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Scientists examine a hot epoch to forecast climate future

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* "Hindcasting" the past to check computer models

* A warm old world with modern carbon dioxide levels

* Higher oceans, forests instead of ice in Greenland

By Deborah Zabarenko

WASHINGTON, April 13 (Reuters) - To figure out what is likely to happen to Earth's climate this century, scientists are looking 3 million years into the past.

They have concluded that the most revealing slice of time is the Pliocene Epoch, a warm, wet period between 3.15 million and 2.85 million years ago, when the world probably looked and felt much as it does now. Global temperatures and the amount of heat-trapping carbon dioxide in the atmosphere were similar to today's climate, according to the U.S. Geological Survey.

Knowing more about the Pliocene is useful for climate modelers around the world who create sophisticated computer programs to simulate what global warming could bring to Earth.

But recreating ancient climate conditions has also given fuel to those who question human-caused global warming. In the Pliocene Epoch, there were no humans to spur carbon dioxide emissions, so the similarity in carbon dioxide levels between then and now points to natural causes, they say.

As Harry Dowsett, a USGS scientist who has made a career of studying the Pliocene, put it, this was a time "before man was able to do anything to Earth."

Hindcasting - looking backward to project forward - relies on tools that are not regularly used in paleontology, the study of fossil evidence of past ages. Techniques like radio-carbon dating, which tracks the gradual decay of radioactive carbon, only work back to about 1 million years ago.

Instead, paleoclimatologists who study ancient climate find clues in cores drilled in sediment layers on ocean bottoms and in some leaf remains. They then examine different isotopes (atomic weights, with varying numbers of neutrons) of non-radioative, stable carbon.

Mark Pagani, a paleoclimatologist at Yale University, described how this works: When algae in the Pliocene sucked up carbon dioxide to perform photosynthesis, they produced organic carbon with distinct isotope signatures that were sensitive to the concentration of CO2 in seawater. These signatures are preserved in fossils that can help determine how much carbon dioxide was in the atmosphere back then.

"We needed to figure out what was on the land, where the plants were growing, where the mountains were, where the sea level was, where the ice sheets were," Dowsett said.

Using these techniques, scientists have estimated carbon dioxide levels at some locations going back as much as 150 million years, Pagani said.

The USGS homed in on the mid-Pliocene as a good analog for modern Earth's changing climate. The agency considered data from 100 sites and a distinct period of time, making the first and only geospatial reconstruction of the Pliocene.

In the last five years, a more complete and detailed picture of the epoch has emerged.

The mid-Pliocene was about as warm as climate models predict it will be by 2100, or about 3.6 degrees F (2 degrees C) above current global mean temperatures, the Geological Survey said.

Sea levels were as much as 70 feet (21 metres) higher than they are now. Florida would have been a narrow strip instead of a broad peninsula, Washington, D.C., might have offered oceanfront views and much of Bangladesh would have been under water. Greenland, now covered in melting glaciers, had forests growing on its northern slope.

Animals and plants would have looked familiar to 21st century eyes, as newly formed grasslands attracted long-legged grazers. The dinosaurs were long gone, and the mountains were basically built. Two-footed ancestors of homo sapiens probably walked the Earth.

Carbon dioxide levels in the atmosphere were between 350 and 400 parts per million (that is, between 350 and 400 carbon dioxide molecules for every million molecules of air), said Pagani, who called the estimates "a pretty good ballpark figure."

CARBON DIOXIDE, JUST LIKE OLD TIMES

Today, the carbon dioxide concentration is similar. An April 5 reading at Hawaii's Mauna Loa Observatory was over 394 parts per million. This figure has climbed from less than 320 ppm in 1960 and could be over 450 ppm by 2100. A graph is visible at the NOAA site http://co2now.org/.

What people care about in the 21st century, Pagani said, is how the temperature responds to rising carbon dioxide, which argues for a detailed look at the last time the Earth was as hot as projections show it will be in coming decades.

A study in the journal Nature Climate Change compared four existing climate models, and found all four are largely consistent with each other and with USGS data on the Pliocene.

But problems with simulating what could happen in the North Atlantic are significant, said Mark Chandler of NASA's Goddard Institute for Space Studies. The models show less North Atlantic warming than occurred during the Pliocene.

"What happens to the North Atlantic in the future is going to dramatically affect the Western world," Chandler said.

The absence of human life during the Pliocene Epoch has offered ammunition to those who question anthropogenic, or human-caused, climate change.

Patrick Michaels, a climate scientist at the libertarian CATO Institute, said Earth's climate over time has gone through natural cycles. While he acknowledged anthropogenic climate change is occurring, Michaels said the issue is how sensitive global temperatures are to fluctuations in carbon dioxide: "It's not the heat, it's the sensitivity."

"They're absolutely right, climate changes naturally, it's constantly changing for natural reasons," said Maureen Raymo of Columbia University's Lamont-Doherty Earth Observatory.

However, Raymo noted that the natural changes caused by volcanic eruptions, other geologic activities and variations in Earth's orbit take eons to unfold. Humans have been putting additional carbon dioxide into the atmosphere through the burning of fossil fuels for only a century or so. And there is a lag between the time when carbon dioxide gets into the air and the full warming effects are felt. (Editing by Marilyn W. Thompson and Doina Chiacu)