

Ancient climate change may portend toasty future

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Scientists, including Ken Caldeira of the Carnegie Institution's Department of Global Ecology, have found that the Earth's global warming, 55 million years ago, may have resulted from the climate's high sensitivity to a long-term release of carbon. This finding contradicts the position held by many climate-change skeptics that the Earth system is resilient to such emissions. The work, led by Mark Pagani of Yale University, is published in the December 8, 2006, issue of *Science* magazine.

For some years scientists have known that an ancient global warming



event, called the Paleocene-Eocene Thermal Maximum (PETM) beginning about 55 million years ago, was caused by a massive release of carbon. The geologic record shows that the ensuing greenhouse effect heated the planet by about 9° F (5° C), on average, in less than 10,000 years. The temperature increase lasted 170,000 years and caused profound changes to the world's rainfall patterns, made the oceans acidic, and affected oceanic and terrestrial plant and animal life, including spawning the rise of our modern primate ancestors. But understanding just how much carbon was responsible for the temperature increase and where it came from remains elusive.

The new calculations used data from carbon found in fossils of ancient land plants and tiny marine organisms known as plankton. "We can tell that the amount of carbon released to the atmosphere and ocean was more or less the same as what is available today as coal, oil, and gas," Caldeira explained. "The carbon heated up the Earth for over 100,000 years. If the climate was as insensitive to CO_2 as the climate skeptics claim, there would be no way to make the Earth so warm for so long."

The source of this ancient carbon is still a mystery. It might have come from massive fires burning coal and other ancient plant material, or it could have come from "burps" of methane from the continental shelves.

"By examining fossils and ancient sediments on the sea floor, we can see that something very unusual happened to Earth's carbon cycle," Caldeira continued. "At the same time the climate near the North Pole became like Miami. We can tell it didn't take all that much carbon to make this change in climate."

If the source of the release was ancient plant material, calculations indicate that for each doubling of atmospheric CO_2 concentration, the Earth would warm at least 4 °F (2.2 °C) and possibly twice this much. If ancient methane was the cause, as many believe, the situation is even



more dire. The methane would have become carbon dioxide in the atmosphere within decades. The research indicates that much less of it would have been available to cause climate change, which means that the climate is even more sensitive to added CO_2 than we have thought.

"If ancient methane 'burps' really occurred, as many believe," Caldeira said, "a doubling of atmospheric CO_2 concentration would warm the Earth by over 10 °F (5.6 °C). If that's what happened, we could be in for a mighty toasty future."

With a continuation of current trends in the use of coal, oil, and gas, natural background atmospheric CO_2 concentrations are expected to double around mid-century. The ancient emissions are comparable to the CO_2 that can be expected from human activity over the coming few centuries. If human-induced carbon emissions continue unabated, there could be a similar shift in species evolution.

"The last time carbon was emitted to the atmosphere on the scale of what we are doing today, there were winners and losers," Caldeira remarked. "There was ecological devastation, but new species rose from the ashes. Luckily for us, our ancient primate ancestors were winners. Who knows who the winners and losers will be in the next go round""

"Our carbon dioxide emissions are risking biological, chemical, and climate changes of a magnitude that has not been seen for more than 50 million years," he warned. "Our work provides even more incentive to develop the clean energy sources that can provide for economic growth and development without risking the natural world that is our endowment."

Source: Carnegie Institution



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