

2018 State of U.S. High Tide Flooding with a 2019 Outlook



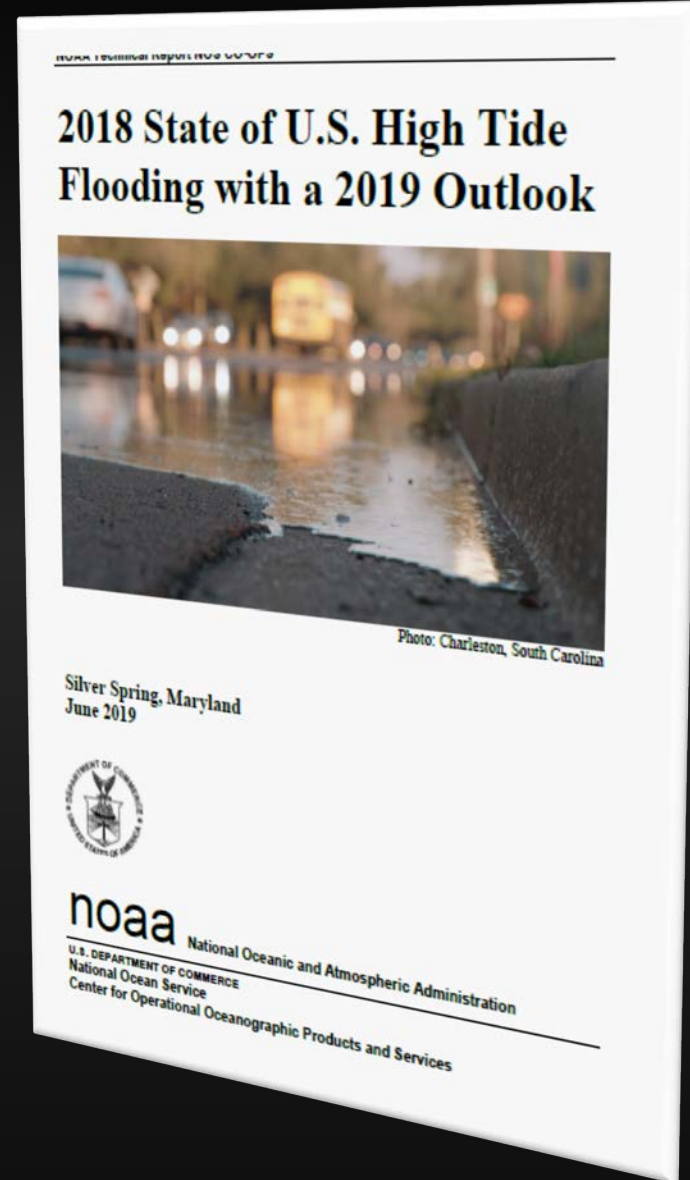
**USCLIVAR Workshop
August 6, 2019**

**William Sweet
NOAA CO-OPS Oceanographer**



Supporting NOAA Sea Level Rise Science and Services

1. Use societal impact thresholds
2. Map regions at risk to flooding
3. 'Score keep' event frequencies
4. Track trend changes
5. Give seasonal guidance
6. Provide annual and decadal projections



Sea Level Rise and Society

Sea level rise (SLR) flooding now happening in East Coast towns

Annapolis, MD



Charleston, SC



Norfolk, VA



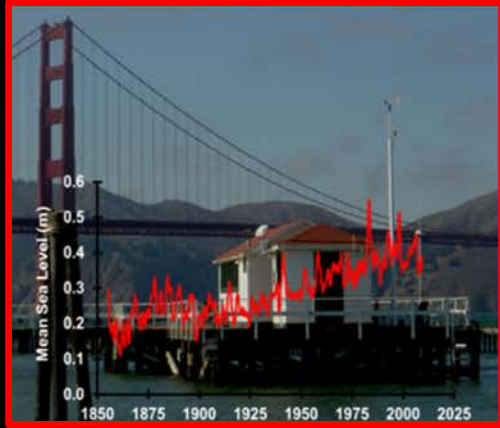
Global warming and SLR complicates **Decision Making**

In 2018, SLR and High Tide Flooding was:

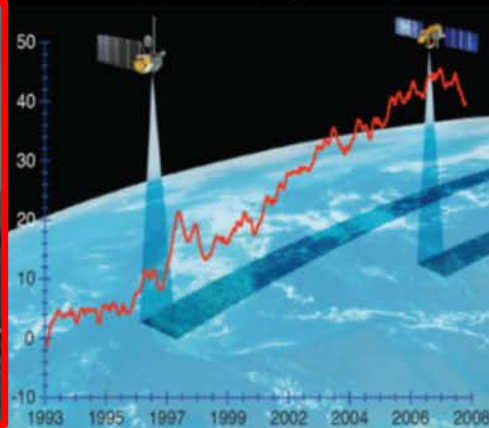
- **Clogging** storm water systems, **flooding** road ways and **disrupting** traffic along the U.S. East Coast
- **Interfering** with parking and commerce at stores in downtown Annapolis, Maryland
- **Raising** groundwater elevations and **degrading** septic system functionalities in South Florida
- **Salting** farmlands within coastal Delaware and Maryland

Global/Local sea level rise and measurement platforms

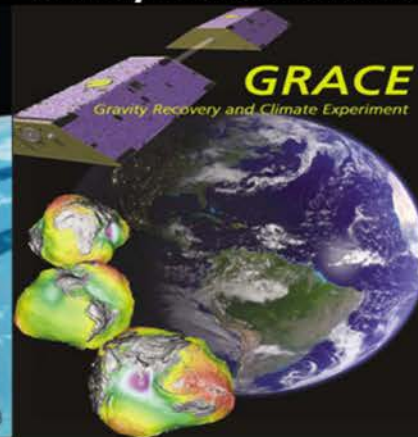
Water Level Stations



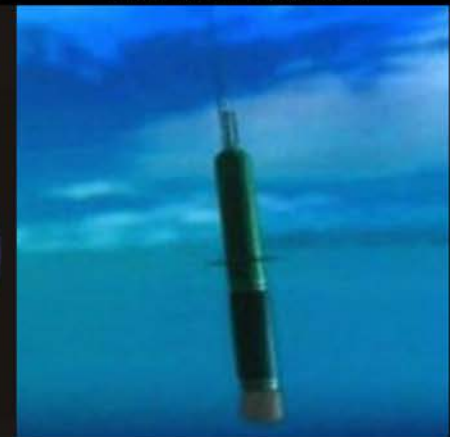
Satellite Altimeter



Gravity Measurements

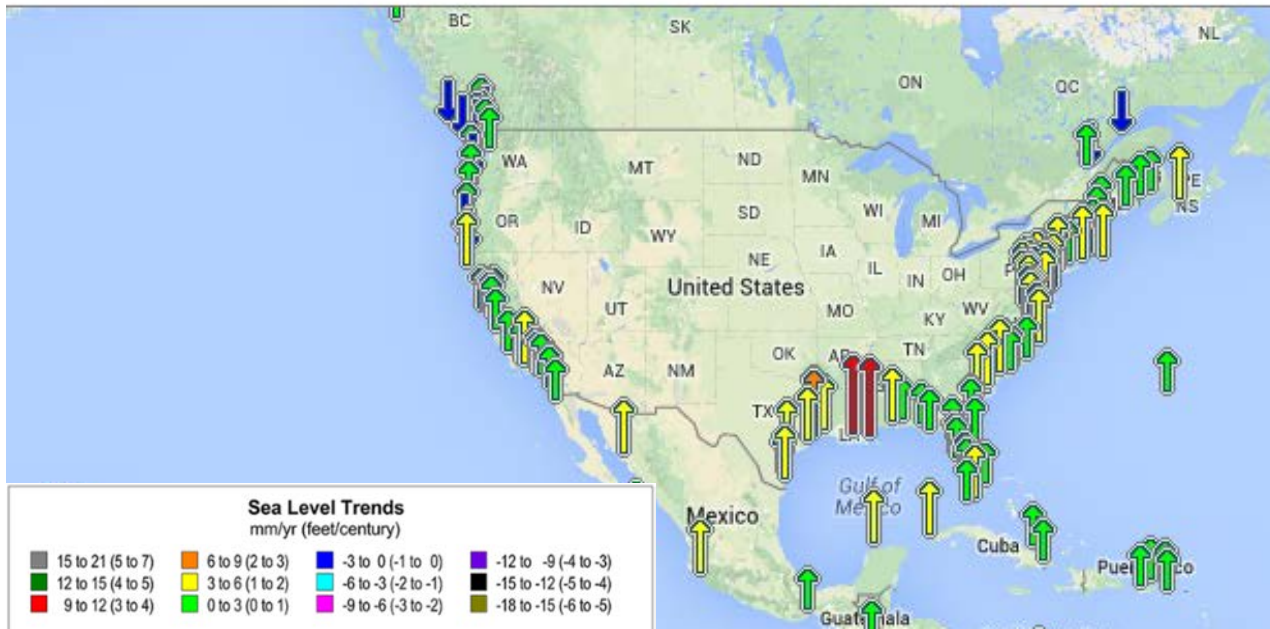


ARGO Profilers



(tidesandcurrents.noaa.gov/sltrends)

- East Coast
- West Coast
- Gulf Coast
- Alaska
- Hawaii
- Global



$$\begin{aligned}
 &\text{Local SLR} \\
 &= \\
 &\text{Global} \\
 &+ \\
 &\text{Regional} \\
 &+ \\
 &\text{Land Motion}
 \end{aligned}$$

Forecasting Weather and Communicating Impacts

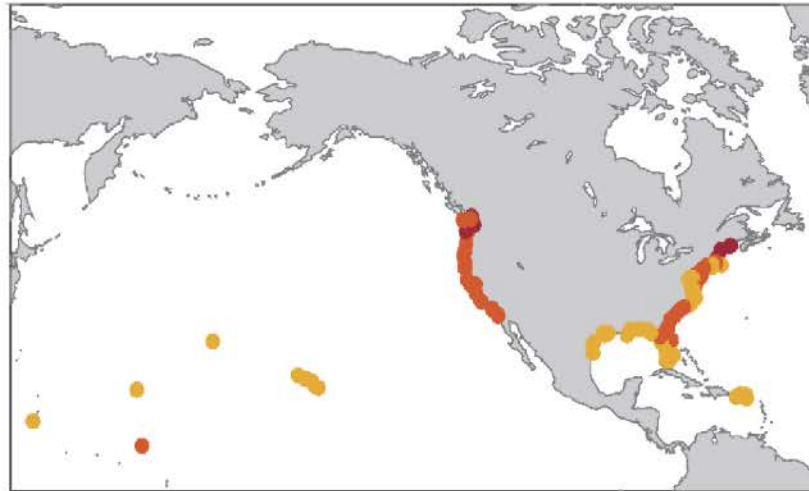


Coastal Flooding Thresholds

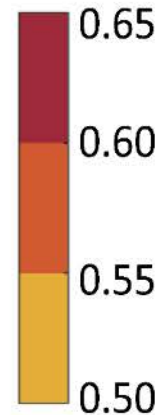
National Weather Service Wakefield, Virginia

a

A Nationally Consistent High Tide Flood Threshold Definition



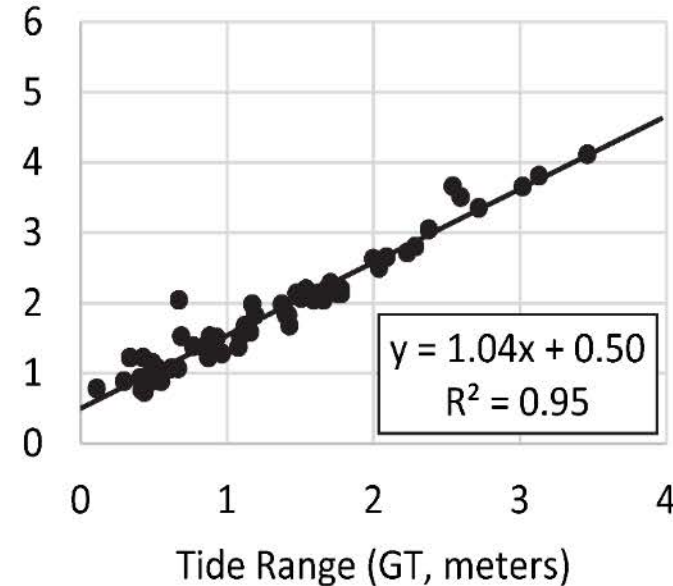
Meters
above
MHHW



b

Local High Tide Flood Threshold
($1.04 \times \text{Local GT} + 0.50 \text{ m}$)

NOAA NWS Flood Thresholds
(Meters above MLLW)



Sweet et al. (2018): Patterns and Projections of High Tide Flooding using a Common Impact Threshold

High tide (minor, nuisance) flooding used now by NOAA

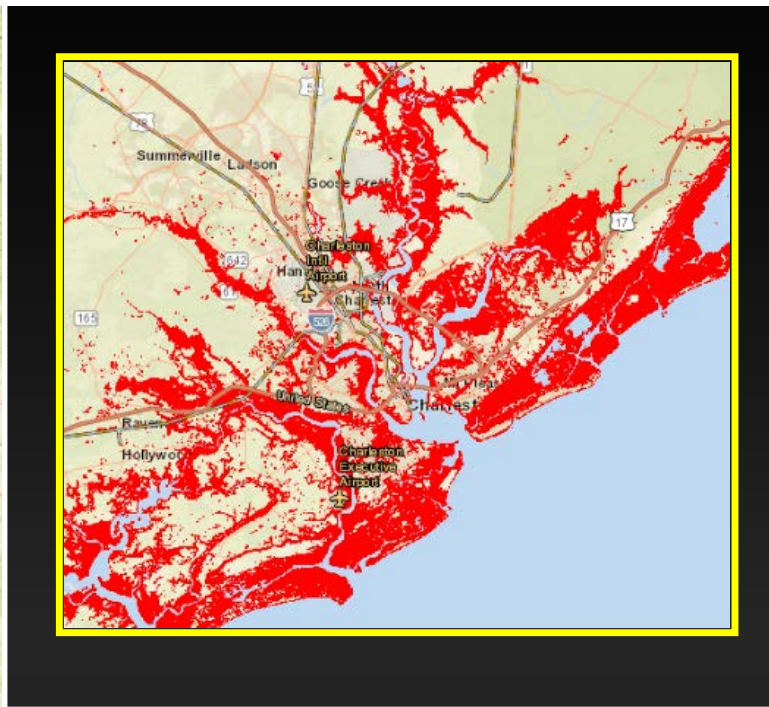


NOAA Tide Gauges and Monitoring Coastal Flooding



High Tide Flooding: Oct 24, 2017

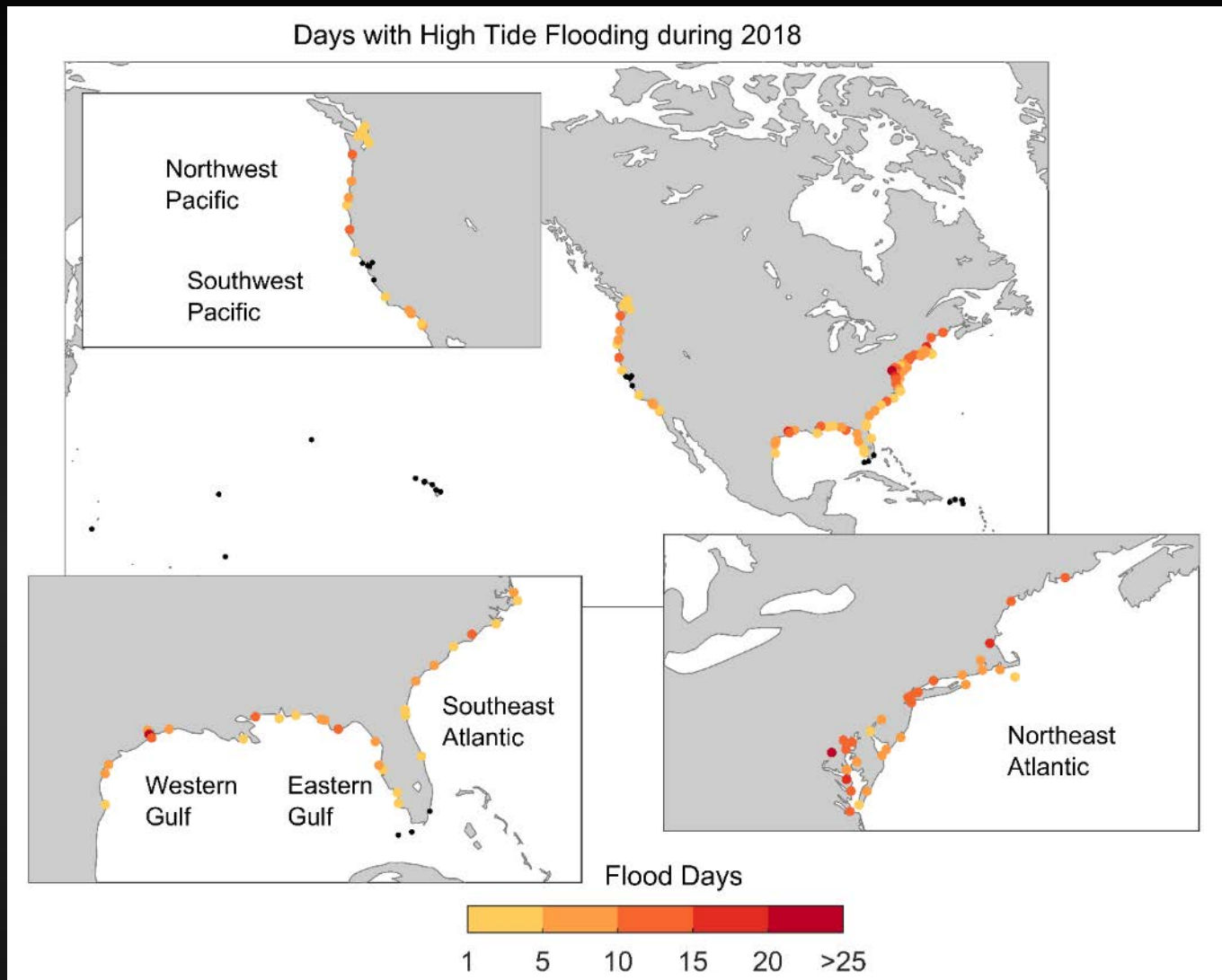
Land at Risk to High Tide Flooding (1.75 – 2')



<https://coast.noaa.gov/floodexposure>

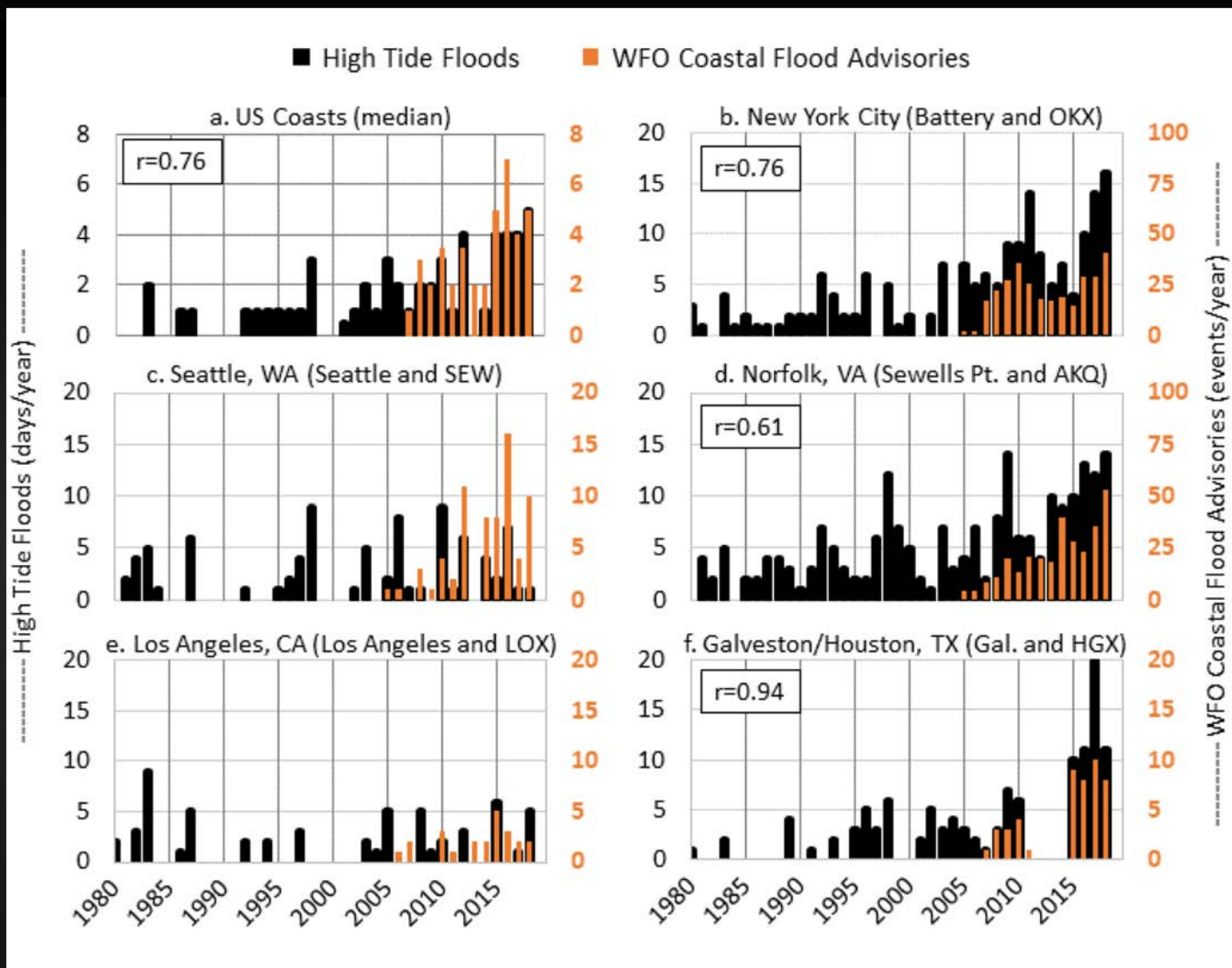


Monitoring and Score Keeping: 2018 High Tide Flooding



In 2018, 12 locations broke/tied records along the East and Gulf Coast

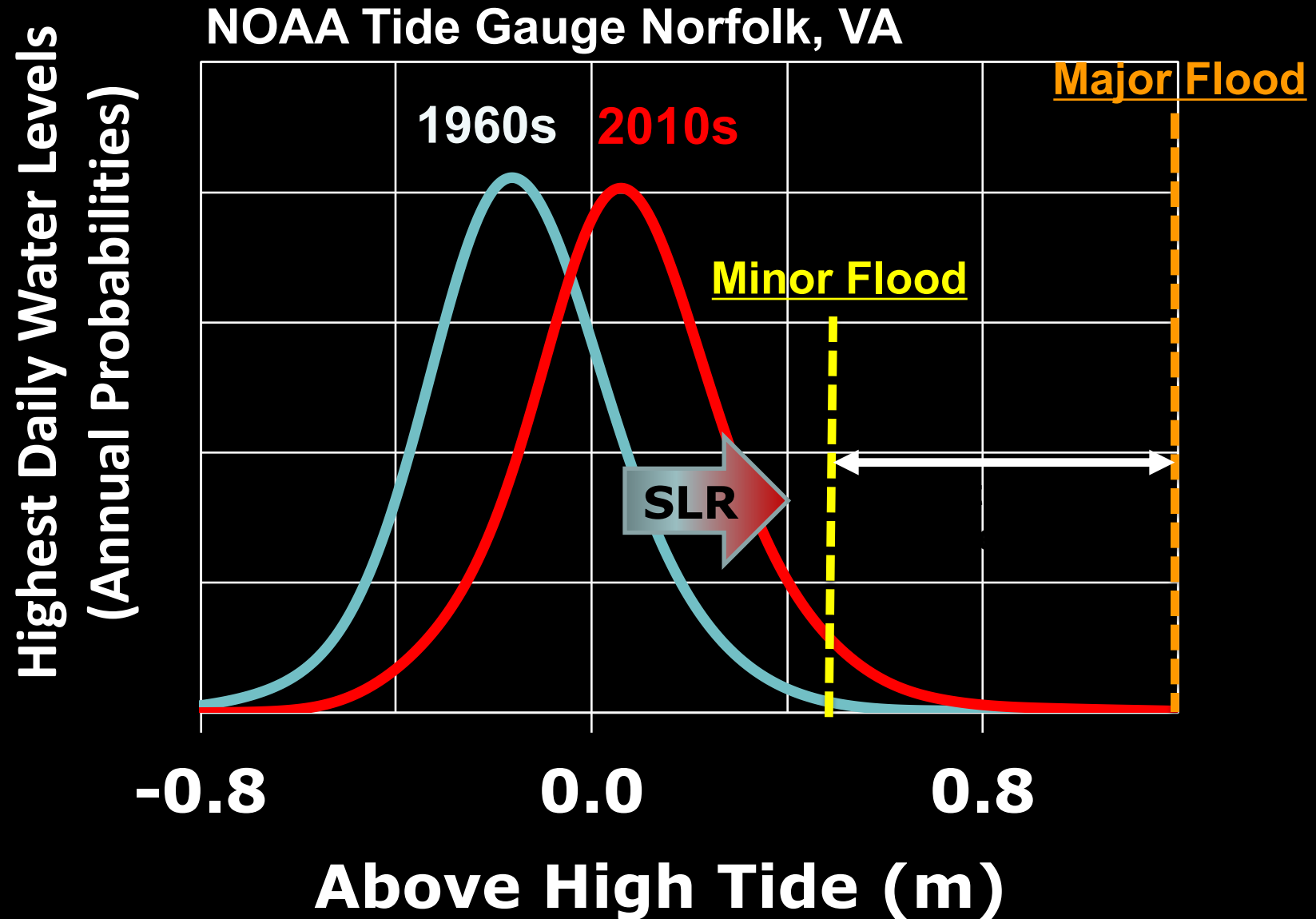
2018 Coastal Flood Advisories and Impacts



In 2018, 7 WFOs issued a record number of advisories. **Weather meet climate, climate weather.**



Tracking Change: Goodbye Freeboard, Hello Flooding

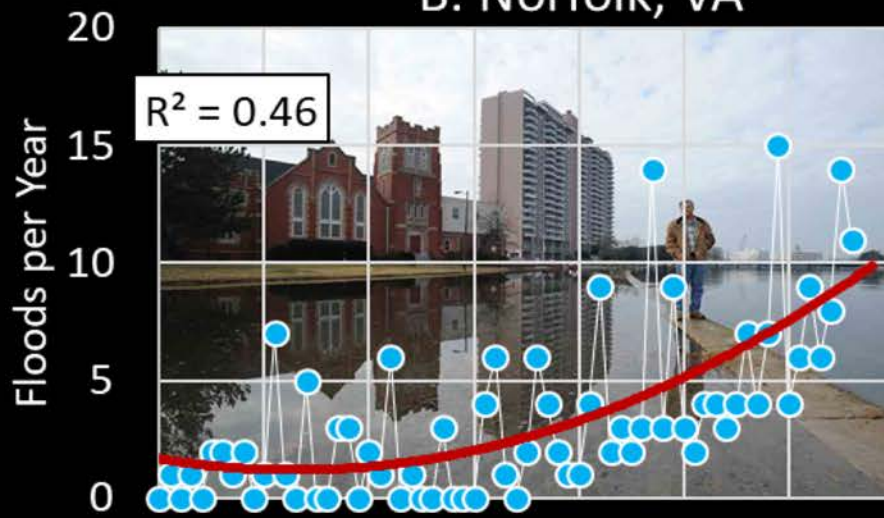


Tracking Changes in High Tide Flood Frequencies

A. Atlantic City, NJ



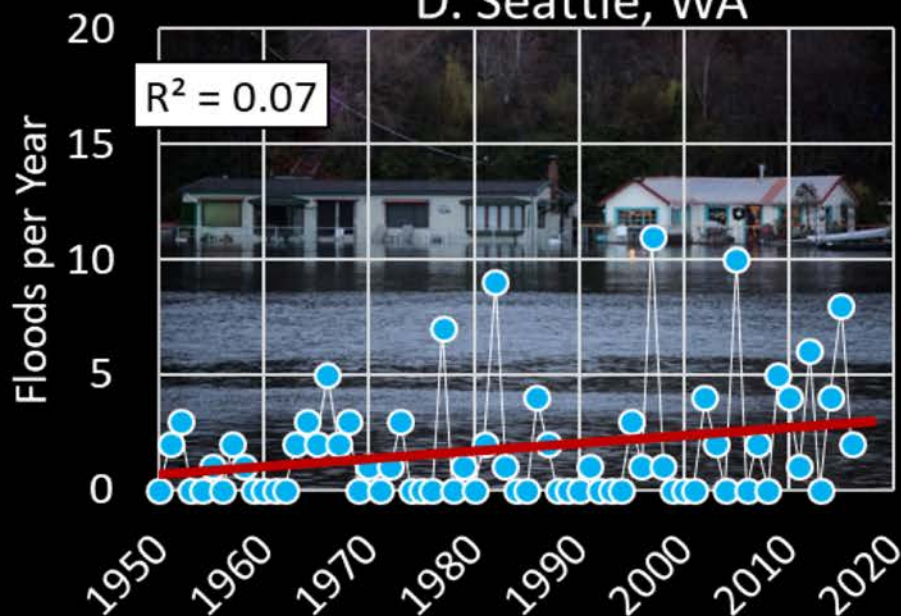
B. Norfolk, VA



C. San Diego, CA

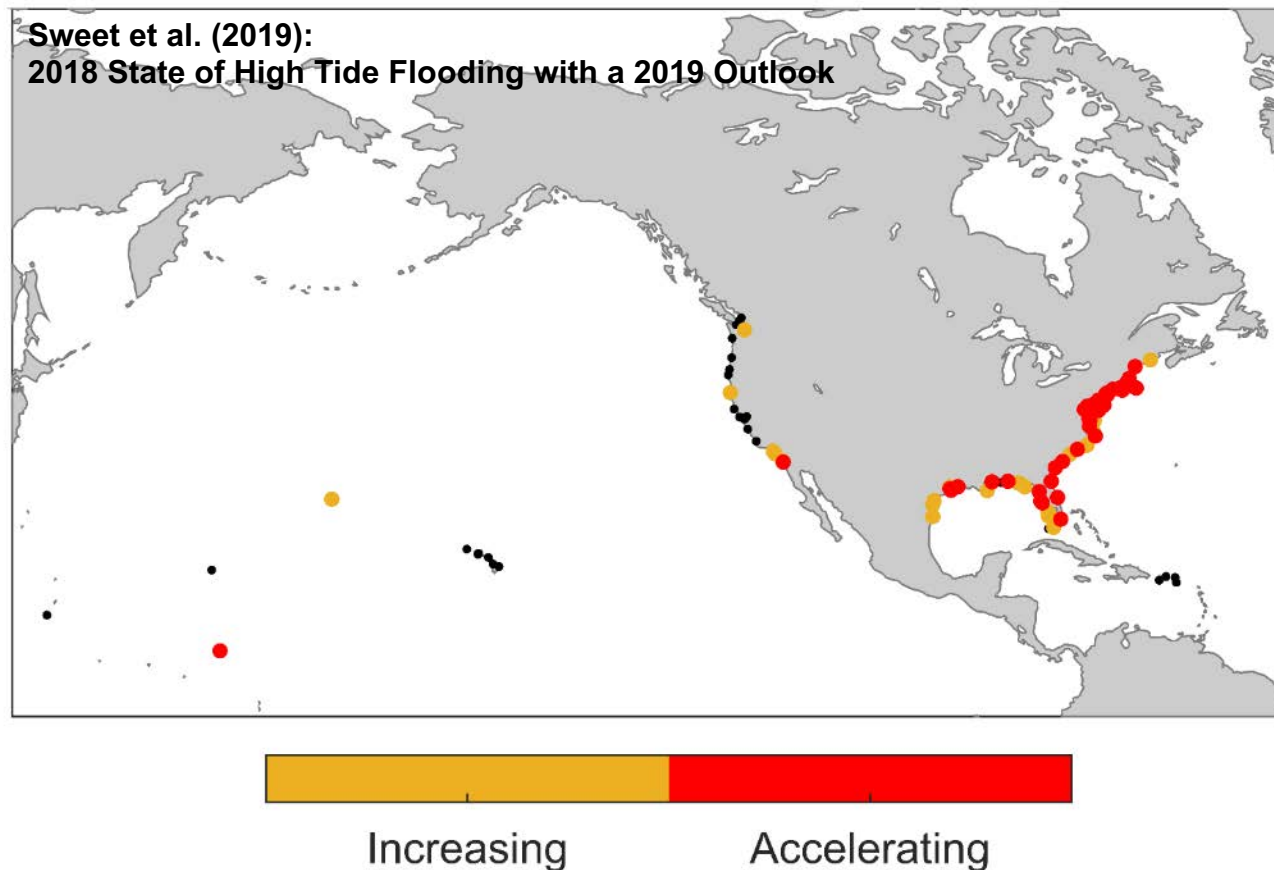


D. Seattle, WA



Trend Changes in High Tide Flood Frequencies

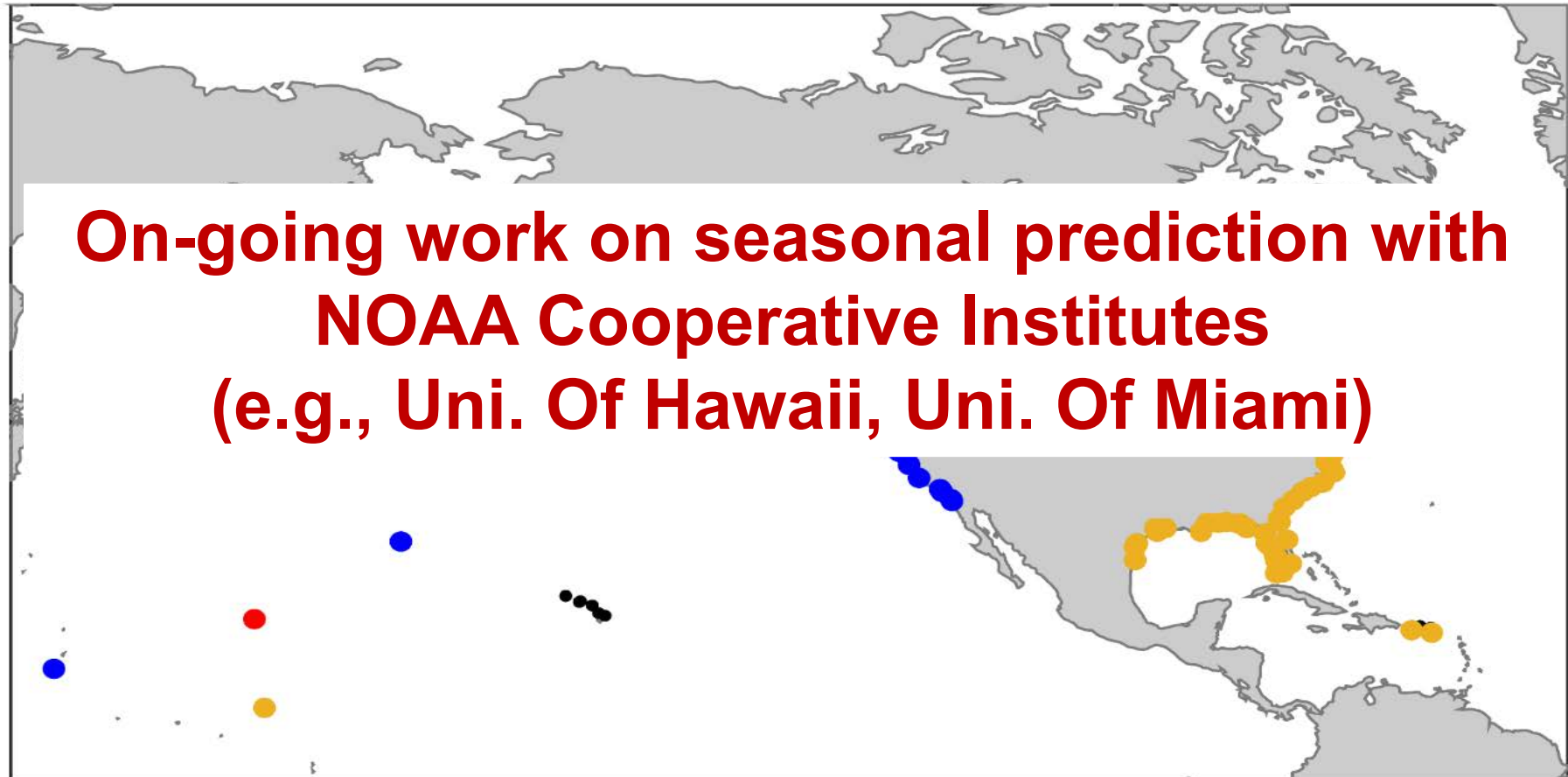
b. Decadal Trends in Annual Flood Frequencies



**Annual rates at >40 locations are accelerating.
Dozens of others (linear rates) are headed that way.**

Seasonality and Driver(s) of High Tide Flooding

a. Season with highest frequency of high tide flooding



On-going work on seasonal prediction with NOAA Cooperative Institutes (e.g., Uni. Of Hawaii, Uni. Of Miami)

Peak Season

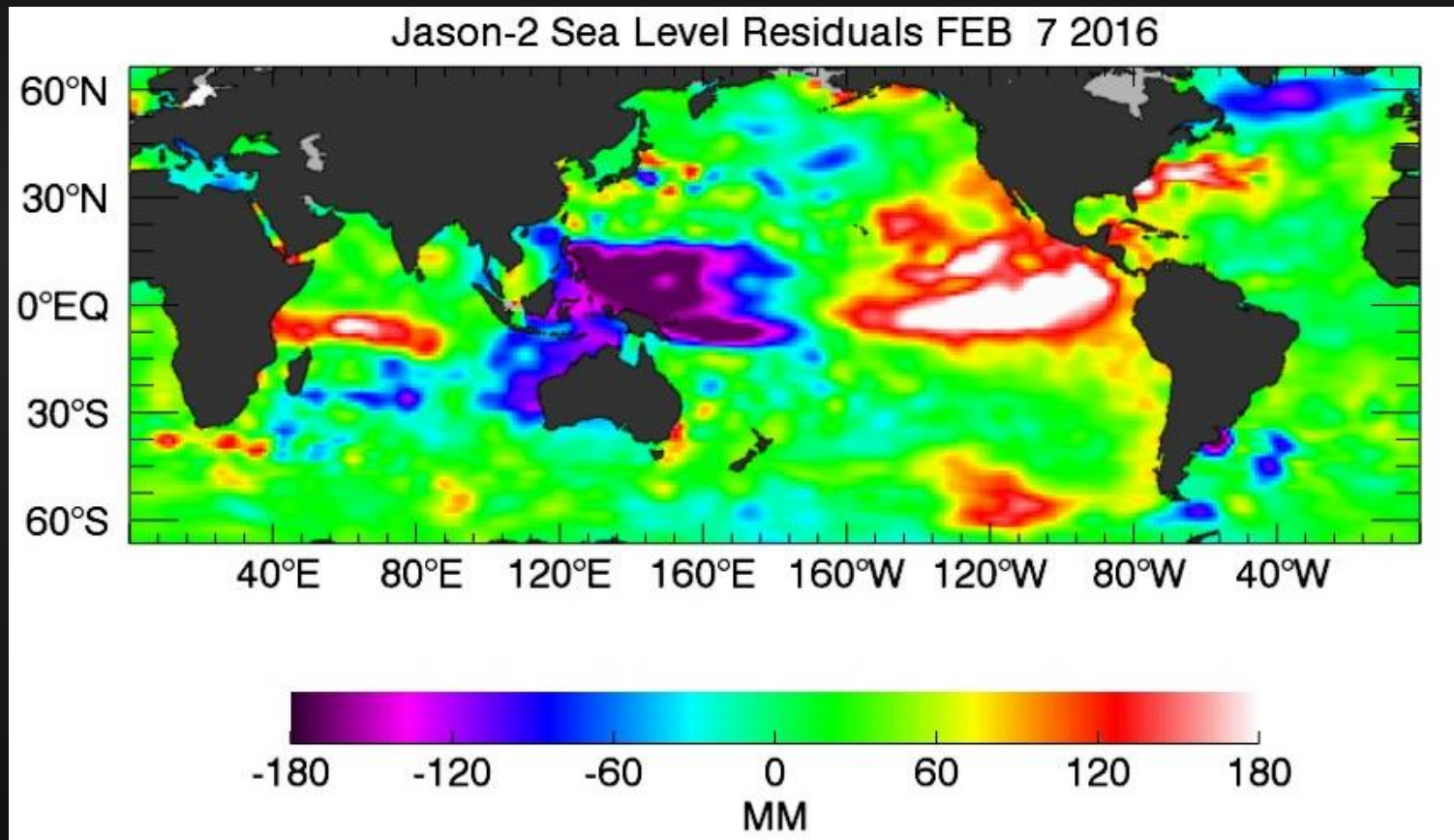


spring summer fall winter

Annual Projections and El Nino

West Coast:

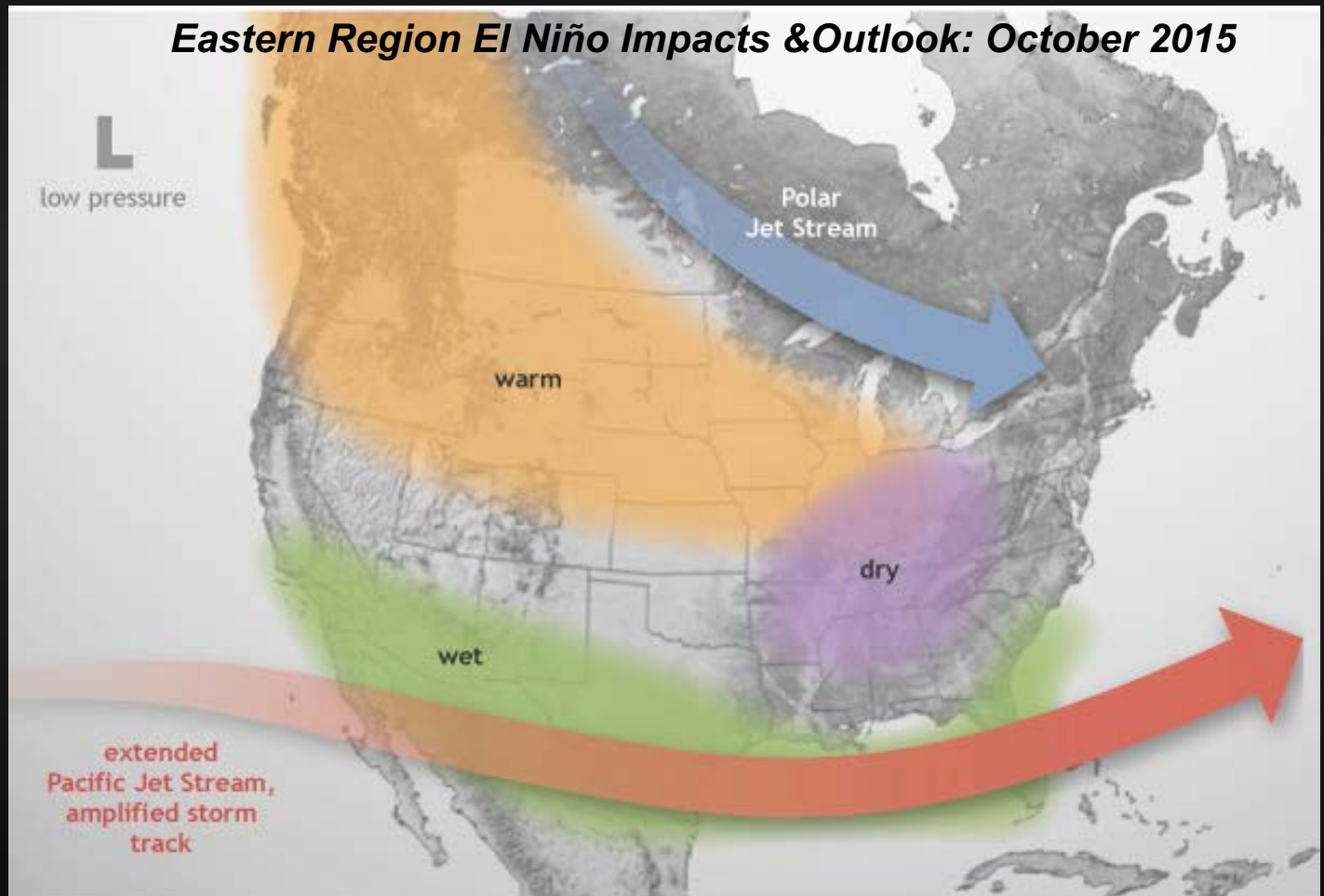
Higher ocean temperatures, sea levels for months increase the reach of (sometimes more) storms and tides



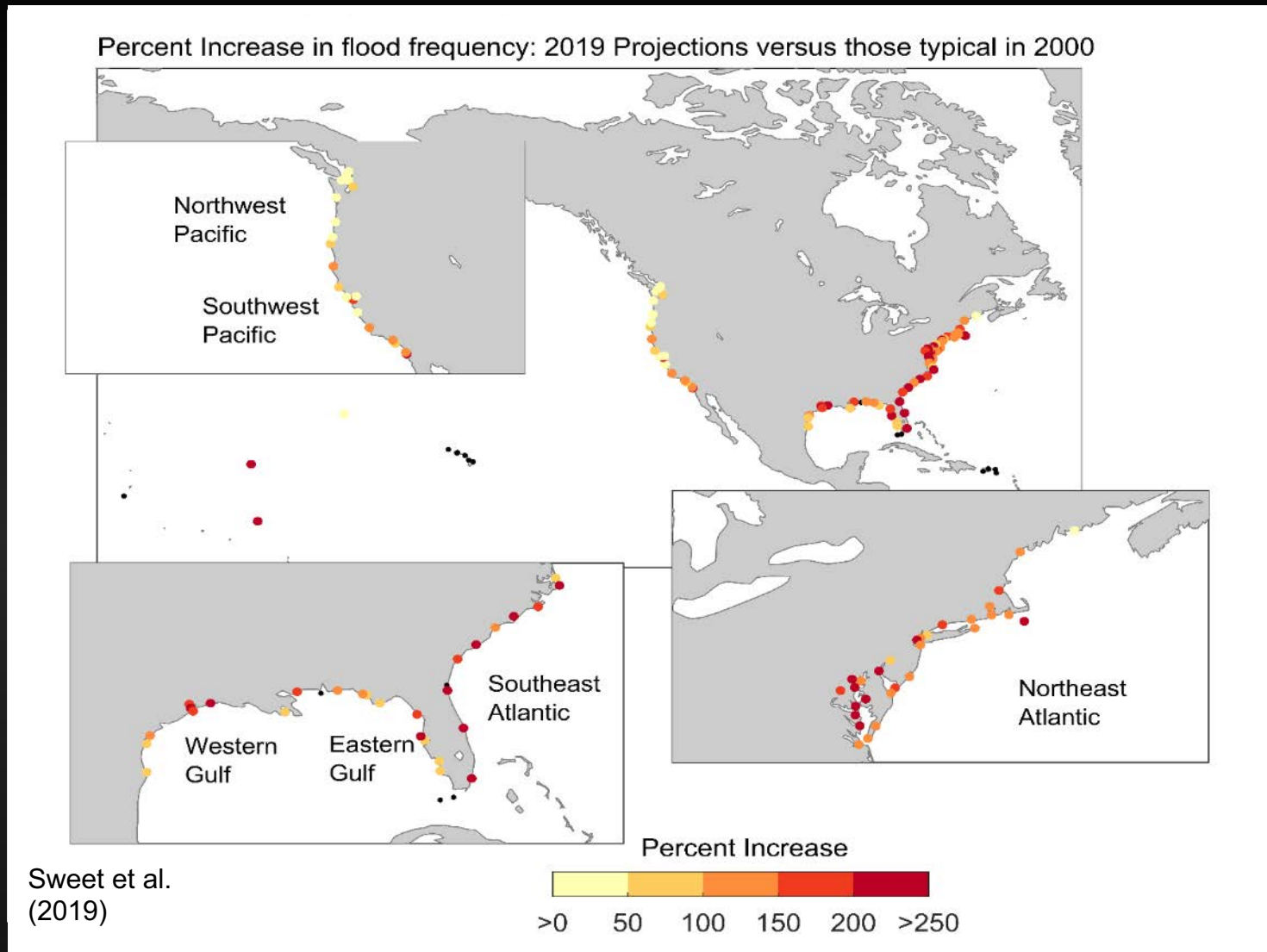
El Niño: More West & East Coast Tidal Flooding

East Coast:

More northerly wind forcing with more frequent storms, surges and/or (quiet) anomalies



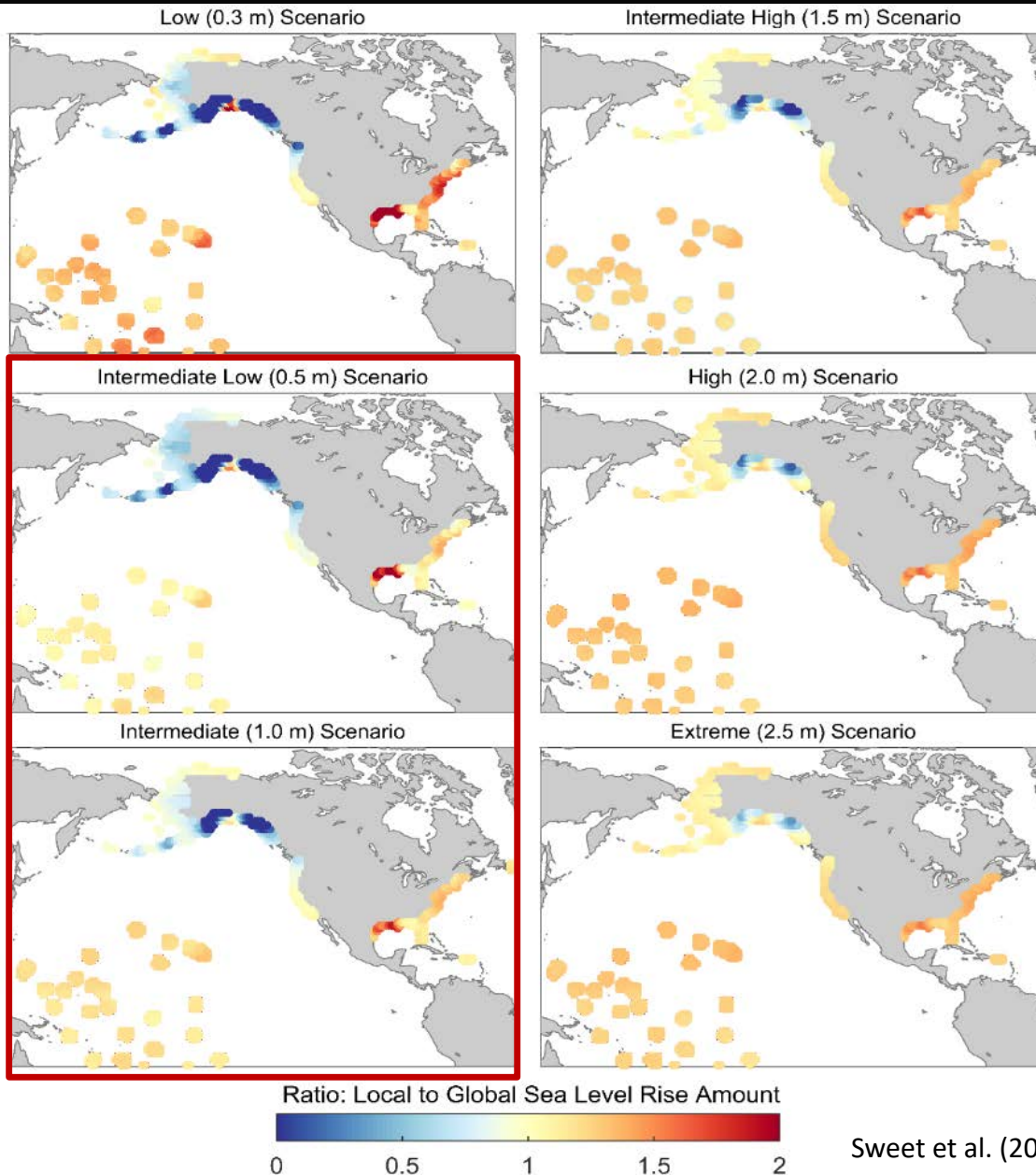
2019 High Tide Flood Projections: SLR and El Nino



Annual flood rates at >40 locations are typically higher during El Nino, which may persist through 2020.



Decadal Projections: NOAA SLR Scenarios

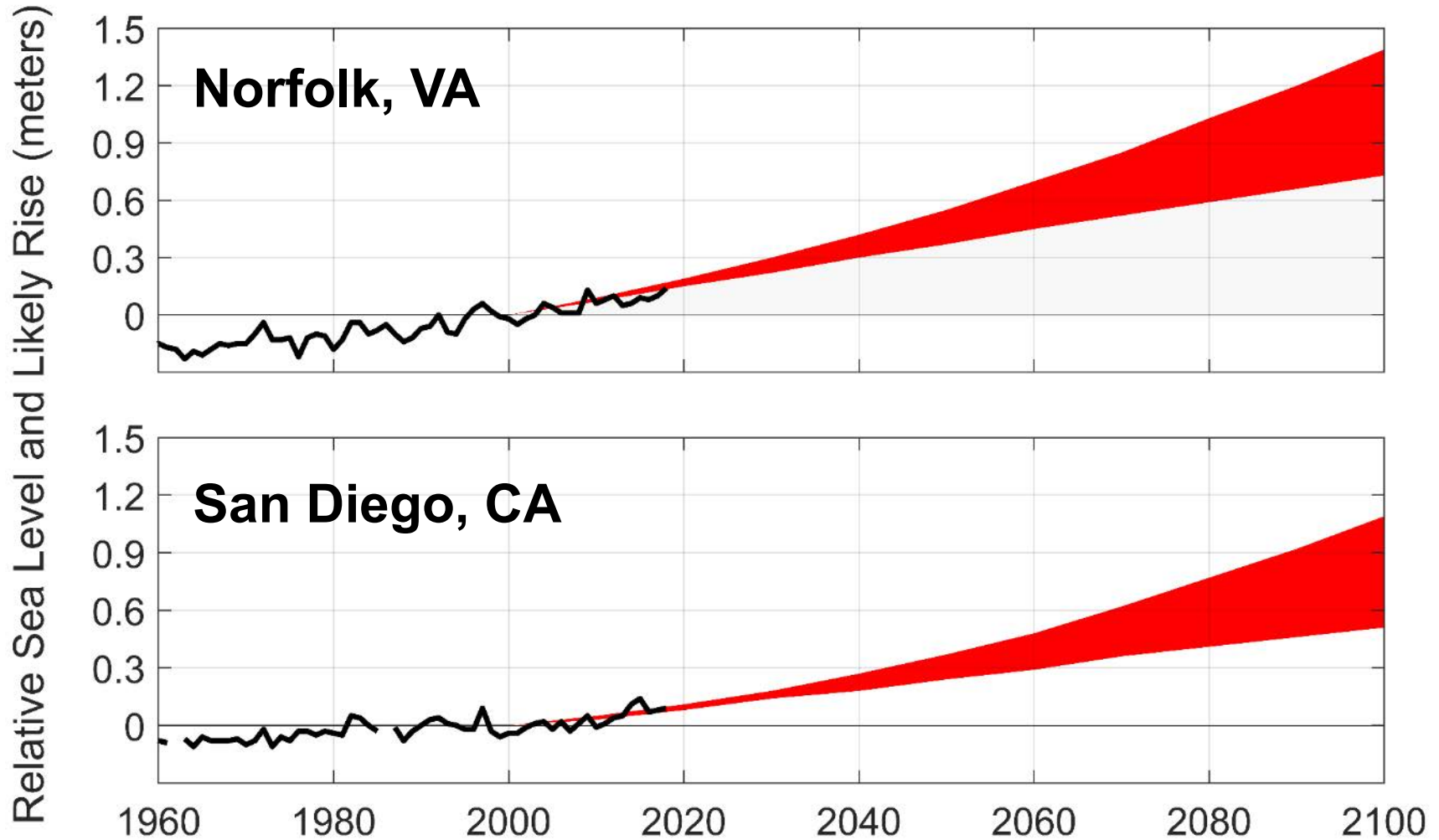


Includes changes in:

- Ocean circulation
- Earth's gravitational field & rotation
- Vertical land motion

Rise consider 'likely' to occur bounded by **Int. Low & Int. Scenario**

Decadal Projections: Trajectory & 'Likely' SLR Rise

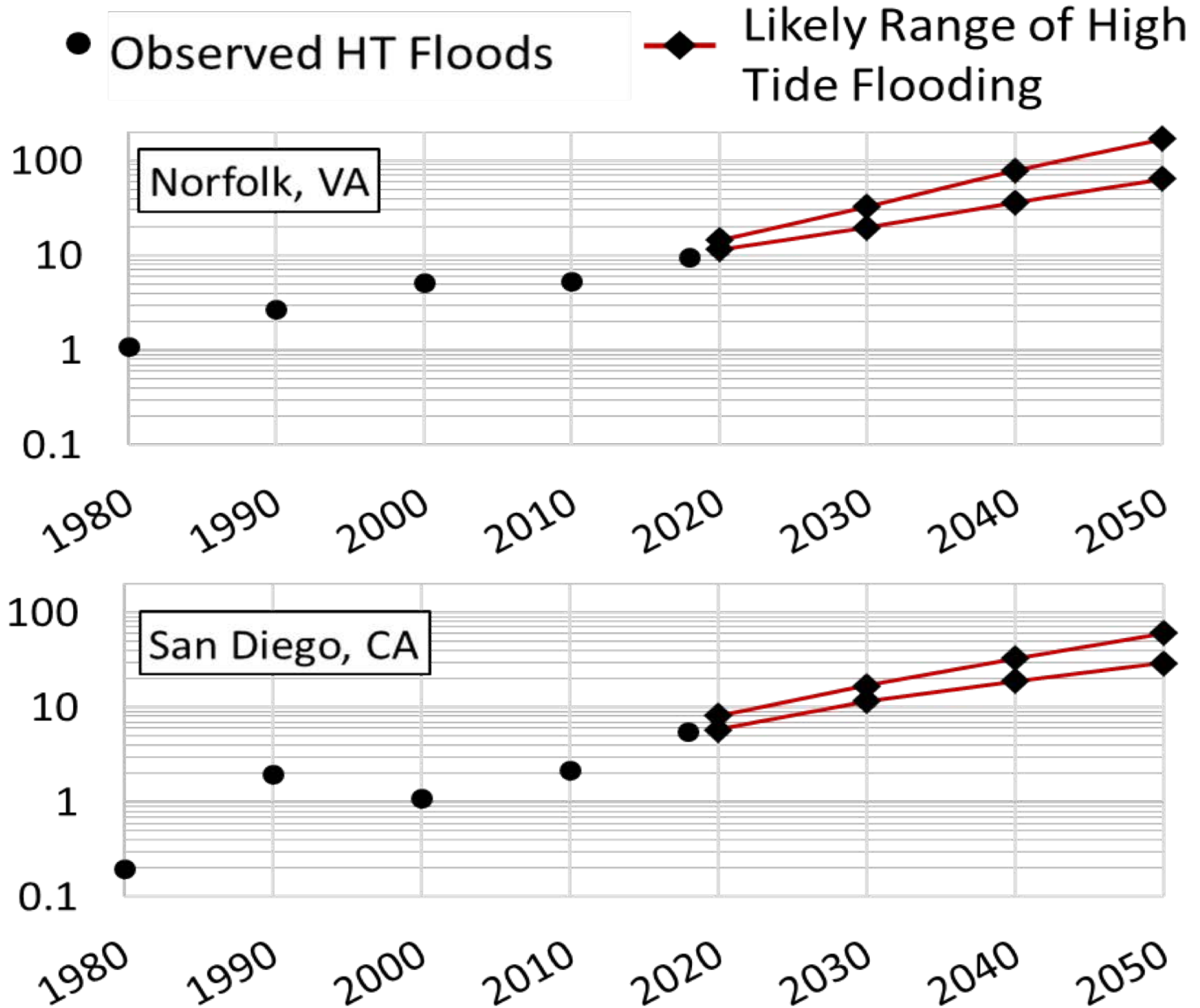


<https://tidesandcurrents.noaa.gov/sltrends>



Projecting Changes in High Tide Flooding

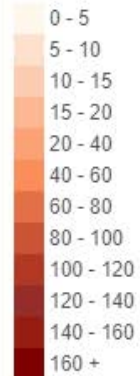
Average Annual High Tide Flooding by Decade
(Days per Year)



New NOAA High Tide Flood Web Product



Projected High Tide Flood Days in 2019



Select Year ▾

Los Angeles, CA

| Year | Flood Days |
|------|------------|
|------|------------|

| | |
|------|---|
| 2018 | 5 |
|------|---|

Projected High Tide Flood Days

| Year | Flood Days |
|------|------------|
|------|------------|

| | |
|------|-----|
| 2019 | 1-4 |
|------|-----|

| | |
|------|------|
| 2030 | 6-10 |
|------|------|

| | |
|------|-------|
| 2050 | 15-40 |
|------|-------|

Average No. of flood days in 2000: 1
Record No. of flood days as of 2017: 6

Flood threshold is 0.57m above MHHW

<https://tidesandcurrents.noaa.gov/tideOutlook2019/>

Questions: Contact William Sweet
(william.sweet@noaa.gov)

