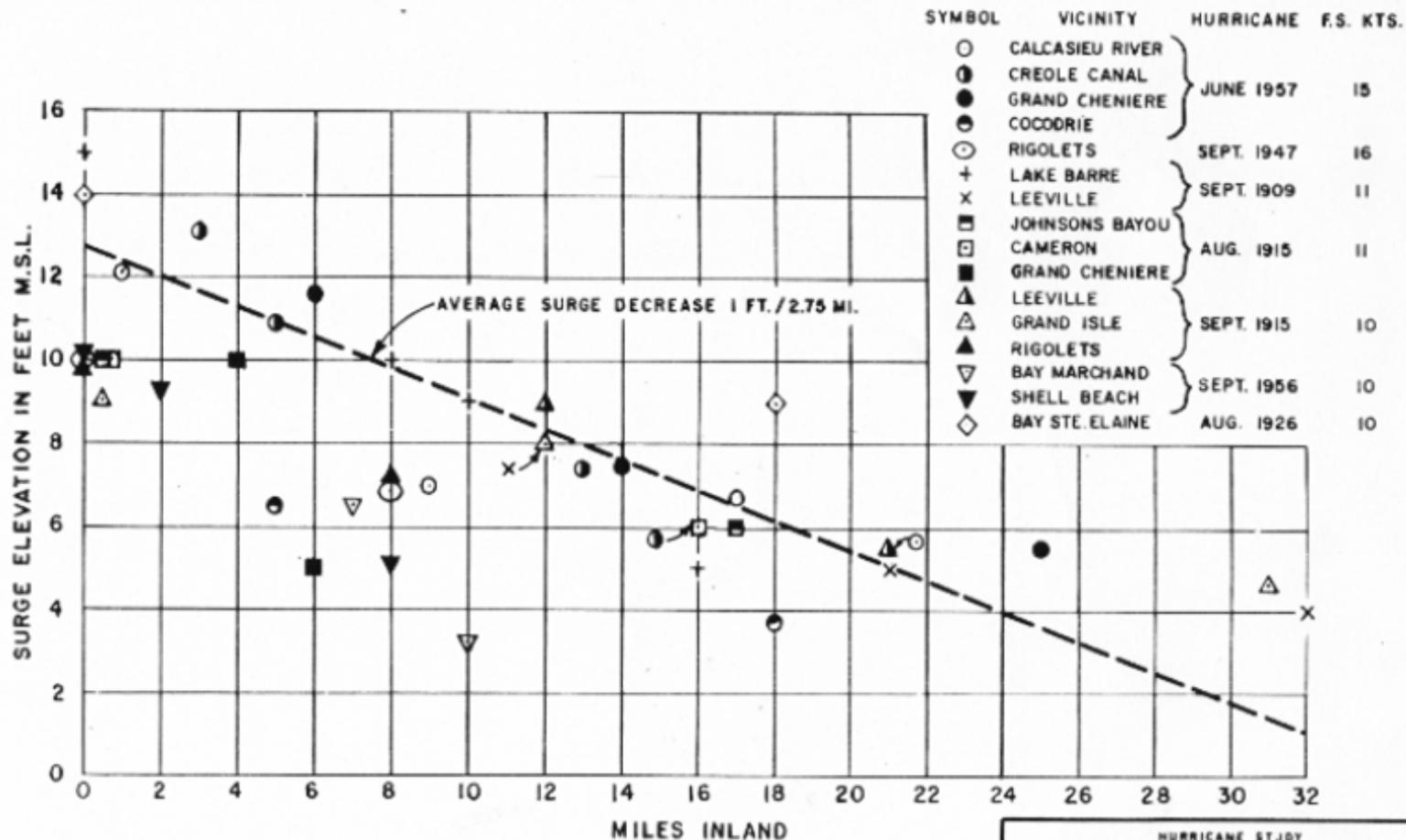


*An analysis of storm surge  
attenuation using  
USGS, FEMA, and NASA data*

*Pat Fitzpatrick and Yee Lau  
Geosystems Research Institute  
Mississippi State University*

*Walter A. Petersen and Courtney D. Buckley  
NASA Marshall Flight Center*



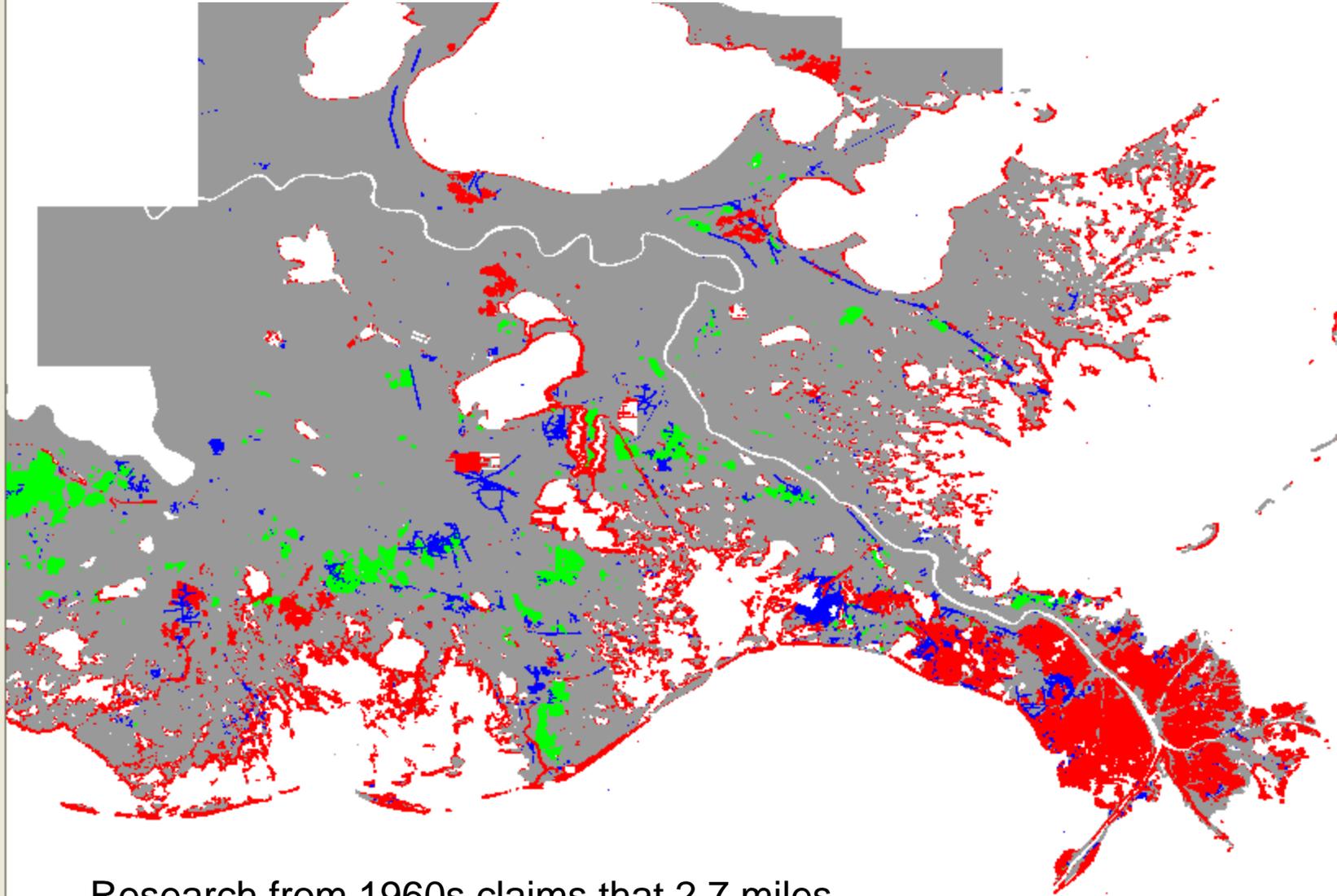
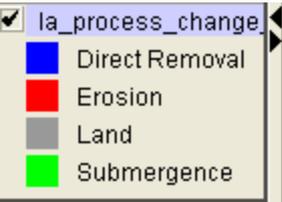
HURRICANE STJBY  
 INTERLYING AREA ALONG COASTAL L.A.  
 IN THE VICINITY OF HOUMA

**OVERLAND SURGE ELEVATIONS  
 COASTAL LOUISIANA**

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS  
 CORPS OF ENGINEERS

OCTOBER 1963      FILE NO. H-2-22823

# Wetland erosion, 1930-2000



Research from 1960s claims that 2.7 miles of wetlands reduces surge by 1 foot

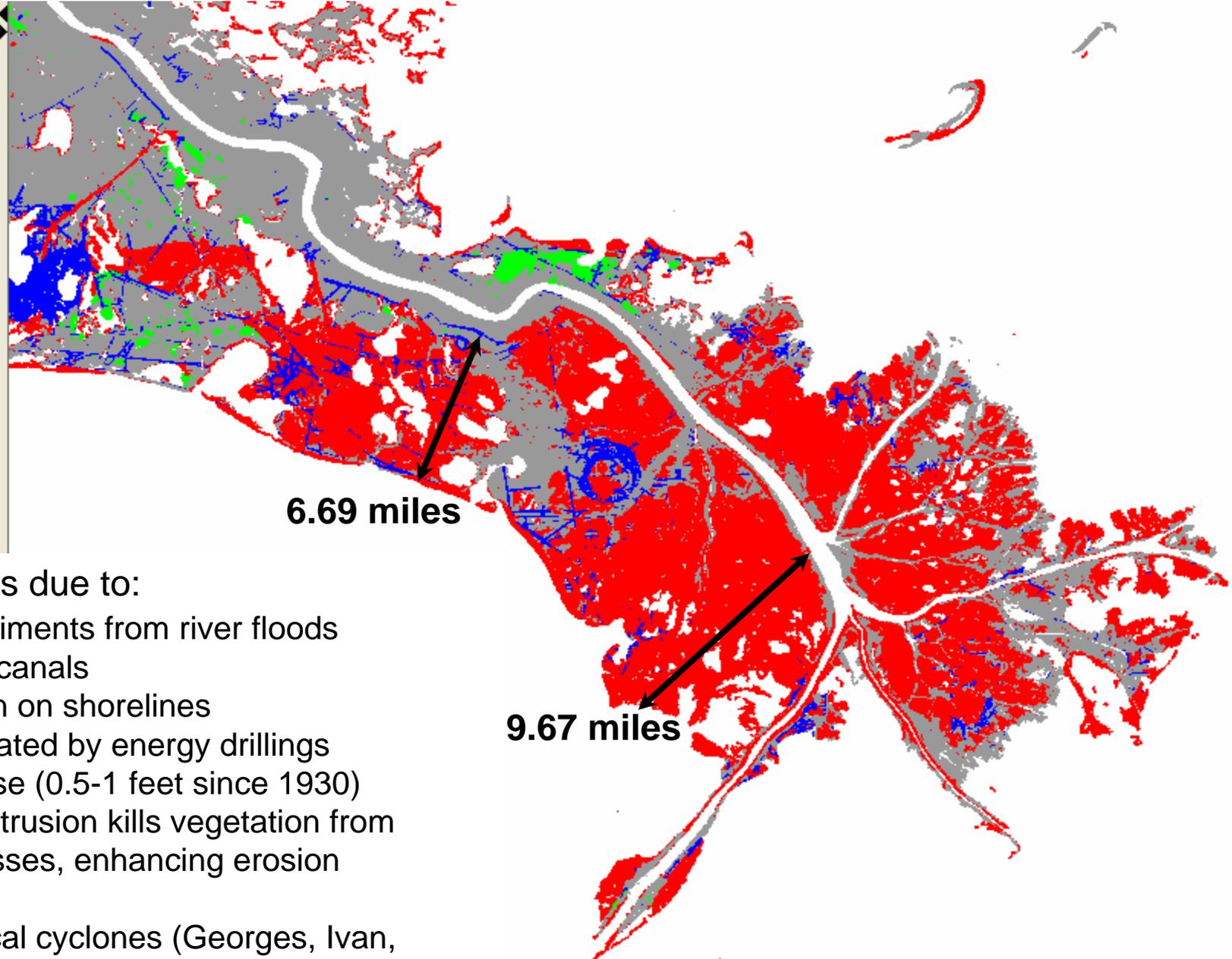
X: -90.258

Y: 30.418

1:1,071,695

One Centimeter = 6.659 Miles



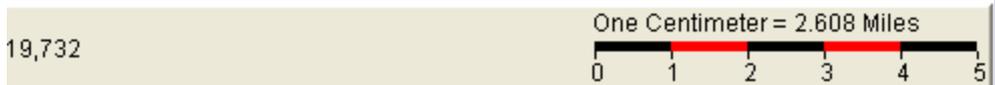


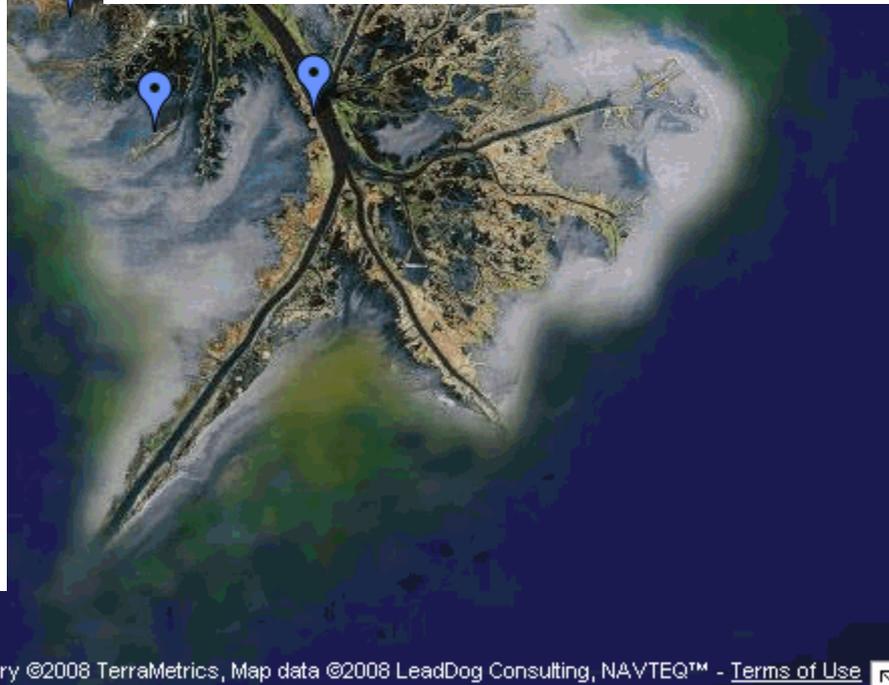
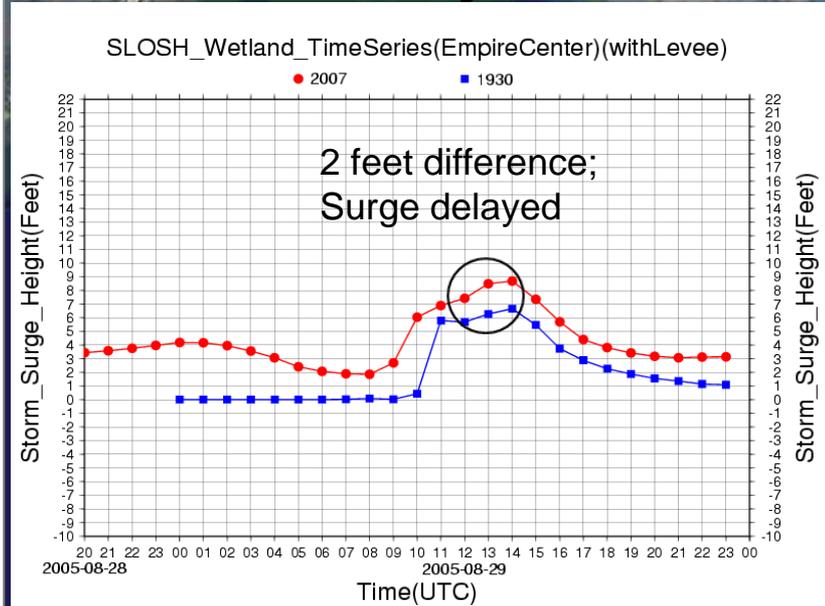
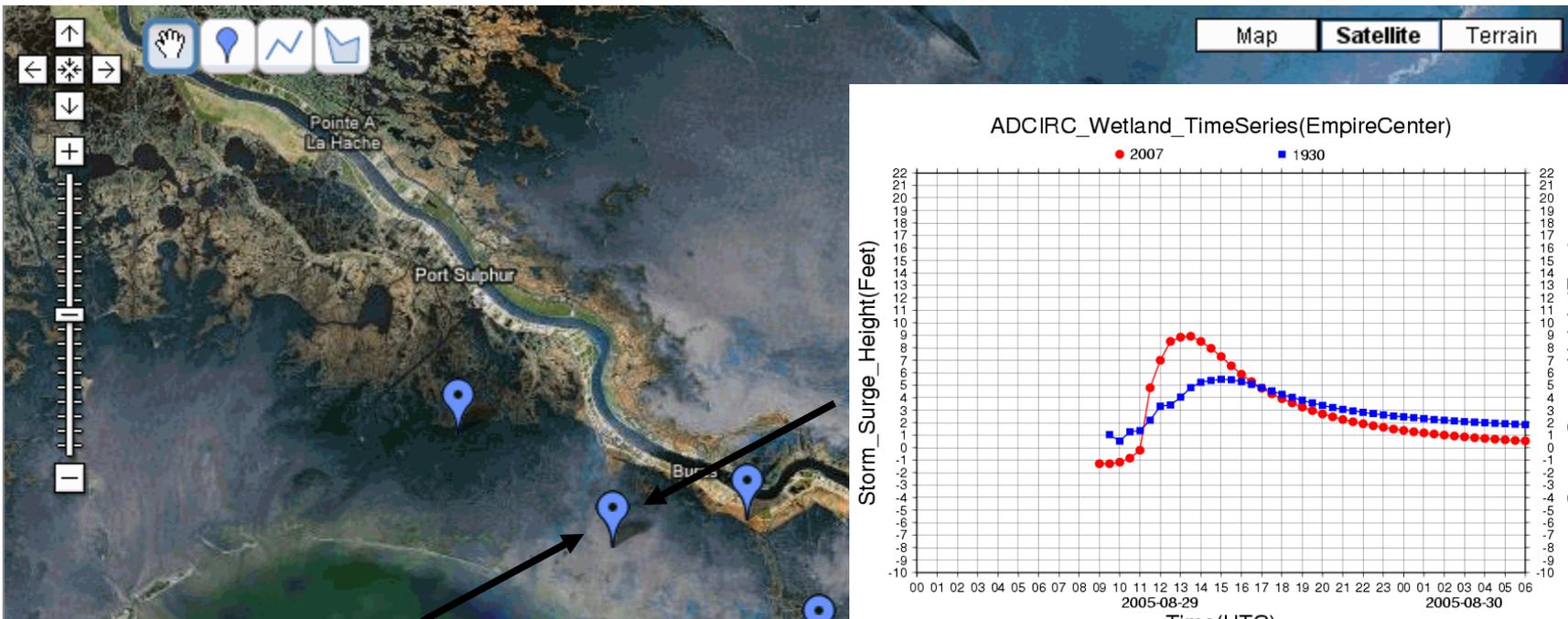
LA coast has 3 feet *relative* sea level rise per century

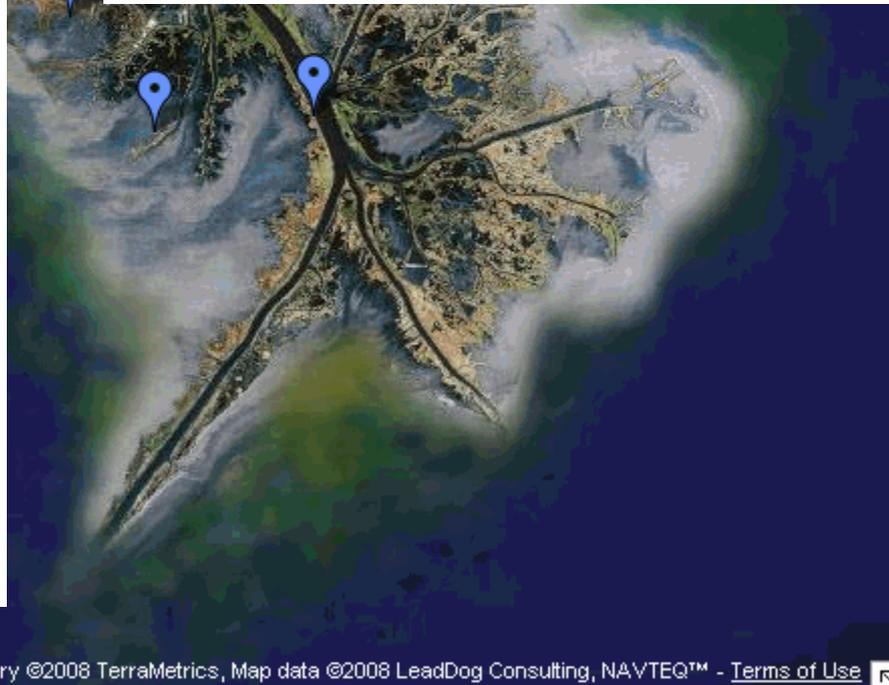
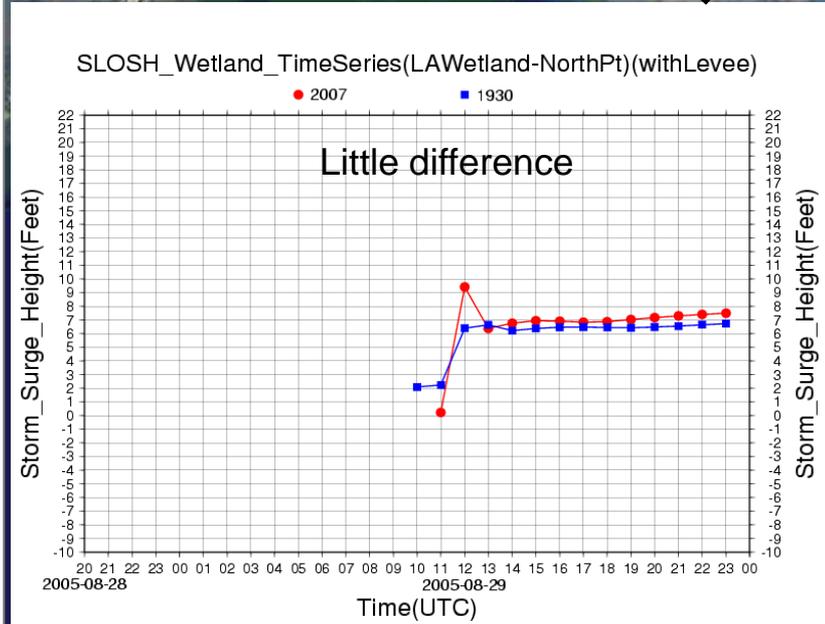
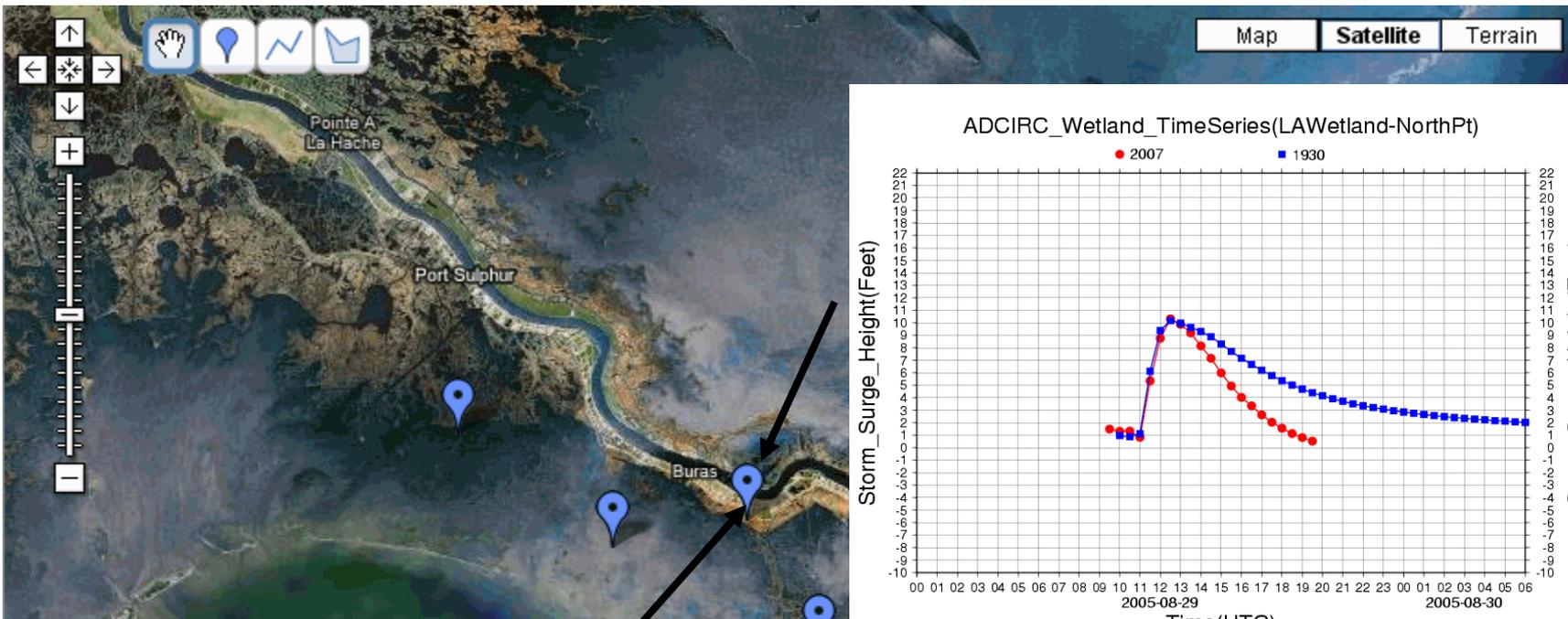
Wetland loss due to:

- Loss of sediments from river floods
- Man-made canals
- Wave action on shorelines
- Faults activated by energy drillings
- Sea level rise (0.5-1 feet since 1930)
- Saltwater intrusion kills vegetation from above processes, enhancing erosion

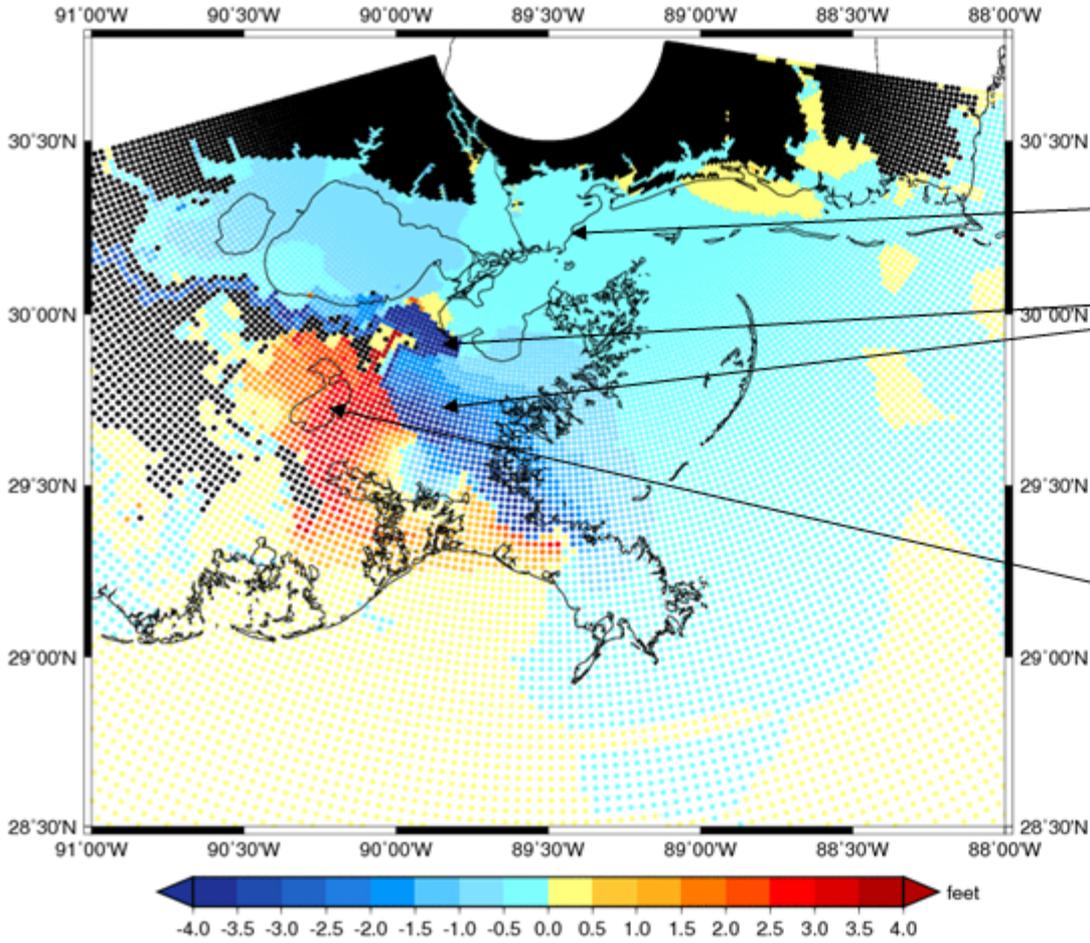
Recent tropical cyclones (Georges, Ivan, Isidore, Lili, Katrina, Gustav) have accelerated erosion







Katrina\_Envelope(WShaffer)(NoLevee-WithLevee)



No impact

More surge, St. Bernard Parish & east

Less surge

# Deliverables (one-year project)

## Wetland attenuation

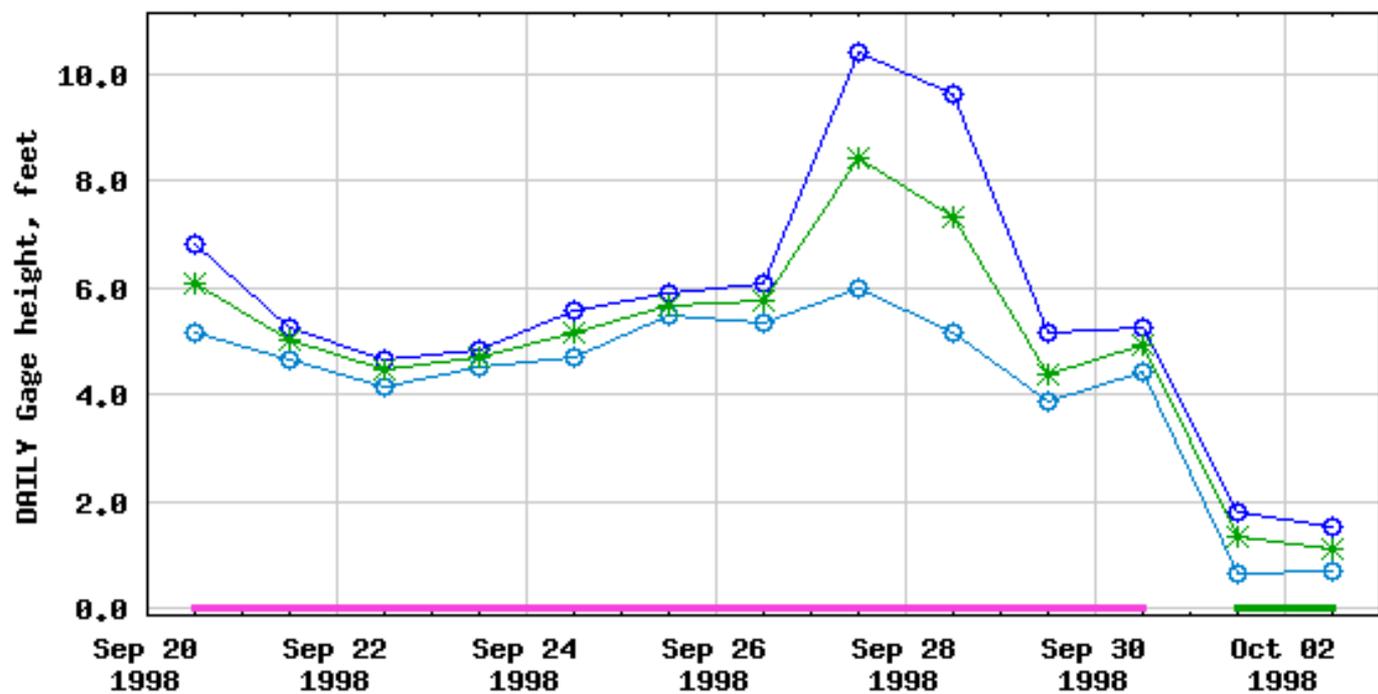
- Examine Hurricane Rita USGS time series data and FEMA high-water marks. Determine surge attenuation as a function of distance inland; linear correlations versus vegetation type, density, and height for several different wetland classification schemes.
- Multivariate relationships will also be examined using stepwise multiple regression and parallel coordinate graphical techniques.
- Wave damping of Rita's waves inland will be quantified through harmonic series analysis, wavelet analysis, and a low-pass filter.
- Repeat analysis on other recent tropical cyclones in wetland regions (i.e., Ike and Gustav).
- Preliminary surge model validation

## Deliverables (one-year project)

### NASA's Advanced Microwave Precipitation Radiometer (AMPR) in Hurricanes Georges (1998)

- Compliments tide gauge data; will examine surge in Hopedale and Delacroix marshes
- Examine surge redistribution along Mississippi River Gulf Outlet, ridges, levees, and Intercoastal Waterway. Multivariate relationships will also be examined using stepwise multiple regression and parallel coordinate graphical techniques.
- Develop a prototype multiple regression model from AMPR data during surge events.

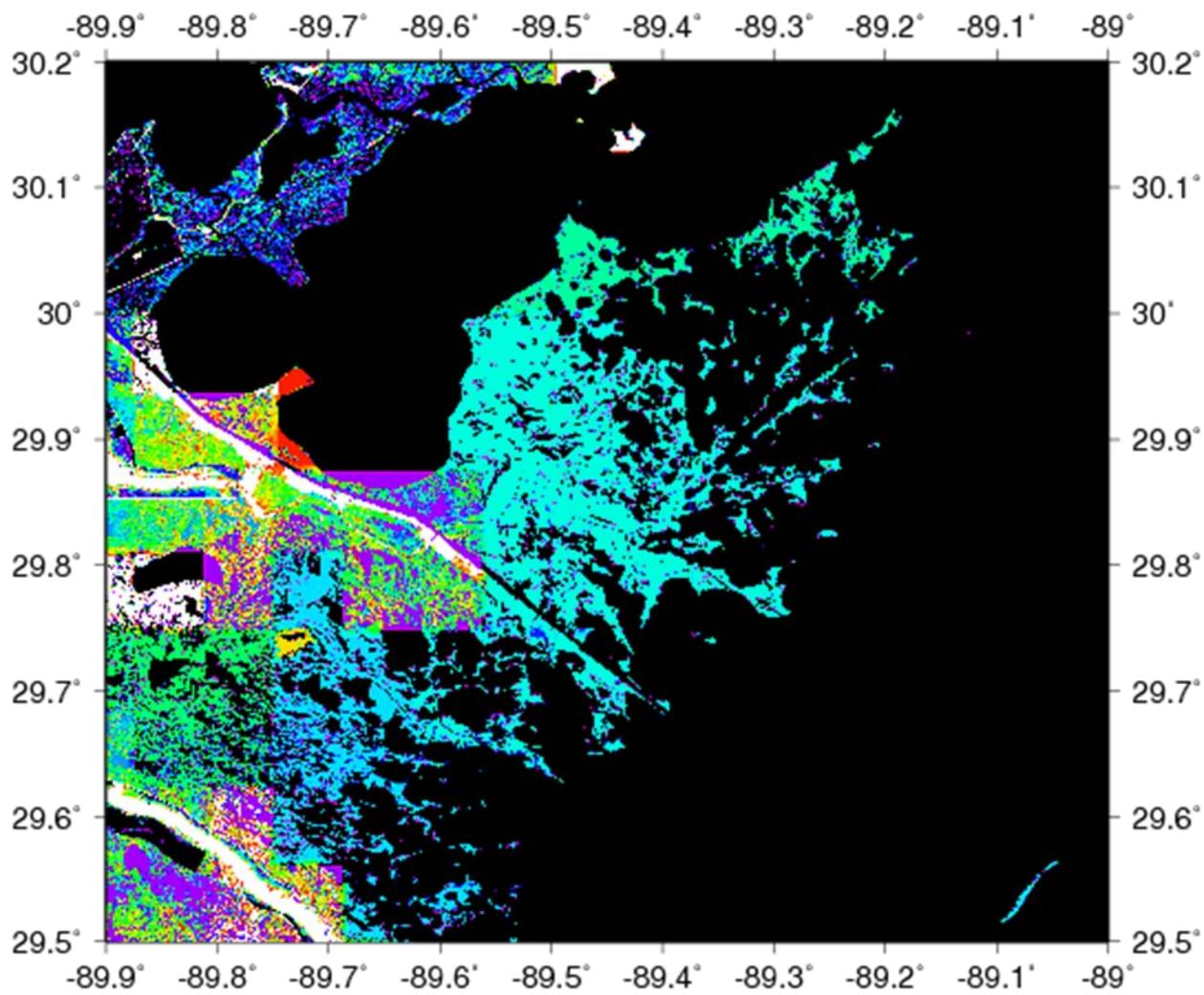
USGS 073745257 Crooked B. NW of L. Cuatro Caballo near Delacroix



- Daily maximum gage height
- Daily minimum gage height
- \* Daily mean gage height

- █ Period of approved data
- █ Period of provisional data

### NED 1ArcSecElev

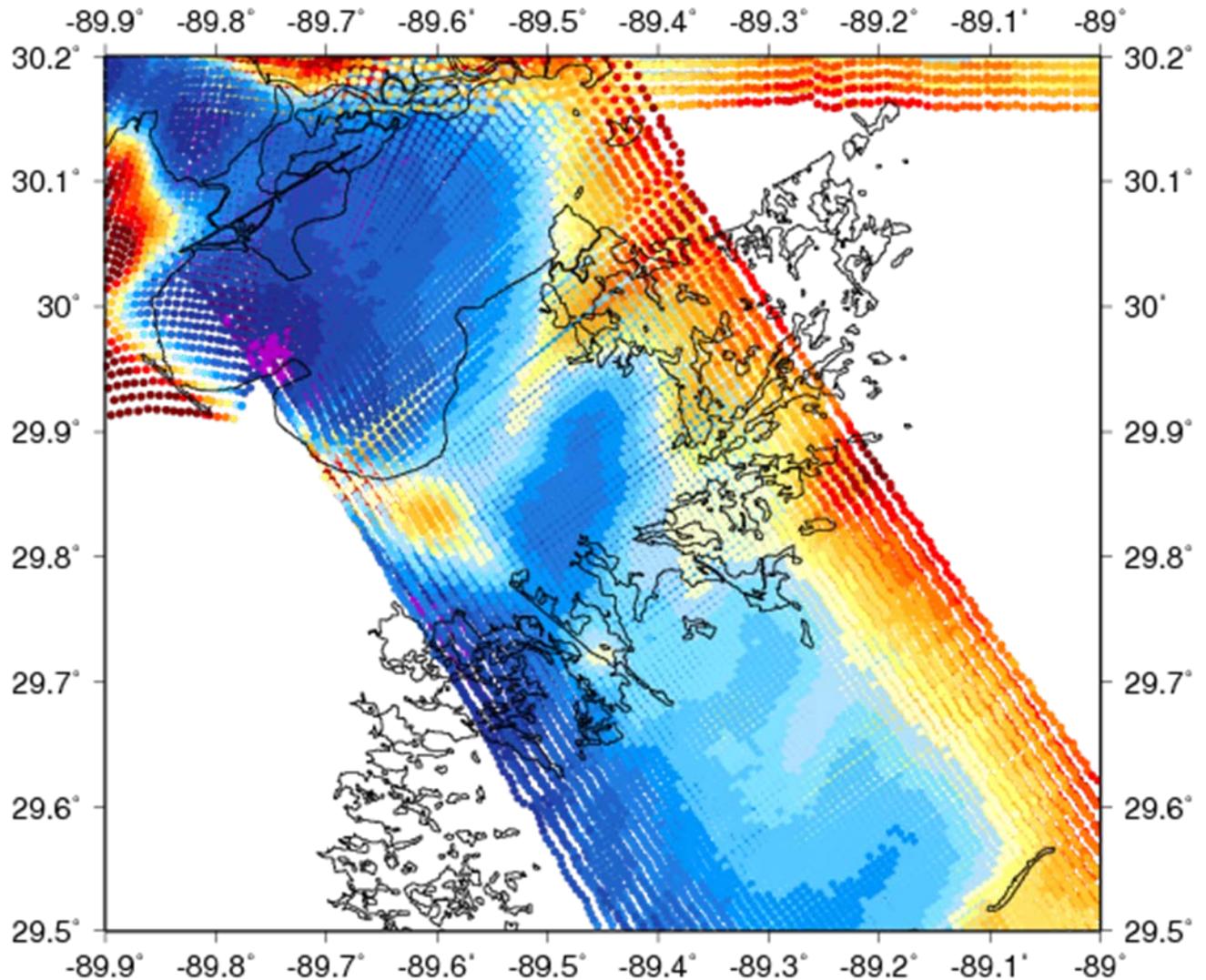


0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

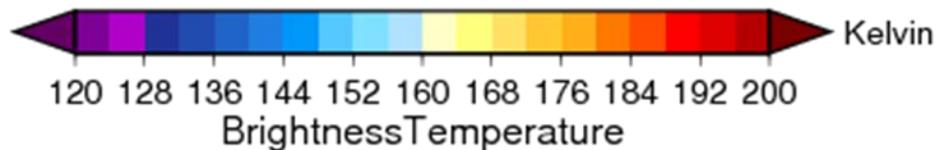
Elevation

meters

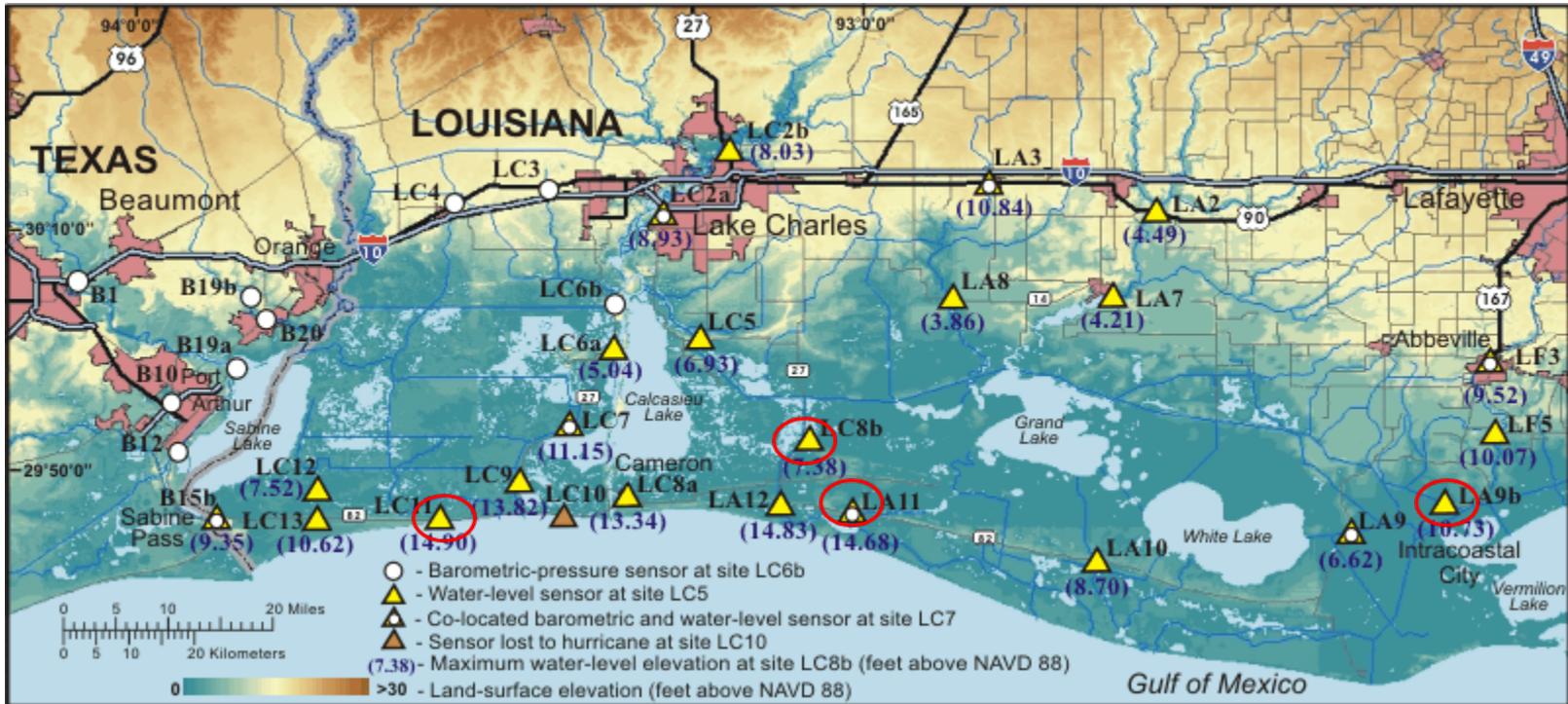
camex3\_ampr 19980927 15:40 - 16:09 UTC



AMPR can infer inland flooding via the presence of surface water detected in the 10.7 GHz band in terms of lower brightness temperatures.



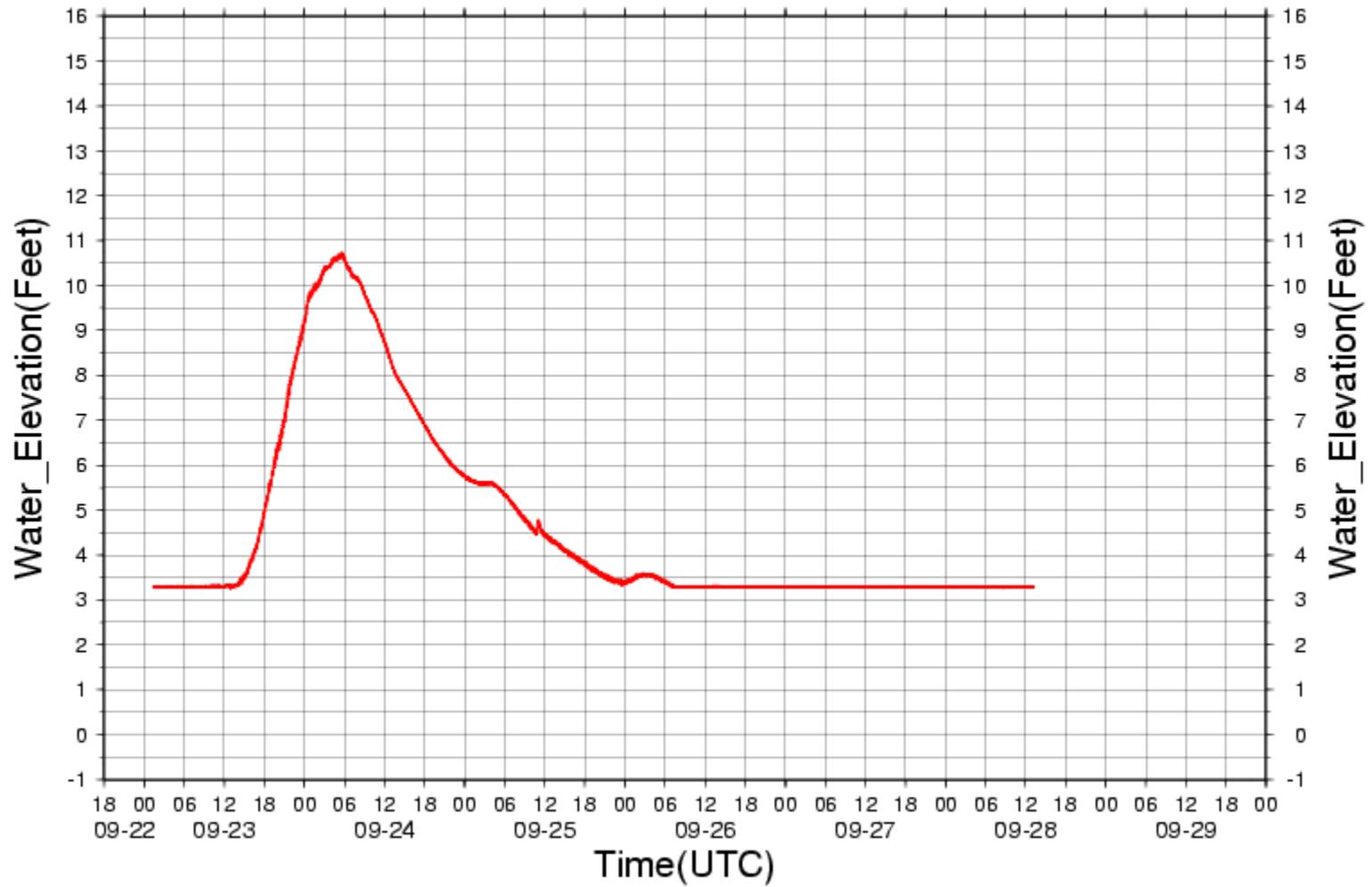
*Preliminary work, Hurricane Rita*



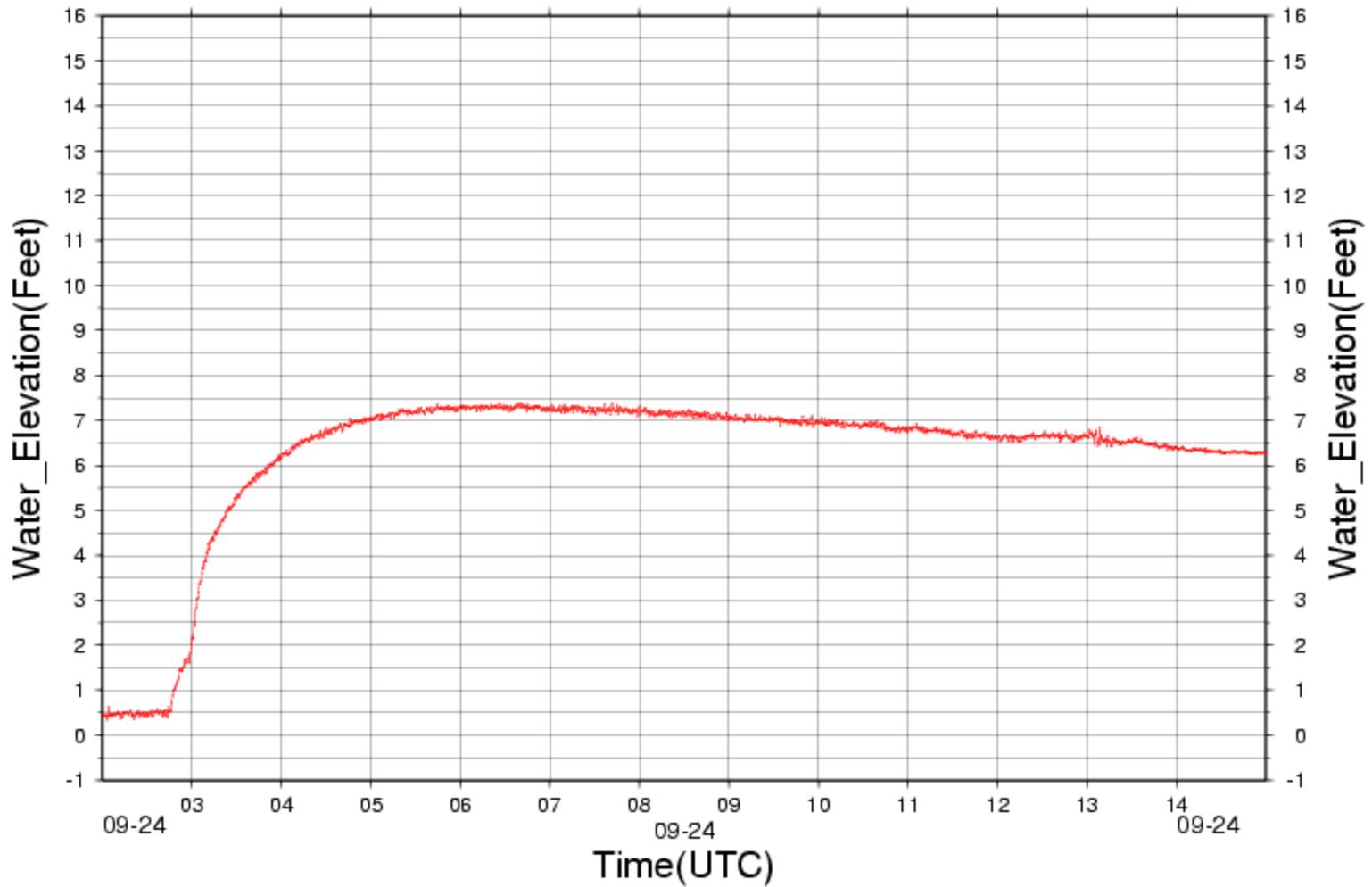


Pressure sensor strapped to a power pole at site LC4 near Vinton, La.

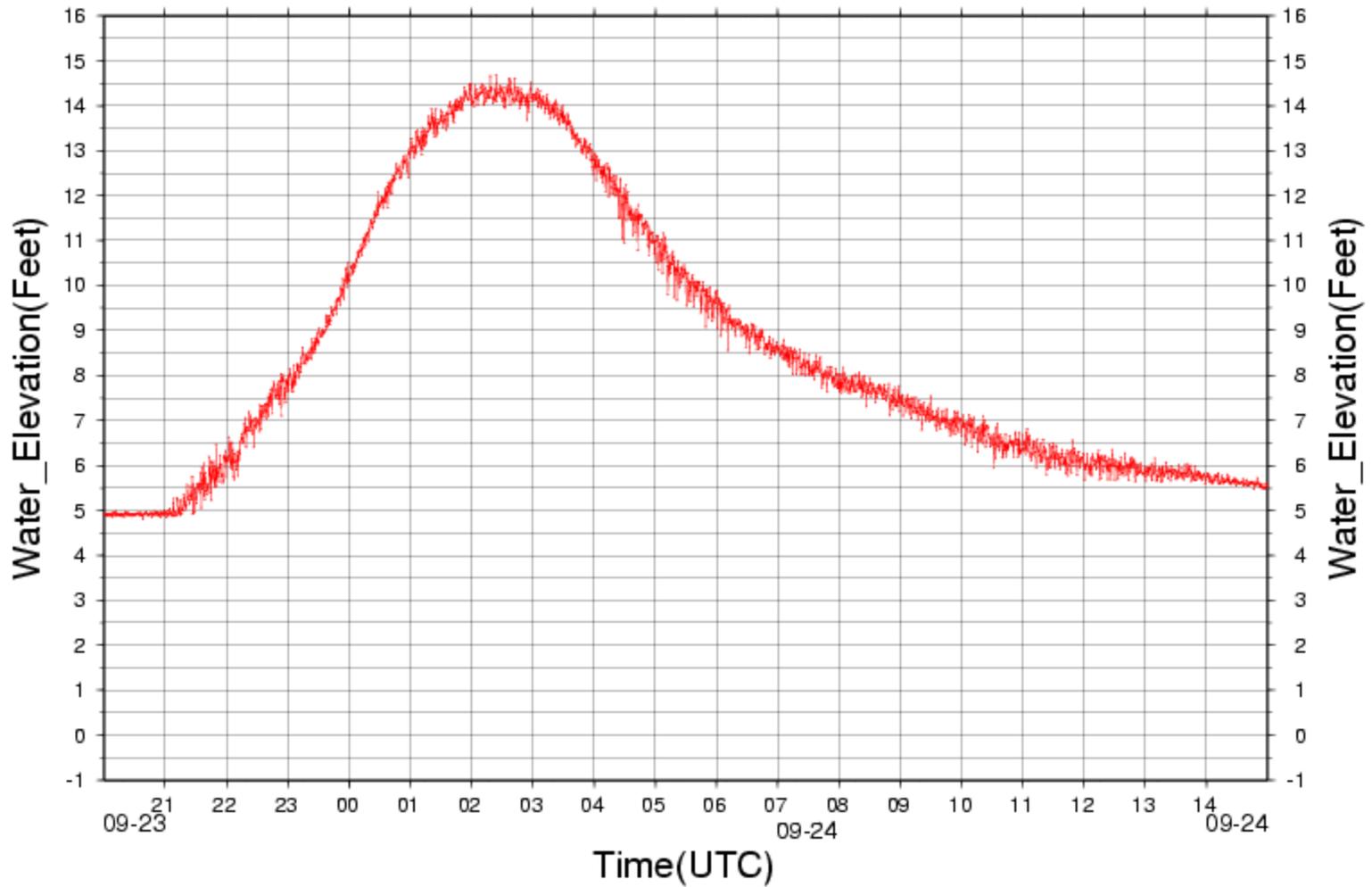
USGS HWM Sensor LA9b(-92.1925,29.78311)



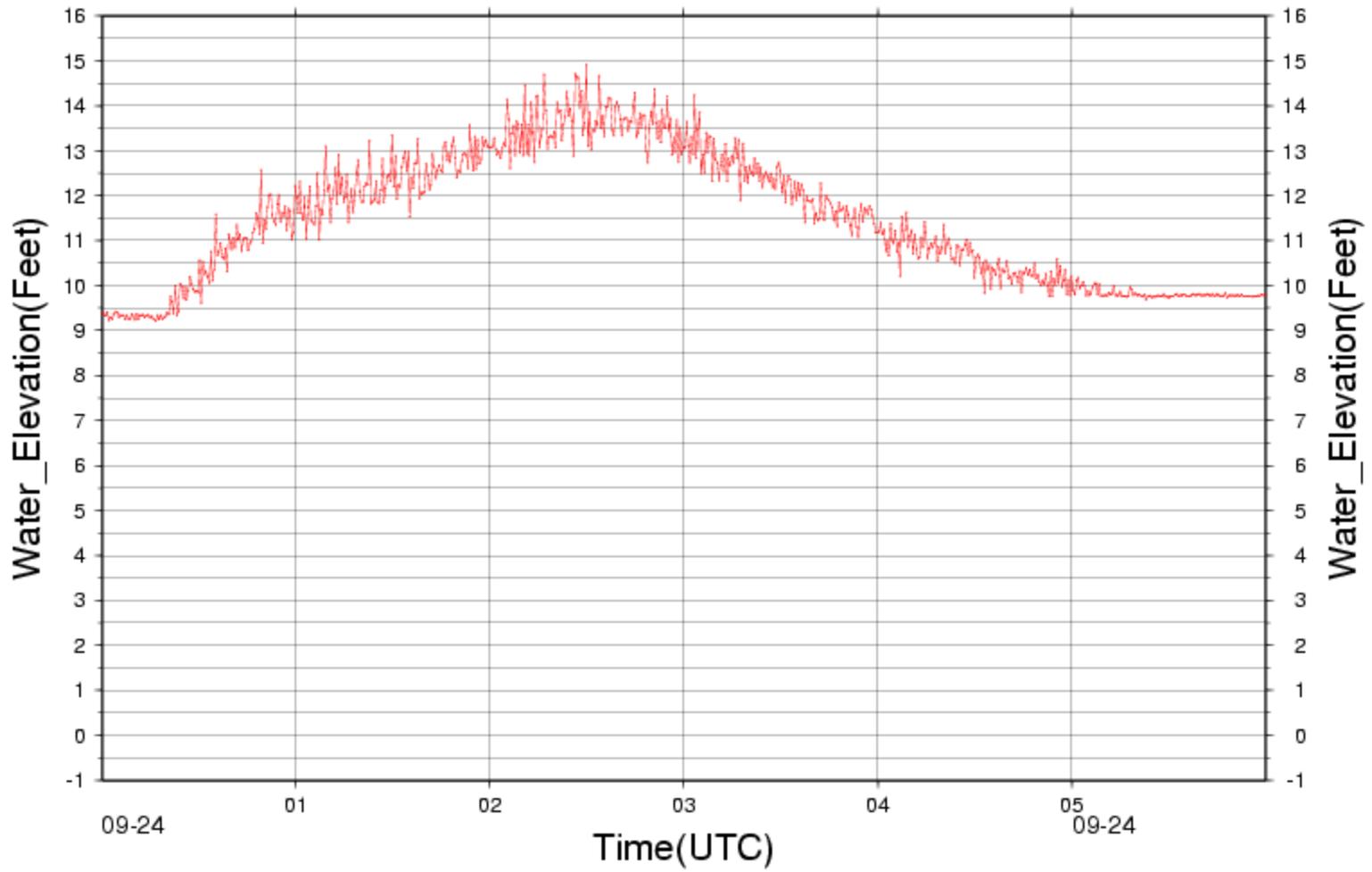
# USGS HWM TimeSeries for Harmonic(Sensor LC8b)



# USGS HWM TimeSeries for Harmonic(Sensor LA11)



# USGS HWM TimeSeries for Harmonic(Sensor LC11)



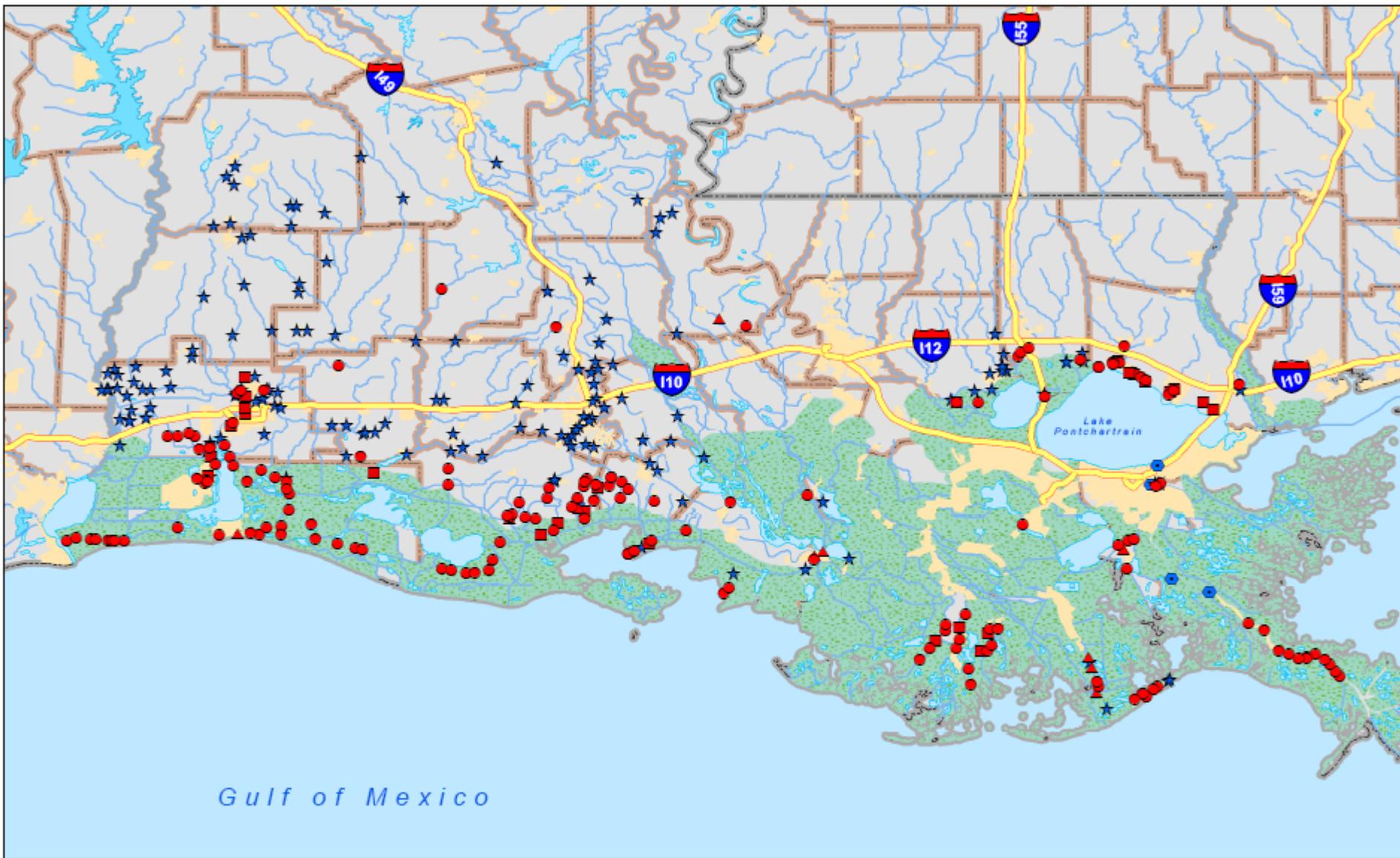


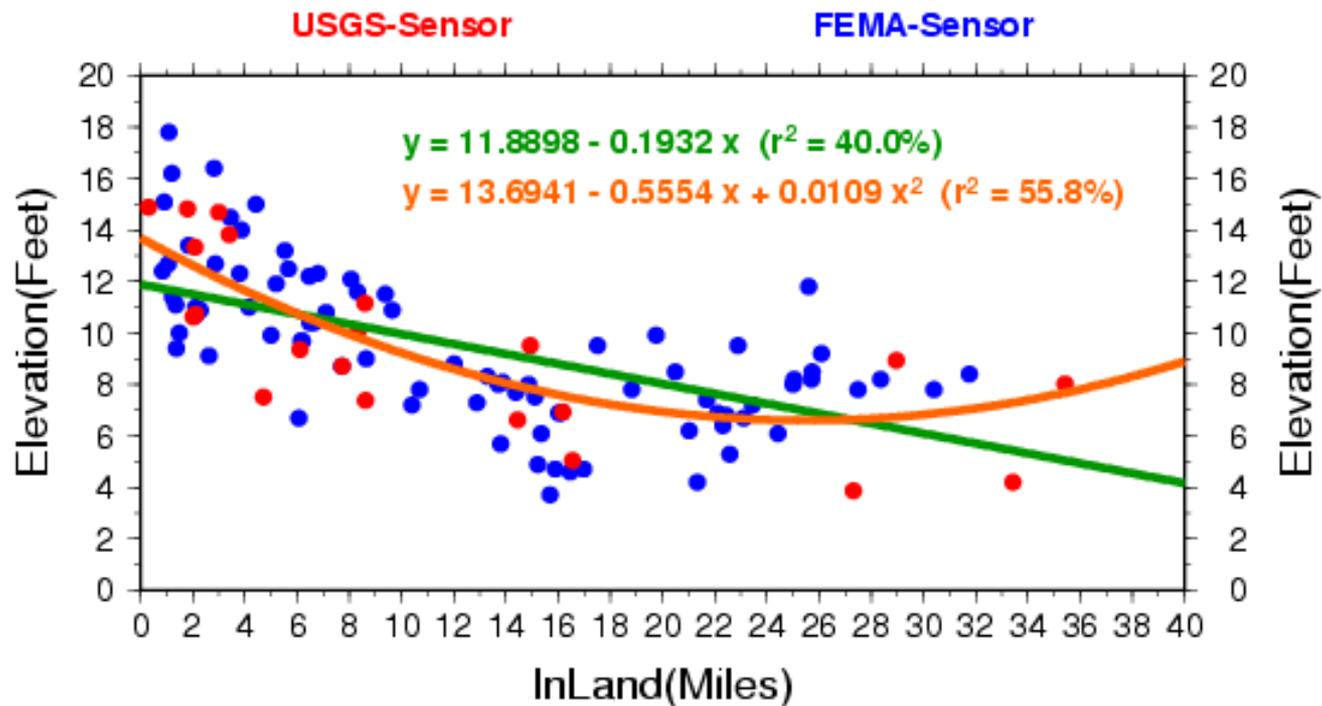
Figure 4 : Hurricane Rita, Louisiana  
 Surveyed Locations of High Water Mark Elevations

- |                       |                  |           |                  |                     |
|-----------------------|------------------|-----------|------------------|---------------------|
| ● Coastal-Surge Only  | ★ Riverine       | Inset     | Water Body       | Road Classification |
| ▲ Coastal-Wave Height | □ Municipalities | Hydrology | ● Limited Access | ● Unknown           |



0 3.5 7 14 21 28  
 Miles

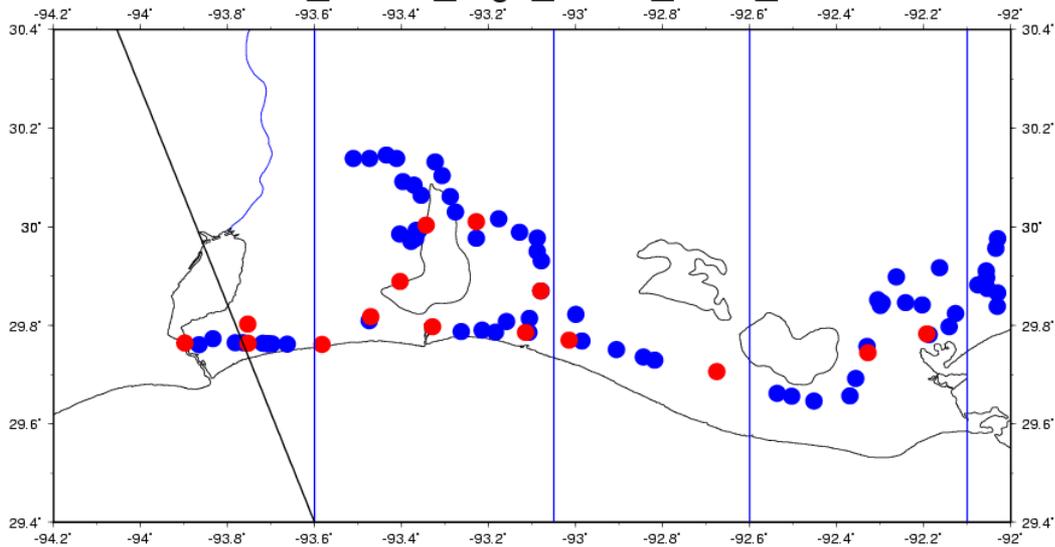
## USGS & FEMA Sensor Location VS Surge Elevation During Rita



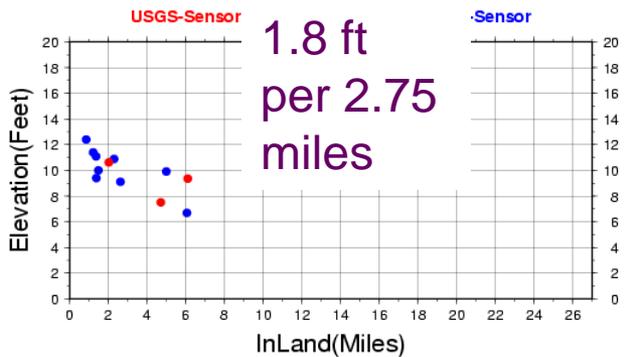
1 foot reduction every 2 miles seven miles inland (1.4 ft per 2.75 miles)

0.5-0.8 foot reduction every 2 miles afterwards

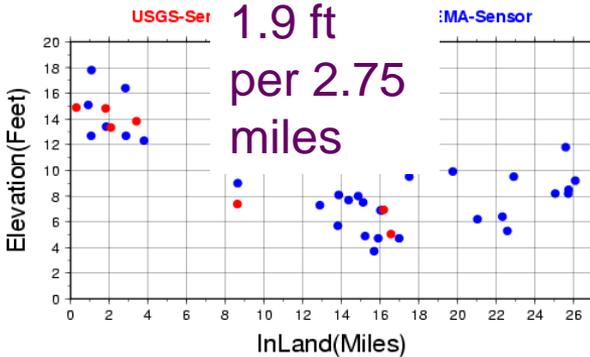
# FEMA\_USGS\_High\_Water\_Mark\_Sites



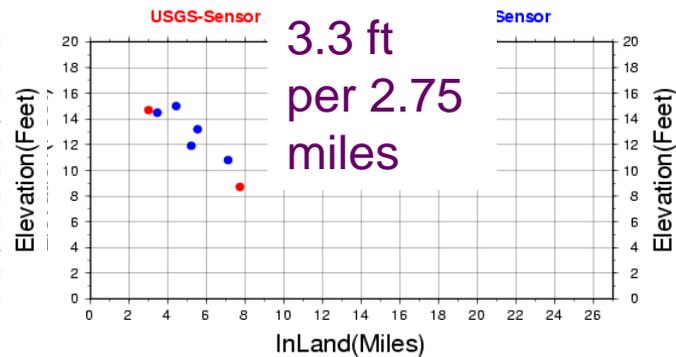
Location VS Surge During Rita (Longitude -94.0 to -93.6)



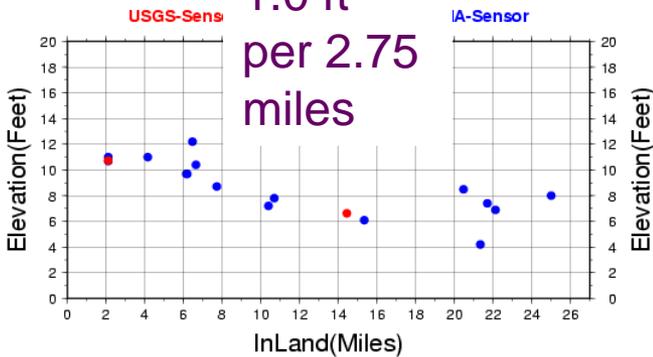
Location VS Surge During Rita (Longitude -93.6 to -93.05)



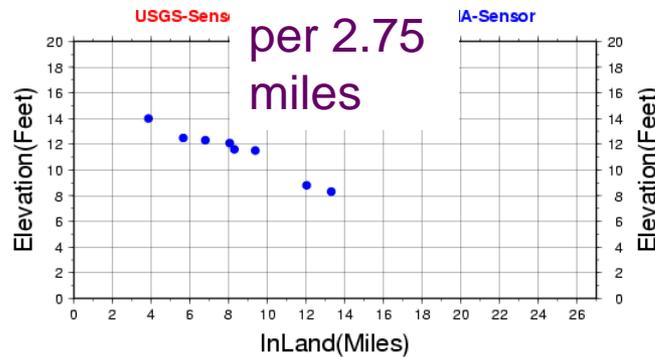
Location VS Surge During Rita (Longitude -93.05 to -92.6)



Location VS Surge (Longitude -92.6 to -92.1)

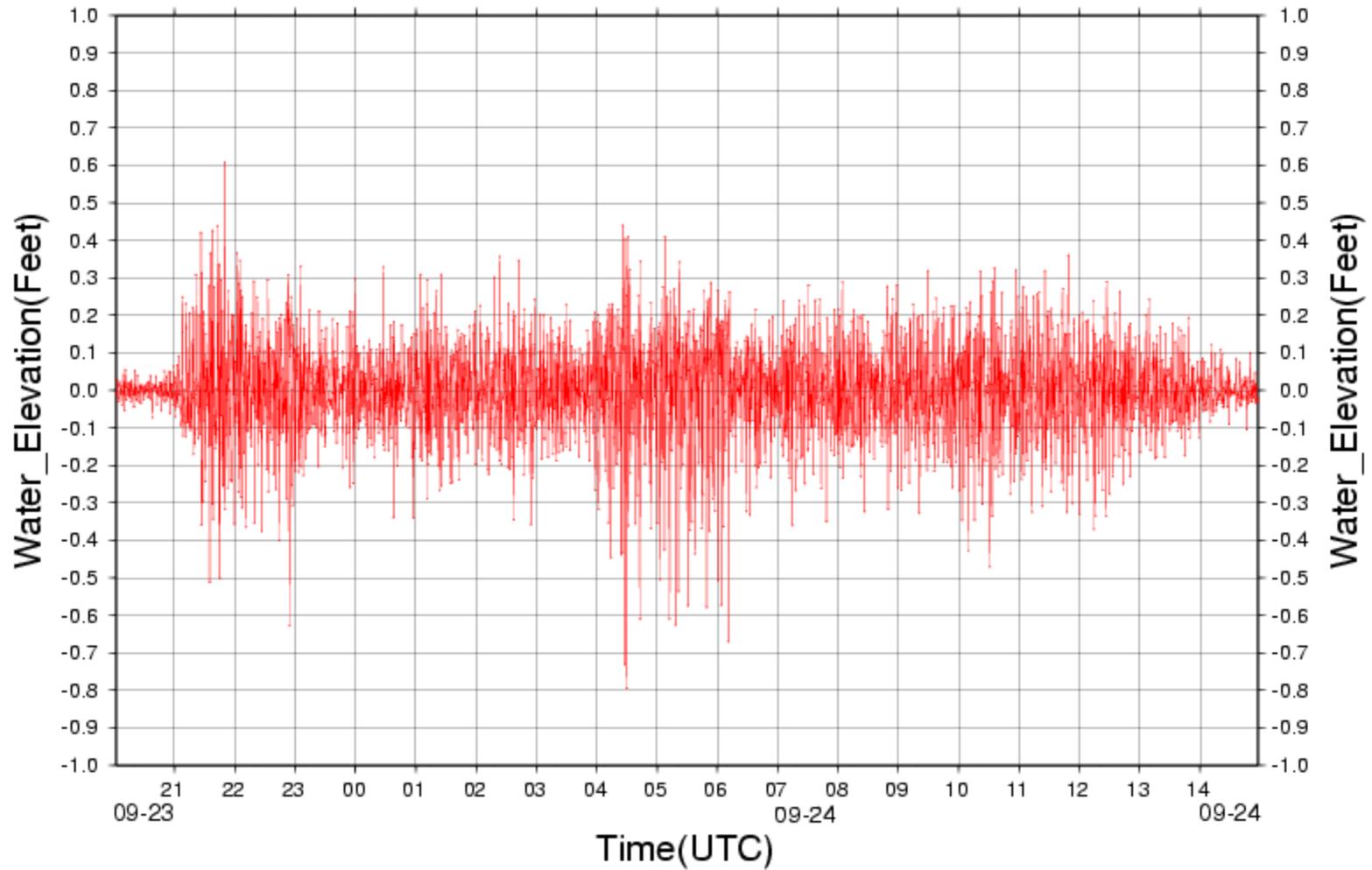


Location VS Surge (Longitude -92.1 to -91.5)

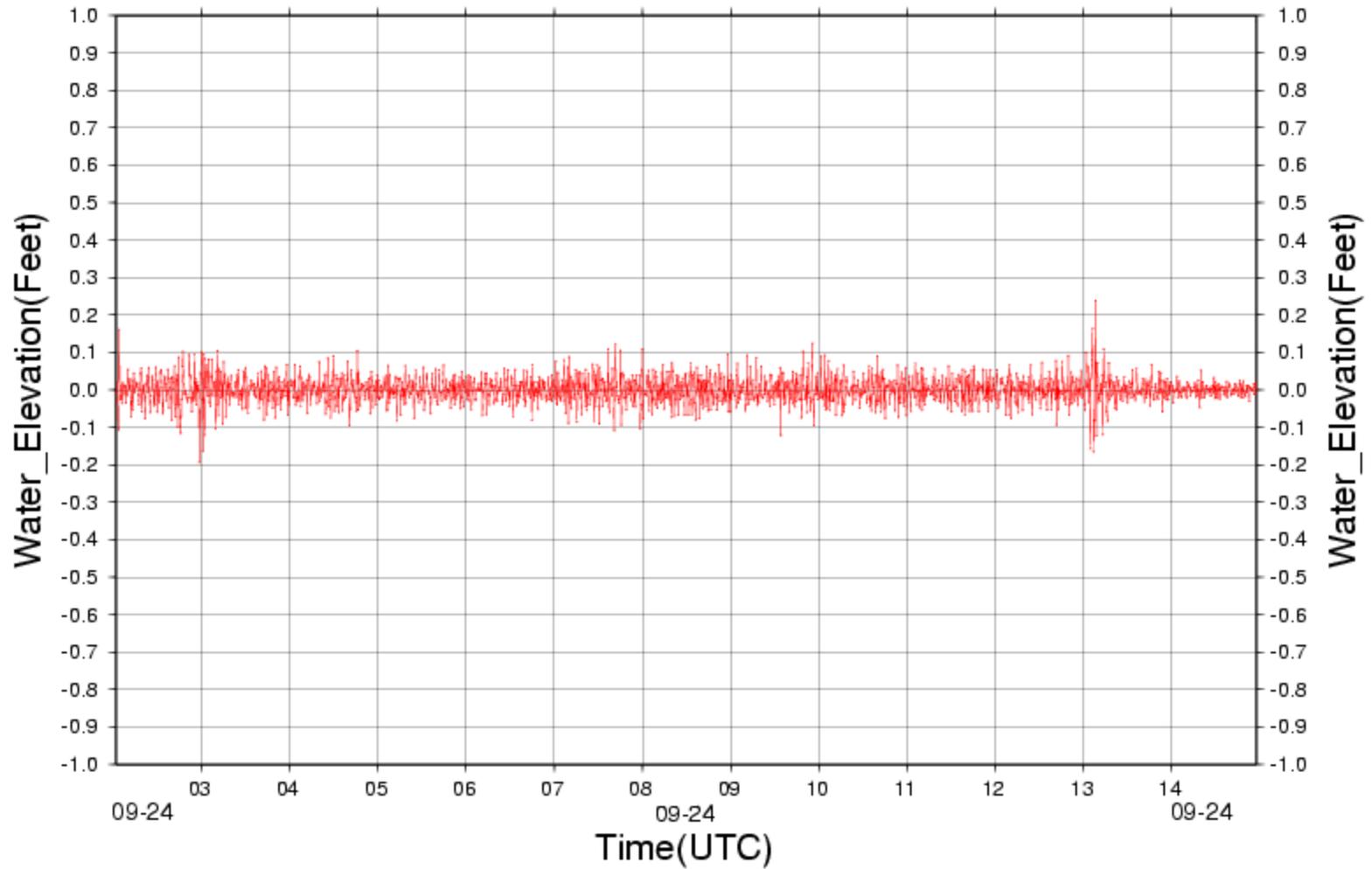


*Reduction of waves on  
storm surge by wetlands*

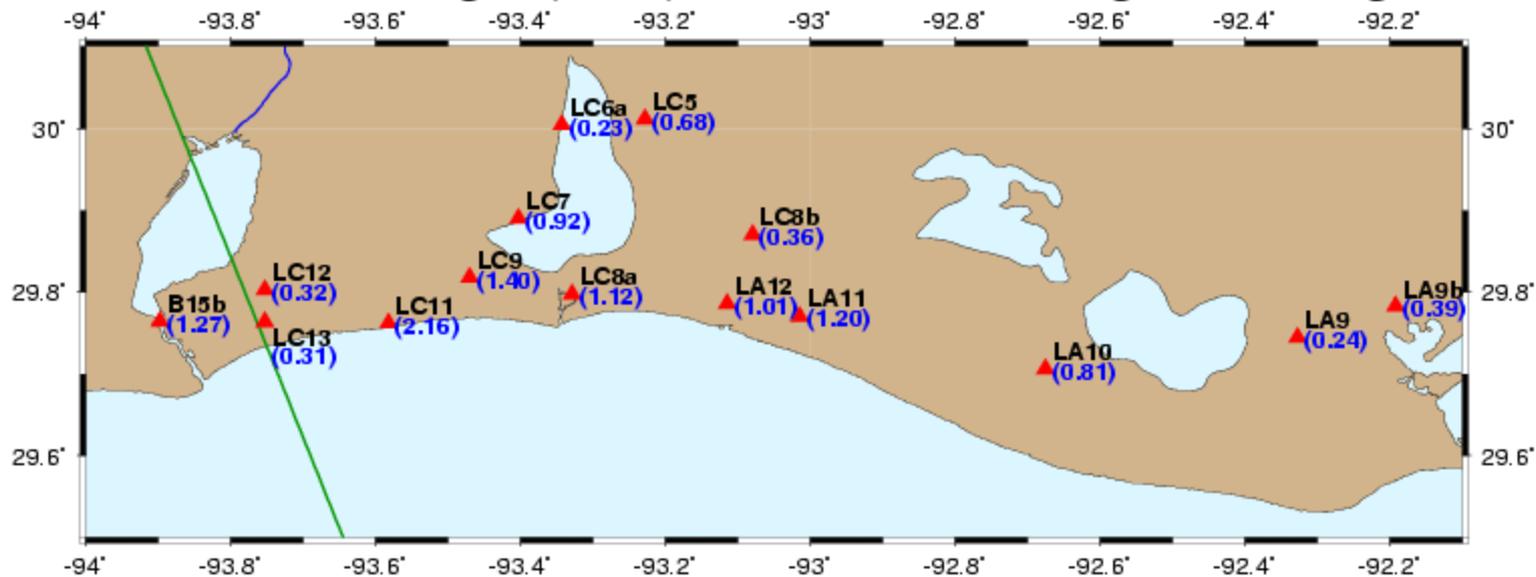
# Observed-Mean55 TimeSeries(Sensor LA11)



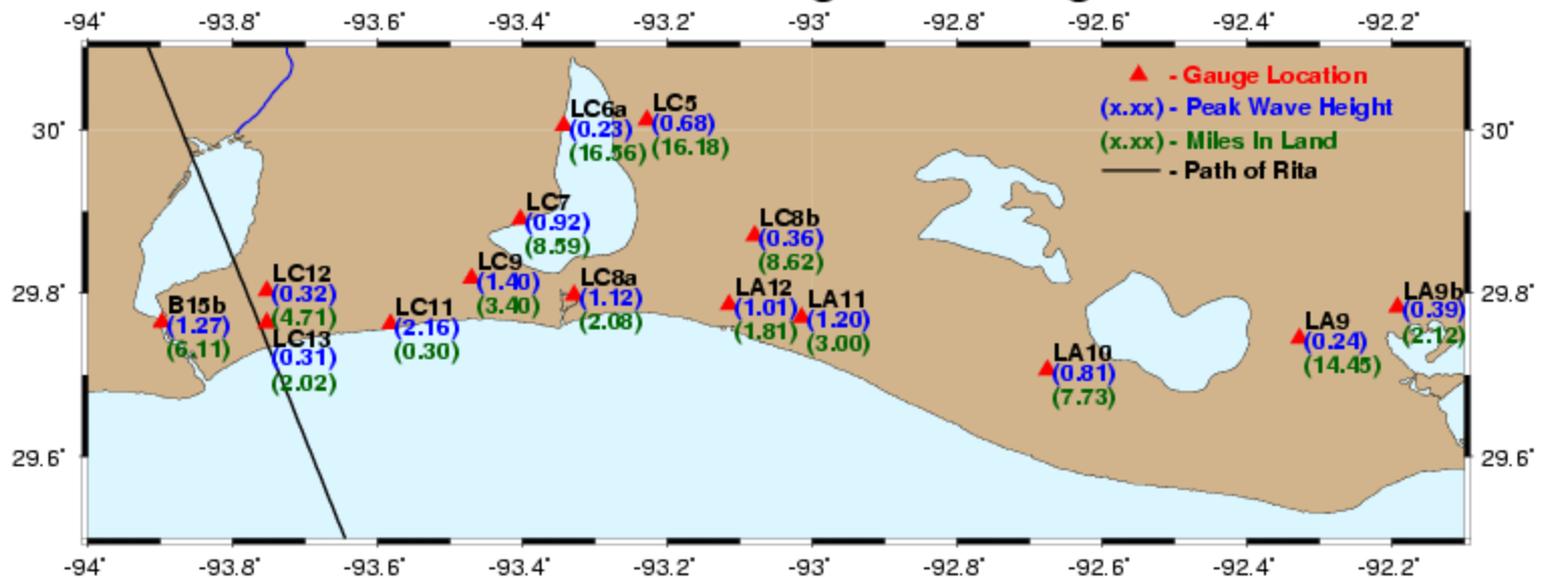
# Observed-Mean55 TimeSeries(Sensor LC8b)



# Peak Wave Height(feet) for USGS Gauges during Rita

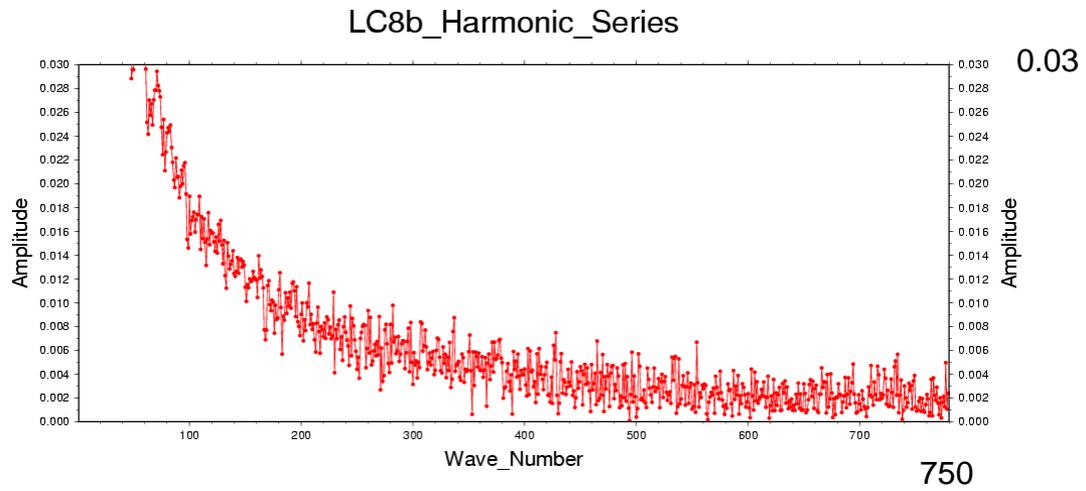


## USGS HWM Gauges during Rita

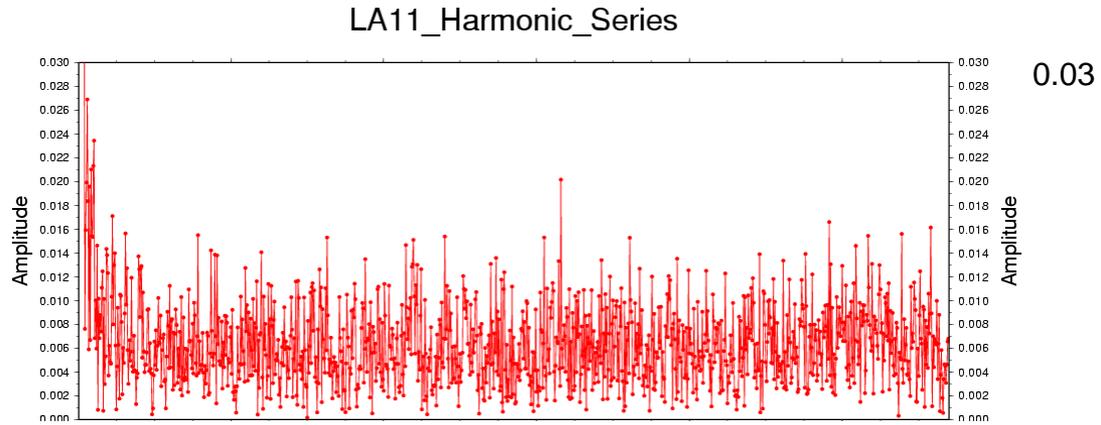


LC8b reduced 64-70% 5.5-6.8 miles inland (compared to LA12 and LA11)  
 LC8a reduced 48% 1.8 miles inland (compared to LC11)  
 LC9 reduced 36% 3.1 miles inland (compared to LC11)

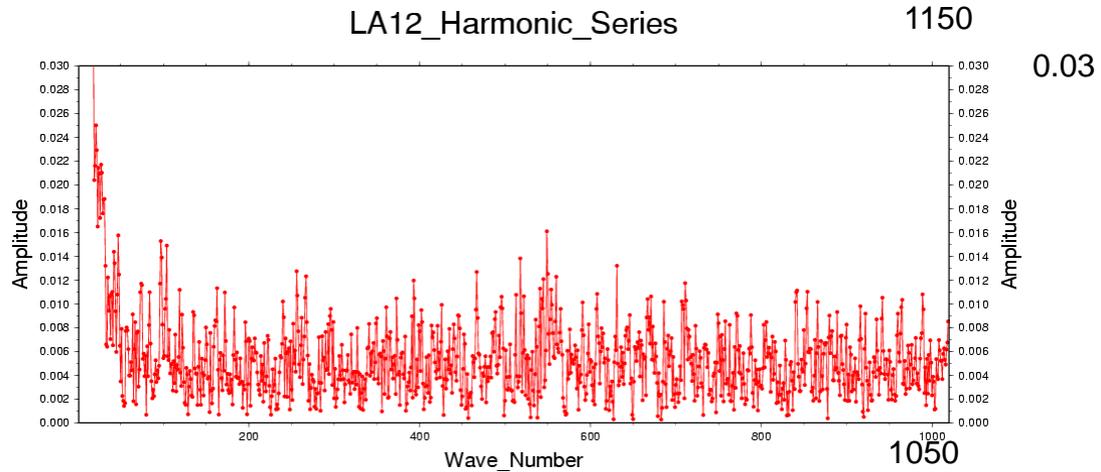
8.6 miles from coast



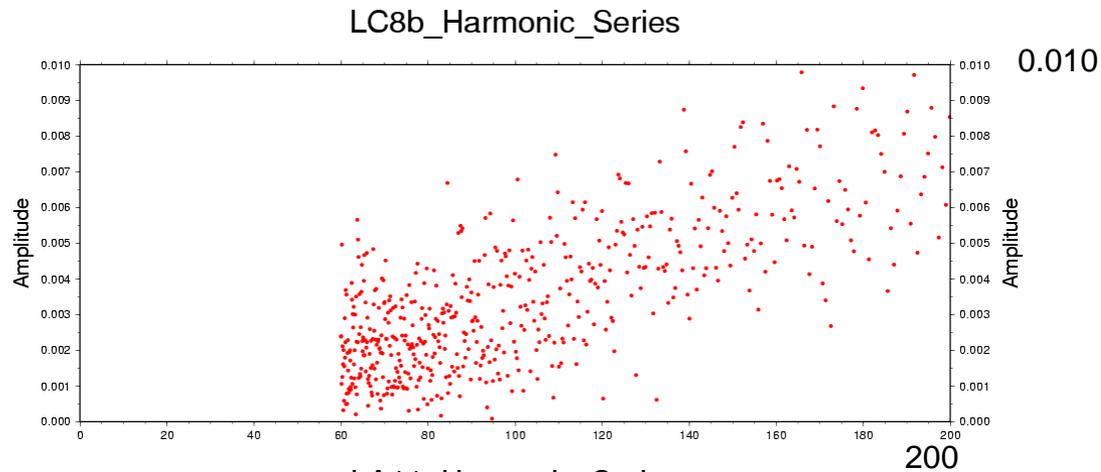
3.0 miles from coast



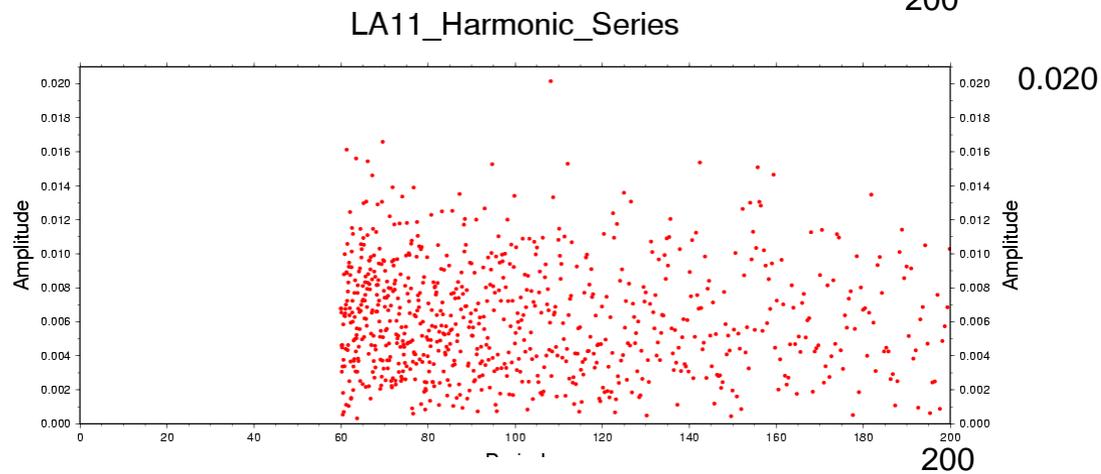
1.8 miles from coast



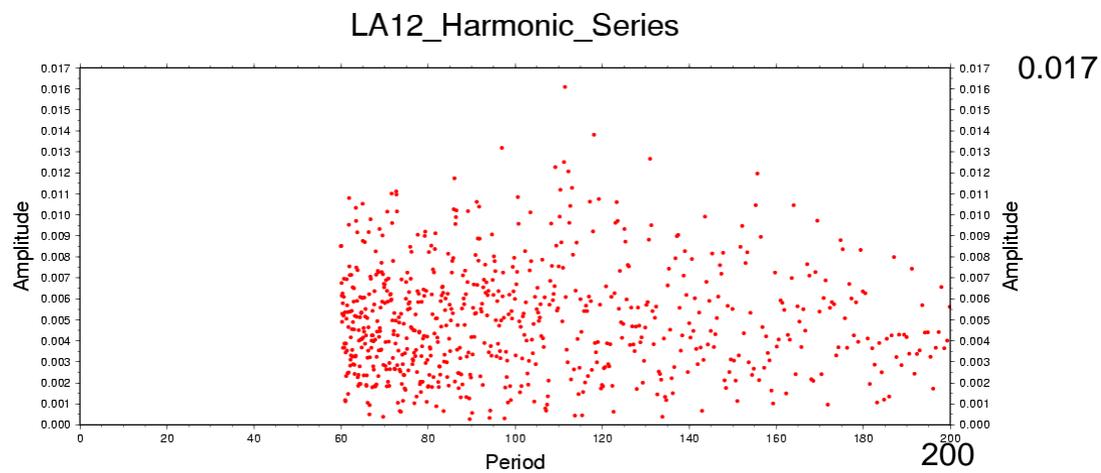
8.6 miles from coast



3.0 miles from coast



1.8 miles from coast



# Summary, wetland impact

- Storm surge **simulations** suggest **2 feet reduction** in surge **every 3 miles** of wetlands (**twice as much** as other research suggests).
- But, **near levees**, where water becomes trapped and reaches an equilibrium, **wetland erosion does not reduce surge**. Topographic forcing must be considered separately.
- **Rita observations**, when carefully stratified, also suggest **same results** (2 feet reduction every 3 miles).
- Rita observations also suggest the buffer **impact may decrease further inland**. **Wave heights reduced 50% 2 miles inland, and 65-70% 6 miles inland**.
- **Shortest period waves** tend to be **damped the most**, and this effect **increases inland**

# Upcoming work

- Filter out rain contamination from Slidell radar data (already downloaded)
- All Hurricanes Georges' deliverables with AMPR
- Multiple regression work for Rita and Georges
- Wetland classification correlations
- Closer examination of levee, road influences in Rita
- Hurricane Ike, Gustav
- Northern Gulf Institute (NGI) brochure (general public education), peer-review article