The Great Dying once wiped out 90% of life on Earth. A new theory may explain why

By Katie Hunt, CNN
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A geological field section reveals a desiccated land surface, evidence of extreme dryness, that was common all over the world at the end of the Permian Period. Paul Wignall

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CNN —
A cataclysm engulfed the planet some 252 million years ago, wiping out more than 90% of all life.

Known as the Great Dying, the mass extinction that ended the Permian geological period was the worst of the five global catastrophic events in Earth's history, more devastating than the one caused by a giant asteroid that spelled doom for the dinosaurs.

The most credible explanation put forward to date has been that carbon dioxide released by volcanic activity in a region known as the Siberian Traps caused a sudden warming of the planet. The emissions in the vast area in what's now Russia that was about the size of Australia resulted in higher temperatures, acid rain and ocean acidification.

However, a mega El Niño effect — similar but more intense and prolonged than how the climate phenomenon is experienced today — could have played a pivotal role, according to new research published Thursday in the journal Science.

"What we're showing is that it was a climate-based extinction crisis. It wasn't just the warming, it's how the climate responded," said study coauthor Paul Wignall, a professor of paleoenvironments at the University of Leeds in the United Kingdom.

"If the conditions were bad but constant,life could have evolved to cope with it. But the fact is, it kept lurching from one extreme to the other over the decades."

The research team built a computer model of the global climate during the close of the Permian Period that suggested that as global temperatures rose, the El Niño events, a climate pattern that originates in the Pacific Ocean but affects weather all over the world, grew in magnitude and length.

The phenomenon turbocharged temperatures and resulted in alternating periods of flooding and scorching drought that would have unleashed wildfires, devastating all manner of species across the globe over a period of around 100,000 years.

Study coauthor David Bond, a paleoenvironmental scientist at the University of Hull, looks for new sections of rock that reflect the end-Permian mass extinction on Ellesmere Island in the Canadian Arctic. Paul Wignall

El Niño events on a massive scale

Today, an El Niño event, which affects wind patterns and ocean currents, typically lasts between nine and 18 months and occurs every two to seven years. Alex Farnsworth, a senior research associate at the UK's University of Bristol and the study's joint lead author, said that during the warmest phases of the extinction event an El Niño episode would have lasted 10 years.

The El Niño of 252 million years ago would have originated in the Panthalassic Ocean, a body of water much larger than today's Pacific that could hold more heat, which in turn would have strengthened and sustained El Niño effects.

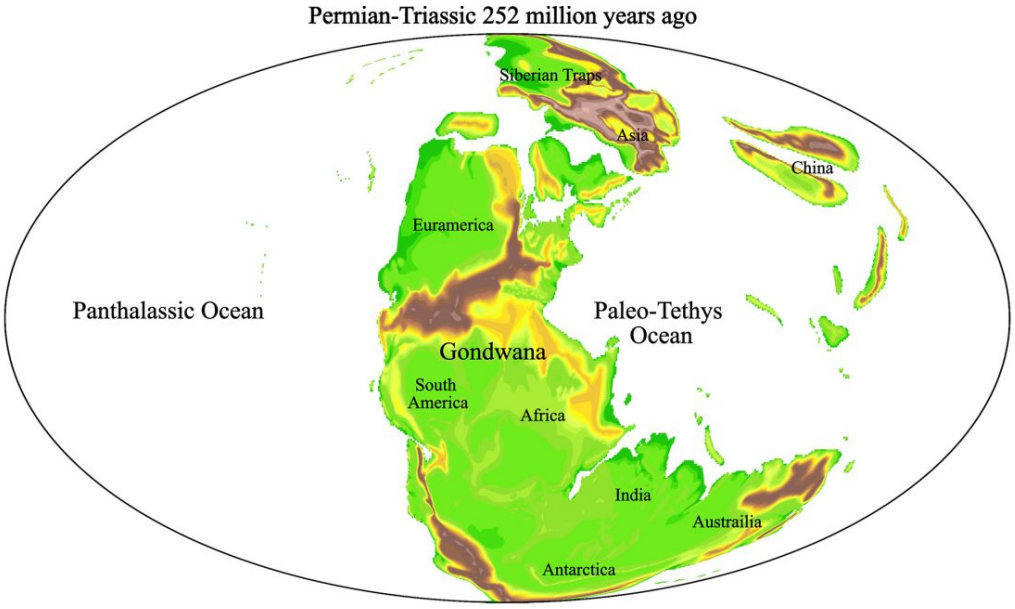
He added that volcanic activity remained a major factor but wasn't sufficient on its own to explain the scale of the biological catastrophe that unfolded. The planet had experienced similar episodes earlier but they hadn't triggered a mass extinction.

"It's volcanism that was the main culprit here, but it had a feedback mechanism on ocean dynamics that led to these much stronger El Niños starting to develop and then (the two things) play in concert," Wignall said.

A prolonged and intense El Niño also explained why extinctions had begun on land before they occurred in the ocean, the study said.

"Whilst the oceans were initially shielded from the temperature rises, the mega-El Nino's caused temperatures on land to exceed most species thermal tolerances at rates so rapid that they could not adapt in time," co-lead author Yadong Sun, a researcher at China University of Geosciences in Wuhan, said in a news release.

"Only species that could migrate quickly could survive, and there weren't many plants or animals that could do that."



Earth looked very different 252 million years ago. Alex Farnsworth/ University of Bristol

A key reason the end-Permian extinction was so dire was because the mega El Niños created incredibly warm conditions in the tropics, which spread quickly to higher latitudes, resulting in the loss of most vegetation and its ability to remove carbon dioxide from the atmosphere.

“You lose all trees at this time, which is amazing. Nothing would have been growing higher than your knees in the early Triassic,” Wignall said, referring to the geological era that followed the extinction event when the ecosystem began to recover.

Past changes in temperature can be determined in several ways — from plant and animal fossils, cores of sediment and ice, and, for more recent changes, tree rings and coral. This proxy data can be used to build computer models that help scientists reconstruct and understand what past conditions and climate systems were like.

Farnsworth said the team’s climate model, which took months to run multiple simulations, was better than its predecessors at piecing together what happened because of new, detailed temperature data gleaned from fossils of tiny eel-like creatures known as conodonts collected and analyzed over a long period. This data showed how temperature rose at different latitudes as the mass extinction unfolded.

The ratio of two different oxygen isotopes or variants in the fossilized tooth material of the conodonts, which were commonplace in the ocean at that time, was dependent on temperature, he added.

Dinosaur-killing asteroid was likely a giant mudball, study says

Alfio Alessandro Chiarenza, Royal Society Newton International Fellow at University College London’s department of Earth sciences, said it would now be interesting to find evidence in the fossil record of how organisms — including trilobites, early amphibians, reptile-like mammal ancestors and early crocodilians — were affected by the extinction, and which aspects of their biology were most severely impacted by these climatic upheavals.

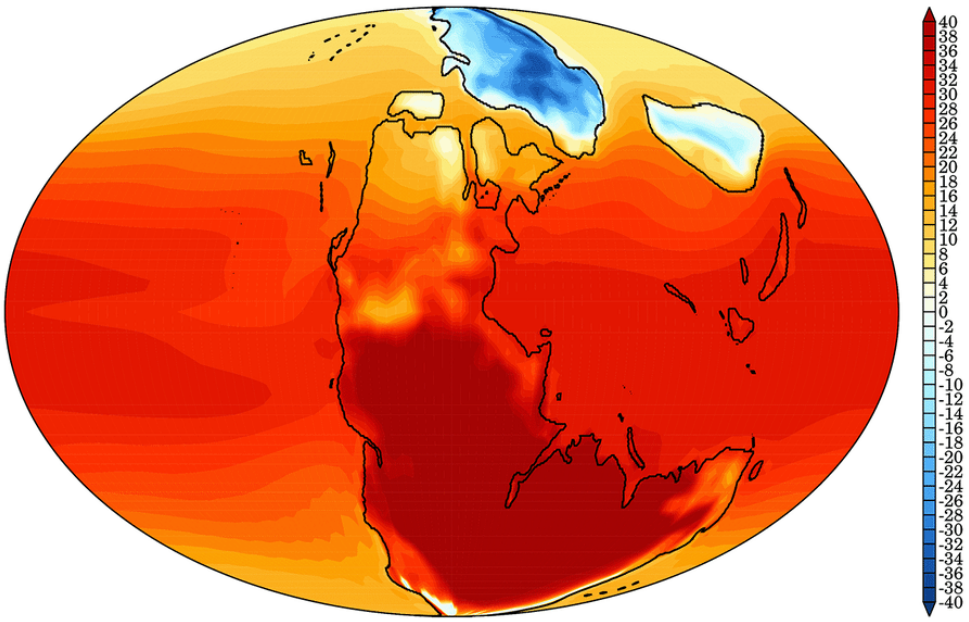
“This study provides yet another example of how complex and interconnected climatic-environmental dynamics are and how such processes can radically affect

ecological balance — a serious warning in light of our current ecological crisis," said Chiarenza, who wasn't involved in the study.

Resonance with today's climate crisis

Some researchers today think we're in the middle of a sixth mass extinction and that the end-Permian extinction may hold lessons for the current climate crisis.

El Niño events today are known to cause coral bleaching and mass mortality of fish, the study noted, but the ecological impact and future trajectory of El Niño events in a warming climate are unknown.



An animation shows monthly average surface temperature (in degrees Celsius) during the peak warmth of the end-Permian extinction crisis based on the model used in the study. Alex Farnsworth/University of Bristol

However, Wignall said the world 252 million years ago was geographically a different place — home to a huge supercontinent called Pangea and a massive ocean, which may have made it more sensitive to the carbon dioxide expelled by supervolcanoes.

"The end-Permian is the biggest crisis in Earth's history from life's standpoint, but I don't think we'll ever get anywhere near those conditions again, because (Earth back then) was a really strange planet with a continent on one side and gigantic ocean on the other," he said.

"The planet was really vulnerable at that time."

How El Nino and mega ocean warming caused the greatest-ever mass extinction

Date:

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Source:

University of Bristol

Summary:

Mega ocean warming El Nino events were key in driving the largest extinction of life on planet Earth some 252 million years ago, according to new research. The study has shed new light on why the effects of rapid climate change in the Permian-Triassic warming were so devastating for all forms of life in the sea and on land.

Mega ocean warming El Niño events were key in driving the largest extinction of life on planet Earth some 252 million years ago, according to new research.

The study, published today in *Science* and co-led by the University of Bristol and China University of Geosciences (Wuhan), has shed new light on why the effects of rapid climate change in the Permian-Triassic warming were so devastating for all forms of life in the sea and on land.

Scientists have long linked this mass extinction to vast volcanic eruptions in what is now Siberia. The resulting carbon dioxide emissions rapidly accelerated climate warming, resulting in widespread stagnation and the collapse of marine and terrestrial ecosystems.

But what caused life on land, including plants and usually resilient insects, to suffer just as badly has remained a source of mystery.

Co-lead author Dr Alexander Farnsworth, Senior Research Associate at the University of Bristol, said: “Climate warming alone cannot drive such devastating extinctions because, as we are seeing today, when the tropics become too hot, species migrate to the cooler, higher latitudes. Our research has revealed that increased greenhouse gases don’t just make the majority of the planet warmer, they also increase weather and climate variability making it even more ‘wild’ and difficult for life to survive.”

The Permian-Triassic catastrophe shows the problem of global warming is not just a matter of it becoming unbearably hot, but also a case of conditions swinging wildly over decades.

“Most life failed to adapt to these conditions, but thankfully a few things survived, without which we wouldn’t be here today. It was nearly, but not quite, the end of the life on Earth,” said co-lead author Professor Yadong Sun at China University of Geosciences, Wuhan.

The scale of Permian-Triassic warming was revealed by studying oxygen isotopes in the fossilised tooth material of tiny extinct swimming organisms called conodonts. By studying the temperature record of conodonts from around the world, the researchers were able to show a remarkable collapse of temperature gradients in the low and mid latitudes.

Dr Farnsworth, who used pioneering climate modelling to evaluate the findings, said: “Essentially, it got too hot everywhere. The changes responsible for the climate patterns identified were profound because there were much more intense and prolonged El Niño events than witnessed today. Species were simply not equipped to adapt or evolve quickly enough.”

In recent years El Niño events have caused major changes in rainfall patterns and temperature. For example, the weather

extremes that caused the June 2024 North American heatwave when temperatures were around 15°C hotter than normal. 2023-2024 was also one of the hottest years on record globally due to a strong El Niño in the Pacific, which was further exacerbated by increased human-induced CO_2 driving catastrophic drought and fires around the world.

“Fortunately such events so far have only lasted one to two years at a time. During the Permian-Triassic crisis, El Niño persisted for much longer resulting in a decade of widespread drought, followed by years of flooding. Basically, the climate was all over the place and that makes it very hard for any species to adapt,” co-author Paul Wignall, Professor of Palaeoenvironments at the University of Leeds.

The results of the climate modelling also help explain the abundant charcoal found in rock layers of that age.

“Wildfires become very common if you have a drought-prone climate. Earth got stuck in a crisis state where the land was burning and the oceans stagnating. There was nowhere to hide,” added co-author Professor David Bond, a palaeontologist at the University of Hull.

The researchers observed that throughout Earth’s history there have been many volcanic events similar to those in Siberia, and many caused extinctions, but none led to a crisis of the scale of the Permian-Triassic event.

They found Permian-Triassic extinction was so different because these Mega-El Niños created positive feedback on the climate which led to incredibly warm conditions starting in the tropics and then beyond, resulting in the dieback of vegetation. Plants are essential for removing CO_2 from the atmosphere, as well as the foundation of the food web, and if they die so does one of the Earth's mechanisms to stop CO_2 building up in the atmosphere as a result of continued volcanism.

This also helps explain the conundrum regarding the Permian-Triassic mass extinction whereby the extinction on land occurred tens of thousands of years before extinction in the oceans.

“Whilst the oceans were initially shielded from the temperature rises, the mega-El Nino’s caused temperatures on land to exceed most species thermal tolerances at rates so rapid that they could not adapt in time,” explained Dr Sun.

“Only species that could migrate quickly could survive, and there weren’t many plants or animals that could do that.”

Mass extinctions, although rare, are the heartbeat of the Earth’s natural system resetting life and evolution along different paths.

“The Permo-Triassic mass extinction, although devastating, would ultimately see the rise of Dinosaurs becoming the dominant species thereafter as would the Cretaceous mass extinction lead to the rise of mammals, and humans,” Dr Farnsworth concluded.

Story Source:

Materials provided by **University of Bristol**. *Note: Content may be edited for style and length.*

Journal Reference:

1. Yadong Sun, Alexander Farnsworth, Michael M. Joachimski, Paul B. Wignall, Leopold Krystyn, David P. G. Bond, Domenico C. G. Ravidà, Paul J. Valdes. **Mega El Niño instigated the end-Permian mass extinction**. *Science*, 2024; 385 (6714): 1189 DOI: 10.1126/science.ado2030