Simultaneous climate extremes a risk to global societies and systems, study finds

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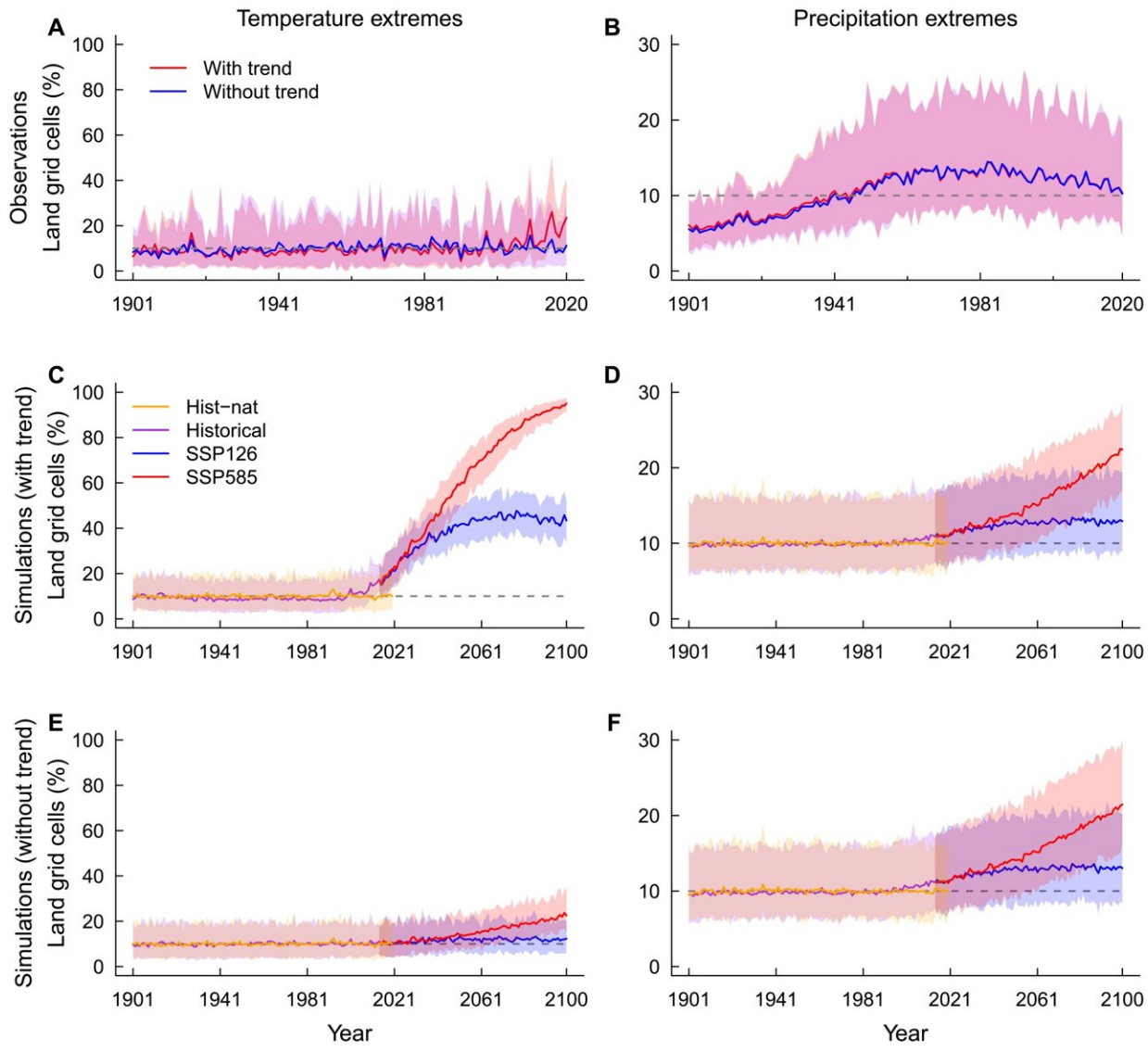

Prevalence of concurrent climate extremes over land. (A and B) Proportion of land grid cells experiencing monthly temperature and precipitation extremes

during the period of 1901–2020 using observations. Climate extremes are identified using temperature (precipitation) data with and without long-term trends, which are determined as the mean temperature (precipitation) of a 20-year moving window. The solid lines show the mean monthly proportion, and the upper and lower bounds of the shading indicate the maximum and minimum monthly proportions, i.e., the greatest departure from the expected proportion (10%, gray dashed lines) when occurrence of climate extremes is independent among different grid cells, for each year. (C to F) Same as (A) and (B) but using monthly temperature and precipitation data during 1901–2100 with (C and D) and without (E and F) long-term trends from hist-nat, historical, SSP126, and SSP585 simulations of 11 GCMs in CMIP6. The mean, maximum, and minimum proportions shown in the figure represent the mean values of observations and the 11 GCMs, respectively. Credit: *Science Advances* (2023). DOI: 10.1126/sciadv.abo1638.
https://www.science.org/doi/10.1126/sciadv.abo1638

A new study of global patterns of simultaneous climate extremes has found future incidents will be exacerbated by human-driven climate change.

Published in *Science Advances*, the study used historical global data to:

- Assess the spatial concurrence of climate extremes by first analyzing the proportion of land grid cells (excluding Antarctica) that experienced climate extremes each month from years 1901–2020.
- Develop a statistical framework for assessing the spatial concurrence of climate extremes at the grid, regional, and global scales.
- Understand future changes in global concurrent climate extremes by splitting historical and future simulations into two 100-year periods—historical (1901–2000) and future (2001–2100)—and

use the historical thresholds to define climate extremes for both periods.

Professor Bofu Yu, from Griffith's School of Engineering and Built Environment and Australian Rivers Institute, co-authored the study and said while the future risks of climate extremes varied geographically, they were becoming more strongly interlinked through further warming with increased climate variability and spatial dependence of climate extremes.

"The increasing global concurrent climate extremes pose large risks to our society and ecosystems," Professor Yu said.

"In particular, the strongest increases in the past and projected future concurrent temperature extremes occur in tropical regions, where many developing countries have been mostly affected by climate change and are probably the least able to afford the consequences of future increases in temperature extremes."

The findings also highlighted that increasingly co-occurring temperature extremes would also weaken the capability of tropical ecosystems to act as the largest land-based carbon sinks and further amplify global climate change.

Simultaneously, increasing rainfall variability and concurrent rainfall extremes would cause more droughts and floods simultaneously, particularly in tropical and northern high-latitude regions, making the adaption to future climate change more difficult.

Professor Yu and the authors also noted that although ambitious climate mitigation targets such as those simulated in SSP126 would ultimately be achieved, climate extremes were still projected to greatly increase compared with historical conditions.

"The increasing concurrent climate extremes and their severe impacts demand urgent international actions to reduce emissions of greenhouse gases and limit climate change impacts," Professor Yu said.

"Our understanding of the global pattern of concurrent climate extremes and their responses to different levels of anthropogenic forcings will inform effective mitigation and adaptation strategies to enable better preparation for future climate extremes."

The research "Global concurrent climate extremes exacerbated by anthropogenic climate change" has been published in *Science Advances*.

More information: Sha Zhou, Global concurrent climate extremes exacerbated by anthropogenic climate change, *Science Advances* (2023). DOI: 10.1126/sciadv.abo1638.
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