Future summers could be hotter than any on record

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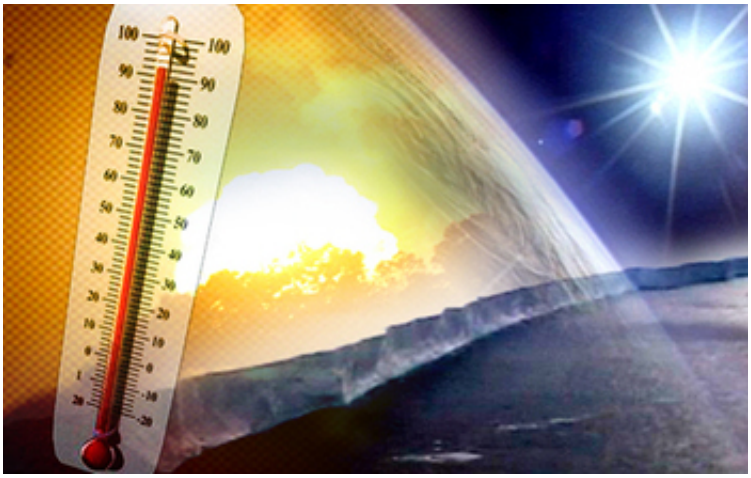


Heat waves affect energy use, farming and other aspects of society. Credit: NASA

This is part 17 in a series on NSF's geosciences risk and resilience interest area. Please see parts one, two, three, four, five, six, seven, eight, nine, 10, 11, 12, 13, 14, 15 and 16.

In 50 years, summers across most of the globe could be hotter than any summer experienced by people to date, according to a study by scientists at the National Center for Atmospheric Research (NCAR) in Boulder, Colo.

If climate change continues on its current trajectory, the probability that

summers between 2061 and 2080 will be warmer than the hottest on record stands at 80 percent across the world's land areas, excluding Antarctica, which was not studied.

If greenhouse gas emissions are reduced, however, that probability drops to 41 percent.

"Extremely hot summers always pose a challenge to society," said NCAR scientist Flavio Lehner, lead author of the study. "They can increase the risk for health issues, and can also damage crops and deepen droughts. Such summers are a true test of our adaptability to rising temperatures."

The study is part of an upcoming special issue of the journal *Climatic Change* that will focus on quantifying the benefits of reducing greenhouse gas emissions. The research was funded by the U.S. National Science Foundation (NSF) and the Swiss National Science Foundation.

Simulating a range of summers

The research team, which includes NCAR scientists Clara Deser and Benjamin Sanderson, used two existing sets of model simulations to investigate what future summers might look like.

How hot will future summers be? According to new research, a lot hotter than in the past. Credit: NSF Central Arizona-Phoenix LTER Site

They created both by running the NCAR-based Community Earth System Model 15 times, with one simulation assuming that greenhouse gas emissions remain unabated and the other assuming that society reduces emissions.

NSF and the U.S. Department of Energy fund the Community Earth System Model. The team ran the simulations on the NCAR-Wyoming Supercomputing Center's Yellowstone system.

"We've thought of climate change as 'global warming,' but it's important to understand how this overall warming affects conditions that hit people locally," said Eric DeWeaver, program director in NSF's Division of Atmospheric and Geospace Sciences, which funds NCAR.

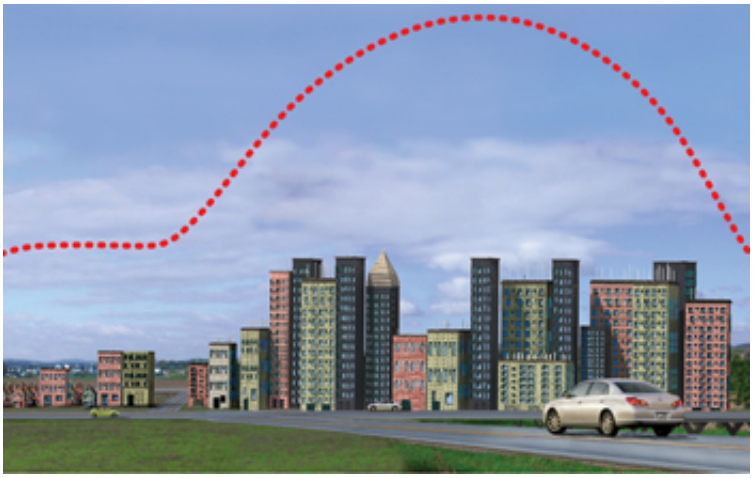
"Extreme temperatures pose risks to people around the globe," DeWeaver said. "These scientists show the power of ensembles of simulations for understanding how these risks depend on the level of greenhouse gas emissions."

By using simulations created by running the same model multiple times, with only tiny differences in the initial starting conditions, the scientists could examine the range of expected summertime temperatures for future "business-as-usual" and reduced-emissions scenarios.

"This is the first time the risk of record summer heat and its dependence on the rate of greenhouse gas emissions have been so comprehensively evaluated from a large set of simulations with a single state-of-the-art climate model," Deser said.

The scientists compared results to summertime temperatures recorded between 1920 and 2014 and to 15 sets of simulated summertime temperatures for the same period.

By simulating past summers—instead of relying solely on observations—the researchers established a large range of temperatures that could have occurred naturally under the same conditions, including greenhouse gas concentrations and volcanic eruptions.



The urban heat island effect further raises summer temperatures in cities. Credit: NASA

"Instead of just comparing the future to 95 summers from the past, the models give us the opportunity to create more than 1,400 possible past summers," Lehner said. "The result is a more comprehensive look at what should be considered natural variability and what can be attributed to climate change."

Emissions cuts could yield big benefits

The results show that between 2061 and 2080, summers in large parts of North and South America, central Europe, Asia, and Africa have a greater than 90 percent chance of being warmer than any summer in the historic record if emissions continue unabated.

That means virtually every summer would be as warm as the hottest to date.

In some regions, the likelihood of summers being warmer than any in the historical record remained less than 50 percent, but in those places—including Alaska, the central U.S., Scandinavia, Siberia and continental Australia—summer temperatures naturally vary greatly, making it more difficult to detect effects of climate change.

Reducing emissions would lower the global probability of future summers that are hotter than any in the past, but would not result in uniformly spread benefits. In some regions, including the U.S. East Coast and large parts of the tropics, the probability would remain above 90 percent, even if emissions were reduced.

But reduced emissions would result in a sizable boon for other regions of the world.

Parts of Brazil, central Europe, and eastern China would see a reduction of more than 50 percent in the chance that future summers would be

hotter than the historic range. Since these areas are densely inhabited, a large part of the global population would benefit significantly from climate change mitigation.

"It's often overlooked that the majority of the world's population lives in regions that will see a comparably fast rise in temperatures," Lehner said.

Provided by National Science Foundation