ASSESSING FUTURE EXPOSURE:

GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES

Chesapeake Bay Program
Climate Resiliency Workgroup Conference Call
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The Concern of Sea Level Rise

Prior permanent inundation, 'sunny-day' tidal flooding will surface and rapidly increase in frequency, depth and extent—in an accelerated manner.

Or: When will the 100-yr event become the 10-yr become the 1-yr become the 0.1-yr become MHHW…

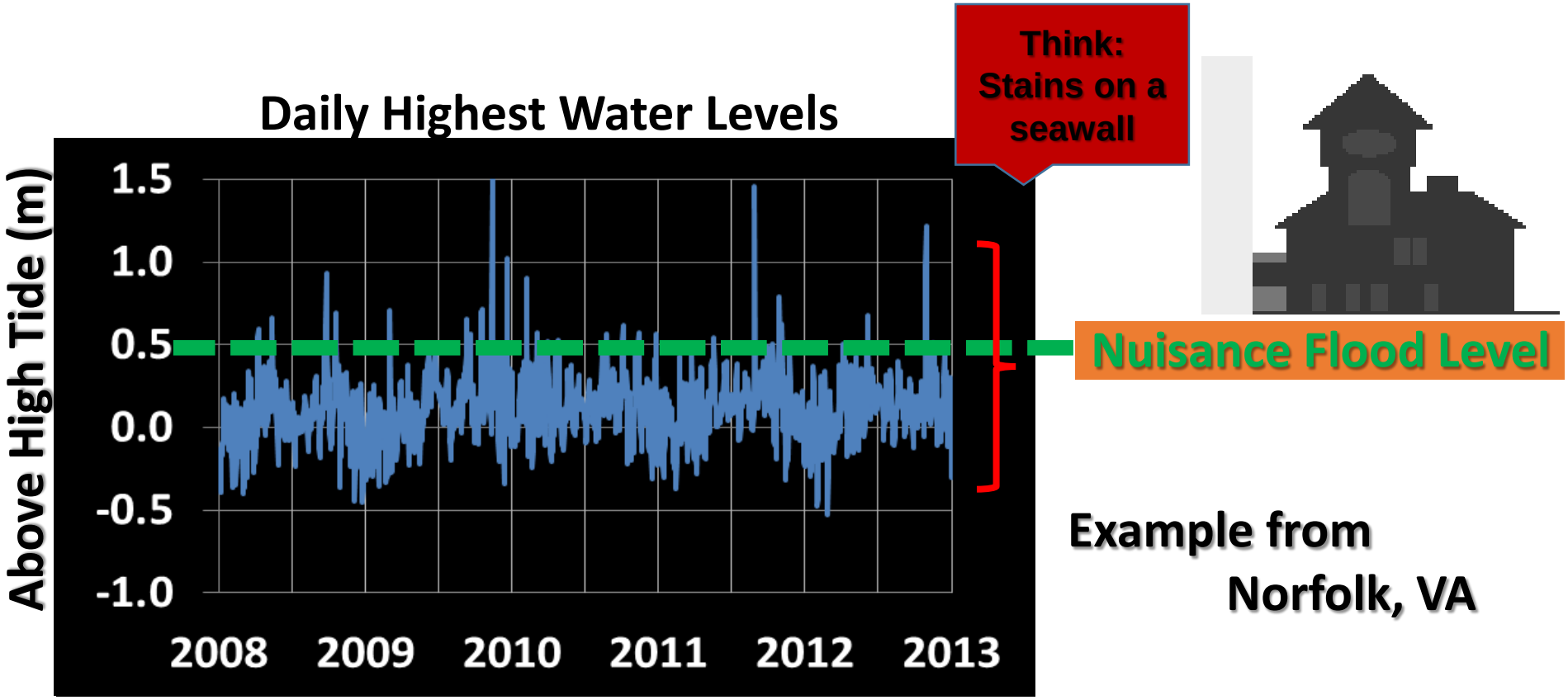
'When' is a function of:

1. **Concern Elevation: assuming today's flood defenses**
2. **Rate of relative sea level rise change (trends, cycles, projections)**
3. **Spread in daily highest water levels (tides, storms)**

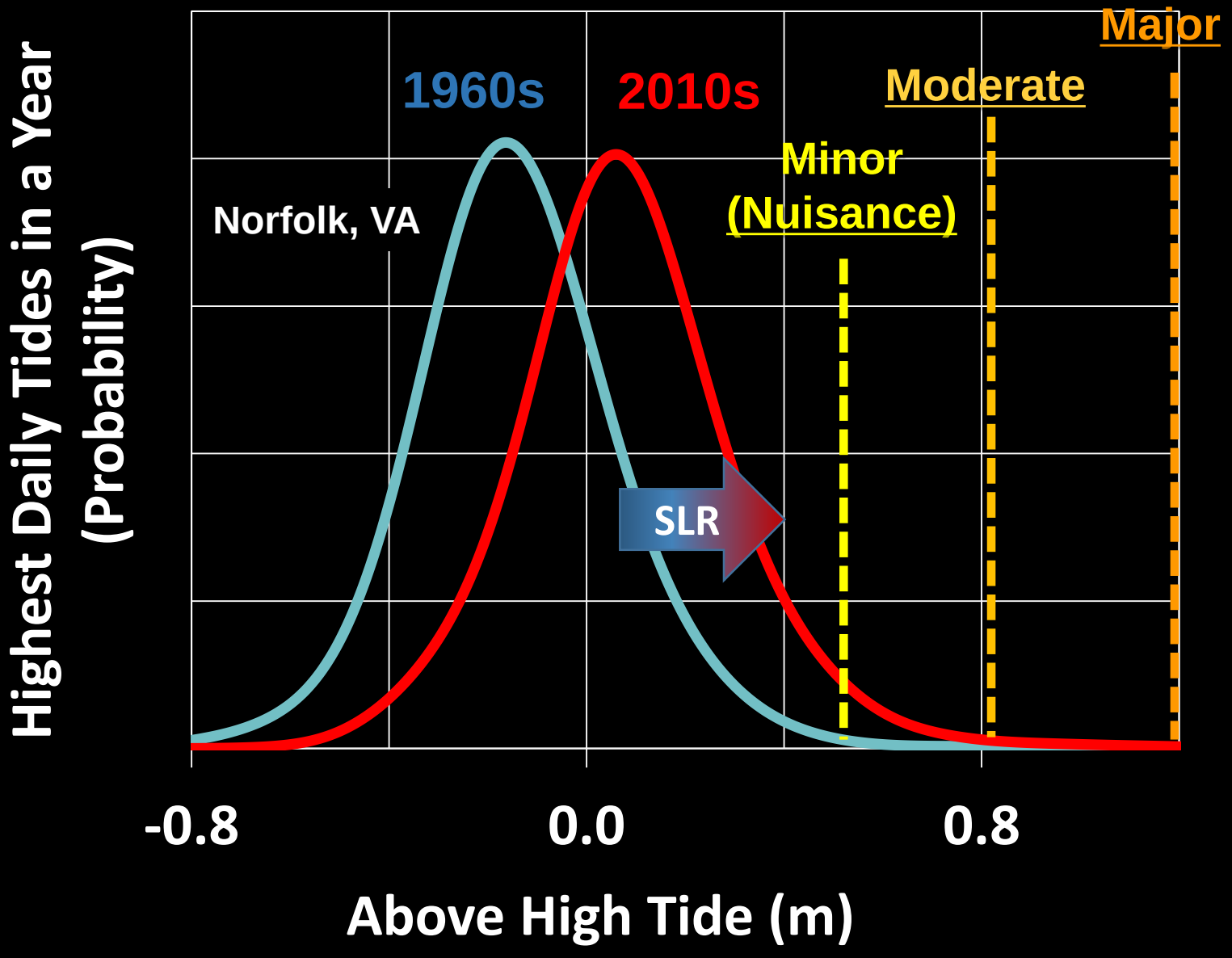
Bob Dylan…the (high) tides, they are a changing!

Years ago, flooding occurred during big storms.

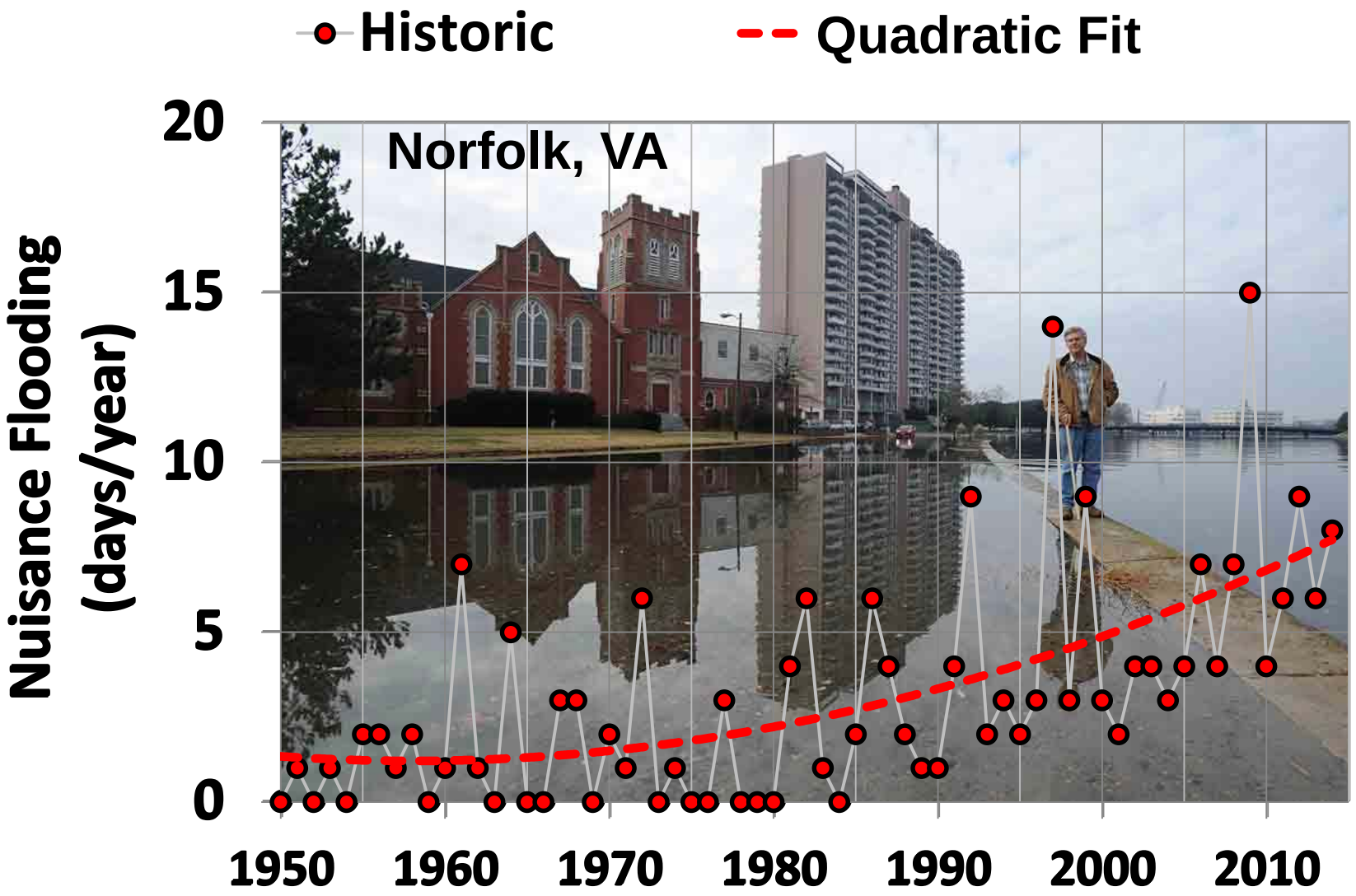
Now, sunny-day tidal flooding is rather common.



The Accelerating Threat of Tidal Flooding

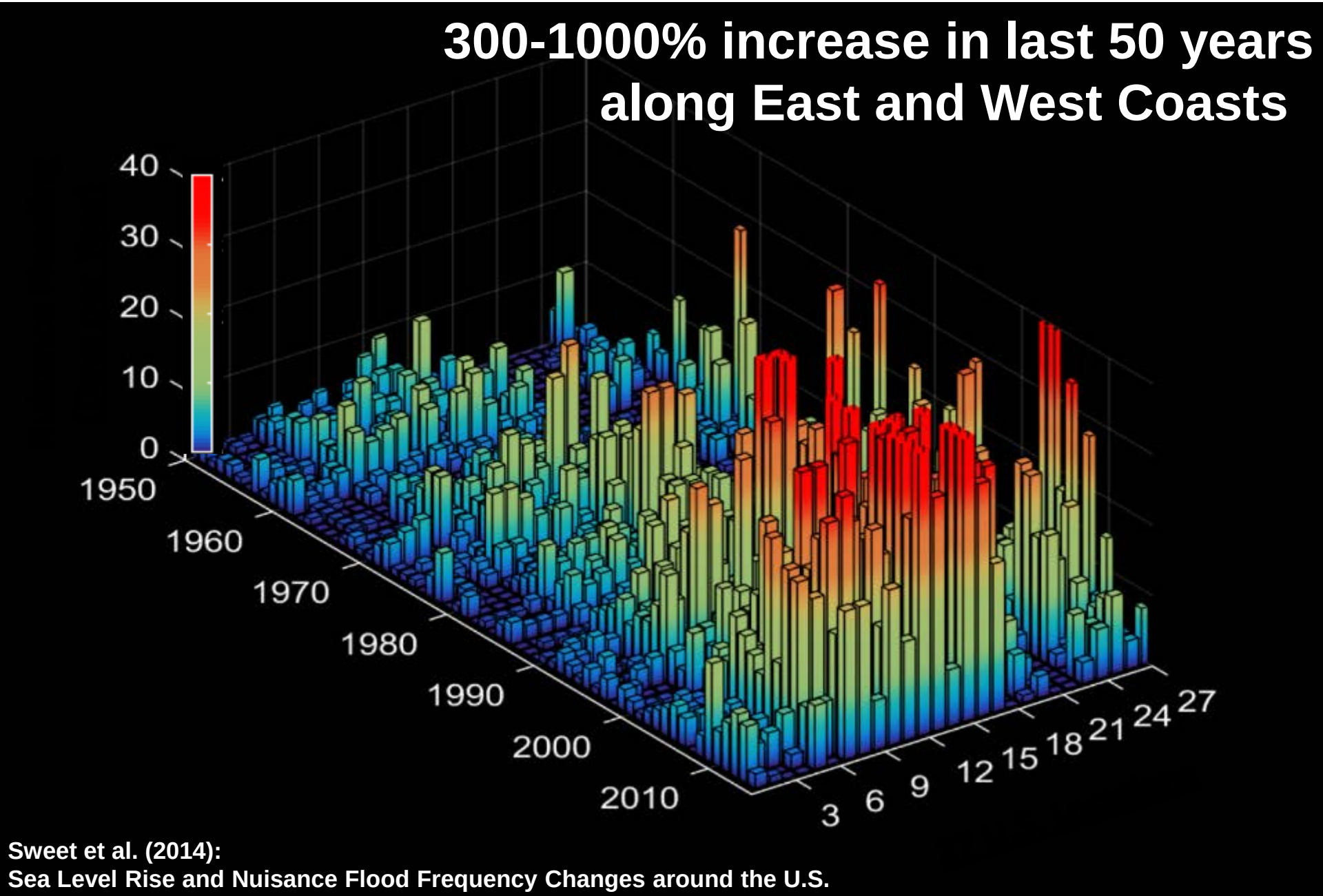


An Accelerating Trend of Tidal Flooding



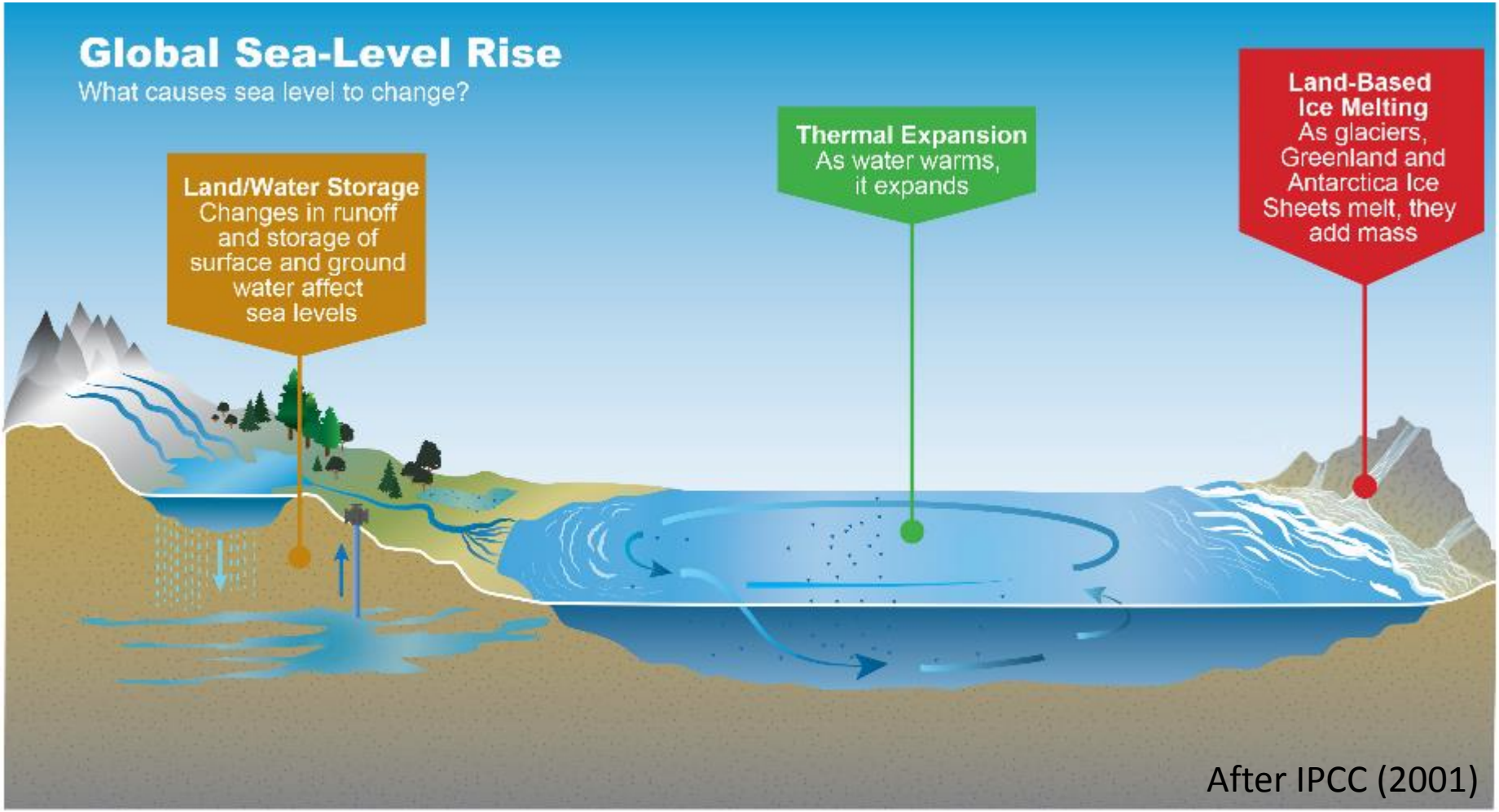
Sweet and Park (2014)

Tidal Flooding Trends: A Growing National Problem



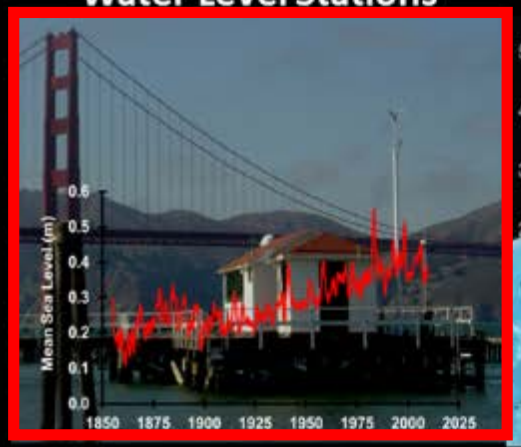
Sweet et al. (2014):
Sea Level Rise and Nuisance Flood Frequency Changes around the U.S.

Global mean sea level rise

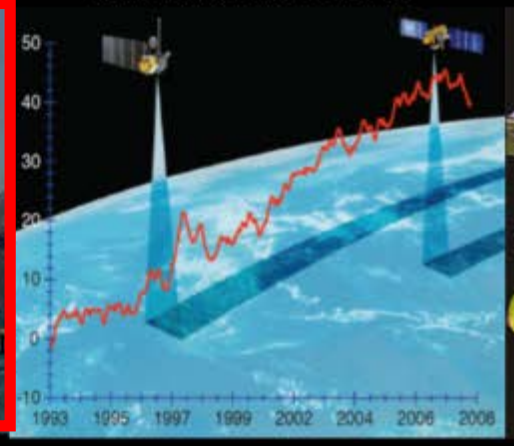


Global sea level rise and measurement platforms

Water Level Stations



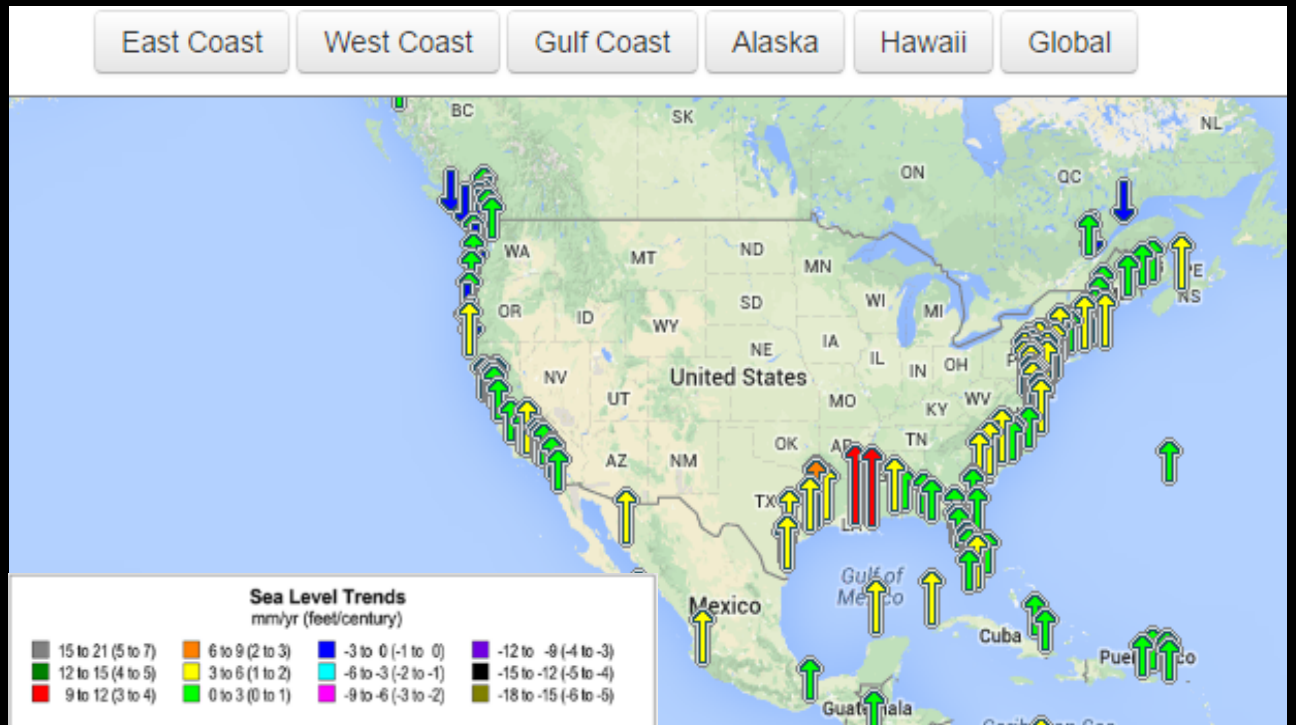
Satellite Altimeter



Gravity Measurements

ARGO Profilers

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



Local SLR

=

Global

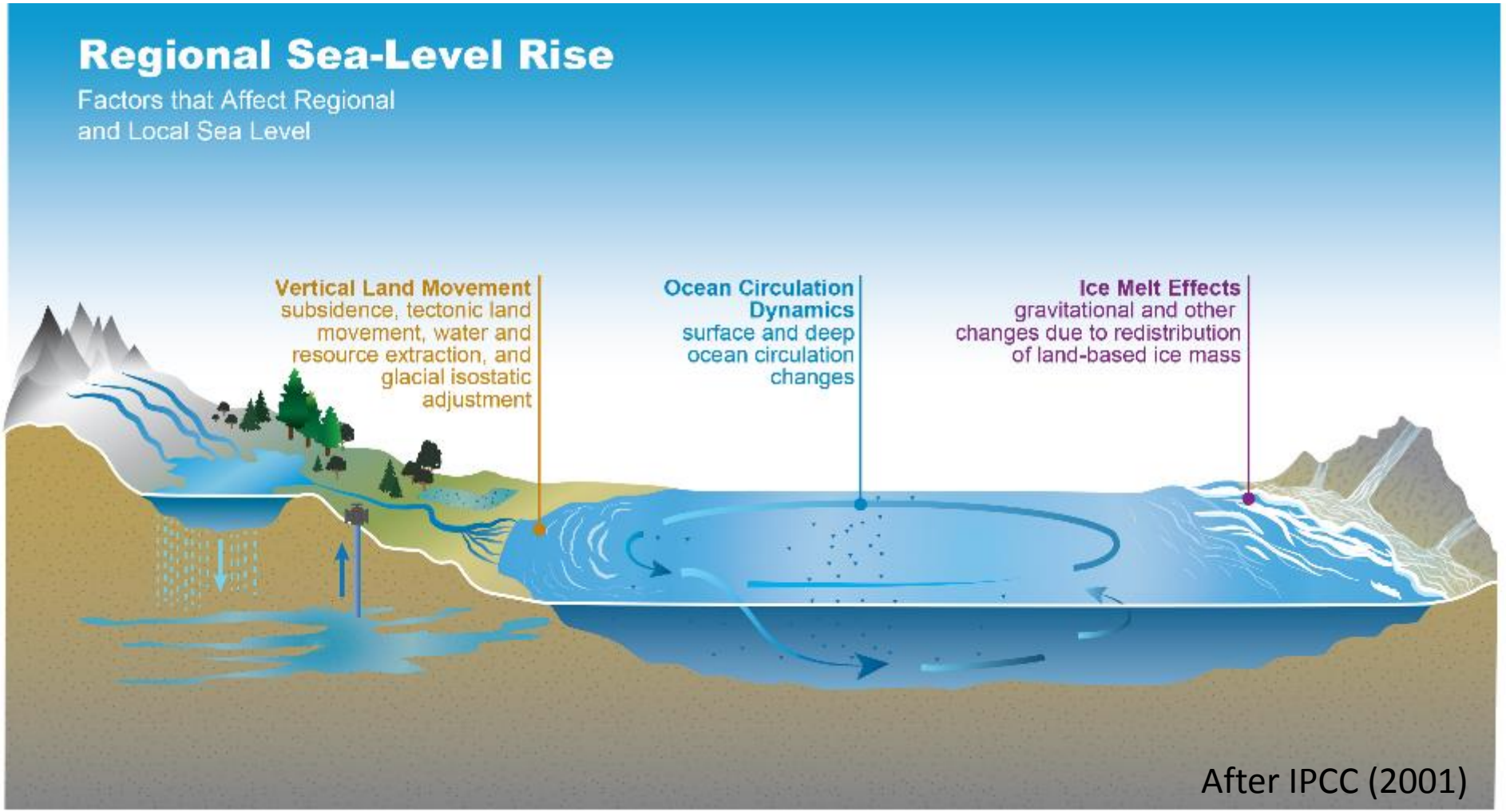
+

Regional

+

Local

Global, regional & local reasons why sea levels change



What is different compared to the Hall et al. (2016) DOD Coastal Assessment Regional Scenario Working Group (CARSWG) report (and the Parris et al., 2012 report).

Sweet et al. (2017) Scenarios:

1. are anchored in year 2000 (i.e., a 1991–2009 epoch), instead of 1992 (i.e., 1983–2001) as to align with Kopp et al. (2014)
2. provide decadal-scale estimates through 2100 and outward to 2200
3. have a broader and higher range for GMSL rise by 2100 (0.3–2.5 m)
4. are downscaled to a 1-degree gridded basis to provide a systematic spatial framework
5. use a spatiotemporal model of tide gauges to assess background (nonclimatic) change in relative sea levels

Δ Relative Sea Level (RSL) of Sweet et al. (2017):

following probabilistic framework of Kopp et al. (2014)

$$\Delta\mathrm{RSL} = \Delta\mathrm{GMSL} + \Delta\mathrm{RSL}_{\text{climatic}} + \Delta\mathrm{RSL}_{\text{non-climatic}}$$

Global Mean Sea Level (GMSL) Scenarios for 2100:

Low (0.3)
Intermediate-Low (0.5 m)
Intermediate (1.0 m)
Intermediate-High (1.5 m)
High (2.0 m)
Extreme (2.5 m)

1) Δ Ice Mass w/ gravity 'fingerprints' of Mitrovica et al. (2011):

2) Δ Oceanographic Processes (thermal expansion, dynamics from CMIP5 models)

3) Land-water storage based upon empirical relationships

GIA, tectonics, sediment compaction, anthropogenic factors:

- Spatiotemporal model of tide gauge data with 3 modes: 1) globally uniform sea level change, 2) **a constant-rate average, long-term, regionally varying trend**, and 3) temporally and spatially varying regional sea-level contributions

GMSL Scenarios for 2100 with a probabilistic 'underpinning'

Table 4. Probability of exceeding GMSL (median value) scenarios in 2100 based upon Kopp et al. (2014).

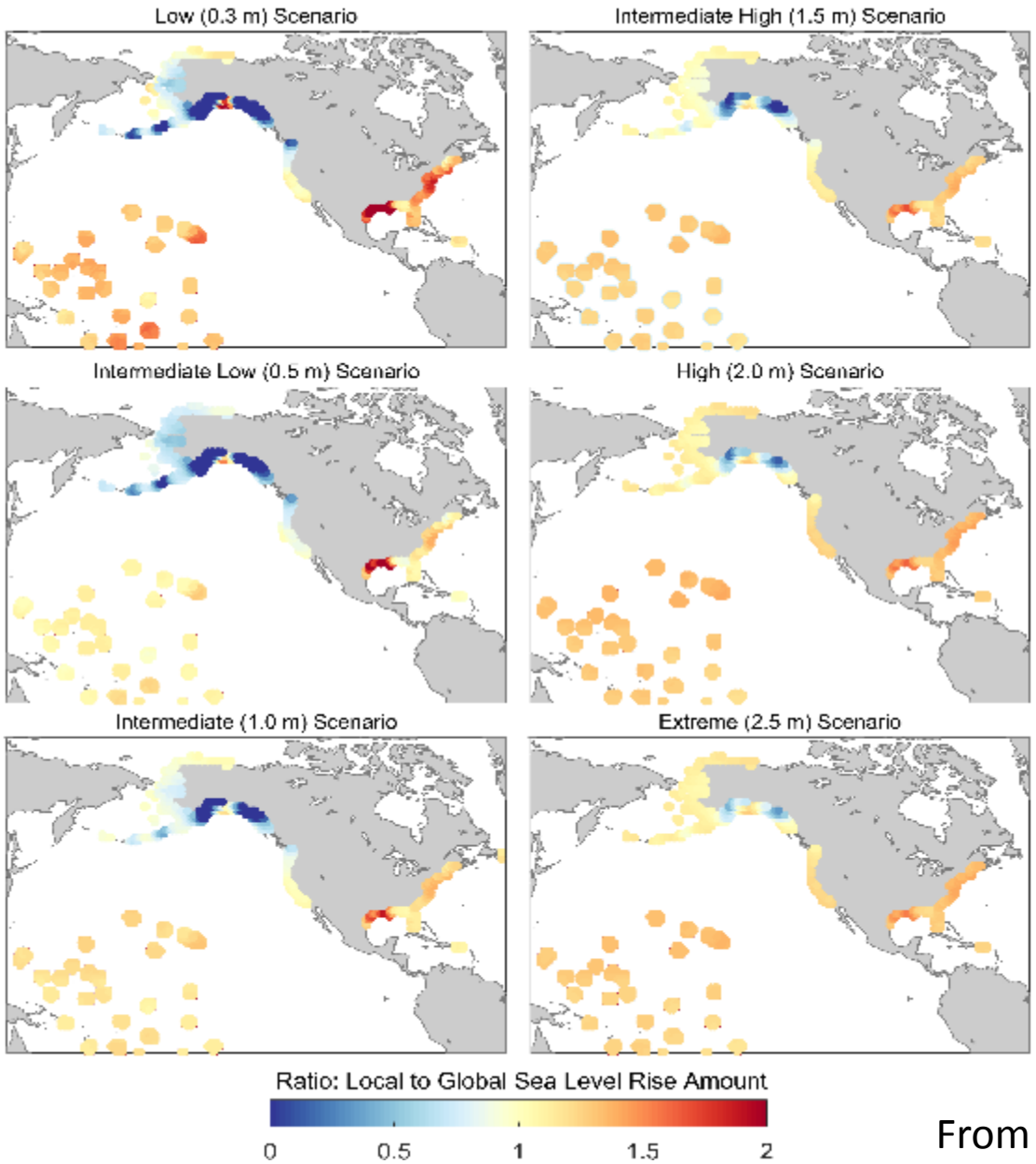
GMSL rise Scenario	RCP2.6	RCP4.5	RCP8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

Central 90% conditional probability ranges (colored boxes) of recent RCP-based GMSL projections (Church et al., 2013a; Kopp et al., 2014; 2016a; Slangen et al., 2014; Grinsted et al., 2015; Mengel et al., 2016), which are augmented (dashed lines) by the difference between the median Antarctic contribution of Kopp et al. (2014) probabilistic GMSL/RSL study and the median Antarctic projections of DeConto and Pollard (2016).

From Sweet et al. (2017)

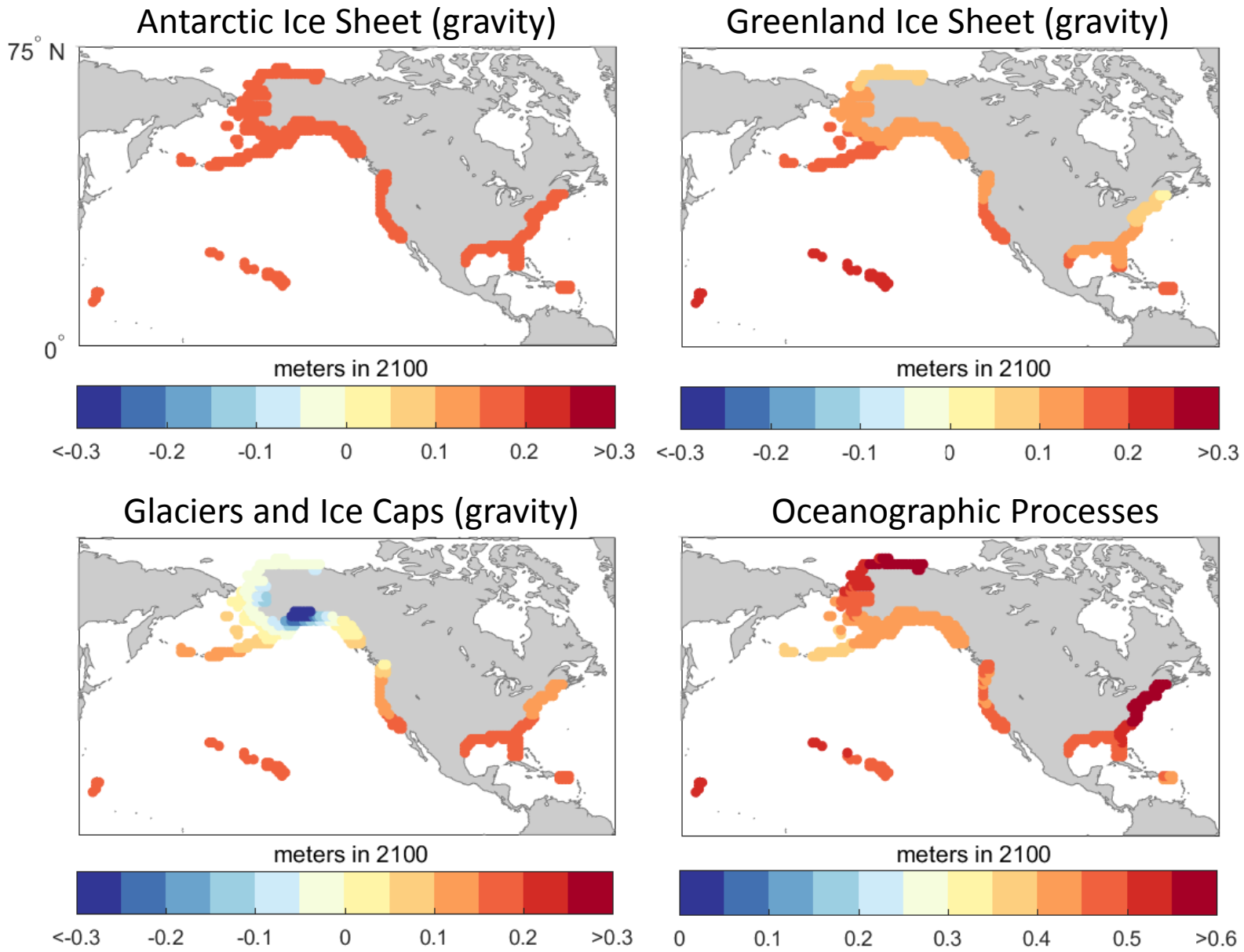
Total RSL change at 1-degree resolution for 2100

(ratio: local to the GMSL rise amount for that scenario)



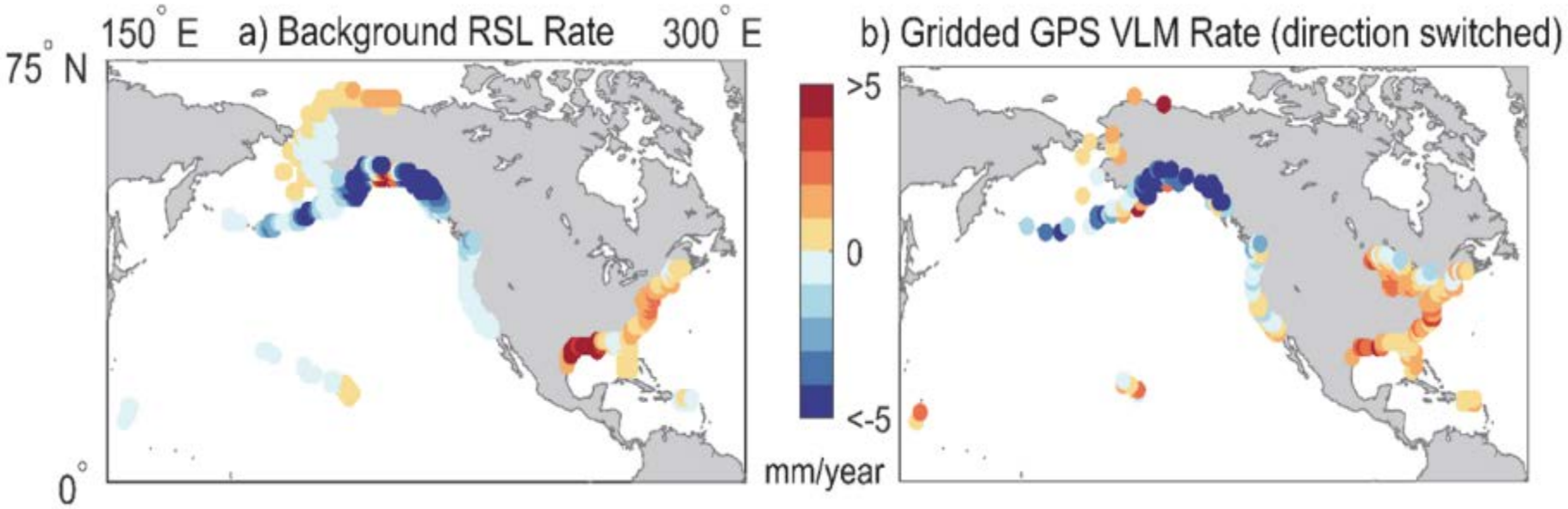
From Sweet et al. (2017)

Components inherent to the Intermediate Scenario (1 m by 2100)



From Sweet et al. (2017)

Nonclimatic (background) RSL change

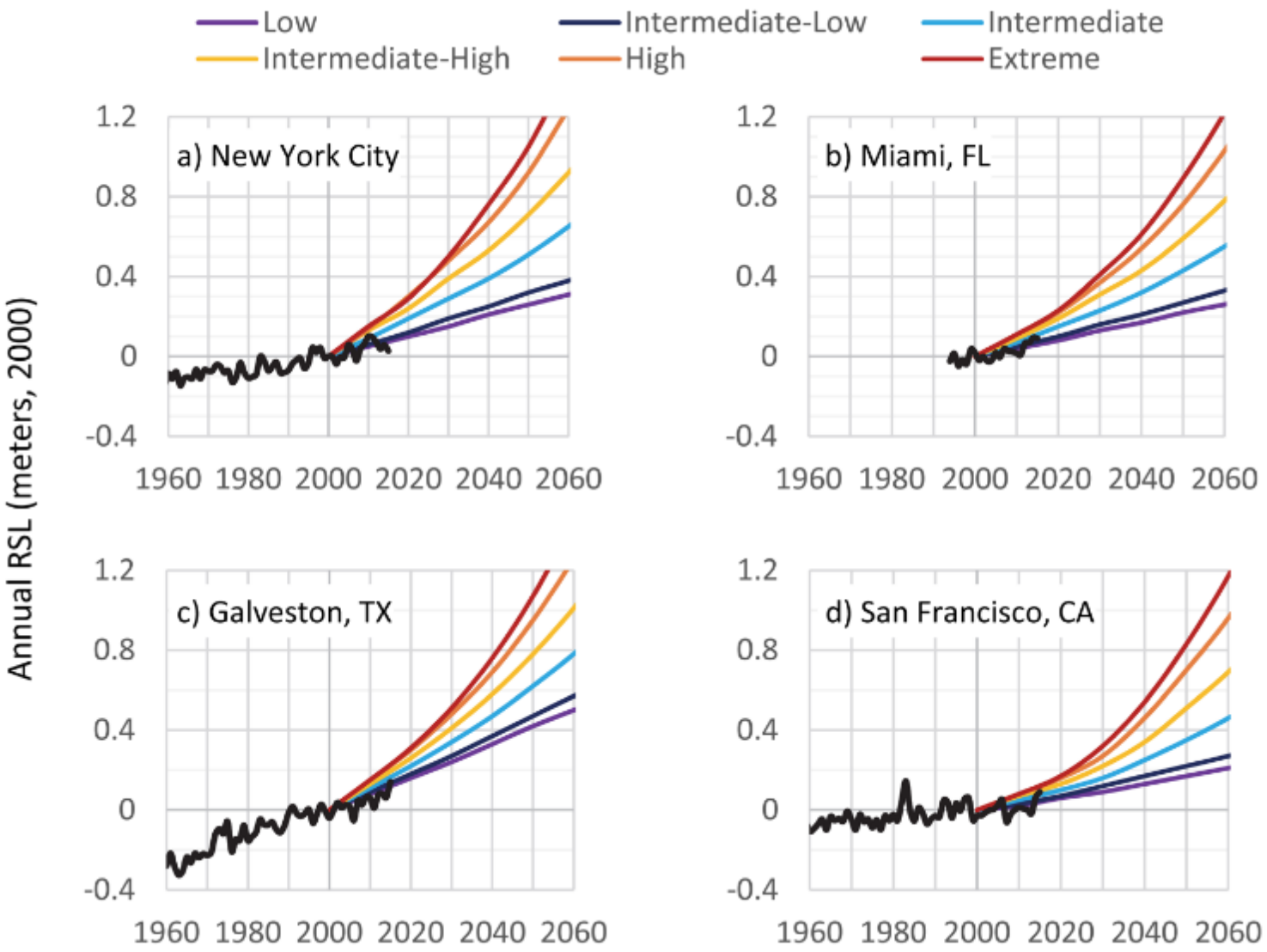


Gridded a) background RSL rates and b) GPS VLM rates (with directionality switched as to directly compare to RSL rate)

From Sweet et al. (2017)

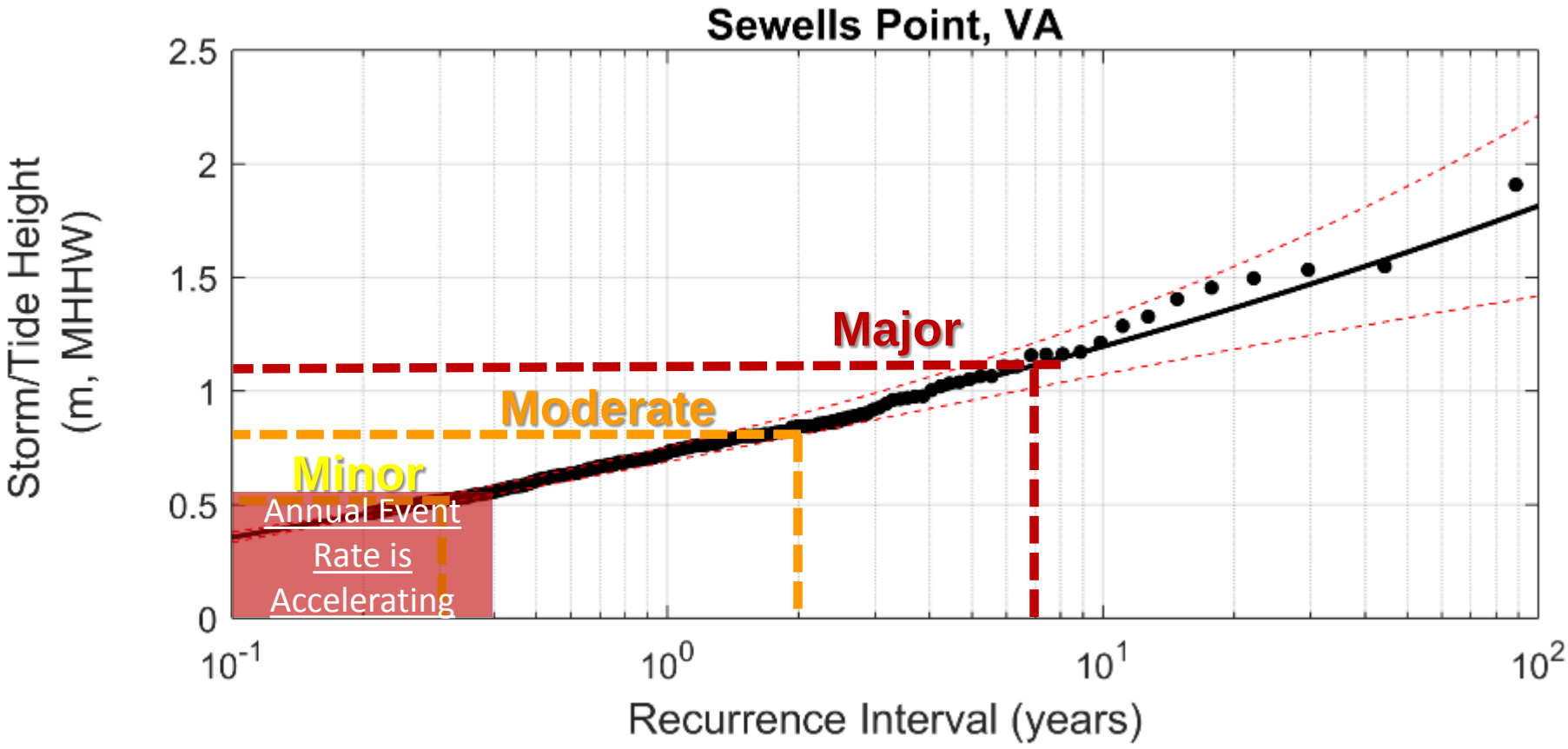
Decadal RSL Projections and Extremes Event Assessments

(have not yet produced 1-degree gridded extremes)



From Sweet et al. (2017)

Flood height probabilities: rare to chronic



Generalized Pareto Distribution fit (Sweet et al., 2014) of high exceedances detrended to year 2000

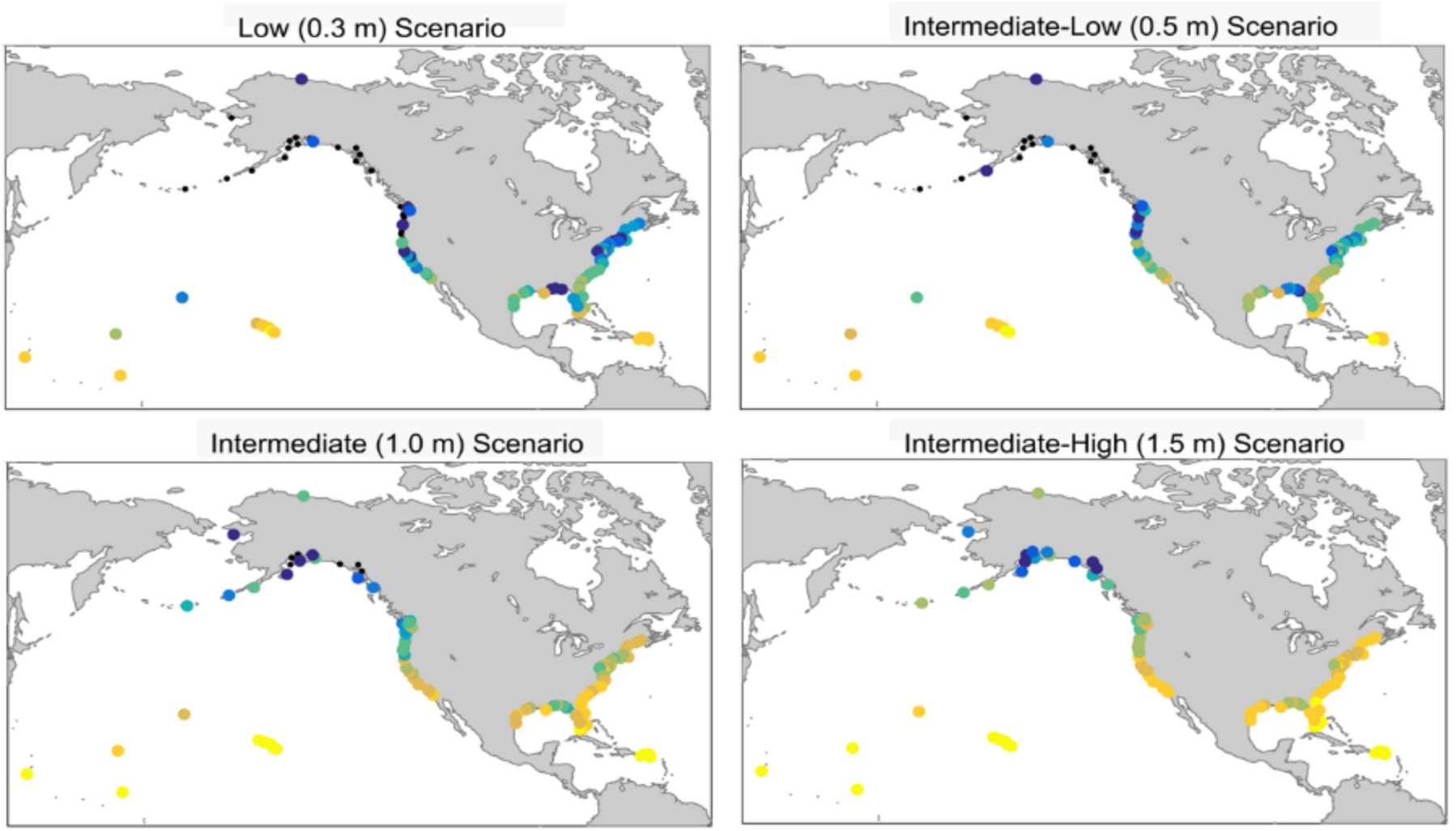
Coastal Flooding Thresholds

National Weather Service Wakefield, Virginia

	Minor	Moderate	Major
Picture			
Hazard	➢ **Shallow flooding** in the most vulnerable locations near the waterfront and shoreline resulting in a **low threat of property damage.** ➢ **Up to 1 foot of inundation** in shoreline and vulnerable areas.	➢ **Widespread flooding** of vulnerable areas will result in an **elevated threat of property damage.** ➢ **1 to 2 feet of inundation** primarily in shoreline and vulnerable areas.	➢ **Severe flooding** will cause extensive inundation and flooding of numerous roads and buildings resulting in a **significant threat to property and life.** ➢ **2 to 3 feet or more of inundation.**
Impact	➢ A few shoreline and vulnerable roadways and adjacent properties will experience shallow flooding. ➢ Minor beach erosion with possible erosion to the front of vulnerable dune structures.	➢ Inundation of roads and low lying property near the waterfront. ➢ Flooding will extend along tidal rivers and creeks resulting in some road closures, flooding of vehicles, and some property. ➢ Severe beach erosion and considerable erosion of dunes, especially during long duration events.	➢ Numerous roads will be impassable, with many unprotected cars submerged. ➢ Evacuations will be necessary for the most vulnerable areas. ➢ Flood waters may extend well inland. ➢ Substantial coastal damage and severe erosion of dunes.

Decadal RSL Projections and Extremes Event Assessments

(at tide gauges…have not yet produced 1-degree gridded extremes)



From Sweet et al. (2017)

Questions?

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