



# How High Did the Water Get?

## Storm Surge Data Analysis at the National Hurricane Center

**Robbie Berg**

NOAA / National Weather Service / National Hurricane Center

**NOAA SECART Webinar  
Monday, May 17, 2021**

Thanks to Jamie Rhome, Cody Fritz, Laura Alaka, and William Booth (NHC)



# Purpose of Post-Storm Analyses

## **NHC Tropical Cyclone Reports**

Documenting storm hazards and impacts

**01**

## **Forecast and Modeling Verification**

Evaluating operational storm surge forecasts, watches/warnings, and modeling

**02**

## **Support Recovery**

Identify hardest-hit areas immediately after the storm

**03**

## **Input for Disaster Declarations**

Facilitate disaster declarations for federal assistance

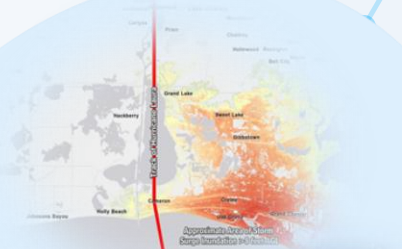
**04**



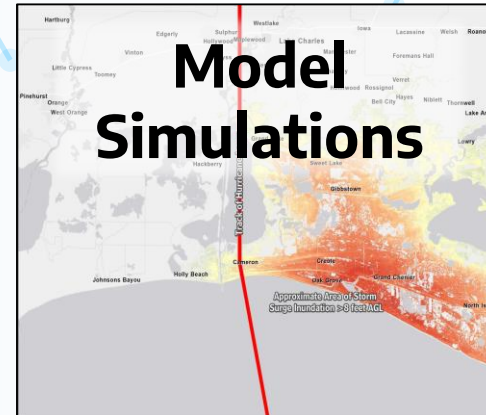
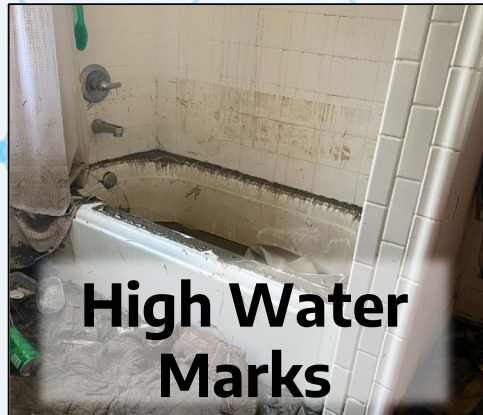
# The Job of a Sleuth



Determine how high the water got ***above normally dry ground*** (inundation) by reconciling differences among available storm surge data, and filling the gaps between them.



# Types of Data





# Datums



## Tidal

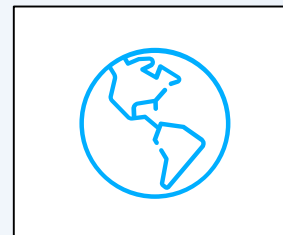
A reference level defined by a certain phase of the tide

Mean Sea Level, Mean Lower Low Water,  
Mean Higher High Water, etc.

## Geodetic / Orthometric

Reference level based on an abstract coordinate system, representing the shape of the Earth

NAVD88, NGVD29, etc.



# Inundation and Mean Higher High Water (MHHW)

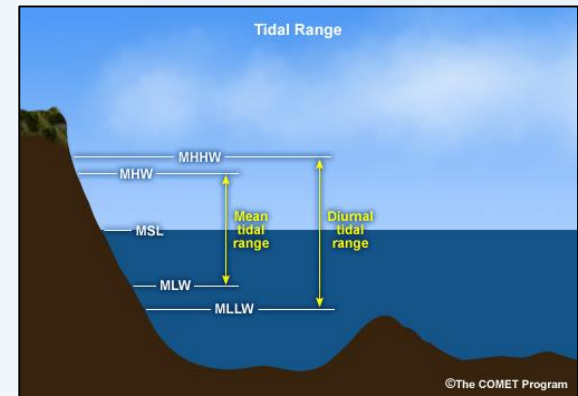
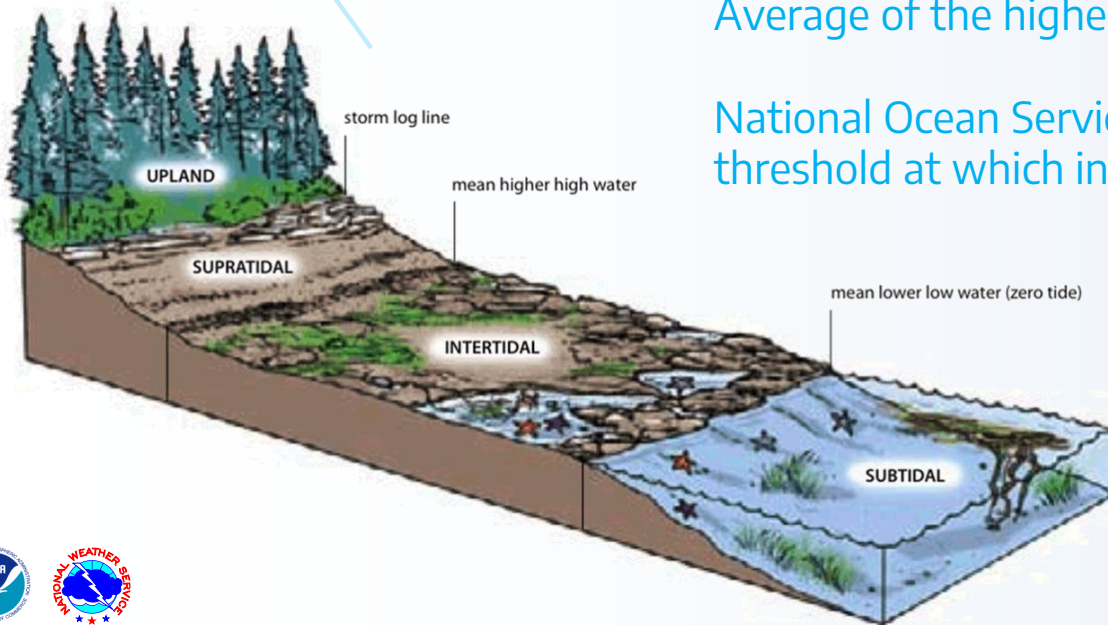
## Inundation

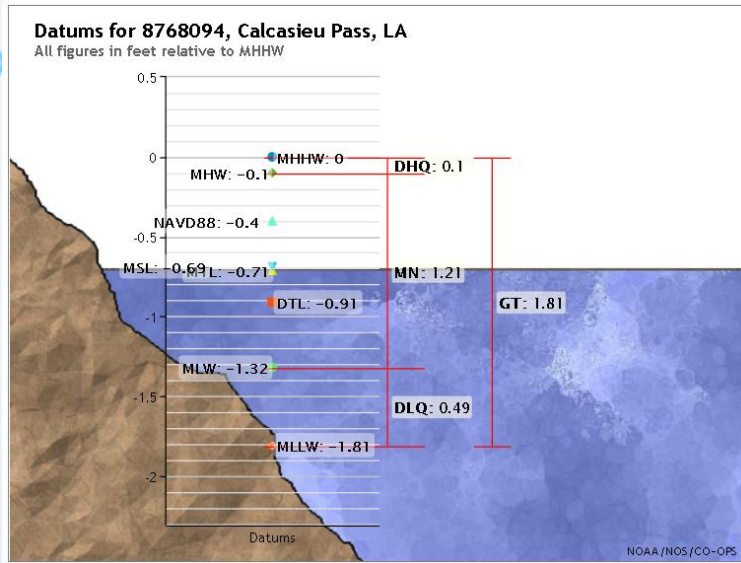
Height of water above normally dry ground

## Mean Higher High Water (MHHW)

Average of the highest high tides each day

National Ocean Service: best approximation for the threshold at which inundation *can begin to occur*

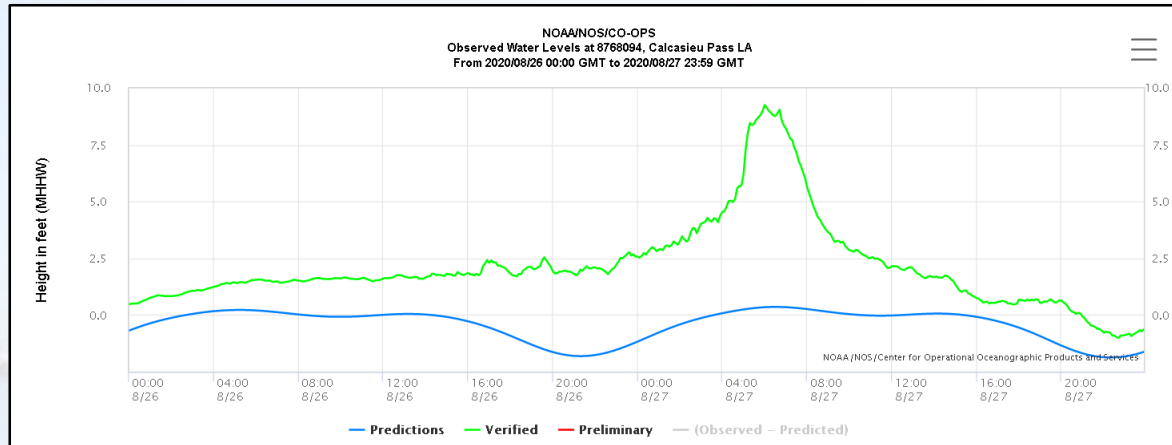




# Tide Gauges

Peak water level relative to MHHW is a proxy for maximum inundation in the vicinity of the gauge

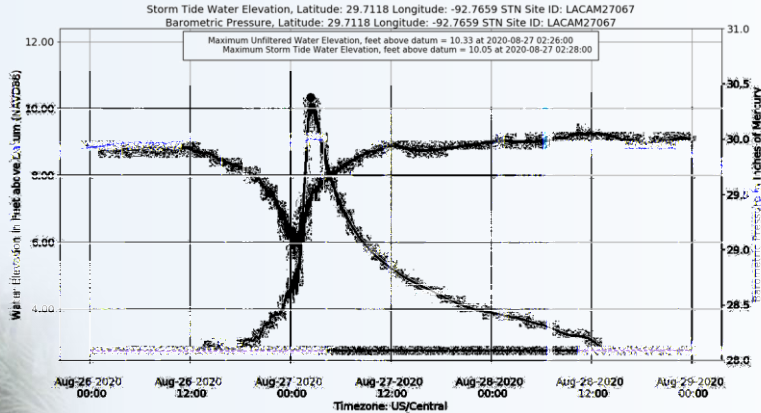
Calcasieu Pass during Laura:  
11.00 ft MLLW  
9.19 ft MHHW



# Pressure Sensors (Typically NAVD88)



EXPLANATION  
— Unfiltered Water Elevation  
— Storm Tide (Lowpass Filtered) Water Elevation  
- - - Minimum Recordable Water Elevation  
— Barometric Pressure  
● Maximum Unfiltered Water Elevation  
▲ Maximum Storm Tide Water Elevation  
Combined Instrument Error (R): 0.14000



## Considerations:

Is the sensor located

- within the intertidal zone?
- on normally dry ground?

Unfiltered or filtered for waves?

Which datum was used?

Hurricane Laura  
Rockefeller National Wildlife Refuge

10.05 ft NAVD88 = **9.1 ft MHHW**



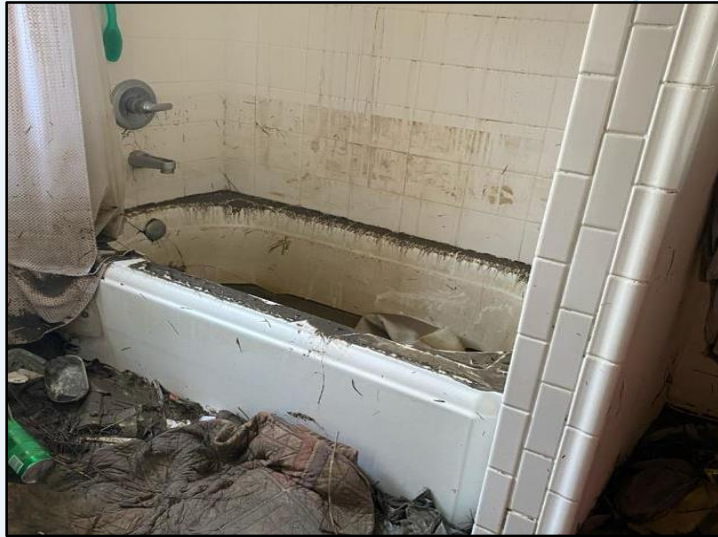


# Types of High Water Marks

(Typically AGL or NAVD88)



## Mud, Foam, Stain, or Seed Lines (Vertical)



Those that tell you how high the water got

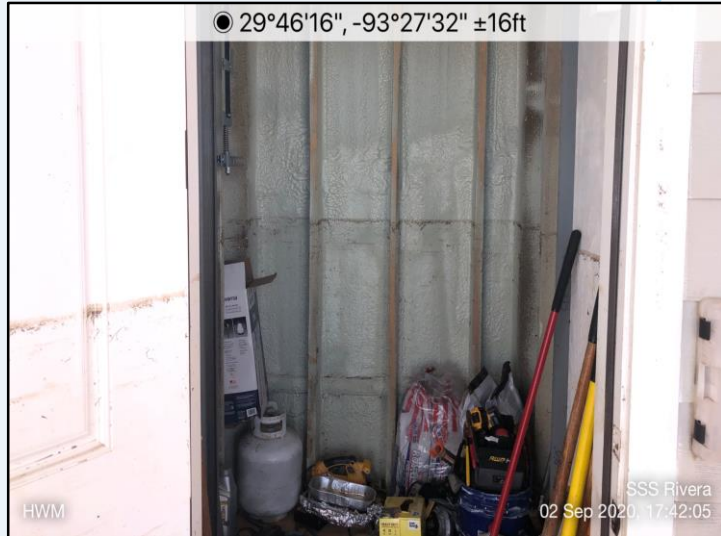
## Debris Lines (Horizontal)



Those that tell you how far inland the water penetrated

# Quality of High Water Marks

## Stillwater



Best stillwater marks found inside structures

## Wave/Current Influenced



Quality of debris snags depends on exposure

# Datum Conversion In/Near Tidal Areas

## NOAA's VDatum Conversion Tool

Used to convert data from one datum to another within applicable areas

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
INTEGRATING AMERICA'S ELEVATION DATA

Home About VDatum Download Docs & Support Contact Us

Regional Information

\* Region : Contiguous United States

Horizontal Information

Source Target

Reference Frame: NAD83(2011) NAD83(2011)

Coord. System: Geographic (Longitude, Latitude) Geographic (Longitude, Latitude)

Unit: meter (m) meter (m)

Zone: [ ] [ ]

Vertical Information

Source Target

Reference Frame: NAVD 88 MHHW

Unit: foot (International) (ft) foot (International) (ft)

Height  Sounding  Height  Sounding

GEOID model: GEOID18  GEOID model: GEOID18

Point Conversion ASCII File Conversion

Input Output

Longitude: -93.647298 Longitude: [ ]

Latitude: 29.878562 Latitude: [ ]

Height: [ ] Height: [ ]

Drive to on map Reset Map Drive to on map Reset Map

to DMS

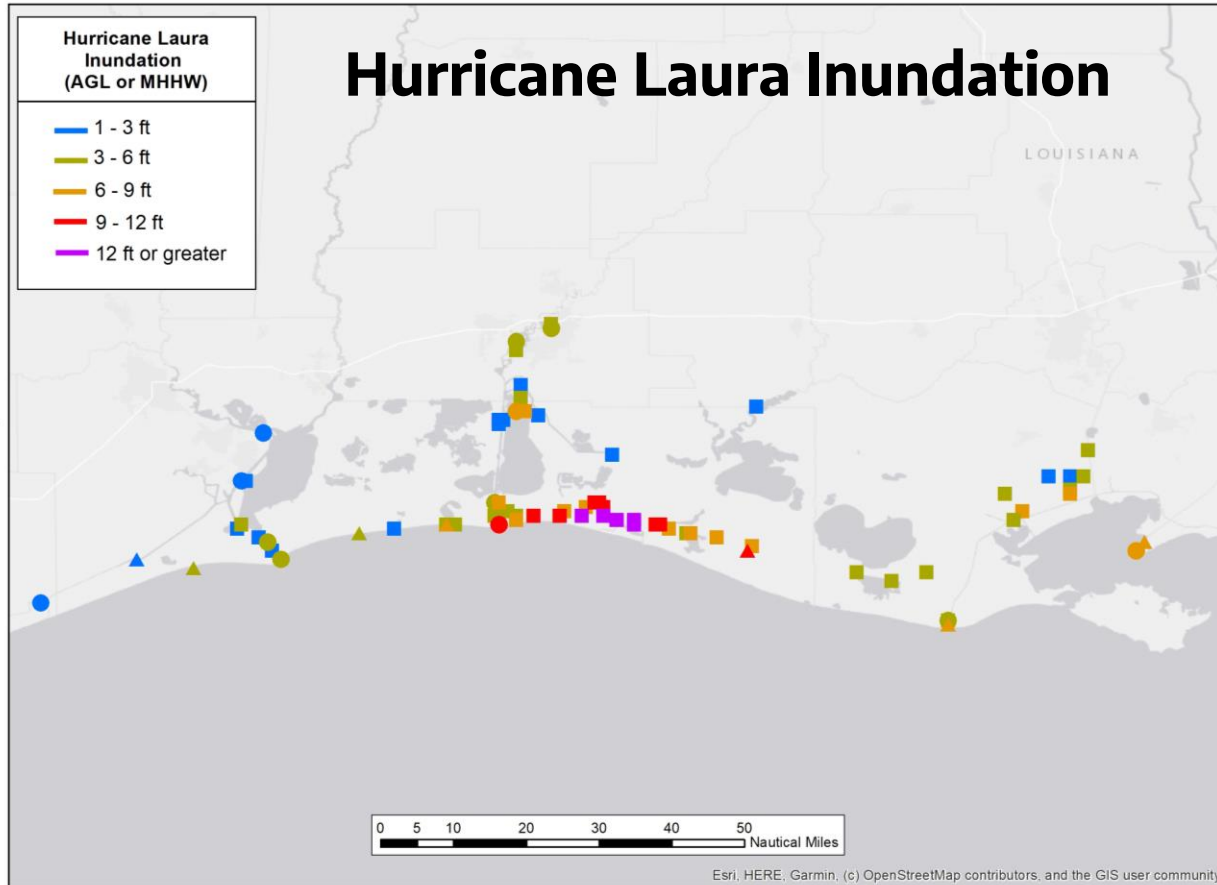
Vertical Uncertainty (+/-): [ ]

Leaflet | Select a point by clicking on map.

Alternating Horiz. Datum Ellipsoidal Datum Orthometric Datum Tidal Datum



# Putting It All Together

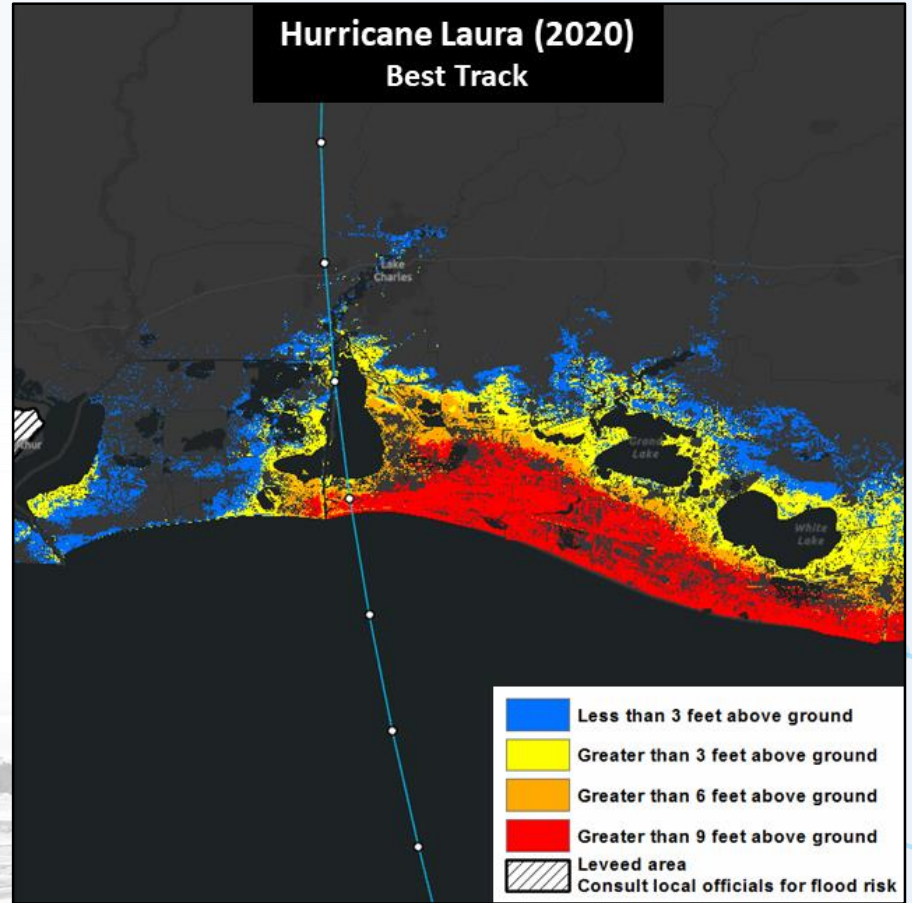




# Post-Storm Simulations

Conducted by the NHC Storm Surge Unit to Meet Interagency Requirements with FEMA

Used to fill in the gaps where there are no *in situ* observations





# A Few Things To Keep in Mind

**Instrument-based observations rarely (never?) capture peak inundation**

**01**

**Datums, datums, datum, and oh yeah, datums**

**02**

**Watch out for Waves**

**03**

**Highest inundation may not be where people actually live**

**04**





# Questions?

**Robbie Berg**

Robert.Berg@noaa.gov