Press Release

GEOMAR
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Exceptionally rapid onset of coastal upwelling offshore Peru

Kiel marine scientists find significant changes in the eastern Pacific during the past 10,000 years

31 July 2015/Kiel. **The coastal upwelling of cold and nutrient-rich waters off Peru and Ecuador is significant not only for the regional fishing industry, but also for the global carbon cycle and thus for the Earth's climate. As part of the Kiel Collaborative Research Centre 754, scientists of the GEOMAR Helmholtz Centre for Ocean Research Kiel examined how this system has developed and changed in the past. Their work showed that coastal upwelling only began there ~10,000 years ago, and then continuously expanded northward along the South American coast. Climatic fluctuations in the northern hemisphere and processes in the tropical western Pacific influenced these processes. The study has now been published in the international journal *Paleoceanography*.**

The interaction between the ocean's surface and climate is extremely complex. On the one hand, the ocean stores the climate-relevant carbon dioxide (CO_2). This process works especially well at low water temperatures, and when large amounts of plankton bind CO_2 by photosynthesis, which both occur in areas where cold, nutrient-rich water from deeper waters reaches the ocean surface. On the other hand, these upwelling processes can also transport old, CO_2-rich waters from the deep ocean to the surface and bring the greenhouse gas back to the atmosphere. Upwelling regions are therefore particularly exciting study regions for marine scientists.

Within the Collaborative Research Centre 754 "Climate - Biogeochemistry Interactions in the Tropical Ocean", a team of paleo-oceanographers of GEOMAR Helmholtz Centre for Ocean Research Kiel has discovered that coastal upwelling in the tropical eastern Pacific changed significantly over the past 17,000 years, sometimes very rapidly. "The changes in the ocean circulation that are shown by very rapid temperature and salinity fluctuations indicate a highly dynamic and sensitive climate system, which we had not expected," says Prof. Dr. Dirk Nürnberg from GEOMAR, lead author of the study, that has just been published in the international journal *Paleoceanography*.

For its climate reconstructions, the team analyzed sediment core samples obtained offshore Peru with the German research vessel METEOR from water depths of 300 to 1000 meters. The researchers extracted microscopic fossils, called foraminifera, as well as organic carbon molecule chains, from the sediments, which cover the time from the end of the last ice age to today. The ratio of stable isotopes in the calcareous shells of foraminifera can provide accurate information about the past temperatures and salinities of seawater. Similar information is provided by the organic molecular compounds produced by calcifying algae (coccolithophorids).

These analyses illustrate the spatial and temporal variability of the water mass structure offshore Peru. "The reasons for this are difficult to understand," says Dr. Tebke Böschen, co-author of the study: "The eastern equatorial Pacific is very complex, but we can identify some individual control mechanisms. The near-surface water masses are driven by the changes in the position of the tropical rain belt. Thus they are influenced by processes in the atmosphere." This also applies to the seasonal coastal upwelling, which began only at the beginning of the present interglacial period (10,000 years ago) and has been very intense especially since about 4000 years ago.

Changes in the deeper water conditions, however, have other causes. "Here, processes in the tropical western Pacific play a role, which control the deeper eastward-moving equatorial waters, and probably are linked with the El Niño and La Niña phenomena," says Professor Dirk Nürnberg.

The findings of this study will not only help in the reconstruction of climate history. "The described fast oceanographic and climatic changes in the past had far-reaching and complex consequences. We must consider these processes if we want to evaluate and assess the current and future consequences of man-made global warming," predicts Dr. Böschen.

Background information: SFB 754
The Collaborative Research Center 754 (SFB 754) "Climate - Biogeochemistry Interactions in the Tropical Ocean" was established in January 2008 as a cooperation between the Kiel University (CAU), the GEOMAR Helmholtz Centre for Ocean Research Kiel and the Max Planck Institute Bremen. The SFB 754 investigates the changes in oceanic oxygen levels, their potential impact on the oxygen minimum zones and the consequences on the global interaction between climate and biogeochemistry of tropical oceans. The SFB 754 is funded by the German Research Foundation (DFG) and is in its second phase (2012-2015).

Reference:
Nürnberg, D., Böschen, T., Doering, K., Mollier-Vogel, E., Raddatz, J. und Schneider, R. (2015): Sea surface and subsurface circulation dynamics off equatorial Peru during the last ~17 kyrs. Paleoceanography, http://dx.doi.org/10.1002/2014PA002706

Links:
www.geomar.de GEOMAR Helmholtz Centre for Ocean Research Kiel
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