

# Climate Change and the Prospects for the Rapid Decarbonization of Energy Supplies

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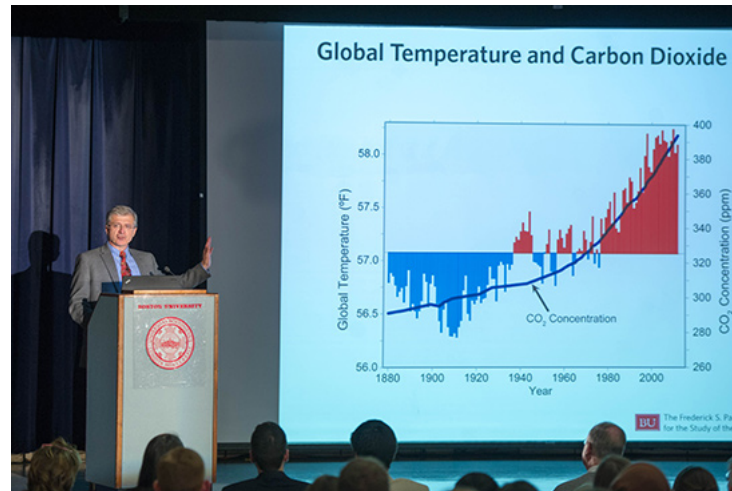
Cutler J. Cleveland

Associate Director, Institute for Sustainable Energy  
Professor, Earth and Environment, College of Arts & Sciences

Peter Fox-Penner

Founding Director, Institute for Sustainable Energy  
Professor, Questrom School of Business

# In Memoria



Anthony Janetos, 1954-2019

# What Has Changed Since 2015?

- Deeper understanding of changing climate system
- Deeper understanding of impacts of climate change on ecosystems and human well-being
- Greater ability to attribute observed changes to anthropogenic drivers



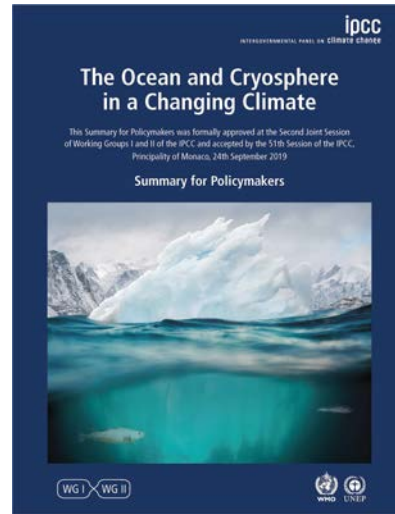
## Anthropogenic climate change is worsening North American pollen seasons

William R. L. Anderegg<sup>a,1</sup> , John T. Abatzoglou<sup>b</sup> , Leander D. L. Anderegg<sup>c,d</sup> , Leonard Bielory<sup>e,f,g</sup> ,  
Patrick L. Kinney<sup>h</sup> , and Lewis Ziska<sup>i</sup> 

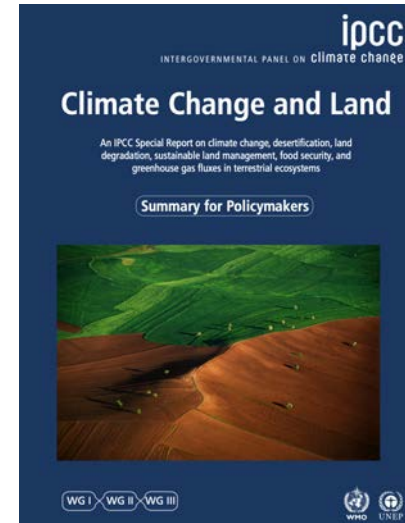
# Major Reports



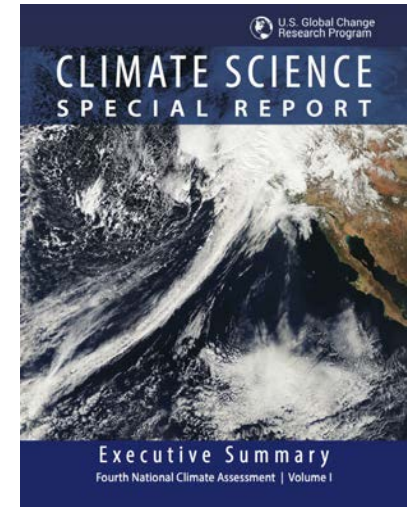
IPCC (2018)



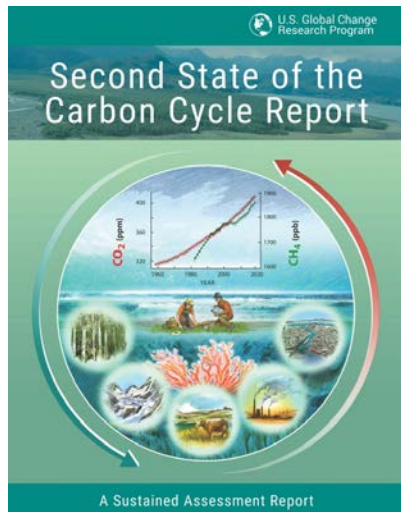
IPCC (2019)



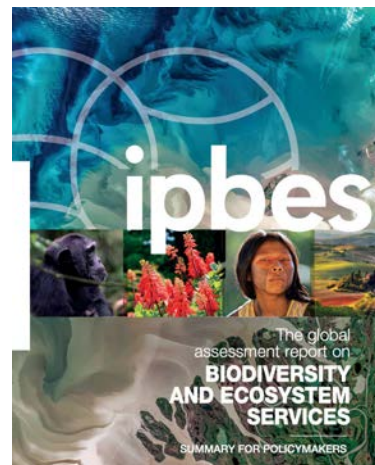
IPCC (2020)



USGCRP (2017)



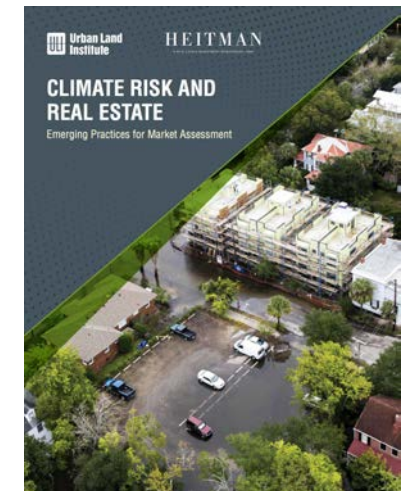
USGCRP (2018)



IPBES (2019)



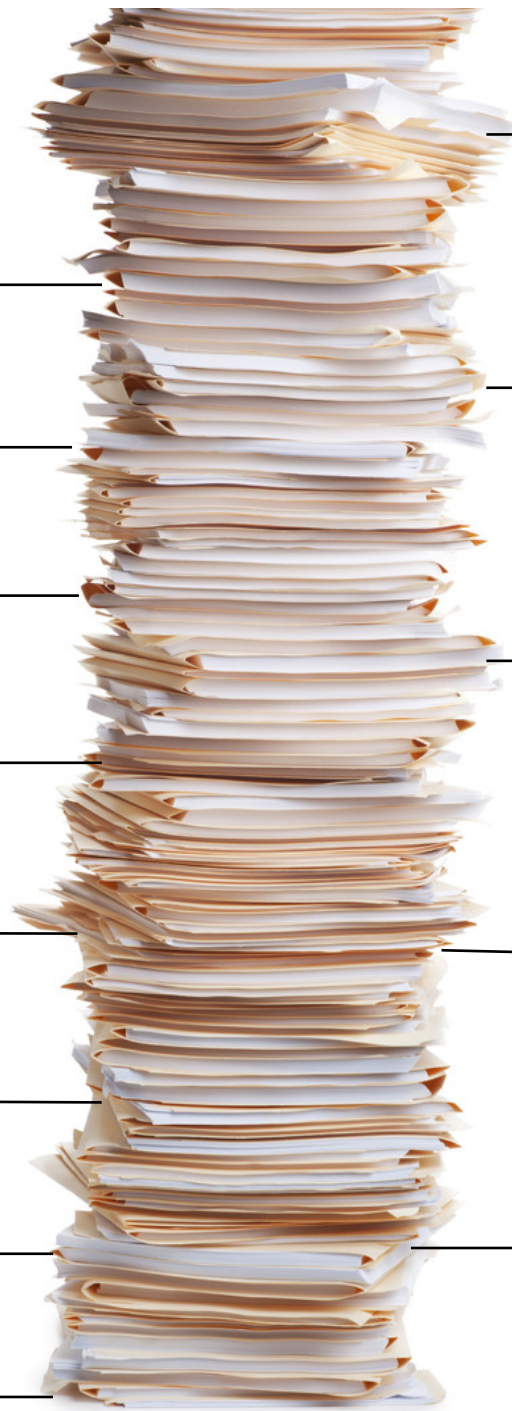
The Lancet (2020)



ULI & Heitman (2020)



# (A Mountain of) Individual Studies



Flammer et al. (2021)



Kulatilaka et al. (2014)



Kaufmann et al. (2021)



Short Gianotti et al. (2018)



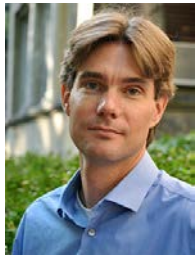
Fox-Penner (2020)



Phillips (2012)



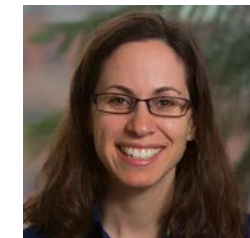
Selin and Selin (2021)



Kinney (2021)



Templer et al. (2017)



Maxwell (2017)



Gately and Hutrya (2017)



Gopalan et al. (2019)



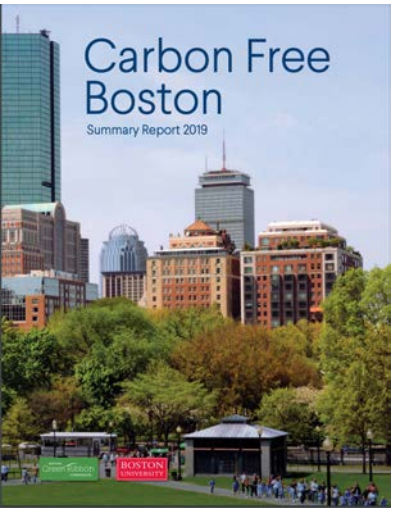
Hawkins et al. (2013)



# What Has Changed at BU?



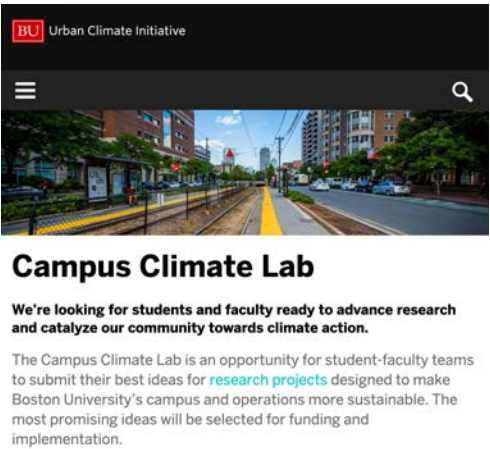
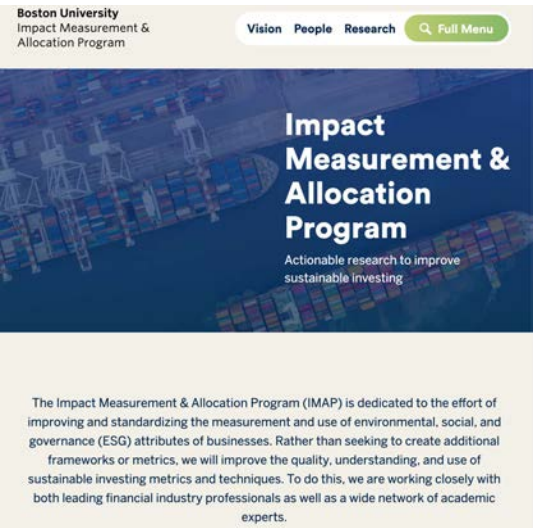
BU Climate Action Plan



Inst. Sustainable Energy

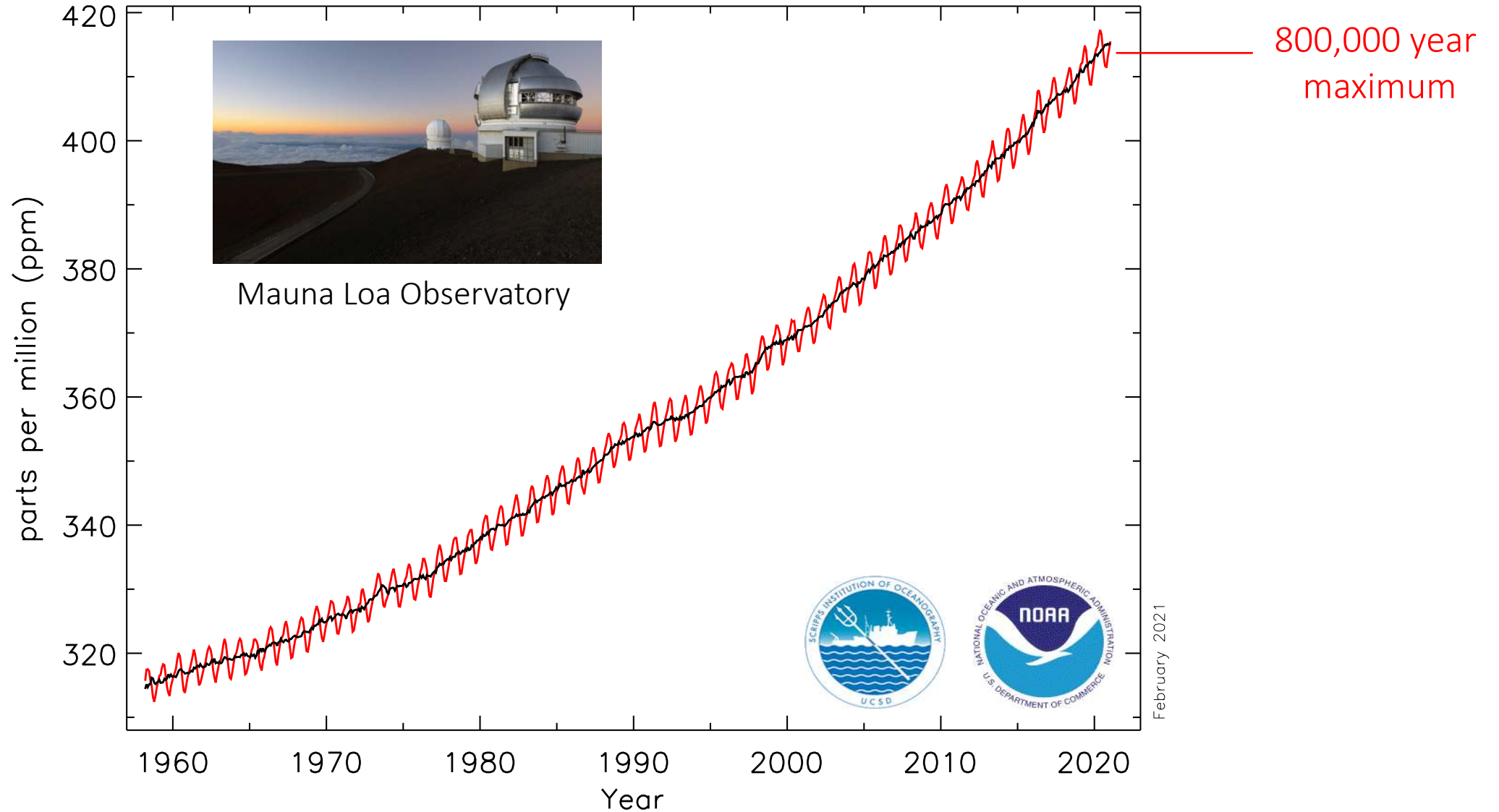


NSF PhD Program

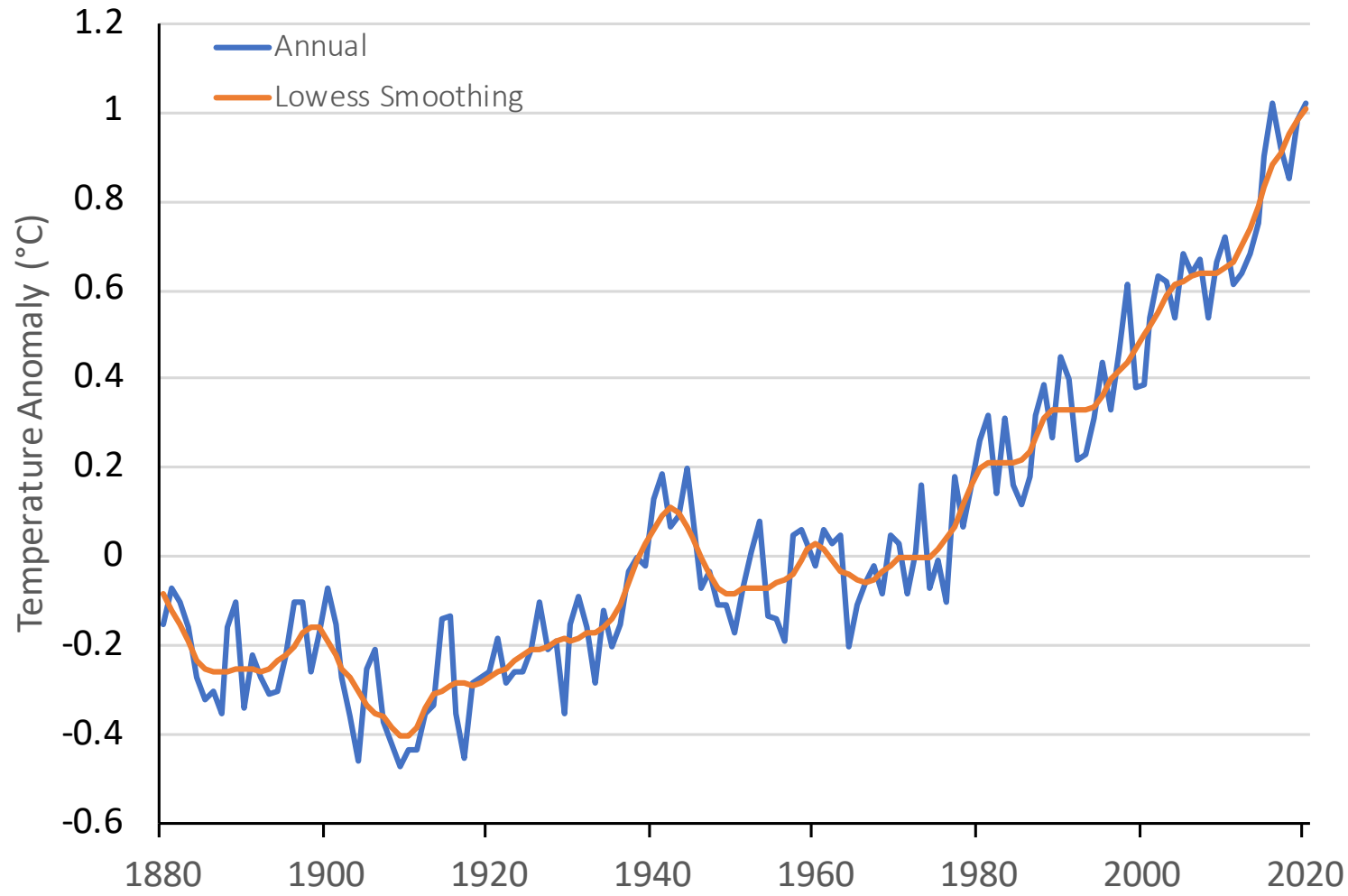




# Carbon Dioxide Concentrations, 1958-2020



# Global Temperature, 1880-2020



Source: NASA/GISS

“Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels... (high confidence)”

- IPCC (2018)



# Additional Evidence



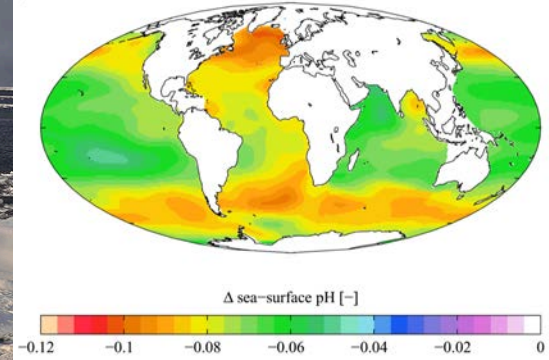
Shrinking Ice Sheets



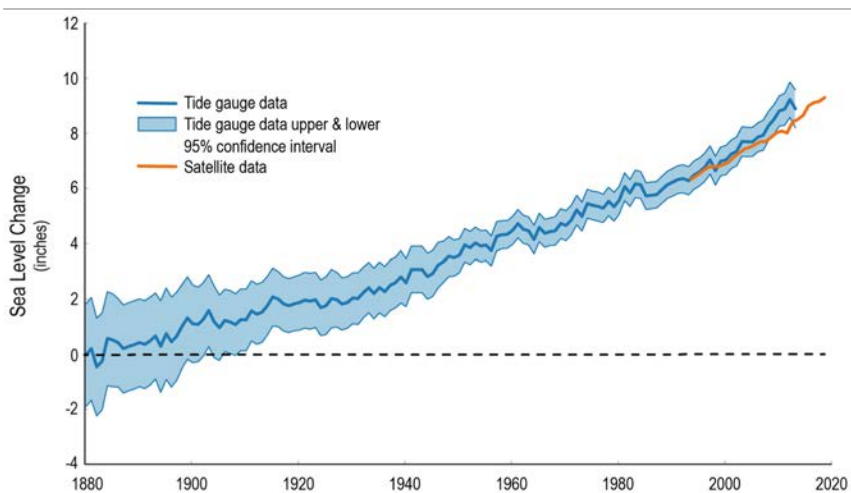
Shrinking Glaciers



Shrinking Sea Ice



More Acidic Ocean



Rising Sea Level

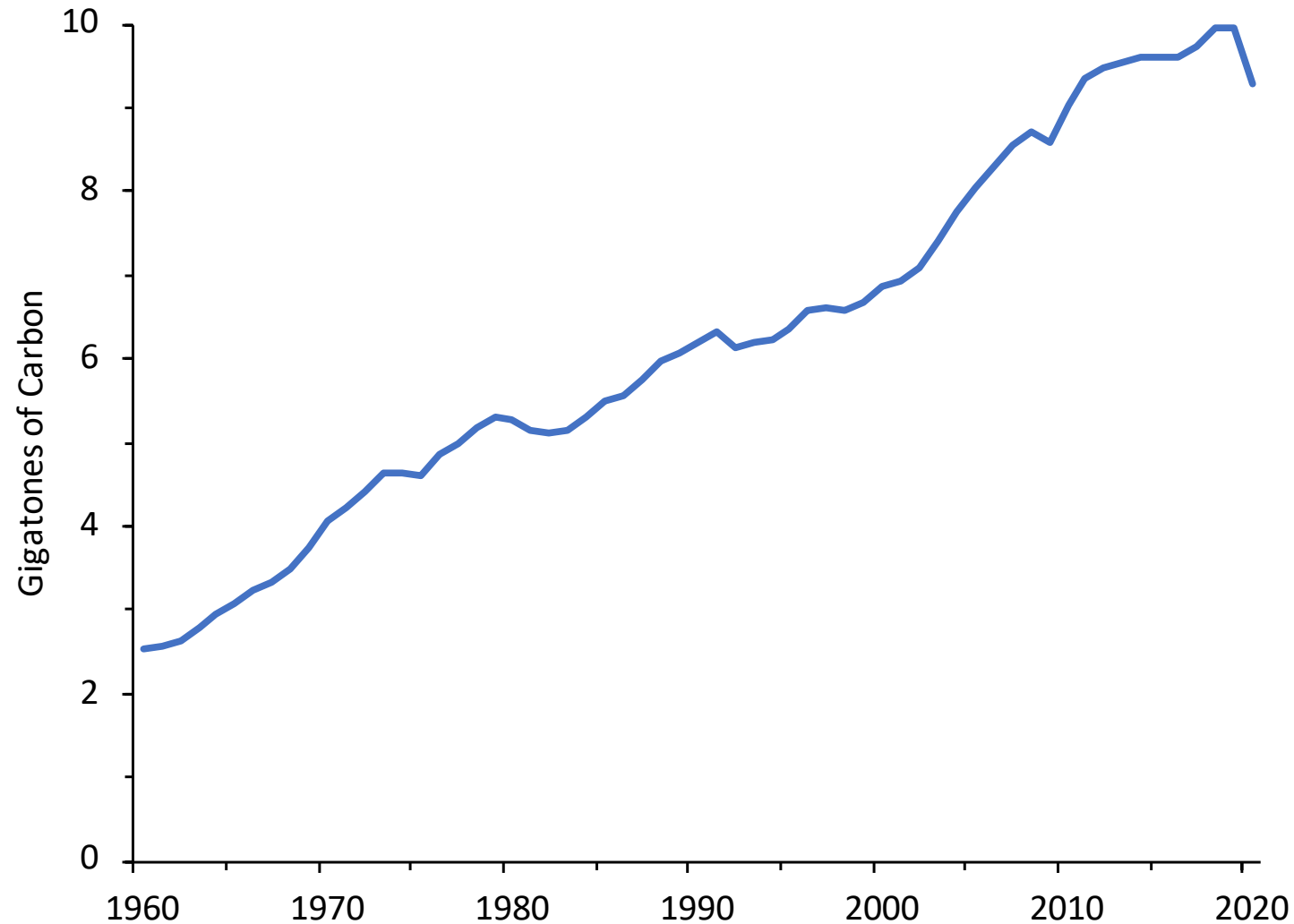


Extreme Events: CA Wildfires



Extreme Events: Cedar Rapids Flood

# Global Carbon Dioxide Emissions from Fossil Fuels 1960-2020

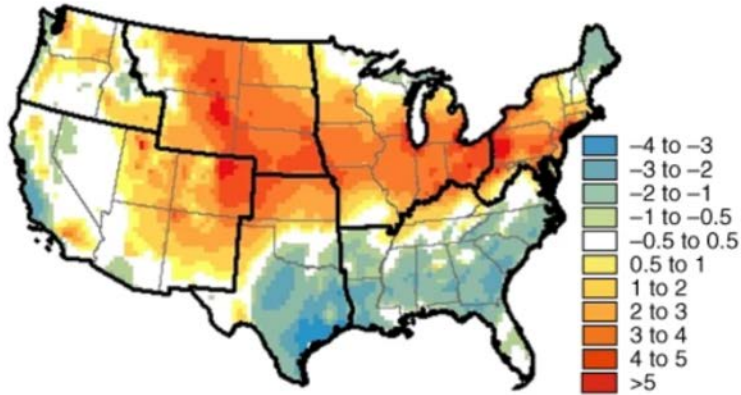


Source: Global Carbon Project (2020)

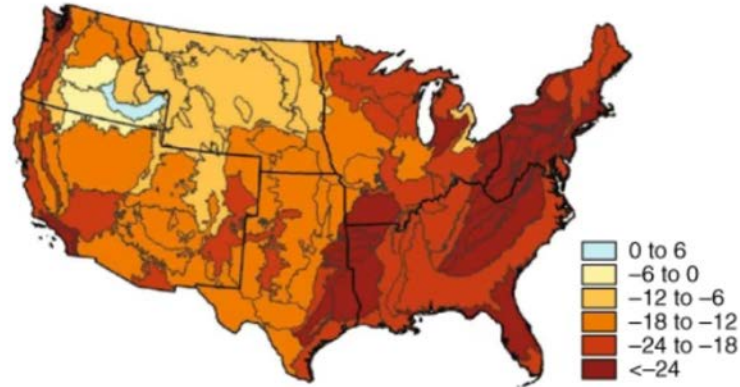


# Climate Impacts in the United States in 2090

Air quality (ozone)  
Change in daily 8-hour ozone concentrations (ppb)



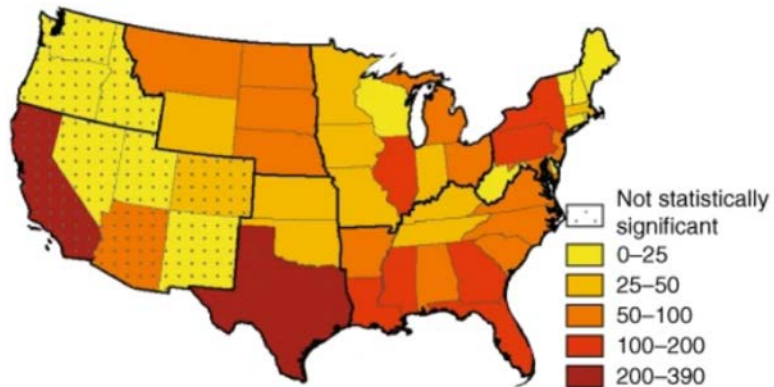
Water quality  
Change in water quality index



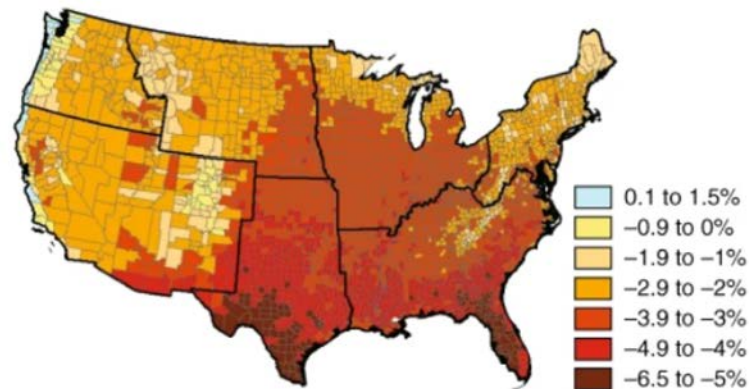
Extreme temperature mortality  
Mortality rate (deaths per 100,000)



West Nile virus  
Change in West Nile neuroinvasive disease cases



Labour  
Percentage change in hours worked

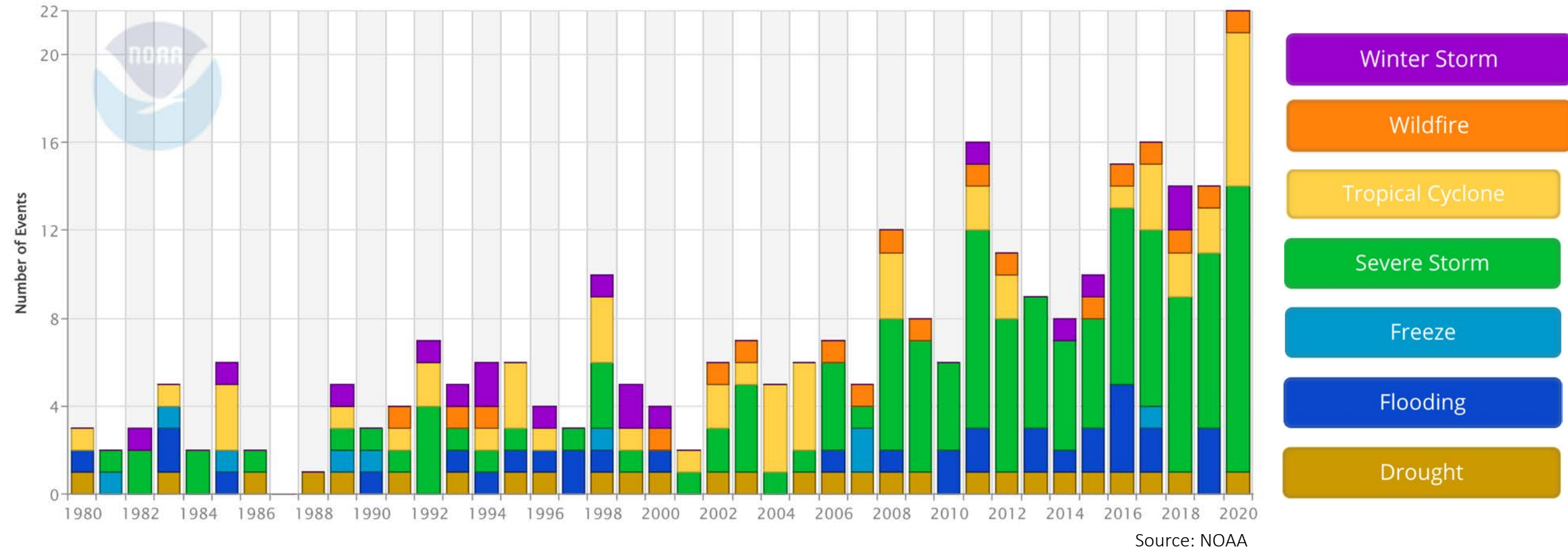


Winter recreation (downhill skiing)  
Percentage change in downhill ski season length



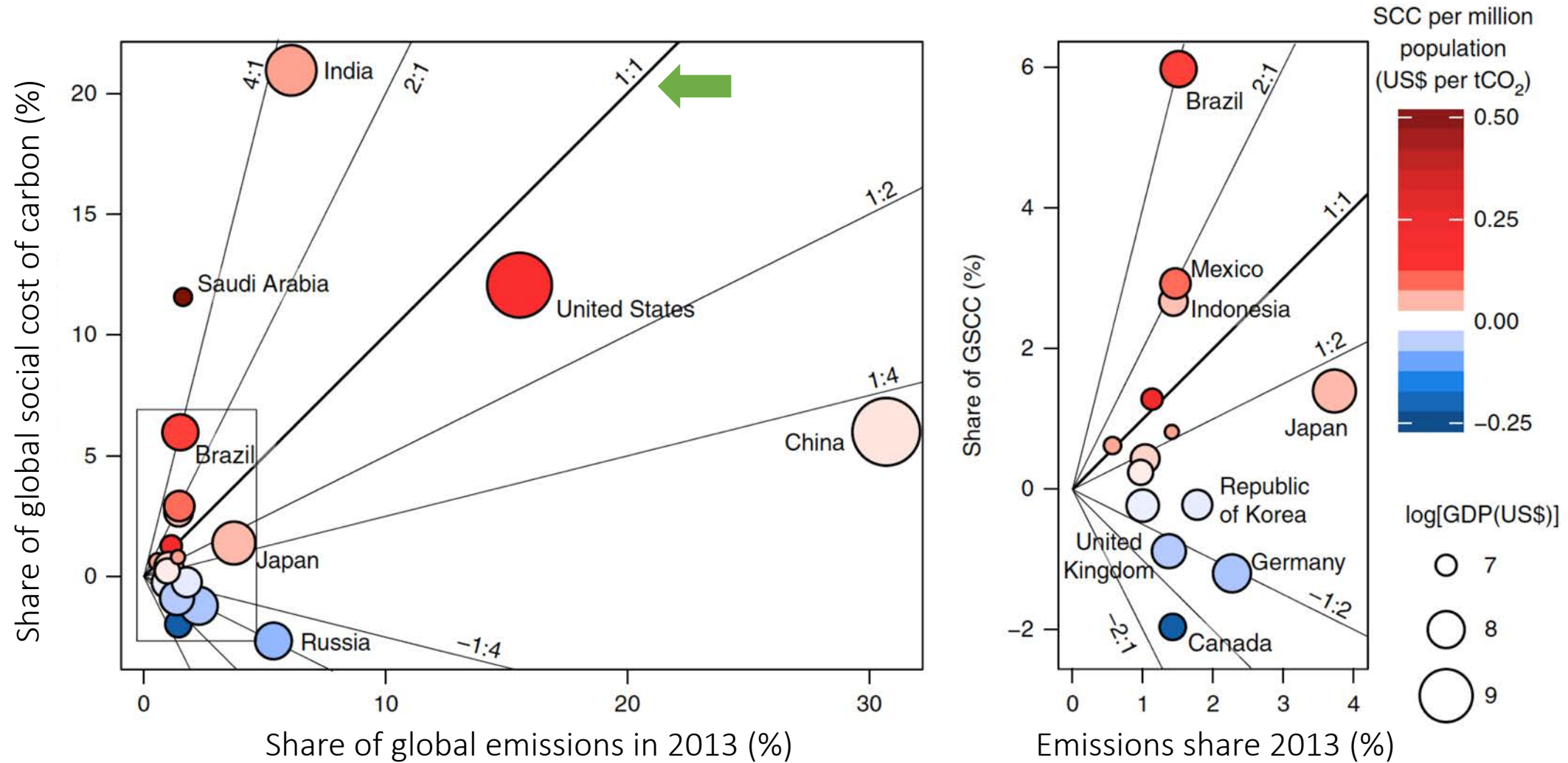


# U.S. Billion-Dollar Weather and Climate Events, 1980-2020

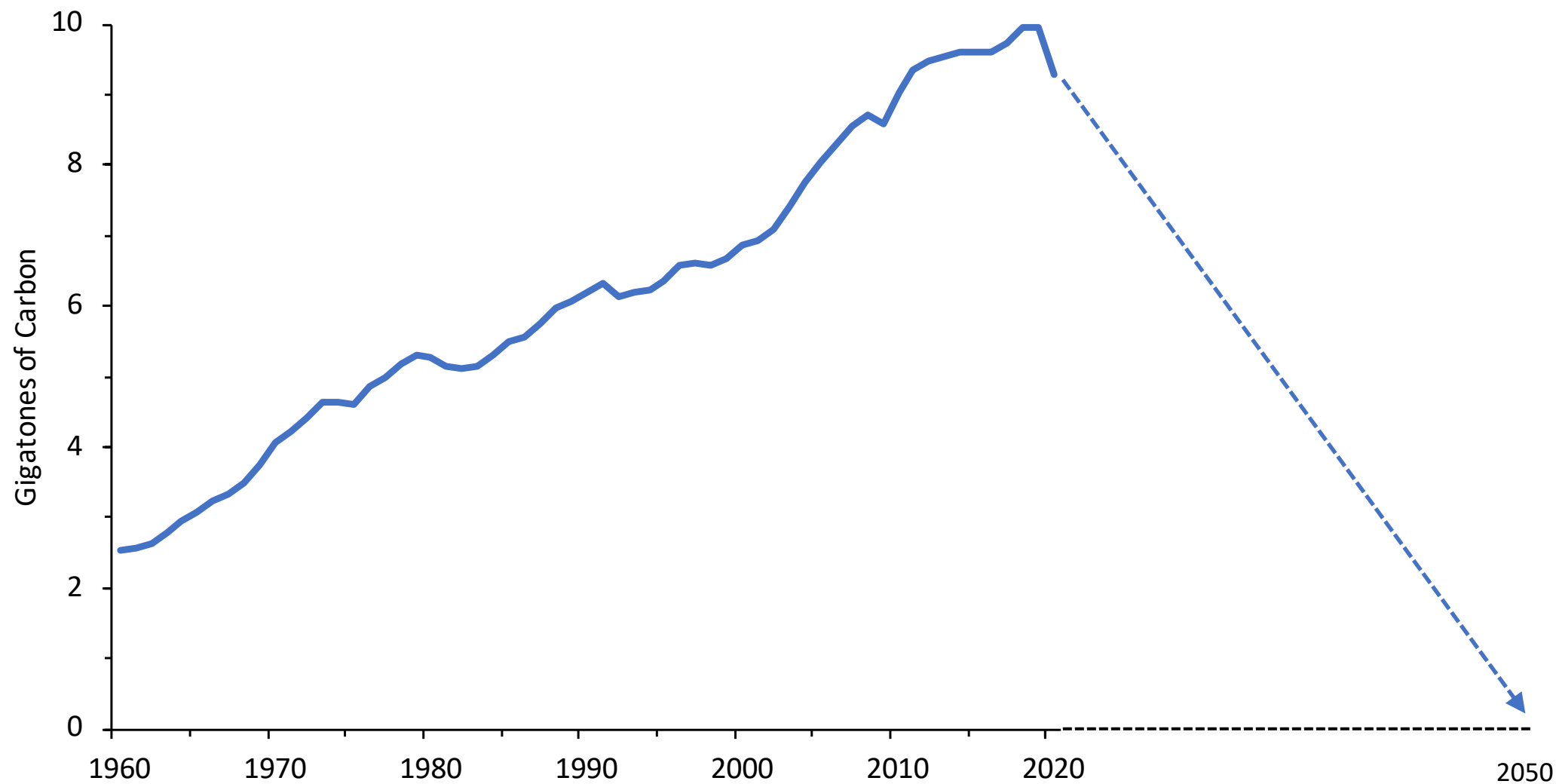


Total Cost 1980-2020: ~ \$2 trillion

# Climate Change is a Global Injustice



# Net Zero CO<sub>2</sub> Emissions by 2050





# Acknowledgements

- Nalin Kulatilaka, Questrom
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- Bruce Anderson, Earth and Environment/CAS
- Lucy Hutrya, Earth and Environment/CAS
- Rick Reibstein, Earth and Environment/CAS
- Robert Kaufmann, Earth and Environment/CAS
- Pam Templer, Biology/CAS

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