

Sea-Level Rise Impacts of Climate Change Pt. 2

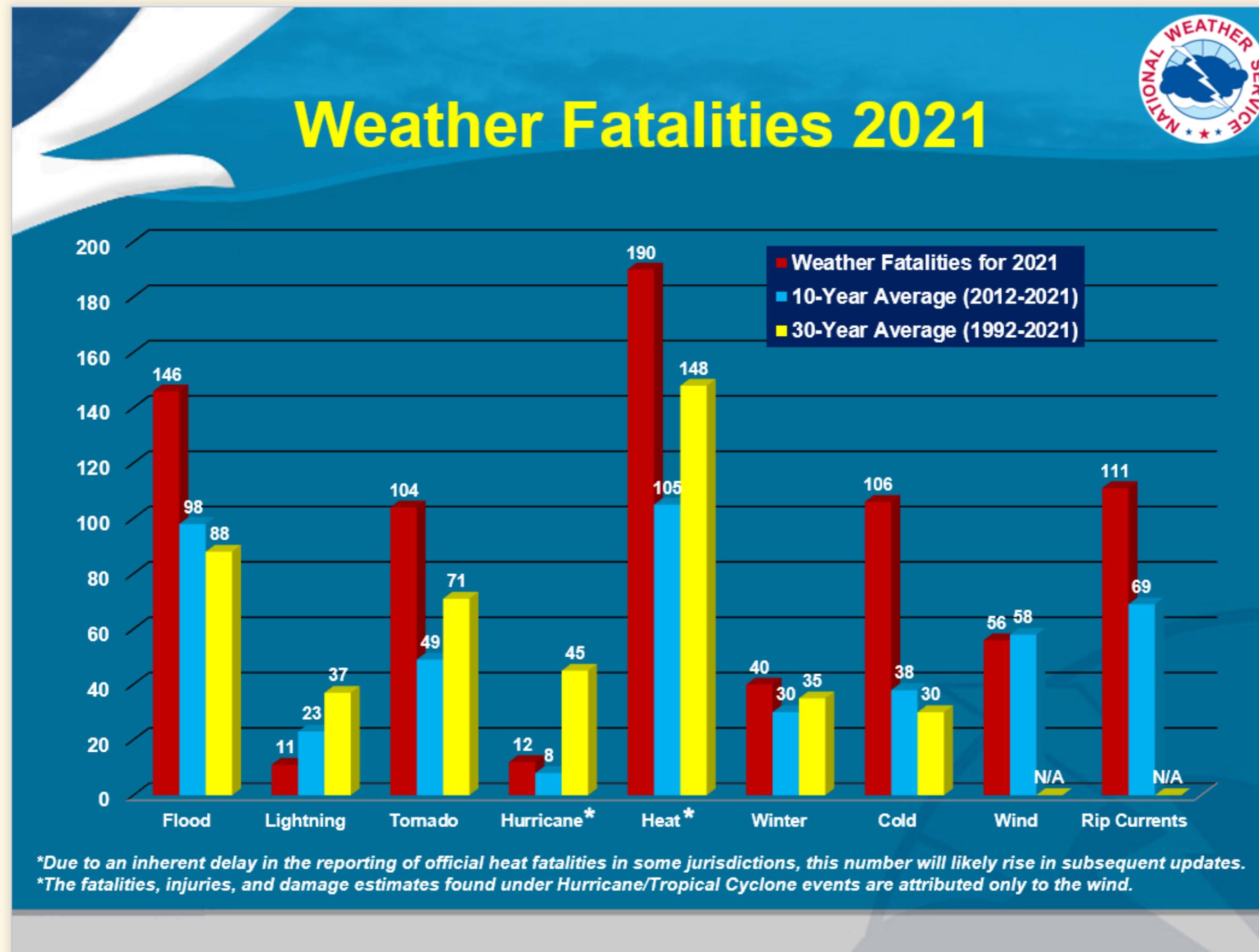
EES 2110

Introduction to Climate Change
Jonathan Gilligan

Class #39: Monday, April 17 2023

Heat and Health

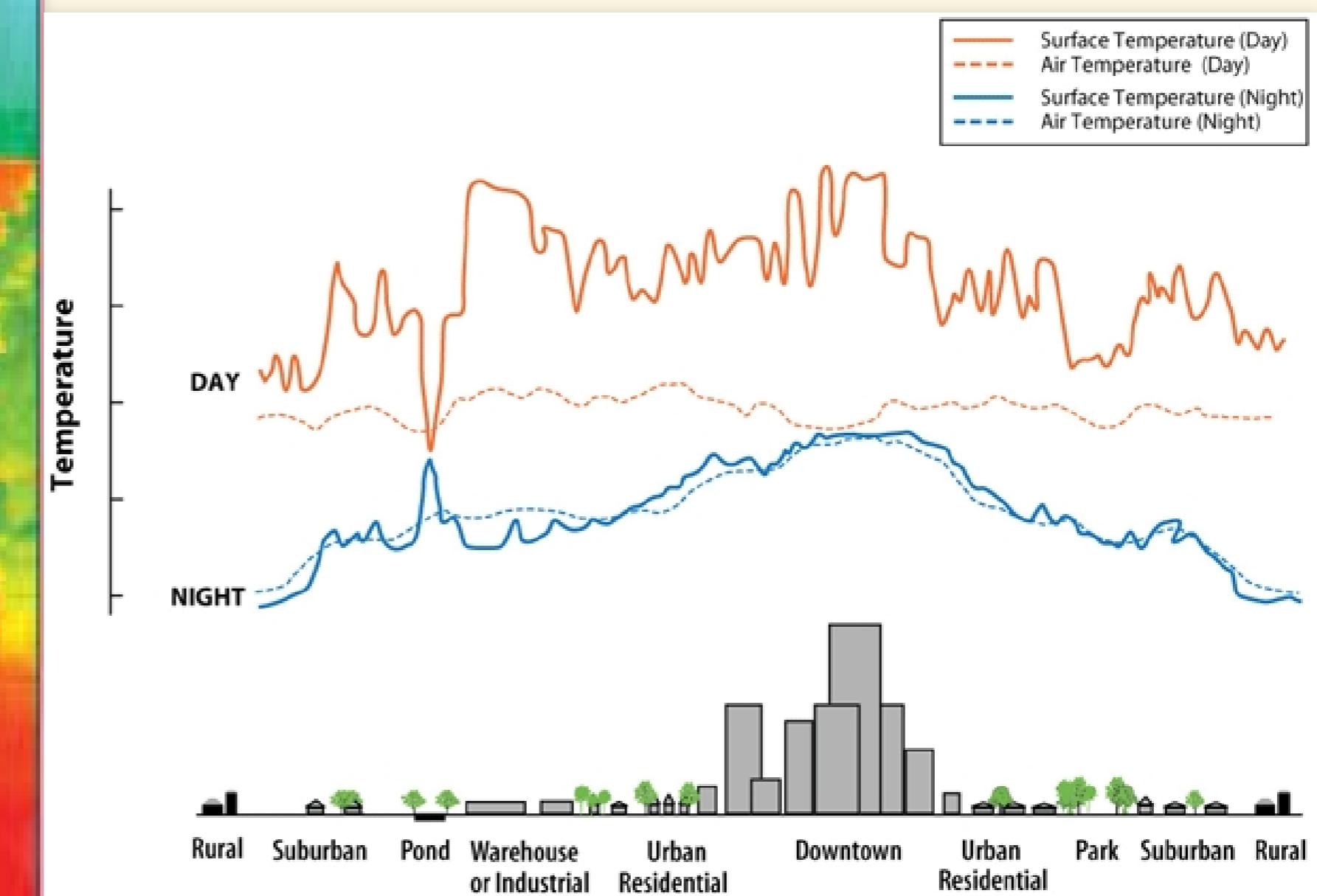
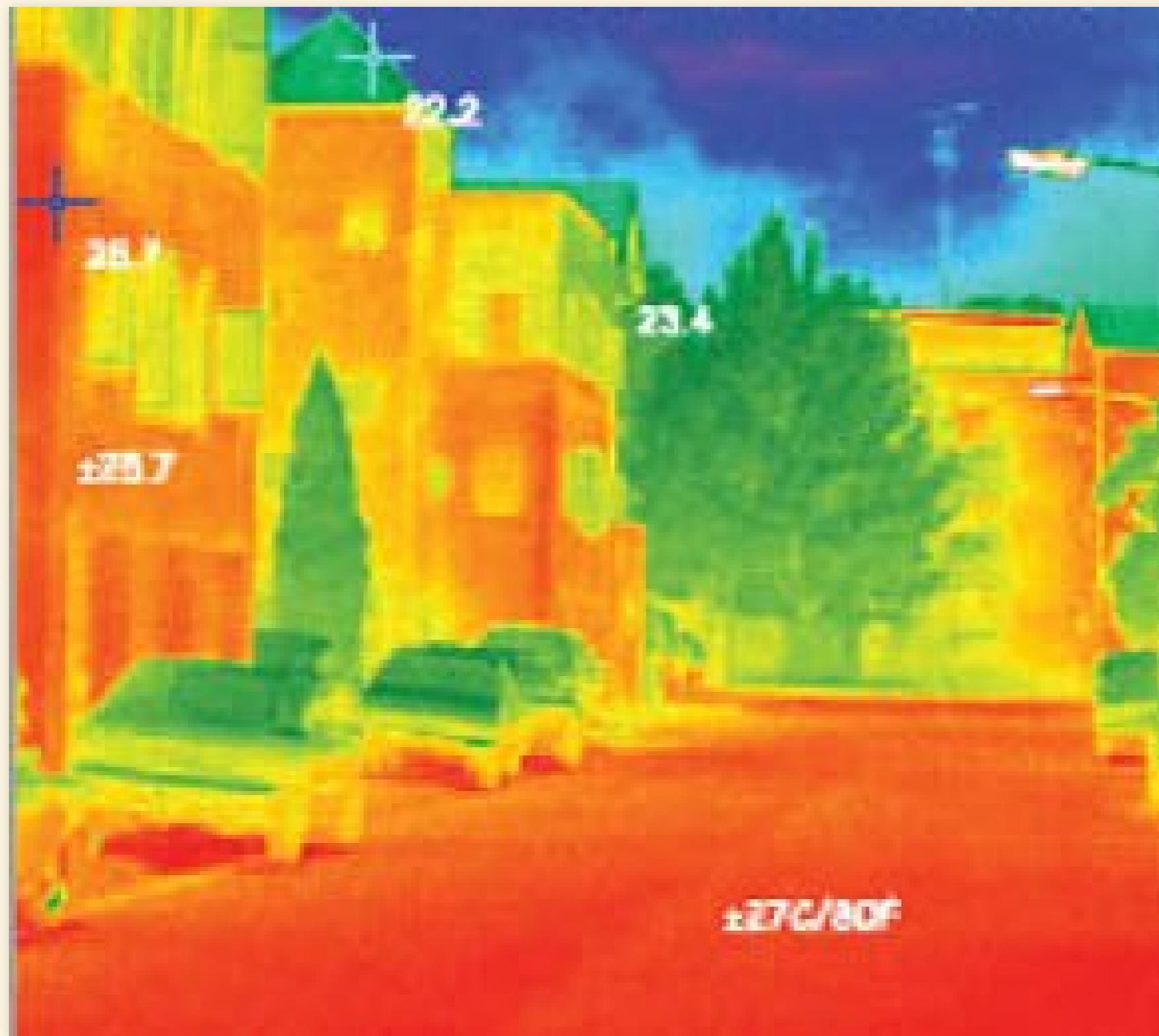
Heat versus Cold



Heat versus Cold

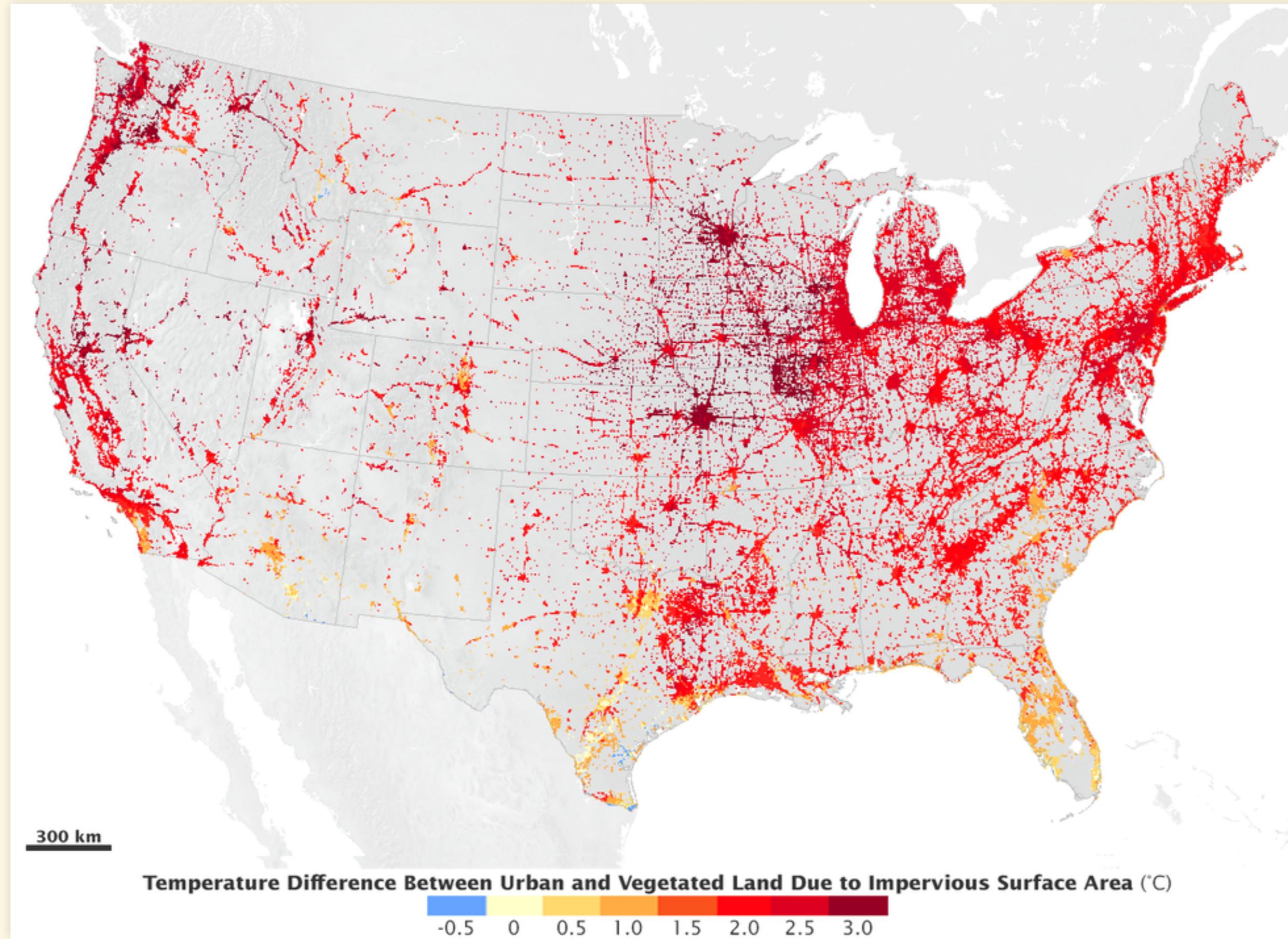
- More people die during cold months than hot months each year
 - Confounding factor: Seasonality of diseases (flu, etc.)
 - Deaths from cold are relative: it's about acclimation
 - Deaths from heat are absolute: threshold temperatures
- Adding extremely hot days raises mortality much more than adding extremely cold days

Urban Heat Islands



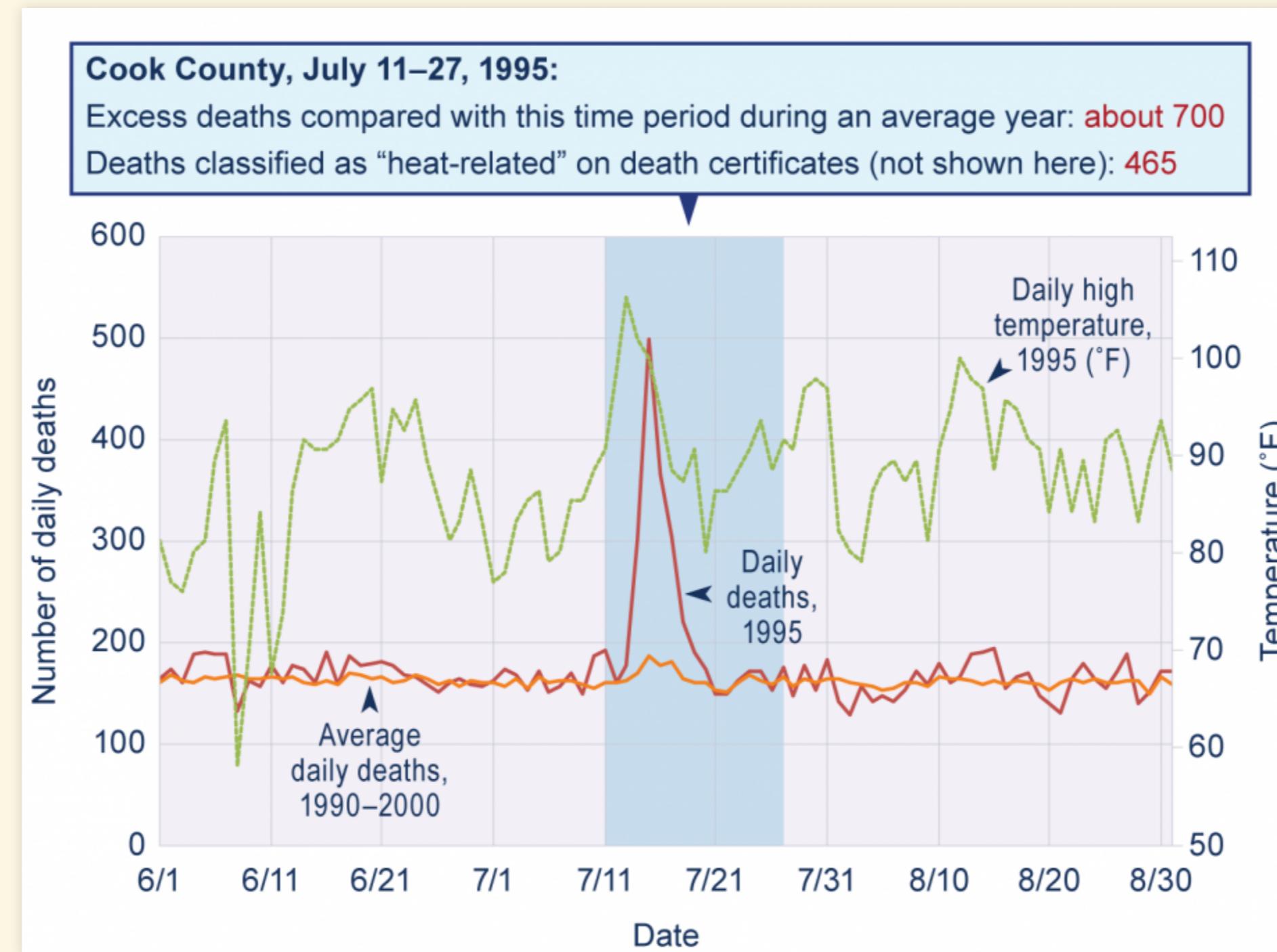
Source: Environmental Protection Agency

Urban Heat Islands in the United States



Urban Heat Mortality

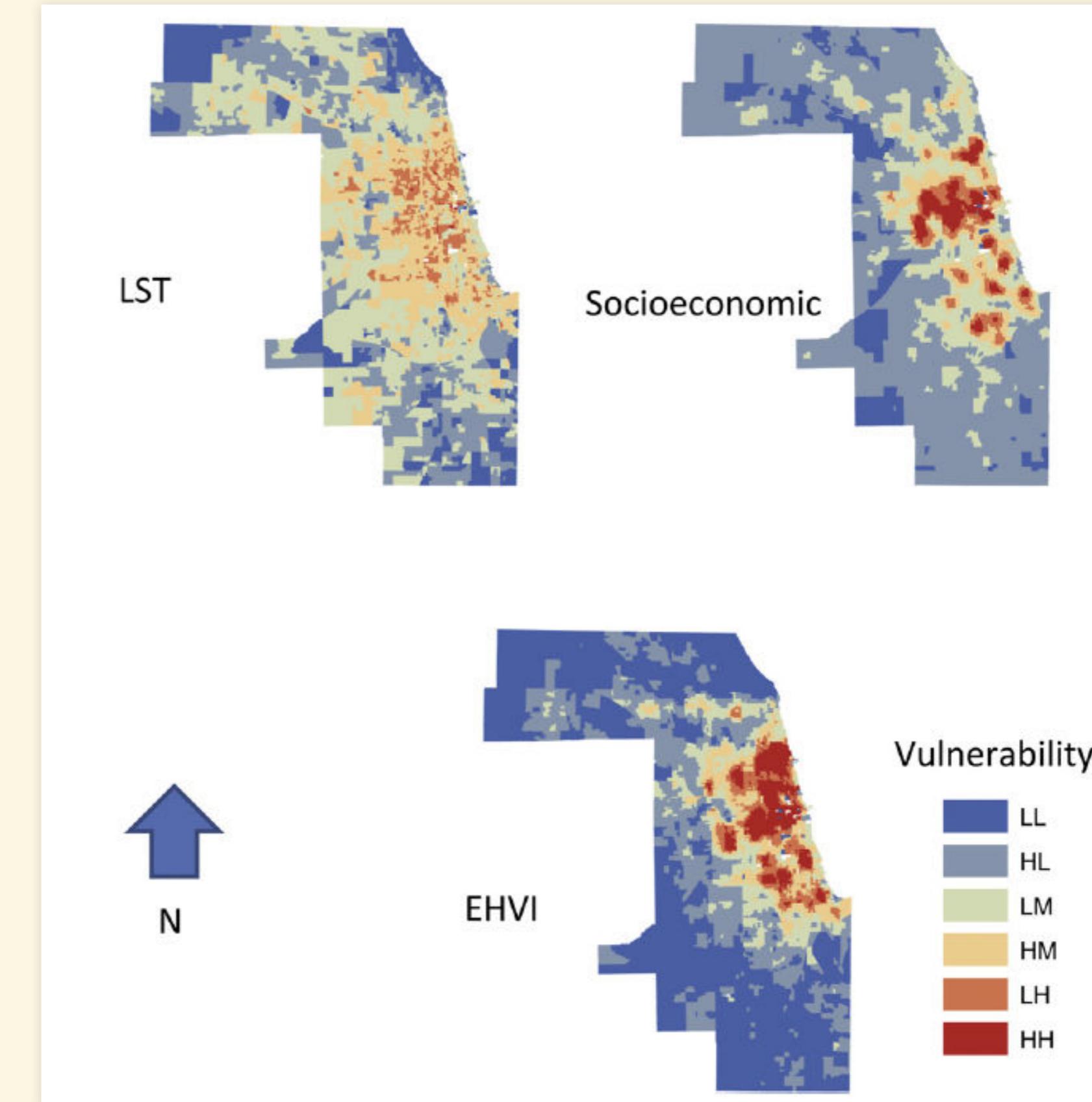
Chicago, 1995



Source: USGCRP, *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (2016).

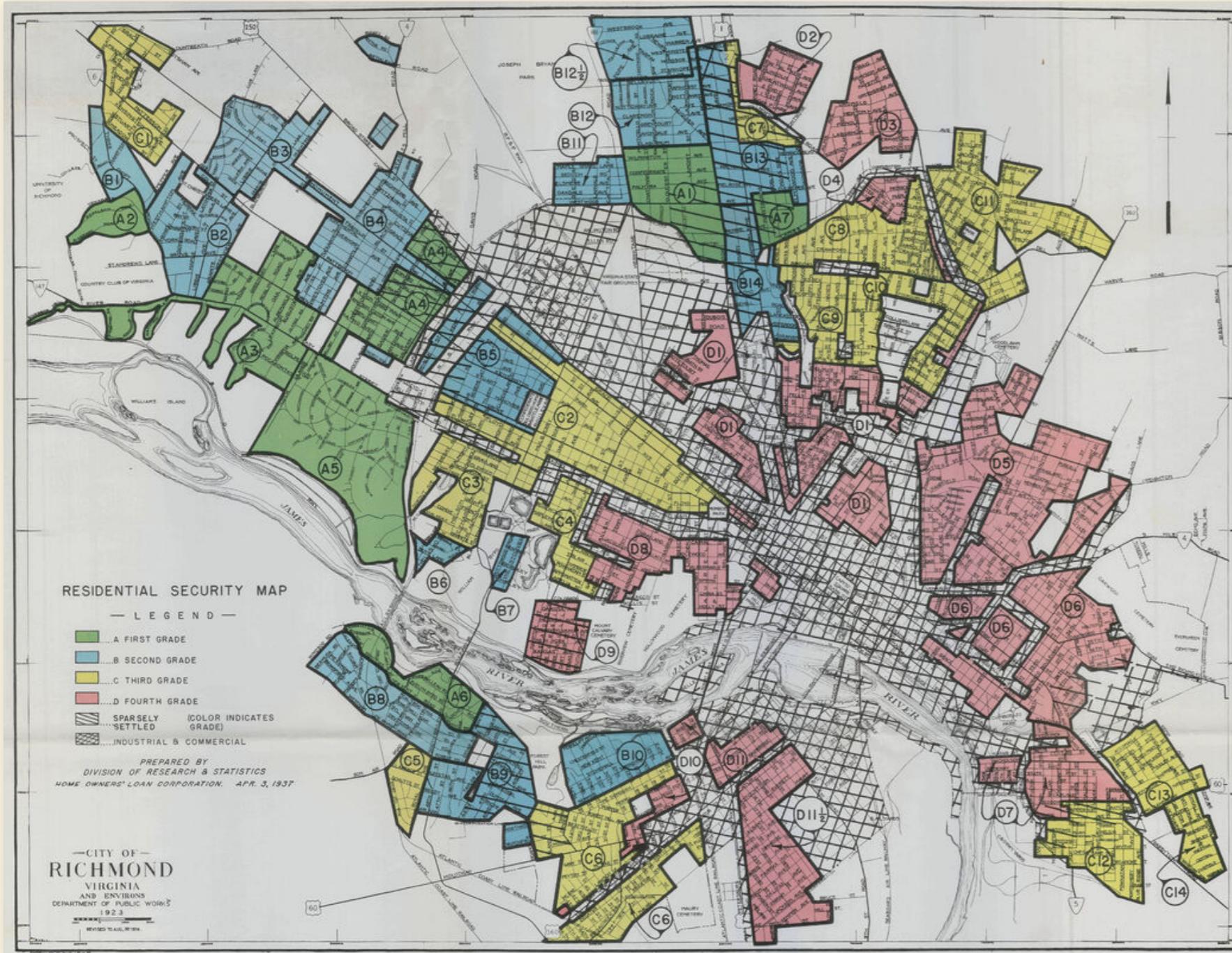
Socioeconomic Status and Vulnerability to Heat

- LST = Urban heat island effect
- EHVI = extreme heat vulnerability index
- EHVI correlates very strongly with socioeconomic variables



Source: D.P. Johnson *et al.*, Appl. Geography 35, 23 (2012).

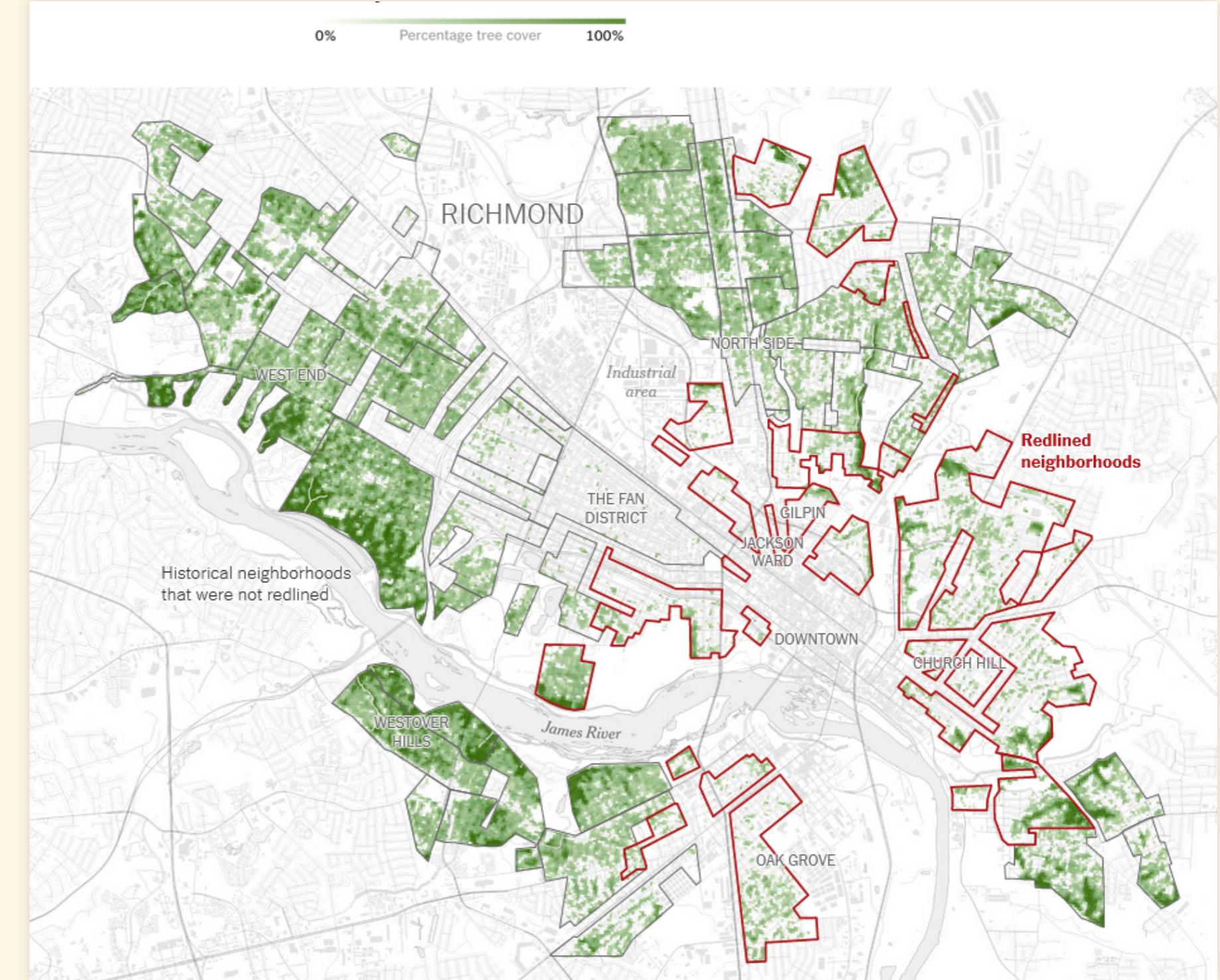
Legacy of Racism and Vulnerability to Heat



B. Plumer & N. Popovich, "How Decades of Racist Housing Policies Left Neighborhoods Sweltering" New York Times Aug 24, 2020.

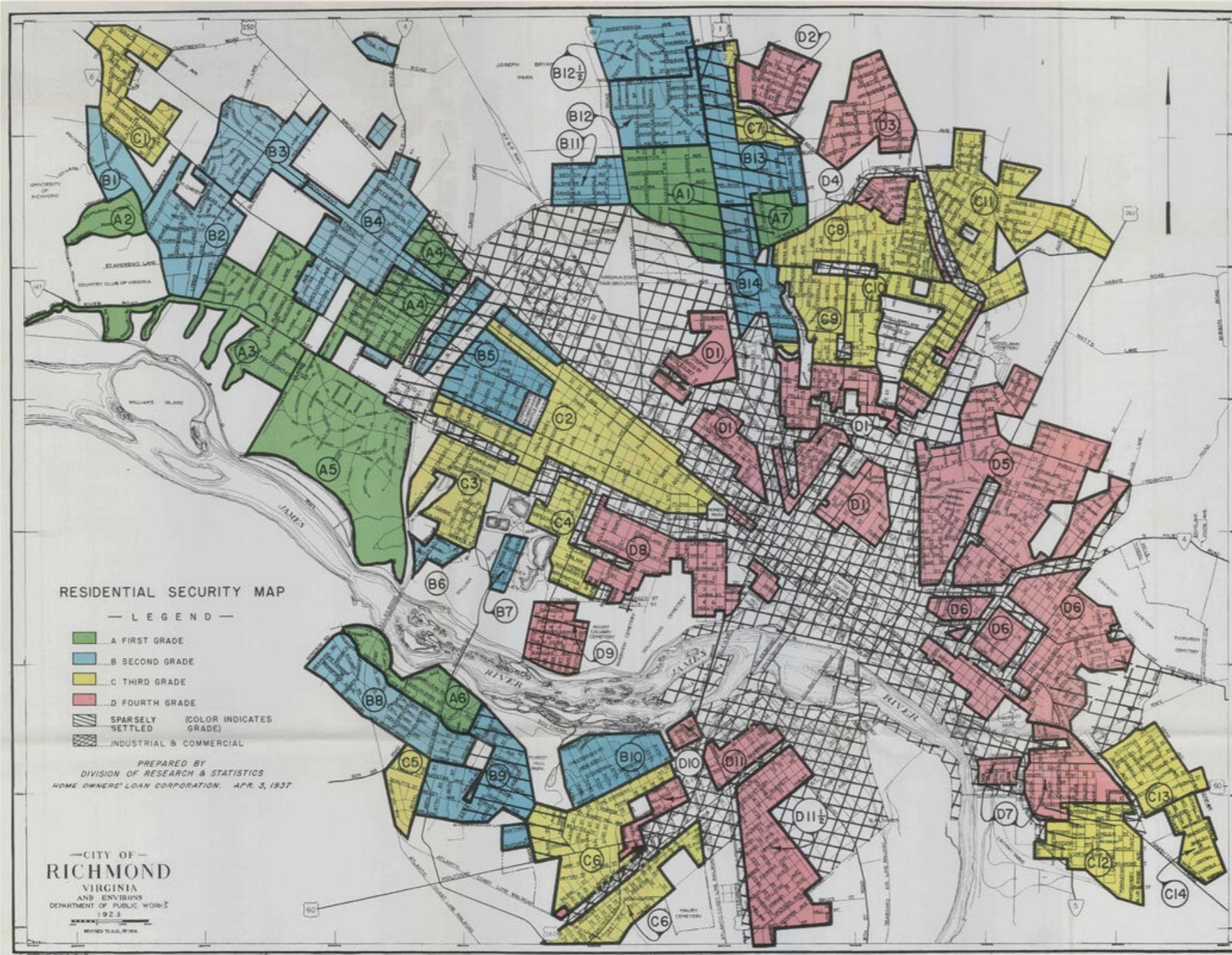
14. CLARIFYING REMARKS: This area is yellow, largely because the school for white children is in the negro area, D-8, and because the negroes of D-8 pass back and forth for access to the William Byrd Park which lies to the west. For this reason losses on properties are being taken.

Southeasternmost cheap bungalows.

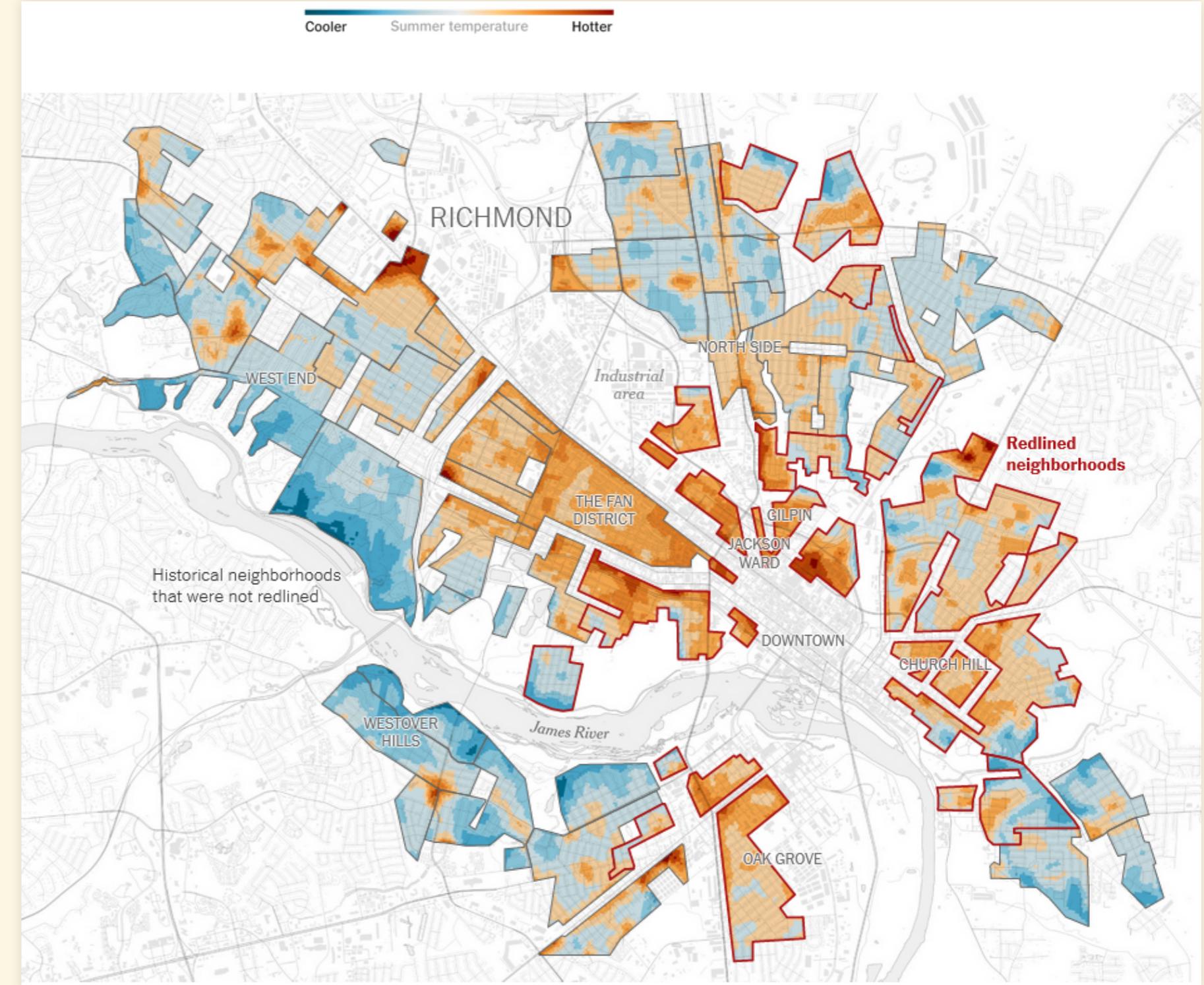


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Legacy of Racism and Vulnerability to Heat

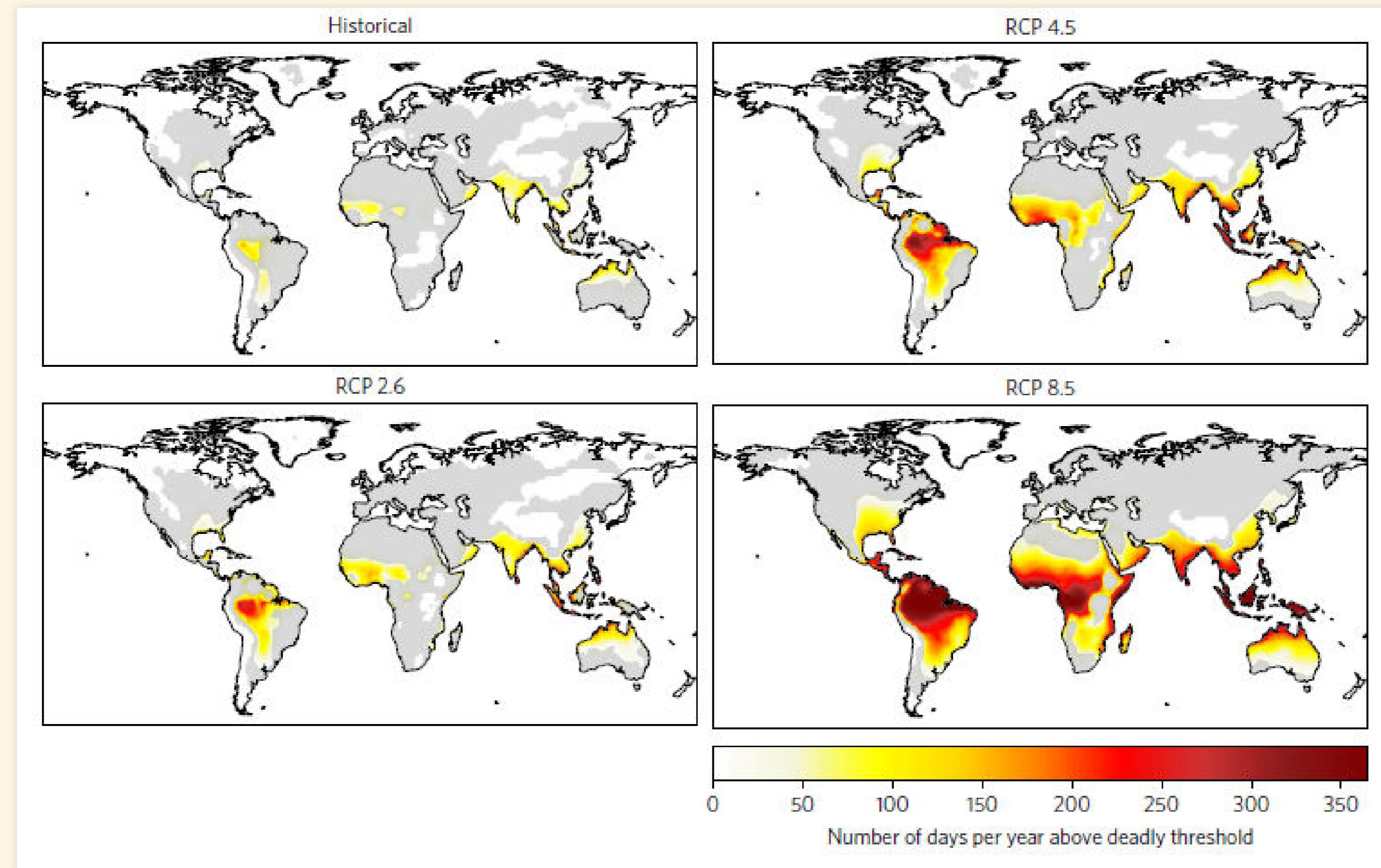


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Climate Change and Deadly Heat



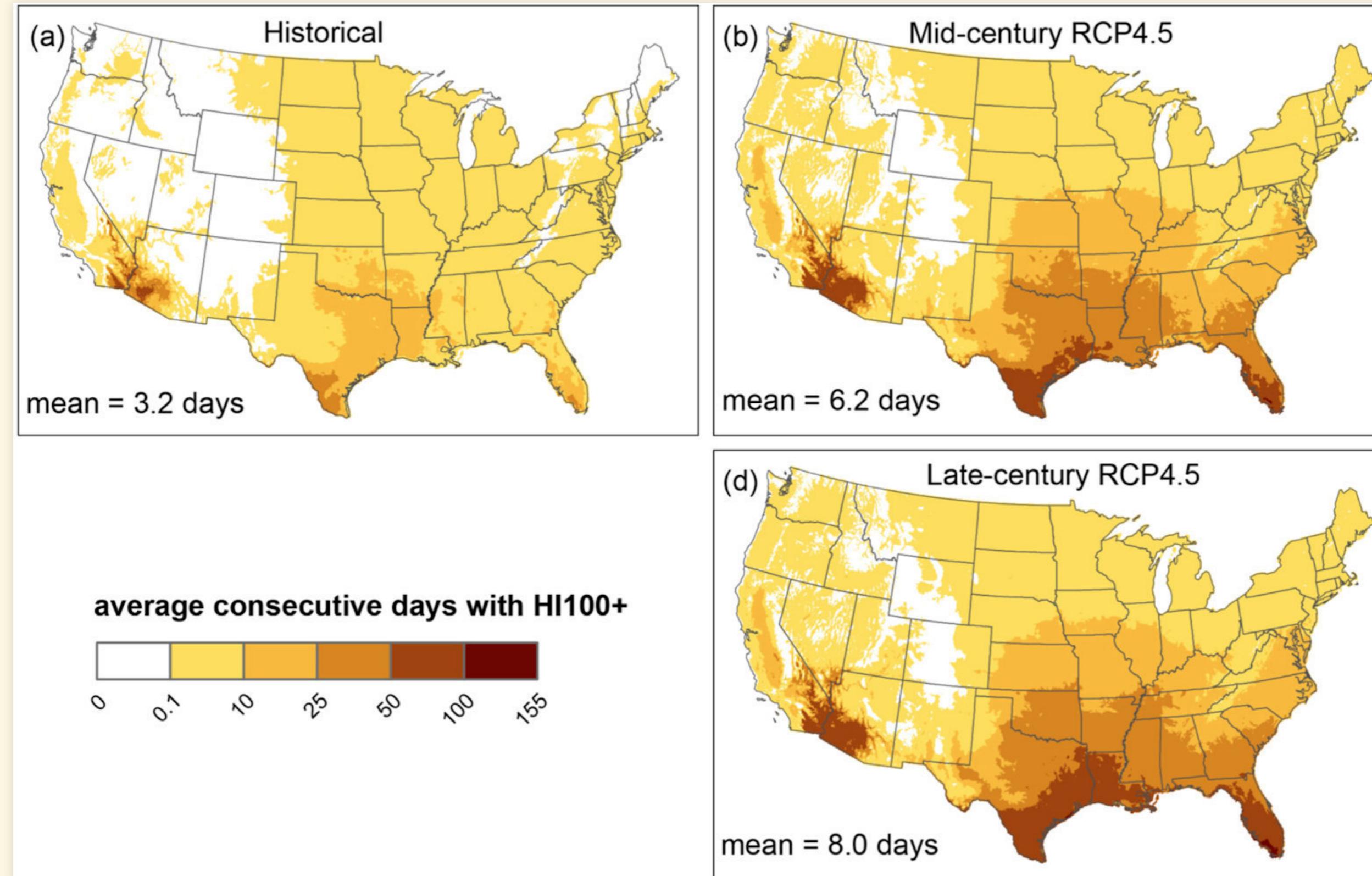
More than Deaths

- In the South, many people work outside
 - Construction, farming, logging, etc.
 - Summer heat waves could make it dangerous to be physically active outdoors
 - Loss of working hours, lower economic productivity, less money



Severe Heat Waves

- Severe heat waves even with serious emission reductions.



Football Practice in Heat

Football practice health/safety rules:

- Heat index of 104 or more is considered **dangerous**
- After 2070:
 - Average of 3 weeks per year in Southeast & Midwest
 - 2 months per year in Texas, Louisiana, Southern Florida

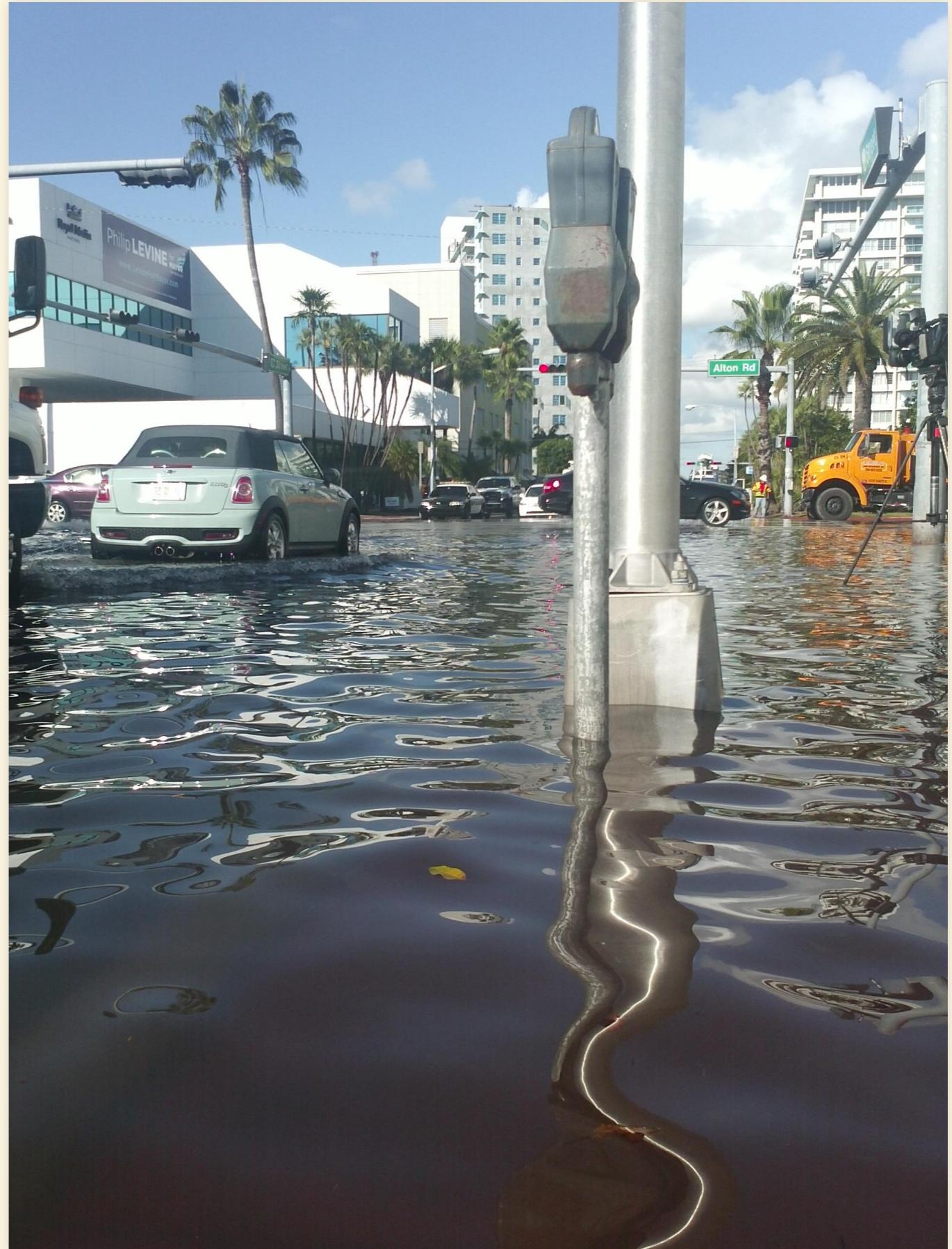


Photo credit: Nathaniel Rutherford/RTI

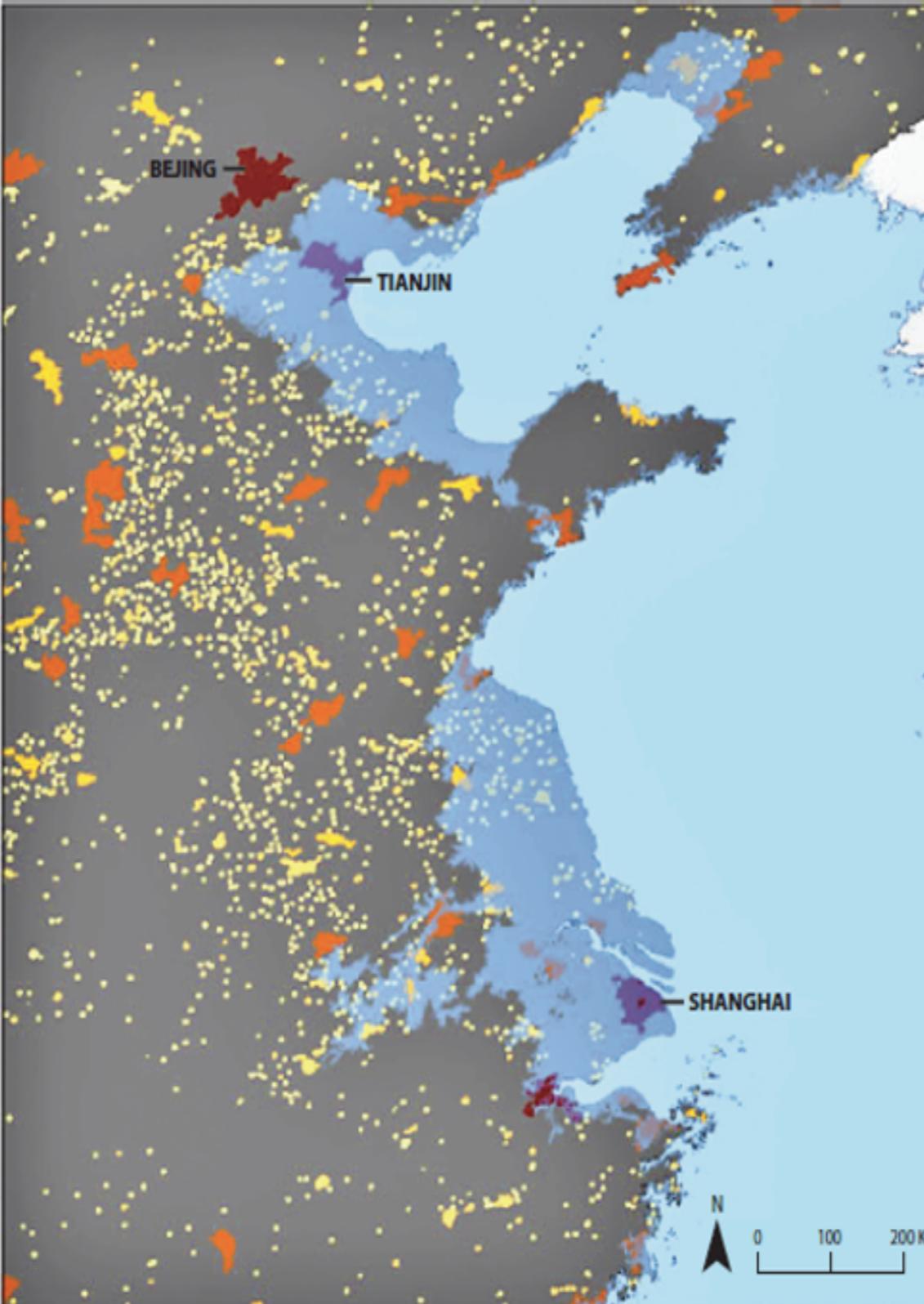
Sea-Level Rise

Sea-Level Rise

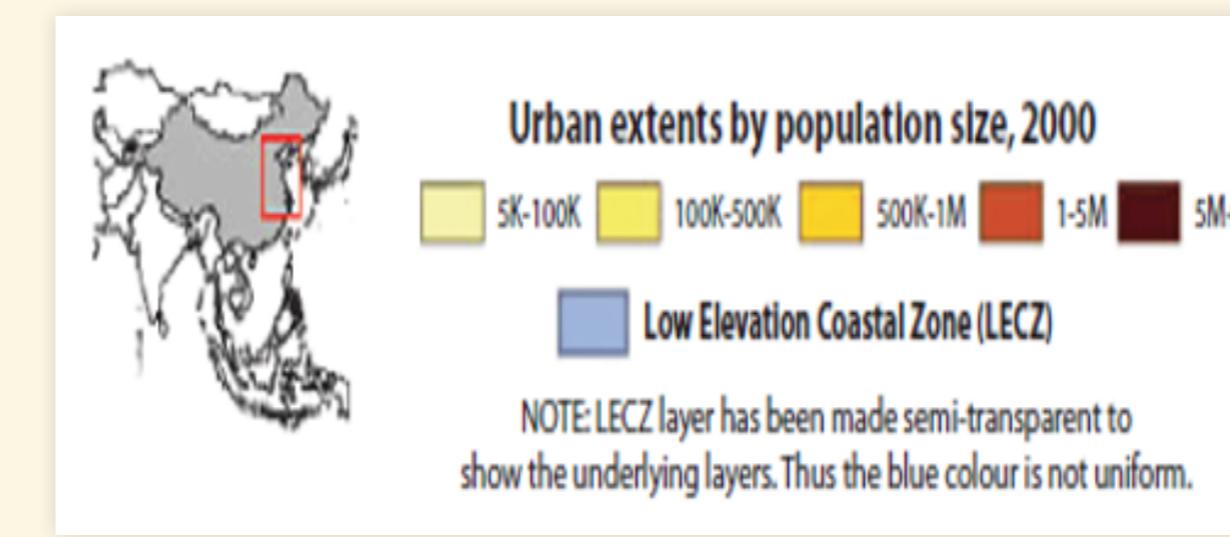
- Sea level rise is causing increasing flooding in coastal cities
 - “King tides” in Miami are flooding the city even in good weather.
 - When hurricanes come, storm surges are higher and more destructive



Low-Elevation Coastal Zone



- Within 10 meters of sea level
- 2/3 of cities with >5 million people
- 10% of world population



Greenland

- Melt descending into Moulin
 - Meltwater lubricates base of glacier
 - Accelerates ice-flow
 - Speeds up melting



Ice Loss from Greenland

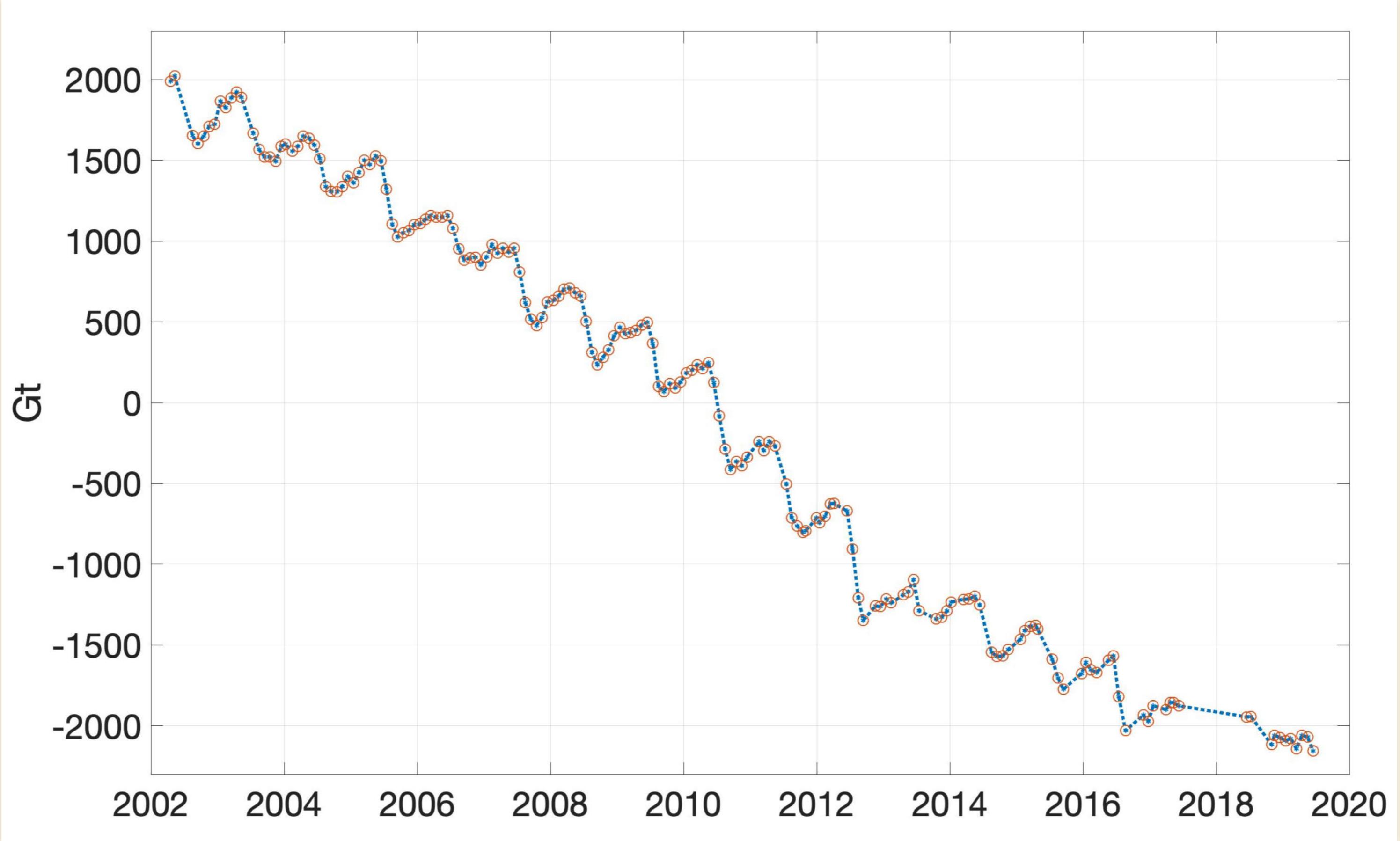
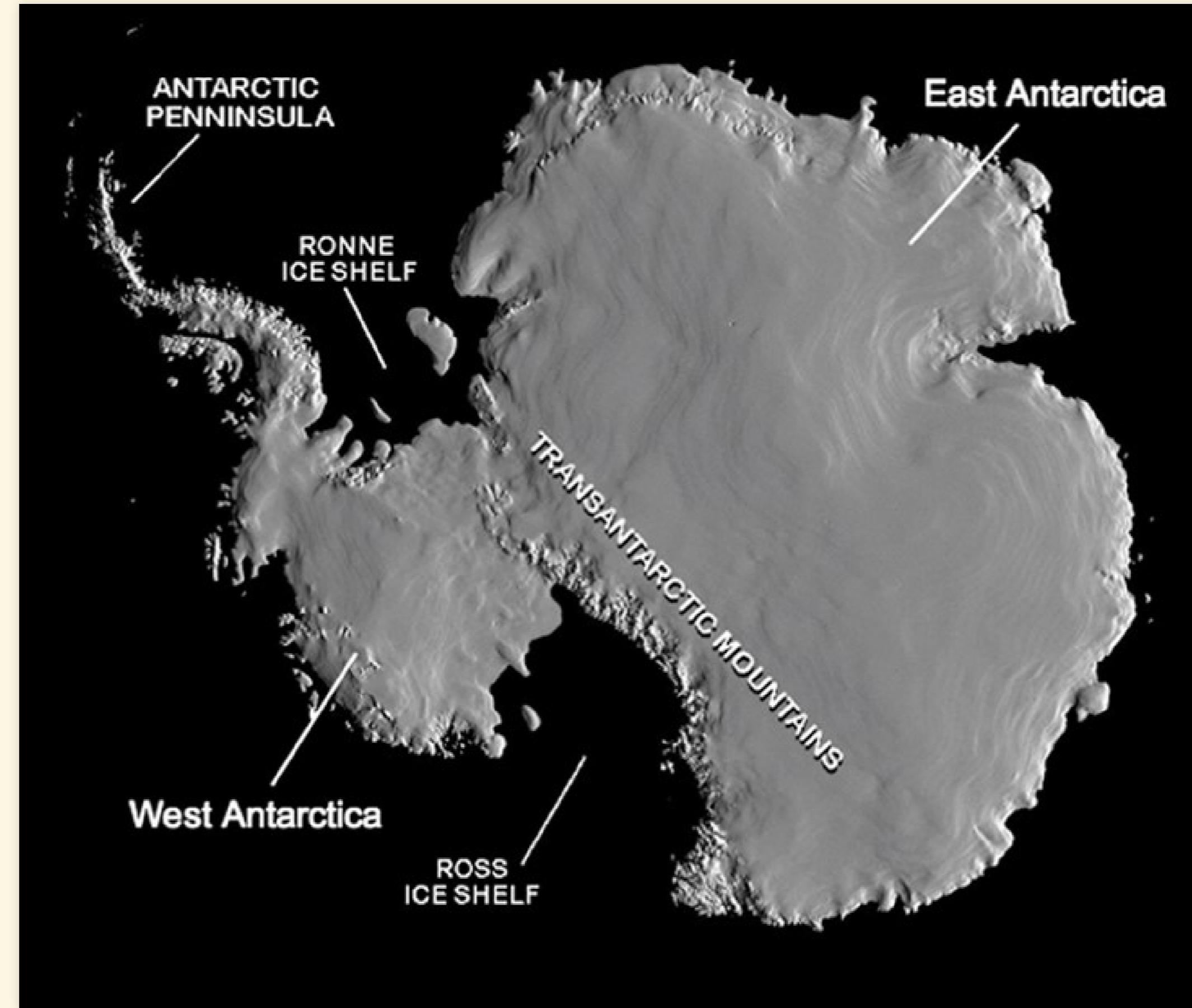


Image credit: M. Tedesco et al., NOAA Arctic Program

Antarctica

Antarctica



GRACE Satellite

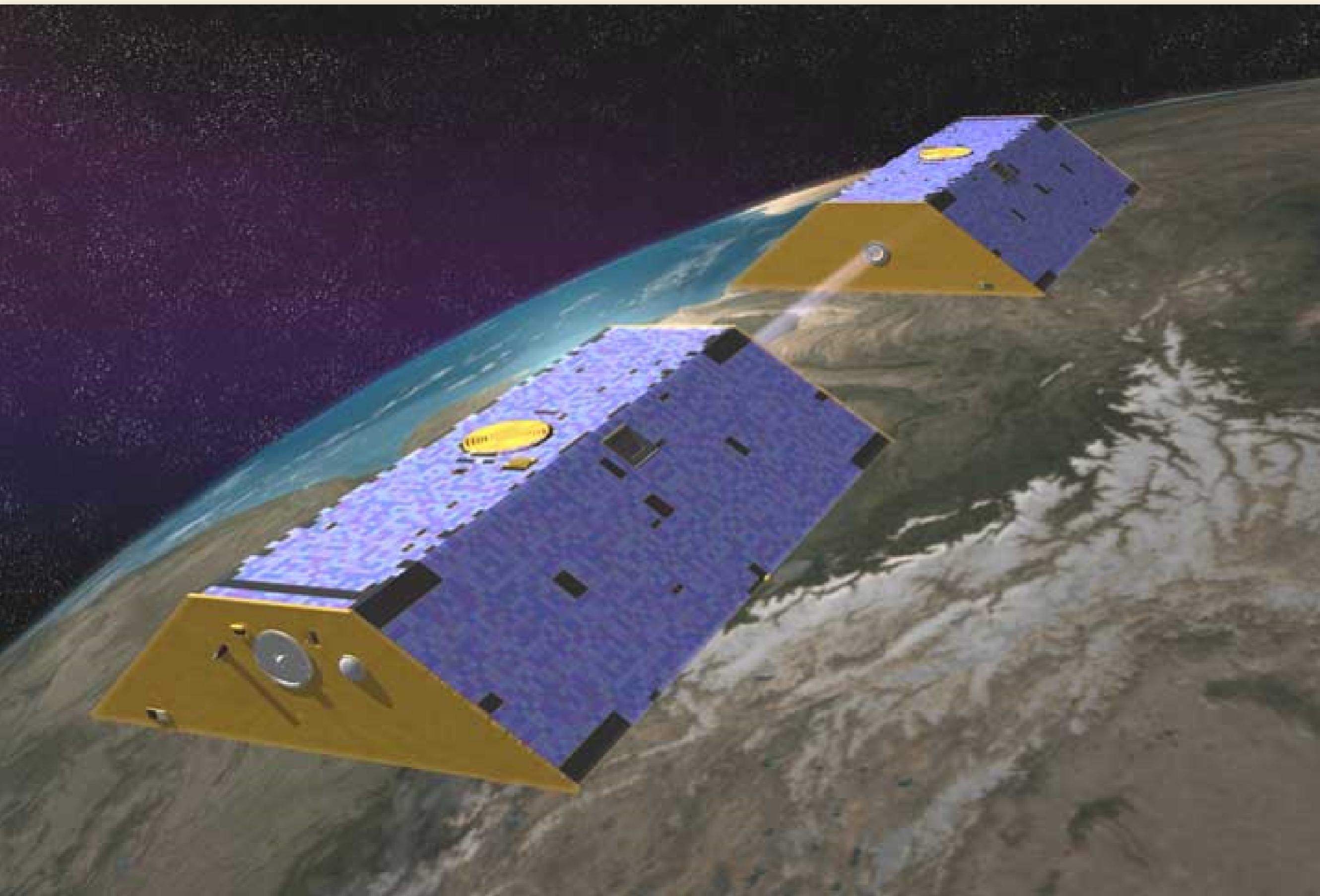


Image credit: NASA

Observations

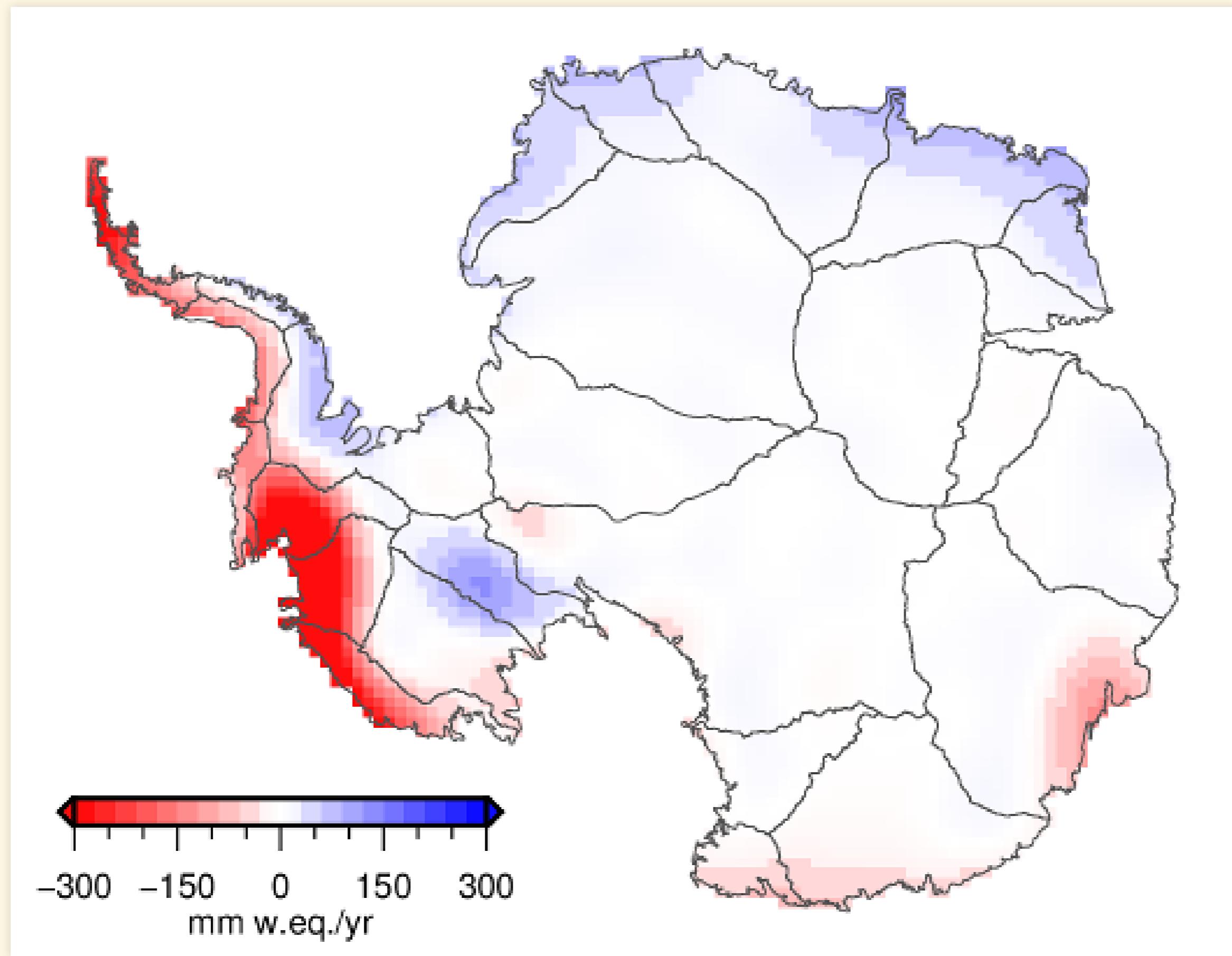
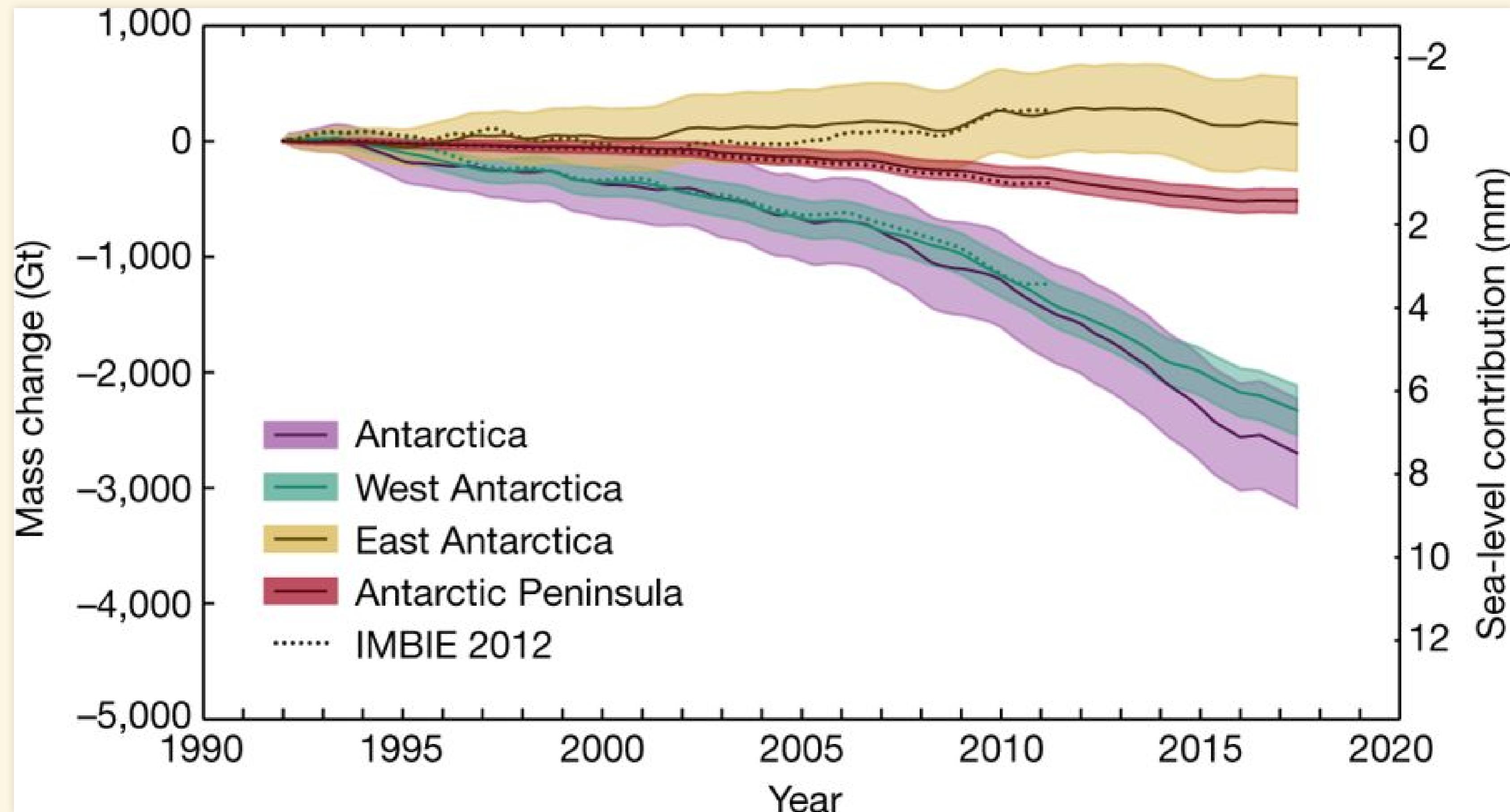


Image credit: Arnoud Jochemsen, Technical University of Dresden

Ice loss



GRACE Results

- Greenland melting faster than previously thought
 - Almost 150 cubic miles per year
 - Loss is accelerating
 - Melting more than 7 times faster than in 1990s.
- Antarctica is losing ice instead of gaining
 - 150 cubic miles per year

Bottom Line:

- Sea level is rising
- Hard to estimate future rise:
 - Glacier dynamics is very uncertain
- Rate matters!
 - Rapid sea-level rise makes it hard to adapt

Adaptation

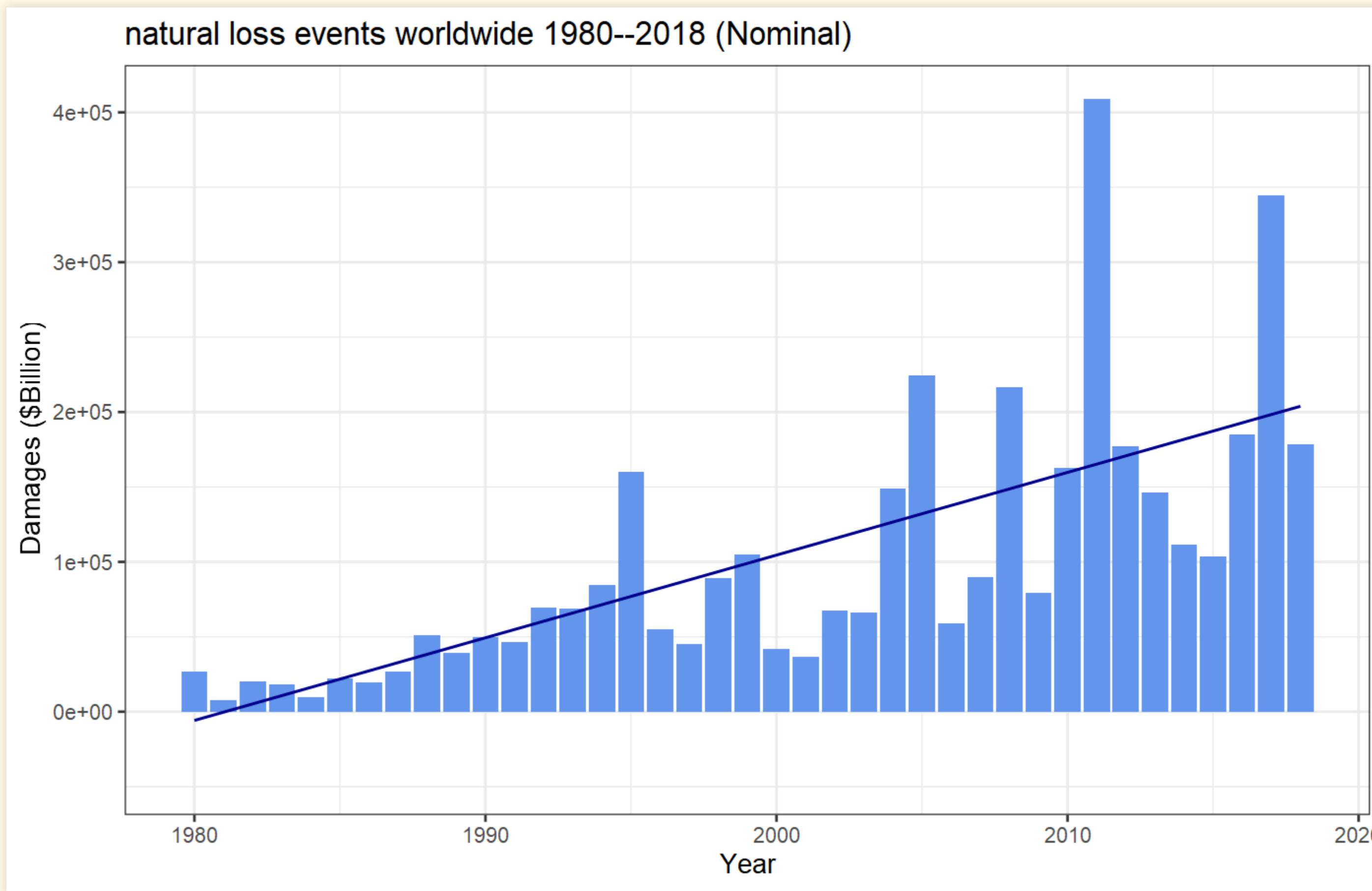
- Abandon vulnerable land
- Protect valuable land
- Raise buildings
- Move inland



Photo credit: Wikipedia

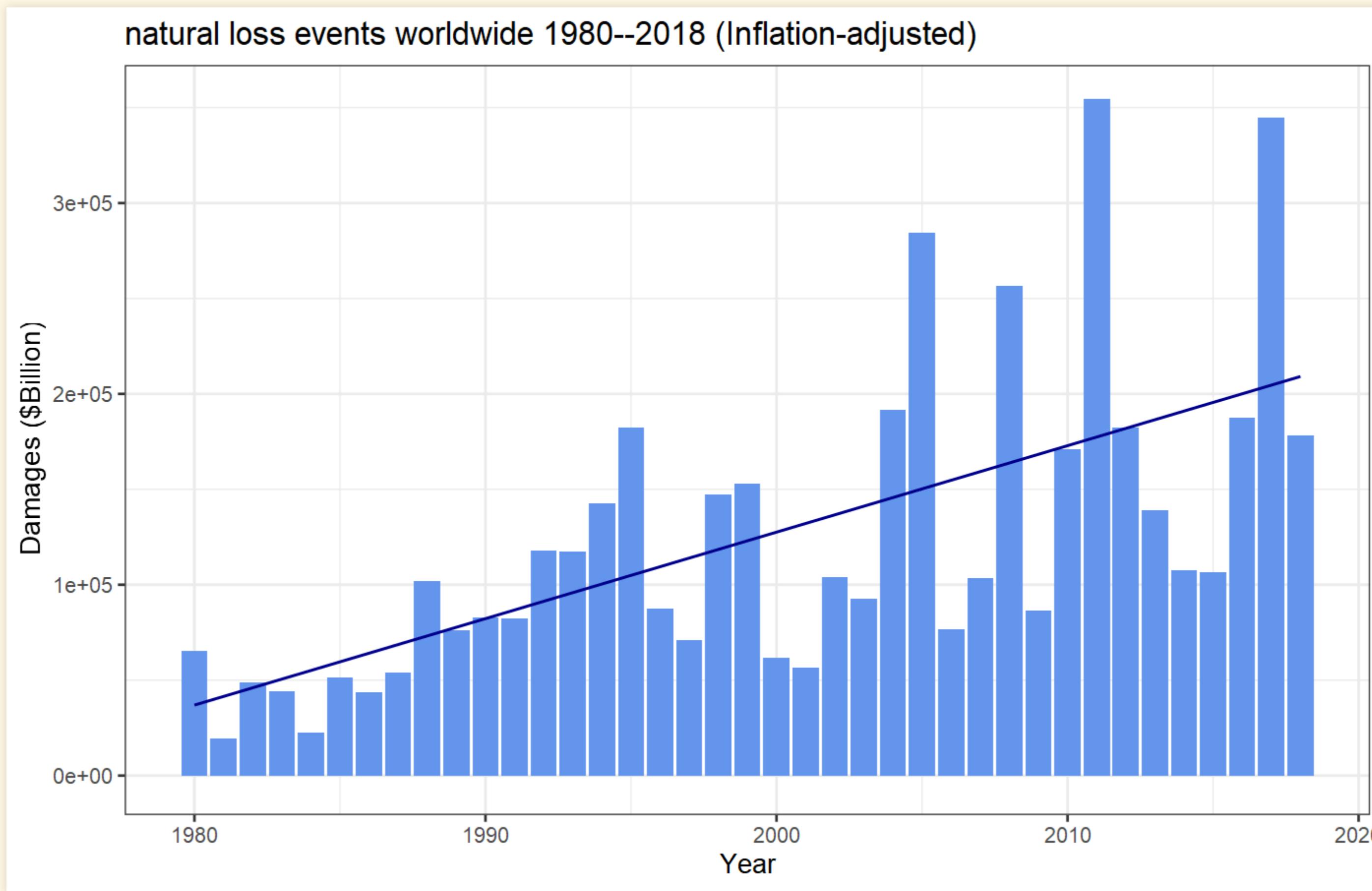
Global Natural Disasters

Cost of Natural Disasters: 1980–2018



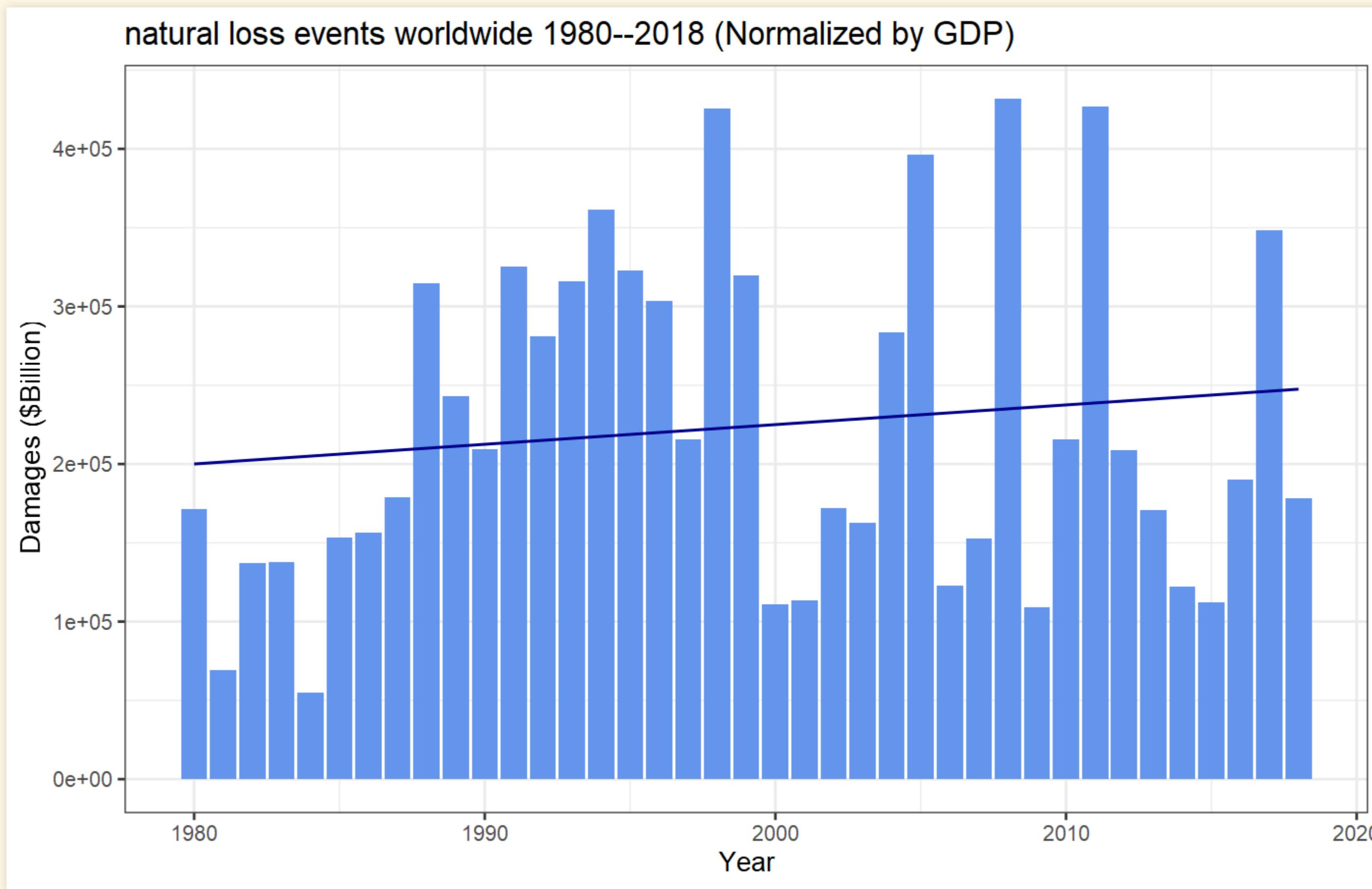
Data: Munich Re: NatCat service

Cost of Natural Disasters: 1980–2018



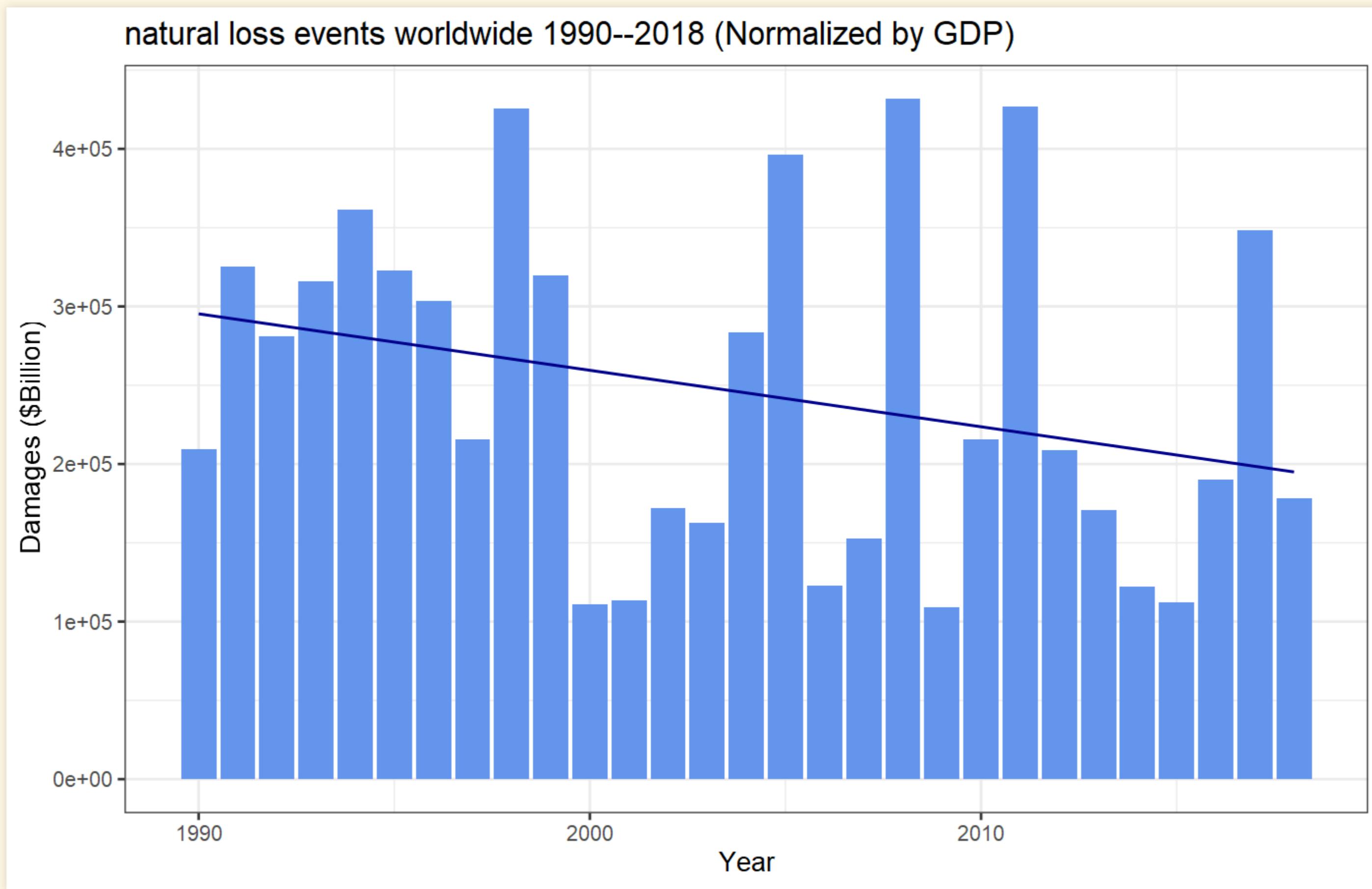
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Cost of Natural Disasters: 1980–2018



Data: Munich Re: NatCat service

Cost of Natural Disasters: 1990–2018



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Hurricanes

Hurricanes and Global Warming

- Hurricanes require ocean surface $\geq 80^{\circ}\text{F}$
- Hurricanes can only form with certain wind conditions
- Warming climates are expected to:
 - Increase sea-surface temperature:
 - More hurricanes
 - Stronger hurricanes
 - Hurricanes farther from tropics
 - Increase unfavorable wind conditions:
 - Fewer hurricanes
 - Expected impact:
 - Number: same or fewer
 - Wind Intensity: greater
 - Rainfall: greater
- Significant expert disagreement

Hurricane Controversy

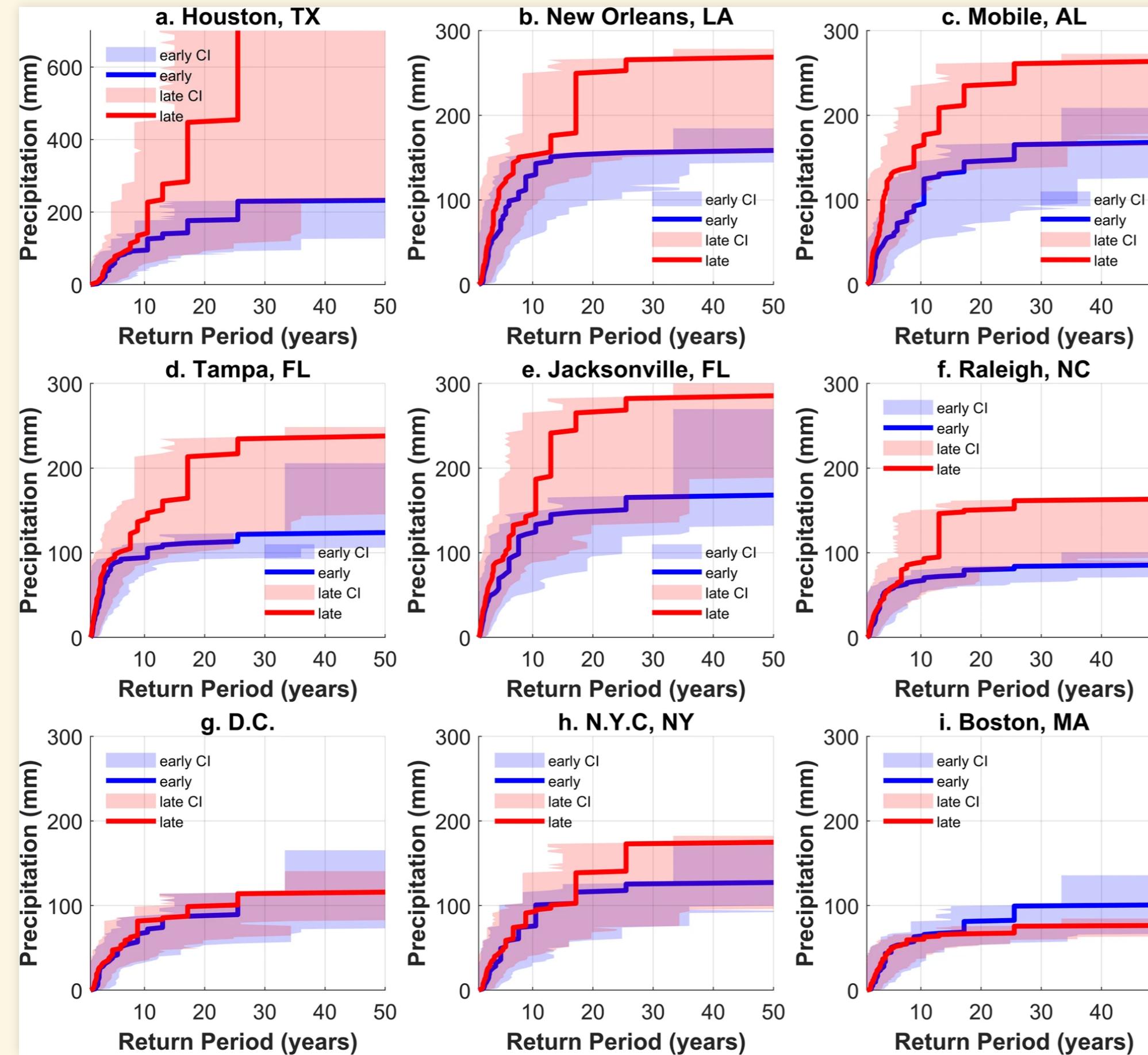
- Hurricane damage is rising
- Much of this is because more people are building more valuable property near the coast
- Dispute over how much is due to climate change

Hurricane Expert Kerry Emanuel



- Many hurricanes in Atlantic Ocean
- Only a small fraction hit the US coast
- Clear trend toward more hurricane activity in North Atlantic
- Suppose bear population in woods was rising sharply...
 - Should hikers wait for clear increase in bear attacks before taking precautions?

Trends in Hurricane Precipitation



- Early = 1949–1998
- Late = 1960–2019
- 100 mm is about 4 inches

Sea-Level Rise

- Island Nations
 - Bahamas
 - Maldives
 - Marshall Islands
- Low-Lying Coastal Countries
 - Netherlands
 - Bangladesh
 - Gambia
- Populous Countries
 - US, India, China, ...
 - Big port cities
 - 5-10% of population at risk
 - 5-15% of GDP at risk

Hurricanes

- Hurricane intensity without sea-level rise:
 - Central America most at risk
 - Small fraction of GDP for all countries
- Hurricanes **and** Sea-Level Rise
 - Sea-level rise multiplies hurricane risk

Adaptation: Sea Level and Hurricanes

- Abandon vulnerable land
- Protect valuable land
- Raise buildings
- Build hurricane-resistant housing
- Harden infrastructure (e.g., electric power)
- Move inland
 - Average structure lasts 50 years
 - Abandoning risky coastal real-estate over 50 years would cost around 0.01% of GDP each year
 - Non-economic losses
 - Value of culture, community, ...

