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Scientist Refutes Notion of Recent Climate as "Uniquely Benign," Sees Evidence of Approaching Ice Age Despite Global Warming

By Kurt Sternlof

Paleoclimatologists agree that during the 10,000 years since the end of the last ice age -- a period known as the Holocene -- Earth has enjoyed a relatively warm and stable climate. During this period human civilizations blossomed into global dominance. The question now is whether another ice age is on its way? And if so, when?

George Kukla

At an international symposium convened by the Lamont-Doherty Earth Observatory last October, the consensus answer was, "Yes, but not for at least another five thousand years." While that sounds like a simple reprieve, the issue of what the geologic record of past climate can tell us about the future remains both complicated and contentious.

In a paper drawn from that symposium and solicited by Science for its 11 February 2000 issue, Lamont-Doherty paleoclimatologist George Kukla argues that a currently popular interpretation of Holocene climate as uniquely benign is both mistaken and misleading. He contends that the weight of evidence shows that neither has the Holocene been uniformly benign, nor is it without precedent in the geologic past. And if there's nothing unique about our current climate pattern, there's no reason to think glacial history won't repeat itself.

In fact, the geologic record reveals that Earth has experienced an ongoing cycle of ice ages dating back millions of years. Cold, glacial periods affecting the polar to mid-latitudes persist for about 100,000 years, punctuated by briefer, warmer periods called interglacials. The Holocene is just another interglacial that is more than half over, Kukla said.

It turns out that this ongoing cycle of glaciation closely matches cyclic variations in Earth's orbit around the sun, leading many researchers to conclude that orbit drives glaciation.

This correspondence between orbit and climate is called the Milankovich cycle, after the scientist who analyzed and popularized it in the 1920s.

"I feel we're on pretty solid ground in interpreting orbit around the sun as the primary driving force behind ice-age glaciation. The relationship is just too clear and consistent to allow reasonable doubt," Kukla said. "It's either that, or climate drives orbit, and that just doesn't make sense."

Although the actual mechanisms that initiate and drive glaciation remain a mystery, evidence suggests that the pendulum-swing to an ice age-type climate may already be underway, Kukla said. For one thing, the configuration of the sun and Earth is fast approaching what it was 116,000 years ago when the last interglacial period ended. And, while the annual mean temperature on earth is now rising -- along with concerns that humanity is to blame -- polar mean temperatures remain steady and ice fields in the upper elevations of Greenland are actually expanding.

Three primary lines of geologic evidence are used to reconstruct Earth's climate history during the last interglacial -- called the Eemian -- and the transition into the most recent ice age, a period running from about 128,000 to 106,000 years ago. These come from ocean sediments, lake sediments and ice cores from the polar regions. All of them provide indirect measures of relative conditions such as temperature and so are open to interpretation.

Evidence from oxygen isotopes recorded in the shells of tiny ocean creatures called foraminifers, a primary component of ocean sediment, yields a measure of the changing global volume of continental ice through time. Similar oxygen isotope data from water molecules trapped in successive layers of old ice yield a measure of actual polar temperatures when the ice formed. Plant pollen deposited in northern European lake sediments provides a record of the transition on land between temperate woodlands and the sparse grasslands that dominate during cold periods.

The view of the Holocene as uniquely benign grew out of an interpretation of a single ice core collected in Greenland by a European team in 1992. The oxygen isotope data from that core showed the Holocene to have been uniformly mild in comparison to the Eemian, which appeared to have witnessed relatively severe temperature swings. Once published, this interpretation spurred other researchers to look for and find evidence of Eemian climate extremes, which point to the Holocene as something other than just another interglacial.

To Kukla, it is a classic example of an interesting, but mistaken, theory gaining validation as other researchers jump onboard and, not surprisingly, uncover evidence of what they expect to find. In fact, the data from the European ice core disagrees with that of another core subsequently collected nearby, as well as the overwhelming weight of ocean sediment data. These lines of evidence show the Holocene to be similar to the early and mid Eemian, he said.

The real problem Kukla sees is that the misinterpretation of Holocene climate as unprecedented could interfere with our ability to recognize future climate trends in evidence from the past.

"There is a tendency these days to focus on whatever agrees with global warming and the idea that we are living in an unusual climatic epoch," Kukla said. "Certainly the earth as a whole is warming right now. But you have to remember that the tropics and subtropics comprise about 50 percent of the total surface area; so, conditions there dominate the average."

On the other hand, glaciation emanates from the polar regions, which together comprise only 14 percent of Earth's surface. And the preponderance of evidence suggests that ice ages begin building at the poles thousands of years before their effects are felt elsewhere, he said. Thus, the important indicator of impending glaciation may not be global mean temperature so much as the temperature difference between the poles and the equator. Theoretically, the larger the difference the stronger the probable flow of water vapor from the tropics toward the poles, where it would fall as snow to feed the growing ice fields.

The ultimate significance of human-induced global warming may therefore depend more on how it affects water-vapor transport, than its influence on average global temperature or any effect on the underlying glacial cycle, Kukla said. It is conceivable that greenhouse warming could even hasten the transition to glacial conditions by exacerbating the polar/equatorial temperature difference and increasing the rate of water transport poleward.

Based on the record revealed in ocean and lake sediments, the most likely scenario over the next few thousand years is for the volume of ice in the polar regions to slowly grow, gradually dropping sea level and increasing the polar/equatorial temperature differential. Except near the poles, oceans and continents will remain relatively warm, although the climate will become increasingly unstable. Ultimately, a surge of built-up polar ice into the mid-latitude oceans will plunge the continents into ice-age conditions.

"As near as we can tell, that is what has happened in the past," Kukla said, "and there's no reason yet to think anything has changed."