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Tectonic forcing in East Africa and its impact on regional climate

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The development of the East African Rift System (EARS) during the last 20 Ma BP caused by tectonic forcing is supposed to influence the regional climate in Africa. The analysis of these tectonic impacts is one topic within the research group RiftLink (www.riftlink.de). To investigate the impact of tectonic forcing the non-hydrostatic regional climate model CCLM (COSMO model in CLimate Mode) is applied with a horizontal resolution of approximately 50 km. The model is forced by simulation results of a coupled ocean-atmosphere model (ECHAM5/MPI-OM).
First sensitivity studies have been performed with changes only in the model topography. These changes represent tectonic forcing. As detailed information on East African topography during the development of the EARS is missing, we first applied topographies introduced by previous global model studies. The applied topographic changes might refer to the end of the Miocene (approximately 5.5 Ma BP). The simulation results indicate that tectonic forcing has a strong impact on precipitation in Africa caused by changes in the circulation and hence moisture transport. The changes in 2m temperature are very regional and associated with changes in topography. Furthermore, the Integrated BIosphere Simulator (IBIS-2) is applied to the climate model results to investigate any vegetation shifts between today and Miocene that are related to tectonic forcing. The vegetatation model tends to simulate drier bioformations with the adapted topography. Thus, the tectonic shift applied in the climate model helps explaining East African aridification from the Miocene to today found in different proxy data. However, other forcing factors seem to be necessary to fully explain the aridification. Therefore, additional work is dedicated to the investigation of the impact of rather global forcing factors like changes in greenhouse gas concentrations or orbital forcing. The combination of these forcing factors is applied for the time slice of the late Miocene.
The impact of modified topography on local climate is also analysed for higher resolutions of roughly 7 km over the central part of the EARS. The shoulders of the rifts are lowered and the valleys are uplifted resulting in a smoothed topography. This changes significantly the local precipitation and temperature patterns.