Tectonic forcing in East Africa and its impact on regional climate

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Introduction

Feedback between 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 biogeographic zone distributions. *RiftLink* addresses the causes of rift-flank uplift in the East African Rift System (ERAS) since the Late Miocene, its impact on climate changes in Equatorial Africa, and the possible consequences for the evolution of hominids. The climate modelling part within *RiftLink* concentrates on climatic changes caused by changes in tectonic forcings. To analyse these forcings the regional climate model COSMO-CLM is applied to simulte the Miocenian Climate in Africa on a horizontal resolution of 0.5°. In a first sensitivity study, the topography was significantly reduced and the affecting impact on regional and local climate was analyzed.

The COSMO-CLM model

The non-hydrostatic regional model COSMO-CLM is the climate version of the regional weather prediction model of the German Meteorological Service and is developed as a community effort of several research centers and universities. In this study it has a horizontal resolution of 0.5° and 32 vertical layers. The simulation area covers nearly the whole of Southern and Eastern Africa.

Precipitation and moisture Transport

Significant impacts can be seen in total accumlated precipitation as well as in vertical integrated meridional moisture transport.

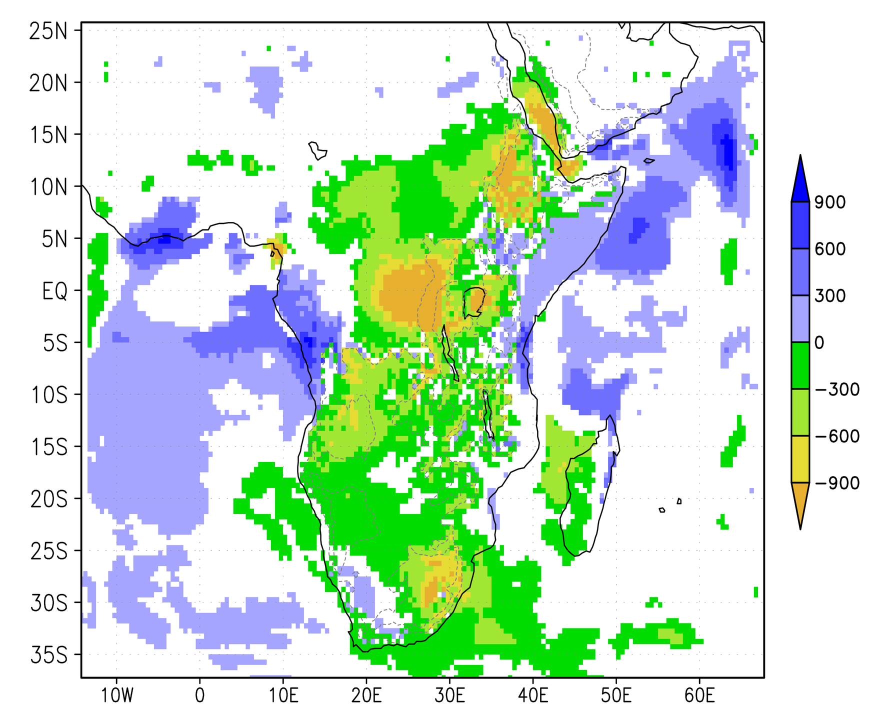

Fig. 2: differences in Precipitation

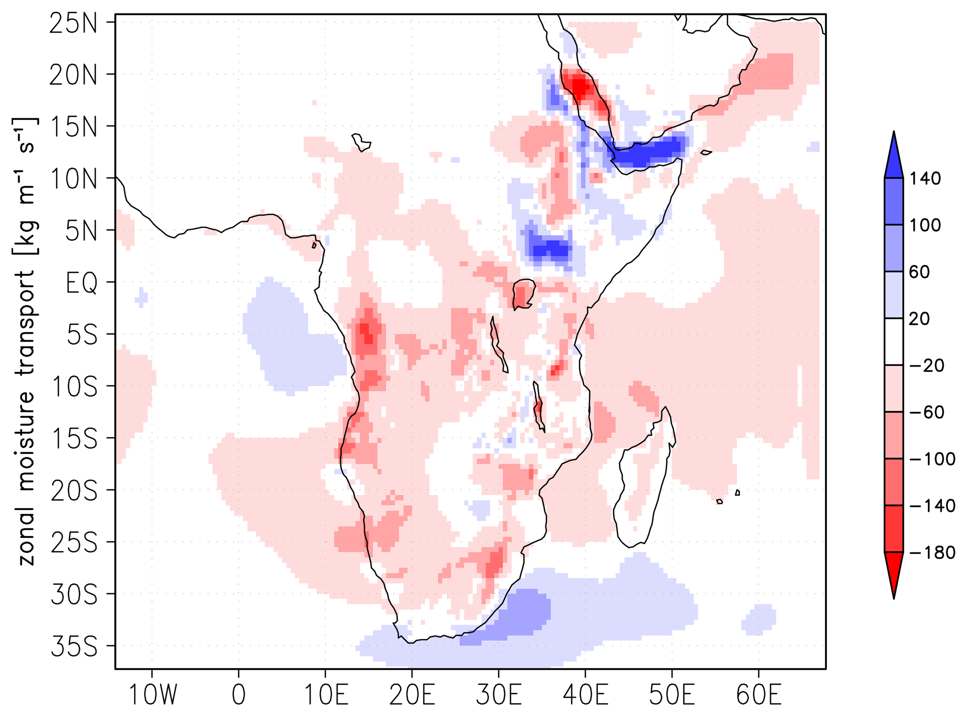

Fig. 3: differences in yearly moisture transport

Model Setup

- 30 (1965-1994) years simulation period with a resolution of 0.5° and 0.0625°
- forced by ERA40[1] reanalysis climate data
- Adjusted topography that were implemented by:

  - removal of the highest peaks of the central EARS (¨no-peaks¨)

  - and 50% reduction of topography.

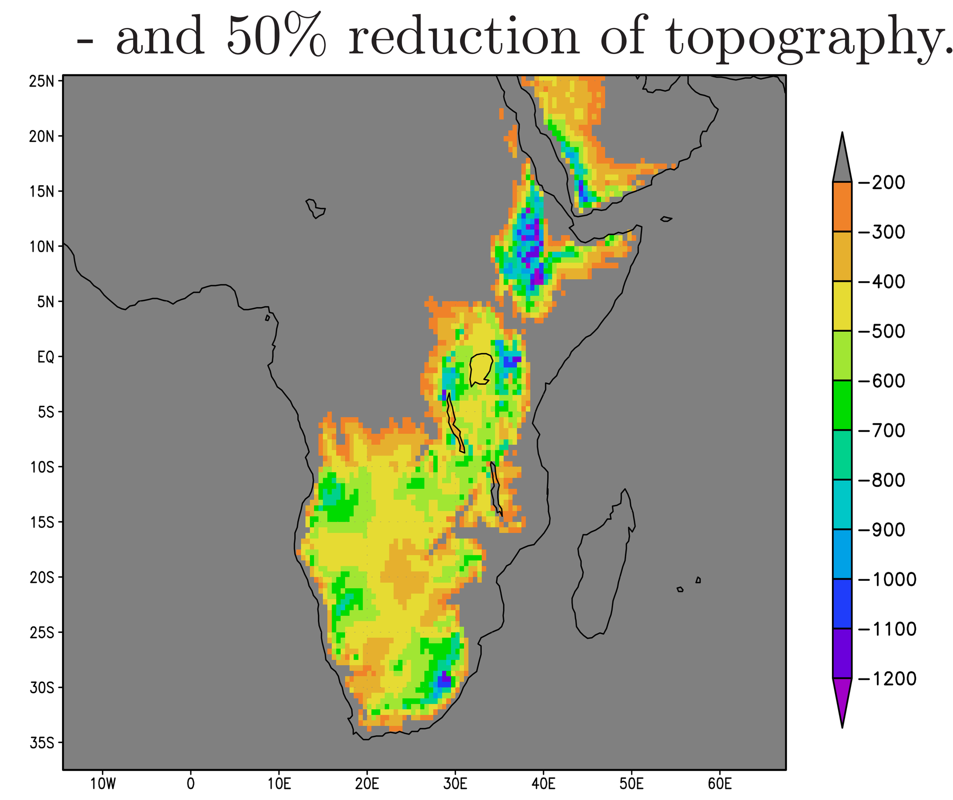

Fig. 1: Considered region an it topography variation

Impacts on Vegetation

Significant differences in precipitation, moisture transport and also temperature lead to a aridification in central and south Africa and to a slightly humidification in east Africa.

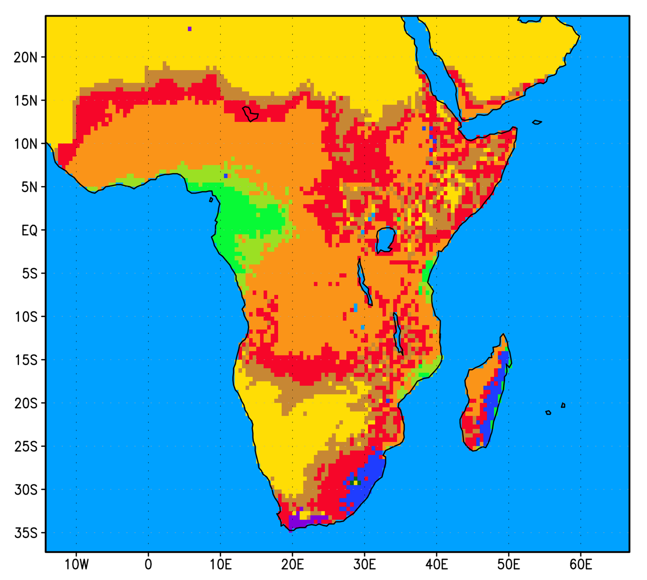

Fig. 8a: Biomes occurring with changed Topography

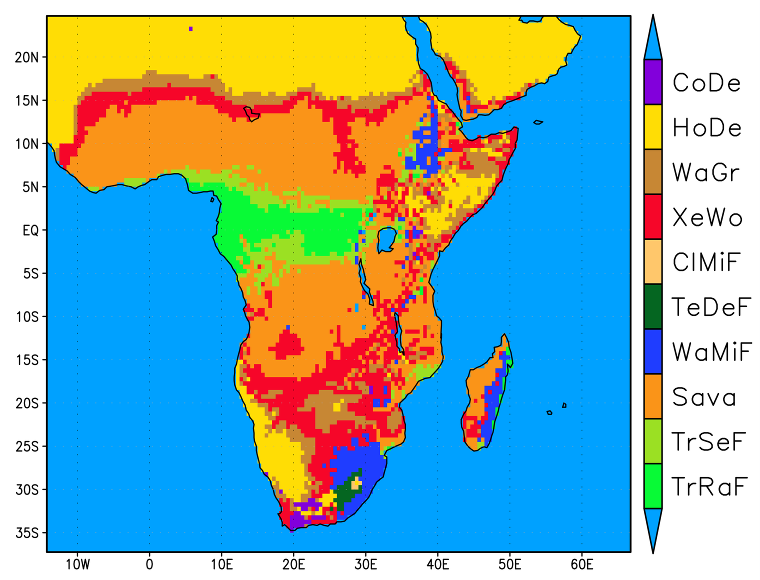

Fig. 8b: Biomes occurring with unchanged Topography

High resolution simulation for Lake Victoria

Double-nesting with 0.0625° horizontal resolution for the Lake Victorian area:

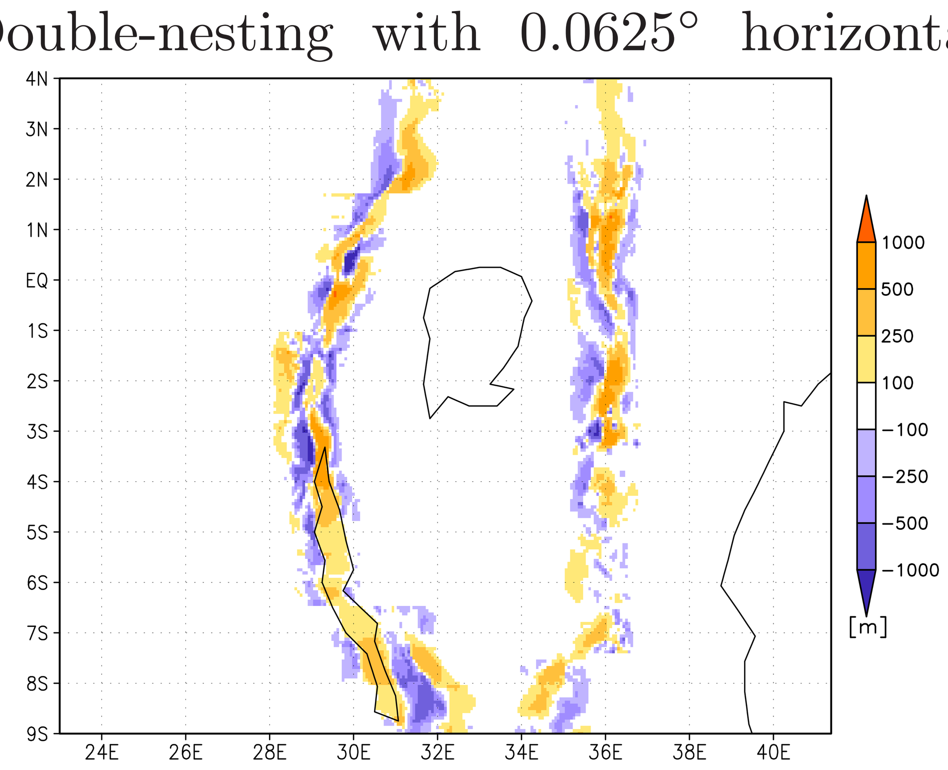

Fig. 5: Topography changes for the region

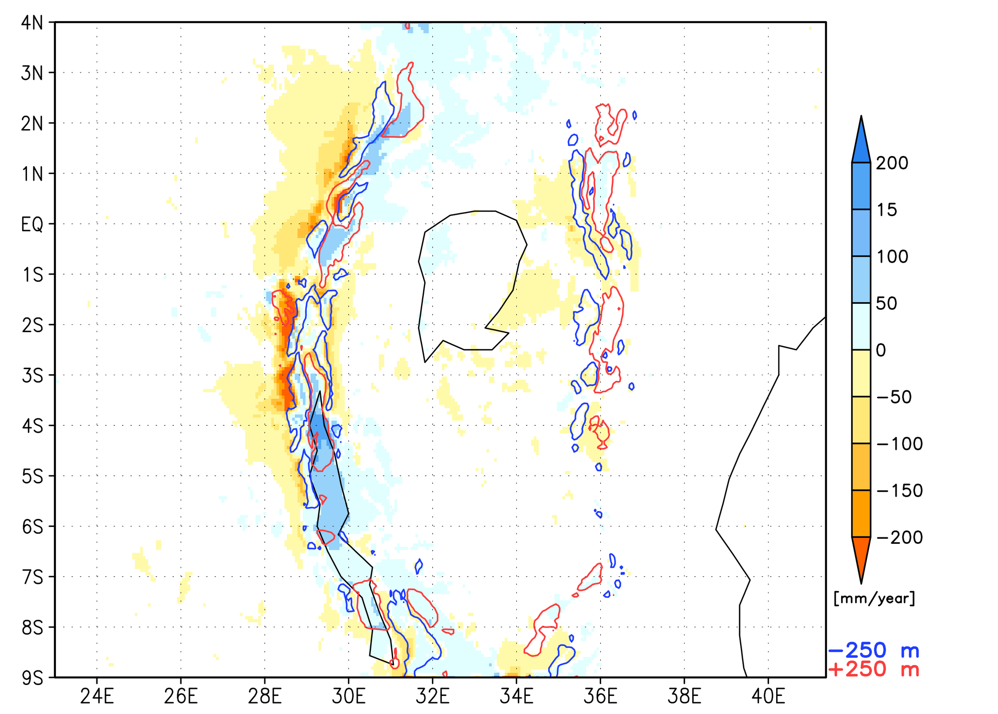

Fig. 6: Yearly total accumulated precipitation

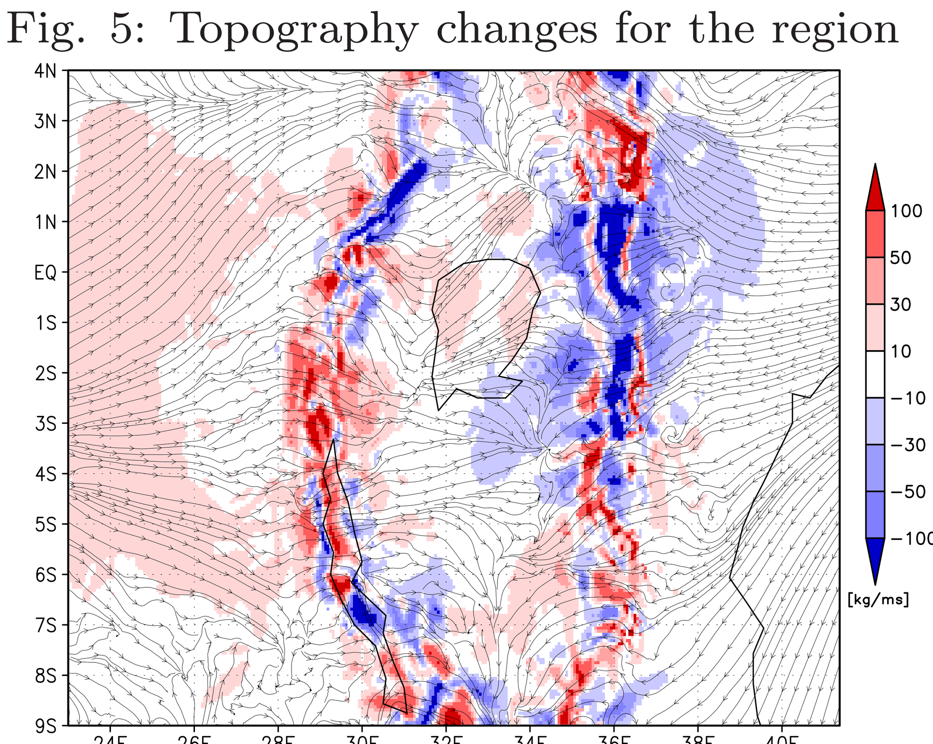

Fig. 7a: changes in mean winter moisture transport

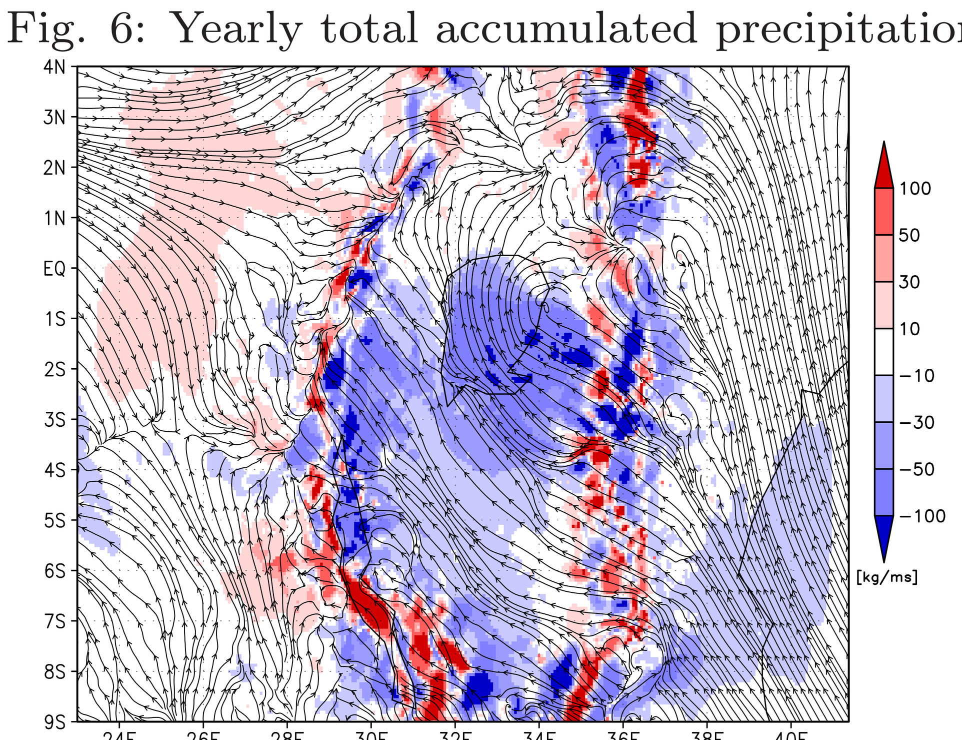

Fig. 7b: changes mean summer moisture transport

Outlook

Future work will be dedicated to:

- further COSMO-CLM simulations driven by ECHAM5/ MPI-OM/JSBACH palaeo simulations corresponding to late-Miocene [2].
- the adjustment of the fixed boundary conditions in COSMO-CLM according to late-Miocene. These are:
  - land-sea distribution
  - vegetation distribution
  - soil distribution
  - topography reduction for the whole continent
  - CO_2 distribution and orbital parameters

References

[1]: Uppala, S. M. et. al, *The ERA-40 re-analysis*, 2005, Quarterly Journal of the Royal Meteorological Society 131(612), 2961-3012
[2]: Krapp, M and J. H. Jungclaus, *The Middle Miocene climate as modelled in an atmosphere-ocean-biosphere model*, 2011, Climate of the Past 7(4),1169-1188