Stanford climate scientists forecast permanently hotter summers

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The tropics and much of the Northern Hemisphere are likely to experience an irreversible rise in summer temperatures within the next 20 to 60 years if atmospheric greenhouse gas concentrations continue to increase, according to a new climate study by Stanford University scientists. The results will be published later this month in the journal Climatic Change.

In the study, the Stanford team concluded that many tropical regions in Africa, Asia and South America could see "the permanent emergence of unprecedented summer heat" in the next two decades. Middle latitudes of Europe, China and North America – including the United States – are likely to undergo extreme summer temperature shifts within 60 years, the researchers found.

"According to our projections, large areas of the globe are likely to warm up so quickly that, by the middle of this century, even the coolest summers will be hotter than the hottest summers of the past 50 years," said the study's lead author, Noah Diffenbaugh, an assistant professor of environmental Earth system science and fellow at the Woods Institute for the Environment at Stanford. The study is co-authored by Stanford research assistant Martin Scherer.

"When scientists talk about global warming causing more heat waves, people often ask if that means that the hottest temperatures will become 'the new normal,'" Diffenbaugh said. "That got us thinking – at what point can we expect the coolest seasonal temperatures to always be

hotter than the historically highest temperatures for that season?"

Climate models, past and future

To determine the seasonal impact of global warming in coming decades, Diffenbaugh and Scherer analyzed more than 50 climate model experiments –including computer simulations of the 21st century when global greenhouse gas concentrations are expected to increase, and simulations of the 20th century that accurately "predicted" the Earth's climate during the last 50 years. The analysis revealed that many parts of the planet could experience a permanent spike in seasonal temperatures within 60 years.

"We also analyzed historical data from weather stations around the world to see if the projected emergence of unprecedented heat had already begun," Diffenbaugh said. "It turns out that when we look back in time using temperature records, we find that this extreme heat emergence is occurring now, and that climate models represent the historical patterns remarkably well."

According to both the climate model analysis and the historical weather data, the tropics are heating up the fastest. "We find that the most immediate increase in extreme seasonal heat occurs in the tropics, with up to 70 percent of seasons in the early 21st century (2010-2039) exceeding the late-20th century maximum," the authors wrote.

Tropical regions may see the most dramatic changes first, but wide swaths of North America, China and Mediterranean Europe are also likely to enter into a new heat regime by 2070, according to the study.

Environmental impact

This dramatic shift in seasonal temperatures could have severe consequences for human health, agricultural production and ecosystem productivity, Diffenbaugh said. As an example, he pointed to record heat waves in Europe in 2003 that killed 40,000 people. He also cited studies showing that projected increases in summer temperatures in the Midwestern United States could reduce the harvest of staples, such as corn and soybeans, by more than 30 percent.

Diffenbaugh was surprised to see how quickly the new, potentially destructive heat regimes are likely to emerge, given that the study was based on a relatively moderate forecast of greenhouse gas emissions in the 21st century.

"The fact that we're already seeing these changes in historical weather observations, and that they match climate model simulations so closely, increases our confidence that our projections of permanent escalations in seasonal temperatures within the next few decades are well founded," Diffenbaugh said.

Provided by Stanford University