Hurricane Katrina

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US Army Corps
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Hurricane Katrina

- Background
- Storm history
- Storm characteristics
- Impacts
- Surge hindcast
- Influences on surge
- Challenges

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Saffir-Simpson Scale

- Formulated in 1969 by Hebert Saffir, a consulting civil engineer, and Dr. Bob Simpson, director of the National Hurricane Center
- Disaster potential scale used to give an estimate of potential property damage and flooding
- Intensity of sustained winds is used to assign a category to the hurricane.

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Saffir-Simpson Scale

Category	Sustained Wind Speed
1	74 – 95 mph
2	96 – 110 mph
3	111 – 130 mph
4	131 – 155 mph
5	> 155 mph

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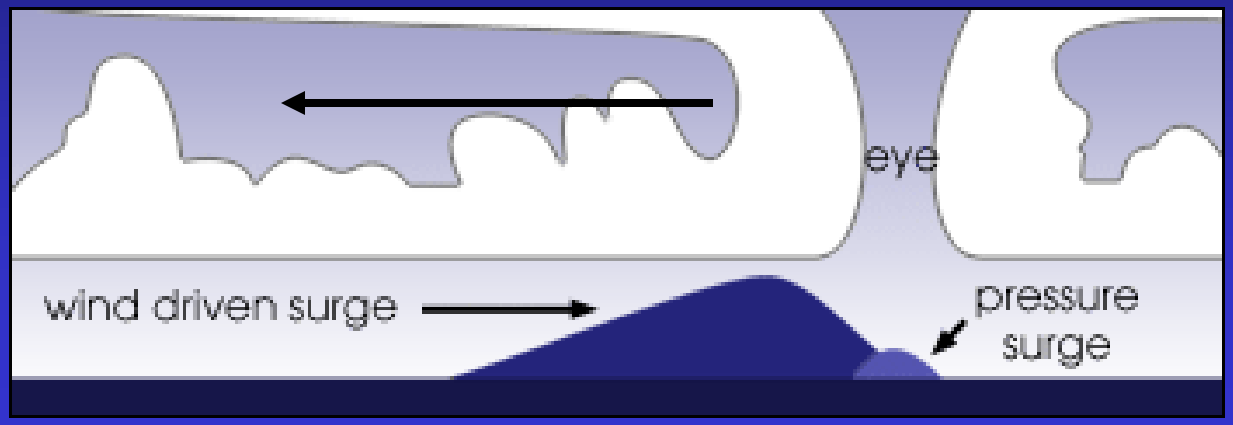
Surge and Storm Tide



Storm Tide =
Storm Surge +
Astronomic Tide +
Anomalies

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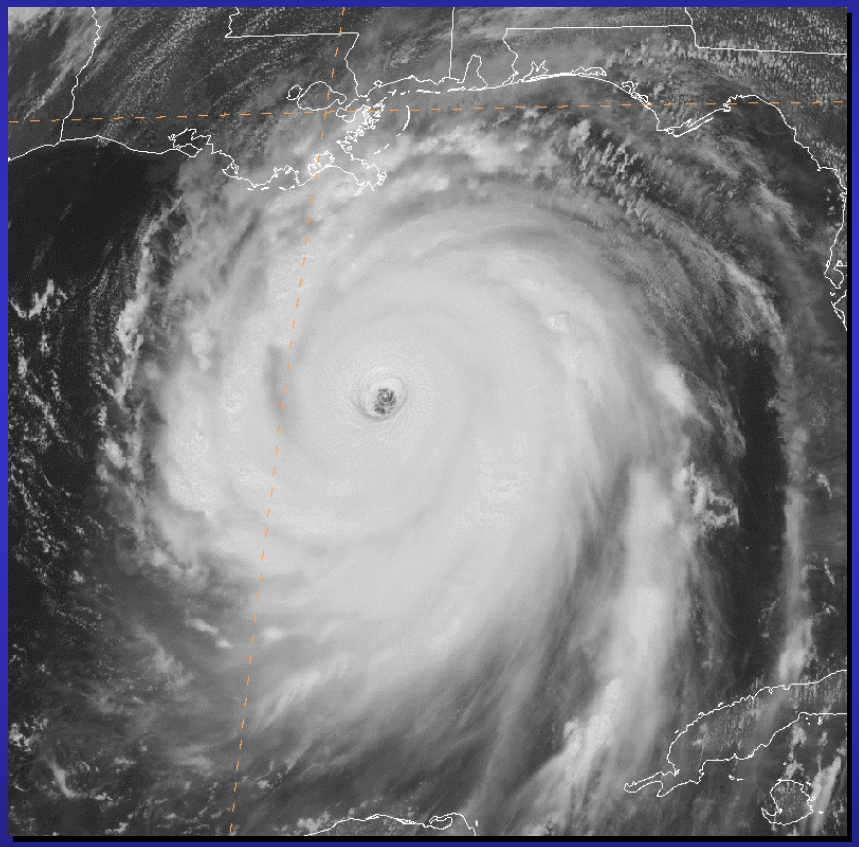
Hurricane Katrina



- Largest natural disaster
- More than 1,300 dead
- 1,900 still missing
- Estimated $100 billion in damage
- Estimated debris volume of 103 million cubic yards
- 41 miles of levees/floodwalls sustained severe damaged
- 128 miles of levees/floodwalls sustained minor damage
- 732,000 acre-ft of floodwaters removed (includes Rita)

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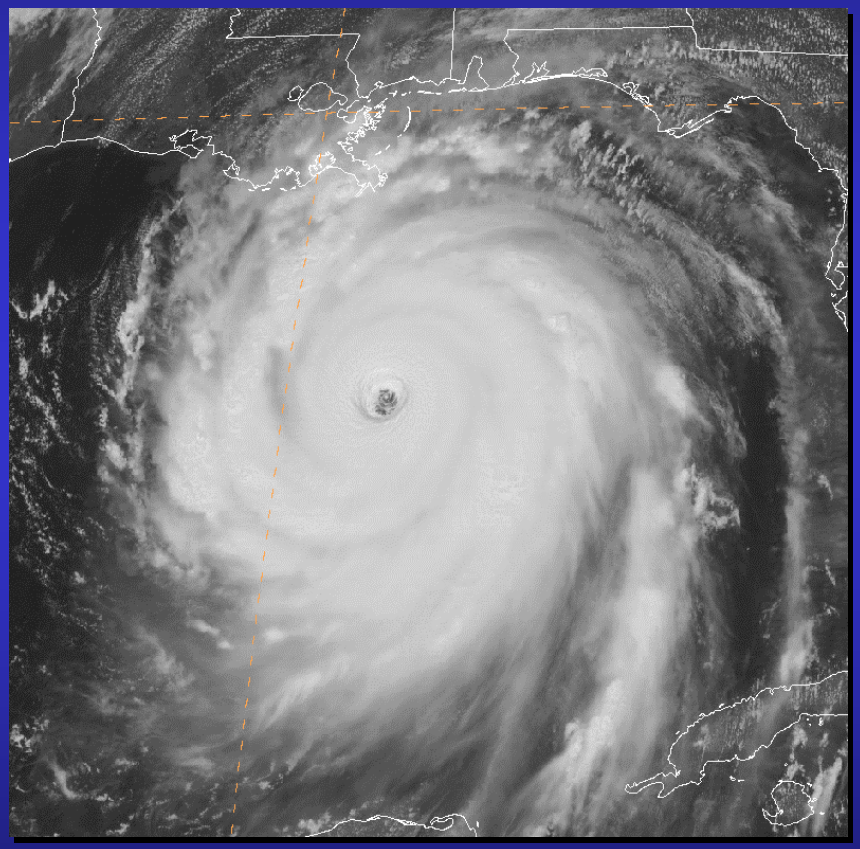
Hurricane Katrina



- Storm History

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Hurricane Katrina

- Tropical Depression 12 – 1800 UTC 23 Aug 2005
- Tropical Storm Katrina – 1200 UTC 24 Aug 2005
- Hurricane Katrina – 2100 UTC 25 Aug 2005
- Landfall as CAT 1 – 2230 UTC 25 Aug 2005
- Entered Gulf of Mexico – 0500 UTC 26 Aug 2005
- Reached CAT 3 Strength – 1200 UTC 27 Aug 2005
- Reached CAT 5 Strength – 1200 UTC 28 Aug 2005
- Reached peak intensity – 1800 UTC 28 Aug 2005, 170 N miles southeast of the mouth of the Mississippi River

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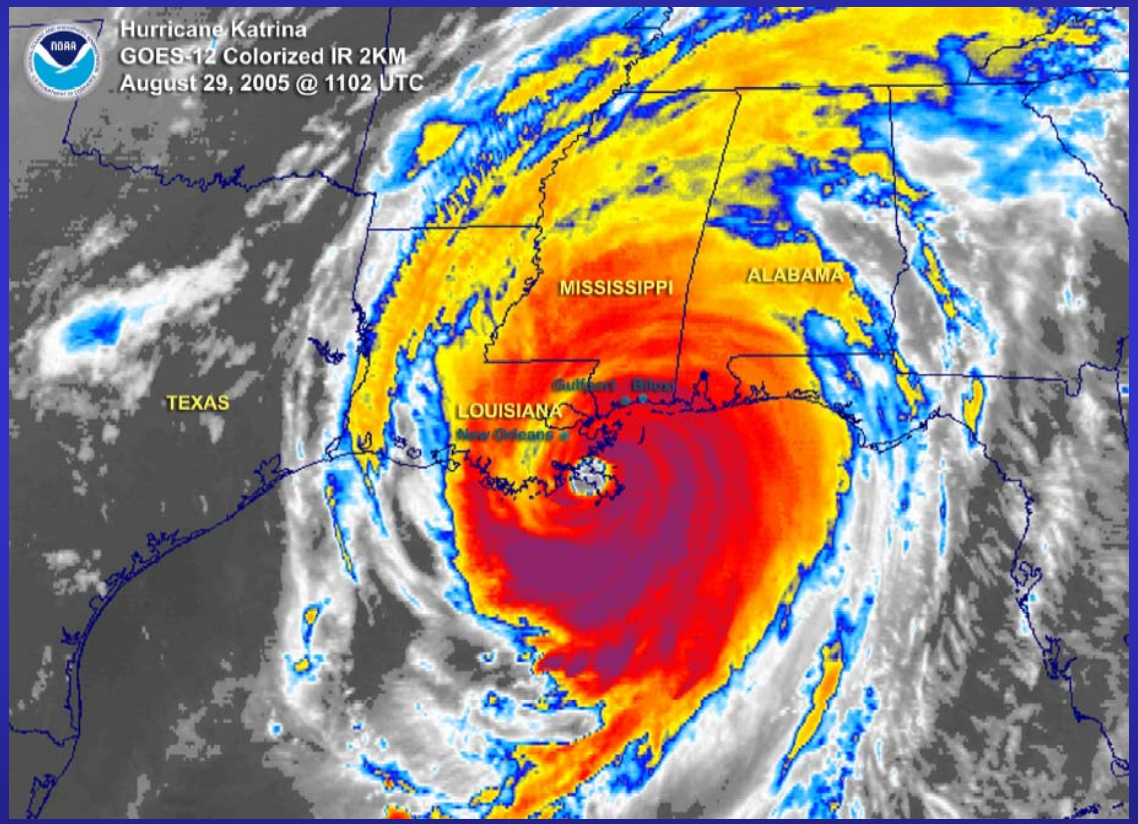
Hurricane Katrina



- **Storm Characteristics**

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Hurricane Katrina

- NOAA National Climate Data Center
- NOAA National Hurricane Center
- NOAA Hurricane Research Division
- LSU
- Louisiana State Climate Office
- U.S. Geological Survey
- Corps of Engineers

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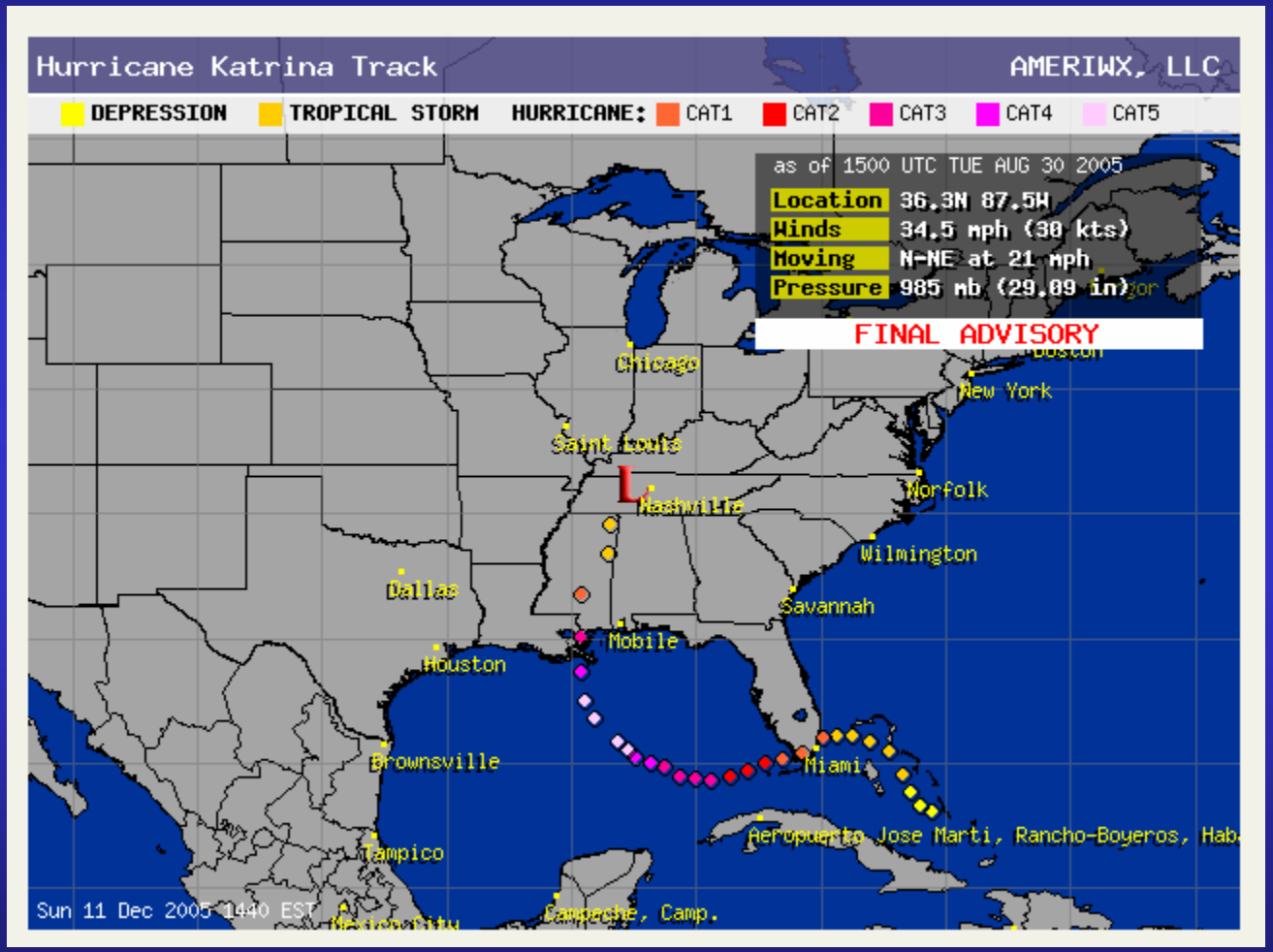
Hurricane Katrina



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Hurricane Katrina

	Landfall near Buras	Landfall near Pearl River
Date and Time	6:10 am CDT Aug 29, 2005	9:45 am CDT Aug 29, 2005
Wind Speed	110 knots 127 mph	105 knots 121 mph
Central Pressure	920 mb	928 mb
Category	3	3

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Hurricane Katrina

- Central Pressure at landfall near Buras is lowest of record in Atlantic Basin for 110 knot intensity storm
- Central Pressure at landfall near Buras is 5th lowest of record in Atlantic Basin
- Maximum observed significant wave height, 55 ft, is largest measured by a NDBC buoy

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Most Intense Hurricanes

Storm		Minimum Central Pressure
Wilma	2005	882
Gilbert	1988	888
Labor Day	1935	892
Rita	2005	897
Allen	1980	899
Katrina	2005	902
Camille	1969	905

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Most Intense Hurricanes

Storm		Central Pressure at landfall
Camille	1969	909
Katrina	2005	920
Andrew	1992	922/956
1915 Storm	1915	931
1947 Storm	1947	940
Rita	2005	937
Audrey	1957	945
Betsy	1965	948

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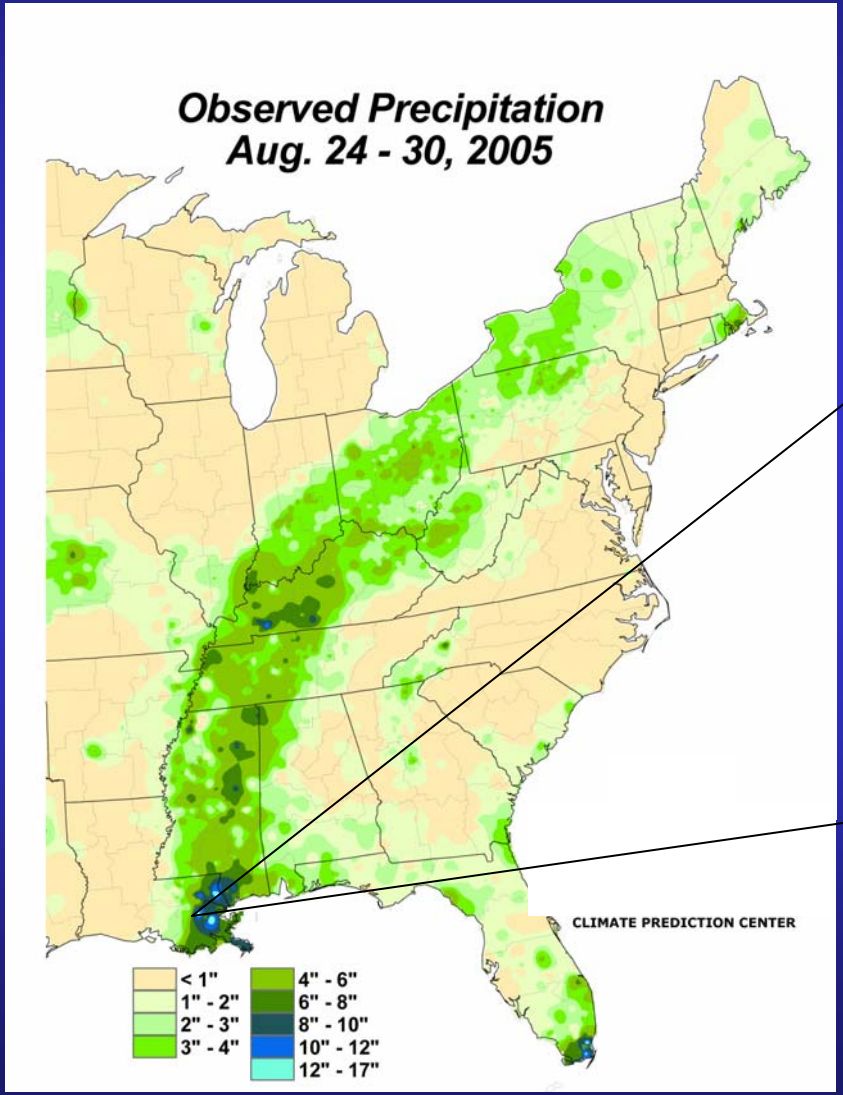
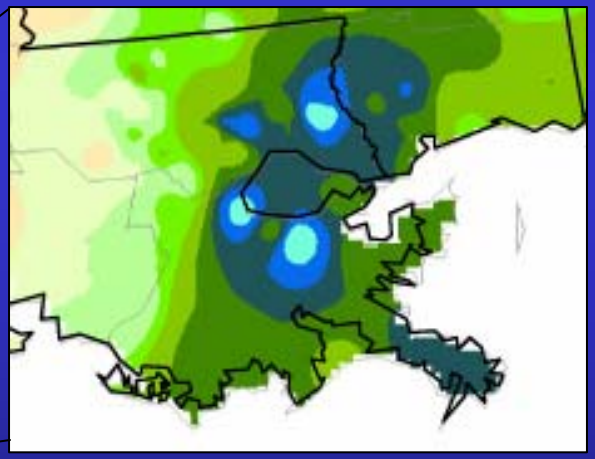
Preliminary Estimate of Rainfall Totals Associated with Hurricane Katrina





NOAA/NWS
CLIMATE PREDICTION CENTER

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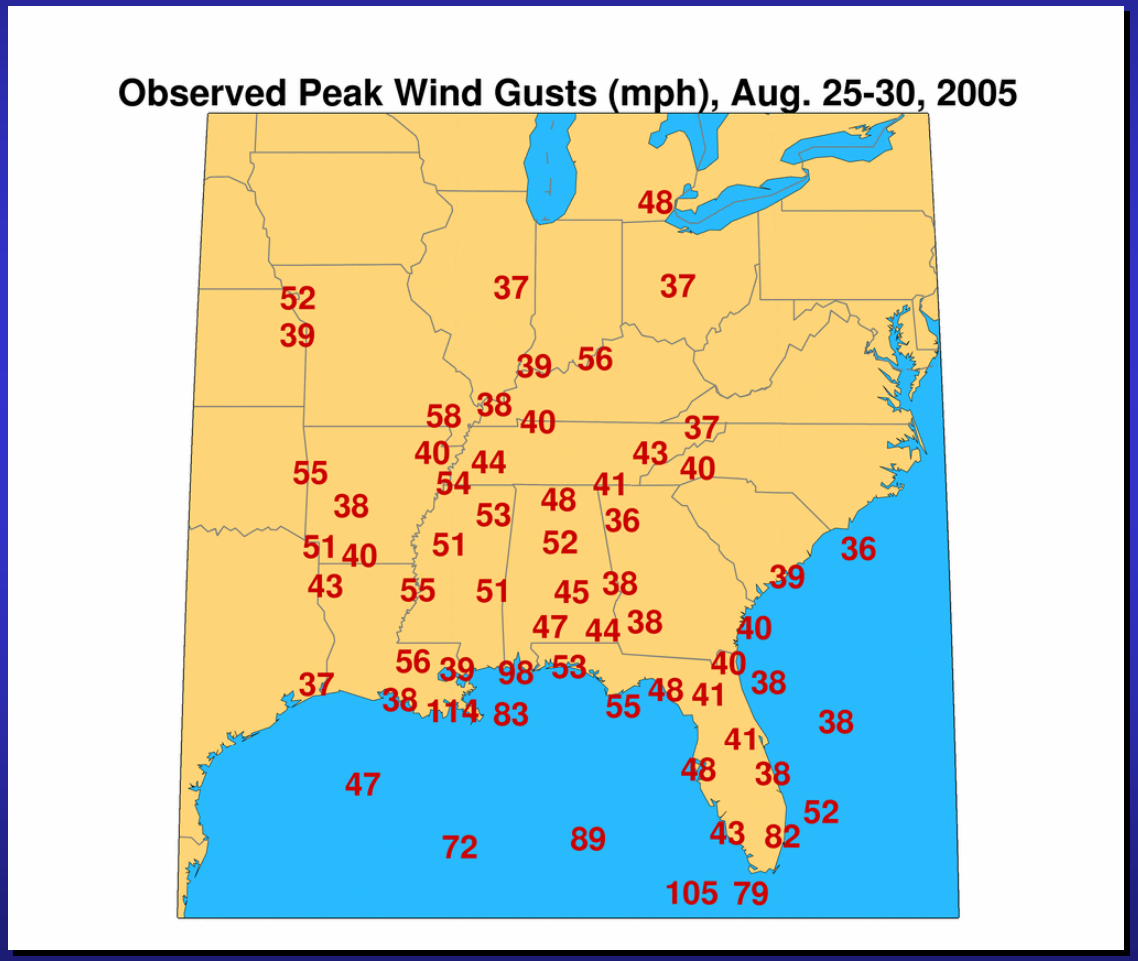
Wind Gusts



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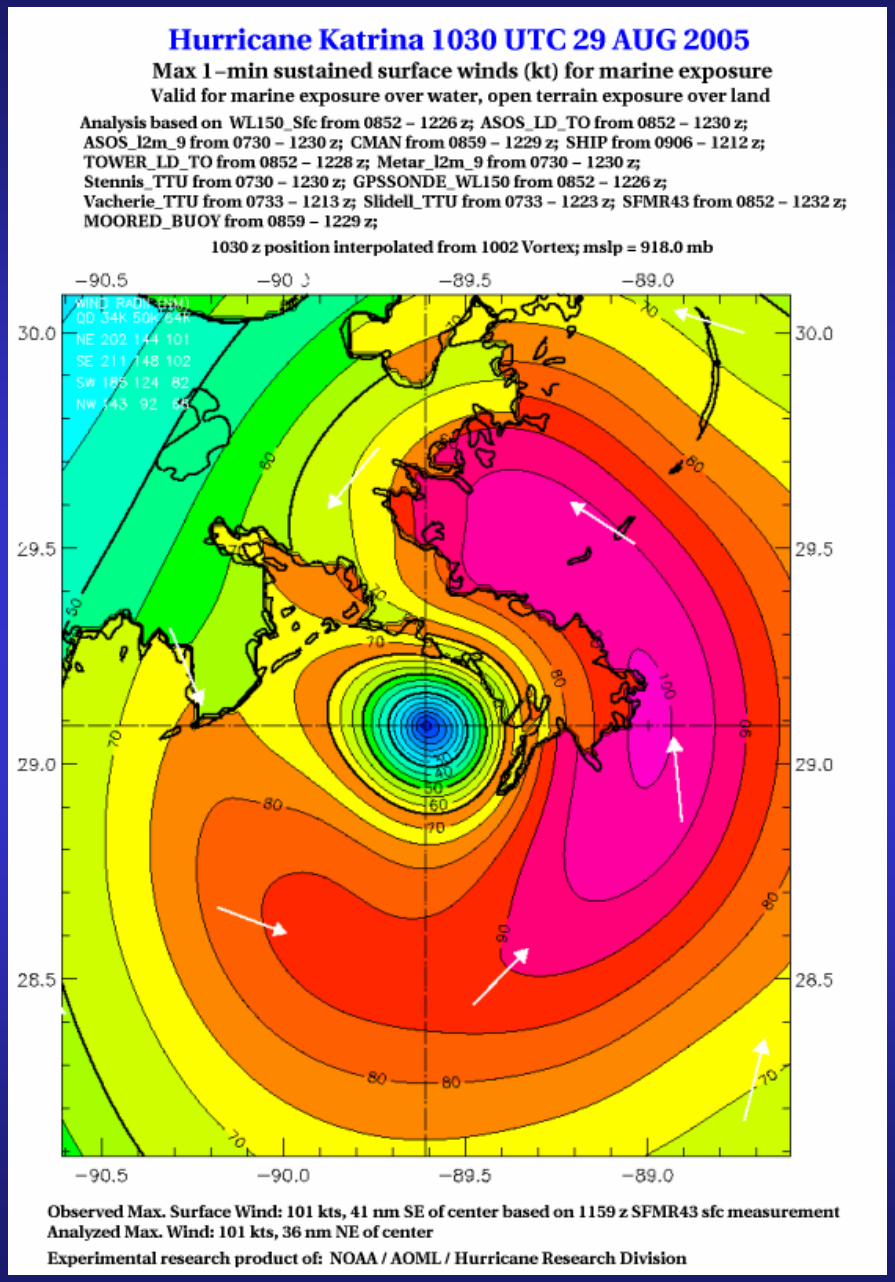

H*Wind on 29 August at 5:30 am CDT

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Hurricane Katrina

- Impacts
  - Flooding
  - Coastal land loss

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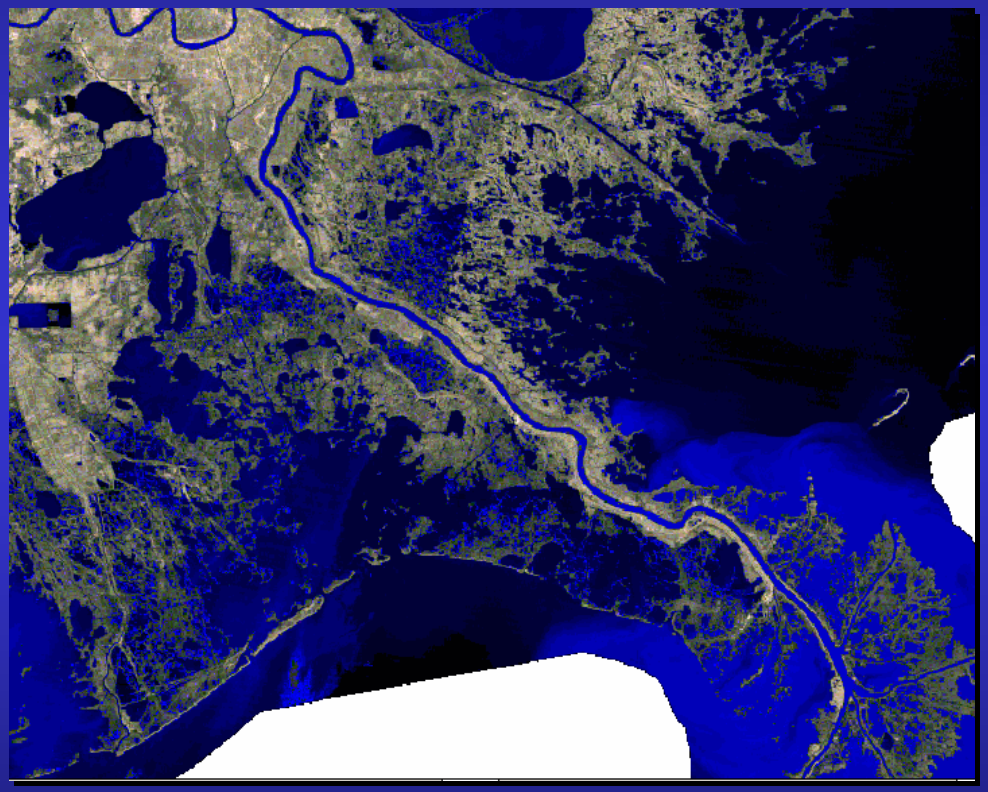
Plaquemines



344,000 acre-ft of Hurricane Katrina and Rita floodwaters removed.

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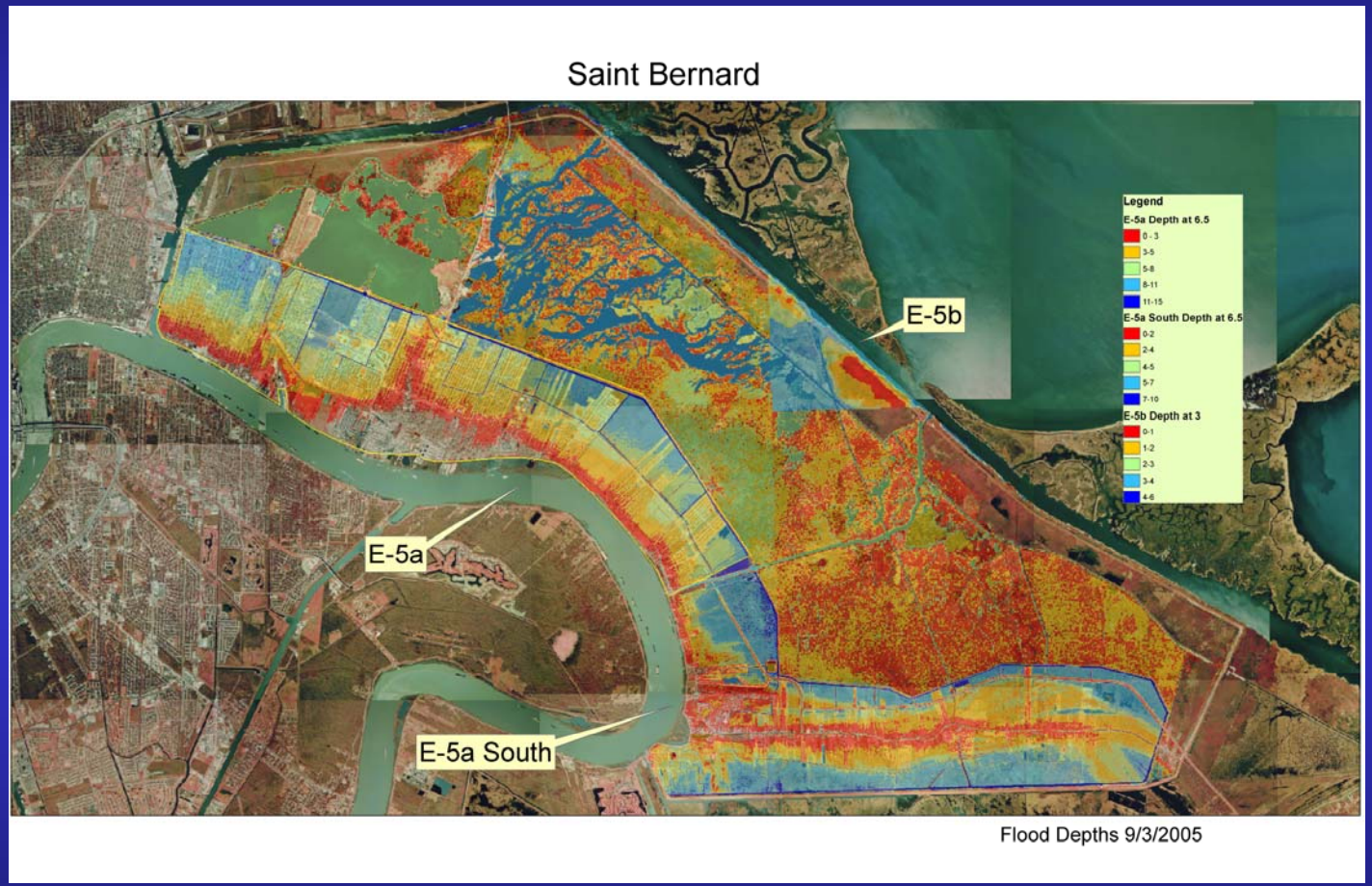
St Bernard



158,000 acre-ft of Hurricane Katrina and Rita floodwaters removed.

Includes Lower 9th Ward

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New Orleans East

120,000 acre-ft of Hurricane Katrina and Rita floodwaters removed.

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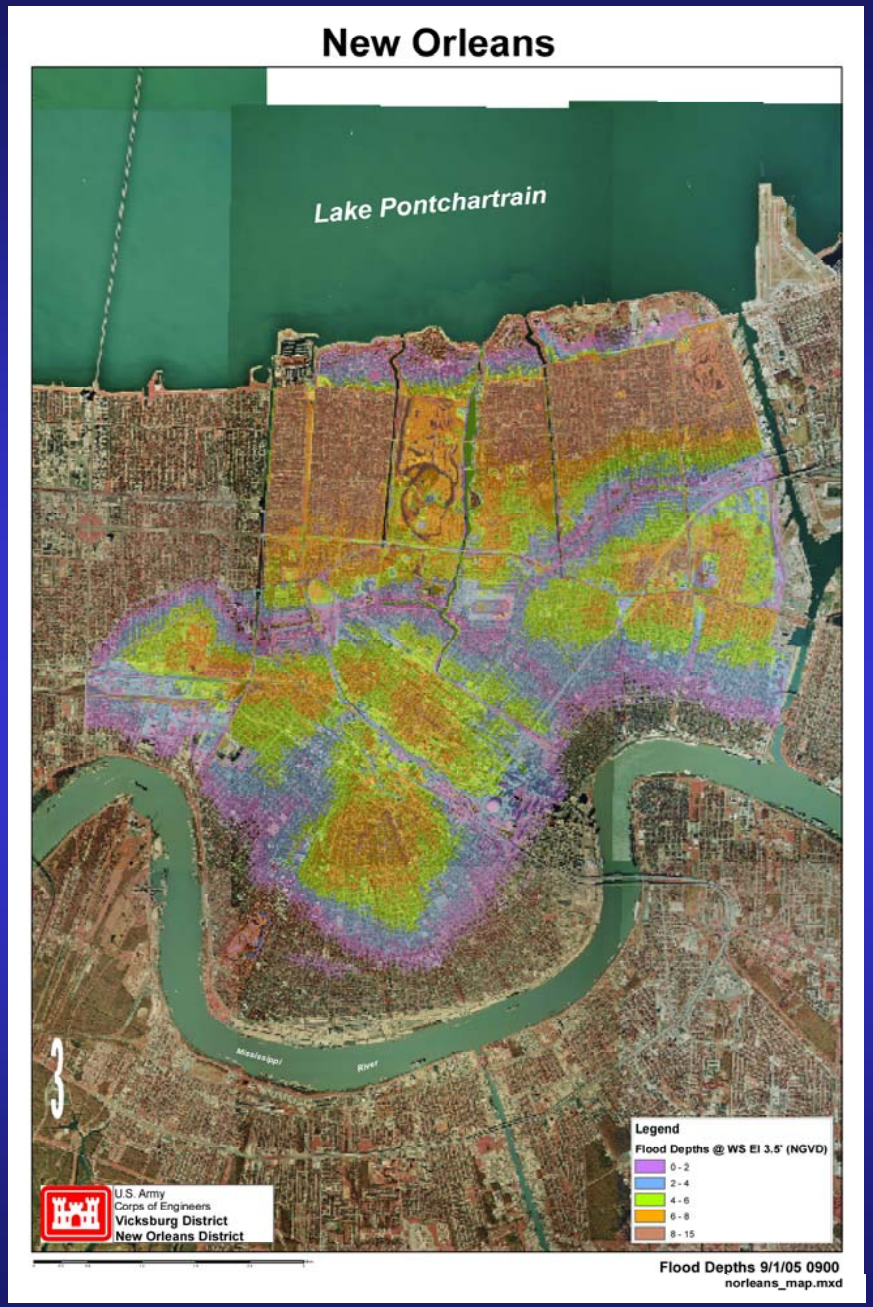

New Orleans Metro

110,000 acre-ft of Hurricane Katrina and Rita floodwaters removed.

includes Hoey Basin in Jefferson Parish

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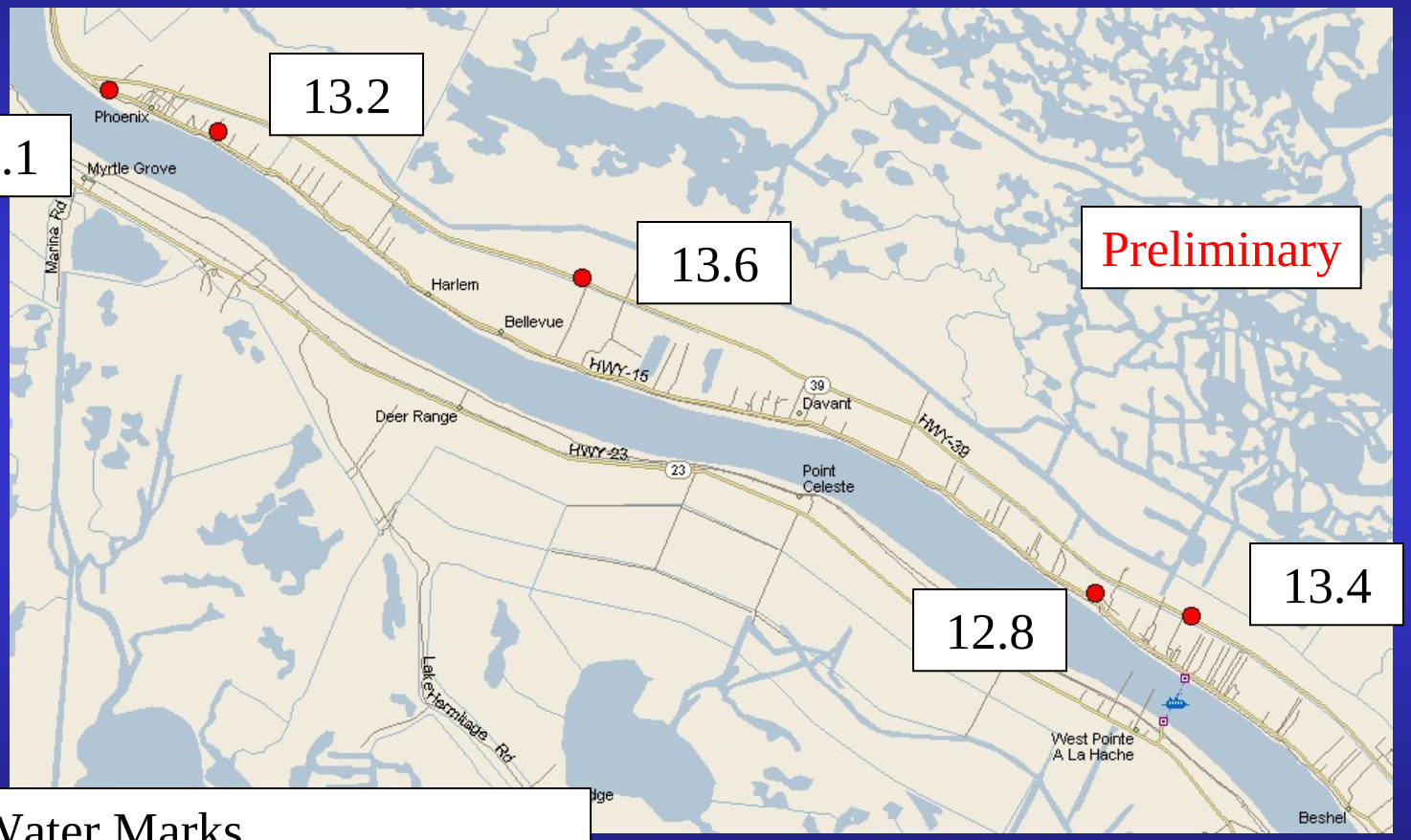
Plaquemines Parish



High Water Marks
Elevation in FT NAVD88 2004.65

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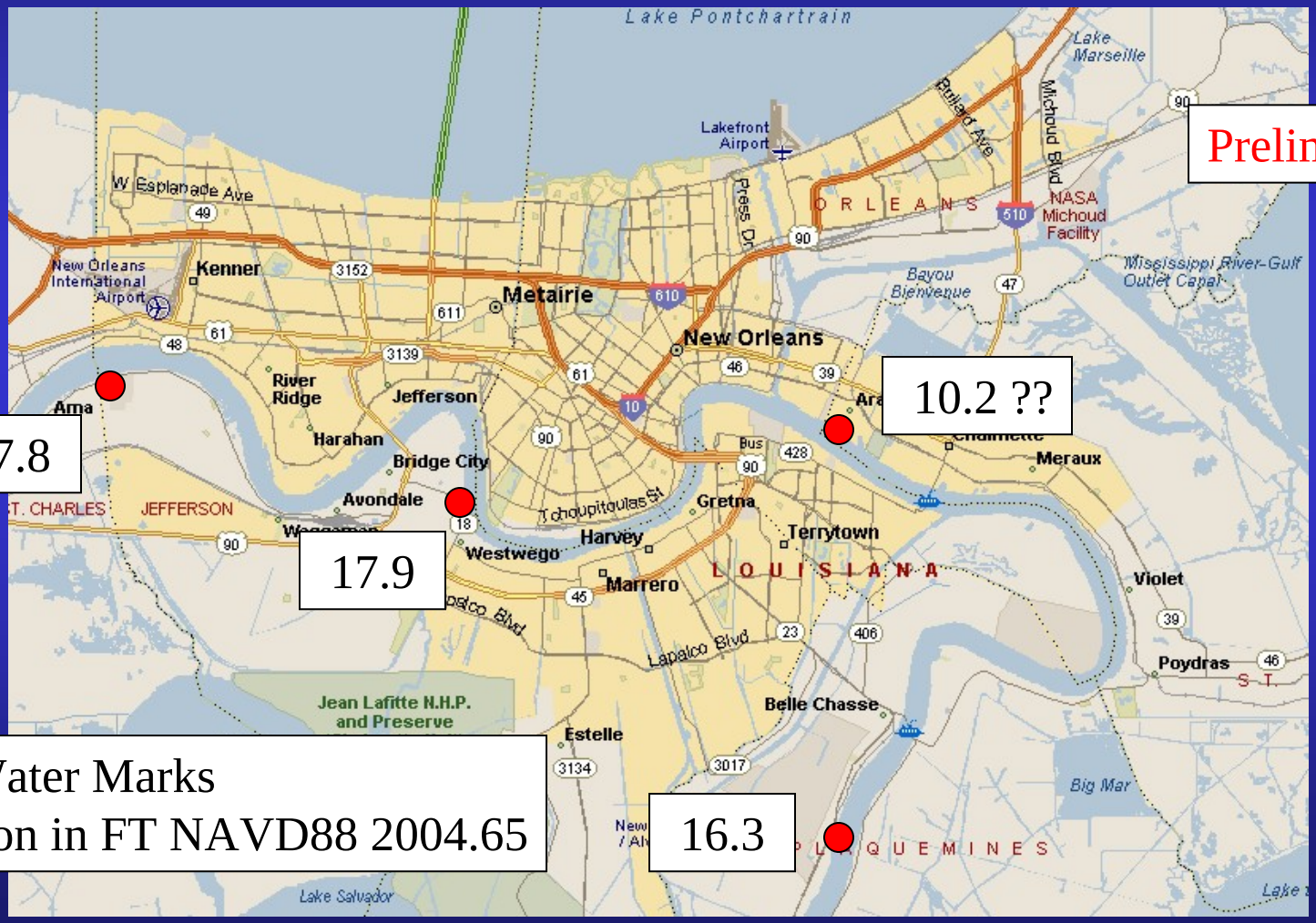
Mississippi River Levee



High Water Marks
Elevation in FT NAVD88 2004.65

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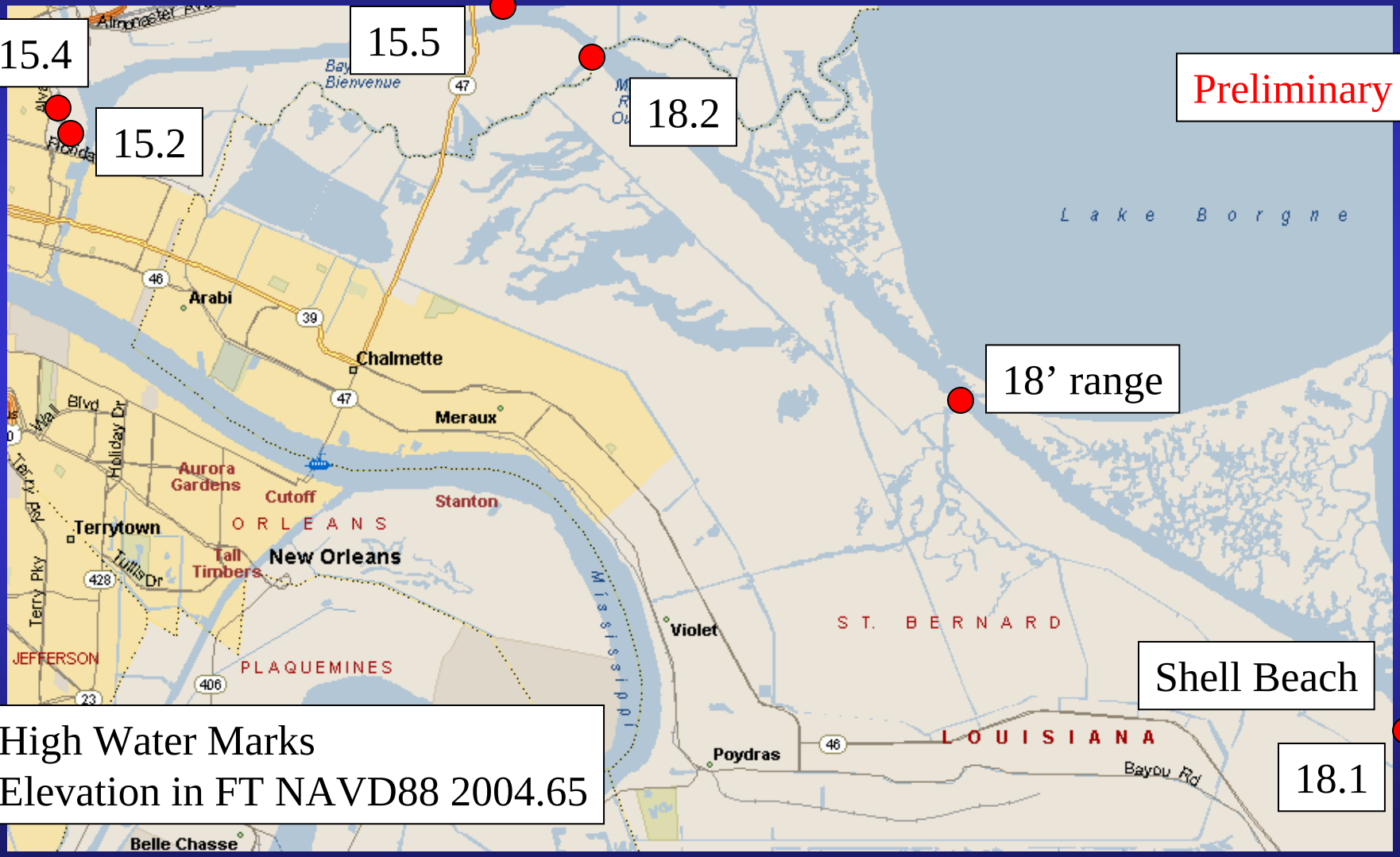
St Bernard and 9th Ward



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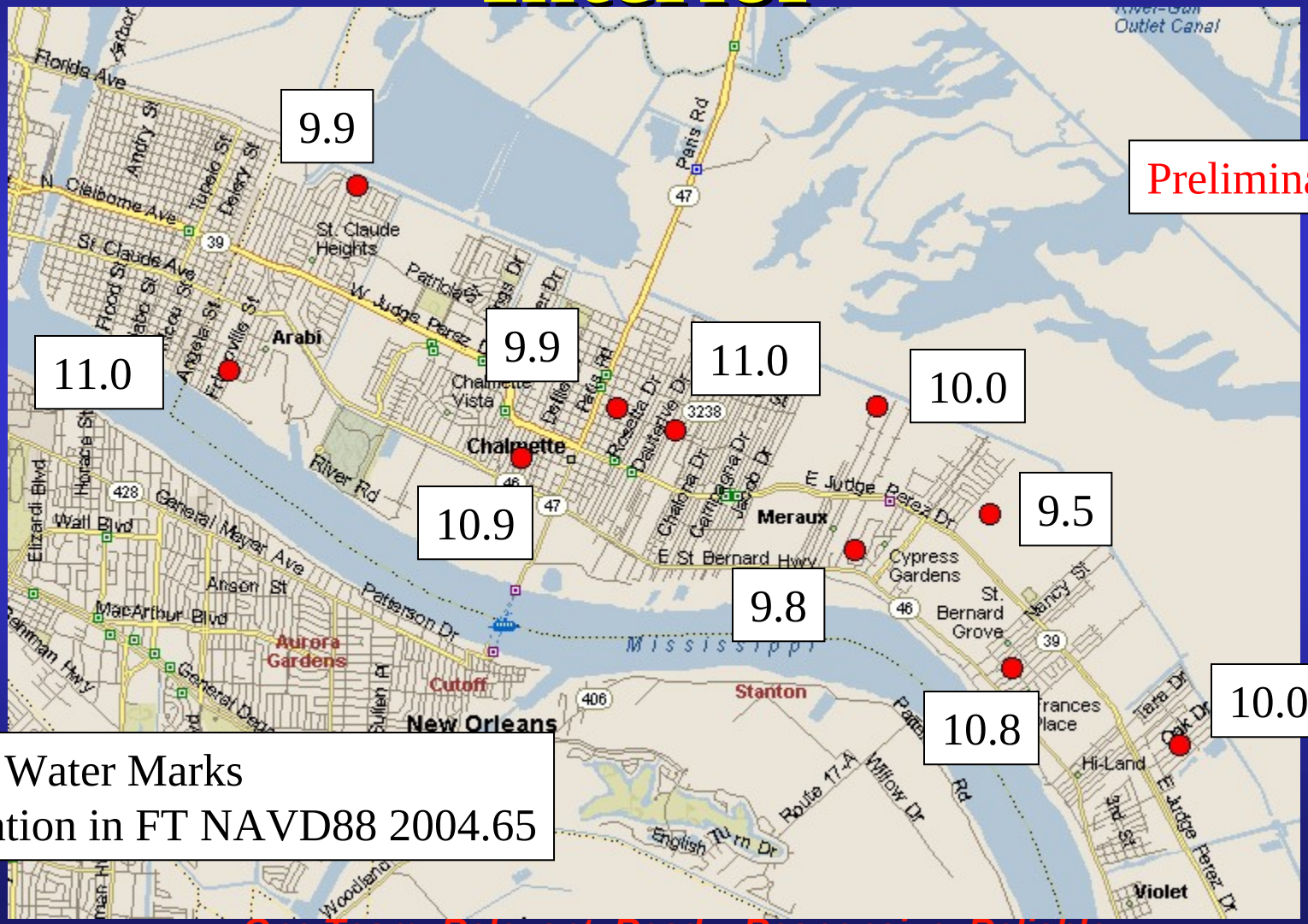
St Bernard and 9th Ward, Interior



High Water Marks
Elevation in FT NAVD88 2004.65

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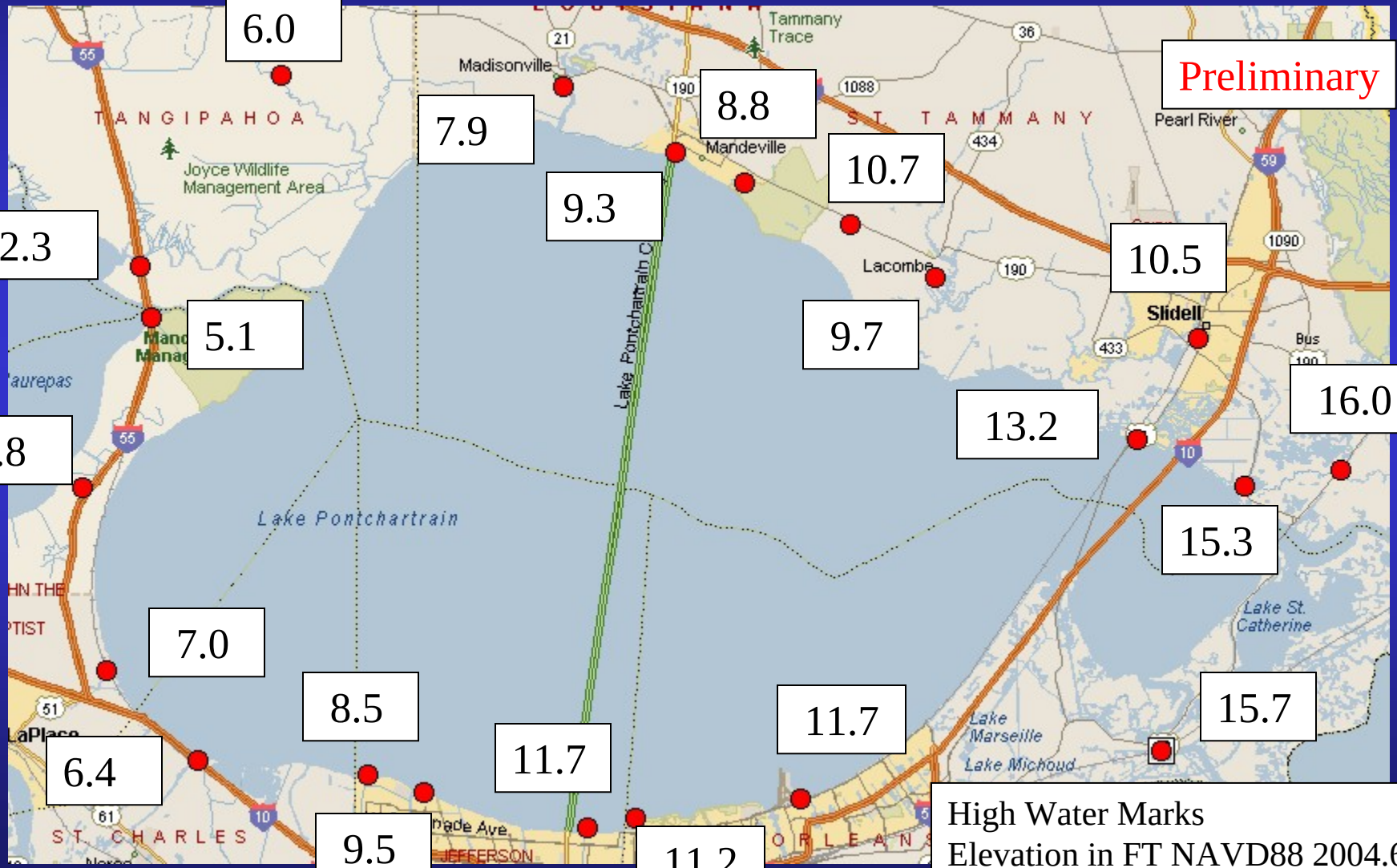
Lake Pontchartrain



High Water Marks
Elevation in FT NAVD88 2004.65

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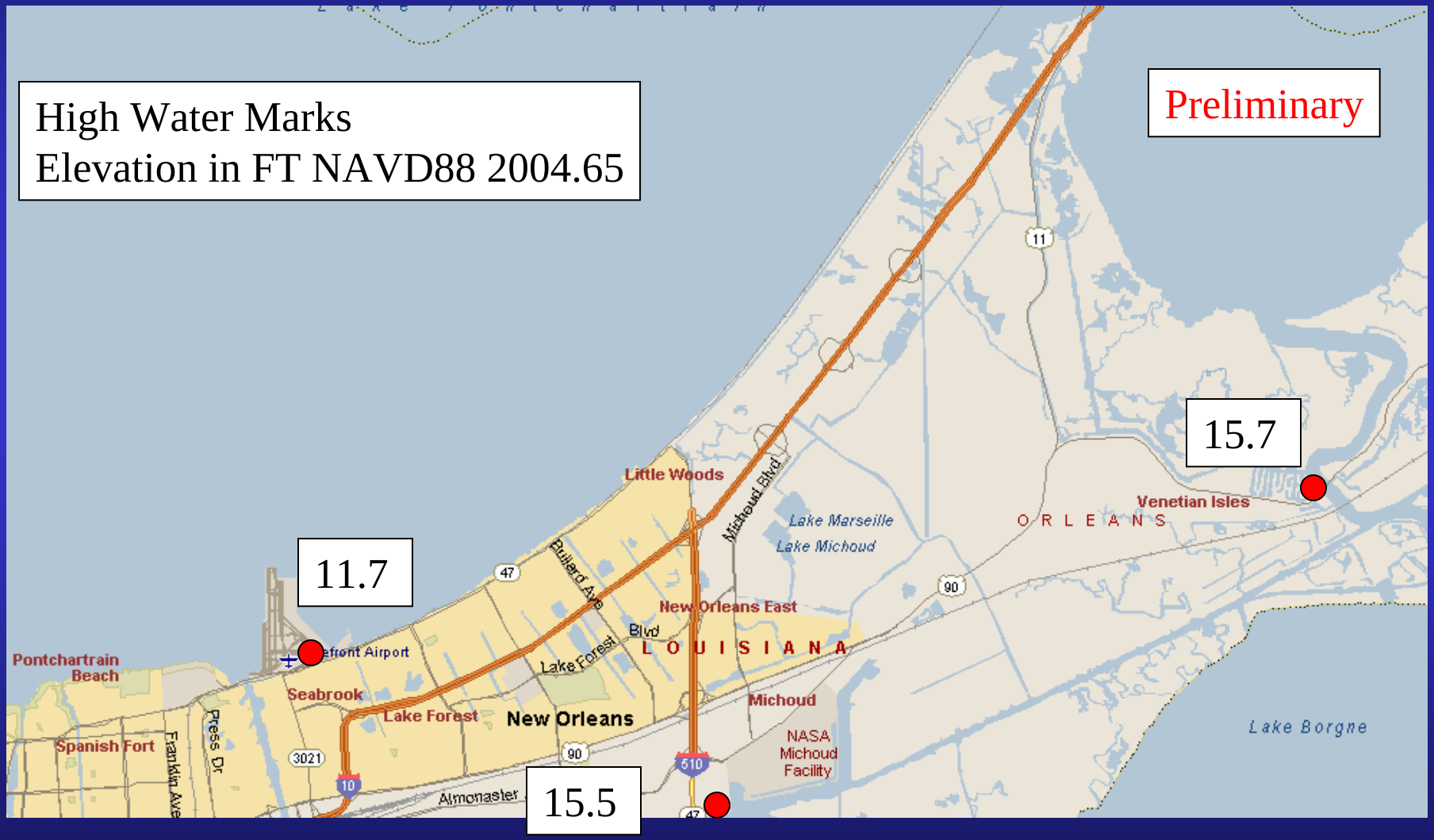
New Orleans East

High Water Marks
Elevation in FT NAVD88 2004.65

Preliminary



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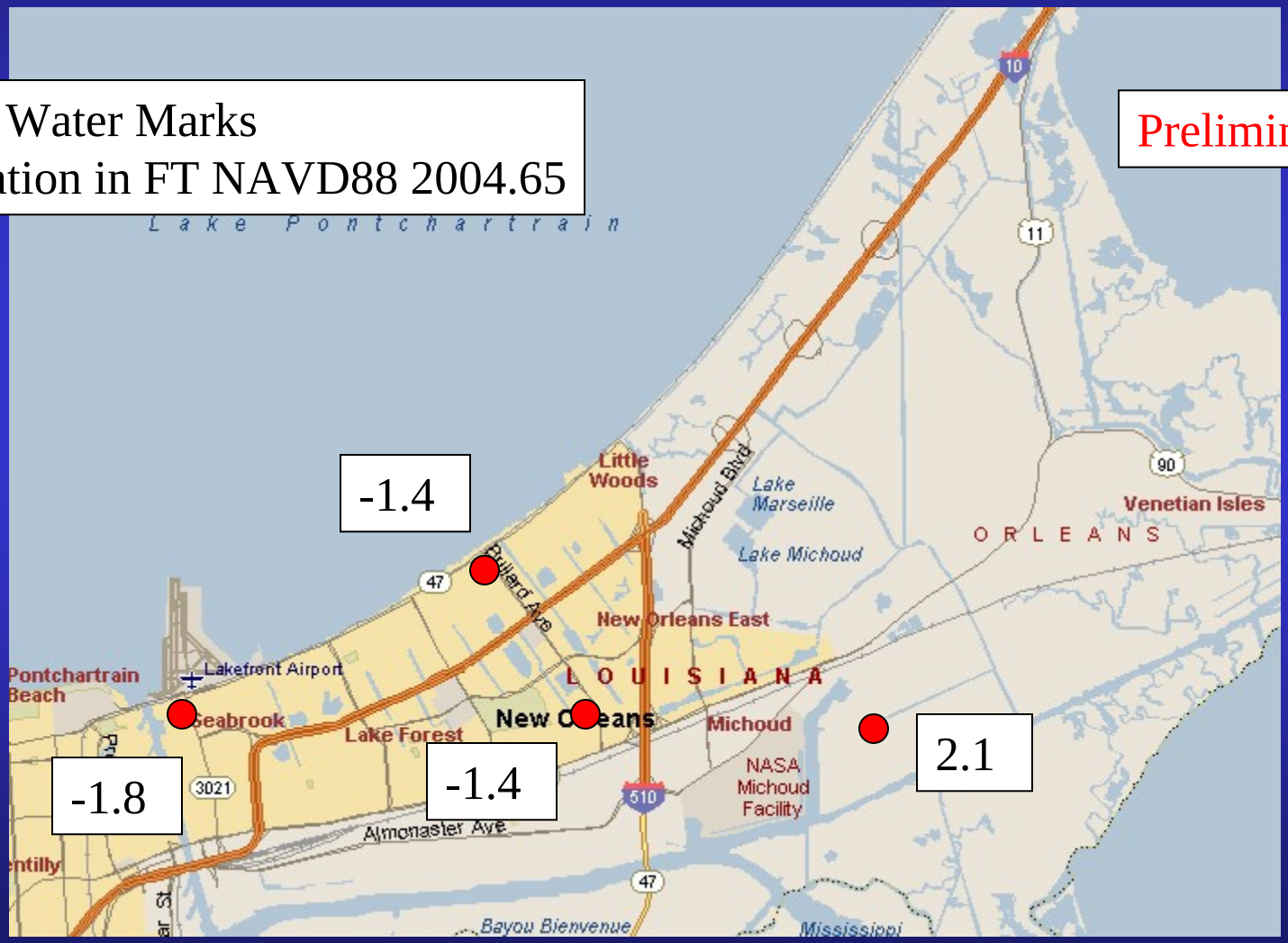
New Orleans East, Interior

High Water Marks
Elevation in FT NAVD88 2004.65

Preliminary



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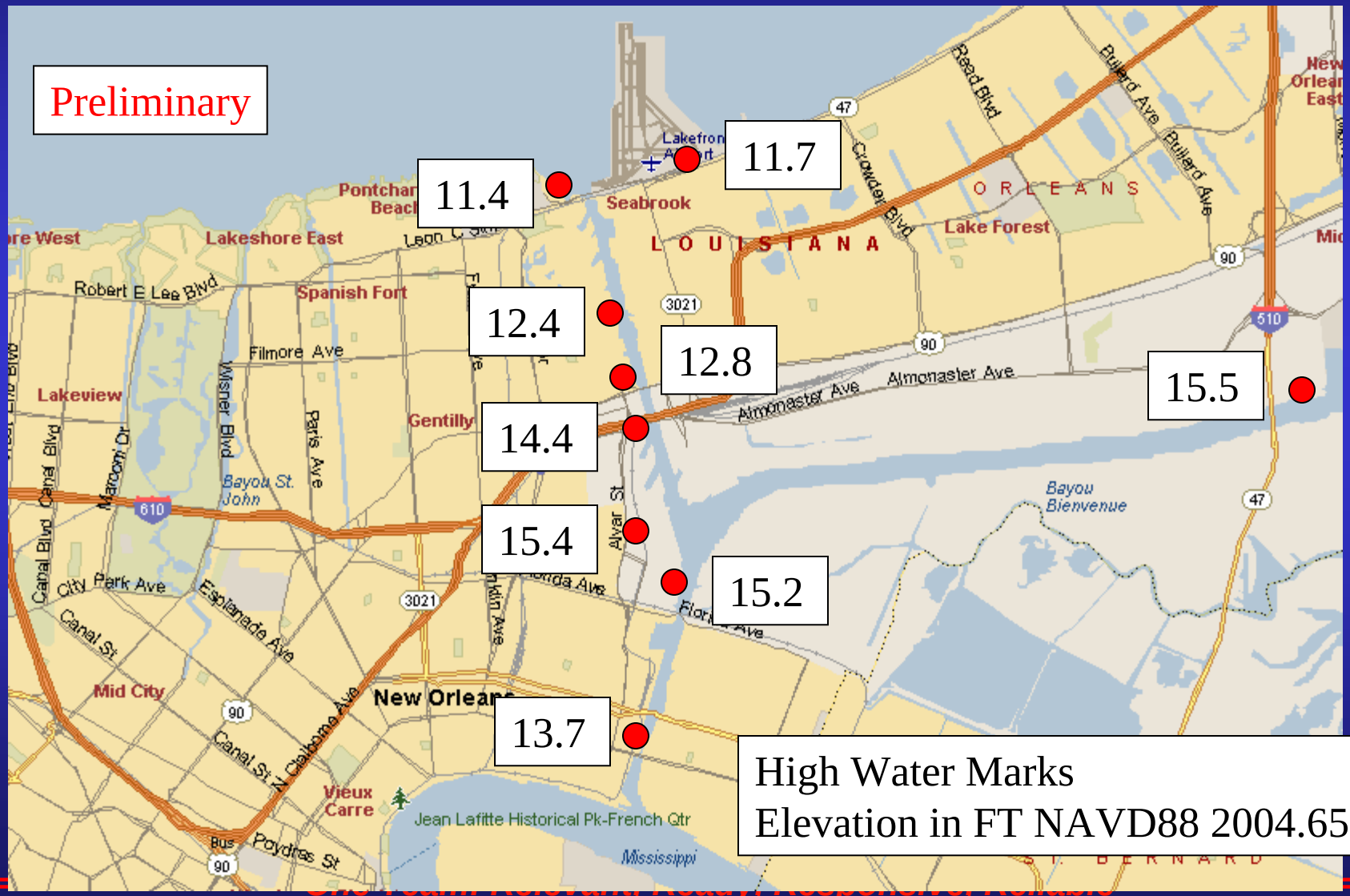
IHNC



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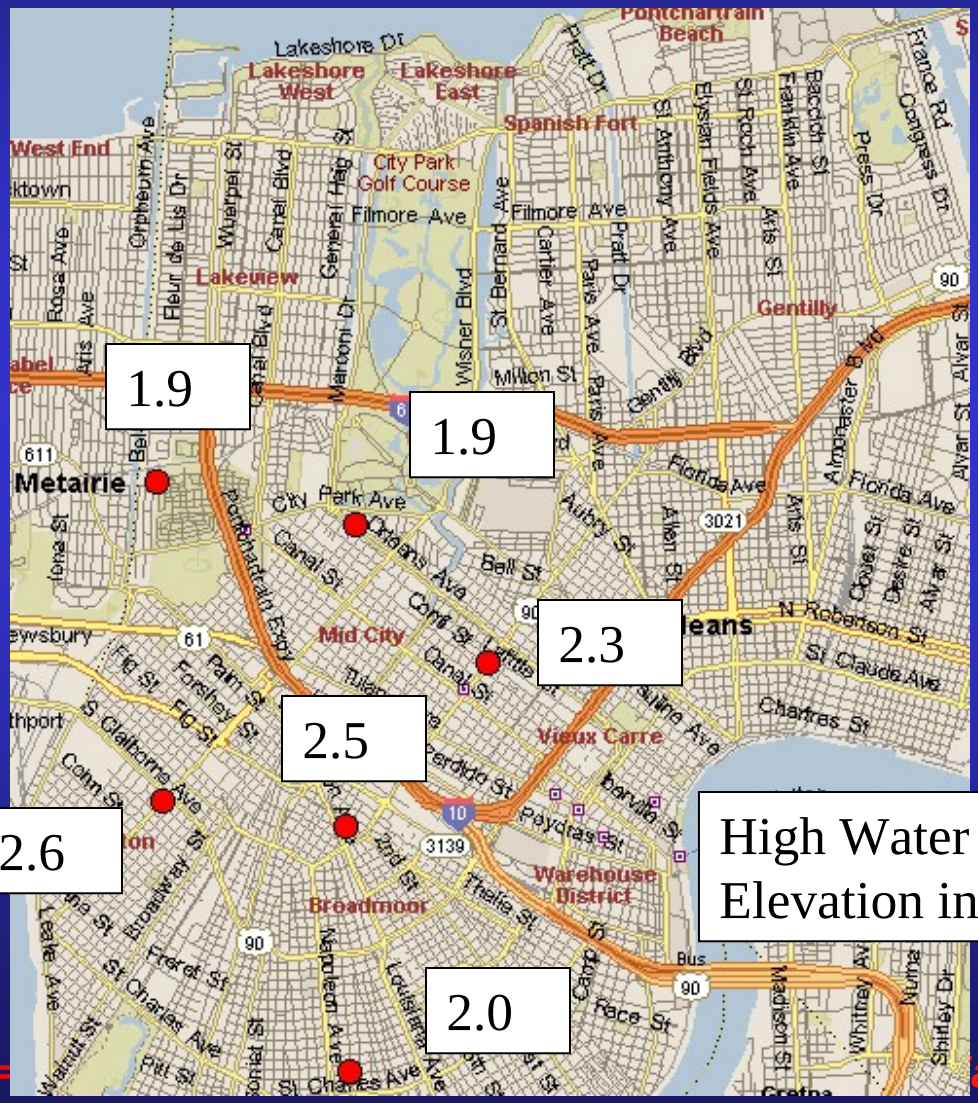
New Orleans, Interior



Preliminary

High Water Marks
Elevation in FT NAVD88 2004.65

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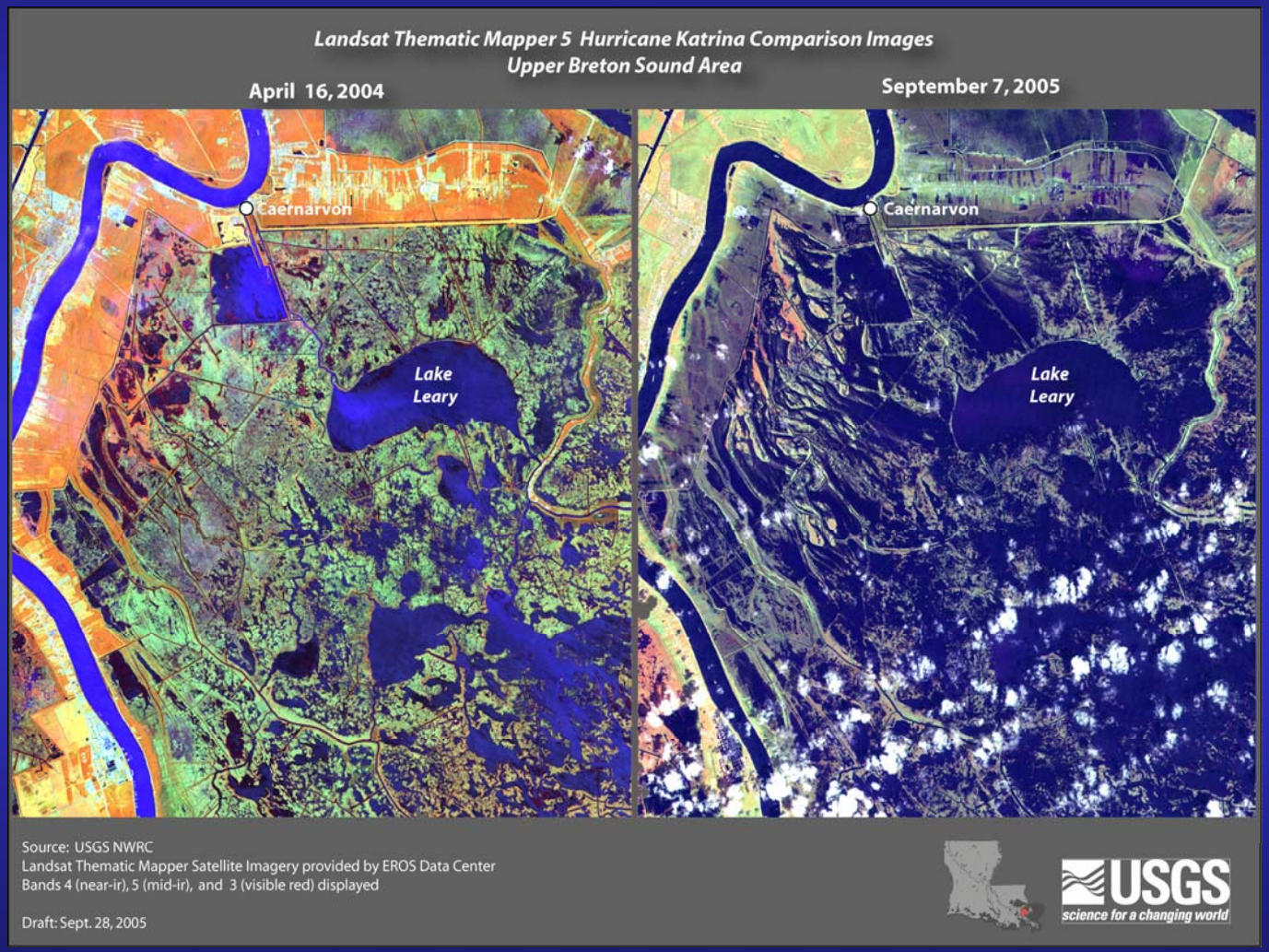

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Hurricane Katrina

- Surge hindcast
  - SLOSH
  - ERDC ADCIRC
  - LSU ADCIRC

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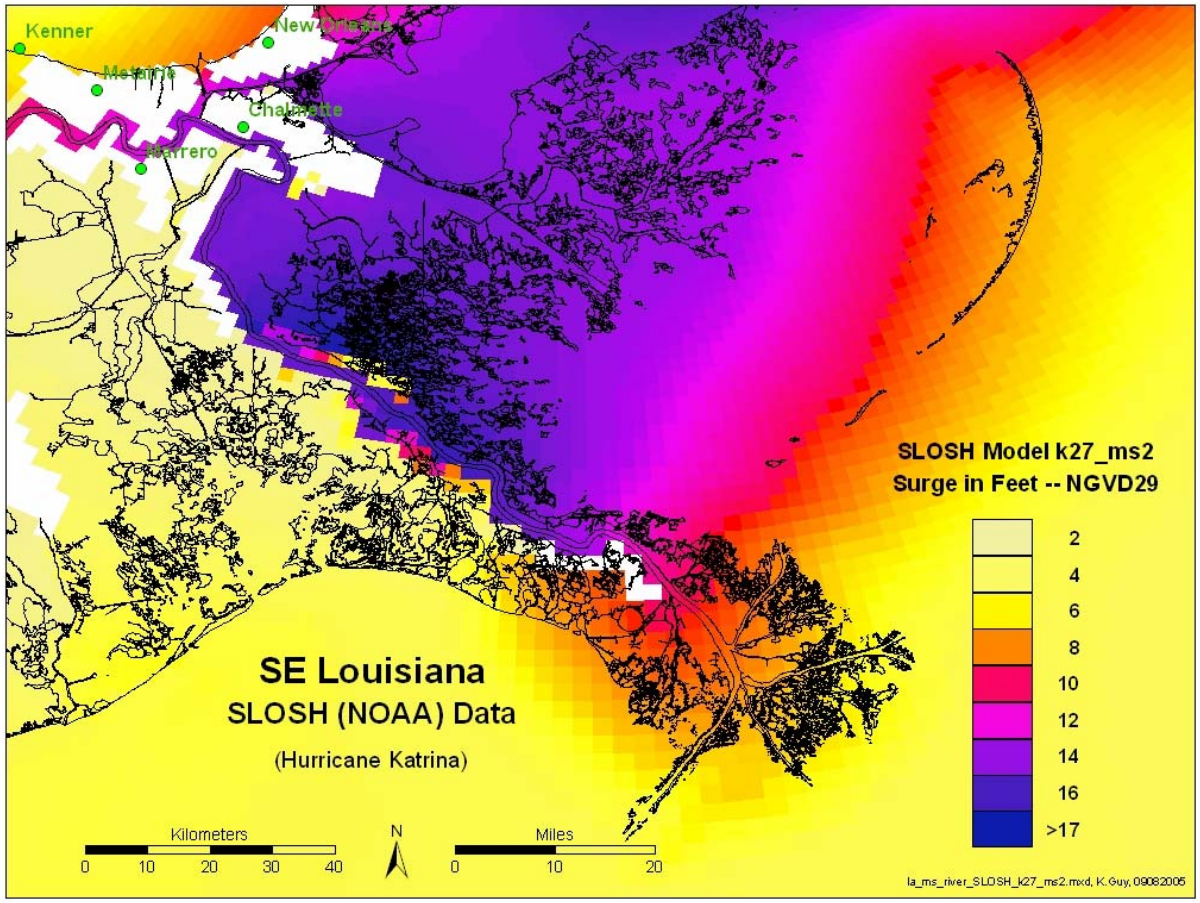
SLOSH Model



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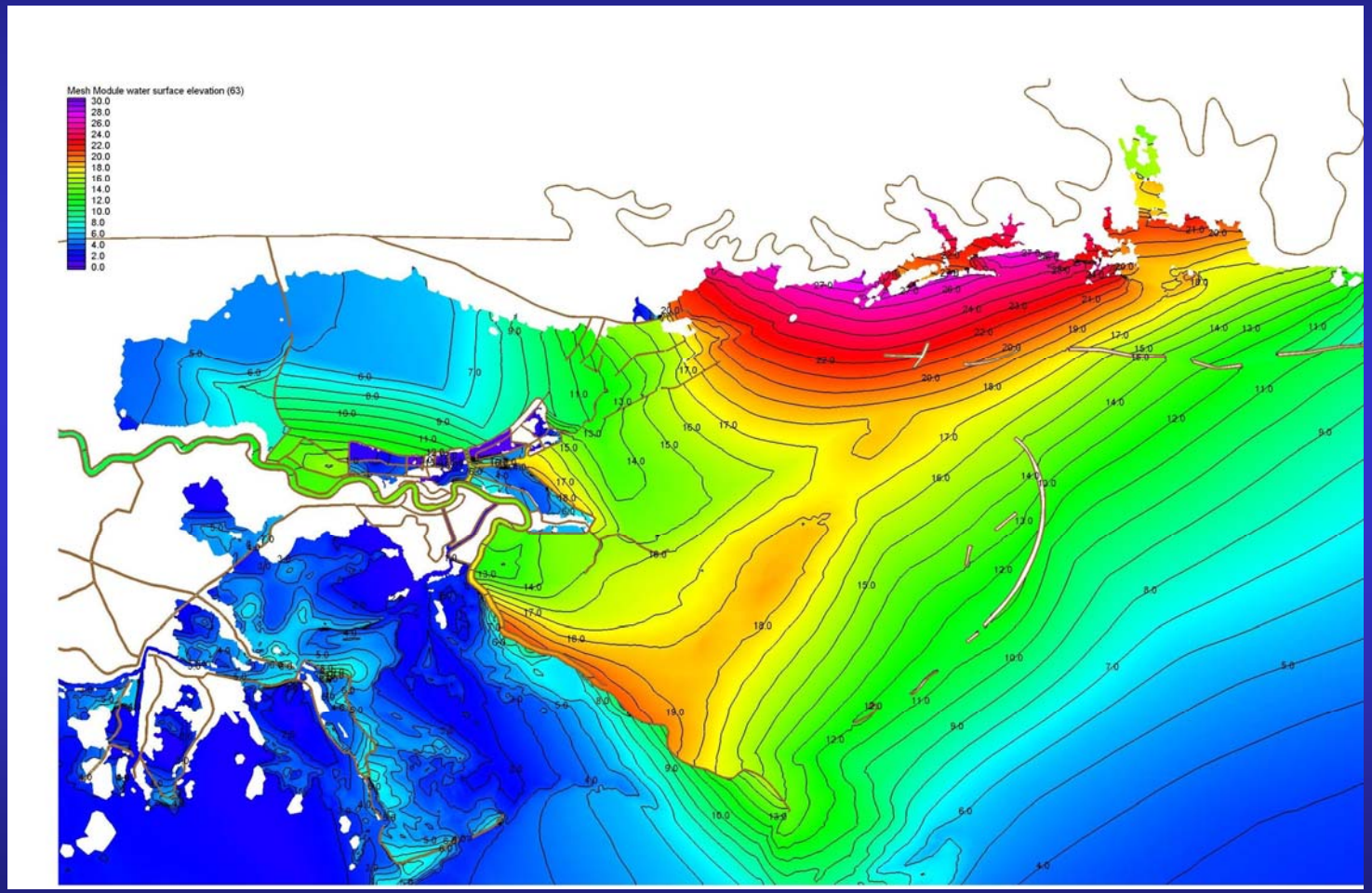
ERDC Hindcast



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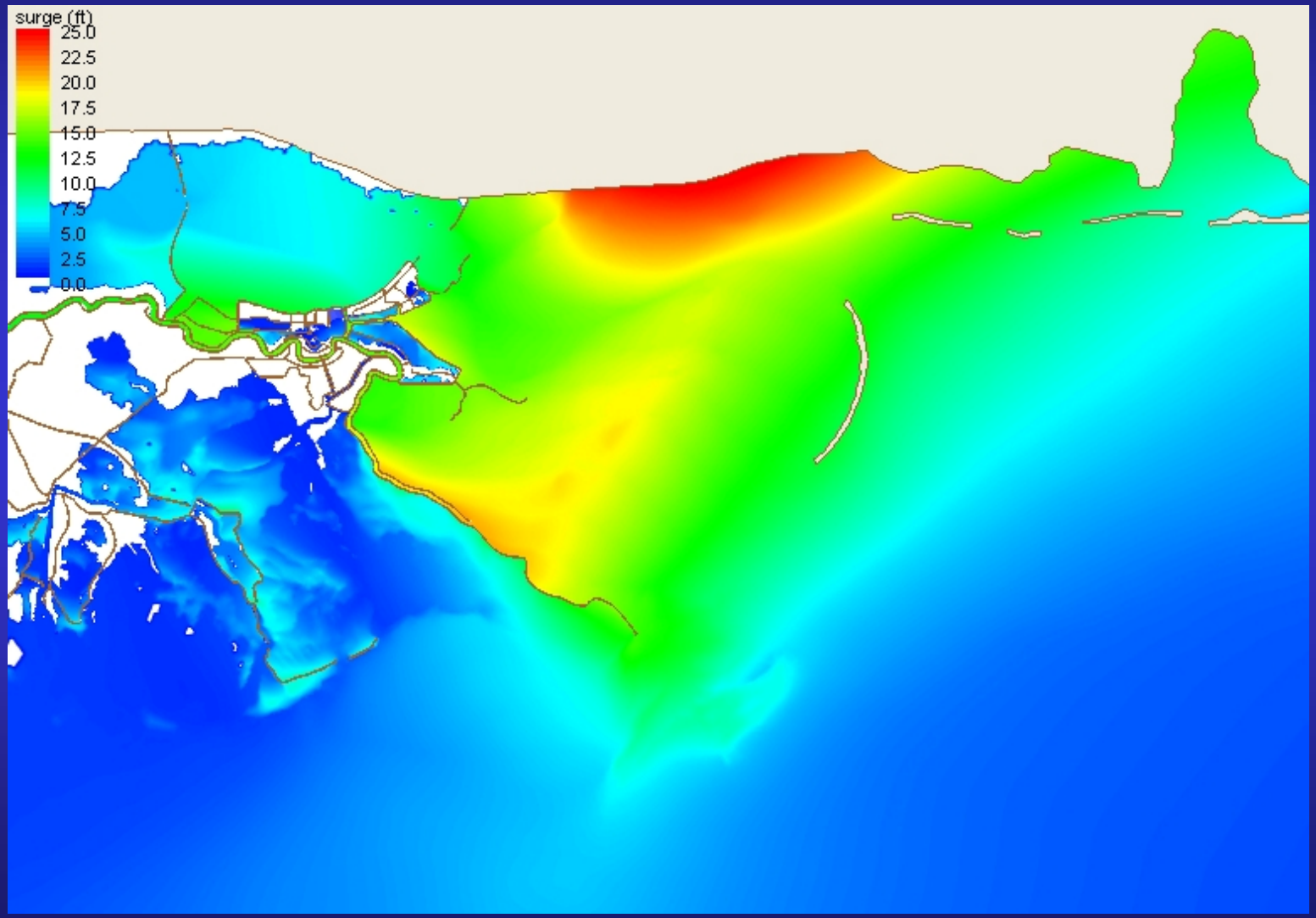
LSU Hindcast



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Hurricane Katrina

- Challenges
  - Datum planes
  - Subsidence
  - Coastal land loss
  - Increasing number of hurricanes?
  - Surge potential

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Datum Planes

- NGVD29
  - > 5 epochs
- NAVD88
  - 3 epochs
- Cairo
- Mean Gulf Level
- Mean Sea Level
- Mean Low Gulf
- Mean Low Water
- Mean Lower Low Water
- Memphis
- Low Water Reference Plane
- Average Low Water Plane

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ALCO 1931 Benchmark

Epoch	Elevation, ft
NGVD29 1951	7.621
NGVD29 1964	7.375
NGVD29 1983	6.869
NGVD29 1985	6.955
NGVD29 1991	6.76
NAVD88 2003	6.24
NAVD88 2004	6.31
NAVD88 2004.65	6.14

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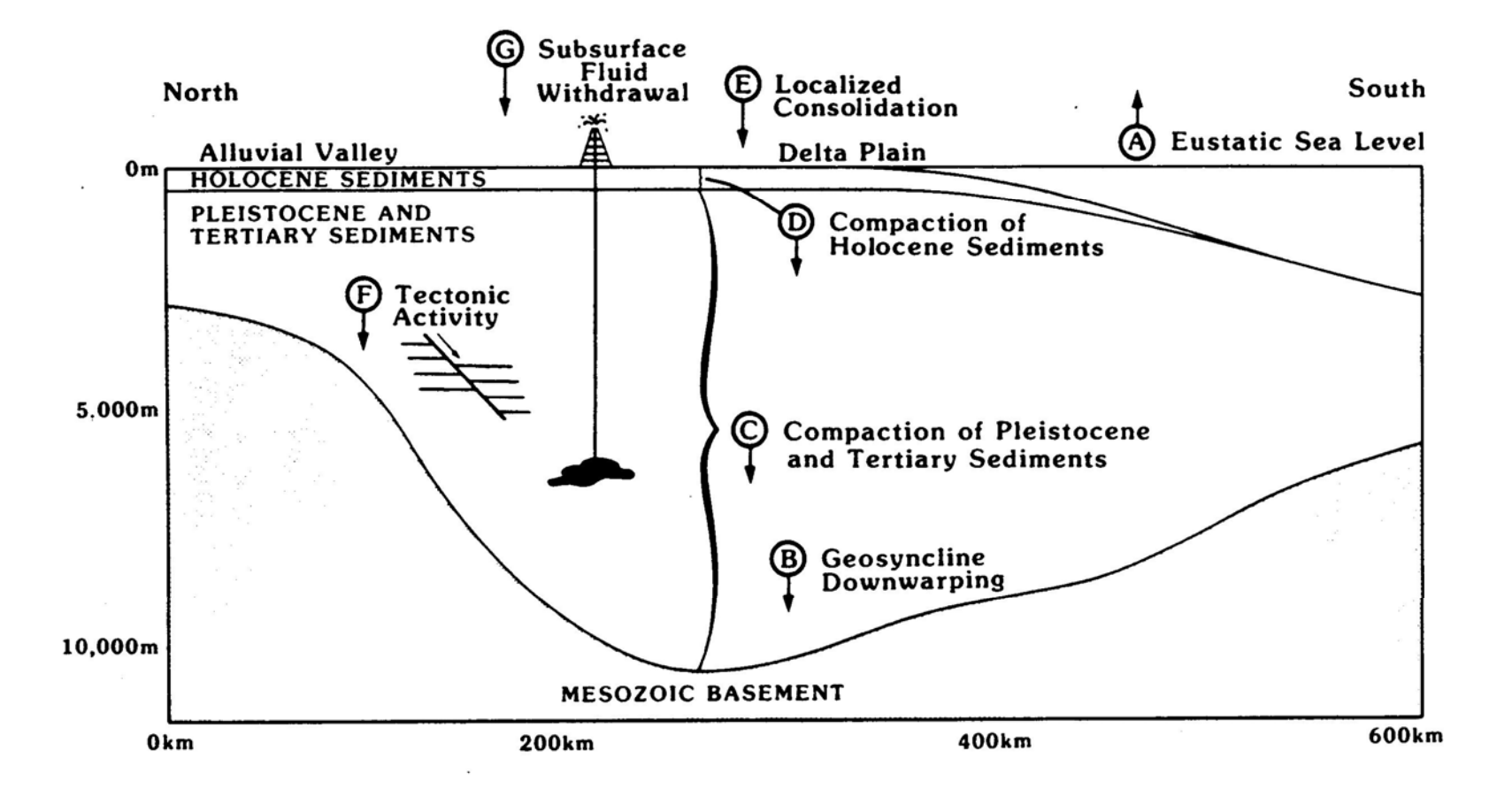
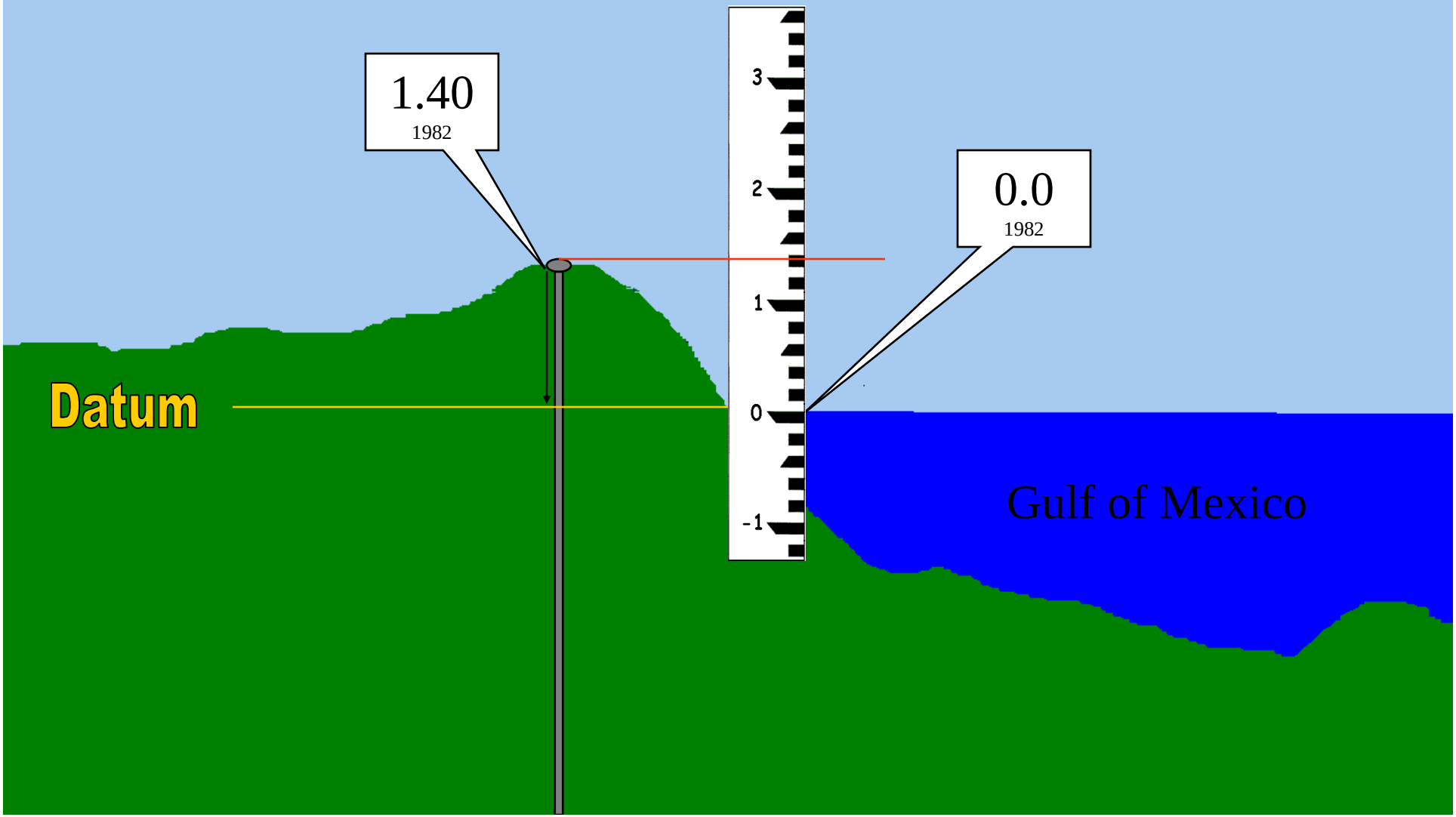
Subsidence



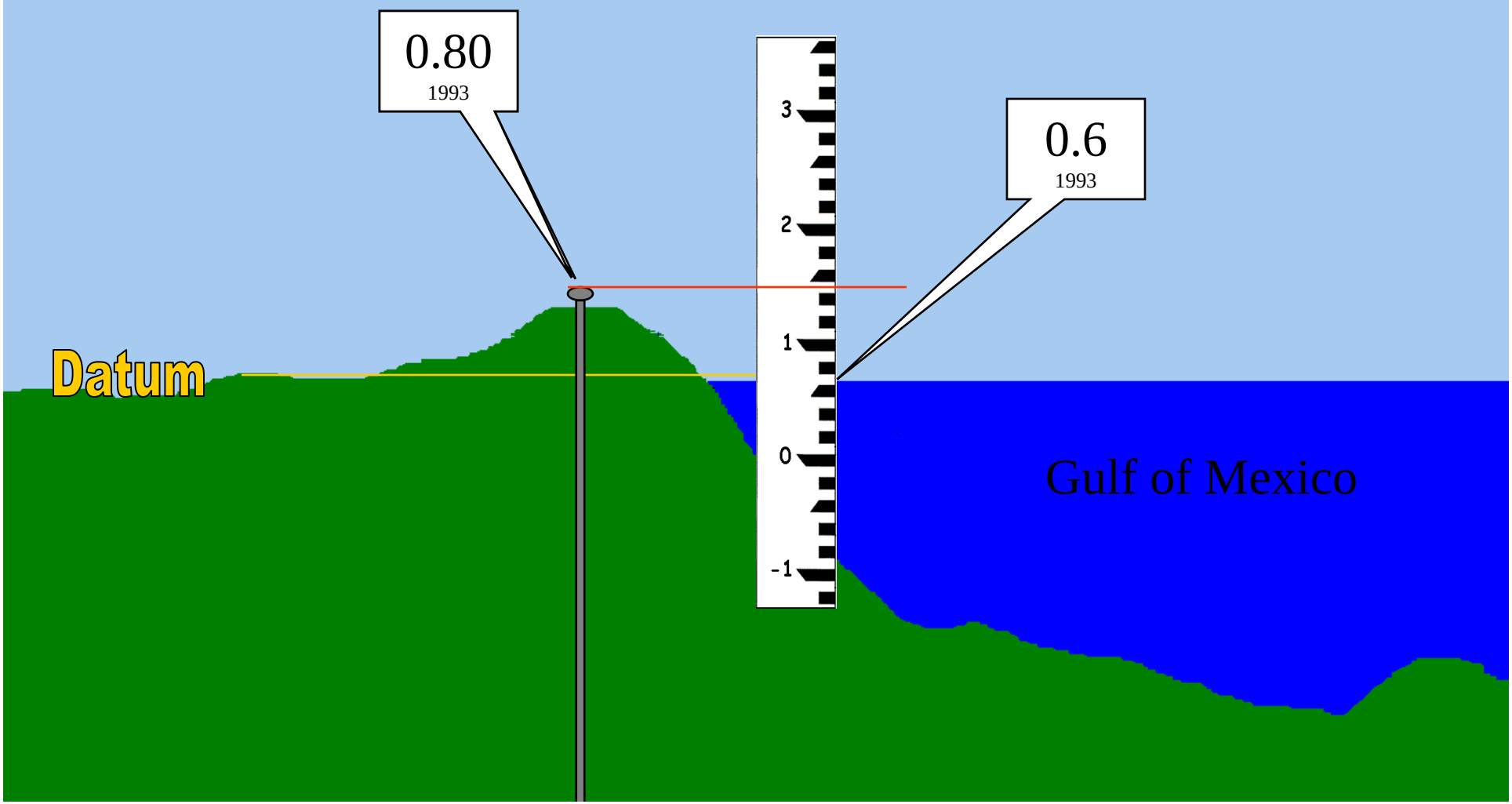
Grand Island Gauge

MSL in 1982

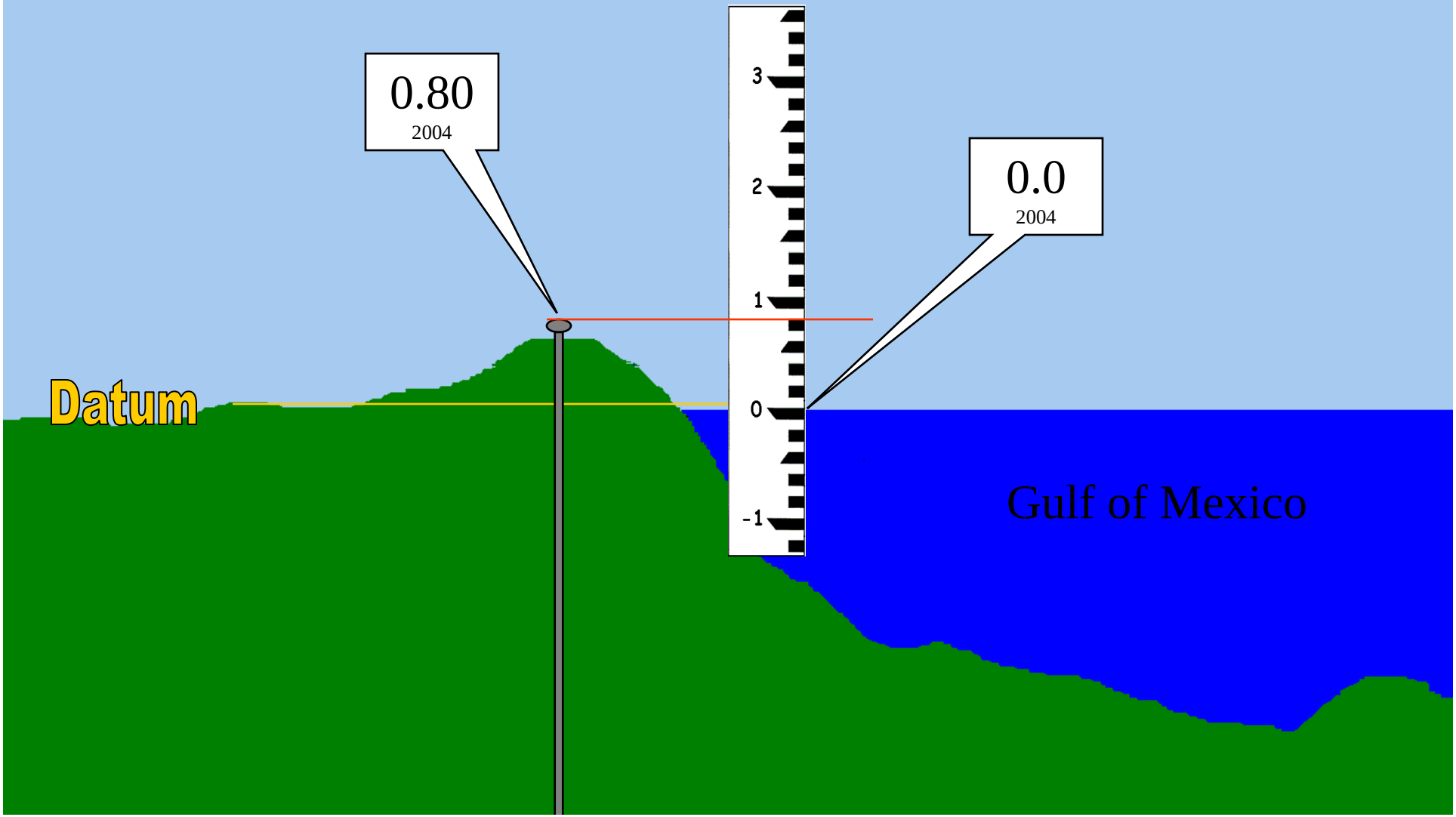


Grand Island Gauge

Subsidence Causes Gauge to read higher



Grand Island Gauge



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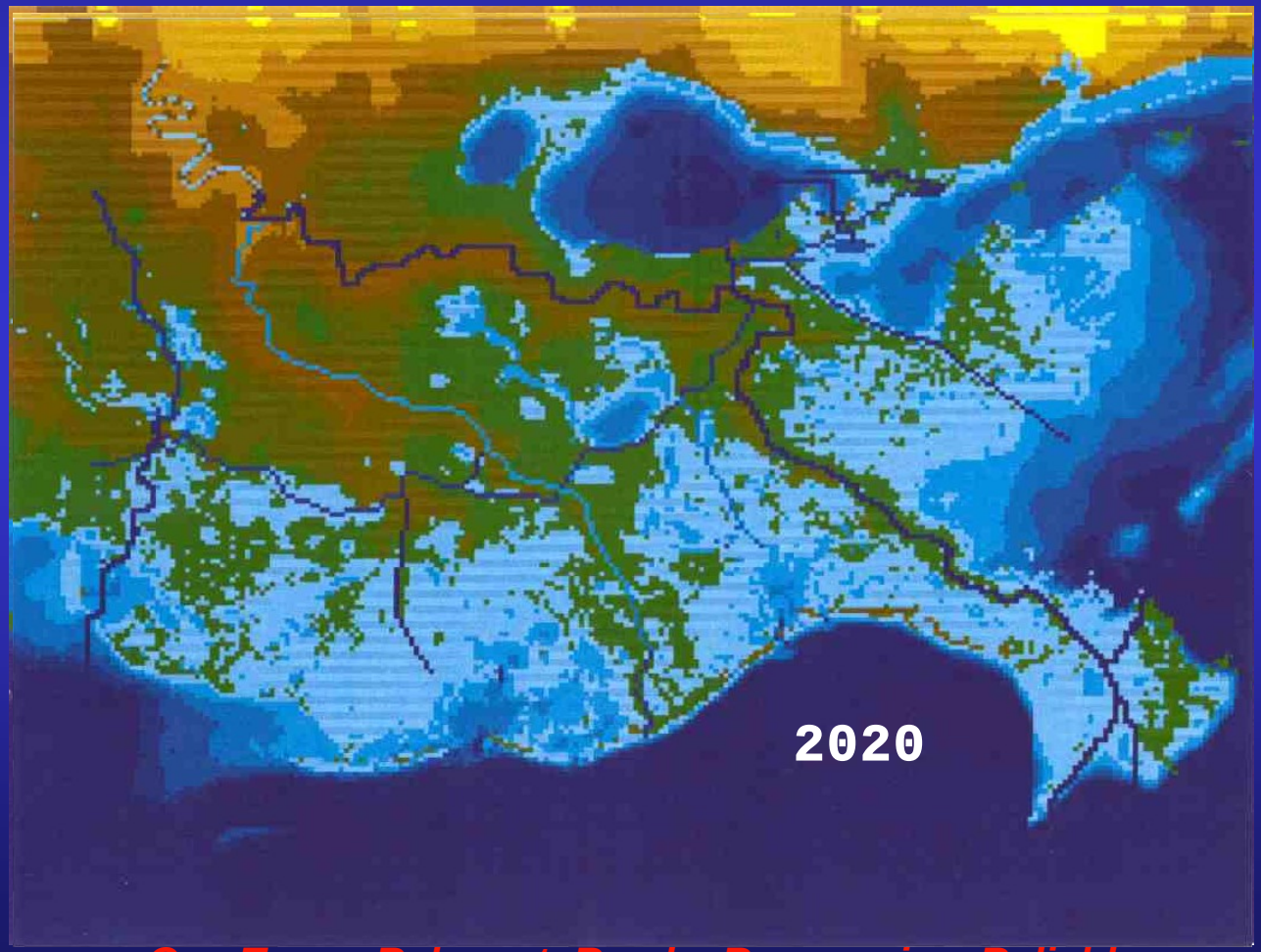
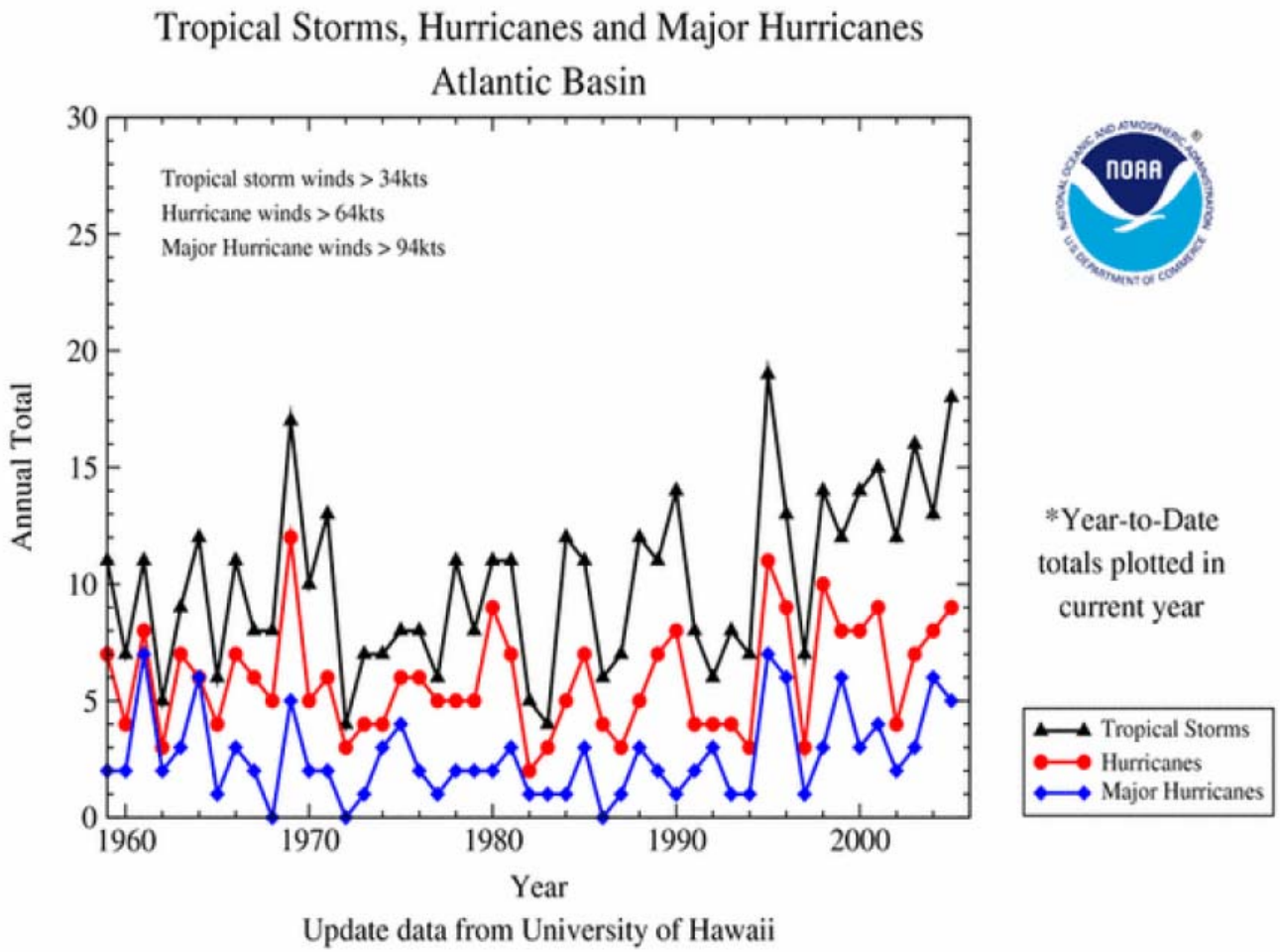
Past and Projected Coastal Wetland Loss (1839 to 2020)




Tropical Storms, Hurricanes and Major Hurricanes
Atlantic Basin
Tropical storm winds > 34kts
Hurricane winds > 64kts
Major Hurricane winds > 94kts
Annual Total
30
25
20
15
10
5
0
1960
1970
1980
1990
2000
Year
*Year-to-Date totals plotted in current year
Tropical Storms
Hurricanes
Major Hurricanes
Update data from University of Hawaii

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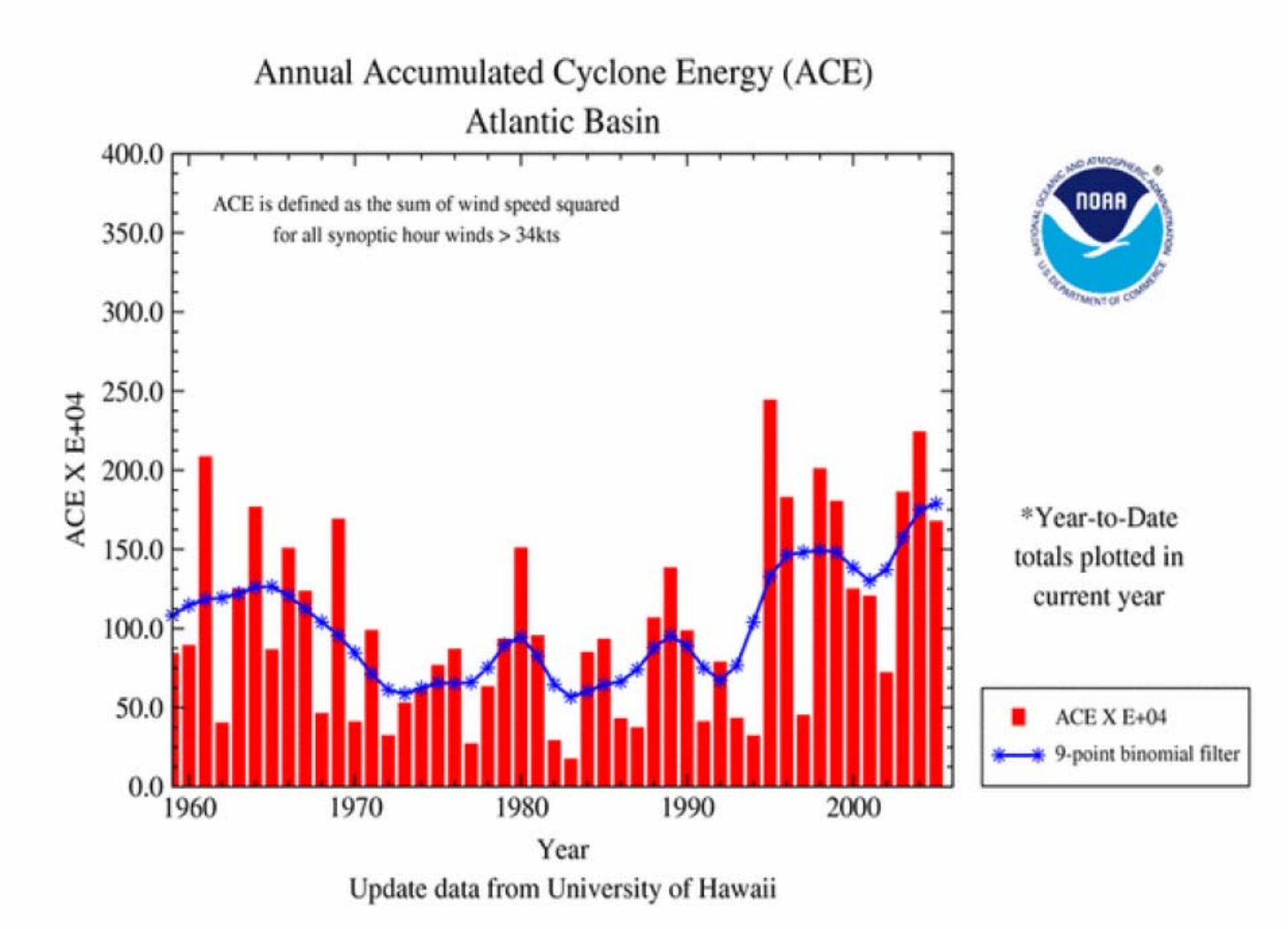

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Factors affecting surge

- Central intensity
- Radius to maximum winds
- Wind speed
- Storm size
- Physical geography
  - Inland waterways
  - Shallow inlets
  - Slope of continental shelf
- Gulf of Mexico currents and temperatures
- Levees

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Importance of Structure on Surge and Waves

- Generally, for storms of equal intensity the amount and aerial coverage of storm surge increases as the radius to maximum wind values gets larger
- Generally, for storms of equal intensity the amount and aerial coverage of storm surge increases as the overall size increases
- Larger radius to maximum wind values and overall sizes generally mean larger fetch areas for wave generation

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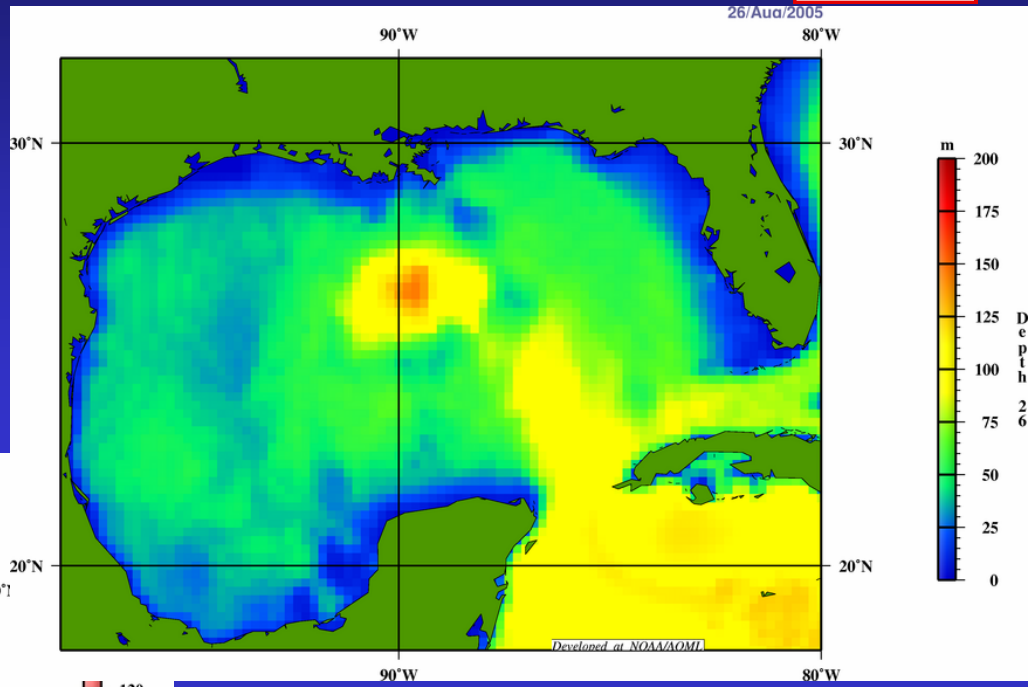
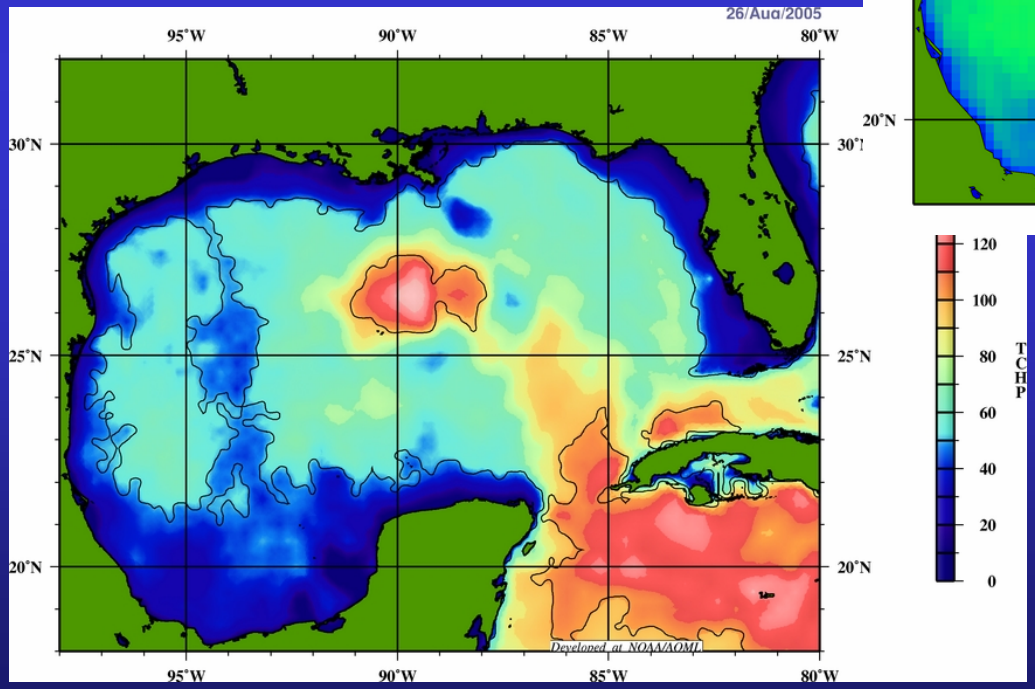
Role of The Loop Current

Depth of 26C Isotherm





Oceanic Heat Content

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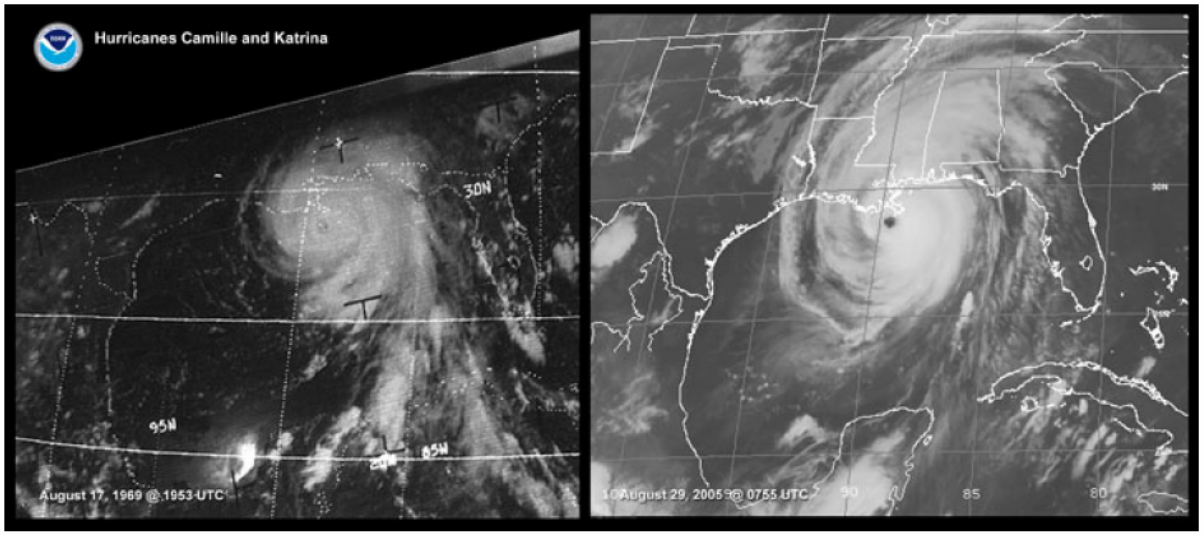
Camille vs Katrina



	Camille	Katrina
Wind speed	> 190 mph	127 mph
Central pressure	~909 mb	920 mb
Radius max winds	~15 N miles	25 to 30 N miles
Extent of Winds	~110 N miles	200 N miles

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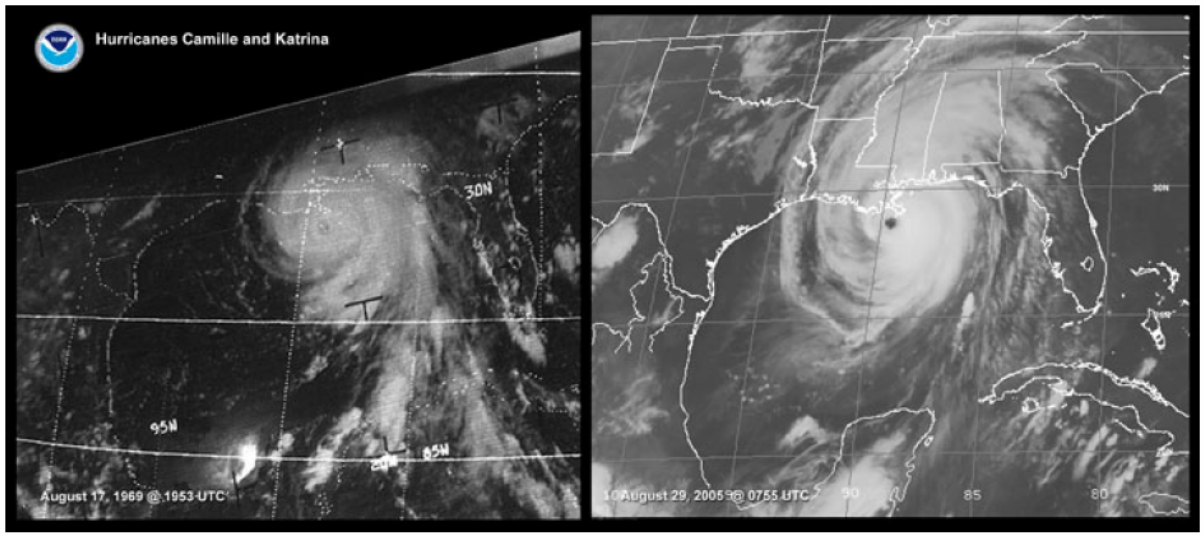
Camille vs Katrina



	Camille	Katrina
Maximum High Water Mark	24 to 25 ft along Mississippi Coast	28 to 30 ft along Mississippi Coast
Max Observed Significant Wave Height	44 feet	55 feet

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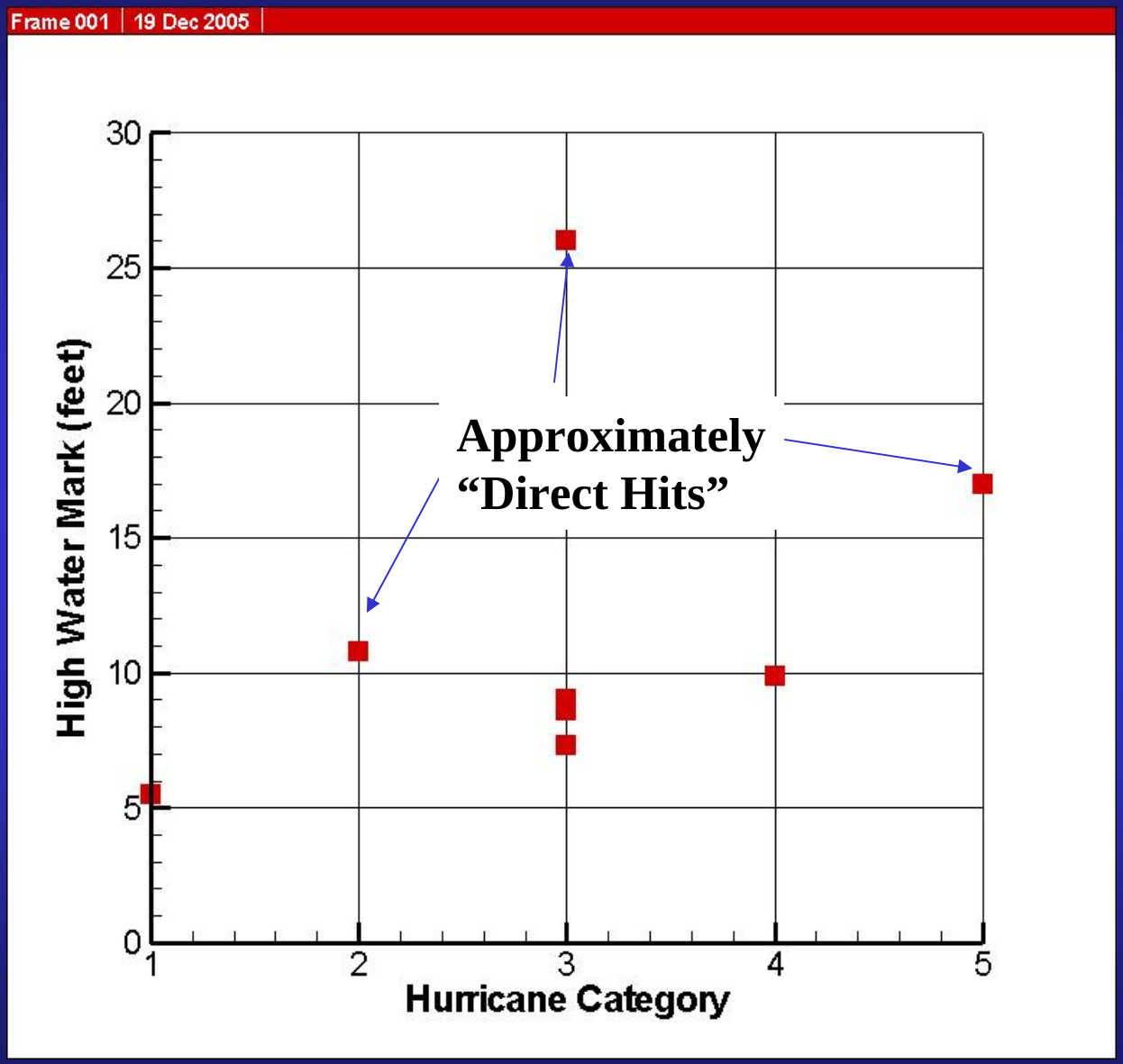
113 years of high water mark data at Biloxi, MS



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New Orleans District