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Topographic development in the late Neogene and the impact on African vegetation

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Hominid evolution, specifically the split of the hominid-chimpansee lineages in the late Miocene has long been hypothesized to be linked to the retreat of the tropical rainforest in Africa in the late Miocene. A main cause for the climatic and vegetation change often considered was uplift of Africa but also uplift of the Himalaya and the Tibetan Plateau was suggested to have contributed to an intensification of the African-Asian monsoon system and hence impacted rainfall distribution over Eastern Africa. In contrast, more recent proxy data suggest that open grassland habitats were available to human ancestors and apes long before their divergence and that there is no evidence for a closed rainforest in the late Miocene.

We use the coupled global circulation model CCSM3 with an online coupled dynamic vegetation module to investigate the impact of the uplift processes on the African-Asian monsoon circulation and consequent changes in tropical African vegetation. The model is run with a resolution of T85 ($\sim$1.4°) for the atmosphere and land surface and a variable resolution for the computation of ocean and sea ice down to a meridional grid spacing of 0.3° around the equator. We performed a set of sensitivity experiments, altering elevations of the Himalaya and the Tibet Plateau and of East and South Africa separately and in combination from half to full present day level.

The simulations confirm the dominant impact of the East and South African uplift for climate and vegetation development of the African tropics. Only a weak, but significant, impact of the prescribed Asian Uplift on African monsoon and vegetation development could be detected. Himalaya/Tibet Plateau uplift lead to slightly dryer conditions in Central Africa and small increases in rainfall over East Africa. According to the model simulations topographic uplift of Africa significantly altered rainfall in Central Africa, which coincides with proxy records from the Congo basin showing a change towards more humid conditions in the late Miocene. In our model simulation this leads to a large increase in the forested area in Central Africa and especially an increase in broadleaved evergreen forest taxa, whereas deciduous forest and grasses decrease. In East Africa also under low-topography conditions a savannah type vegetation coverage characterized by grassland and shrubs exists. Uplift leads to a significant drying which goes along with a reduction in vegetation cover density. Hence, despite a drying trend with uplift, also with lowered African topography the conditions were not favorable enough to maintain a closed rainforest in eastern Africa, which is in agreement with the most recent proxy data.