Corals Lock El Nino History in Radiocarbon

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By Melanie Lenart

University of Arizona Earth scientist Warren Beck is using radiocarbon levels in corals to derive long records of El Niño variability in the equatorial Pacific. He also suggests these results are useful for tracking variations in carbon dioxide emissions from the equatorial Pacific, an important region for controlling releases of this potent greenhouse gas.

"I think you'd have to agree that there's pretty good agreement between those two records," Beck noted during his recent talk at the Laboratory of Tree-Ring Research, pointing to his graph comparing radiocarbon fluctuations in corals to the sea surface temperature record that scientists use to track El Niño. The two curves moved in tandem through time, staying in line through numerous peaks and troughs.

"The bottom line is coral 'C-14' can be used as a proxy for timing and intensity of the El Niño phenomenon," said Beck, a research scientist in the department of physics and atmospheric sciences. Radiocarbon is also known as 14C (pronounced "C-14") because it has a total of 14 particles in its nucleus, with two more neutrons than the most common form of carbon.

Beck's was the first in a series of LTRR talks focusing on "natural archives" that reveal environmental conditions beyond those captured in instrumental records. (For a list of the talks, go to http://www.ltrr.arizona.edu/seminar.html)

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As with tree rings, the annual layers of coral tell tales of environmental conditions in times and places where the instrumental record is nonexistent. And they can do so to the specific year. Every year, living anemone-like polyps lay down a layer of calcium carbonate on the surface of the coral. These layers act like natural tape recorders, keeping track of such things as ocean temperature, sea surface salinity, and ocean circulation patterns.

In some cases, individual coral "heads" can reach the size of small houses, leaving as many as 1,000 annual layers that can be used like an internal calendar for that coral. As a result, corals can help scientists unravel the causes of climate fluctuations like the Asian Monsoon, the Little Ice Age or the last glaciation. Corals speak well to sea-related influences such as El Niño, which involves a warming of the eastern Pacific Ocean.

Because reliable records of Pacific Ocean surface temperatures extend back only a few decades, proxy records of its probable temperature drawn from corals may prove essential for reconstructing long records of El Niño's ups and downs. By default, these records also speak to rainfall and snowfall patterns in much of the western hemisphere because of large-scale links between the ocean and the atmosphere.

Ancient coral heads can also shed light on ocean circulation patterns from before humans had developed instrumentation -- or even writing. Beck has found an ancient coral head that spans 700 years of the Younger Dryas, a cool spell that occurred about 12,000 years ago. Radiocarbon levels in the second half of this record shift every few years, mimicking modern cycles of sea surface temperature variability, but the earlier part of this record shows shifts lasting decades rather than years.

In addition to exposing mysteries on ancient circulation patterns, coral radiocarbon fluctuations might be useful in estimating oceanic fluxes of carbon dioxide. Carbon dioxide, also called CO2, is the greenhouse gas blamed most for the industrial-age global warming of the planet. So scientists like to keep a close eye on its movements. Yet even in modern times, instrumental records measuring carbon dioxide releases from the ocean are rare.

The equatorial Pacific represents the most significant region of the world's oceans with a net release of carbon dioxide to the atmosphere. According to Beck, it appears that El Niño cycles influence the extent of these releases, through its effect on thermocline. The thermocline is the underwater boundary layer between warmer surface waters and cooler deep waters.

El Niño events cause, in effect, a stagnation of warmer surface waters that puts a lid on underlying cooler waters. As a result, less carbon dioxide is able to escape into the atmosphere. During events of El Niño's counterpart, La Niña, the eastern Pacific thermocline behaves in an opposite fashion.

"During La Niña events, the thermocline can disappear entirely in this region, resulting in exposure of these deeper CO2-rich waters," Beck explained.

Under these circumstances, deeper waters can well up, carrying with them nutrients and carbon that had been buried in the deep waters or even sediments. While fish thrive with the input of nutrients to the surface, the influx of carbon dioxide released from deep waters can contribute to global warming.

"This region is an important region for controlling CO2 emissions into the atmosphere," Beck said. "It's apparent that El Niño modulates these emissions. Whether or not we'll be able to use coral radiocarbon variations to quantify CO2 emissions from the equatorial Pacific remains to be seen."