



**Learning From  
The Past...**



**...Surveying  
The Future**



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# SLR: Nuisance flooding patterns along the Coastal Bend

**Philippe Tissot**  
Conrad Blucher Institute

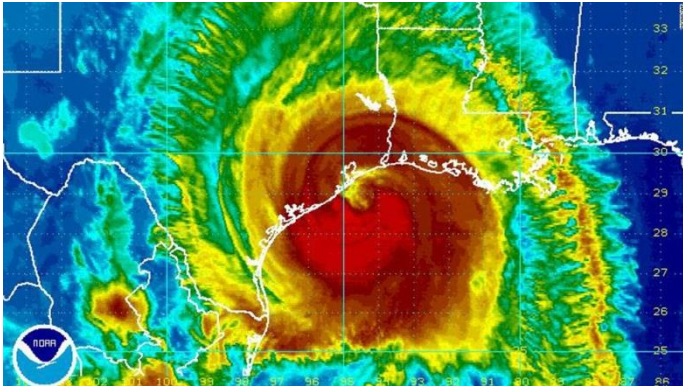
**Resilient Texas: Planning for Sea Level Rise**  
**August 8, 2017**

# Hurricane Ike - 9/13/2008



## RSLR Impact: Changes in Inundation Frequencies?

- Large Surges (e.g. Hurricane Ike):



- “Nuisance” Flooding:





Politics • Analysis

## Flooding in Miami is no longer news – but it’s certainly newsworthy

By Philip Bump August 4



Ginger Zee @Ginger\_Zee Follow

FLORIDA FLOODING: 4-5" of rain caused flash flooding in Florida - Video: Aaron Stockholm

Aug. 2, Brian McNoldy: as the average water level increases due to sea-level rise, high tides become more of a problem — either by **reducing the ability of storm drains to function** or by **actually bringing salt water up onto the streets** when they’re very high.

## Flooding cuts Sandbridge off, closes other Virginia Beach roads (WTKR.COM)

POSTED 5:14 AM, MAY 2, 2017, BY RACHAEL CARDIN, UPDATED AT 06:41PM, MAY 2, 2017



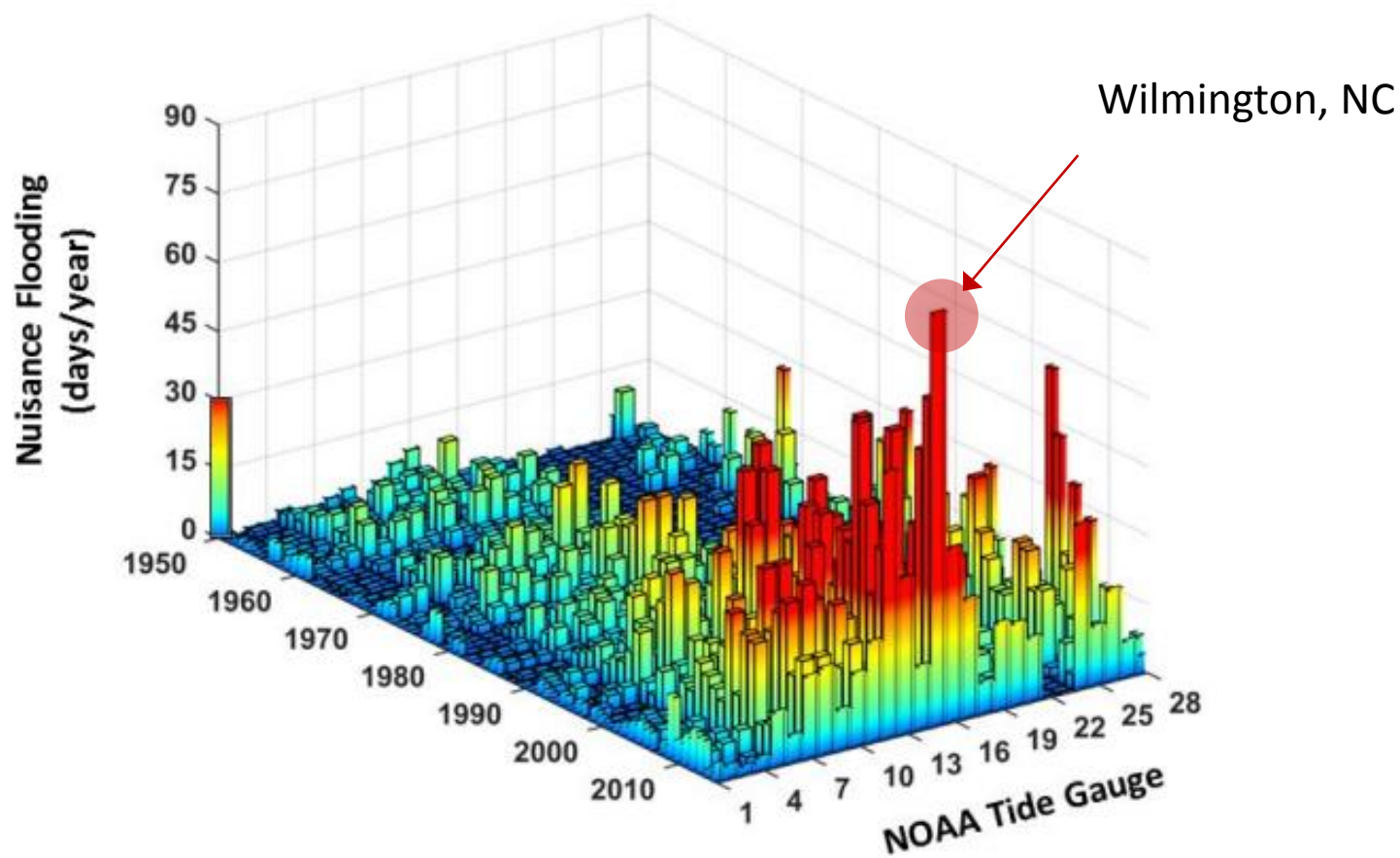
Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Ocean & Coastal Management

journal homepage: [www.elsevier.com/locate/ocecoaman](http://www.elsevier.com/locate/ocecoaman)

Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida

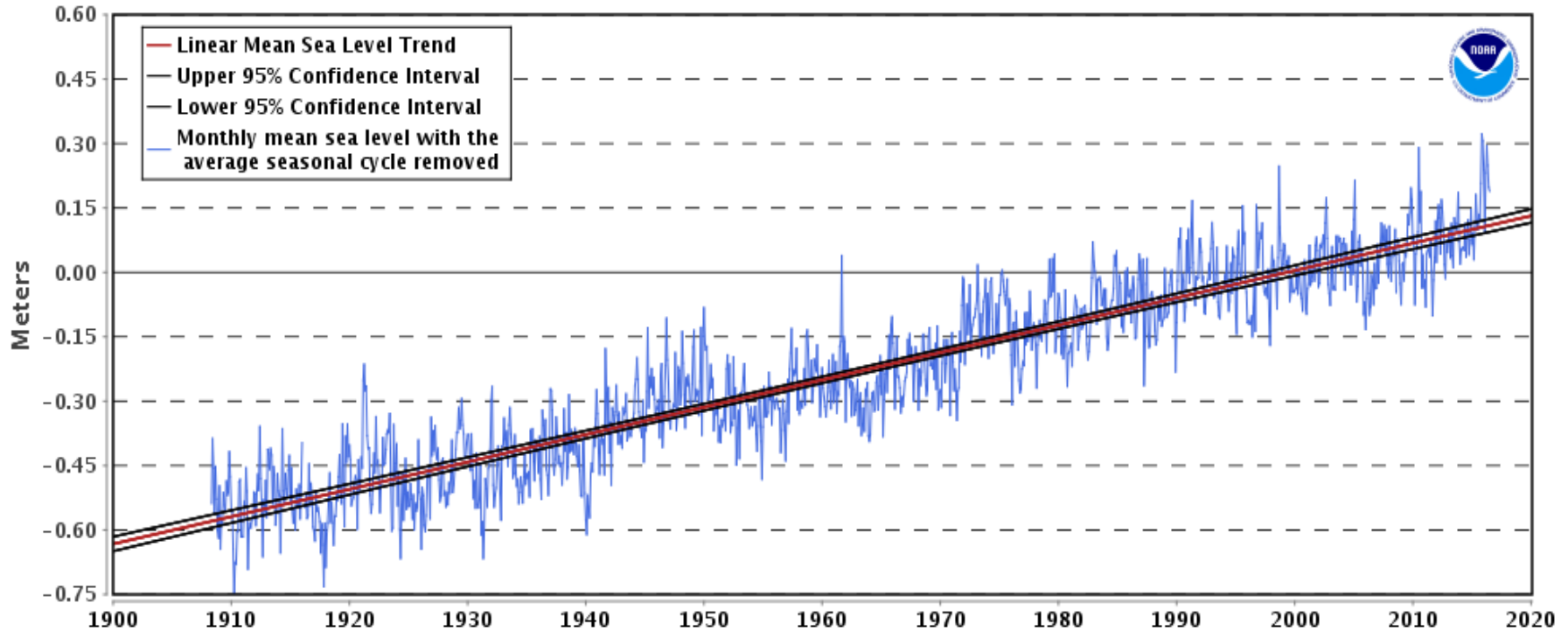
Shimon Wdowinski <sup>a,\*</sup>, Ronald Bray <sup>a</sup>, Ben P. Kirtman <sup>a</sup>, Zhaohua Wu <sup>b</sup>



**Figure 3.** Annual tidal flood frequencies from 1950 – 2015 (meteorological year: May – April) above the local nuisance level for 28 NOAA tide gauges (location number listed in the Table 1)

8771450 Galveston Pier 21, Texas

6.37 +/- 0.24 mm/yr



**Galveston Pier 21**

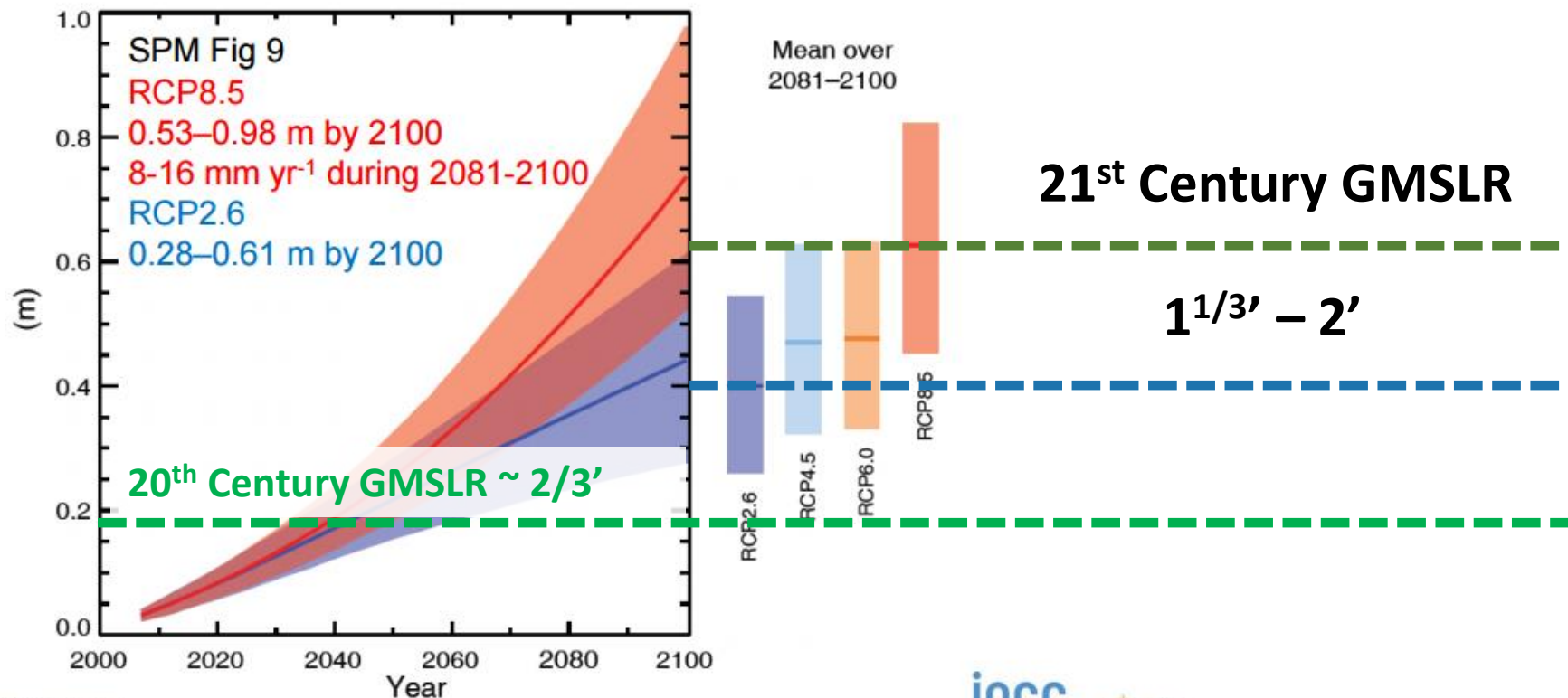
**0.25" / year**

**100 years = 2.1 ft**



## Projections of 21st-century GMSLR under RCPs

*Medium confidence in likely ranges*

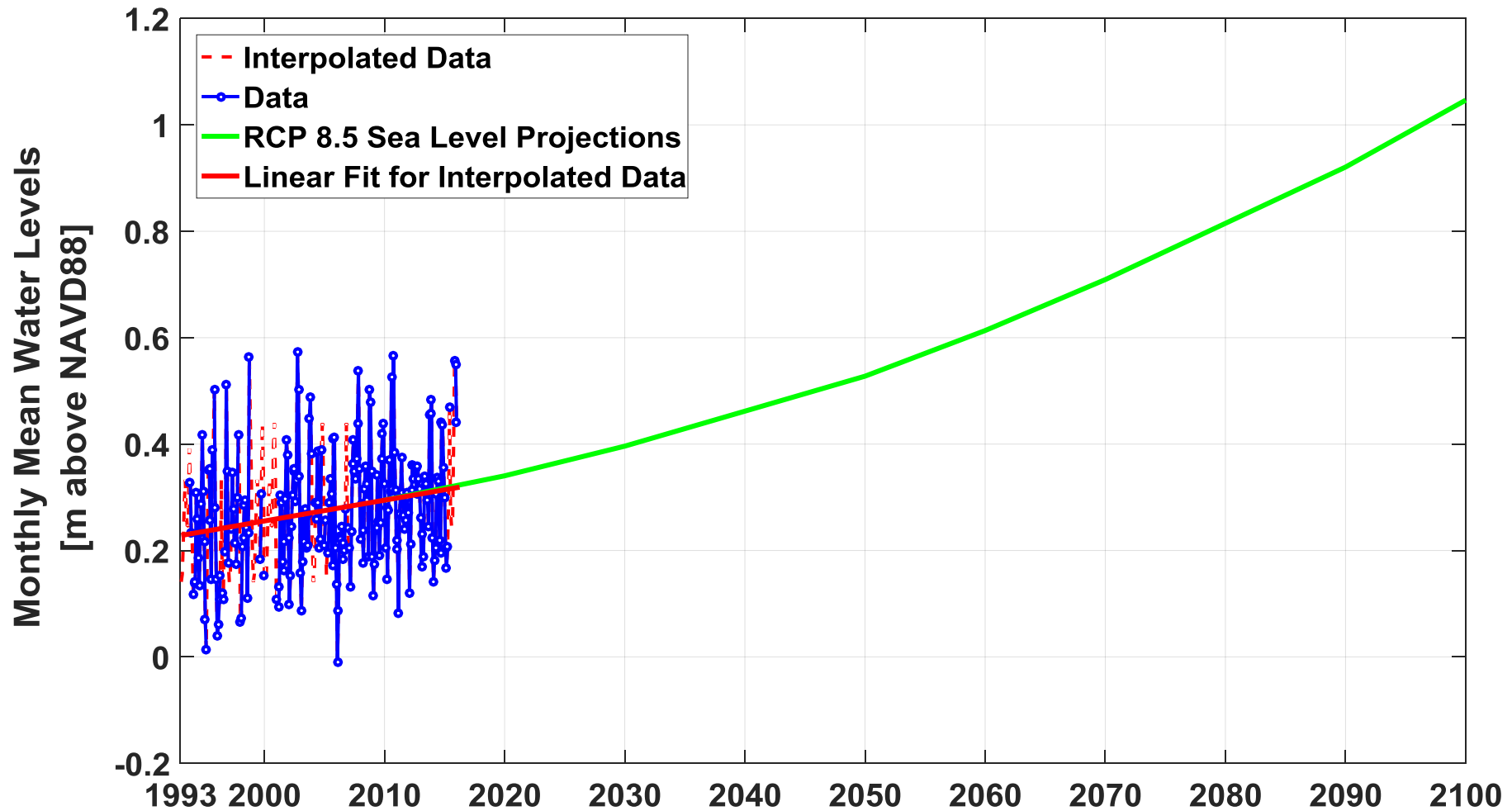


### IPCC ARV (2013):

Likely range of GMSLR for 2081-2100 is 0.40 to 0.63 m above 1986-2015 (medium confidence)  
It is virtually certain that GMSLR will continue for many centuries beyond 2100



## Sea Level Rise at Aquarium Station 1993-2100

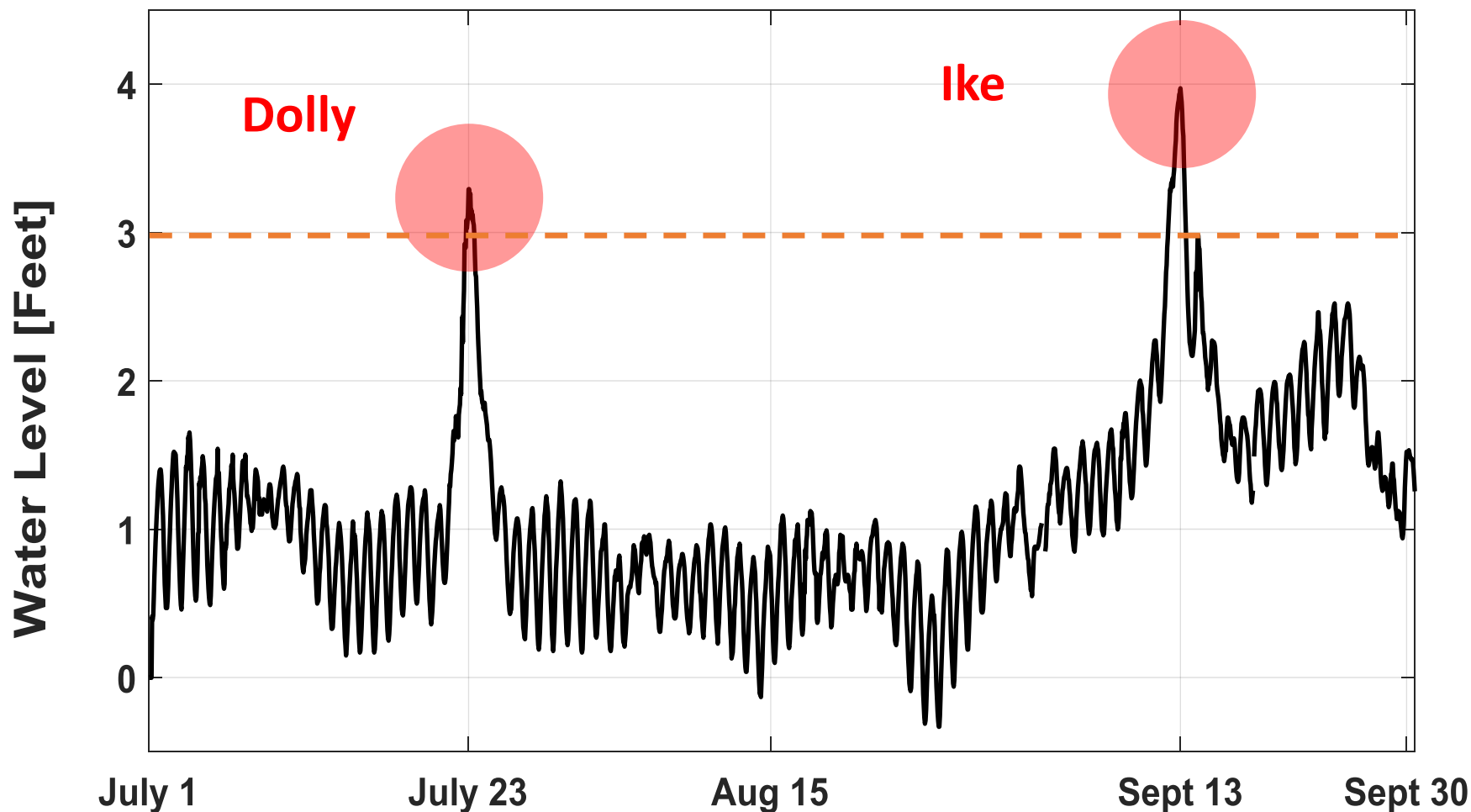


## Nuisance Flooding: Corpus Christi North Beach Summer 2008

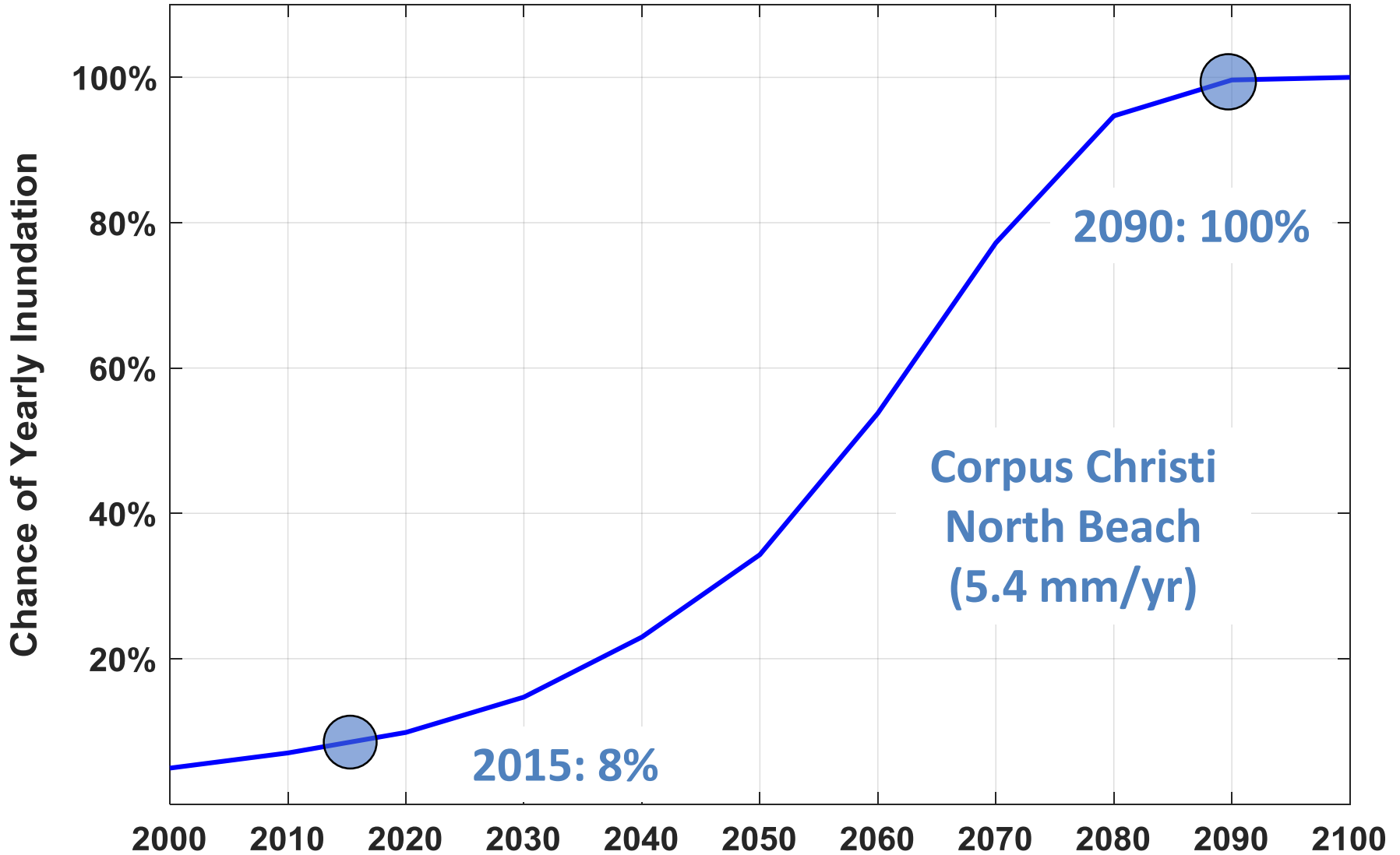


Ike

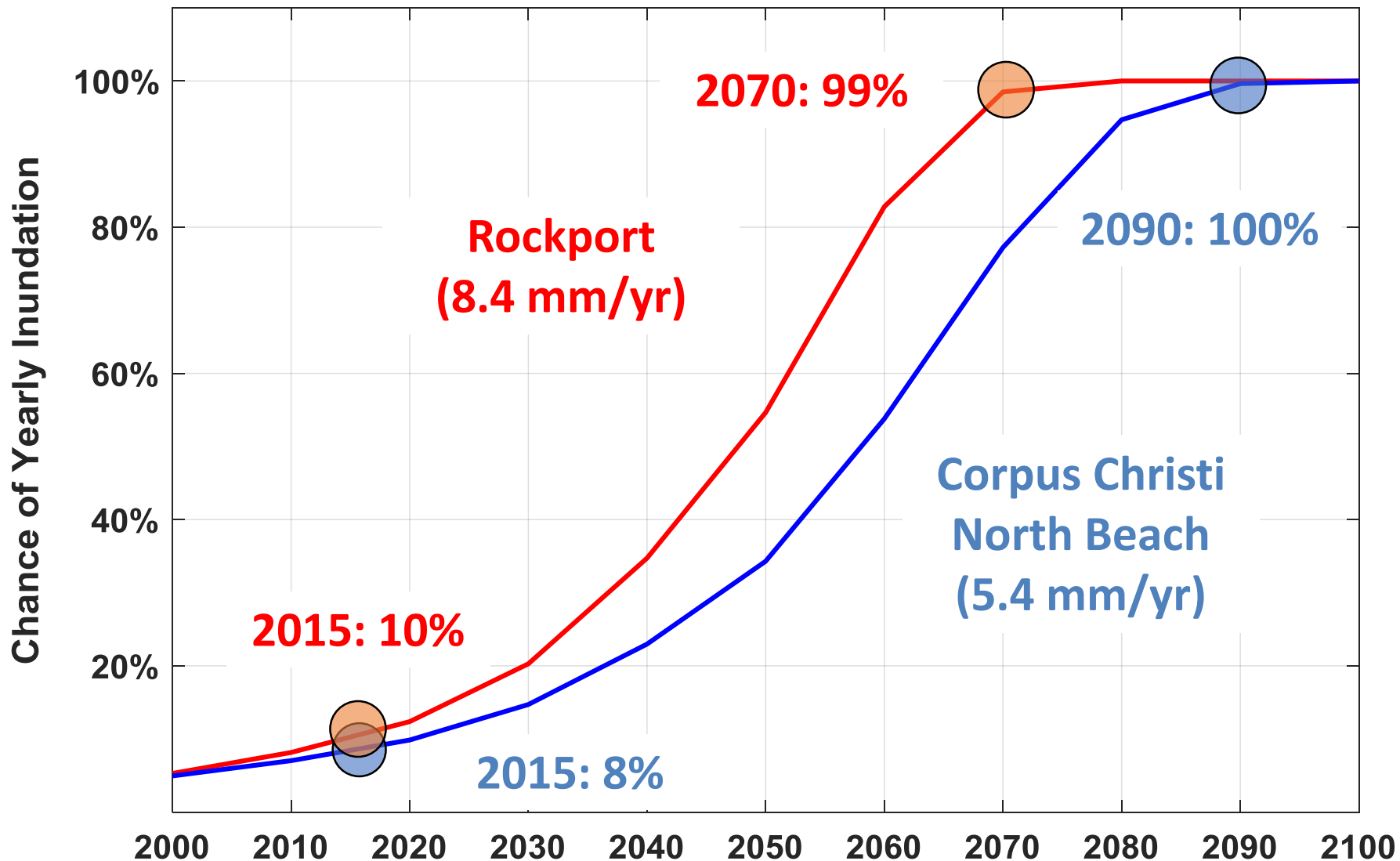
## Water Level: North Beach Summer 2008

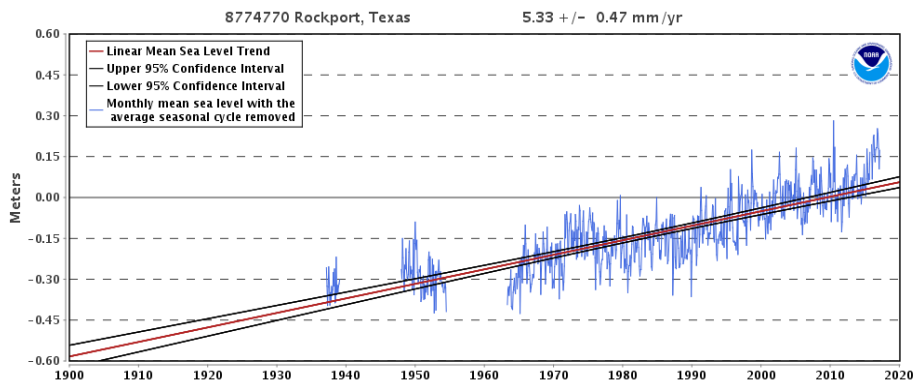


## Probability of at Least one Innundation

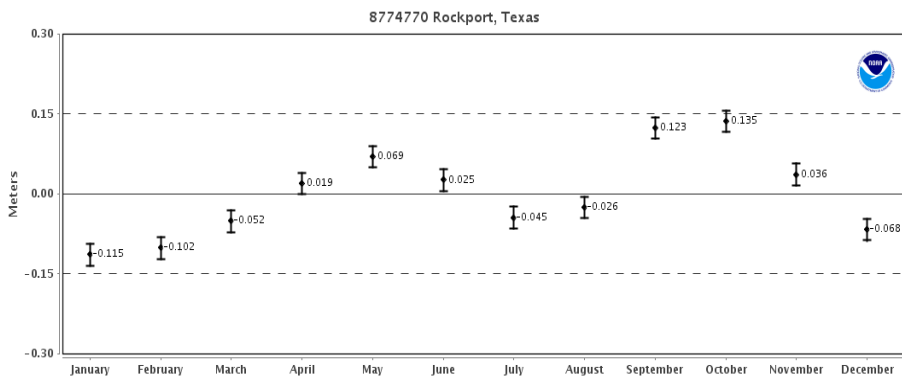


## Probability of at Least one Innundation

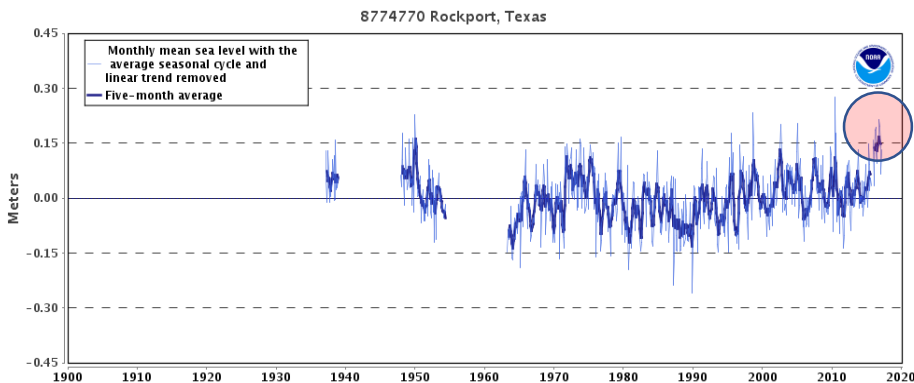




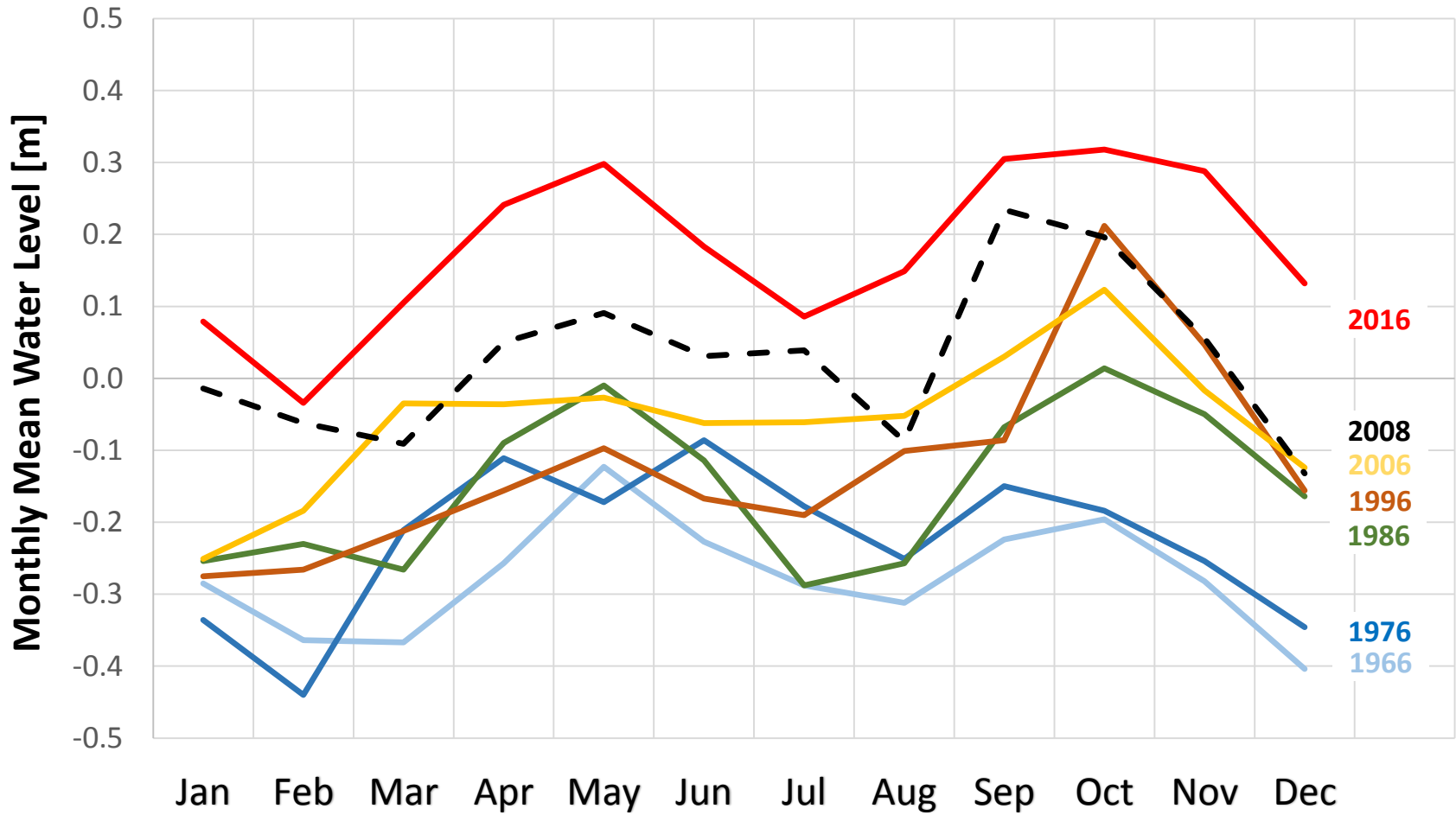
Long term relative sea level rise:  
**5.3 +/- 0.5 mm/yr (1.7 ft/100 yr)**



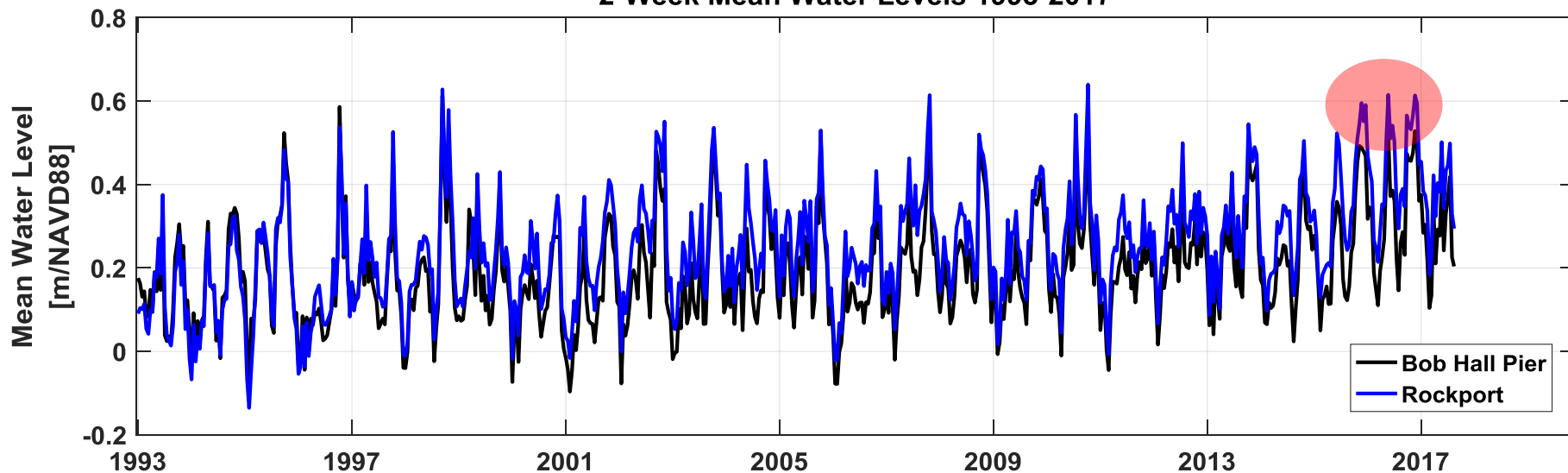
Seasonal variability: **~ 1 ft**



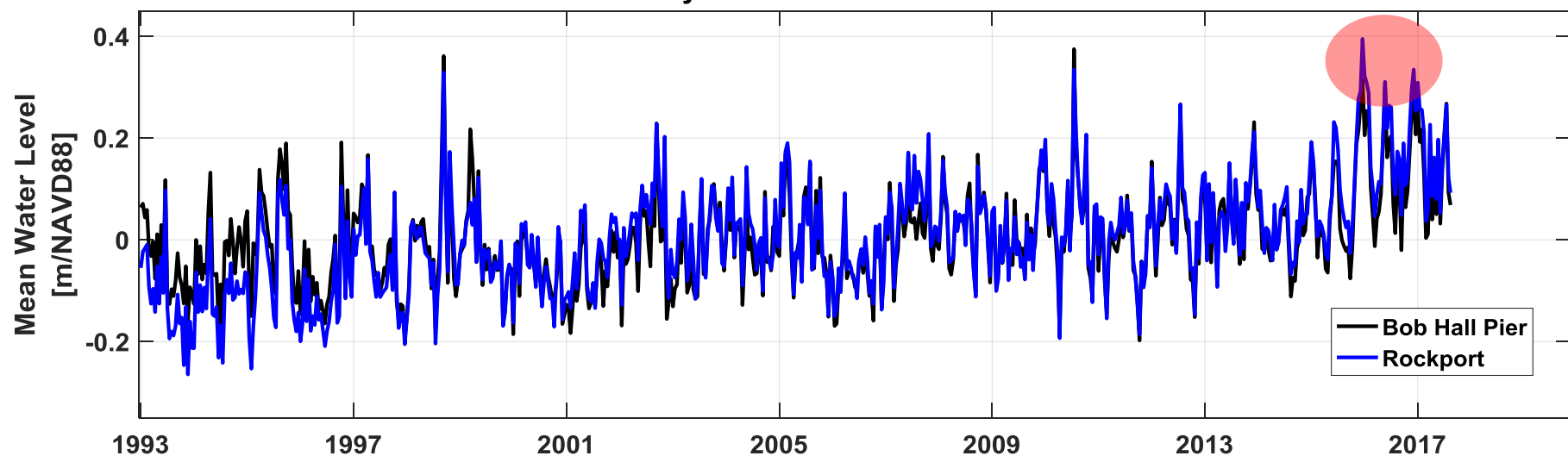
Interannual variability: **~ 1 ft**



### 2-Week Mean Water Levels 1993-2017



### 2-Week Seasonally Detrended Mean Water Levels 1993-2017

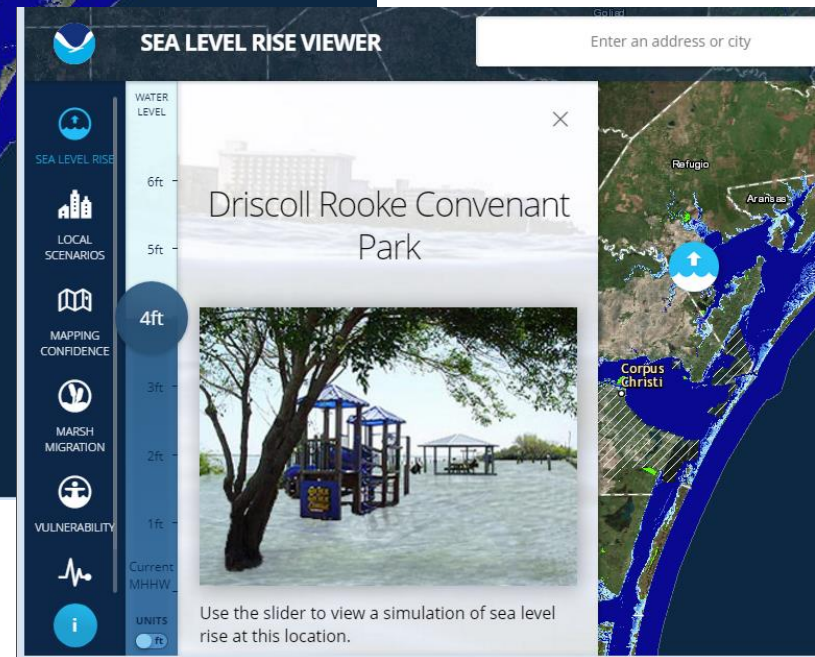
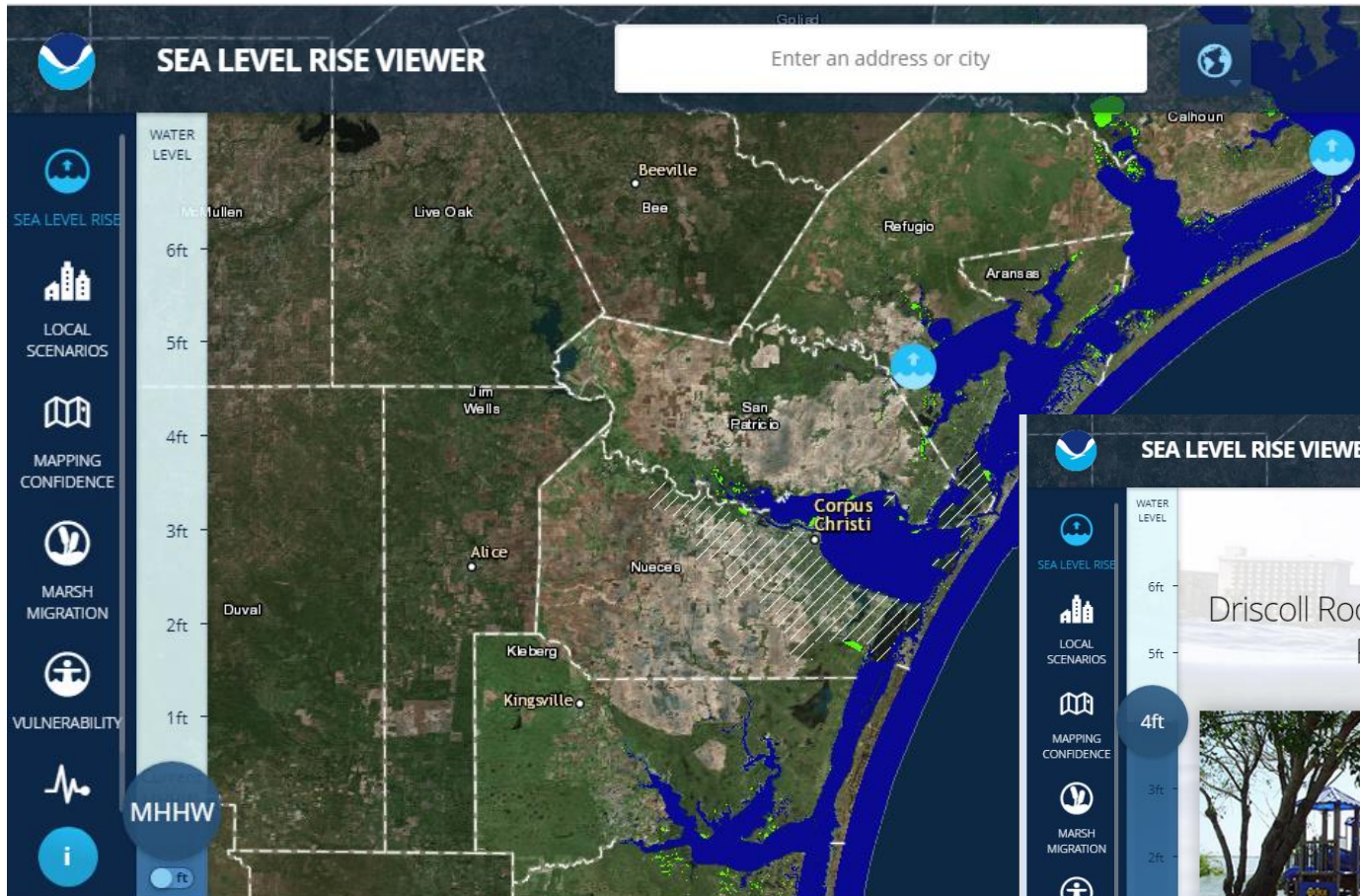




# Visualization of Tidal Datums & “Inundation Frequencies” Bob Hall Pier, Texas

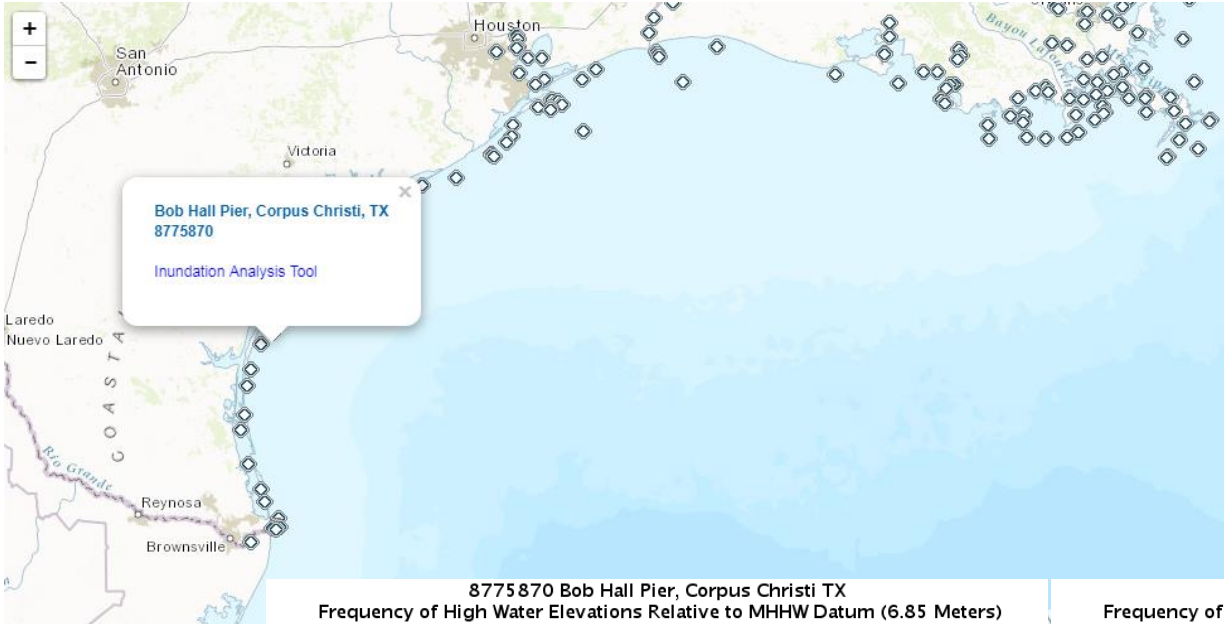


# Sea Level Rise Viewer: Visualization of Community-Level Impacts

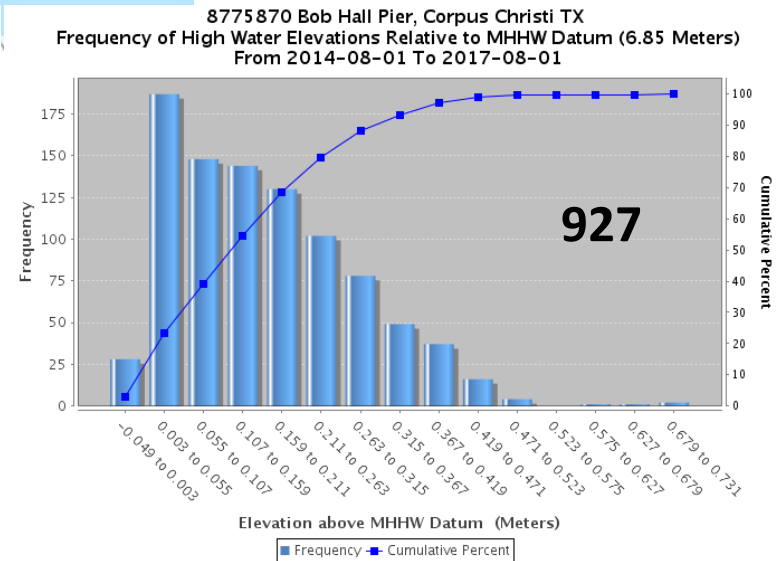
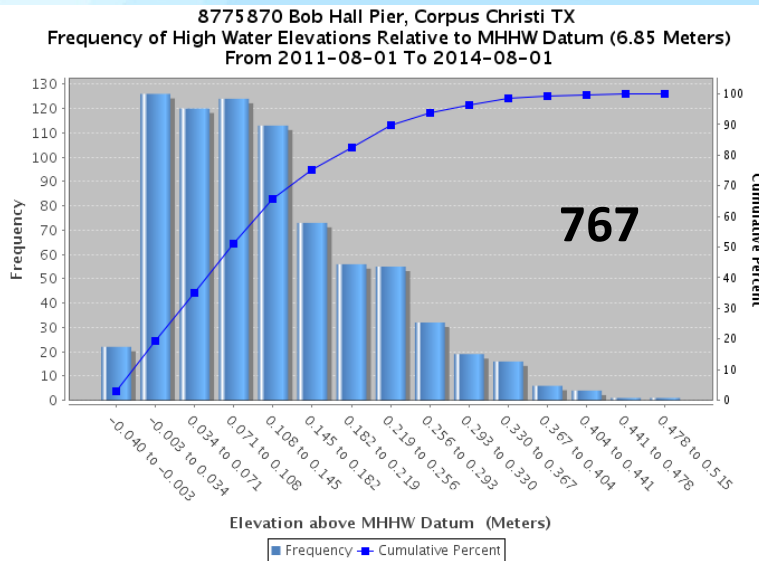


In Coastal Bend: Rockport, Corpus Christi, Port Mansfield

## NOAA Tides and Currents: inundation analysis tool (for NWLON stations)



How often are water levels above Mean Higher High Water (MHHW) at Bob Hall Pier tide gauge?





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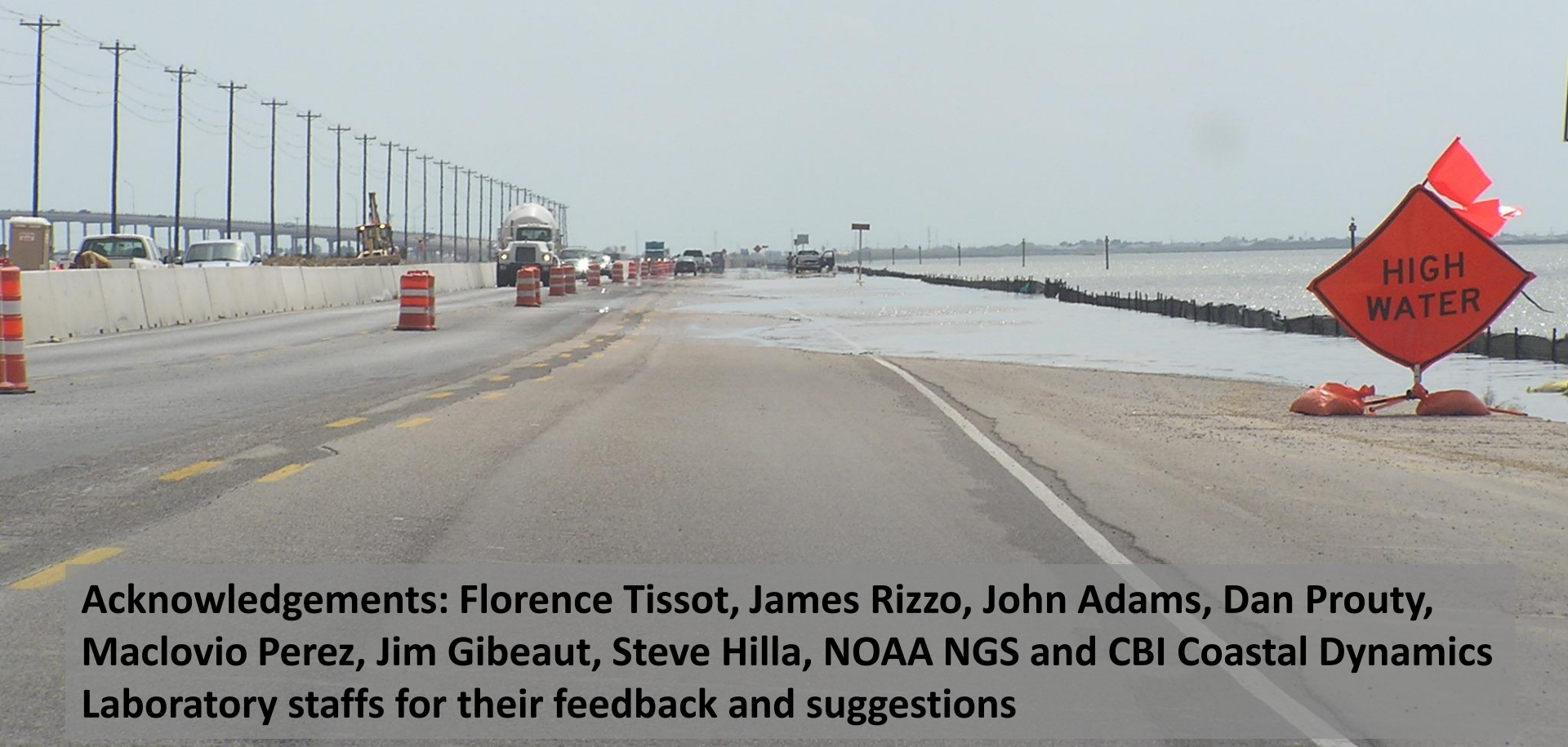
**Nuisance Flooding (NOAA):** Flooding which causes public inconvenience

**Impacts:** Road closures, storm drains, insurance claims, *beach access, ...*

**Progression:** exponential increase of the number and duration of nuisance floods

**Caveats for Coastal Bend/Texas:** Impact of tides not as important as along other coastal areas

# Questions/Discussion



**Acknowledgements: Florence Tissot, James Rizzo, John Adams, Dan Prouty, Maclovio Perez, Jim Gibeaut, Steve Hilla, NOAA NGS and CBI Coastal Dynamics Laboratory staffs for their feedback and suggestions**



Regional Sea Level Changes and Coastal Impacts  
350 participants registered, 41 countries represented, 250 posters presented

## Regional Sea Level Changes and Coastal Impacts 10-14 July 2017, Columbia University, New-York (NY) - USA

### Conference Sessions:

- Paleo sea level data and GIA modeling
- Millennial-scale ice sheet and sea level interactions
- Contemporary contributions from ice sheets and glaciers
- Contemporary sea level change
- Coastal zone
- Sea level rise adaptation in greater New York: the response to Sandy and beyond
- Projections

## Components to Global Sea Level rise (IPCC AR5, 2013)

(1993-2010)

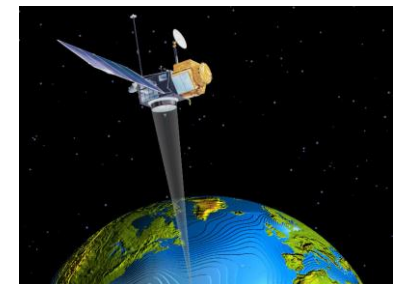
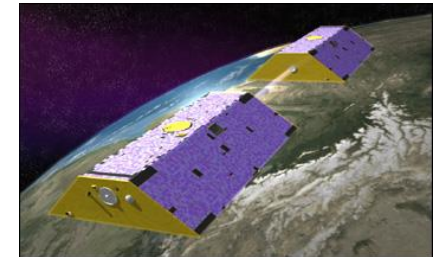
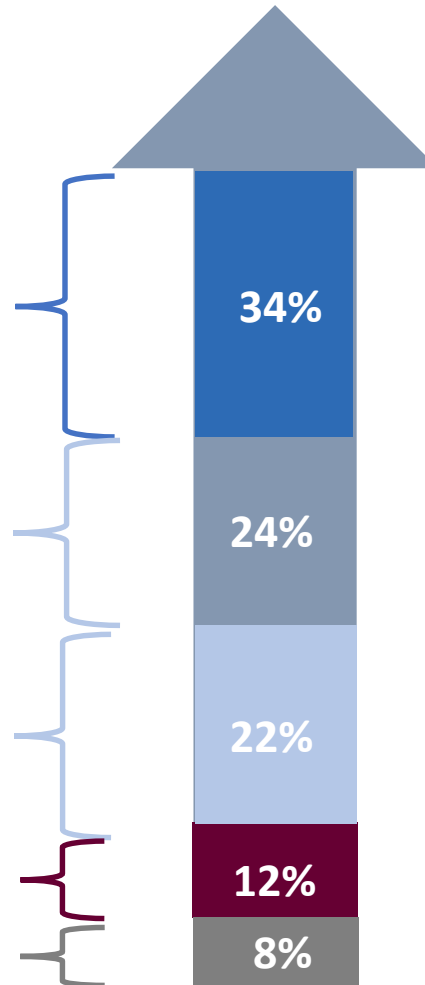
**Upper Ocean Warming/Expansion**

**Glaciers**

**Ice Sheets**

**Land Water Storage**

**Unattributed**

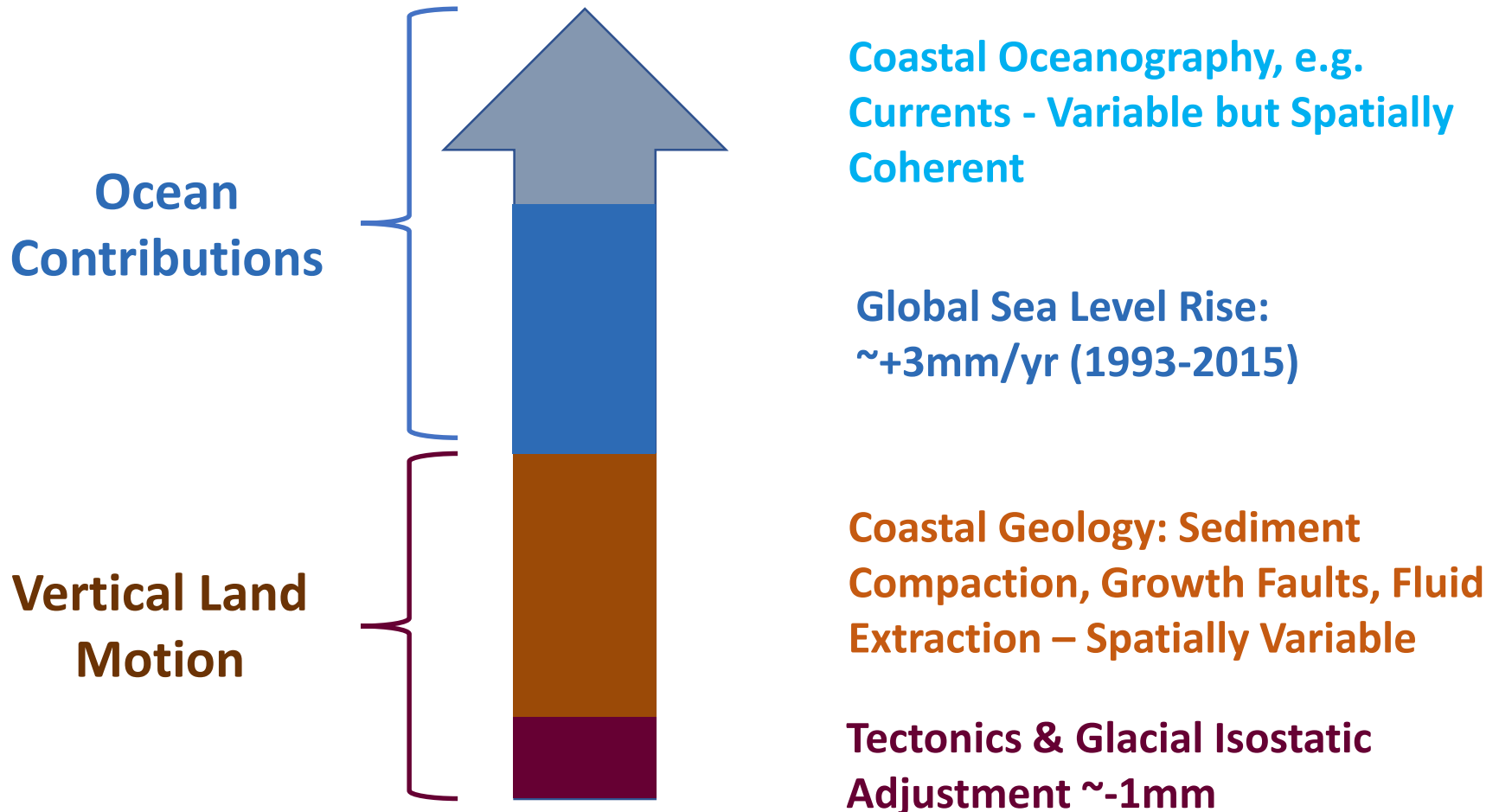




	1993-2010 Observed		2018-2100 Projections (RCP 8.5)	
<b>Thermal Expansion</b>	<b>1.1 mm/yr</b> [0.8 to 1.4]	<b>34%</b>	<b>0.27 m</b> [0.21 to 0.33]	<b>44%</b>
<b>Glaciers</b>	<b>0.76</b> [0.39 to 1.13]	<b>24%</b>	<b>0.16 m</b> [0.09 to 0.23]	<b>26%</b>
<b>Combined Ice-sheets</b>	<b>0.70 mm/yr</b>	<b>22%</b>	<b>0.15 m</b>	<b>24%</b>
<b>Land Water Storage</b>	<b>0.38 mm/yr</b> [0.26 to 0.49]	<b>12%</b>	<b>0.04 m</b> [-0.01 to 0.09]	<b>6%</b>
<b>Unattributed</b>	0.26 mm/yr	<b>8%</b>		
<b>Total</b>	<b>3.2 mm/yr</b> [2.8 to 3.6]	<b>100%</b>	<b>0.63 m</b> [0.45 to 0.82]	<b>100%</b>

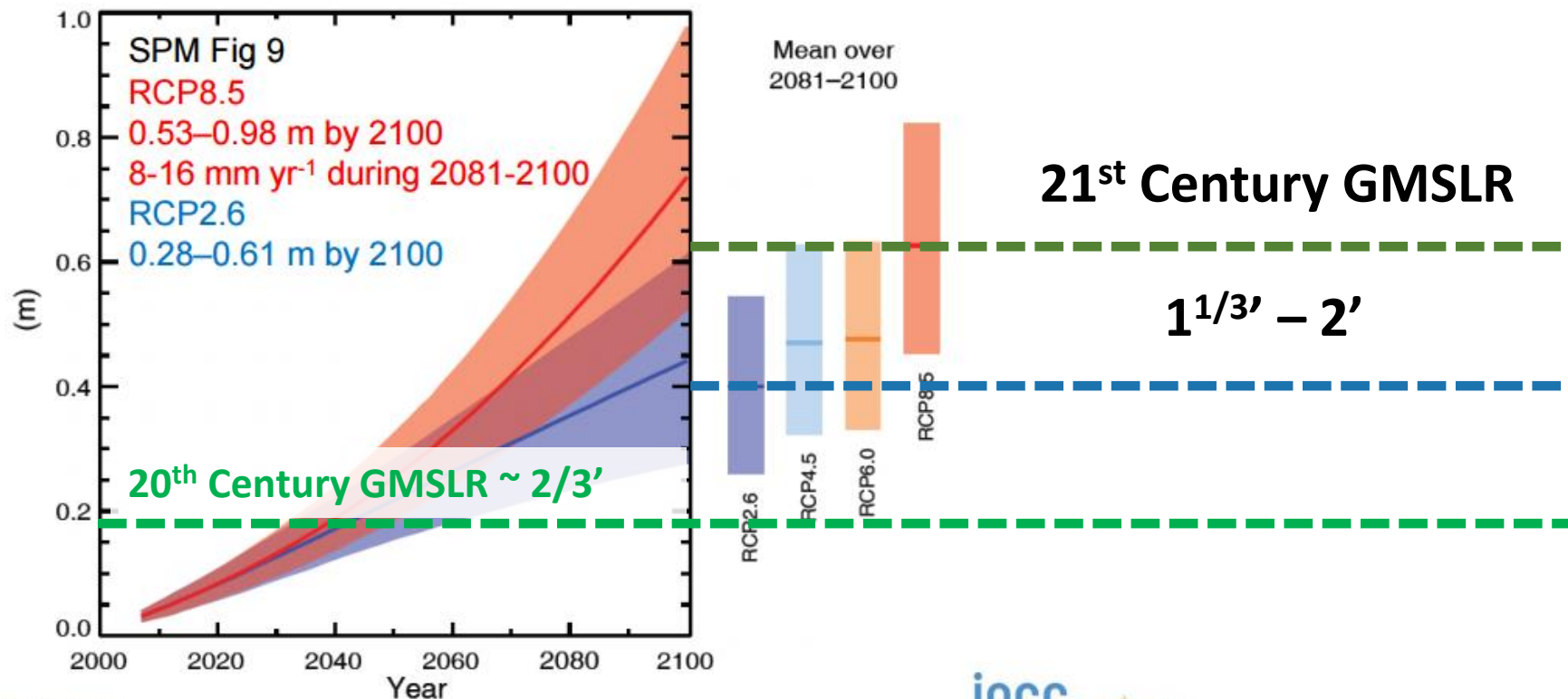
Table based on data from Church, J.A. et al., 2013: Sea Level Change. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F. et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

## Components to Relative Sea Level Rise: Texas Coastal Bend



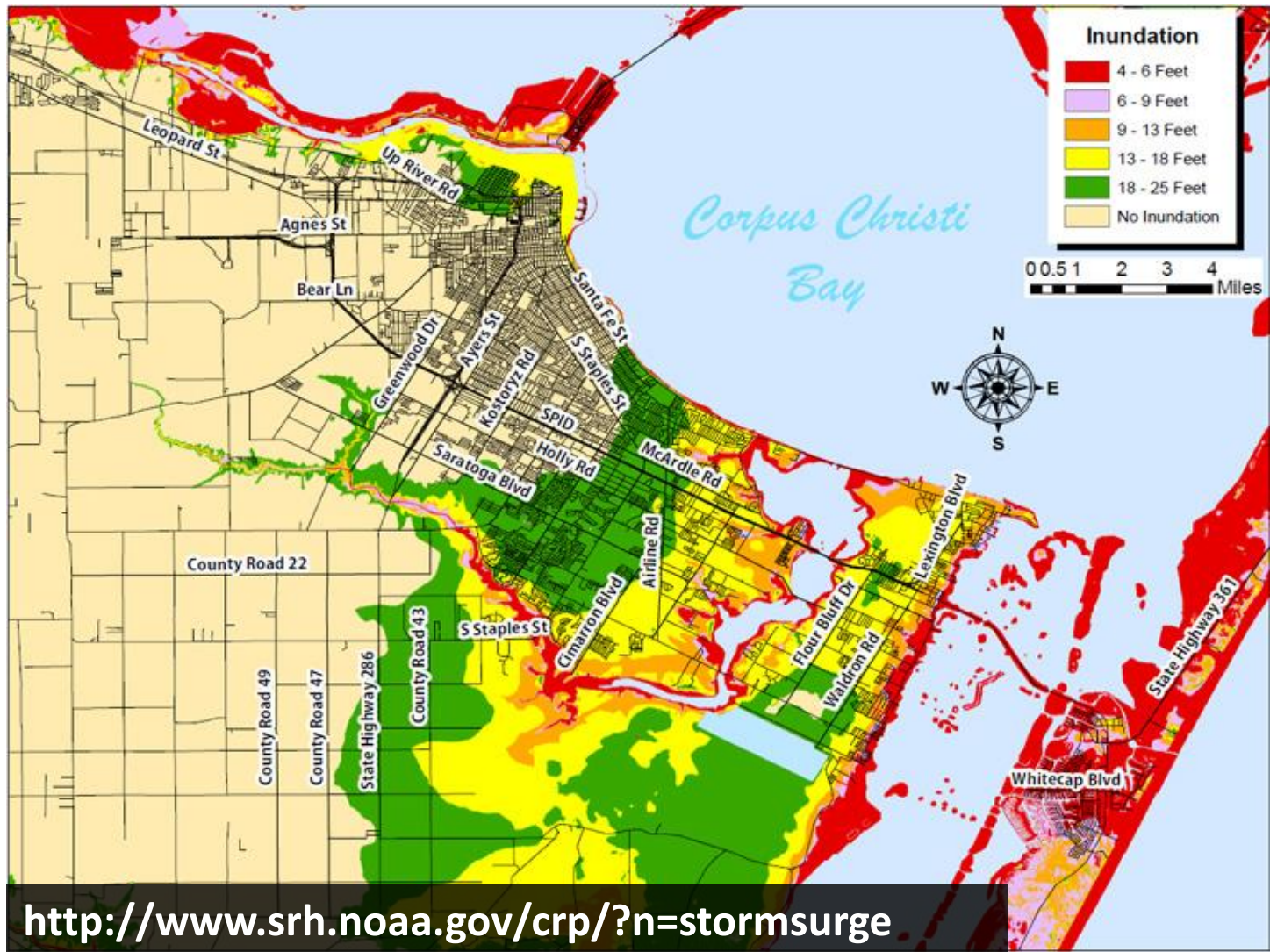
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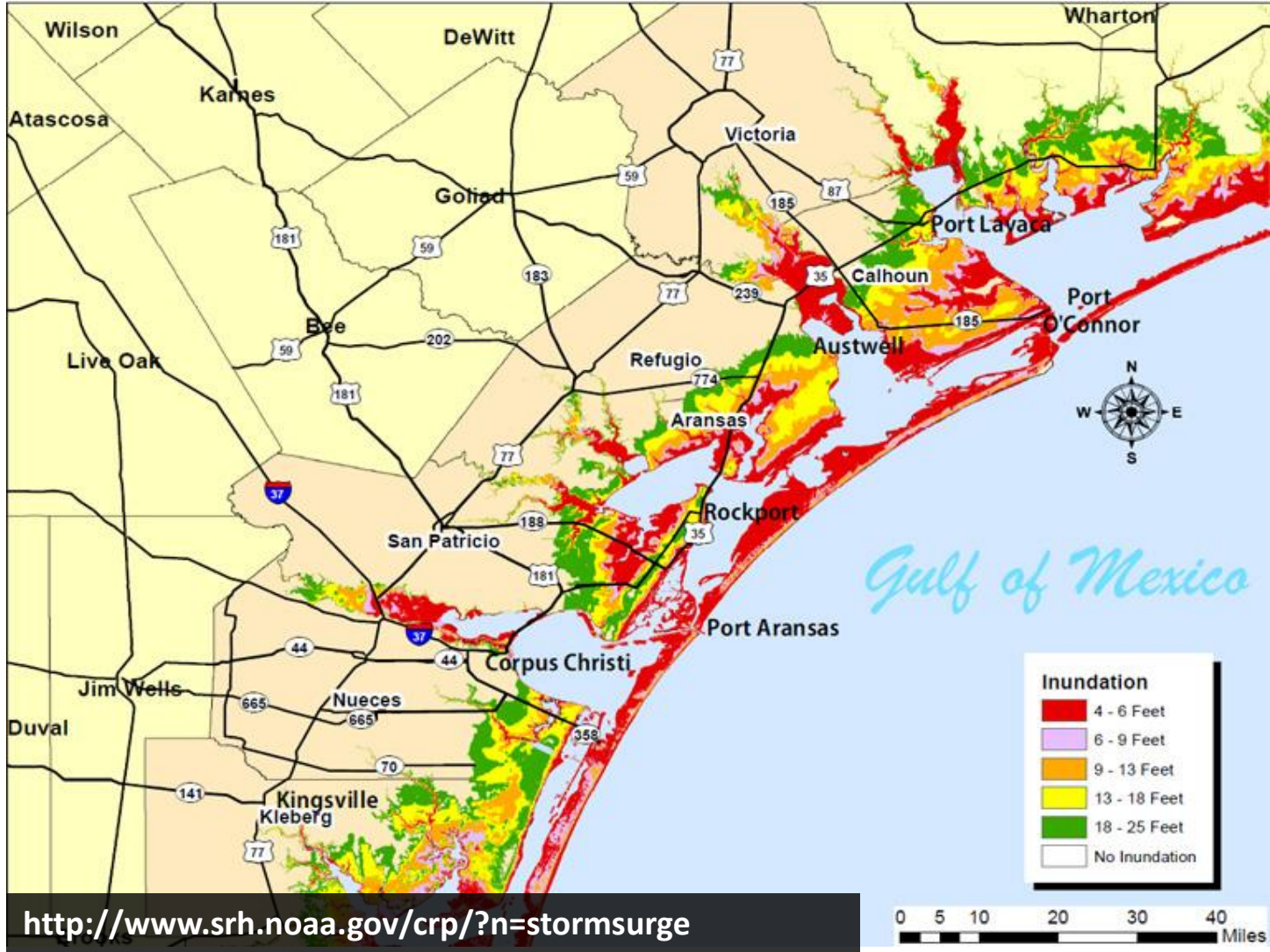


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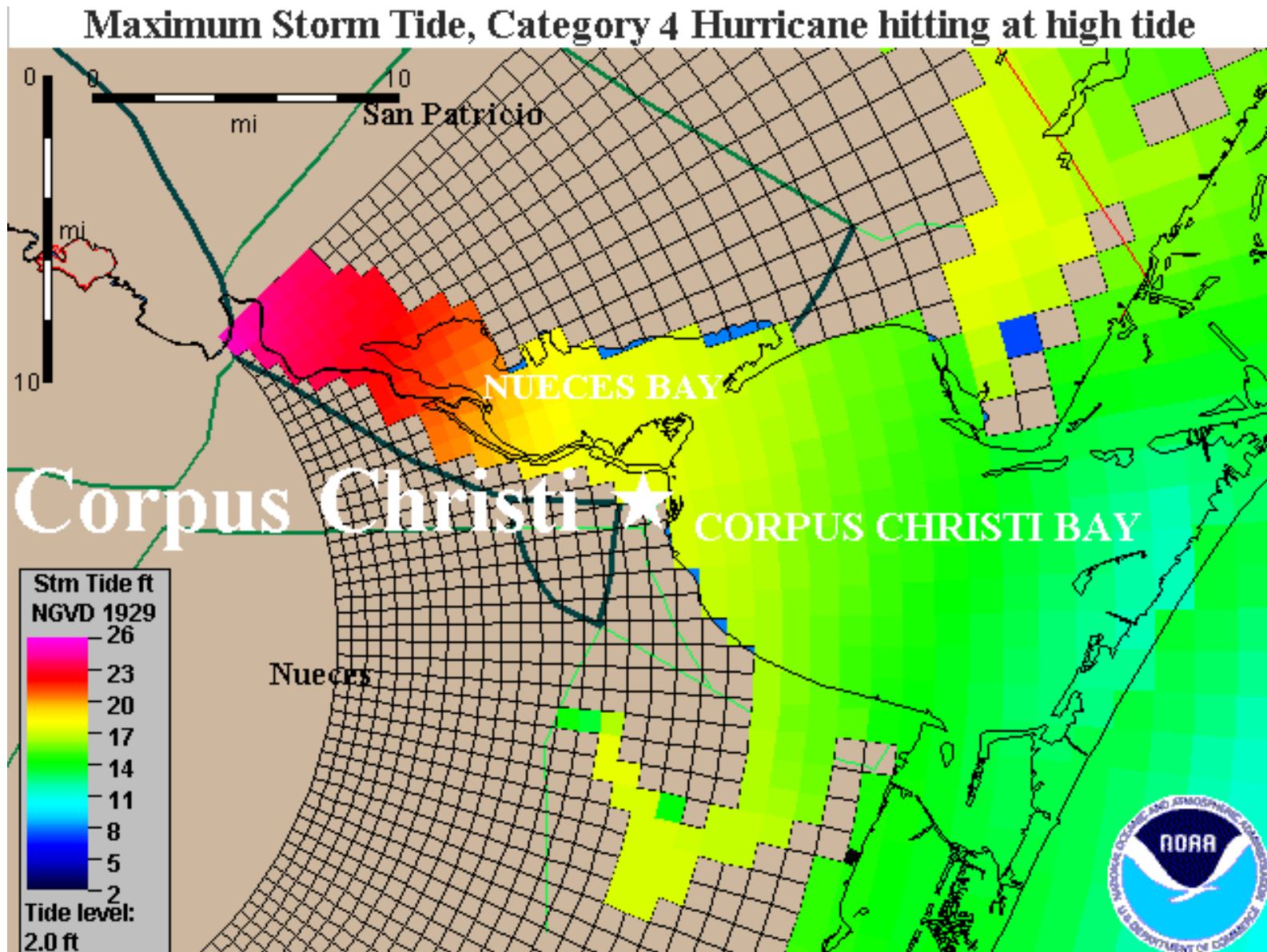
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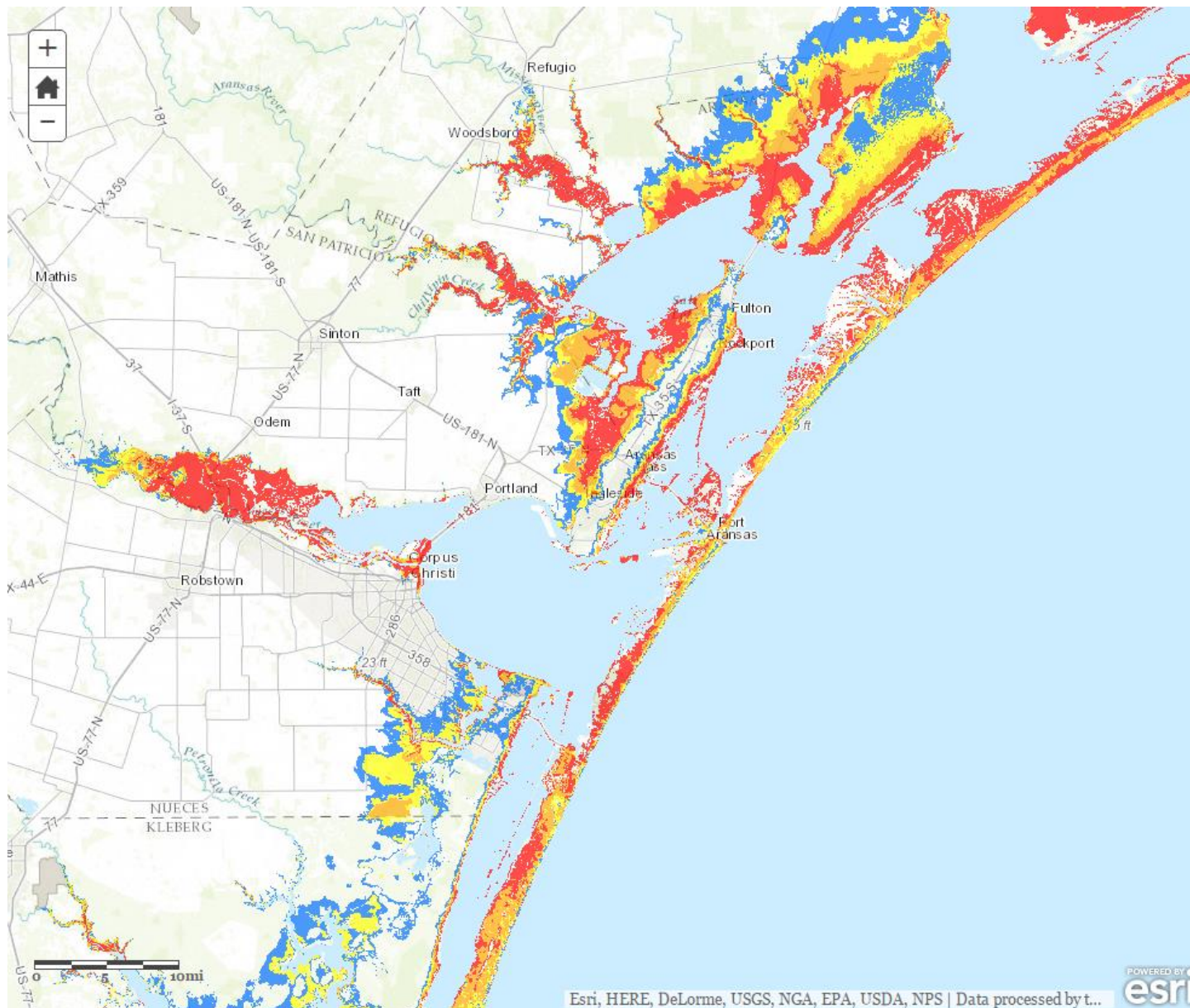
<http://www.srh.noaa.gov/crp/?n=stormsurge>



# Hurricane Impact



# Hurricane Impact



## Category 4 (SLOSH MOMs) Storm Surge Inundation

### Inundation Depth

- Up to 3 feet above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground
- Levee Areas - Consult Local Officials For Flood Risk