

# National parks bear the brunt of climate change

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Yosemite National Park. Credit: Patrick Gonzalez

Human-caused climate change has exposed U.S. national parks to conditions hotter and drier than the rest of the nation, says a new UC Berkeley and University of Wisconsin-Madison study that quantifies for

the first time the magnitude of climate change on all 417 parks in the system.

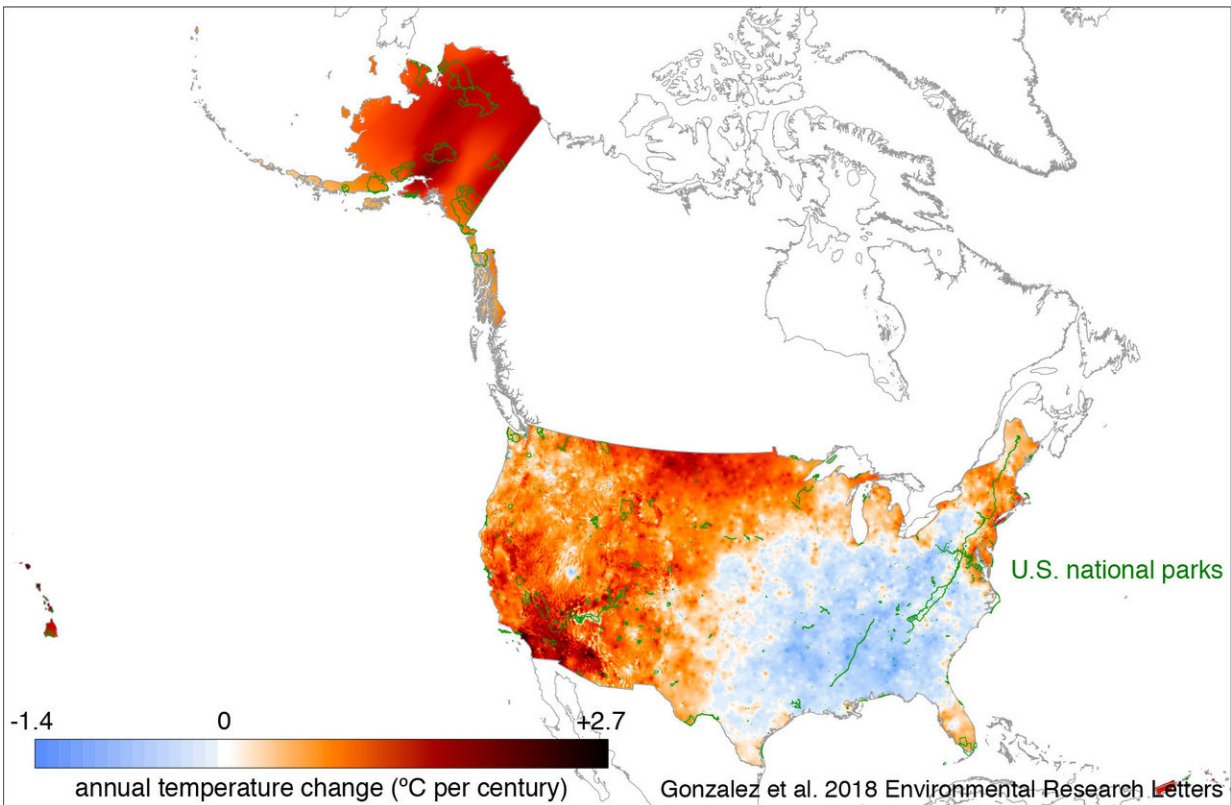
Without action to limit greenhouse gas emissions, many small mammals and plants may be brought to the brink of extinction by the end of the century, the study shows.

The analysis reveals that over the past century, average temperatures in national parks increased at twice the rate as the rest of the nation and yearly rainfall decreased more in national parks than in other regions of the country.

At the current rate of emissions, the team projects that temperatures in the most exposed national parks could soar by as much as 9 degrees Celsius or 16 degrees Fahrenheit by 2100. This rate of change is faster than many small mammals and plants can migrate or "disperse" to more hospitable climates.

"Human-caused climate change is already increasing the area burned by wildfires across the western U.S., melting glaciers in Glacier Bay National Park and shifting vegetation to higher elevations in Yosemite National Park," said Patrick Gonzalez, associate adjunct professor in the Department of Environmental Science, Policy and Management at UC Berkeley and a lead author for the Intergovernmental Panel on Climate Change (IPCC) report, a summary of the most up-to-date scientific knowledge of climate change.

"The good news is that, if we reduce our emissions from cars, power plants, deforestation, and other human activities and meet the Paris Agreement goal, we can keep the [temperature](#) increase in national parks to one-third of what it would be without any emissions reductions," Gonzalez said.



Using data from weather stations scattered throughout the U.S., climate researchers have created maps of the average annual temperature and rainfall totals at points approximately 800 meters apart over much of the United States. In this study, the team used these maps to calculate historical temperature and rainfall trends within the parks and over the U.S. as a whole. Credit: Patrick Gonzalez

The locations of these unique ecosystems are what make them particularly exposed to climate change, Gonzalez said. Many national parks are found in deserts, high mountains or in the Arctic region of Alaska, climates that are known to be the hardest hit by global warming.

"National parks aren't a random sample—they are remarkable places and

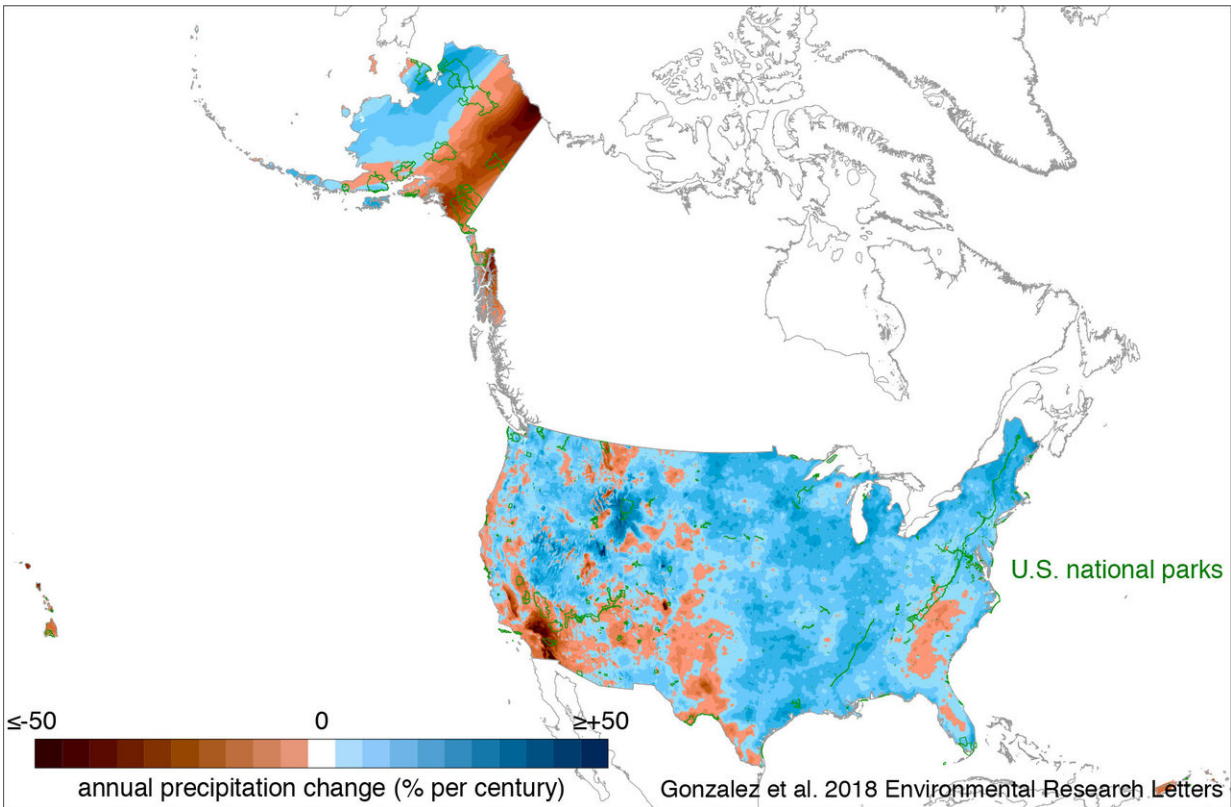
many happen to be in extreme environments," Gonzalez said. "Many are in places that are inherently more exposed to human-caused climate change."

The analysis, which includes all 50 U.S. states, the District of Columbia and four territories in the Caribbean and Pacific, appears Sept. 24 in the journal *Environmental Research Letters*.

## **Mitigation and Adaptation**

Weather stations scattered throughout the U.S. have been gathering monthly data on temperature and rainfall dating back to 1895. Using this data, climate researchers have created maps of the average annual temperature and rainfall totals at points approximately 800 meters over much of the United States.

In this study, the team used these maps to calculate historical temperature and rainfall trends within the parks and over the U.S. as a whole. They found that the temperature in national parks increased by a little over 1 degree Celsius from 1895 to 2010, roughly double the warming experienced by the rest of the country. Yearly rainfall totals decreased over 12 percent of national park land, compared to 3 percent of land in the United States. Alaska and its national parks saw the most dramatic increases in temperature, while rainfall decreased most in Hawaii.



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The team mapped projected future changes in temperature and precipitation for [climate models](#) representing each of four [climate change scenarios](#) developed by the IPCC. These four "storylines of the future," as scientists call them, include a scenario where no action has been taken to reduce emissions, one that is consistent with the Paris Agreement and two that are intermediate.

Under the most extreme climate change scenario, the average



temperature of all the national parks together is projected to increase between 5 and 7 degrees Celsius. Sticking to the Paris Agreement could limit this rise to between 1 and 3 degrees Celsius. Under both scenarios, temperature could increase most in Alaska and its national parks, while rainfall could decrease most in the Virgin Islands and the southwestern U.S.

To analyze future projections, the team also "downscaled" the climate models, making more detailed maps of future climate trends within the parks. Whereas the climate models themselves have coarse resolutions of approximately 100 to 400 kilometers, the downscaled data have resolutions of 100 to 800 meters over most of the country.

These maps can help park service employees plan for future vulnerabilities to climate change of endangered species and other park resources by developing measures to protect against wildfires and controlling invasive species.

"The park service is already integrating this [climate](#) change information into their planning and resource management," said Fuyao Wang, a research associate at the University of Wisconsin-Madison.

"It is important to note that even if we really do a strong mitigation of greenhouse gases, the [national park](#) system is still expected to see a 2 degree temperature change," said John Williams, a professor of geography at the University of Wisconsin-Madison. "At this point, it is likely that the glaciers in Glacier National park will ultimately disappear, and what is Glacier National [park](#) if it doesn't have glaciers anymore? So I think this adds weight to the importance of reducing our future levels of [climate change](#) and also extends the National Park Service mission to both adapt to these changes and educate all of us about these changes."

Provided by University of California - Berkeley

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