NCA 5 The 5th National Climate Assessment in 15 Maps

The 5th National Climate Assessment in 15 Maps

The National Climate Assessment Interactive Atlas provides insight into future climate conditions in your neighborhood

Allison Crimmins, Director of the Fifth National Climate Assessment
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To help Americans anticipate how changing climate conditions might affect their families, homes, and livelihoods, the United States Global Change Research Program conducts a comprehensive assessment of scientific information on climate risks and responses in the United States known as the National Climate Assessment.

The Fifth National Climate Assessment, or NCA5, is accompanied by the NCA Atlas, which provides interactive, online access to the climate projections used in the Assessment. The NCA Atlas allows users to explore localized climate projections to inform resilience, adaptation, and mitigation efforts. This Story brings together these two resources, merging maps from the NCA Atlas with findings from NCA5.

(1) Devastation caused by Hurricane Ian in Florida (2) Hiker looks over valley filled with wildfire smoke (3) Road is destroyed from a landslide after heavy rains (4) Dangerous air quality in New York City from Canadian wildfires

The Choices We Face

Future climate change under a given scenario is often expressed in two ways: as a range of potential outcomes in a future year (e.g., impacts in 2050 under a given scenario) or the time at which a specific outcome is expected (e.g., when the world reaches a 2 °C

global warming level). The term “global warming level” is used to describe the level of global temperature increase relative to preindustrial temperatures conditions (the 1851–1900 average). A given global warming level is reached when global annual warming, defined by the average temperature over multiple decades, exceeds a specified level. For example, the Paris Agreement set a goal of holding the increase in global average temperature to “well below” 2 °C (3.6 °F) and pursuing efforts to limit the temperature increase to 1.5 °C (2.7 °F) above preindustrial levels. To achieve this goal, global carbon dioxide emissions would have to reach net zero by around 2050; global emissions of all greenhouse gases would then have to reach net zero within the following few decades.

The risk of exceeding a particular global warming level depends on future emissions. Since future emissions can change, these projections are conditional: when or if the world reaches a particular level of warming is largely dependent on human choices. NCA5 evaluates impacts under different scenarios and global warming levels to better understand the different risks our Nation faces based on the choices we make today.

> Many of the maps below refer to changes compared to *recent conditions*. That reference is calculated from a 1991-2020 baseline for each map topic.

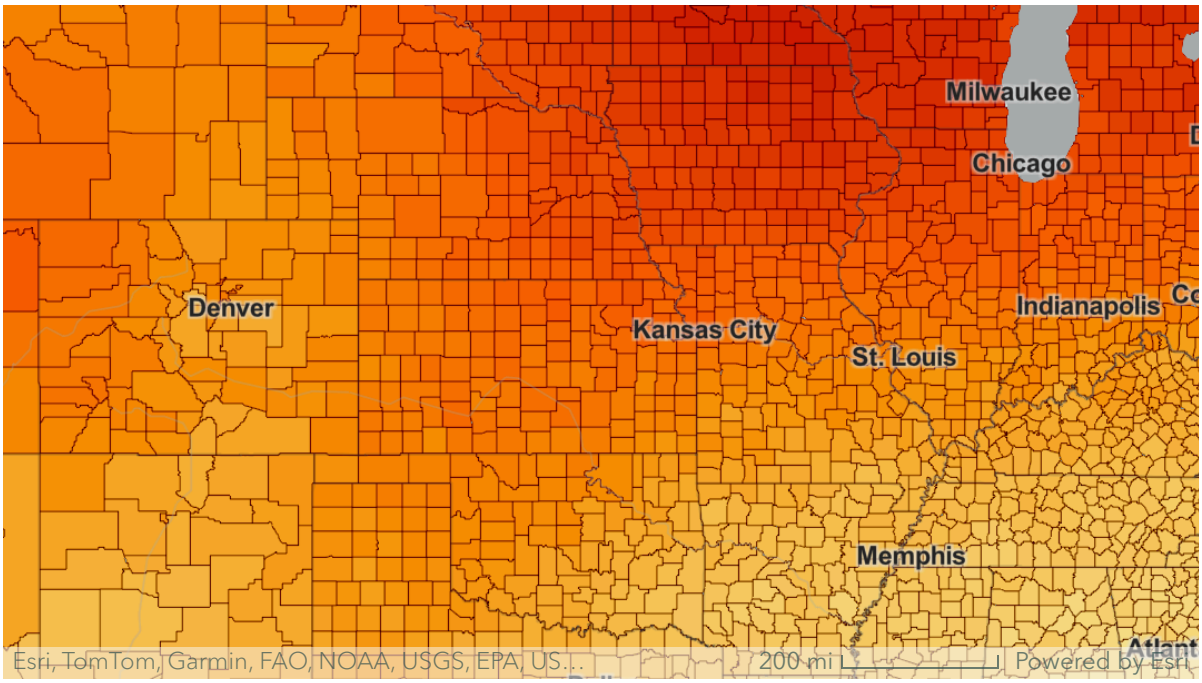
Exploring Projected Changes in Annual and Seasonal Temperature and Precipitation Patterns in the U.S.

Key Takeaway: The U.S. is Warming Faster than the Global Average

Since 1970, annual average temperature in the contiguous United States has risen by 2.5 °F and Alaska’s average temperature has risen

by 4.2 °F. During that same time, the average temperature for the entire globe rose 1.7 °F. For every additional 1 °C of global warming, the average U.S. temperature is projected to increase by around 2.5 °F (1.4 °C), with greater warming occurring in the northern and western parts of the country.

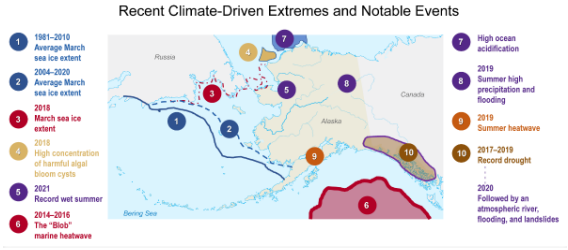
The map below shows how average annual temperatures are projected to change compared to recent conditions — the average measured from 1991 to 2020 — at a GWL of 2 °C (3.6 °F). Notice that many counties are projected to warm far more than the global average value.



Change in Average Annual Temperature

Key Takeaway: Alaska is Warming Two to Three Times Faster than the Global Average

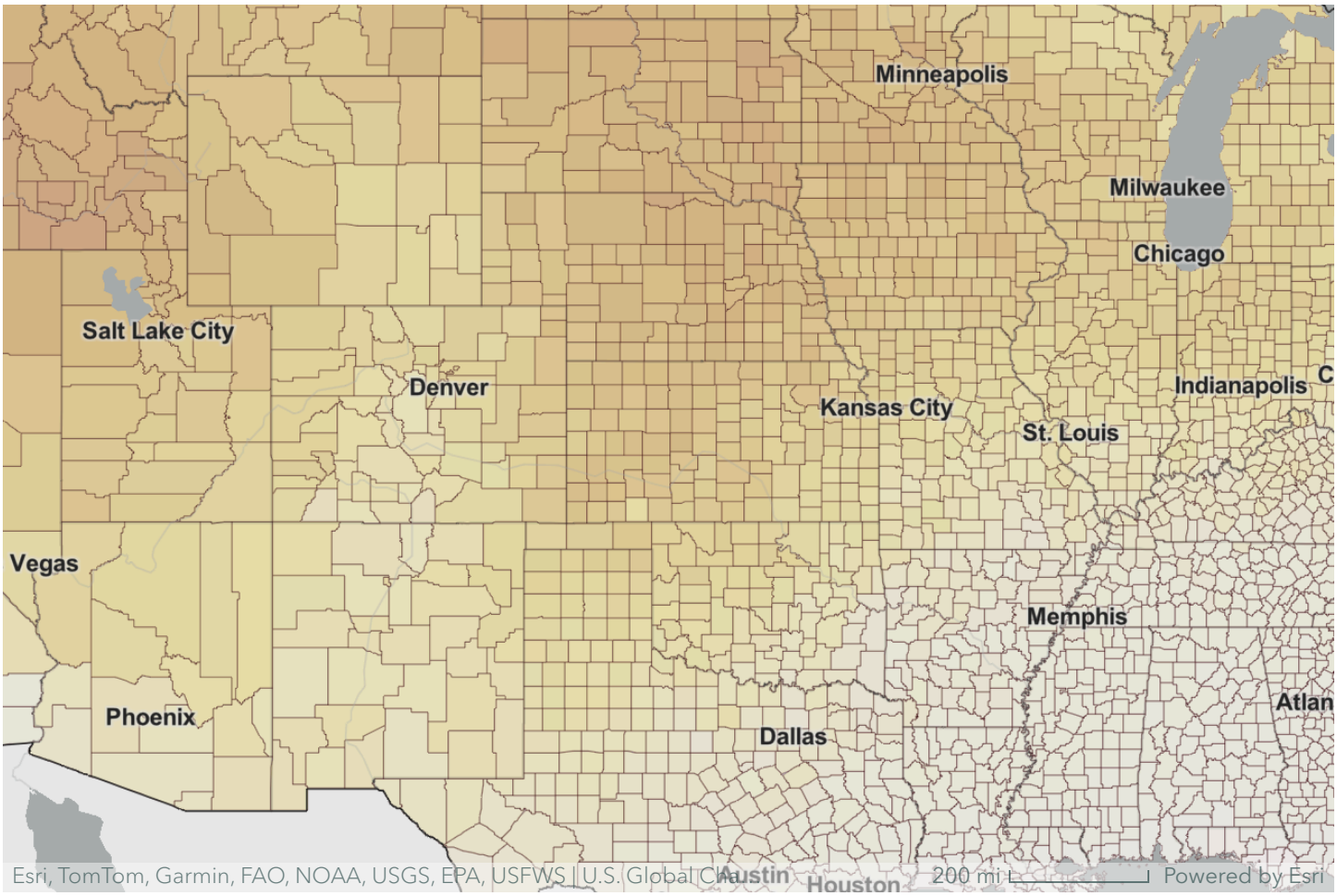
Climate-driven extremes and notable events have recently affected different regions of Alaska. These events have redefined expectations of regional extremes and challenged preparedness.



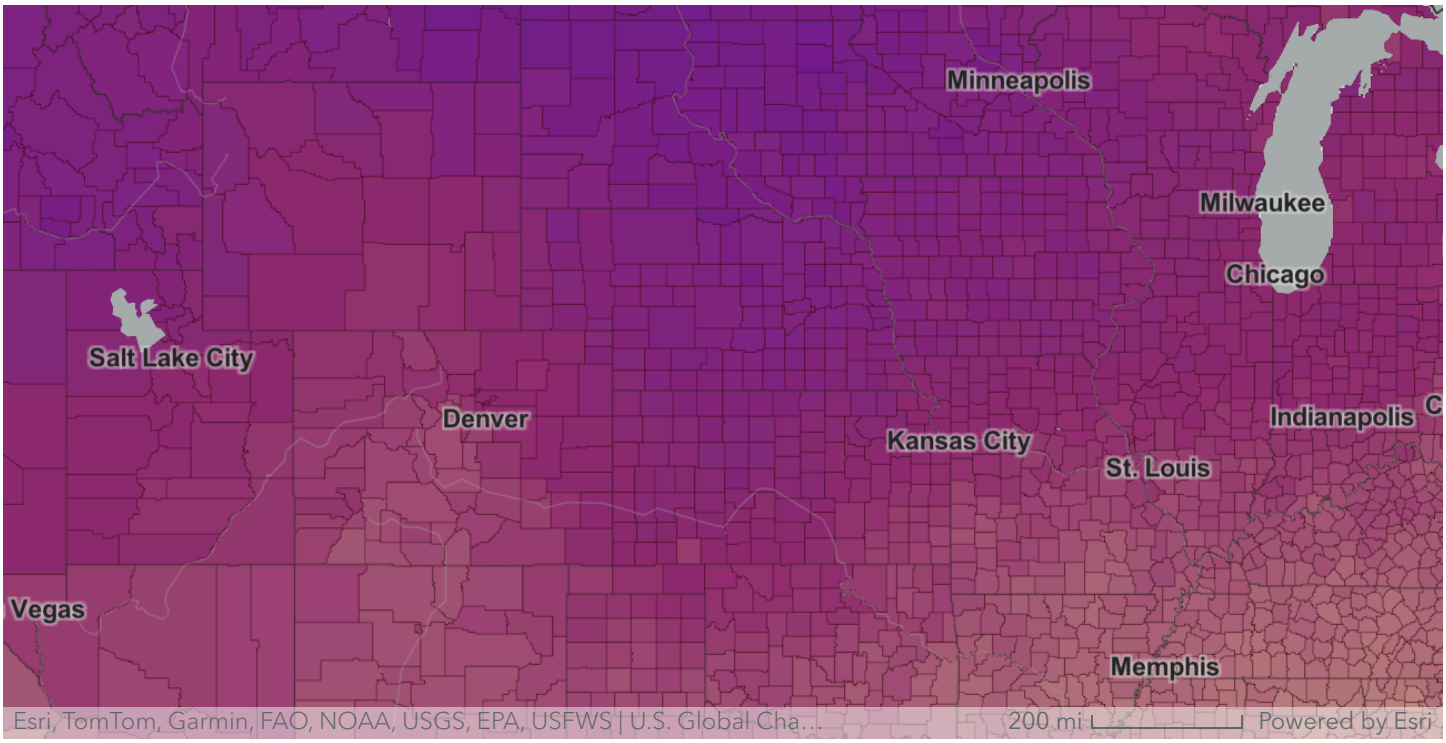
Climate-driven events across the Alaskan Region. Click image to expand.

Key Takeaway: Warming Varies Across Regions and Seasons

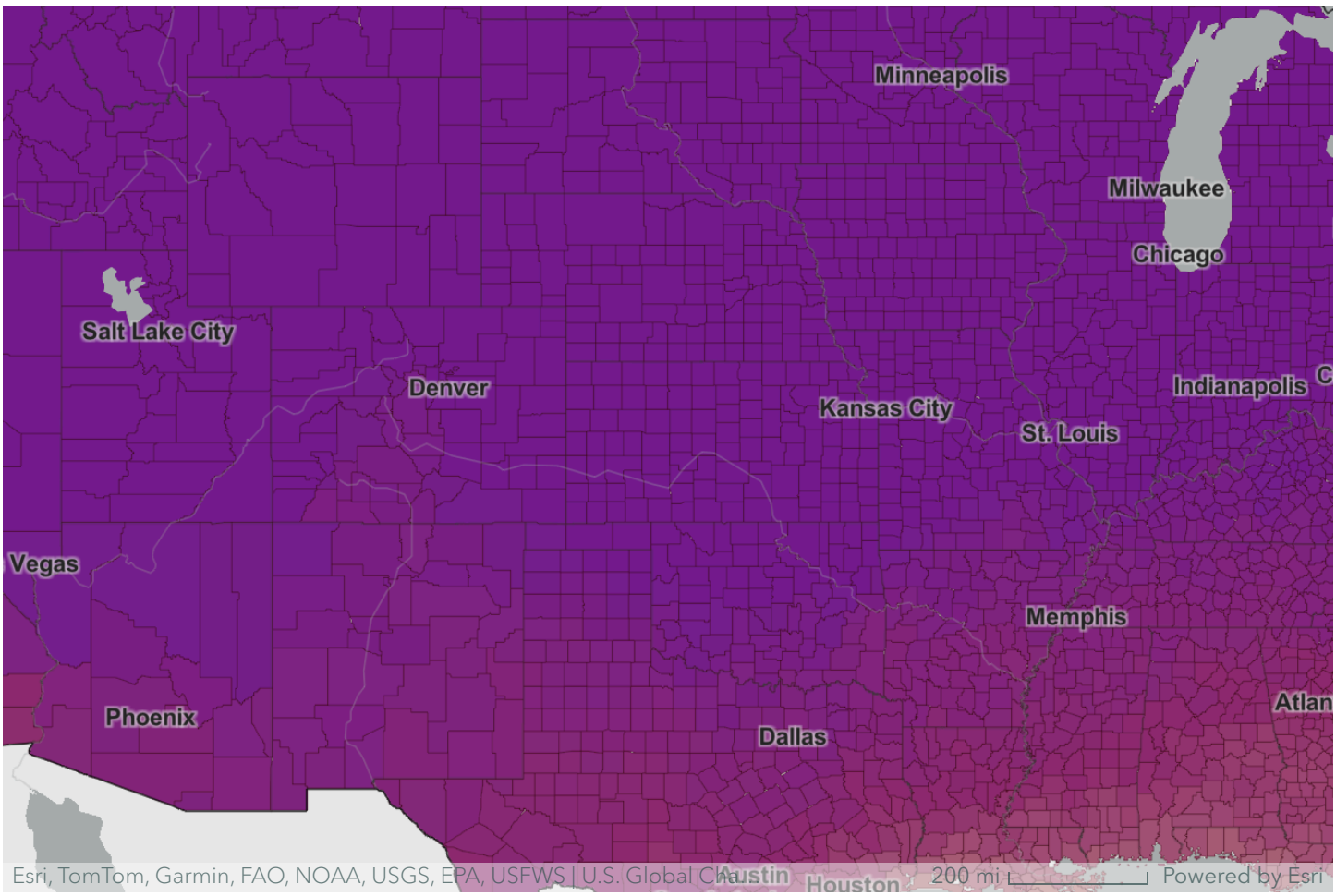
There are substantial seasonal and regional variations in temperature trends across the U.S. and its territories. Winter is warming nearly twice as fast as summer in many northern states (Figure 2.4). Annual average temperatures in some areas (including parts of the Southwest, upper Midwest, Alaska, and Northeast) are more than 2 °F warmer than they were in the first half of the 20th century, while parts of the Southeast have warmed less than 1 °F. These regional differences are most pronounced in the summer: seasonal temperatures in some regions east of the Rockies have decreased.



This map displays the change in mean summertime temperature compared to recent conditions at a GWL of 2 °C.



Notice the accelerated warming as we move from GWL 2 °C to GWL 3 °C. Many areas in the Northern Plains, such as North Dakota may see increases in seasonal average temperatures of 8-10 °F compared to recent conditions.

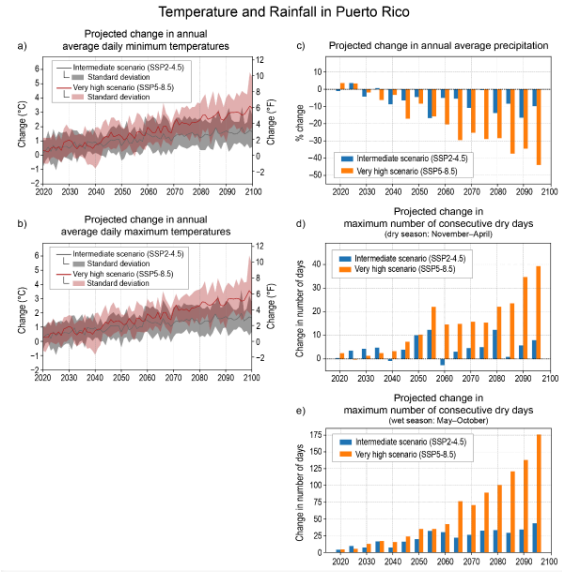


Lastly we can look at GWL 4 °C (7 °F), where much of the United States is experiencing significantly warmer summers.

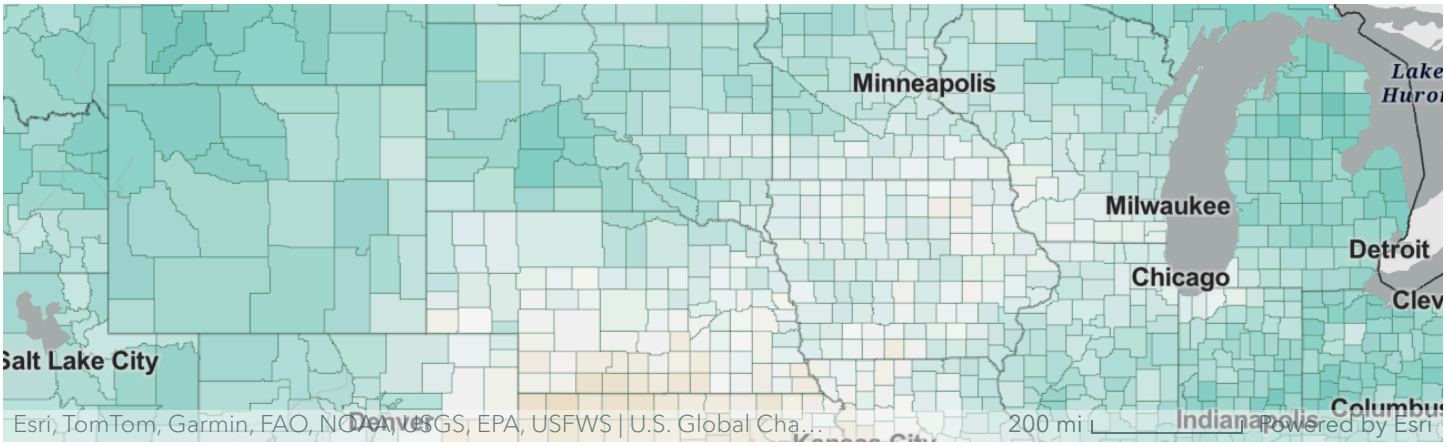
Changes in seasonal temperatures have led to shifts in the seasonality of certain events or processes, such as the blooming of wildflowers in spring. In some areas, the combination of high humidity and high temperatures is contributing to the emergence of heat index values too severe for human tolerance. These changes are not restricted to temperature. Significant changes are also projected for precipitation patterns.

Key Takeaway: Some Regions Will Get Wetter, While Others Will Get Drier

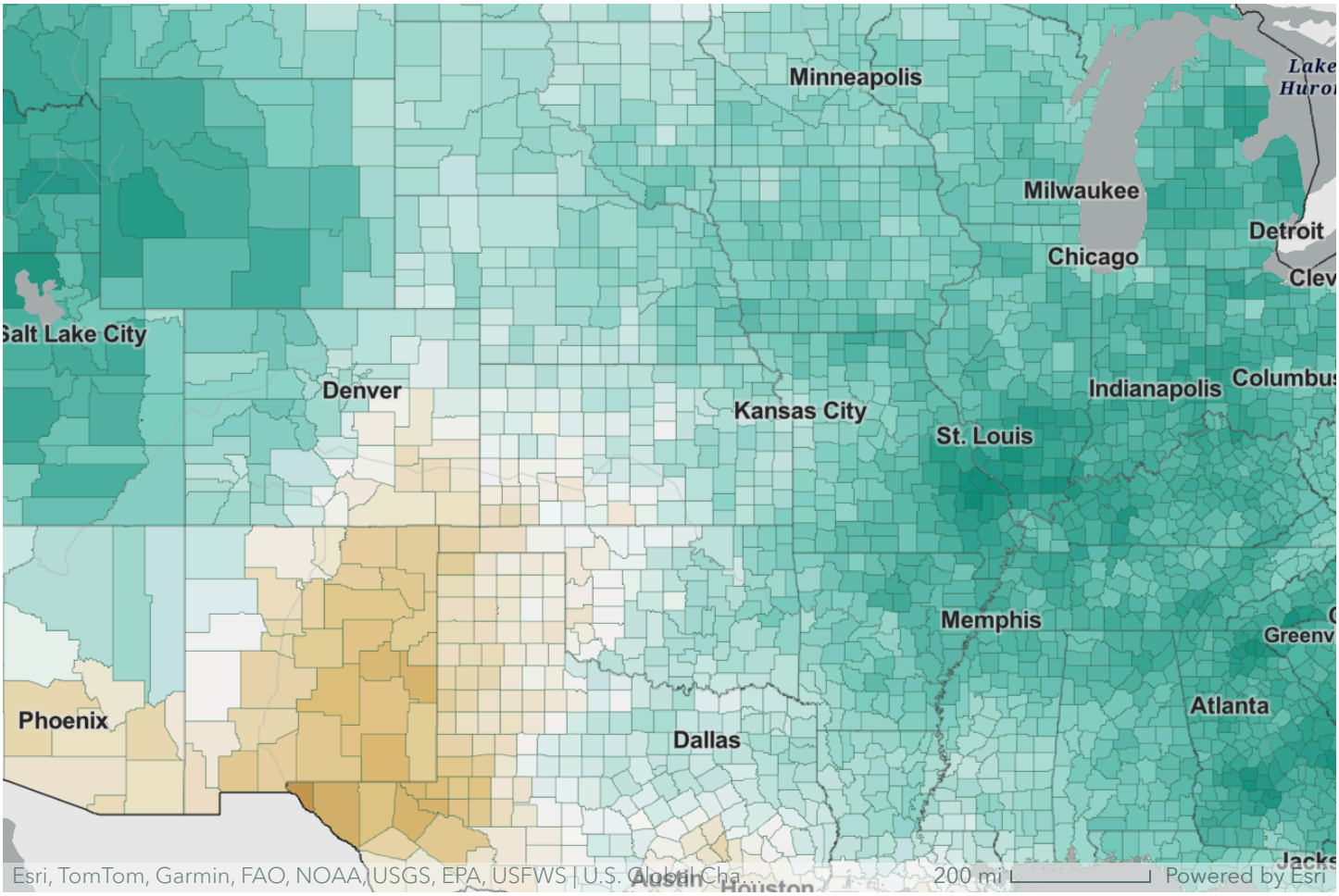
As global temperature rises, total precipitation is expected to increase in some regions, but decrease in others. Changes to the seasonal cycle of precipitation are also expected. For instance, in the Northwest, precipitation is expected to increase during winter and decrease in the summer. In a warmer world, less precipitation will fall as snow. This change will lead to large reductions in mountain snowpack and decreases in spring runoff in the mountain West.



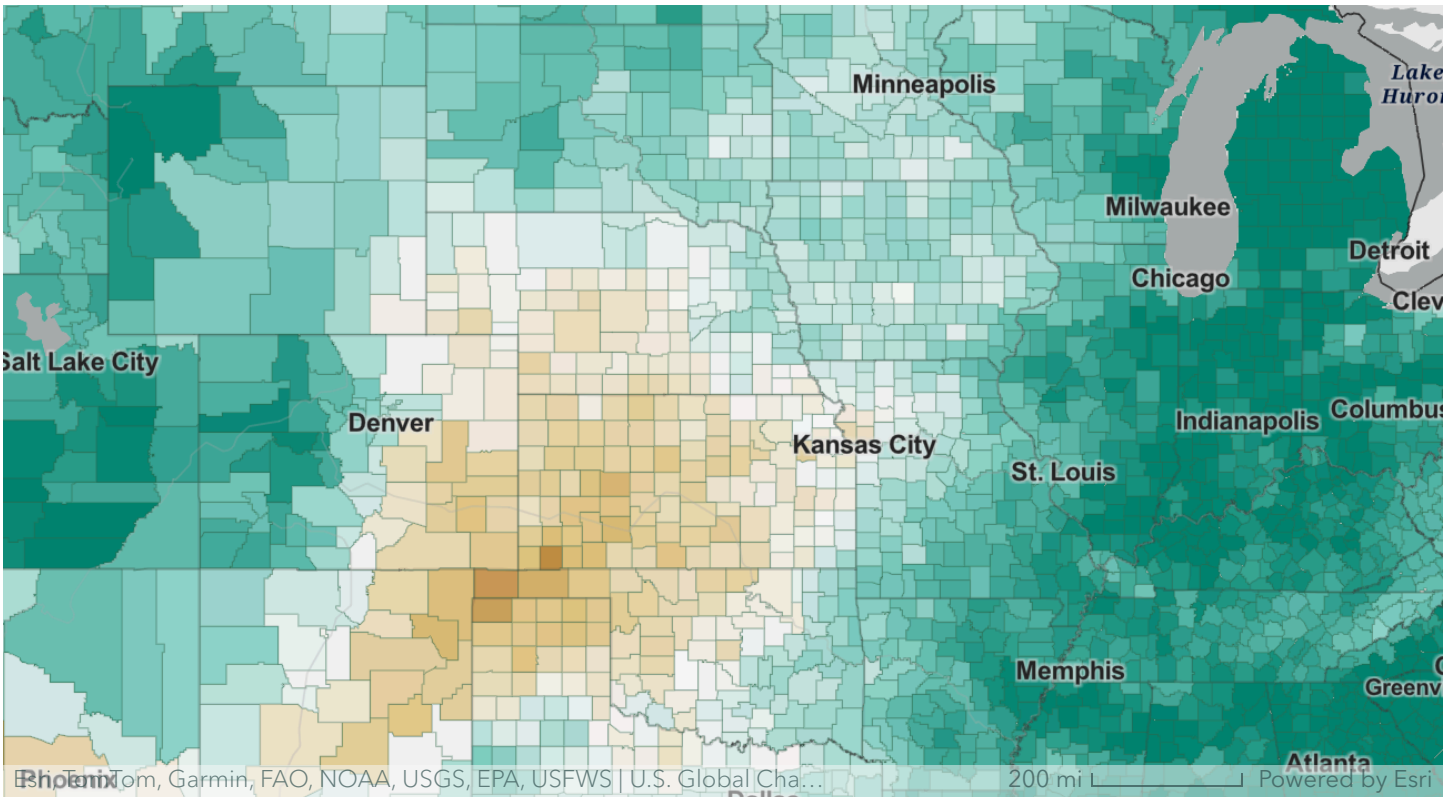
Puerto Rico is projected to become warmer and drier



At a Global Warming Level of 2 °C (3.6 °F), increased drying patterns in the Southwest, Southern Great Plains, and the U.S. Caribbean are beginning to emerge.



Those patterns are strengthened at 3 °C (5.4 °F), and precipitation totals begin to increase significantly across the Northeast, Southeast, Northwest, and Alaska.



By Global Warming Level 4 °C (7.2 °F), counties in the wetter areas are seeing a 15% increase in total average annual precipitation. The Southern Great Plains and U.S. Caribbean continue to dry.

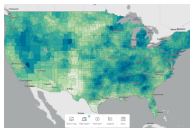
Changes to the water cycle pose risks to people and nature. For instance, freshwater availability is affected by the quantity of water in storage, the timing of water movement, how much water is used, and its quality. Changes in precipitation patterns affect soil moisture and runoff as well as floods and droughts. As you'll see below, changes in the intensity of precipitation patterns can lead to increases in extreme events.

Exploring Changes in Extreme Temperature and Precipitation in the U.S.

The maps above have demonstrated the impact of global warming on average annual or season temperature and precipitation. Let's examine some of the other maps available in the NCA Atlas that demonstrate changes in extreme thresholds of temperature and

precipitation. Use the Atlas Explorer application to see the full set of GWLs for each map topic.

NCA Interactive Atlas Explorer



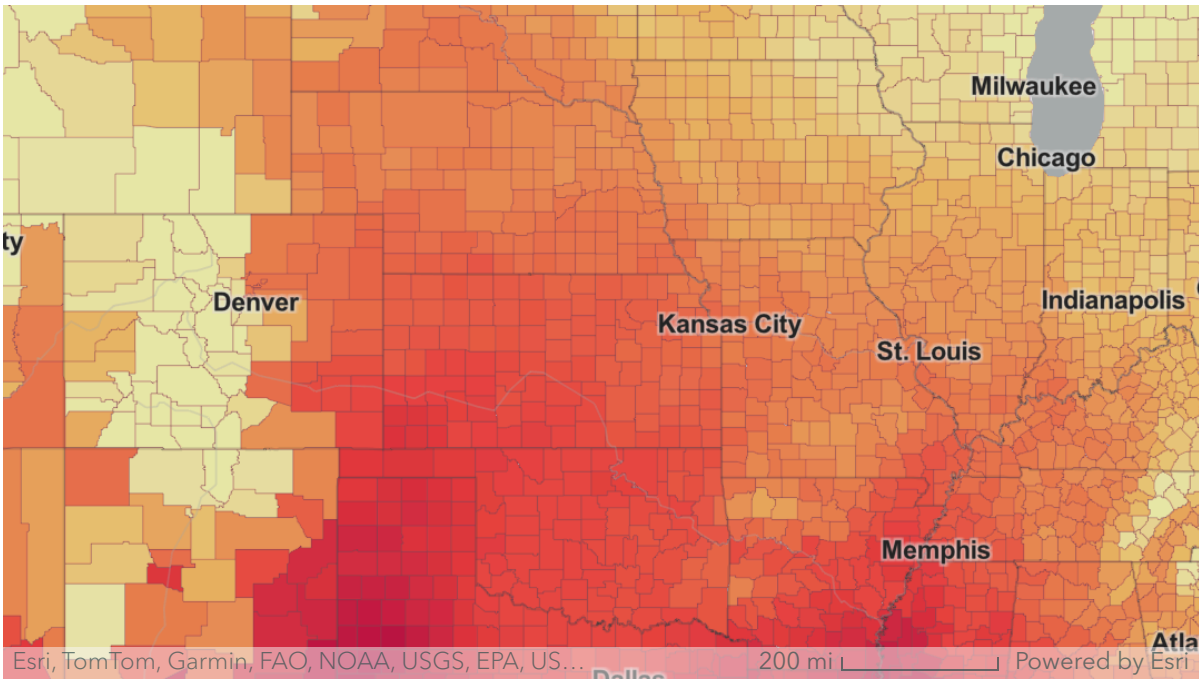
Explore a collection of maps from the NCA5 along with other contextual layers.

https://atlas.globalchange.gov/#explore

Key Takeaway: The Risk of Extreme Heat Increases with Each Global Warming Level

In recent decades, heatwaves have become more frequent, particularly in the western United States. Across 50 large U.S. cities, the average number of heatwaves has doubled since the 1980s. Several major heatwaves have affected the U.S. since 2018, including a record-shattering event in the Pacific Northwest in 2021.

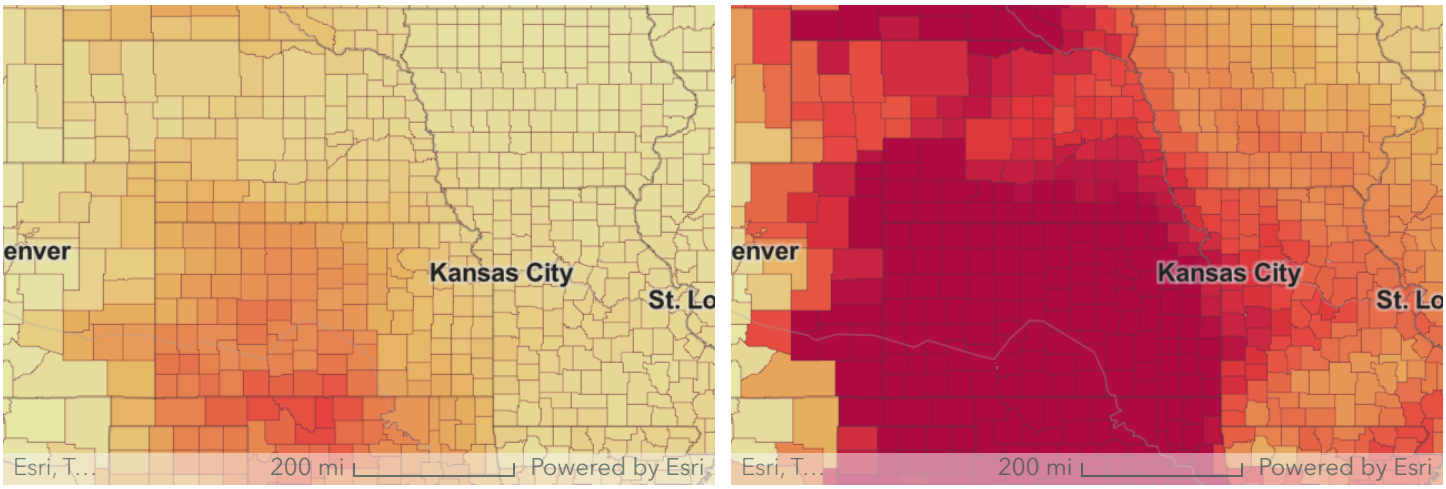
The map below shows projected changes in the number of days at or above 95 °F at a global warming level of 2 °C. In addition to changes in the number of hot days, multiday heatwaves are very likely to last longer, affect a larger spatial extent, and become more severe, exposing more people and infrastructure simultaneously and for longer periods. The length of the heatwave season in the U.S. has increased from 40 days in the 1980s to 70 days.



Change in the Number of Days Over 95 °F

Extreme heat threatens human health. Higher temperatures are associated with adverse pregnancy and birth outcomes, mental health impacts, and increased emergency room visits and hospitalizations related to cardiovascular disease, diabetes, electrolyte imbalance, renal failure, and respiratory outcomes. Heat-related health impacts are greatest among children, adults over age 65, those with disabilities, people with mental health or substance-use disorders; and those who are pregnant, lack access to cooling, or engage in outdoor labor and activities.

People who regularly struggle to afford energy bills — such as rural, low-income, and older fixed-income households and communities of color — are especially vulnerable to more intense extreme heat events and associated health risks, particularly if they live in homes with poor insulation and inefficient cooling systems. For example, Black Americans are more likely to live in older, less energy efficient homes and face disproportionate heat-related health risks from extreme heat.



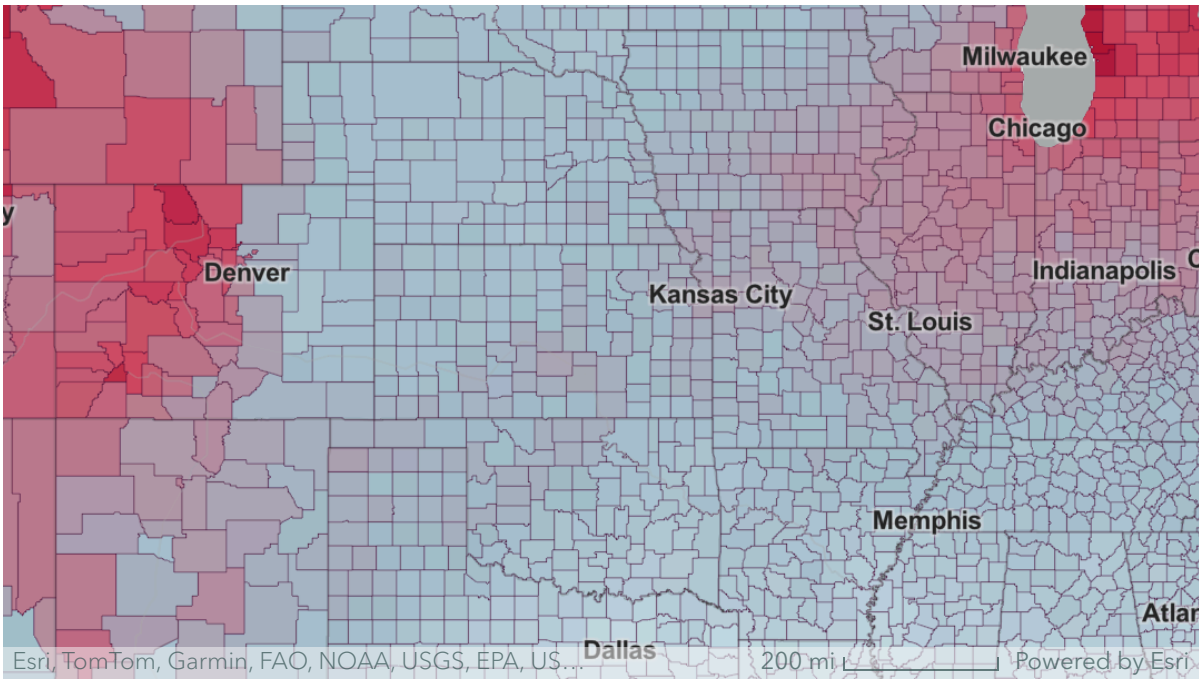
Swipe to compare the number of days per year where temperatures are greater than 105 °F using a GWL 2 °C (left) and GWL 4 °C (right)

In addition to health threats, extreme temperatures can impact ecosystems and our built environment. For instance, days where temperatures exceed 105 °F can cause significant structural failure to roads and railroads. Exposure to these extremes is only exacerbated by the fact that many infrastructure systems across the country are at the end of their intended useful life and already requiring repair or replacement. The maps above show projected changes in the number of days at or above 105 °F at global warming levels of 2 °C and 4 °C.

Key Takeaway: Cold Days and Nights are Decreasing

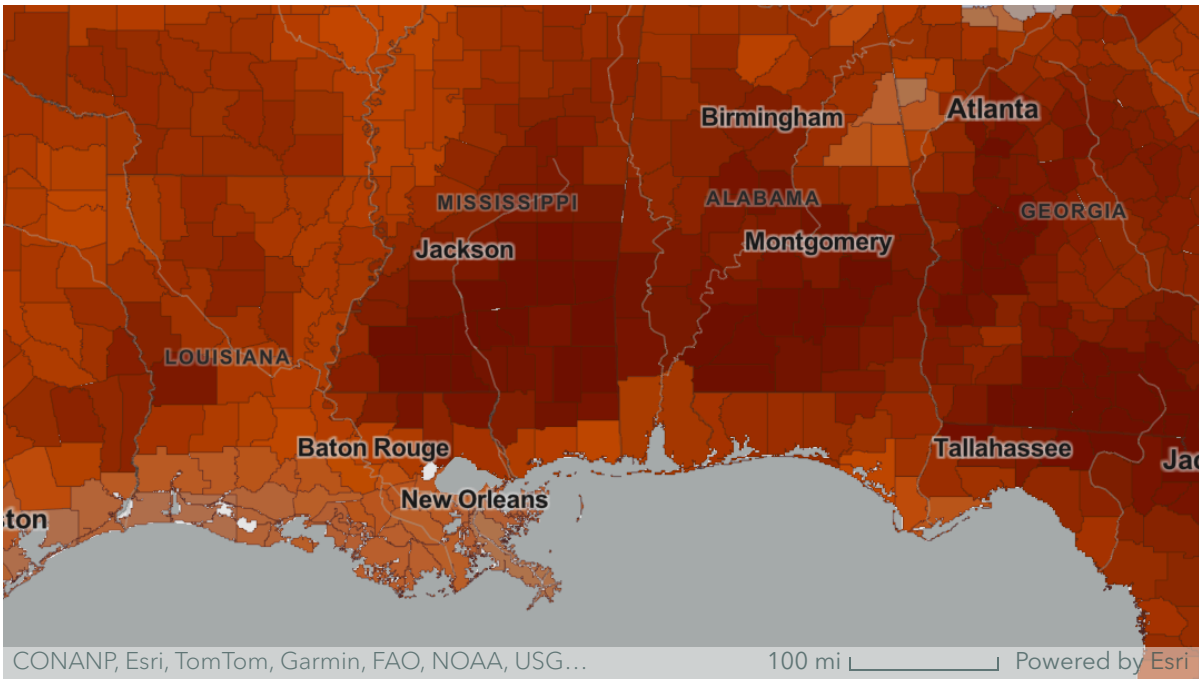
Stands of spruce trees killed by beetles in Alaska

By contrast, the number of cold days is projected to decrease. Under a future with global warming of 2 °C, much of the northeastern and western U.S. may see a week to a month fewer days below 32 °F compared to recent conditions. This decrease in freezing days will impact recreation economies, such as skiing. Extended periods with below freezing temperatures are also critical for keeping certain pest species in check, such as the spruce bark beetle in Alaska, which has decimated forests as temperatures have warmed significantly across the state.



Change in the number of days with a maximum temperature under 32 °F at GWL 2 °C

Nighttime temperatures have increased faster than daytime temperatures, and this trend is projected to continue at higher global warming levels. An increase in the frequency and intensity of warm nights can have significant impacts, as it means that human (and animal) bodies, crops, and infrastructure do not get a chance to cool down or recover overnight. The increase in warm nights projected under 2 °C of global warming is particularly concerning in the Southeast and Southern Great Plains, with some areas expected to see more than a month of additional warm nights (above 70 °F) per year.



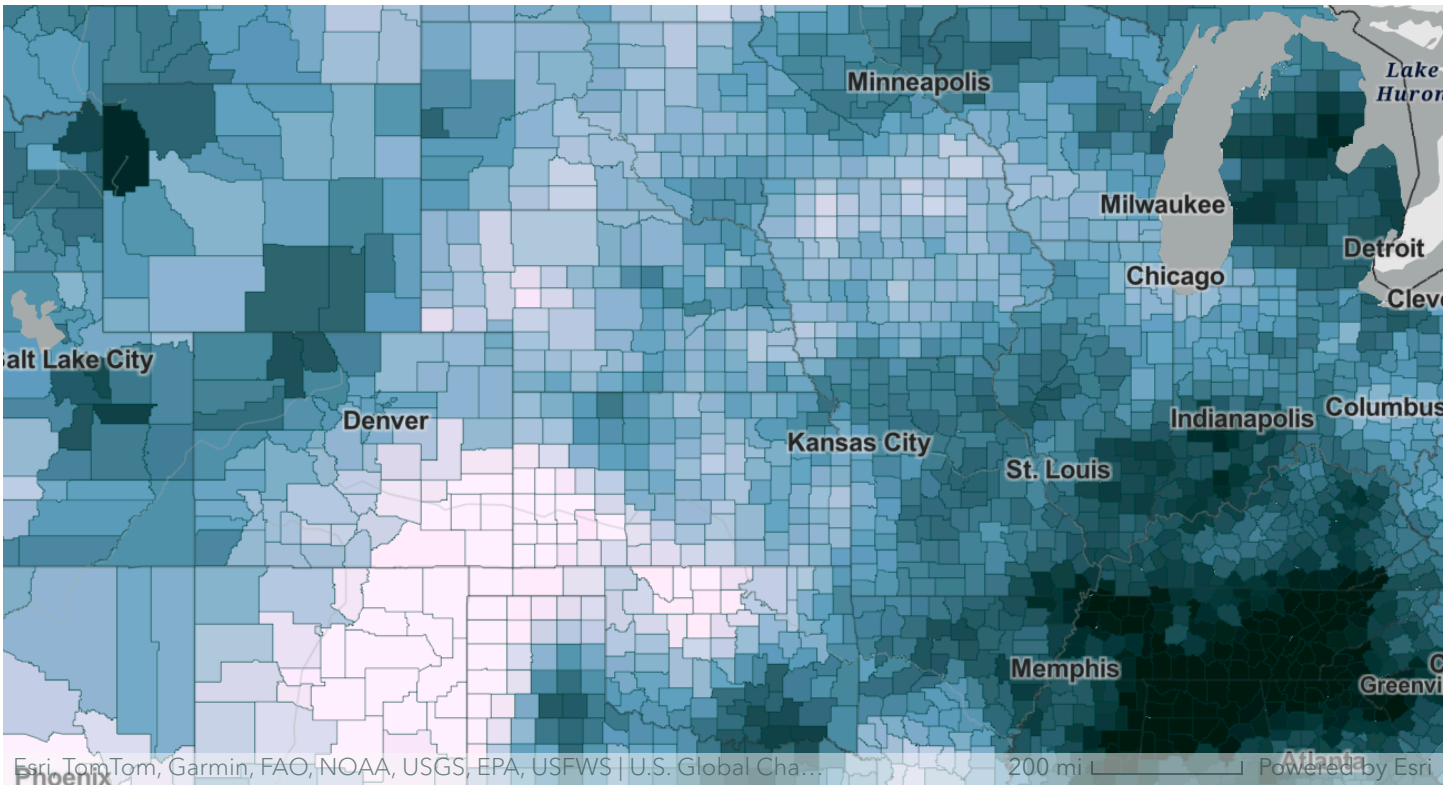
Change in the number of nights with temperatures over 70 °F

Key Takeaway: Rainfall Is Becoming More Extreme

Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous U.S. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity. The largest increase in the number of extreme precipitation days (defined as the top 1% of heaviest precipitation events) has occurred over the Northeast (an increase of around 60%) and Midwest (around 45%).

Houses flooded from extreme precipitation events

Recent increases in the frequency, severity, and amount of extreme precipitation are expected to continue across the U.S. even under lower global warming levels.

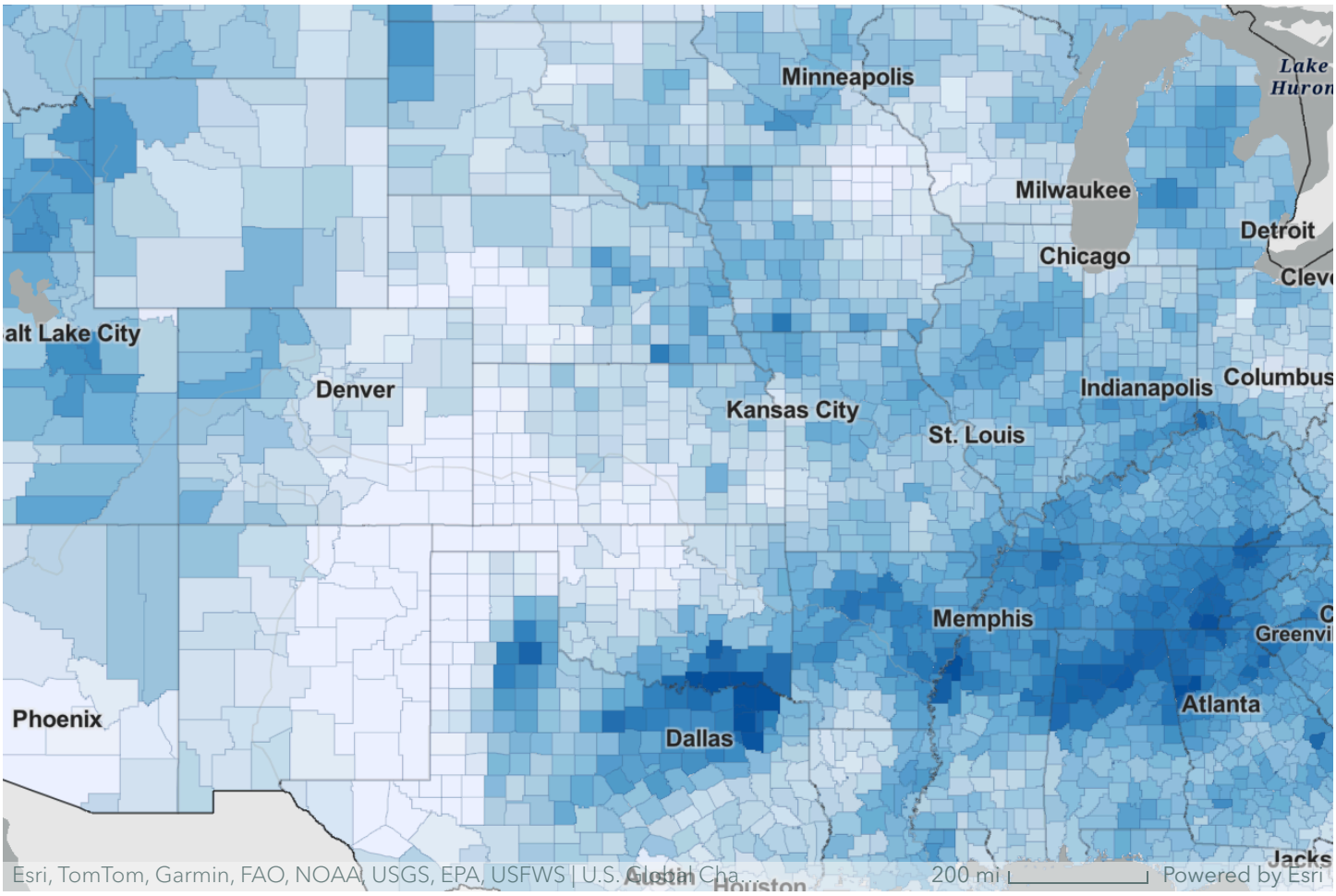


Map: Changes in Extreme Precipitation Amounts

At GWL 2 °C, the **amount of rain** expected to fall on days with extreme precipitation amounts (top 1% annually) continues to increase in the Northeast, across the upper Midwest, and in Alaska, and expands into Hawai'i and Appalachia as well.

Map: Change in the Wettest Day in 5-Years

Extreme precipitation–producing weather systems ranging from tropical cyclones to atmospheric rivers are very likely to produce heavier precipitation at higher global warming levels. At GWL 2 °C, there are upwards of 20% increases in the **amount of rain on the wettest day** over a 5-year period.



Map: Change in the Number of Days with Extreme Precipitation

Not only does the amount of extreme precipitation increase, but the **number of days with extreme precipitation** events also increases. At GWL 2 °C, there are counties, especially concentrated across the Southeast, that may experience a 45% increase in the number of days with extreme precipitation events.

How We Create a More Resilient and Just Nation

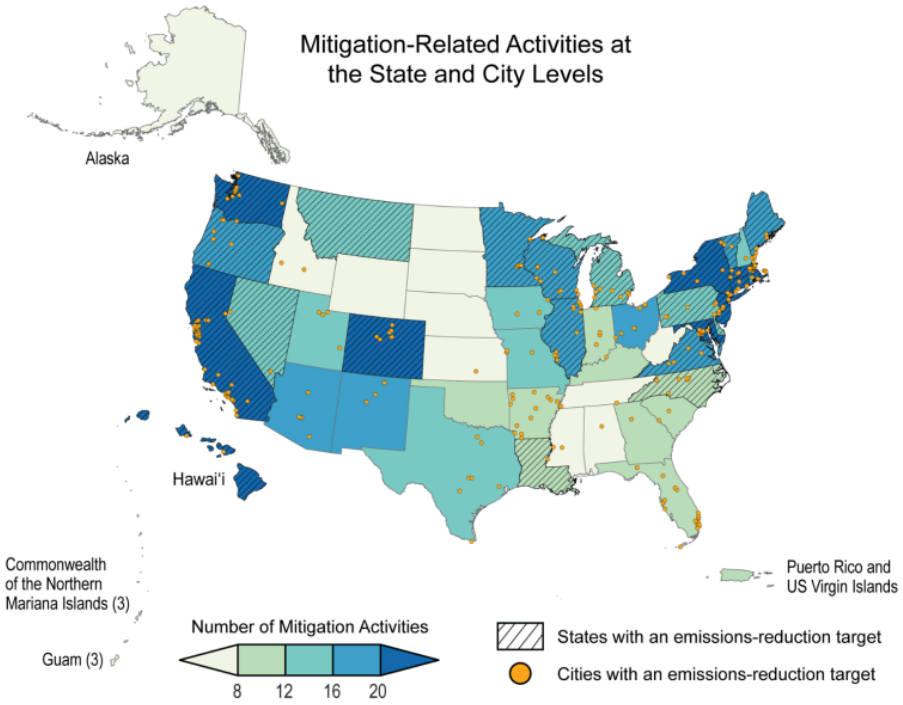
> ***Mitigation***: *Measures to reduce the amount and rate of future climate change by reducing emissions of heat-trapping gases (primarily carbon dioxide) or removing greenhouse gases from the atmosphere.*

> ***Adaptation***: *The process of adjusting to an actual or expected environmental change and its effects in a way that seeks to moderate harm or exploit beneficial opportunities.*

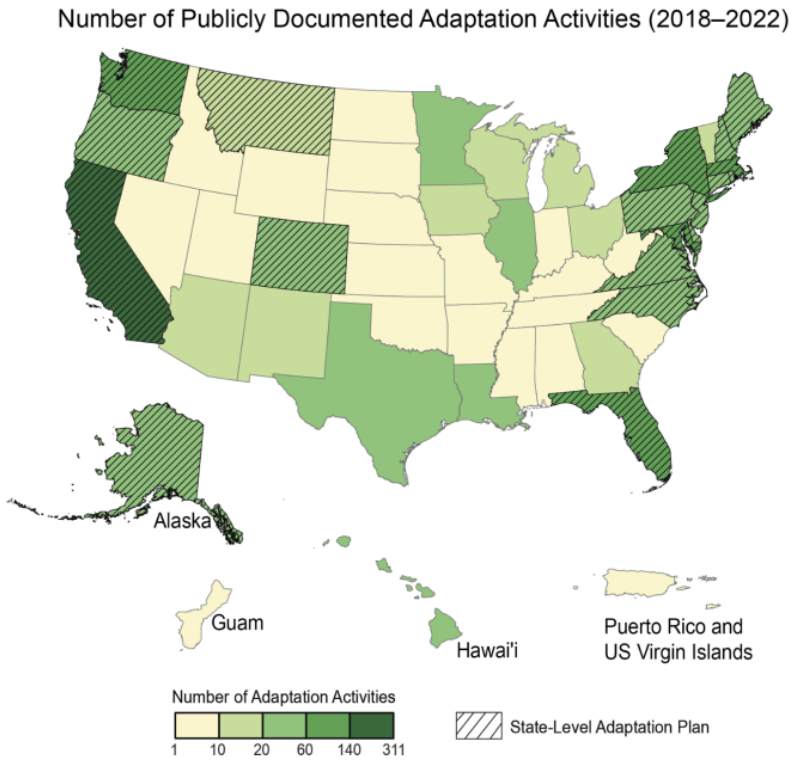
> ***Resilience***: *The ability to prepare for threats and hazards, adapt to changing conditions, and withstand and recover rapidly from adverse conditions and disruptions.*

Key Takeaway: Climate action has increased in every region of the U.S.

Efforts to adapt to climate change and reduce net greenhouse gas emissions are underway in every U.S. region and have expanded since 2018. Many actions can achieve both adaptation and mitigation goals.



As more people face more severe climate impacts, individuals, organizations, companies, communities, and governments are taking advantage of adaptation opportunities that reduce risks. State climate assessments and online climate services portals – like this Atlas – are providing communities with location- and sector-specific information on climate hazards to support adaptation planning and implementation across the country.



Key Takeaway: Limiting severe climate risks to the United States requires accelerated mitigation and adaptation efforts

Future climate conditions depend on choices we all make today. We have cost-effective ways to make large cuts in greenhouse gas emissions with technologies that are available today. But if we want to avoid the worst impacts of climate change in the U.S., we need to explore additional mitigation options and implement more transformative adaptation measures.

Two volunteers help demonstrate and install solar panels in Highland Park, Michigan, in May 2021. Adopting energy storage with decentralized solutions, such as microgrids or off-grid systems, can promote energy equity in overburdened communities.

The good news is that actions taken now to accelerate emissions reductions and adapt to ongoing changes not only reduce risks to current and future generations, but can also result in a range of near-term benefits that outweigh the costs. Climate action has the potential to improve well-being, strengthen resilience, benefit the economy, and, in part, redress legacies of racism and injustice.

(1) Children play in fountains to cool down during hot summer days; (2) Rain gardens help decrease impervious surfaces and reduce urban flooding; (3) Students design clean energy turbines of the future; (4) Community gardens in urban neighborhoods create green spaces and promote equitable access to healthier food choices.

The NCA Interactive Atlas can serve as a spark, encouraging and empowering local communities to explore risks and plan for a more resilient future.

Other resources available for these communities include:

- The U.S. Climate Resilience Toolkit can help communities build equity as they work together to recognize their climate-related issues. Communities can find help to understand what's at risk and learn of strategies that can help them avoid disaster and thrive under new conditions.
- The Climate Mapping for Resilience and Adaptation (CMRA) portal can help climate champions document changing conditions,

recognize current and future climate hazards, and identify areas most in need of action to increase their climate resilience, leveraging geospatial tools and open data.

- And the developing Climate Resilience Information System—an ecosystem of people, computers, and climate and social data—will provide new ways to help people find the information they need at all stages of their efforts to build resilience.

Credits

This Story is a product of the National Climate Assessment Interactive Atlas - a collaboration between the U.S. Global Change Research Program, NOAA, the Cooperative Institute for Climate and Satellites, and Esri.

Map Cartography and Production	Dan Pisut, Emily Meriam, and LuAnn Dahlman