Climate Change – A Hot Topic Session 2

# The Fifth National Climate Assessment

The state of the science of climate change and its potential impact on the American people.

Roy Campbell and Don Fournier

January 22, 2024

How the United States Is Addressing Climate Change

The effects of human-caused climate change are already farreaching and worsening across every region of the United States. Rapidly reducing greenhouse gas emissions can limit future warming and associated increases in many risks. Across the country, efforts to adapt to climate change and reduce emissions have expanded since 2018, and US emissions have fallen since peaking in 2007. However, without deeper cuts in global net greenhouse gas emissions and accelerated adaptation efforts, severe climate risks to the United States will continue to grow.

How the United States Is Experiencing Climate Change

As extreme events and other climate hazards intensify, harmful impacts on people across the United States are increasing. Climate impacts combined with other stressors—are leading to ripple effects across sectors and regions that multiply harms, with disproportionate effects on underserved and overburdened communities.

Current and Future Climate Risks to the United States

Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities. Many of the extreme events and harmful impacts that people are already experiencing will worsen as warming increases and new risks emerge.

The Choices That Will Determine the Future

With each additional increment of warming, the consequences of climate change increase. The faster and further the world cuts greenhouse gas emissions, the more future warming will be avoided, increasing the chances of limiting or avoiding harmful impacts to current and future generations.

How Climate Action Can Create a More Resilient and Just Nation

Large near-term cuts in greenhouse gas emissions are achievable through many currently available and costeffective mitigation options. However, reaching net-zero emissions by midcentury cannot be achieved without exploring additional mitigation options. Even if the world decarbonizes rapidly, the Nation will continue to face climate impacts and risks. Adequately and equitably addressing these risks involves longer-term inclusive planning, investments in transformative adaptation, and mitigation approaches that consider equity and justice.

### **Climate Change Risks and Opportunities in the US**

Climate change is happening now in all regions of the US Each additional increment Without deeper cuts in global net emissions, Figure 1.1. of warming leads to climate risks to the US will continue to grow **Annual Temperature Annual Precipitation** Sea Level greater risks ▶ A person born in North America in 2020 will experience Climate more climate hazards during their lifetime, on average, Water supply than a person born in 1965. Ÿ **Global Warming Above Preindustrial Levels** Food security change Heatwaves 5x events? 2.7°F 📕 4.3°F 📕 6.3°F Infrastructure  $\widehat{}$ 4x **Heavy Precipitation** Warm Nights many times more presents risks Health and well-being Tropical 3x **Direction of Change** cyclones Drought River Ecosystems 2x -Wildfiresfloods Crop while action \$ Economy failure Not applicable How Livelihoods and heritage Y to limit How much more the US warms depends on choices made today Action to limit future warming and reduce risks warming and can have near-term benefits and opportunities Temperature Change Compared ▶ Future global greenhouse gas emissions from human activities to 1951–1980 Average determine whether and how quickly the US reaches warming levels Low-carbon Economic Health Improved -1ºF ∎ 11°F reduce risks associated with greater risks. benefits air quality benefits energy jobs Today ပါပ် \_\_\_\_\_ Very high (SSP5-8.5) presents High (SSP3-7.0) Reduced risks Reduced risks Climate More options Social Intermediate (SSP2-4.5) for adaptation Scenarios to biodiversity benefits to ecosystems opportunities Low (SSP1-2.6) Very low (SSP1-1.9) 1951 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 for the US. Fifth National Climate Assessment U.S. Global Change Research Program nca2023.globalchange.gov

\$

Figure 1.2. Increasing capacities and decreasing costs of lowcarbon energy technologies are supporting efforts to further reduce emissions.

Historical Trends in Costs and Capacity of Low-Carbon Energy Technologies in the United States

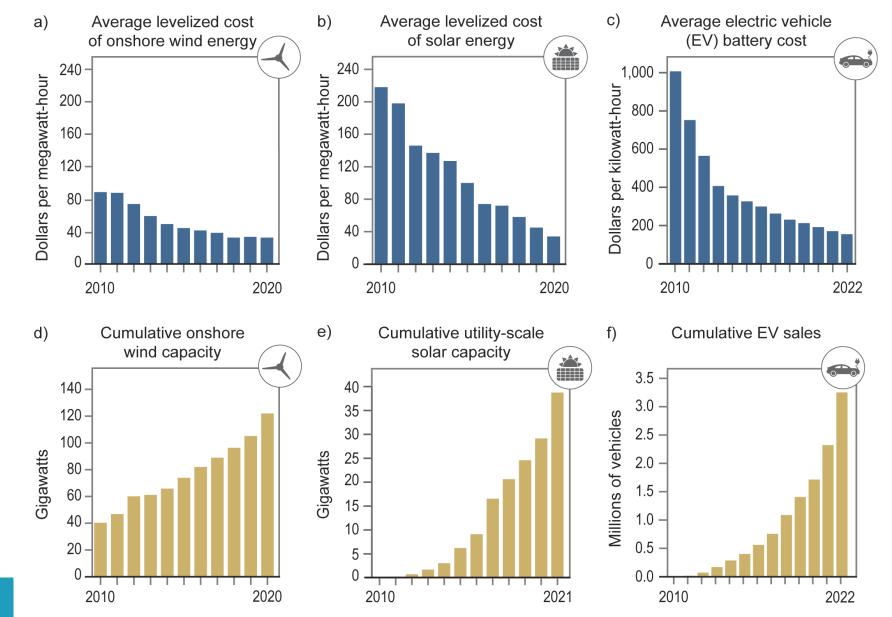
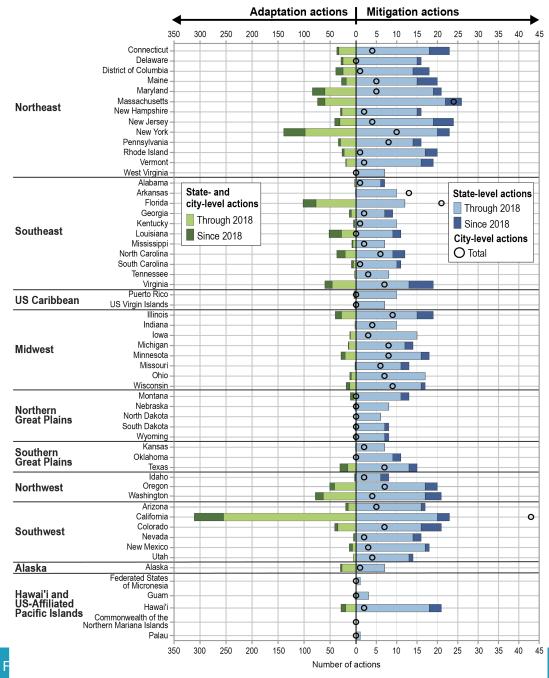


Figure 1.3. Cities and states are acting on climate change, with a substantial increase in new activities underway since 2018.

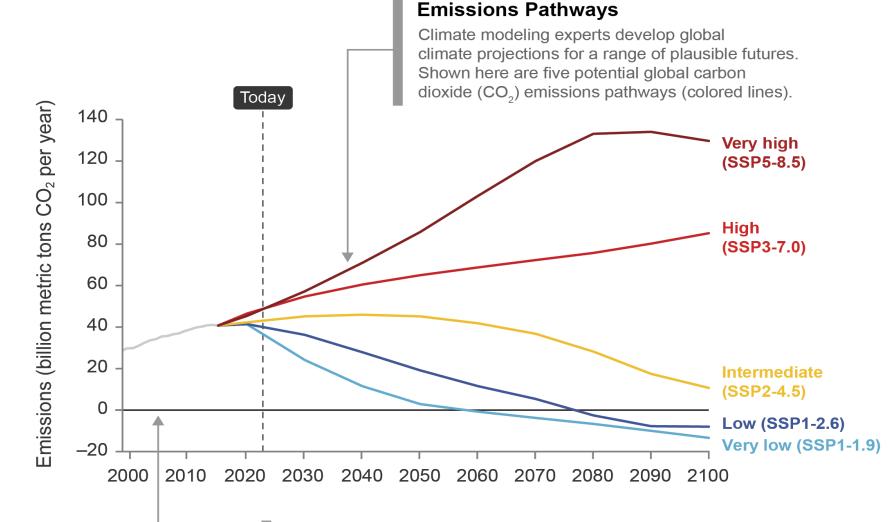
Chapter 1



US Adaptation and Mitigation Actions

Figure 1.4. Different scenarios of future carbon dioxide emissions are used to explore the range of possible climate futures.

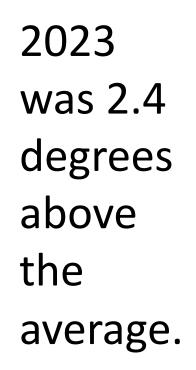
### Future Global Carbon Dioxide Emissions Pathways



### **Net-Zero CO<sub>2</sub> Emissions**

Net zero occurs when human-caused global  $CO_2$  emissions cross this zero-line. Where an emissions pathway falls below this line, more  $CO_2$  is being removed from the atmosphere than is being added.

US and Global Changes in Average Surface Temperature



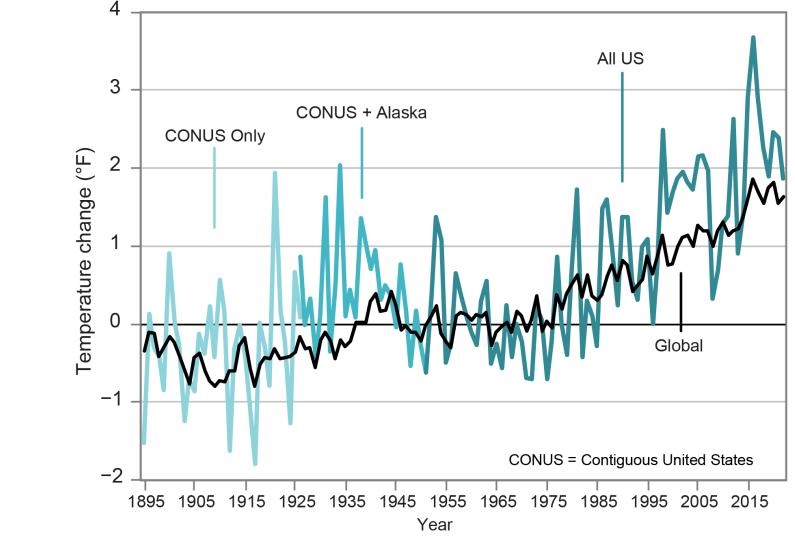


Figure 1.5. The US has warmed rapidly since the 1970s.

Rapid and Unprecedented Changes

Present-day levels of greenhouse gases in the atmosphere are higher than at any time in at least the past 800,000 years, with most of the emissions occurring since 1970.

The rate of sea level rise in the 20th century was faster than in any other century in at least the last 3,000 years.

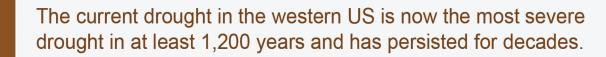


1,20

800k years

3,000

Global temperature has increased faster in the past 50 years than at any time in at least the past 2,000 years.

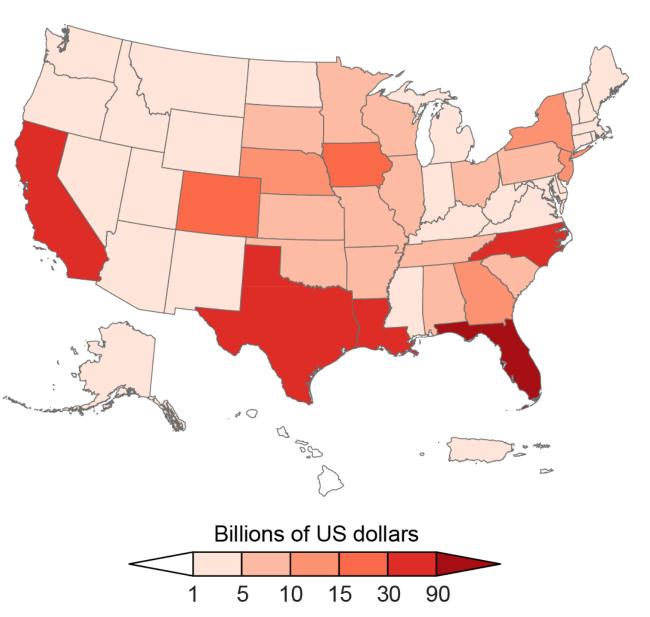


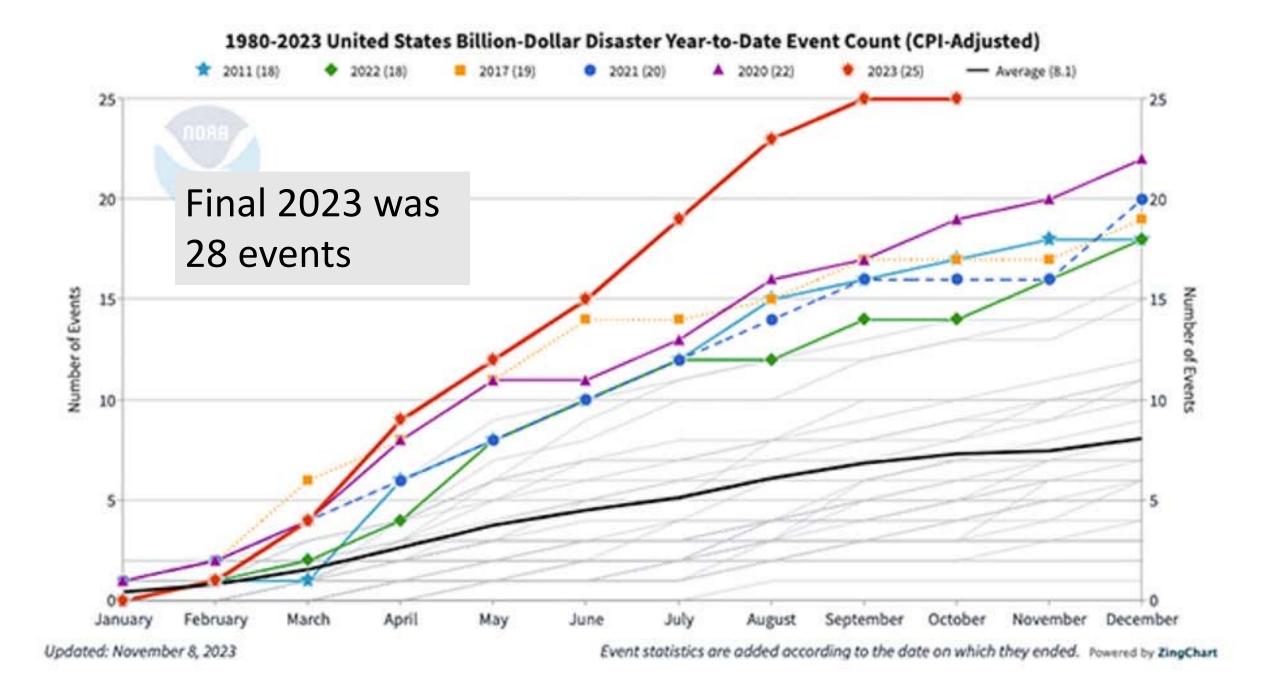
# Figure 1.6. Current climate conditions are unprecedented for thousands of years.

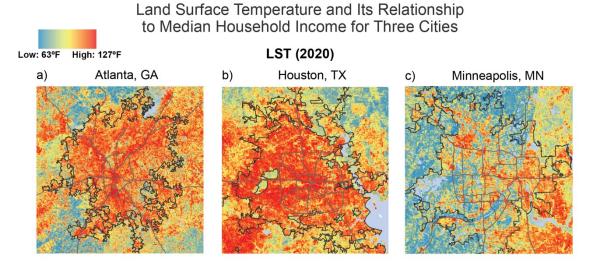
Damages by State from Billion-Dollar Disasters (2018–2022)

Figure 1.7. The US now experiences, on average, a billion-dollar weather or climate disaster every three weeks.

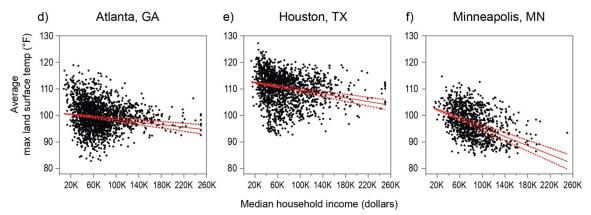
Chapte





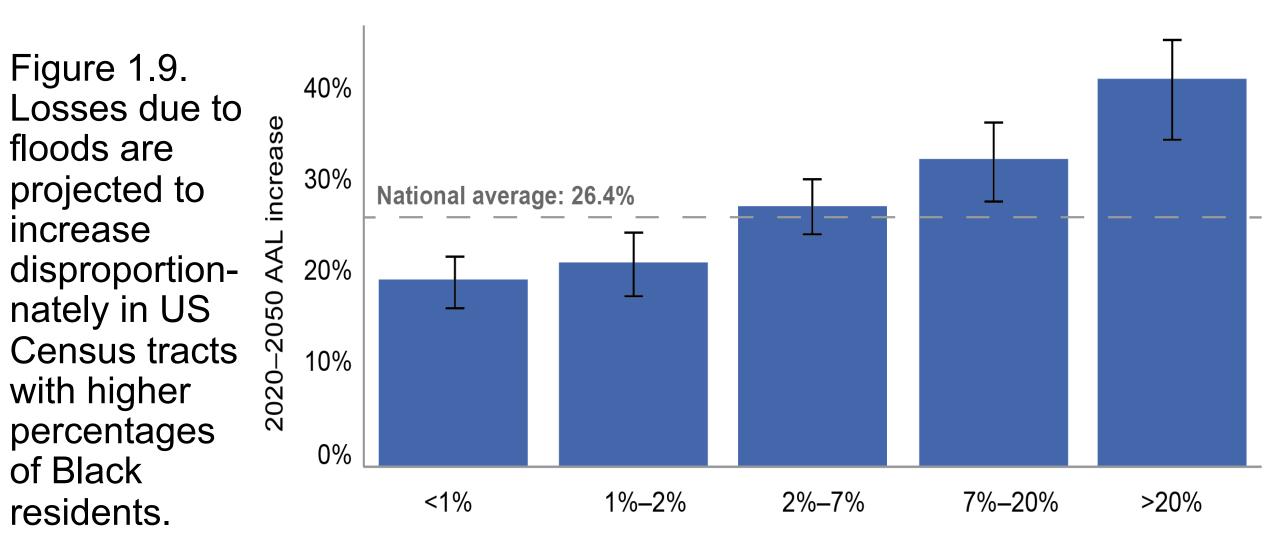


LST versus household income by census tract (2020)



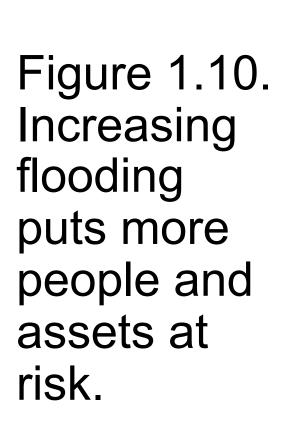
# Figure 1.8. Lower-income urban neighborhoods experience higher surface temperatures.

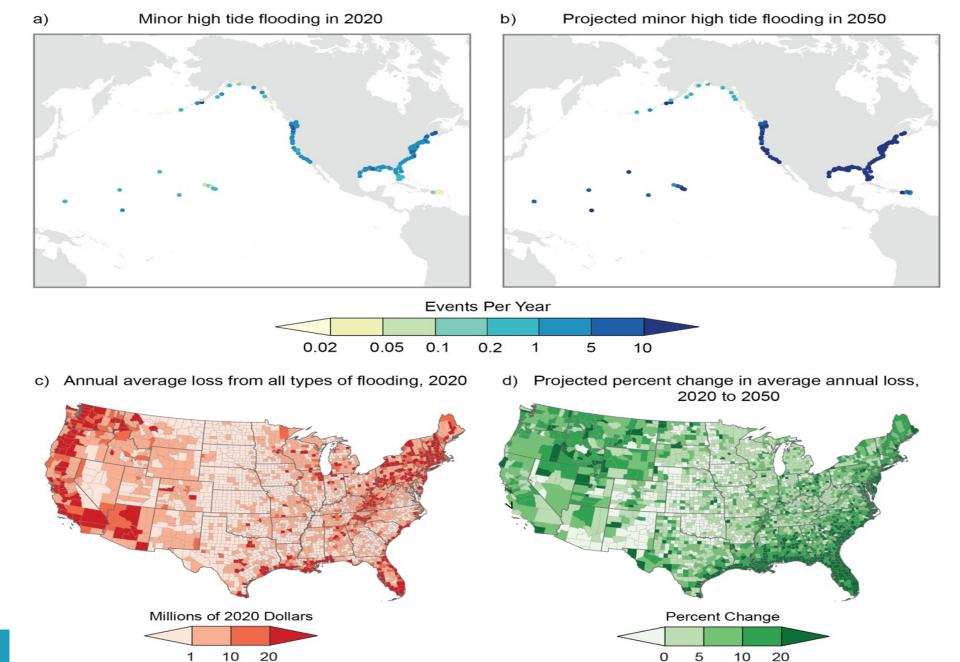
Projected Increases in Average Annual Losses (AALs) from Floods by 2050



Percentage of Black residents in US Census tracts

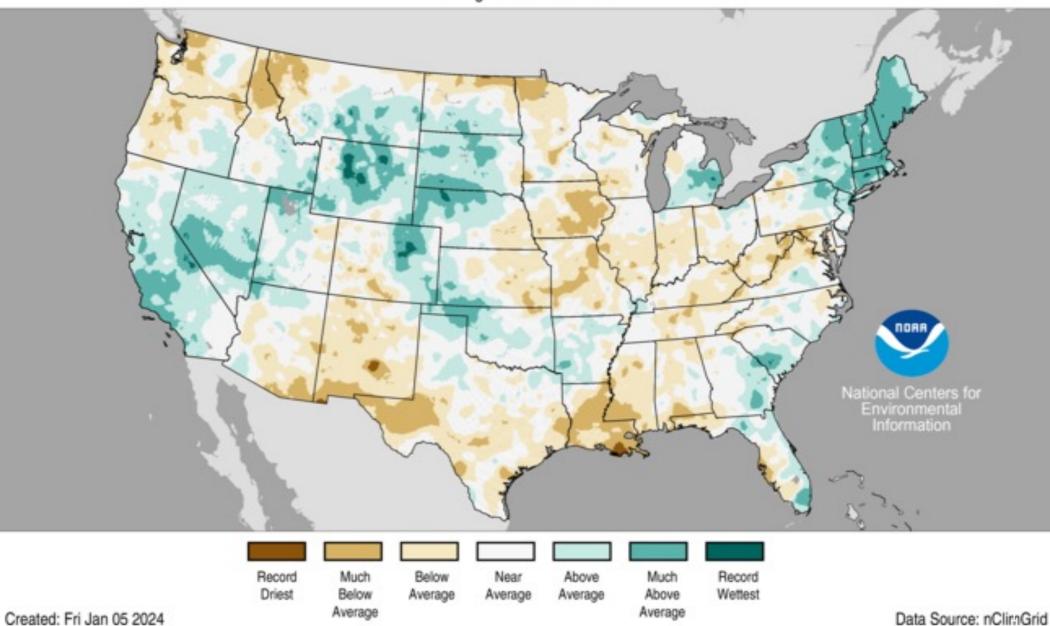
US Flooding Risks in 2020 and 2050





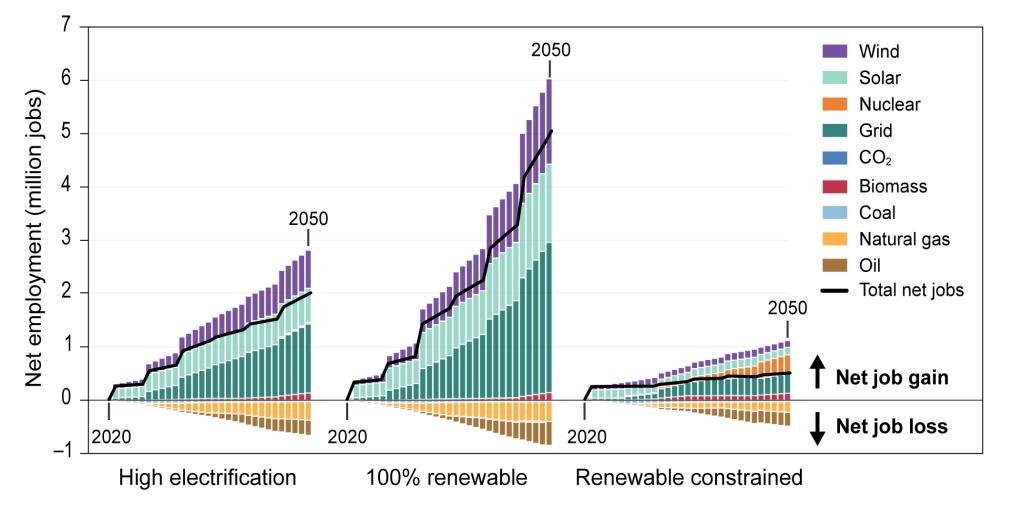
# Total Precipitation Percentiles January-December 2023

Ranking Period: 1895-2023



## Energy Employment (2020–2050) for Alternative Net-Zero Pathways

Figure 1.12. Employment gains in electrification and renewable energy industries are projected to far outpace Job losses in fossil fuel industries.

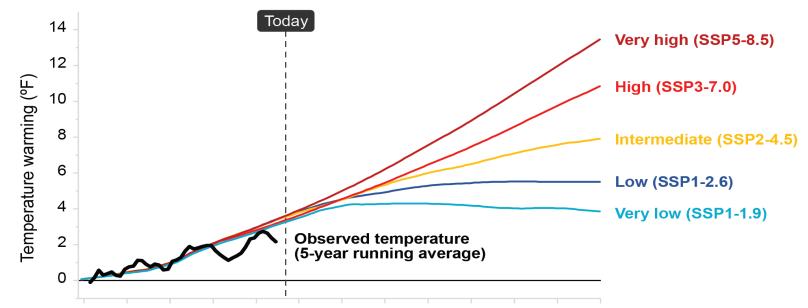


### Potential Warming Pathways in the United States

Figure 1.13. When or if the US reaches a particular level of warming depends on global greenhouse gas emissions from human activities.

### **Future Warming**

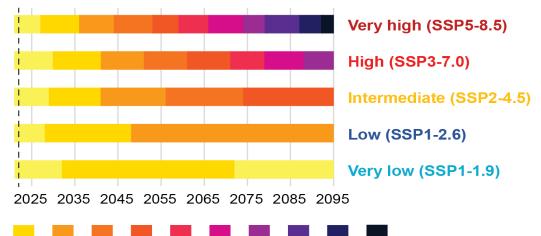
Future warming in the United States will depend on the total amount of global greenhouse gas emissions.



1975 1985 1995 2005 2015 2025 2035 2045 2055 2065 2075 2085 2095

### Crossing Times

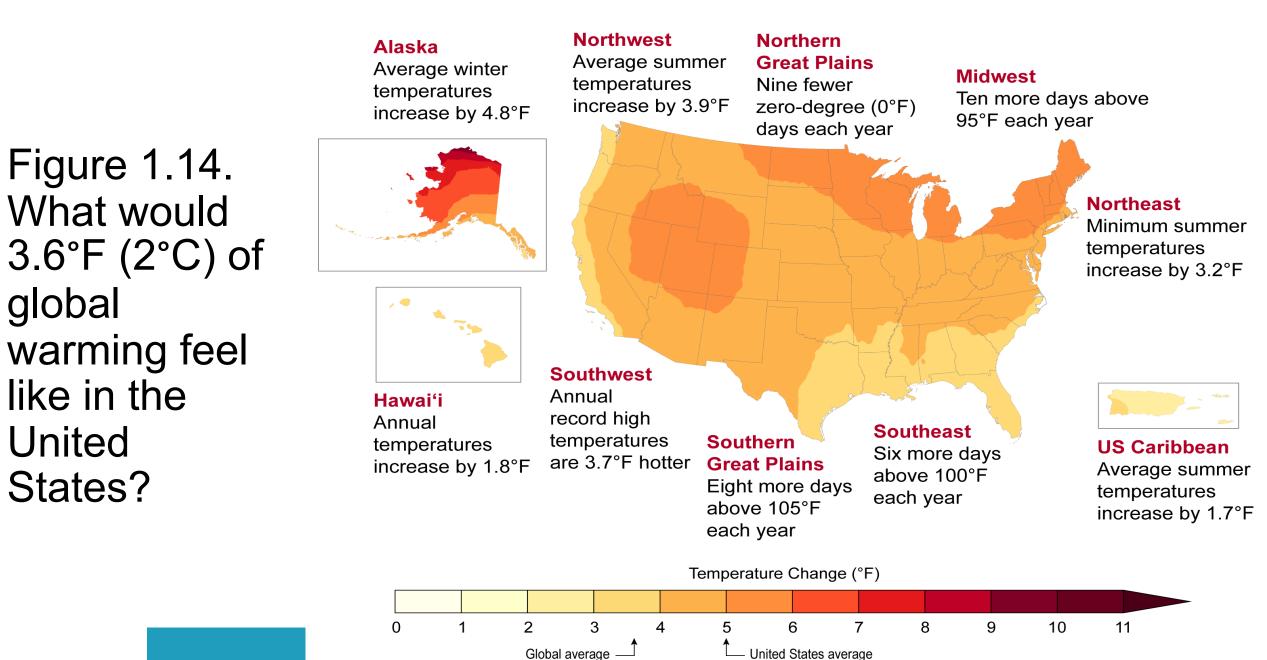
Whether–and when–a given temperature threshold is crossed depends on both the amount and rate of global greenhouse gas emissions.



10°F

11°F 12°F 13°F

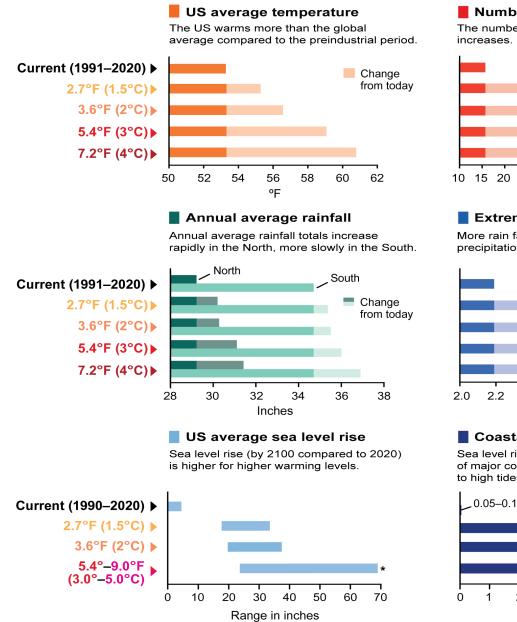
### Projected Changes at 3.6°F (2.0°C) of Global Warming



global

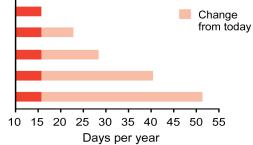
United

Figure 1.15. At higher lobal warming levels, the US will experience more severe climate impacts.



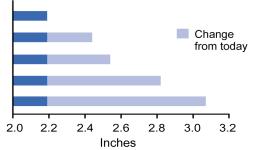
#### Number of days ≥ 95°F

The number of very hot days (95°F or hotter) increases.



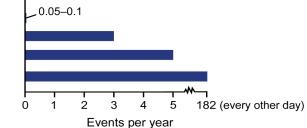
#### Extreme precipitation events

More rain falls during the most extreme precipitation events.



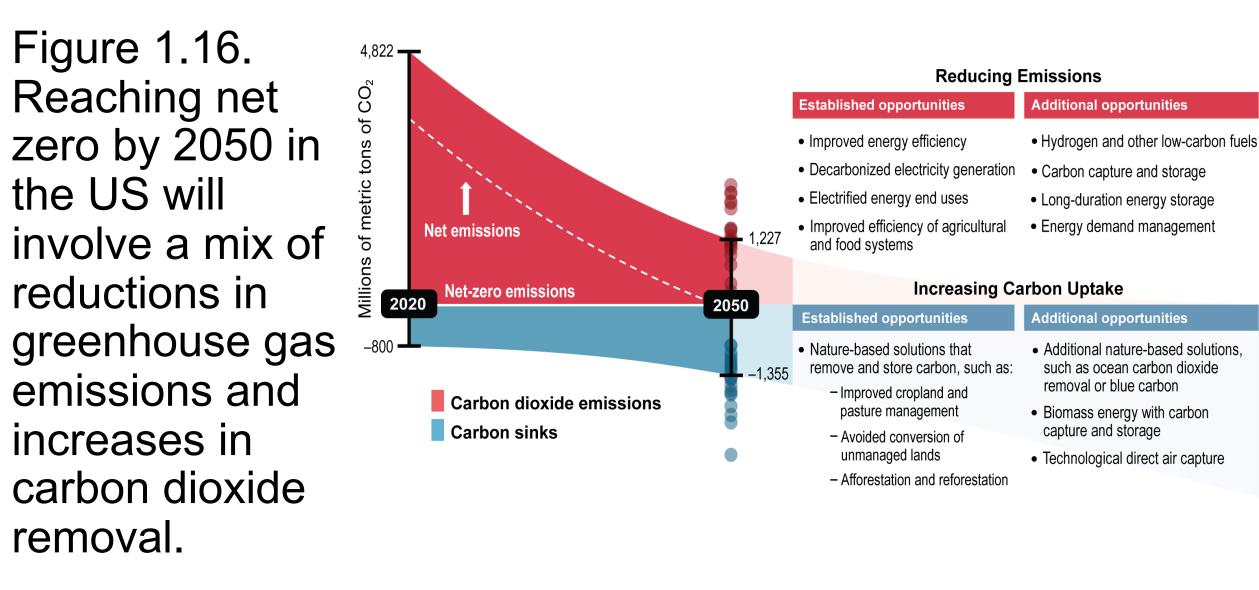
#### Coastal flooding events

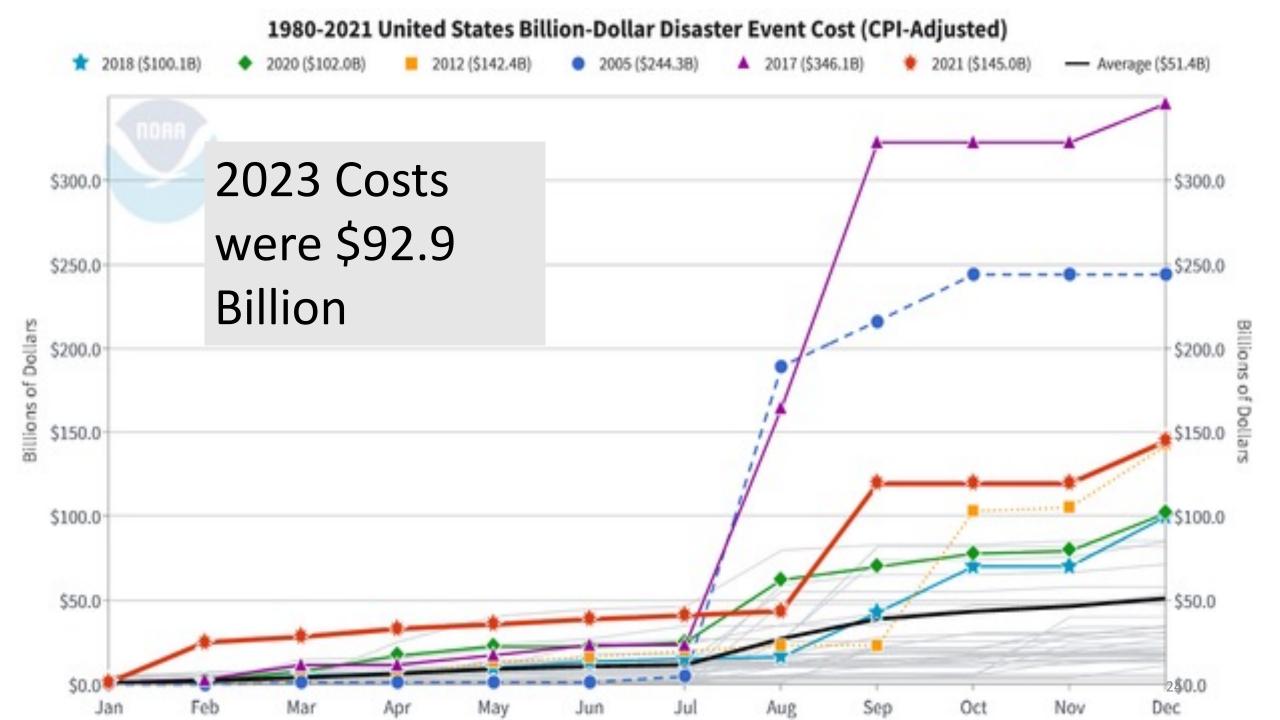
Sea level rise drives an increase in the number of major coastal flooding events per year due to high tides alone.



\*Rise at the upper end of this range cannot be ruled out due to the possibility of rapid ice sheet loss. The amount of warming required to trigger such loss is not currently known but is assessed to be above 3.6°F (2°C).

## Portfolio of Mitigation Options for Achieving Net Zero by 2050





# Global Costs of Climate Change

- The global cost of climate change damage is estimated to be between \$1.7 trillion and \$3.1 trillion per year by 2050.
- This includes the cost of damage to infrastructure, property, agriculture, and human health.
- This cost is expected to increase over time as the impacts of climate change become more severe.
- The poorest countries in the world are at greatest risk from the economic impacts of climate change.

# Climate Change is Here

- The changes required to our Built and Natural Environments over the next few decades will be a tremendous undertaking.
- Climate Change has already cost the USA over **\$2.5 trillion** and that will continue to increase each year.
- The total cost of U.S. billion-dollar disasters over the last seven years (2017-2023) was **\$900 billion.**
- Inaction will exceed the cost of action.
- Much can be done at a profit.

Figure 2 illustrates some representative climate change hazards and potential impacts on DoD missions around the world.

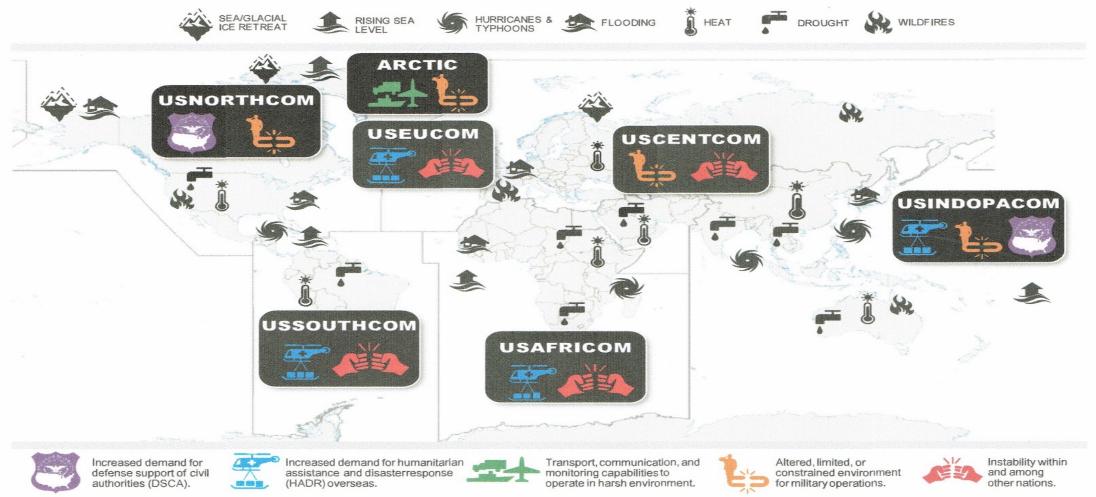


Figure 2. Selected regional hazards worsened by climate change (key to symbols on the top row above map) and identified security implications (key to symbols on the bottom row below the map). This map illustrates some of the key risks by region, but is not comprehensive of all risk.

# ADAPTATION VS. MITIGATION

# ADAPTATION

A variety of actions that are meant to reduce or compensate for or adapt to the adverse impacts that arise from changes in the Earth's climate

## MITIGATION

Actions or changes in societal behavior taken to reduce or eliminate greenhouse gas (GHG) emissions and/or to remove GHGs from the atmosphere to prevent significant adverse climate effects