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Past changes in African climate and vegetation based on regional climate simulations

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With regional climate models African climate can be analysed for special periods in time with more spatial detail than with global climate models. In this study we used the non-hydrostatic regional climate model CLM (www.clm-community.eu) with a spatial resolution of approx. 50 km for two different periods in the past. These regional simulations were driven by global simulations performed with the coupled ocean-atmosphere general circulation model ECHO-G. The first period we analysed is the last interglacial called Eemian at 125,000 years before present. During the Eemian the orbital configuration was different compared to today resulting in a different distribution of insolation at the top of the atmosphere with enhanced seasonality on the northern hemisphere and weakened seasonality on the southern hemisphere. The regional simulation shows that this orbital configuration leads to strong changes in temperature and precipitation over large parts of Africa. These changes are very different for boreal winter and summer. From December to February it was mainly colder and drier during the Eemian, whereas from June to August the Eemian was warmer and wetter compared to preindustrial African climate. To analyse changes in vegetation we applied a biome model, which was driven by mean annual cycles of the simulated temperature, precipitation and total cloud cover. The results show e.g. a northward shift the southern border of the Sahara, a meridional enlargement of the tropical forests, and the development of a desert over Botswana and Zimbabwe. The second period we analysed represents a possible stage of the development of the East African Rift System within the last 20 million years. During this stage the orography over large parts of Eastern and Southern Africa was half as elevated as today. This change in orography leads to a warming over the less elevated regions and a more complex change in precipitation patterns with a strong decrease over central Africa. This results in a strong reduction of rain forest extent.