Tracking the Little Ice Age

What subtropical corals tell us about historical climate change

Mark Roberts, Delia Oppo & Ann McNichol

Some of the most striking images of the climatic event known as the Little Ice Age—a period of large scale, possibly global, cooling between the 16th and the mid-19th centuries—are paintings by Pieter Brueghel the Elder. His iconic works featuring frozen Netherlands canals and other unusually harsh winter scenes are often cited as anecdotal evidence of a cooler planet during this period. At Woods Hole Oceanographic Institution, researchers are looking for evidence of the Little Ice Age in a far more tropical scene: corals.

Delia Oppo, Ann McNichol and Mark Roberts, all of the Geology and Geophysics Department, are evaluating the link between ocean circulation and the sea surface temperature in the low-latitude western Atlantic using radiocarbon measurements in corals from the Bahamas, Yucatan and U.S. Virgin Islands. We know that even small changes in sea surface temperature gradients can influence climate at low latitudes, and these gradients vary on decadal and multi-decadal time scales. To learn more about variation on centennial time scales, researchers need an archive that has lived over hundreds of years.

Coral colonies are the ideal archive for measuring climate over time. They can live for hundreds of years and the annual growth bands in their skeletons—similar to those on trees—can be counted to create a precise timescale. The chemistry of their skeletons also tell us something about ocean conditions at the time of their growth, as measured in properties such as carbon-14, a naturally occurring radioactive isotope of carbon that forms in the atmosphere and enters ocean surface waters. Carbon-14 also appears in coral skeletal bands and when in low amounts might reflect times when deep mixing brought low-radiocarbon from colder deeper waters nearer to the surface where the corals live, whereas skeletal bands with more carbon-14 might reflect times of less intense vertical mixing. Thus, radiocarbon variations recorded in a coral has the potential to tell us about changes in oceanography and circulation, and helps us test ideas about why tropical sea surface temperatures might have been colder in the past.

"When we compare data from the Bahamas versus data from the Florida Keys, we see some interesting differences. Oppo said. "The Bahamas dataset — going back to about 1550 A.D.—more closely reflects the mean carbon-14 in the atmosphere whereas the Florida record shows more evidence of mixing with deeper low-radiocarbon waters. The WHOI NOSAMS laboratory produces data with very small errors, allowing us to resolve very small changes in surface radiocarbon, that might be significant oceanographically. In the future, we'll collaborate with WHOI modelers to understand what these small variations may mean."

The team's goal is not only to take measurements, but also to utilize high precision radiocarbon to understand climate change over the last 400+ years. This multidisciplinary approach has created new opportunities for these researchers.

"Our work capitalizes on our different capabilities," explained Roberts, a physicist who specializes in making high precision measurements. "Delia couldn't do the climate work she does without our carbon dating technologies, and I couldn't do the work I do if she wasn't asking these questions. The data we generate can also be used to test numerical models. If the models do a good job reproducing our data, I have confidence that they can be used to tell us something about the future changes in climate and oceanography."

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>
> —*Mark Roberts*

OCCI awarded $56,723 to Delia Oppo, Ann McNichol and Mark Roberts (co-PIs) for the study, "Using Coral Radiocarbon as a Tracer of Atlantic Circulation during the Last 400 Years."