Ancient Arctic Water Cycles are Red Flags to Future Global Warming

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Ancient plant remains recovered in recent Arctic Ocean sampling cores shows that during a period of carbon dioxide-induced global warming, humidity, precipitation and salinity of the ocean water altered drastically, along with elevated global and regional temperatures, according to a report in the August 10 issue of *Nature*.

The Arctic Ocean drilling expedition in 2004 allowed scientists to directly measure samples of biological and geological material from the beginning of the Paleocene/Eocene thermal maximum (PETM), a period of rapid, extreme global warming about 55 million years ago. It has given researchers a direct resource of measurable information on global warming — from a time when the overall global temperature was higher and more uniform from the subtropics to the arctic.

The researchers measured carbon and hydrogen isotopes in fossil plants remains and reconstructed the pattern of precipitation and characteristics of the ancient arctic water. “Our results told us a lot about the way that the large-scale water cycle is affected during global warming,” said Mark Pagani, professor of geology and geophysics at Yale and principal author of the study.

The large-scale water cycle refers to the way water vapor is transported from the tropics and subtropics to the poles. “We are all familiar with the rain and storms that occur when warm air masses meet cool northern fronts. During the PETM, temperature differences from the tropics to the poles were lower, reducing rainfall between the subtropics and the

North Pole and increasing the amount of water transported to the Arctic," said Pagani. "It looks like a substantial increase in precipitation led to increased river runoff, lower ocean salinity, and drastically lower oxygen levels in the Arctic Ocean."

"It is important to realize that the impact of global warming is not just about searing hot summers — it also concerns the water cycle. We need to anticipate big changes in patterns of precipitation as temperatures rise – where and when it will rain and whether or not water resources are available," said Pagani. "This work is potentially a red flag for things to come."

Co-author Matthew Huber, an assistant professor of earth and atmospheric sciences at Purdue University's College of Science compared data from the research expedition with complex climate-model simulations to study and predict the effects of greenhouse gases. Their measurements confirm that the carbon dioxide level increase in the PETM was at least twice as large as those previously proposed.

"We now have a pretty good correlation between records of past warmth and higher carbon dioxide concentrations," Huber said. "What it tells you is that it's not too difficult to push the climate system to a warm state. If you work out the numbers, it's almost identical to what we are expected to do over the next few hundred years."

Co-authors of the work were Nikolai Pedentchouk at Yale; Appy Sluijs and Henk Brinkhuis at Utrecht University; Gerald Dickens now at Rice University; Stefan Schouten and Jaap Sinninghe Damste at the Royal Netherlands Institute for Sea Research, and "the Expedition 302 Scientists."

The expedition was an operation of the Integrated Ocean Drilling Program (IODP), an international marine research program primarily

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Source: Yale University