Project: **1374**

Project title: **TIPPing points Explained by Climate Change (TIPPECC)**

Principal investigator: **Torsten Weber**

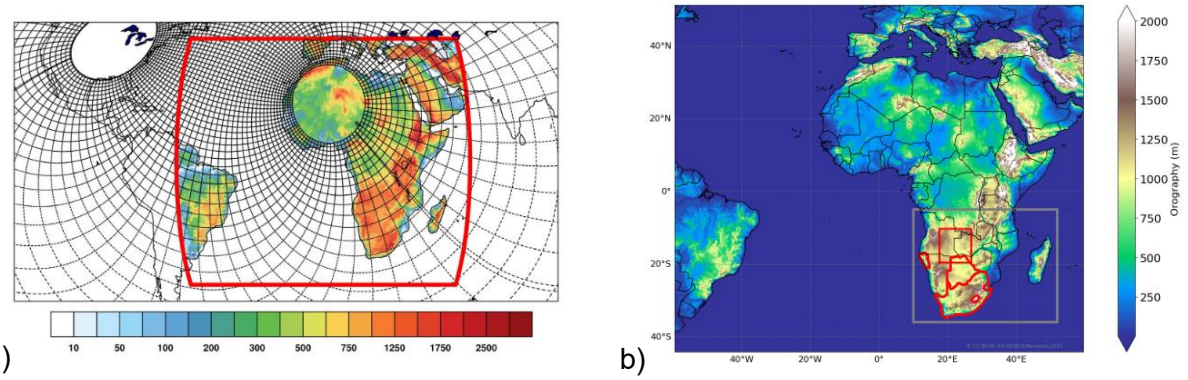
Report period: **2024-05-01 to 2025-04-30**

Project Overview

The TIPPECC project ("Tipping Points Explained by Climate Change") focuses on southern Africa and is funded through the BMBF SASSCAL 2.0 program (FKZ01LG2049B) for three years plus a cost-neutral one-year extension. In response to the SADC Grand Challenge, TIPPECC addresses climate change-induced tipping point risks in the region. At GERICS, we lead Work Package 1 (WP1), developing new high-resolution regional climate projections for southern Africa using the ROM (GERICS-AWI) model driven by the AWI-CM GCM from the CMIP6 simulations.

Planned work, performed simulations, summary of preliminary result

As part of the work package 1, GERICS is providing a high-resolution regional climate projection using a GCM from the CMIP6 ensemble as the driving model. In the previous plan, GERICS will use the coupled system ROM[1] currently maintained in AWI, which contains REMO as the atmospheric component and the Max Planck Institute Ocean Model (MPIOM) as the global oceanic component. The modelling domain at a horizontal resolution of 0.22 degree x 0.22 degree for REMO is shown in Fig. 1a and the new resolution at 0.11 degree x 0.11 degree resolution for REMO with regions of research interest is shown in Fig. 1b.



a) b)

Fig. 1 Model domains at 0.22 degrees (a) and at 0.11 degrees (b) spatial resolution and orography (m). In (a), the coupled domain has a spatial resolution of 0.22 degrees (red box) and for MPIOM with a TR04 grid (black grid). Source: Weber et al, 2023. In (b) the large gray box shows the TIPPECC region over southern Africa. The red outlines show the case study regions of Kunene and Upper Zambezi river basins in Namibia and the countries of Botswana and South Africa.

To contribute to the high resolution simulations that were planned in this project, the resolution of the REMO was increased to 0.11 degree x 0.11 degree. Due to the increase of resolution and storage spaces, the planned experiment using the ERA5 reanalysis is postponed to prioritized the historical simulations of the coupled and uncoupled simulations of ROM.

The revised plan and current status of the simulations are listed in Table 1.

[1]Weber, T., Cabos, W., Sein, D.V. et al. Benefits of simulating precipitation characteristics over Africa with a regionally-coupled atmosphere–ocean model. Clim Dyn 60, 1079–1102 (2023). https://doi.org/10.1007/s00382-022-06329-7.

Table 1. Revised planned simulations at 0.11 x 0.11 degree simulation.

Experiment ID	Description	Simulation years	Status
REMO_uncoupled_REAN	Uncoupled ROM driven by reanalysis	1981 to 2010 (30)	Postponed
REMO_AWICM_HIST	Uncoupled ROM driven by AWI-CM	1951 to 2014 (64)	Done
ROM_AWICM_HIST	ROM driven by AWI-CM	1951 to 2014 (64)	Done
ROM_AWICM_ssp370	ROM driven by AWI-CM	2015 to 2100 (86)	In preparation

As preliminary results, Fig. 2 show the mean annual precipitation results for the historical period (1981 to 2010) from observational datasets (CRU and CHIRPS) compared with the uncoupled and coupled simulations of ROM. The coupled simulation (ROM_AWICM_HIST) reproduced the annual rainfall pattern well especially over West Africa compared to the uncoupled simulation (REMO_AWICM_HIST). These results were presented[2] during a conference in South Africa, where we acknowledge the use of the computing resources in DKRZ.

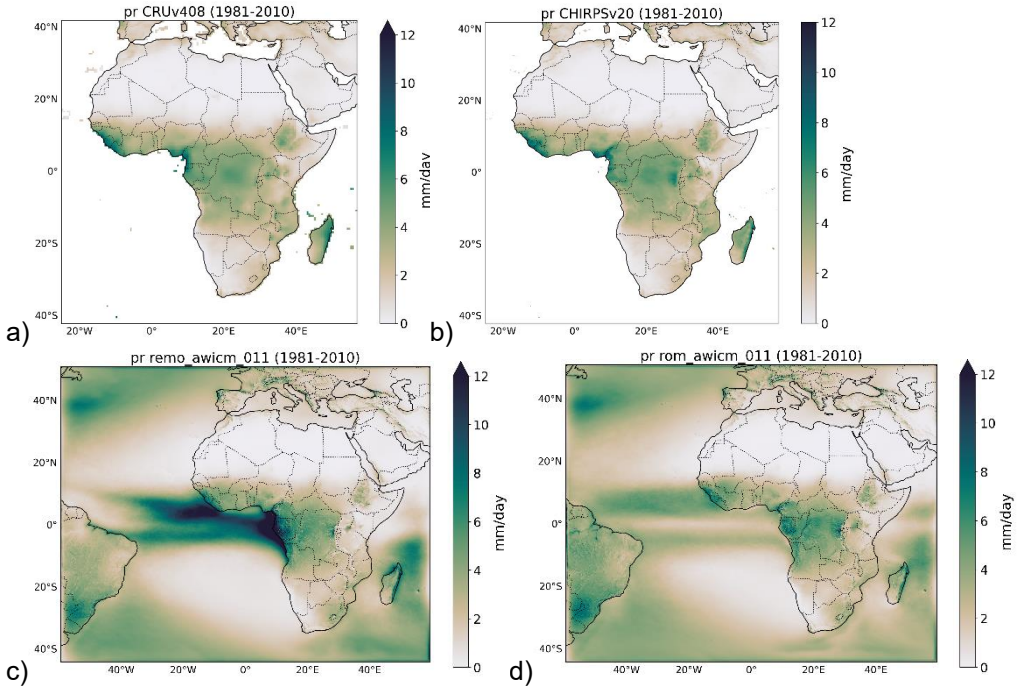


Fig. 2. Mean annual precipitation (mm/day) of a) CRU, b) ERA5, c) REMO-AWICM, and d) ROM-AWICM for the historical period (1981 to 2010).

The next steps will be a transient, high-resolution projection using the ssp370 scenario with the AWI-CM GCM (ROM_AWICM_ssp370). Details of computing resource requests are being applied for in the accompanying DKRZ Computing Request Form for 7/2025 to 6/2026.

Resources used at DKRZ

Table 4 shows the computing time used during the reporting period based on luv.dkrz.de. With the high resolution setup over the whole African domain, the estimated data storage for a-files is about 180 GB/month and for e-files is about 260 GB/month.

Table 4: Resources used in levante (Node-hours).

System	Period	Node-hours
Levante	7/2024 to 6/2025	39872

[2]Remedio, A., Weber, T., Sein, D., Steinkopf, J., Padvatan, J., Goikantswemang, T., Dhliwayo, M., Perkins, J., and Engelbrecht, F. Representing Historical Drought Conditions using the Latest High-Resolution Regional Climate Simulations over Southern Africa, 38th Annual Conference of the South African Society for Atmospheric Sciences, 29-30 October 2024, Potchestroom, South Africa (Conference Proceedings ISBN: 978-1-0370-1666-0).