Study of centuries of weather suggests record warming ahead

By observing several indirect indicators, researchers looking at weather patterns since the end of the last Ice Age predict that average surface temperatures will be at their highest point in human experience by the end of this century.

Monte Morin, Los Angeles Times, 3-8-13

First the good news: In the last 11,300 years, humans have endured a planet warmer than today's, even as they set about building their earliest civilizations.

Now the bad news: That will no longer be true 87 years from now, according to scientists who have conducted a comprehensive analysis of the planet's climate history since the world's ice sheets began their most recent retreat from North America and Europe.

New research into Earth's ancient climate is providing a clearer, more detailed view of how the planet's average surface temperature fluctuated over the period known as the Holocene epoch, which continues today. It's the time in which humans truly began making their mark on the planet, abandoning their hunting and gathering traditions and adopting a settled, agricultural lifestyle.

In a study published in Friday's edition of the journal Science, researchers used eight indirect temperature indicators — such as pollen and shells from marine organisms — to chart long-term global warming and cooling trends. The research team concluded that temperatures in the last decade had not exceeded the Holocene's steamiest periods from thousands of years ago. However, if current warming trends hold, those records will be broken by the end of the century.

“By the year 2100, we will be beyond anything human society has ever experienced,” said study leader Shaun Marcott, a postdoctoral researcher at Oregon State University's College of Earth, Ocean and Atmospheric Sciences.

According to NASA, the average global temperature for 2012 was 58.3 degrees Fahrenheit, making it the ninth-hottest year in recorded history. However, there is no single, agreed-upon method of calculating these temperatures, so scientists tend to discuss climate change by highlighting deviations from a specific reference point.

While a 1-degree Fahrenheit increase sounds small, it represents an enormous amount of heat energy. For instance, a 10-degree drop would plunge the world into another period of major glaciation, while every 1.8-degree increase would gradually amount to a roughly 65-foot rise in sea level due to melting polar ice, according to NASA climatologist James Hansen.

Previous efforts to measure past climate conditions have relied heavily on measurements of tree ring thickness. At high latitudes, tree growth is controlled mostly by temperature, so thick rings suggest warm years. But trees don't live longer than several thousand years, so those efforts have focused on shorter periods of time — just 1,500 to 2,000 years.

These earlier studies have also featured “hockey stick” graphs, in which average temperatures fluctuate in a long band that vaguely resembles the shaft of a hockey stick before rising sharply in the last 100 years, like the hockey stick's blade. Such diagrams have generated virulent criticism from those who rebut the idea that man-

made greenhouse gases are heating the climate.

Marcott and colleagues from Harvard University said that by estimating temperature fluctuations for the entire Holocene, they hoped to provide a new perspective on the debate.

The researchers collected data from 73 sites across the globe, on land and beneath the sea. They included ice cores from Greenland, stalagmites in Borneo, and fossilized pollen in Scandinavia.

Some of the data came from the shells of long-dead aquatic microbes that were buried as many as 50 feet or more below the ocean floor. The shells' chemical makeup gives scientists clues about the water temperature at the time the creatures existed — shells formed in warm water will have a greater percentage of stable oxygen isotopes, while shells formed in cold water will have a lower ratio.

Similarly, sediment core samples taken from the bottom of a pond, lake or ocean will contain fossilized pollen grains, which have very distinctive shapes when viewed under a microscope. By examining the variety of species and their abundance, scientists can gauge the area's past climate.

Trans fats produced by a type of algae were also used in the study as temperature indicators. The chemical bonds of these fat molecules, called alkenones, change according to water temperature. When the algae die, the alkenones sink to the bottom of the sea or lake bed, where they are mostly preserved.

What the researchers found was a climate that warmed and cooled gradually over a period of milleniums, then experienced a sudden, unprecedented rise in temperatures — similar to earlier hockey stick graphs.

After the retreat of vast ice sheets in the Northern Hemisphere, global average temperature rose roughly 1 degree from the start of the Holocene to about 9,500 years ago, authors found. Average temperatures then plateaued for roughly 4,000 years, with the exception of two relatively short-lived spikes.

After that, things began to cool again. From about 5,500 years ago to roughly a century ago, average global surface temperature dropped 1.3 degrees.

But what concerns many scientists is what occurred next: In just the last 100 years, the average temperature has increased by 1.3 degrees. Although global temperatures of the last decade have not exceeded peak Holocene highs, they are warmer than 75% of the epoch.

“Global temperature, therefore, has risen from near the coldest to the warmest levels of the Holocene within the past century,” the researchers wrote.

By the end of the century, climate warming models predict an additional increase of 2 to 11.5 degrees, due largely to carbon emissions, the study noted.

The Science study was not the first to use such proxies to assess the ancient climate, but it was the first to pull together so many of them from all over the world, the researchers said. Previous studies used only regional data, which may be influenced by localized events like monsoons and the cyclical ocean-warming phenomenon known as El Niño.

Michael Mann, a physicist and climatologist at Pennsylvania State University who was not involved in the study, said the paper was important because it illustrated clearly that the rate and magnitude of recent warming was unprecedented in at least the last 11,000 years.

“We know that there were periods in the past that were warmer than today — for example, the Cretaceous period 100 million years ago,” he said. “The real issue is the rate of change, because that's what challenges our adaptive capacity.”

Mann, who was among the first climate scientists to introduce the hockey stick graph a decade ago — and has been strongly criticized by climate warming skeptics ever since — said the authors should prepare themselves for similar judgment.

“I am certain that professional climate-change deniers will attack the study and the authors, in an effort to discredit this important work,” Mann said.