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Impacts of tectonic and orbital forcing on East African climate: A comparison based on global climate model simulations.

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Tectonic uplift and erosional denudation can have drastic effects on global and regional climate patterns, which in turn have a significant impact on ecosystems and the distribution of biogeographic zones. The interdisciplinary Research Unit RiftLink (www.riftlink.de) addresses the causes of rift-flank uplift in the East African Rift, its impact on climate changes in equatorial Africa, and the possible connection to the evolution of hominids. Understanding the mechanisms and origin of atmospheric moisture transport is essential for the interpretation of paleoclimatic proxies.

Here, we present results from the climate modelling component of RiftLink. The global atmosphere-ocean model ECHO-G has been forced with topographic and orbital scenarios in order to evaluate the relative role of both factors for the past climate of East Africa. The model consists of the ECHAM4 atmosphere model at approx. 3.75° resolution coupled to the HOPE-G ocean model at approx. 2.8°. Forcing the model with a significantly reduced topography in Eastern and Southern Africa leads to a distinct increase in moisture transport from the Indian ocean into the eastern part of the continent and increased precipitation in Eastern Africa. Simulations with step-wise reduced height show that this climate change occurs continuously with the change in topography, i.e. an abrupt change of local climatic features with a critical height is not found.

If these results are used for the interpretation of proxy data, it has do be considered that other forcing factors can lead to comparable changes in moisture availability. As an example, we tested the impact of changes in the Earth's orbit around the Sun. For these simulations, we forced the same climate model with the orbital configuration of the last interglacial (at 125,000 years before present, i.e. the Eemian interglacial) and the last glacial inception (at 115,000 years before present). The induced changes in the seasonal and spatial structure of insolation lead to modifications in meridional temperature gradients, which are in turn responsible for changes in moisture transport.

For the Eemian, this also leads to a drastic reorganization of moisture transport over the African continent and results in a change in East African precipitation of the same order of magnitude as for the topographic scenarios. For the last glacial inception, the simulated seasonal cycle in precipitation does not differ much from the preindustrial case. For both cases the impact of orbital-induced changes is stronger in other regions of Africa than in East Africa. The East African highlands reduce the effect on this region due to the redirection of moisture transport. It can therefore be assumed that orbital impacts on East African climate would be even stronger during episodes with reduced elevation.