Microfossils unravel climate history of tropical Africa

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Scientists from the NIOZ Royal Netherlands Institute for Sea Research obtained for the first time a detailed temperature record for tropical central Africa over the past 25,000 years. They did this in cooperation with a German colleague from the University of Bremen, The scientists developed an entirely new method to reconstruct the history of land temperatures based on the molecular fossils of soil bacteria.

They applied the method to a marine sediment core taken in the outflow of the Congo River. This core contained eroded land material and microfossils from marine algae. The results show that the land environment of tropical Africa was cooled more than the adjacent Atlantic Ocean during the last ice-age. This large temperature difference between land and ocean surface resulted in drier conditions compared to the current situation, which favours the growth of a lush rainforest. These findings provide further insight in natural variations in climate and the possible consequences of a warming earth on precipitation in central Africa. The results were published in this week's issue of *Science*.

One of the techniques currently used to estimate past sea surface temperatures, is based on organic molecules from algae growing in the surface layer of the Ocean. These organisms adapt the molecular composition of their cell membranes to ambient temperature to maintain constant physiological properties. When such molecules sink to the sea floor and are buried in sediments where oxygen does not penetrate, they can be preserved for thousands of years. The ratios between the different molecules from the algal cell membrane can be used to approximate the

past temperature of the sea surface. These techniques are therefore called 'proxies'.

New method to measure soil temperatures

Reconstructing continental temperature history is more difficult than for the oceans, because soils on the continent do not form a continuous archive but are often eroded. The researchers developed an entirely new proxy for the annual mean air temperature on land, based on molecules from the cell membrane of soil inhabiting bacteria. They analysed eroded soil material in a sediment core in the outflow area of the river Congo in the South Atlantic Ocean at a depth of almost 1000m. Since the Congo River drains a large part of tropical central Africa, the land derived material gives an integrated signal for a very large area.

Cool tropical Africa

The new proxy was used in this sediment core to obtain both a continental and a sea surface temperature record. A comparison of both records shows that ocean surface and land temperatures behaved differently during the past 25,000 years. During the last ice age, temperatures over tropical Africa were 21°C, about 4°C lower than today, whereas the tropical Atlantic Ocean was only about 2.5°C colder.

By comparing this temperature difference with existing records of continental rainfall variability, lead author Johan Weijers and his colleagues concluded that the land-sea temperature difference has by far the largest influence on continental rainfall. This can be explained by the strong relationship of air pressure to temperature. When the temperature of the sea surface is higher than that of the continent, stronger offshore winds reduce the flow of moist sea air onto the African continent.

This occurred during the last ice age and, as a consequence, the land climate in tropical Africa was drier than it is in today's world, where it favours the growth of a lush rainforest. These results provide further insight into the natural variation of climate and the possible consequences of a warming earth on precipitation in central Africa.

Source: Netherlands Organization for Scientific Research