Storm Surge:
Myths, Misconceptions and Facts

Maurice Wolcott
Coastal GIS Specialist
LSU AgCenter / Louisiana Sea Grant Program

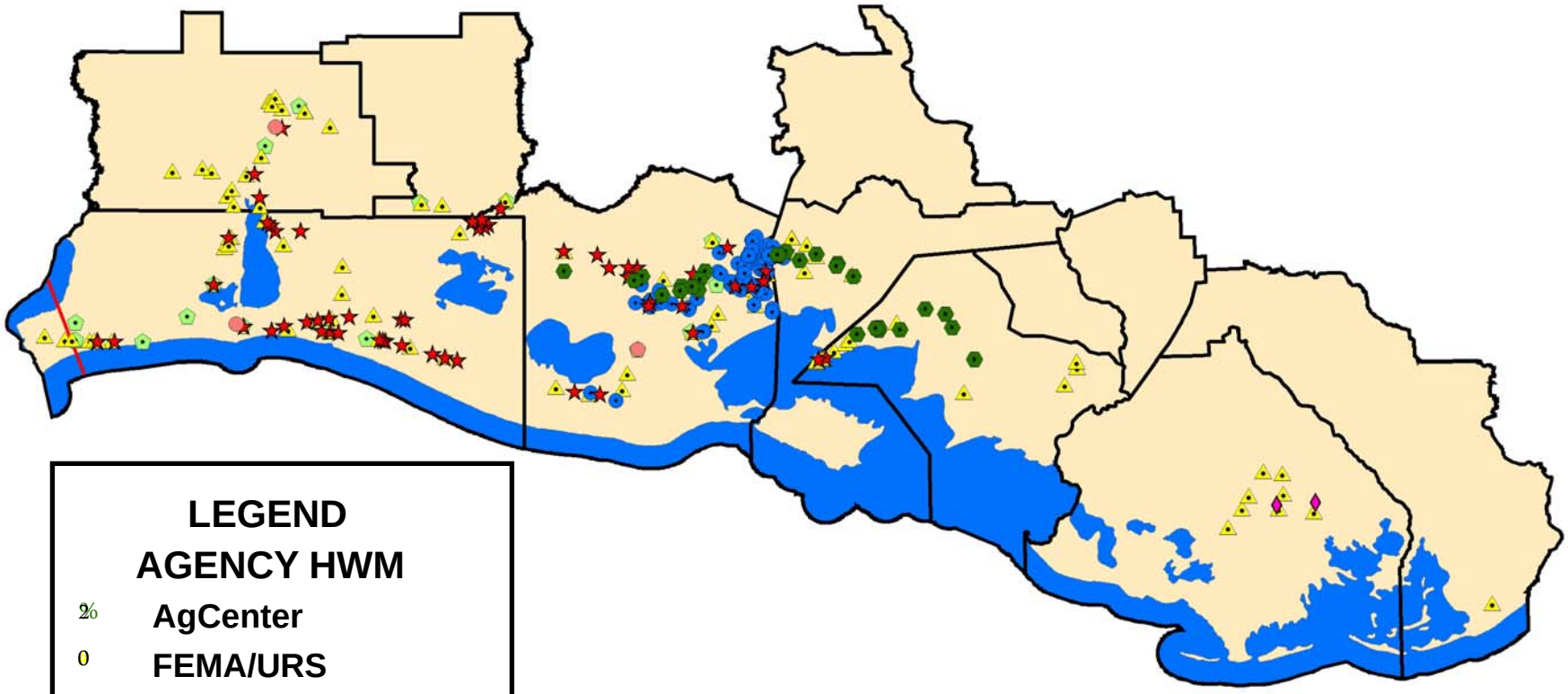
LA Department of Natural Resources
Local Coastal Programs Quarterly Meeting
Baton Rouge, LA October 7, 2009

Image Courtesy of NOAA

LA Cooperative Extension Service

- 2005 – Hurricane Rita
- Congressional Disaster Program for Sugarcane Producers to be implemented by USDA
- LSU AgCenter named to develop data related to area of damage due to storm surge inundation

FINAL HWM FOR PROJECT AREA



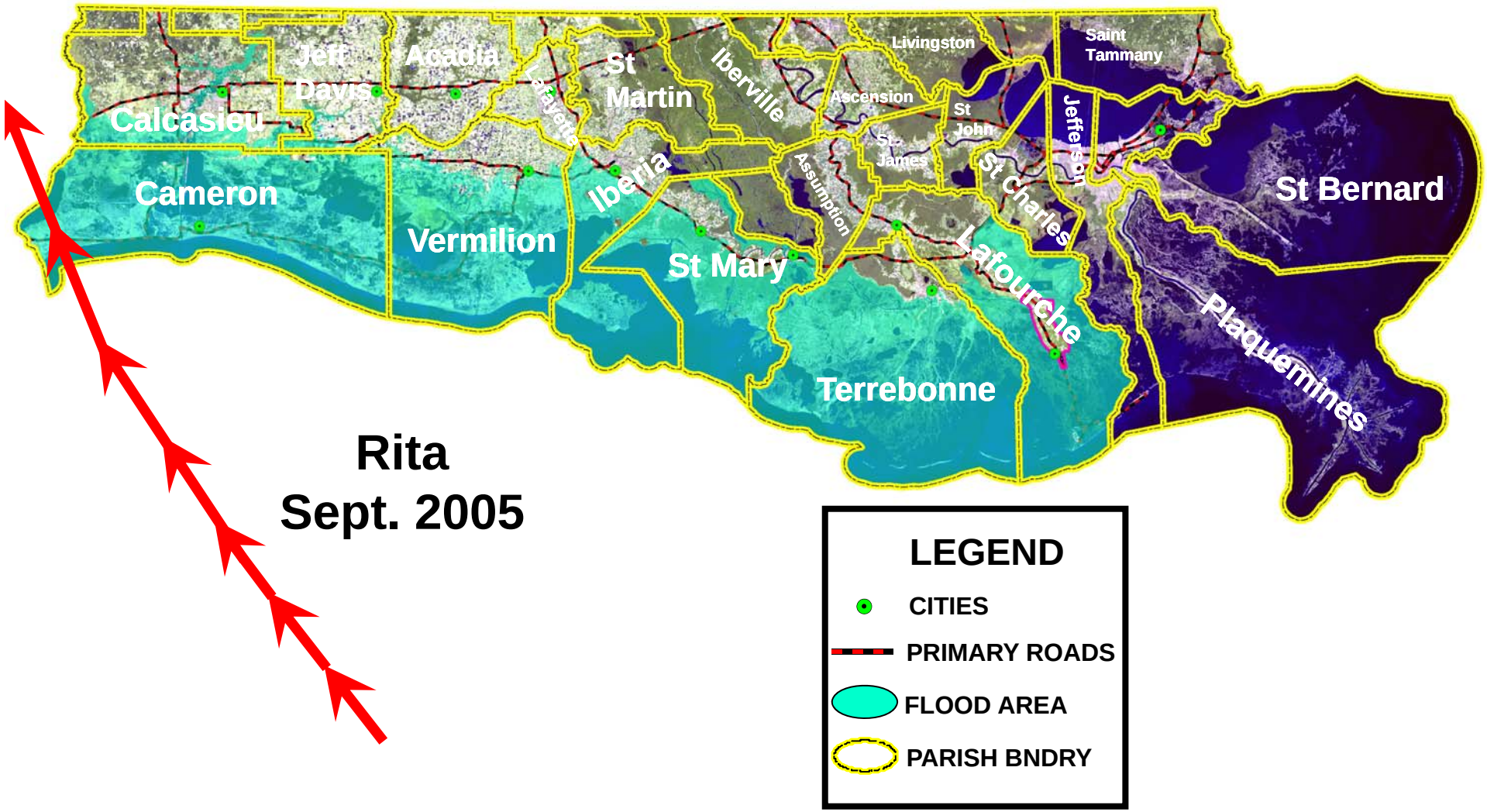
LEGEND

AGENCY HWM

- % AgCenter
- 0 FEMA/URS
- (FEMA Pine / Baush
- ^ LSU Hurricane Center
- ! Private Engineer
- 1 USGS - Gage Study
- X USGS - Gages

®

Hurricane Rita Storm Surge



An education and outreach program to inform the public about hurricane storm surge, and the vulnerability of coastal communities to its impact

LSU AgCenter Research & Extension

CADGIS

LSU HURRICANE CENTER

Sea Grant LOUISIANA

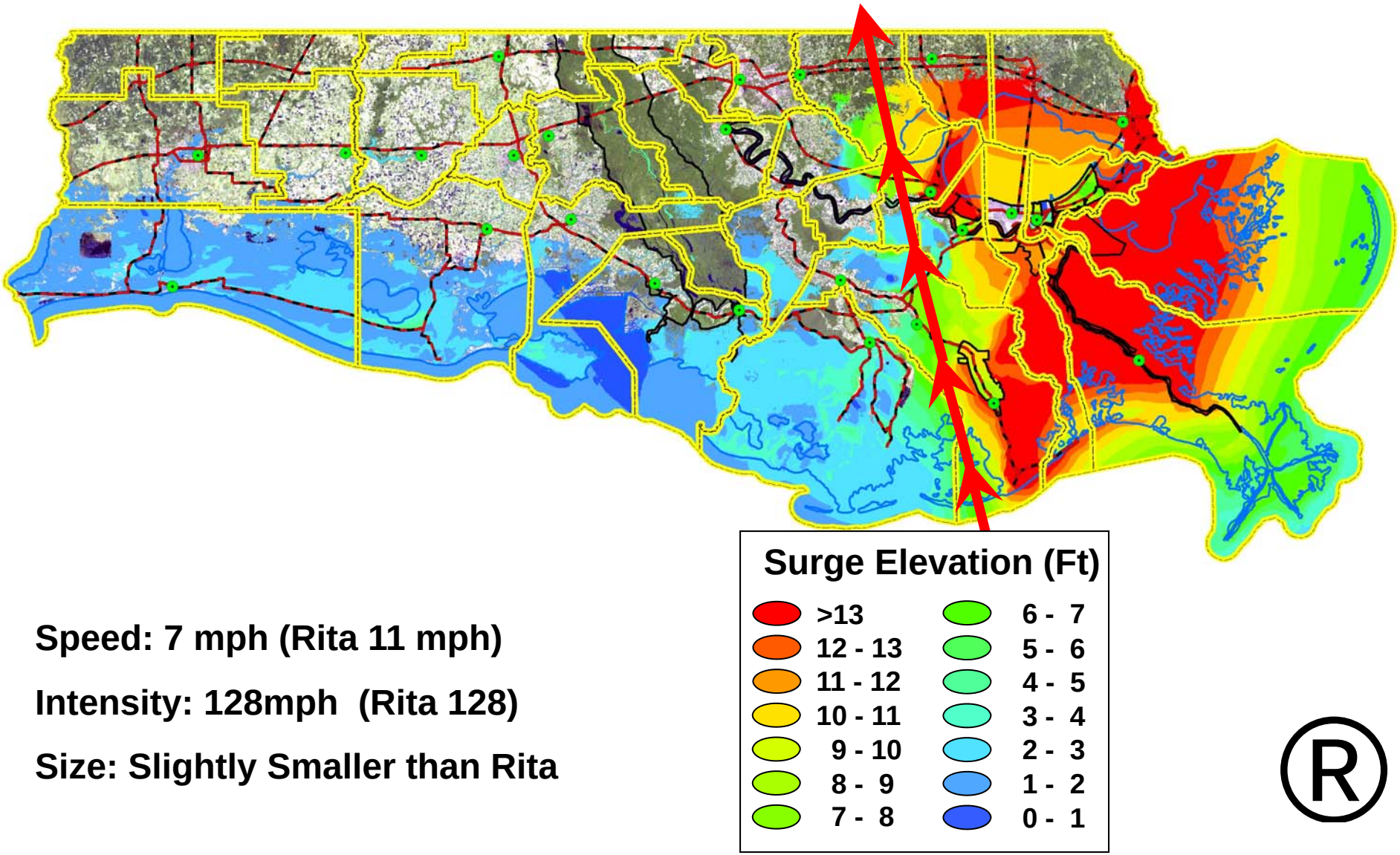

Terrebonne and Lafourche Parishes Aerial View
Assumption
St. Charles
St. Martin
St. Mary
Lafourche
Jefferson
Terrebonne
Hurricane Rita Storm Surge

Factors Impacting Storm Surge

- **Coastal Factors**
  - Elevation
  - Proximity to Coastline
  - Bathymetry
  - Slope of coast
  - Roughness of coast
  - Natural or man made barriers
- **Storm Factors**
  - Intensity of storm
  - Wind speed
  - Atmospheric pressure
  - Radius of maximum winds
  - Forward speed
  - Track of the storm

Lake Pontchartrain Area

Hypothetical Storm



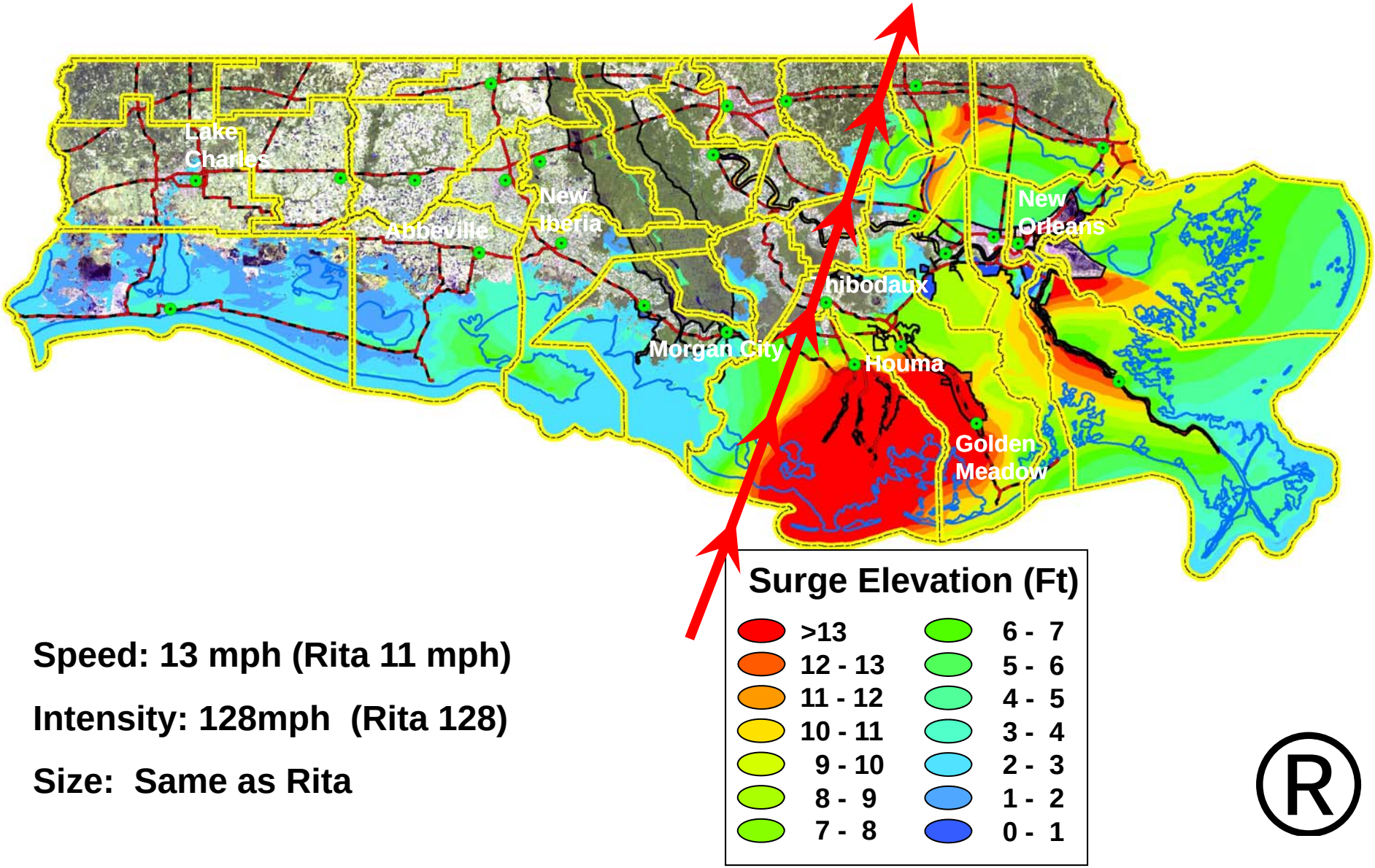
Speed: 7 mph (Rita 11 mph)

Intensity: 128mph (Rita 128)

Size: Slightly Smaller than Rita

®

Terrebonne – Lafourche Region
Hypothetical Storm



Speed: 13 mph (Rita 11 mph)

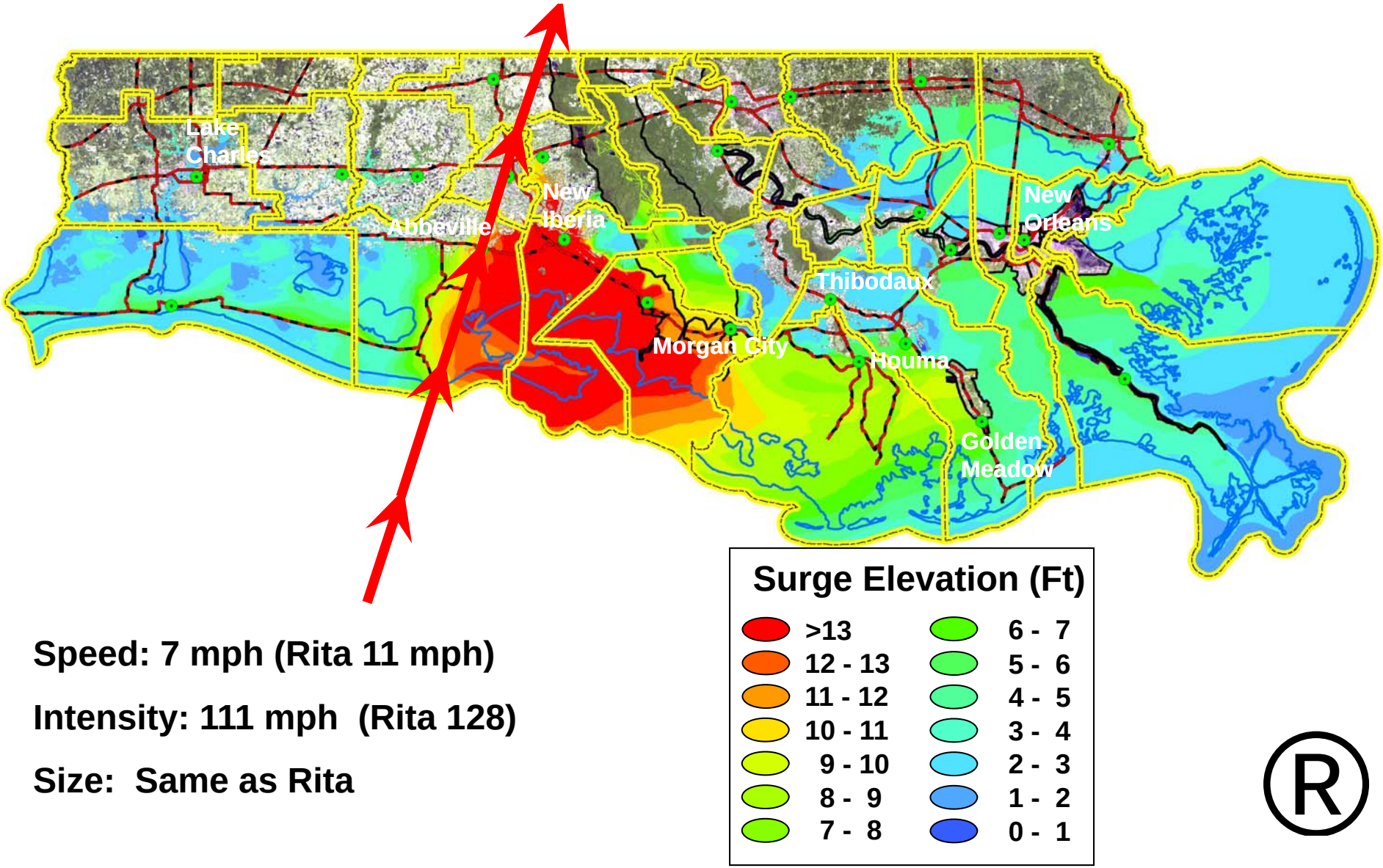
Intensity: 128mph (Rita 128)

Size: Same as Rita

®

Vermilion – Iberia Region

Hypothetical Storm



Speed: 7 mph (Rita 11 mph)

Intensity: 111 mph (Rita 128)

Size: Same as Rita

®

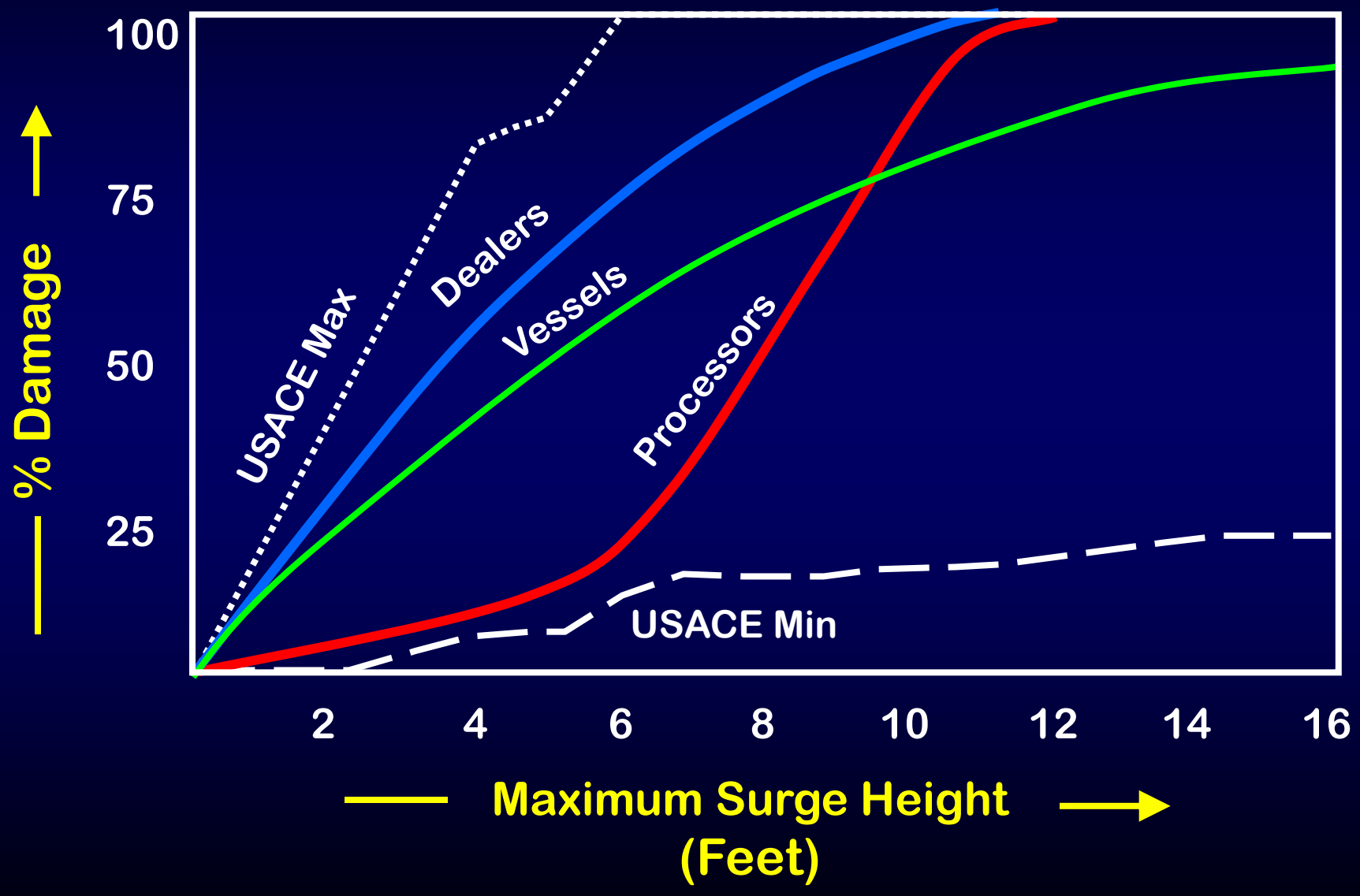
Goal: An Informed (and Safer) Public

- Understand how storm surge is predicted and the limitations of those predictions
- Understand how to interpret surge
- Understand that surge estimates do not include waves, and flooding estimates do not include inland rainfall
- Understand its destructive potential
- Realize the potential extent of its impact - how far inland it can go

LA Cooperative Extension Service

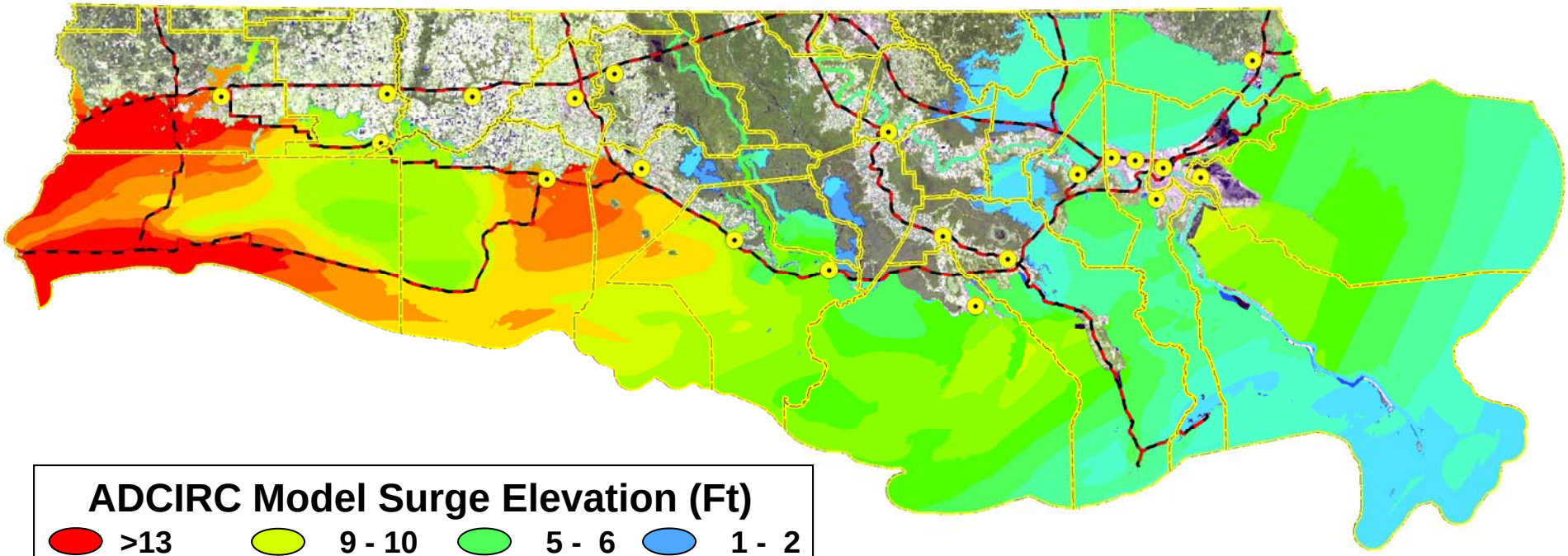
- Land Grant – LSU AgCenter
  - Agriculture & Forestry Revenue Loss Estimates
- Sea Grant – LA Sea Grant Program
  - Aquaculture and Commercial Fisheries and Infrastructure Losses

3. Estimating: Surge Damage Curves



Mapping the Ike Storm Surge

Ike Advisory 46 ADCIRC Max Surge Elevations

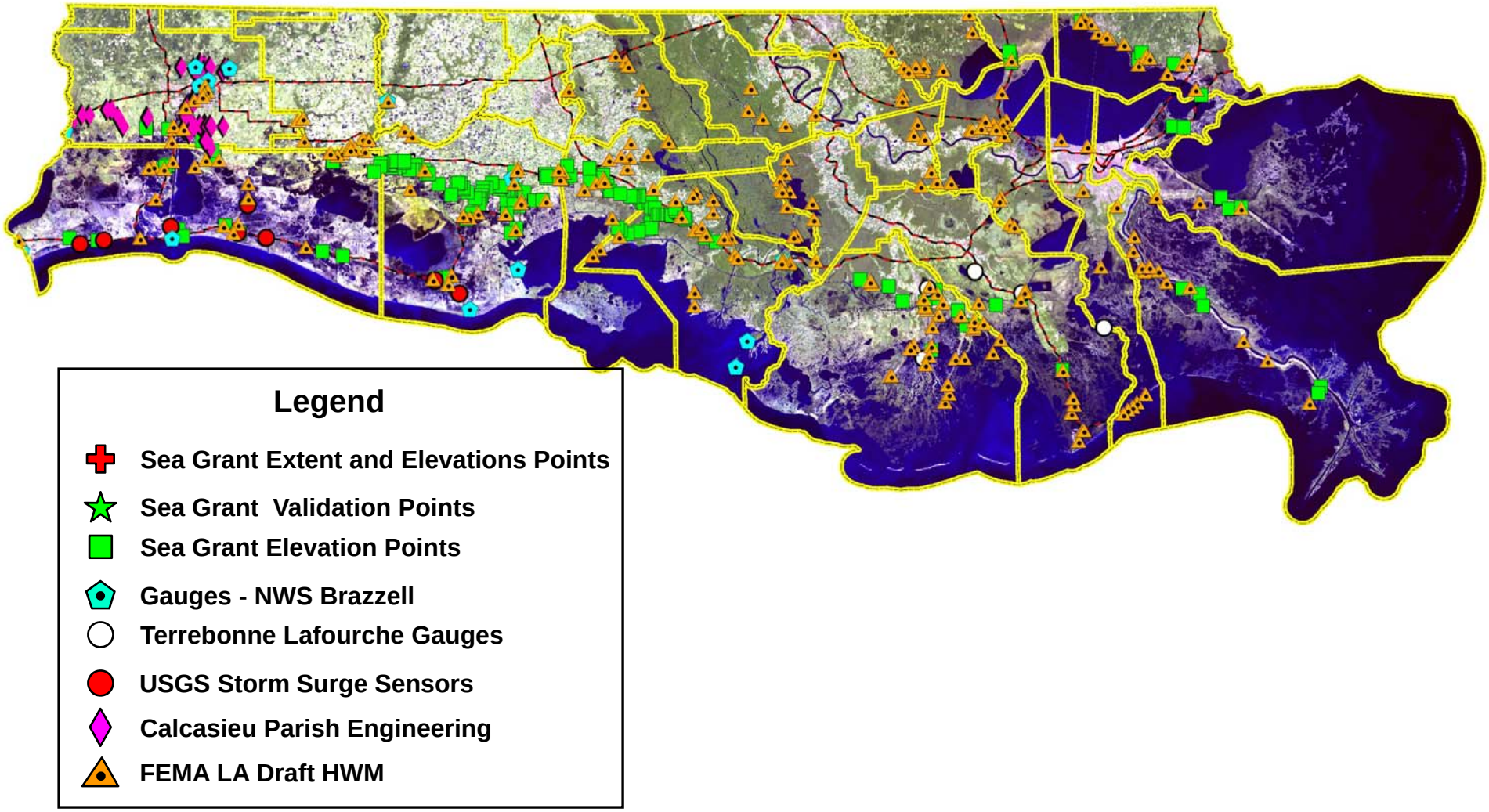


ADCIRC Model Surge Elevation (Ft)

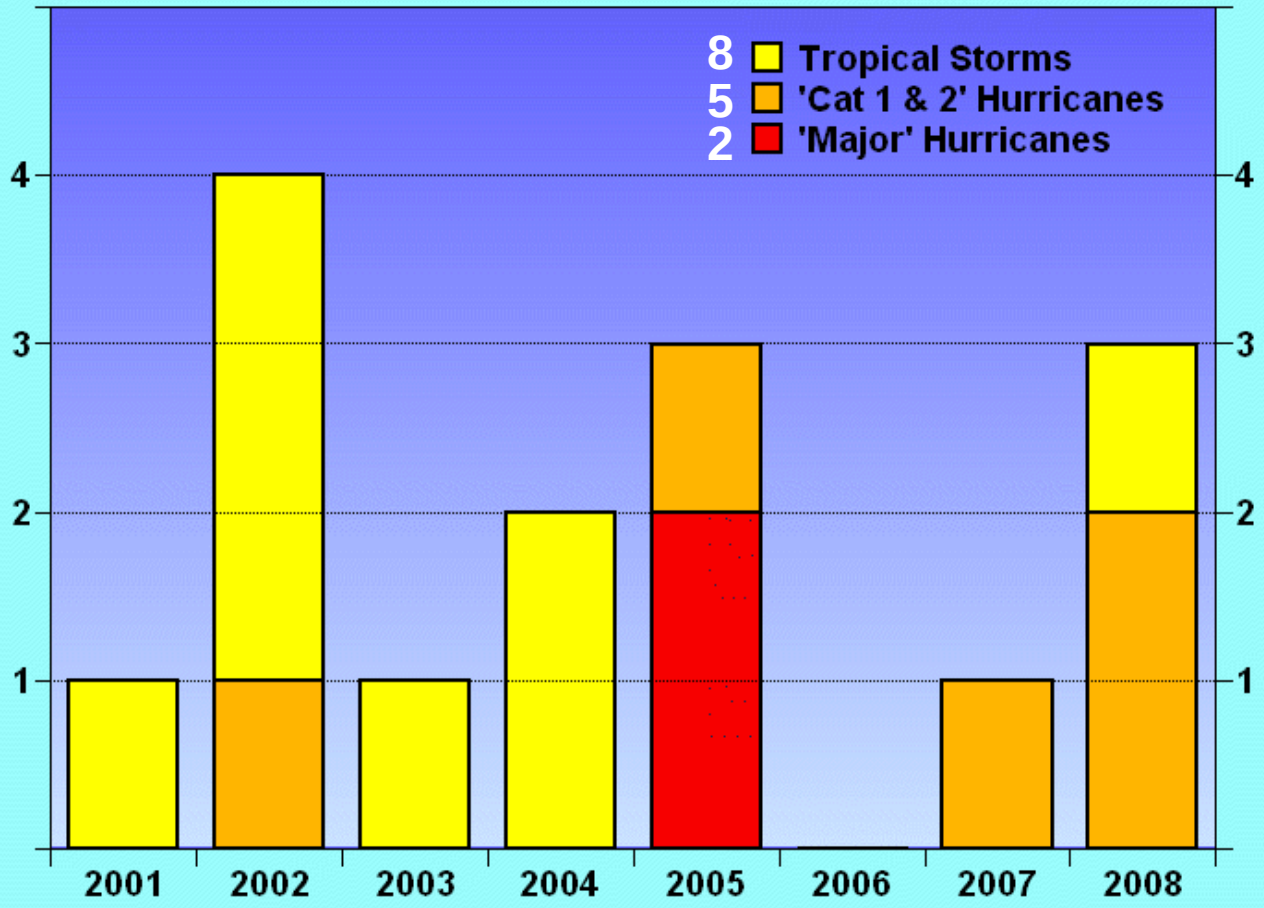
>13	9 - 10	5 - 6	1 - 2
12 - 13	8 - 9	4 - 5	0 - 1
11 - 12	7 - 8	3 - 4	
10 - 11	6 - 7	2 - 3	

ADCIRC storm surge model data provided by:
LSU Coastal Emergency and Risks Assessment
LSU CLEAR
UNC Institute of Marine Sciences
Notre Dame Computational Hydraulics Laboratory

Mapping the Ike Storm Surge



Louisiana Tropical Cyclones: 2001 - 2010



Sources:
NOAA / National Hurricane Center
NOAA / Atlantic Oceanographic and Meteorological Laboratory

Jay Grymes
LSU AgCenter Climatologist
& WAFB-TV Chief Meteorologist

The Louisiana Coast

A Vulnerable Area for Storm Surge

Katrina
Aug. 2005

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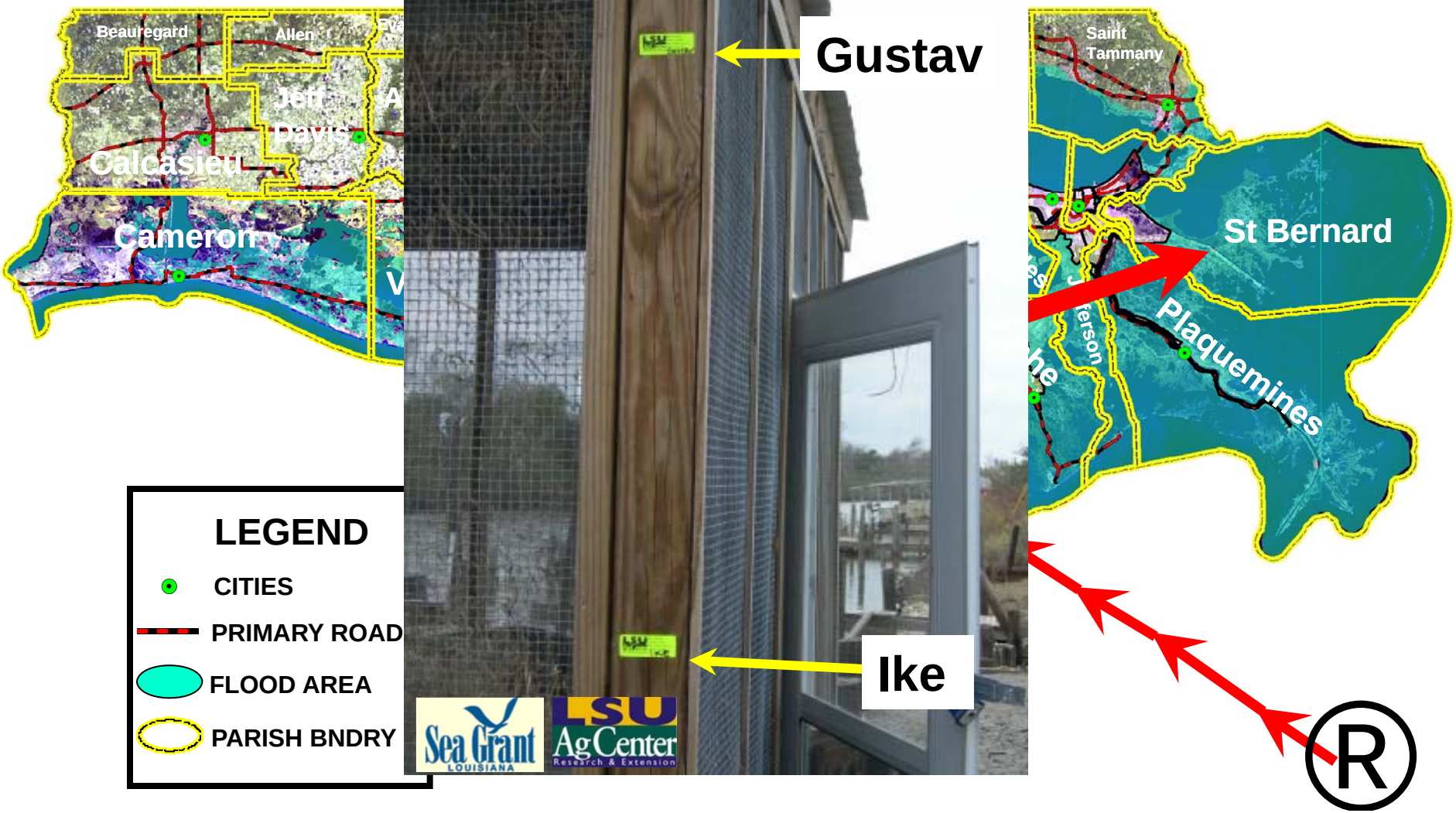
The Louisiana Coast

A Vulnerable Area for Storm Surge

The Louisiana Coast

A Vulnerable Area for Storm Surge



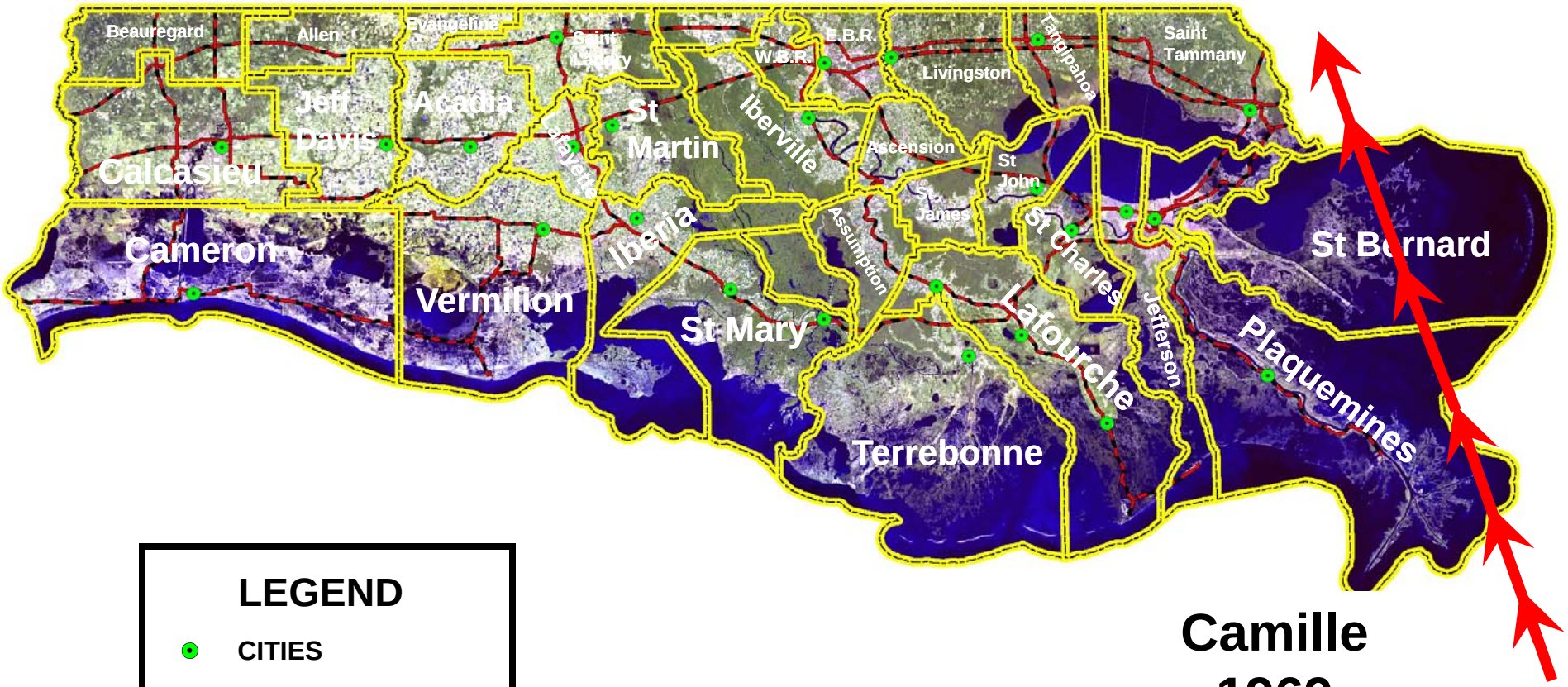
The Louisiana Coast

A Vulnerable Area for Storm Surge

FLOOD AREA

PARISH BNDRY

The Louisiana Coast
A Vulnerable Area for Storm Surge



LEGEND

- CITIES
- PRIMARY ROADS
- PARISH BOUNDARY

Camille
1969

Storm Surge Record: 24.6 ft

®

The Louisiana Coast

A Vulnerable Area for Storm Surge

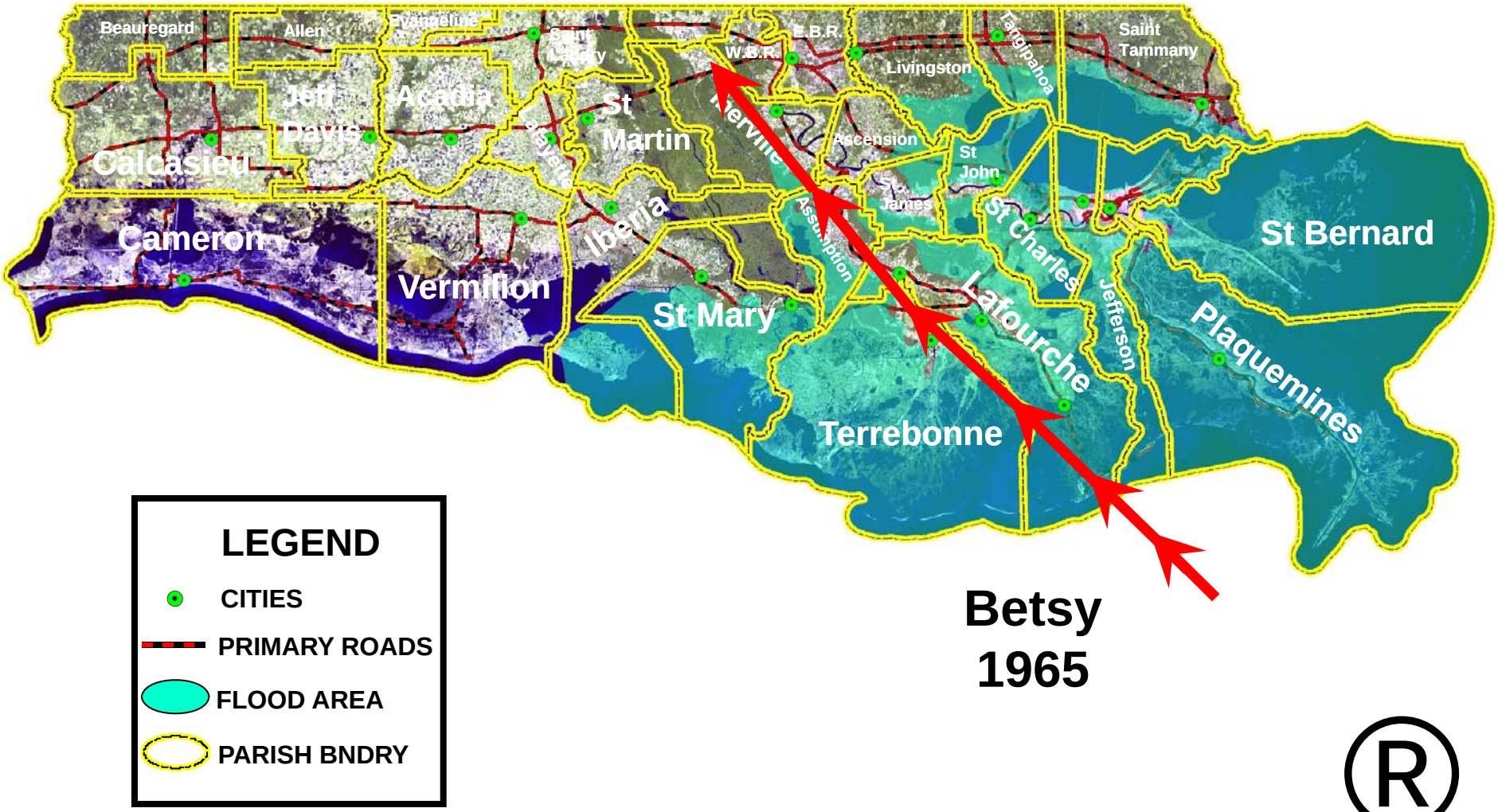
LEGEND

- CITIES
- PRIMARY ROADS
- FLOOD AREA
- PARISH BNDRY

Betsy
1965

®

Hurricane Betsy Storm Surge

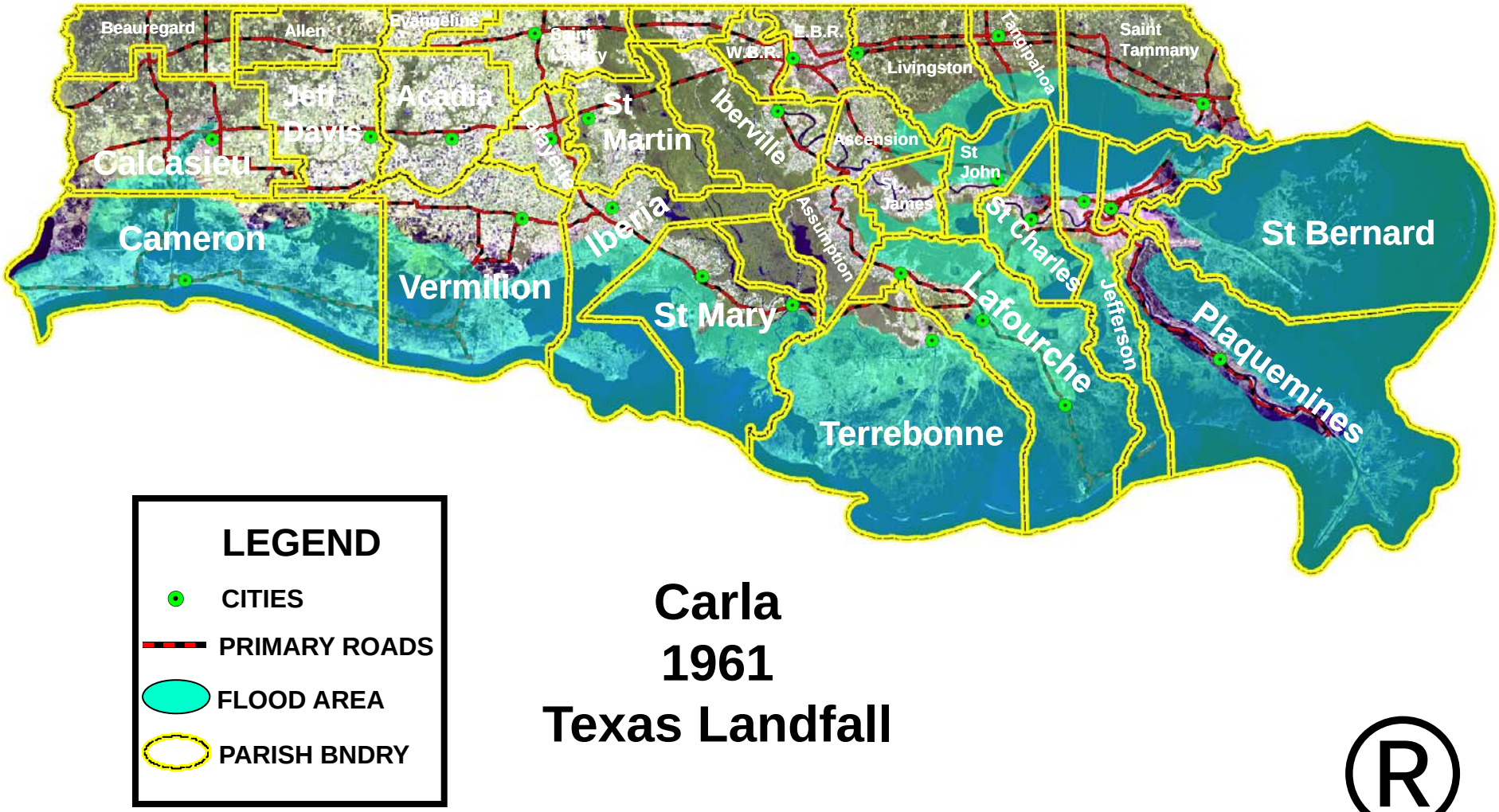


LEGEND

- CITIES
- PRIMARY ROADS
- FLOOD AREA
- PARISH BNDRY

®

Hurricane Carla Storm Surge



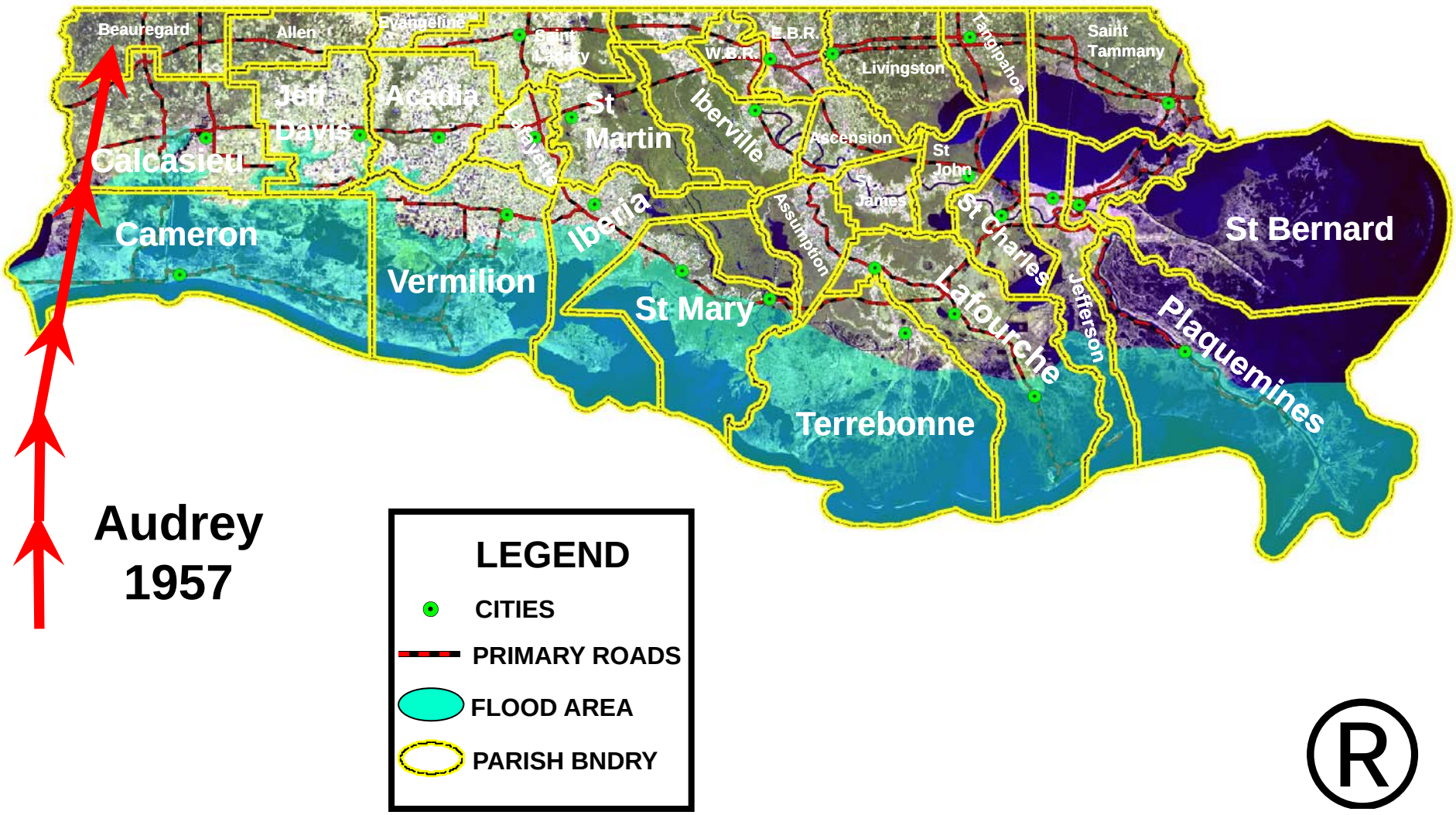
LEGEND

- CITIES
- PRIMARY ROADS
- FLOOD AREA
- PARISH BNDRY

Carla
1961
Texas Landfall

®

Hurricane Audrey Storm Surge



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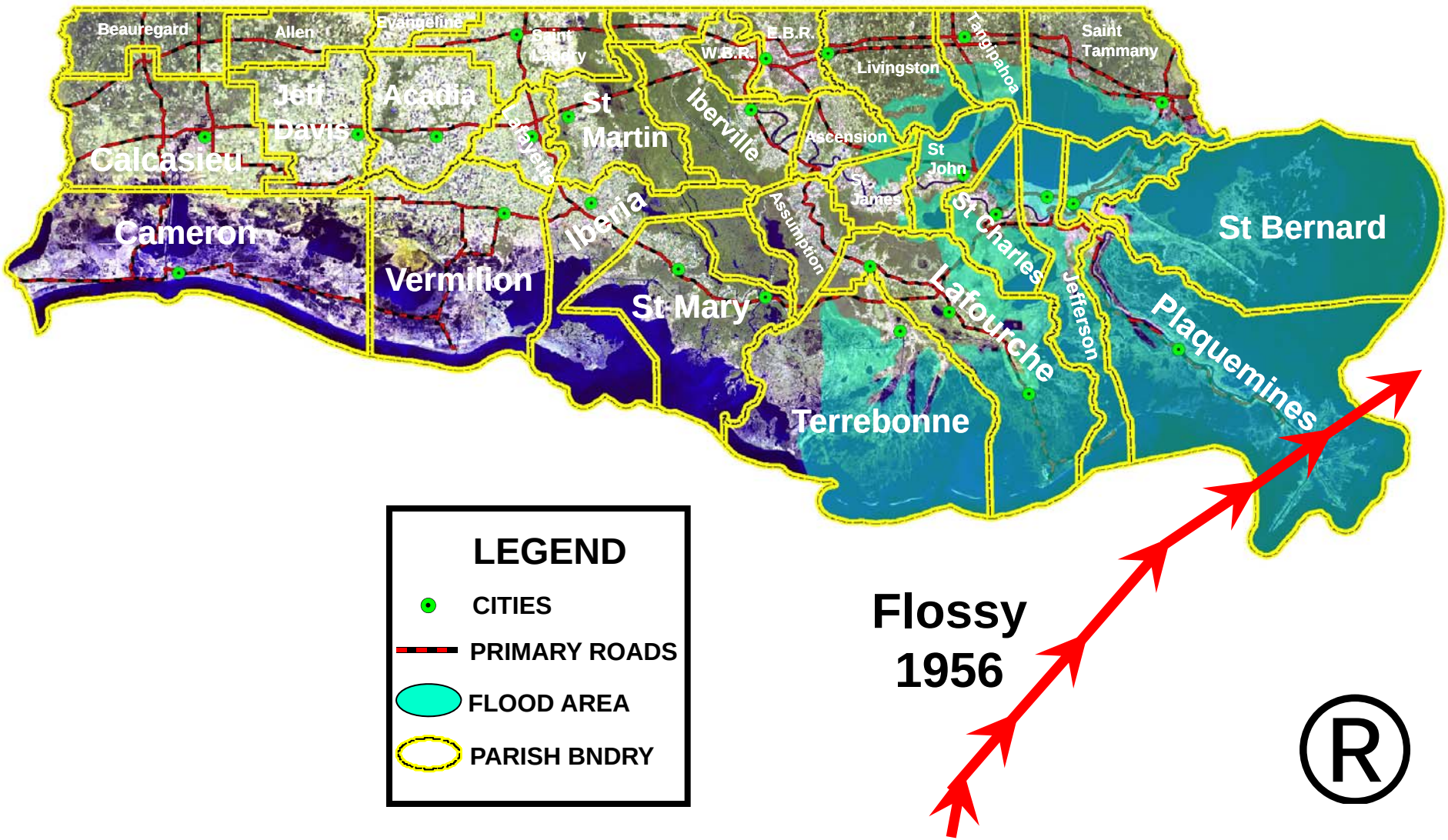
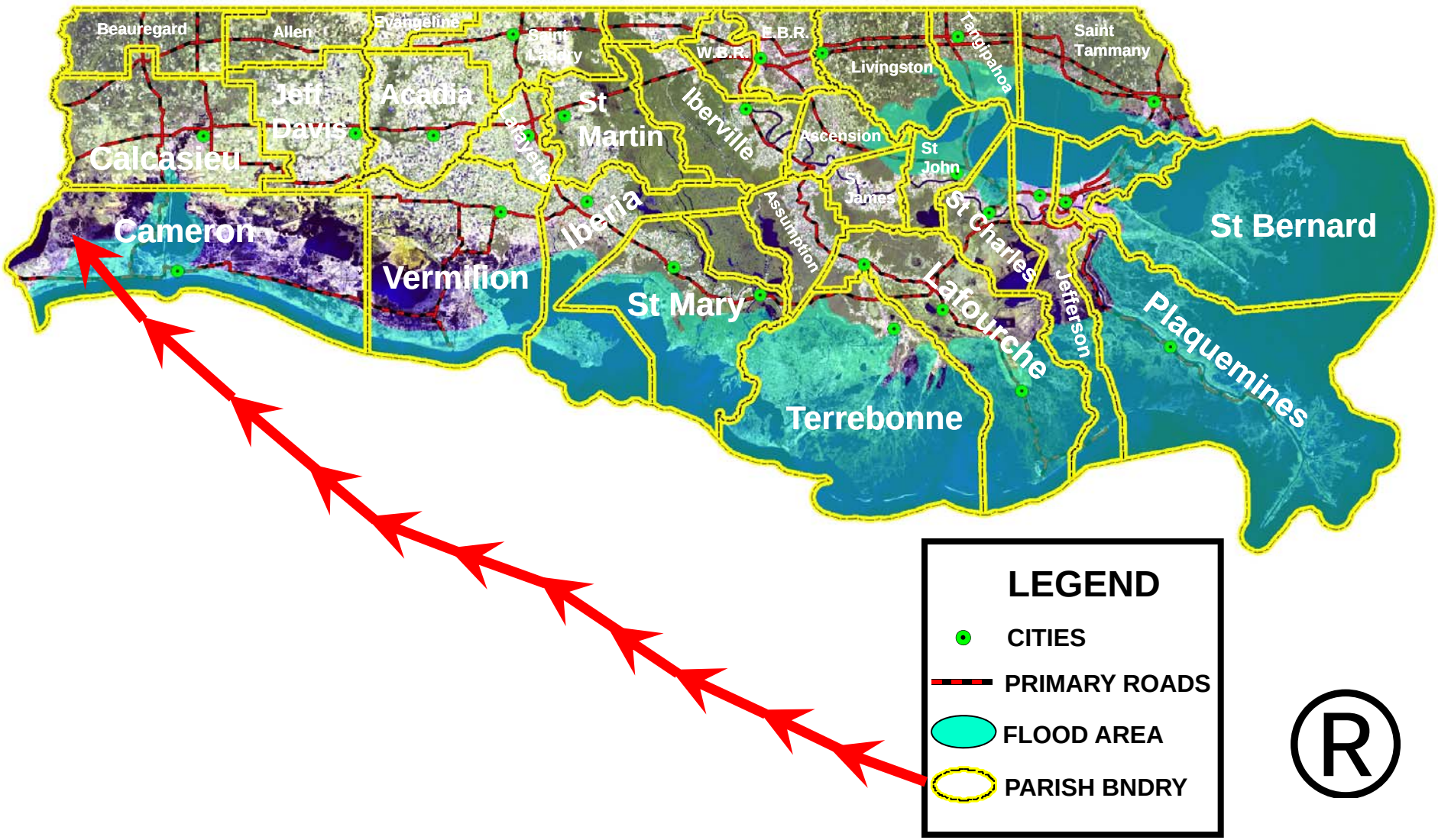
Hurricane Flossy Storm Surge



August 1940 Hurricane Storm Surge



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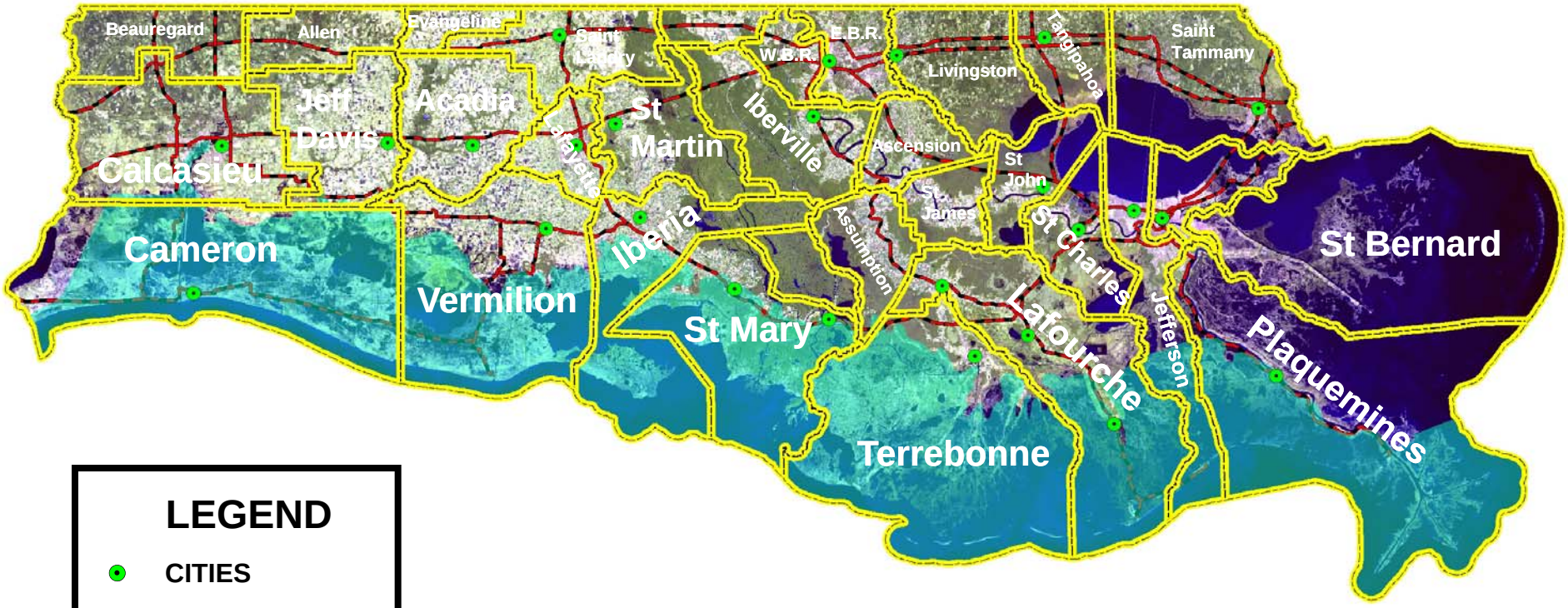
August 1915 Hurricane Storm Surge



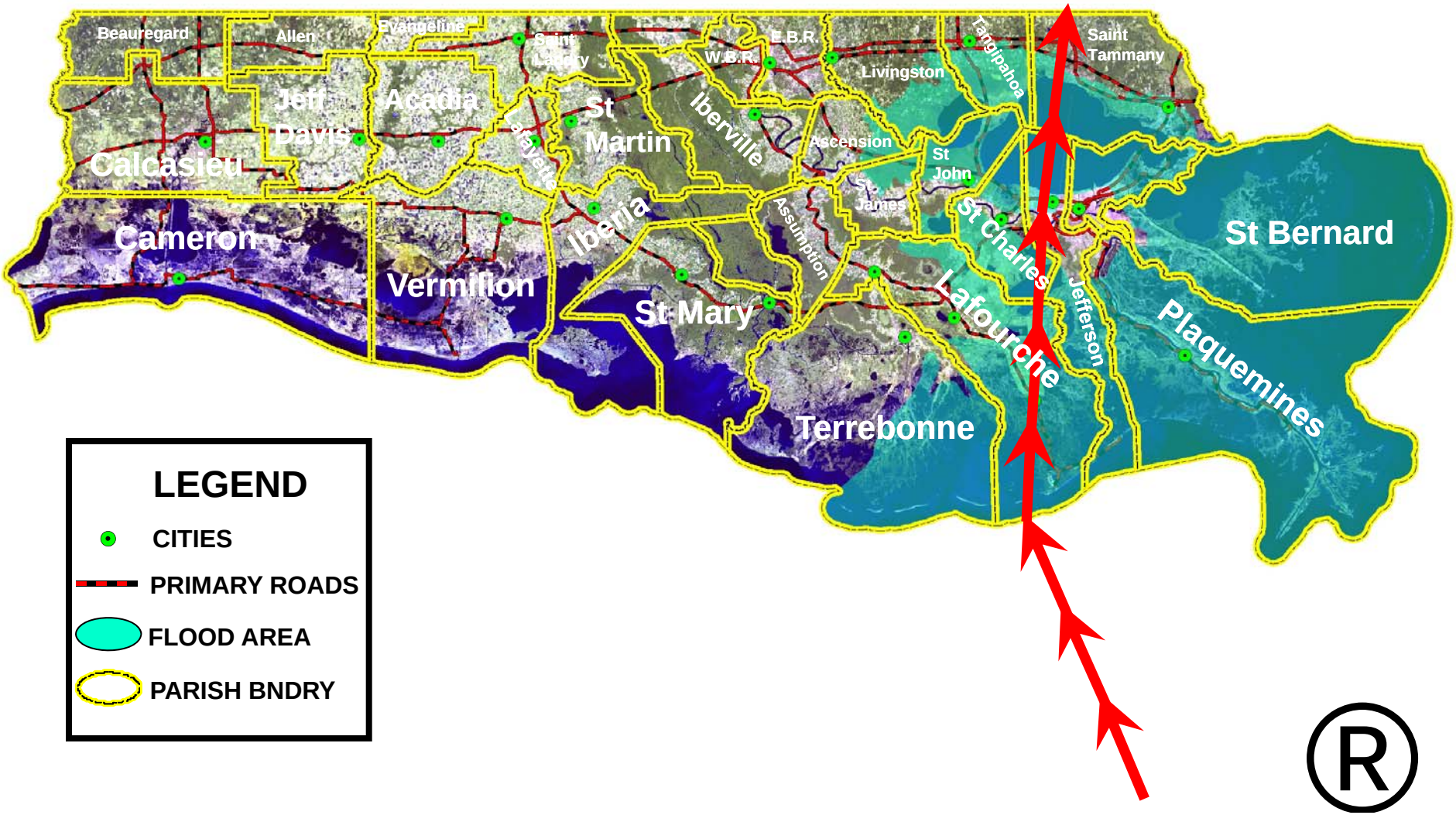
LEGEND

- CITIES
- PRIMARY ROADS
- FLOOD AREA
- PARISH BNDRY

Hurricane of August 1915 Texas Landfall

®

Sept. 1915 Hurricane Storm Surge



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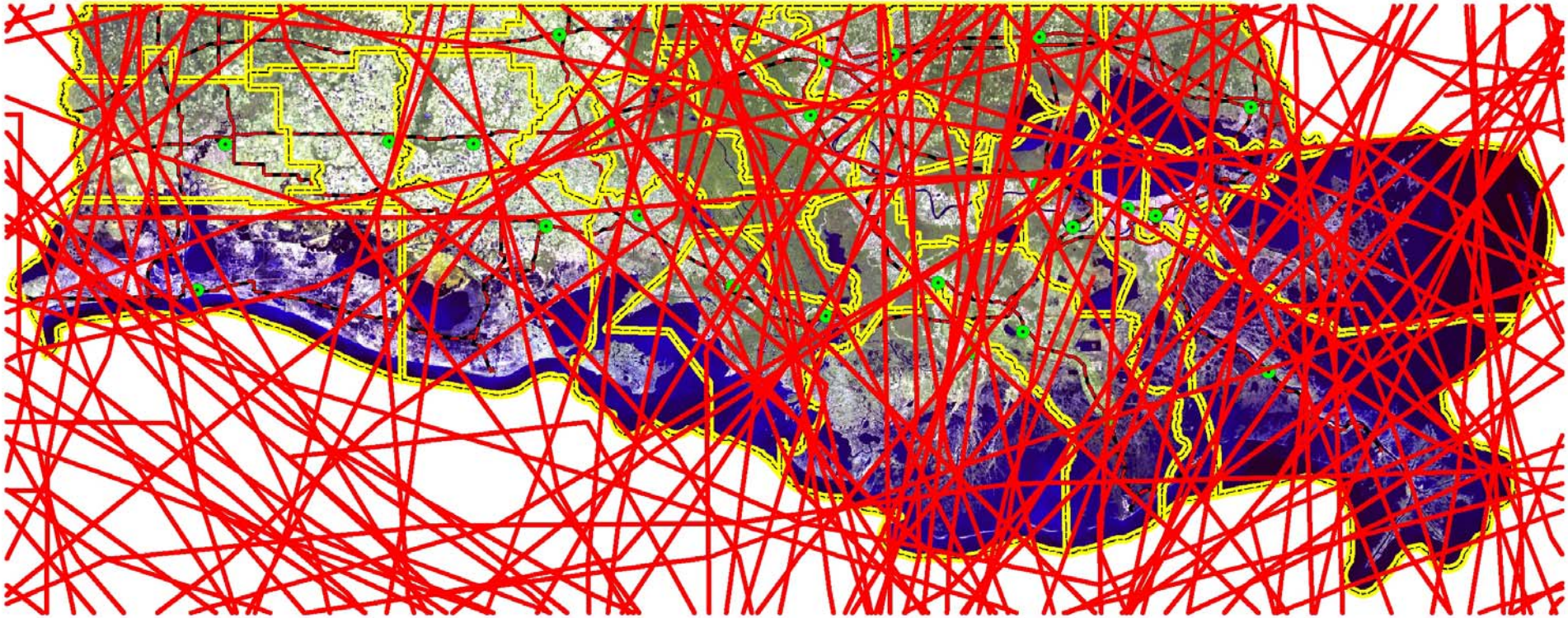
The Louisiana Coast
A Vulnerable Area for Storm Surge



All Atlantic Basin Tropical Systems

National Hurricane Center 1850 - 2008

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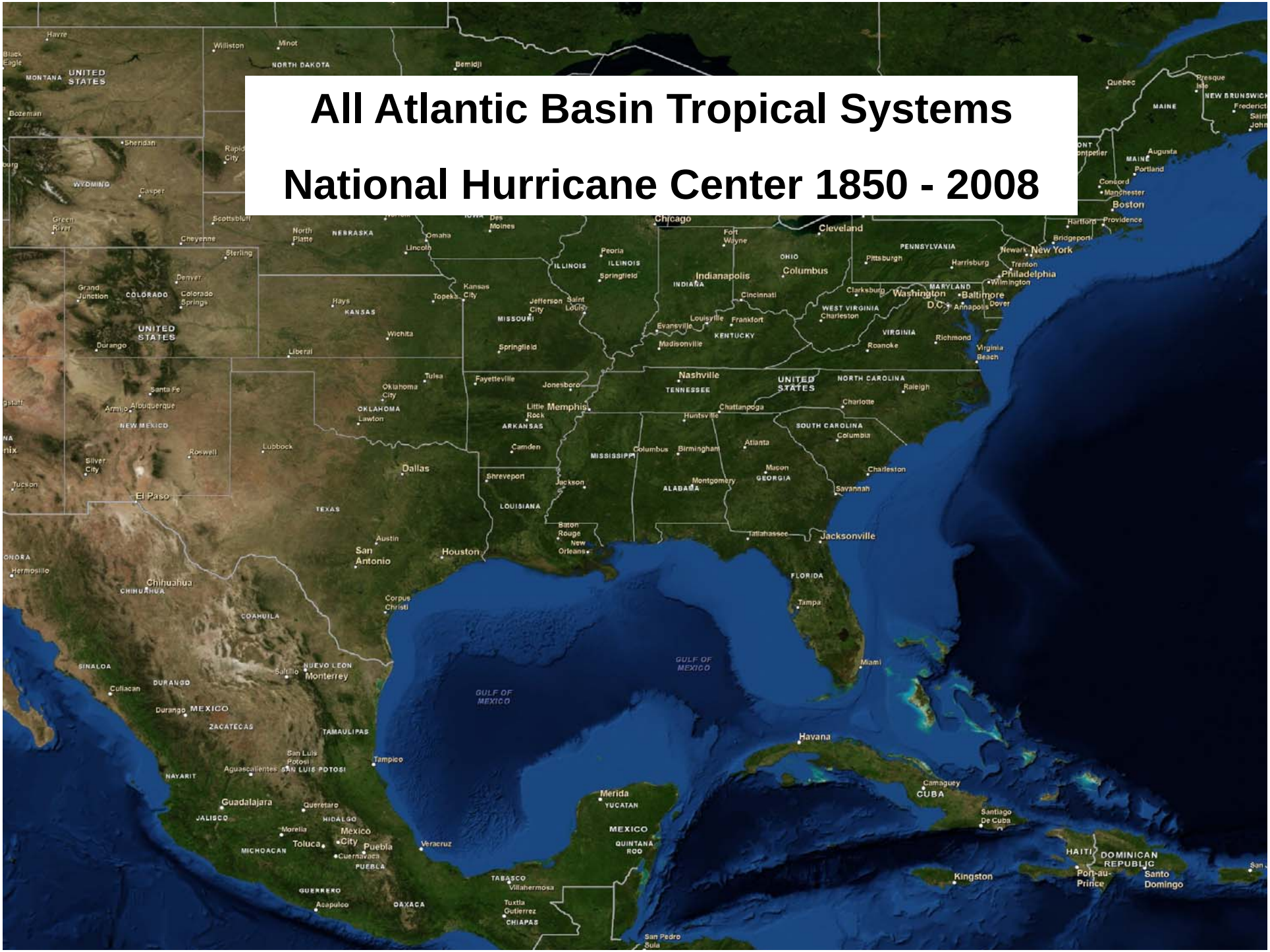
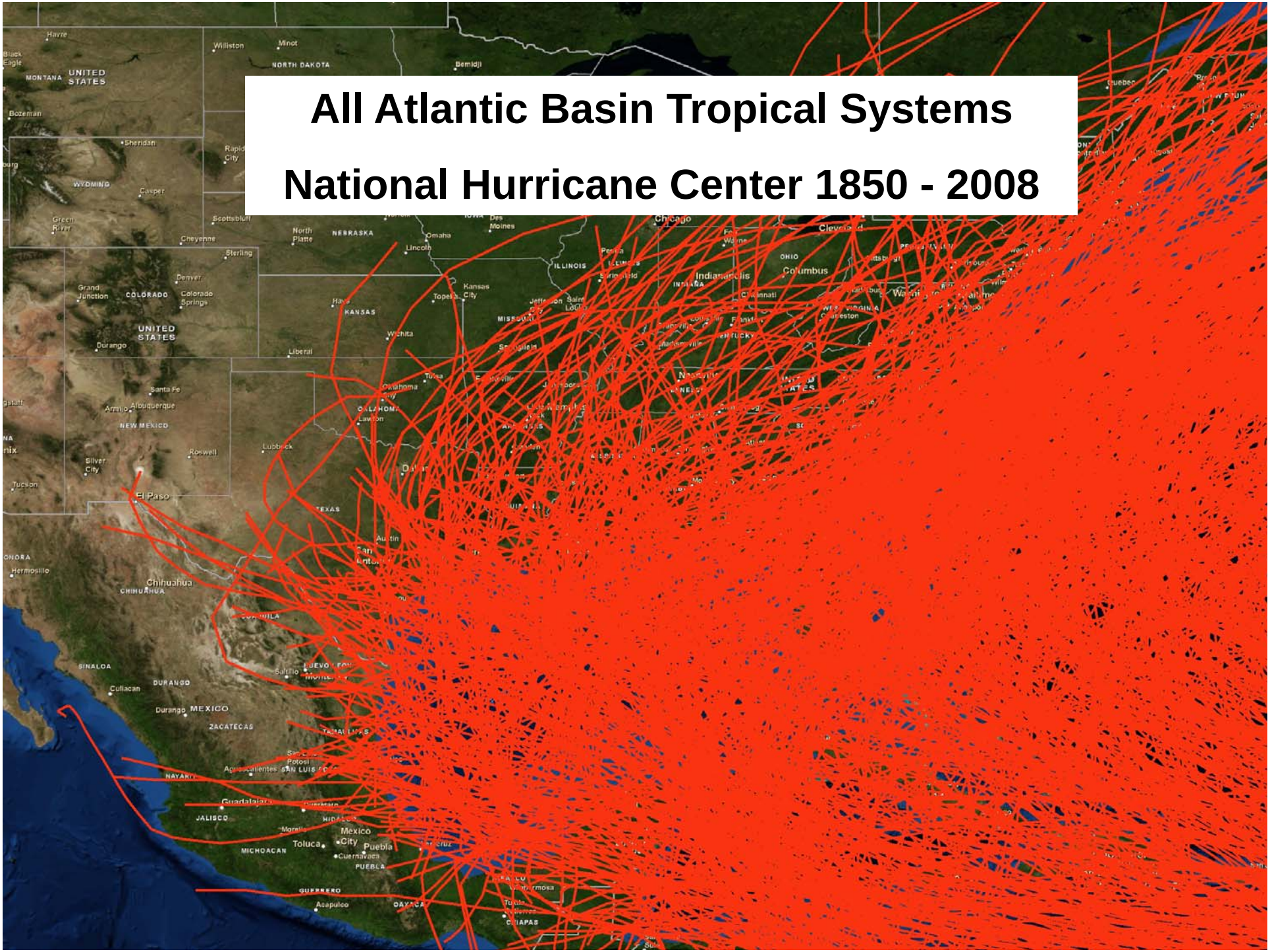
All Atlantic Basin Tropical Systems

National Hurricane Center 1850 - 2008

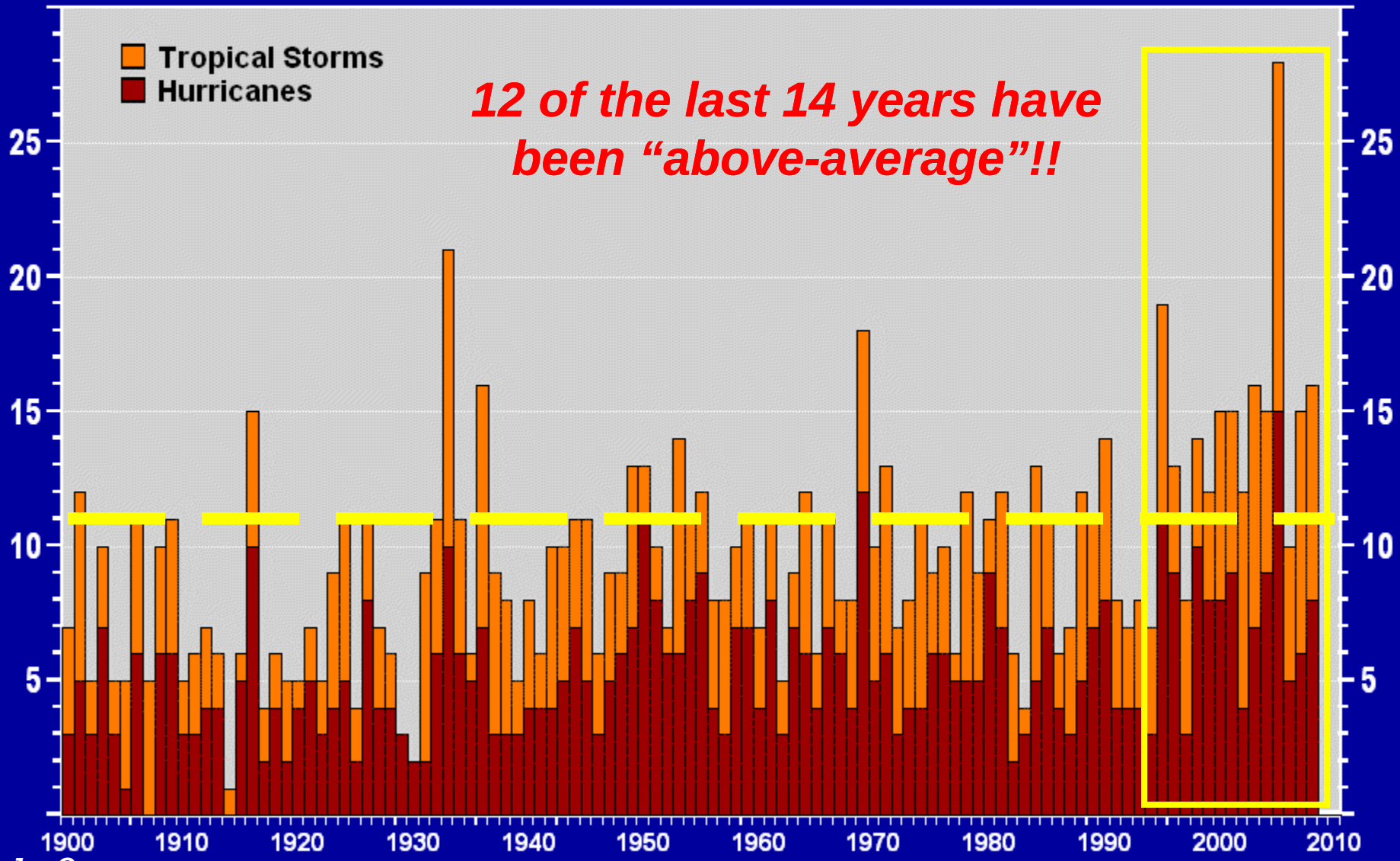


All Atlantic Basin Tropical Systems

National Hurricane Center 1850 - 2008

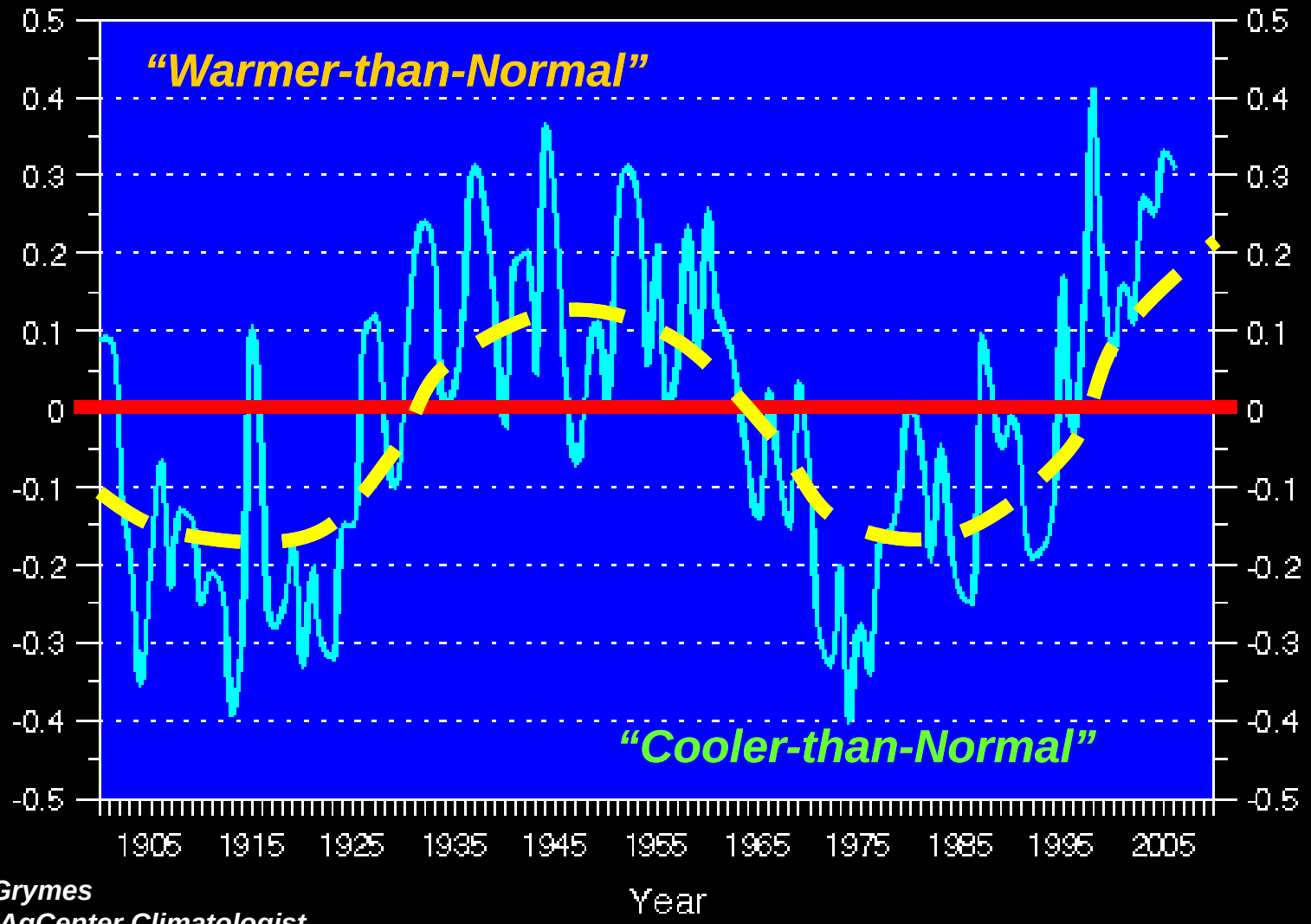


Atlantic Basin Tropical Cyclone Activity



Jay Grymes
LSU AgCenter Climatologist
& WAFB-TV Chief Meteorologist

Atlantic Multidecadal Oscillation (AMO)
1900 - 2006



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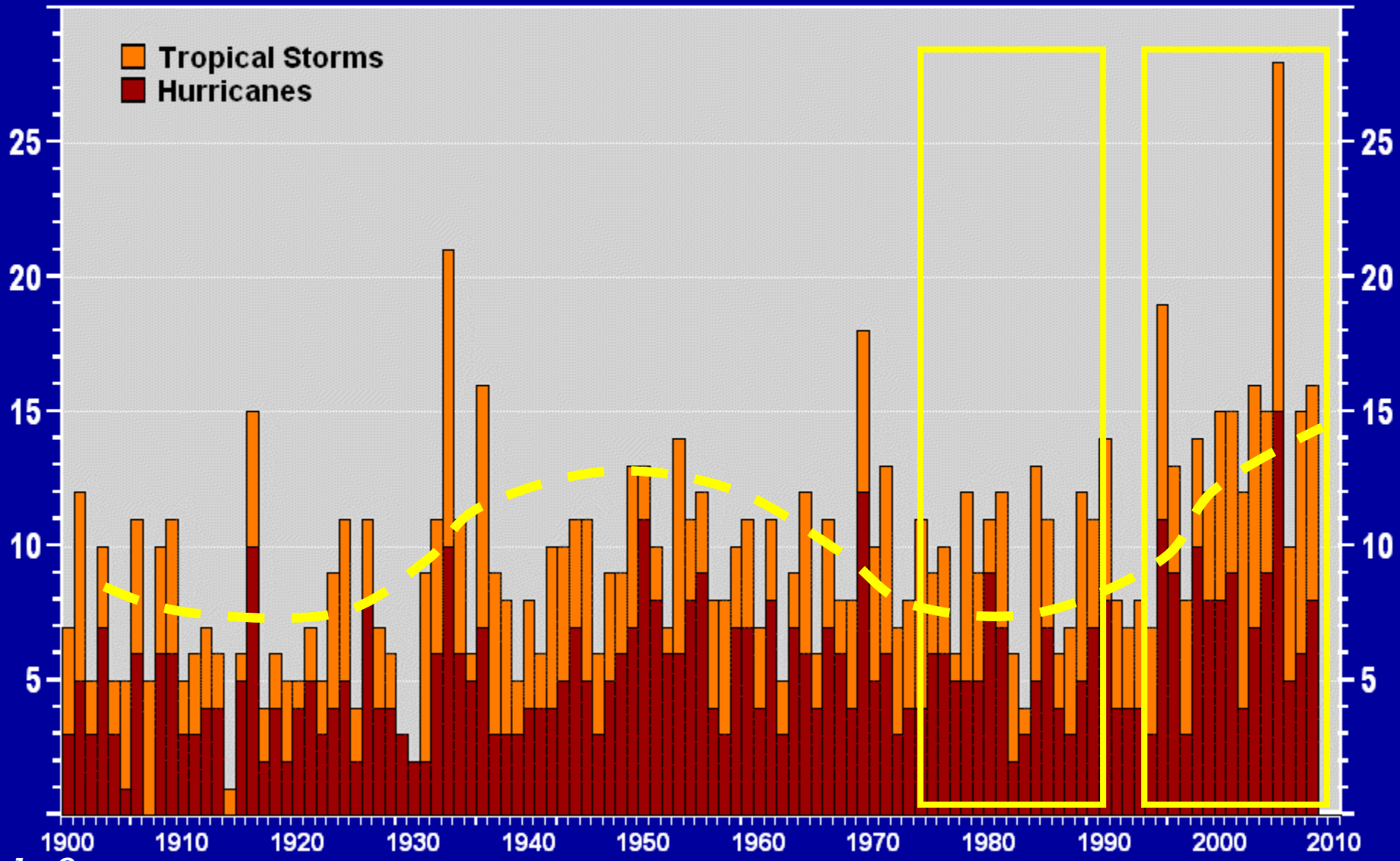
Atlantic Basin Tropical Cyclone Activity



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LSU AgCenter Climatologist
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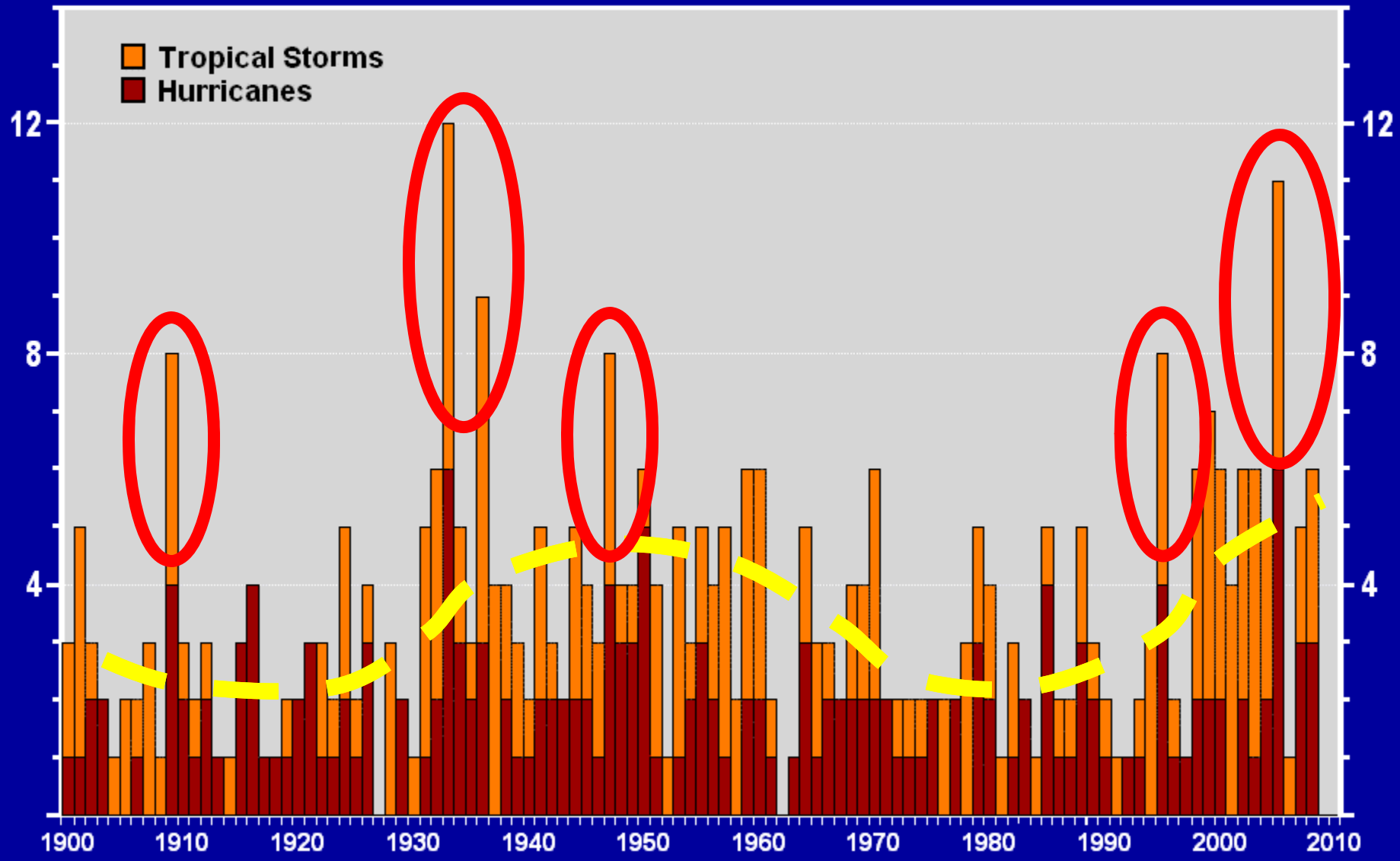
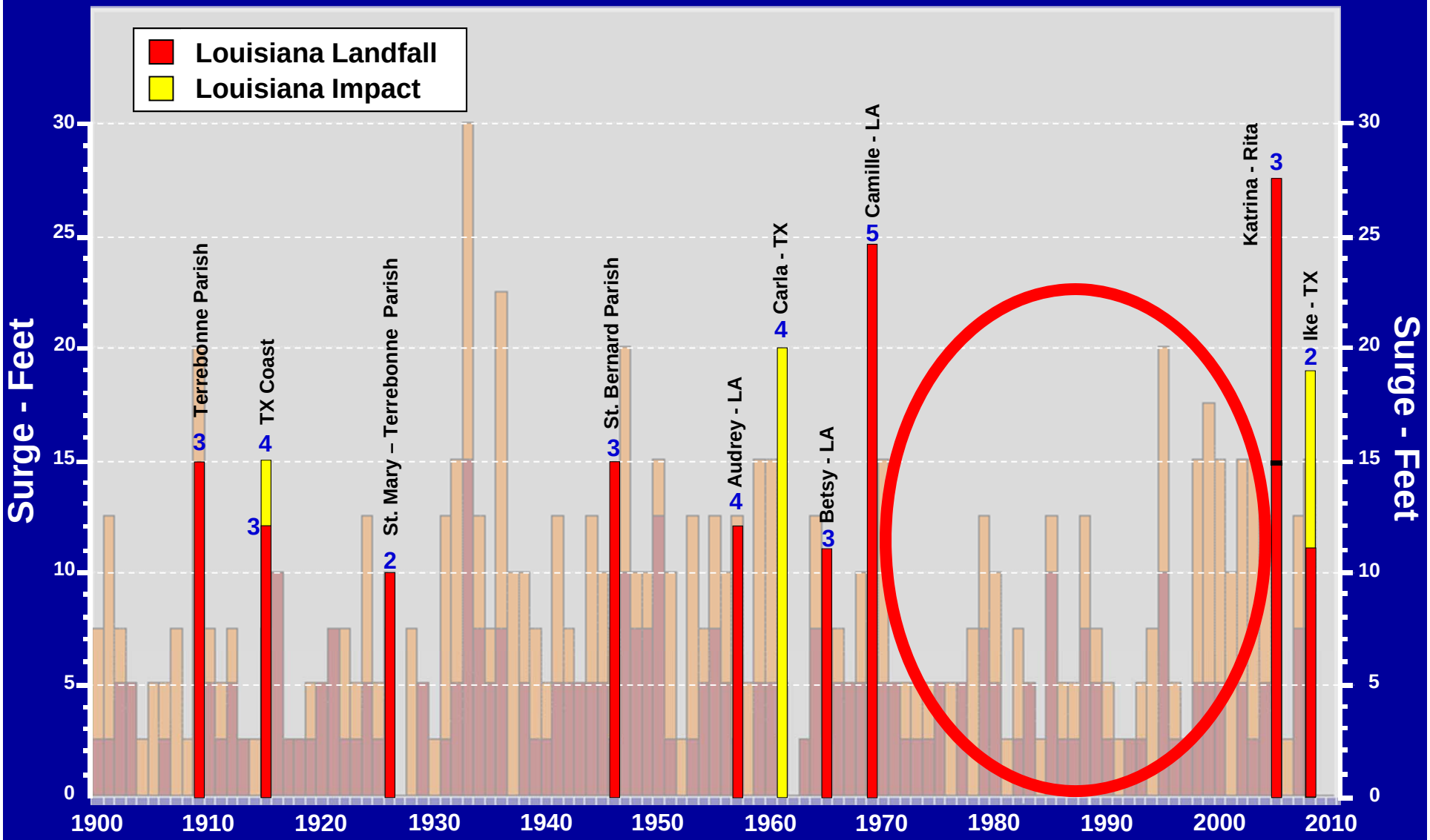
Gulf of Mexico Tropical Cyclone Activity



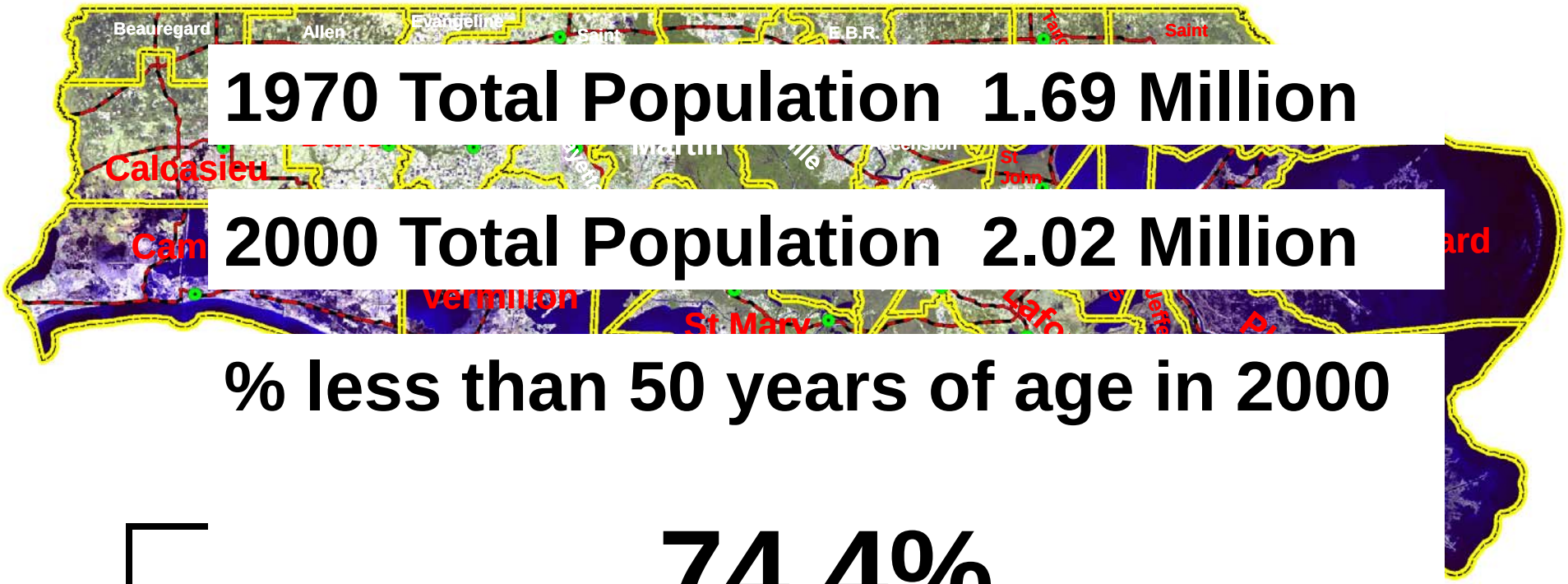
Gulf of Mexico Historical Storm Surge Activity

Hurricanes Producing 10' + Storm Surge

Central Texas to Appalachicola Florida



The Louisiana Coast
Population and Demographics



1970 Total Population 1.69 Million

2000 Total Population 2.02 Million

% less than 50 years of age in 2000

74.4%

PRIMARY ROADS

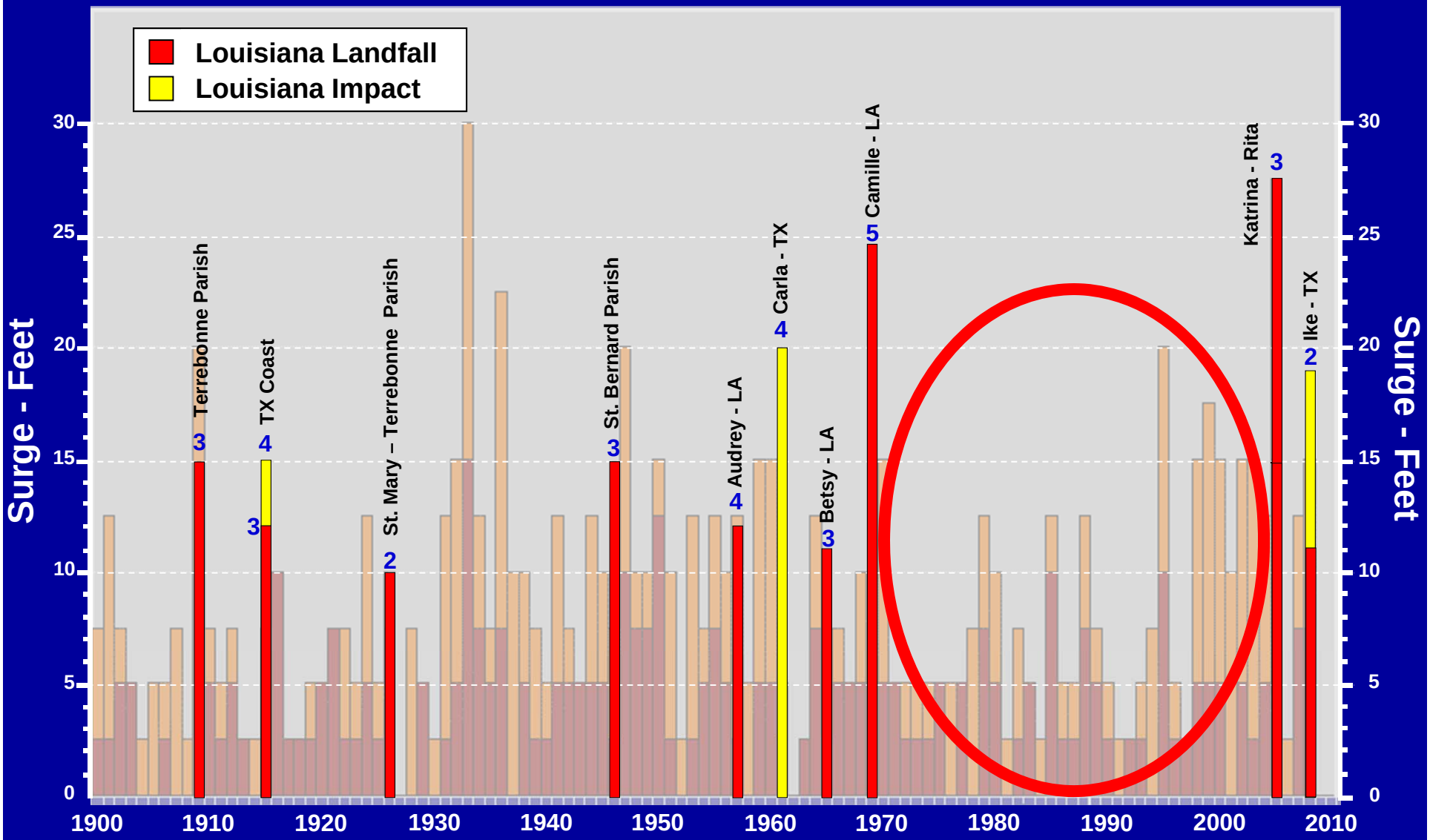
PARISH BOUNDARY

®

Gulf of Mexico Historical Storm Surge Activity

Hurricanes Producing 10' + Storm Surge

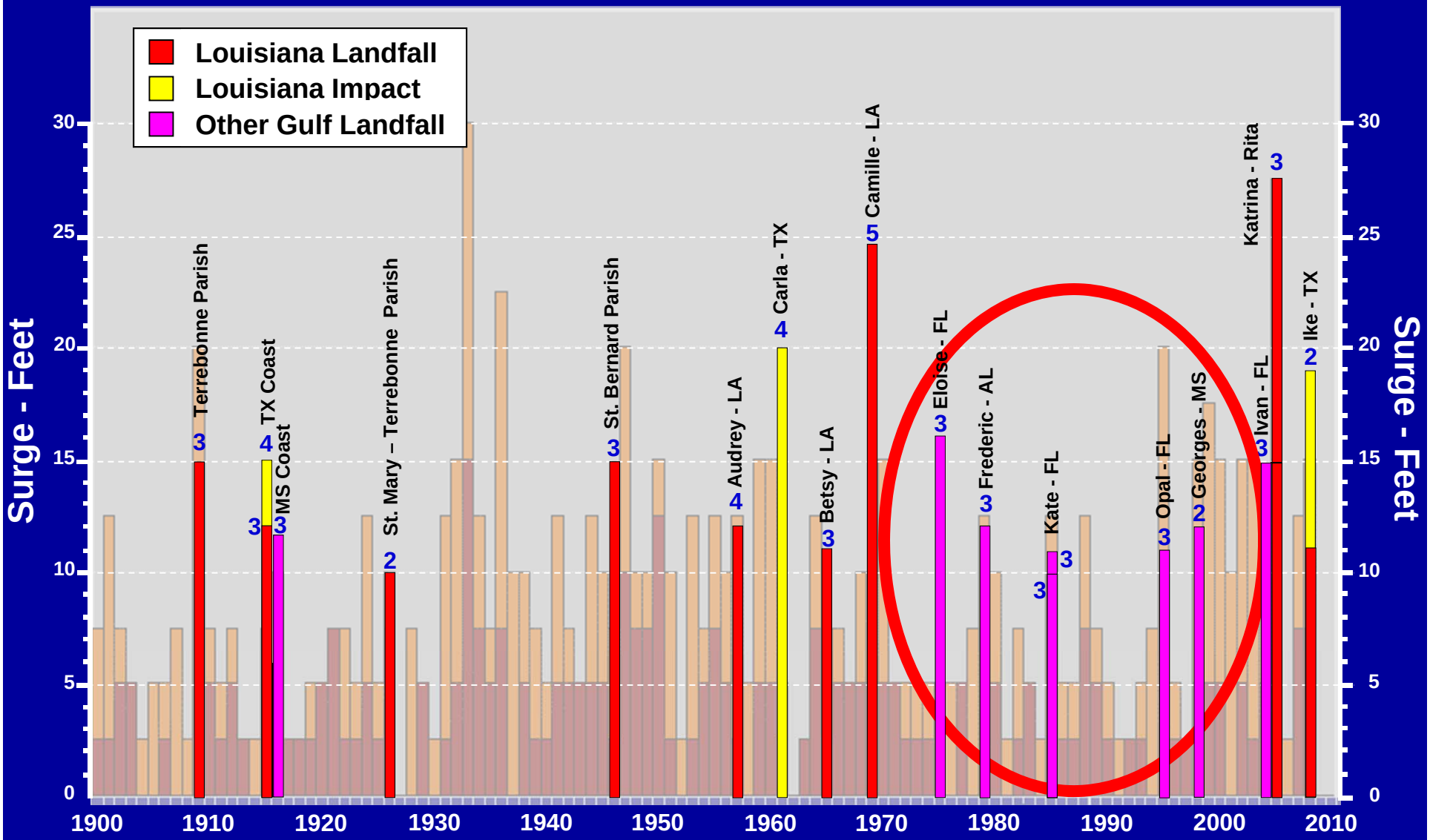
Central Texas to Appalachicola Florida



Gulf of Mexico Historical Storm Surge Activity

Hurricanes Producing 10' + Storm Surge

Central Texas to Appalachicola Florida



It is essential that the citizens of coastal LA understand the facts and potential impacts of hurricane storm surge!

Hurricane Storm Surge

Storm surge flooding from hurricanes causes significant damage and 90% of the deaths associated with a hurricane landfall.

Storm surge holds the greatest potential for loss of life during a hurricane.

http://hurricanetrack.com/surge.html

Storm Surge

Picture by Don McClosky, Entergy's Michoud Power Plant Manager

Hurricane Storm Surge Damage

Cameron Parish

Storm Surge Destruction of Home
East of Creole on Hwy 1143

LSU HURRICANE CENTER

Hurricane Storm Surge Damage

Rita - Cameron Parish

Storm Surge Destruction of Home East of Creole on Hwy 1143

Images courtesy of Kevin Savoie

Sea Grant
LOUISIANA

Images courtesy of Kevin Savoie

Sea Grant
LOUISIANA

Bolivar Peninsula - Before Ike

Bolivar Peninsula - After Ike

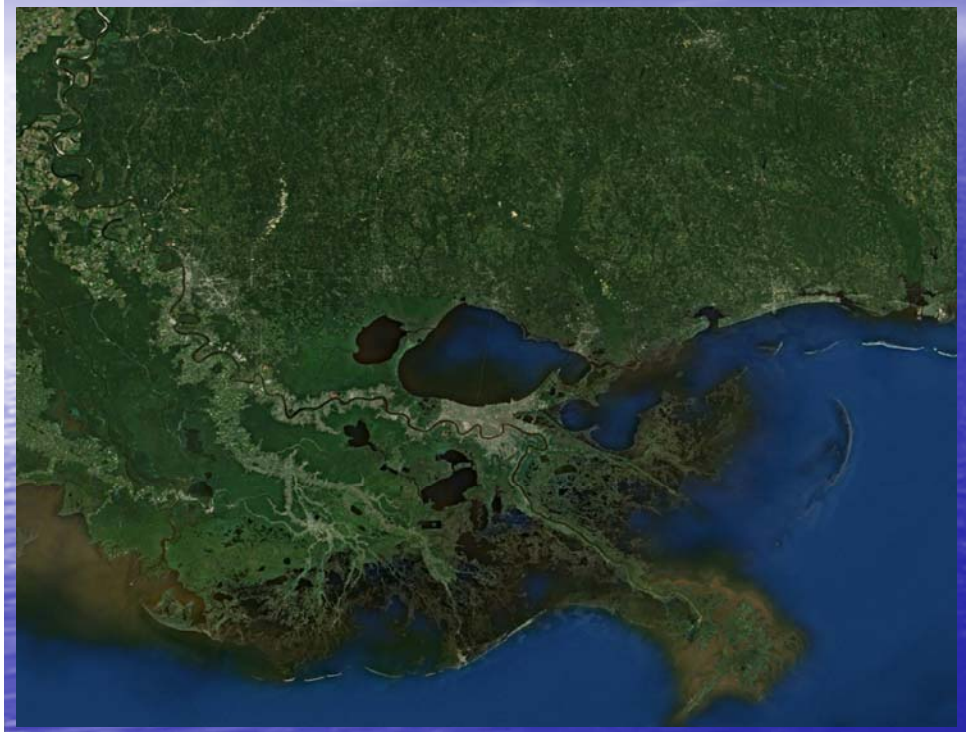
Ike Storm Surge Destruction

Bolivar Peninsula, Texas

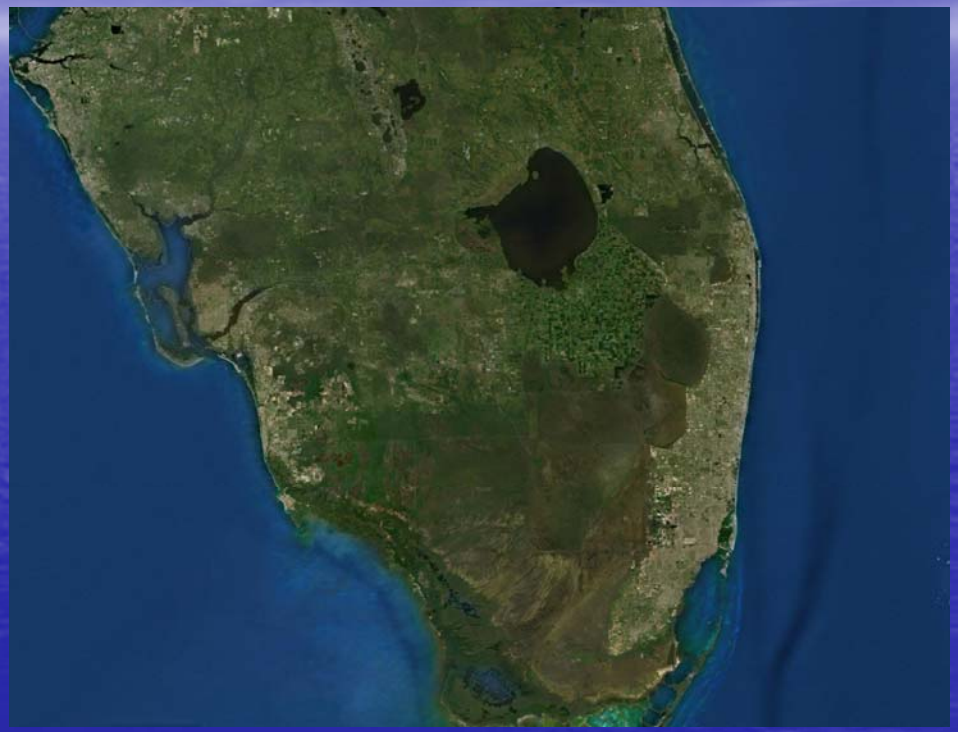
Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "Gates at Chef Pass and the Rigolets will protect us from storm surge"

INLAND LAKE STORM SURGE



Lake Pontchartrain
Louisiana



Lake Okeechobee
Florida

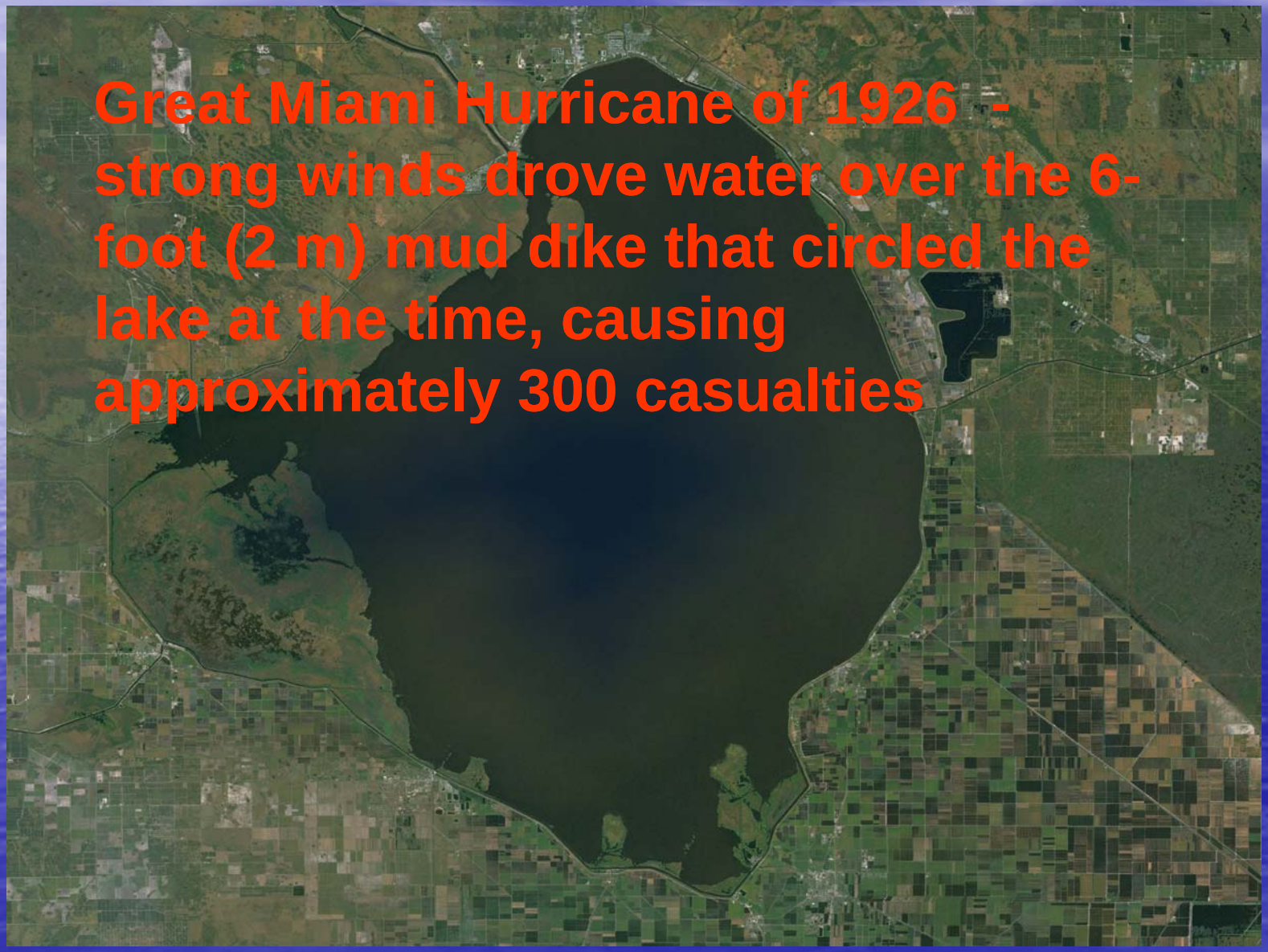
INLAND LAKE STORM SURGE

Lake Pontchartrain
Louisiana
630 Square Miles

Lake Okeechobee
Florida
730 Square Miles

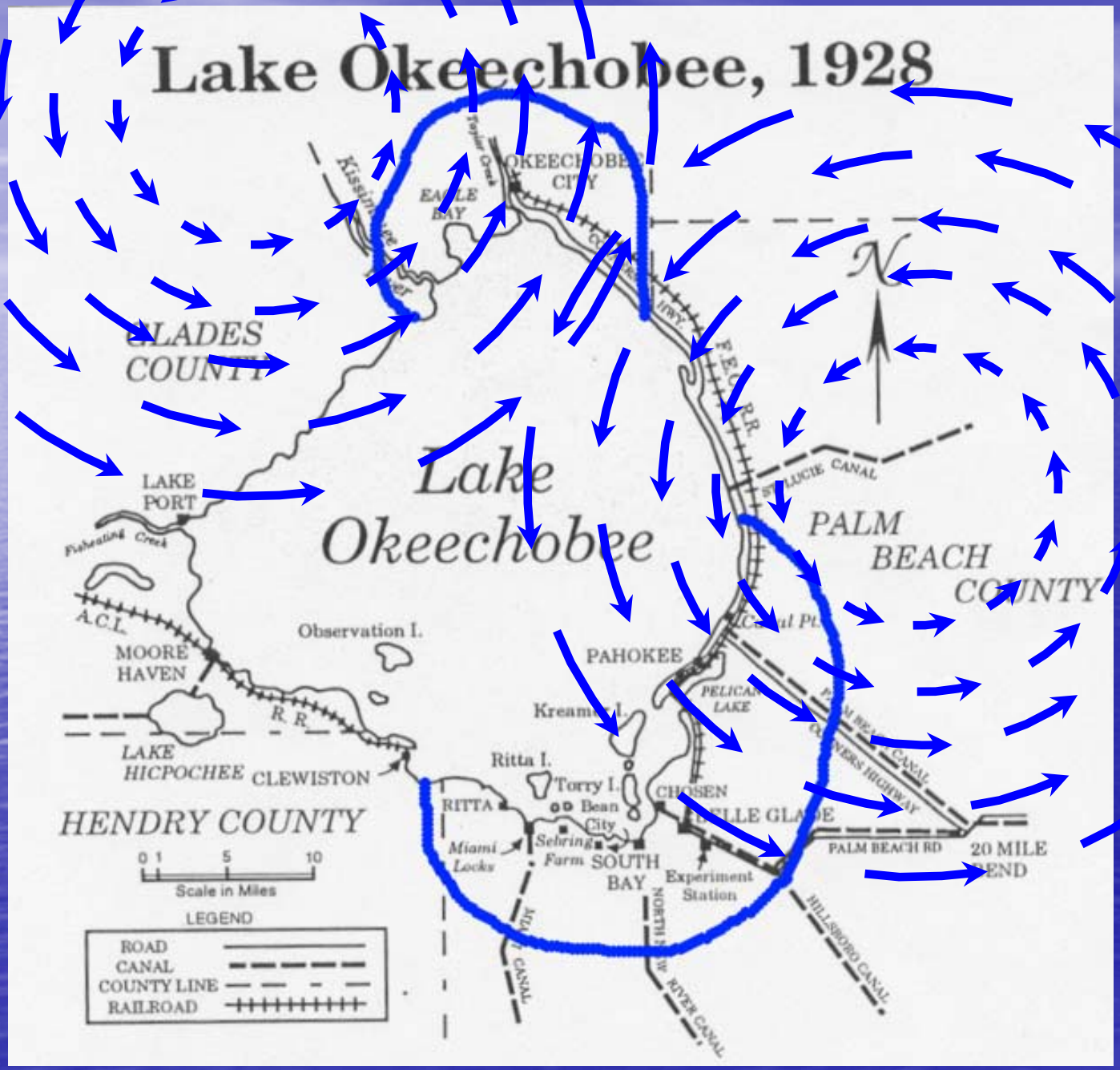
INLAND LAKE STORM SURGE

INLAND LAKE STORM SURGE

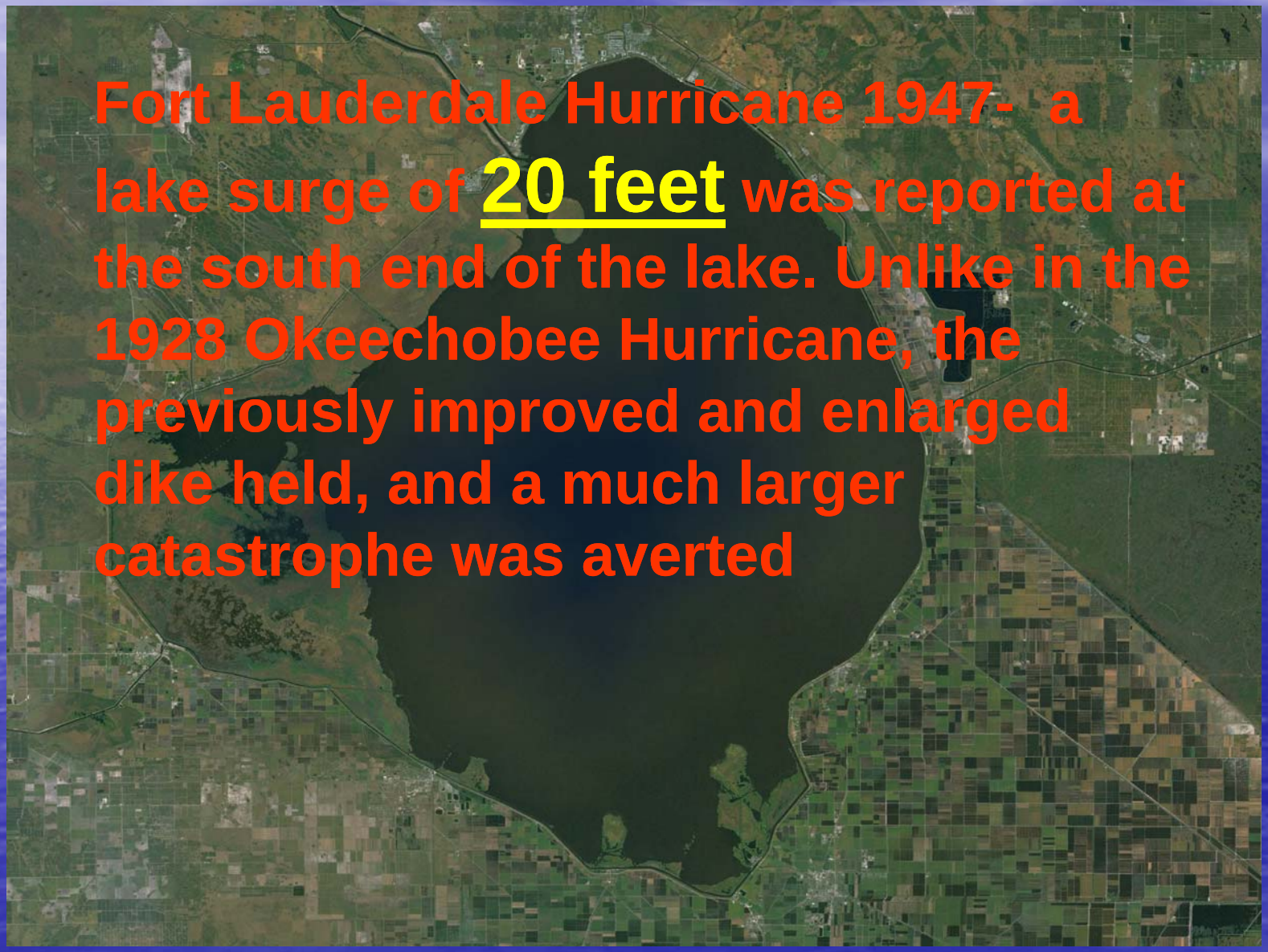


Great Miami Hurricane of 1926 - strong winds drove water over the 6-foot (2 m) mud dike that circled the lake at the time, causing approximately 300 casualties

INLAND LAKE STORM SURGE

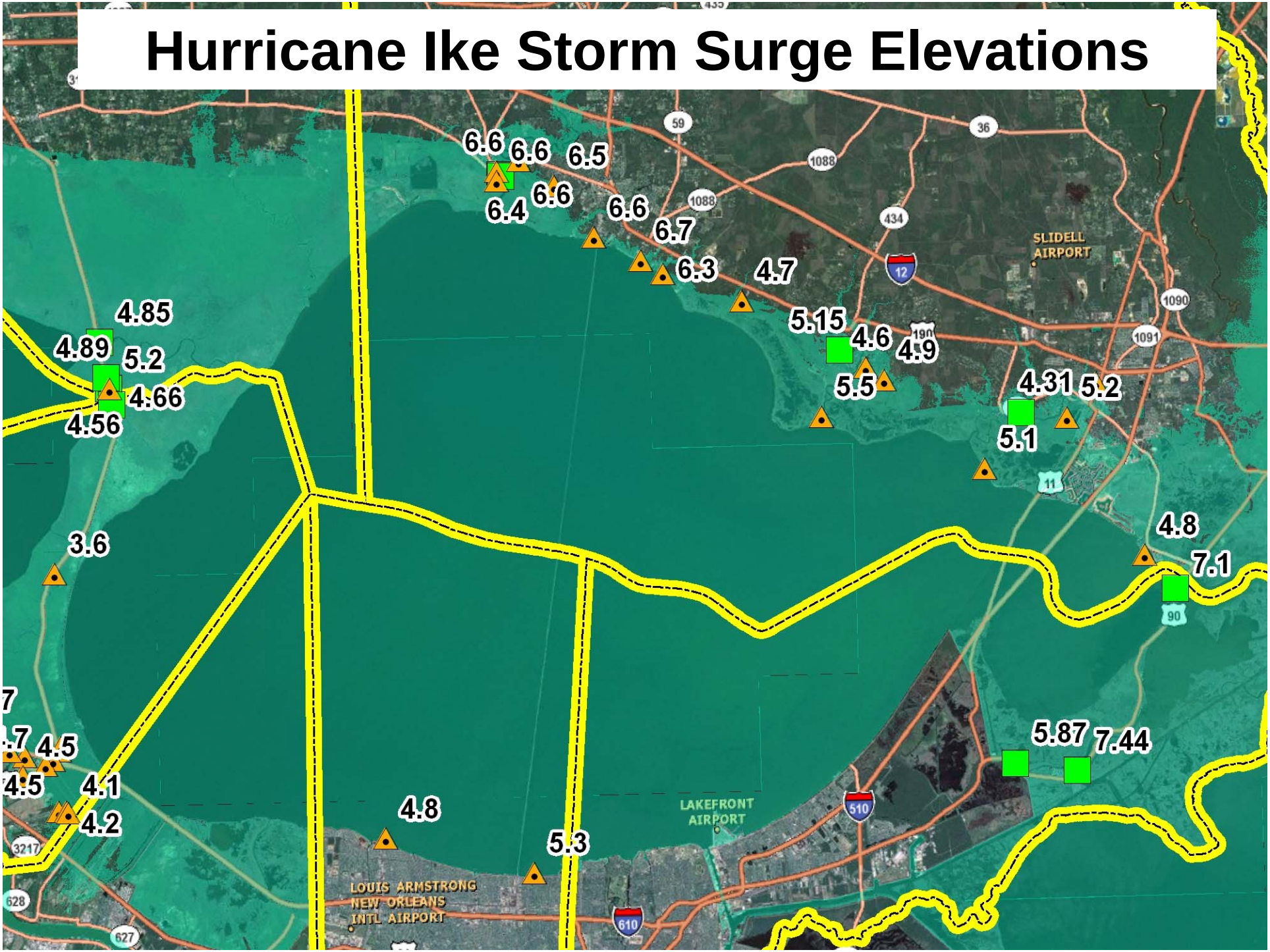

Lake Okeechobee, 1928
Lake Okeechobee
GLADES COUNTY
HENDRY COUNTY
PALM BEACH COUNTY
LAKE PORT
MOORE HAVEN
LAKE HICPOCHEE
CLEWISTON
Observation I.
PAHOKEE
Kreamer I.
Ritta I.
Torry I.
Bean City
RITTA
Miami Locks
Sebring Farm
SOUTH BAY
Experiment Station
CHOSEN
BELLE GLADE
PELICAN LAKE
EAGLE BAY
OKEECHOBEE CITY
Fisheating Creek
A.C.L.
R. R.
ST. LUCIE CANAL
PALM BEACH RD
20 MILE END
HILLSBORO CANAL
NORTH NEW RIVER CANAL
Scale in Miles
LEGEND
ROAD
CANAL
COUNTY LINE
RAILROAD

INLAND LAKE STORM SURGE



Fort Lauderdale Hurricane 1947- a lake surge of **20 feet** was reported at the south end of the lake. Unlike in the 1928 Okeechobee Hurricane, the previously improved and enlarged dike held, and a much larger catastrophe was averted

Hurricane Ike Storm Surge Elevations



Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "I'm outside the flood zone!"

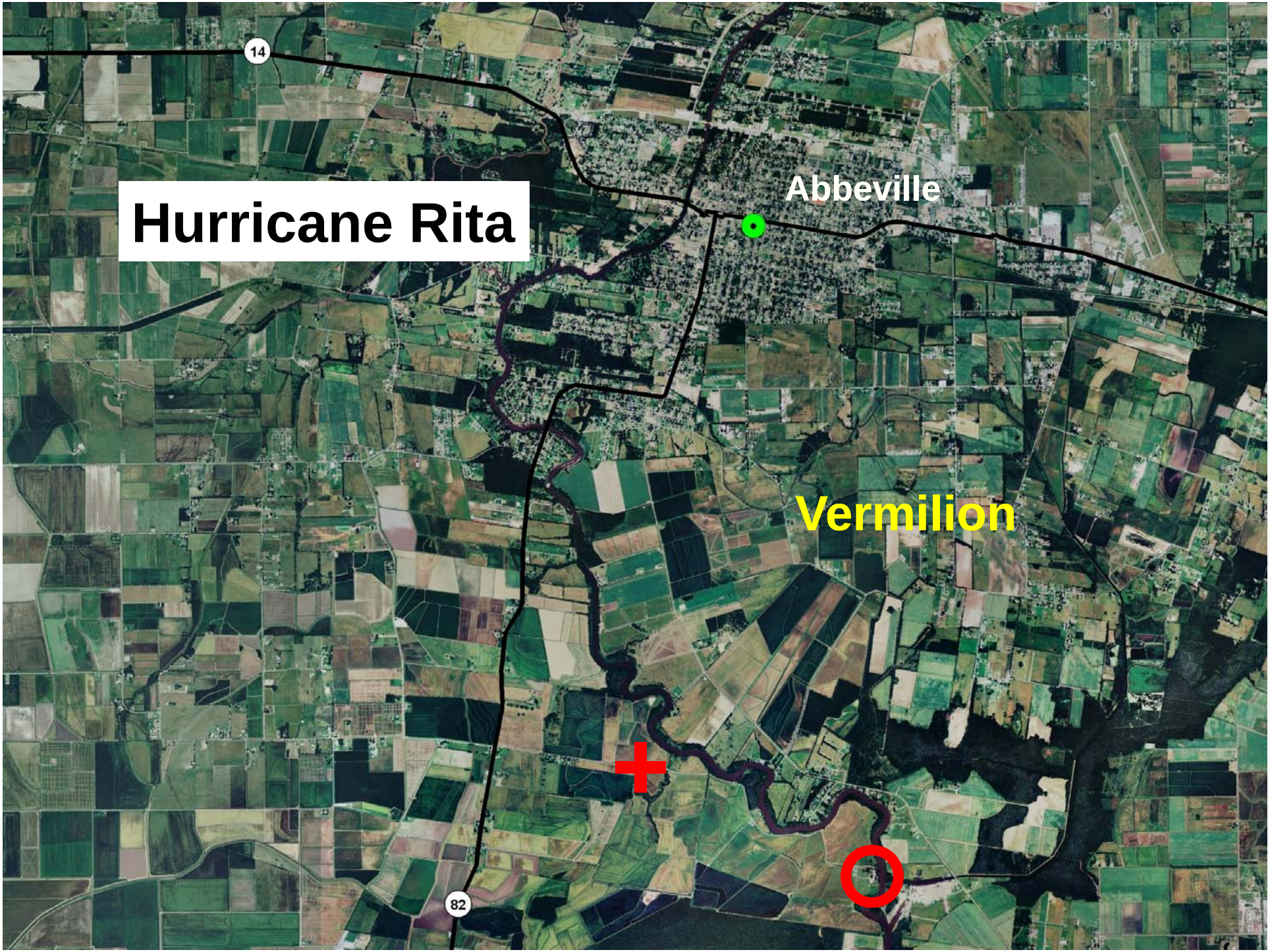
Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "The local water gauge levels show the water is beginning to drop, we should be able to go home now."

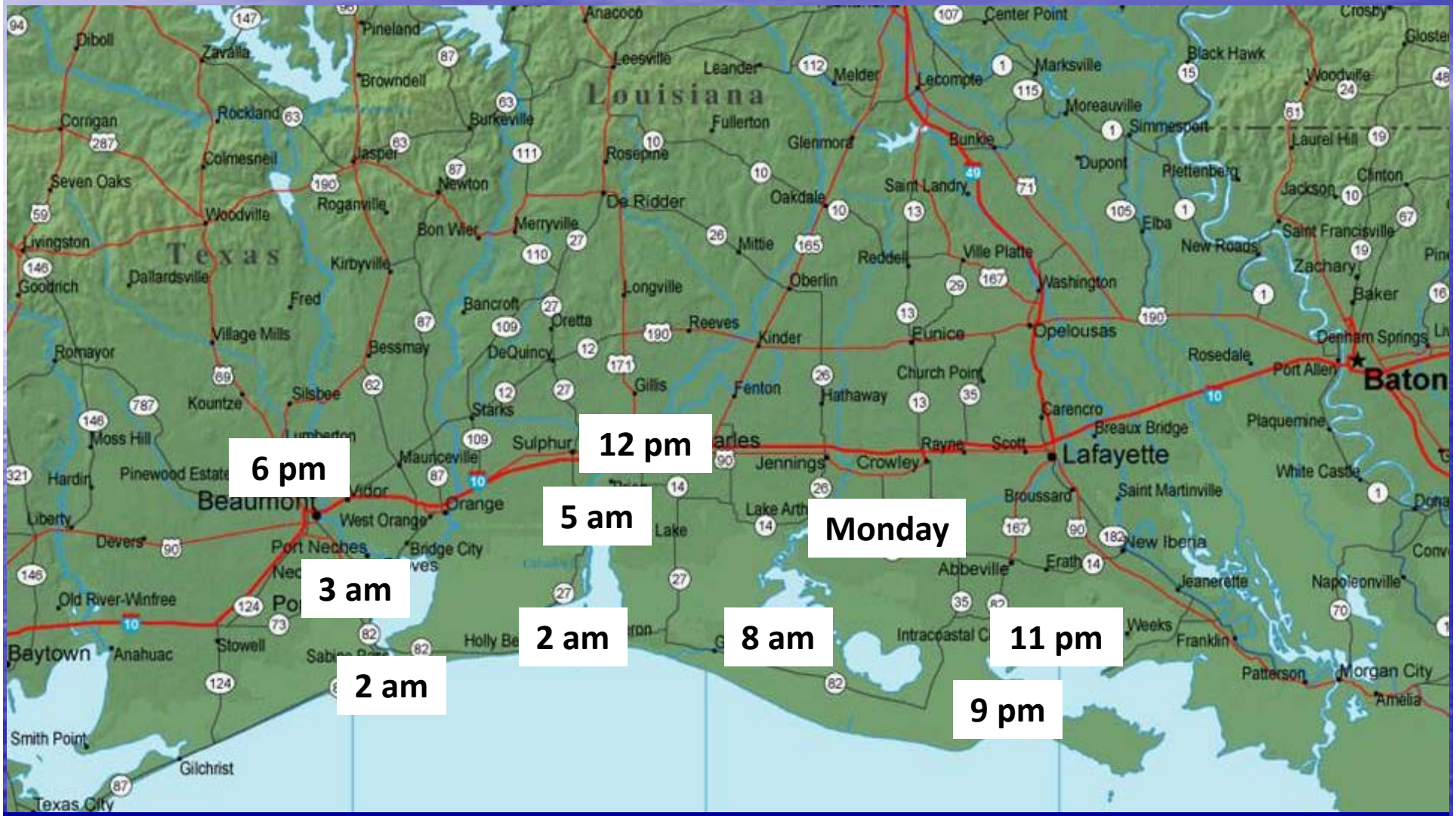
When Does the Storm Surge Arrive?

Storm Surge Continues to Rise after Landfall
Delcambre on Hwy 14

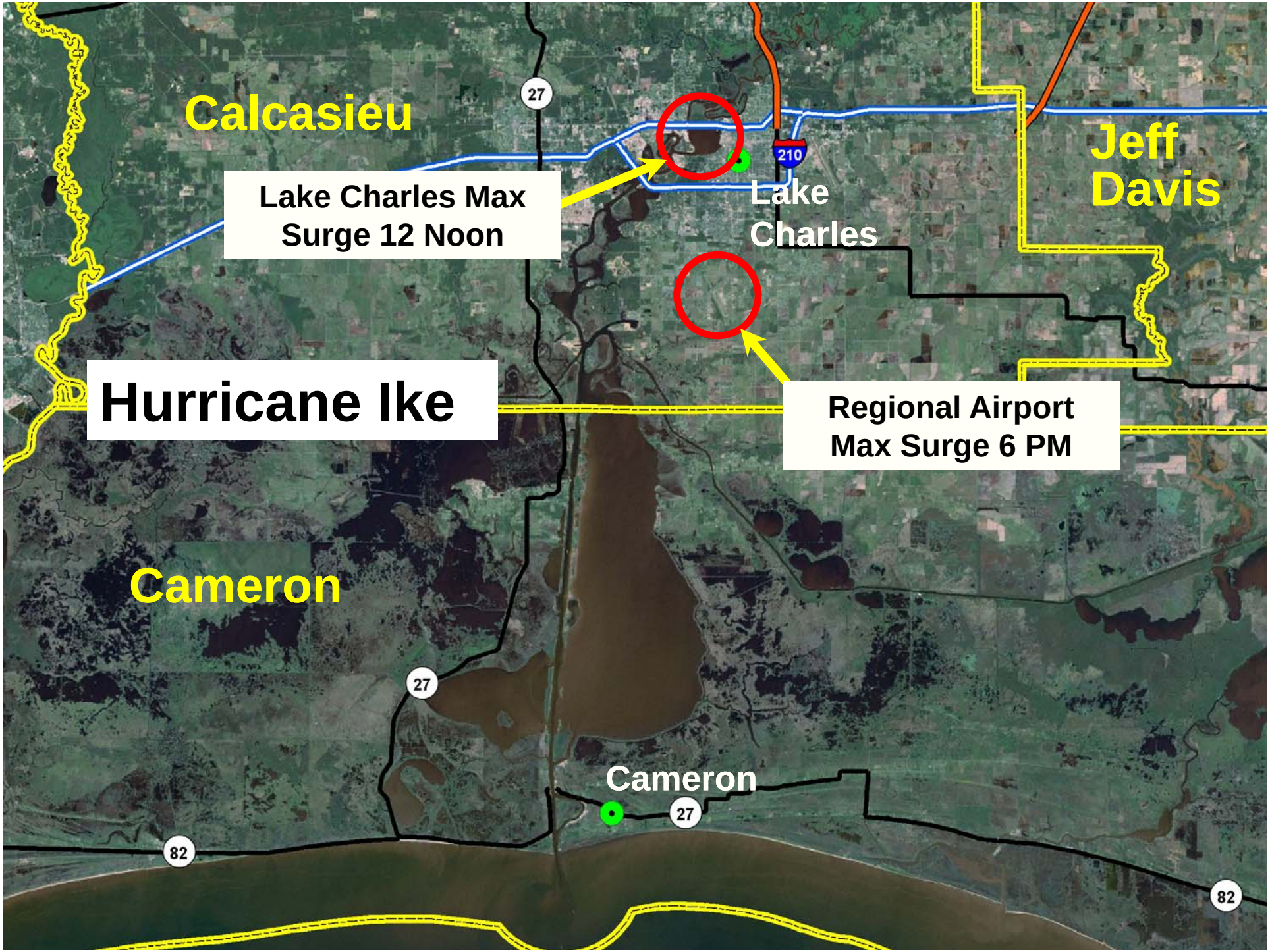
Vermilion Parish


Hurricane Rita
Abbeville
Vermilion
14
82

Hurricane Ike

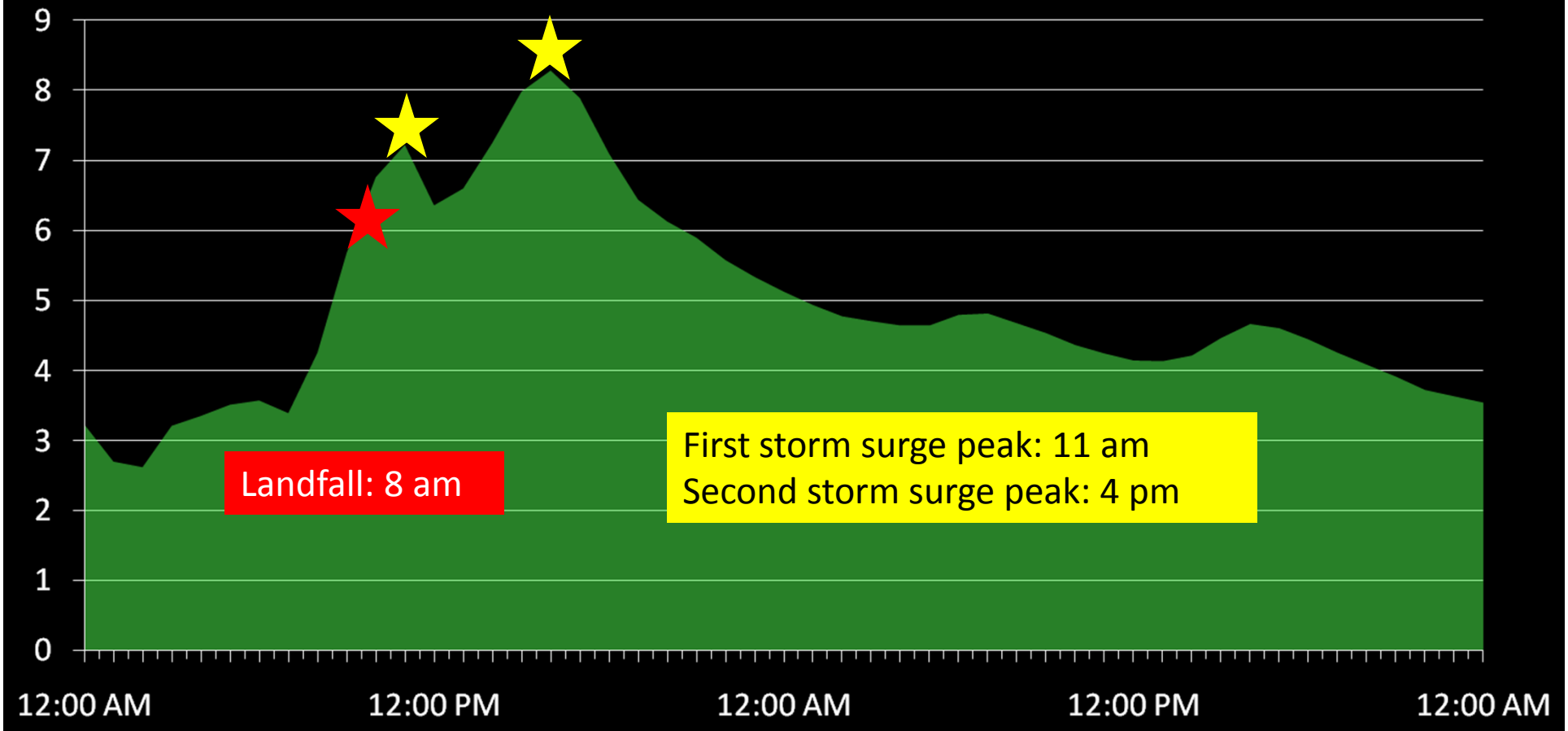


Time of highest storm surge


Calcasieu
Jeff Davis
Lake Charles Max Surge 12 Noon
Lake Charles
Hurricane Ike
Regional Airport Max Surge 6 PM
Cameron
Cameron
27
210
27
27
82
82

Hurricane Lili 2002

Intracoastal Waterway near Vermilion Lock



If winds stay onshore after landfall, there can be a second storm surge maximum hours after landfall

Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "We have levees to protect us."

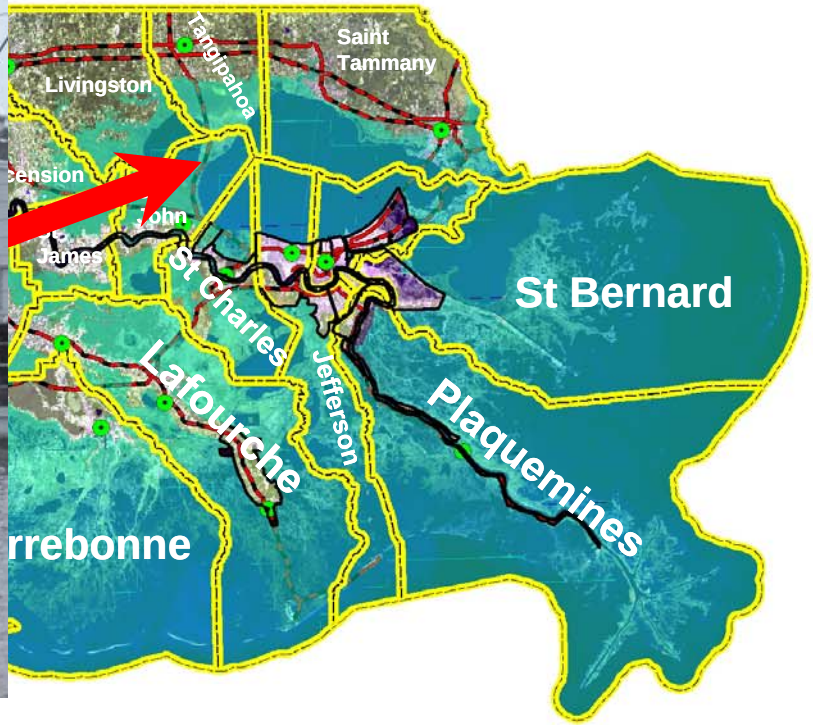
The Louisiana Coast
A Vulnerable Area for Storm Surge

®

Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "It's making landfall far to the west."

Hurricane Ike Storm Surge

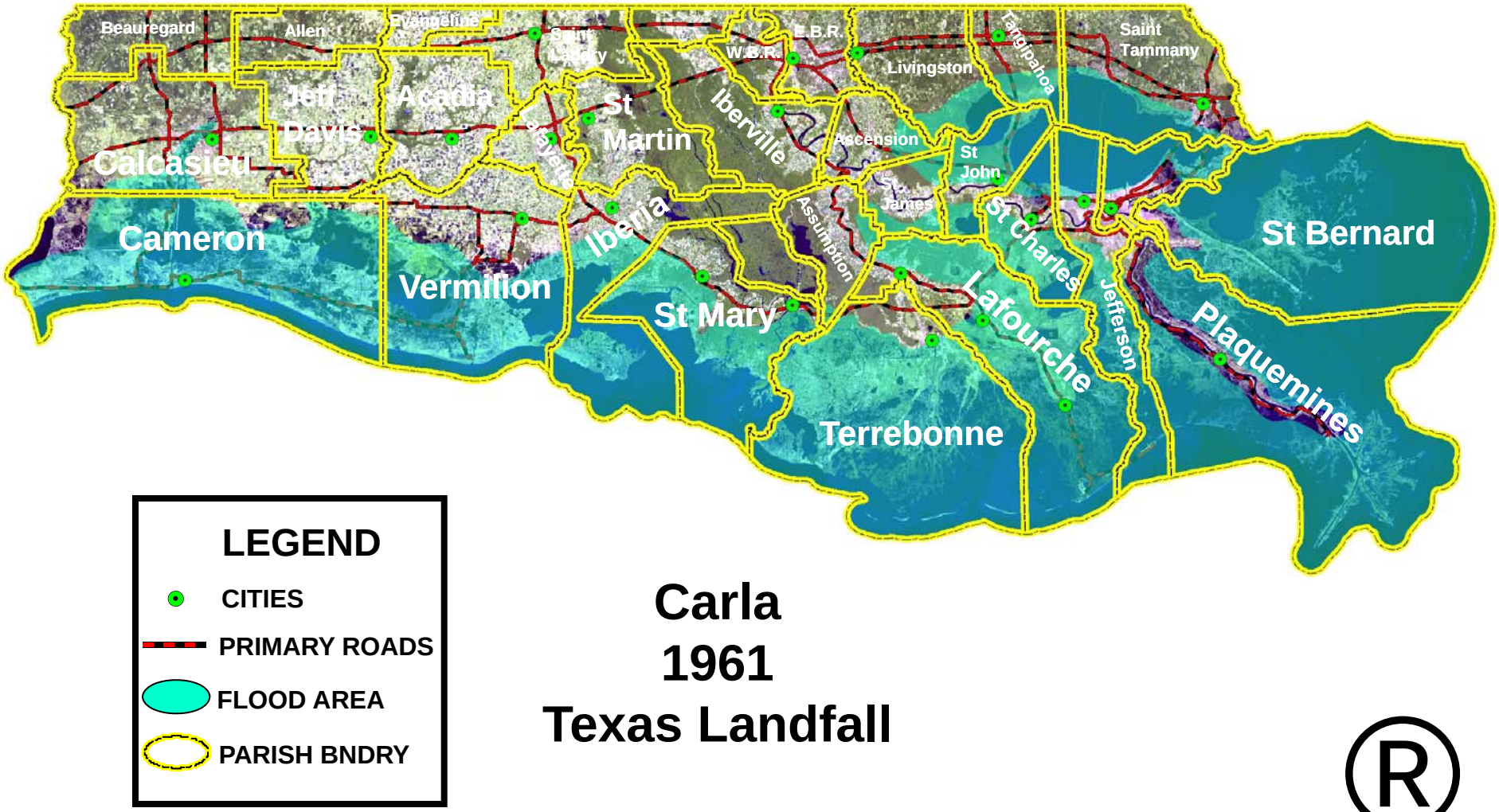


CITIES
PRIMARY ROADS
FLOOD AREA
PARISH BNDRY

Ike
Sept. 2008

®

Hurricane Carla Storm Surge



LEGEND

- CITIES
- PRIMARY ROADS
- FLOOD AREA
- PARISH BNDRY

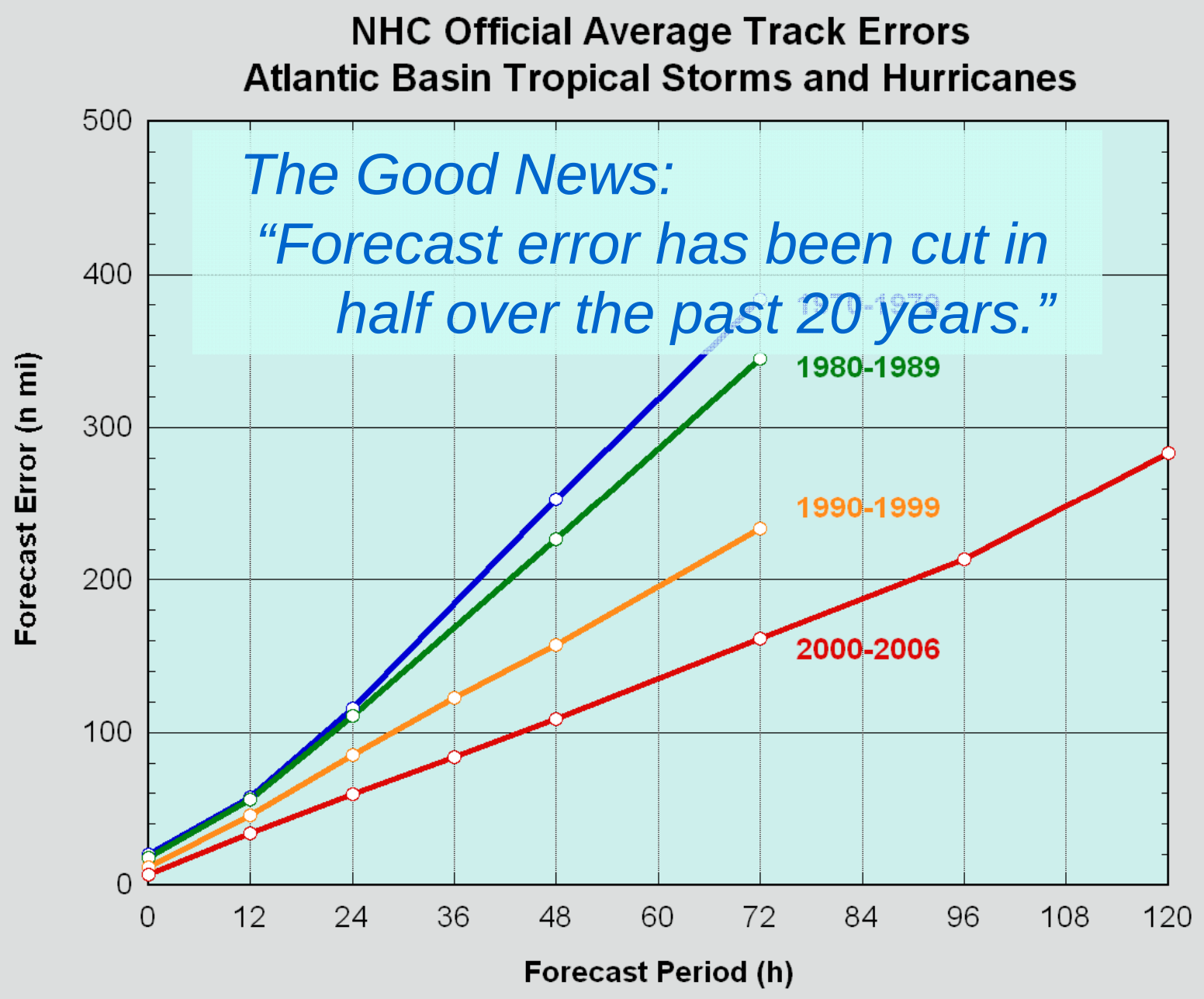
Carla
1961
Texas Landfall

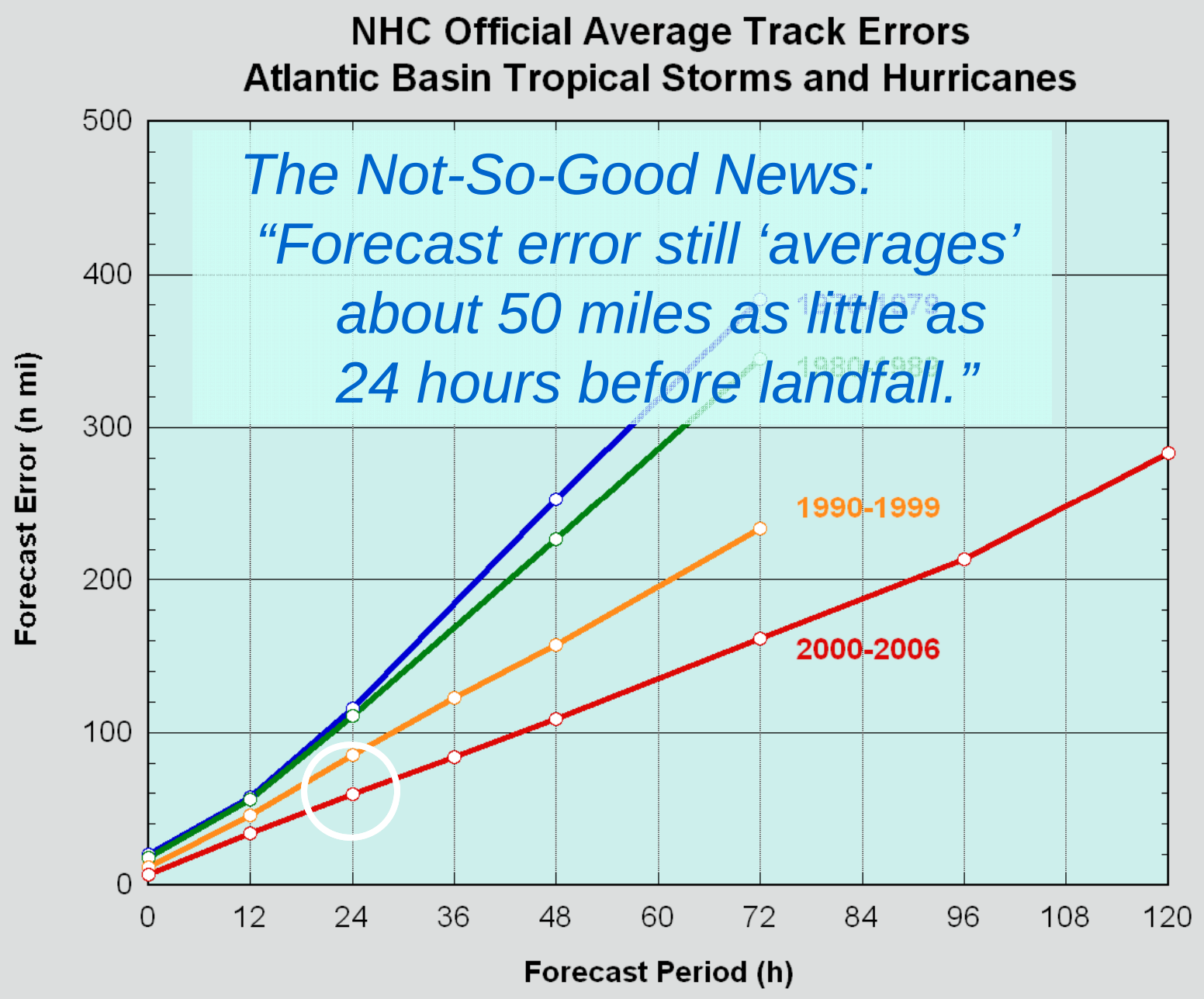
®

Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

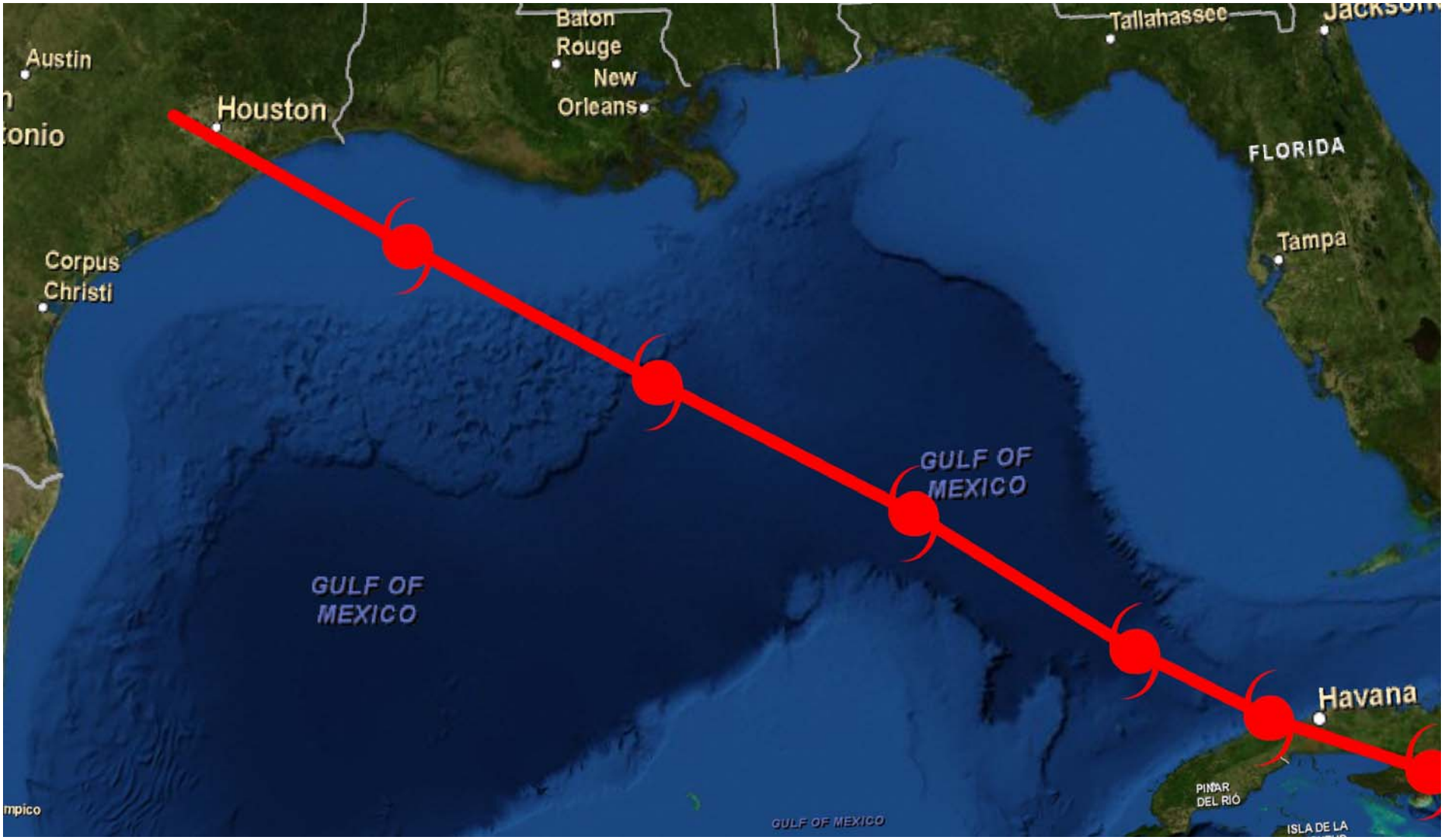
- "It's making landfall far to the west."

ARE YOU SURE?? What about predicted track error??

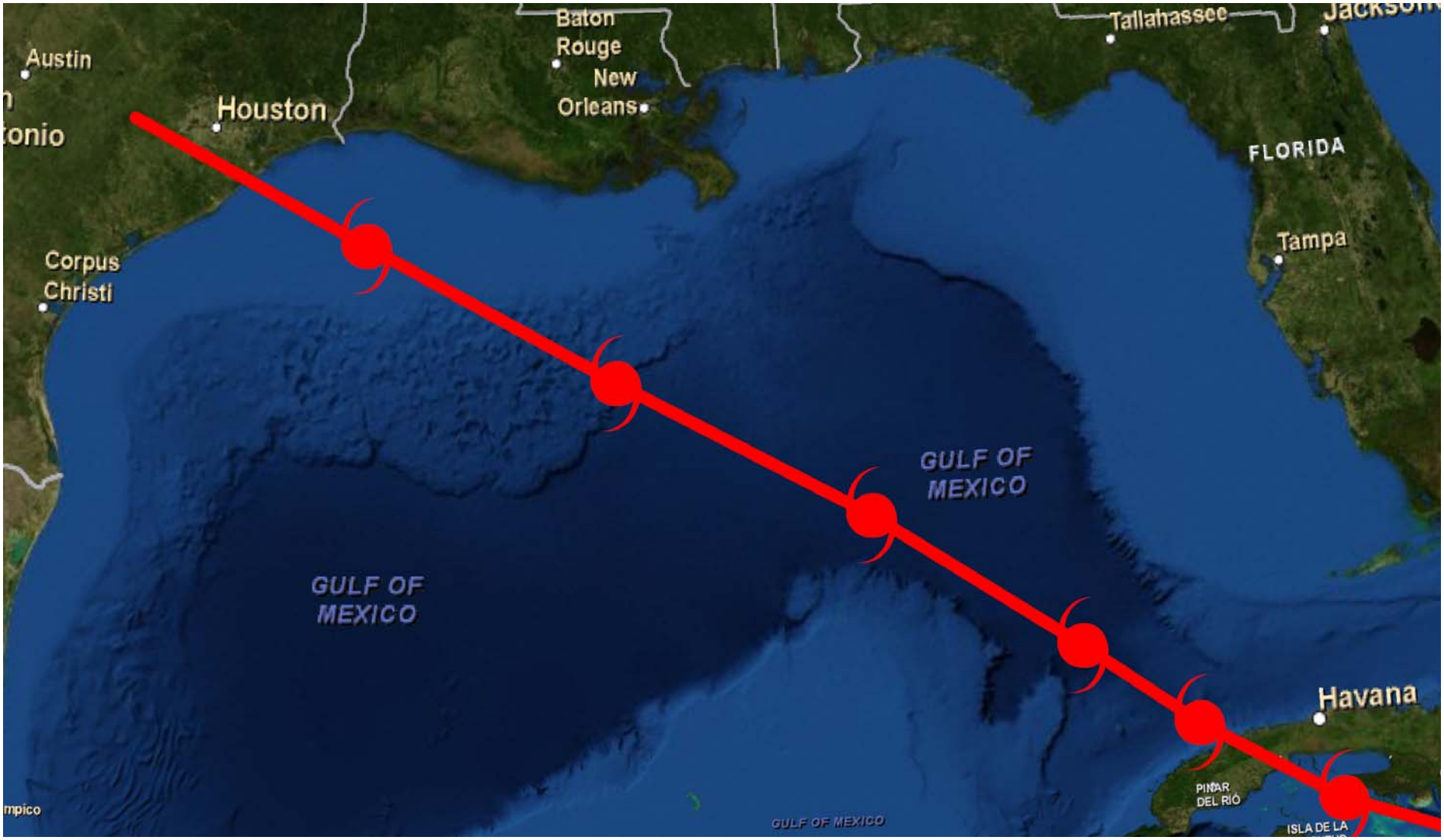

NHC Official Average Track Errors
Atlantic Basin Tropical Storms and Hurricanes
The Good News:
"Forecast error has been cut in half over the past 20 years."
1980-1989
1990-1999
2000-2006
Forecast Error (n mi)
Forecast Period (h)
0
100
200
300
400
500
0
12
24
36
48
60
72
84
96
108
120


NHC Official Average Track Errors
Atlantic Basin Tropical Storms and Hurricanes
The Not-So-Good News:
"Forecast error still 'averages' about 50 miles as little as 24 hours before landfall."
1990-1999
2000-2006
Forecast Error (n mi)
Forecast Period (h)
0
100
200
300
400
500
0
12
24
36
48
60
72
84
96
108
120

Ike Predicted Track – NHC Advisory #29



Ike Predicted Track – NHC Advisory #30



Ike Predicted Track – NHC Advisory #31

Ike Predicted Track – NHC Advisory #32

Ike Predicted Track – NHC Advisory #33

Ike Predicted Track – NHC Advisory #34

Ike Predicted Track – NHC Advisory #35

Ike Predicted Track – NHC Advisory #36

Ike Predicted Track – NHC Advisory #37

Ike Predicted Track – NHC Advisory #38

Ike Predicted Track – NHC Advisory #39

Ike Predicted Track – NHC Advisory #40

Ike Predicted Track – NHC Advisory #41

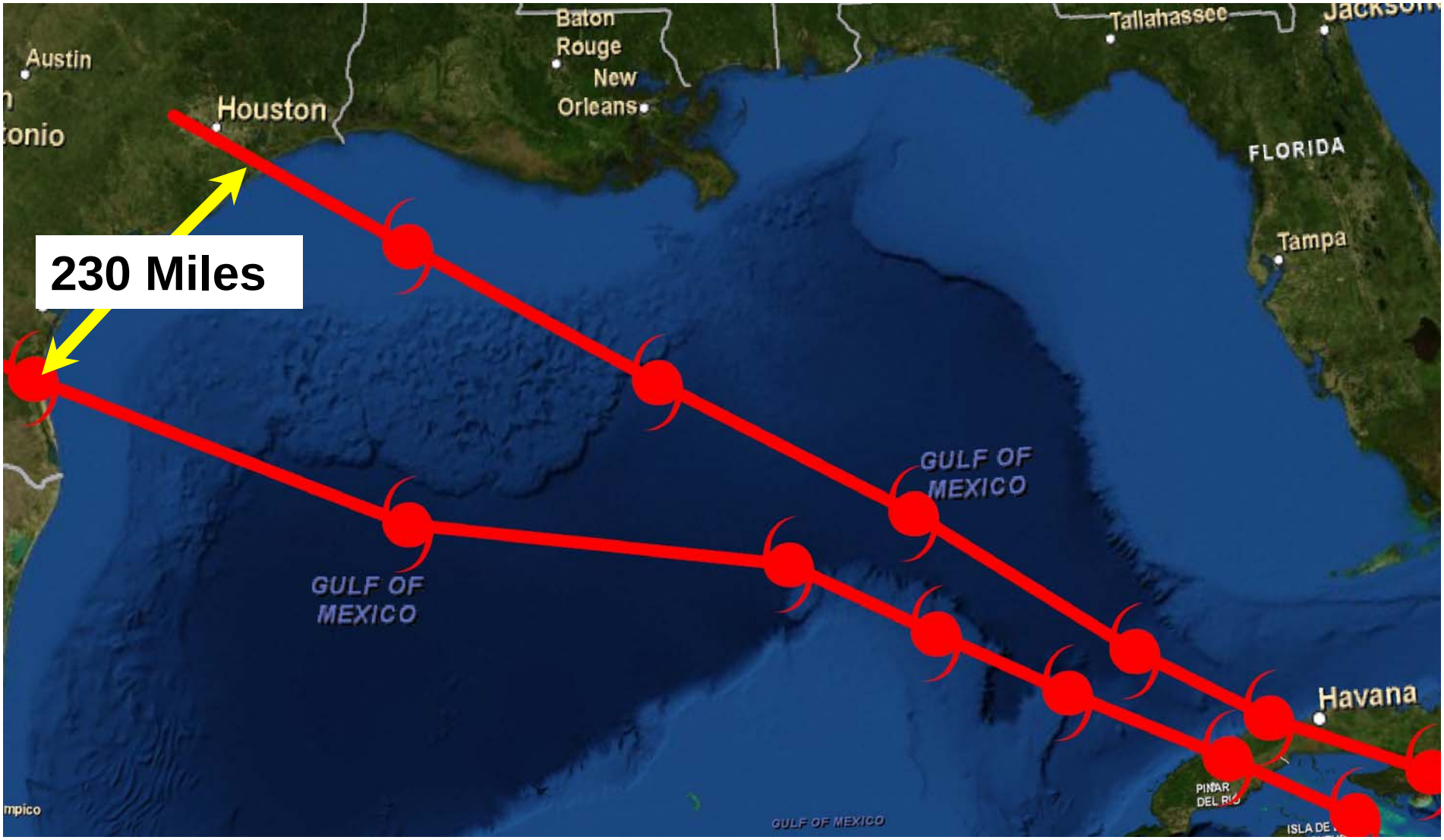
Ike Predicted Track – NHC Advisory #42

Ike Predicted Track – NHC Advisory #43

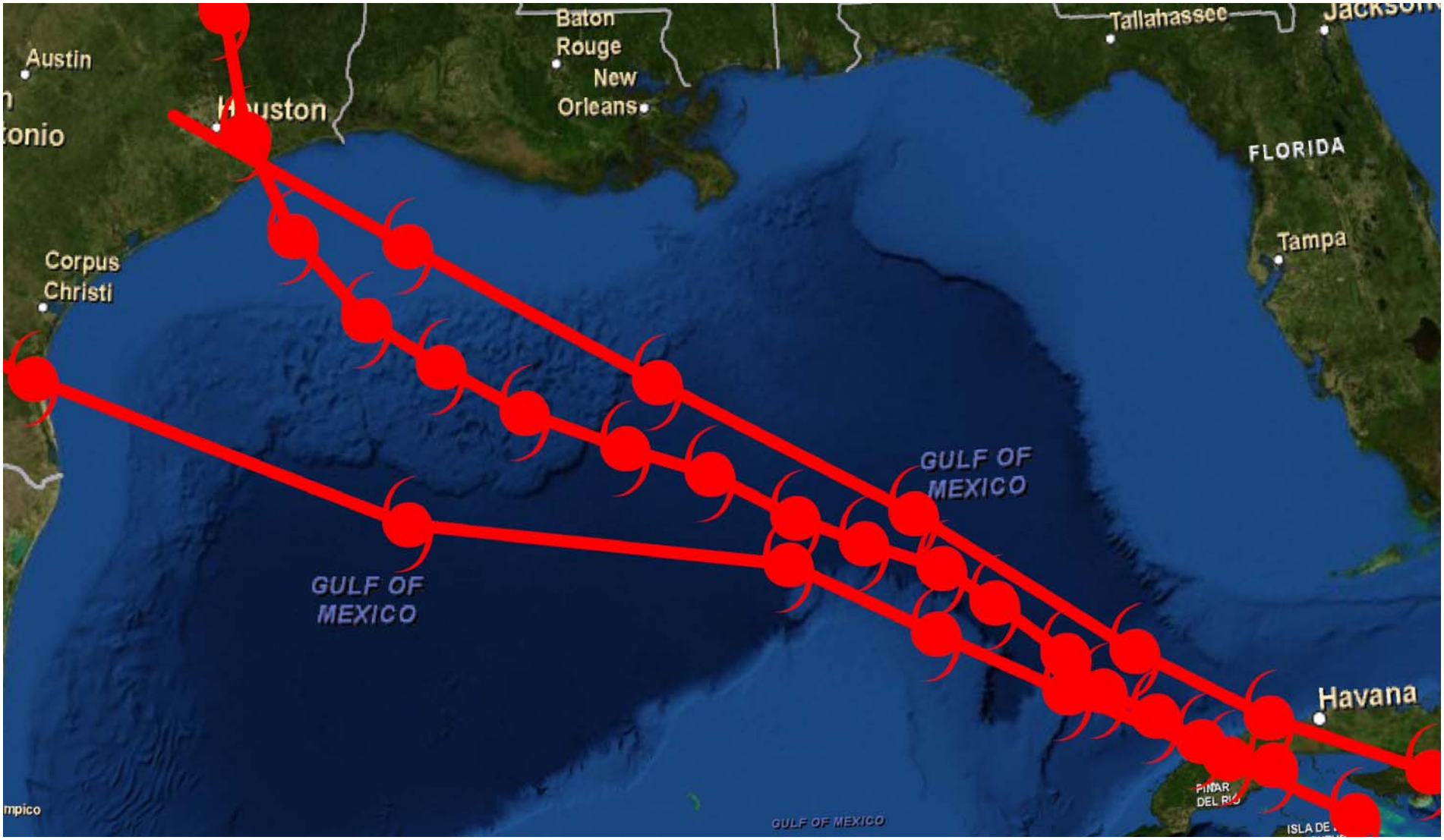
Ike Predicted Track – NHC Advisory #44

Ike Predicted Track – NHC Advisory #45

Ike Predicted Track – Range

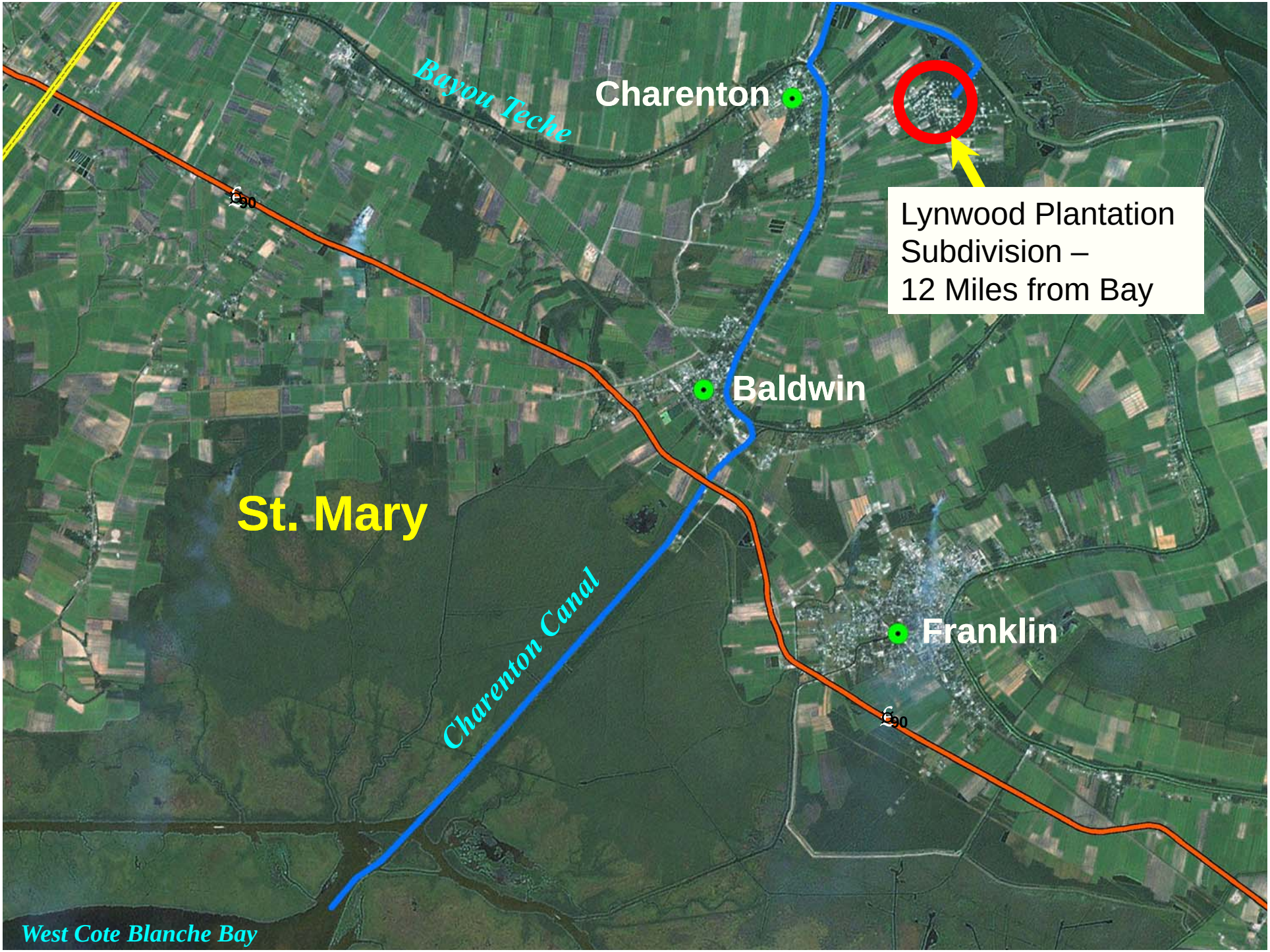


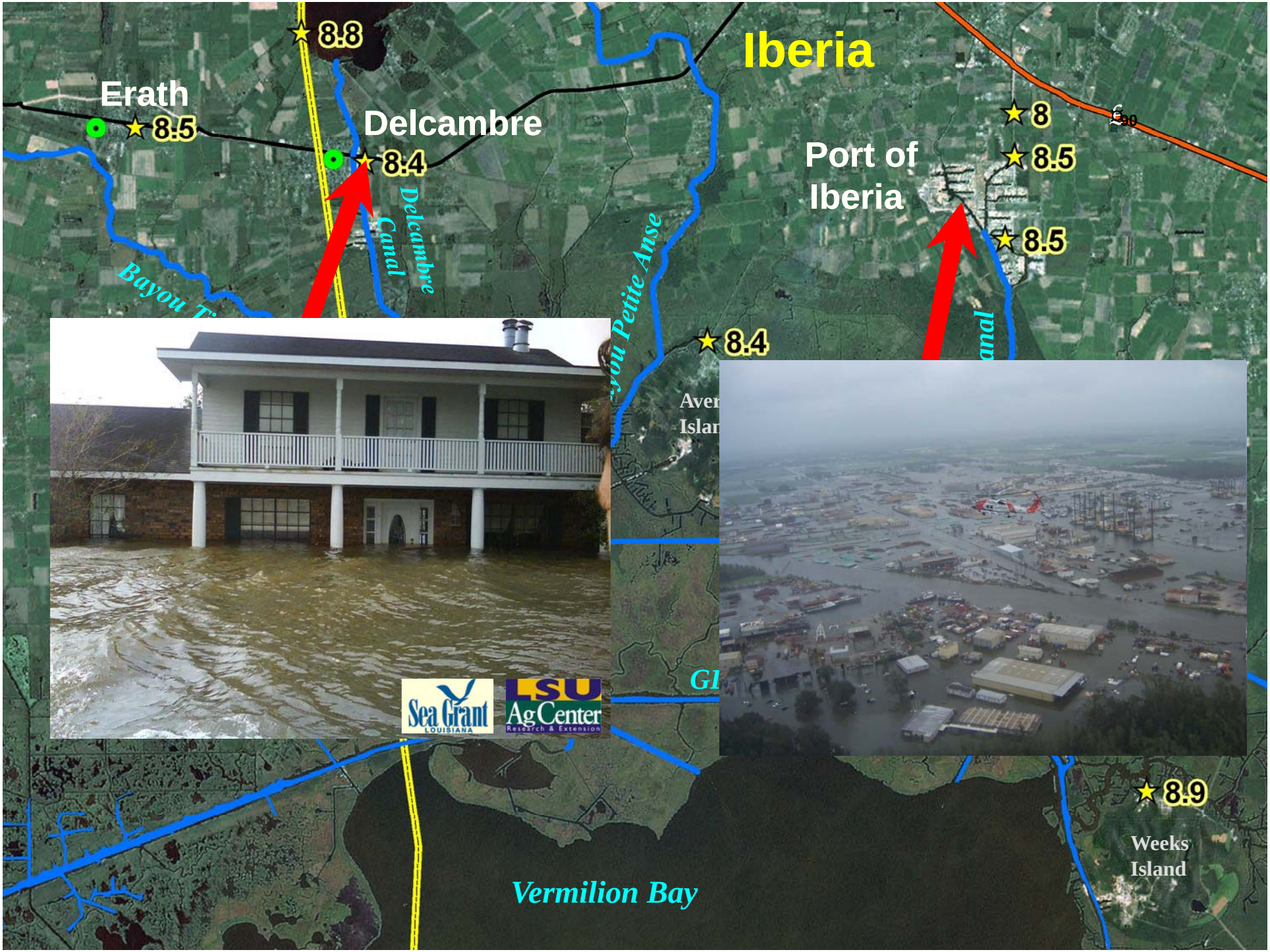
Ike Actual Track – Range

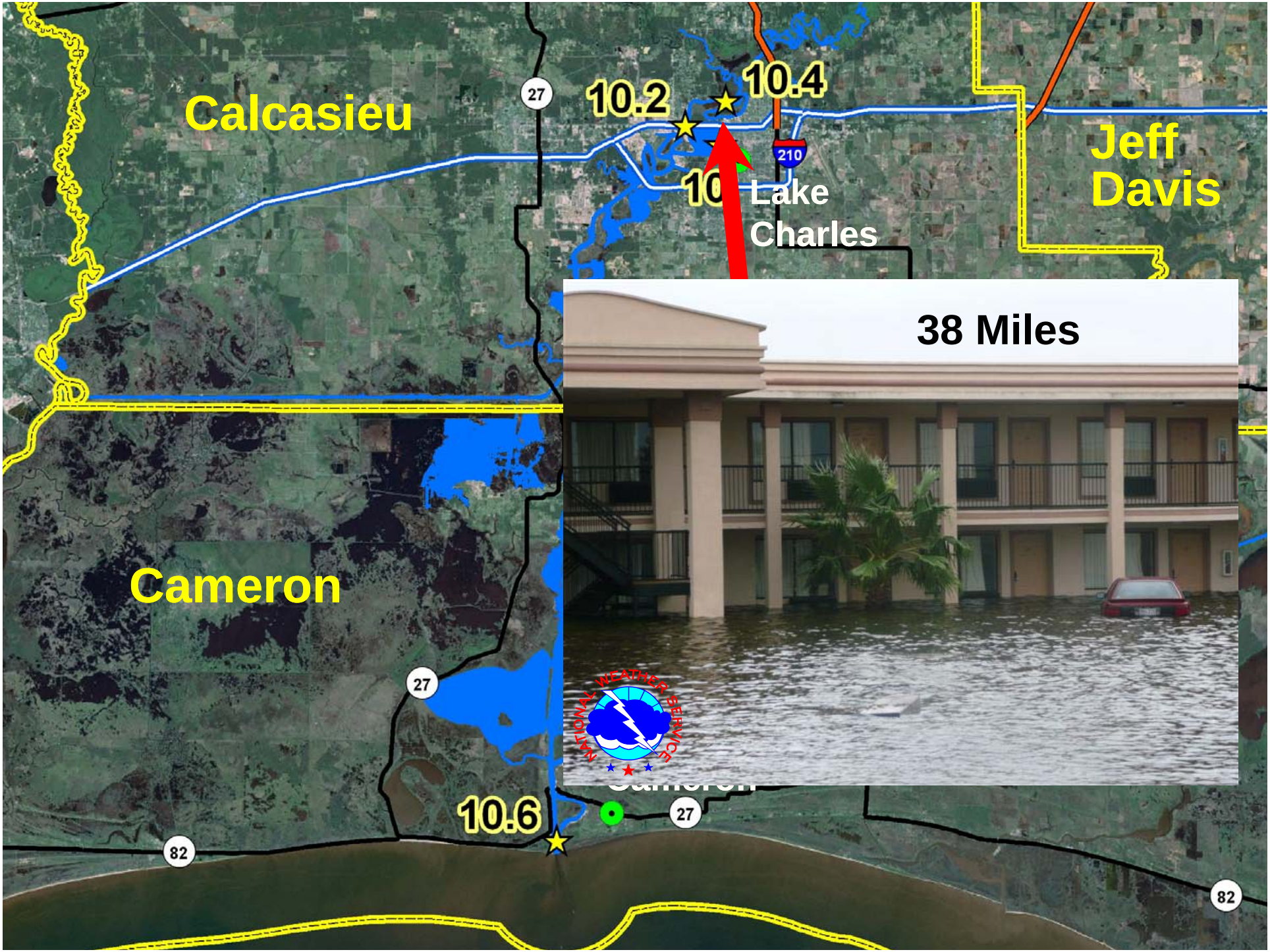


Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "Storm surge can't come this far inland."

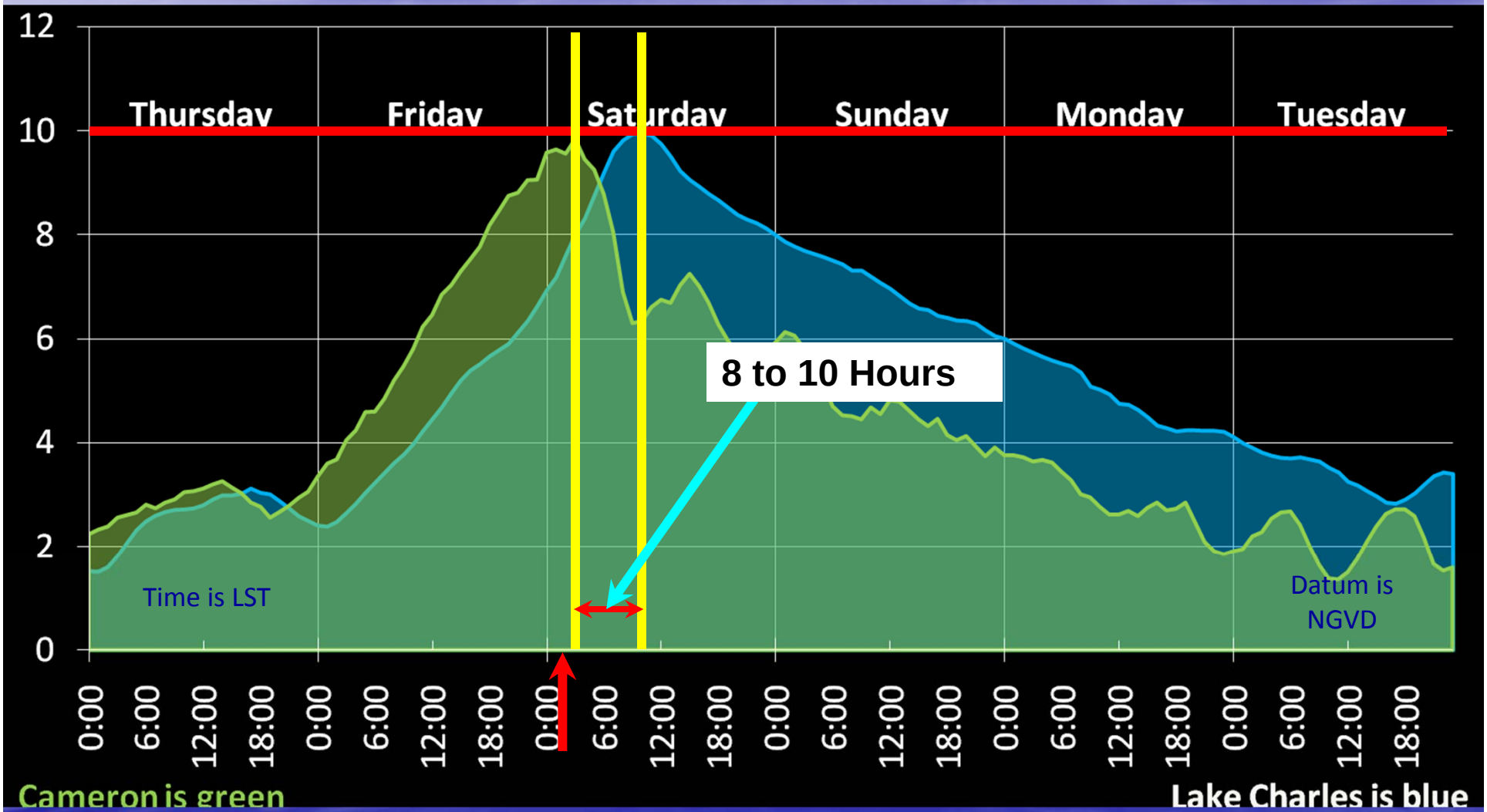

Bayou Teche
Charenton
Lynwood Plantation
Subdivision –
12 Miles from Bay
Baldwin
St. Mary
Charenton Canal
Franklin
West Cote Blanche Bay


Iberia
Erath
8.5
8.8
Delcambre
8.4
Delcambre Canal
Bayou Petite Anse
Port of Iberia
8
8.5
8.5
8.4
8.9
Weeks Island
Vermilion Bay
Sea Grant LOUISIANA
LSU AgCenter Research & Extension


Calcasieu
Jeff Davis
Cameron
10.2
10.4
10.6
Lake Charles
38 Miles
27
210
82
NATIONAL WEATHER SERVICE

Hurricane Ike

Cameron vs. Lake Charles Water Levels

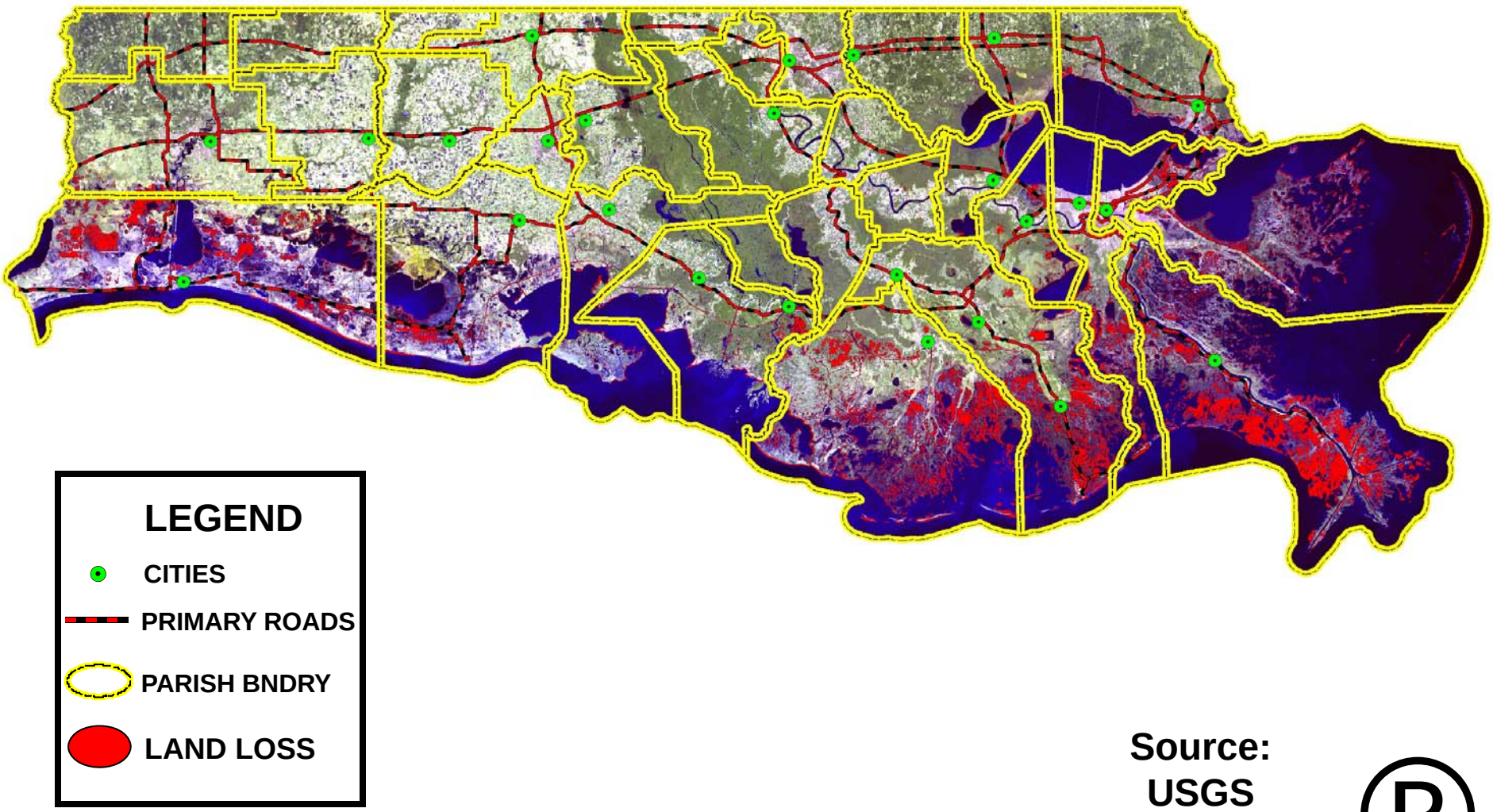


Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "Storm surge can't come this far inland."

As measured from where???

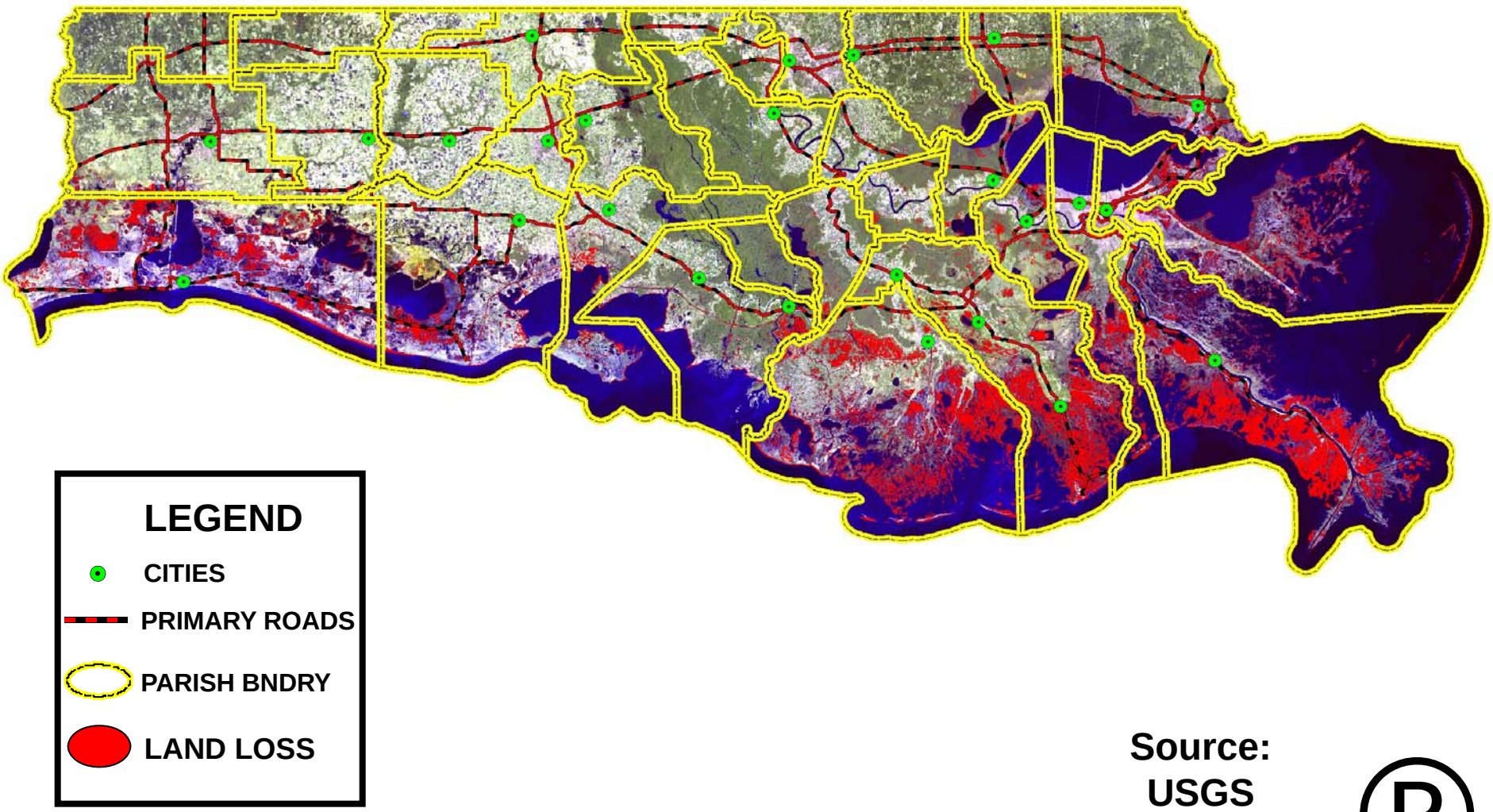
COASTAL LAND LOSS (1932 – 2000)



Source:
USGS
J. Barras

®

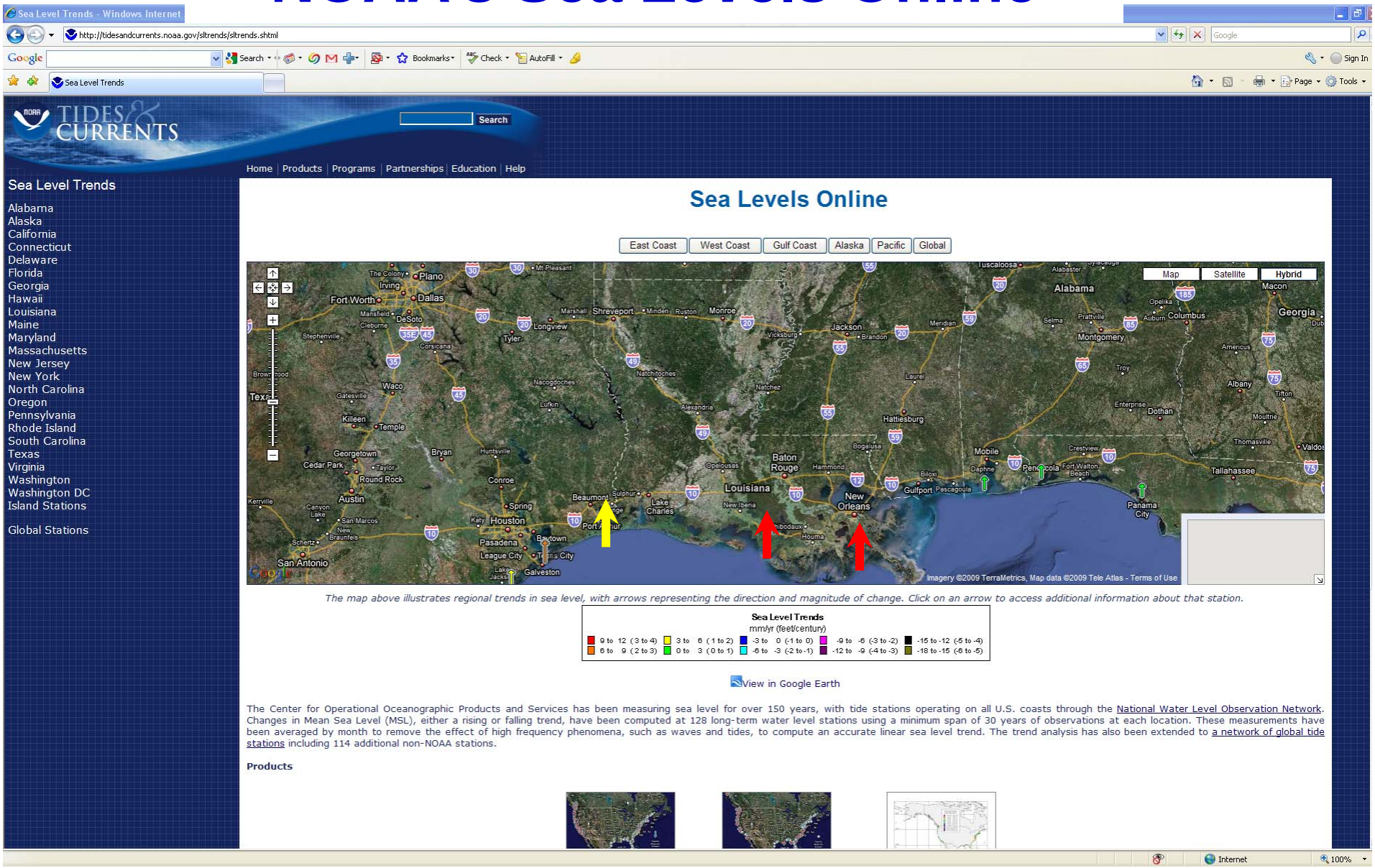
COASTAL LAND LOSS (1932 – 2050)



Source:
USGS
J. Barras

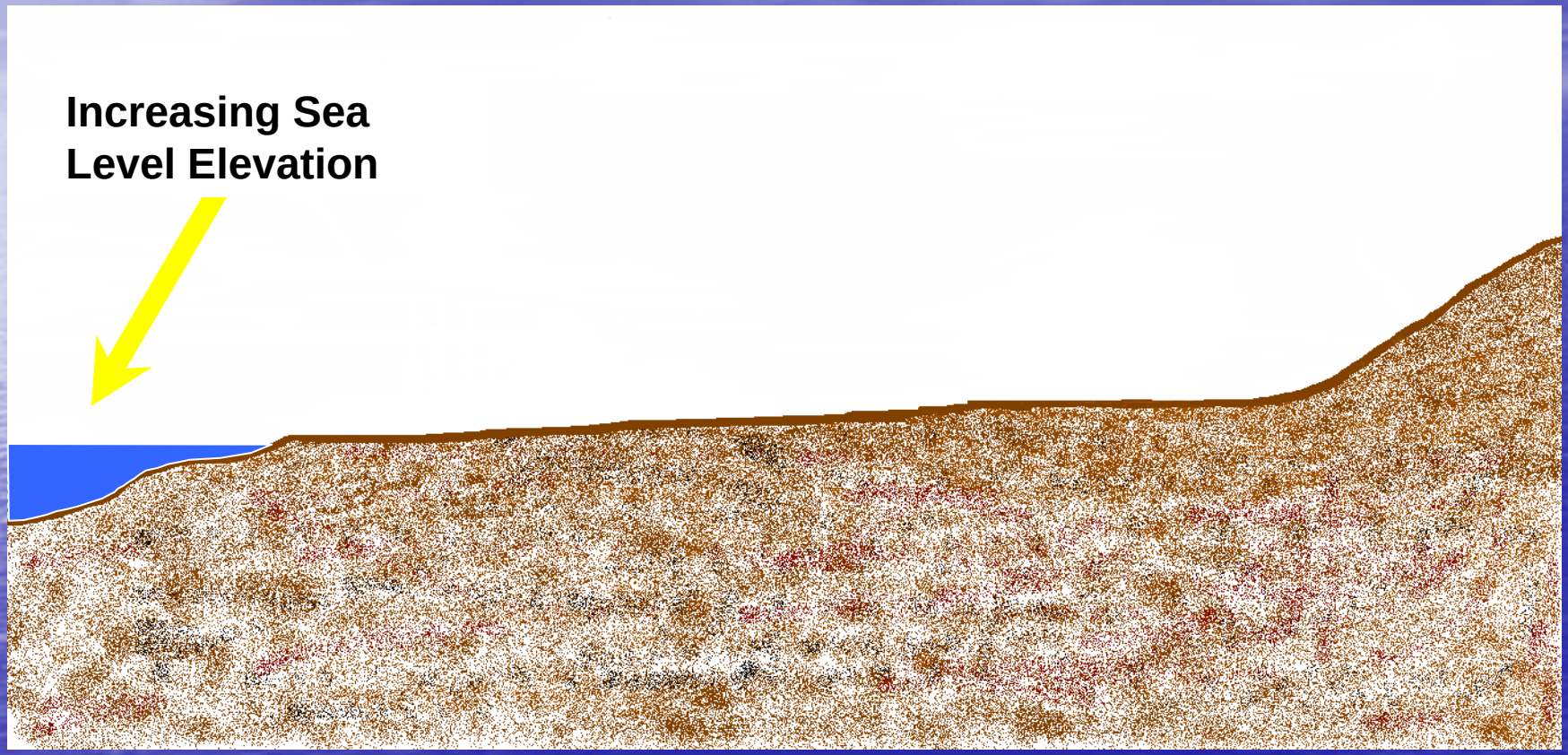
®

NOAA's Sea Levels Online

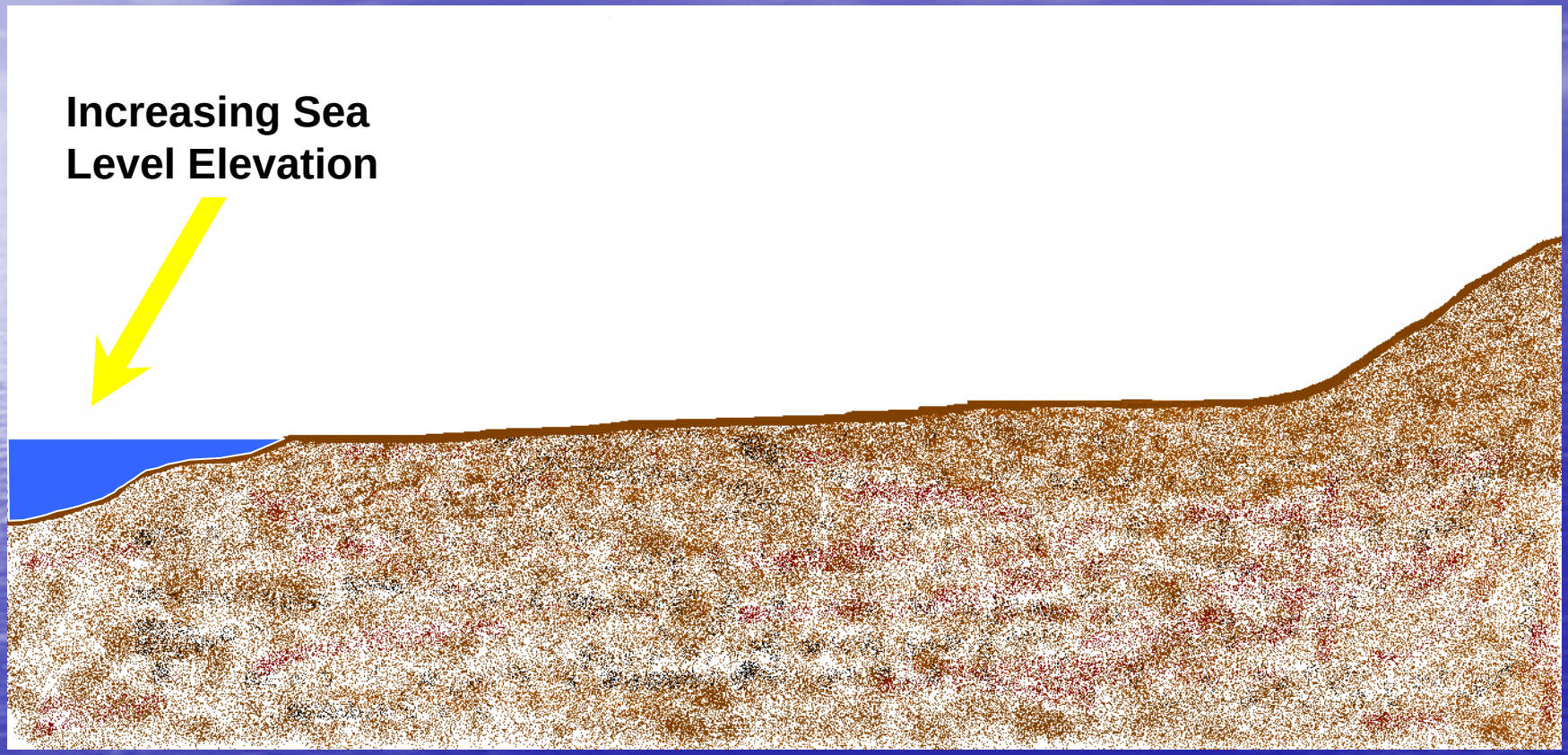


http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

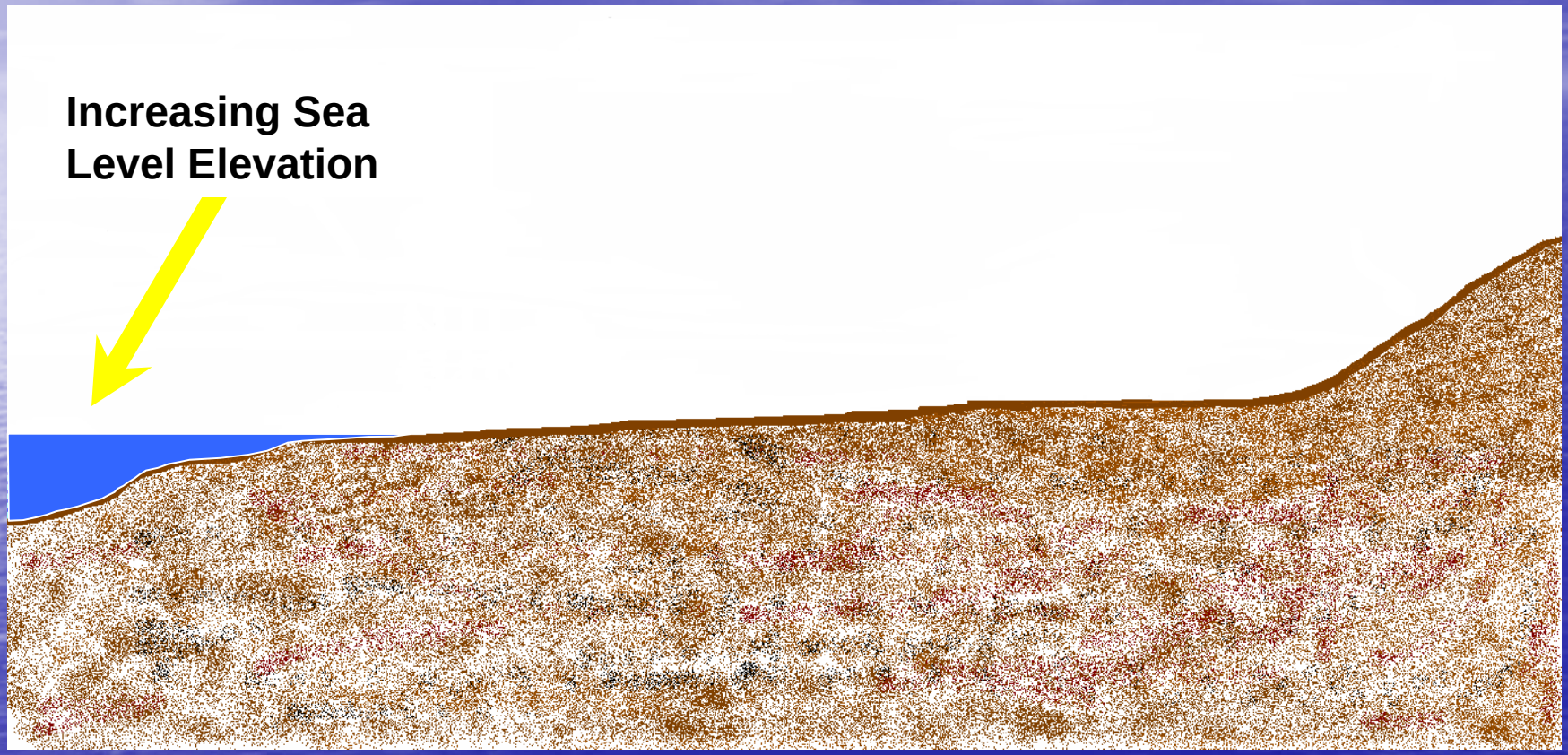
Relative Sea-Level Rise Components



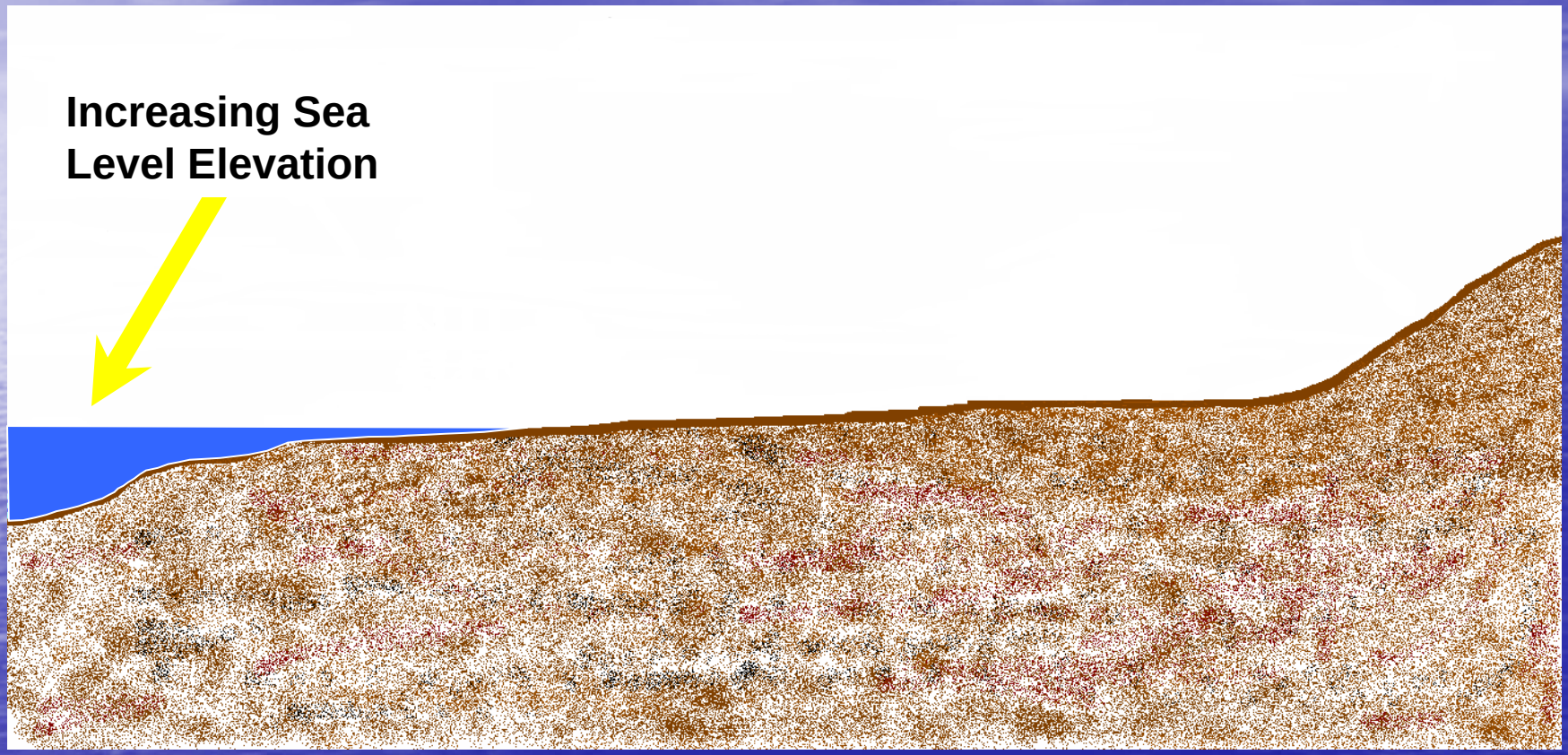
Relative Sea-Level Rise Components



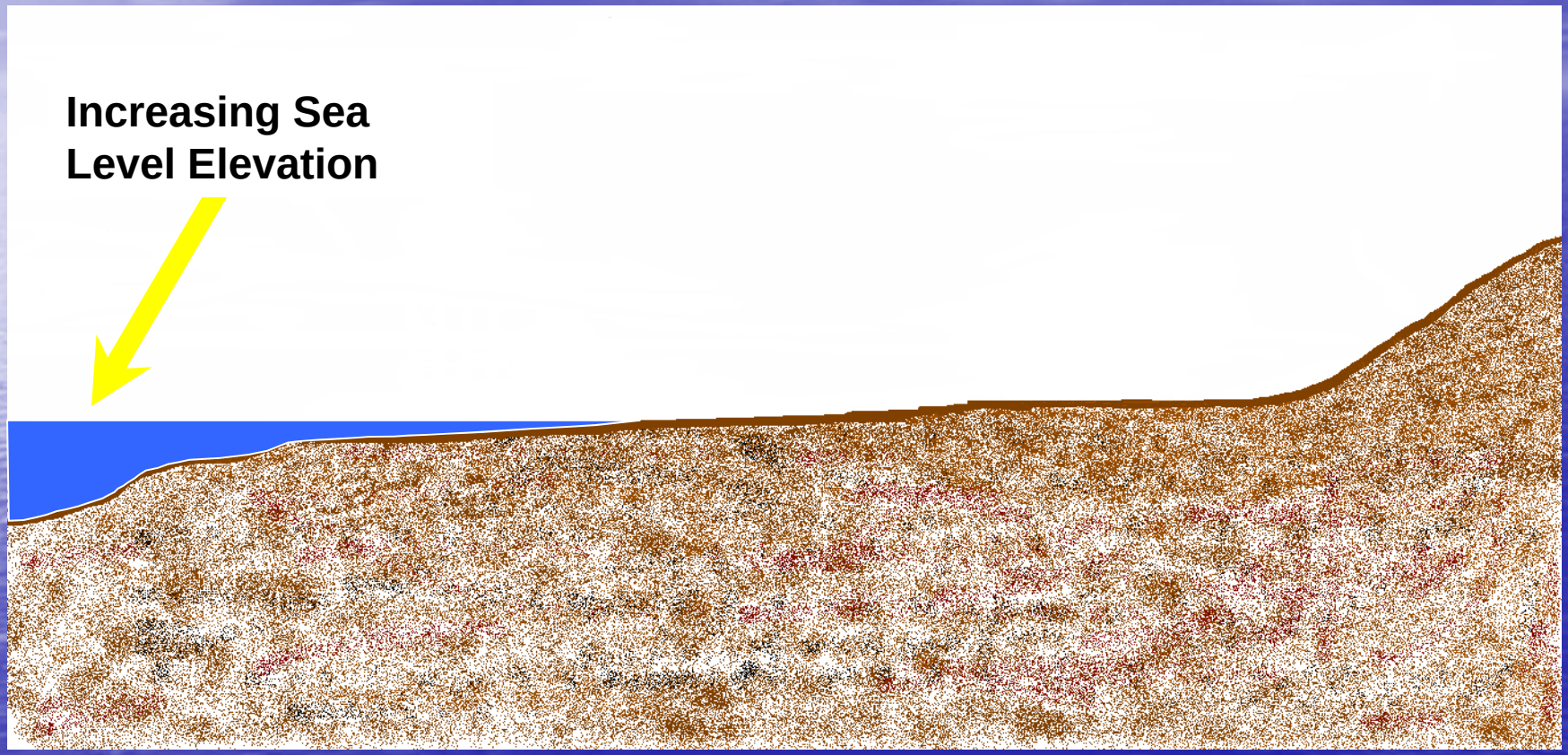
Relative Sea-Level Rise Components



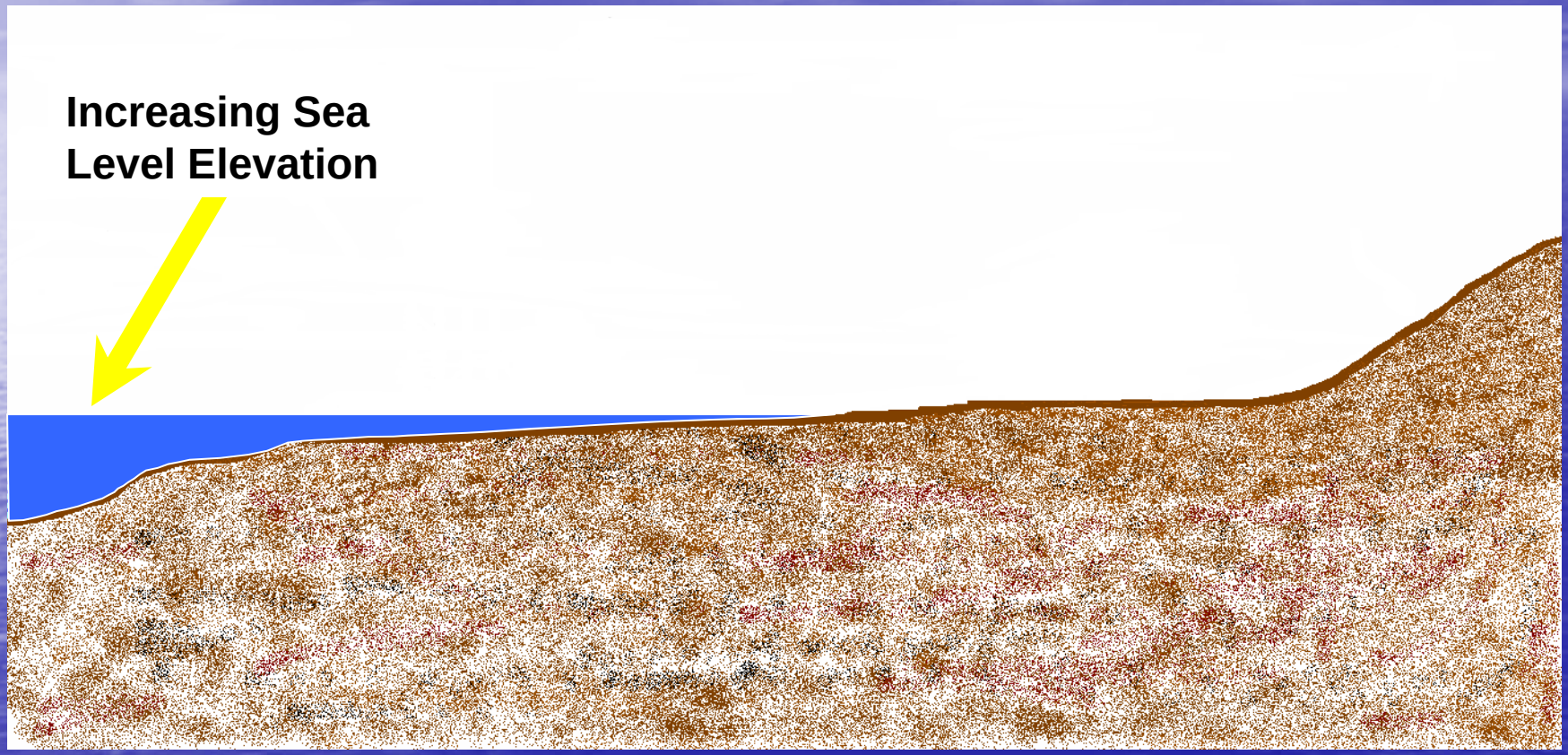
Relative Sea-Level Rise Components



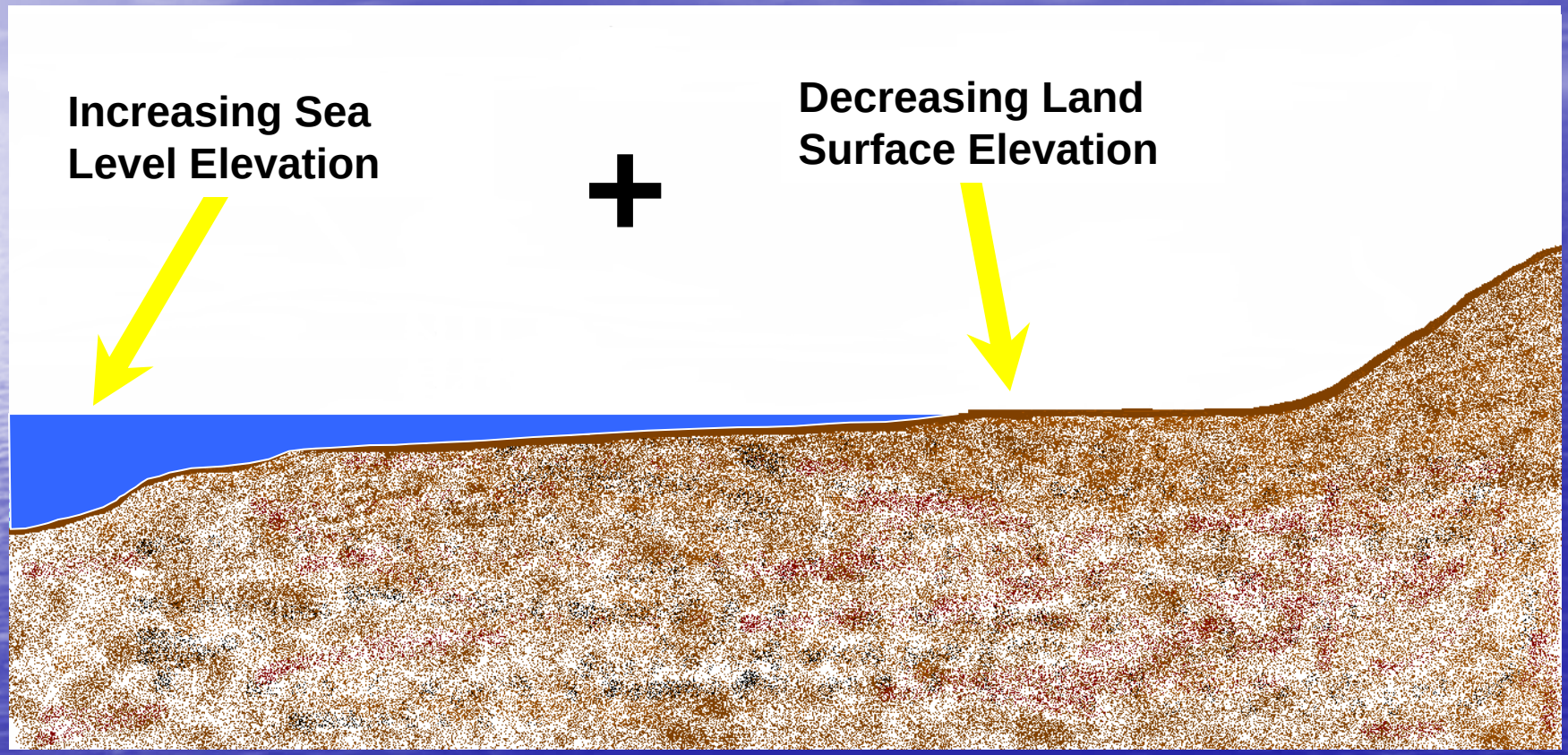
Relative Sea-Level Rise Components



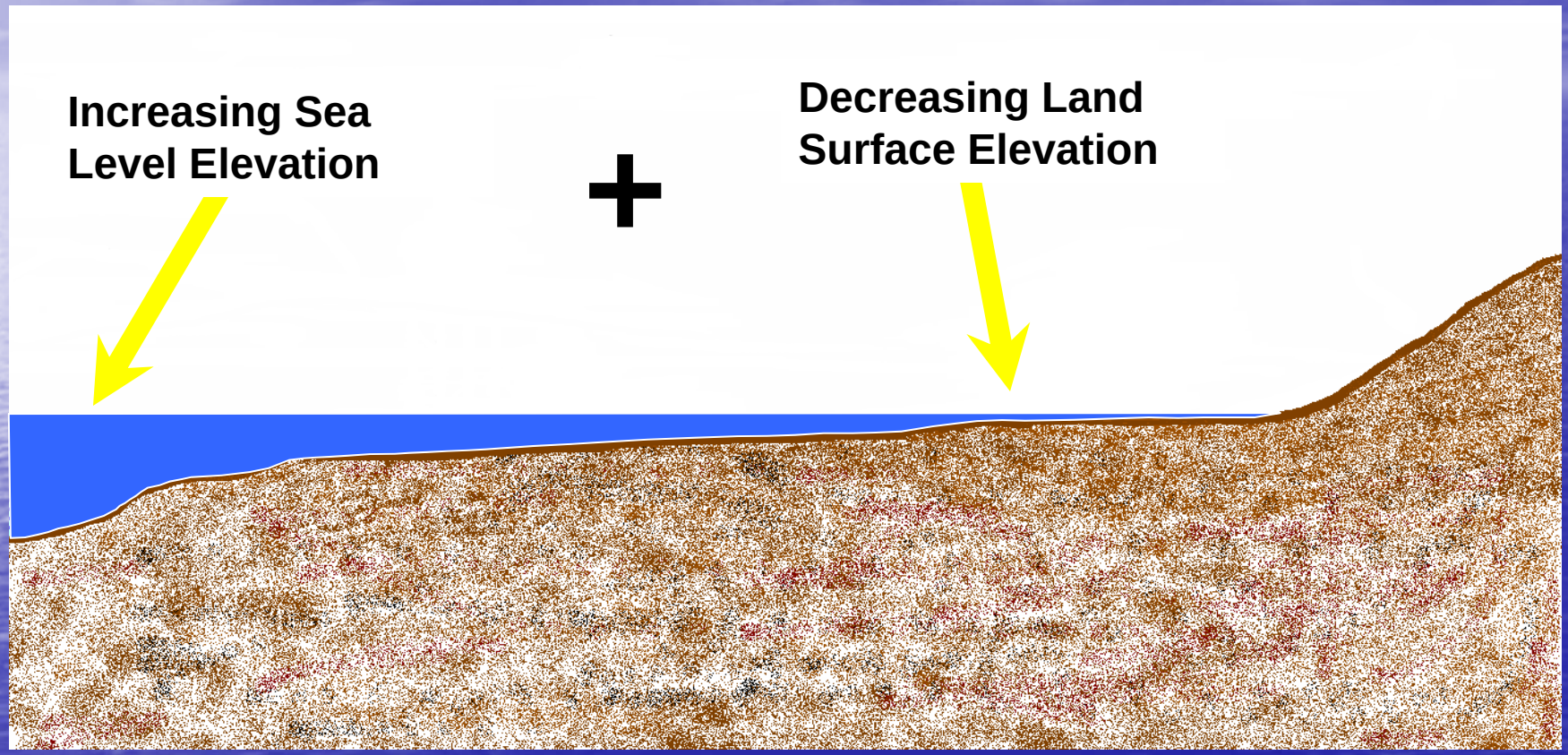
Relative Sea-Level Rise Components



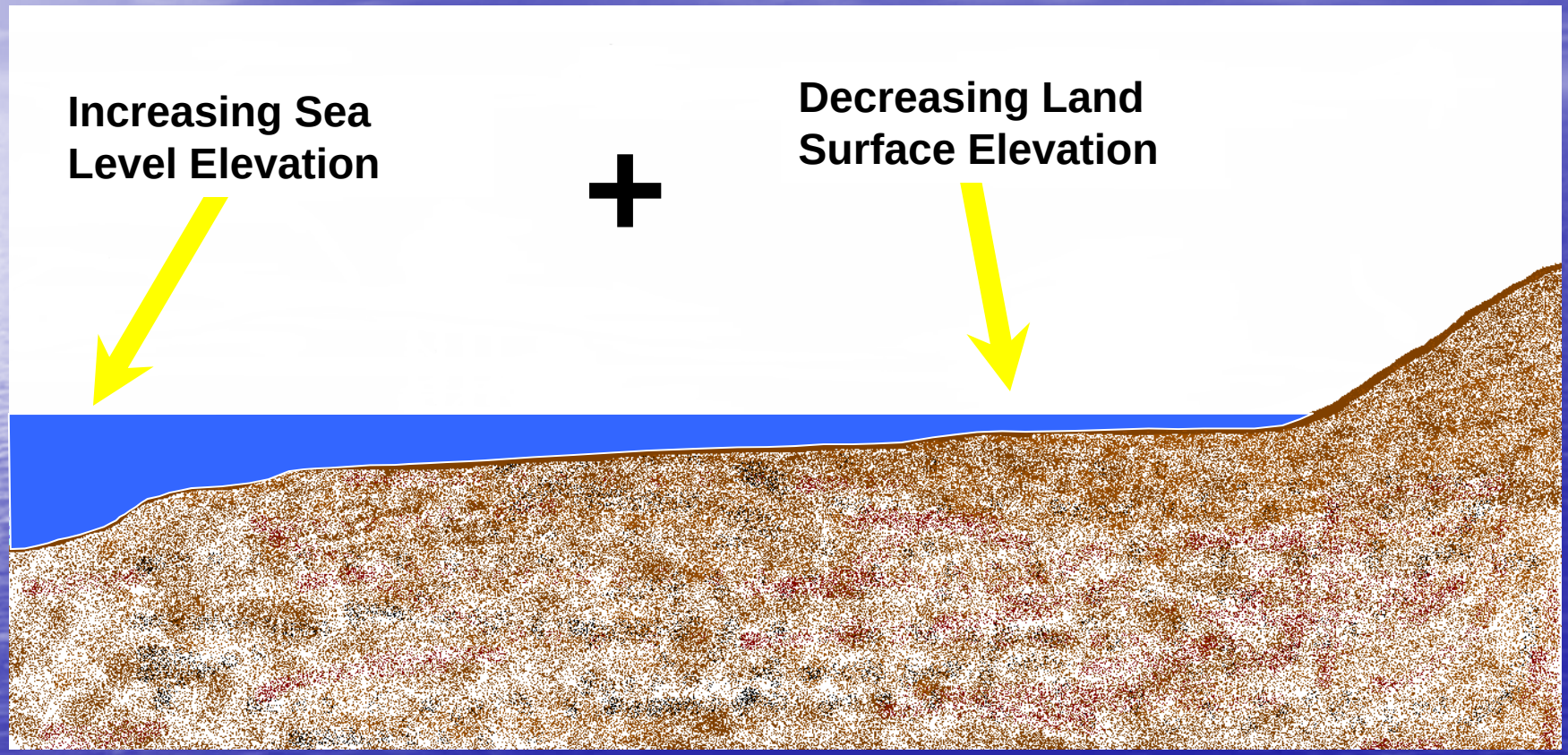
Relative Sea-Level Rise Components



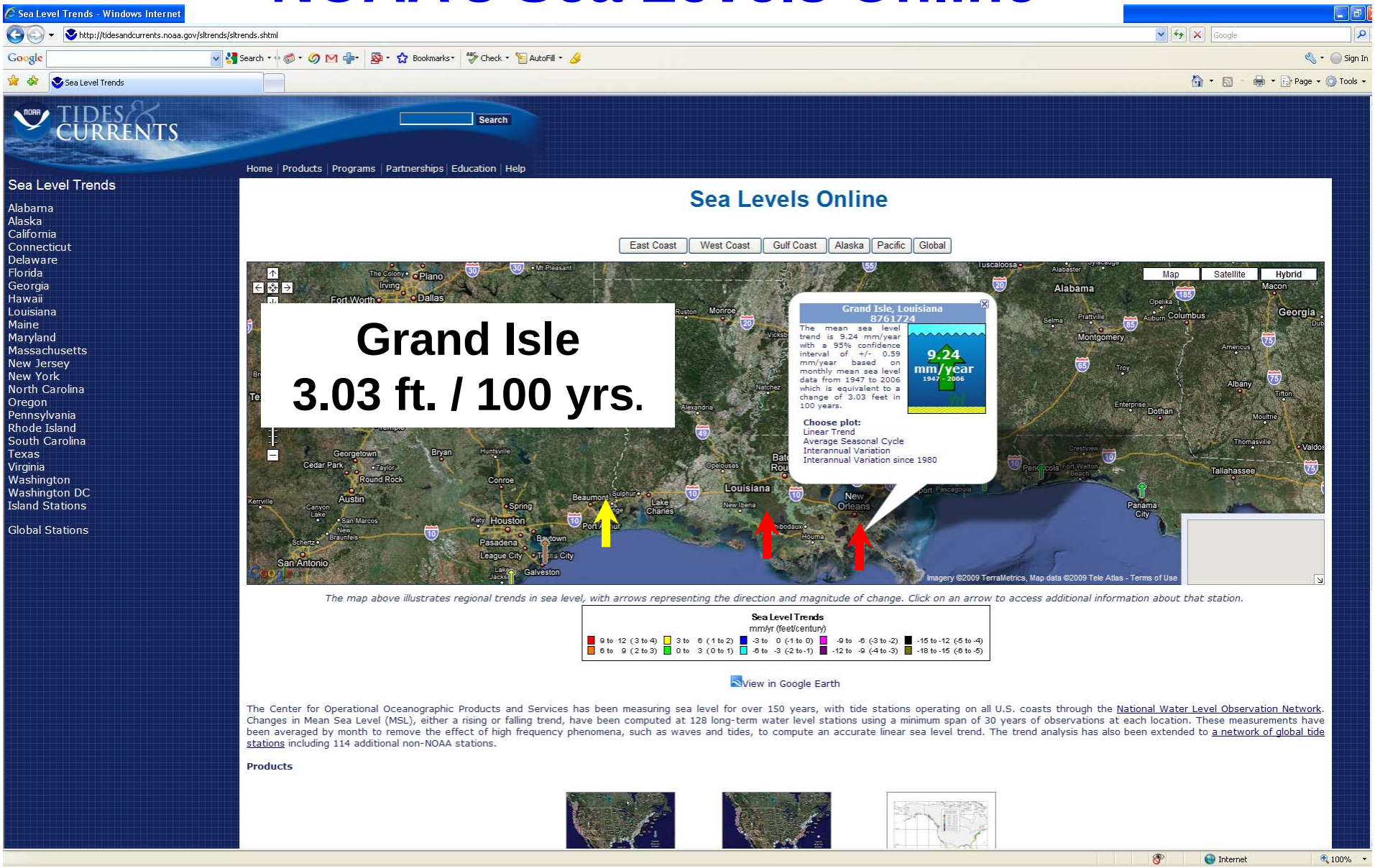
Relative Sea-Level Rise Components



Relative Sea-Level Rise Components

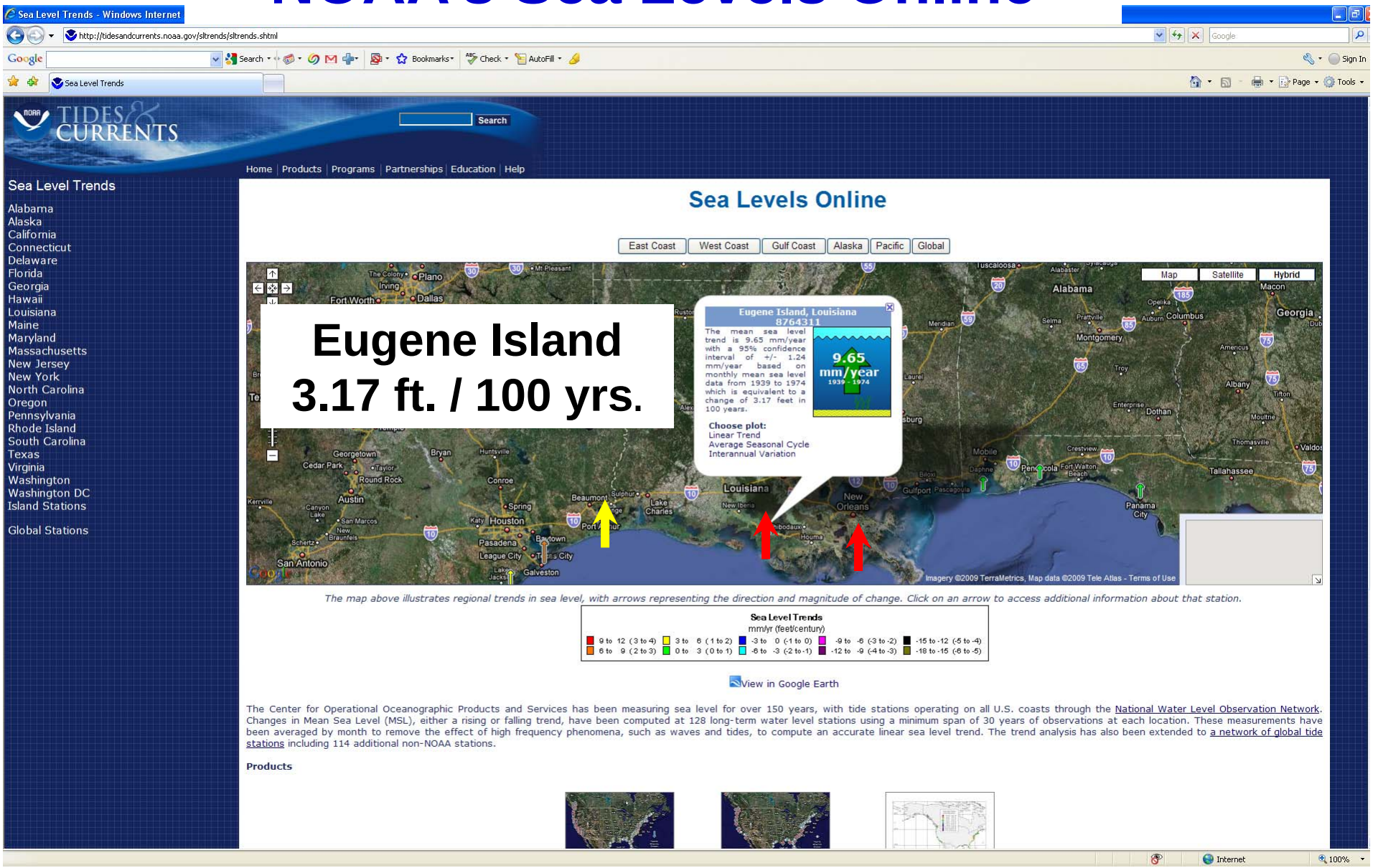


NOAA's Sea Levels Online



http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

NOAA's Sea Levels Online



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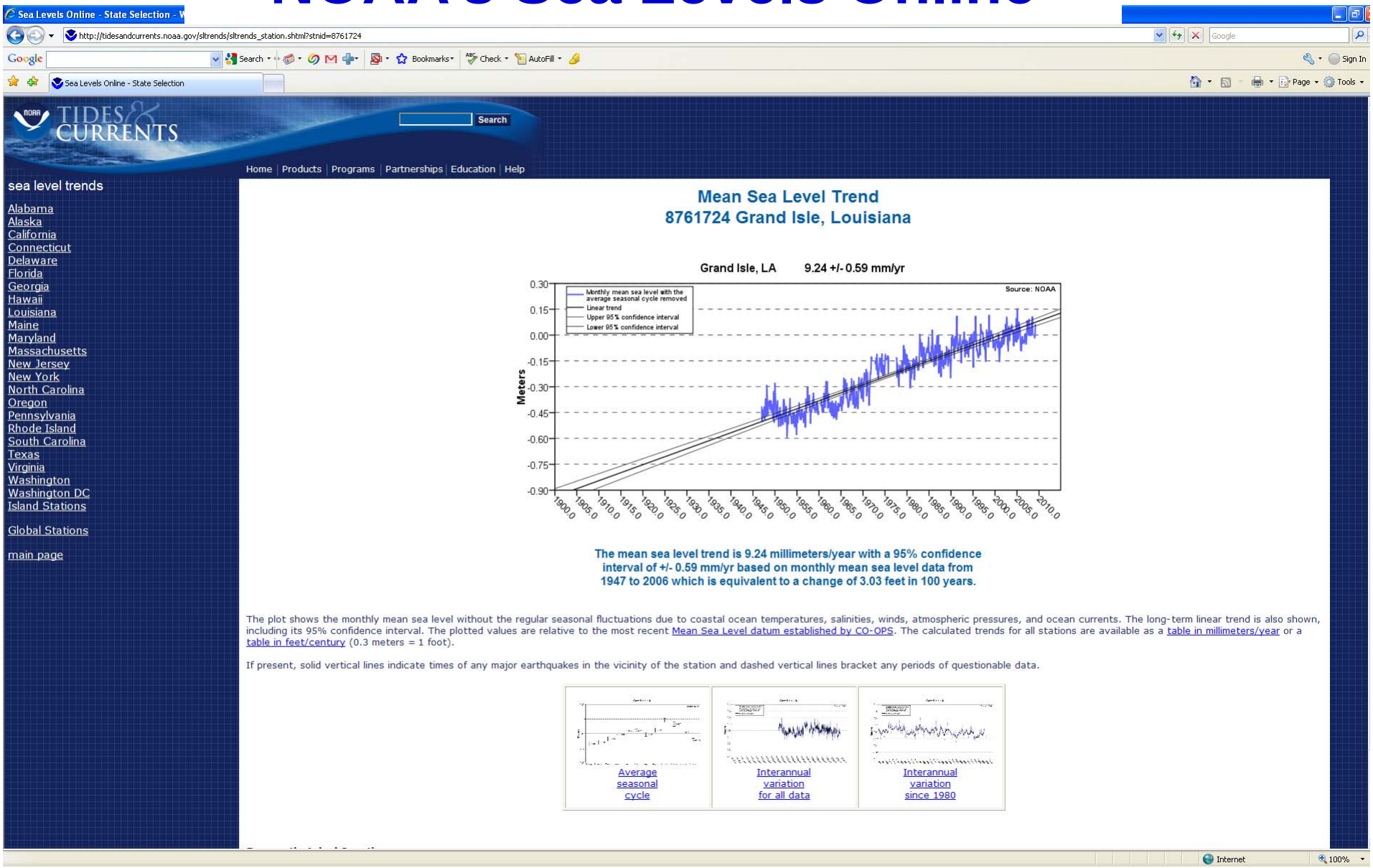
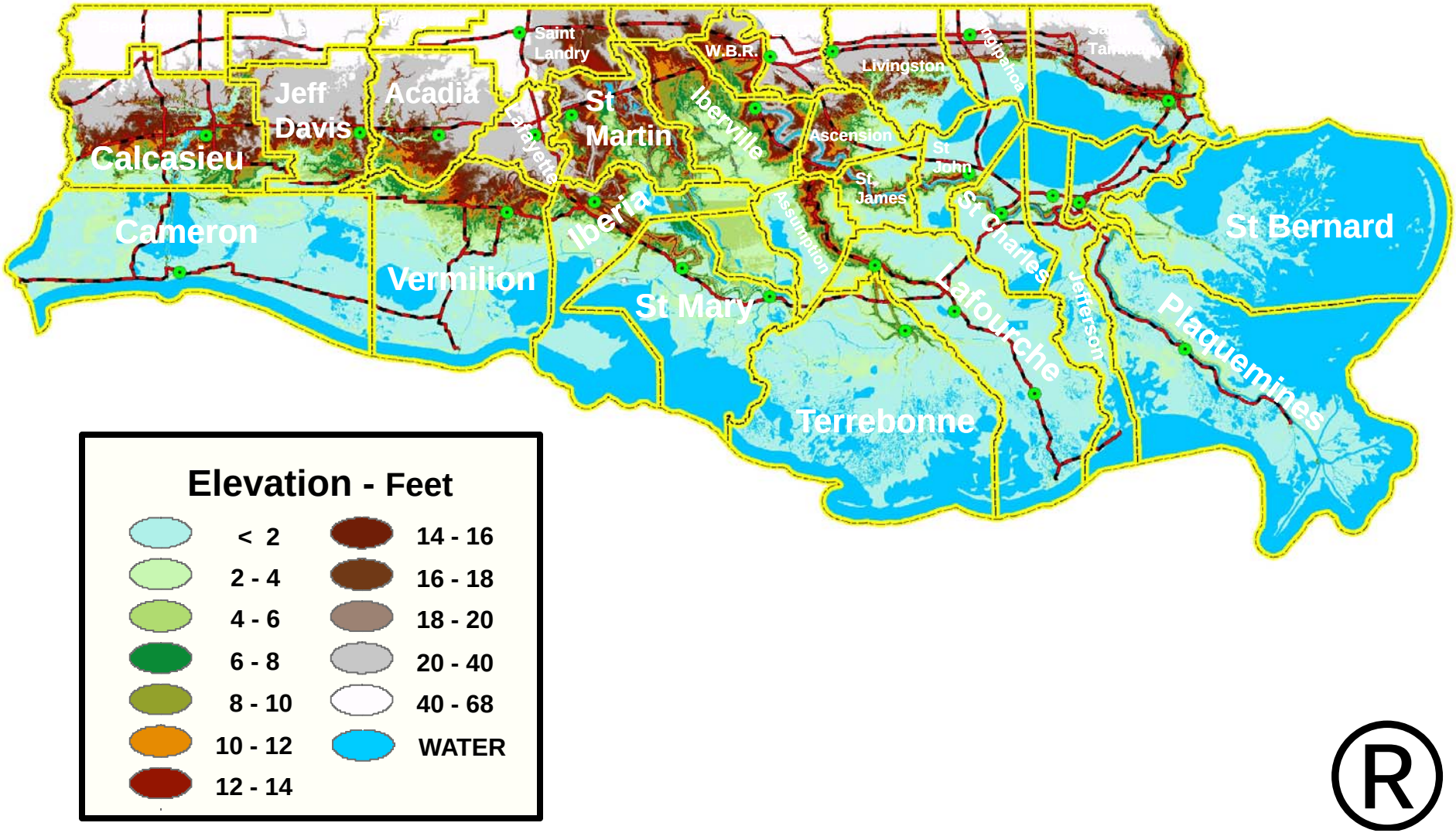
NOAA's Sea Levels Online



http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

ELEVATION – COASTAL LA. IS <u>LOW</u>

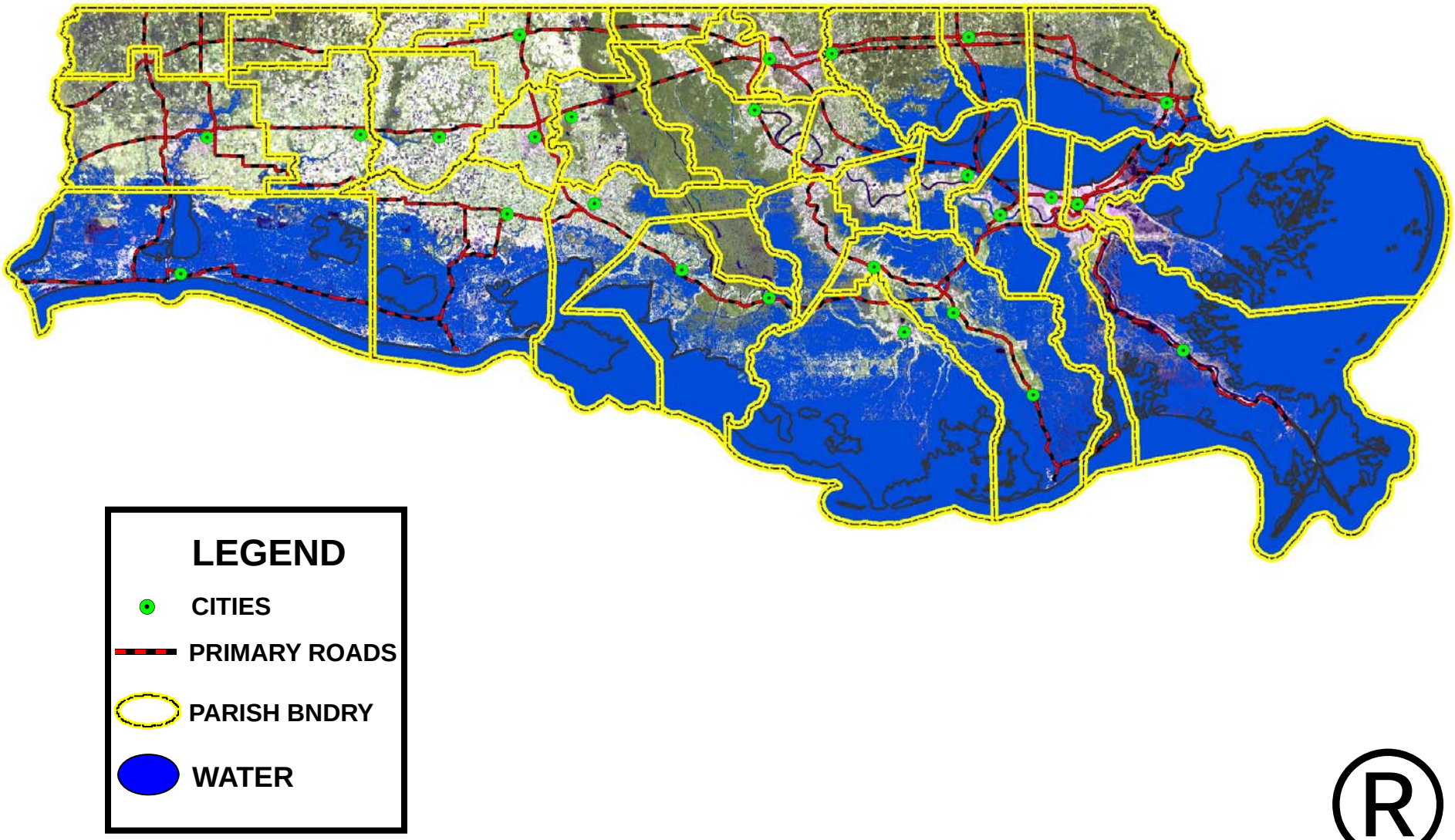
LIDAR SURFACE ELEVATION



®

POTENTIAL IMPACTS OF SEA LEVEL RISE

Inundation to 2.0 ft. Elevation



®

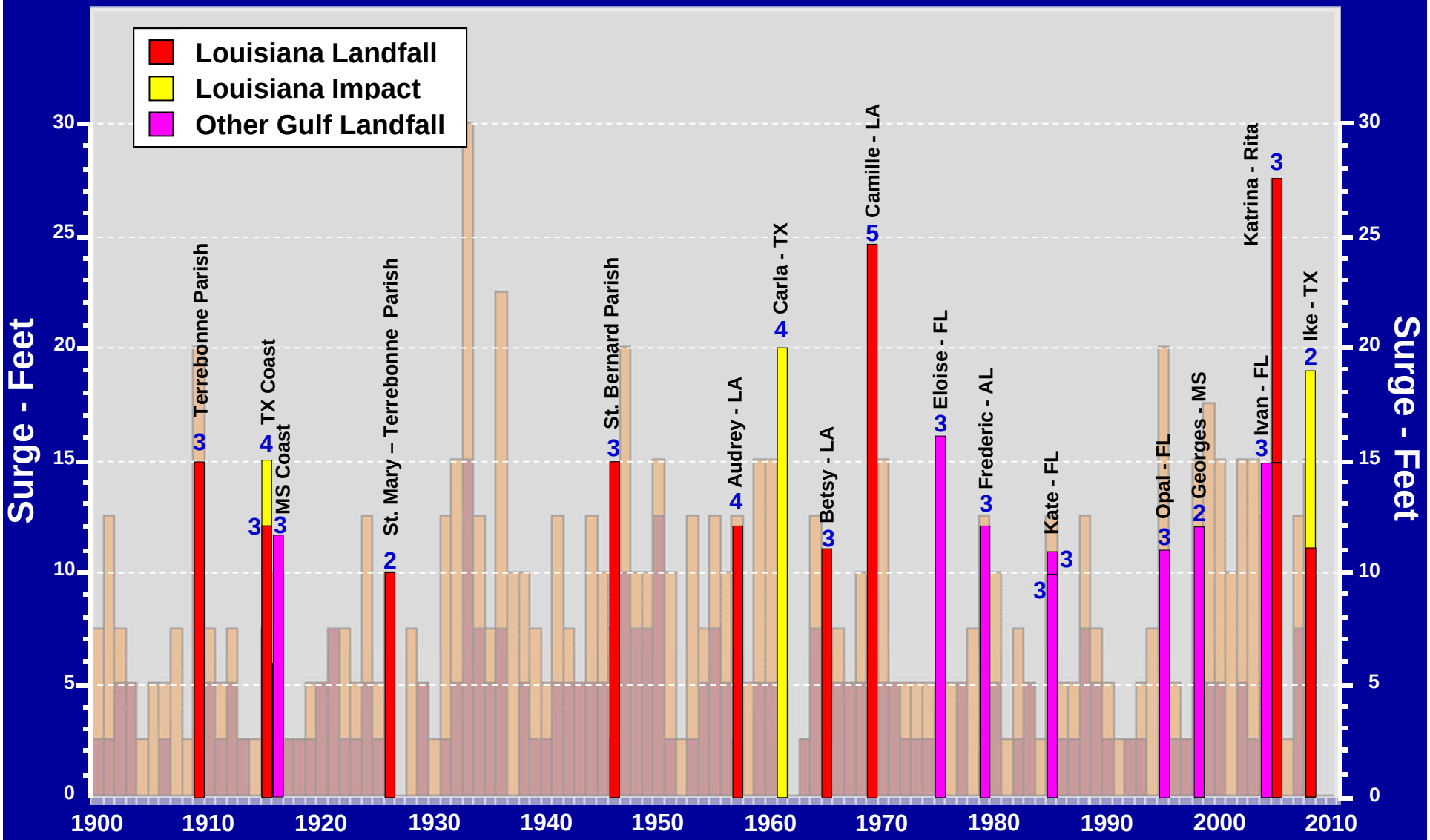
Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "It was 50 years since Audrey; it won't happen again for another 50 years." Southwest LA after Rita.

Gulf of Mexico Historical Storm Surge Activity

Hurricanes Producing 10' + Storm Surge

Central Texas to Appalachicola Florida



Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "It's only a Category 2!!!"
- "We will evacuate tomorrow morning, there is still plenty of time." Bolivar Peninsula, Texas, before Ike

Saffir – Simpson Scale

- Relates wind speeds to the potential for damage on land
- Designed to measure potential wind damage to man-made structures

- Category 1 – Winds 74 to 95 mph
- Category 2 – Winds 96 to 110 mph
- Category 3 – Winds 111 to 130 mph
- Category 4 – Winds 131 to 155 mph
- Category 5 – Winds exceed 155 mph

Saffir – Simpson Scale FAILURE

Potential Surge

- Category 1 – [illegible] – [illegible] ft
- Category 2 – 6 – 8 [illegible]
- Category 3 – [illegible] – [illegible] ft
- Category 4 – 13 – 18 ft
- Category 5 – >18 ft

Charley - Category 4	Surge 6 – 9 ft
Katrina - Category 3	Surge 27+ ft
Ike - Category 2	Surge 15 – 20 ft

Saffir – Simpson Scale

- For 2009, the National Hurricane center will be using a “new” version of the the Saffir-Simpson Hurricane Scale
- It will be called the Saffir-Simpson Hurricane WIND Scale
  - Will assess only wind speed
  - All information related to storm surge and flooding will be removed

HURRICANE IKE ADVISORY NUMBER 42

NWS TPC/NATIONAL HURRICANE CENTER, MIAMI, FL
10 AM CDT THUR SEPT 11 2008
(Ike made landfall SEPT 13, 2008 2:00 AM)

COASTAL STORM SURGE FLOODING OF UP TO 20 FEET ABOVE NORMAL TIDE LEVELS...LOCALLY UP TO 20 FEET AT HEAD OF BAYS AND NEARBY RIVERS...WITH LARGE AND DANGEROUS BATTERING WAVES...CAN BE EXPECTED NEAR AND TO THE EAST OF WHERE THE CENTER MAKES LANDFALL.

HURRICANE IKE ADVISORY NUMBER 44

NWS TPC/NATIONAL HURRICANE CENTER, MIAMI, FL
10 PM CDT THUR SEPT 11 2008
(Ike made landfall SEPT 13, 2008 2:00 AM)

THE SURGE EXTENDS A GREATER THAN USUAL DISTANCE FROM THE CENTER DUE TO THE LARGE SIZE OF THE CYCLONE. WATER LEVELS HAVE ALREADY INCREASED TO 9 TO 12 FEET ABOVE NORMAL ALONG MUCH OF THE NORTHWESTERN GULF COAST.

Communicating the threat from Ike was not so easy

- It's **just** a **Category 2**
- It's making landfall well to the west
- It's just weather propaganda

Led to strongly worded warnings:

"Hurricane Ike has the potential to produce a storm surge similar to a Category 4 storm!"

Communicating the threat from Ike was not so easy

- It's **just** a **Category 2**
- It's making landfall well to the west
- It's just weather propaganda

Led to strongly worded warnings:

"Neighborhoods that are affected by the storm surge … and possibly entire coastal communities … will be inundated during the period of peak storm tide."

Communicating the threat from Ike was not so easy

- It's **just** a **Category 2**
- It's making landfall well to the west
- It's just weather propaganda

Led to strongly worded warnings:

"Persons not heeding evacuation orders in single-family, one- or two-story homes may face certain death. … Widespread and devastating personal property damage is likely."

Communicating the threat from Ike was not so easy

- It's **just** a **Category 2**
- It's making landfall well to the west
- It's just weather propaganda

Led to strongly worded warnings:

In other words,

"LEAVE or DIE"

Ike - Friday morning 9/12/2008: Bolivar - Its too late!

AP

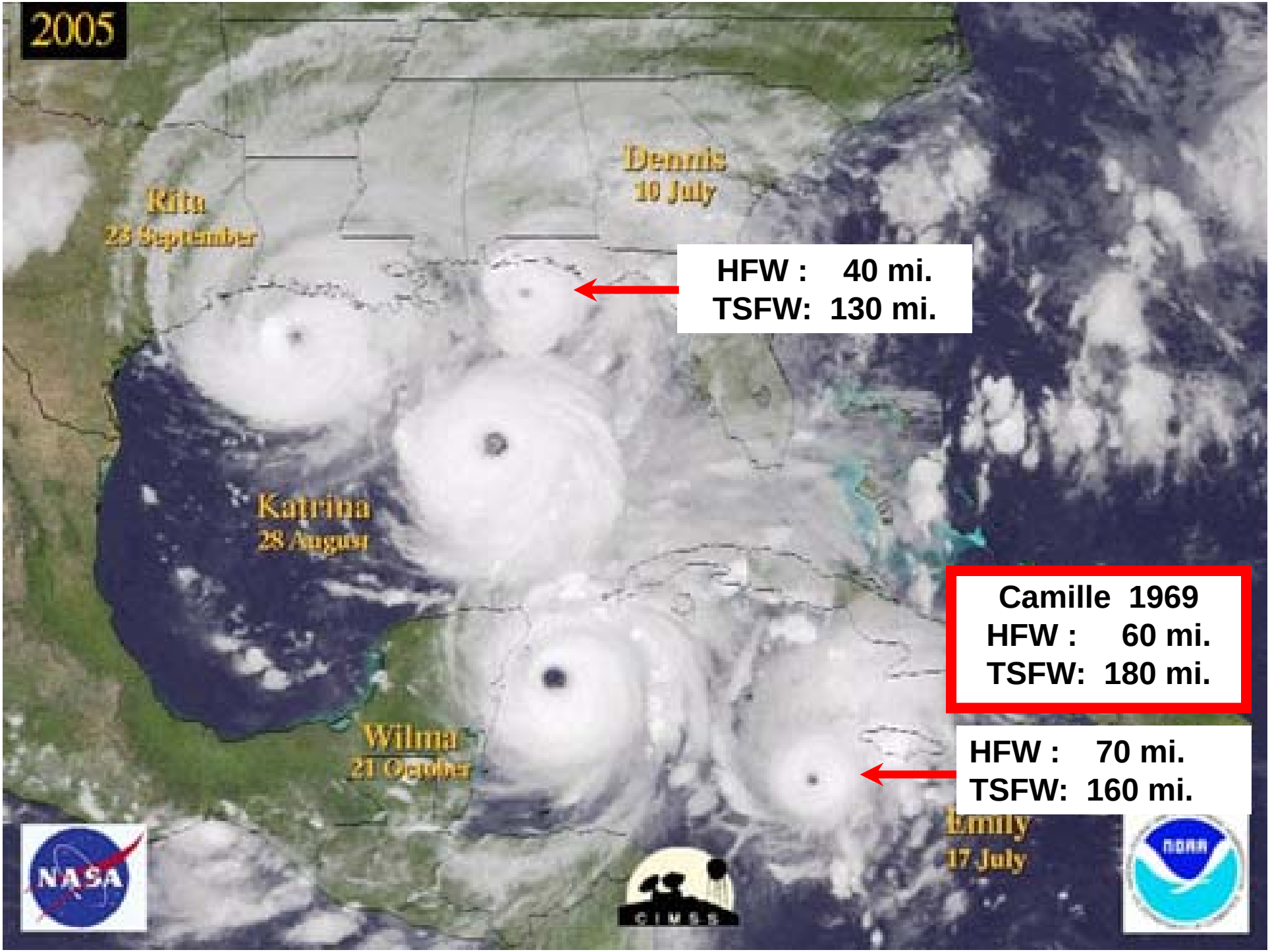
Saffir – Simpson Scale

- While higher wind speeds create the potential for higher storm surges, there **IS NOT** an ideal relationship between storm category and storm surge

WHY? Many other factors are involved

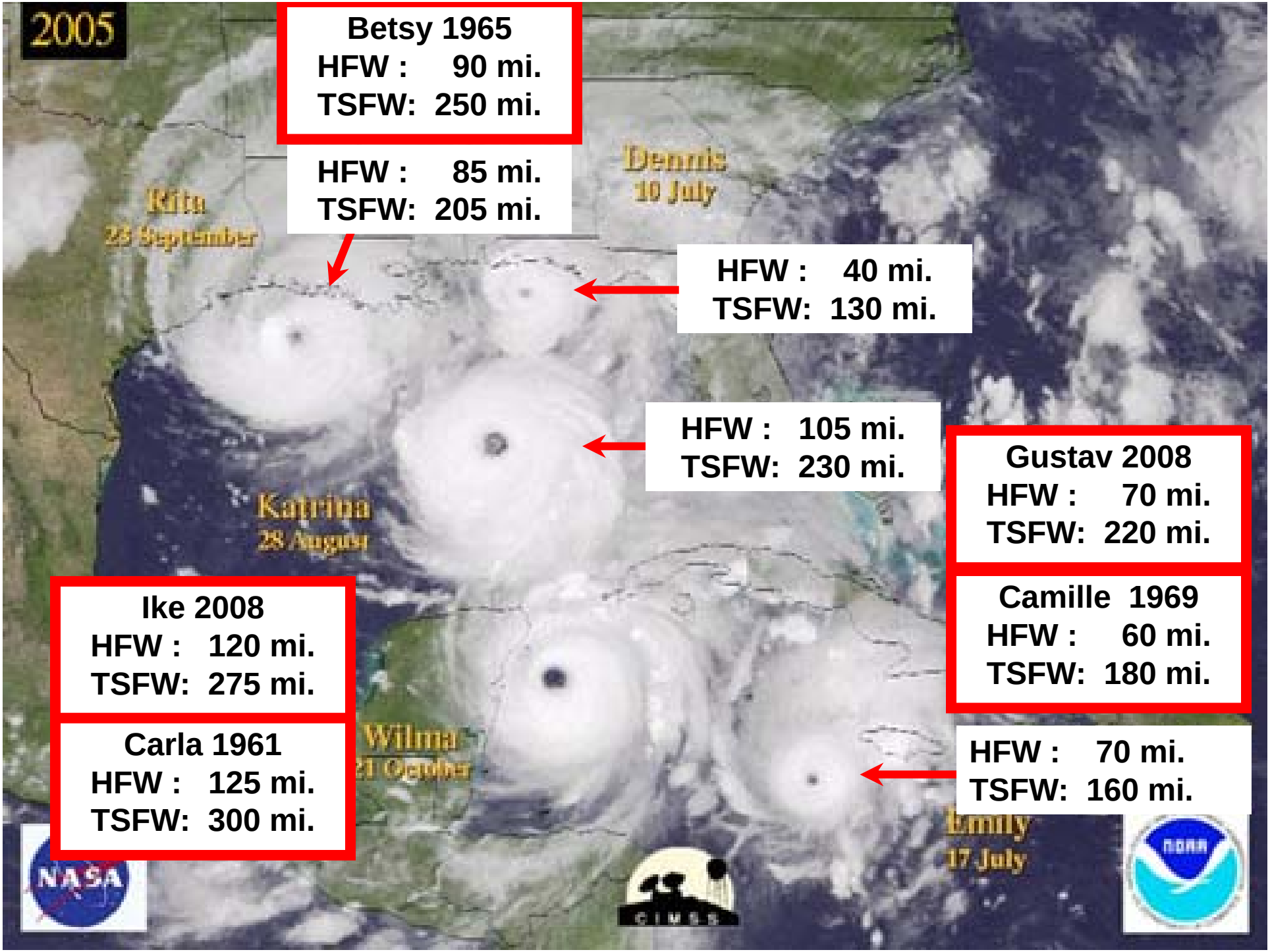
Factors Impacting Storm Surge

- Storm Factors
  - Intensity of storm
  - Wind speed
  - Radius of maximum winds - SIZE
  - Atmospheric pressure


2005
Dennis
10 July
Rita
23 September
HFW : 40 mi.
TSFW: 130 mi.
Katrina
28 August
Camille 1969
HFW : 60 mi.
TSFW: 180 mi.
Wilma
21 October
HFW : 70 mi.
TSFW: 160 mi.
Emily
17 July
NASA
CIMSS
NOAA

Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "This (house, building) survived Camille, it will survive anything." Mississippi Gulf Coast resident prior to Katrina
  - Camille Syndrome – "It looks like Hurricane Camille killed more people in 2005 than it did in 1969." (Attributed to Jim Holt of Biloxi, quoted in the *Biloxi Sun Herald.)*


2005
Betsy 1965
HFW : 90 mi.
TSFW: 250 mi.
HFW : 85 mi.
TSFW: 205 mi.
Rita
23 September
Dennis
10 July
HFW : 40 mi.
TSFW: 130 mi.
HFW : 105 mi.
TSFW: 230 mi.
Katrina
28 August
Gustav 2008
HFW : 70 mi.
TSFW: 220 mi.
Ike 2008
HFW : 120 mi.
TSFW: 275 mi.
Camille 1969
HFW : 60 mi.
TSFW: 180 mi.
Carla 1961
HFW : 125 mi.
TSFW: 300 mi.
Wilma
21 October
HFW : 70 mi.
TSFW: 160 mi.
Emily
17 July
NASA
CIMSS
NOAA

Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "We didn't flood for Gustav, why should we worry about Ike?"
- "We didn't flood for Andrew, why should we worry about ???"

- Storm Factors
  - Forward speed
  - Track of the storm

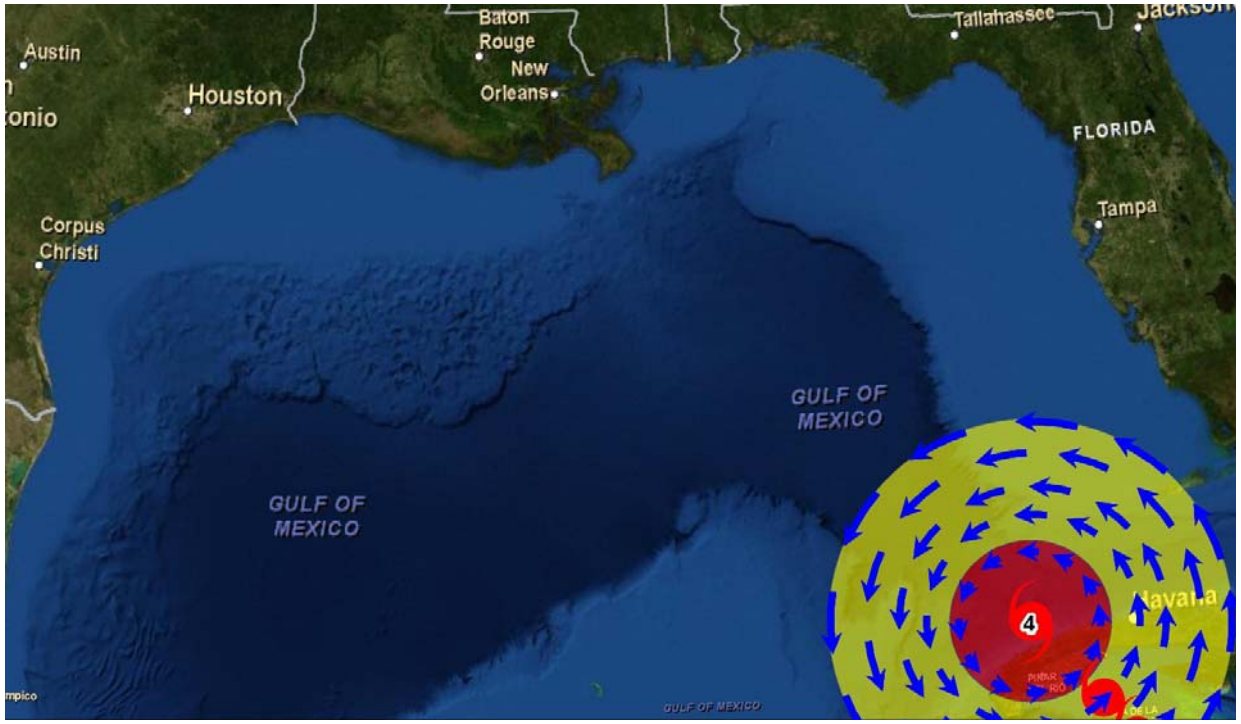
How does this impact storm surge?

- Fast moving storms cause high surges along open coast and lower surges in sheltered bays and estuaries.
- Slow moving storms usually result in greater flooding inside bays and estuaries, with smaller values along the open coast.
- **The longer the wind blows over water toward land, the greater the potential for flooding.**

GULF + 0 hrs.

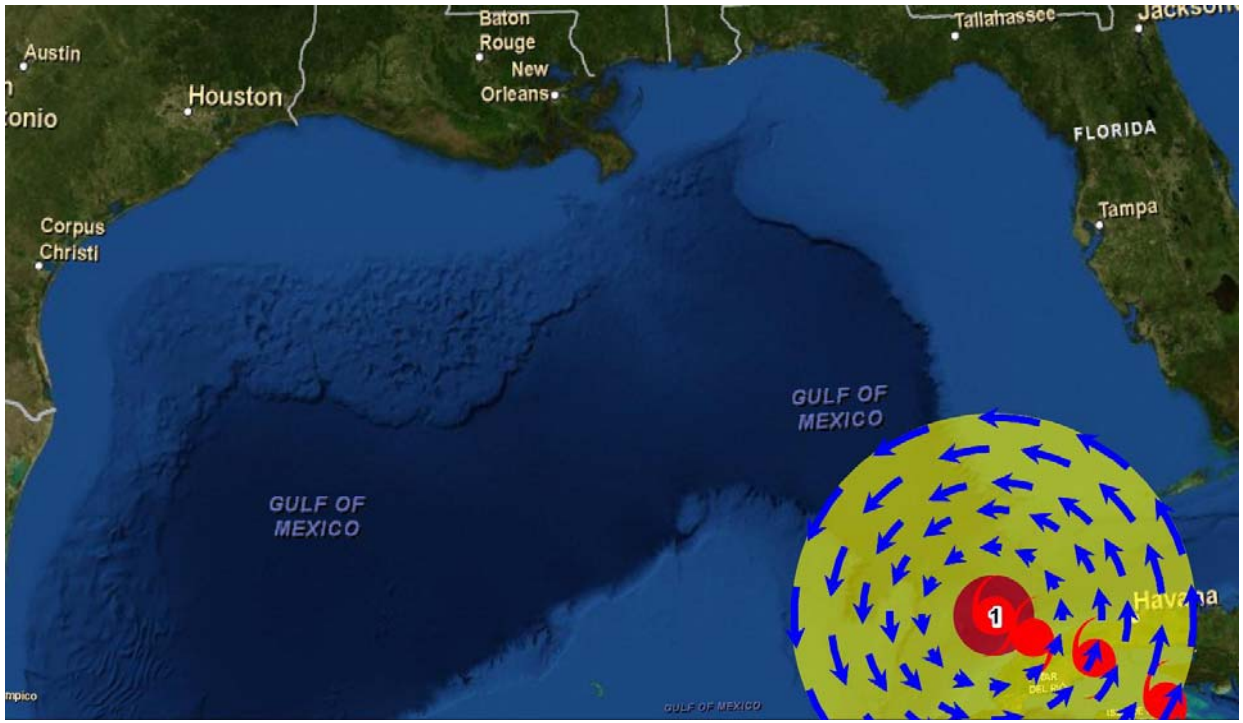
Gustav

HFW	70 mi.
TSFW	175 mi.
Max Winds	140 mph
In Wind Field	0 hr.



Ike

HFW	35 mi.
TSFW	175 mi.
Max Winds	80 mph
In Wind Field	0 hr.



GULF + 6 hrs.

Gustav

HFW	50 mi.
TSFW	200 mi.
Max Winds	125 mph
In Wind Field	0 hr.

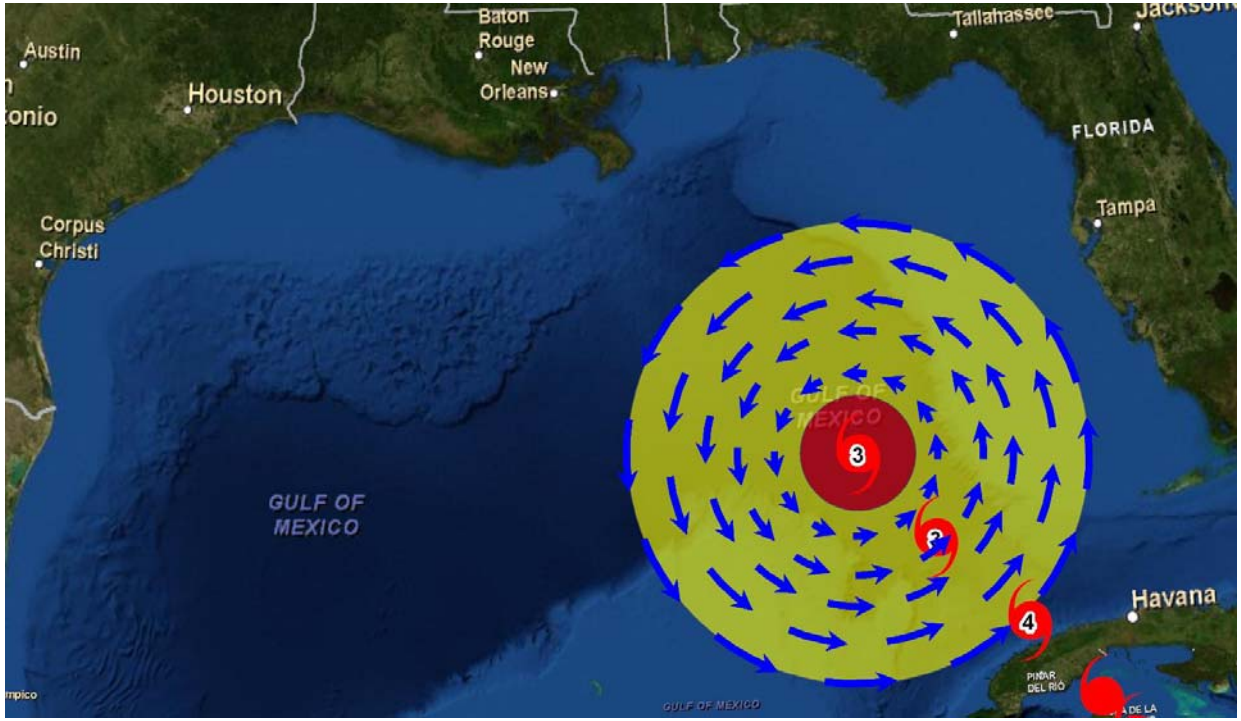
Ike

HFW	35 mi.
TSFW	175 mi.
Max Winds	85 mph
In Wind Field	0 hr.

GULF + 12 hrs.

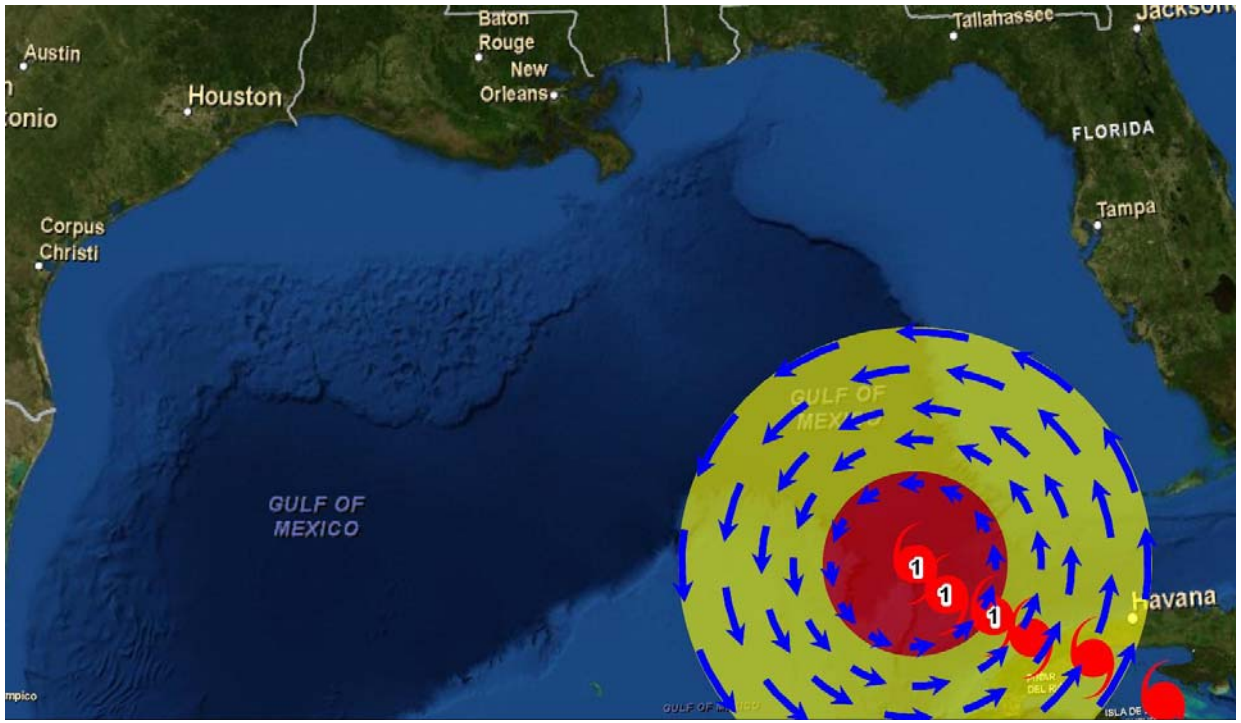
Gustav

HFW	50 mi.
TSFW	200 mi.
Max Winds	120 mph
In Wind Field	0 hr.



Ike

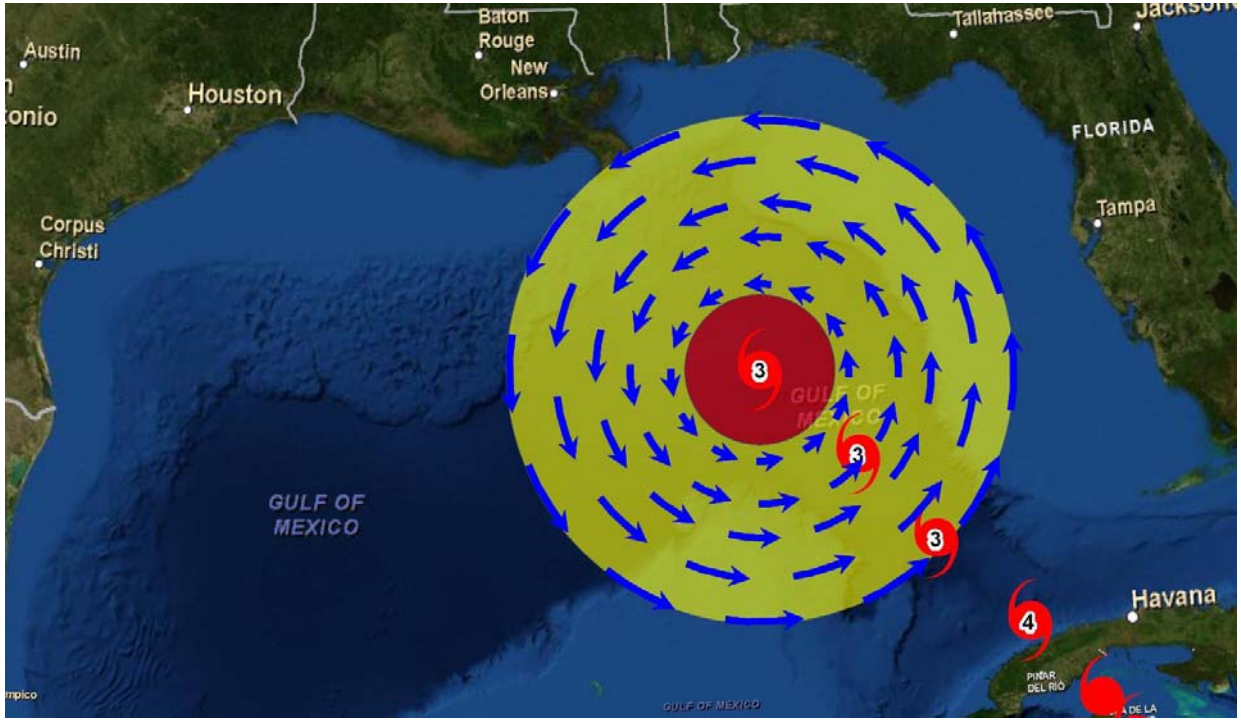
HFW	80 mi.
TSFW	205 mi.
Max Winds	90 mph
In Wind Field	0 hr.



GULF + 18 hrs.

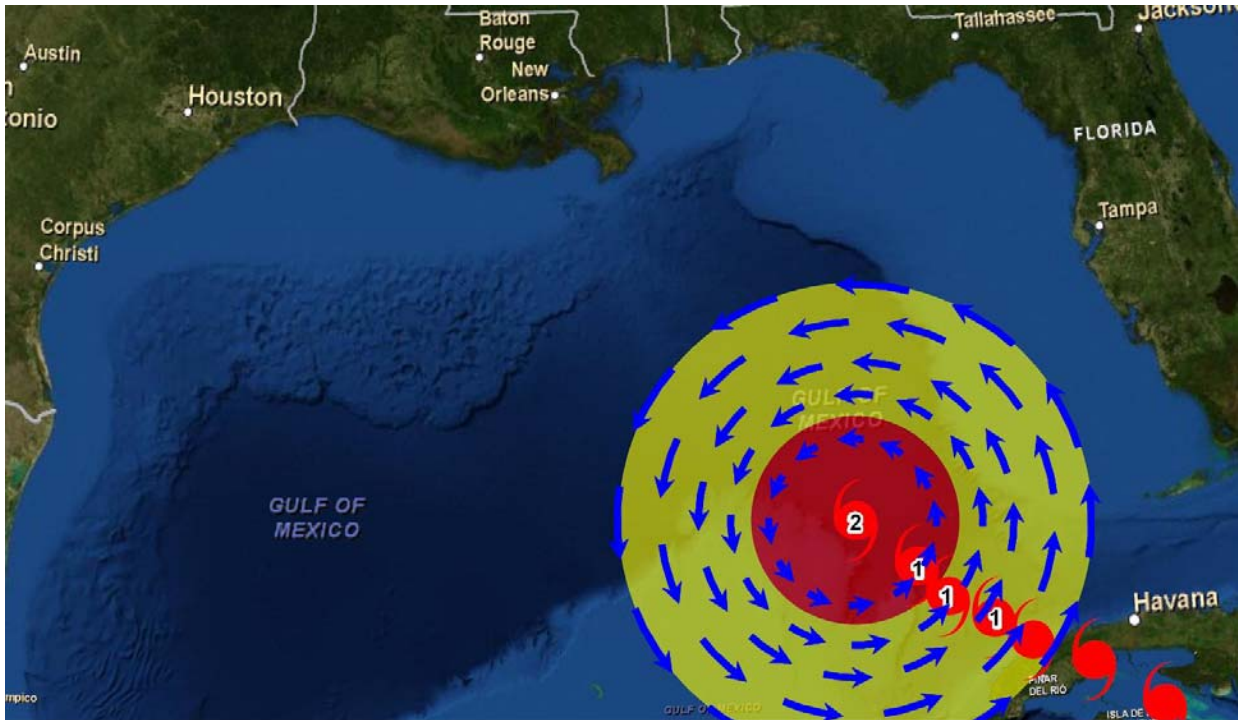
Gustav

HFW	65 mi.
TSFW	220 mi.
Max Winds	115 mph
In Wind Field	0 hr.



Ike

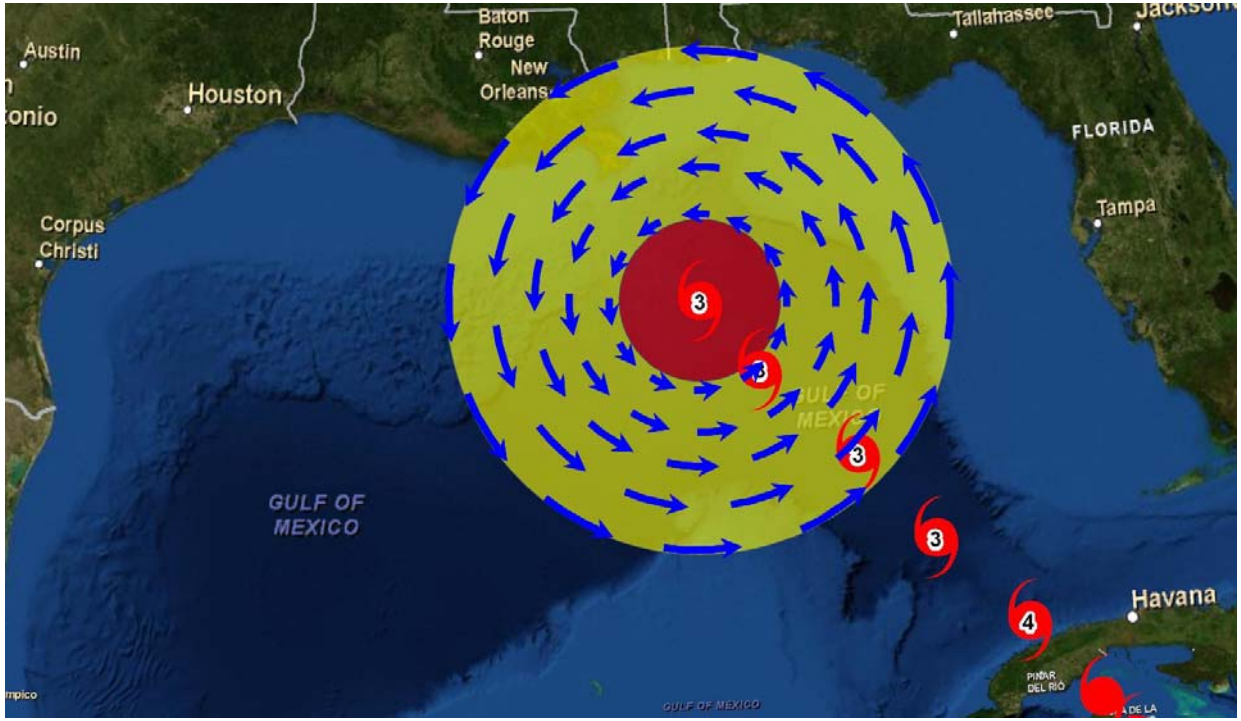
HFW	90 mi.
TSFW	205 mi.
Max Winds	100 mph
In Wind Field	0 hr.



GULF + 24 hrs.

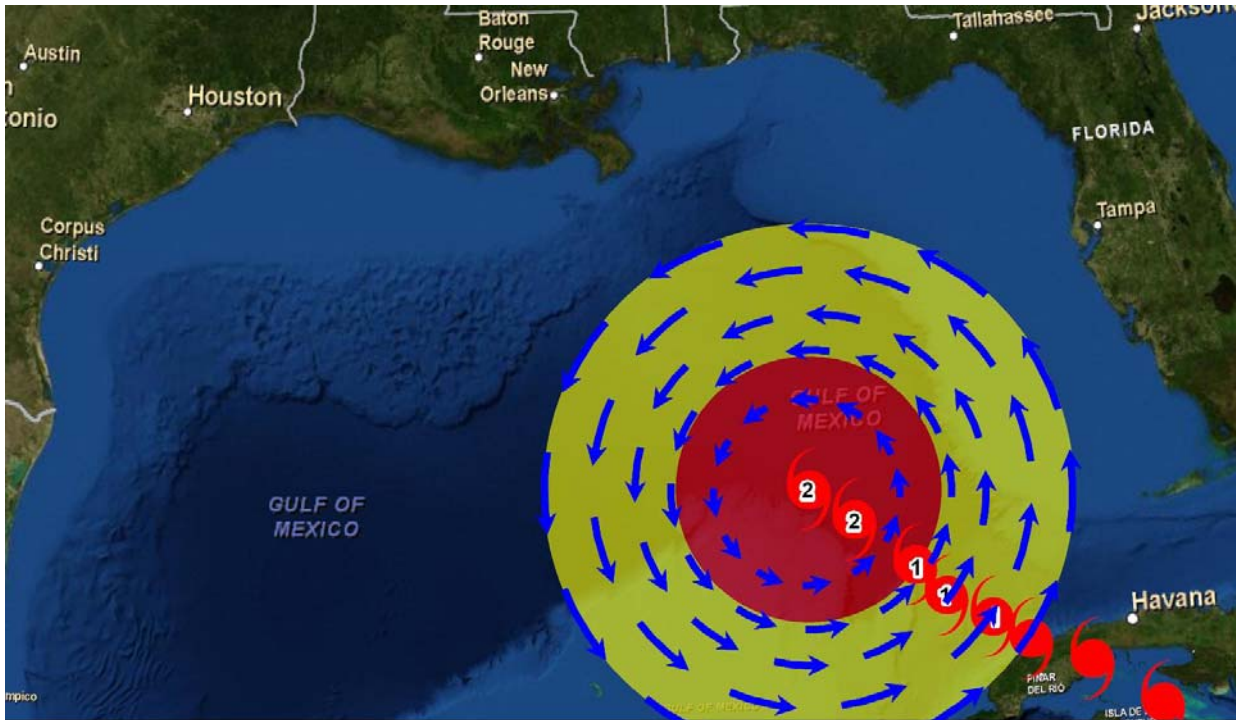
Gustav

HFW	70 mi.
TSFW	220 mi.
Max Winds	115 mph
In Wind Field	6 hr.



Ike

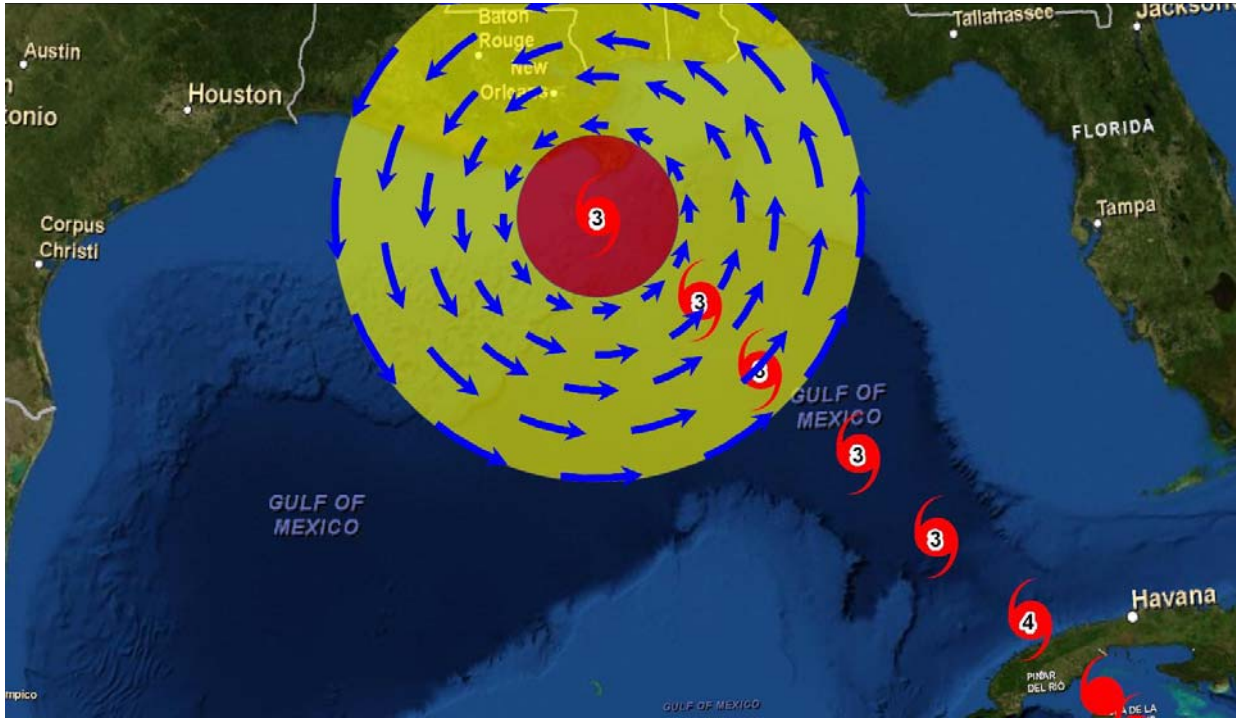
HFW	115 mi.
TSFW	230 mi.
Max Winds	100 mp h
In Wind Field	0 hr.



GULF + 30 hrs.

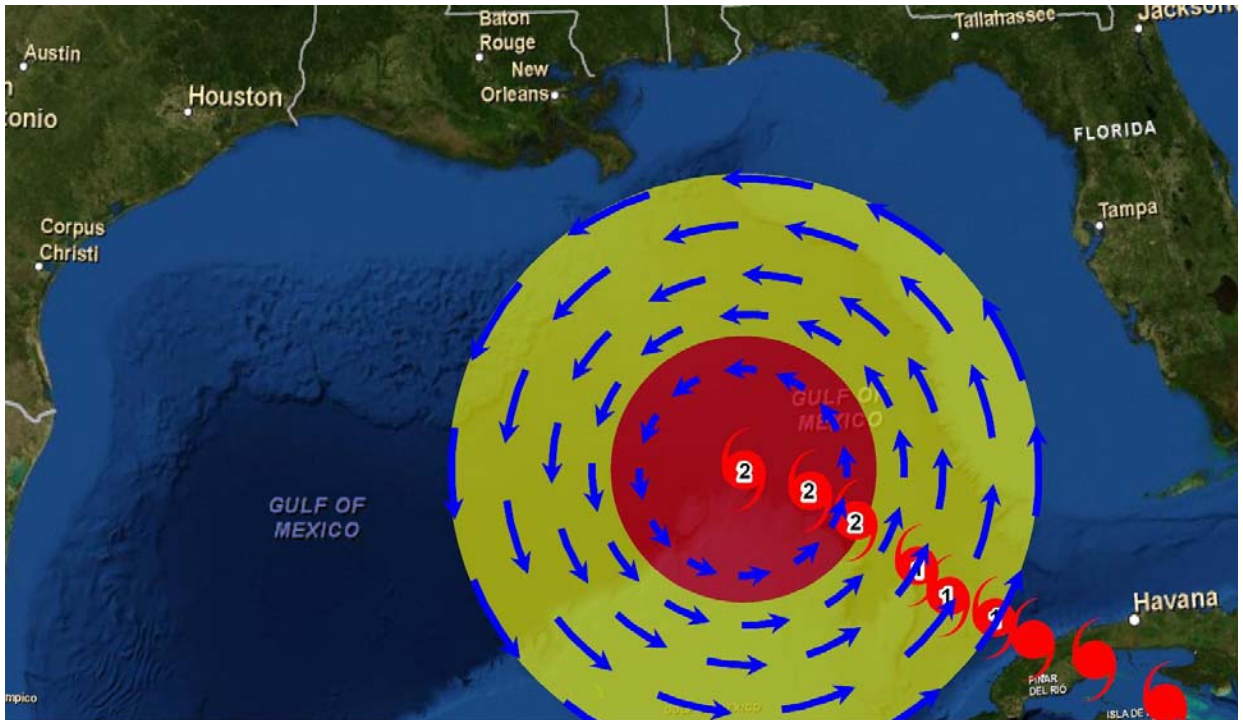
Gustav

HFW	70 mi.
TSFW	230 mi.
Max Winds	115 mph
In Wind Field	12 hr.



Ike

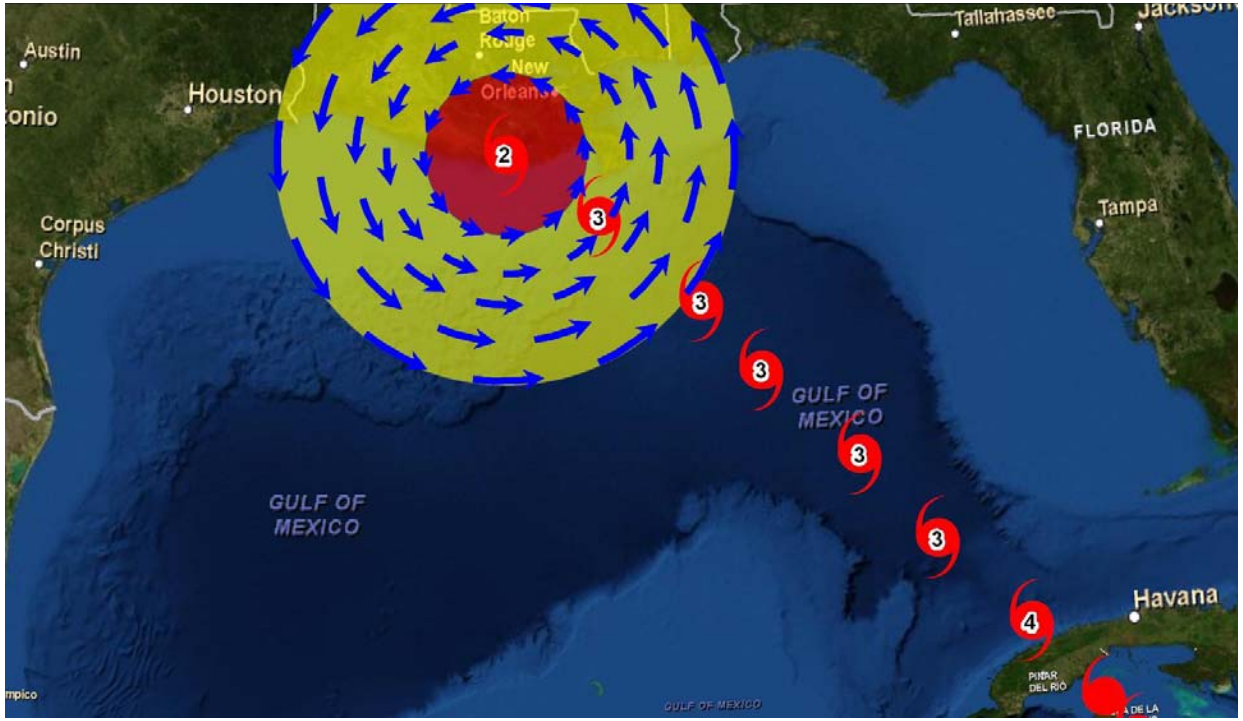
HFW	115 mi.
TSFW	255 mi.
Max Winds	100 mph
In Wind Field	0 hr.



GULF + 36 hrs.

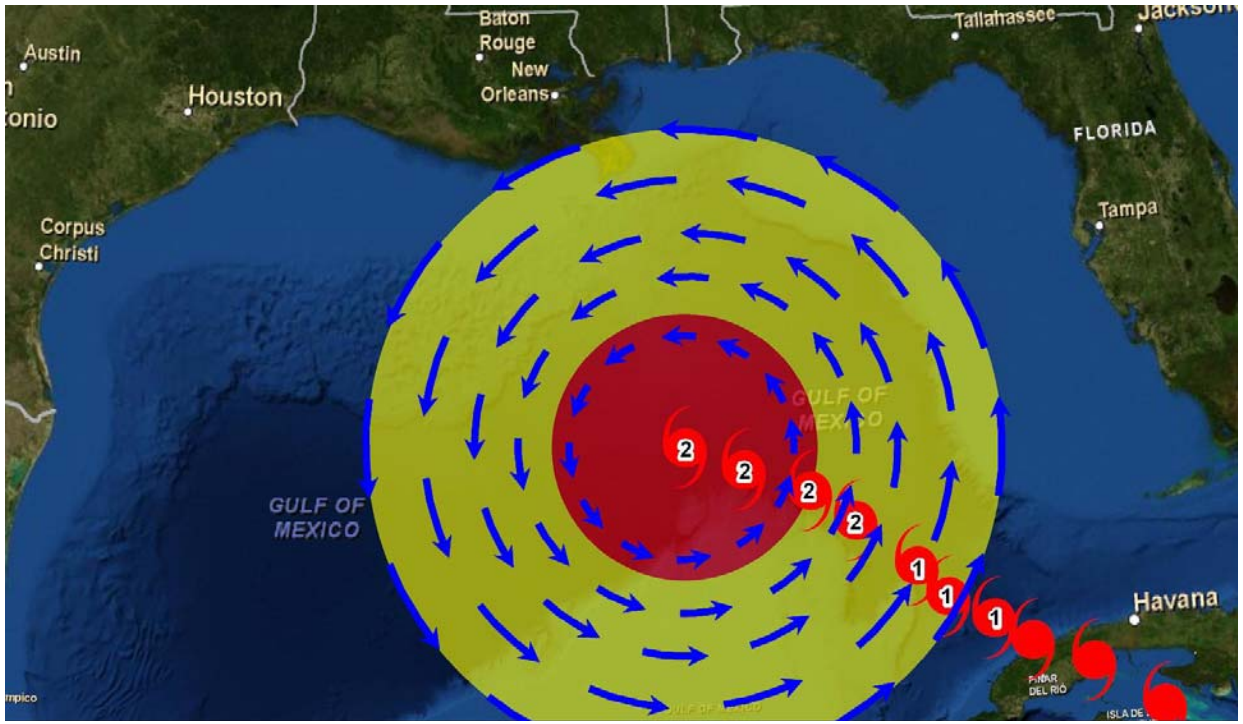
Gustav

HFW	70 mi.
TSFW	200 mi.
Max Winds	110 mph
In Wind Field	18 hr.



Ike

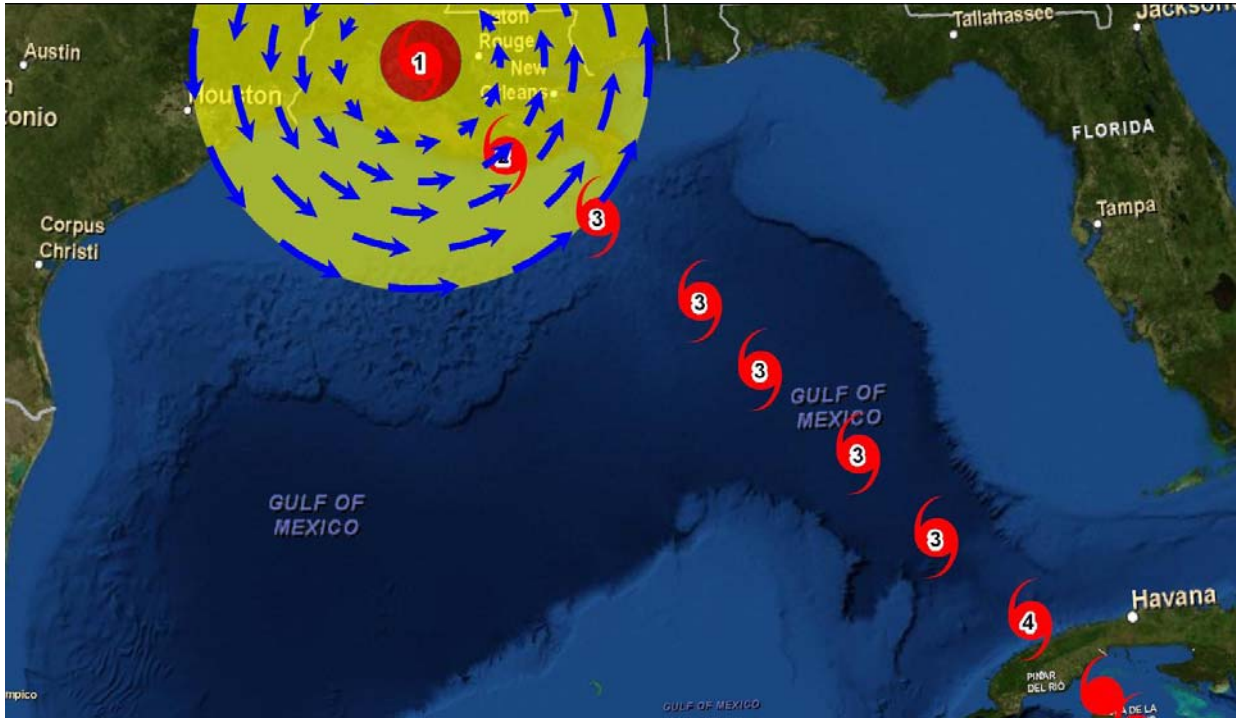
HFW	115 mi.
TSFW	275 mi.
Max Winds	100 mph
In Wind Field	0 hr.



GULF + 42 hrs.

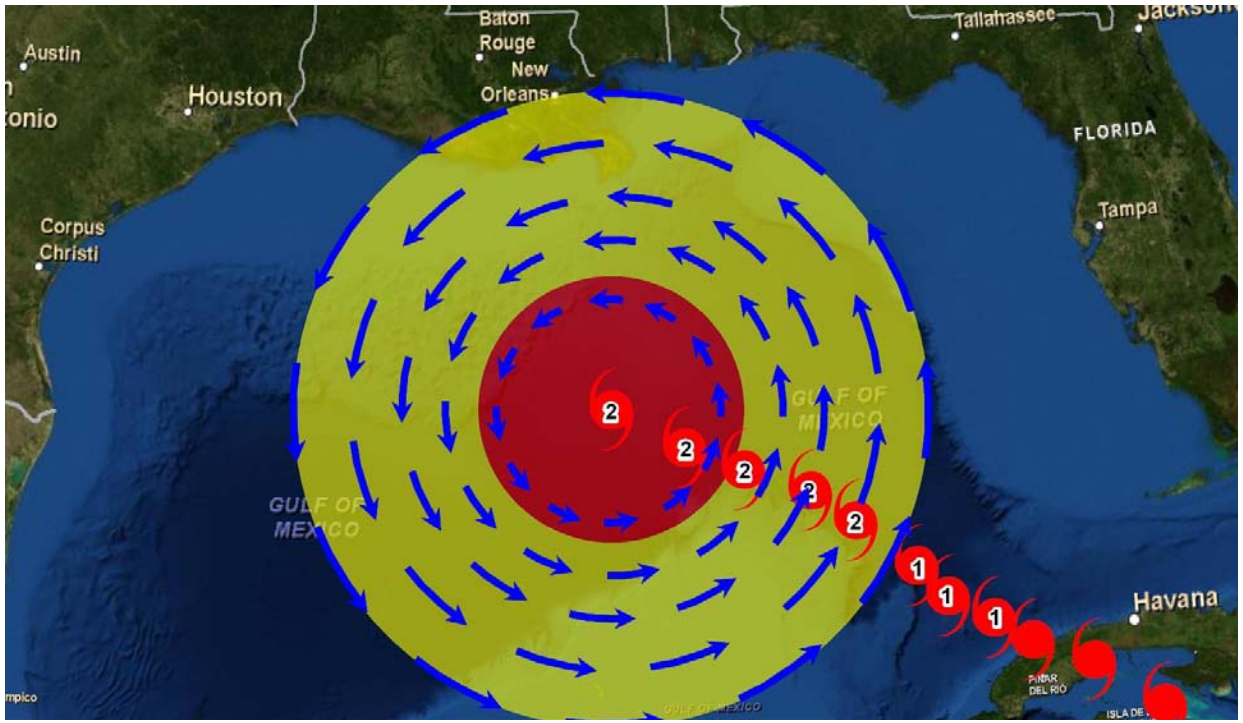
Gustav

HFW	35 mi.
TSFW	200 mi.
Max Winds	80 mph
In Wind Field	24 hr.



Ike

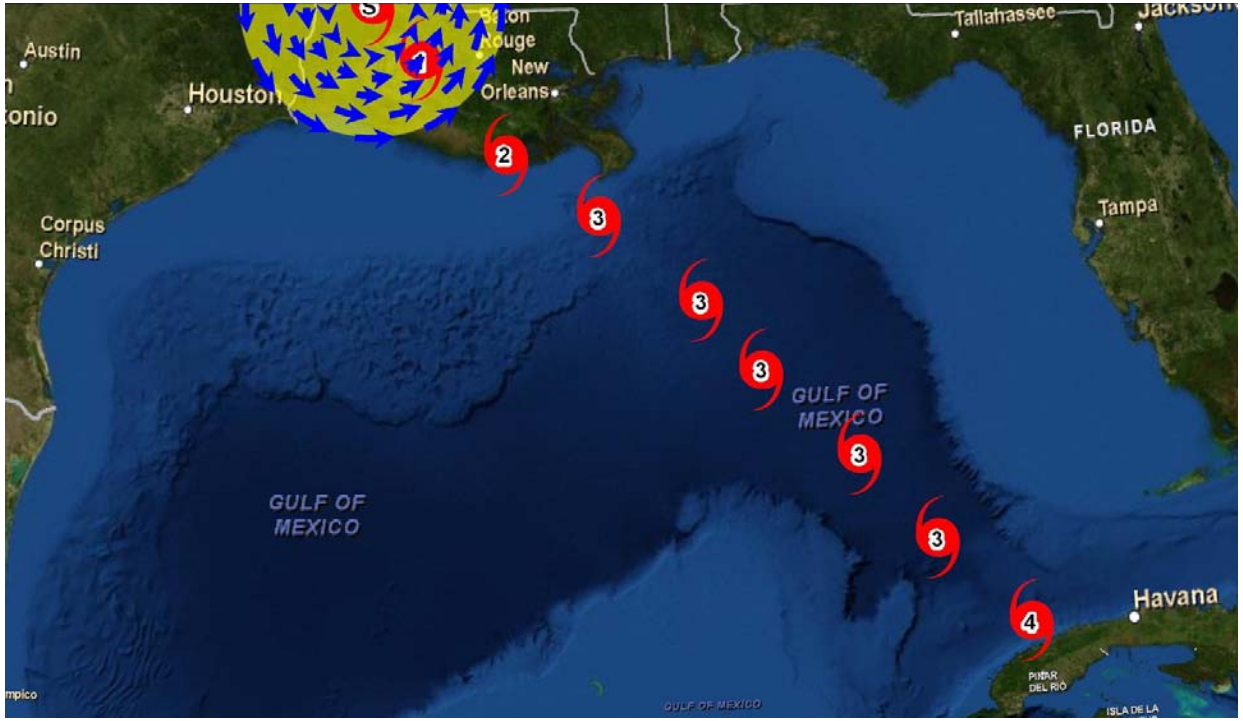
HFW	115 mi.
TSFW	275 mi.
Max Winds	100 mph
In Wind Field	6 hr.



GULF + 48 hrs.

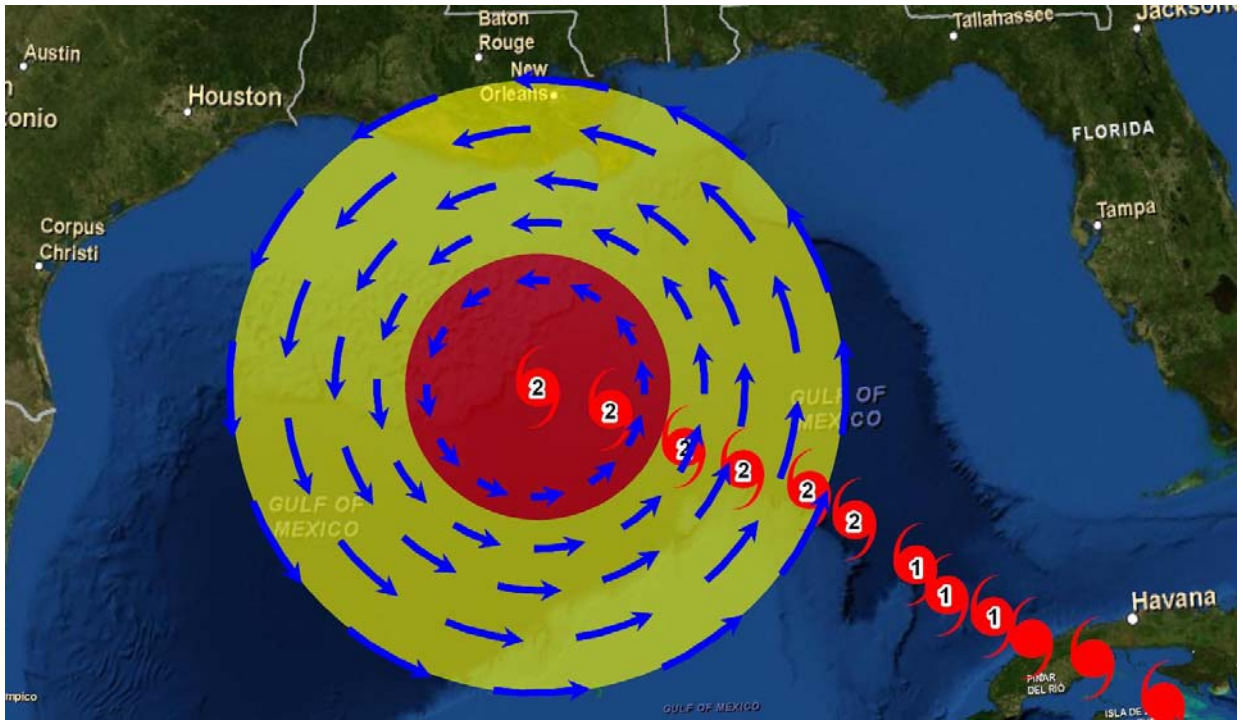
Gustav

HFW	
TSFW	115 mi.
Max Winds	60 mph
In Wind Field	30 hr.



Ike

HFW	115 mi.
TSFW	265 mi.
Max Winds	100 mph
In Wind Field	12 hr.



GULF + 54 hrs.

Gustav

HFW

TSFW

Max Winds

In Wind Field **35 hr.**

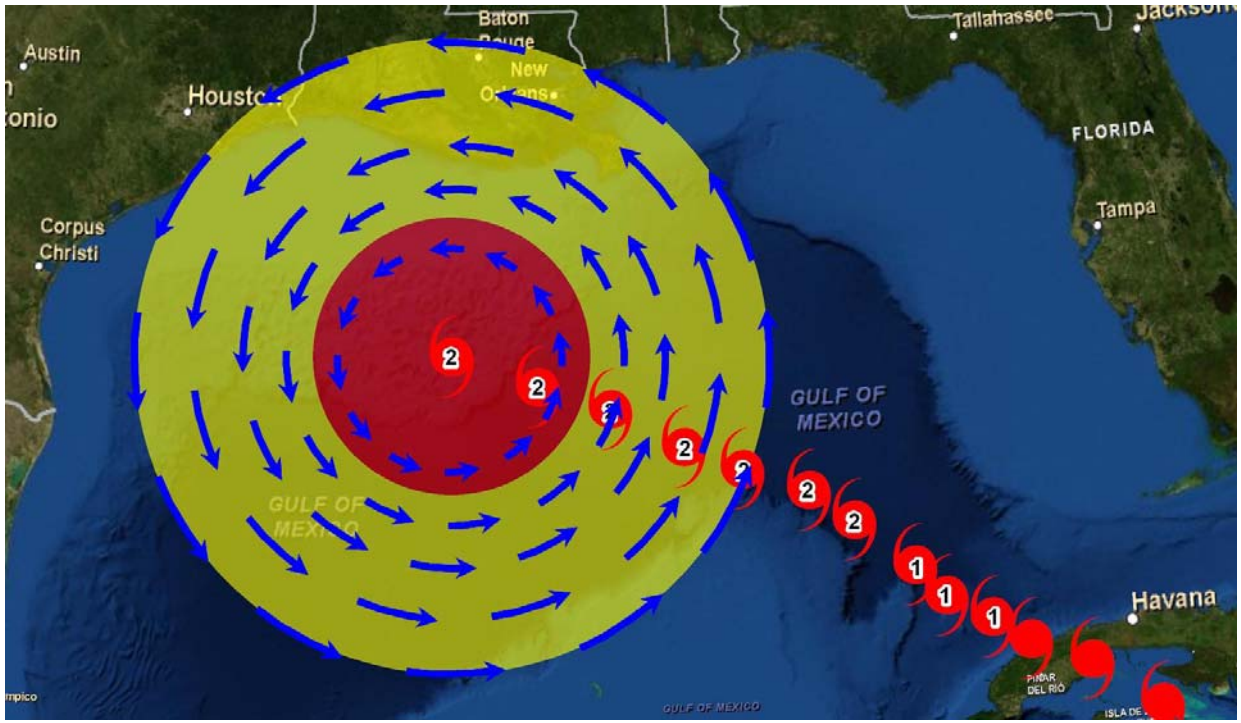
Ike

HFW **120 mi.**

TSFW **275 mi.**

Max Winds **105 mph**

In Wind Field **18 hr.**



GULF + 60 hrs.

Gustav

HFW

TSFW

Max Winds

In Wind Field **30 hr.**

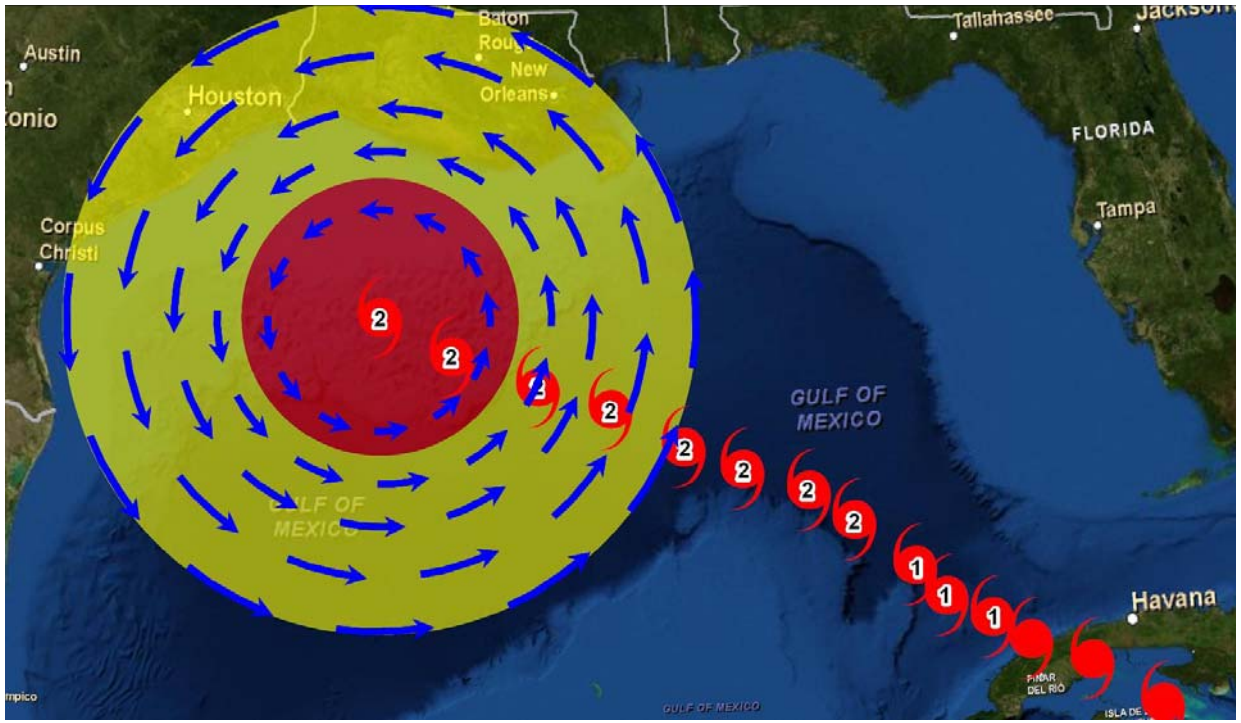
Ike

HFW **120 mi.**

TSFW **275 mi.**

Max Winds **105 mph**

In Wind Field **24 hr.**



GULF + 66 hrs.

Gustav

HFW

TSFW

Max Winds

In Wind Field **30 hr.**

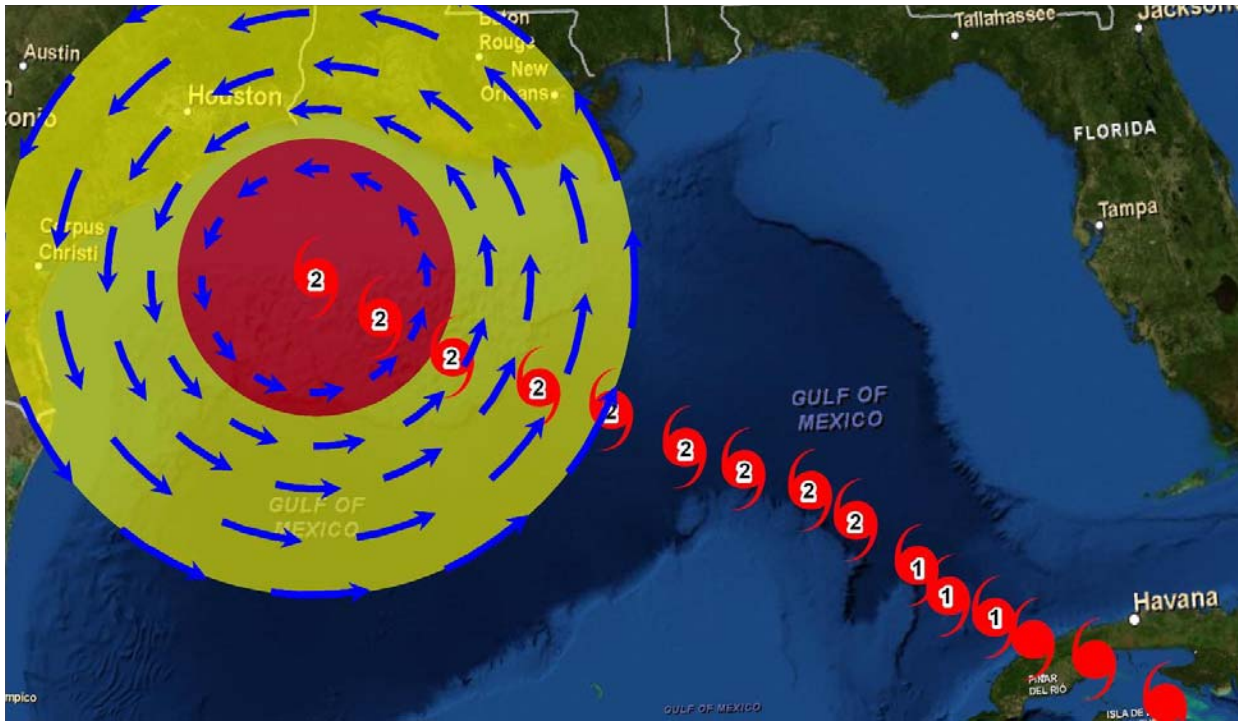
Ike

HFW **120 mi.**

TSFW **275 mi.**

Max Winds **105 mph**

In Wind Field **30 hr.**



GULF + 72 hrs.

Gustav

HFW

TSFW

Max Winds

In Wind Field **30 hr.**

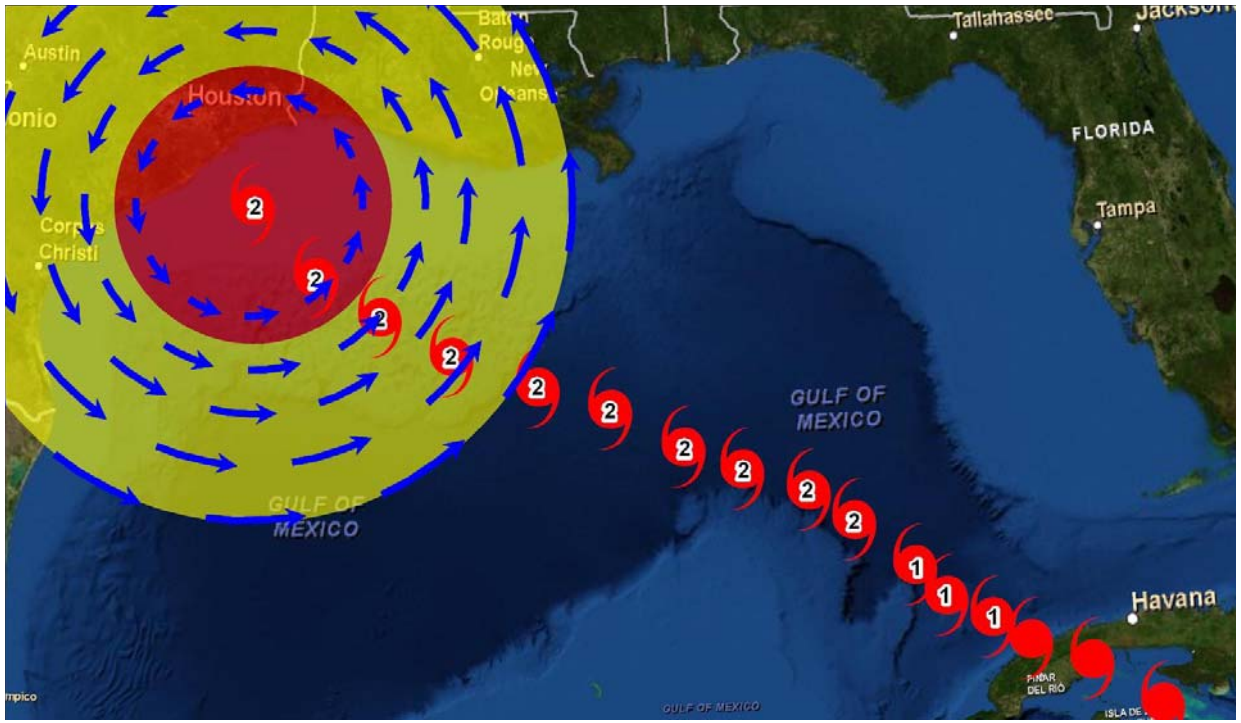
Ike

HFW **120 mi.**

TSFW **275 mi.**

Max Winds **110 mph**

In Wind Field **36 hr.**



GULF + 78 hrs.

Gustav

HFW

TSFW

Max Winds

In Wind Field **30 hr.**

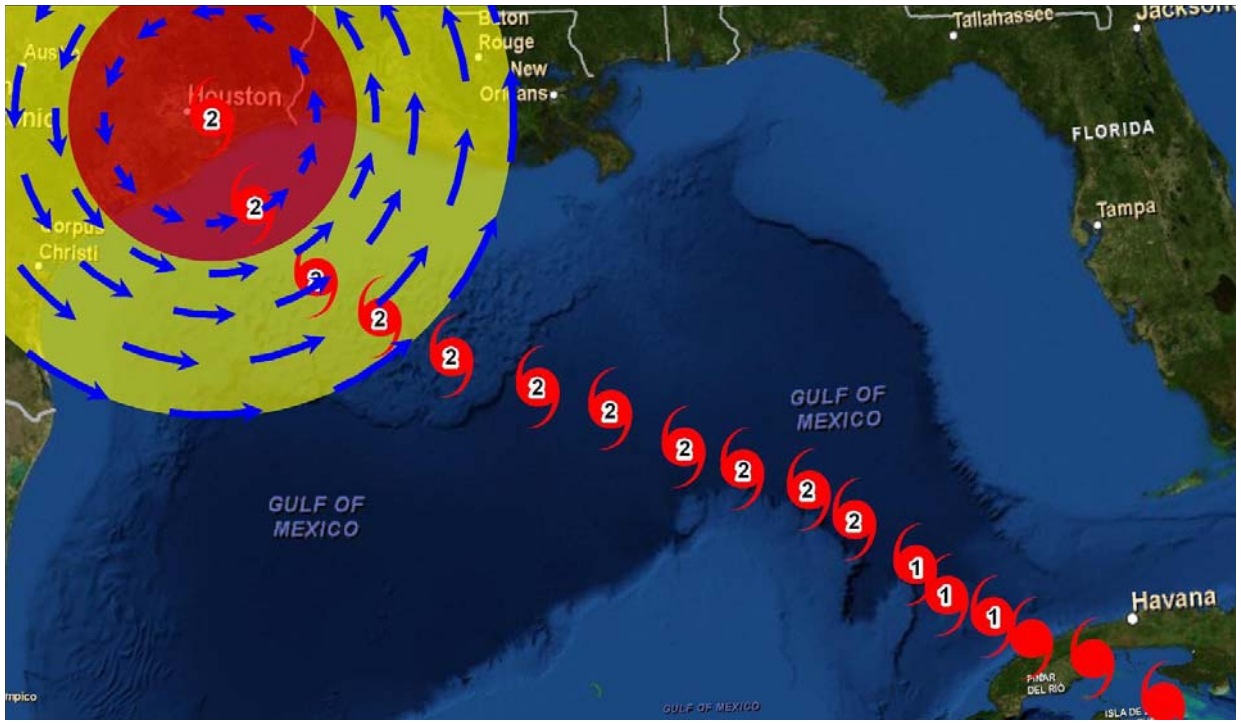
Ike

HFW **125 mi.**

TSFW **260 mi.**

Max Winds **110 mph**

In Wind Field **42 hr.**



GULF + 84 hrs.

Gustav

HFW

TSFW

Max Winds

In Wind Field **30 hr.**

Ike

HFW **45 mi.**

TSFW **230 mi.**

Max Winds **80 mph**

In Wind Field **50 hr.**

GUSTAV

Cuba to Landfall: 630 mi.
Time over Gulf: 36 hrs.
Average Speed: 17.5 mph
HFW Radius: 70 mi.
TSFW Radius: 230 mi.
Wind Speed: 110 mph
Coast in wind field: 30 hr

IKE

Cuba to Landfall: 850 mi.
Time over Gulf: 82 hrs.
Average Speed: 10 mph
HFW Radius: 125 mi.
TSFW Radius: 260 mi.
Wind Speed: 110 mph
Coast in wind field: 62+ hr

GUSTAV

Cuba to Landfall: 630 mi.
Time over Gulf: 36 hrs.
Average Speed: 17.5 mph
HFW Radius: 70 mi.
TSFW Radius: 220 mi.
Wind Speed: 110 mph

RITA

Cuba to Landfall: 912 mi.
Time over Gulf: 87 hrs.
Average Speed: 10.5 mph
HFW Radius: 85 mi.
TSFW Radius: 205 mi.
Wind Speed: 128 mph

ANDREW - 1992

Gulf to Landfall: 692 mi.
Time over Gulf: 42 hrs.
Average Speed: 16.5 mph
HFW Radius: 70 mi.
TSFW Radius: 175 mi.

KATRINA - 2005

Gulf to Landfall: 747 mi.
Time over Gulf: 84 hrs.
Average Speed: 8.9 mph
HFW Radius: 105 mi.
TSFW Radius: 230 mi.

Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "Katrina was an anomaly."
  - "Rita was an an anomaly."
  - "Ike was an anomaly?"
  - "Betsy was an anomaly?"
  - "Carla was an anomaly?"
  - "The hurricane of August 1915 was an anomaly?"

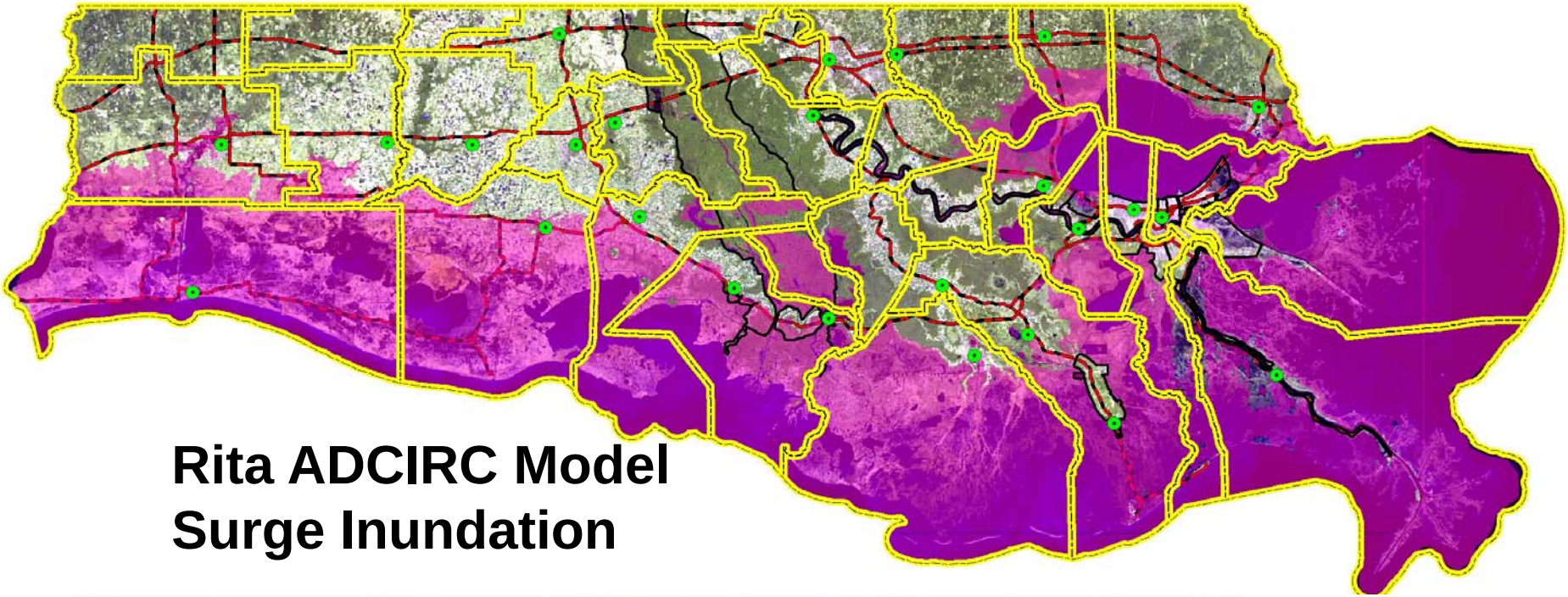
Storm Surge Myths, Misconceptions, Misunderstanding, and Confusion

- "The models are wrong!"
- "It can't happen here!"

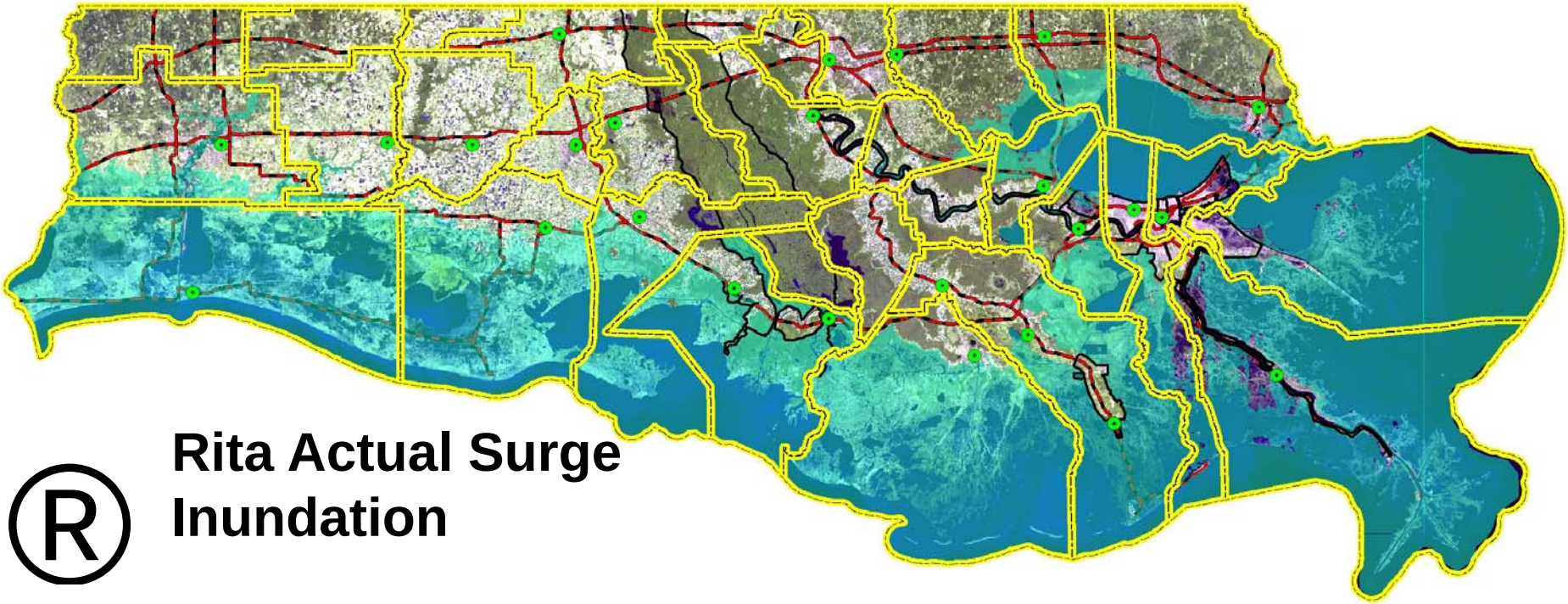
HURRICANE RITA ADVISORY NUMBER 24

NWS TPC/NATIONAL HURRICANE CENTER, MIAMI, FL
10 AM CDT FRI SEPT 23 2005

COASTAL STORM SURGE FLOODING OF 15 FEET ABOVE NORMAL TIDE LEVELS...LOCALLY UP TO 20 FEET AT HEAD OF BAYS AND NEARBY RIVERS...WITH LARGE AND DANGEROUS BATTERING WAVES...CAN BE EXPECTED NEAR AND TO THE EAST OF WHERE THE CENTER MAKES LANDFALL. TIDES ARE CURRENTLY RUNNING ABOUT 2 FEET ABOVE NORMAL ALONG THE LOUISIANA COAST, …….

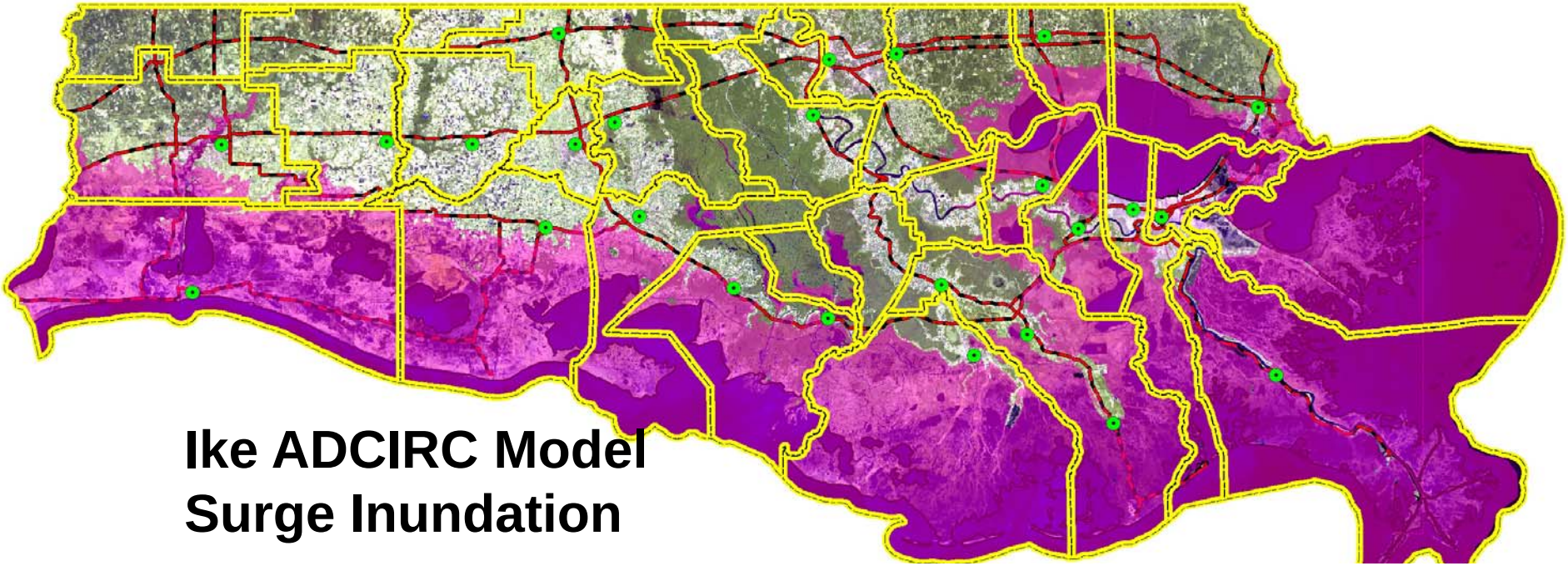


Rita ADCIRC Model Surge Inundation

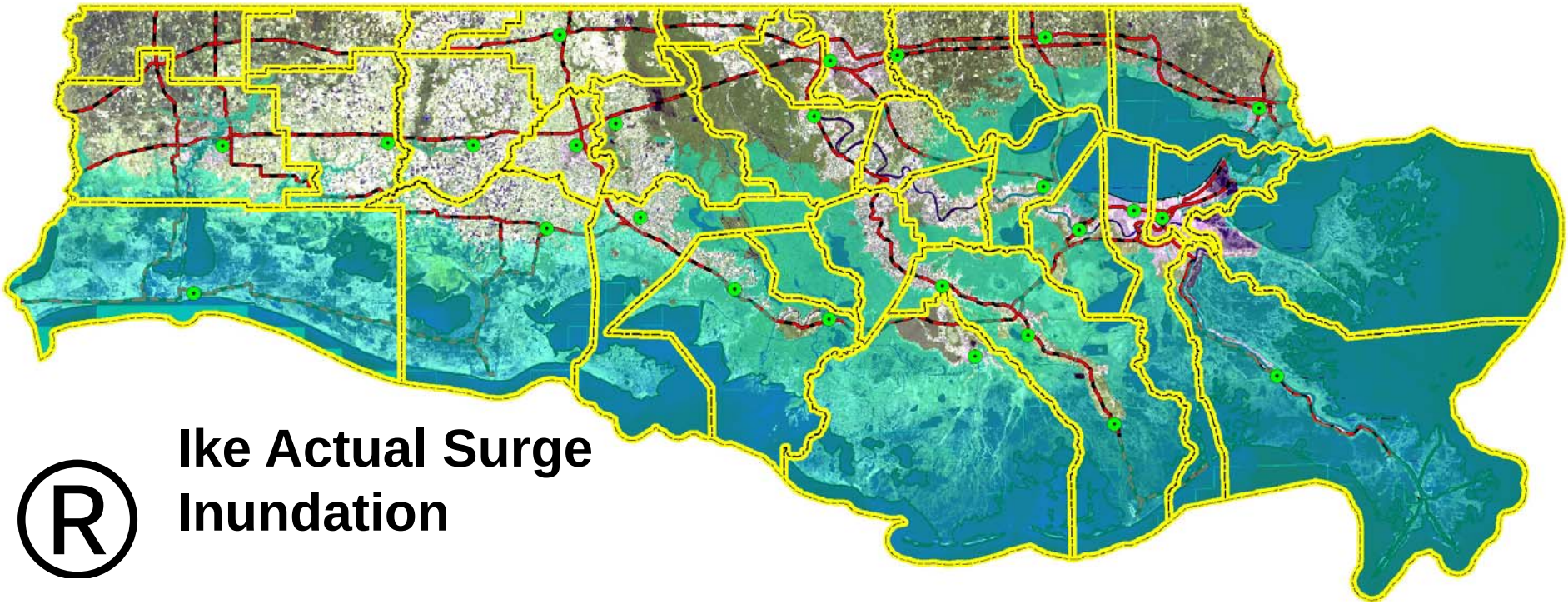


Rita Actual Surge Inundation

®



Ike ADCIRC Model Surge Inundation

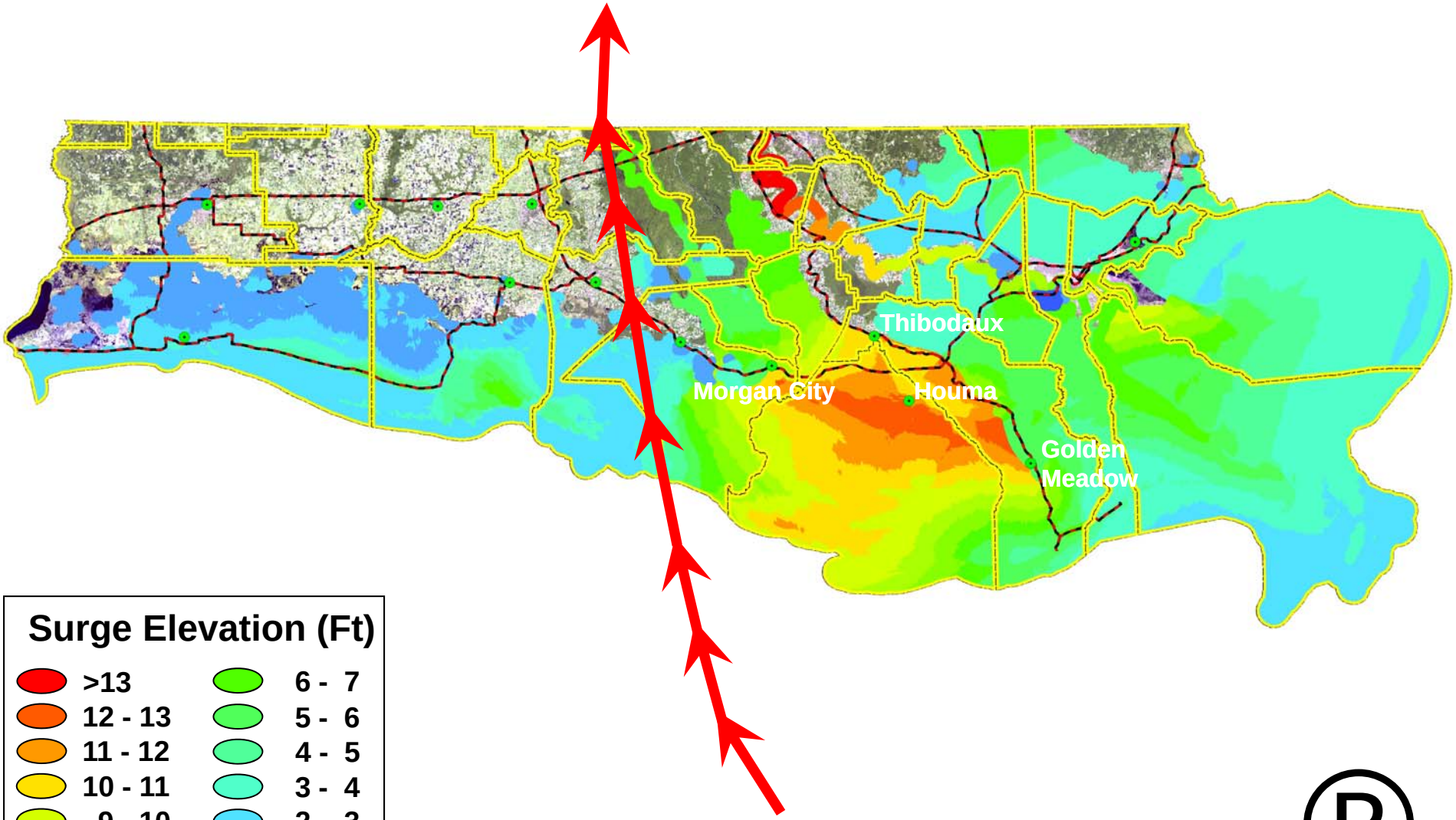


Ike Actual Surge Inundation

®

RITA IBERIA / ST MARY TRACK

ADCIRC PREDICTED STORM SURGE ELEVATIONS

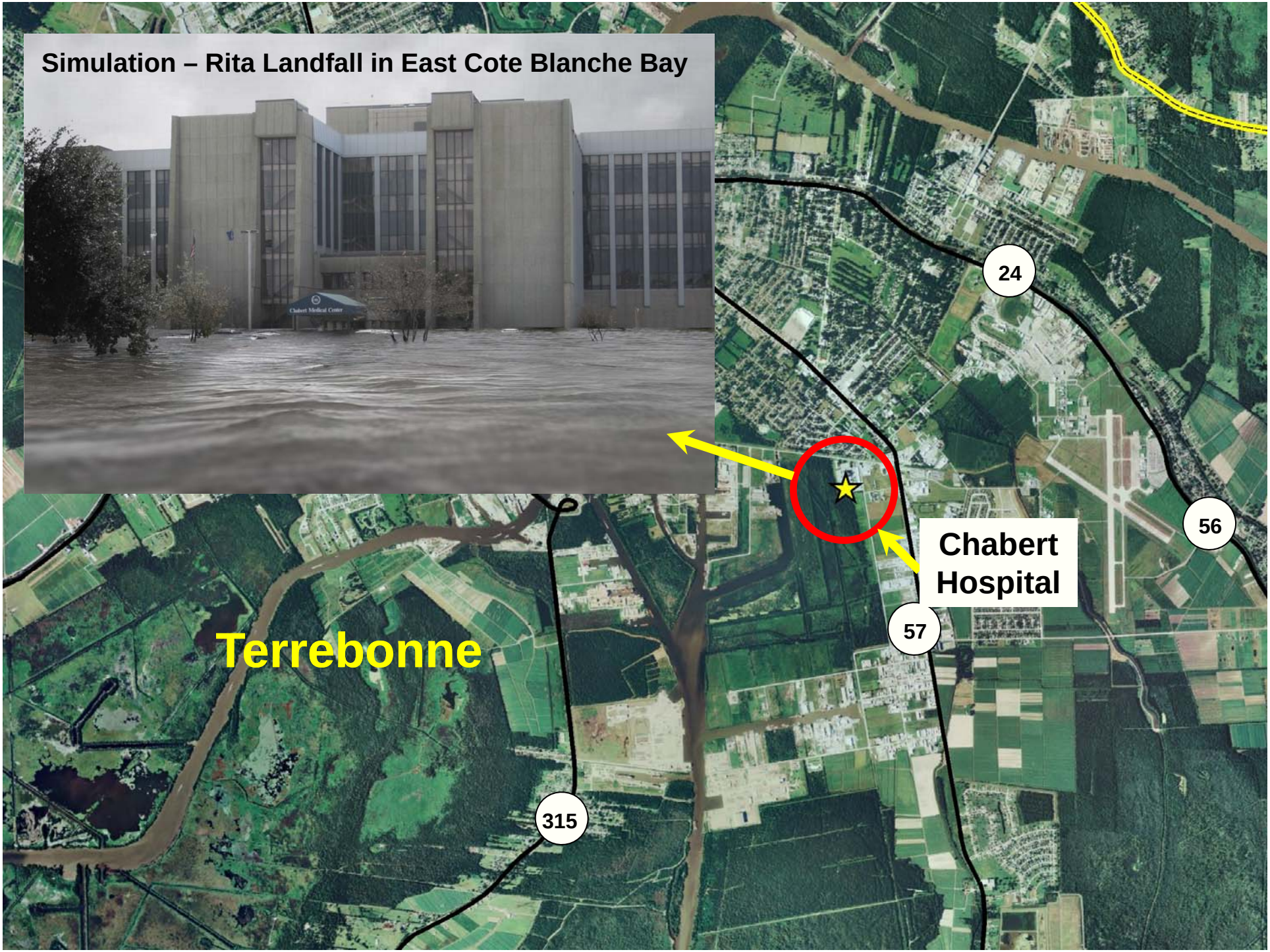


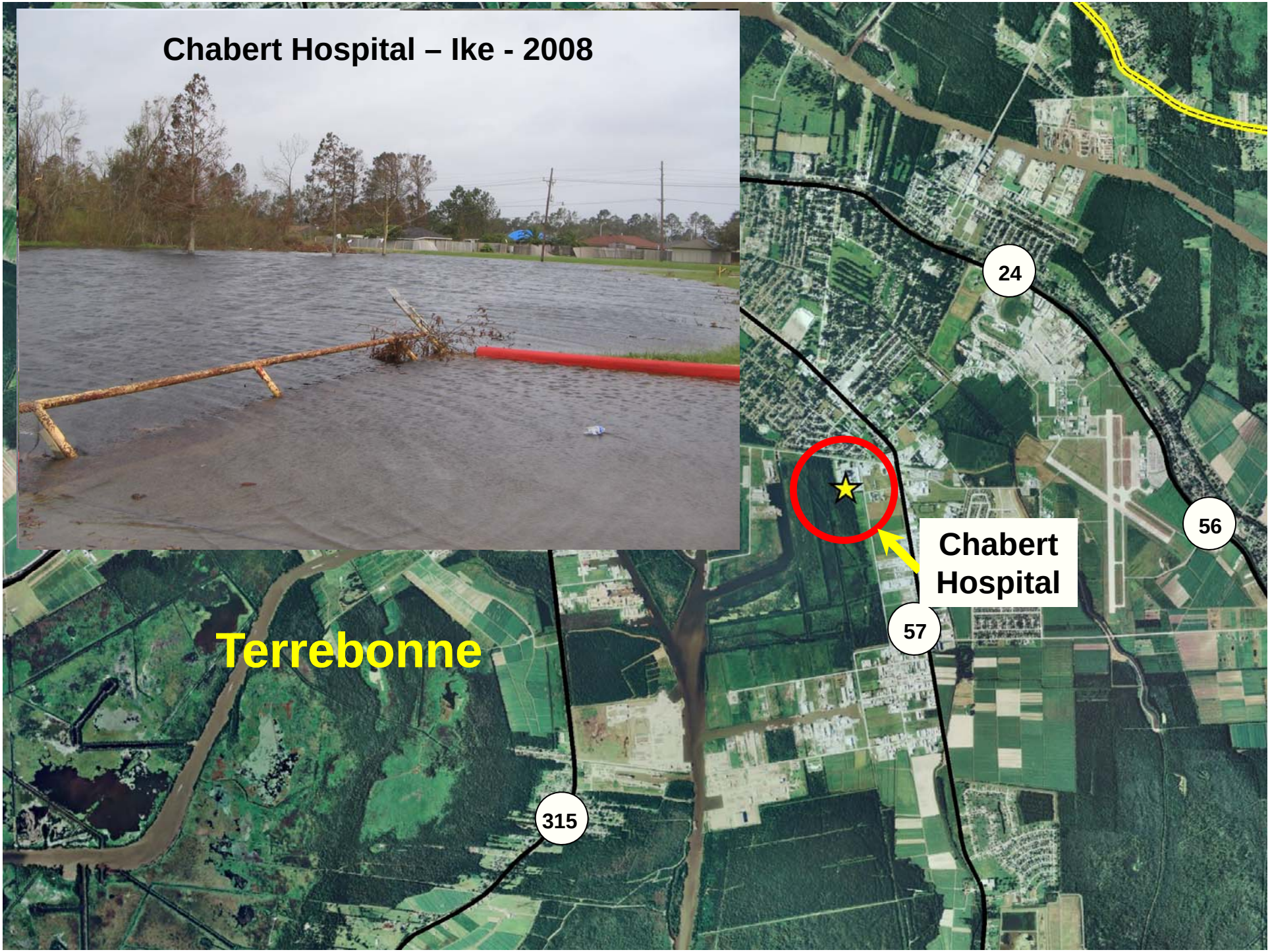
Surge Elevation (Ft)

>13	6 - 7
12 - 13	5 - 6
11 - 12	4 - 5
10 - 11	3 - 4
9 - 10	2 - 3
8 - 9	1 - 2
7 - 8	0 - 1

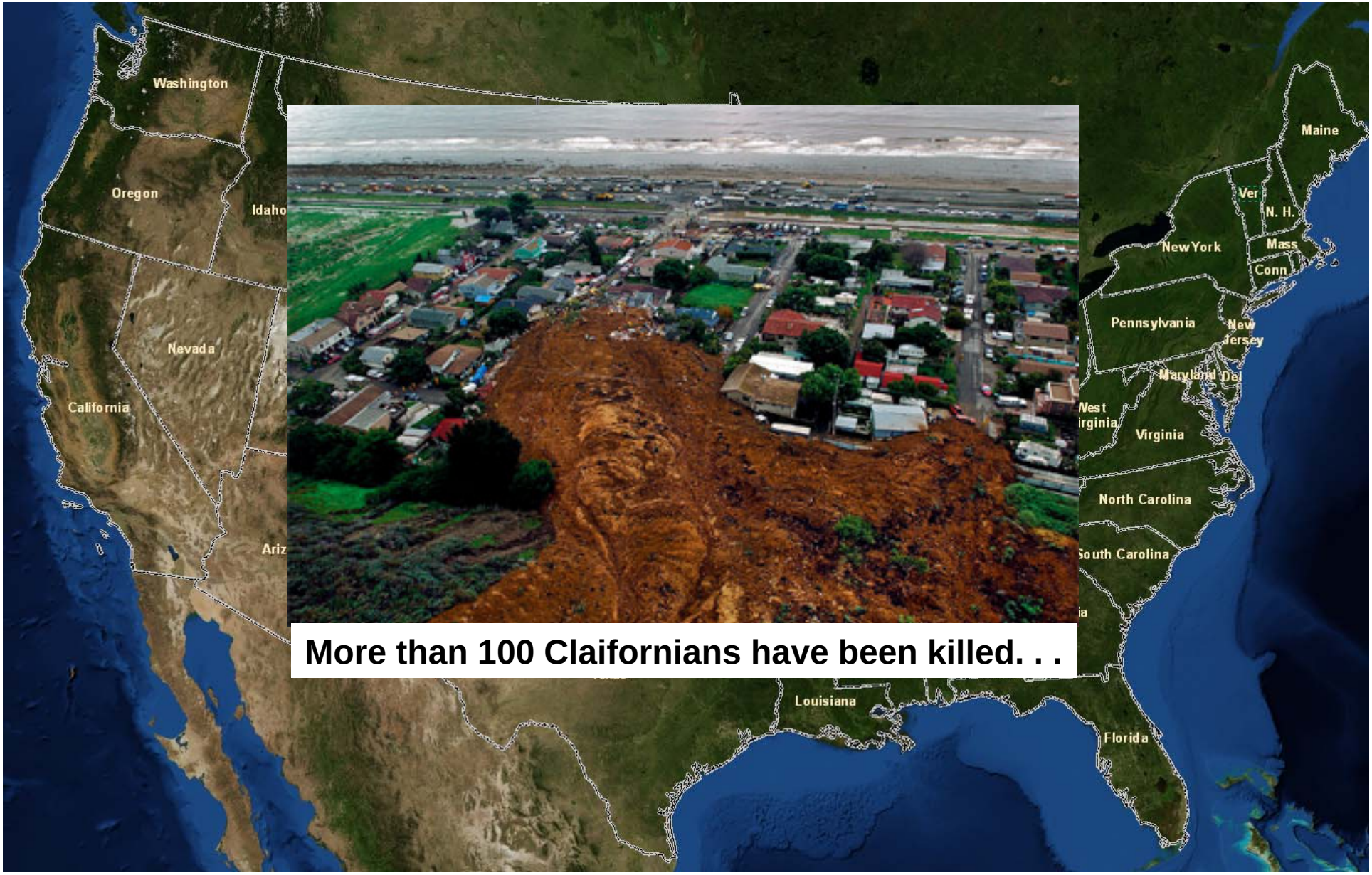
ADCIRC storm surge model data provided by:
Dr. Hassan Mashriqui
LSU AgCenter / LA Sea Grant

®


Simulation – Rita Landfall in East Cote Blanche Bay
Chabert Medical Center
24
56
Chabert Hospital
57
Terrebonne
315


Chabert Hospital – Ike - 2008
24
56
Chabert Hospital
57
Terrebonne
315

KEEPING THINGS IN PERSPECTIVE


Washington
Oregon
Idaho
Nevada
California
Ariz
Maine
Ver
N. H.
New York
Mass
Conn
Pennsylvania
New Jersey
Maryland
Del
West Virginia
Virginia
North Carolina
South Carolina
Louisiana
Florida
More than 100 Claifornians have been killed. . .


Washington
Oregon
Idaho
Nevada
California
Maine
Ver
N. H.
New York
Mass
Conn
Pennsylvania
New Jersey
Maryland
Del
West Virginia
Virginia
North Carolina
South Carolina
Florida


Washington
Oregon
Idaho
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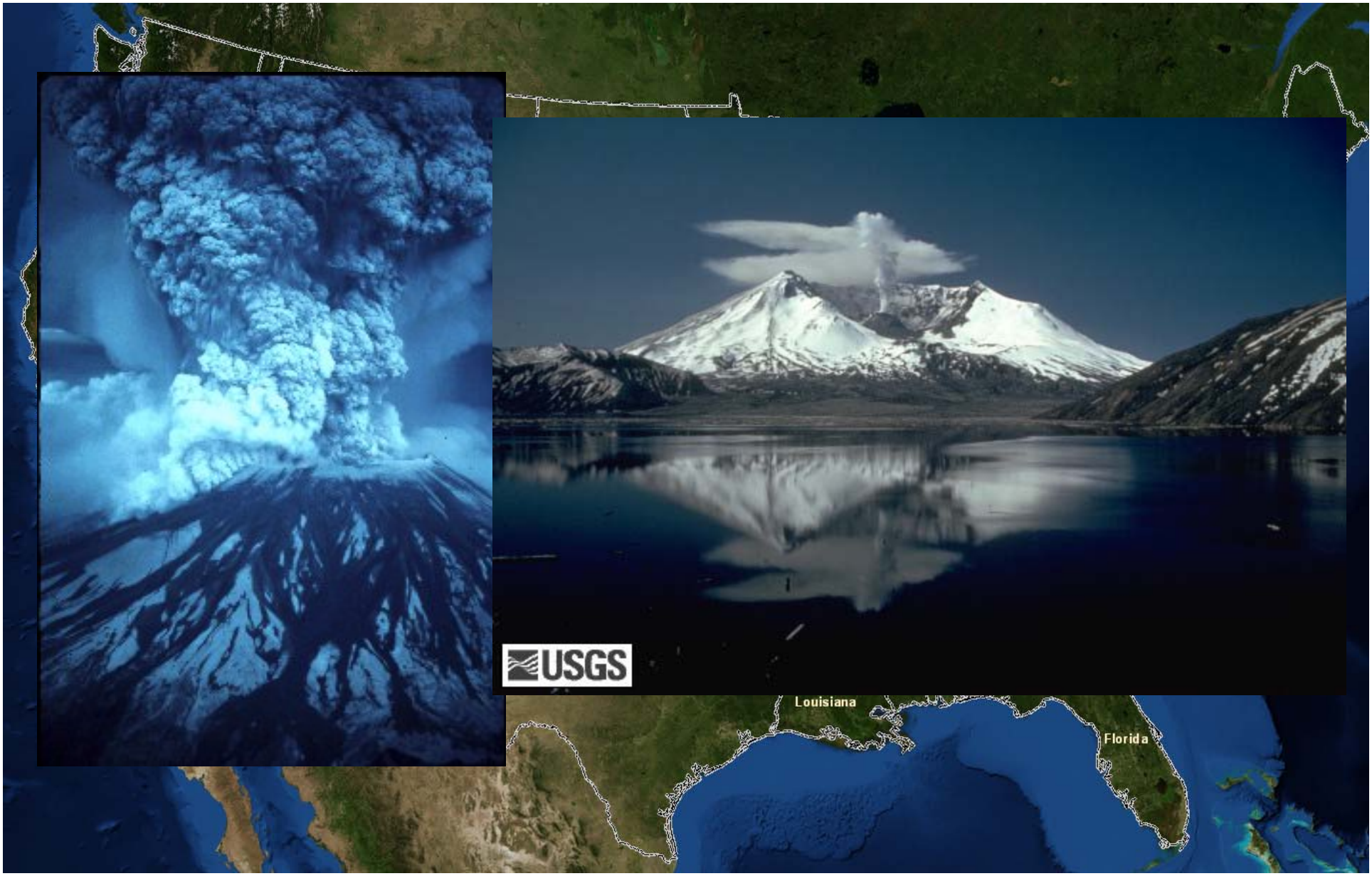
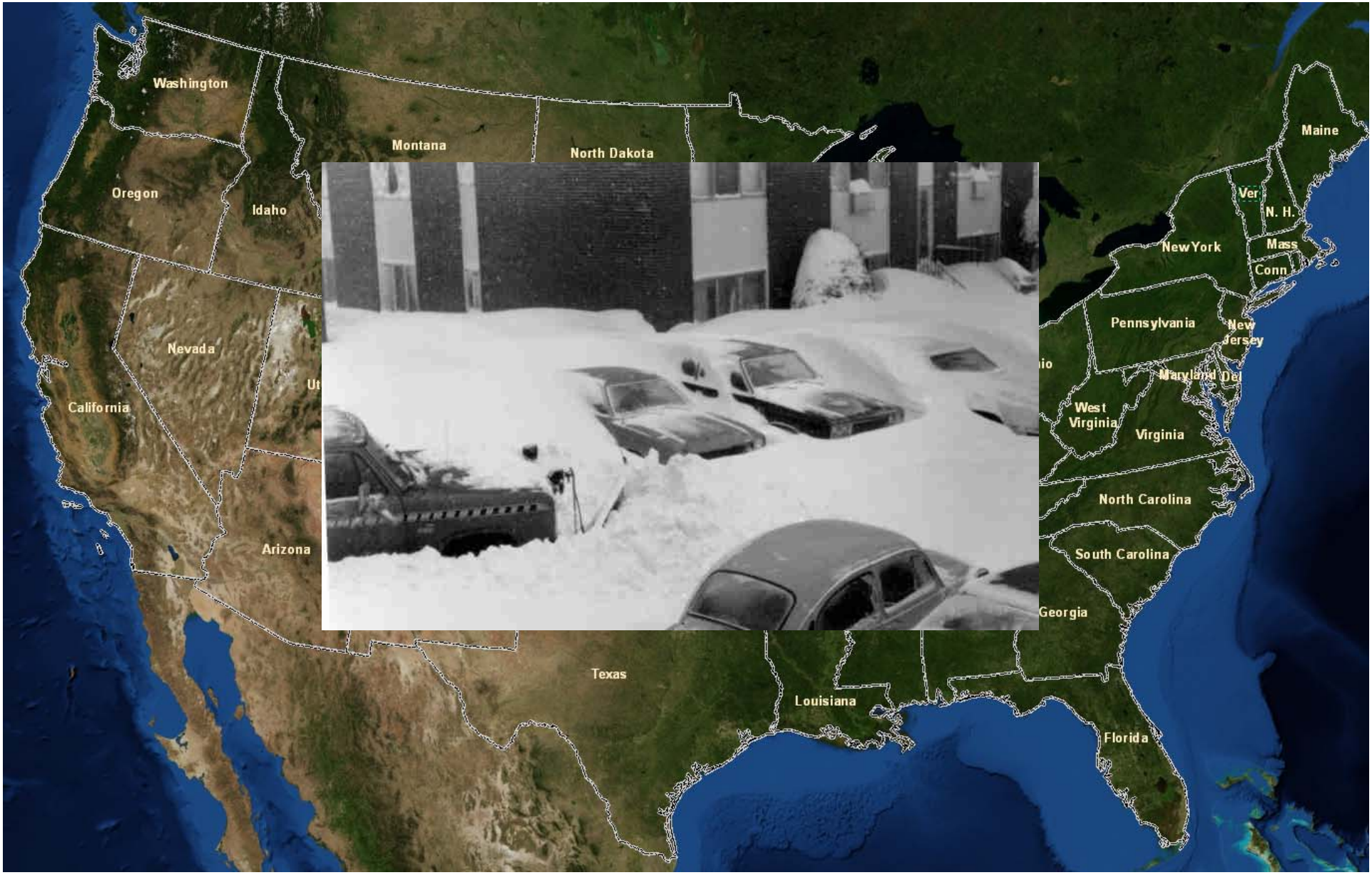
N. H.
New York
Mass
Conn
Pennsylvania
New Jersey
Maryland
Del
M. Celebi, U.S. Geological Survey


USGS
Louisiana
Florida


Washington
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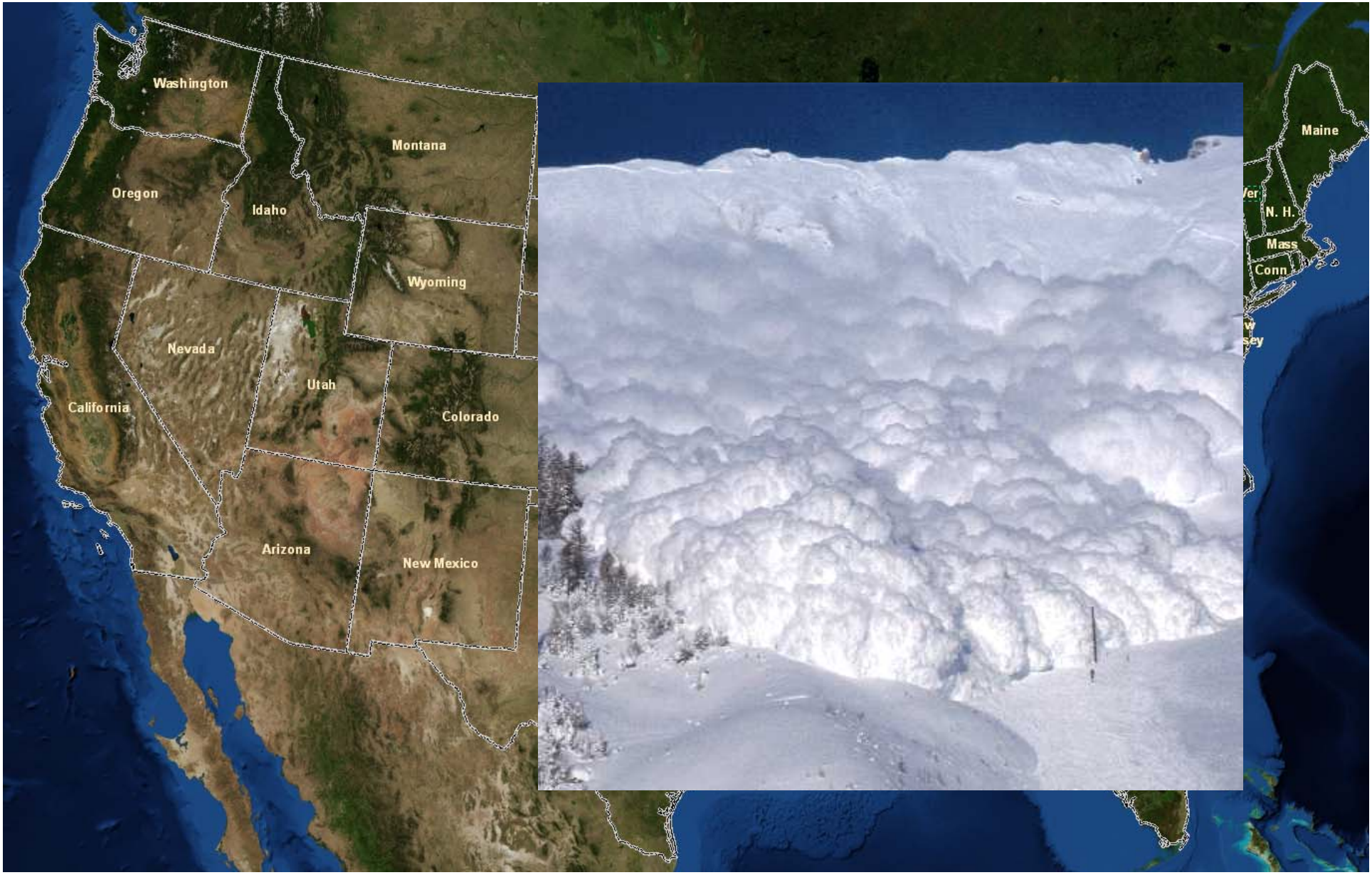
South Carolina
Georgia
Texas
Louisiana
Florida


Washington
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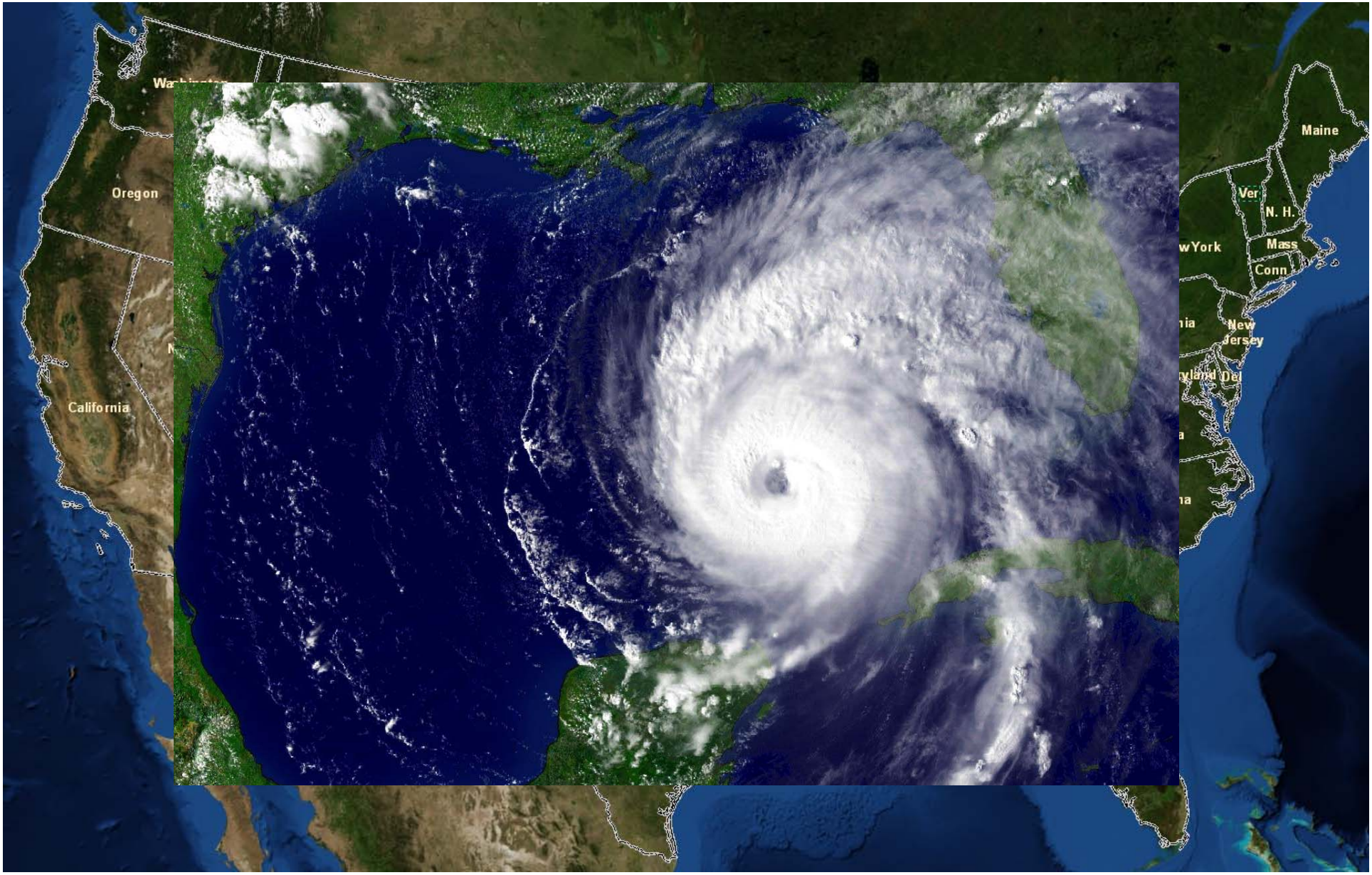
Arizona
New Mexico
Maine
N. H.
Mass
Conn


Washington
Califo
Arizona
New Mexico
Oklahoma
Texas
Arkansas
Louisiana
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Tennessee


Oregon
California
Maine
N. H.
Mass
Conn
New
Jersey

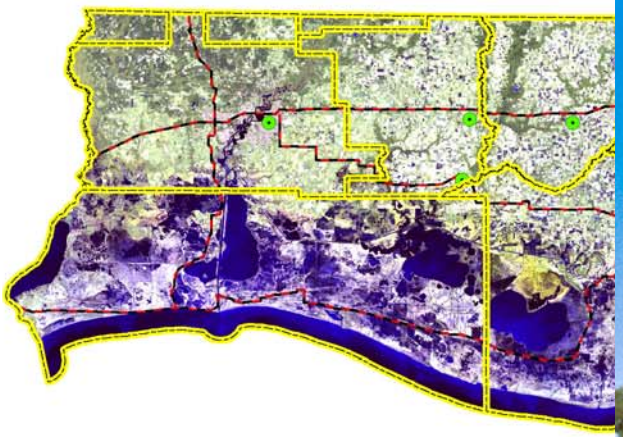

Oregon
California
Maine
Ver
N. H.
Mass
Conn
New
Jersey

Shocking cold wave drops temps to 40 below zero

Print

Tue Jan 13, 6:16 pm ET

“IT CAN’T HAPPEN HERE”



®

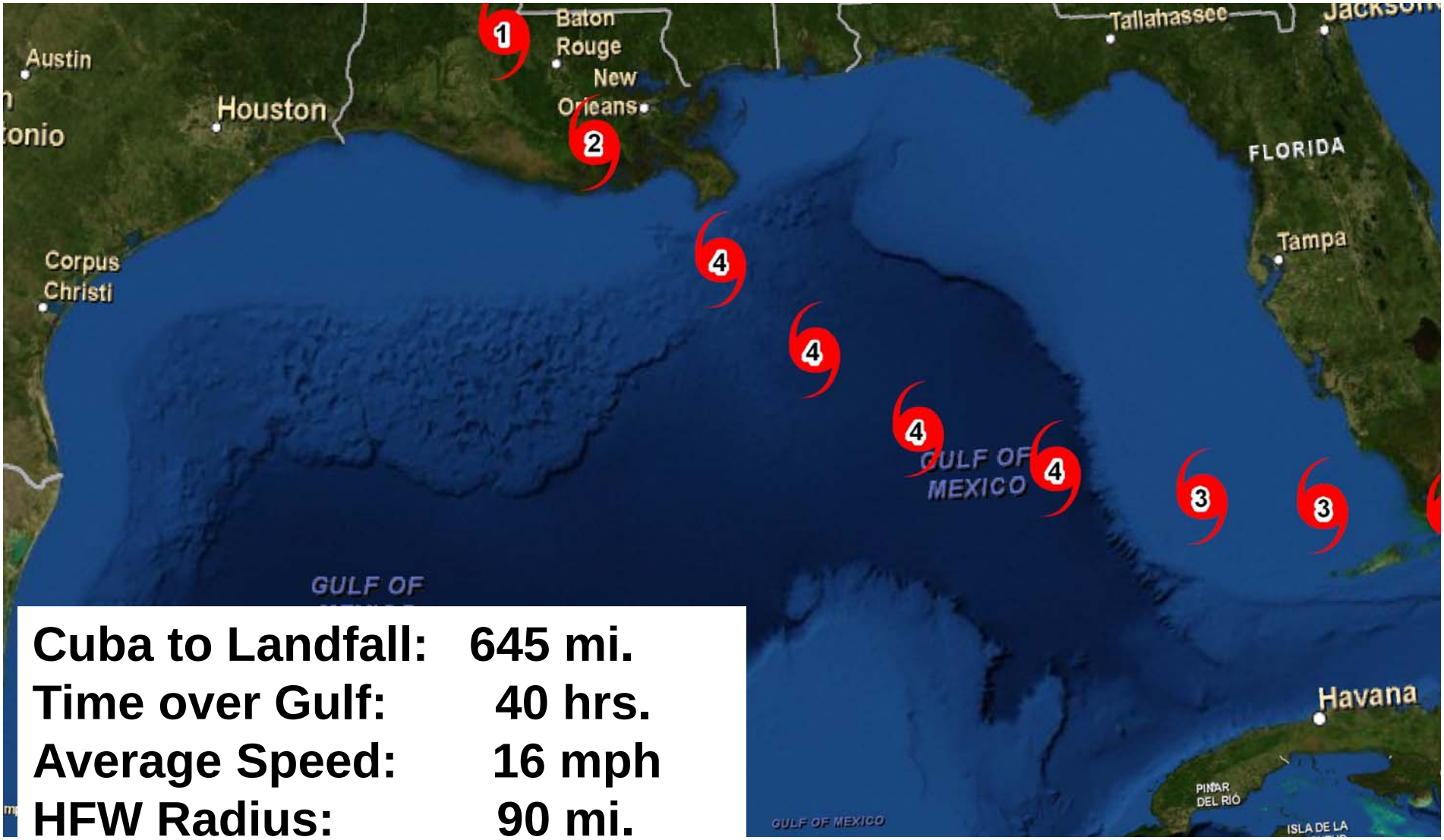
“THANK YOU”

Maurice Wolcott
LSU AgCenter
Louisiana Sea Grant Program
mwolcott@agcenter.lsu.edu

PHOTOS COURTESY OF NOAA

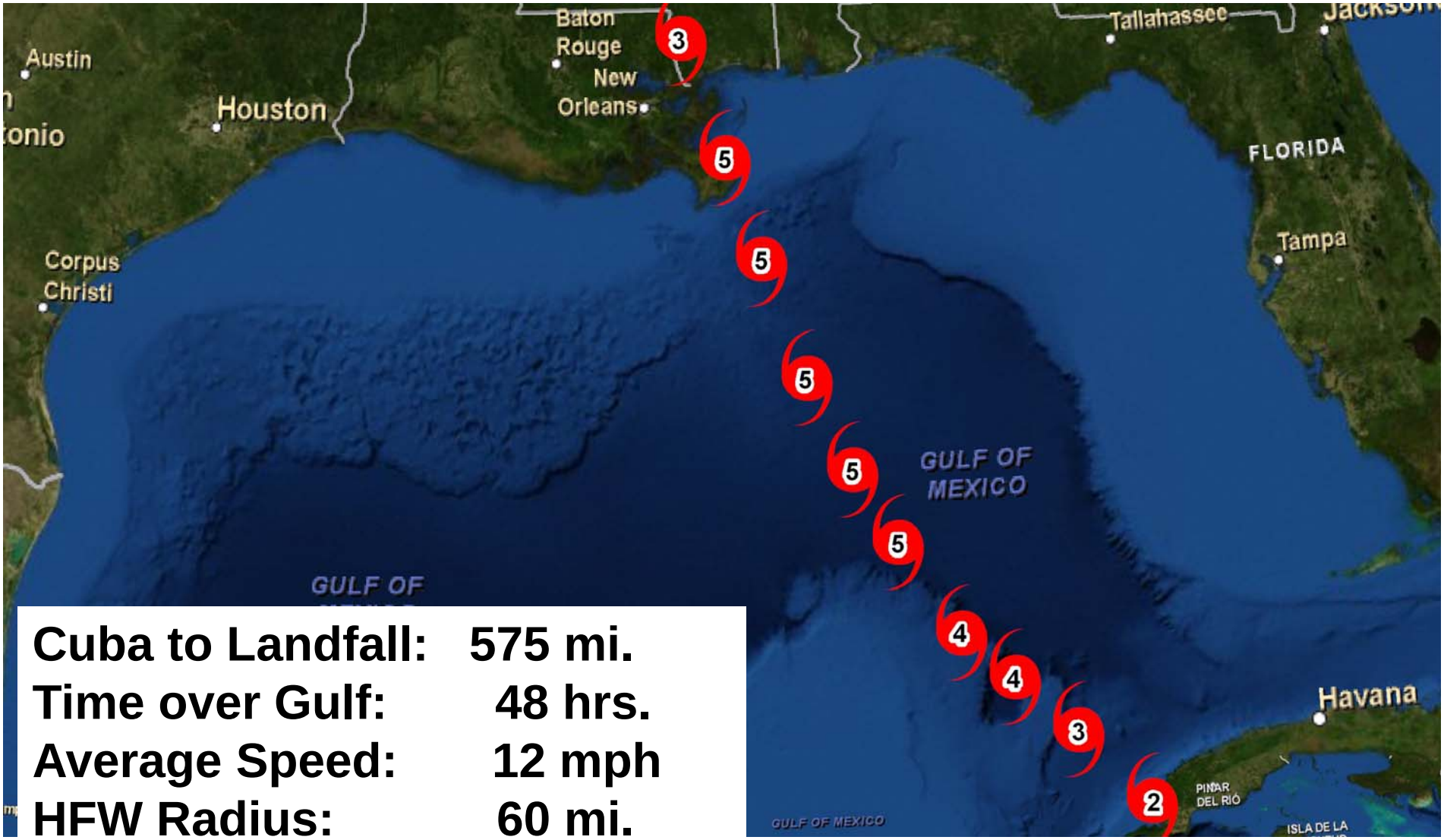
The representations of potential flood extent and depth were derived from the results of the ADCIRC storm surge model, based on the best data currently available to the LSU AgCenter and LA Sea Grant, and are meant to illustrate the vulnerability of coastal Louisiana to significant storm surge events. The results are estimates, and should not be considered exact, as wave action, rainfall accumulation, and potential localized efforts to prevent flooding will impact localized areas.

HURRICANE BETSY - 1965



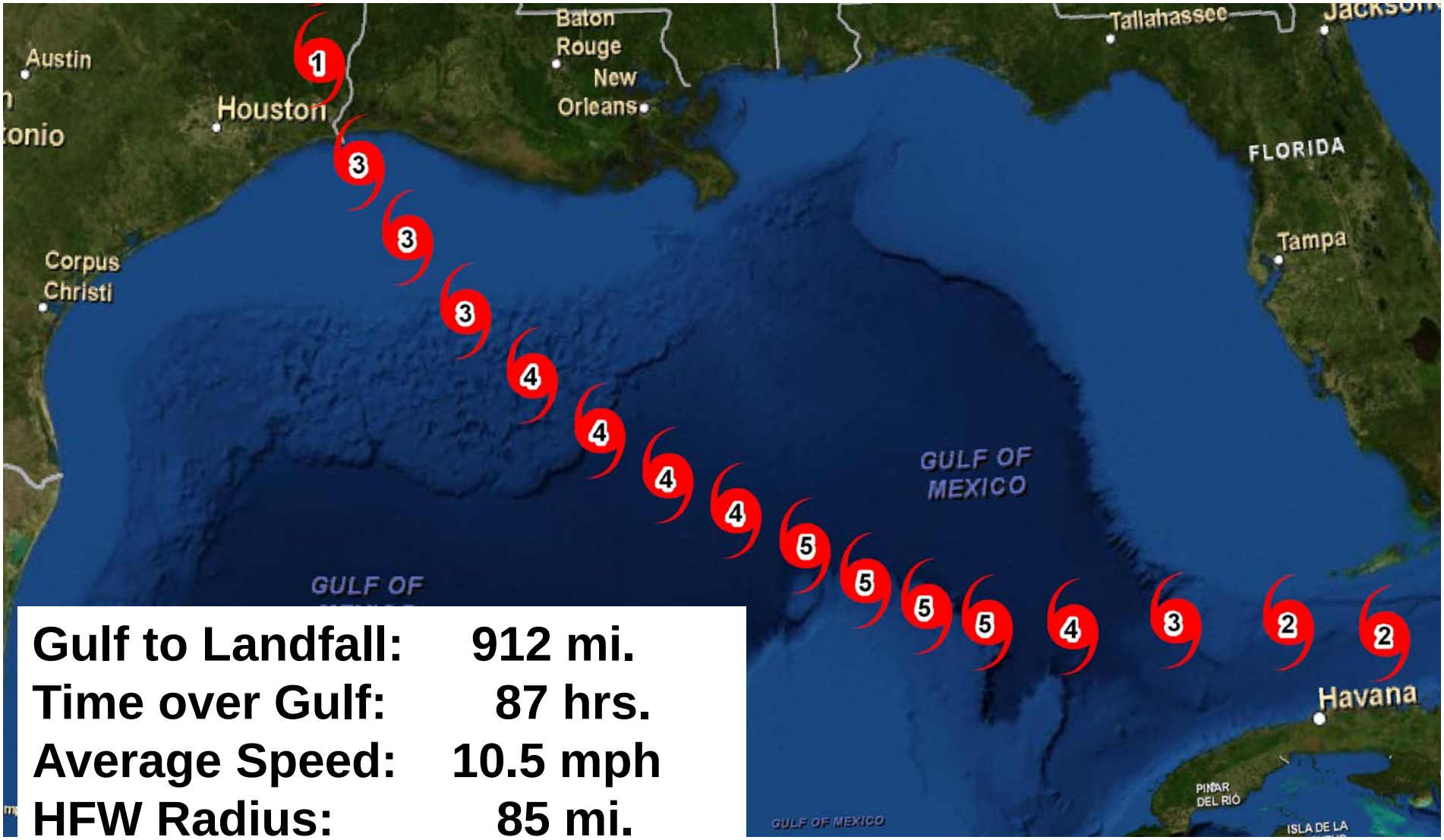
Cuba to Landfall: 645 mi.
Time over Gulf: 40 hrs.
Average Speed: 16 mph
HFW Radius: 90 mi.
TSFW Radius: 250 mi.

HURRICANE CAMILLE - 1969



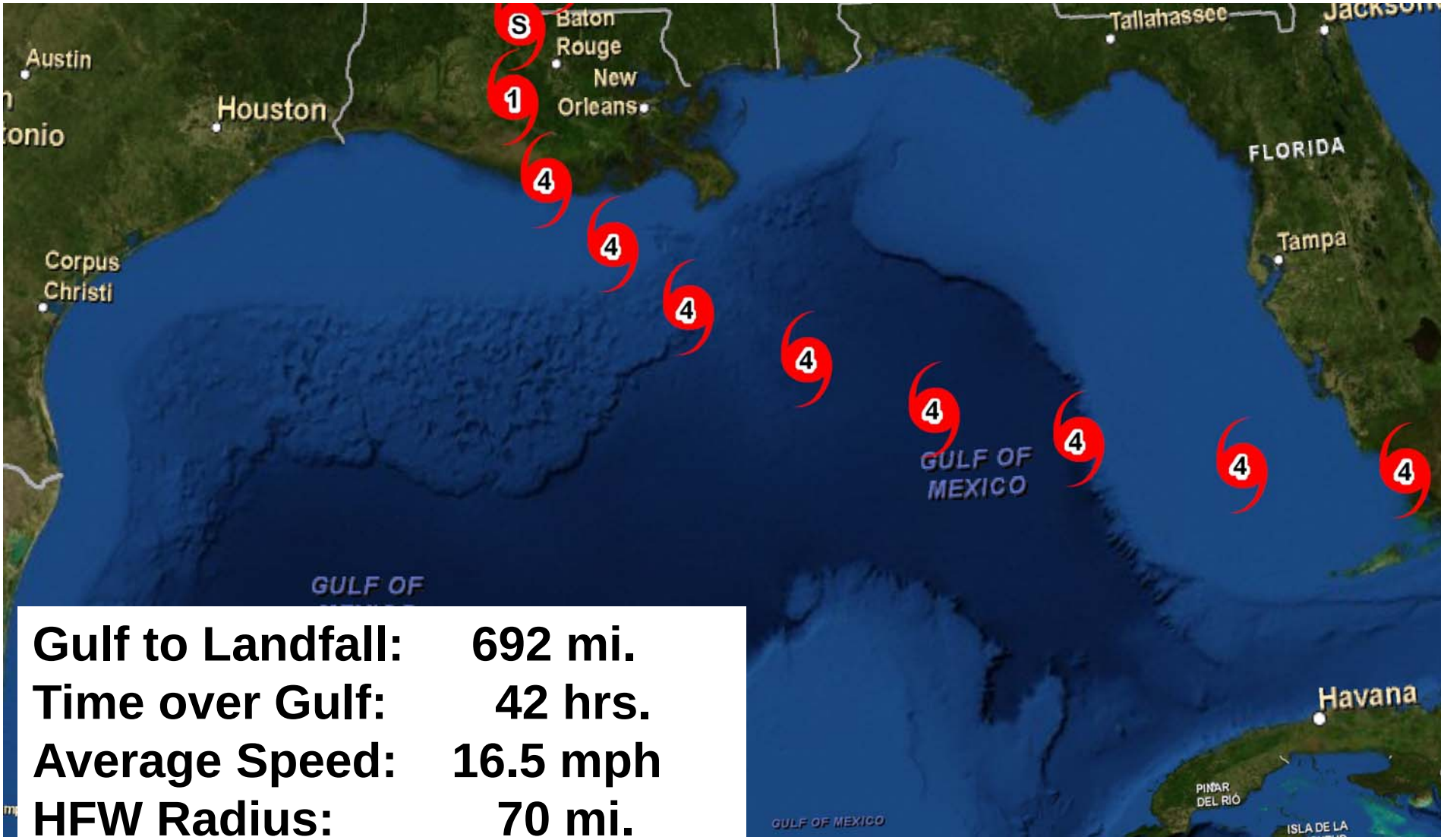
Cuba to Landfall: 575 mi.
Time over Gulf: 48 hrs.
Average Speed: 12 mph
HFW Radius: 60 mi.
TSFW Radiuw: 180 mi.

Rita – 2005



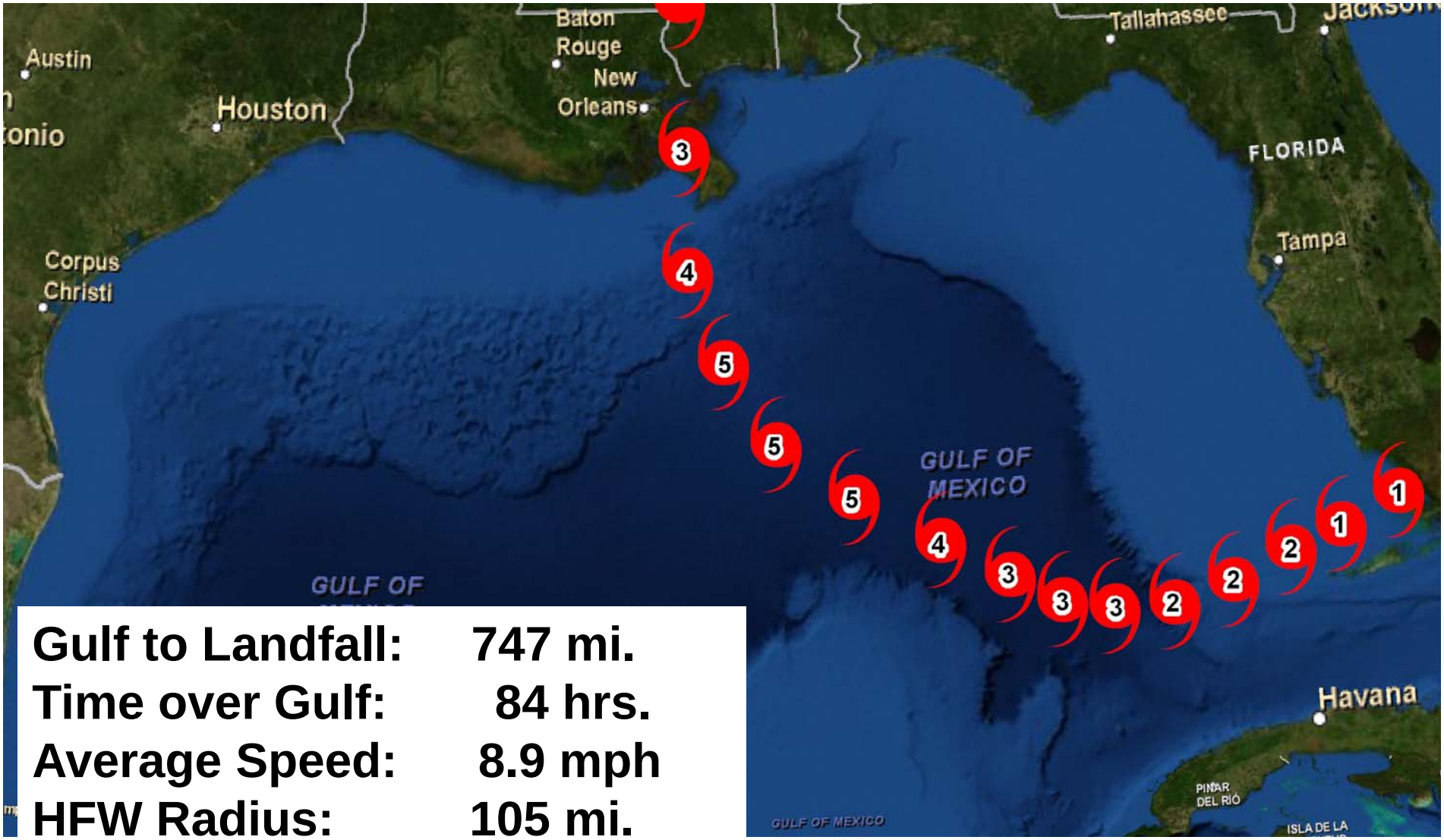
Gulf to Landfall:	**912 mi.**
Time over Gulf:	**87 hrs.**
Average Speed:	**10.5 mph**
HFW Radius:	**85 mi.**
TSFW Radius:	**205 mi.**

Andrew – 1992



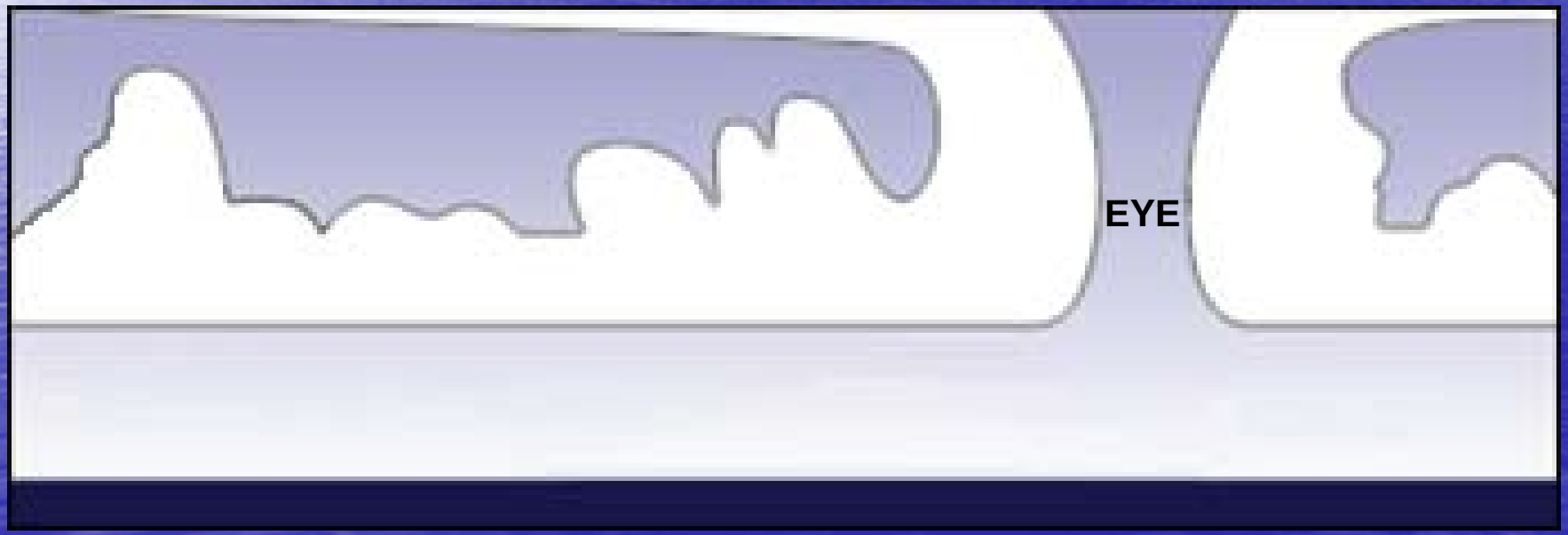
Gulf to Landfall:	**692 mi.**
Time over Gulf:	**42 hrs.**
Average Speed:	**16.5 mph**
HFW Radius:	**70 mi.**
TSFW Radius:	**175 mi.**

Katrina – 2005



Gulf to Landfall:	**747 mi.**
Time over Gulf:	**84 hrs.**
Average Speed:	**8.9 mph**
HFW Radius:	**105 mi.**
TSFW Radius:	**230 mi.**

STORM SURGE is an abnormal rise of water generated by a storm, over and above the predicted normal tide, due to a storm (hurricane/typhoon.)



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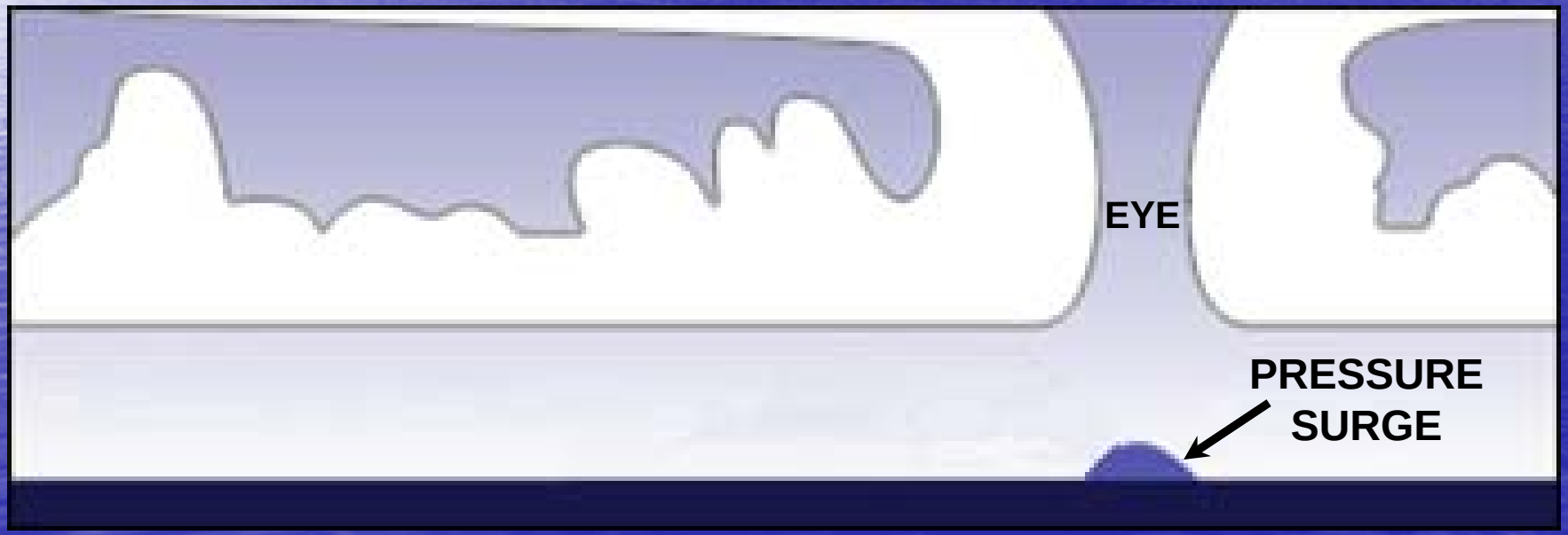

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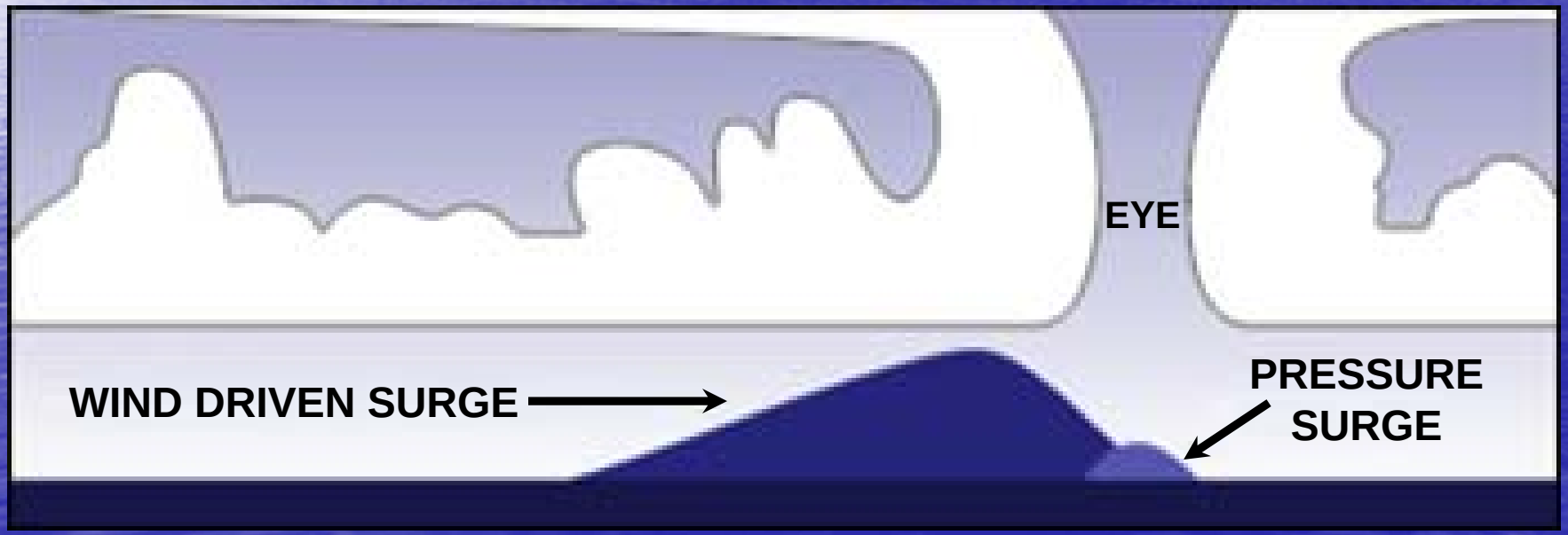
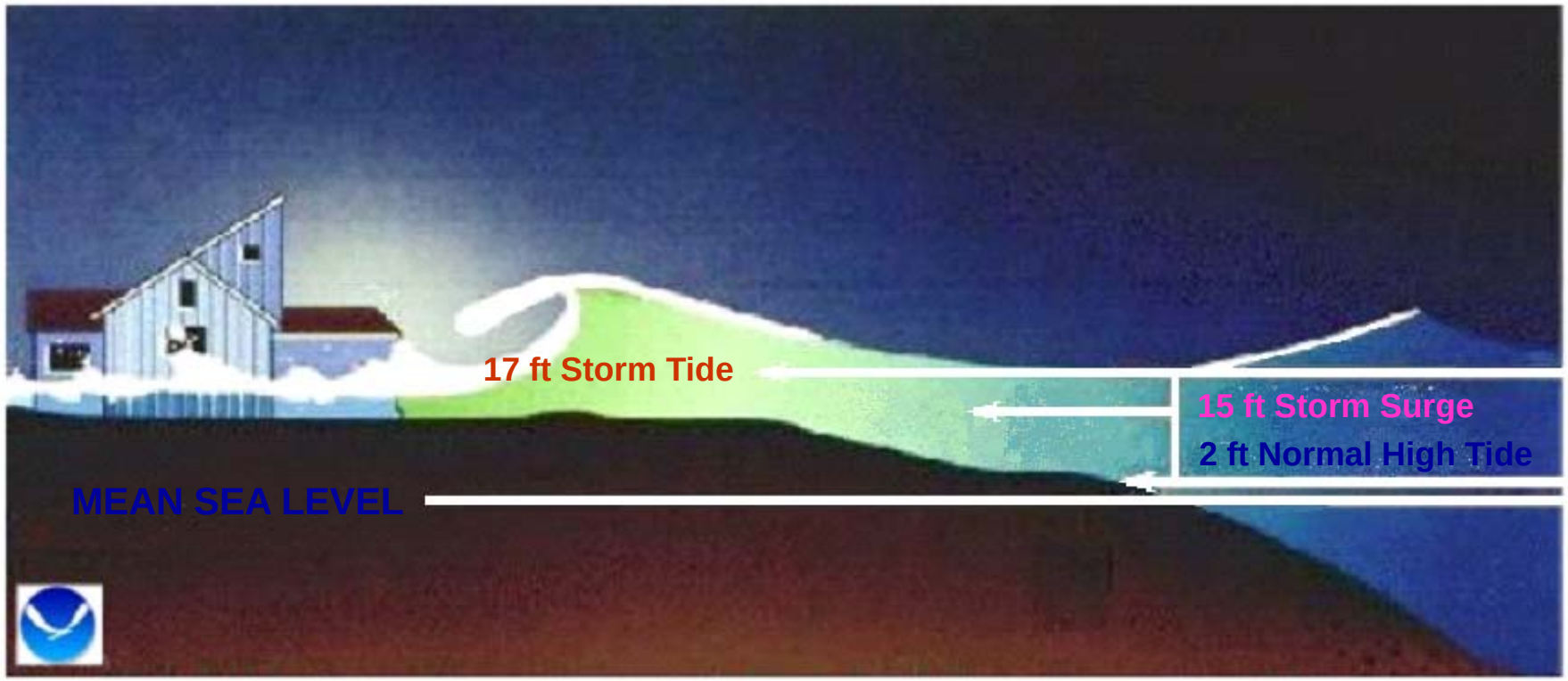
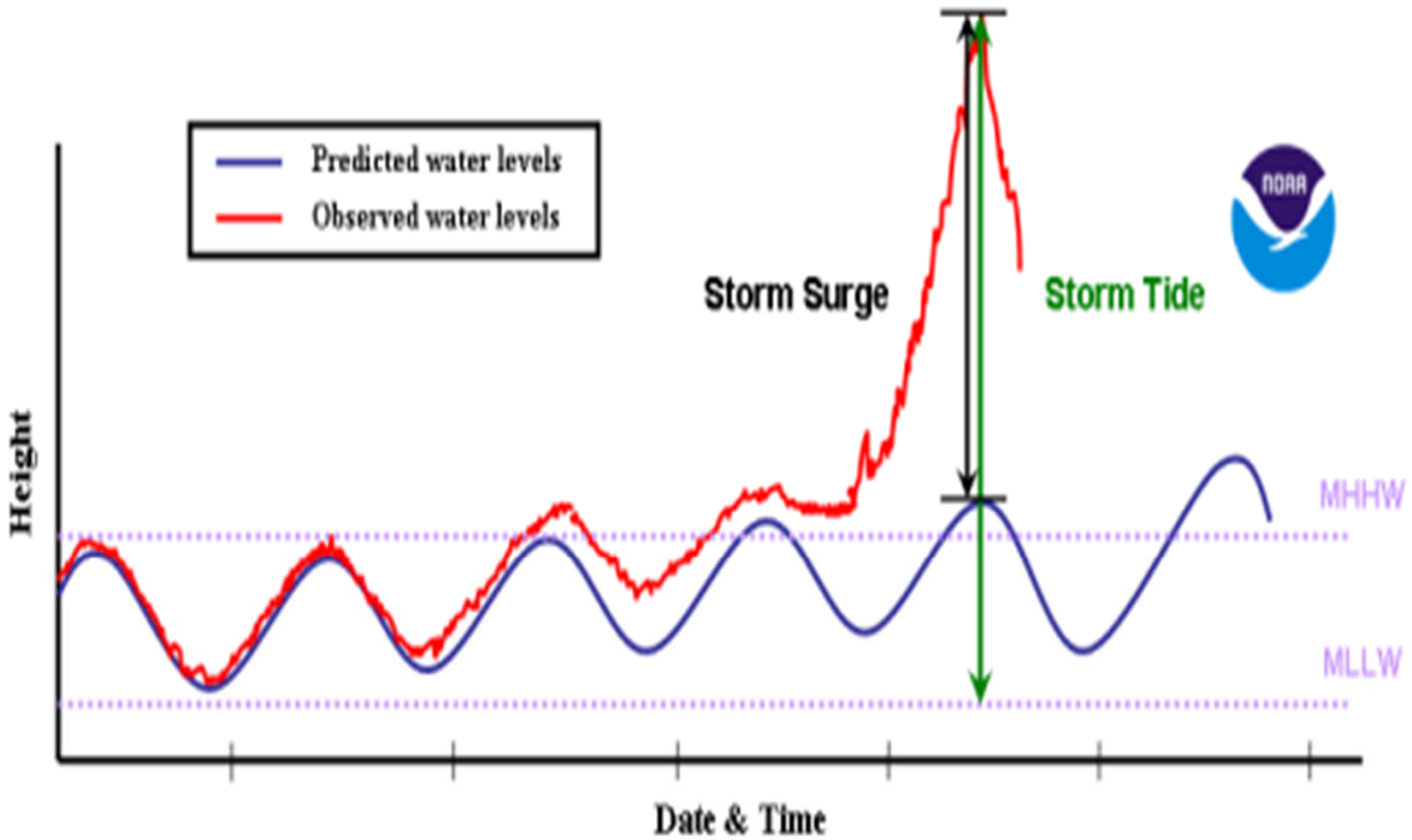


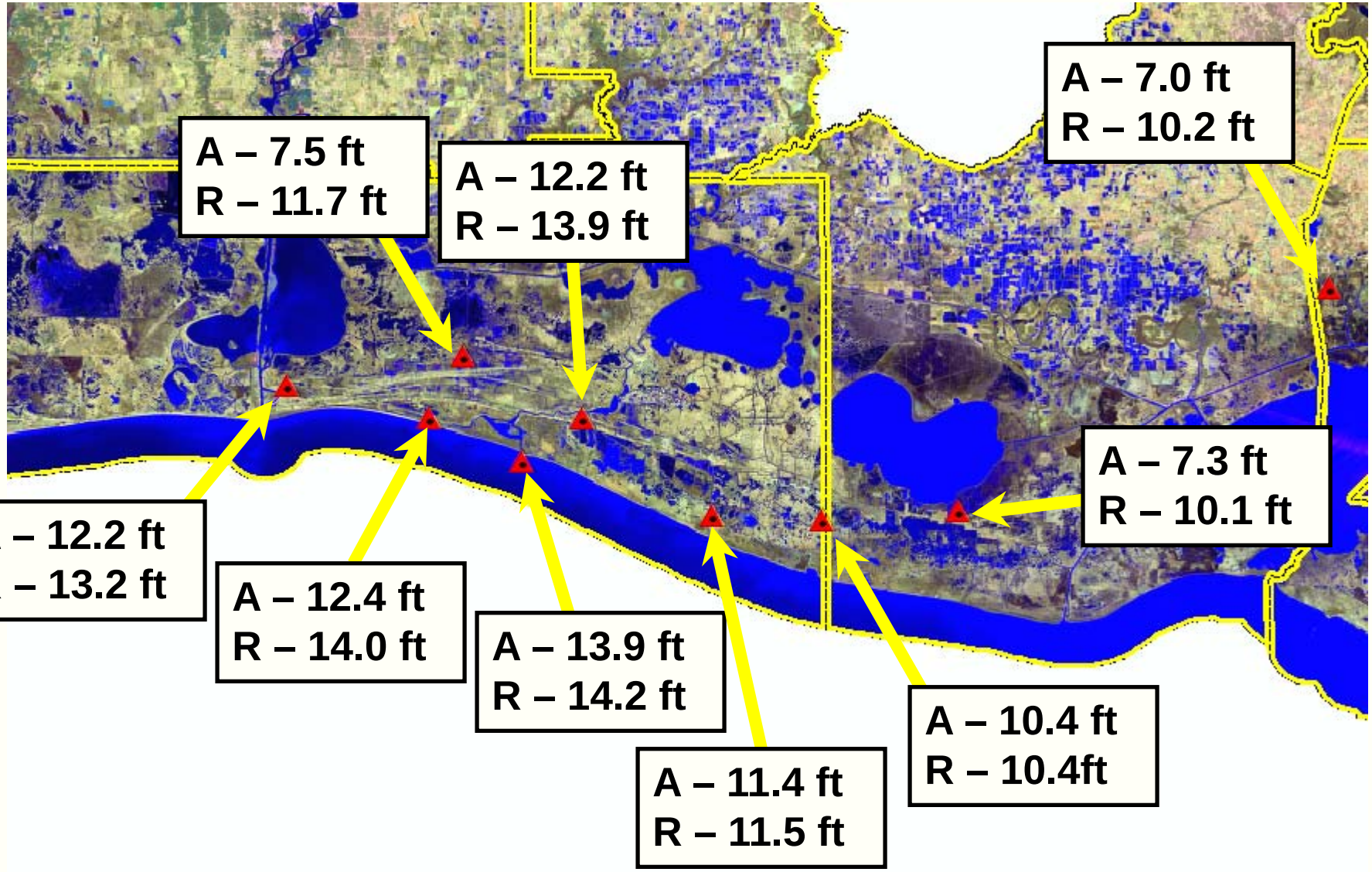
STORM TIDE is the total water level (elevation) during a storm

= Normal Tide + STORM SURGE+ anomaly




Predicted water levels
Observed water levels
Storm Surge
Storm Tide
MHHW
MLLW
Height
Date & Time

High Water Mark Comparison – Audrey vs Rita



Factors Impacting Storm Surge

- **Coastal Factors**
  - **Elevation**

"THE REASON FOR INUNDATION IS ELEVATION!"

Having good information about elevation is critical for planning!

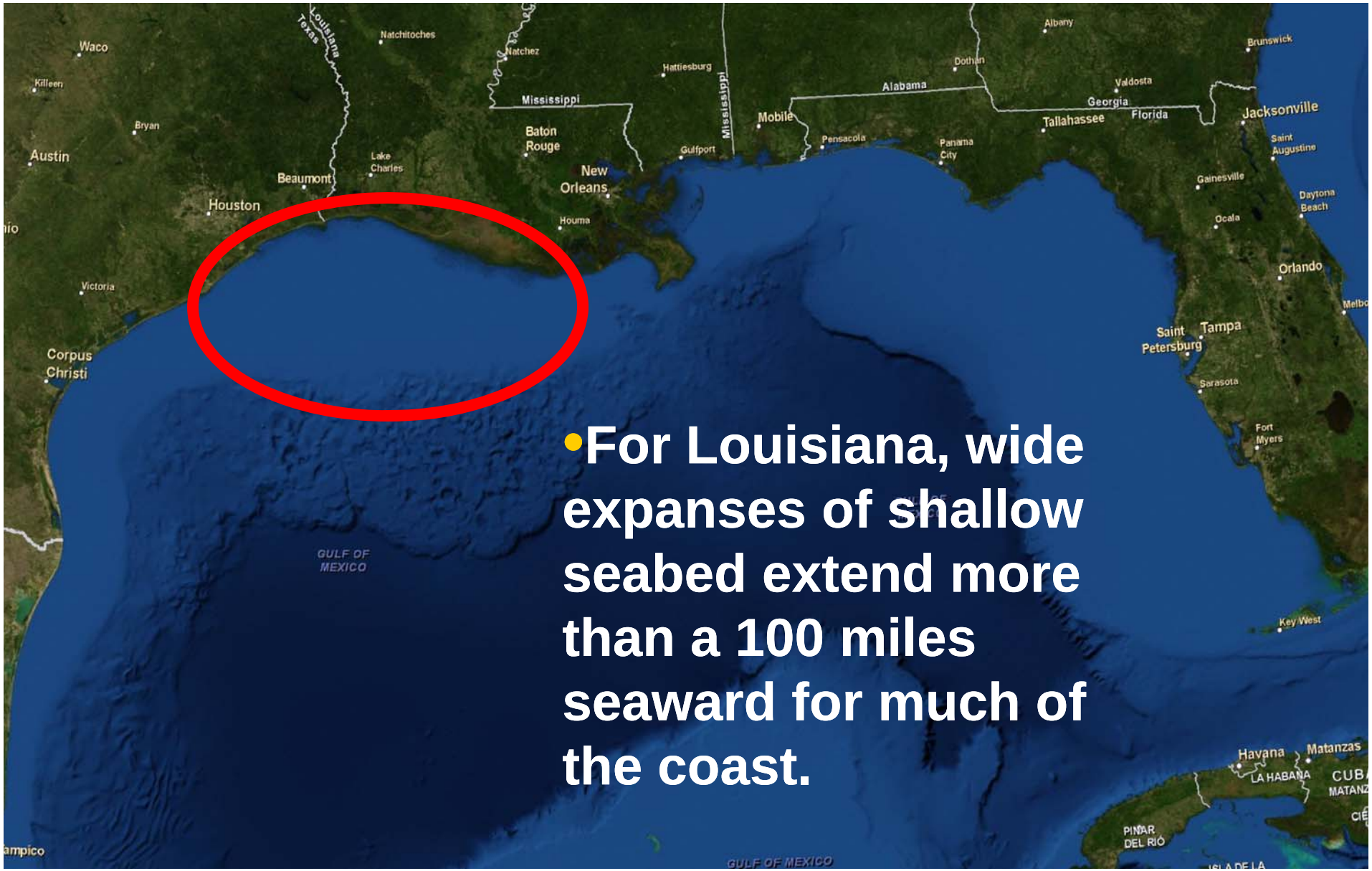
Factors Impacting Storm Surge

- **Coastal Factors**
  - Elevation
  - Proximity to Coastline
  - **Bathymetry (Water Depth)**
  - **Slope of coast**

What does this have to do with storm surge?

- A shallow continental shelf will allow a greater surge to inundate coastal communities. Areas with a steeper continental shelf will not see as much surge inundation.

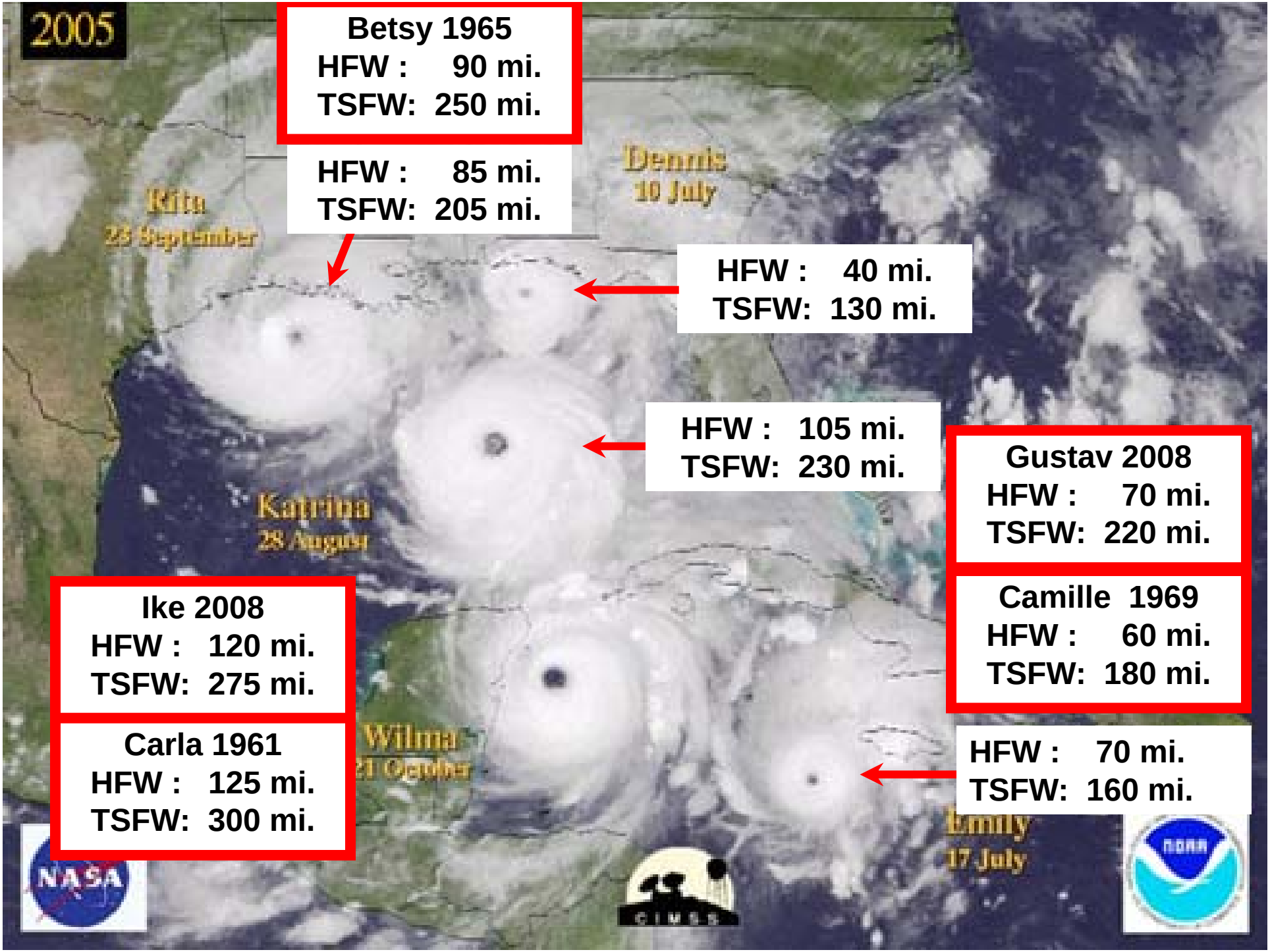
Gulf of Mexico Bathymetry (Water Depth)



- For Louisiana, wide expanses of shallow seabed extend more than a 100 miles seaward for much of the coast.

Gulf of Mexico Bathymetry (Water Depth)

- This tends to increase the peak of the storm surge that eventually comes ashore.


2005
Betsy 1965
HFW : 90 mi.
TSFW: 250 mi.
HFW : 85 mi.
TSFW: 205 mi.
Rita
23 September
Dennis
10 July
HFW : 40 mi.
TSFW: 130 mi.
HFW : 105 mi.
TSFW: 230 mi.
Katrina
28 August
Gustav 2008
HFW : 70 mi.
TSFW: 220 mi.
Ike 2008
HFW : 120 mi.
TSFW: 275 mi.
Camille 1969
HFW : 60 mi.
TSFW: 180 mi.
Carla 1961
HFW : 125 mi.
TSFW: 300 mi.
Wilma
21 October
HFW : 70 mi.
TSFW: 160 mi.
Emily
17 July
NASA
CIMSS
NOAA

Storm Surge Misconceptions, Misunderstanding, and Confusion

- "Gates at Chef Pass and the Rigolets will protect us from storm surge"

  (Inland Lake Storm Surge)
- "I'm outside the flood zone!"
- "The water is beginning to recede, we should be able to go home now."
  - (Johnny Boudreaux, "Second Surge" slides

Storm Surge Misconceptions, Misunderstanding, and Confusion

- "We have levees to protect us."
- "It's making landfall far to the west."
- "Katrina was an anomaly."
  - "Rita was an an anomaly."
  - "Ike was an anomaly?"
  - "Carla was an anomaly?"

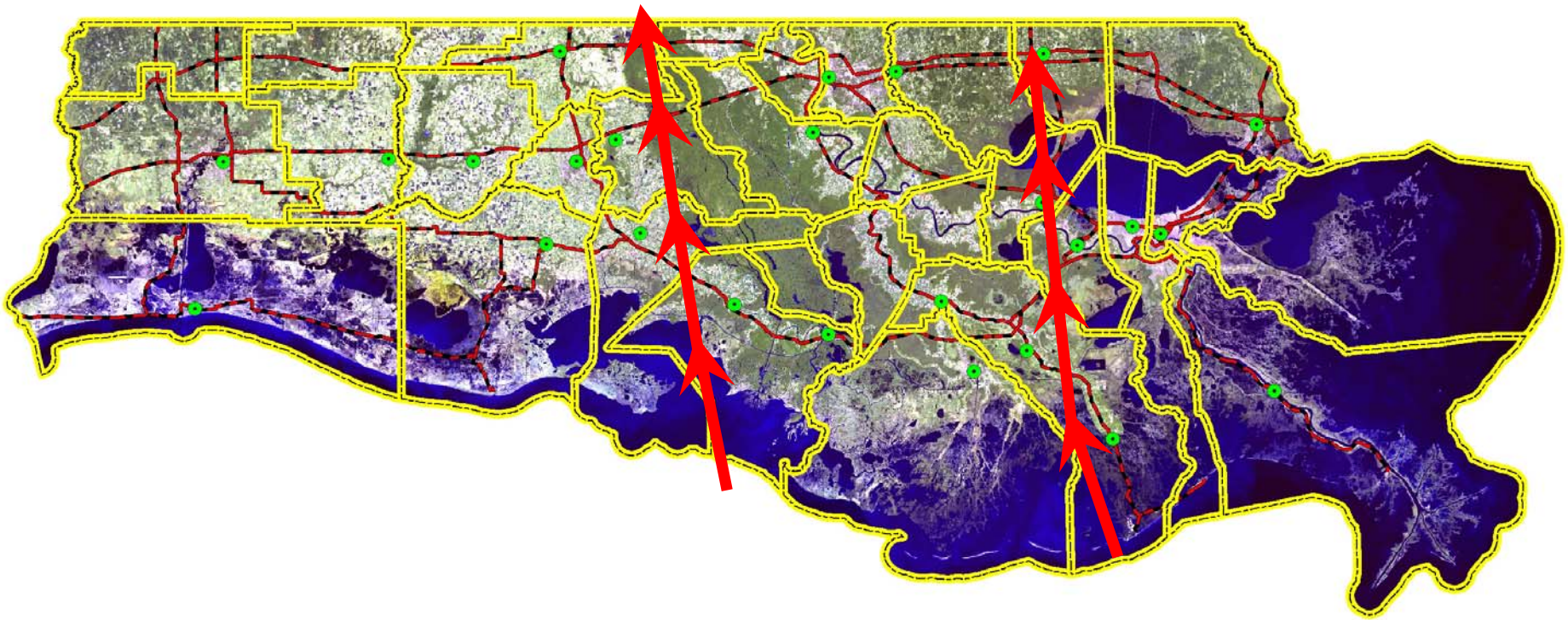
Storm Surge Misconceptions, Misunderstanding, and Confusion

- "This (house, building) survived Camille, it will survive anything." Mississippi Gulf Coast resident prior to Katrina
- "Storm surge can't come this far inland."

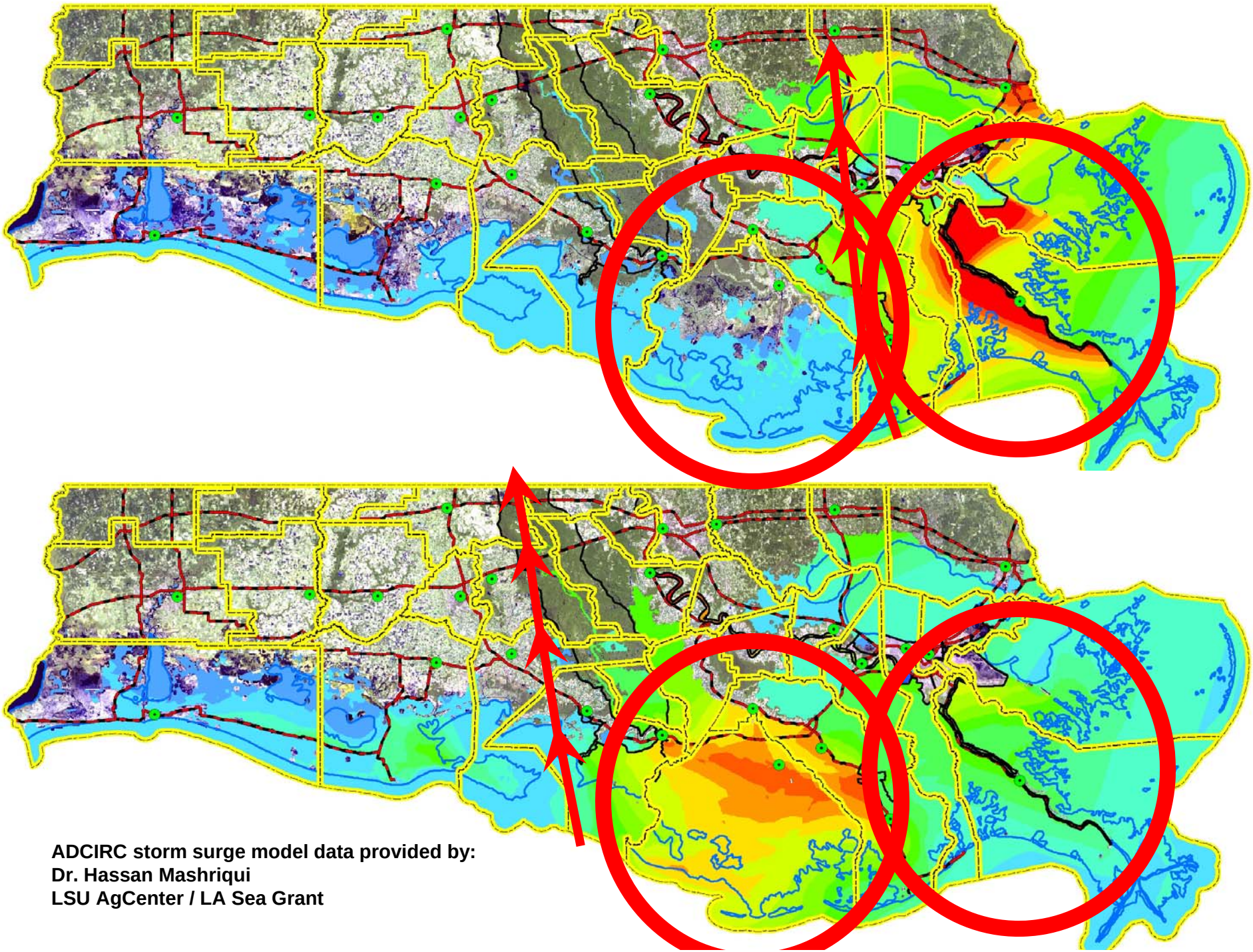
Storm Surge Misconceptions, Misunderstanding, and Confusion

- "It's only a Category 2!!!"
- "It was 50 years since Audrey; it won't happen again for another 50 years." Cameron parish after Rita.
- "We will evacuate tomorrow morning, there is still plenty of time." Bolivar Peninsula, Texas, before Ike
- "It can't happen here!"

TWO HYPOTHETICAL RITA ADCIRC MODELS



ADCIRC storm surge model data provided by:
Dr. Hassan Mashriqui
LSU AgCenter / LA Sea Grant



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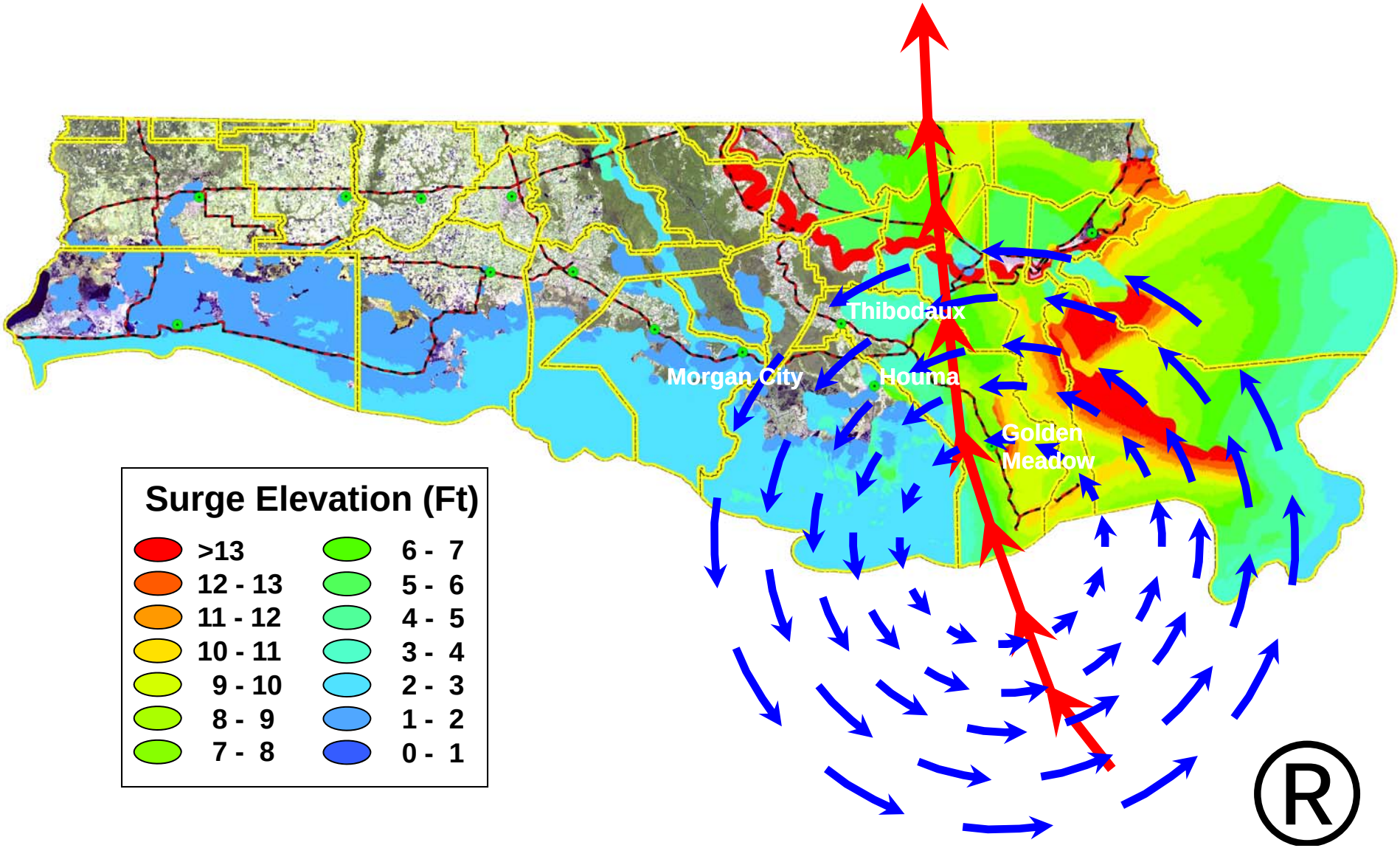
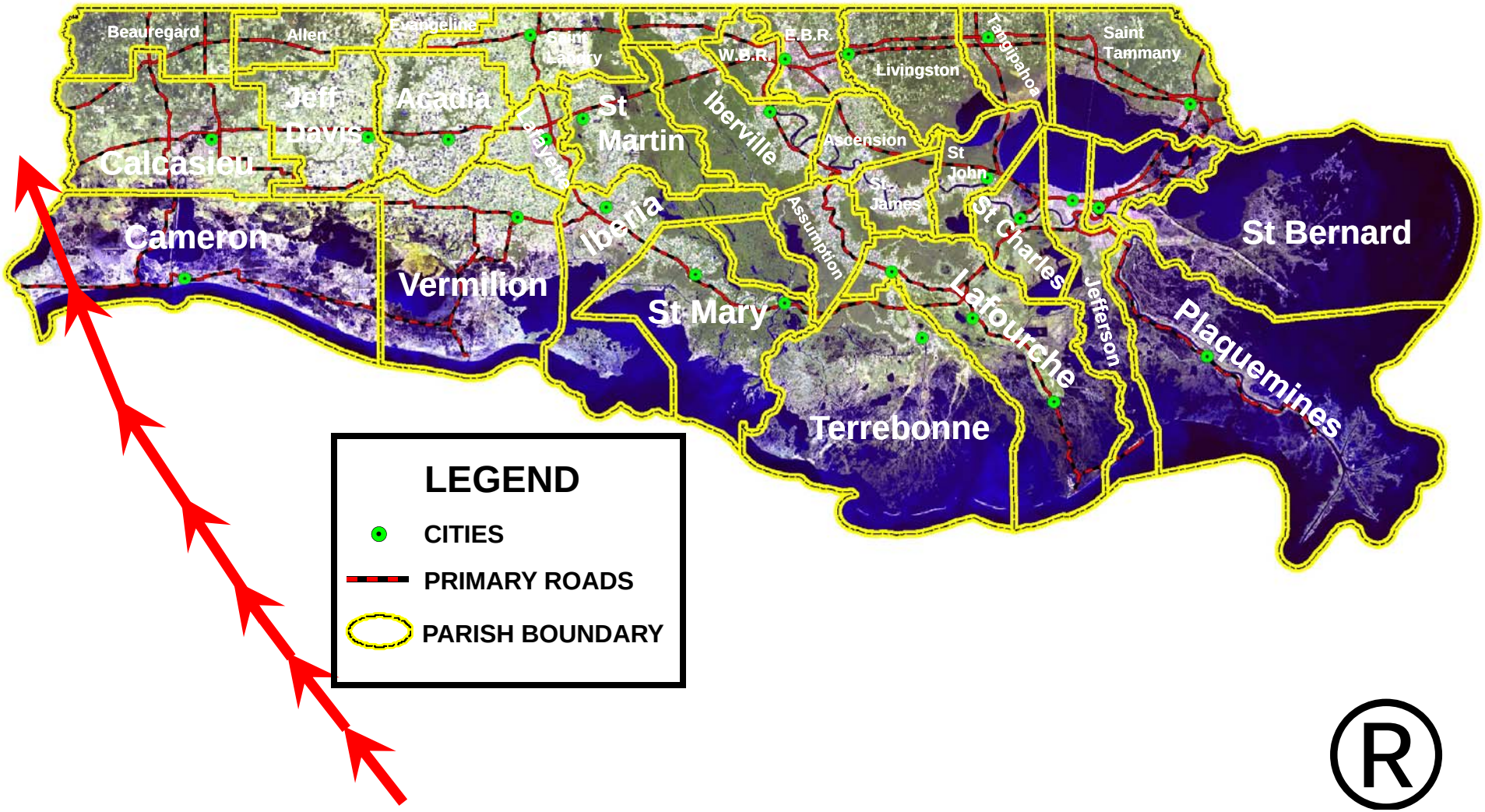
LSU AgCenter / LA Sea Grant

RITA TERREBONNE / LAFOURCHE (EAST) TRACK

ADCIRC PREDICTED STORM SURGE ELEVATIONS



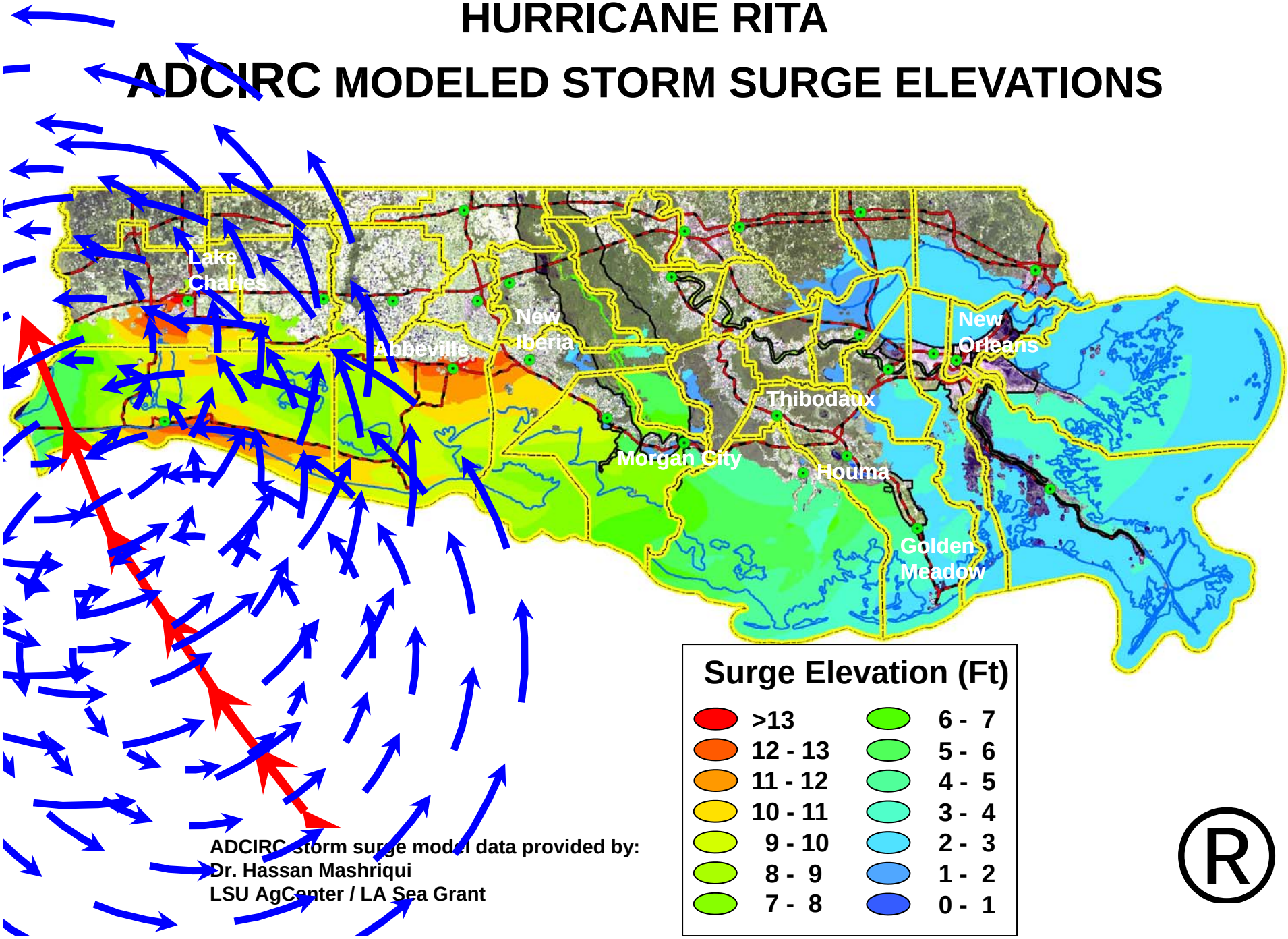
Hurricane Rita



®

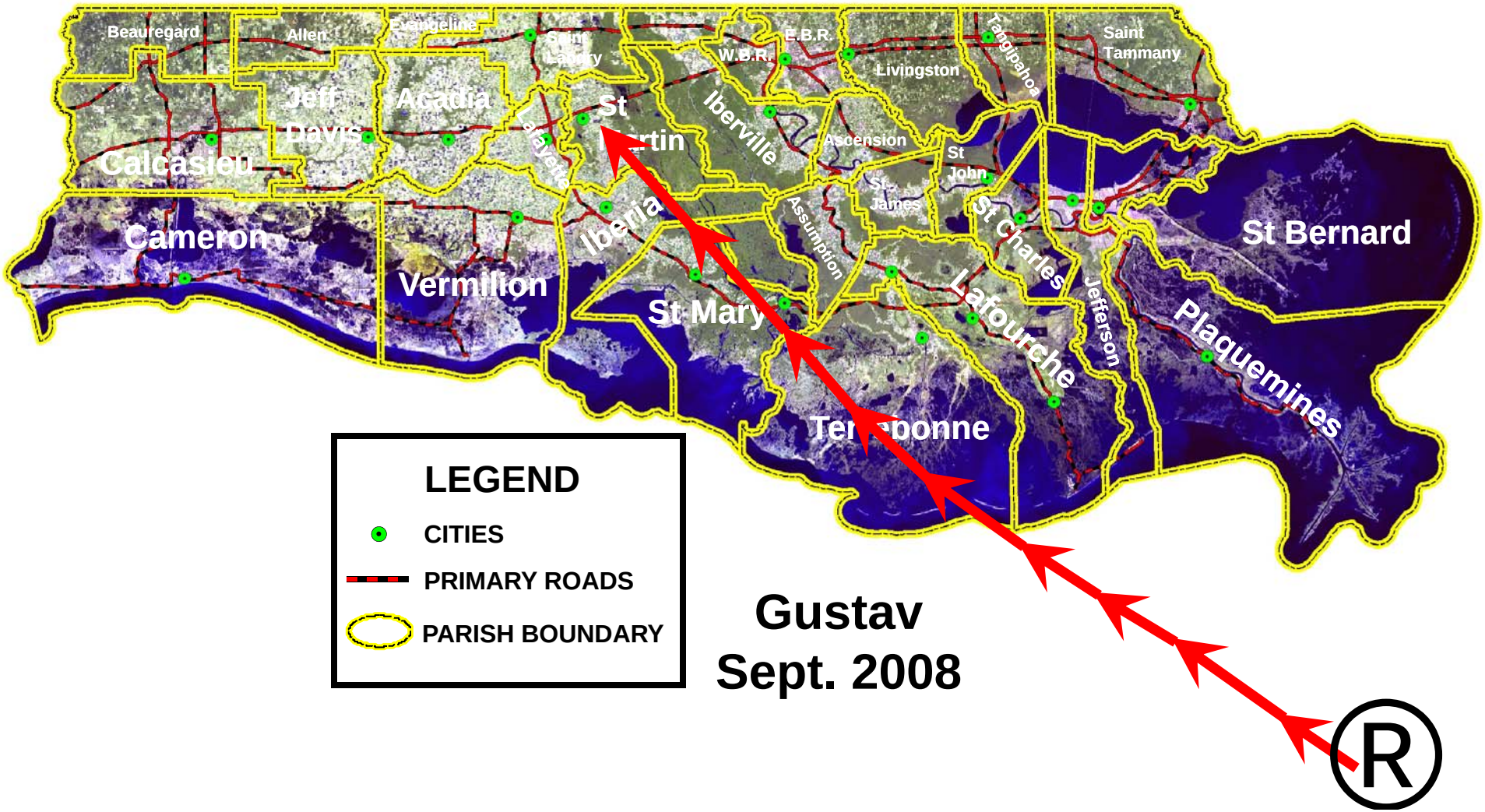
HURRICANE RITA

ADCIRC MODELED STORM SURGE ELEVATIONS



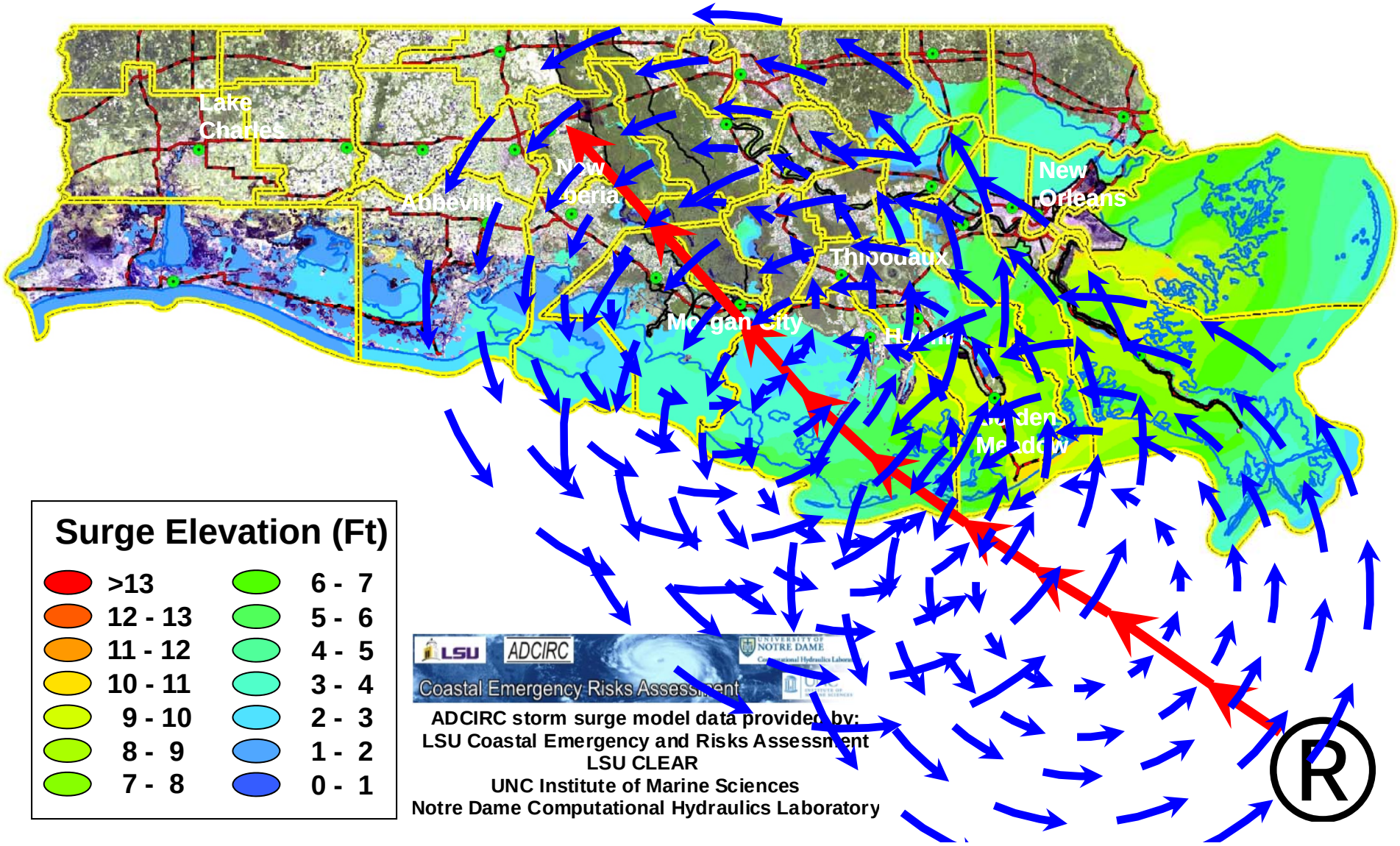
®

HURRICANE GUSTAV

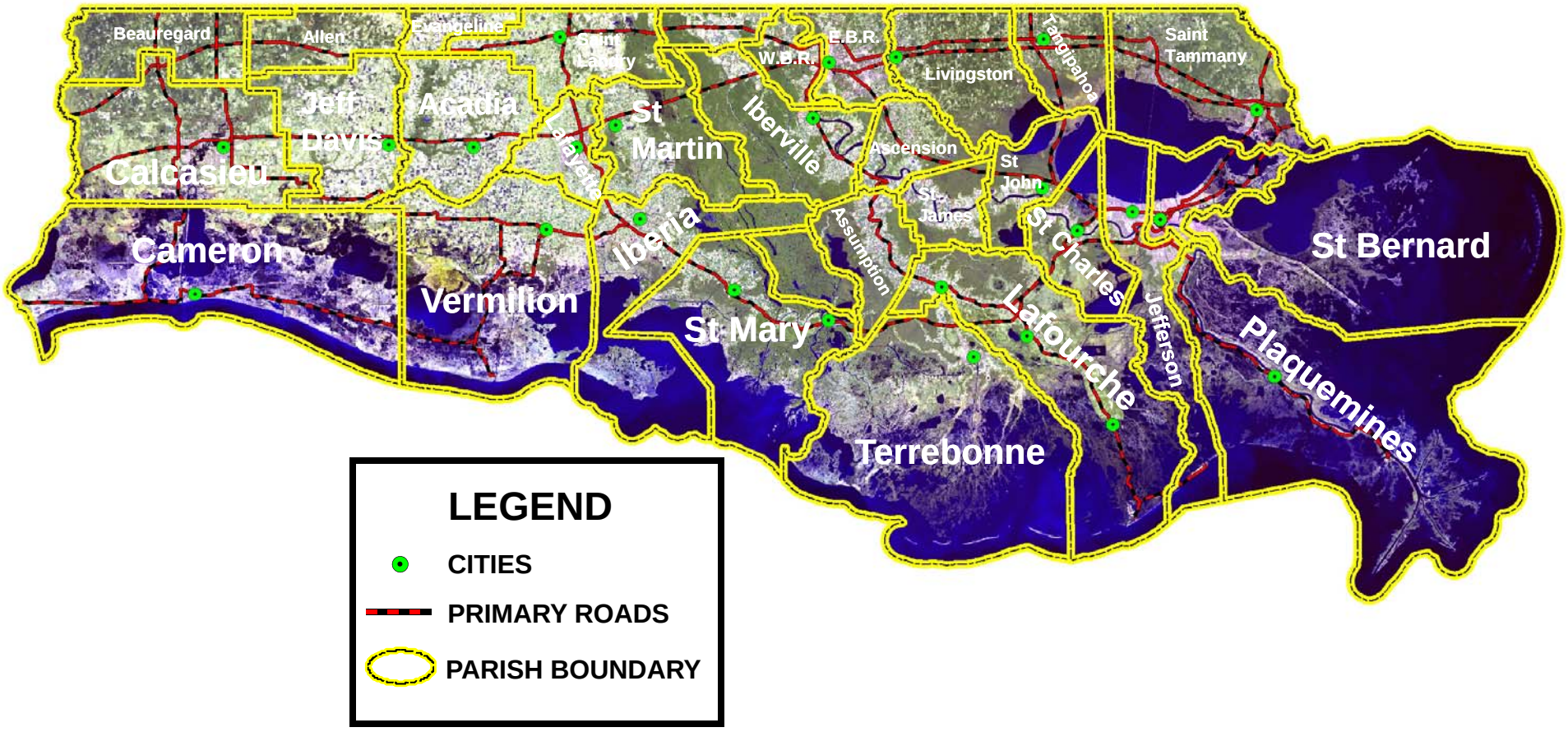


HURRICANE GUSTAV

ADCIRC MODELED STORM SURGE ELEVATIONS



HURRICANE IKE



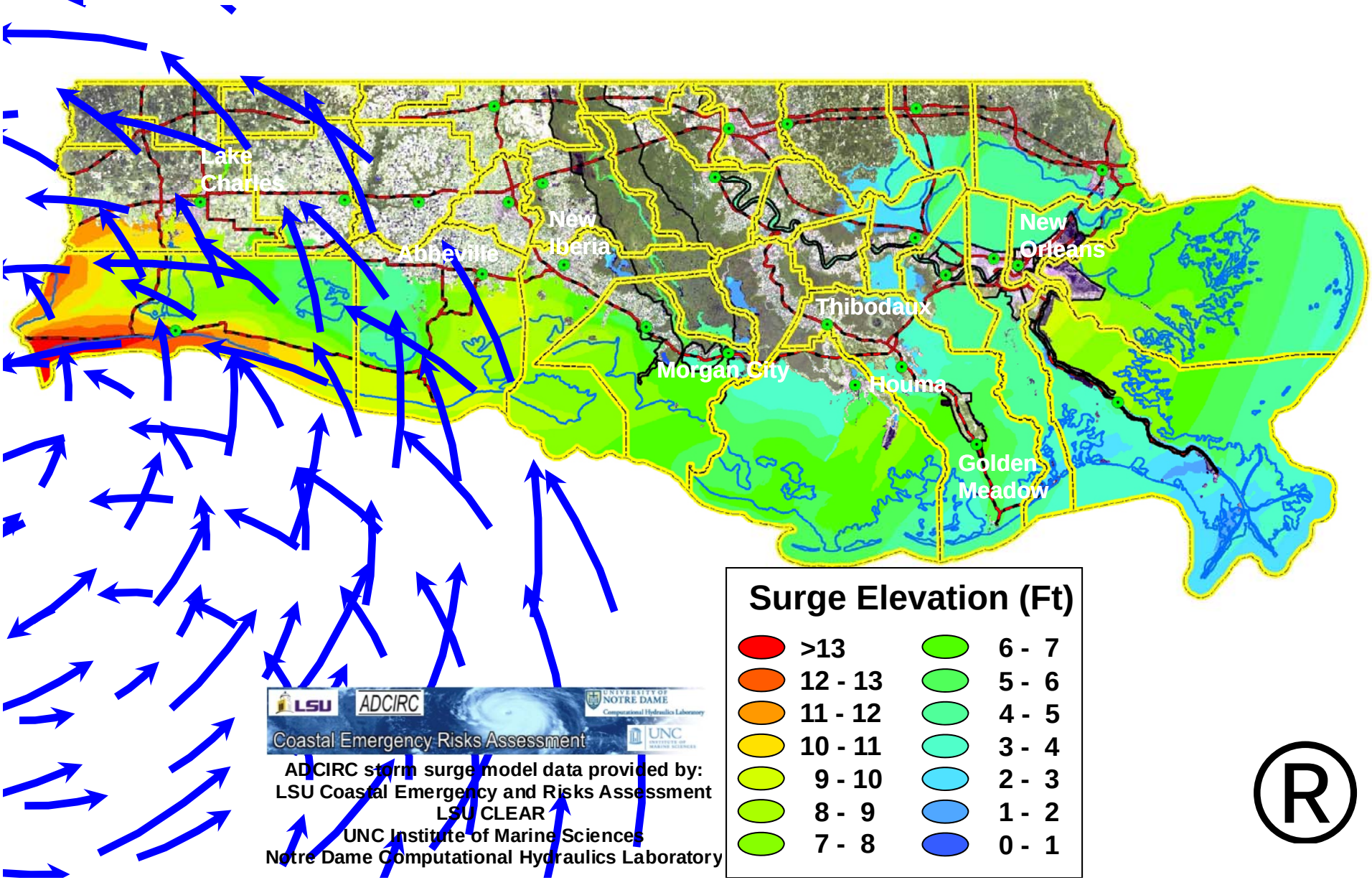
LEGEND

- CITIES
- PRIMARY ROADS
- PARISH BOUNDARY

®

HURRICANE IKE

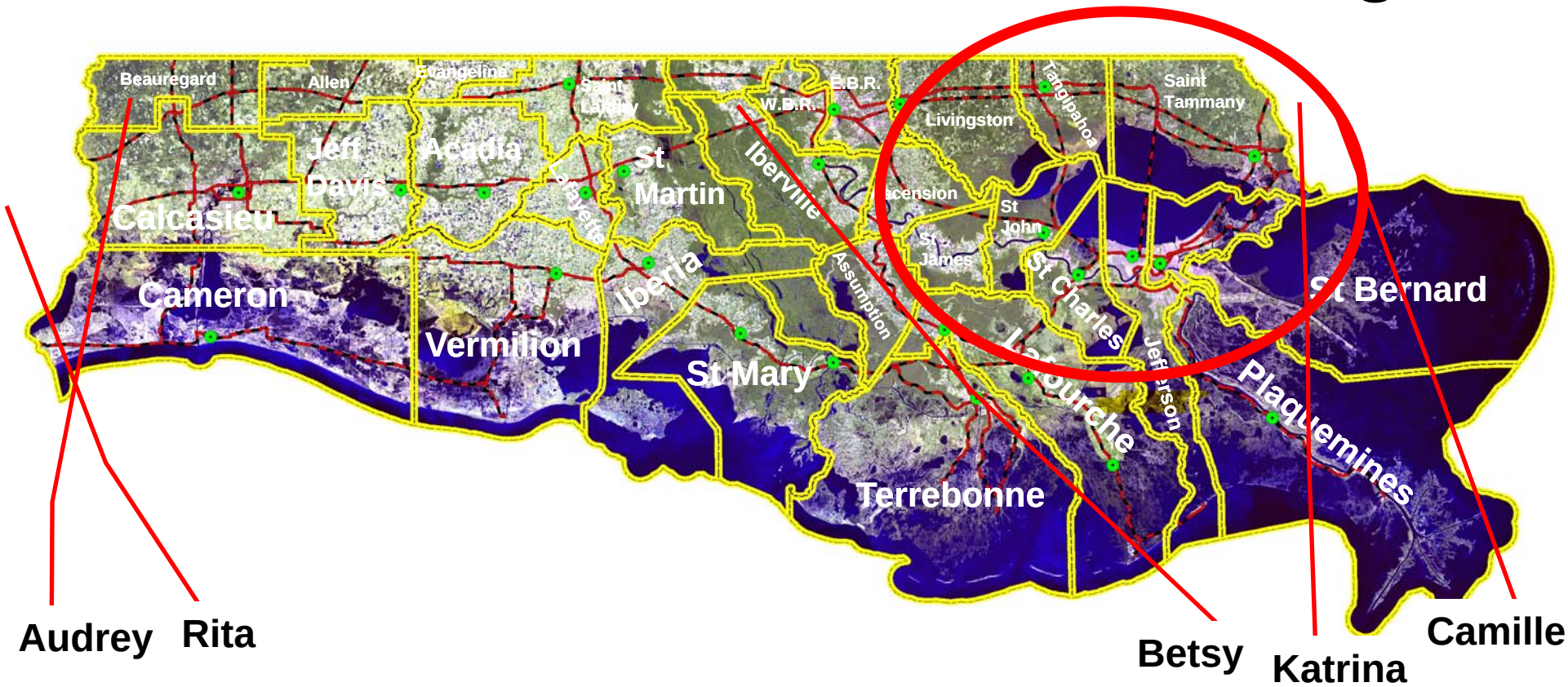
ADCIRC MODELED STORM SURGE ELEVATIONS



®

The Louisiana Coast

A Vulnerable Area for Storm Surge



Major <u>Storm Surge</u> Events Impacting LA

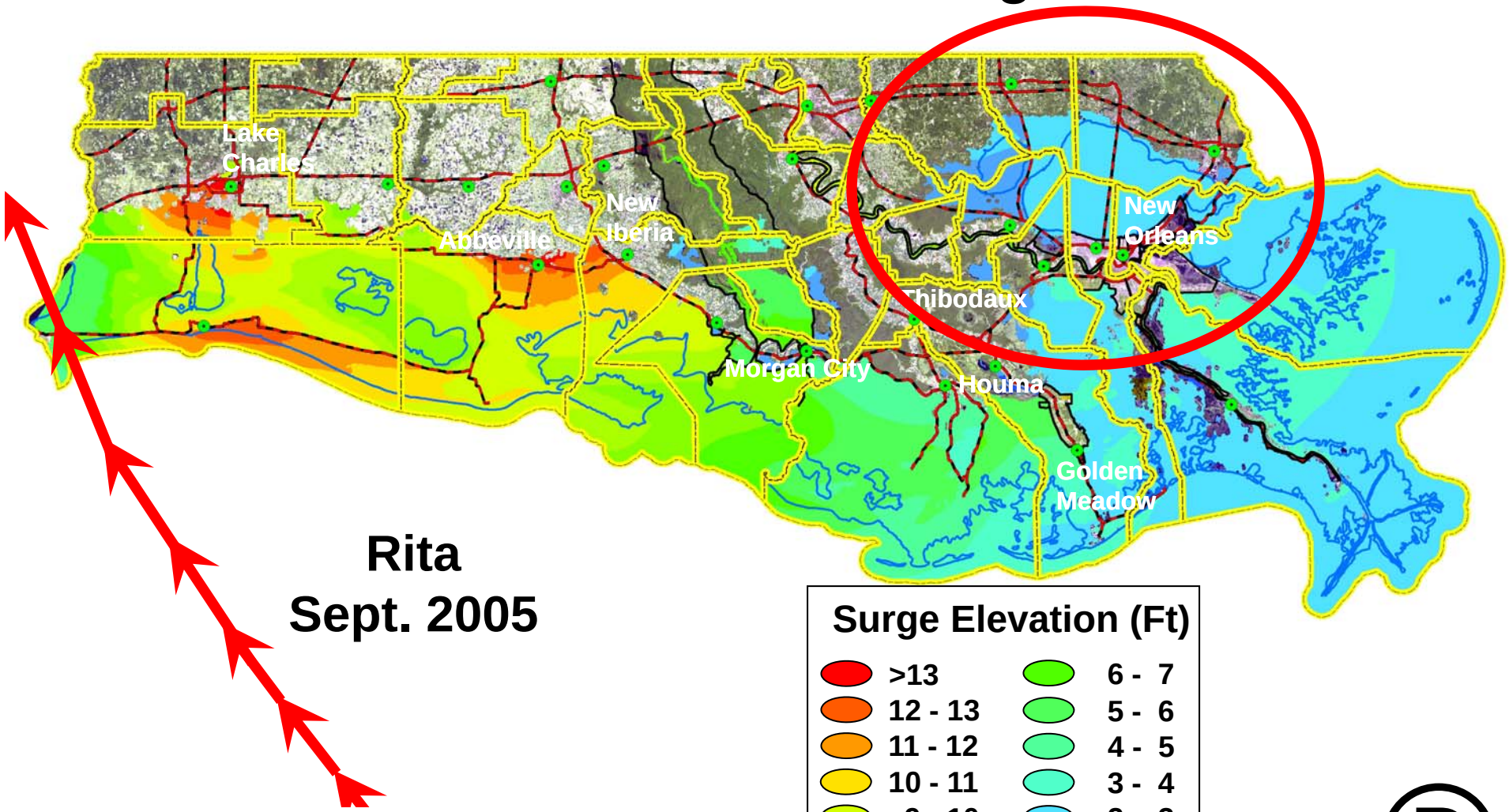
Ike, Carla

Texas Landfall

®

HURRICANE RITA

ADCIRC Predicted Storm Surge Elevations



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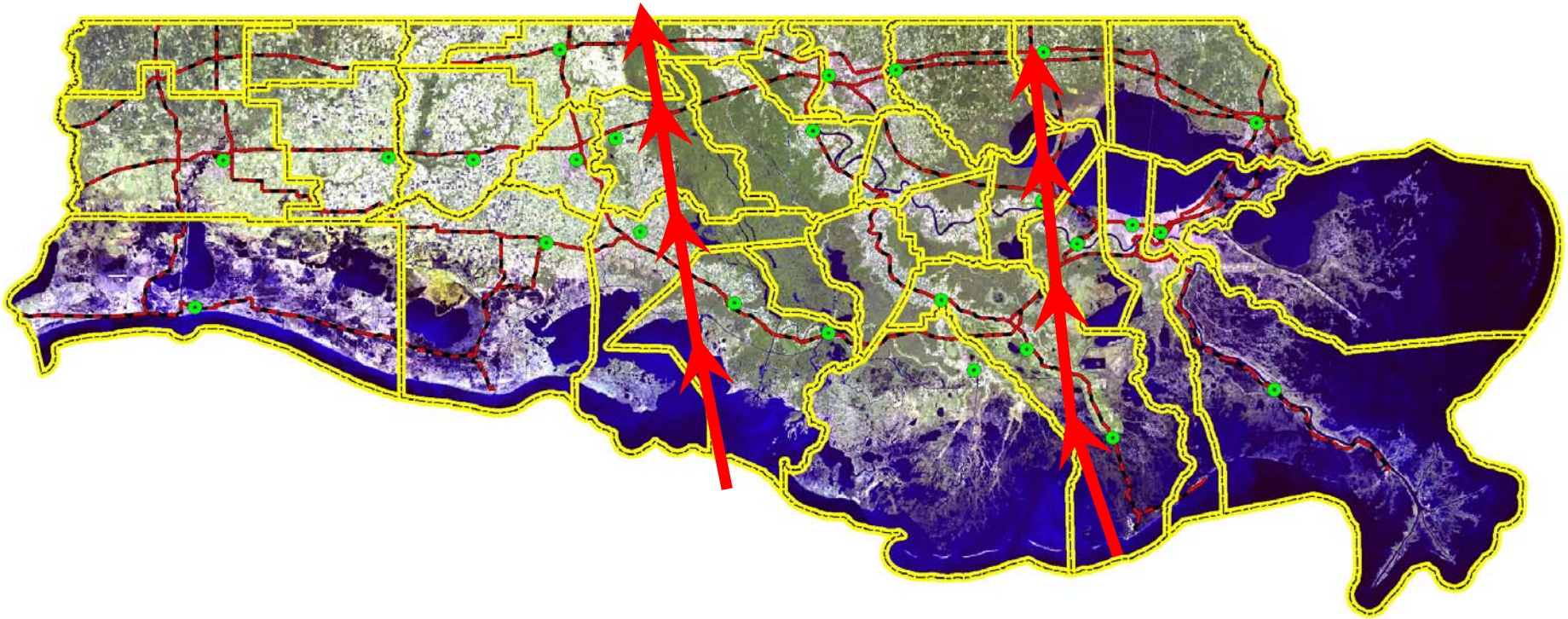
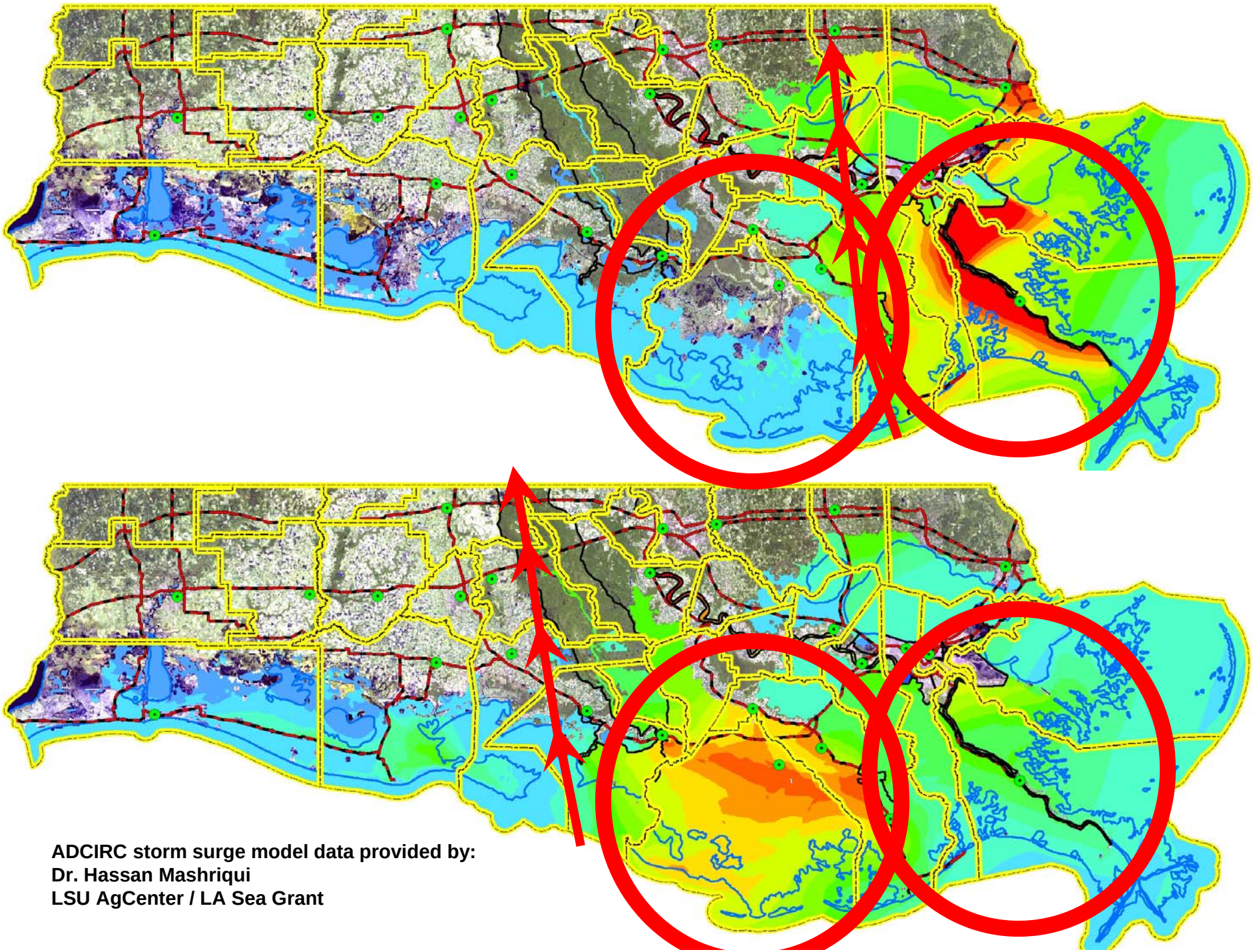
TWO HYPOTHETICAL RITA ADCIRC MODELS





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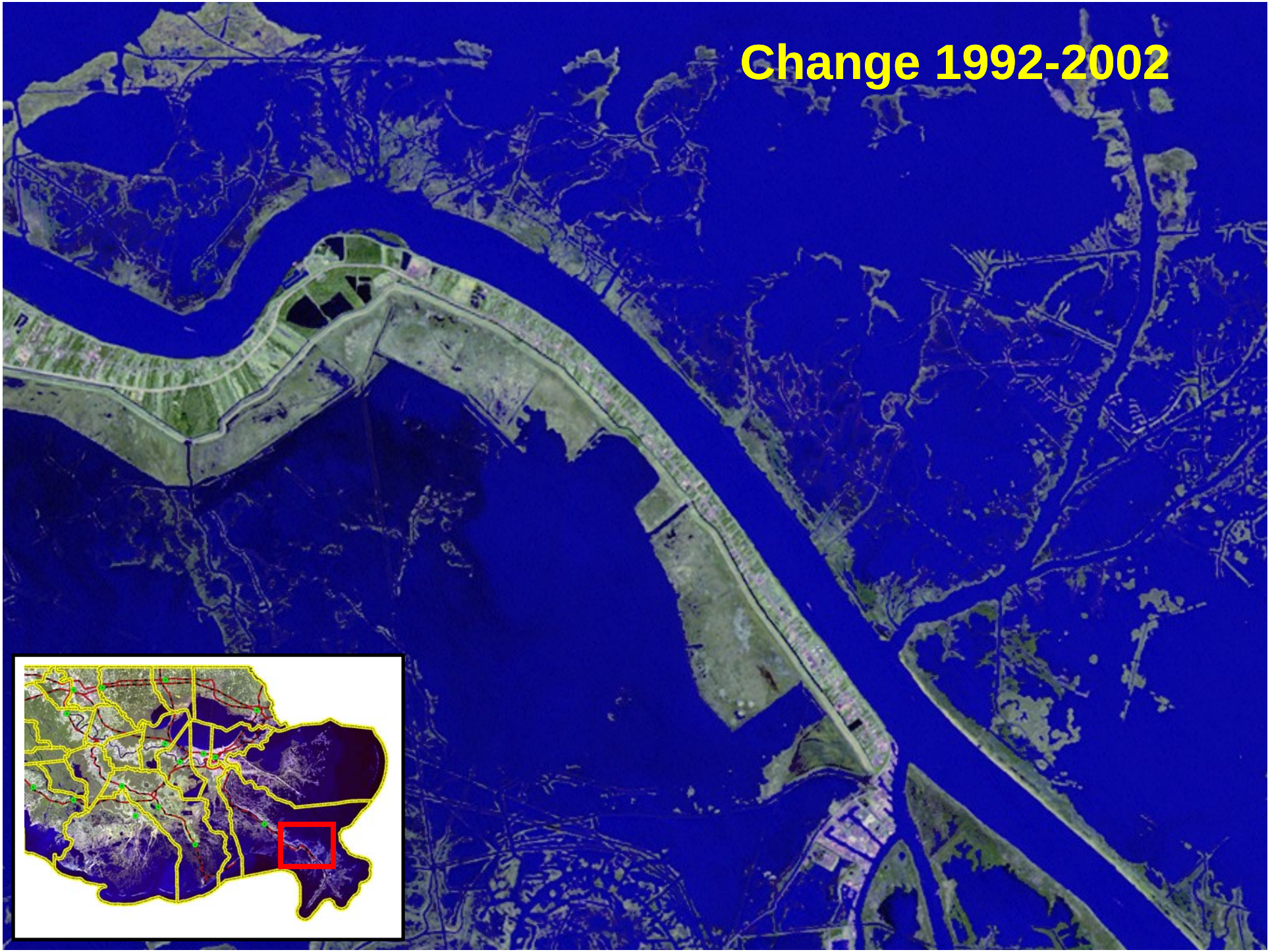
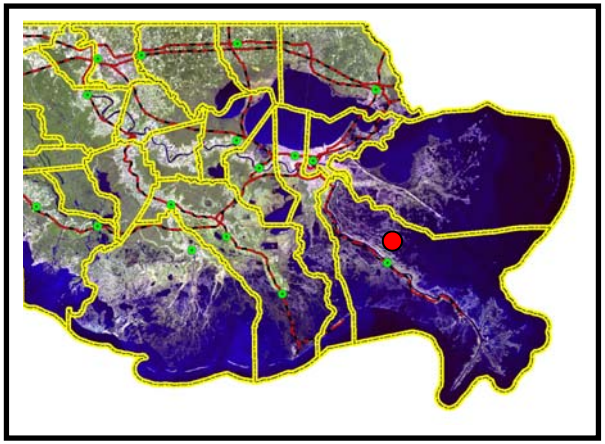
Change 1992-2002



BM set in 1980. Marker ID – 1108 D 1980. 158 ft south of the south shore of Lost Bayou, 118 ft west of the west shore of a small freshwater pond, 46 ft north of the south shore of the island. The bench mark is set 0.21 m (0.7 ft) above ground level, crimped to a stainless steel rod driven19.5 m (64 ft) to substantial resistance, and encased in a 4-inch PVC pipe, and concrete kickblock.



NOAA – Gardene Bay