Projections of Recurrent Tidal Flooding

NOAA CPO MAPP: High Water Levels Seminar

March 23, 2016

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Coastal communities: prepare and plan for rising tides now!

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Charleston plans to complete major projects to address downtown flooding by 2020

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Miami Beach in race to control flood ahead of annual King Tide

Pumps, such as the one at left, were designed to counteract rising waters. In Miami in October 2012, left, tides flooded bus stations. Daniel Bock; Joe Raedle/Getty Images

What Climate Change Looks Like: Miami's $300 Million Pumps

- **Storm/tidal flooding follows a regional seasonality.**
- **Sea Level Rise (SLR) is causing rapid growth in annual flood frequencies.**
- **<u>El Niño</u> Southern Oscillation compounds this trend.**

Setting the Stage: Seasonal/Annual Tidal Flood Projections

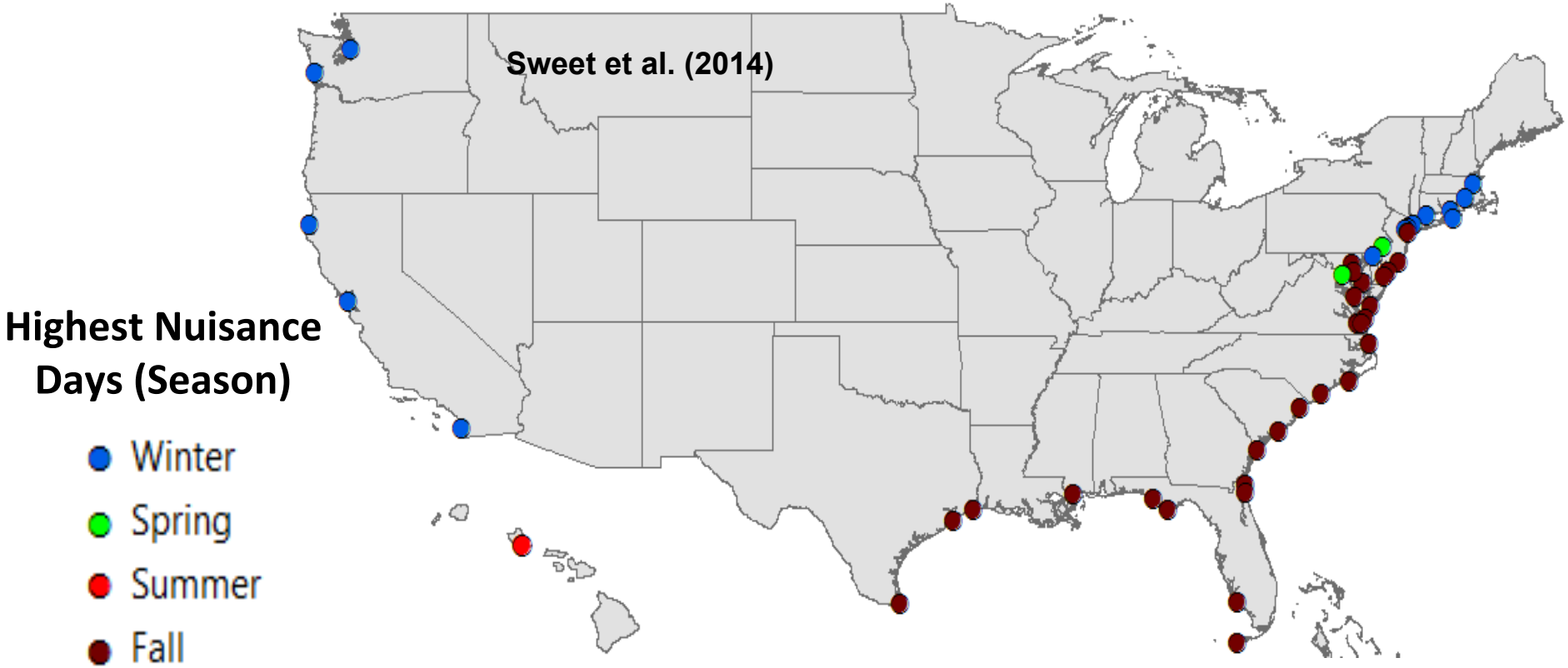
- Define (nuisance) high-tide thresholds
- Identify seasonal/regional patterns in physical forcing and high water climatologies
- Establish contemporary (accelerating) baseline from SLR
- Quantify inter-annual El Nino Southern Oscillation (ENSO) effects via a bivariate (SLR, ENSO) statistical model
- Provide "empirical" projections of tidal flood frequencies using IRI/CPC ENSO predictions

NOAA Tide Gauges and Flood Impact Levels

Minor or nuisance impacts occur locally around U.S. when water levels reach 1-2' above high tide on NOAA tide gauges.

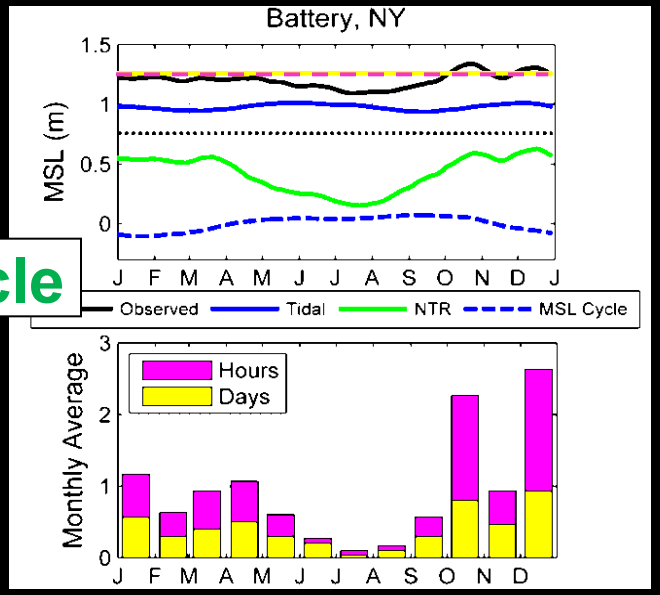
Elevation thresholds are determined locally by the National Weather Service.

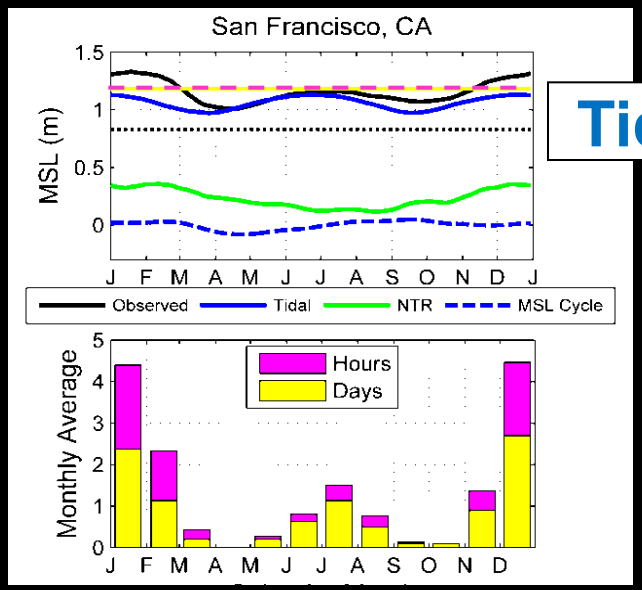
Seasonal and Regional High Tide Flooding Patterns



Seasonal and Regional High Tide Flooding Patterns

Nuisance Flood Level ····· MHHW Tidal Datum Elevation

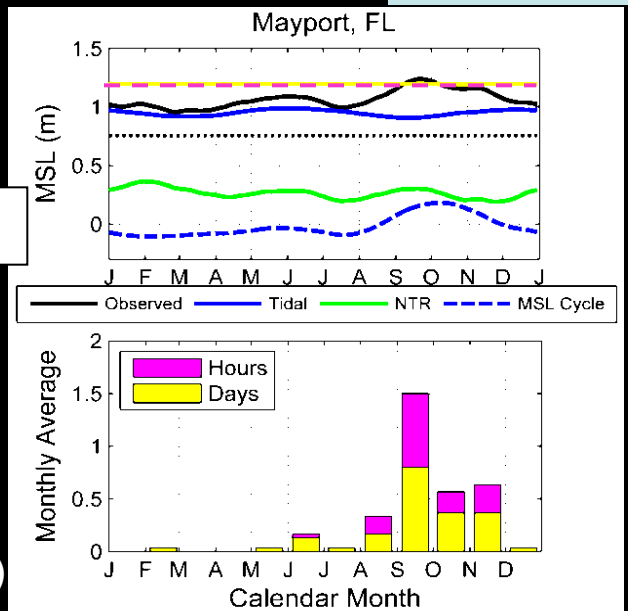


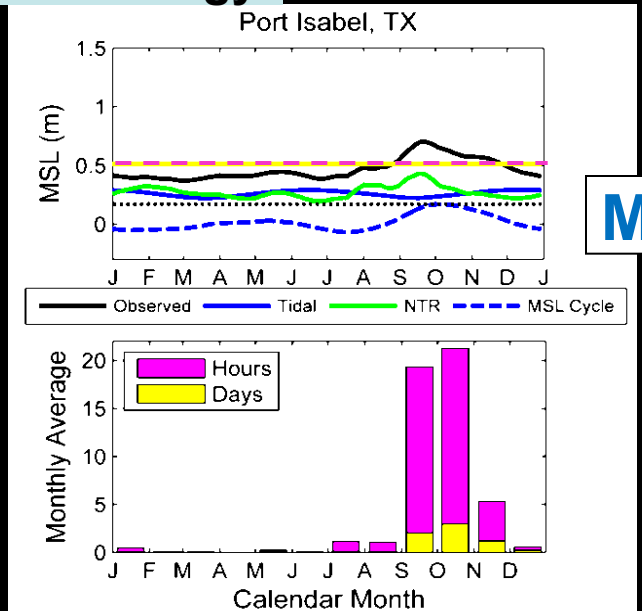


Storm cycle

Tidal cycle

1980-2010 Climatology





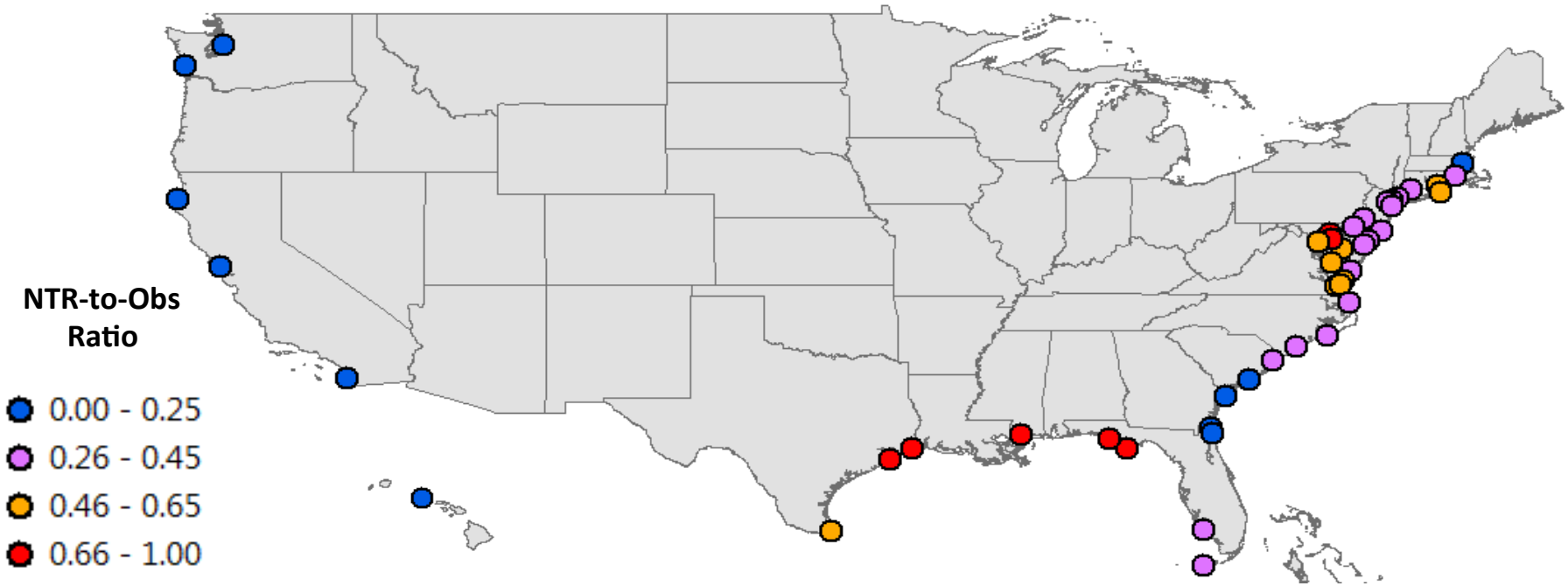
MSL cycle

MSL cycle

Sweet et al. (2014)

Seasonal and Regional High Tide Flooding Patterns

Blue = tide-cycle driven & ~predictable (king tide)
Red = more random; event driven (storm or anomaly)



Sweet et al. (2014)

Seasonal and Regional High Tide Flooding Patterns

Seasonal and Regional High Tide Flooding Patterns

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Coastal Flood Advisory In Effect Until 6 p.m.

October 3, 2014 12:00 PM

Related Tags: Annapolis, Anne Arundel County, coastal flooding, flood advisory, Flood Watch

ANNAPOLIS, Md (WJZ) — A coastal flood advisory is in effect until 6p.m. tonight for Annapolis and parts of Anne Arundel County.

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Baseline Changes in Local Mean Sea Level

Relative Sea Level Trends
(tidesandcurrents.noaa.gov/sltrends)

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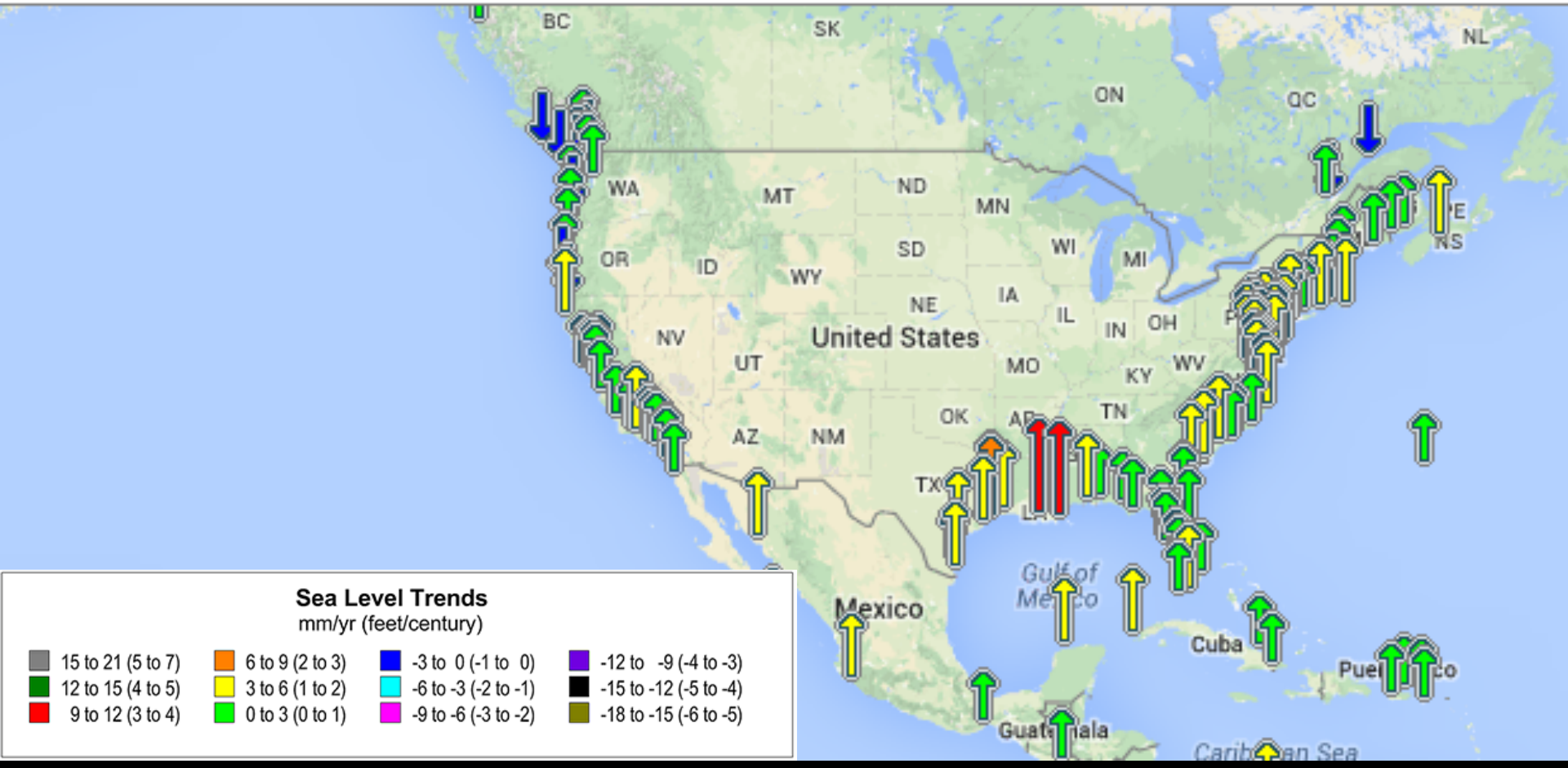
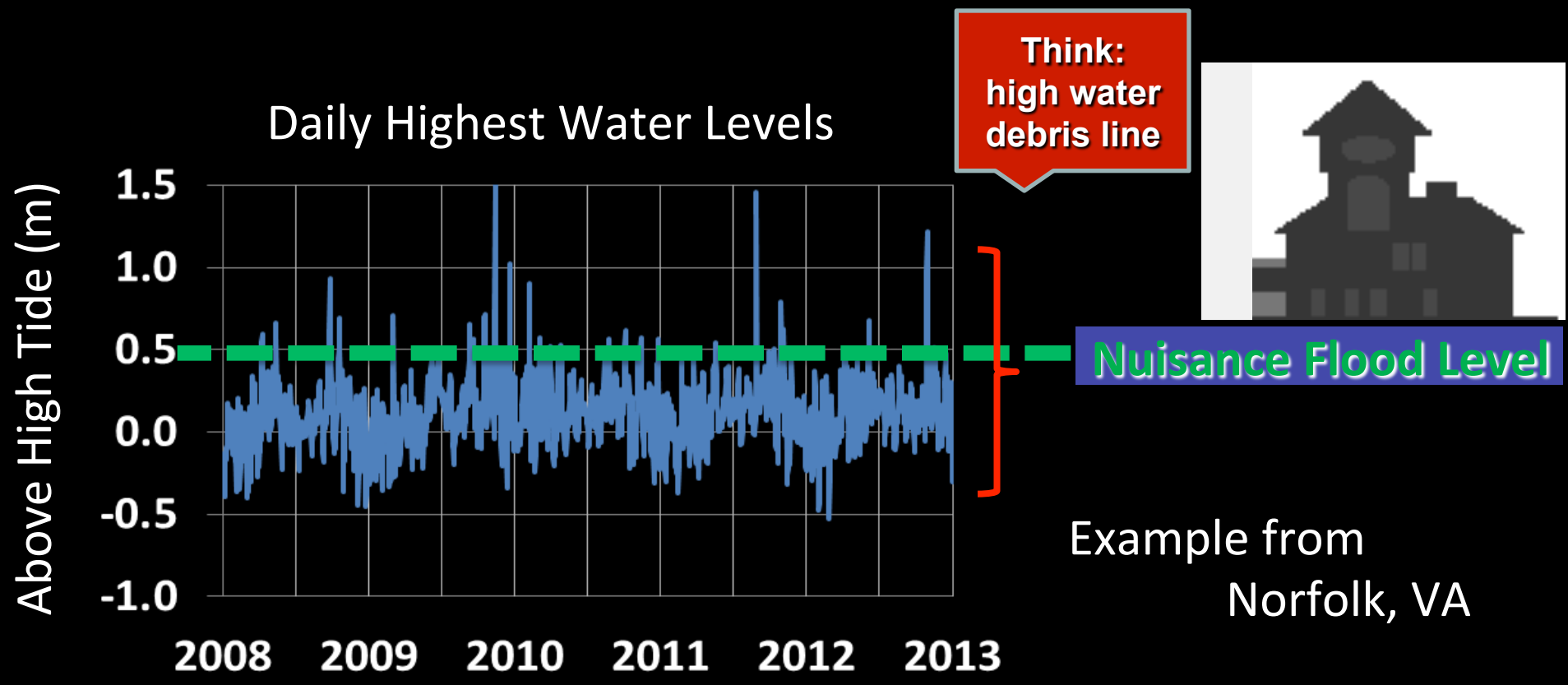


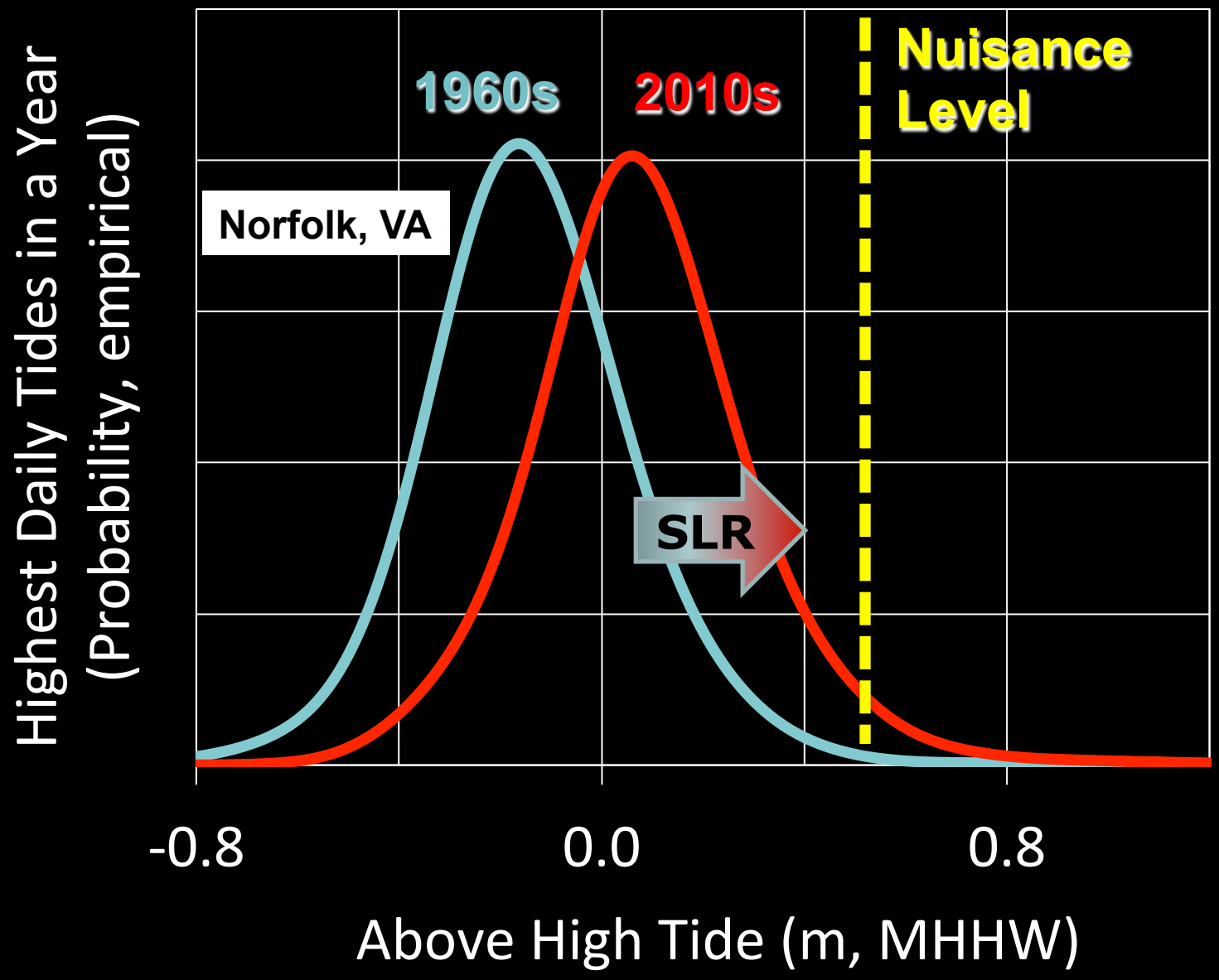
Dylan's B-side…the (high) tides, they're a changing!

Years ago, flooding occurred during big storms.

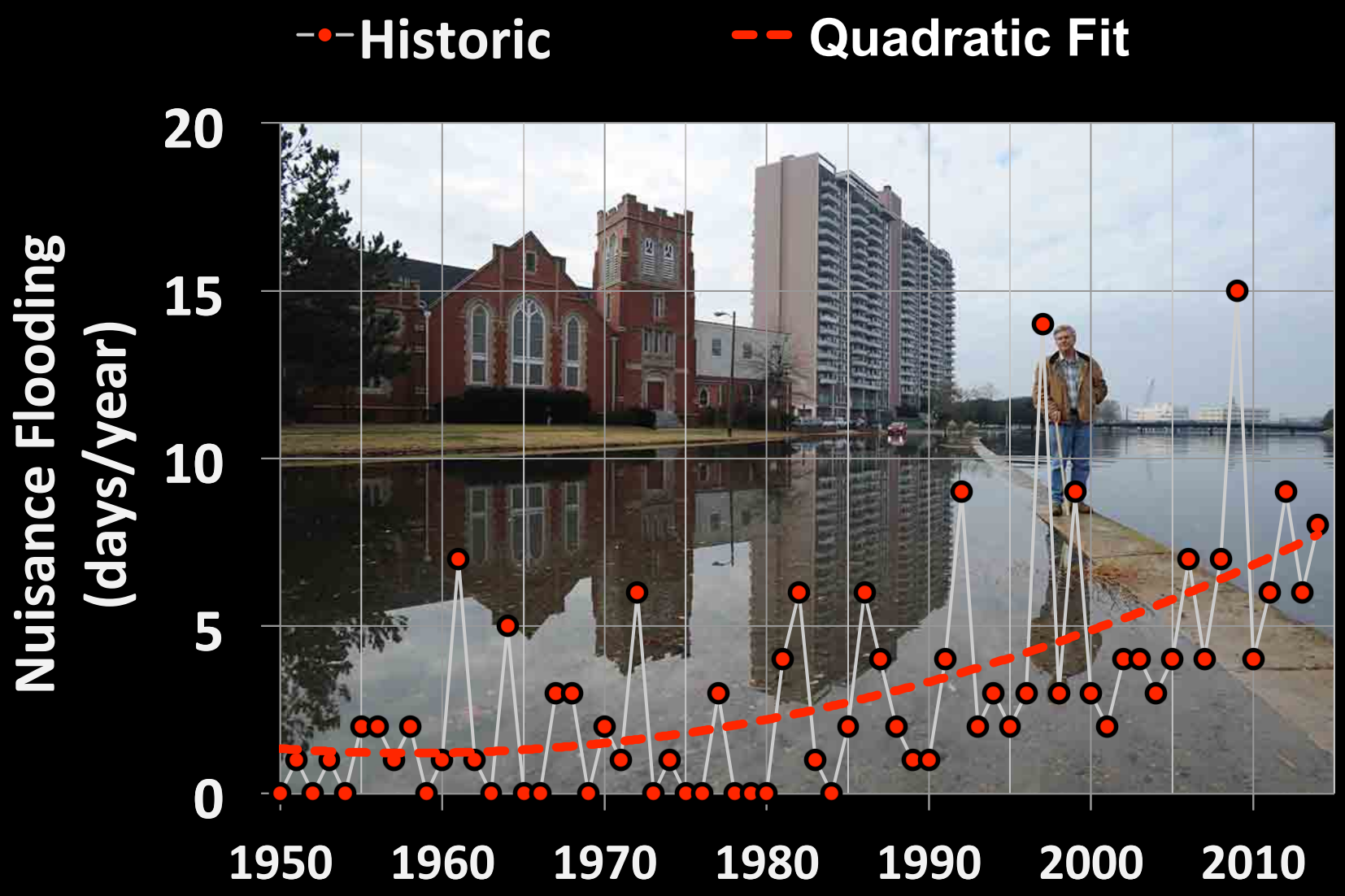
Now, sunny-day tidal flooding is rather common.



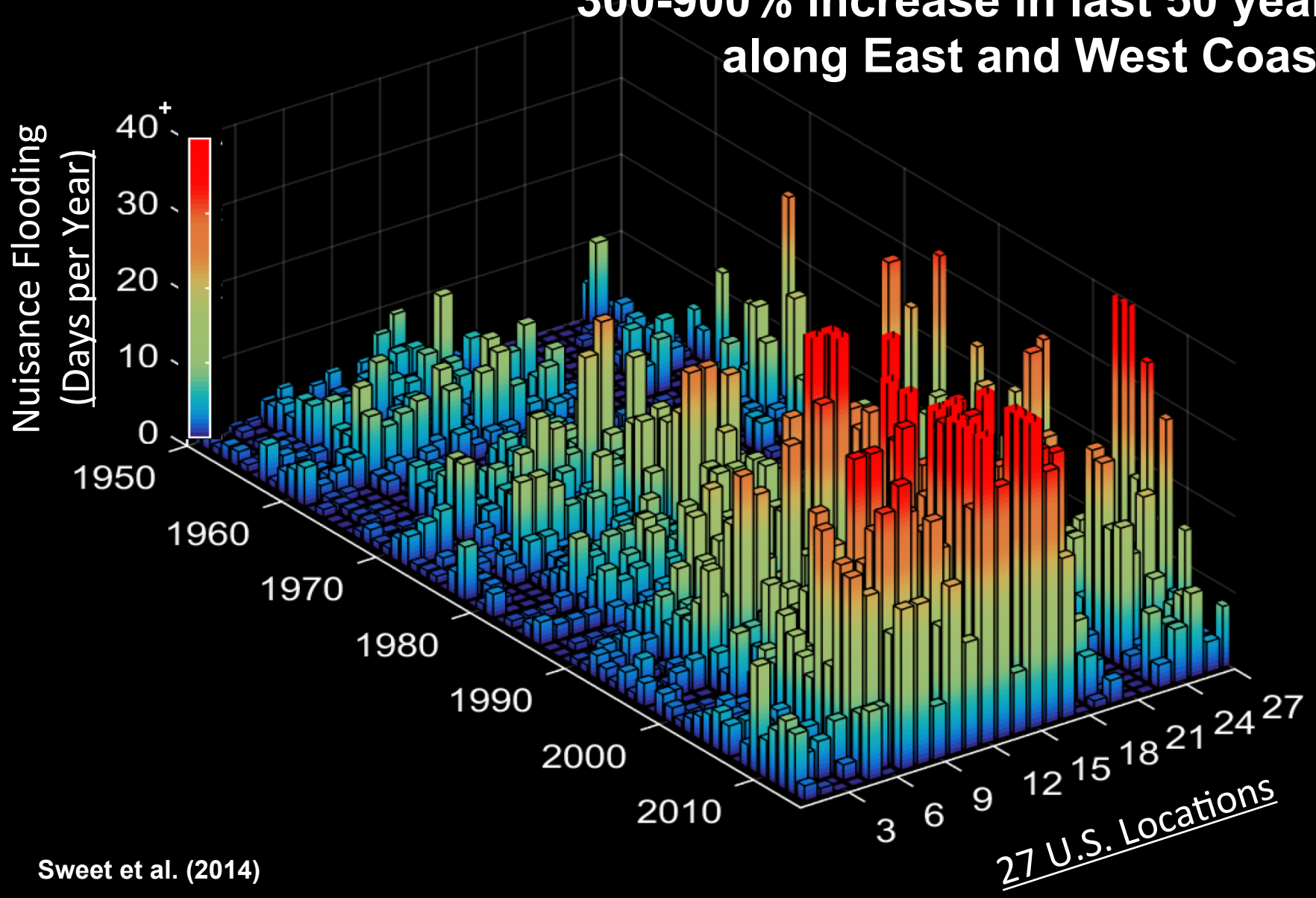
The Accelerating Threat of Tidal Flooding



An Accelerating Baseline of Tidal Flooding



Tidal Flooding Trends: A Growing National Problem

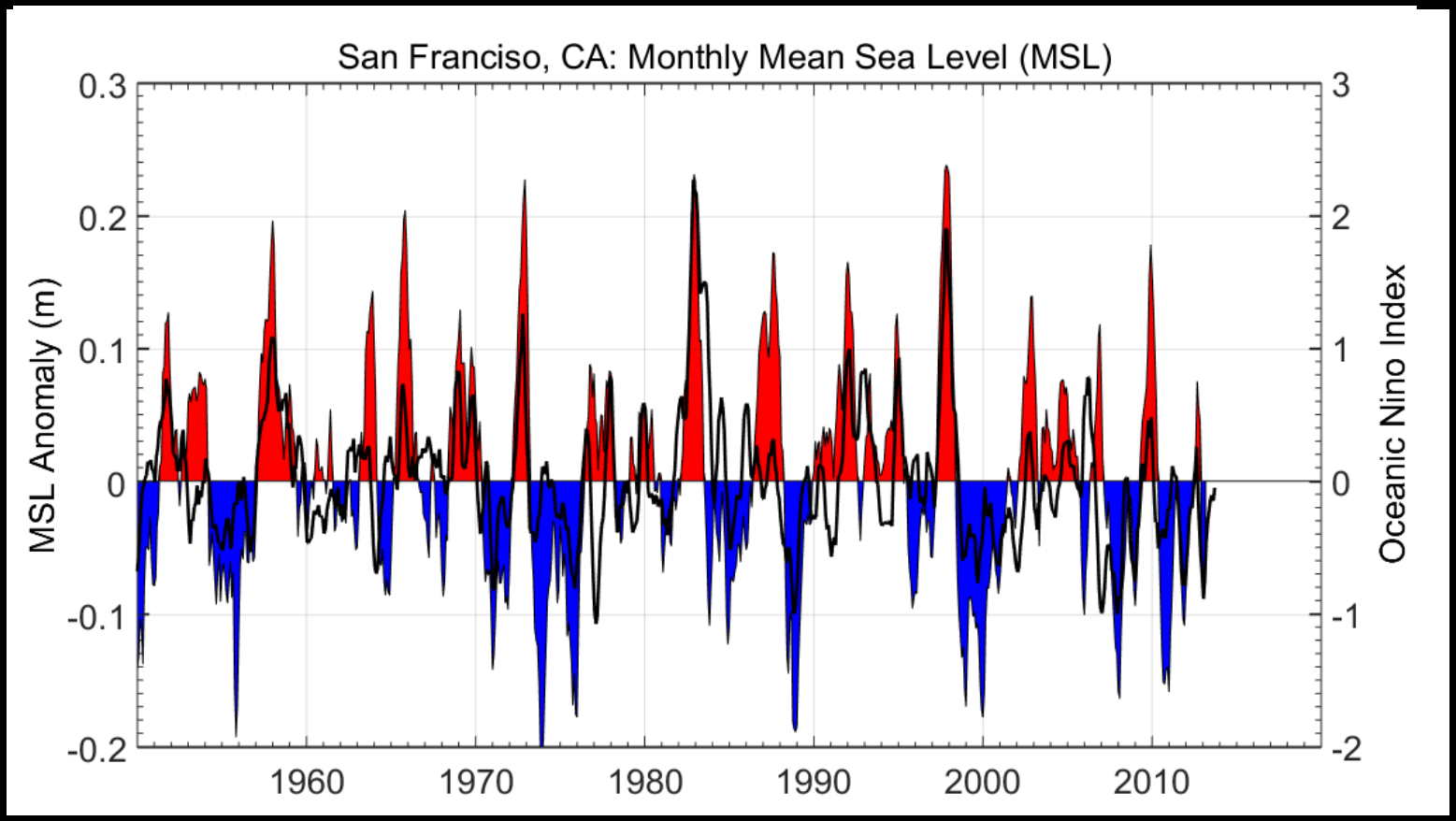


Sweet et al. (2014)

El Niño Pattern: More West & East Coast Tidal Flooding

West Coast:

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



ENSO Warm

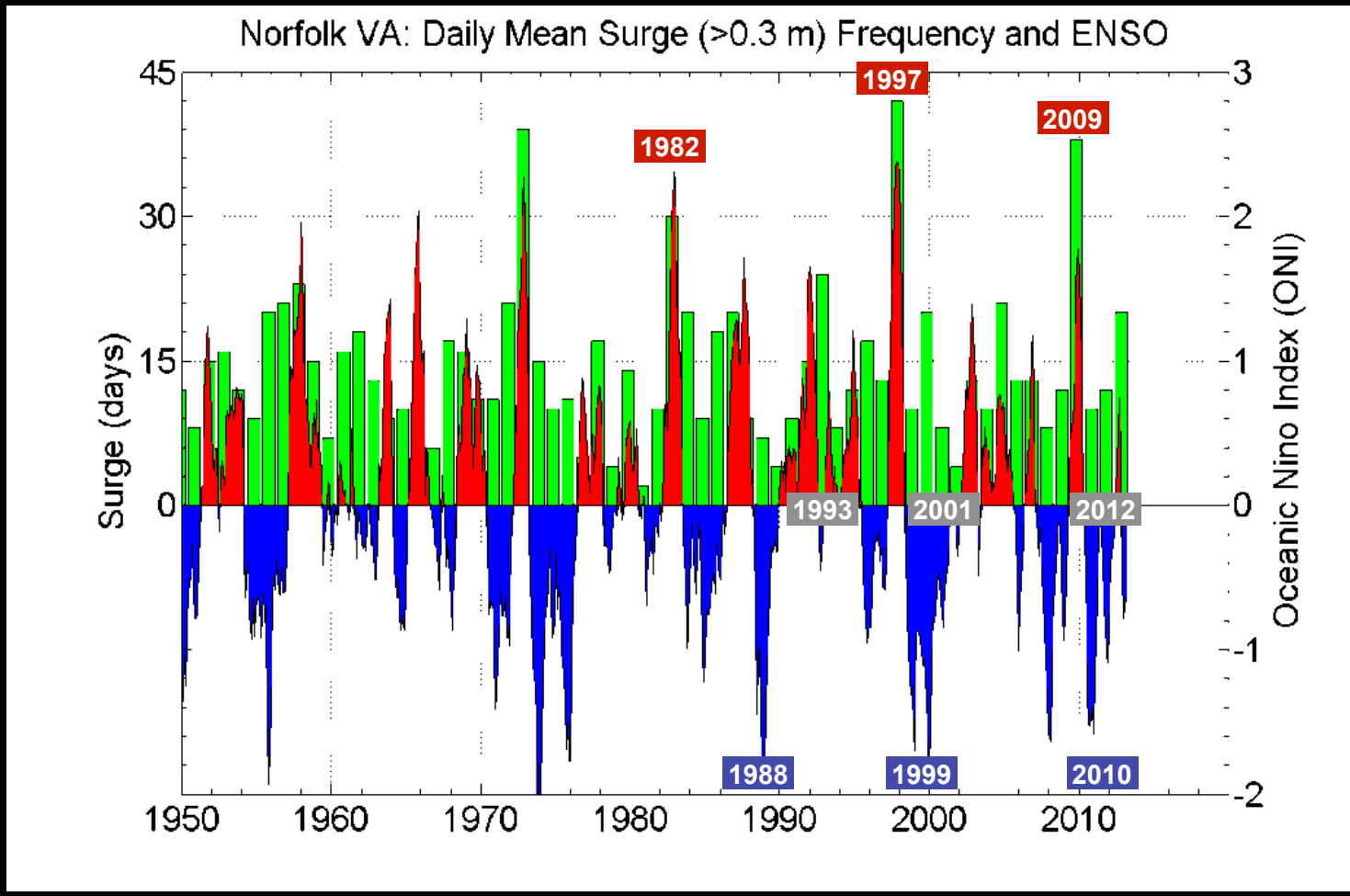
ENSO Cool

Sweet et al. (2014)

El Niño Pattern: More West & East Coast Tidal Flooding

East Coast:

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



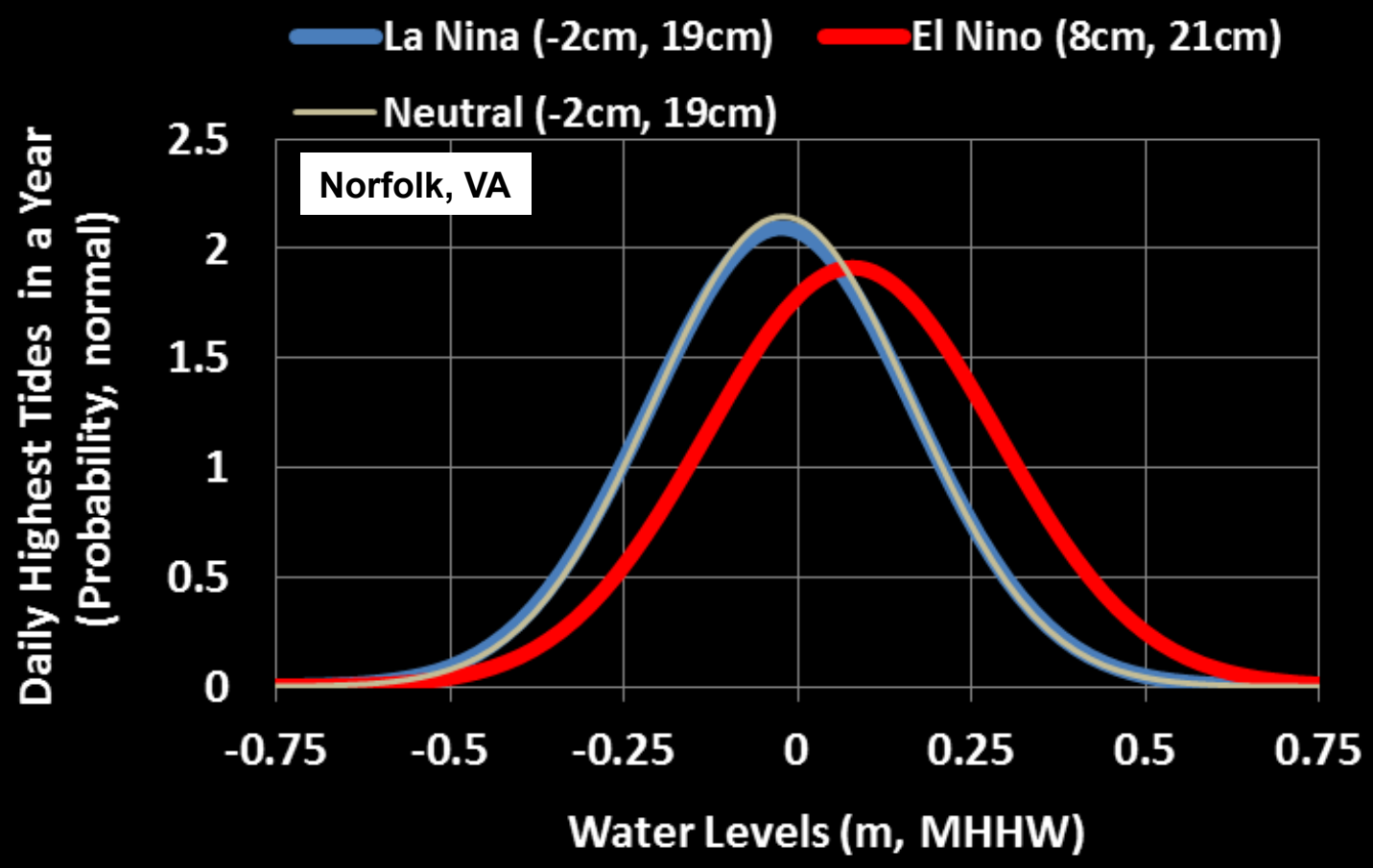
ENSO Warm

ENSO Cool

Sweet and Zervas (2011)

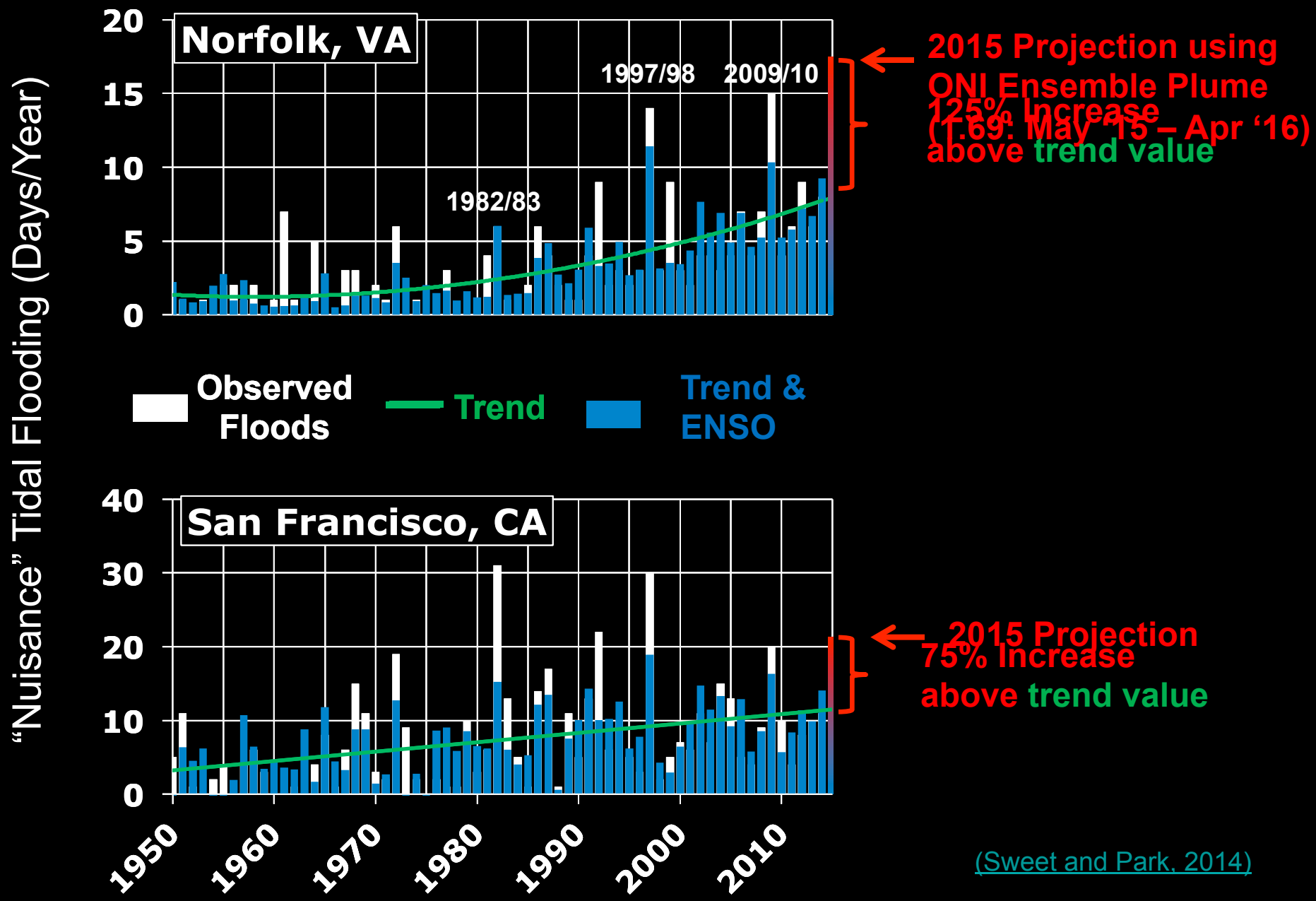
El Niño Pattern: More West & East Coast Tidal Flooding

During (strong) El Nino, noticeable change in: "mean" & "variance"



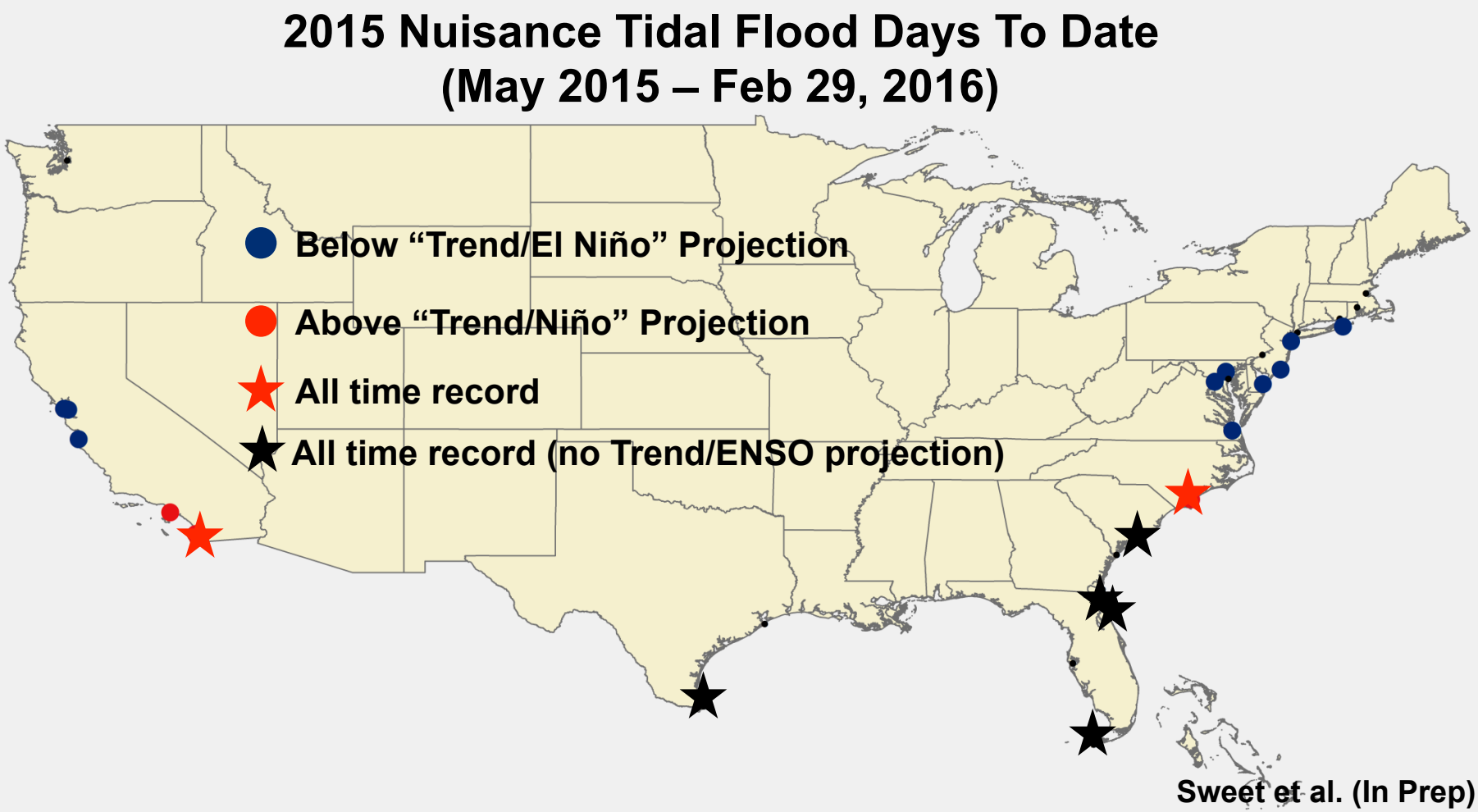
(Detrended for interannual comparison)

Tidal Flood Baselines, Projections & Bivariate Statistical Model



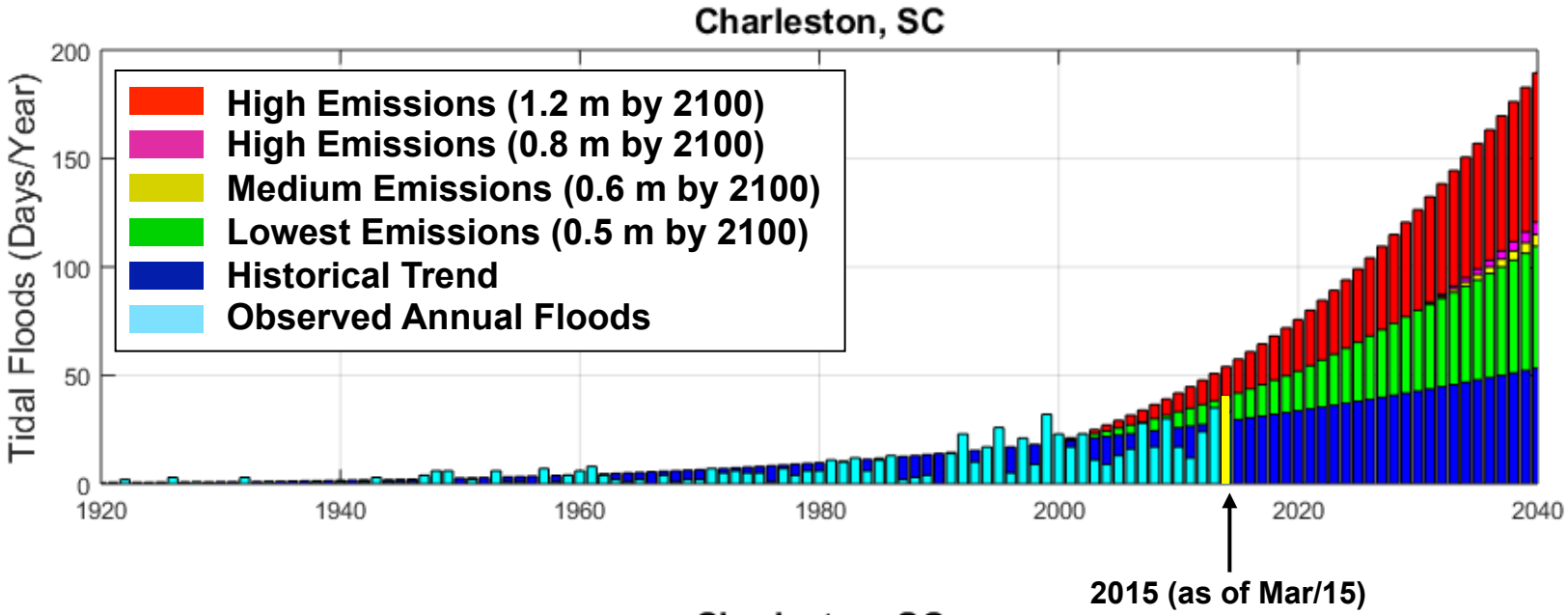
(Sweet and Park, 2014)

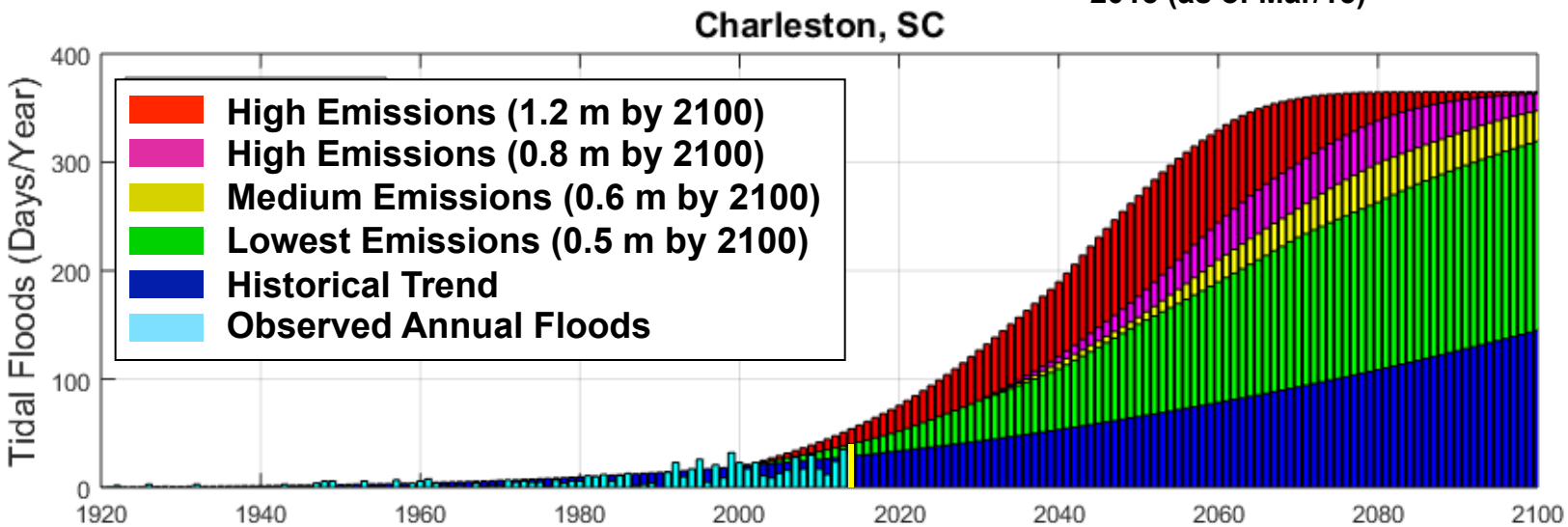
2015 El Nino Pattern: 33-200% Tidal Flood Increase Projected



2015 Outlook (May 2015 – April 2016) issued in summer of 2015

Next Steps: Seasonal Projections of Recurrent Tidal Flooding





Sweet and Park (2014)

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