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A comparison of tectonic, orbital and vegetation forcing on East African climate based on simulations with a global coupled ocean-atmosphere model

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A set of global climate simulations was performed in order to compare the role of different forcing factors for East African climate. The simulations consider changes in topography, orbital parameters and land surface. The coupled ocean-atmosphere general circulation model ECHO-G (ECHAM4 atmosphere model at approx. 3.75° resolution coupled to HOPE-G ocean model at approx. 2.8°) has been used to perform time-slice experiments with different combinations of these forcing factors. One simulation with present-day topography, vegetation cover and orbital parameters is used as default configuration for comparison. Compared to this run, the topography of Eastern and Southern Africa is removed in one simulation. This run is similar to the configuration used by Sepulchre et al. (Science, 2006). Consistent to their results, our simulations show a distinct increase of East African precipitation, when the topographic barrier is reduced. However, as tectonic forcing is not the only relevant forcing factor at these time scales, we compare the simulation with additional model runs: As contrasting examples for the possible impact of orbital forcing, we used simulations of the last interglacial (Eemian, approx. 125000 years before present) and the last glacial inception (115000 years before present). These phases are characterized by enhanced and weakened seasonality of northern hemispheric insolation. For the Eemian a belt with significantly increased summer precipitation occurs over Africa around 10°N, which is caused by enhanced moisture transport from the Atlantic ocean, whereas a distinct reduction of precipitation is simulated for Eemian winter as well as for the glacial inception. As changes in topography and climate imply changes in vegetation, we evaluate the role of land cover in an additional model experiment. Here, we assumed that without the elevated topography, the vegetation coverage in Eastern Africa

would be similar to that of the western part on the same latitudes. In the simulation, this also leads to distinct changes in precipitation in Eastern Africa. The sign of changes is regionally different, but their magnitude is less than the direct effects of the topographic changes.