

# Impacts of Climate Change

Part 2

EES 3310/5310

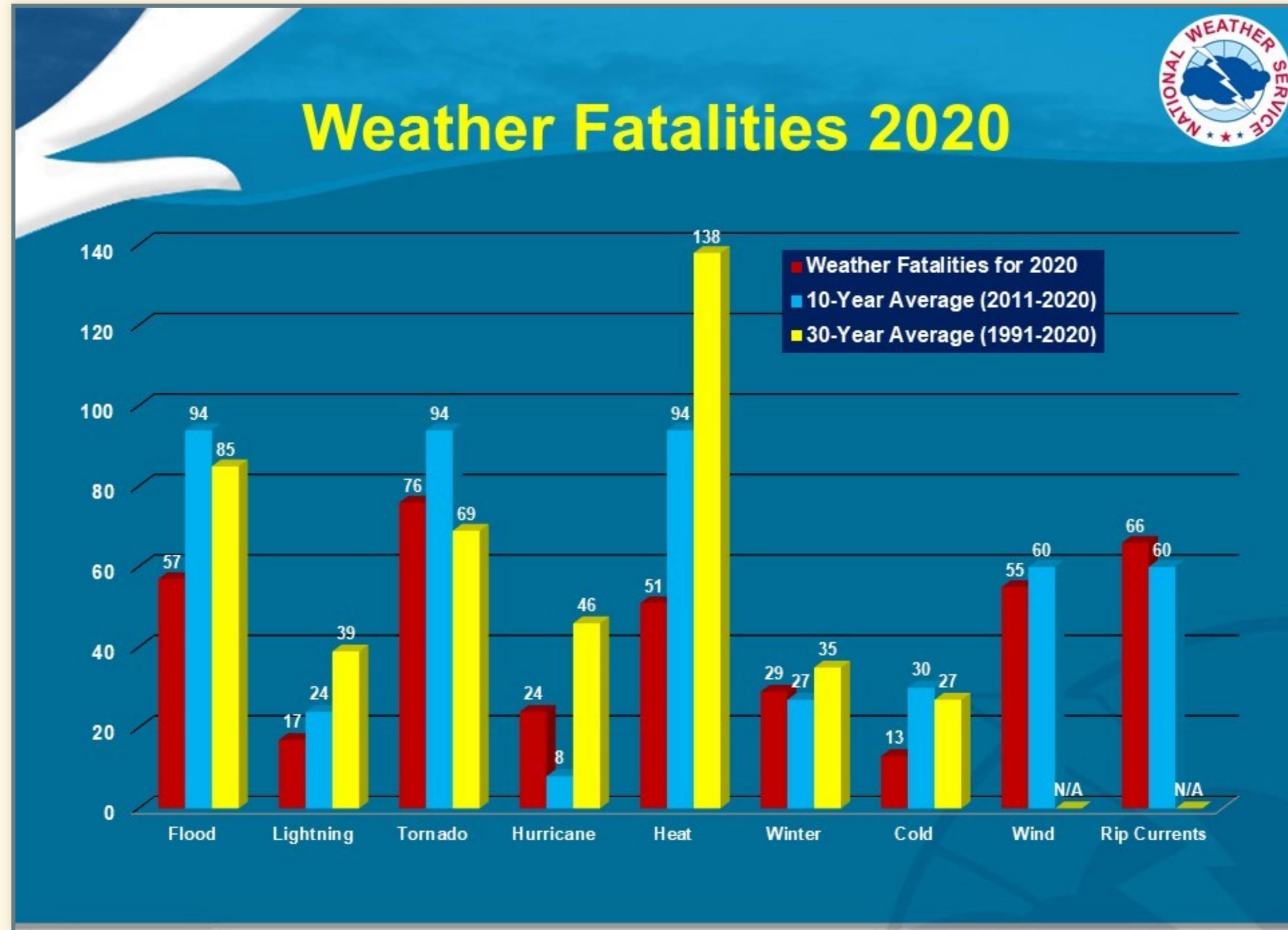
Global Climate Change

Jonathan Gilligan

Class #22: Wednesday, March 16 2022

# Heat and Health

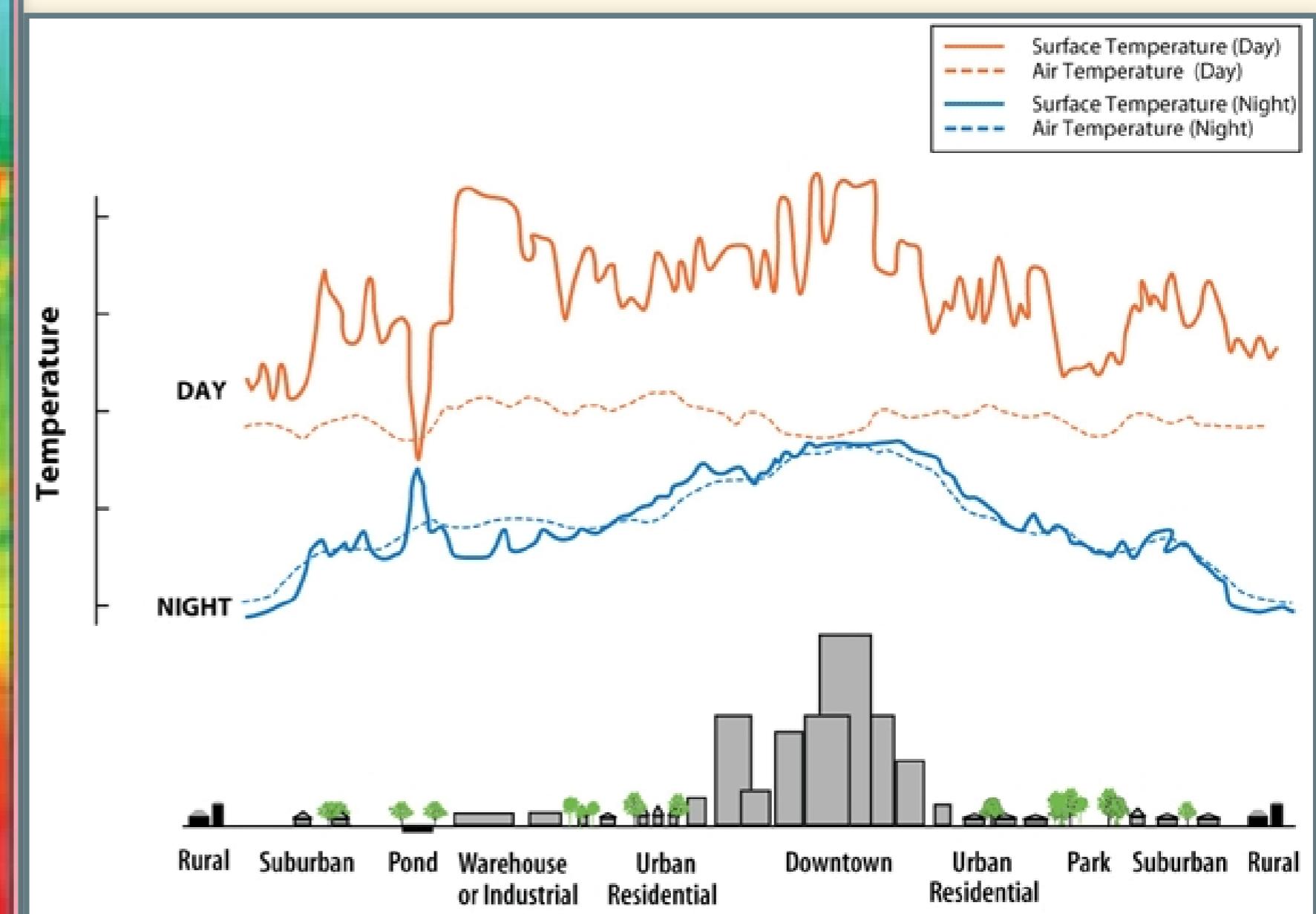
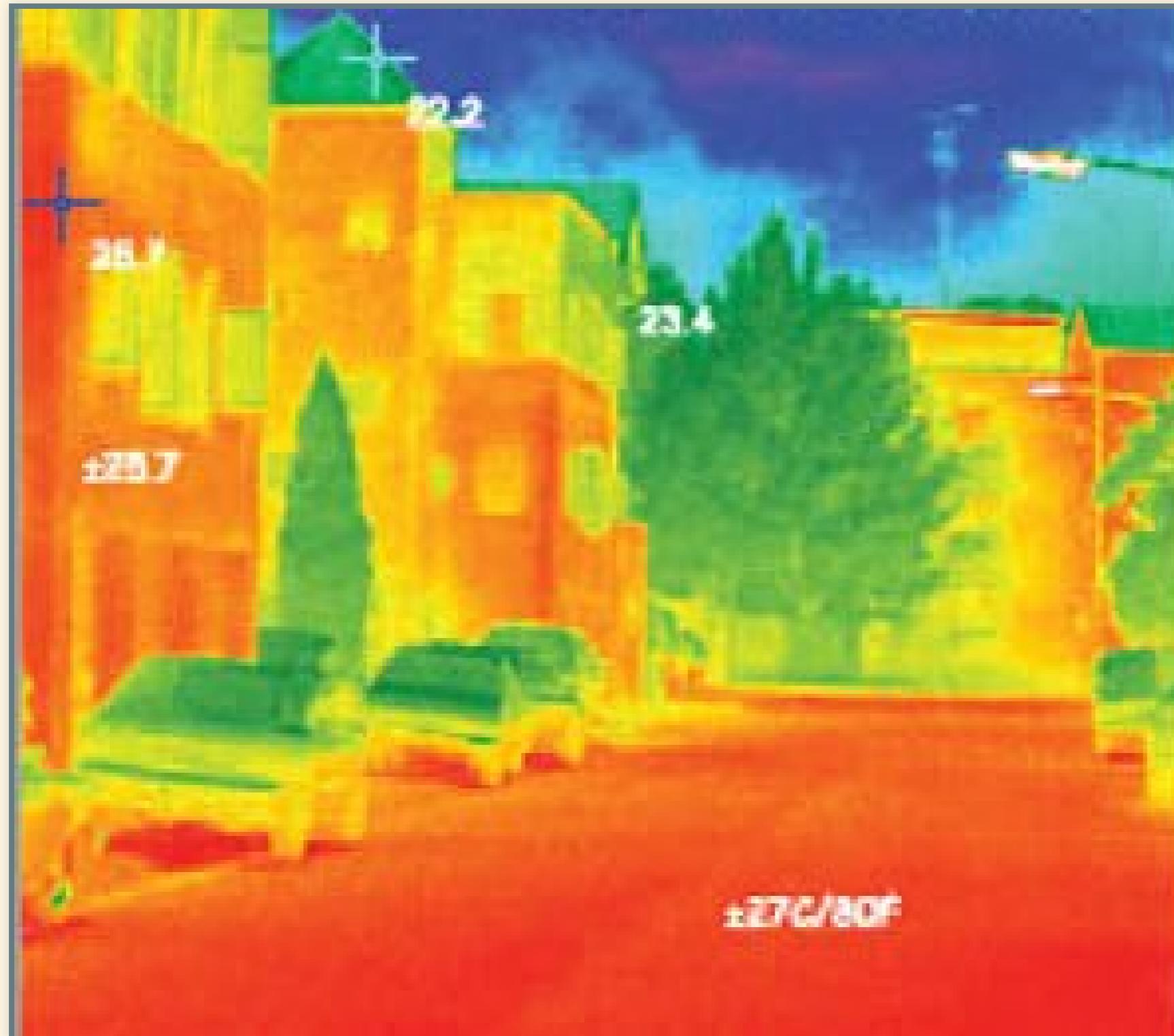
# Heat versus Cold



# Heat versus Cold

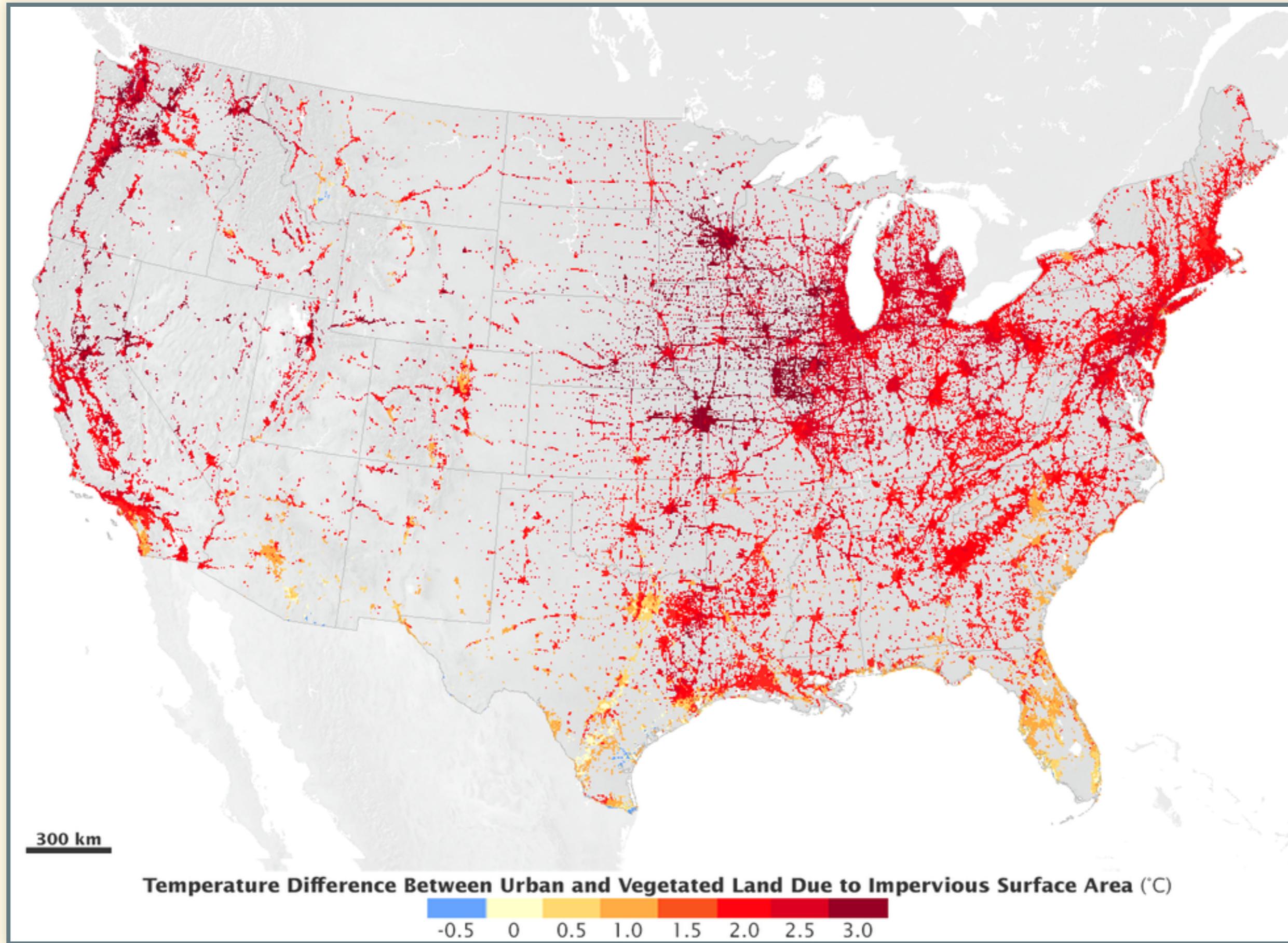
- More people die during cold months than hot months each year
  - Confounding factor: Seasonality of diseases (flu, etc.)
  - Deaths from cold are relative: it's about acclimation
  - Deaths from heat are absolute: threshold temperatures
- Adding extremely hot days raises mortality much more than adding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

# Urban Heat Islands



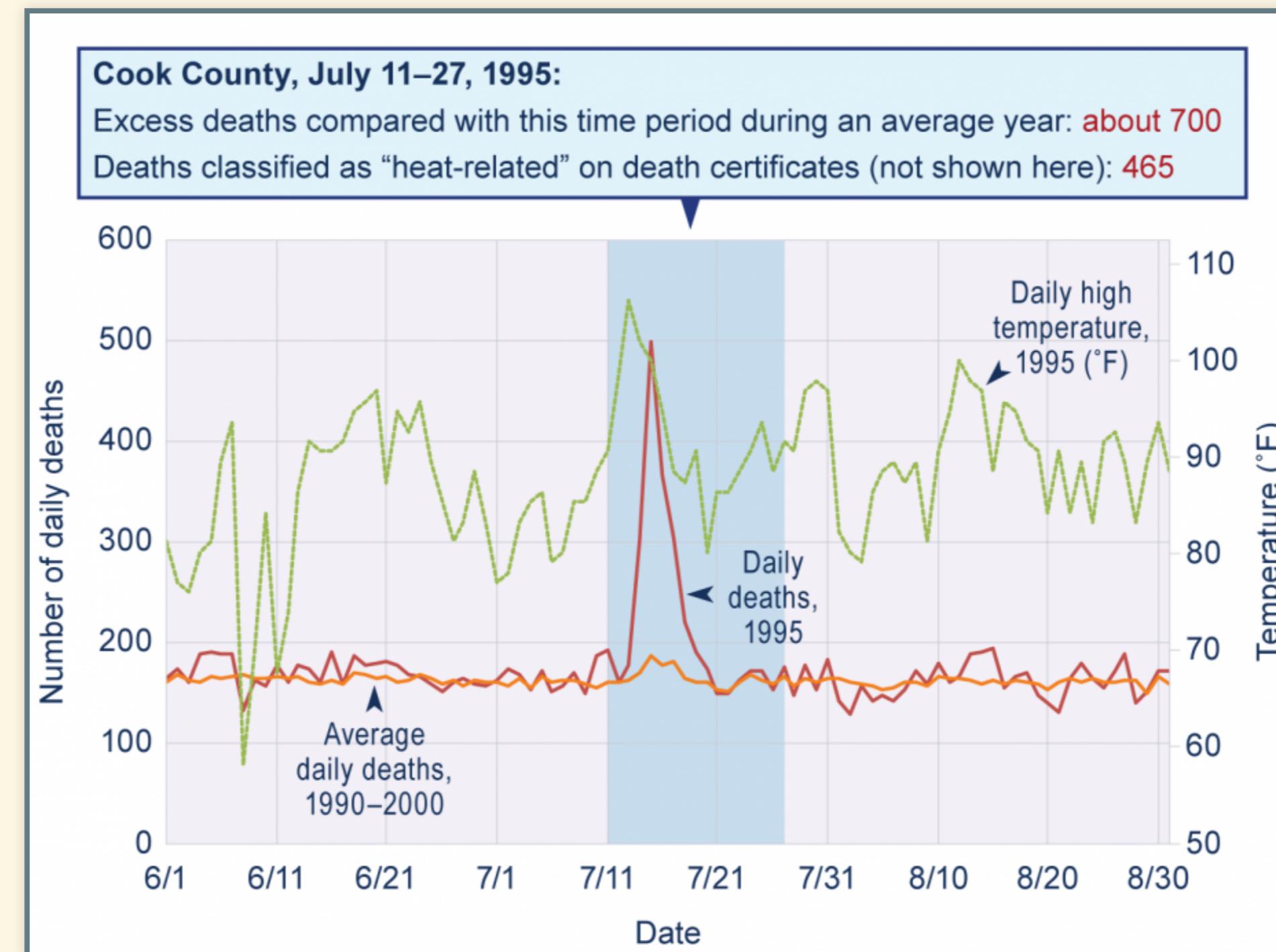
Source: Environmental Protection Agency

# Urban Heat Islands in the United States



# Urban Heat Mortality

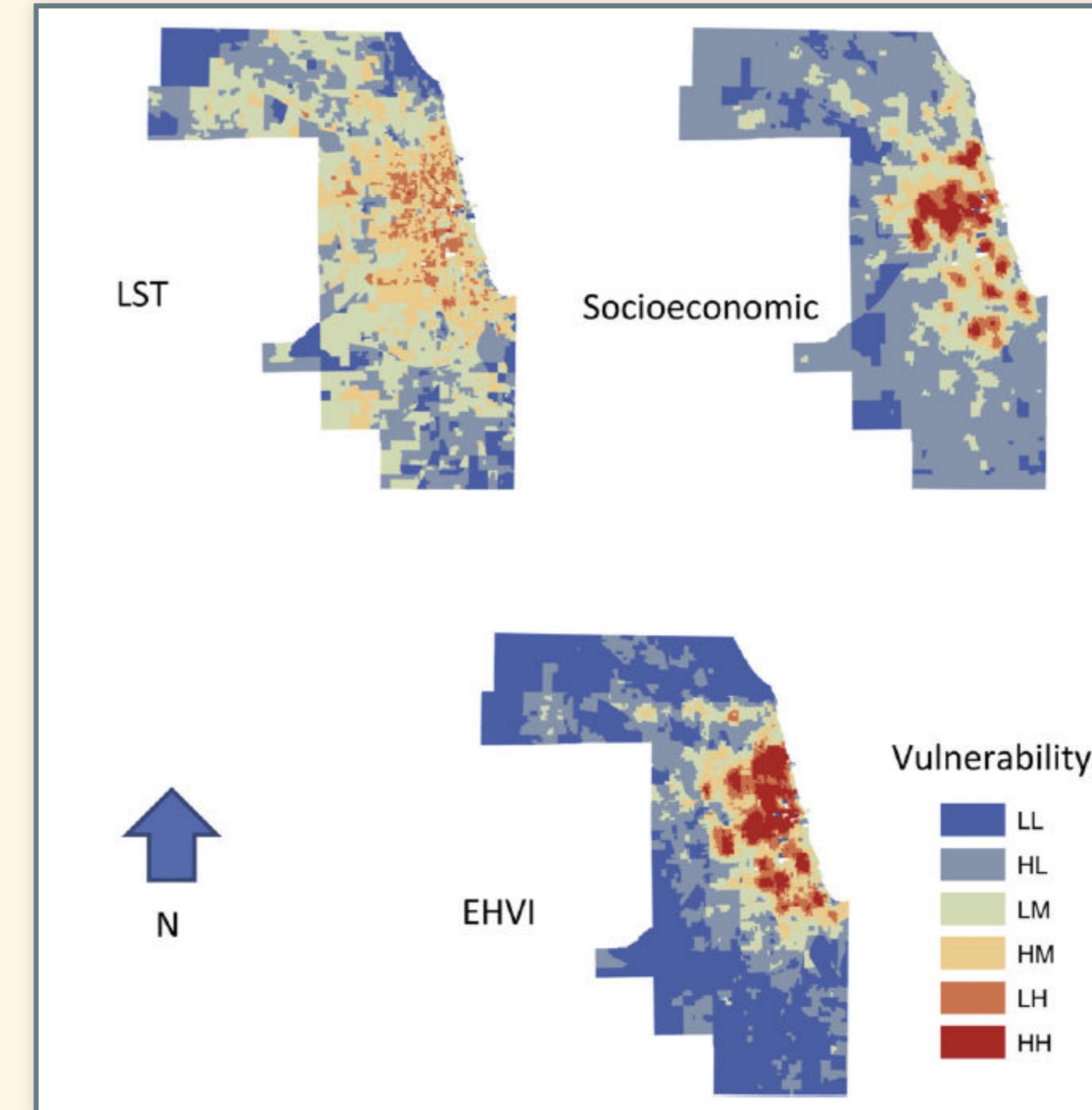
## Chicago, 1995



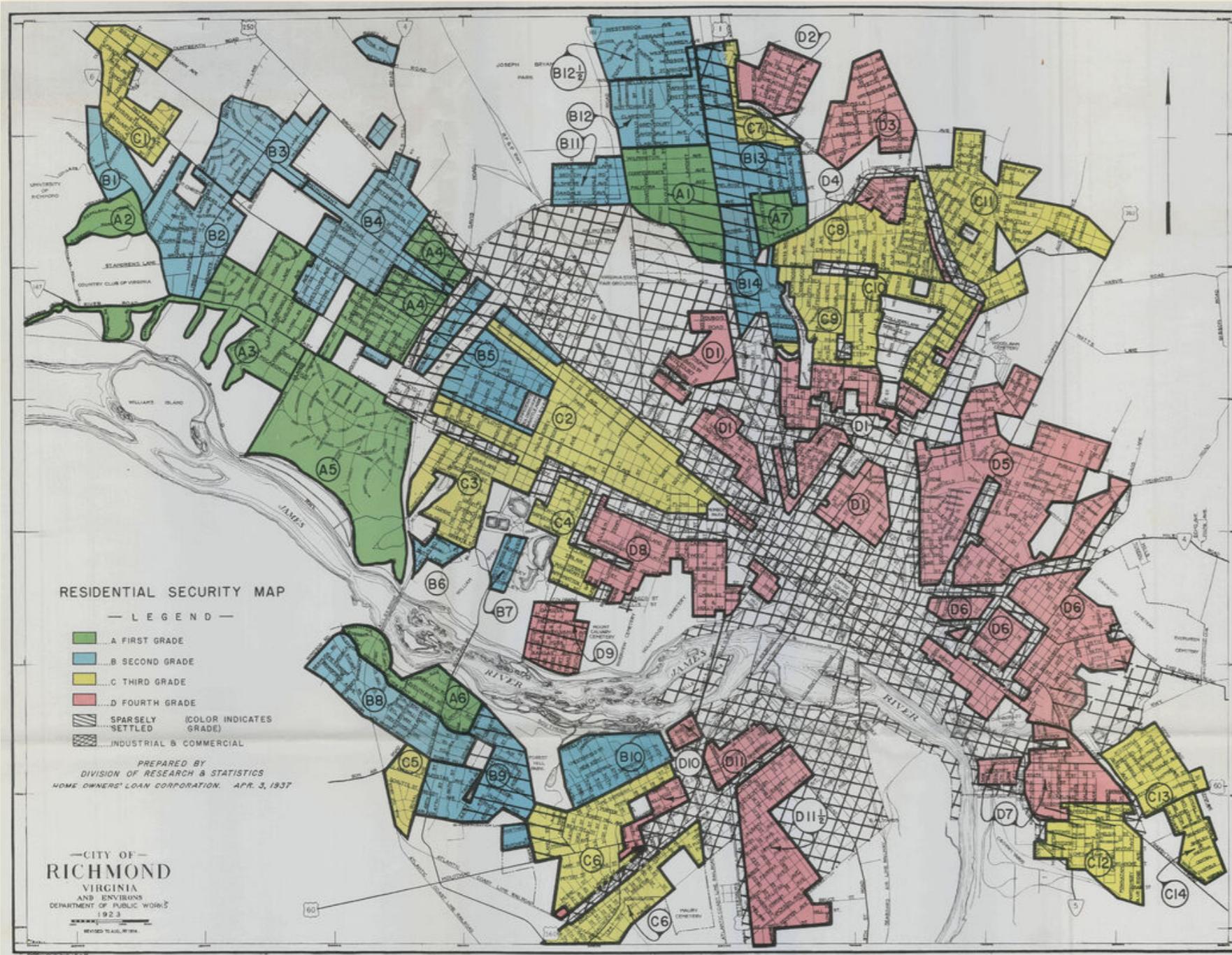
Source: USGCRP, *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (2016).

# Socioeconomic Status and Vulnerability to Heat

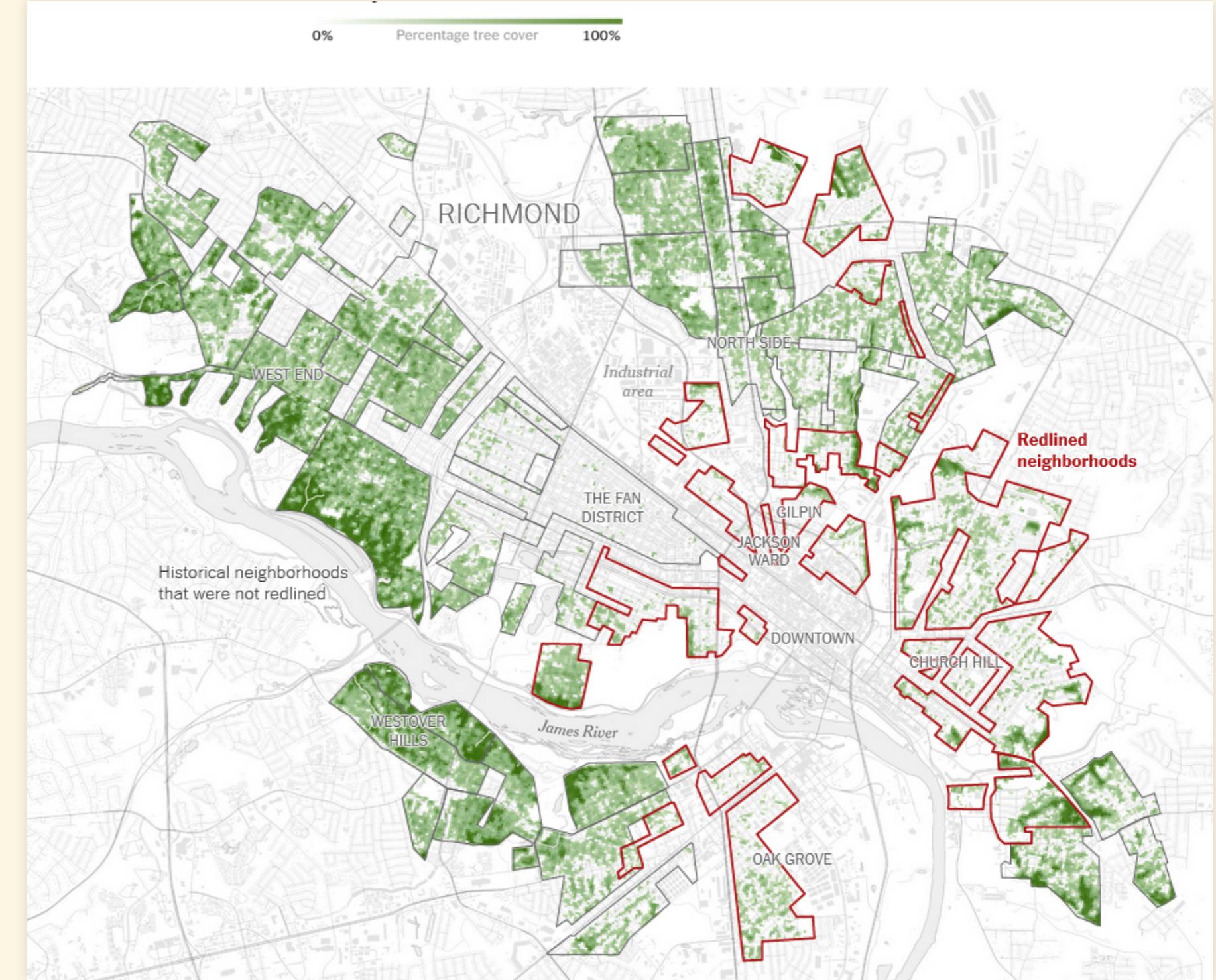
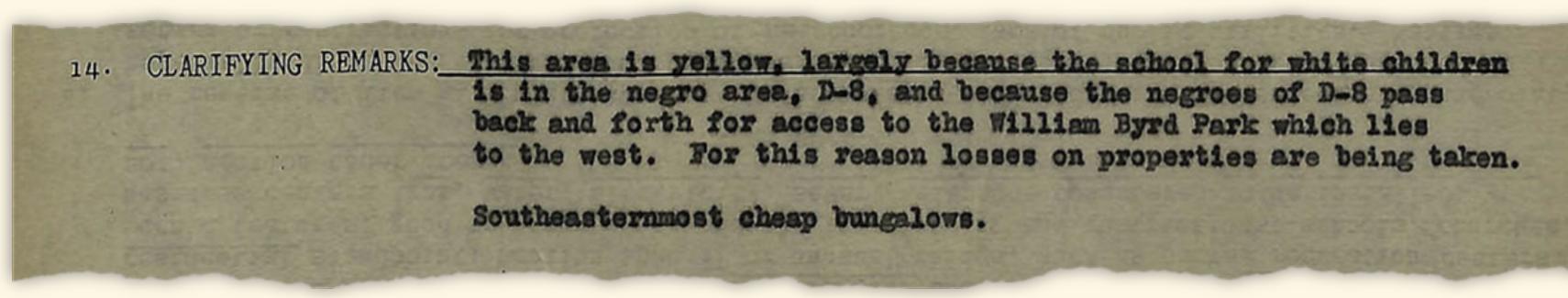
- LST = Urban heat island effect
- EHVI = extreme heat vulnerability index
- EHVI correlates very strongly with socioeconomic variables



# Legacy of Racism and Vulnerability to Heat

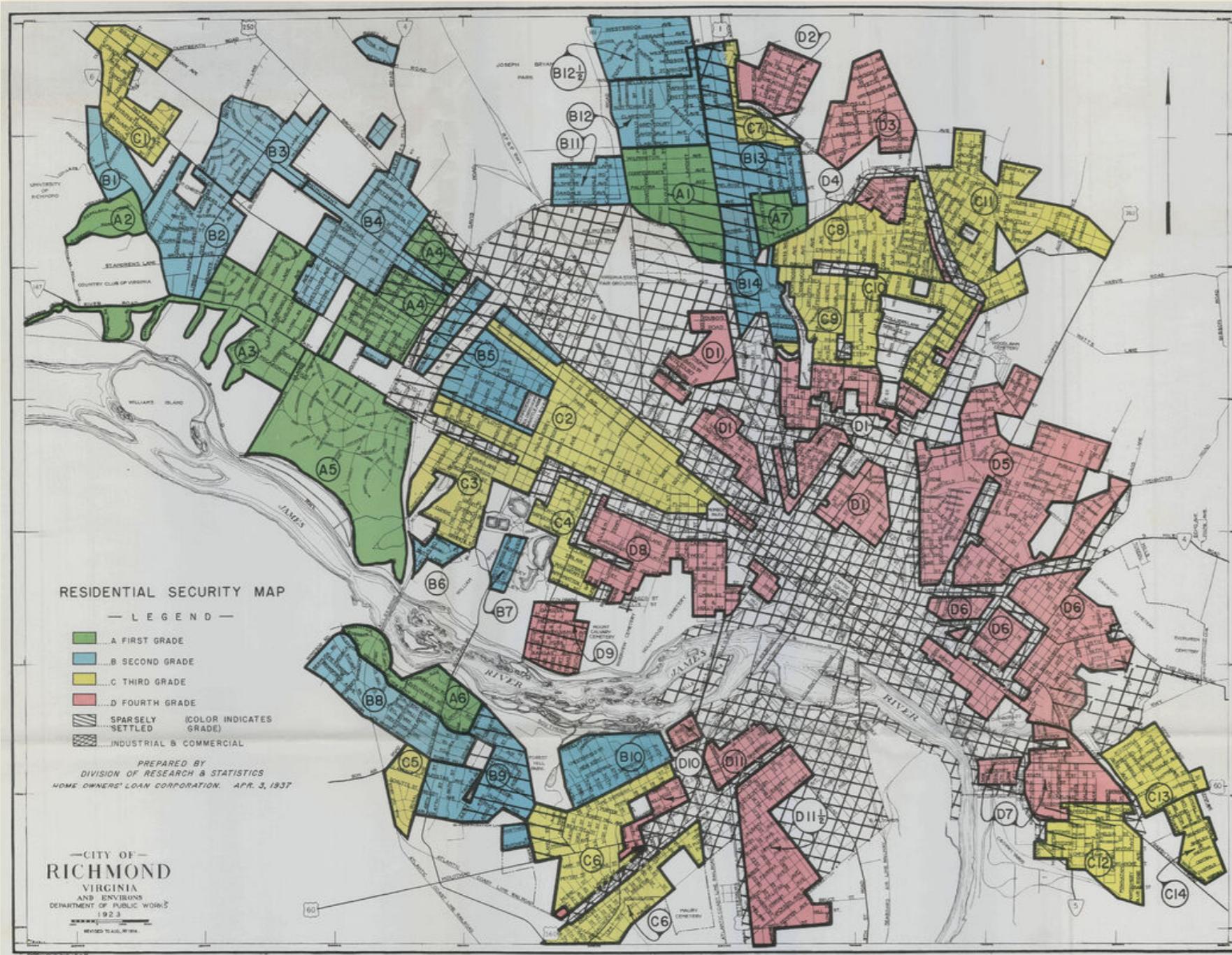


B. Plumer & N. Popvich, "How Decades of Racist Housing Policies Left Neighborhoods Sweltering" New York Times Aug 24, 2020.

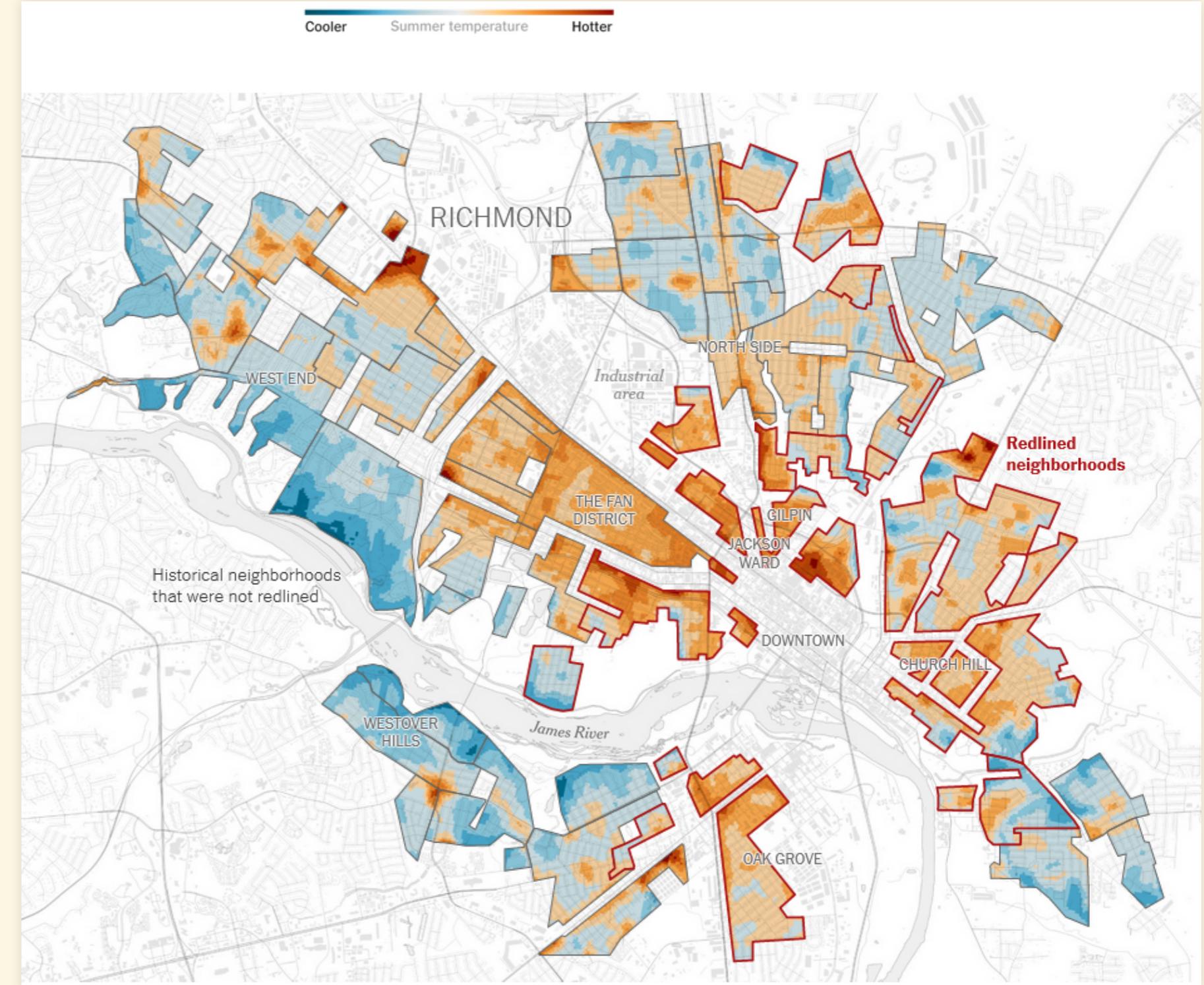


B. Plumer & N. Popvich, "How Decades of Racist Housing Policies Left Neighborhoods Sweltering" New York Times Aug 24, 2020.

# Legacy of Racism and Vulnerability to Heat

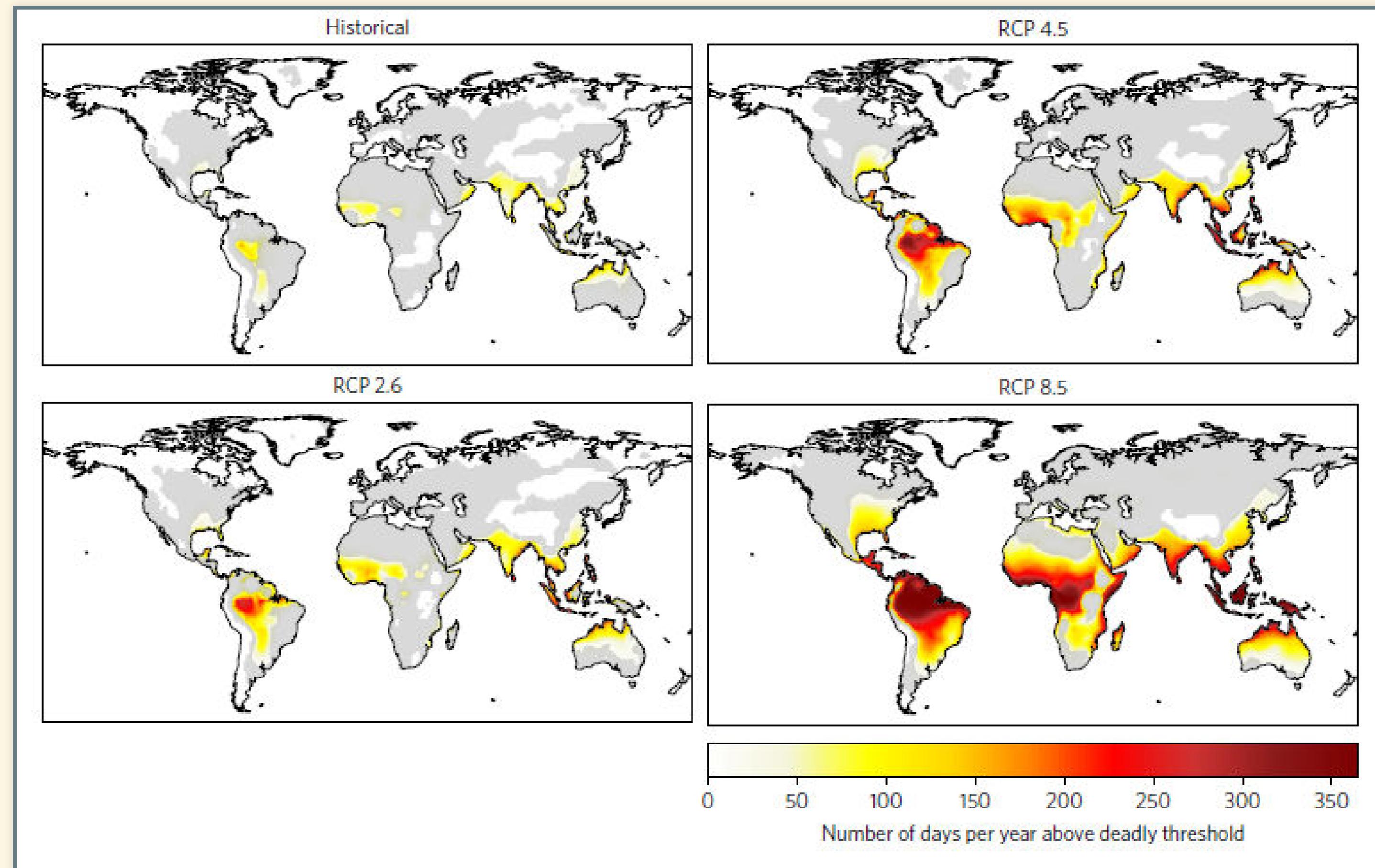


B. Plumer & N. Popovich, "How Decades of Racist Housing Policies Left Neighborhoods Sweltering" New York Times Aug 24, 2020.



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

# Climate Change and Deadly Heat



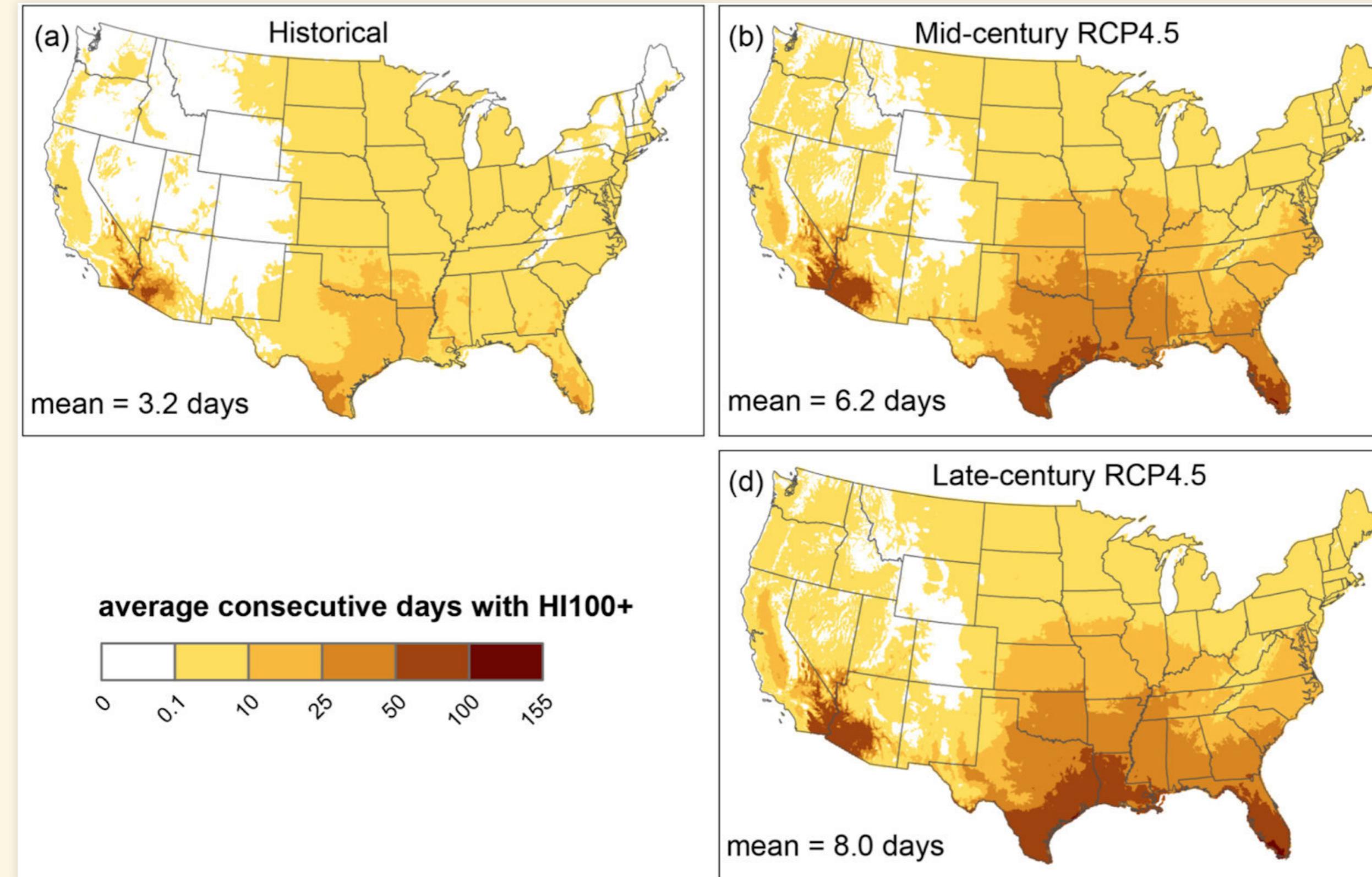
# More than Deaths

- 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

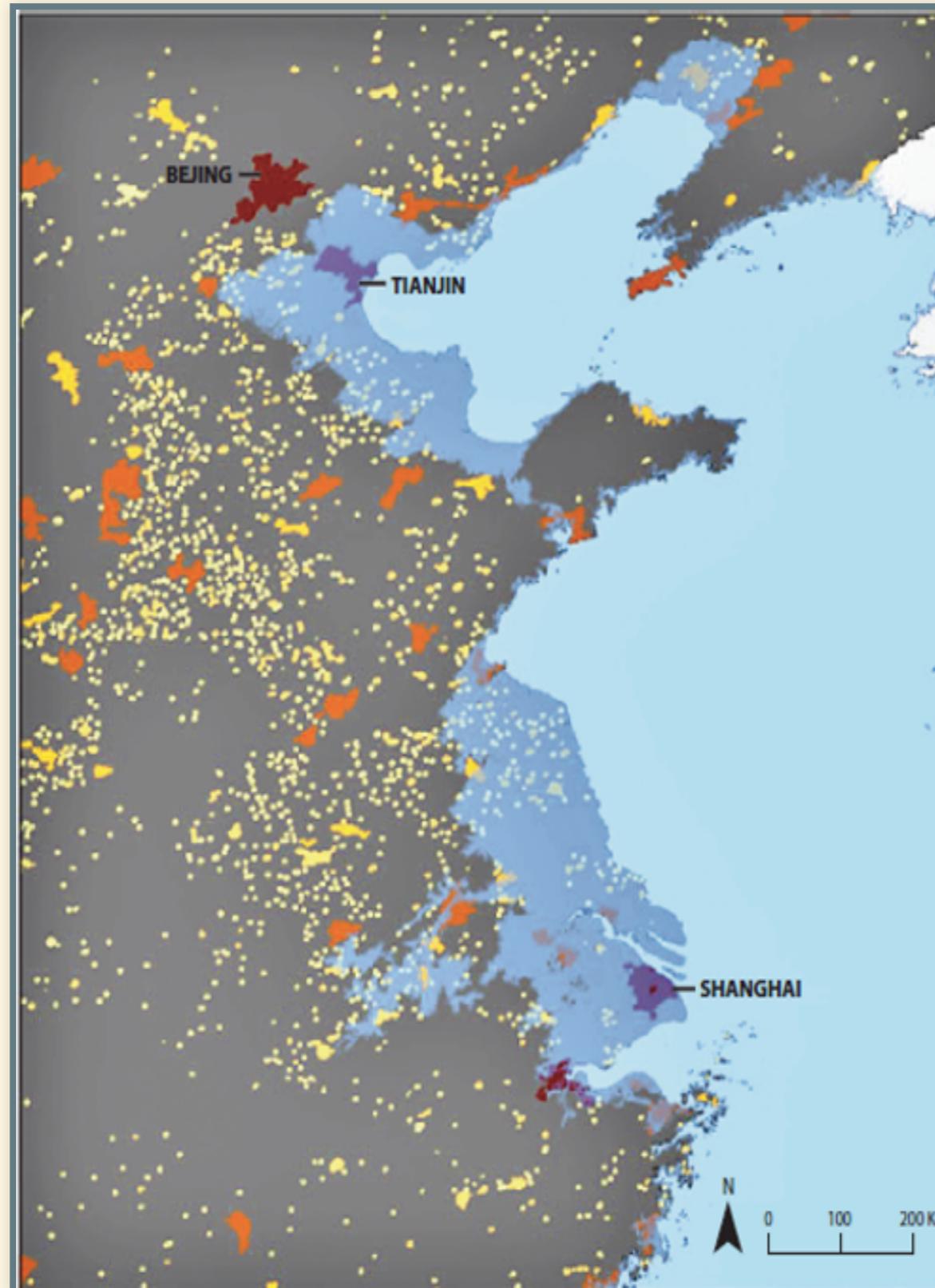
# Sea-Level Rise

# Sea-Level Rise

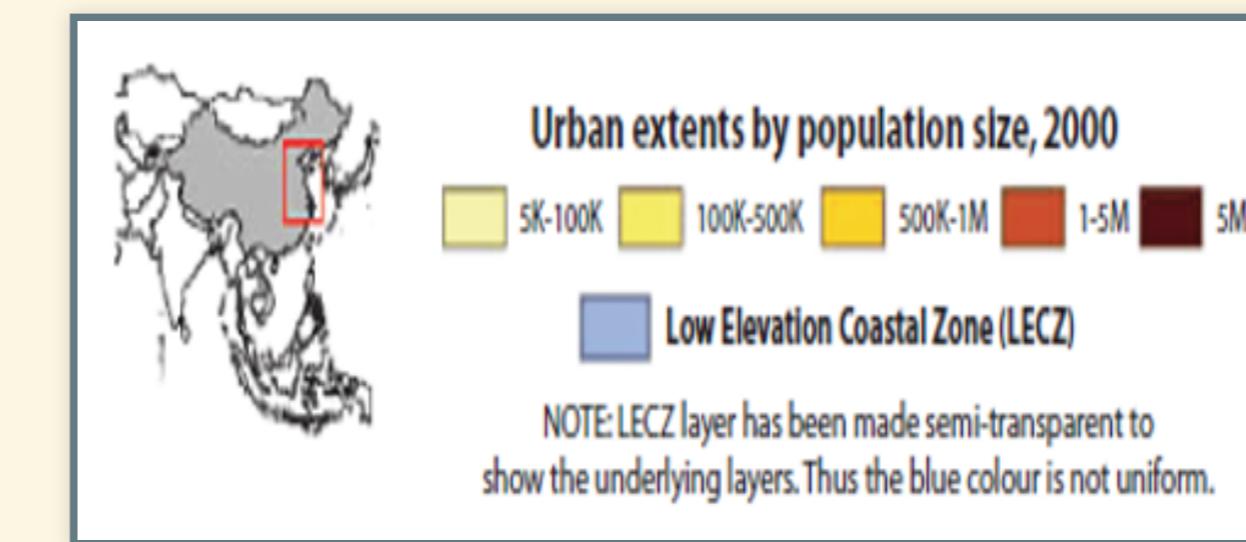
- Sea level rise is causing increasing flooding in coastal cities
  - “King tides” in Miami are flooding the city even in good weather.
  - When hurricanes come, storm surges are higher and more destructive



# 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

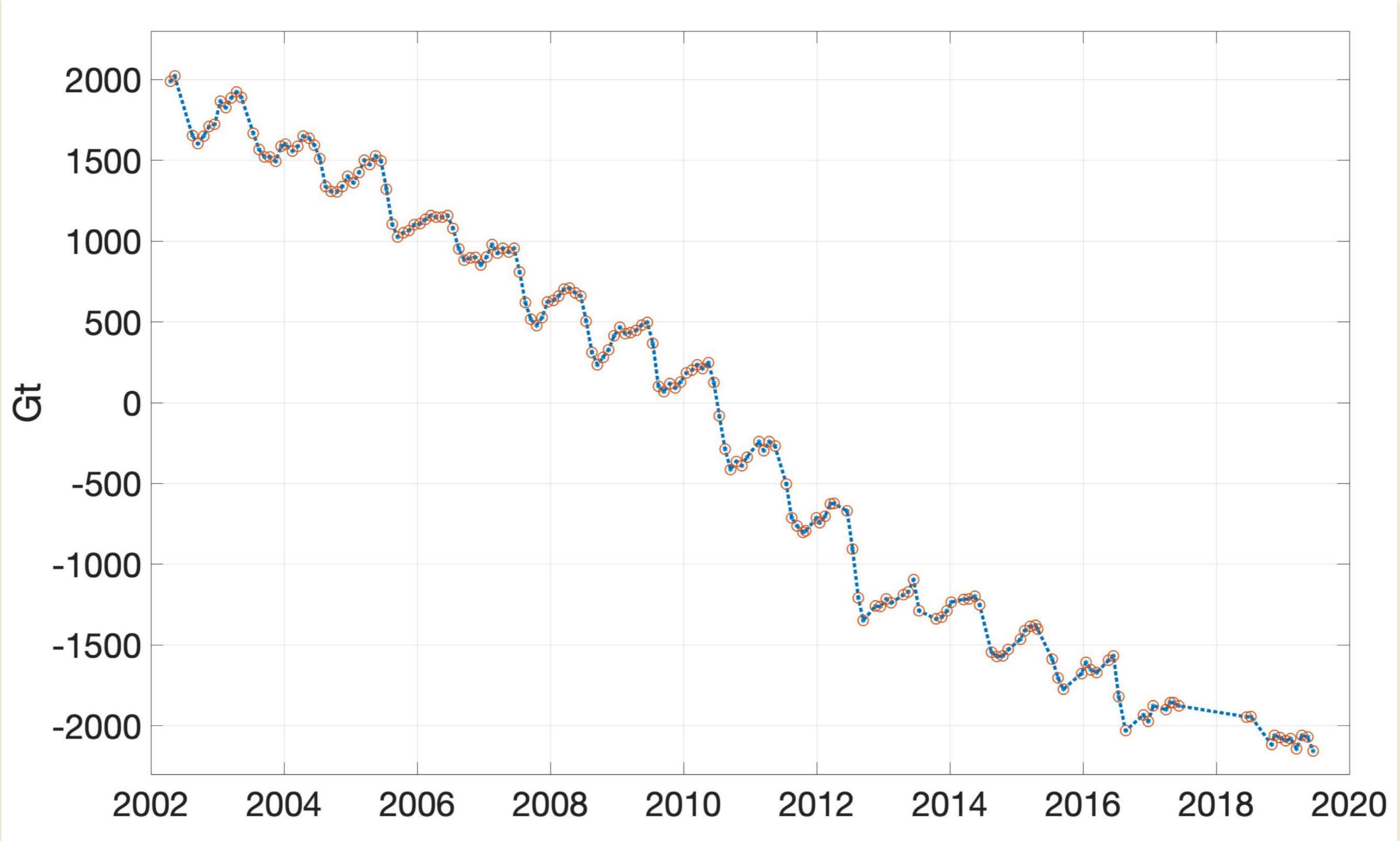
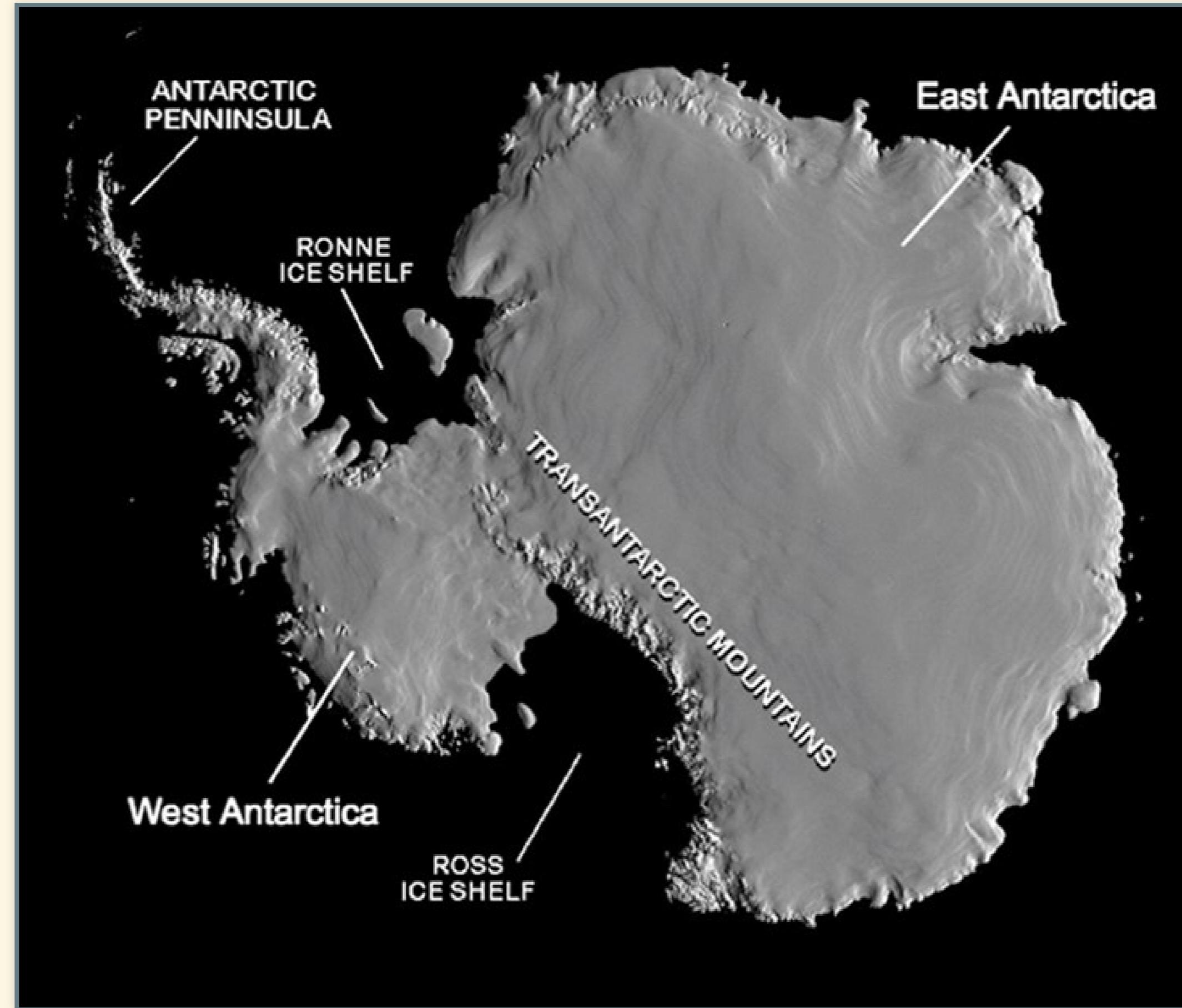


Image credit: M. Tedesco et al., NOAA Arctic Program

# Antarctica

# Antarctica



# GRACE Satellite

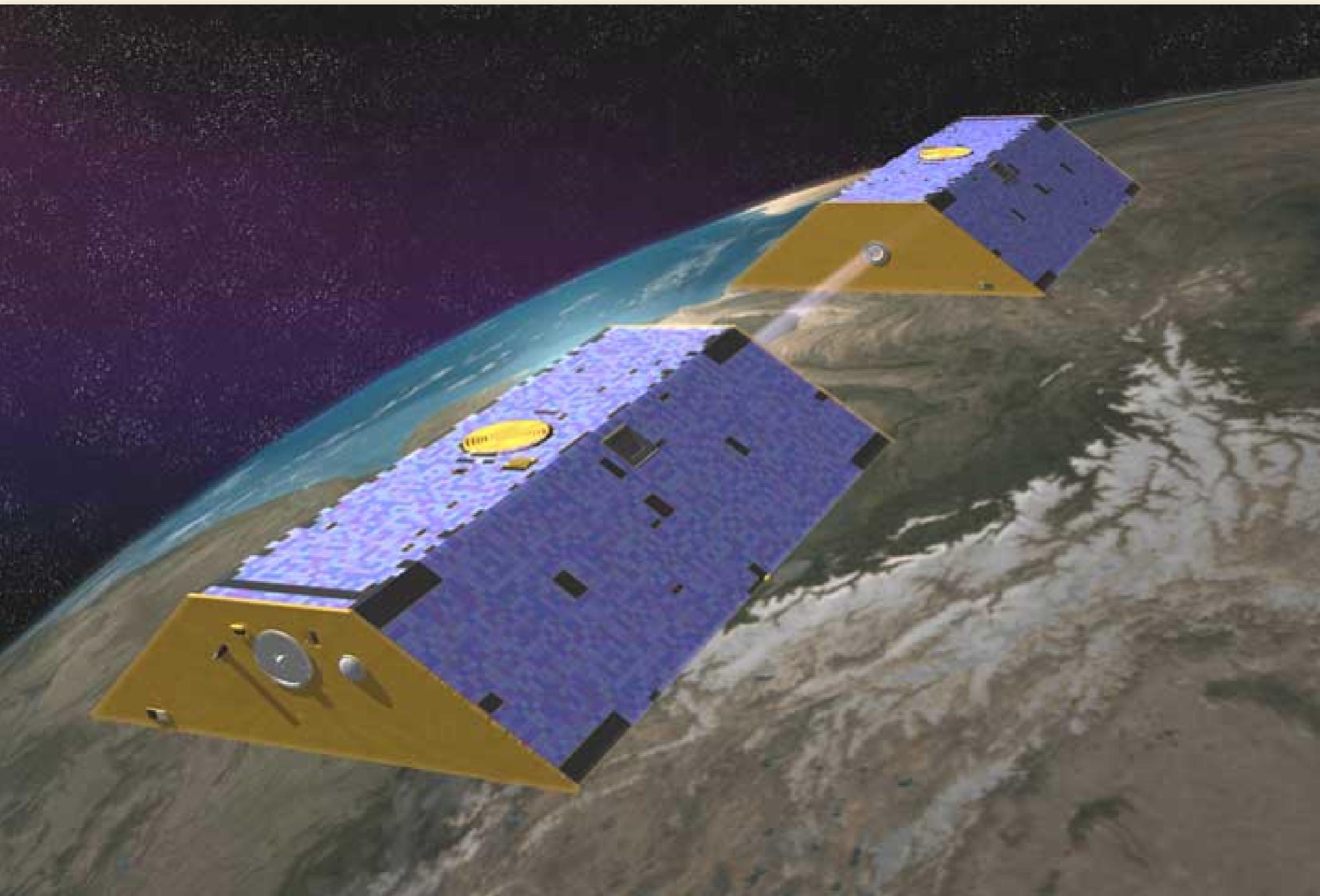
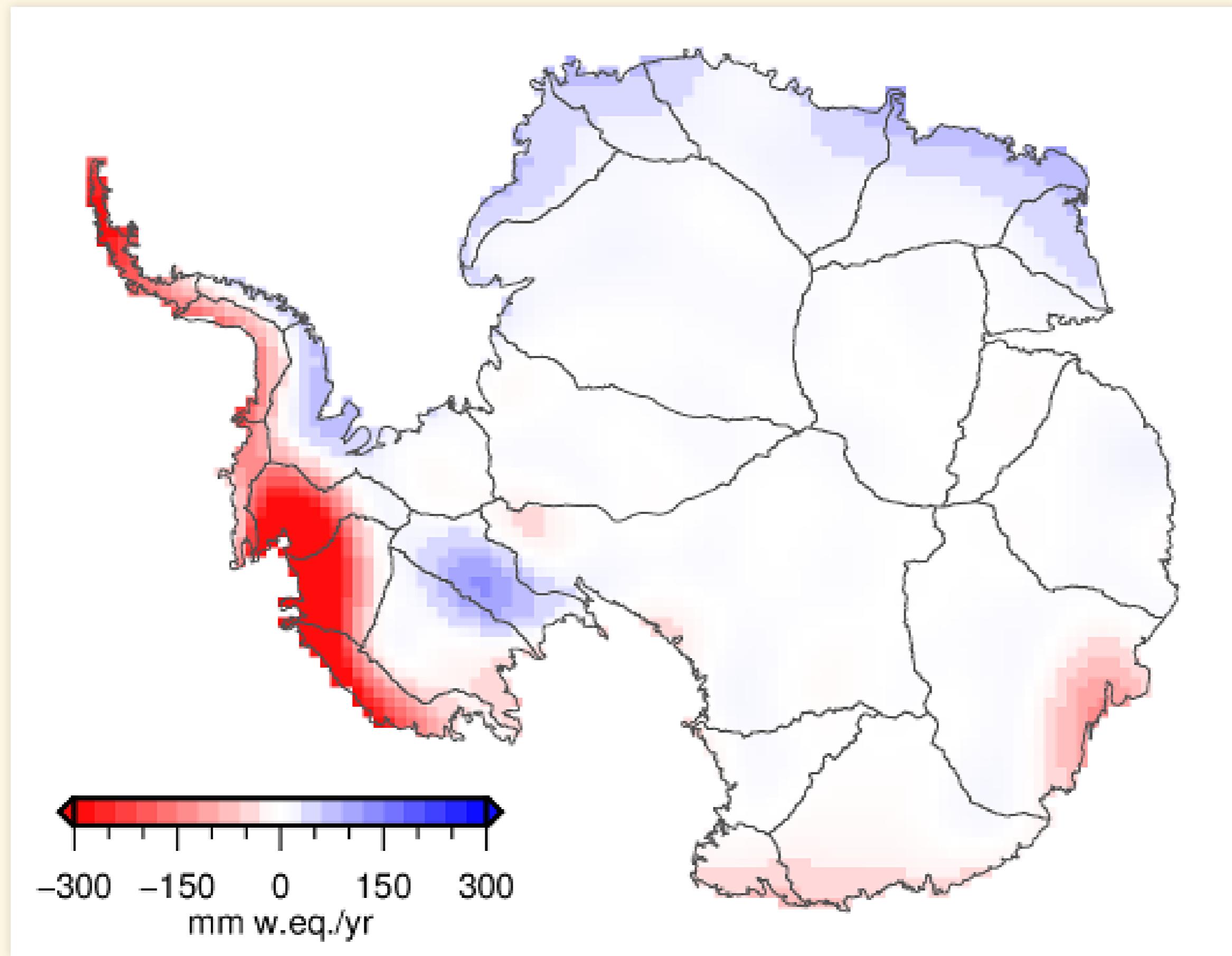
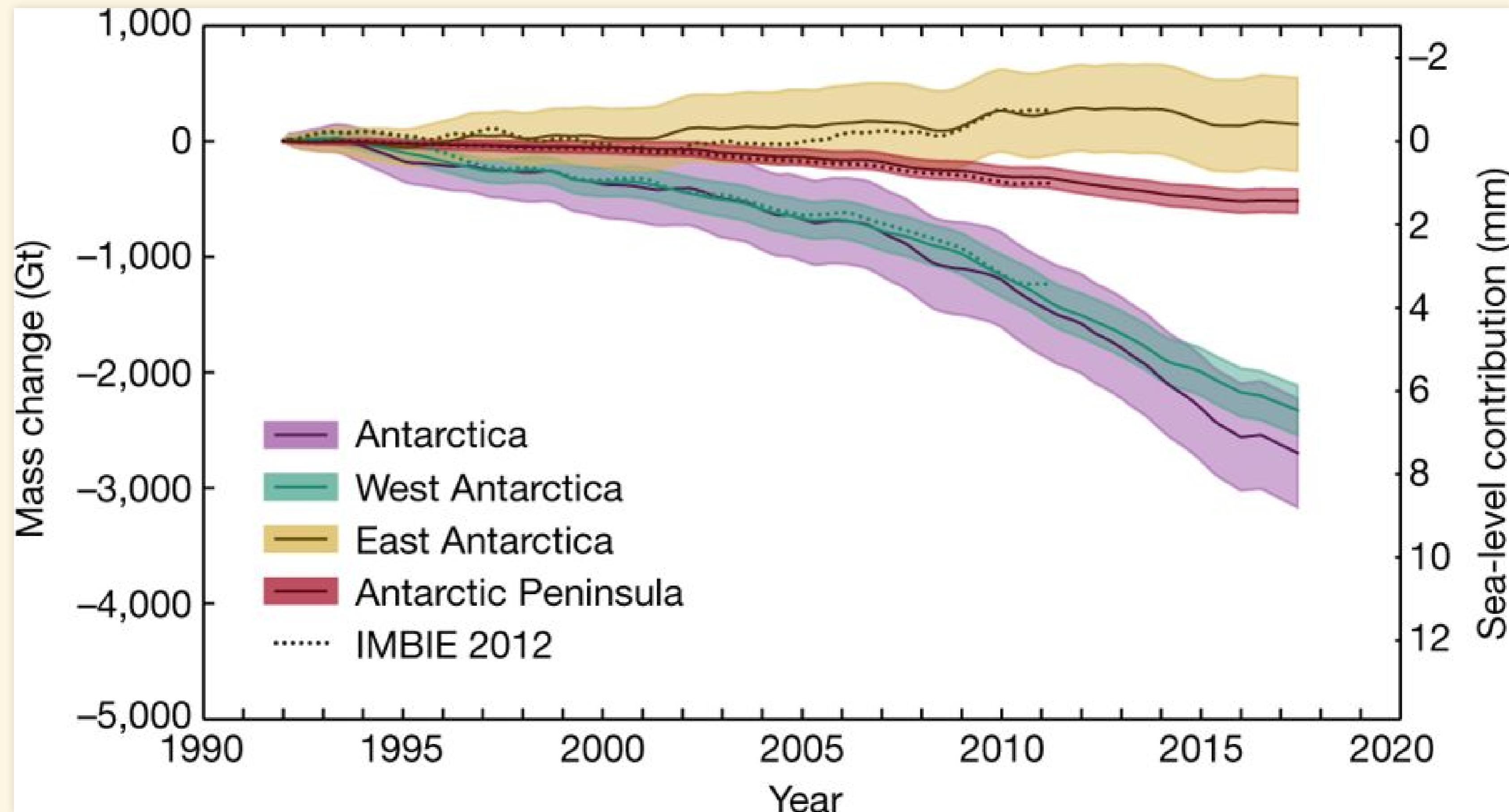


Image credit: NASA

# Observations



# 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

# Adding Up Damages

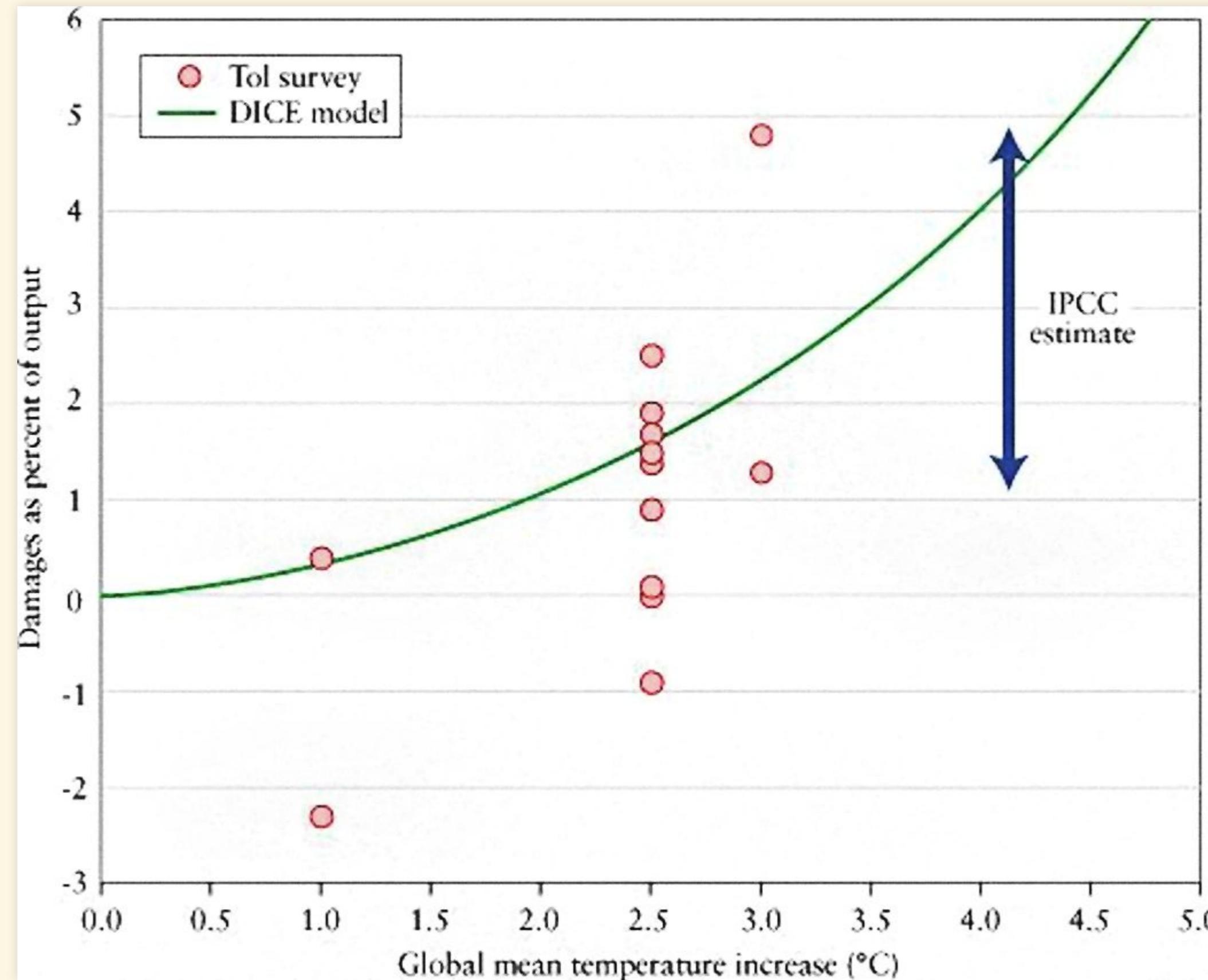
# Risk Premiums

- Why do people buy insurance?
- Costs and benefits of insurance
  - How does insurance company set premiums relative to expected payouts?
  - On average do customers get more, less, or the same back as they paid in?
  - So why does anyone buy insurance?
- Is there a lesson here for climate policy?

# Overview of Damage Assessment

- Climate change is an externality:  
Unintended consequence of economic activity
- Zero growth would dramatically slow warming
- Climate change can slow future growth
  - If climate change causes negative growth,  
economic calculations stop making sense
- Converting unmanaged  $\rightarrow$  managed systems reduces damage, vulnerability
- Forecasting damage from climate change requires forecasting economies:
  - How much of economy will be managed?
  - What technology will be available to adapt & mitigate damage?
- Value of non-economic goods  
(wilderness, ecosystems, biodiversity, ...)

# How much damage?



Source: R.S.J. Tol, J. Econ. Perspect. 23, 29 (2009). doi:10.1257/jep.23.2.29

- Note benefits at 1.0 and 2.5 degrees...

# Oops! Gremlins!

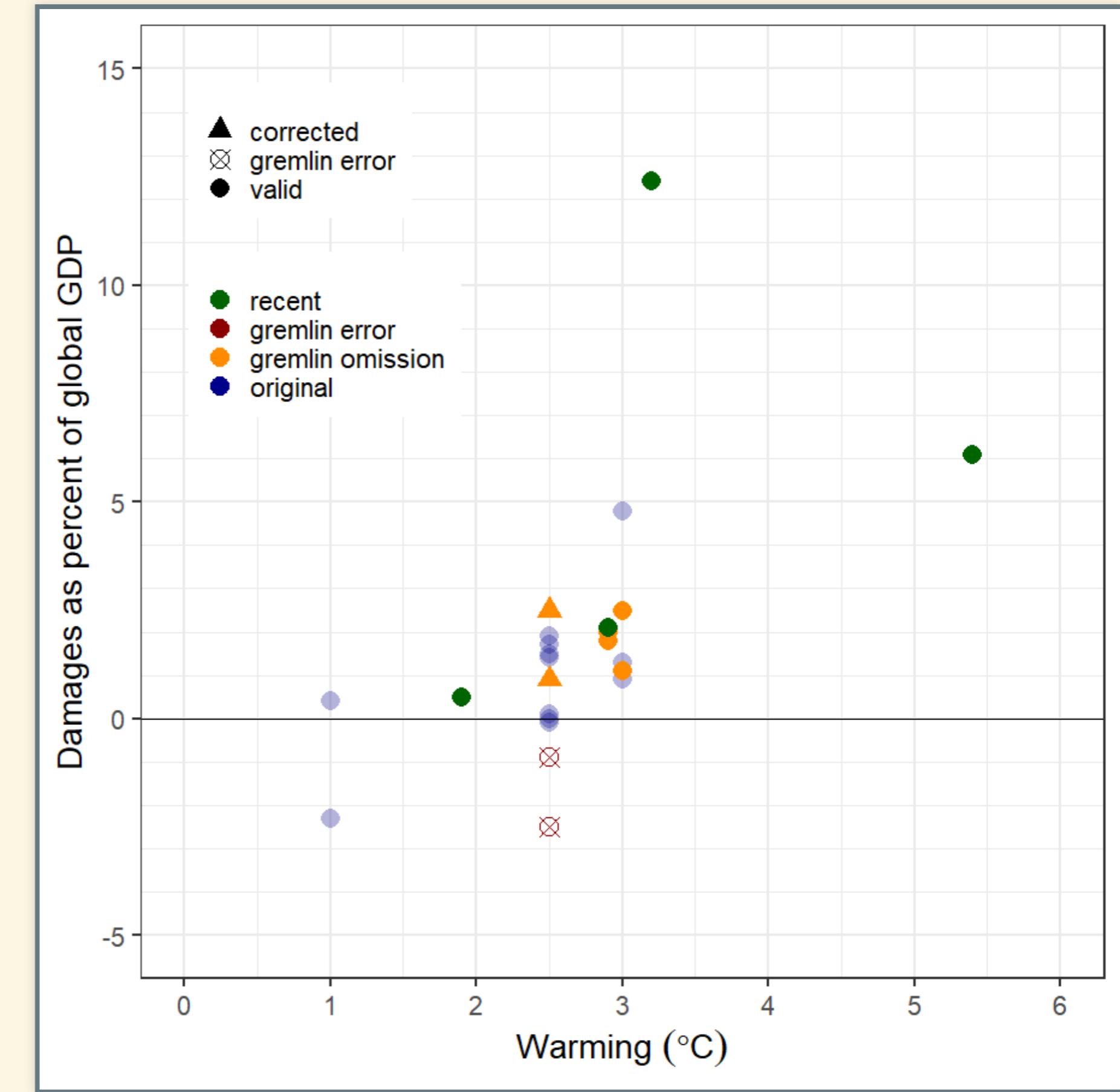
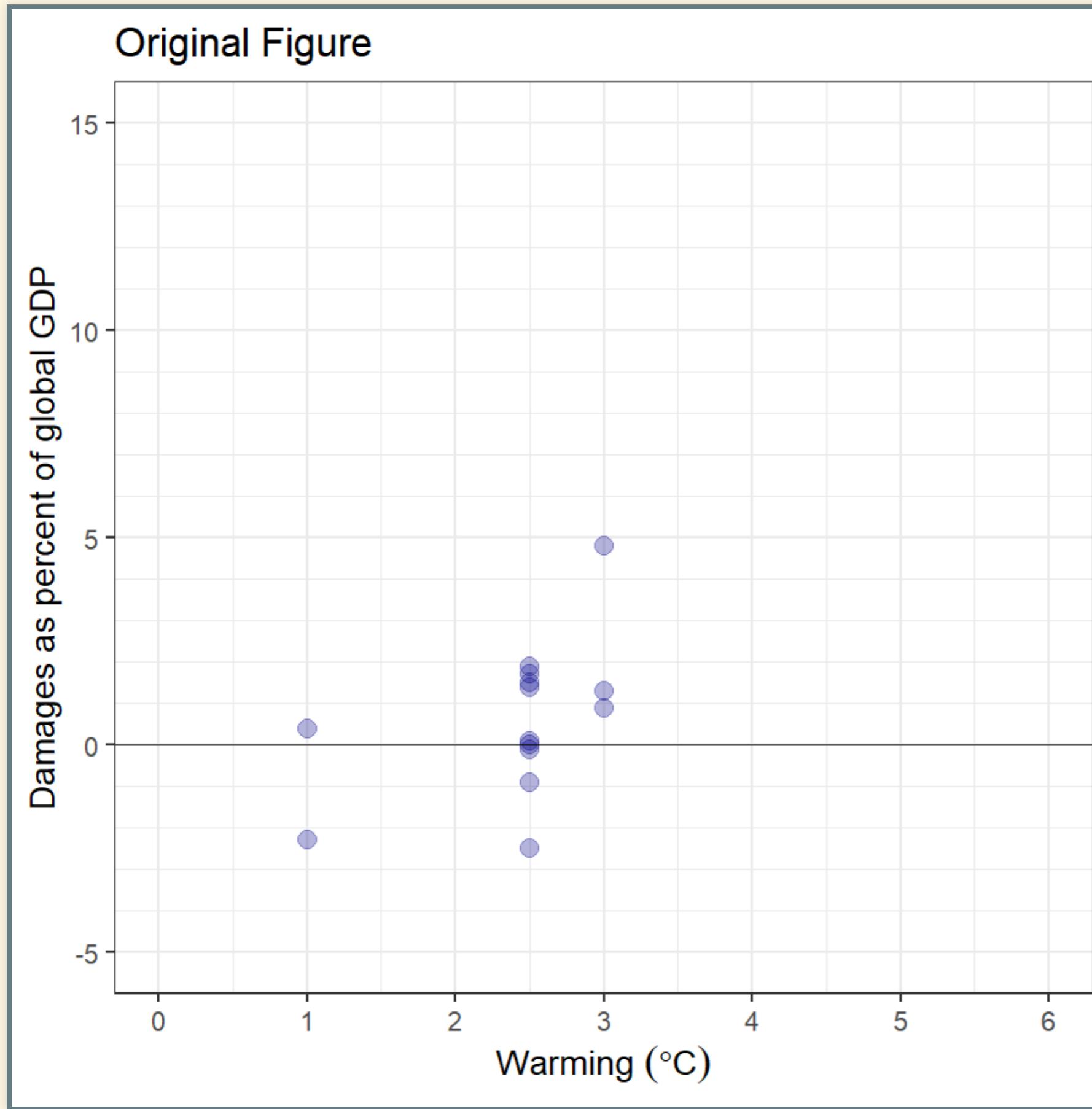
*“Gremlins intervened in the preparation of my paper ... minus signs were dropped from the two impact estimates ...”*

R.S.J. Tol, J. Econ. Perspect. **28**, 221 (2014) doi: 10.1257/jep.28.2.221

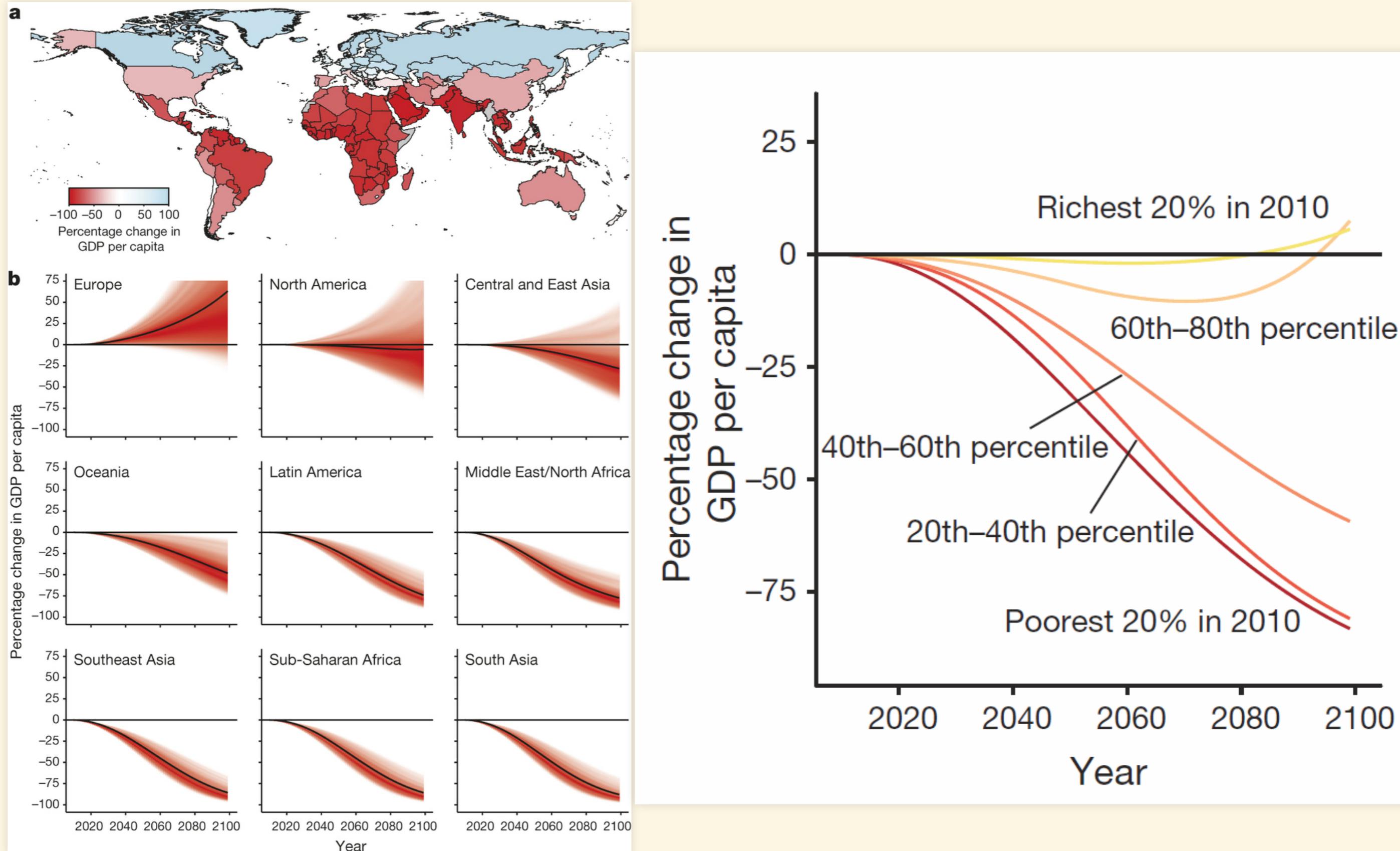


- Global warming was worse than Tol thought:
  - Two studies that found net harm from global warming were reported as net benefits.
  - Four studies that found net harm were simply omitted.
- Then, in 2015, more Gremlins:
  - numbers were not even calibrated correctly.

# Damages from Warming



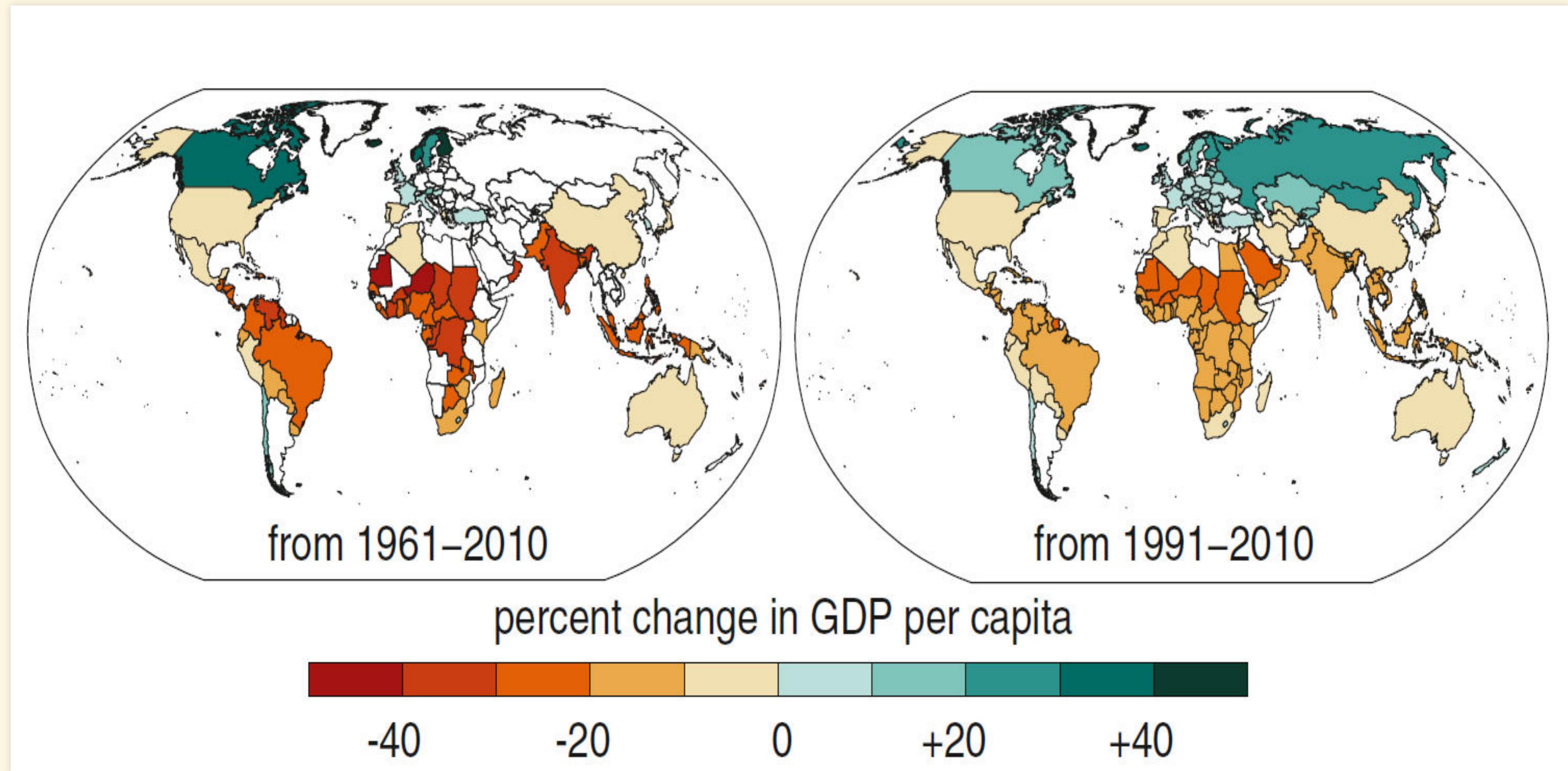
# More Recent Work



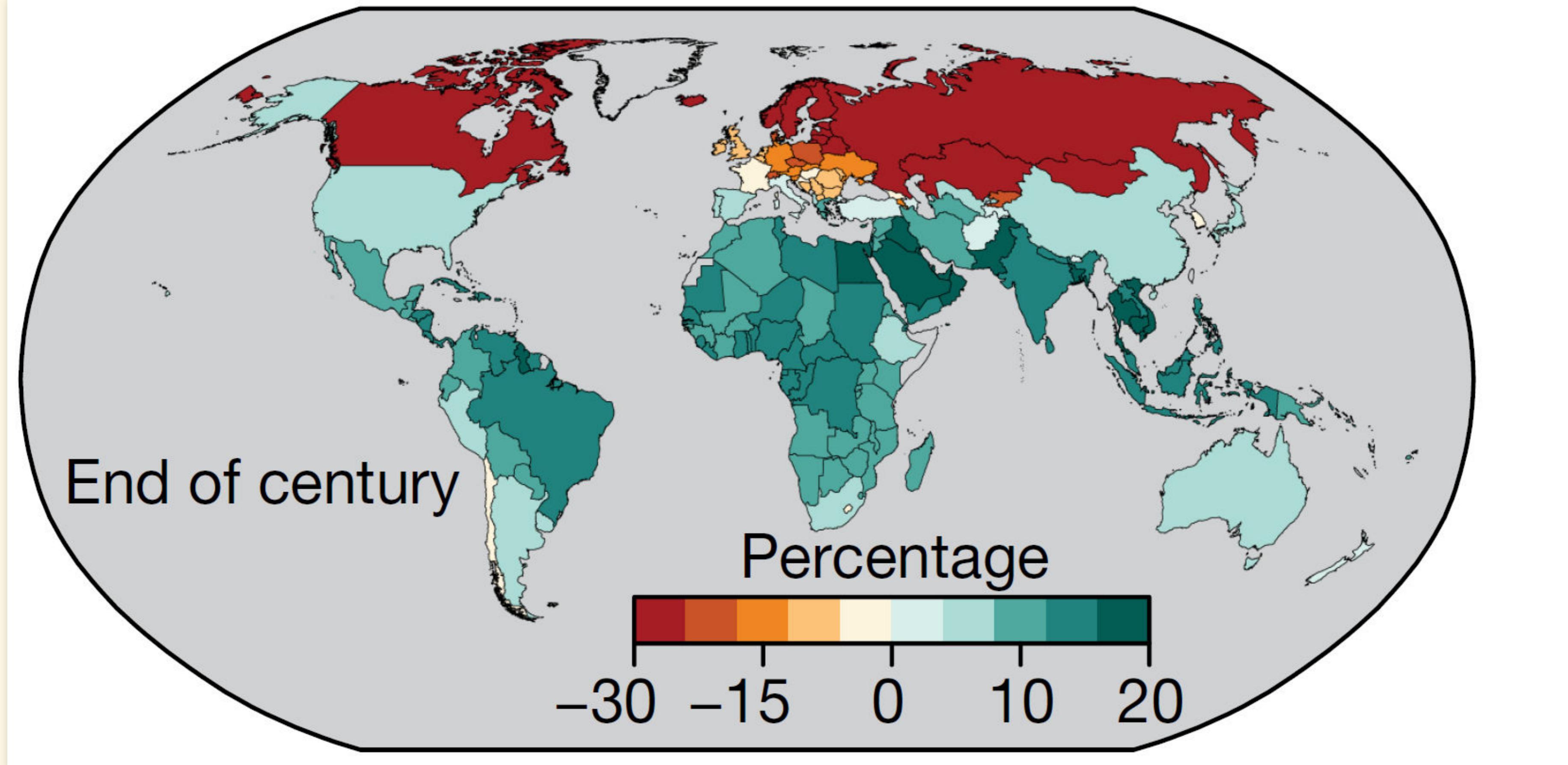
M. Burke *et al.*, Nature 527, 235 (2015). doi:10.1038/nature15725

Under a worst-case scenario

# Global Warming is Already Affecting Economic Inequality



# Benefits of Reaching International Climate Goals



# 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
    - Intensity: 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?

# Adaptation: Sea Level and Hurricanes

- Abandon vulnerable land
- Protect valuable land
- Raise buildings
- Build hurricane-resistant housing
- Move inland
  - Average structure lasts 50 years
  - Abandoning risky coastal real-estate over 50 years would cost around 0.01% of GDP each year