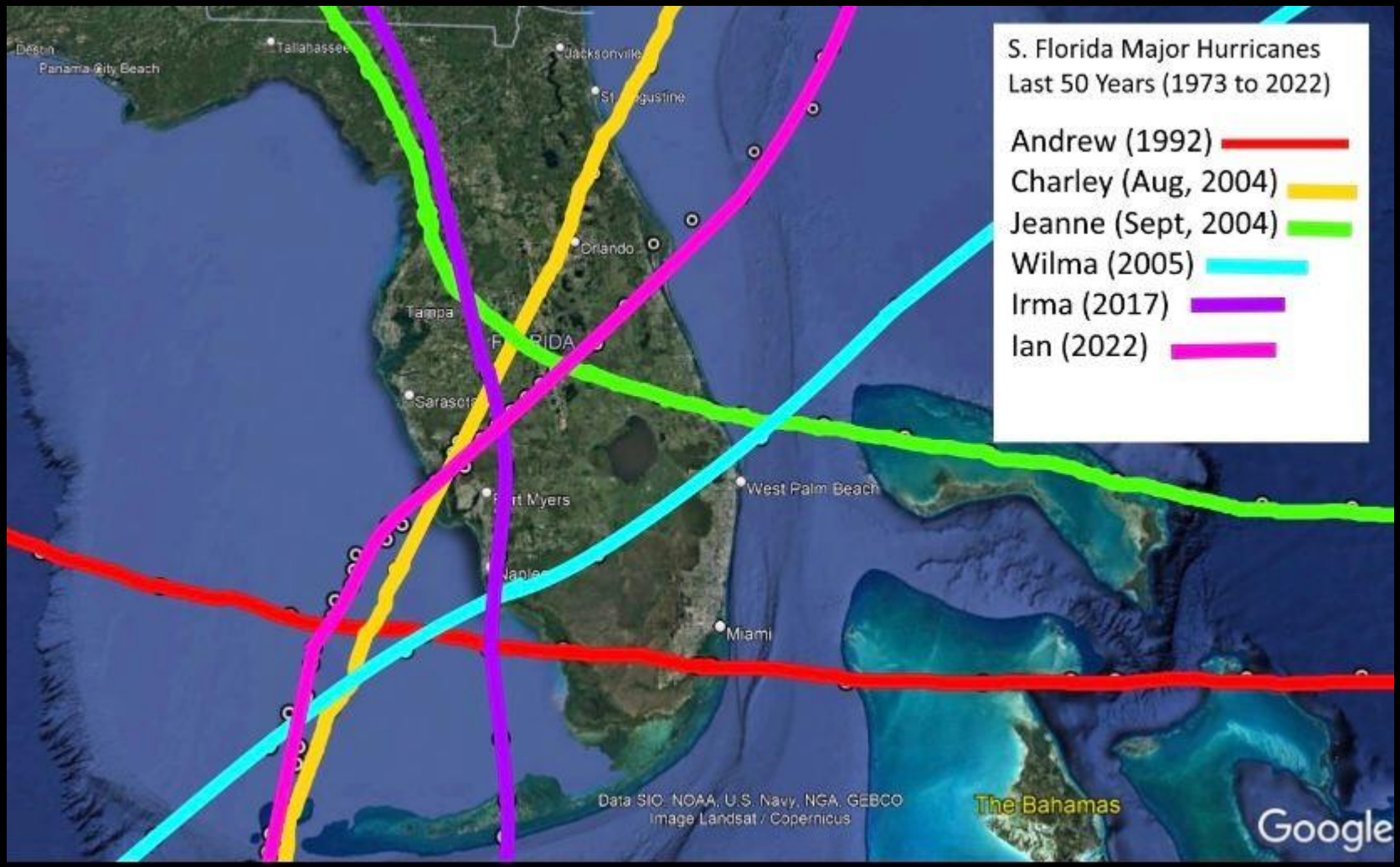
3. Communicate better with visuals

# 1. Know your Regional Disaster History

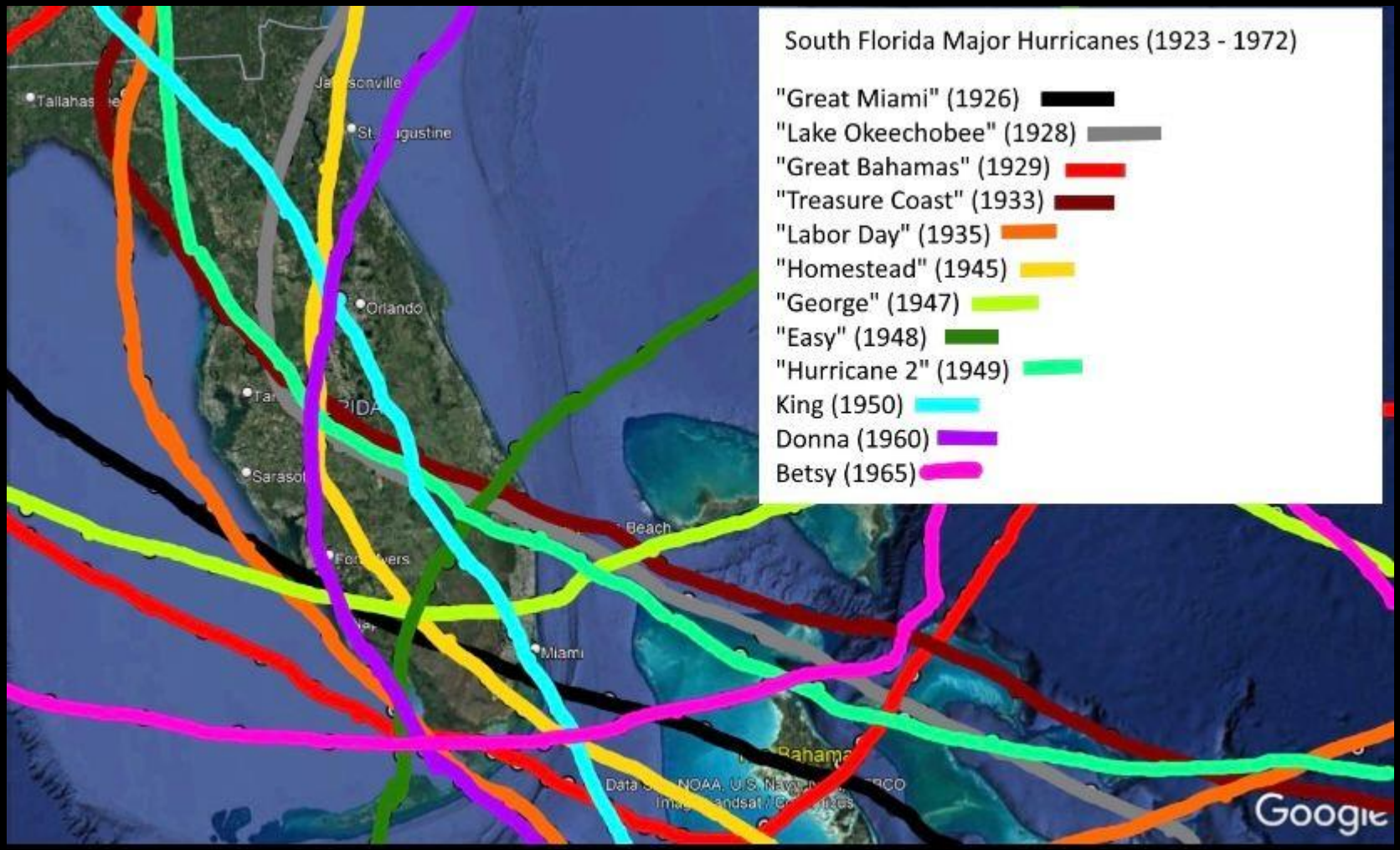
# Know your Regional Disaster History

Look back far in time!

# Know your Regional Disaster History



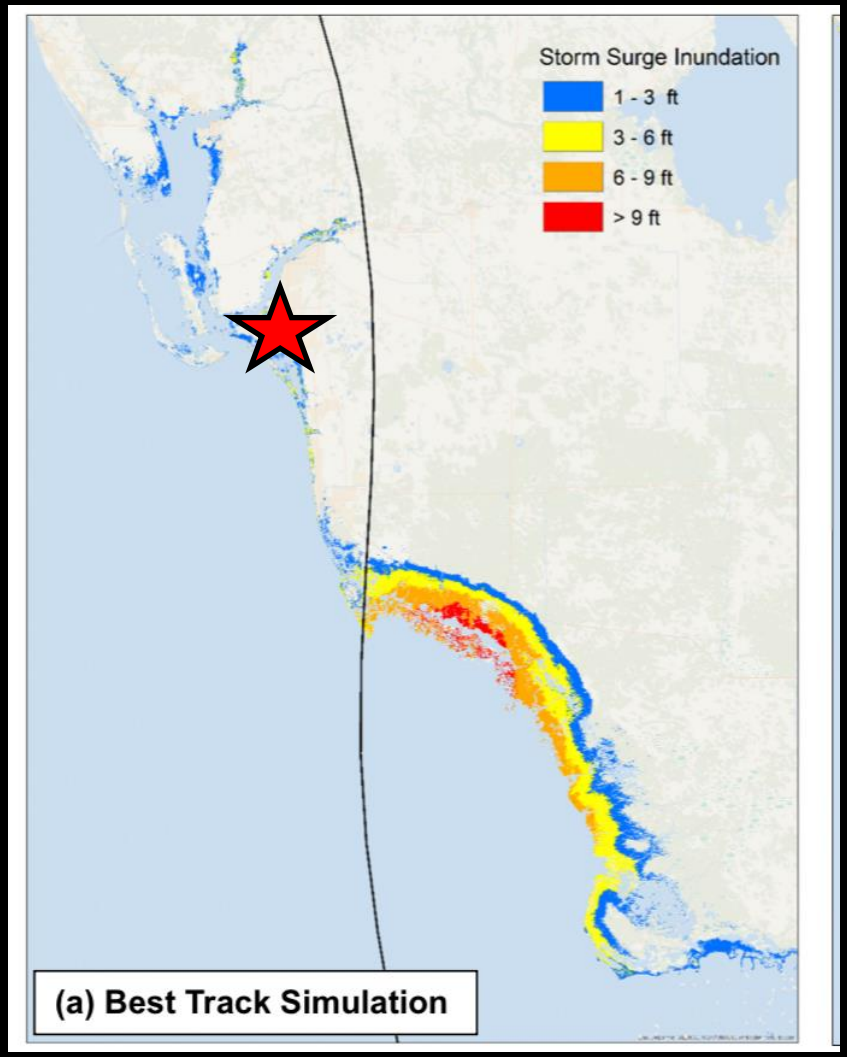
# Know your Regional Disaster History



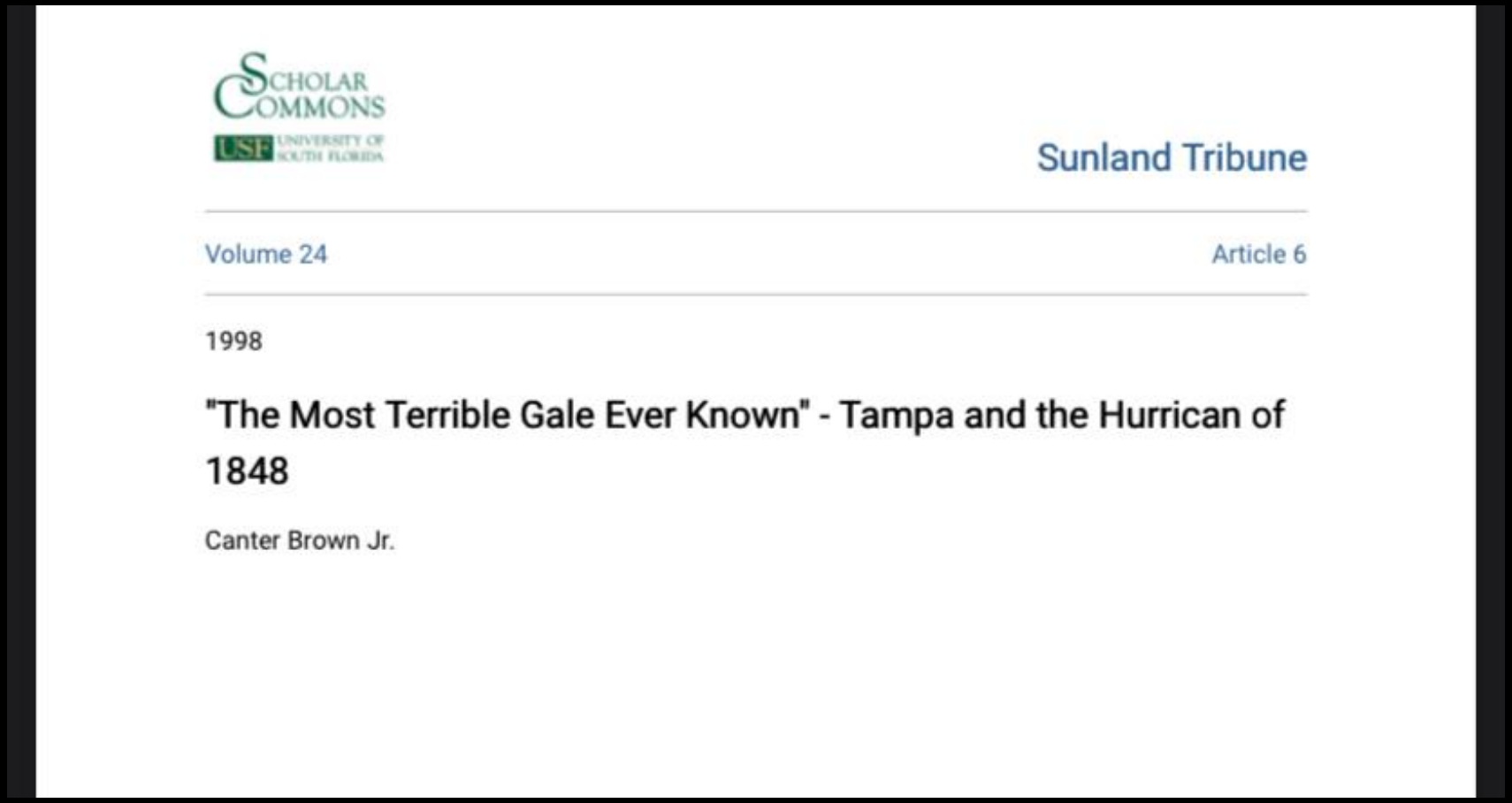
# Know your Regional Disaster History

Look to your right and left!!!

# Know your Regional Disaster History



# Know your Regional Disaster History





Sunland Tribune

Volume 24 Article 6

1998

"The Most Terrible Gale Ever Known" - Tampa and the Hurrican of 1848

Canter Brown Jr.

# Know your Regional Disaster History

The soldiers' failure resulted from the speed with which the storm picked up force. Within two hours after 8:00 a.m., the winds had swung around from the southeast to the southwest. Then, at 10:00 a.m. the tide commenced to rise. A young woman who endured the storm insisted that "at one time it rose five feet in fifteen minutes." The water quickly submerged the shore, blown toward the post and village with terrific force by the hurricane winds. Meanwhile, the barometric pressure dipped to unprecedented levels, a fact that emphasizes the powerful natural forces that were battering the community. At 11:00 a.m. it stood at 30.122. Three hours later it bottomed out at 28.181. By then water stood fifteen feet above the mean low watermark.[8]

Caught unprepared, local residents panicked, especially those who lived near the water. Schoolmaster Wilson dismissed his students at 10:00 a.m., adding to the equation seared children trying to reach their homes in the face of the storm's force. "Our house was

longer thought it advisable for anyone to remain there."[10]

Inhabitants of the Hillsborough River's western side fared no better. At the Robert Jackson home, wife Nancy Collar Jackson witnessed what she called a "tidal wave of alarming proportions." A friend preserved her story. "The waters overflowed the banks as never before known, and the immense steam-ways near their house were washed off their piers and were floating," described Cynthia K. Farr. "Mr. Jackson, an invalid at the time, had taken the older children to a little store nearby, to divert them and to relieve their mother of their care, but realizing that danger was threatening her in the home, sent an employee to bring her and the babe away."[11]

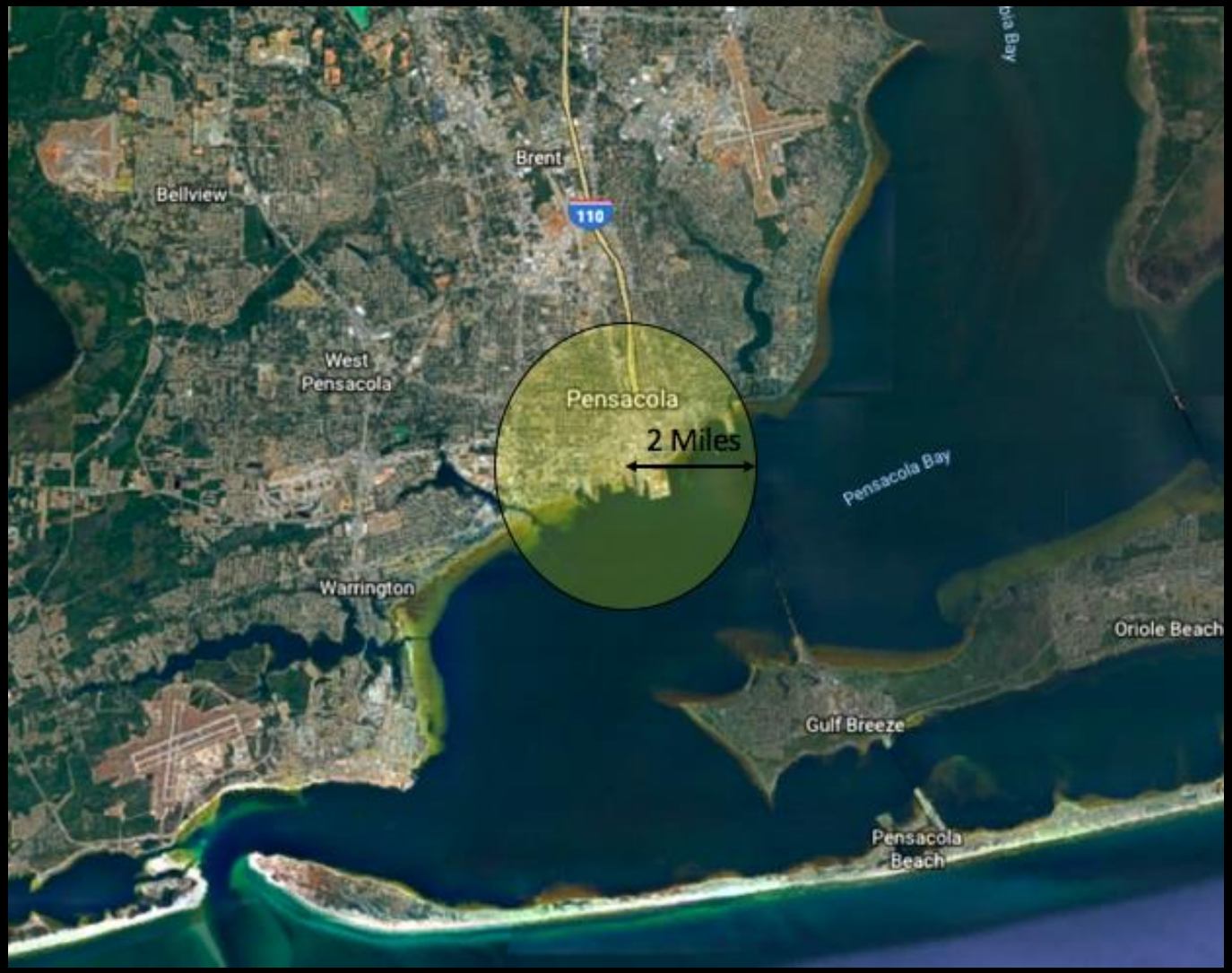
The details of Nancy's escape illustrate the immediacy of the storm's threat to life and limb. "On nearing the house the man saw the 'ways' floating and surging to and fro, and made all haste to tell Mrs. Jackson, who had

# Looking at Disaster Histories from Other Angles…

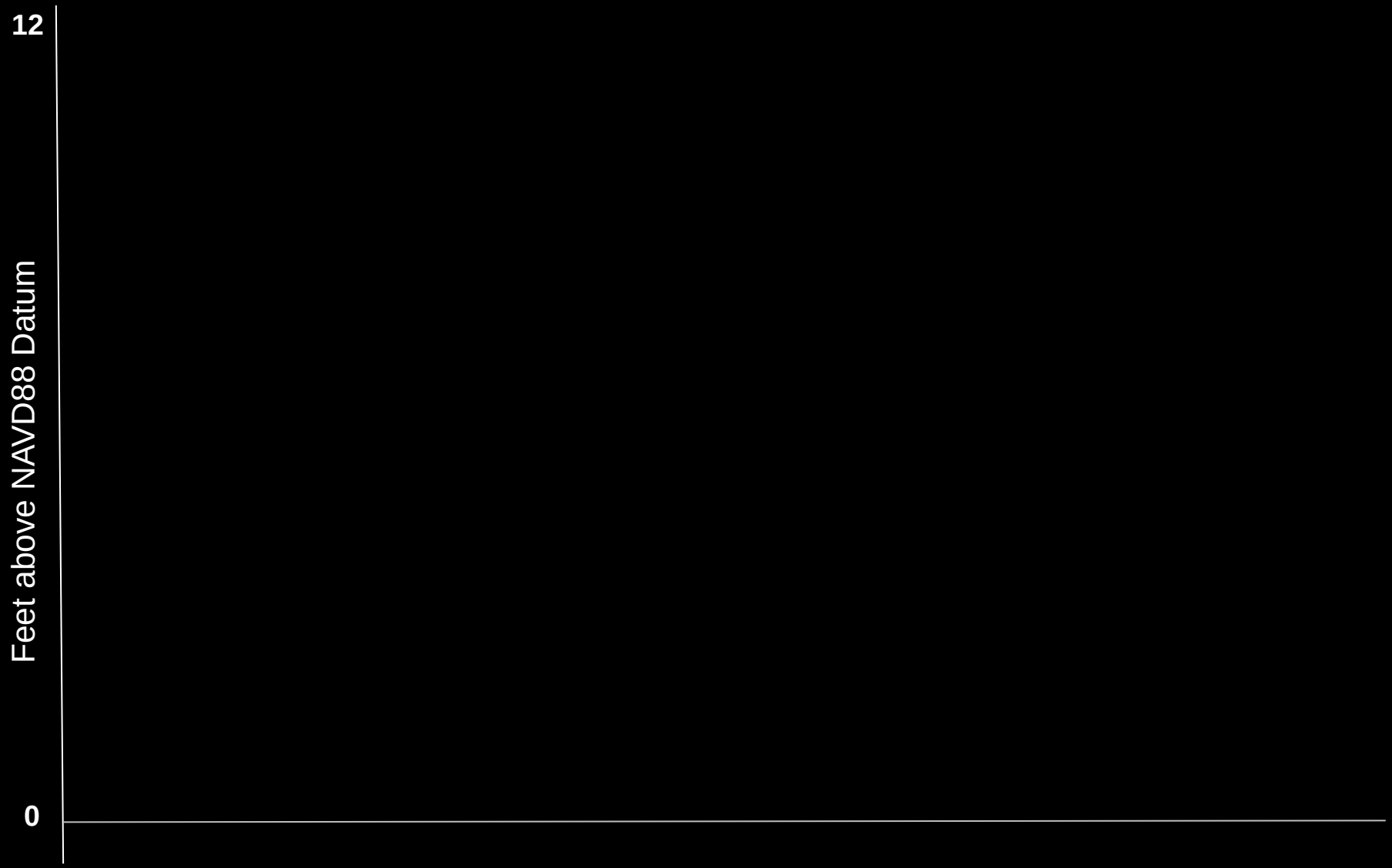
# Pensacola

- Native Americans – thousands of years
- Spanish arrived in 1550s
- Five flags have flown over the city
- Storm surge data since 1890

# Location-Based Flood History

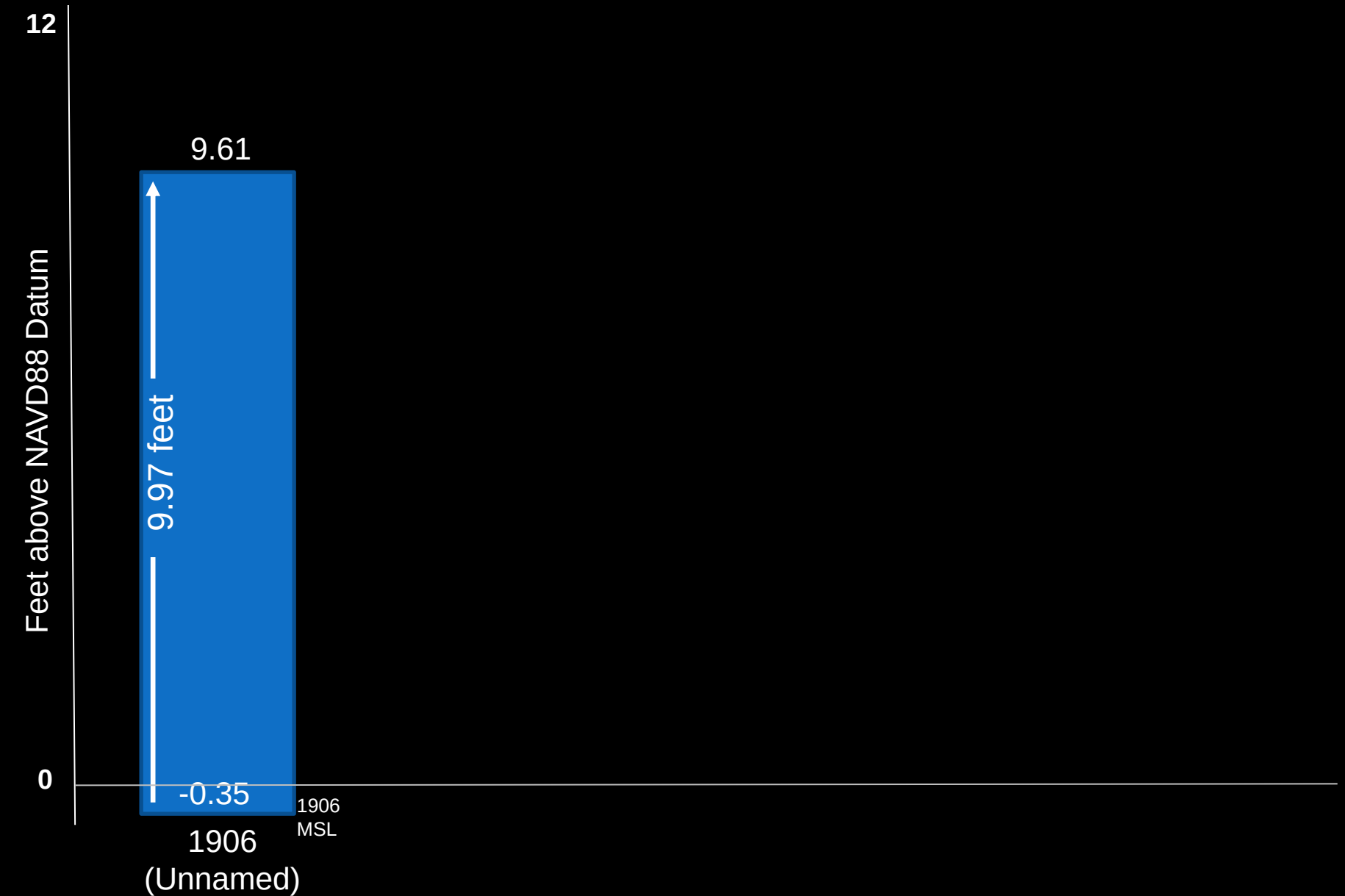


# Pensacola’s Most Severe Storm Surges



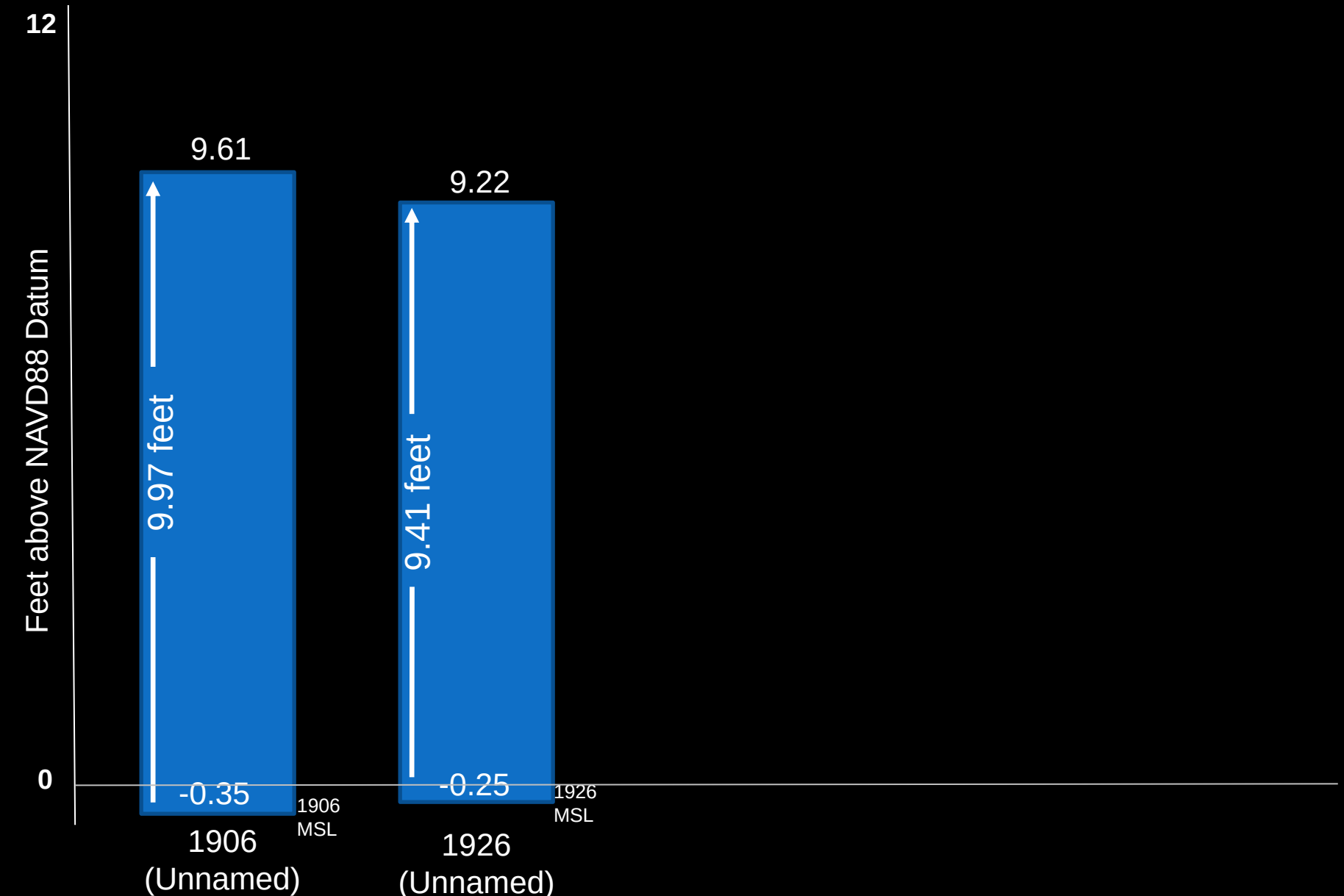
# Pensacola 1906

# Pensacola’s Most Severe Storm Surges



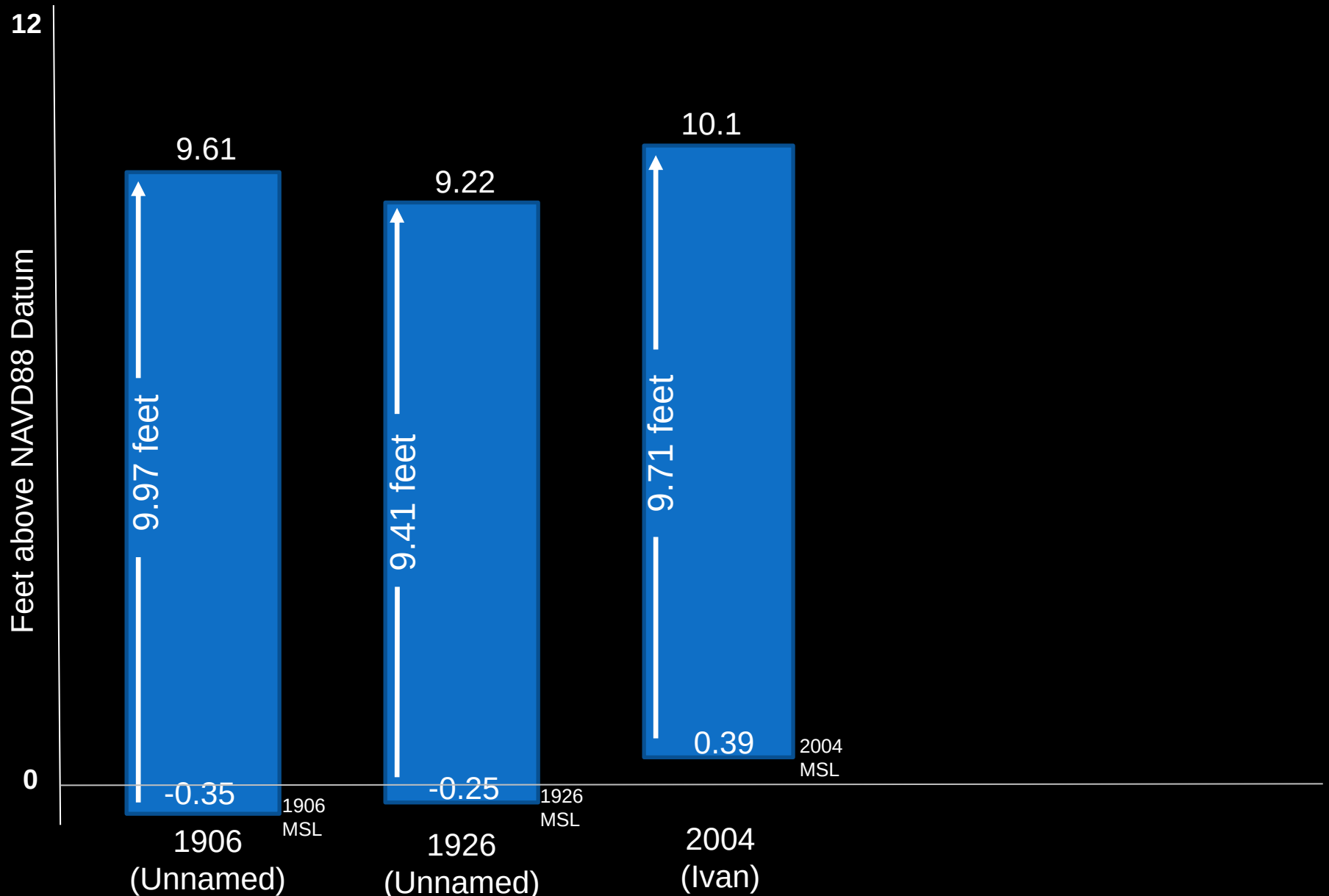
# Great Miami Hurricane (1926)

# Pensacola's Most Severe Storm Surges



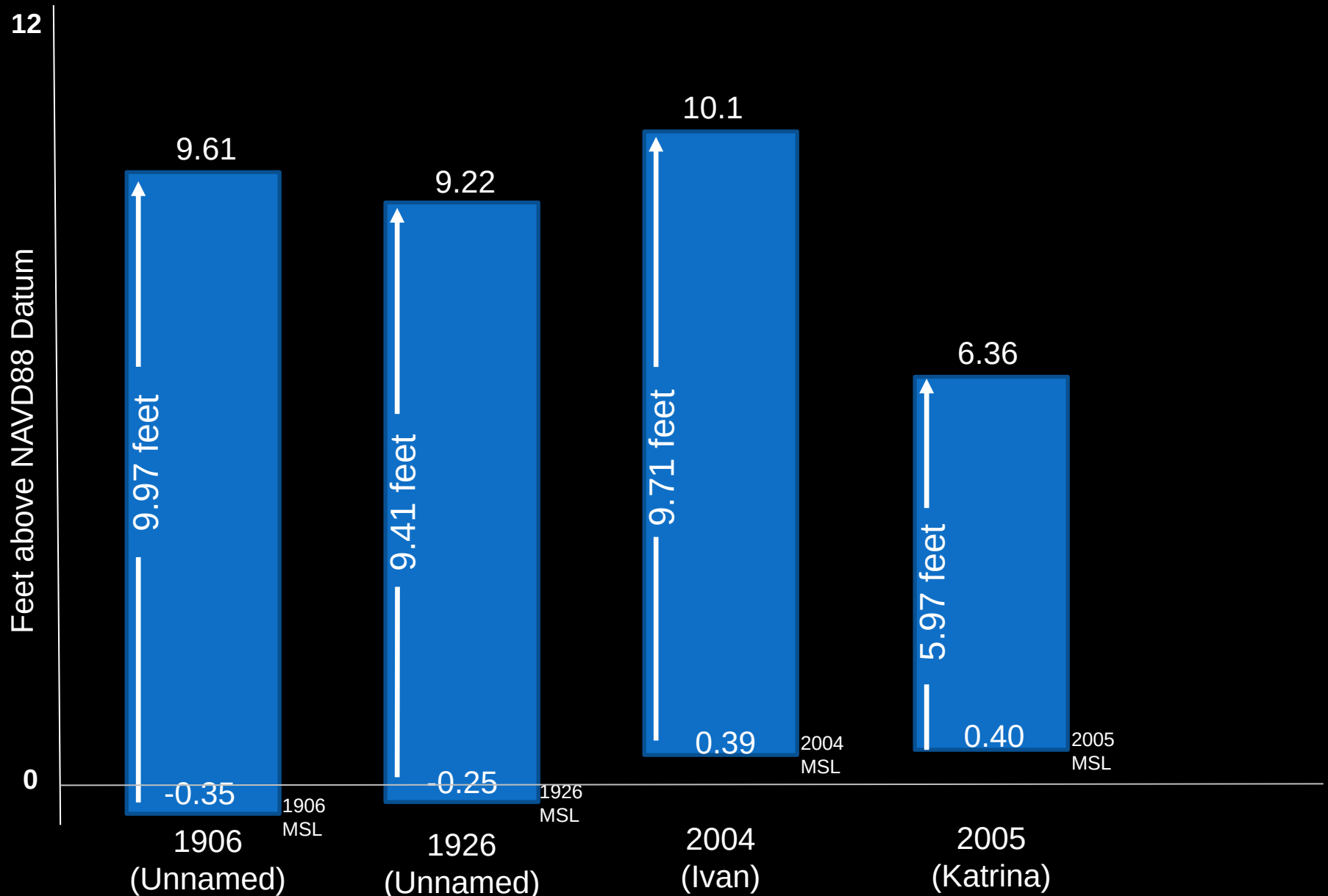
# Hurricane Ivan (2004)

# Pensacola's Most Severe Storm Surges

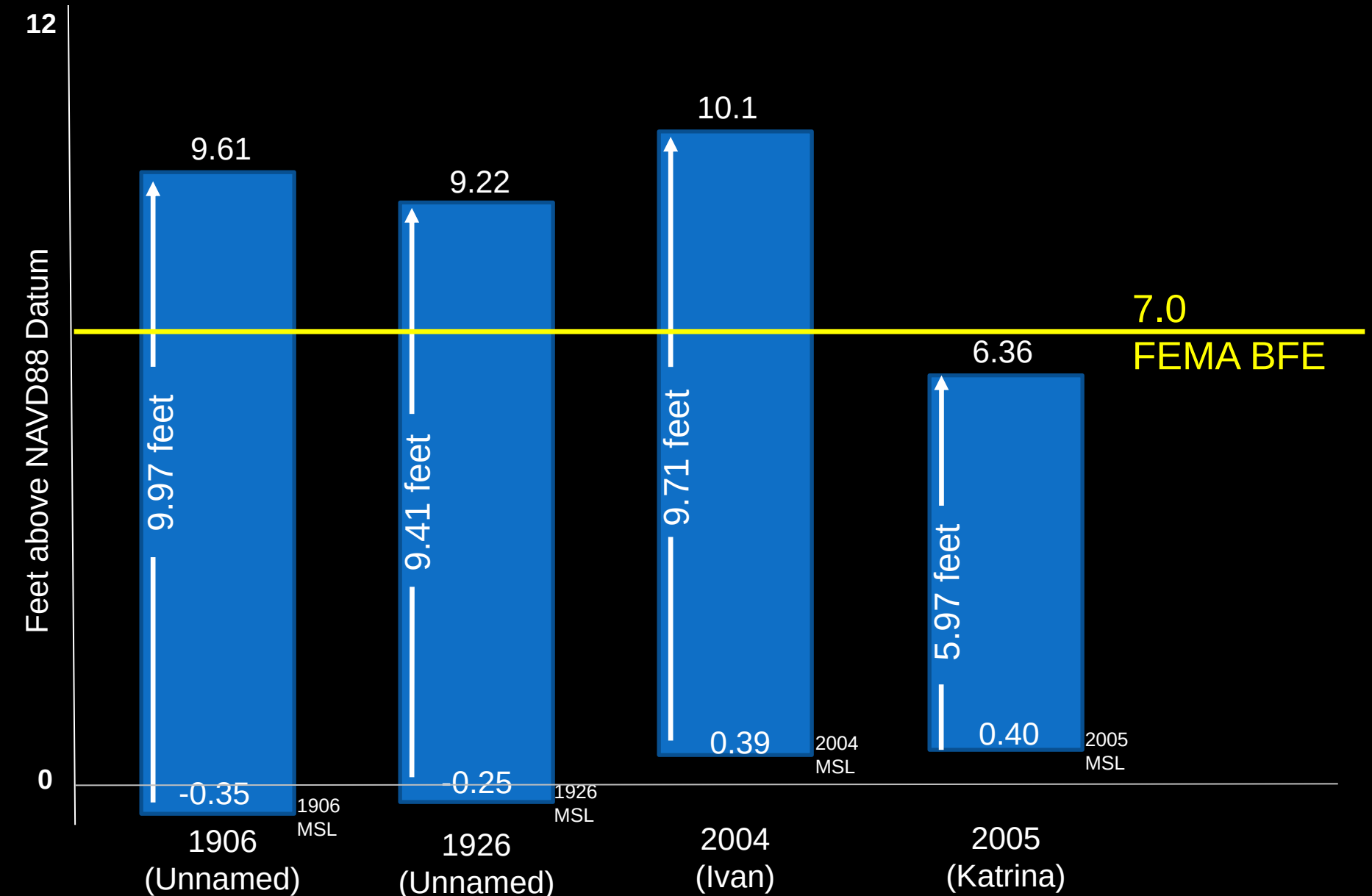


# Hurricane Katrina (2005)

# Pensacola's Most Severe Storm Surges

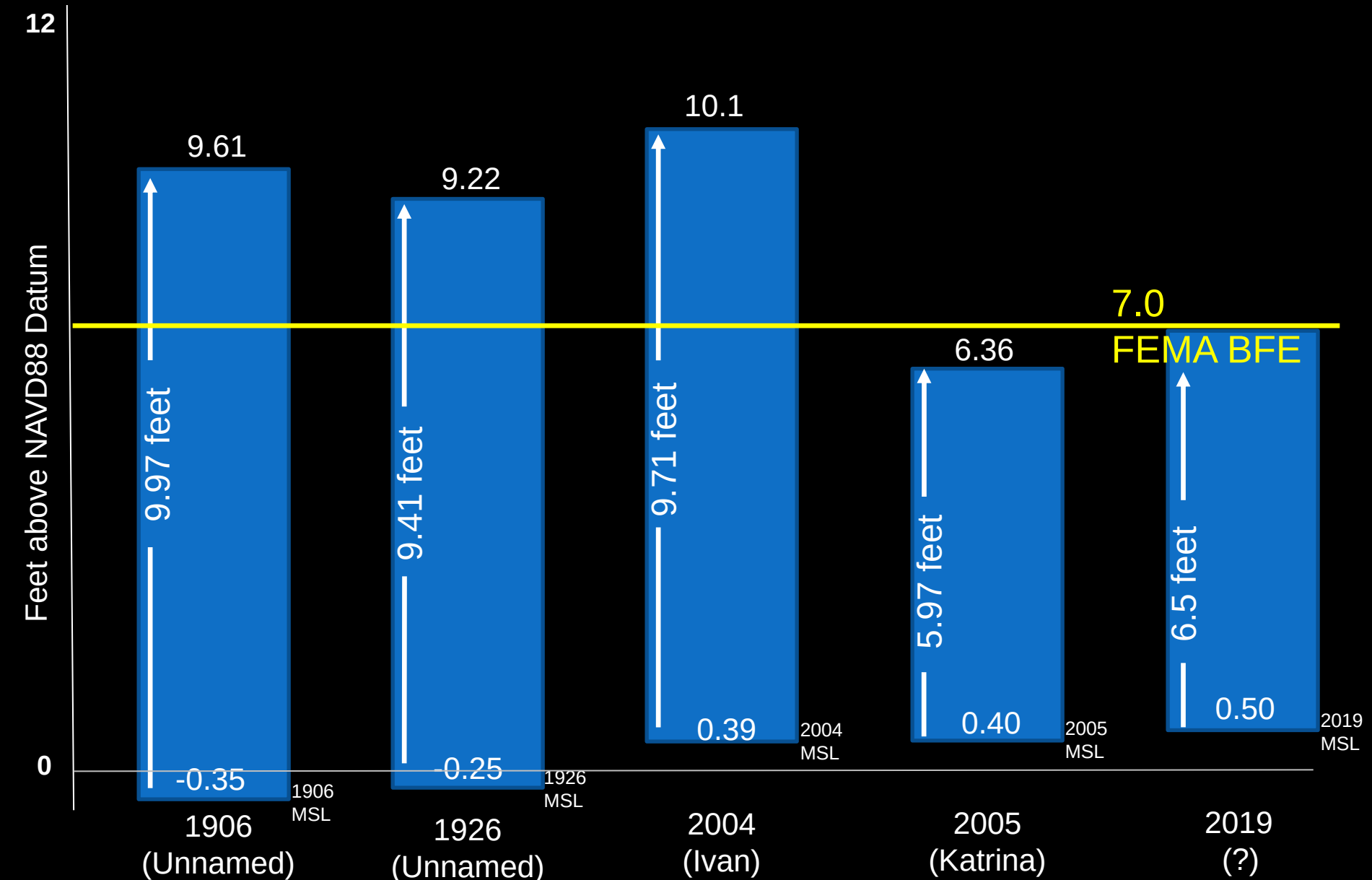


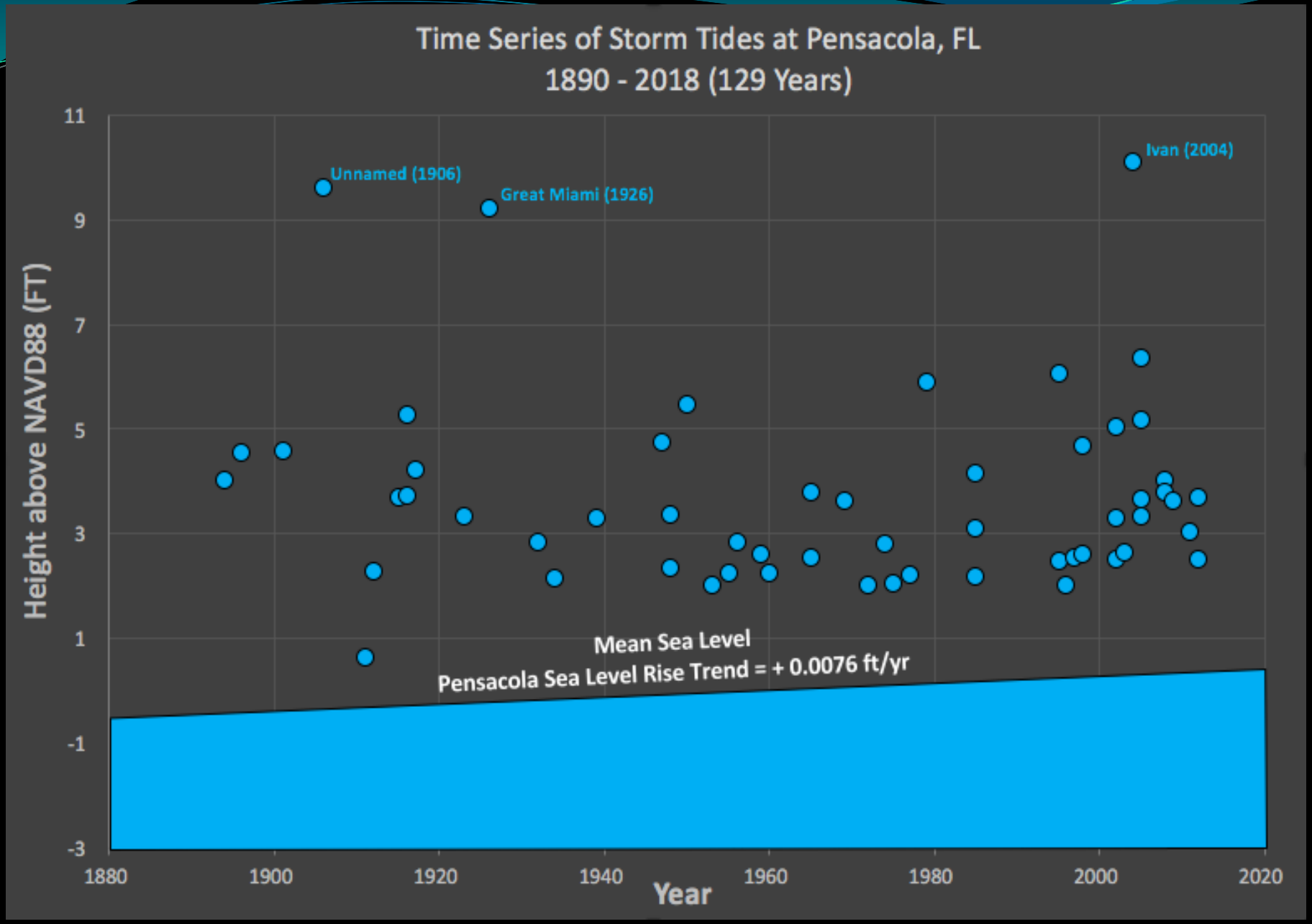
# Pensacola's Most Severe Storm Surges

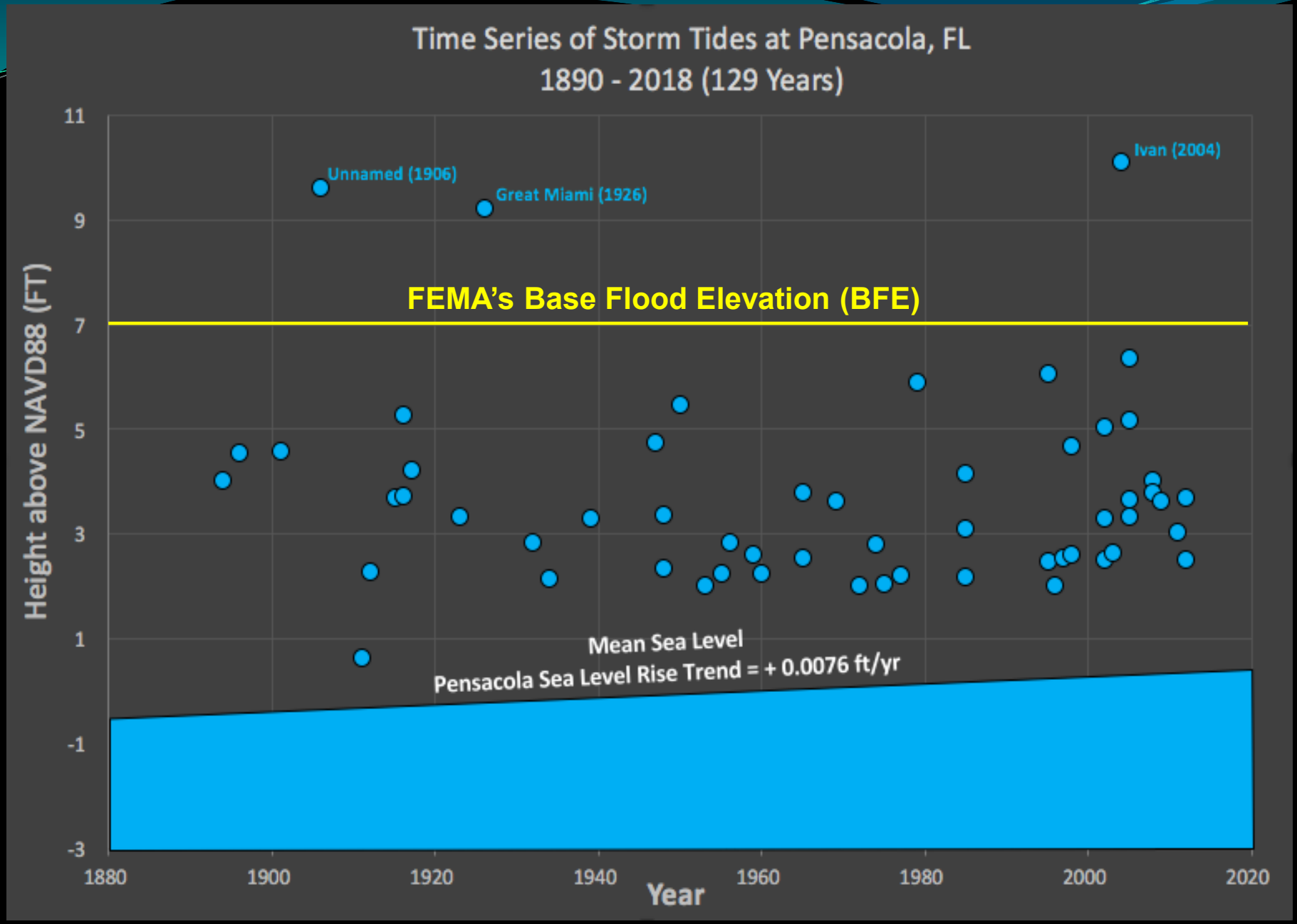



7
AREA OF MINIMAL FLOOD HAZARD
Zone X
26
Zone AE
(EL 7 Feet)
Zone AE
(EL 8 Feet)
CITY OF PENSACOLA
120082
12033C0390G
eff. 9/29/2006
Zone VE
(EL 9 Feet)
Zone VE
(EL 10 Feet)
Zone AE
(EL 9 Feet)
Zone VE
(EL 11 Feet)
Streets
USGS The National Map: Orthoimagery. Data refreshed October, 2017.
POWERED BY esri

# Pensacola's Most Severe Storm Surges




Time Series of Storm Tides at Pensacola, FL
1890 - 2018 (129 Years)
Unnamed (1906)
Great Miami (1926)
Ivan (2004)
Mean Sea Level
Pensacola Sea Level Rise Trend = + 0.0076 ft/yr
Height above NAVD88 (FT)
Year
11
9
7
5
3
1
-1
-3
1880
1900
1920
1940
1960
1980
2000
2020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Mean Sea Level
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Height above NAVD88 (FT)
11
9
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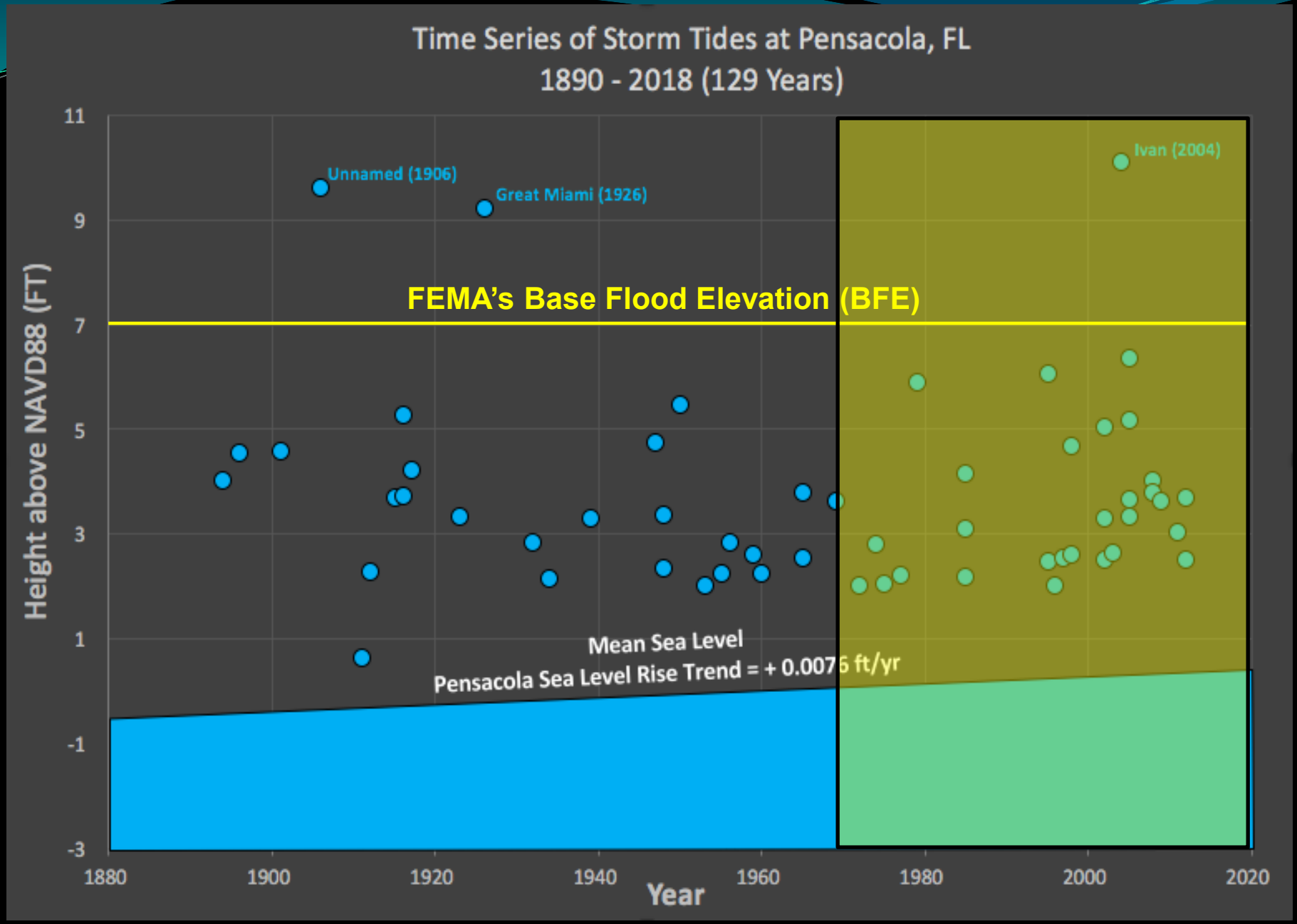
-3
1880
1900
1920
1940
1960
1980
2000
2020
Year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Height above NAVD88 (FT)
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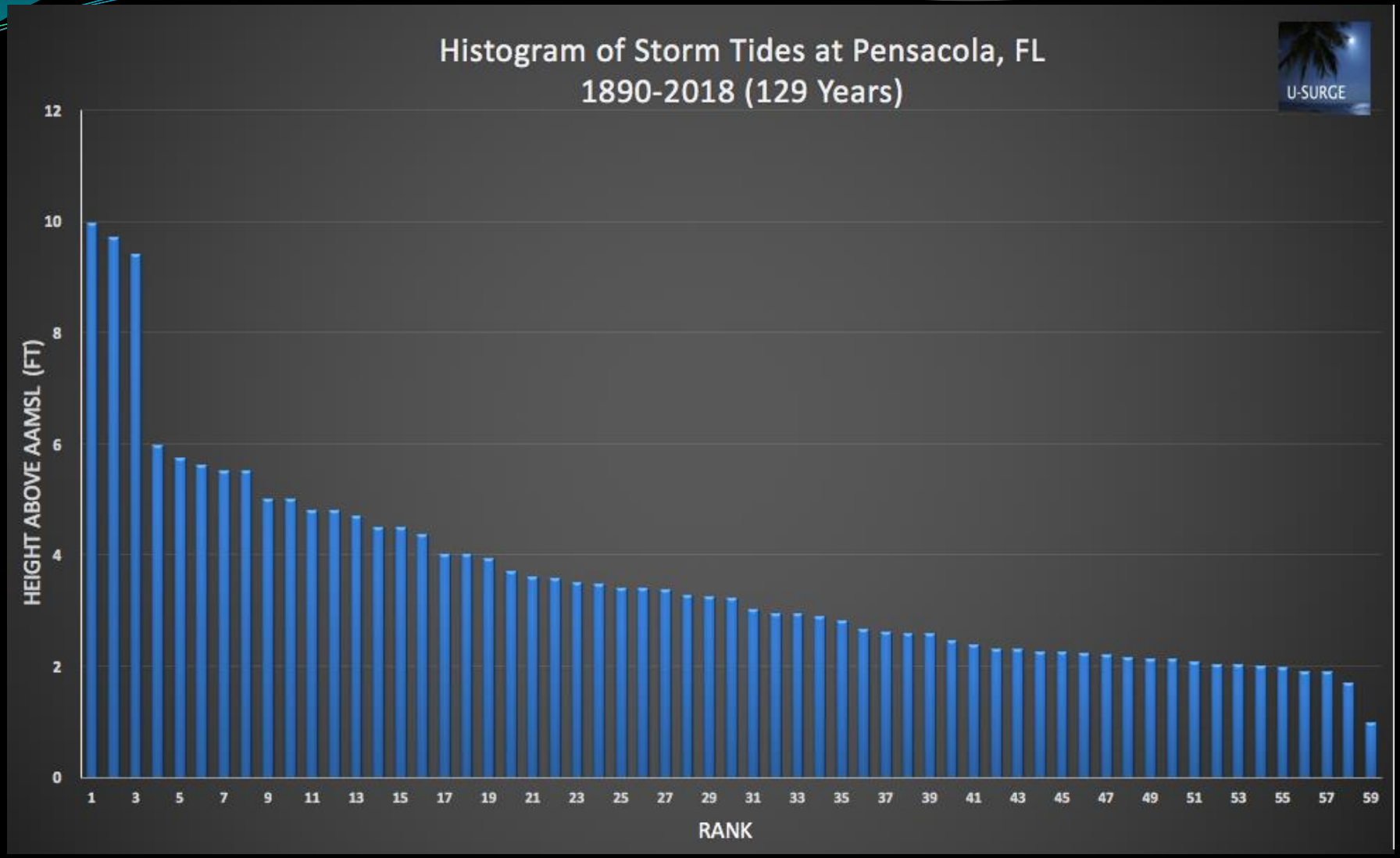
Year


Histogram of Storm Tides at Pensacola, FL
1890-2018 (129 Years)
U-SURGE
HEIGHT ABOVE AAMSL (FT)
0
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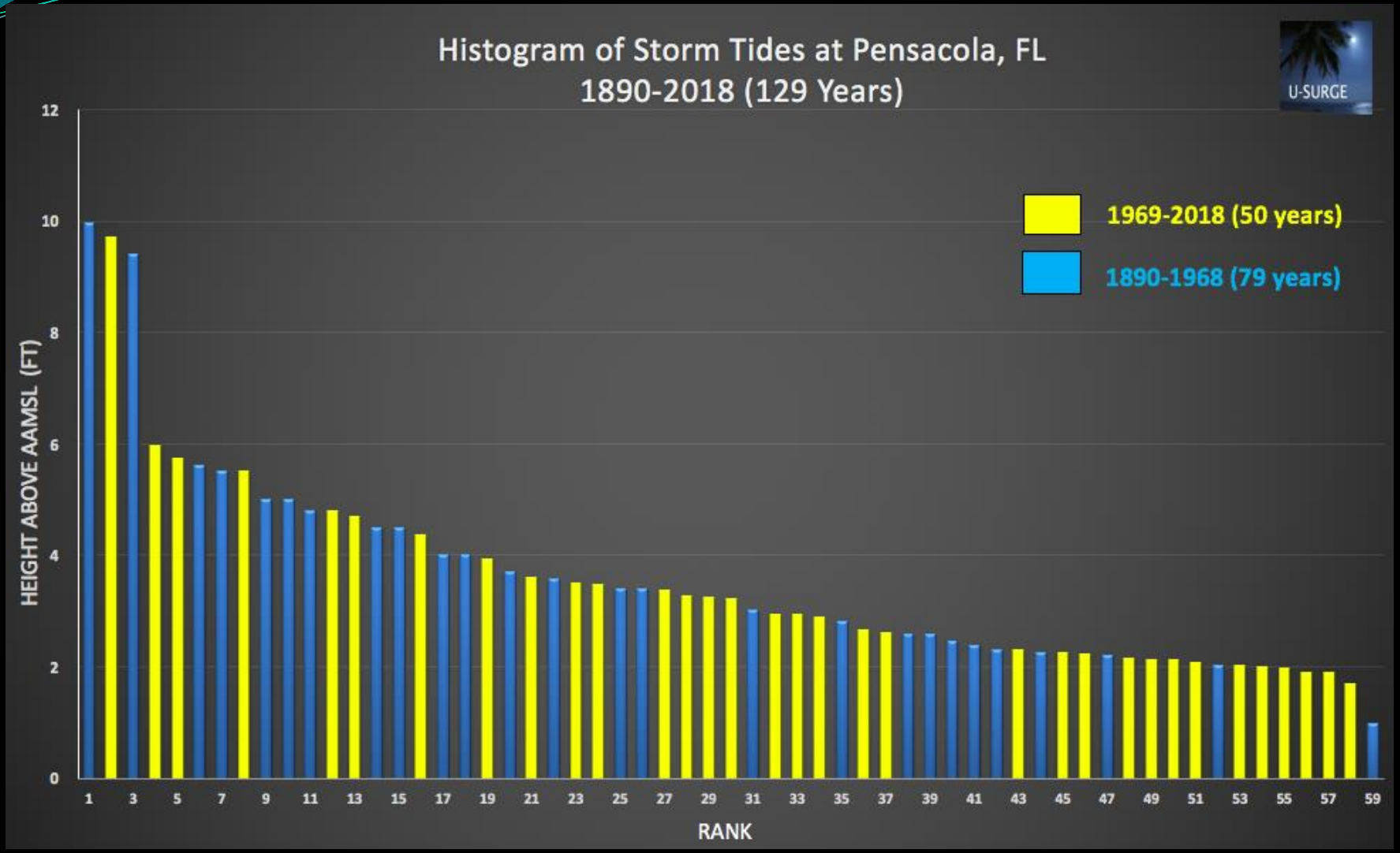
4
6
8
10
12
RANK
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59


Histogram of Storm Tides at Pensacola, FL
1890-2018 (129 Years)
U-SURGE
1969-2018 (50 years)
1890-1968 (79 years)
HEIGHT ABOVE AAMSL (FT)
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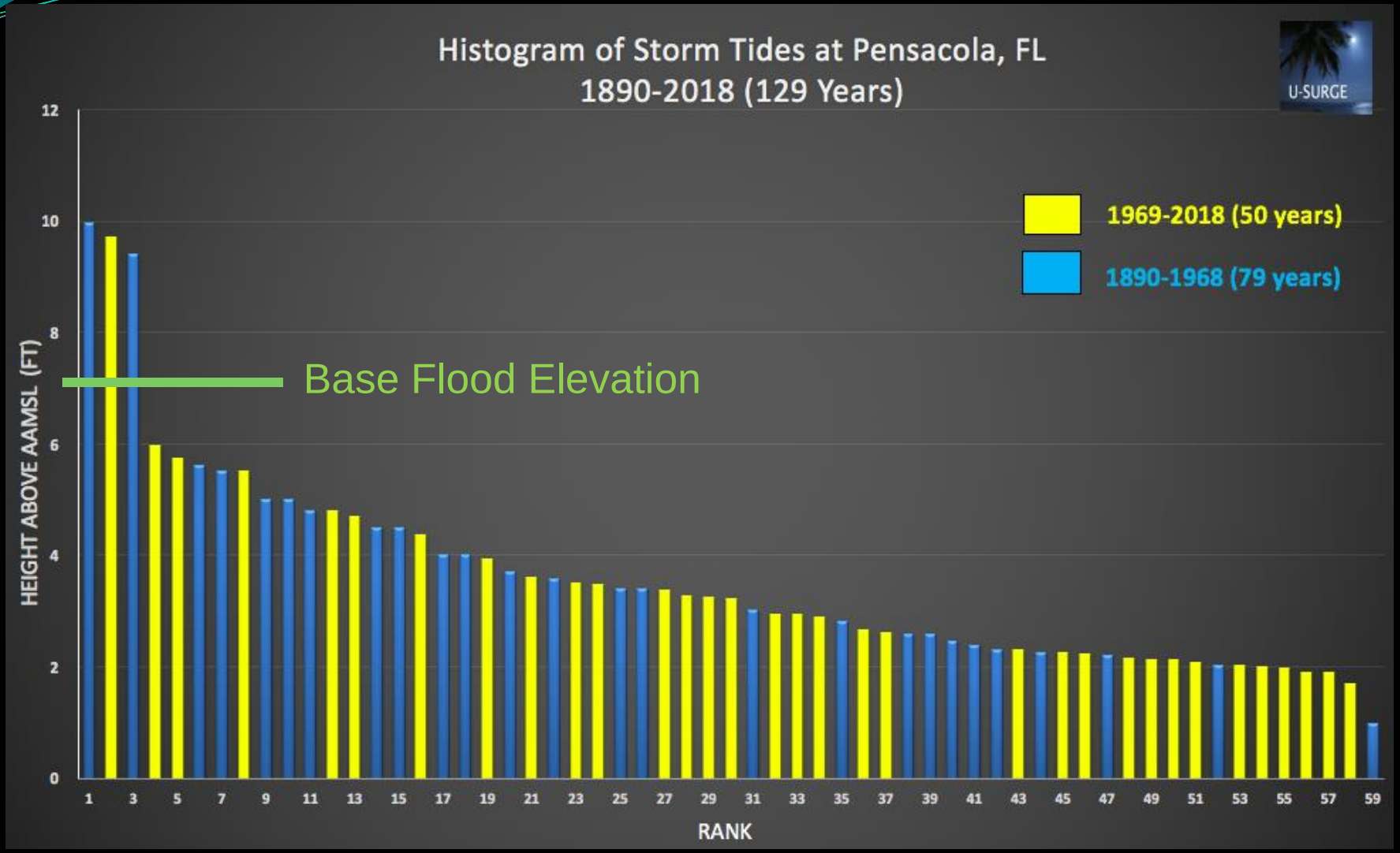
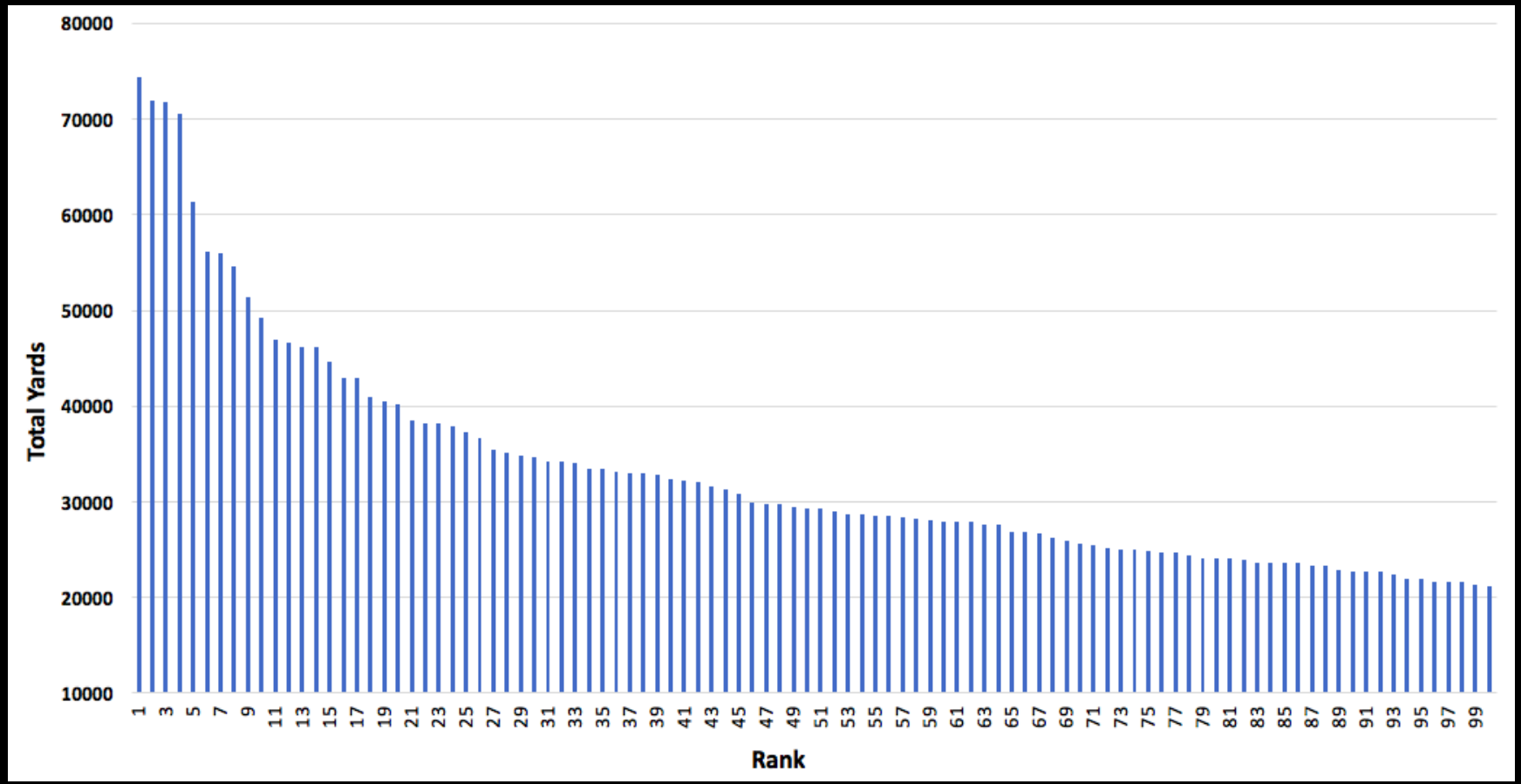
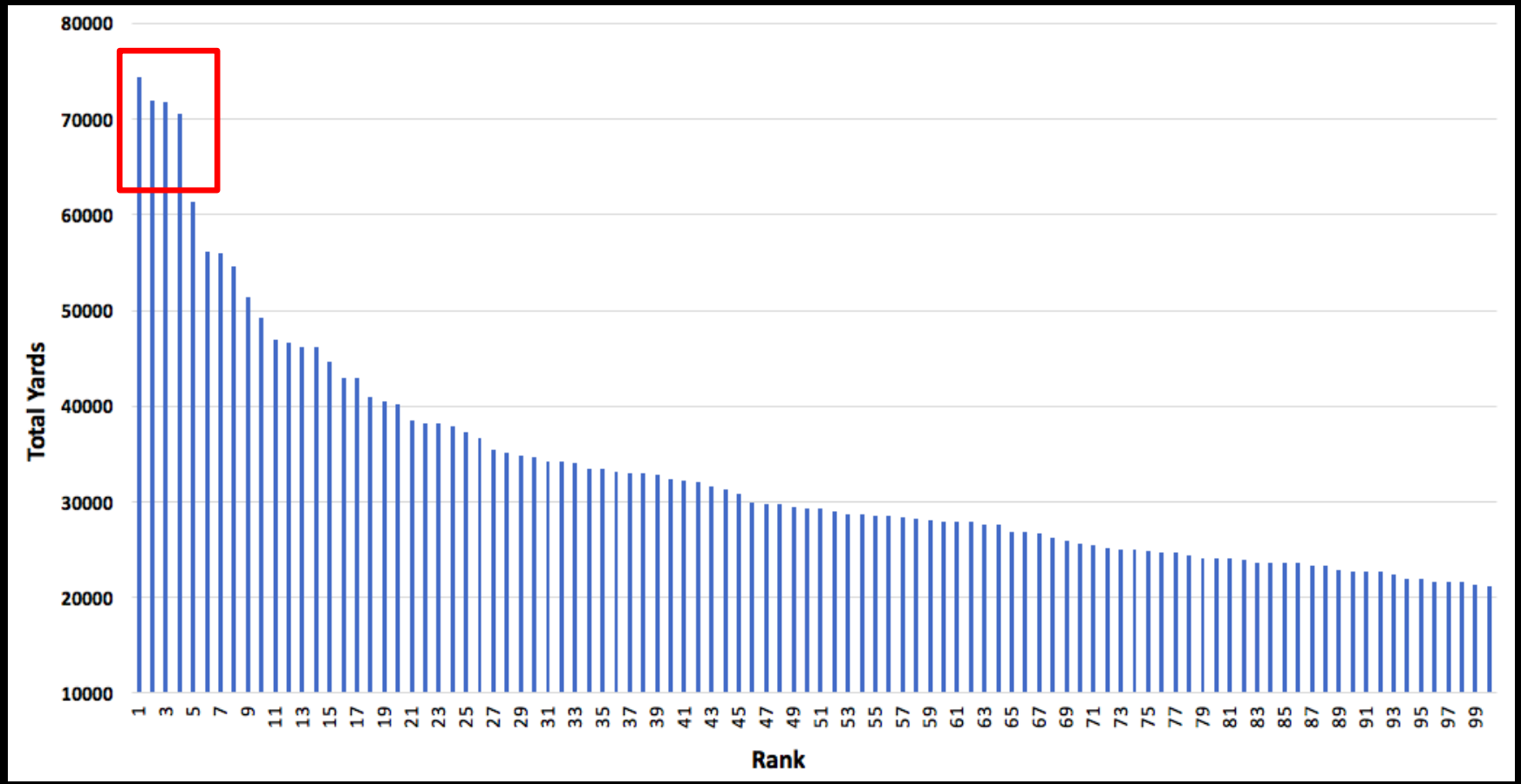
12
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59
RANK


Histogram of Storm Tides at Pensacola, FL
1890-2018 (129 Years)
U-SURGE
1969-2018 (50 years)
1890-1968 (79 years)
Base Flood Elevation
HEIGHT ABOVE AAMSL (FT)
0
2
4
6
8
10
12
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59
RANK

# All-Time NFL Passing Leaders



# All-Time NFL Passing Leaders



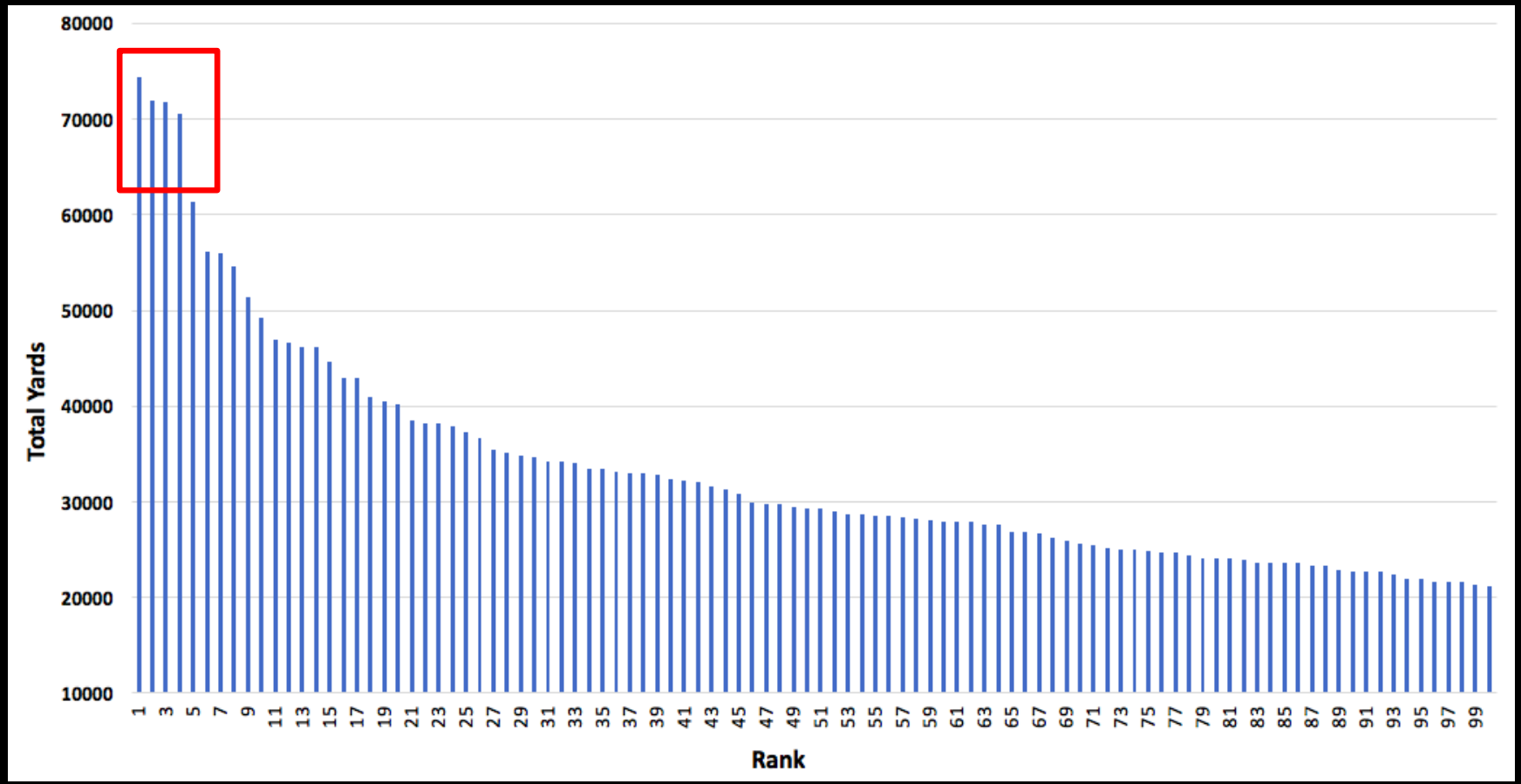
Drew Brees

Peyton Manning

Brett Favre

Tom Brady

# All-Time NFL Passing Leaders



# Knowing Our Regional Disaster History:

- Need to look back far in time
- Need to look to the left and right
- High-magnitude/ low-frequency disasters are much more severe than other events

Key to Disaster Resiliency:

1. Know your regional disaster history

AND

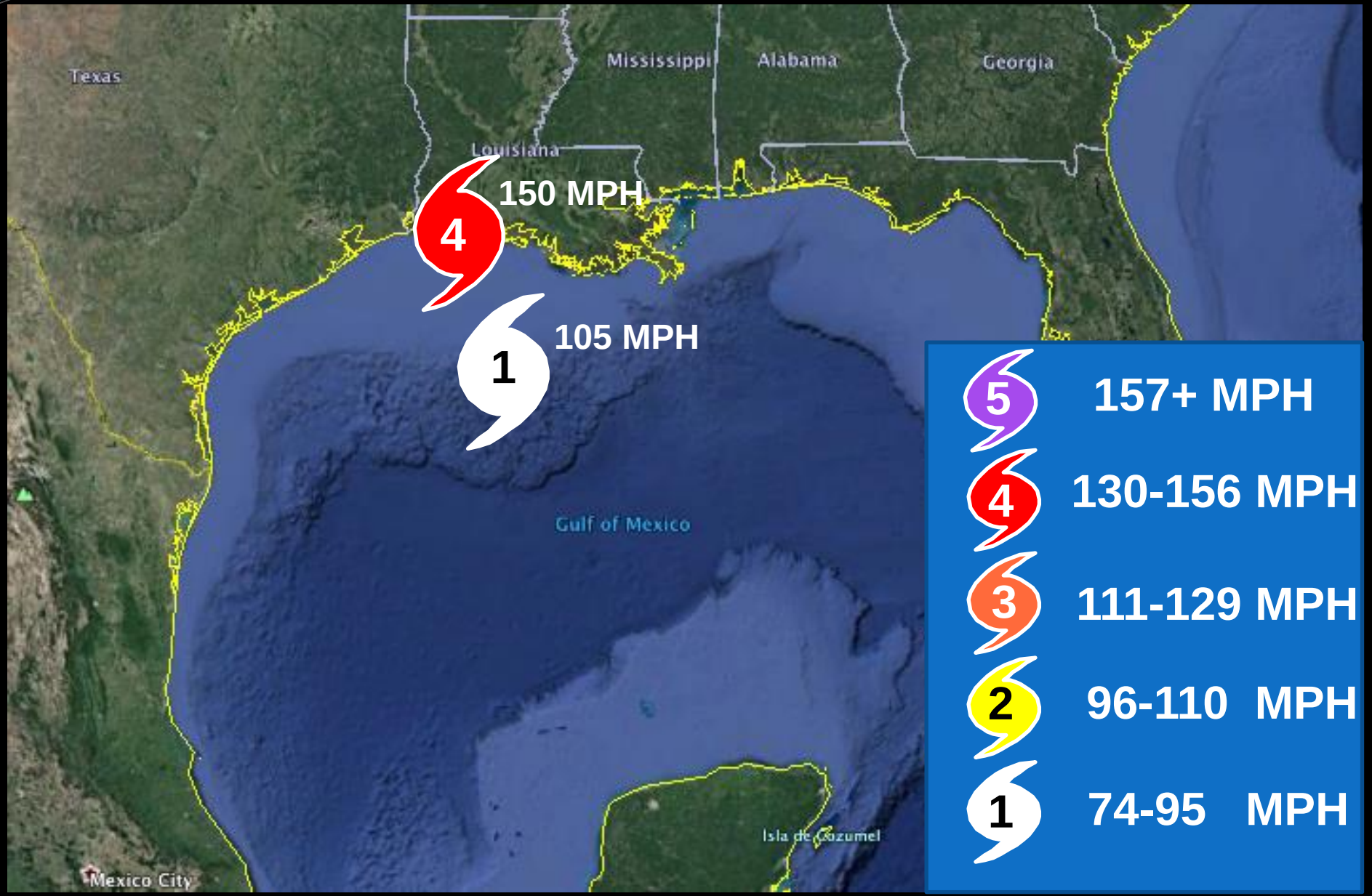
2. Build in a buffer for future storms

AND

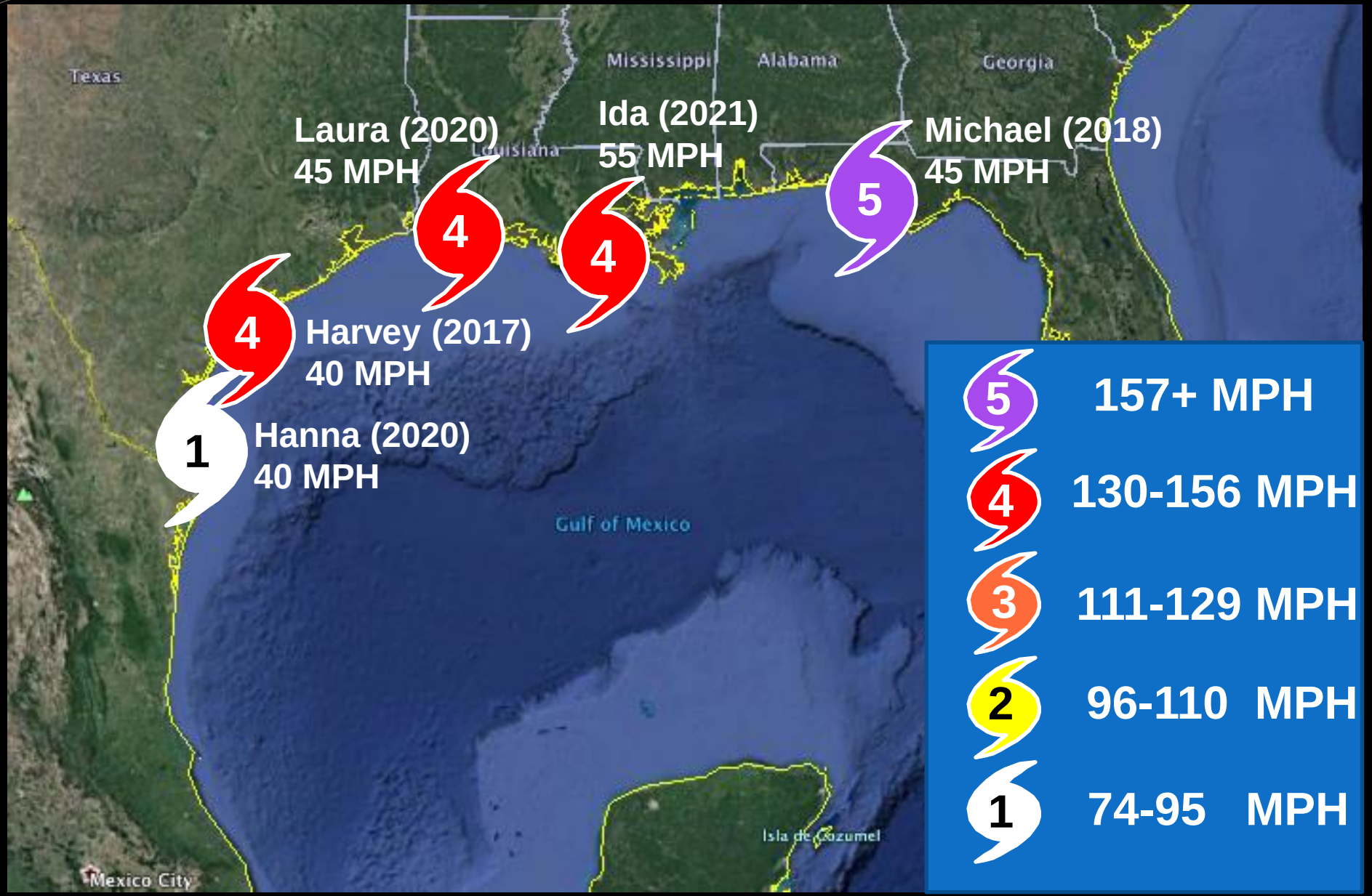
3. Communicate better with visuals

2. Build in a Buffer for Future Storms

# Hurricane Laura's Rapid Intensification



# Rapid Intensification Over the Past Five Years



Since 1950, the greatest 24-hour intensification rates prior to a U.S. landfall:

| | |
|---|---|
| Humberto (2007): | 65 mph increase |
| King (1950): | 60 mph increase |
| Eloise (1975): | 60 mph increase |
| Ida (2021) | 55 mph increase |
| Danny (1997): | 50 mph increase |
| Michael (2018): | 45 mph increase |
| Laura (2020): | 45 mph increase |
| Cindy (2005): | 40 mph increase |
| Harvey (2017): | 40 mph increase |
| Hanna (2020): | 40 mph increase |

(List adapted from CAT-6 Weather Blog)

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| | | |
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| ★ | Hanna (2020): | 40 mph increase |

★ 2017-2021 Average = 1 per year

(List adapted from CAT-6 Weather Blog)

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| | | |
|---|---|---|
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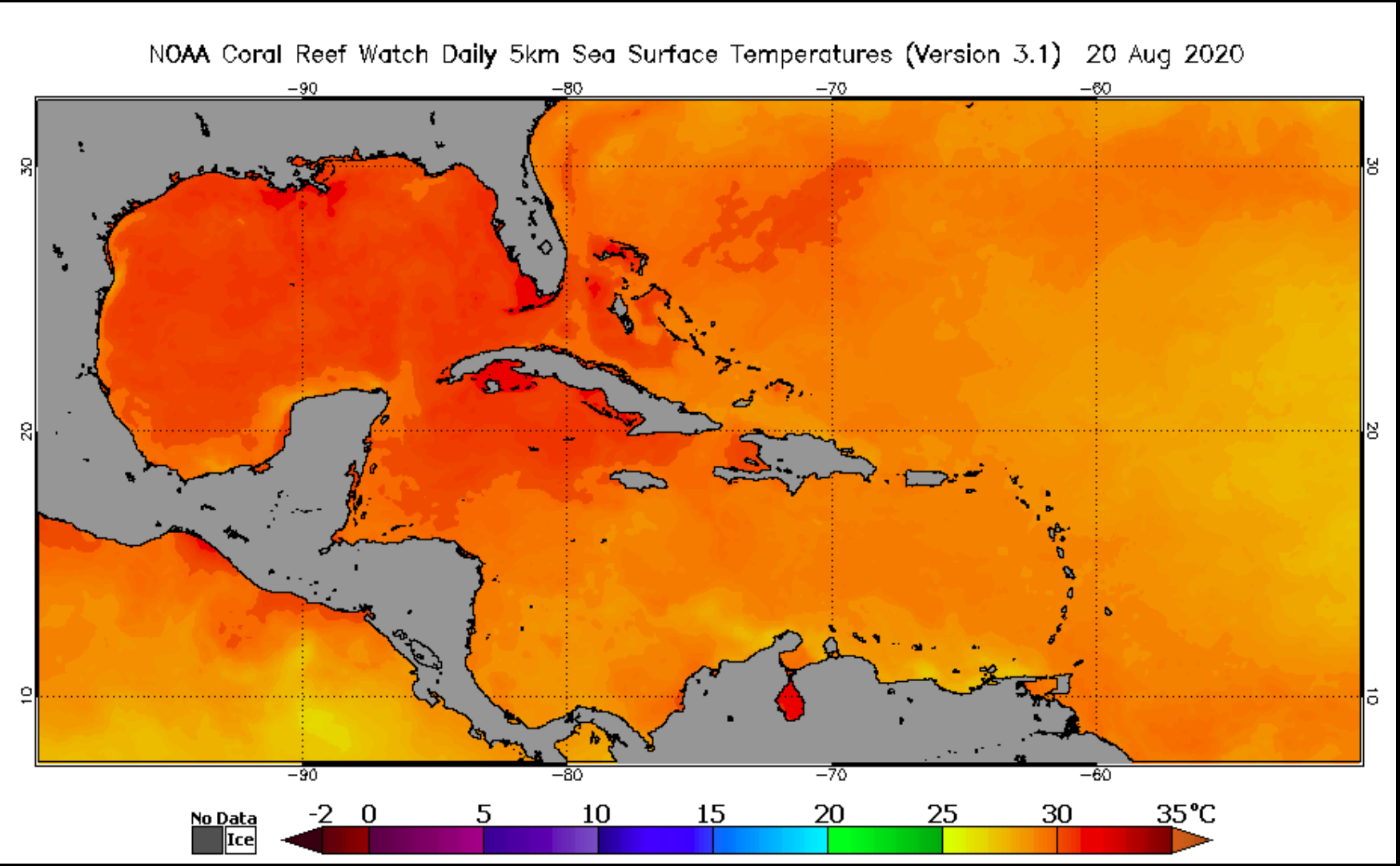
| | Harvey (2017): | 40 mph increase |
| | Hanna (2020): | 40 mph increase |

★ 1950-1999 Average = 1 per 17 years

(List adapted from CAT-6 Weather Blog)

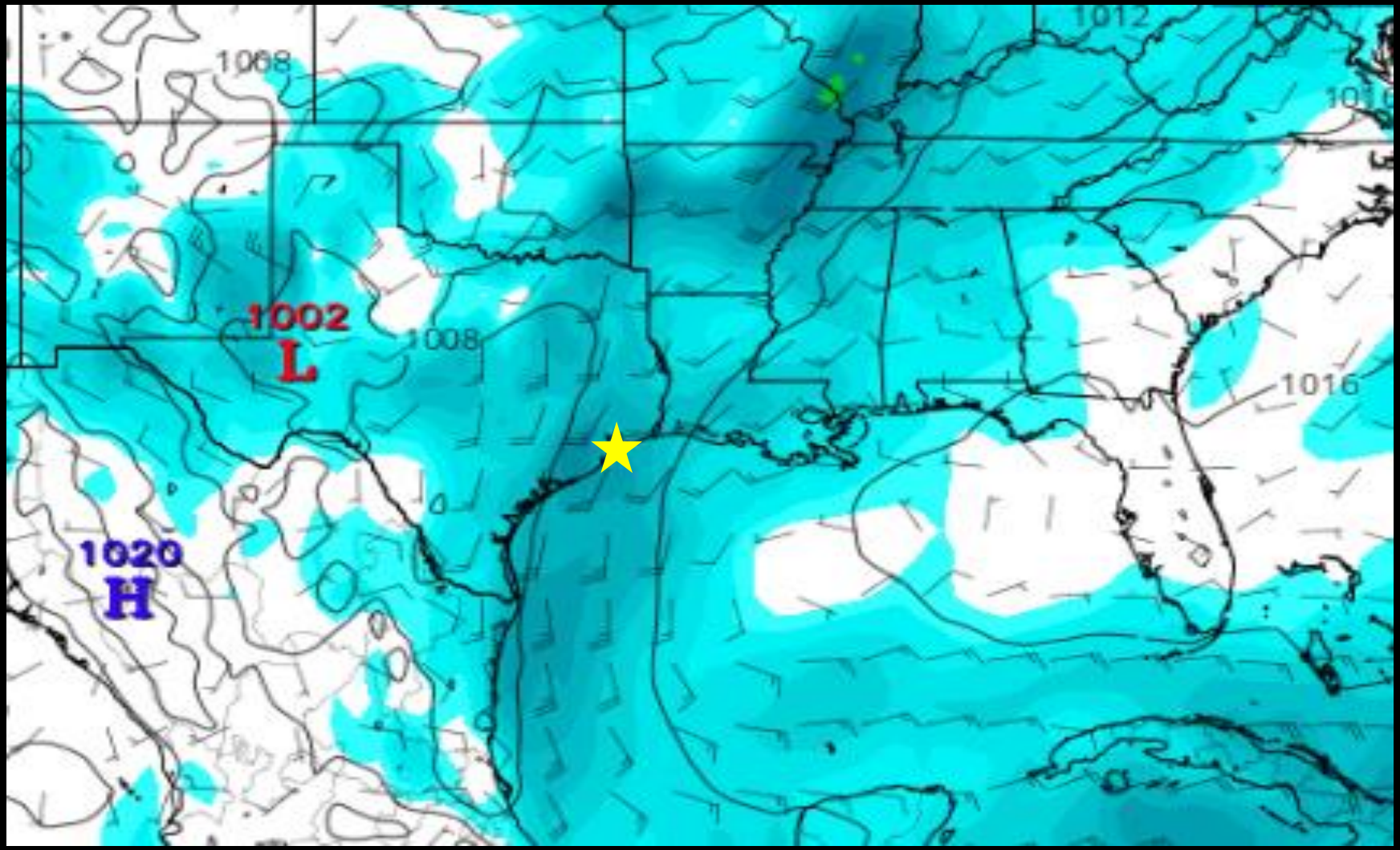
# Sea Surface Temp (Aug 20, 2020)




https://coralreefwatch.noaa.gov/data/5km/v3.1/image/daily/sst/gif/2020/coraltemp5km_sst_20200820_crb_930x580.gif

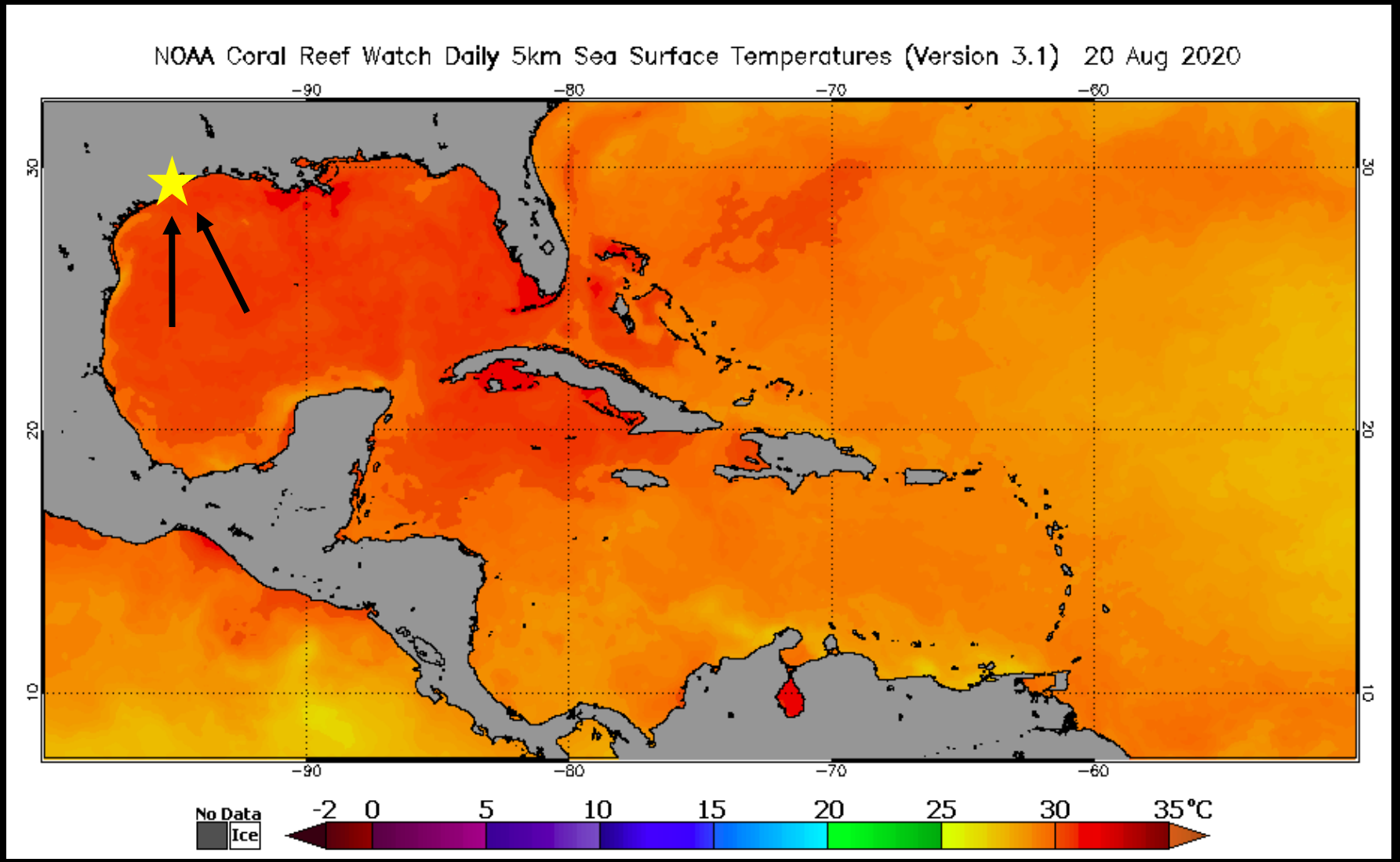
Galveston, Texas
Oldest Weather Records West of Mississippi River
1871-2020 (150 Years)

Mean Sea Level Pressure and Surface Winds
Tue Sep 01 700AM Central Time: Euro Model

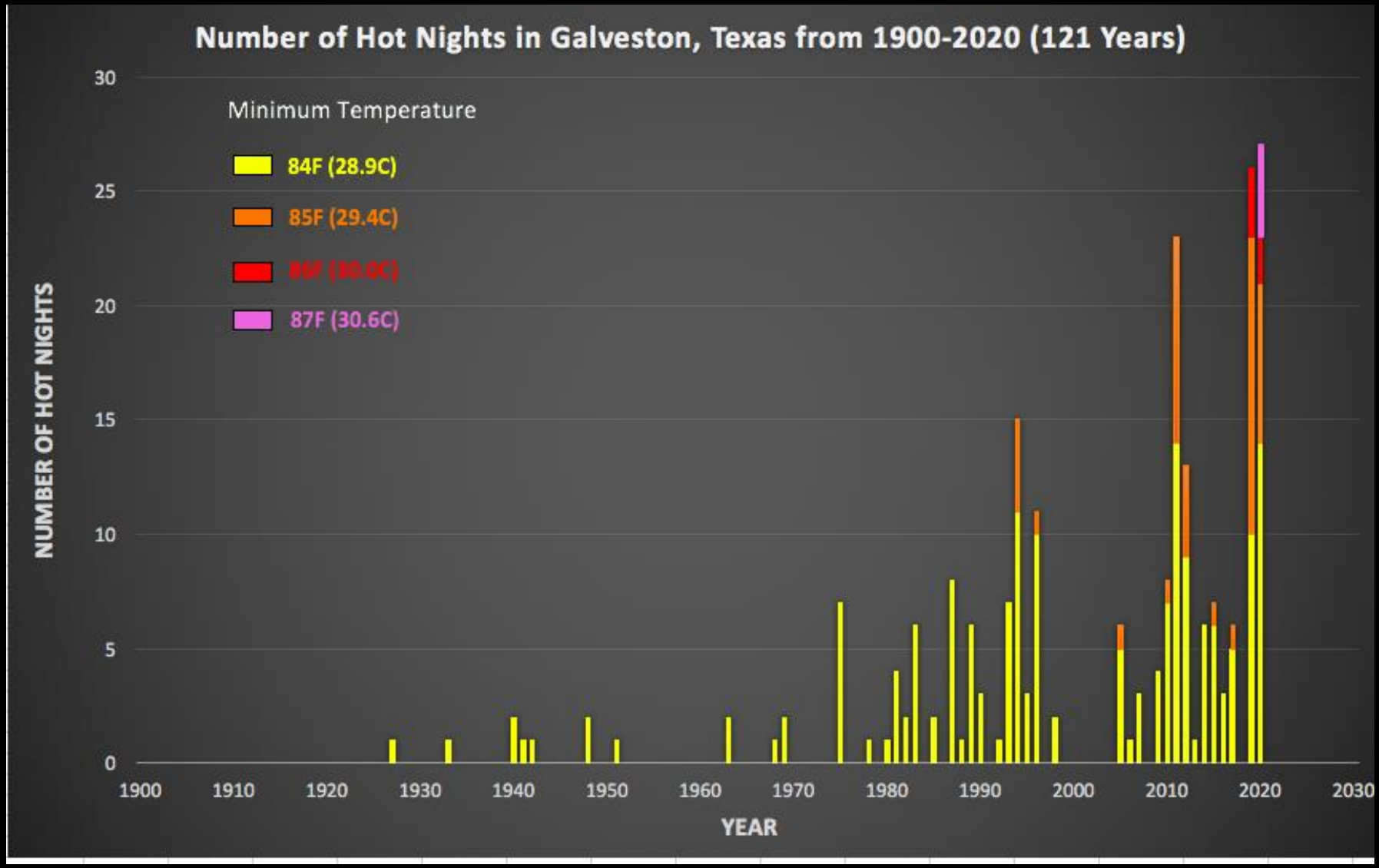



Source: Tropical Tidbits

# Sea Surface Temp - Aug 20, 2000




Source: NOAA


Number of Hot Nights in Galveston, Texas from 1900-2020 (121 Years)
Minimum Temperature
84F (28.9C)
85F (29.4C)
86F (30.0C)
87F (30.6C)
NUMBER OF HOT NIGHTS
YEAR
0
5
10
15
20
25
30
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030

# Will Global Warming Make Hurricane Forecasting More Difficult?

Kerry Emanuel
*Lorenz Center, Massachusetts Institute of Technology, Cambridge, Massachusetts*

https://doi.org/10.1175/BAMS-D-16-0134.1
*Final Form: 8 August 2016*
*Published Online: 31 March 2017*

Dr. Emanuel used a computer model that generated a set of 22,000 landfalling U.S. hurricanes during the recent climate period of 1979 - 2005, then compared their intensification rates to a similar set of hurricanes generated in the climate expected at the end of the 21st century. For the future climate, he assumed a business-as-usual approach to climate change—the path we are currently on. The analysis found that the odds of a hurricane intensifying by 70 mph or greater in the 24 hours just before landfall were about once every 100 years in the climate of the late 20th century. But in the climate of the year 2100, these odds increased to once every 5 - 10 years. What's more, 24-hour pre-landfall intensifications of 115 mph or more—which were essentially nonexistent in the late 20th Century climate—occurred as often as once every 100 years by the year 2100. The major metropolitan areas most at risk for extreme intensification rates just before landfall included Houston, New Orleans, Tampa/St. Petersburg, and Miami.

# Six Consecutive Years of Stalled Storms

## South Carolina - 2015

Image: https://www.nytimes.com/video/us/100000003958698/9-dead-in-south-carolina-weather.html

# South Louisiana - 2016

# Hurricane Harvey – Texas (2017)

# Hurricane Florence (2018)

# Tropical Storm Imelda (2019)

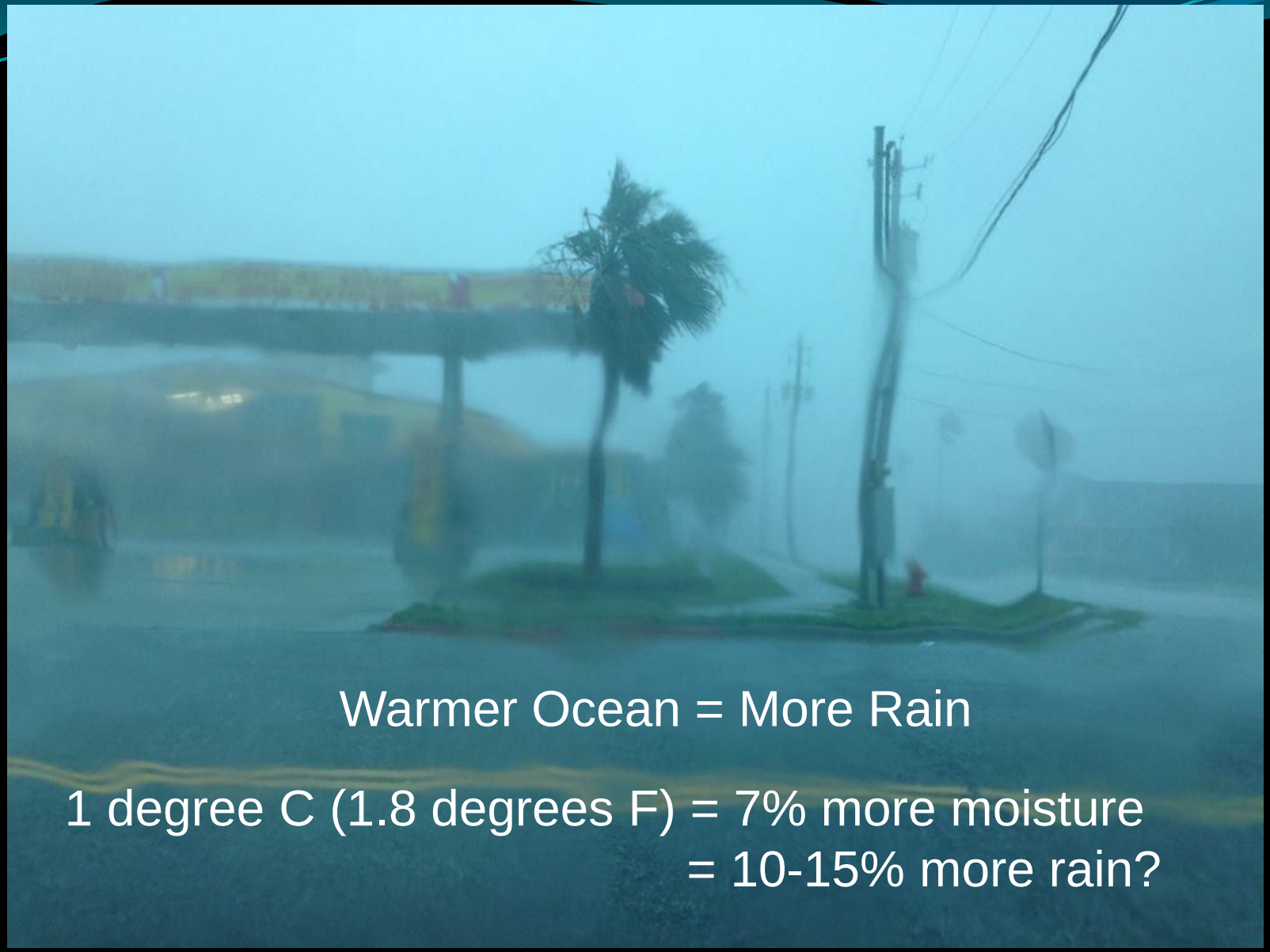
Source: Brett Coomer/ Houston Chronicle

# Hurricane Sally (2020)

Photo: Dr. Hal Needham

# “How a Warming World May have Caused Hurricane Florence to Stall”


https://www.pbs.org/newshour/show/how-a-warming-world-may-have-caused-hurricane-florence-to-stall




https://blogs.scientificamerican.com/eye-of-the-storm/a-review-of-the-atlantic-hurricane-season-of-2019/

# Sea Level Rise

Photo: Dr. Hal Needham

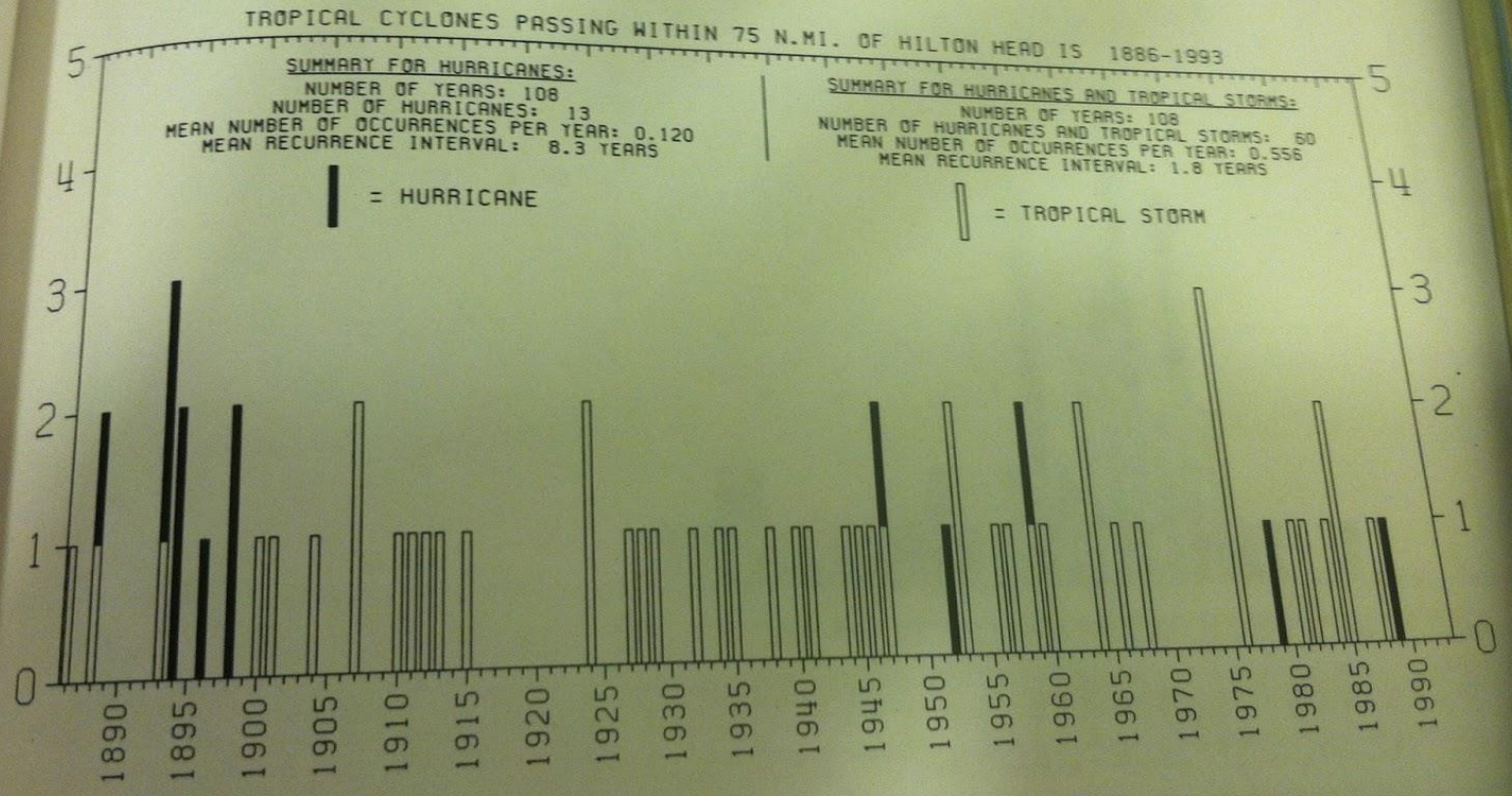

now you see it
now you don't
photo: William O. Field
photo: Bruce F. Molnia
Muir Glacier, Alaska: August 13, 1941 and August 31, 2004
CLIMATE 365
climate365.tumblr.com | go.nasa.gov/climate365

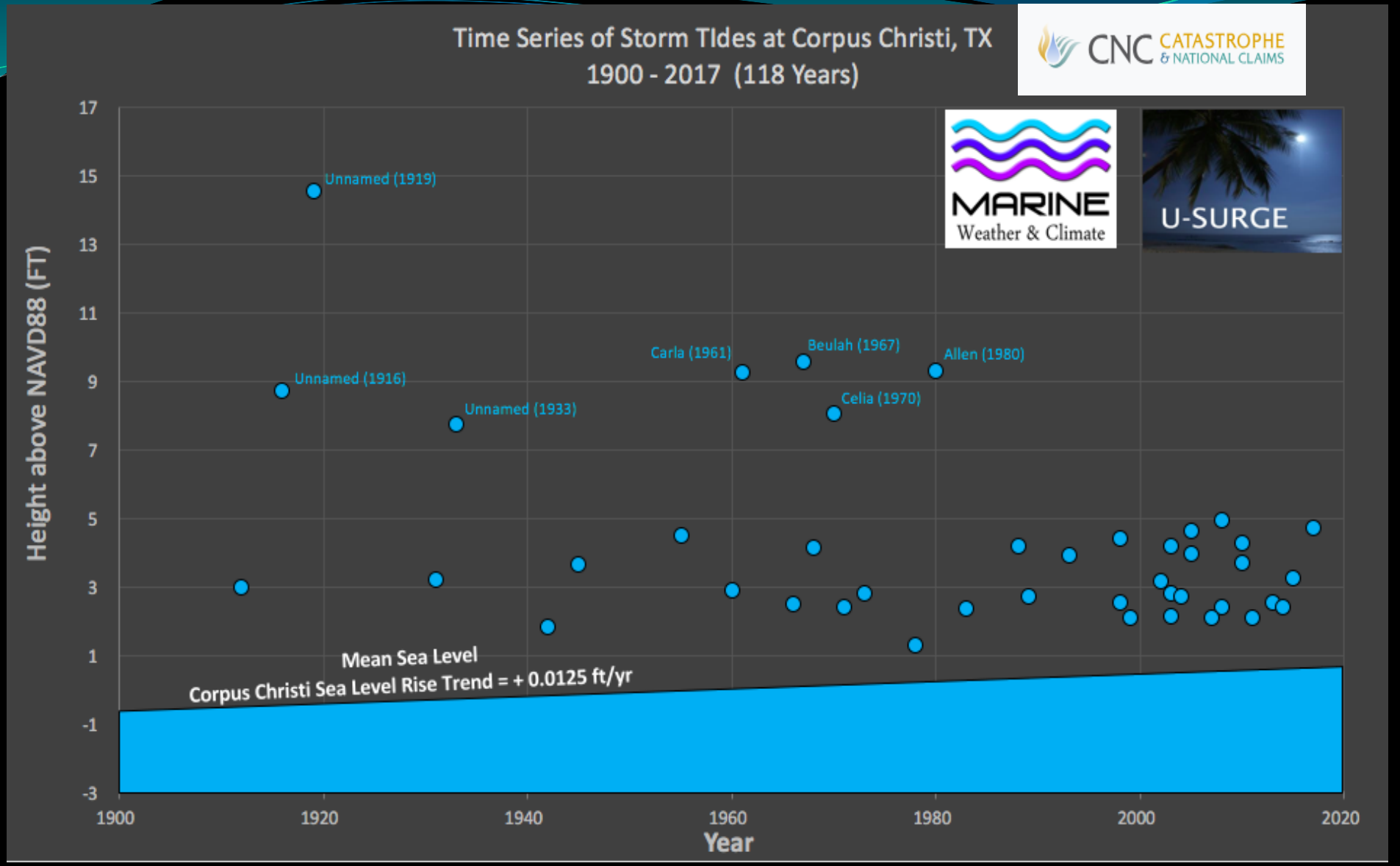
- Climate change is likely increasing Gulf/ ocean temps, which leads to more rapid hurricane intensification, heavier rainfall and sea level rise…BUT…

We need to be careful…

- Every storm/ disaster is not climate change…
- Randomness and clustering can fool us…

indicates that a hurricane is likely once every 8.3 years and a tropical storm is likely once every 1.8 years. Also note that the occurrence of hurricanes is not equally distributed through time; of the 13 hurricanes, none occurred from 1899 to 1946.




Time Series of Storm TIdes at Corpus Christi, TX
1900 - 2017 (118 Years)
CNC CATASTROPHE & NATIONAL CLAIMS
MARINE Weather & Climate
U-SURGE
Height above NAVD88 (FT)
17
15
13
11
9
7
5
3
1
-1
-3
Unnamed (1919)
Unnamed (1916)
Unnamed (1933)
Carla (1961)
Beulah (1967)
Allen (1980)
Celia (1970)
Mean Sea Level
Corpus Christi Sea Level Rise Trend = + 0.0125 ft/yr
1900
1920
1940
1960
1980
2000
2020
Year


UNITED STATES OF AMERICA
IN GOD WE TRUST
LIBERTY
S
QUARTER DOLLAR

Fake Sequence

1. H
2. T
3. H
4. H
5. T
6. H
7. T
8. T
9. H
10. H

Real Sequence

Fake Sequence

1. H
2. T
3. H
4. H
5. T
6. H
7. T
8. T
9. H
10. H

Real Sequence

1. H
2. T
3. H
4. H
5. T
6. T
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8. T
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10. H

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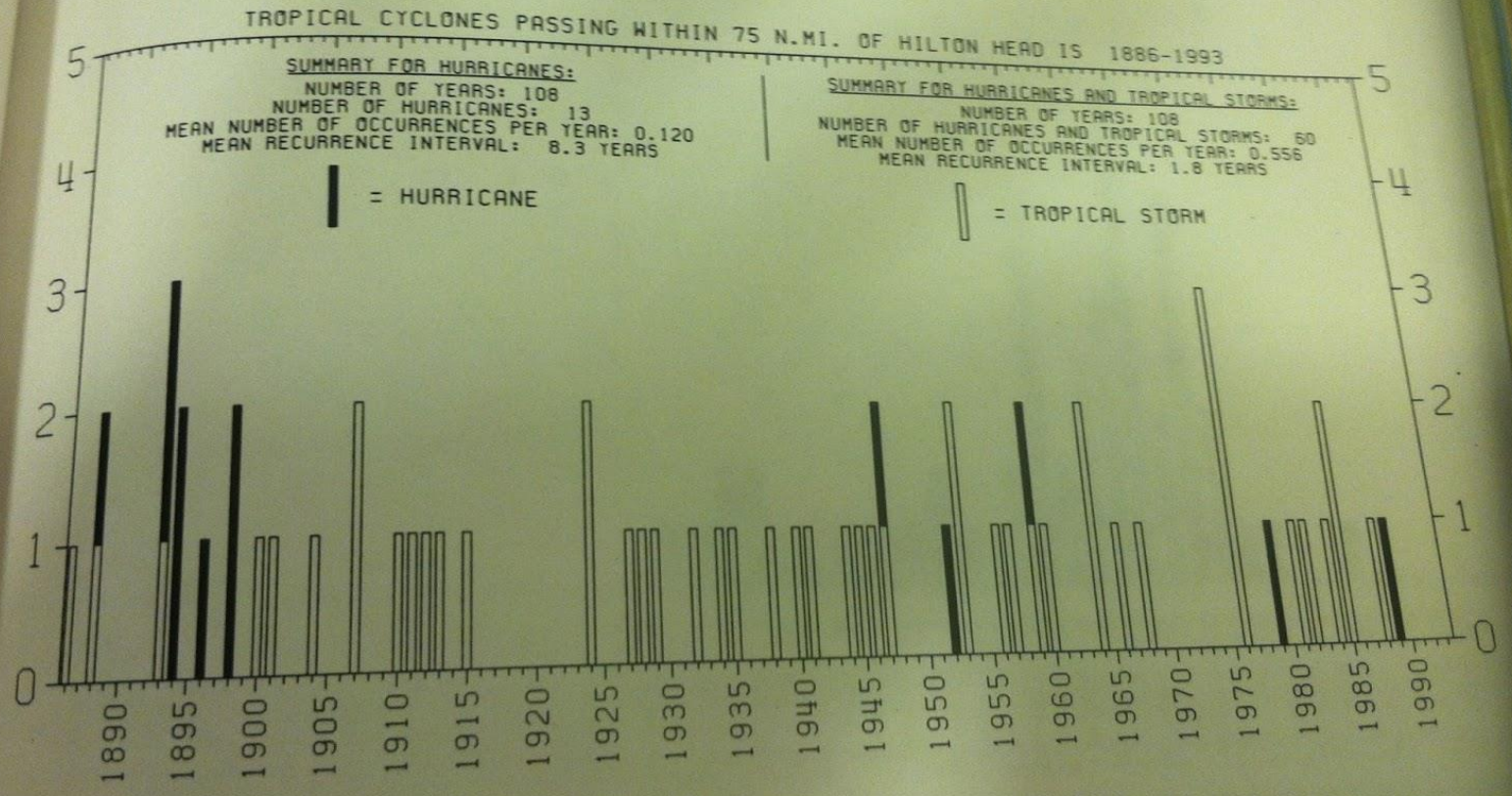


# True Climate Change is Tied to a Process

Warmer air temps

↓

Warmer water temps

↓

More moisture for storms

Key to Disaster Resiliency:

1. Know your regional disaster history

AND

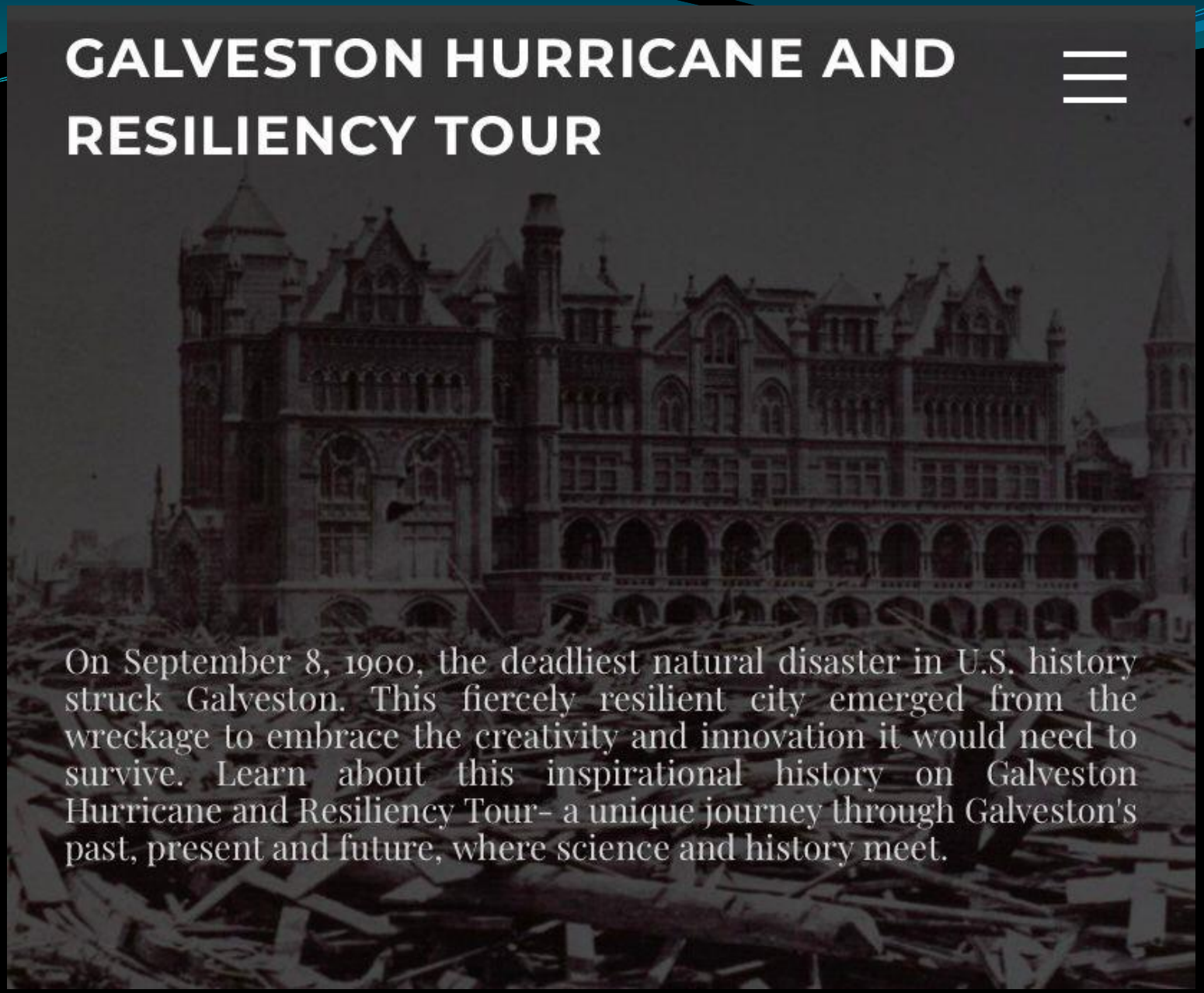
2. Build in a buffer for future storms

AND

3. Communicate better with visuals

3. Communicate Better with Visuals

# GALVESTON HURRICANE AND RESILIENCY TOUR



On September 8, 1900, the deadliest natural disaster in U.S. history struck Galveston. This fiercely resilient city emerged from the wreckage to embrace the creativity and innovation it would need to survive. Learn about this inspirational history on Galveston Hurricane and Resiliency Tour- a unique journey through Galveston's past, present and future, where science and history meet.


TEQUILA'S
cantina
tex
Fajitas


1900
STORM


HIGH WATER MARK
HIGH WATER MARK
9.0 FEET
October 29, 2012
ON THIS DAY, HURRICANE SANDY BROUGHT A STORM SURGE OF 9 FEET TO THIS COMMUNITY AS INDICATED BY THE RED LINE ABOVE.
FOR MORE INFORMATION ABOUT HURRICANES IN NYC, VISIT:
NYC EMERGENCY MANAGEMENT
NYC.gov/EmergencyManagement
KNOW YOUR ZONE
NYC.gov/KnowYourZone
OR CALL 311
(212-639-9675 for Video Relay Service, or TTY: 212-504-4115)
NYC Emergency Management
FEMA

Mitch Pacyna

**Mitch Pacyna** is with **Mary J Wojciechowski** at **103 Hercules Dr.**

Sep 28 · Fort Myers Beach, FL ·

Hopefully didn't make a bad decision to stay !! 8am 40mph winds,,,,SO FAR !!!!


181

78 comments 33 shares

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AND

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# Contact Info


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GeoTrek/ Flood Information Systems

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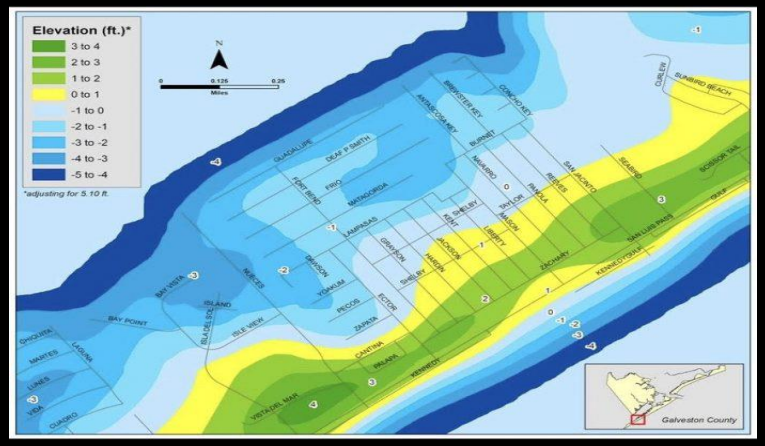
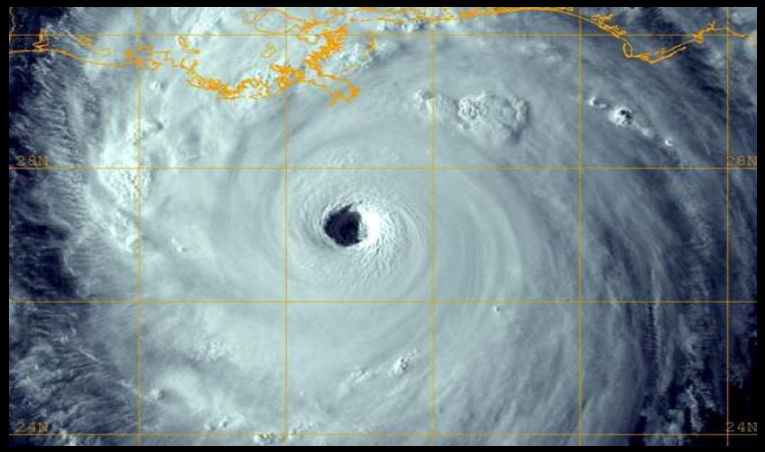
Geo-trek.com
Floodinformationsystems.com


Check out GeoTrek Podcast!

# Navigating Evolving Weather Patterns In a Rapidly Changing World




Hal Needham, Ph.D.

October 28, 2022