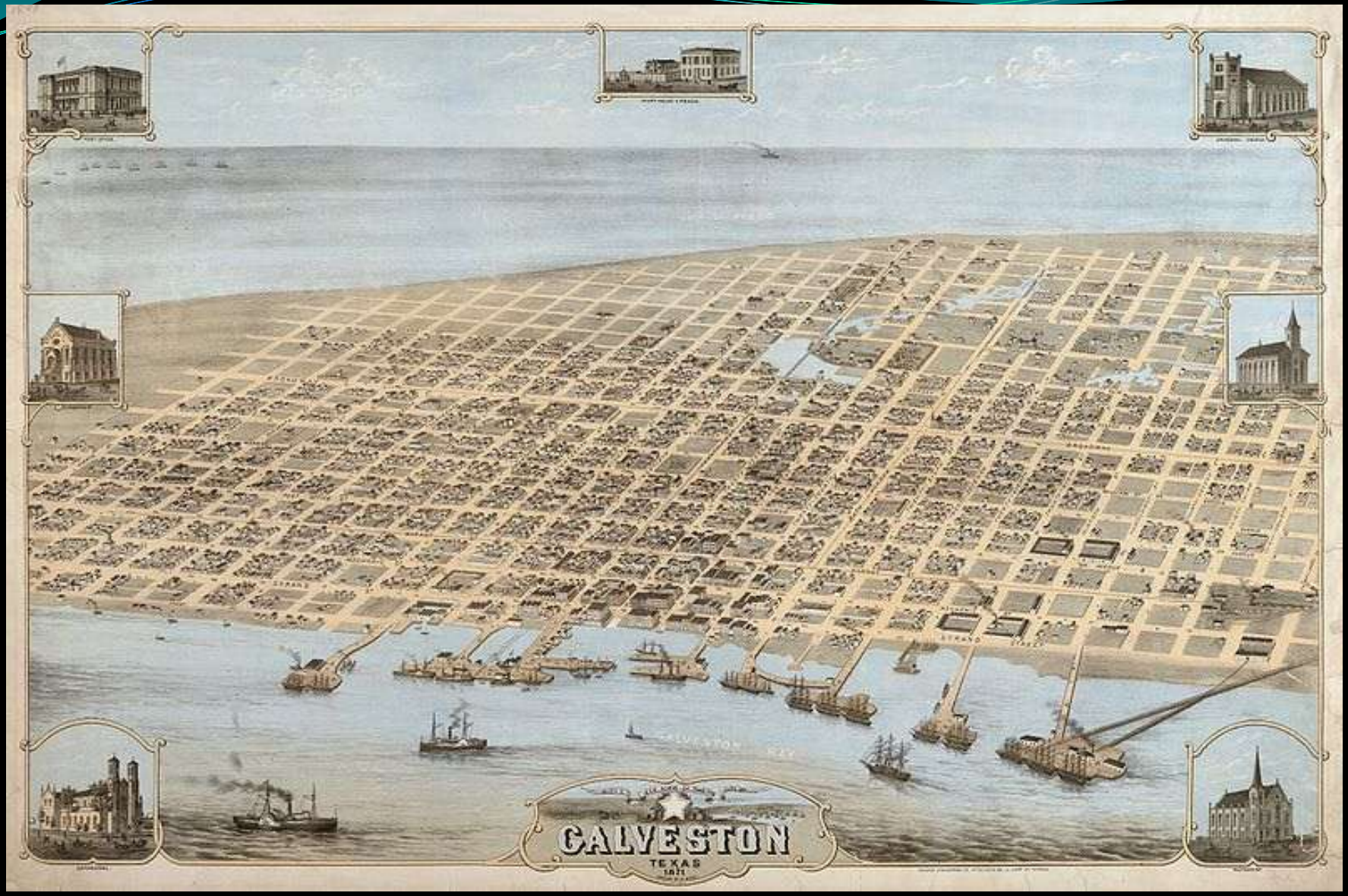
Storm Surge Risk Analysis for the U.S. Gulf Coast

Southern Climate Impacts Planning Program

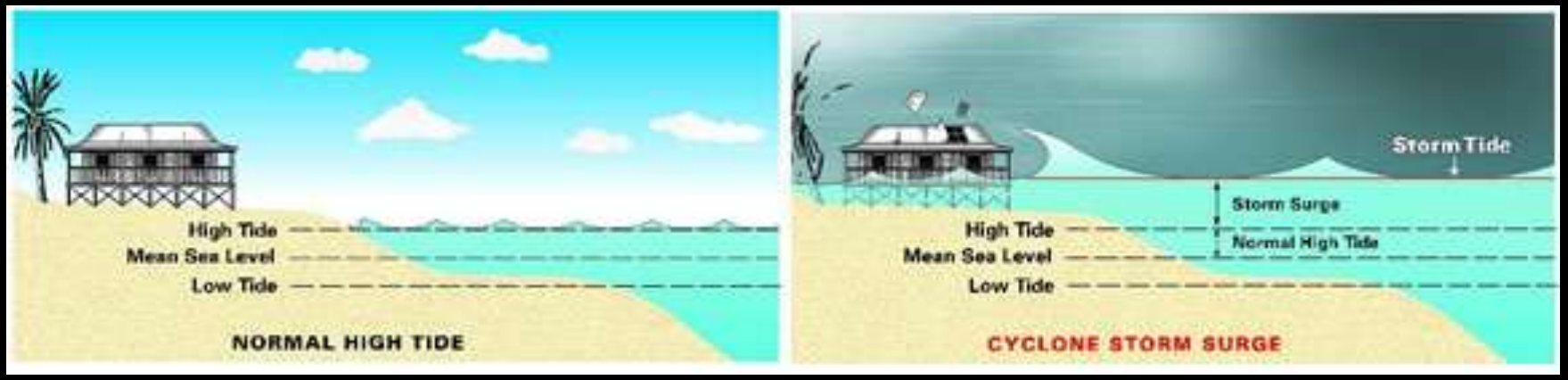
Hal Needham

February 27, 2014


GALVESTON
TEXAS
1871


Aerial Photo of Levee Break Caused by Hurricane Katrina, New Orleans, LA 30 August 2005
Photo by Jocelyn Augustino / FEMA

What is Storm Surge?

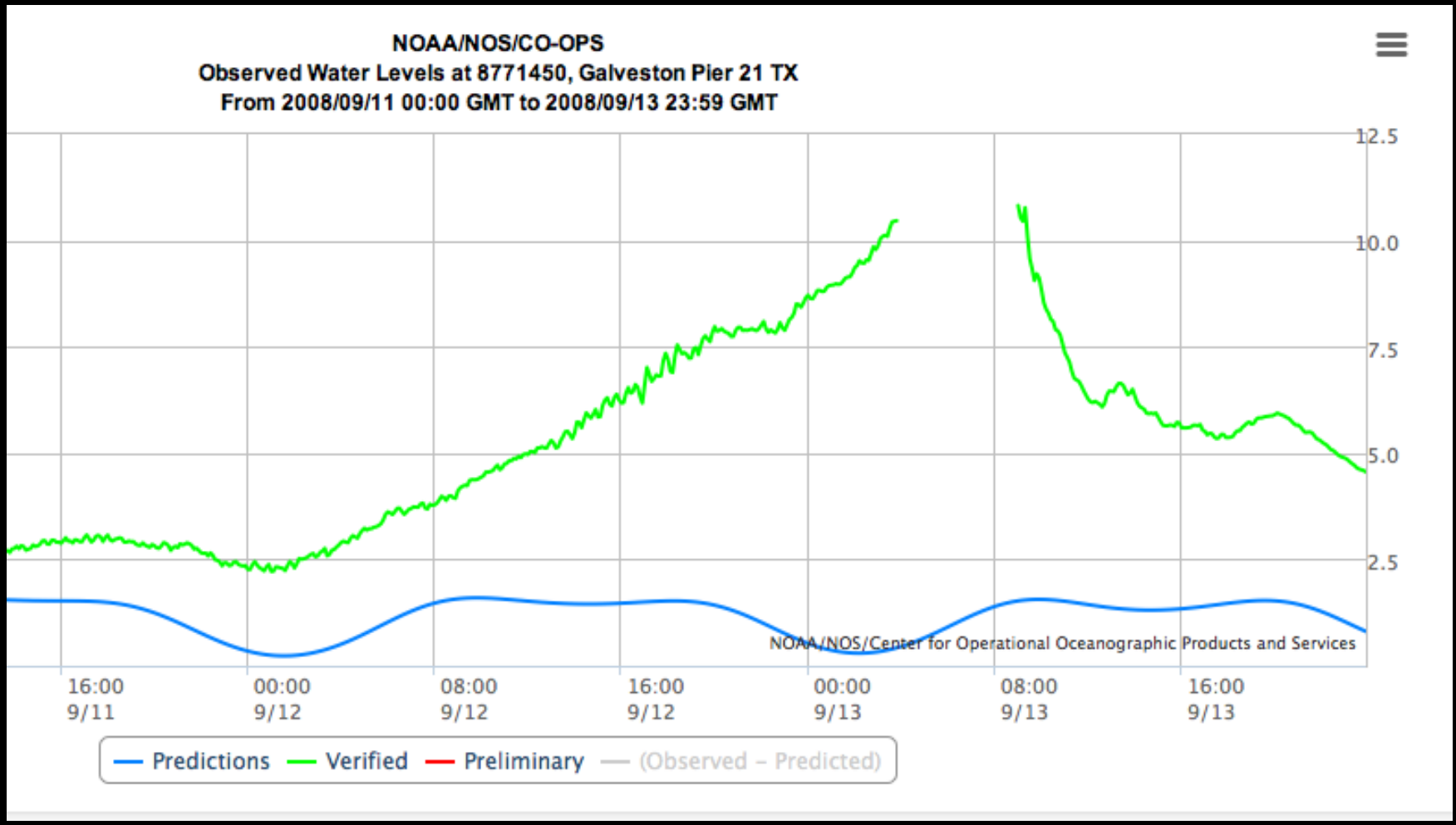


www.bom.gov.au

As of 2008…..

No Storm Surge Database


NOAA/NOS/CO-OPS
Observed Water Levels at 8768094, Calcasieu Pass LA
From 2005/09/22 00:00 GMT to 2005/09/24 23:59 GMT
Height in feet (MSL)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
00:00 9/22
08:00 9/22
16:00 9/22
00:00 9/23
08:00 9/23
16:00 9/23
00:00 9/24
08:00 9/24
16:00 9/24
NOAA/NOS/Center for Operational Oceanographic Products and Services
Predictions
Verified
Preliminary
(Observed – Predicted)
Datums (MSL)
MHHW
MHW
MTL
MSL
MLW
MLLW


NOAA/NOS/CO-OPS
Observed Water Levels at 8771450, Galveston Pier 21 TX
From 2008/09/11 00:00 GMT to 2008/09/13 23:59 GMT
12.5
10.0
7.5
5.0
2.5
NOAA/NOS/Center for Operational Oceanographic Products and Services
16:00 9/11
00:00 9/12
08:00 9/12
16:00 9/12
00:00 9/13
08:00 9/13
16:00 9/13
Predictions
Verified
Preliminary
(Observed – Predicted)

Surge Data Available from 67 sources (U.S. Gulf Coast)

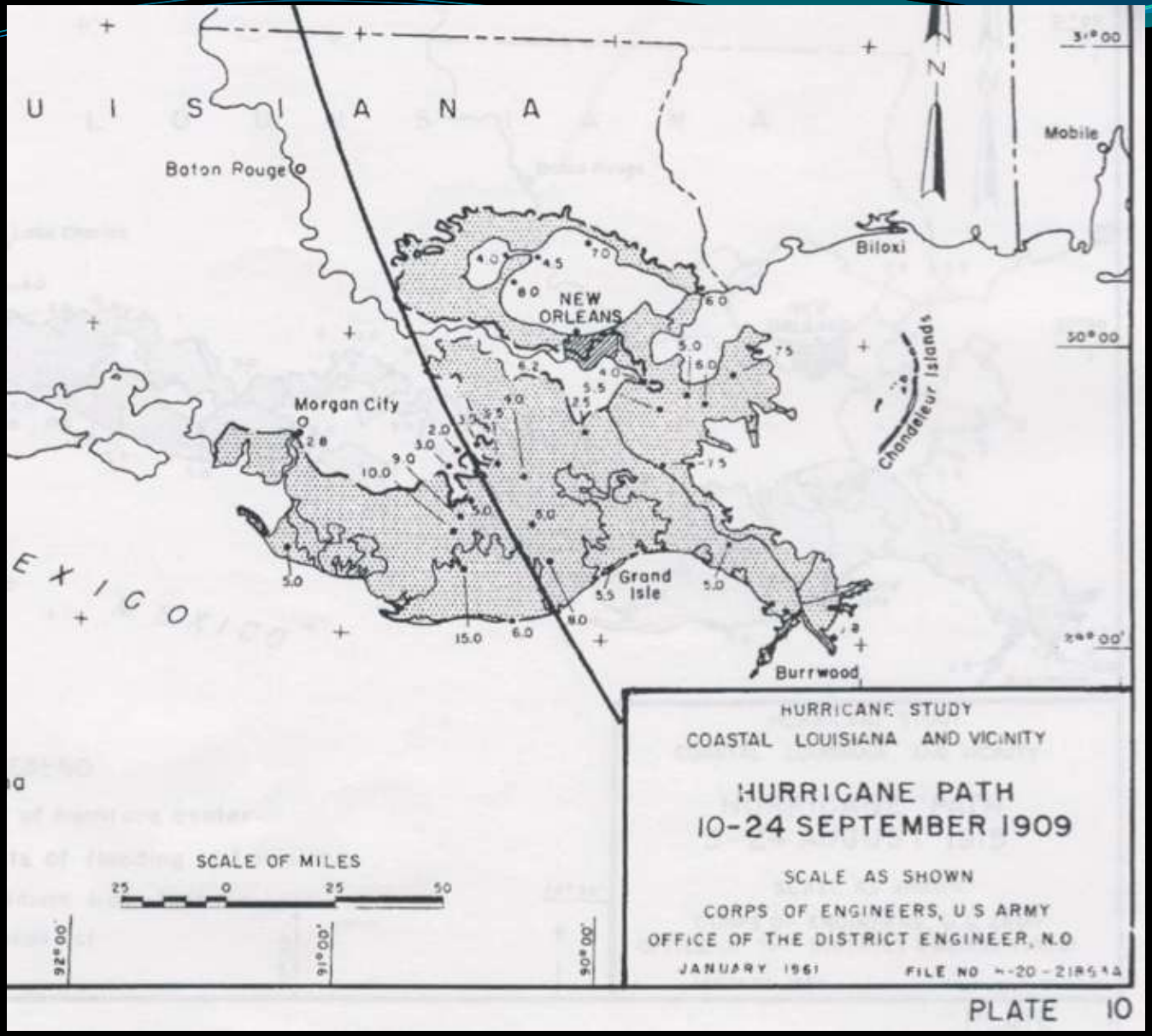
Federal Government: 28

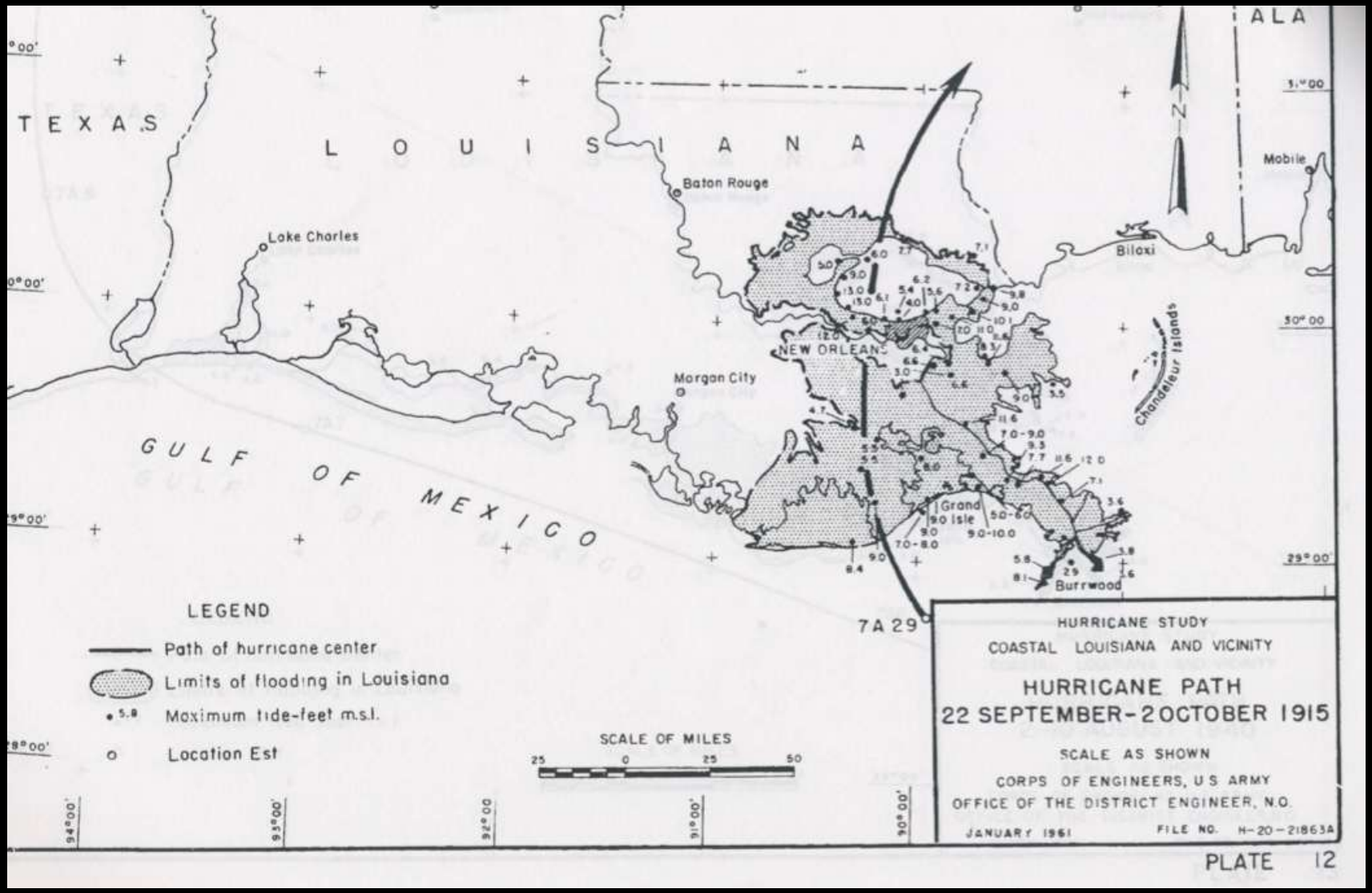
Books and Academic Publications: 23

Historic newspapers: 16 titles

3,120 pages of newspaper read

U.S. Government Data


U I S I A N A
Baton Rouge
Mobile
Biloxi
NEW ORLEANS
Morgan City
Chandeleur Islands
Grand Isle
Burrwood
EXICO
N
SCALE OF MILES
25 0 25 50
92° 00'
91° 00'
90° 00'
30° 00'
29° 00'
HURRICANE STUDY
COASTAL LOUISIANA AND VICINITY
HURRICANE PATH
10-24 SEPTEMBER 1909
SCALE AS SHOWN
CORPS OF ENGINEERS, U S ARMY
OFFICE OF THE DISTRICT ENGINEER, N.O.
JANUARY 1961
FILE NO
PLATE 10


TEXAS
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ALA
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Path of hurricane center
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5.8 Maximum tide-feet m.s.l.
Location Est
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HURRICANE STUDY
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22 SEPTEMBER-2 OCTOBER 1915
SCALE AS SHOWN
CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER, N.O.
JANUARY 1961
FILE NO. H-20-21863A
PLATE 12

16 PAGES TODAY

St. Petersburg Times

Good Morning!

CITY RECOVERS FROM GRIP OF TROPICAL HURRICANE

County Suffers Property Damage, Estimated at Less Than $2,000,000, With Known Loss of Two Lives

The Galveston Daily News

Hayden Reports LBJ

Dora Smashes Seawall, Steals 35-Foot Beach

Windswept Waves Flatten Buildings

Two Groups Back Push For College

SUN-SENTINEL

5¢

$100 MILLION DAMAGES

A Goal In Wake Of Those Below

Insurance Rates May Climb

KATRINA: THE STORM WE'VE ALWAYS FEARED

The Times-Picayune

CATASTROPHIC

STORM SURGE SWAMPS 9TH WARD, ST. BERNARD

LAKEVIEW LEVEE BREACH THREATENS TO INUNDAT

TAMPA IS HARD HIT BY TROPICAL STORM

Part of Florida City Under Three Feet of Water

INDUSTRY AT STANDSTILL

West Coast of Florida Without Light, Wire or Car Service

TAMPA DAILY TIMES

TAMPA CITY OF RUINS

HUNDRED BEACH HOMES DISAPPEAR

ESTIMATED LOSSES MORE THAN MILLION DOLLARS

RAILROADS AND YBOR CITY, PORT TAMPA AND BAY SHORE SUFFER

September 17, 1943

The Times-Picayune

RESIDENTS FLEE AS 60-MILE WIND HERALDS STORM

Center of Tropical Hurricane May Hit Texas Coast

The center of a tropical storm of hurricane force was expected to reach the Texas coast in the Freeport-Galveston area near daybreak today, accompanied by winds from 75 to 85 miles per hour and gusts up to 100 miles per hour, according to the local office of the United States weather bureau.

A majority of the residents of Freeport departed as a 60-mile-an-hour wind struck there late Thursday night, a dispatch stated. The barometer reading was 29.84 and the tide 4.5.

Hurricane warnings were or-

July 16, 1931

Blows 6-Foot Tide

Accompanied by driving rain, the gale kicked up a 6-foot tide that pounded the sea wall and dashed over into the Coastline Highway, wrecking public and private piers. The waves were reported to have leaped high enough to hit residences along the beach near Bay St. Louis and Waveland.

The new seawall withstood its first severe test without damage.

Isaac Cline

Chief Meteorologist at Galveston, TX 1889 - 1901

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

VOL. XXVIII. SEPTEMBER, 1900. No. 9

The water rose at a steady rate from 3 p. m. until about 7:30 p. m., when there was a sudden rise of about four feet in as many seconds. I was standing at my front door, which was partly open, watching the water, which was flowing with great rapidity from east to west. The water at this time was about eight inches deep in my residence, and the sudden rise of 4 feet brought it above my waist before I could change my position. The water had now reached a stage 10 feet above the ground at Rosenberg avenue (Twenty-fifth street) and Q street, where my residence stood. The ground was 5.2 feet elevation, which made the tide 15.2 feet. The tide rose the next hour, between 7:30 and 8:30 p. m., nearly five feet additional, making a total tide in that locality of about twenty feet. These observations were carefully taken and represent to within a few tenths of a foot the true conditions. Other personal observations in my vicinity confirm these estimates.

Decided to Build a Dataset

Name: Water Height Observation Data

Water Height Observation Data

Acronym: WHODAT


WHO DAT!
NOLA


WHO DAT NATION


WHO DAT

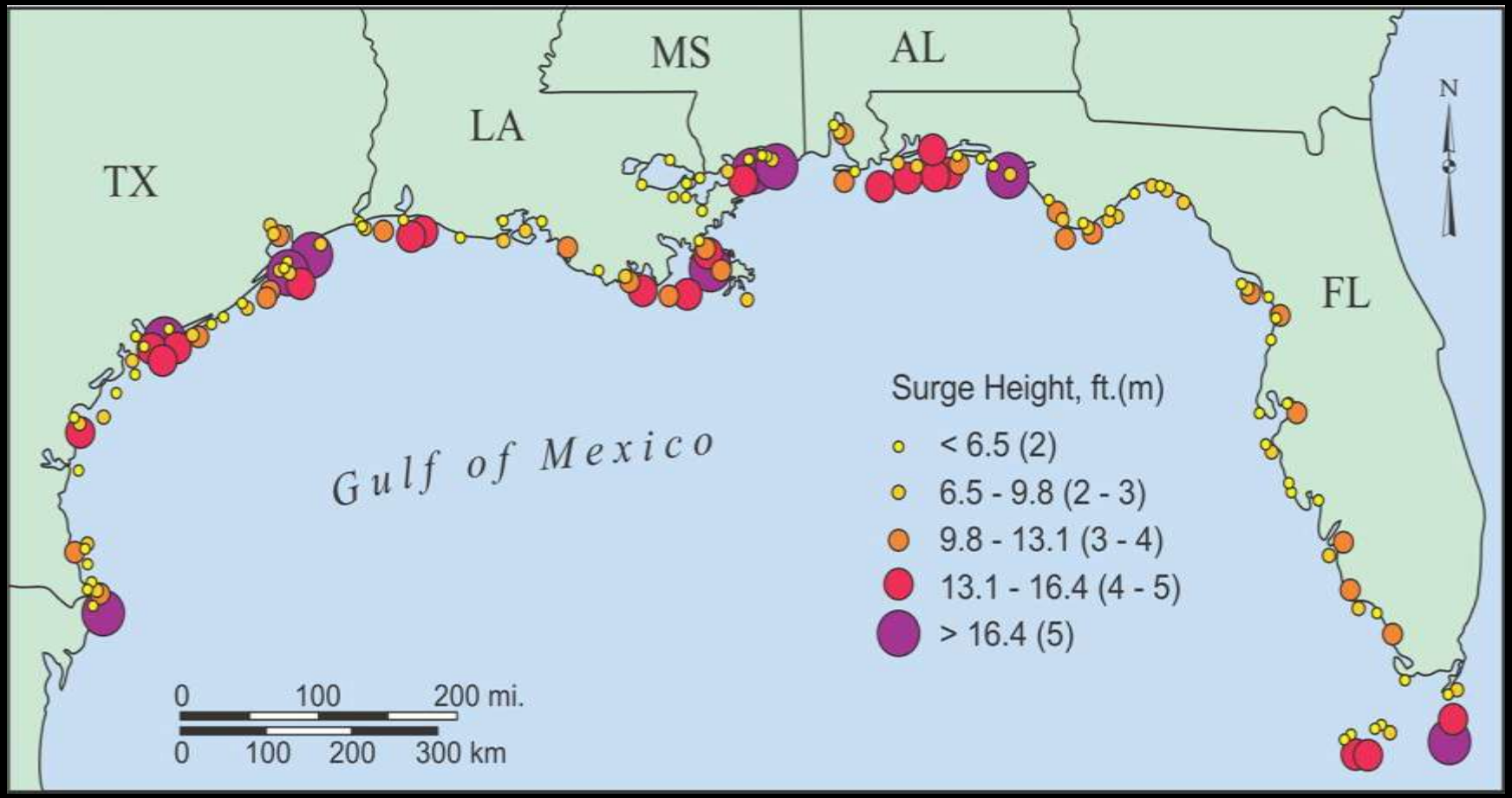

WHO DAT!


#WHODAT

SURGEDAT

- Tropical cyclone-generated storm surges
- Time period: 1880-2013 (134 years)
- 8,100 high water marks (U.S.)
- Peak Surge Obs:
  - 703 Global
  - 350 U.S.

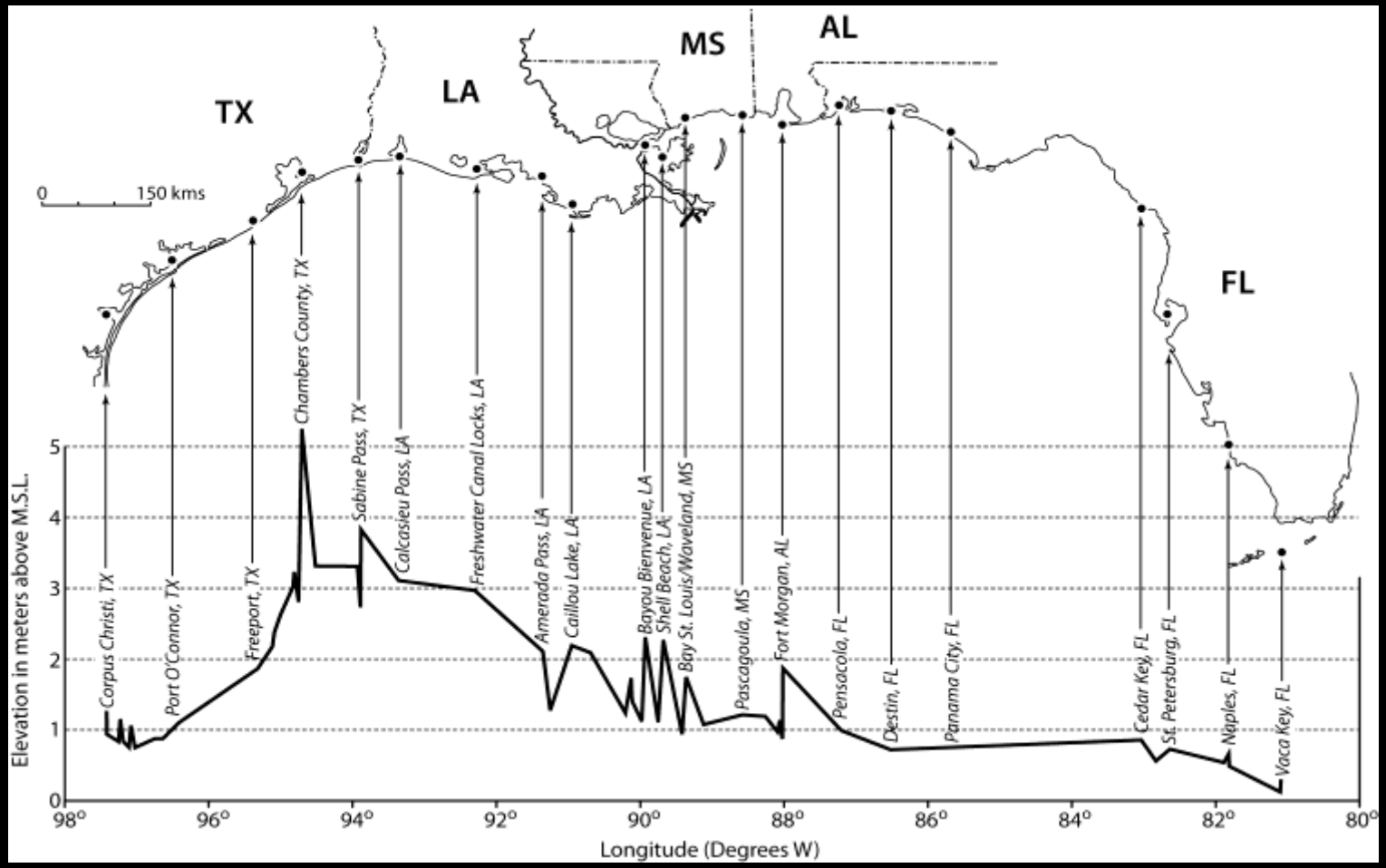
Map of Surge Activity along the U.S. Gulf Coast



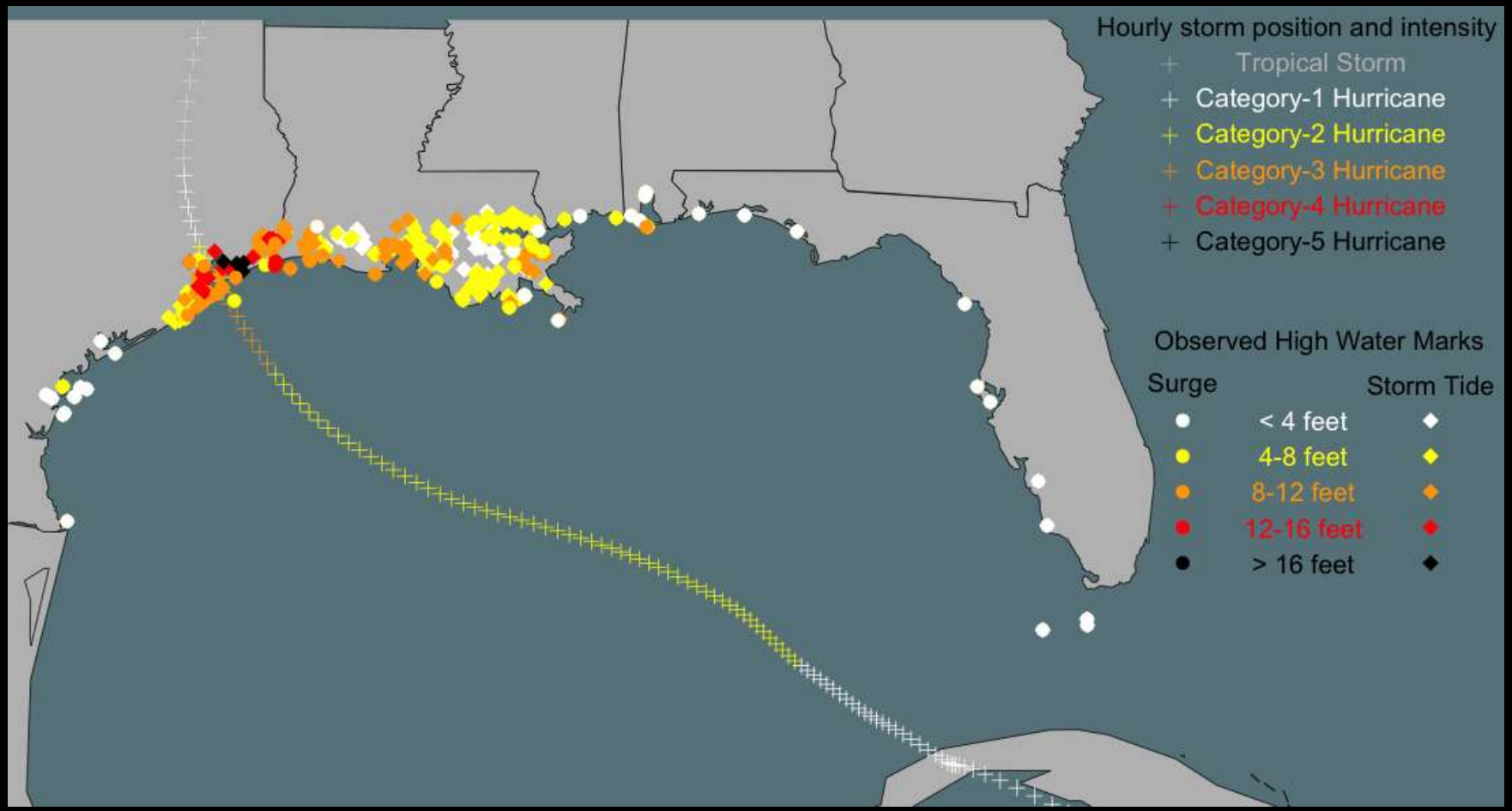

EXXON
Cypress Plaza
EXXON

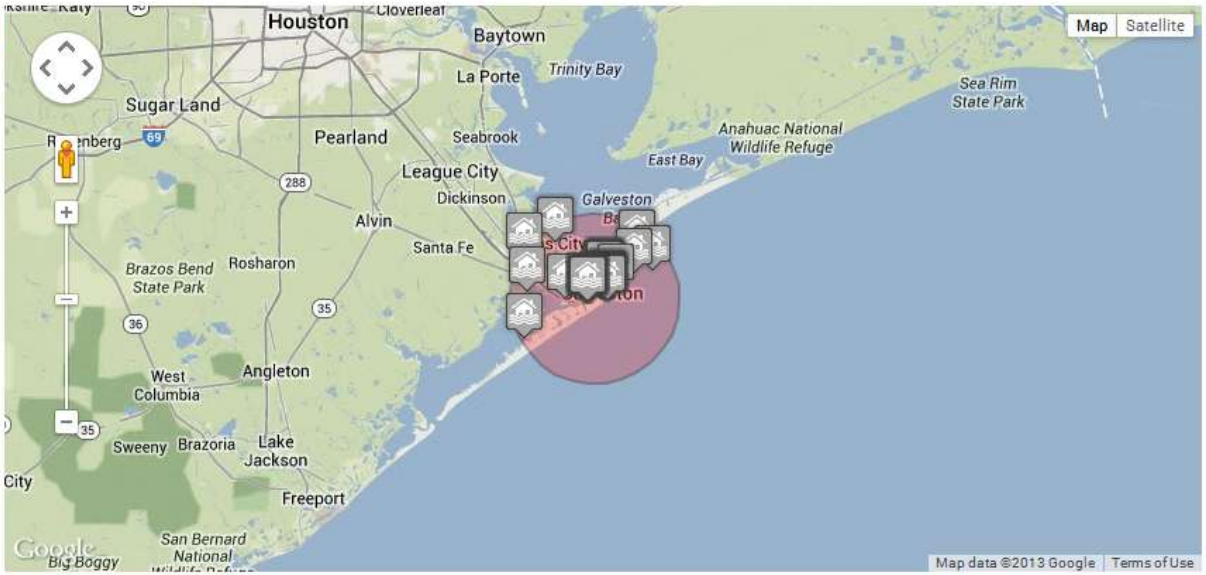

TX 7285 DJ

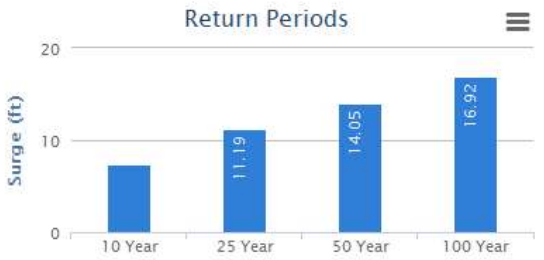
Hurricane Ike Extent of Storm Surge



Hurricane Ike (2008) Storm Surge/ Storm Tide Obs



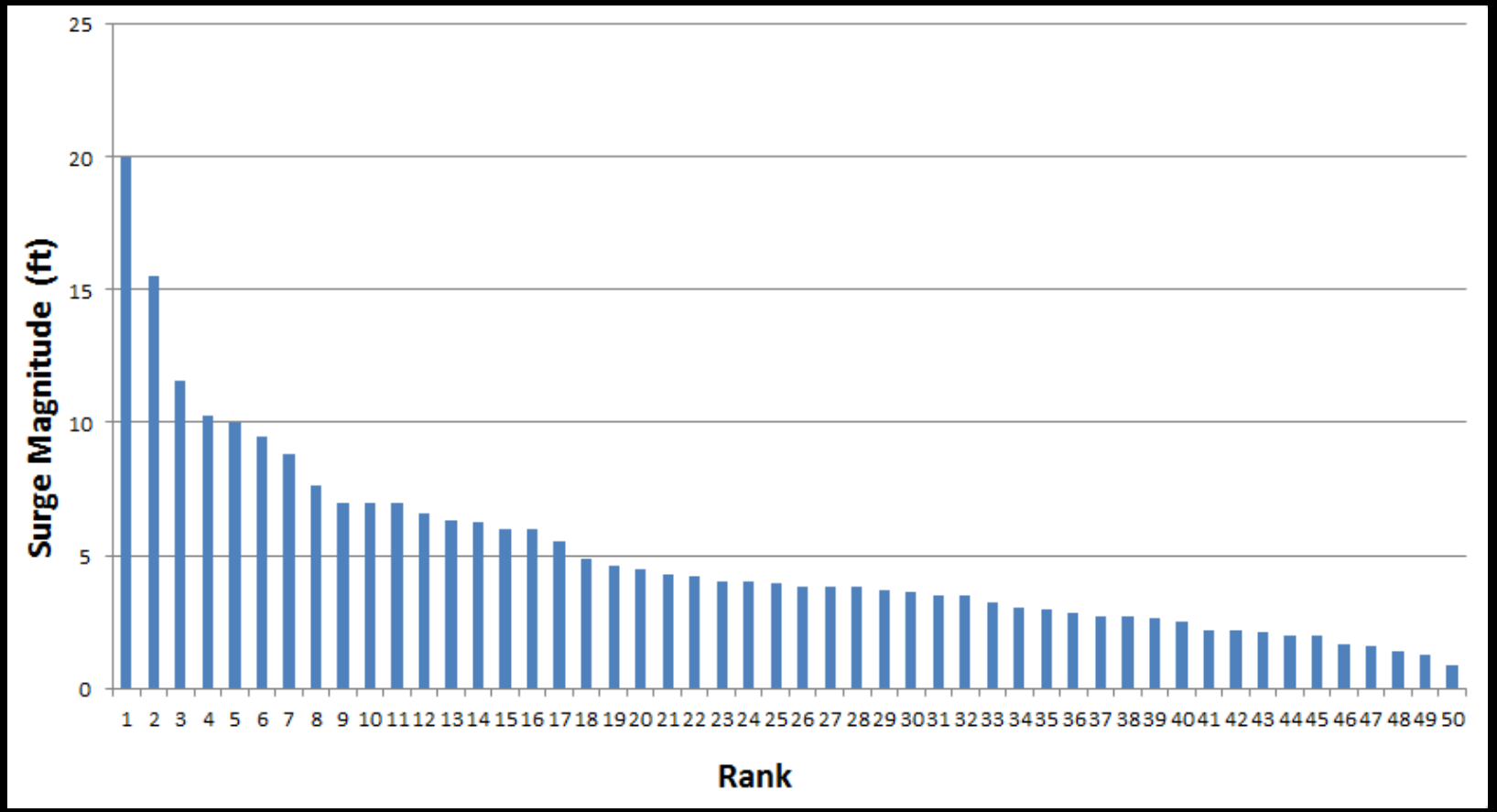




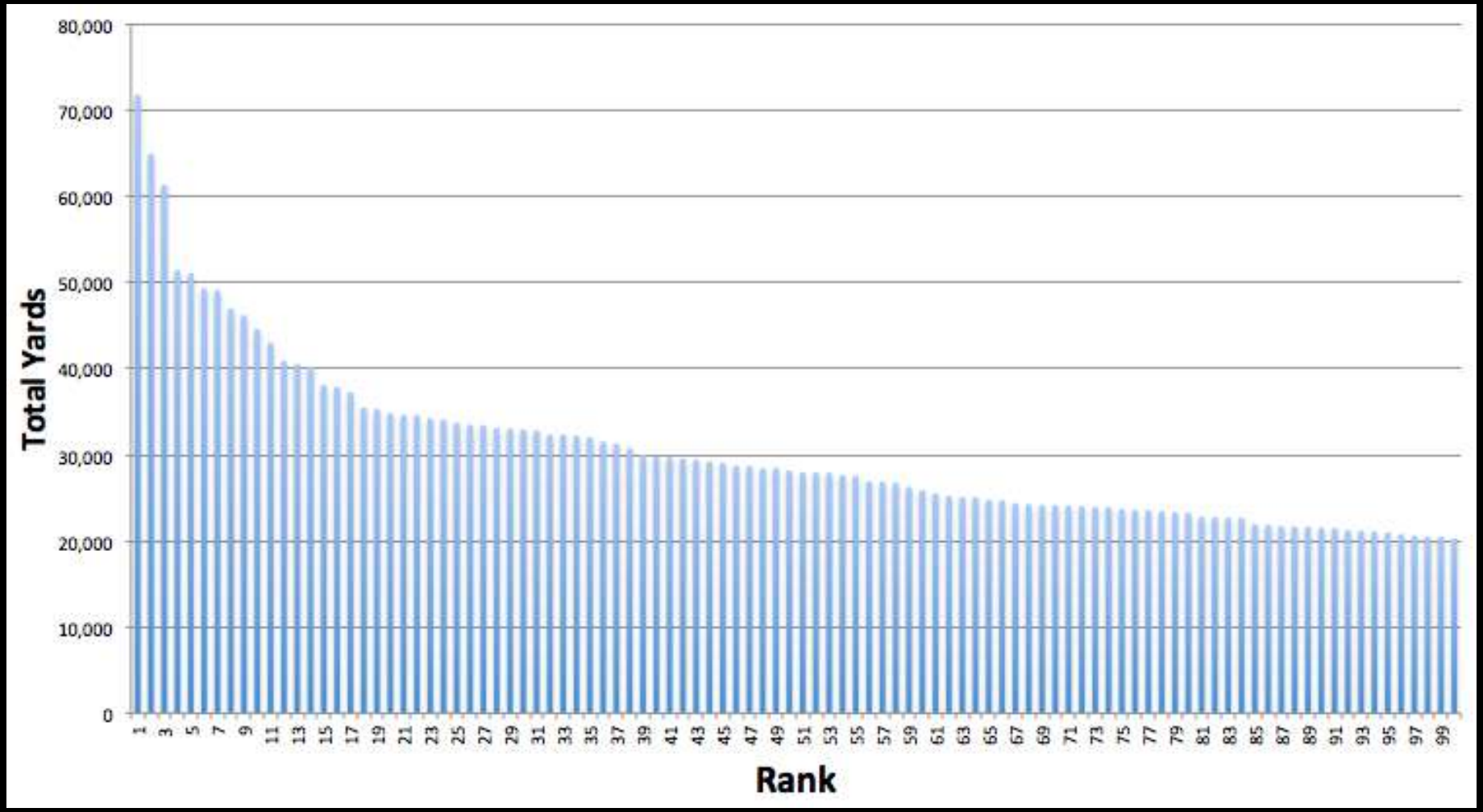
<< first < prev **1** 2 3 4 5 next > last >>

Storm Name	Year	Longitude	Latitude	Storm Tide(ft)	Storm Tide(m)	Surge(ft)	Surge(m)	Location	Basin	State
Frances	1998	-94.7883	29.285	7.10				Galveston Pleasure Pier	U.S. Gulf Coast	TX
Galveston	1915	-94.7894	29.2889	15.50	4.72			GLS Seawall	U.S. Gulf Coast	TX
Cindy	1963	-94.7933	29.31	4.60				Pier 21 - Galveston Channel	U.S. Gulf Coast	TX

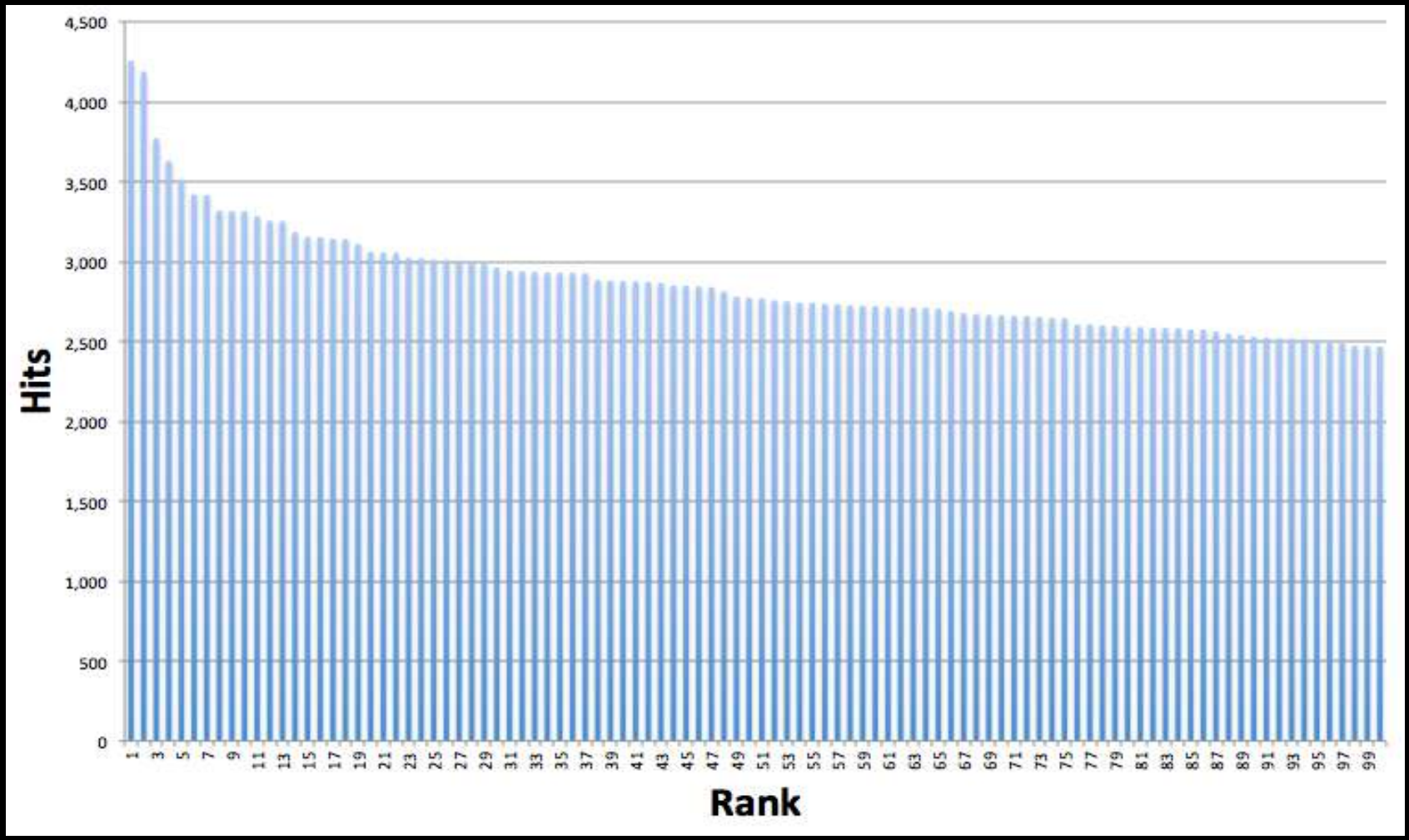
Storm Surge History at Galveston, TX



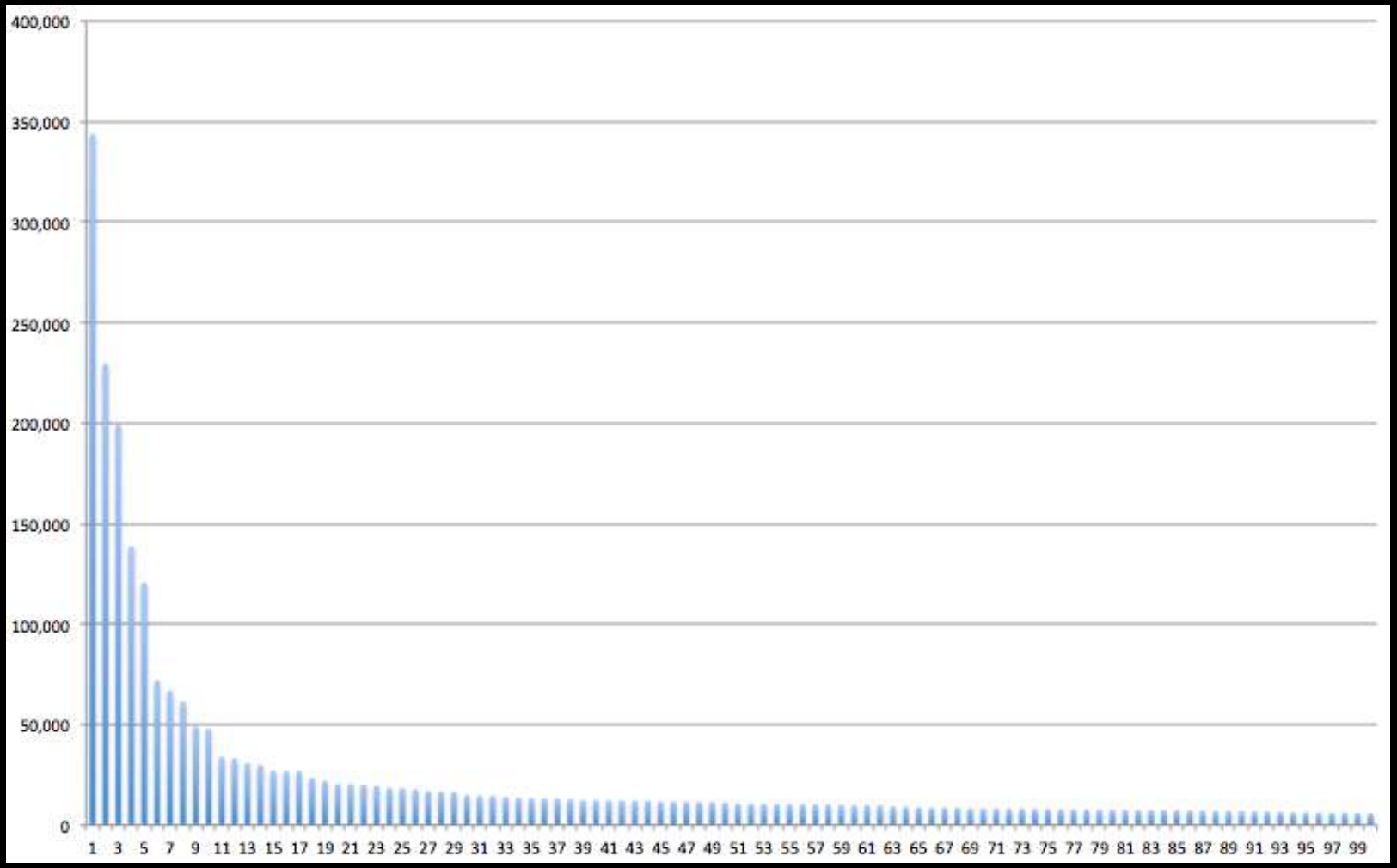
All-Time NFL Passing Leaders



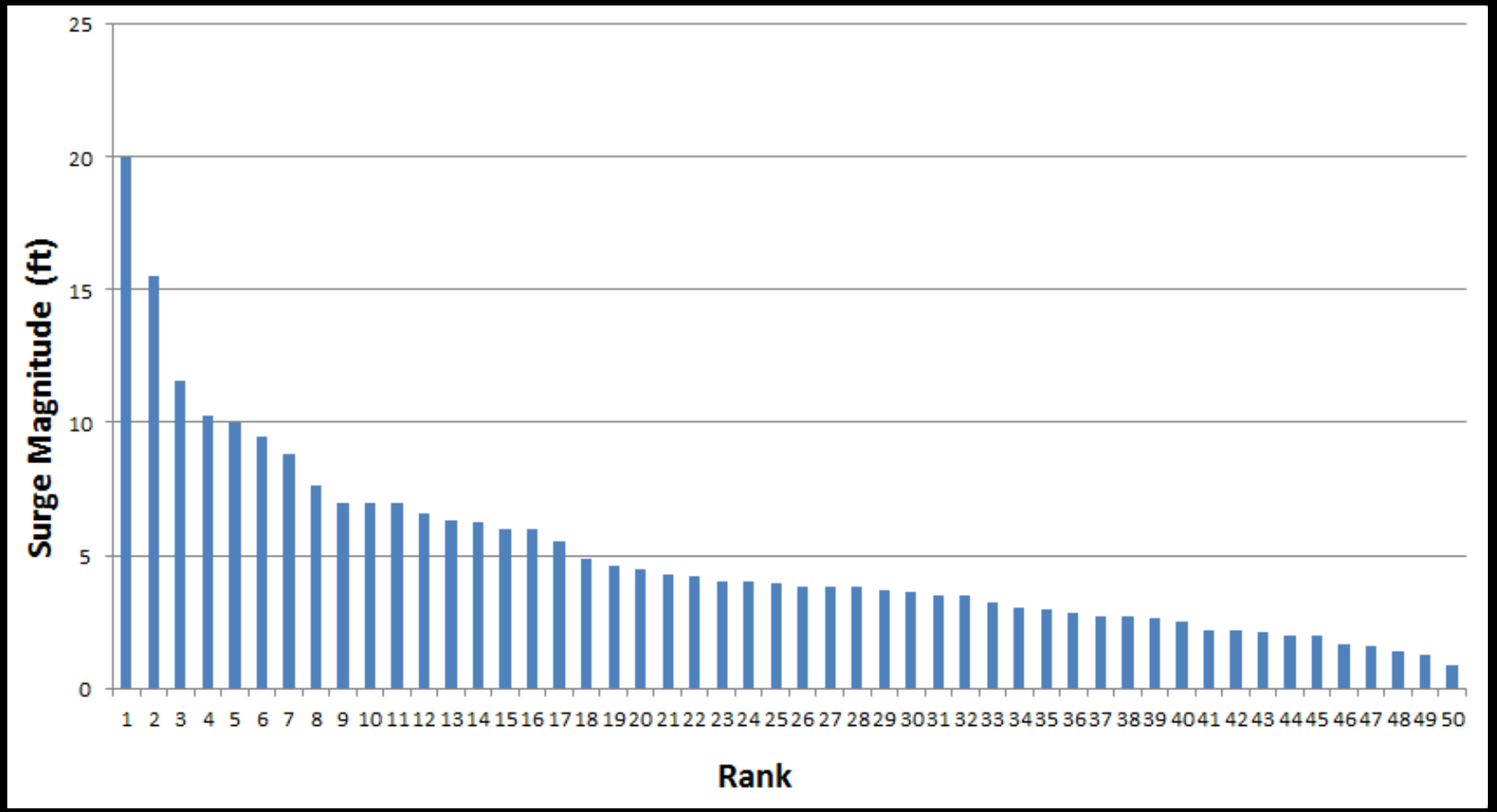
All-Time MLB Base Hits



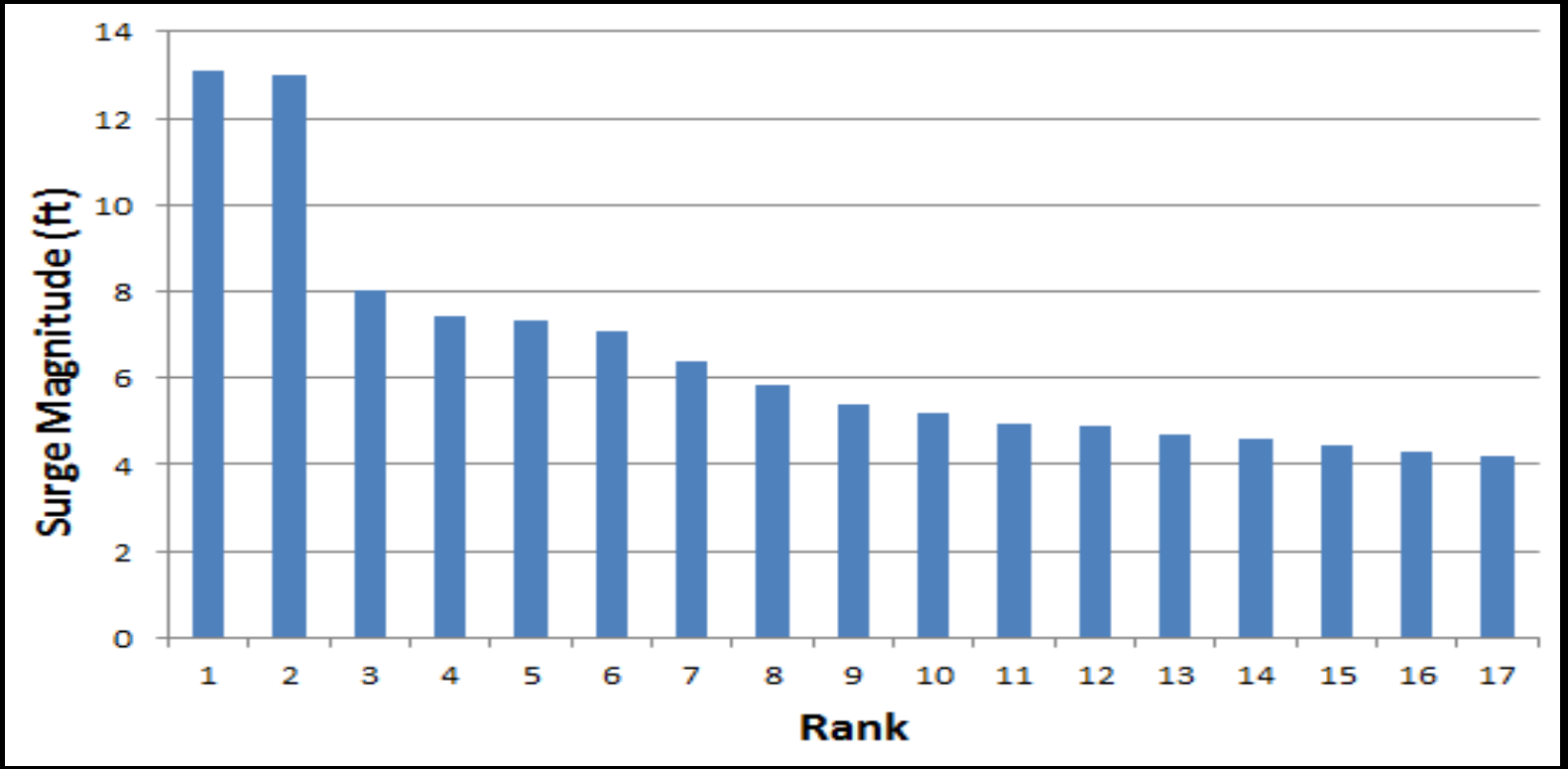
Size of Louisiana Cities according to 2010 Census



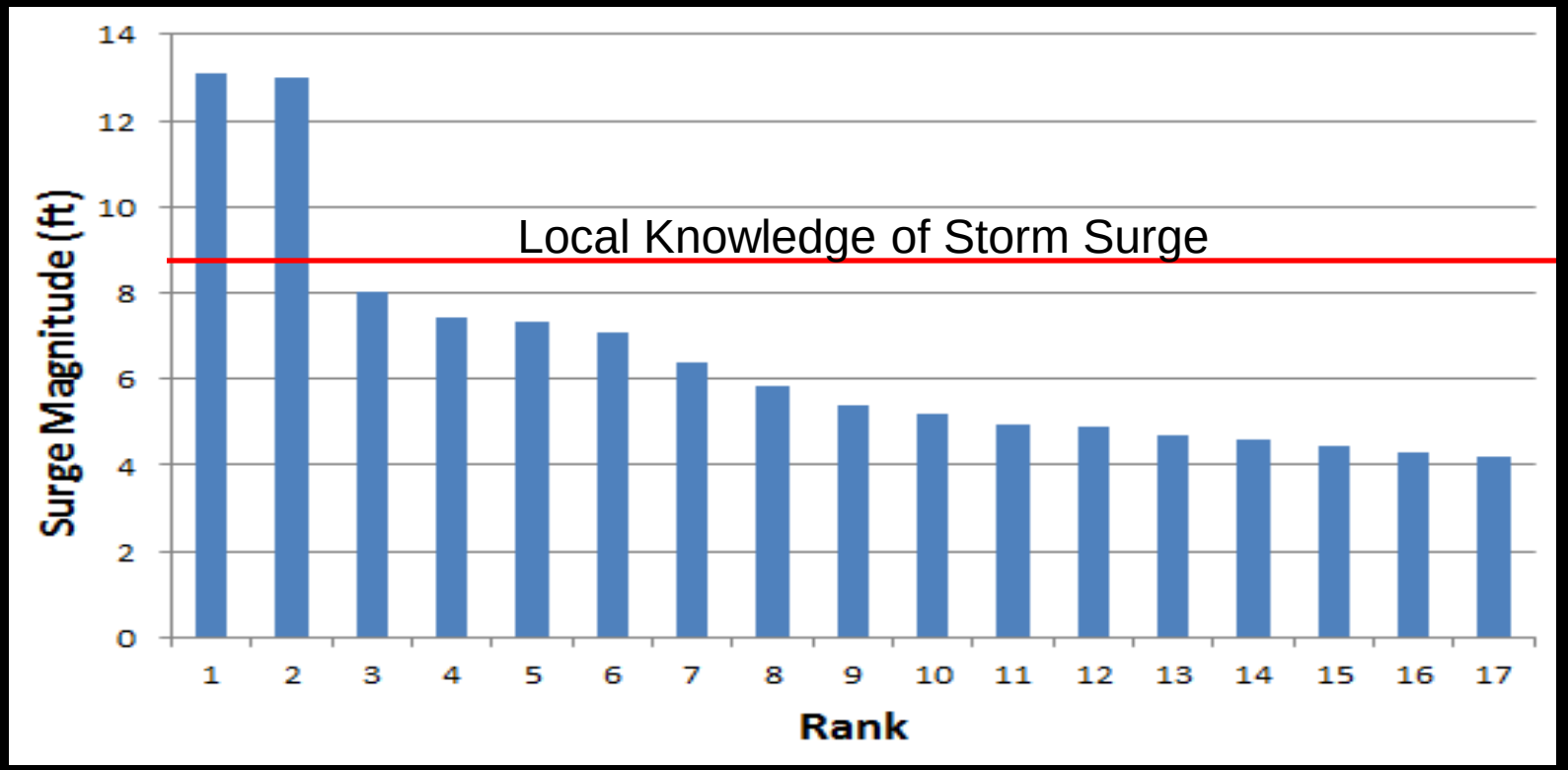
Storm Surge History at Galveston, TX



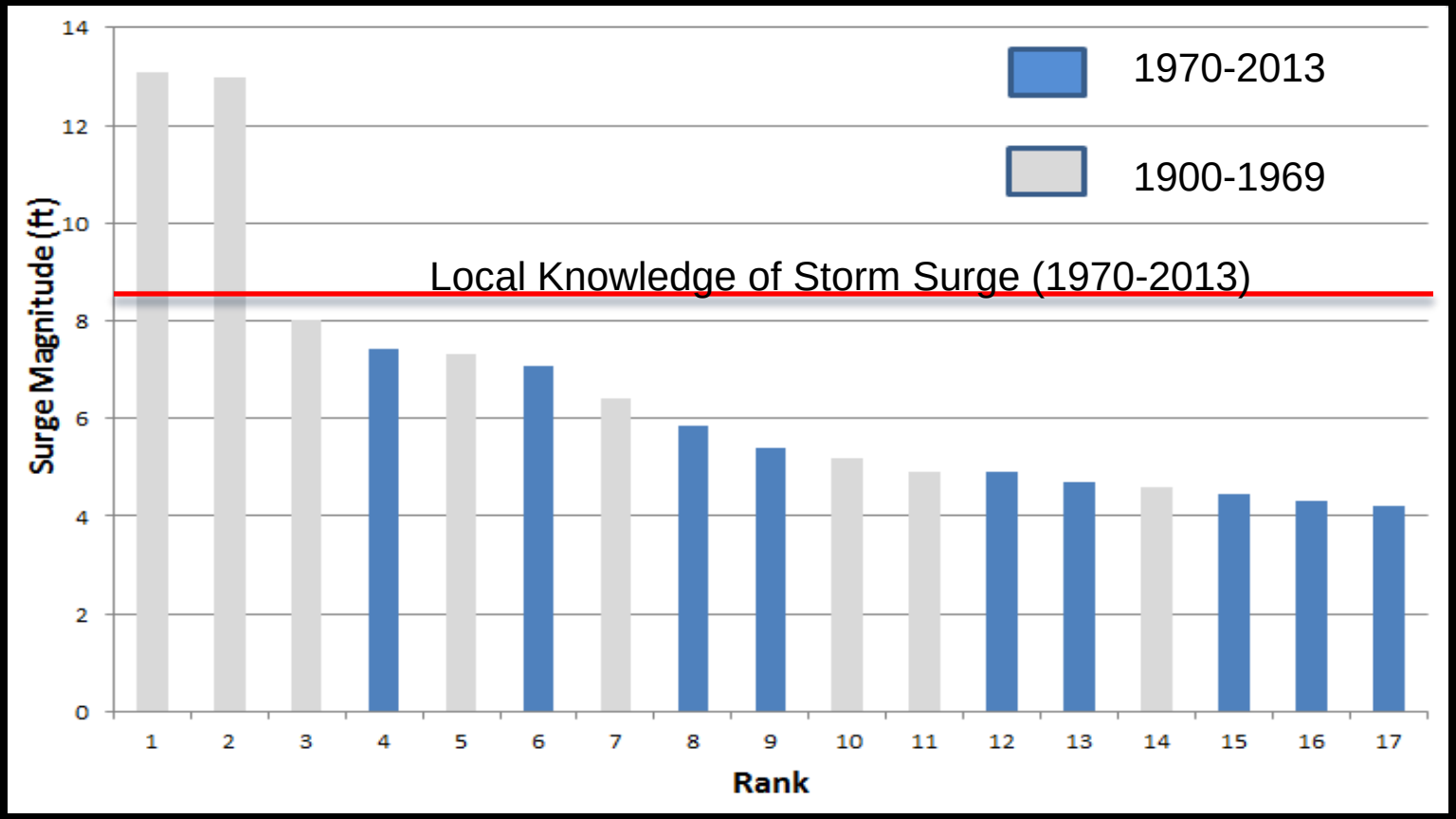
Storm Surge History at Frenier, LA

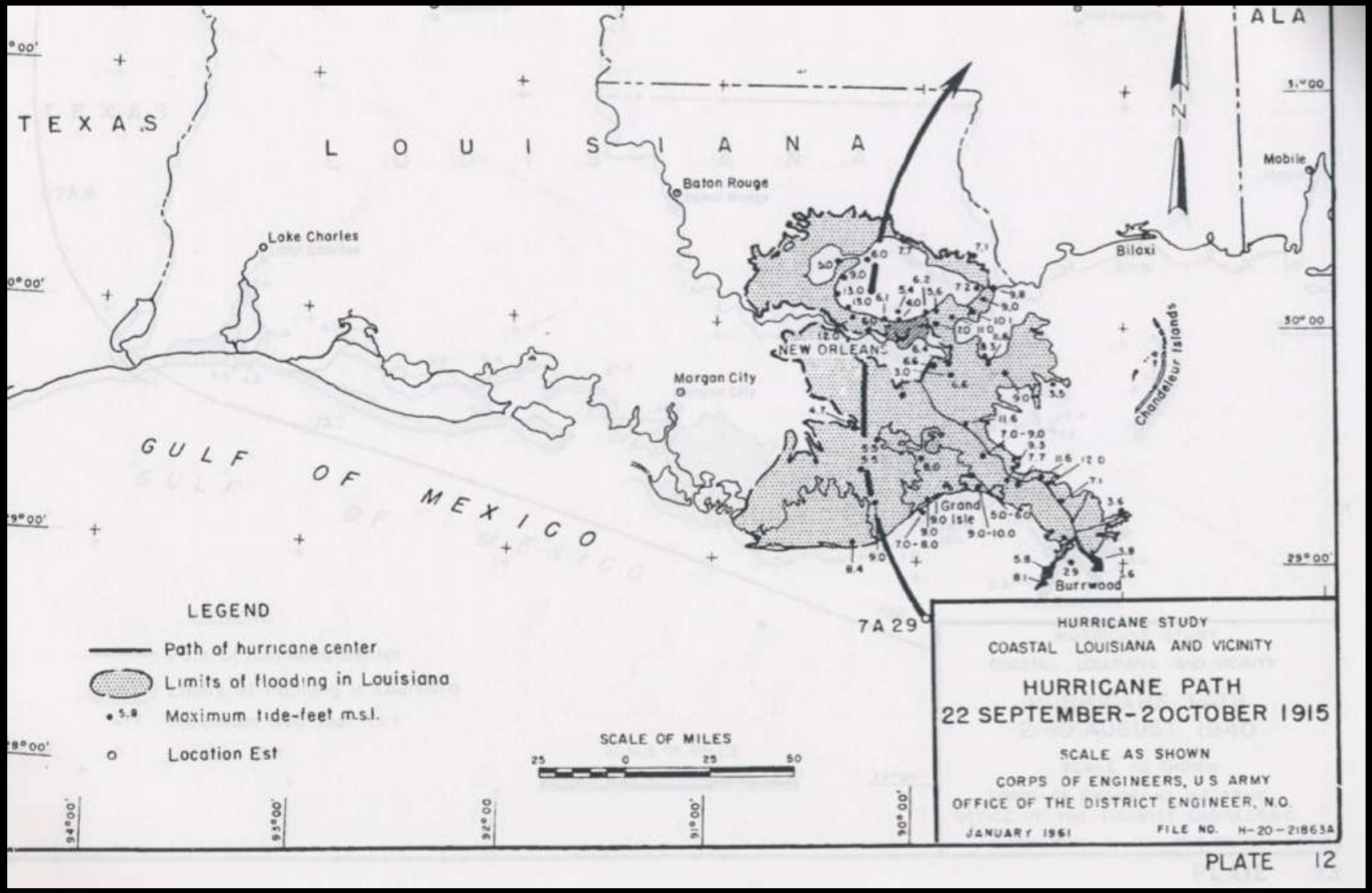


Storm Surge History at Frenier, LA



Storm Surge History at Frenier, LA




TEXAS
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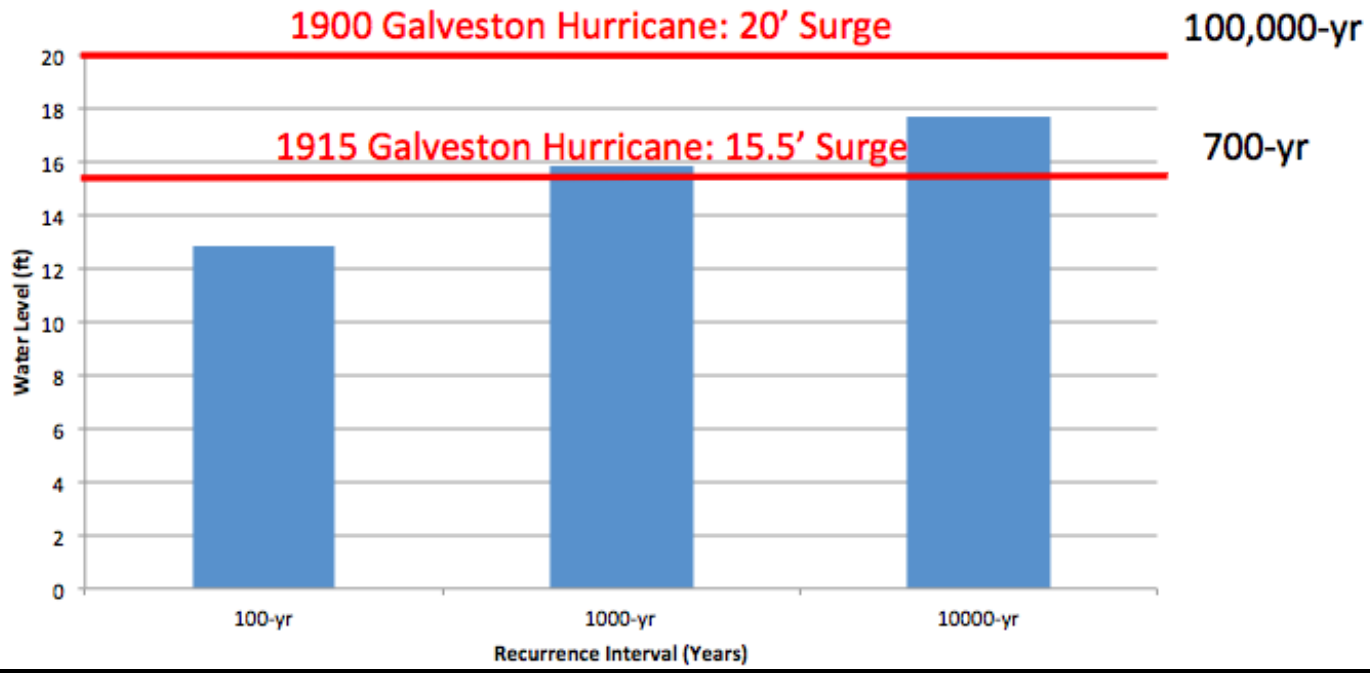
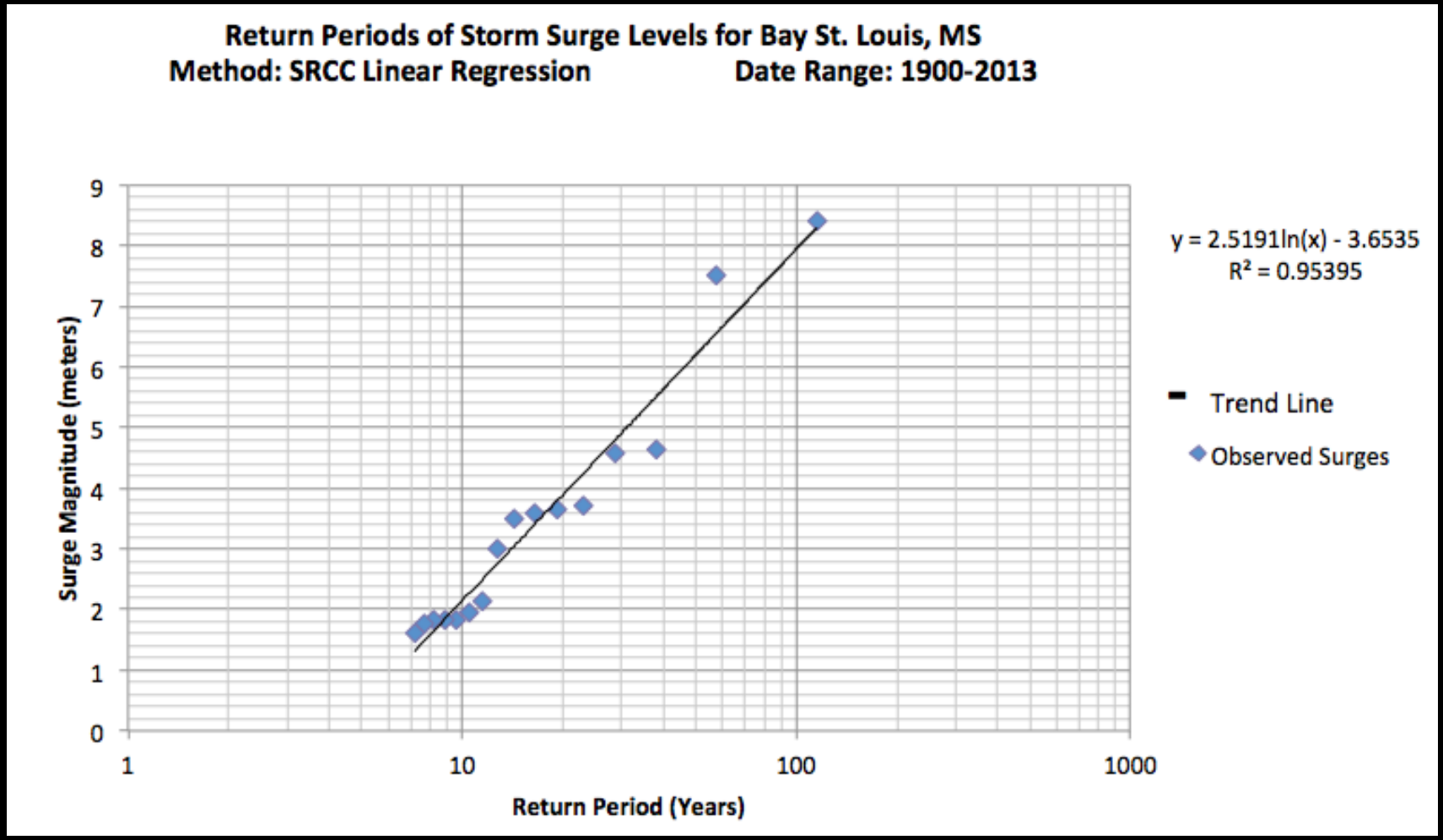
JANUARY 1961
FILE NO. H-20-21863A
PLATE 12

Storm Surge Return Periods for Galveston, TX (Dutch Model)



Statistical Methodology

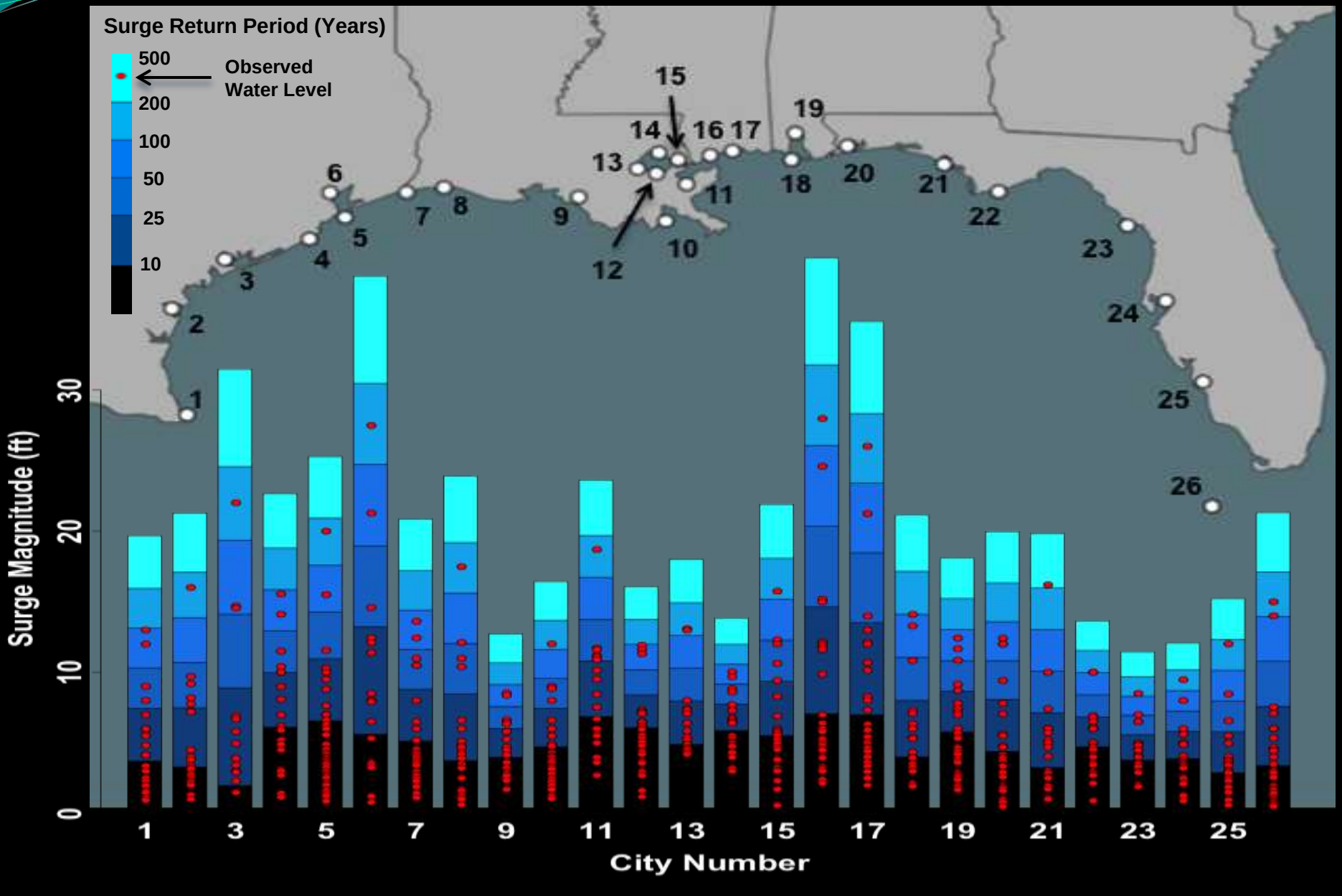
- Taken from Coles (2001)
- Point Process Model for Extremes
- Related to Generalize Pareto Dist.
- Data-Driven Method (Ex. Val. Theory)


Return Periods of Storm Surge Levels for Bay St. Louis, MS
Method: SRCC Linear Regression
Date Range: 1900-2013
Surge Magnitude (meters)
0
1
2
3
4
5
6
7
8
9
1
10
100
1000
Return Period (Years)
y = 2.5191ln(x) - 3.6535
R² = 0.95395
Trend Line
Observed Surges

100-Year Storm Surge Level

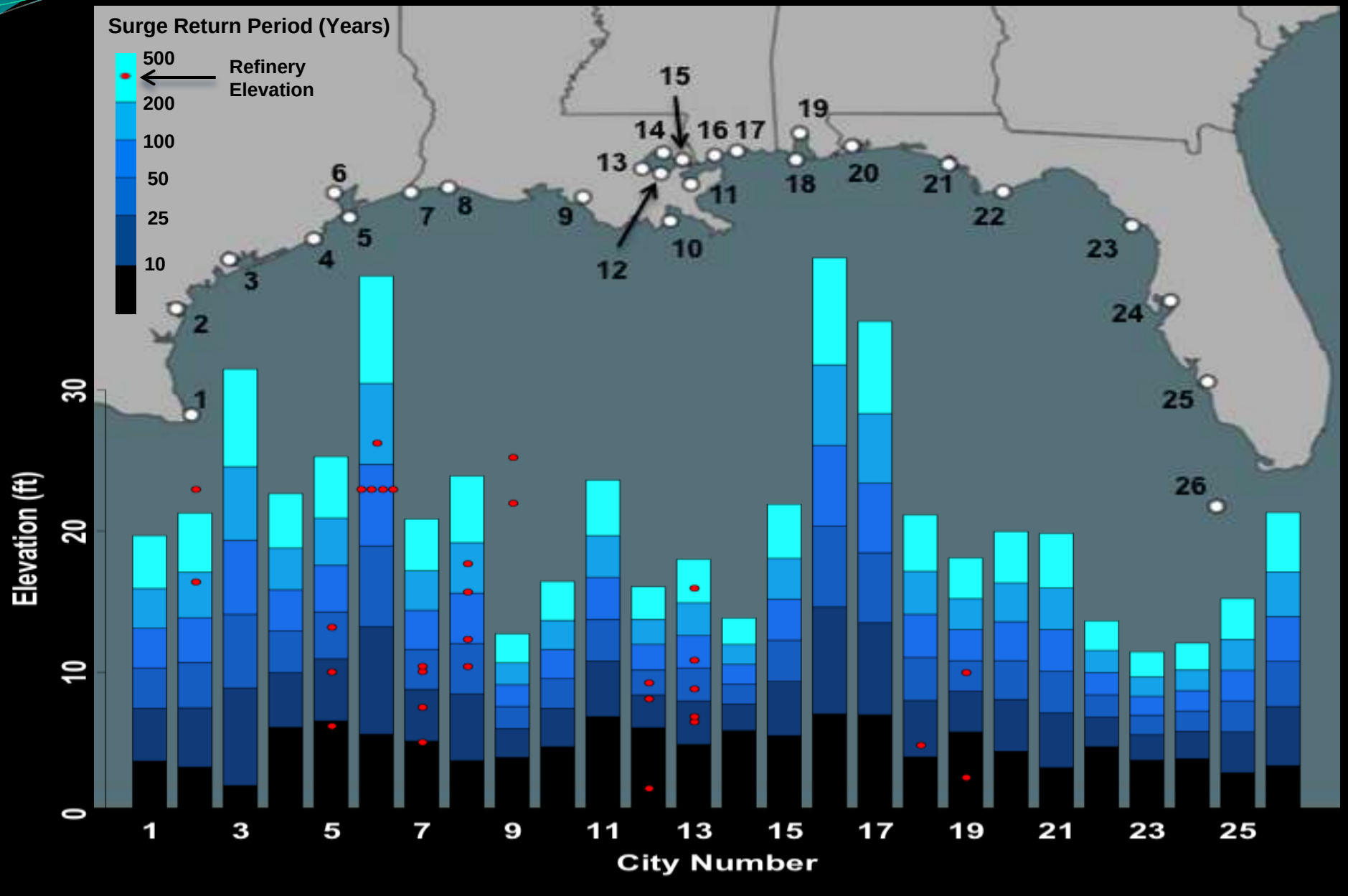
Location	Surge (ft)
Shell Beach	16.7
New Orleans Lakefront	12.0
Frenier	12.6
Mandeville	10.6
Slidell	15.2
Bay St. Louis/ Pass Christian	26.1
Gulfport/ Biloxi	23.4

Storm Surge Return Levels and Observed Storm Surges for the U.S. Gulf Coast

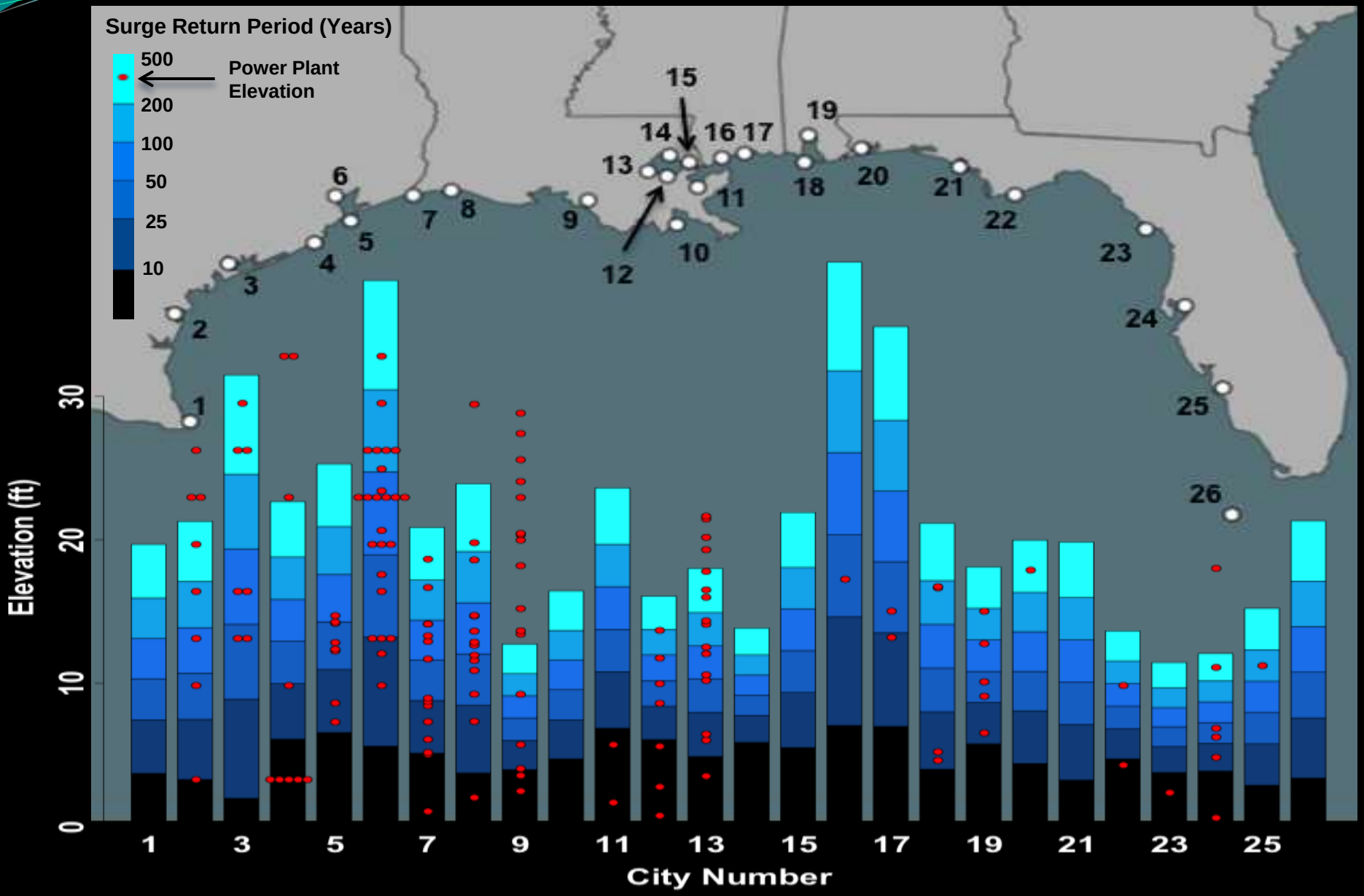


National Energy Infrastructure

Storm Surge Return Levels and Refinery Elevations for the U.S. Gulf Coast



Storm Surge Return Levels and Power Plant Elevations for the U.S. Gulf Coast



This Research Impacts Many Industries

Fishing/ Seafood

Beaches/ Resorts

Coastal development

Oil and gas industry

Where do we go from here?

- How do we use a data-driven storm surge analysis as we prepare for future?
- What is the role of climate change/ sea level rise for coastal areas?
- How can coastal modelers and empiricists work together?
- Any thoughts/ questions?

Links/ Contact Info

- SCIPP
  - www.southernclimate.org
- SURGEDAT
  - http://surge.srcc.lsu.edu
- Contact info:
  - Hal Needham
  - hneedh1@lsu.edu

Storm Surge Risk Analysis for the U.S. Gulf Coast

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Hal Needham

February 27, 2014