Climate Processes Amplify Response To Orbit Changes

04.02.2015

04.02.2015 07:16 Age: 14 hrs

According to a recent study the earth's orbit affects the stability of Antarctica's Eastern ice cap

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From the University of Granada

Seabed sediments dating back to around 2.2-4.3 million years reveal that there was a generalized thaw, according to an article published in the journal Nature Geosciences

This research, which counts with the participation of the Andalusian Institute of Earth Sciences, indicates that the emission of greenhouse gases has a higher impact upon thaw than changes in the earth's orbit.

An international research team led by the High Council for Scientific Research (CSIC in its Spanish acronym) and with the participation of the University of Granada, has found that there is a direct relation between the changes in the earth's orbit and the stability of the Eastern ice cap of Antarctica, more specifically, on the continental fringe of Wilkes Land (East Antarctica). 29 scientists from 12 different countries participated in this study, which has been published in the journal Nature Geosciences.

This study is based upon the analysis of seabed sediments which were transported by icebergs around 2.2-4.3 million years ago, and which have been collected during an expedition of the Integrated Ocean Drilling Program.

The data obtained reveal that natural climatic processes can increase the response of polar ice caps to minor changes in energy caused by modifications in the earth's orbit. The sea level can either decrease or increase by as much as dozens of metres. This study shows that 2.5 million years ago, when the concentration of carbon dioxide in the atmosphere was similar to the current one, the thawing of the eastern Antarctic ice cap was a generalized process.

"This study helps solve the mystery of how the Earth's orbit around the Sun contributes to the stability of ice caps", according to Carlota Escutia, a researcher at the Andalusian Institute of Earth Sciences (a CSIC-UGR joint institution), which has led the expedition.

Greenhouse effect gases

"The emission of greenhouse effect gases has, nevertheless, a much larger energy impact than that provided by any changes in the earth's orbit", according to Escutia.

The analysis of sediments shows that the stability of the largest ice cap on earth is influenced by the presence of sea ice in the oceans that surround Antarctica. This sea ice is a layer of frozen seawater that creates a protective shield around the continent and the Antarctic ice caps, and it is sensitive to the warming up of oceans generated as a result of the increase in greenhouse effect gasses. "The disappearance of this sea ice can result in the melting of the ice caps and in the increase of sea level by several metres", adds Escutia.

Millions of years ago, under conditions of high concentration of carbon dioxide—as is also the case now—and ocean temperatures slightly higher than those currently registered, the oceans surrounding Antarctica could no longer sustain the sea ice. Escutia points out that “the disappearance of this protective shield allowed oceanic currents pushed by the winds to penetrate down to the base of the ice caps, provoking their thaw”.

This study speculates with a potentially generalized thaw of Antarctica’s Eastern ice cap in the future if we fail to reduce the levels of carbon dioxide in the atmosphere.

Abstract

The Pliocene and Early Pleistocene, between 5.3 and 0.8 million years ago, span a transition from a global climate state that was 2–3 °C warmer than present with limited ice sheets in the Northern Hemisphere to one that was characterized by continental-scale glaciations at both poles. Growth and decay of these ice sheets was paced by variations in the Earth’s orbit around the Sun. However, the nature of the influence of orbital forcing on the ice sheets is unclear, particularly in light of the absence of a strong 20,000-year precession signal in geologic records of global ice volume and sea level. Here we present a record of the rate of accumulation of iceberg-rafted debris offshore from the East Antarctic ice sheet, adjacent to the Wilkes Subglacial Basin, between 4.3 and 2.2 million years ago. We infer that maximum iceberg debris accumulation is associated with the enhanced calving of icebergs during ice-sheet margin retreat. In the warmer part of the record, between 4.3 and 3.5 million years ago, spectral analyses show a dominant periodicity of about 40,000 years. Subsequently, the powers of the 100,000-year and 20,000-year signals strengthen. We suggest that, as the Southern Ocean cooled between 3.5 and 2.5 million years ago, the development of a perennial sea-ice field limited the oceanic forcing of the ice sheet. After this threshold was crossed, substantial retreat of the East Antarctic ice sheet occurred only during austral summer insolation maxima, as controlled by the precession cycle.

Citation

Orbital forcing of the East Antarctic ice sheet during the Pliocene and Early Pleistocene by O. Patterson, R. McKay, T. Naish, C. Escutia, F. J. Jimenez-Espejo, M. E. Raymo, S. R. Meyers,, L. Tauxe, H. Brinkhuis, IODP Expedition 318 Scientists. Orbital forcing of the East Antarctic ice sheet during the Pliocene and Early Pleistocene by M. O. Patterson, R. McKay, T. Naish, C. Escutia, F. J. Jimenez-Espejo, M. E. Raymo, S. R. Meyers,, L. Tauxe, H. Brinkhuis, IODP Expedition 318 Scientists published in Nature Geosciences DOI: 10.1038/NGEO2273

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