Antarctic climate: Short-term spikes, long-term warming linked to tropical Pacific

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Dramatic year-to-year temperature swings and a century-long warming trend across West Antarctica are linked to conditions in the tropical Pacific Ocean, according to a new analysis of ice cores conducted by scientists at the National Center for Atmospheric Research (NCAR) and the University of Washington (UW). The findings show the connection of the world's coldest continent to global warming, as well as to periodic events such as El Niño.

"As the tropics warm, so too will West Antarctica," says NCAR's David Schneider, who conducted the research with UW's Eric Steig. "These ice cores reveal that West Antarctica's climate is influenced by atmospheric and oceanic changes thousands of miles to the north."

The research appears this week in the online Early Edition of *Proceedings of the National Academy of Sciences*. The work was supported by the National Science Foundation, NCAR's sponsor.

Scientists are keenly interested in whether warming will destabilize the West Antarctic ice sheet over a period of decades or centuries. The ice sheet covers an area the size of Mexico, averages about 6,500 feet deep, and, if melted, would raise global sea levels by about 8 to 16 feet (2.5-5 meters).

Antarctica's climate is difficult to study, partly because there are few observations of this vast and remote region and partly because the cold, dry atmosphere is unlike that of the other six continents. Scientists

previously determined that Antarctica overall probably warmed by about 0.4 degrees Fahrenheit (0.2 degrees Celsius) in the last century. But it has not been apparent until now that low-lying West Antarctica is more responsive to global warming trends than East Antarctica, where wind patterns have largely kept out comparatively warm air.

Schneider and Steig estimate that West Antarctica warmed about 1.6 degrees F (0.9 degrees C) over the 20th century. That is slightly more than the global average of about 1.3 degrees F (0.7 degrees C). Because of the large swings in annual temperature during the 1930s and 1940s, there is a considerable margin of uncertainty in the century-long estimate, says Schneider. He notes that there is increased confidence that warming has occurred since 1950, averaging about 0.8 degree F (0.4 degrees C) per decade.

The new set of cores analyzed by Schneider and Steig comes from a relatively snowy part of the continent. This provides enough detail for scientists to infer year-to-year temperature changes. The data show that the Antarctic climate is highly responsive to changes in the Pacific. For example, during a major El Niño event from 1939 to 1942, temperatures in West Antarctica rose by about 6 to 10 degrees F (3-6 degrees C), and then dropped by an estimated 9 to 13 degrees F (5-7 degrees C) over the next two years. El Niño is a periodic shift in air pressure accompanied by oceanic warming in the tropical Pacific.

Although the heart of El Niño's oceanic warming is in the tropical Pacific, it often fosters a circulation pattern that pushes relatively mild, moist air toward West Antarctica, where it can temporarily displace much colder air. As a result, West Antarctica has one of the world's most variable climates.

"These results help put Antarctica's recent climate trends into a global context," says Schneider.

Steig adds that while the influence of tropical climate on West Antarctica climate was not unknown, "these results are the first to demonstrate that we can unambiguously detect that influence in ice core records."

Decoding the climate record

Ice-core analysis is critical for understanding the climate of West Antarctica. Few weather stations existed before the 1950s, and even satellite readings can be unreliable because of the difficulty in distinguishing clouds from snow cover.

To reconstruct climate trends over the last century, Schneider and Steig analyzed ice cores collected from eight locations across West Antarctica. They measured heavy and light stable isotopes of oxygen and hydrogen, the elements that make up the ice itself. During warm episodes, the heavy isotopes are more common because of a number of processes, such as a reduction in condensation that would otherwise remove them.

The ice cores for the study were collected from 2000 to 2002 during the U.S. International Trans-Antarctic Scientific Expedition, which Schneider and Steig participated in. The expedition and subsequent ice core analysis was sponsored by the National Science Foundation's Office of Polar Programs.

Source: National Center for Atmospheric Research