

# On ancient Earth, it never rained but it poured

November 3 2021

---



Credit: CC0 Public Domain

Today, we are experiencing the dramatic impacts that even a small increase in global temperatures can have on a planet's climate. Now, imagine an Earth 20 to 30 degrees Fahrenheit (11 - 17 C) hotter than

today. Earth likely experienced these temperatures at various times in the distant past and will experience them again hundreds of millions of years from now as the sun continues to brighten.

Little is known about how the [atmosphere](#) and climate behaved during these so-called hothouse periods. In a new study, researchers from Harvard University found that during these epochs of extreme heat, Earth may have experienced cycles of dryness followed by massive rain storms hundreds of miles wide that could dump more than a foot of rain in a matter of hours.

"If you were to look at a large patch of the deep tropics today, it's always raining somewhere," said Jacob Seeley, a Postdoctoral Fellow in Environmental Science and Engineering at the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and the Department of Earth and Planetary Science at Harvard and first author of the paper. "But we found that in extremely warm climates, there could be multiple days with no rain anywhere over a huge part of the ocean. Then, suddenly, a massive rainstorm would erupt over almost the entire domain, dumping a tremendous amount of rain. Then it would be quiet for a couple of days and repeat."

"This episodic cycle of deluges is a new and completely unexpected atmospheric state" said Robin Wordsworth, the Gordon McKay Professor of Environmental Science and Engineering at SEAS and senior author of the study.

The research not only sheds light on Earth's distant past and far-flung future but may also help to understand the climates of exoplanets orbiting distant stars.

The research is published in *Nature*.

In an [atmospheric model](#), Seeley and Wordsworth cranked up Earth's [sea surface temperature](#) to a scalding 130 degrees Fahrenheit (54 C), either by adding more CO<sub>2</sub>—about 64-times the amount currently in the atmosphere—or by increasing the brightness of the sun by about 10 percent.

At those temperatures, surprising things start happening in the atmosphere. When the air near the [surface](#) becomes extremely warm, absorption of sunlight by atmospheric water vapor heats the air above the surface and forms what's known as an "inhibition layer", a barrier that prevents convective clouds from rising into the [upper atmosphere](#) and forming rain clouds.

Instead, all that evaporation gets stuck in the near-surface atmosphere.

At the same time, clouds form in the upper atmosphere, above the inhibition layer, as heat is lost to space. The rain produced in those upper-level clouds evaporates before reaching the surface, returning all that water to the system.

"It's like charging a massive battery," said Seeley. "You have a ton of cooling high in the atmosphere and a ton of evaporation and heating near the surface, separated by this barrier. If something can break through that barrier and allow the surface heat and humidity to break into the cool upper atmosphere, it's going to cause an enormous rainstorm."

That's exactly what happens. After several days, the evaporative cooling from the upper atmosphere's rainstorms erodes the barrier, triggering an hours-long deluge. In one simulation, the researchers observed more rainfall in a six-hour period than some tropical cyclones drop in the U.S. across several days.

After the storm, the clouds dissipate, and precipitation stops for several

days as the atmospheric battery recharges and the cycle continues.

"Our research goes to show that there are still a lot of surprises in the climate system," said Seeley. "Although a 30-degree increase in sea surface temperatures is way more than is being predicted for human-caused climate change, pushing atmospheric models into unfamiliar territory can reveal glimpses of what the Earth is capable of."

"This study has revealed rich new physics in a climate that is only a little bit different from present-day Earth from a planetary perspective." said Wordsworth. "It raises big new questions about the [climate](#) evolution of Earth and other planets that we're going to be working through for many years to come."

**More information:** Jacob Seeley, Episodic deluges in simulated hothouse climates, *Nature* (2021). DOI: [10.1038/s41586-021-03919-z](https://doi.org/10.1038/s41586-021-03919-z). [www.nature.com/articles/s41586-021-03919-z](https://www.nature.com/articles/s41586-021-03919-z)

Provided by Harvard John A. Paulson School of Engineering and Applied Sciences

Citation: On ancient Earth, it never rained but it poured (2021, November 3) retrieved 26 April 2024 from <https://phys.org/news/2021-11-ancient-earth.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.
---