Polar oceans key to temperature in the tropics

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Scientists have found that the ocean temperature at the earth's polar extremes has a significant impact thousands of miles away at the equator.

Newcastle University's Dr Erin McClymont is part of an international team of researchers who have published research in *Science* today (18 June 2010) demonstrating a close link between the changes in the subpolar climate and the development of the modern tropical Pacific climate around two million years ago.

The team believes this solves another piece of the puzzle concerning oceanic behaviour and its influence on climate.

This research, led by the Institut de Cičncia i Tecnologia Ambientals in Barcelona, studied the Northern Pacific and Southern Atlantic sea-surface temperatures from the Pliocene Era (3.65 million years ago) to the present day. Data obtained during the reconstruction indicates that the regions close to the poles of both oceans have played a fundamental role in the way the tropical climate has evolved.

The cooling and expansion of polar waters between 1.8 and 1.2 million years ago increased the temperature difference between the equator and the poles. This intensified atmospheric circulation and helped to develop the modern day 'cold tongue' in the east Pacific.

Created by a shallow thermocline - the layer of ocean water in which

temperatures fall rapidly - the cold tongue brings cold, deep waters to the surface in the east tropical Pacific. Under the warmer climate of the Pliocene, the thermocline was deeper and the cold tongue was much smaller, creating a situation more like the 'El Niño' events that hit the Pacific every three to five years.

"Our results show that the polar oceans play a key role in the global climate, and that one outcome of a rise in global temperature could be an increase in the depth of the thermocline and contraction of the cold tongue in the eastern Pacific," said Dr McClymont. "The high-latitudes are currently experiencing large climate changes, and our data show that this could impact on tropical climates as we saw in the Pliocene."

The study of Pliocene climate has been the subject of intense research as this era represents the most recent climatic period in the Earth's history when average temperatures were significantly higher than today over a sustained period. As a result, the Pliocene is thought to be the closest predictor of the Earth's climate in the future.

How it works: Analysing deep sea 'fossils'

Researchers analysed marine sediment collected by the international Integrated Ocean Drilling Program, which is supported in the UK by the Natural Environment Research Council (NERC). Sediment cores were drilled in water depths exceeding 3km to measure the composition of alkenones - highly resistant organic compounds produced by phytoplankton.

The phytoplankton live in the surface ocean and change their alkenone chemistry in response to temperature changes. The researchers used these 'biomarkers' or 'chemical fossils' to reconstruct the temperatures of the surface ocean.

"These molecules are 'fossils' in the same way that shells or fish fall to the bottom of the ocean and are preserved," said Dr McClymont, who is a member of the Quaternary Research Group within Newcastle University's School of Geography, Politics and Sociology. "Molecules which remained from the phytoplankton were gradually buried beneath layers of sediment beneath the ocean floor, and by analysing these we were able to reconstruct the temperatures of the surface ocean in the past."

Reconstruction of the surface temperature in the Northern Pacific and Southern Atlantic has enabled a simultaneous sea-surface cooling to be identified in the subpolar regions of the two hemispheres in the period between 1.8 and 1.2 million years ago. This finding coincides with the formation of the equatorial Pacific cold tongue—which currently almost disappears during any El Niño conditions.

Previous studies have shown that, during the warm conditions of the Pliocene, this cold tongue was not present, creating a situation similar to a permanent El Niño situation in the equatorial Pacific.

More information: "Subpolar link to the emergence of the modern equatorial Pacific cold tongue". Alfredo Martínez-García, A; Rosell-Melé, A; McClymont E L; Gersonde R; Haug G. H. Science, 18 June 2010.

Provided by Newcastle University