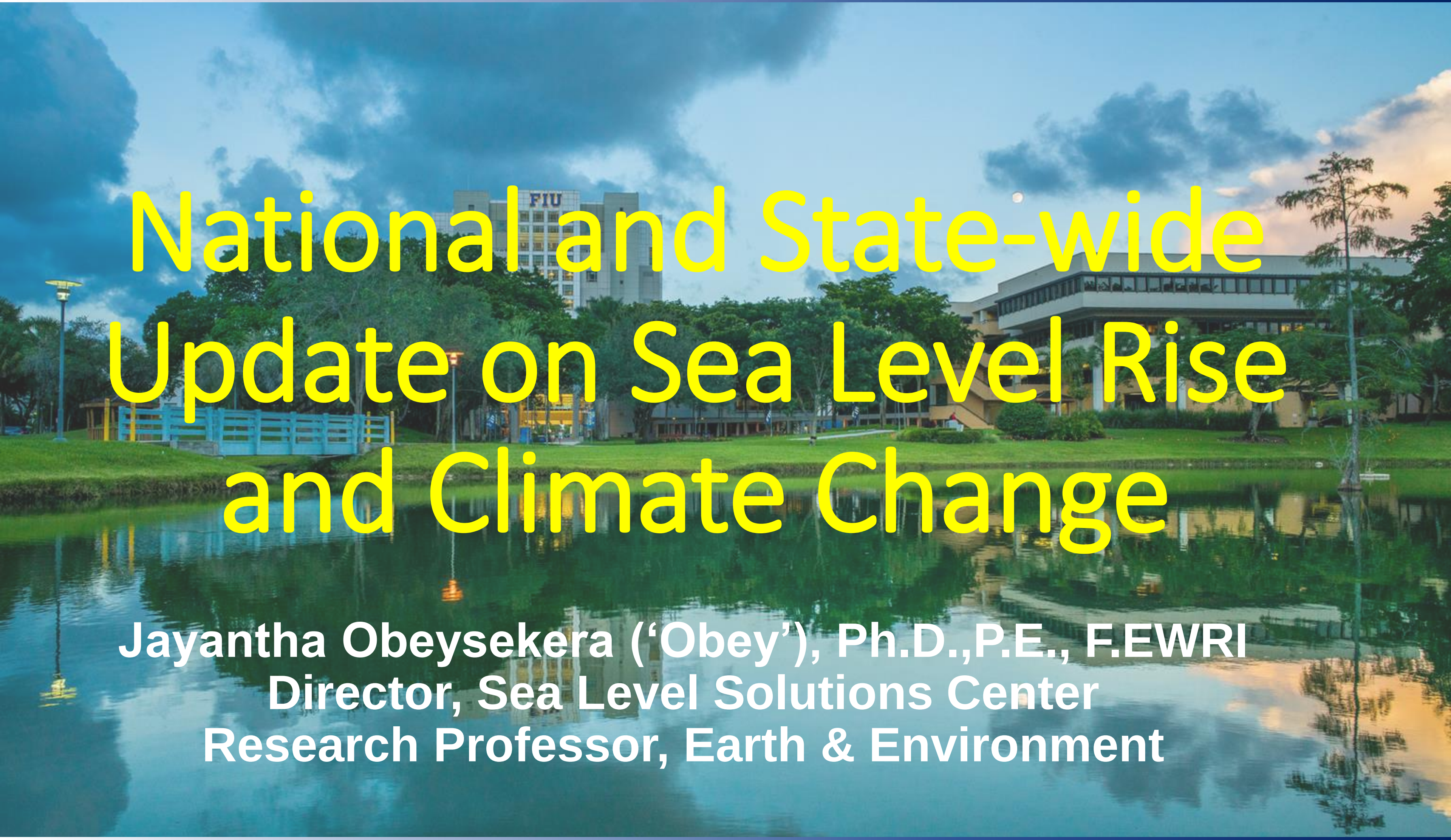

National and State-wide Update on Sea Level Rise and Climate Change

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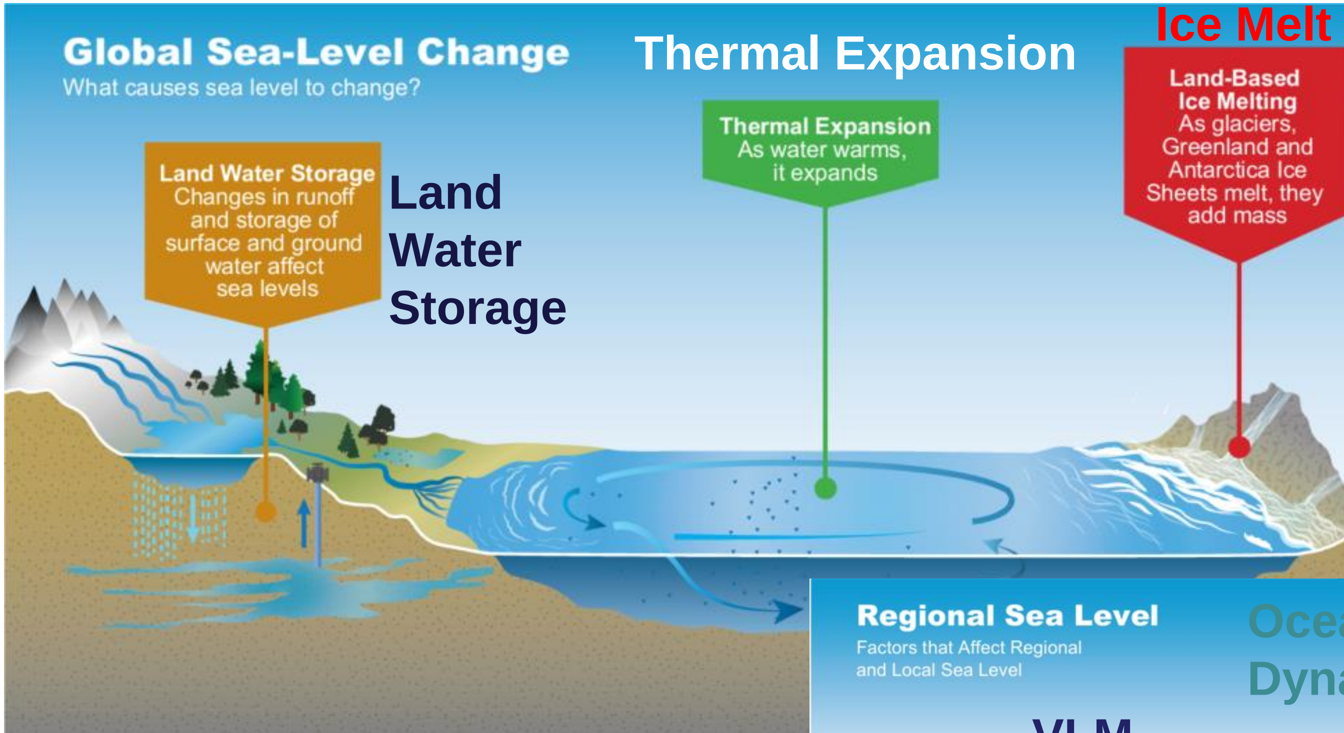
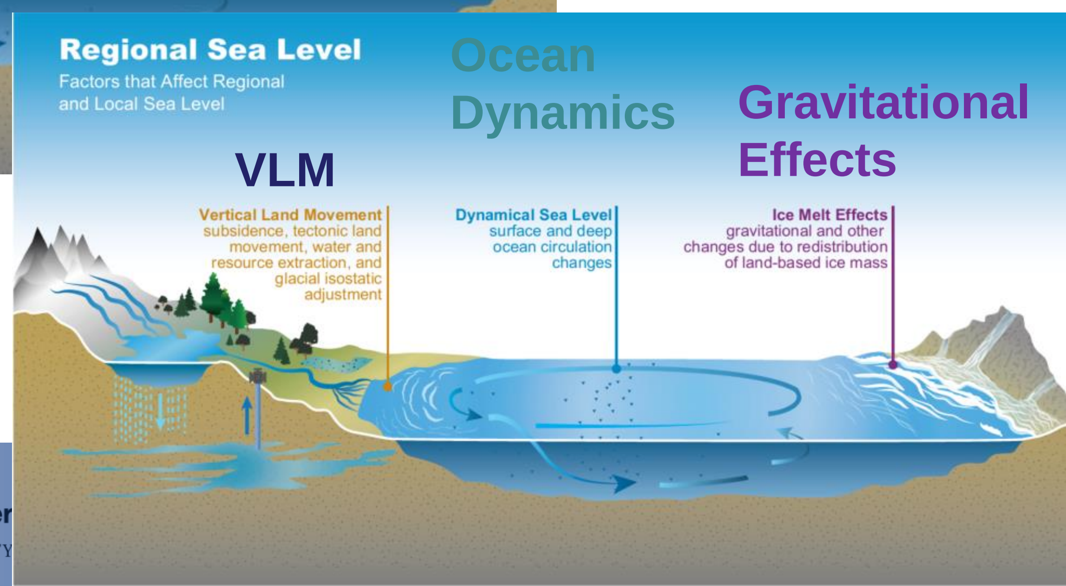
Director, Sea Level Solutions Center
Research Professor, Earth & Environment

Sources of Global and Regional Sea Level Change





Regional/Local Sea Level Change

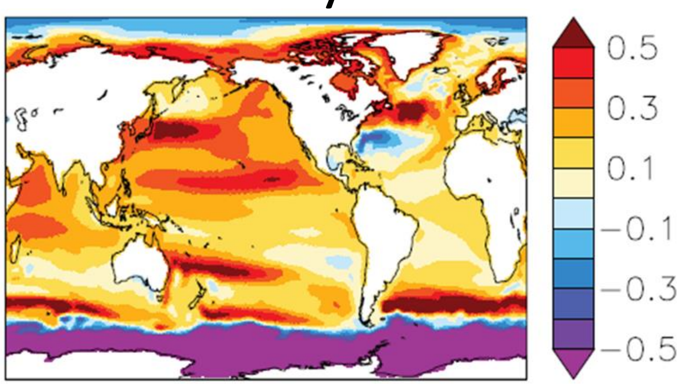
- Change in Relative Sea Level (RSL):

$$\Delta \mathrm{RSL} = \Delta \mathrm{SL}_{\mathrm{G}} + \Delta \mathrm{SL}_{\mathrm{RM}} + \Delta \mathrm{SL}_{\mathrm{RG}} + \Delta \mathrm{SL}_{\mathrm{VLM}}$$

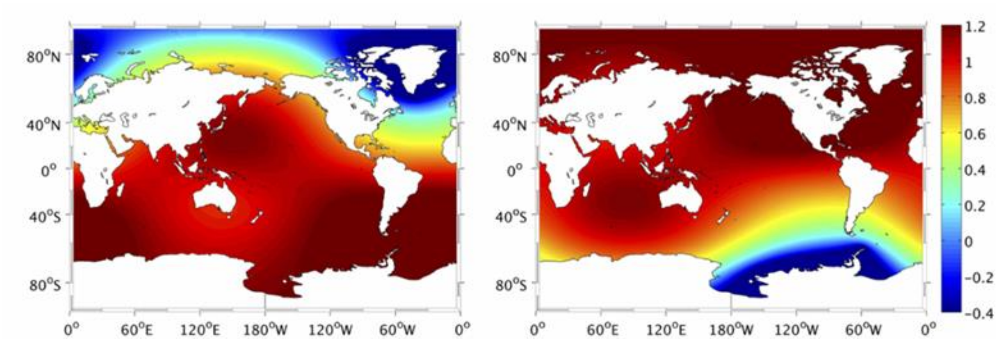
Global

Vertical Land Movement (Uplift/Subsidence,GIA)

Ocean Dynamics



Gravitational Effects (Glaciers, Ice Sheets)



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

following probabilistic framework of Kopp et al. (2014)

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

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):

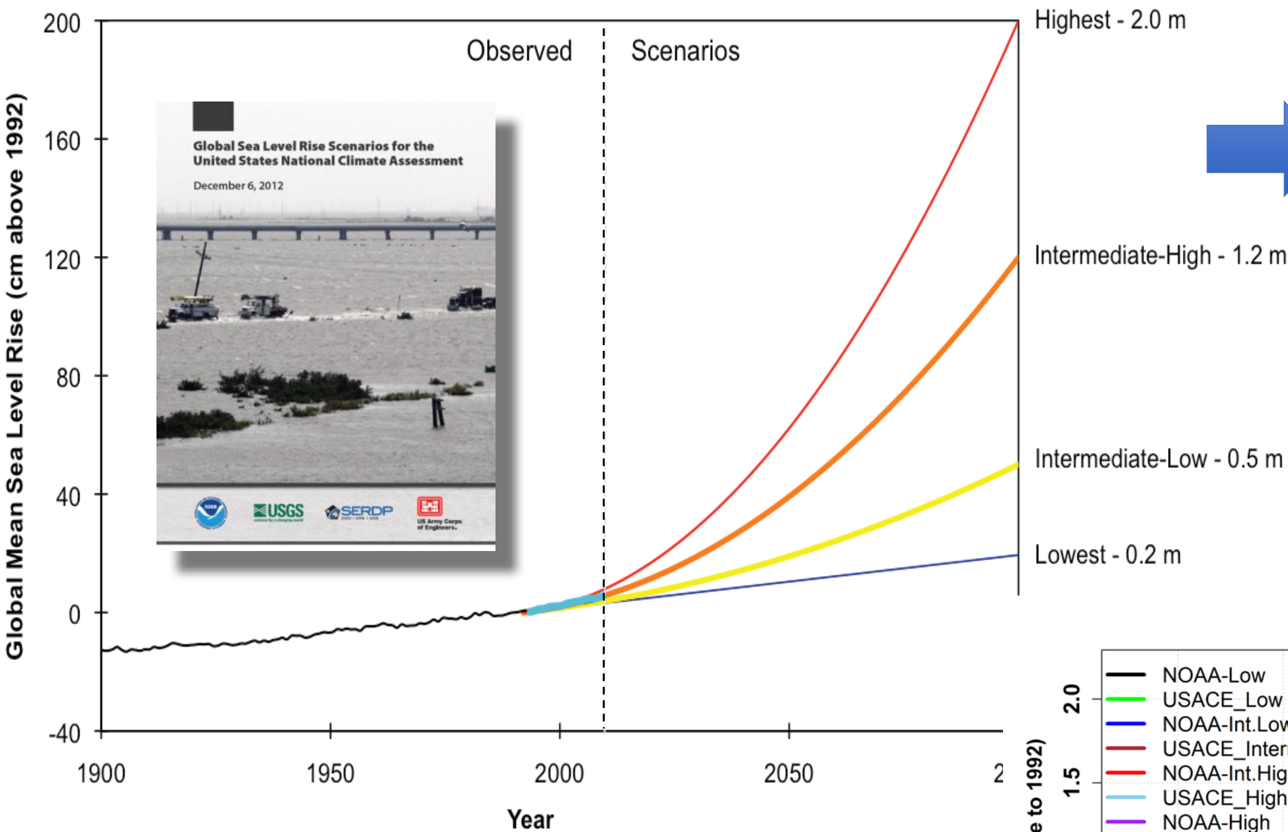
2) Δ Oceanographic Processes (thermal expansion, dynamics from CMIP5 models)

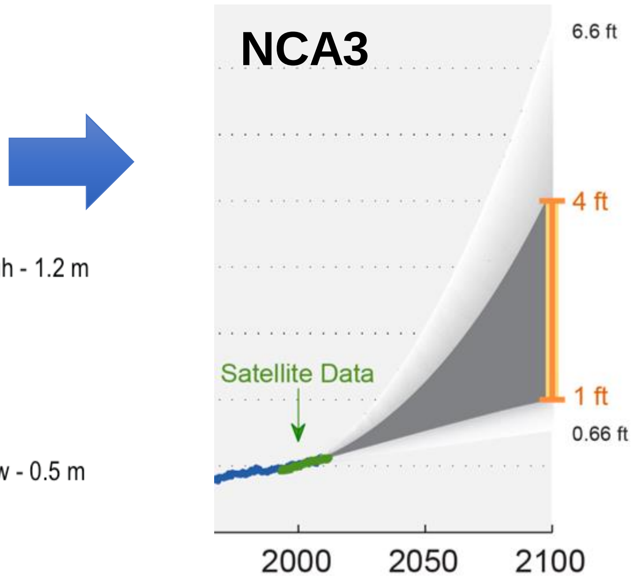
3) Land-water storage based upon empirical relationships

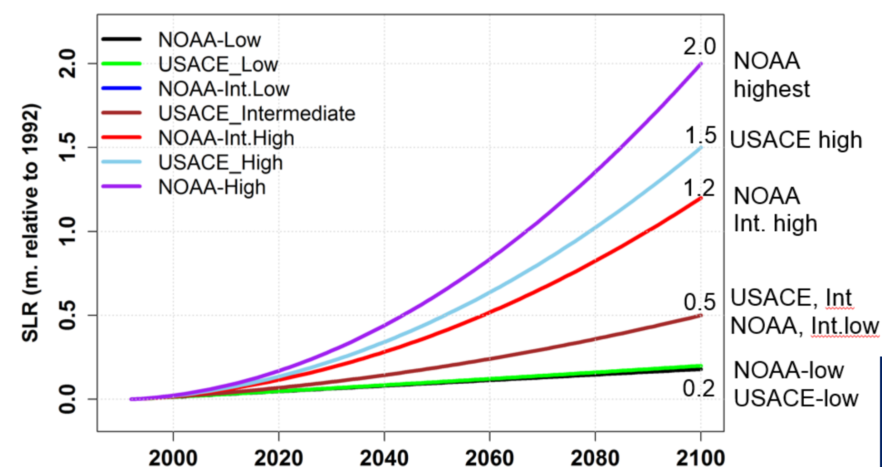
GIA, tectonics, sediment compaction, anthropogenic factors:

- 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

Scenario approach (NOAA, 2012) for 3rd National Climate Assessment

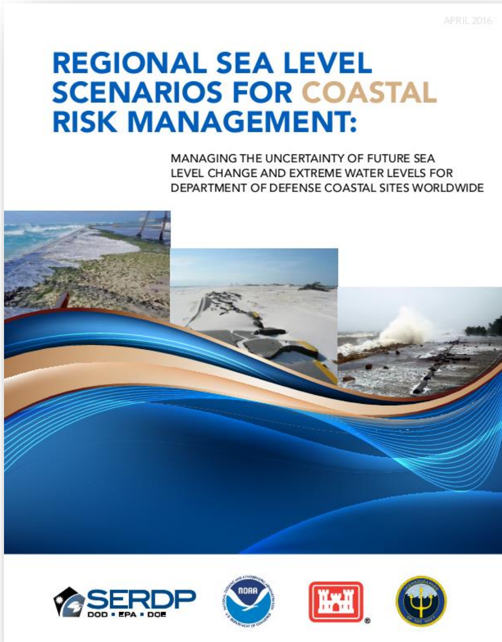


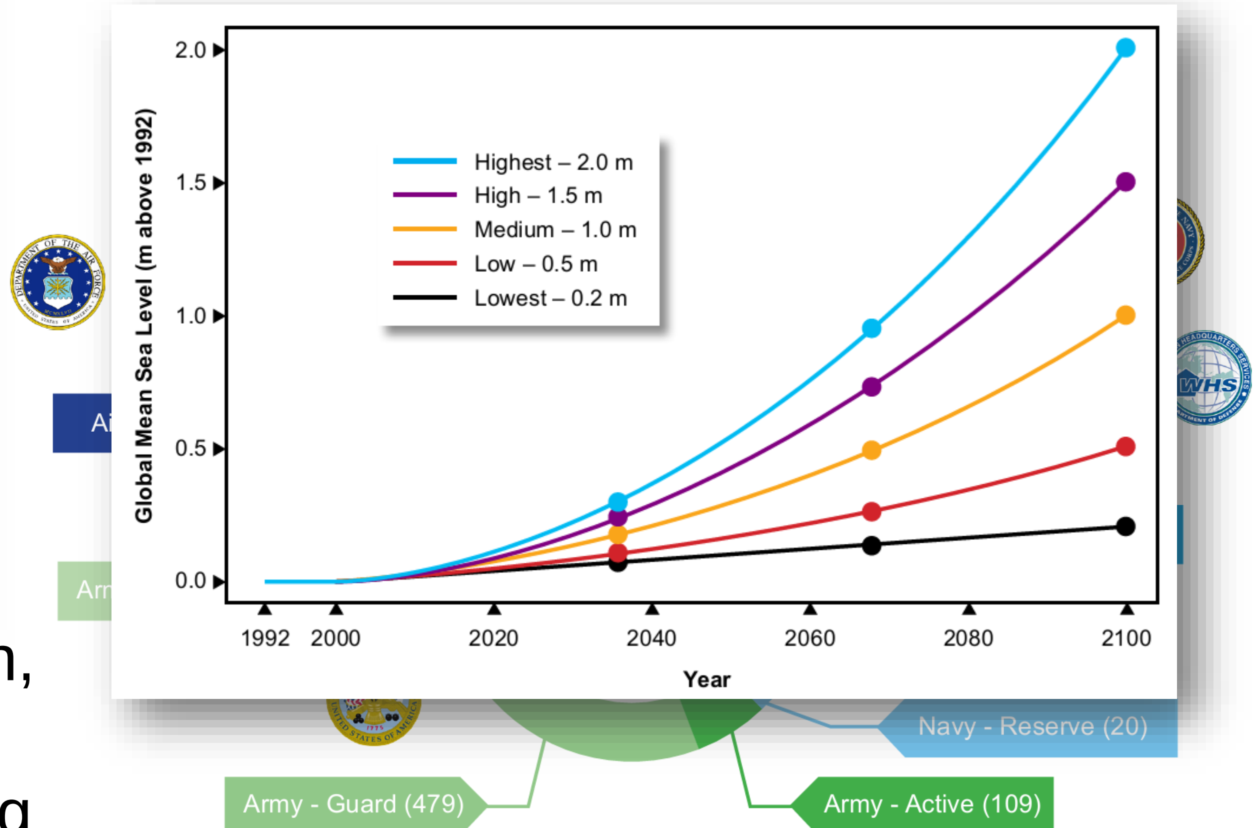




Confidence (>90%) was assigned to the range as bounding possible futures, with no likelihoods assigned to individual scenarios.

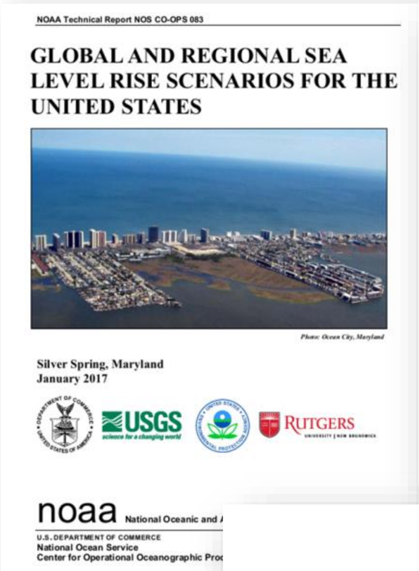
DoD Project (Hall et al. 2016): GMSL Scenarios for installations world-wide

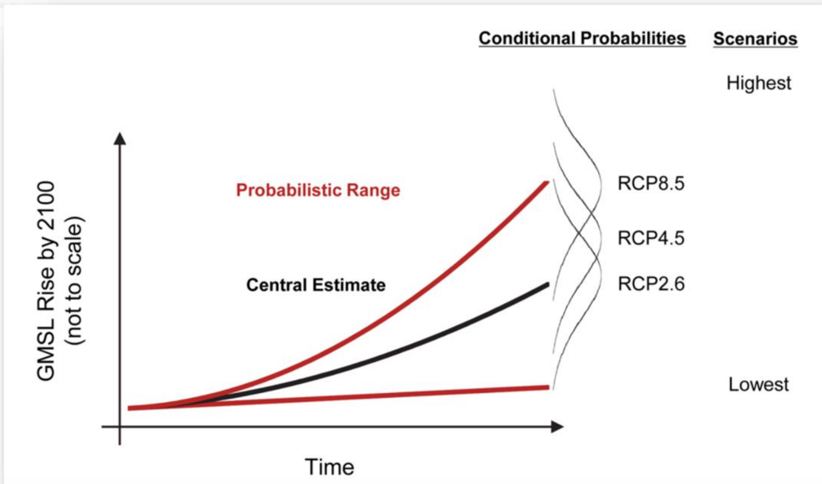




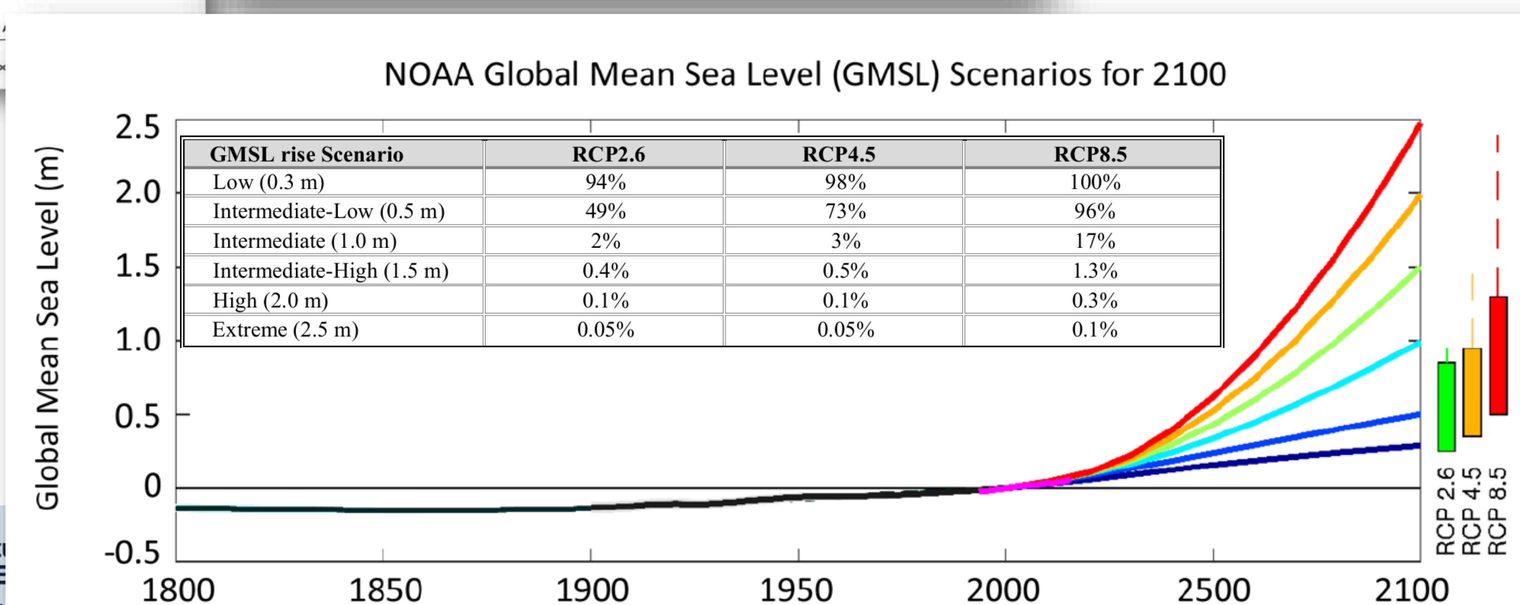
- ➢ Scenario approach, no probabilities
- ➢ Risk-based framing
- ➢ Upper limit still based on Pfeffer (2008)

NOAA (Sweet et al. 2017) for 4th National Climate Assessment



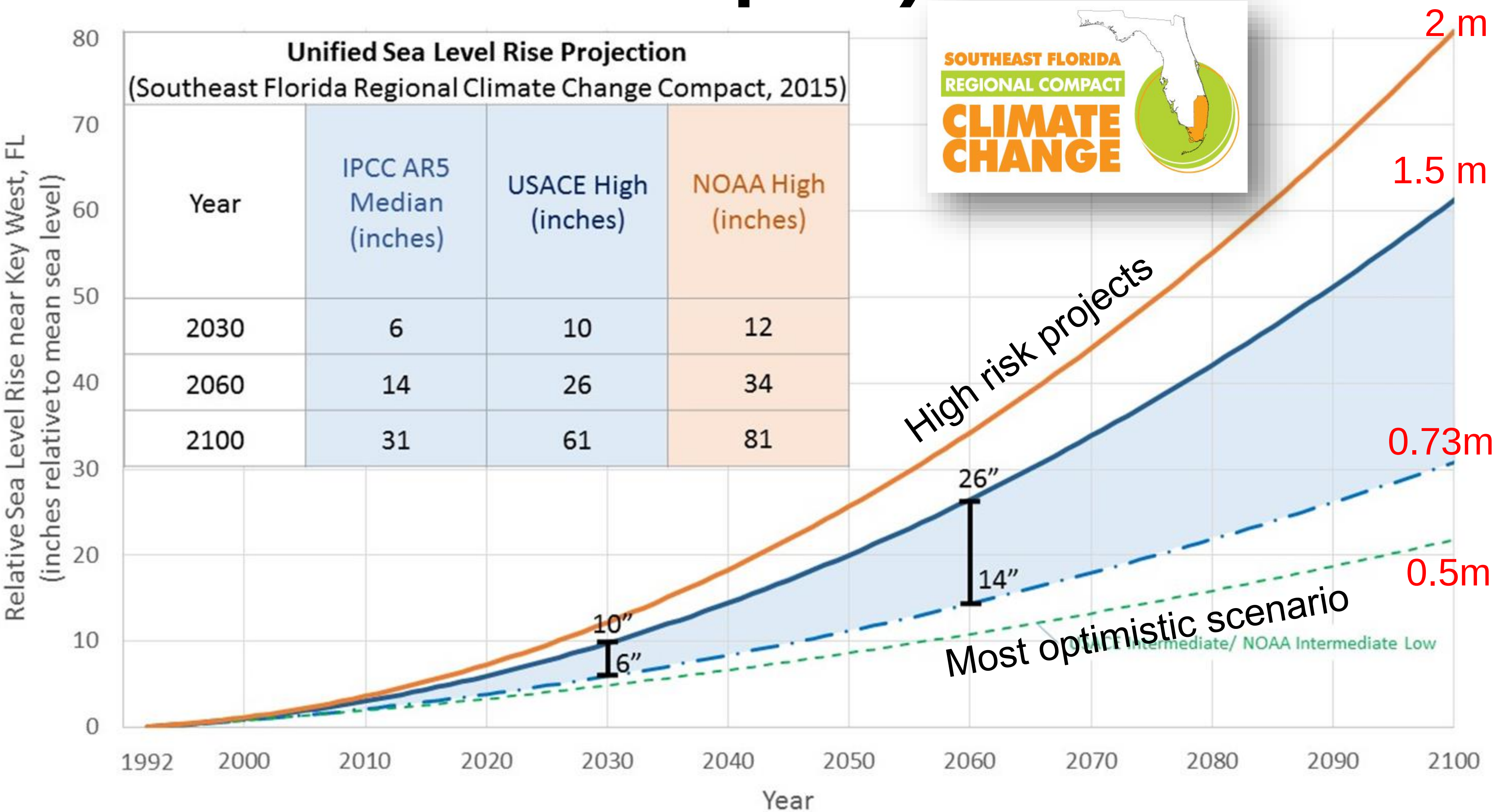


- Kopp et al. (2014)
- Bayesian Probabilities
- Expert elicitation to get the tails
- **DeConto & Pollard (2016):** Antarctica can contribute more, hence 2.5 m scenario



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%

Unified SLR Projections (Climate Compact)

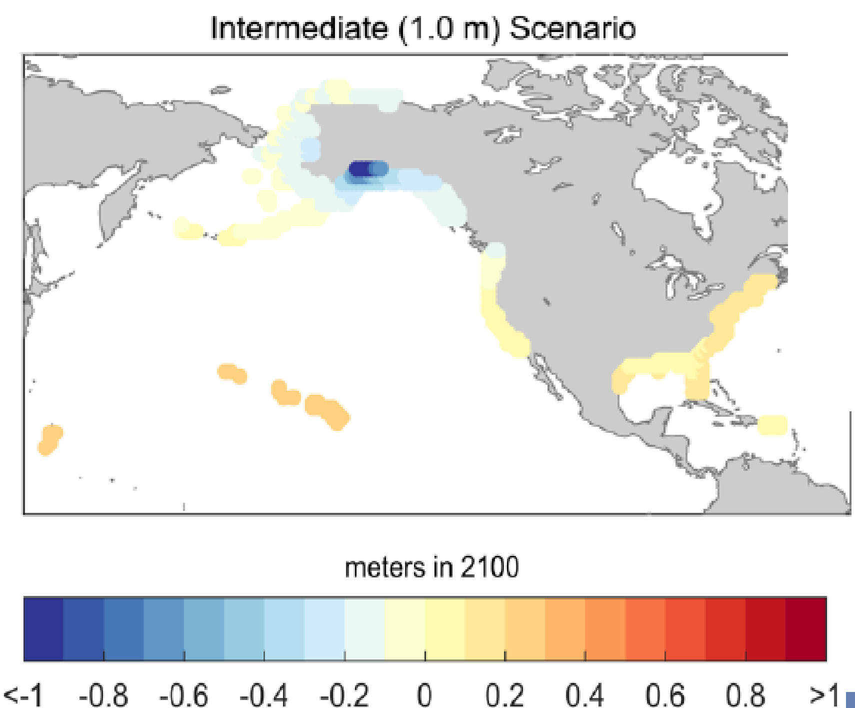


Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81

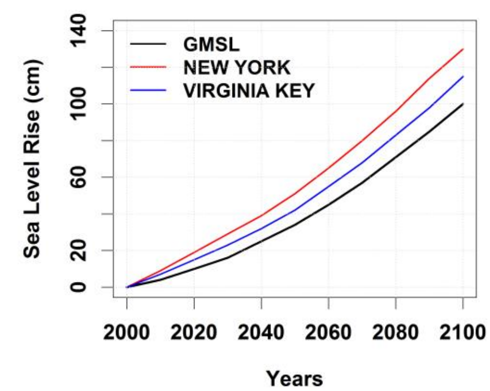
Regional Sea Level Projections

- Both Hall et al. (DoD 2016) and Sweet et al. (NOAA 2017) accounted for all components



Florida

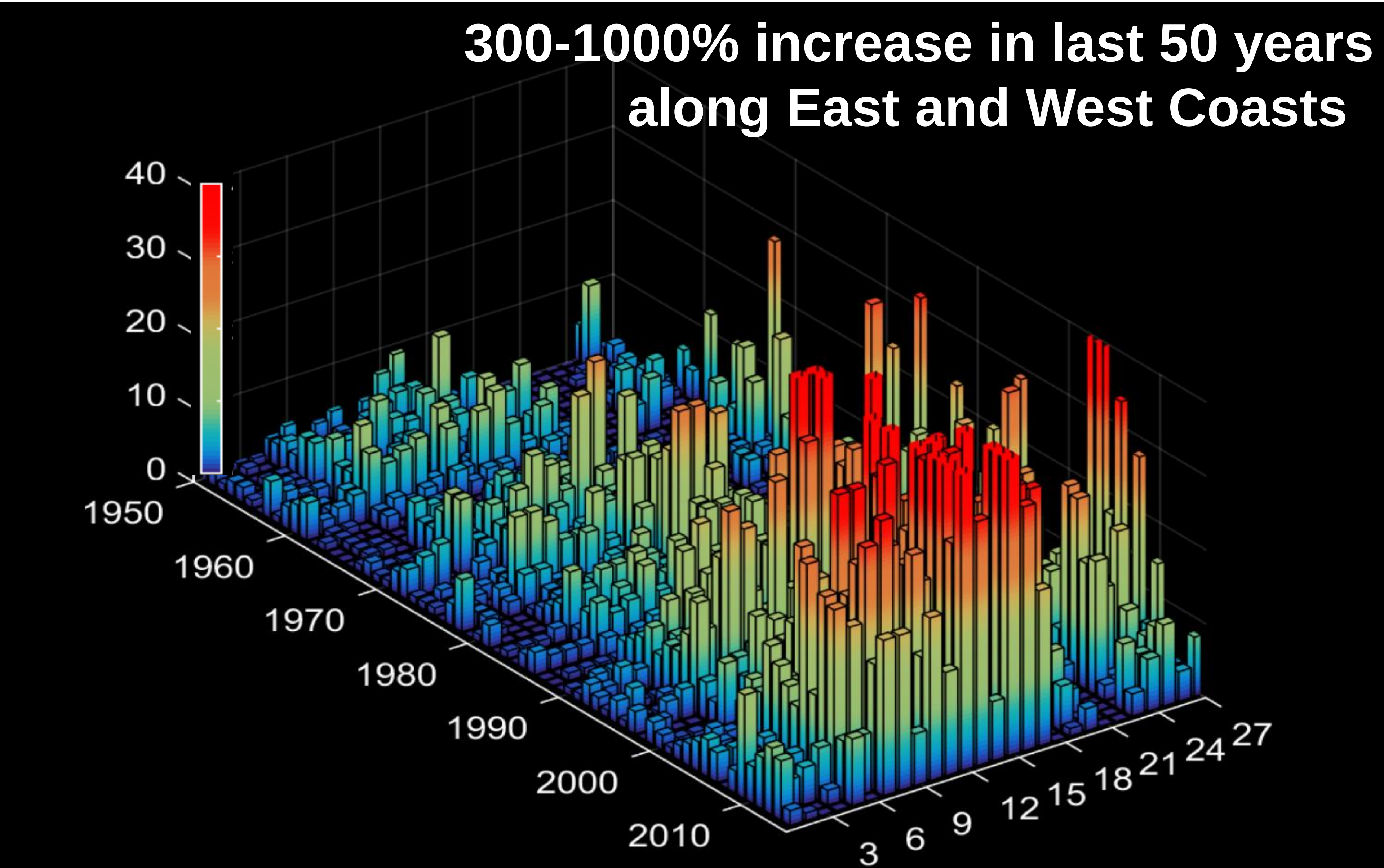
Regional Sea Level Curves



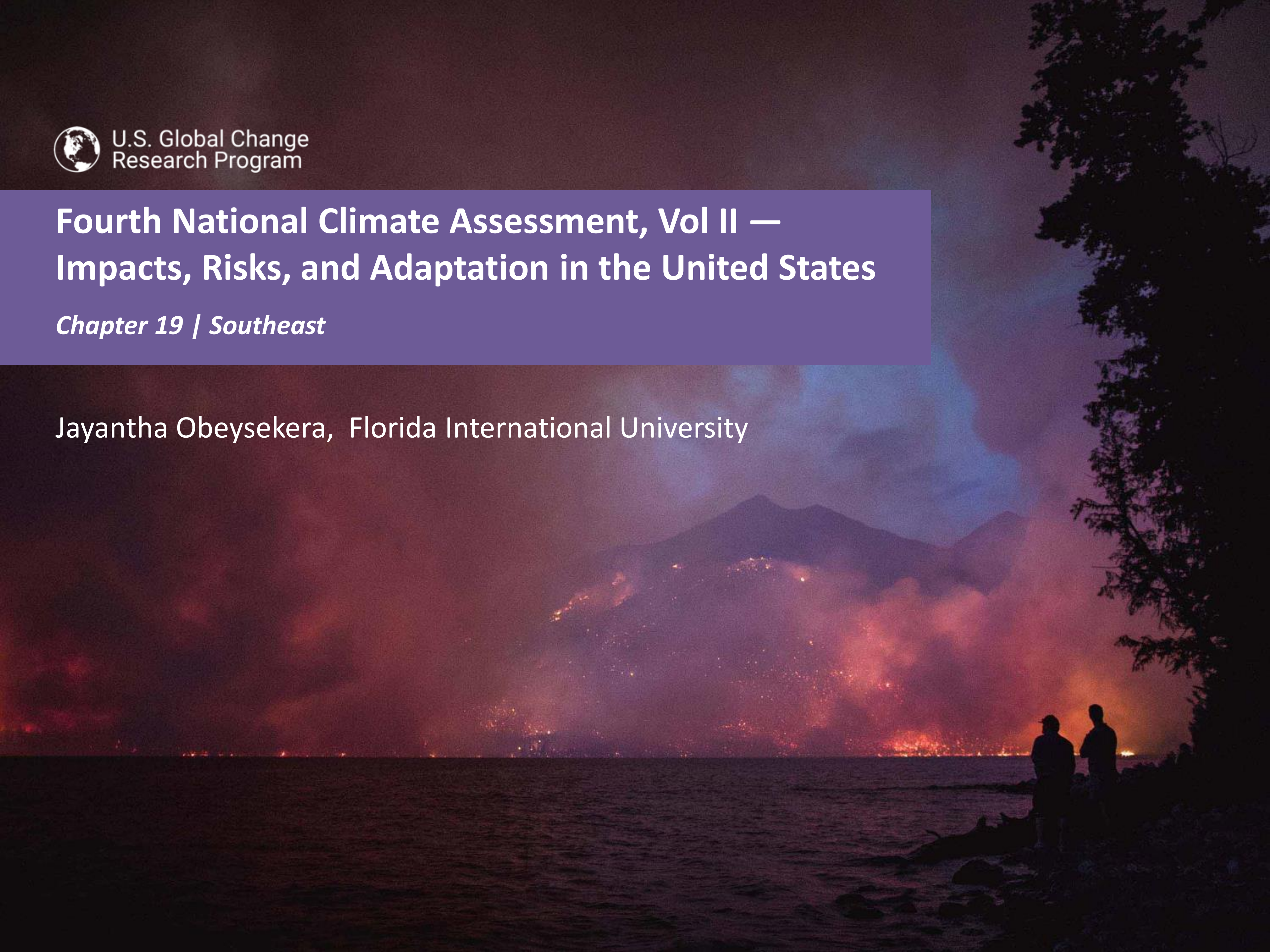
FIU Institute of Water and Environment
Florida International University

FIU Sea Level Solutions Center
Florida International University

Tidal Flooding Trends: A Growing National Problem



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



U.S. Global Change
Research Program

Fourth National Climate Assessment, Vol II — Impacts, Risks, and Adaptation in the United States

Chapter 19 | Southeast

Jayantha Obeysekera, Florida International University

19 Key Messages

Urban Infrastructure and Health Risks

Increasing Flood Risks in Coastal and Low-Lying Regions

Natural Ecosystems Will Be Transformed

Economic and Health Risks for Rural Communities

Fig. 19.4: Historical Number of Warm Nights

The map shows the historical number of warm nights (days with minimum temperatures above 75°F) per year in the Southeast, based on model simulations averaged over the period 1976–2005. *Sources: NOAA NCEI and CICS-NC.*

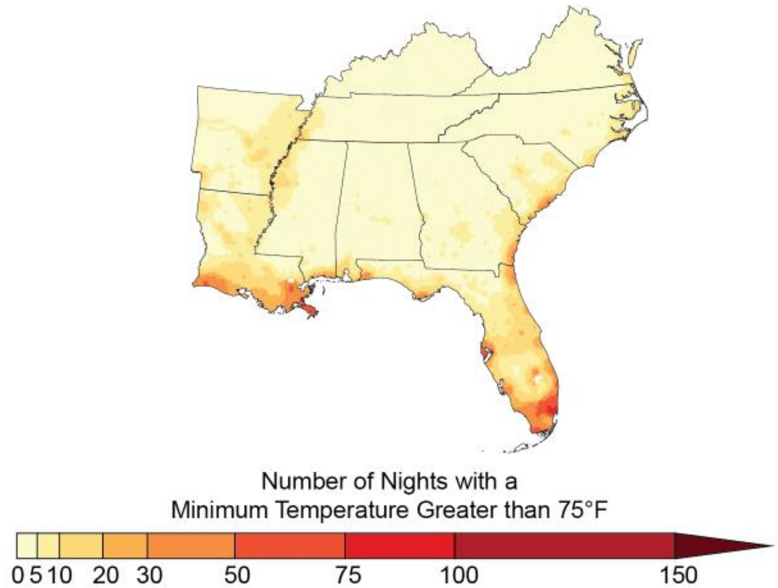
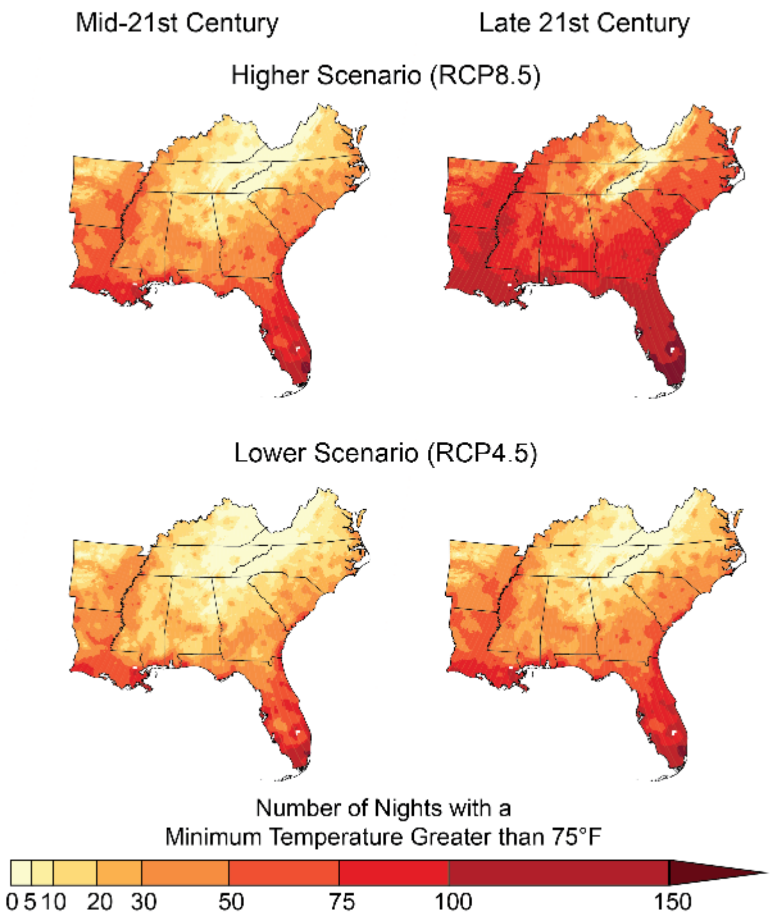


Fig. 19.5: Projected Number of Warm Nights

The maps show the projected number of warm nights (days with minimum temperatures above 75°F) per year in the Southeast for the mid-21st century (left; 2036–2065) and the late 21st century (right; 2070–2099) under a higher scenario (RCP8.5; top row) and a lower scenario (RCP4.5; bottom row). These warm nights currently occur only a few times per year across most of the region (Figure 19.4) but are expected to become common events across much of the Southeast under a higher scenario. Increases in the number of warm nights adversely affect agriculture and reduce the ability of some people to recover from high daytime temperatures. With more heat waves expected, there will likely be a higher risk for more heat-related illness and deaths. *Sources: NOAA NCEI and CICS-NC.*



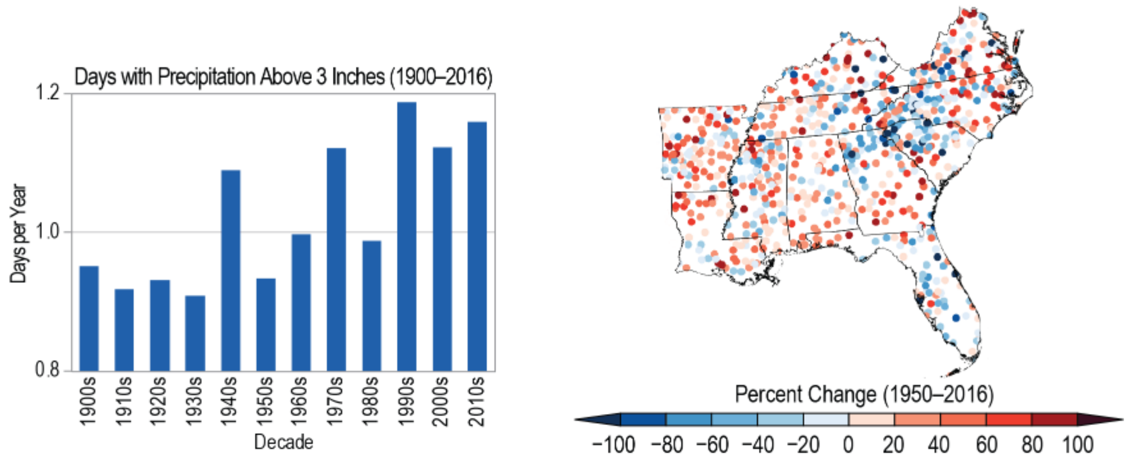


Fig. 19.3: Historical Change in Heavy Precipitation

The figure shows variability and change in (left) the annual number of days with precipitation greater than 3 inches (1900–2016) averaged over the Southeast by decade and (right) individual station trends (1950–2016). The numbers of days with heavy precipitation has increased at most stations, particularly since the 1980s. *Sources: NOAA NCEI and CICS-NC.*

Fig. 19.6: Potential Abundance of Disease-Carrying Mosquito

The map shows current suitability for the *Aedes aegypti* mosquito in July in 50 different cities. *Aedes aegypti* mosquitoes can spread several important diseases, including dengue fever, chikungunya, and Zika fever. The Southeast is the region of the country with the greatest potential mosquito activity. Warming temperatures have the potential to expand mosquito habitat and disease risk. *Source: adapted from Monaghan et al. 2016.*[30]

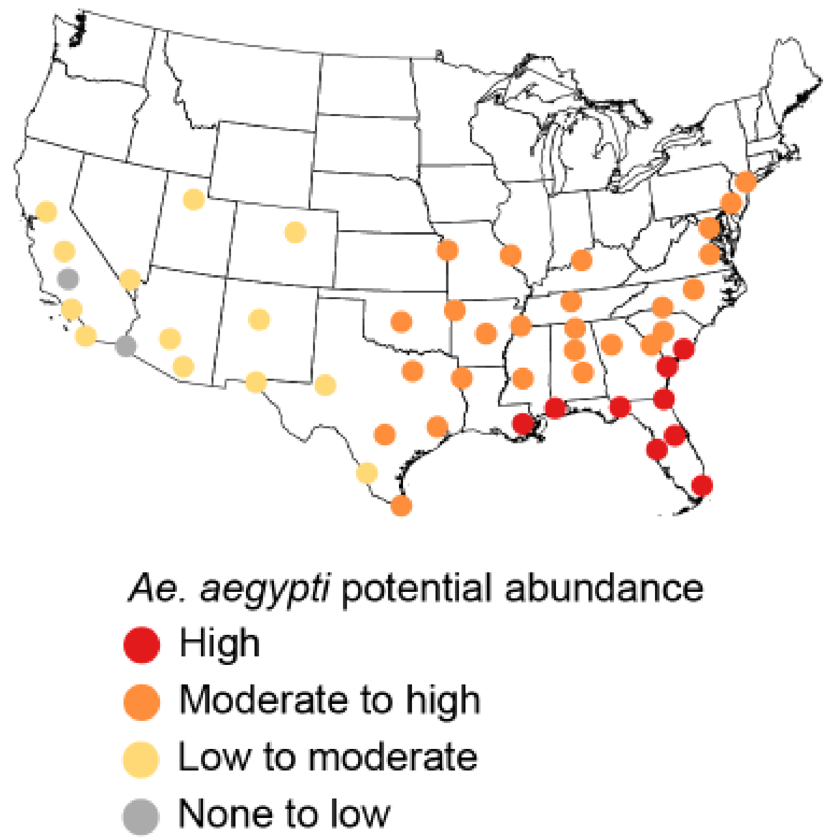


Fig. 19.18: Warm Winters Favor Invasive Species

Burmese pythons are apex predators (not preyed upon by other animals) that are sensitive to cold temperatures and are expected to be favored by warming winters. This photo is from Everglades National Park, where unintentionally introduced pythons have expanded and reduced native mammal populations. *Photo credit: U.S. Geological Survey.*

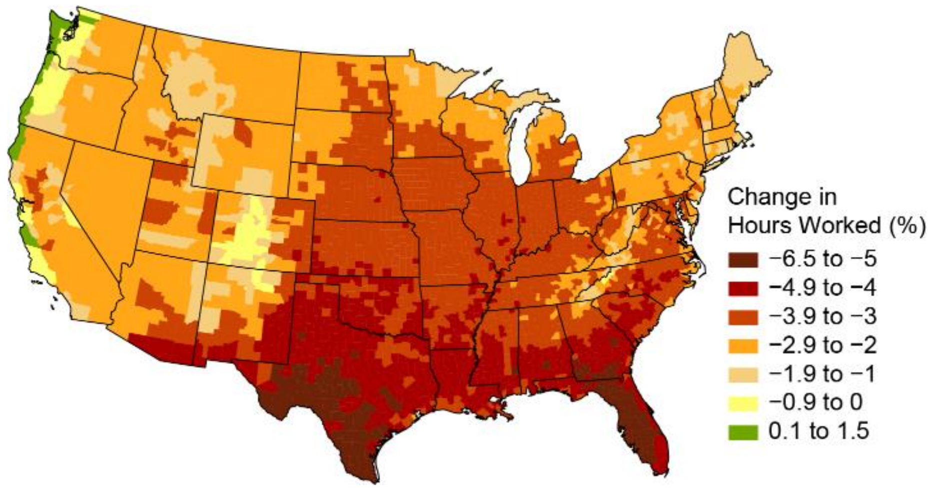


Fig. 19.21: Projected Changes in Hours Worked

This map shows the estimated percent change in hours worked in 2090 under a higher scenario (RCP8.5). Projections indicate an annual average of 570 million labor hours lost per year in the Southeast by 2090 (with models ranging from 340 million to 820 million labor hours).[35] Estimates represent a change in hours worked as compared to a 2003–2007 average baseline for high-risk industries only. These industries are defined as agriculture, forestry, and fishing; hunting, mining, and construction; manufacturing, transportation, and utilities. *Source: adapted from EPA 2017.*[35]

FLORIDA

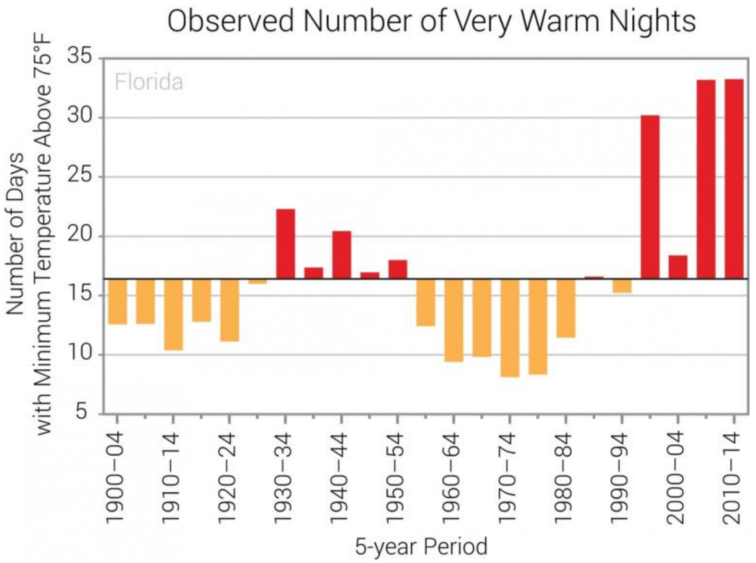
Key Messages

Under a higher emissions pathway, historically unprecedented warming is projected by the end of the 21st century.

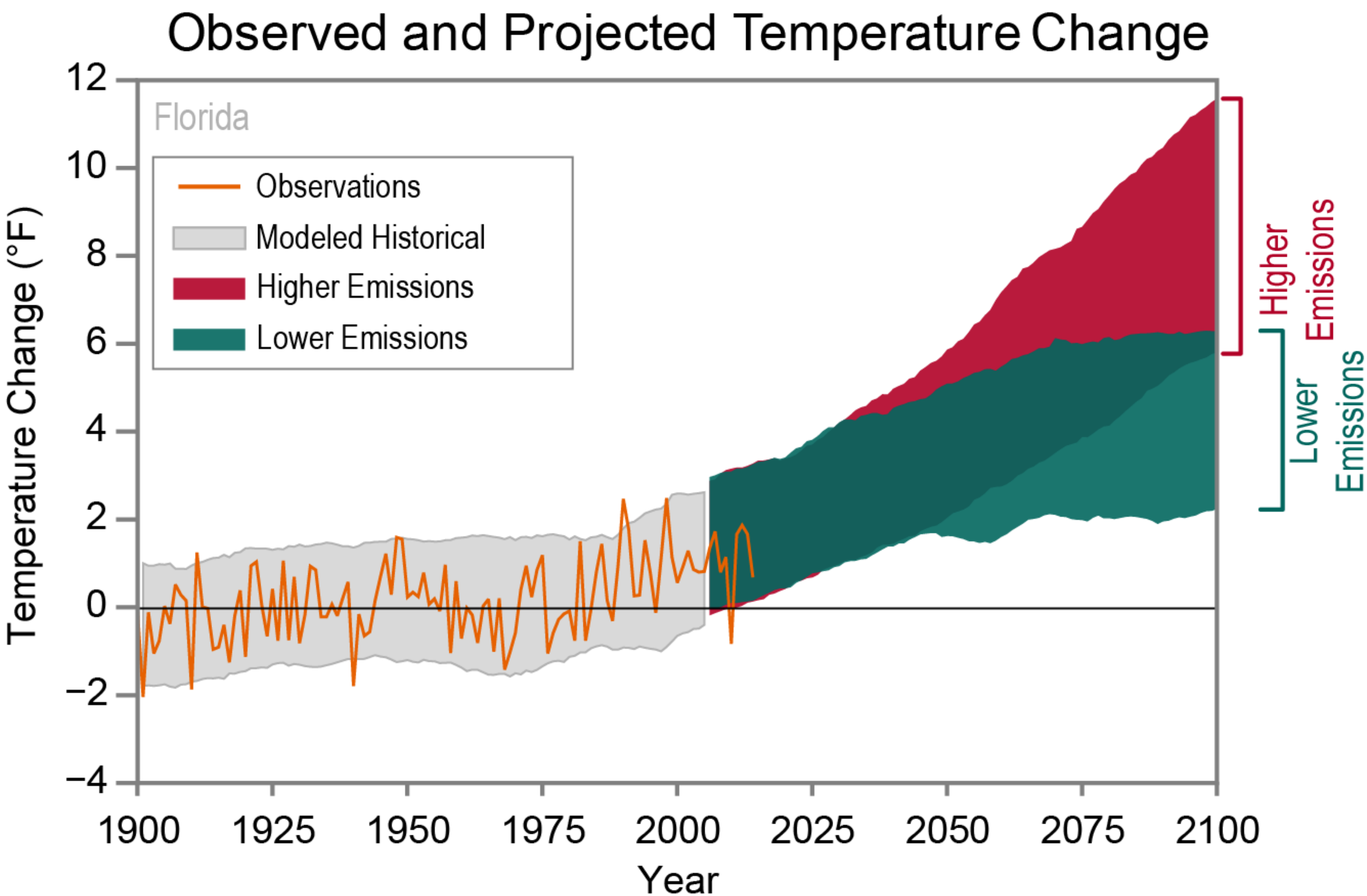
Rising temperatures will likely increase the intensity of naturally-occurring droughts in this area because of increases in rate of loss of soil moisture.

The number of landfalling hurricanes in Florida is highly variable from year to year. Hurricane rainfall rates are projected to increase as the climate continues to warm.

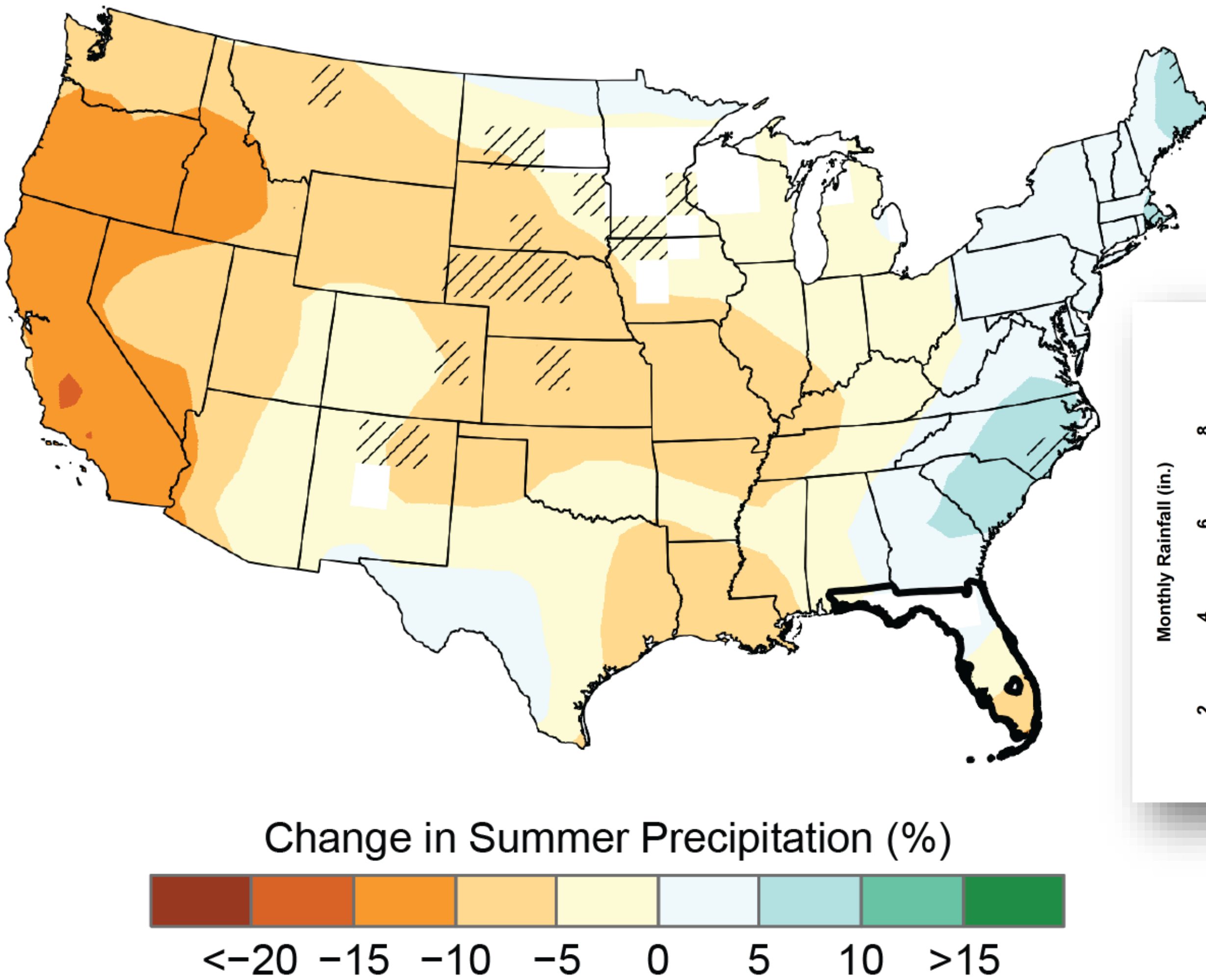
Global sea level has risen about 8 inches since reliable record keeping began in 1880. It is projected to rise another 1 to 4 feet by 2100, likely causing increases in nuisance-level coastal flooding and contributing to saltwater contamination of coastal groundwater reservoirs.

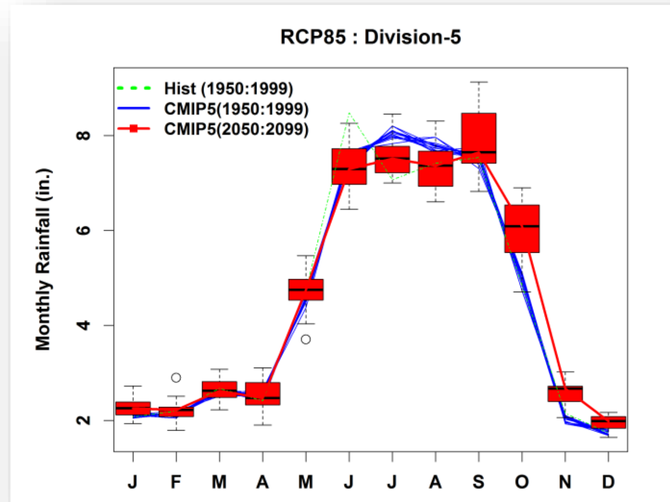


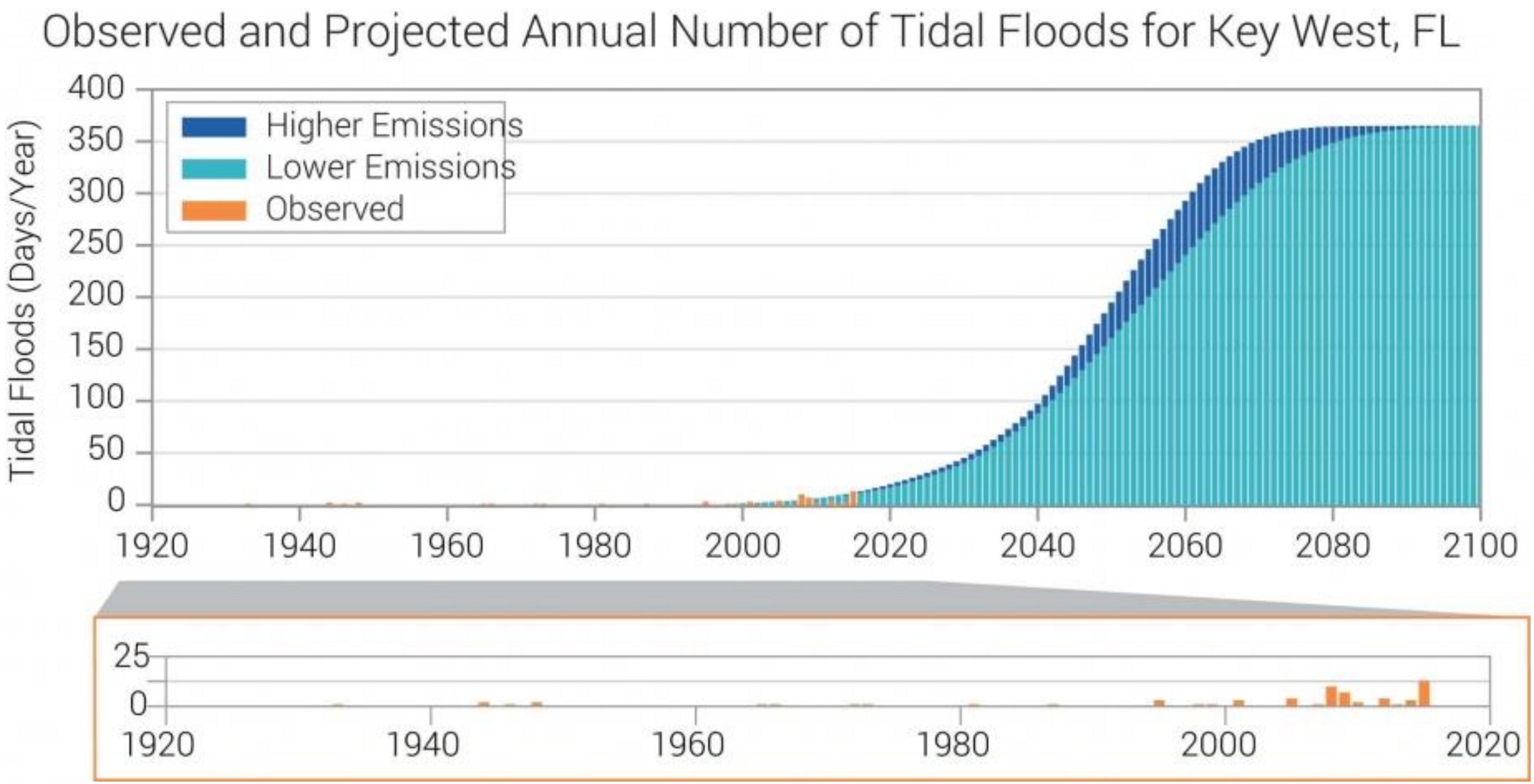
Over the past decade, Florida has experienced 13 weather and climate disaster events that exceeded $1 billion in damages. Hurricane rainfall is expected to increase for Florida as the climate continues to warm.


Observed and Projected Temperature Change
Florida
Observations
Modeled Historical
Higher Emissions
Lower Emissions
Temperature Change (°F)
12
10
8
6
4
2
0
−2
−4
1900
1925
1950
1975
2000
2025
2050
2075
2100
Year
Higher Emissions
Lower Emissions

Projected Change in Summer Precipitation






Observed and Projected Annual Number of Tidal Floods for Key West, FL
Tidal Floods (Days/Year)
400
350
300
250
200
150
100
50
0
Higher Emissions
Lower Emissions
Observed
1920
1940
1960
1980
2000
2020
2040
2060
2080
2100
25
0
1920
1940
1960
1980
2000
2020

Ongoing efforts

- Rainfall workshop funded by SFWMD
- "Florida Climate Assessment" spearheaded by Florida Climate Institute (FCI)
  - White paper and two workshops (climate, coastal issues) in preparation/planning stage
- HYPERION project

Questions?