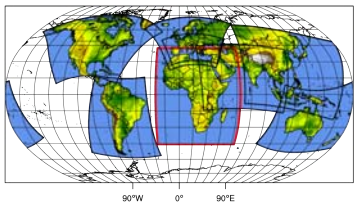

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Regional climate change assessment for central Africa

Some findings from the project "Climate Changes Scenarios for the Congo Basin" and CORDEX Africa

I) Analysis of projected change signals in the RCM and its forcing GCM simulations

Transient climate change projections have been conducted with REMO over the CORDEX Africa domain (0.44° horizontal resolution) for the RCP2.6; RCP4.5 and RCP8.5 emission scenarios for the period 1950 to 2100. REMO has been forced with MPI-ESM_LR and EC-EARTH. Projections conducted under konsortial share as well as under the CONGO project (bc0705). For the latter the projections served as base for a regional climate change assessment (see right part of poster).

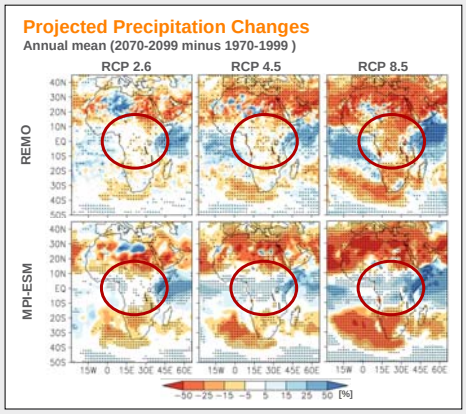


Figure I.1 presents the projected changes for annual total precipitation in the REMO (upper row) and its forcing MPI-ESM_LR (bottom row) simulations for the end of the 21st century following three different RCP scenarios. The black dots in the precipitation figures highlight regions with statistical significant changes (on the 95th confidence level using Man-Whitney U-Test).

	ECHAM			REMO		
	1961-90	2036-65	2071-00	1961-90	2036-65	2071-00
RCP2.6	12.39	18.95	18.03	135.6	137.1	138.7
RCP4.5	12.39	29.57	31.6	135.6	144.6	144.4
RCP8.5	12.39	36.92	64.86	135.6	146.8	140.8

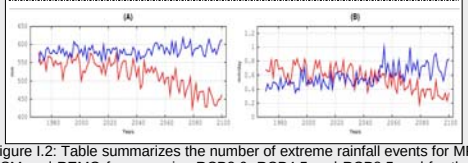


Figure I.2: Table summarizes the number of extreme rainfall events for MPI-ESM and REMO for scenarios RCP2.6, RCP4.5 and RCP8.5 and for three time periods 1961-90, 2036-65 and 2071-2100. The panels below depict (A) total soil moisture in mm and (B) surface runoff in mm/day for as simulated by REMO (red) and the forcing MPI-ESM_LR (blue). All curves represent annually averaged values over the region 15°N-30°N; 8°S-10°N for RCP 8.5 emission scenario.

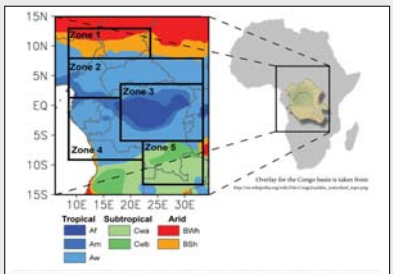
Summary of major findings

- **Contradicting precipitation signals in downscaled projections of REMO and the forcing MPI-ESM_LR simulations over the central African region (Fig I.1).**
- **High number of extreme events (Table in Fig I.2) causes moisture loss via surface runoff in REMO as compared to MPI-ESM_LR, hence resulting in lower soil-moisture (Fig I.2).**
- **Once the soil-moisture becomes critically low, it remains unable to retain the soil moisture-evaporation-precipitation feed-back loop after 2050.**

Note: Also climate change projections with WRF were started within the CONGO project; however could not yet be finished. It will be assessed if also WRF projects a contradicting precipitation signal when forced with MPI-ESM_LR, or if this is a REMO feature.

II) Multi-model multi-scenario climate change assessment for the central African region

In the framework of the project "Climate changes scenarios for the Congo basin" ("CONGO-project" funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) a regional climate change assessment is conducted over the greater Congo basin region (Fig II.1). The analysis is based on a state-of-the-art multi-model multi-scenario ensemble of global and regional climate change projections. Altogether data from 77 different climate change projections are analysed; separated into 31 projections for a "high" and 46 for a "low" emission scenario (see Table in Fig II.1 for details).



	CMIP3	CMIP5	WATCH	RCMs	ALL
„HIGH" scenario	14	10	3	4	31
„LOW" scenario	16	20	3	7	46
both scenarios	30	30	6	11	77
Details of the analysed sub-ensembles	• Models: Projections of 14 different global models from the CMIP3-ensemble have been included • Scenarios: SRES A2 (HIGH); SRES B1 (LOW) • Analysed Data: Daily data available for periods 1961-1990, 2036-2065 and 2071-2100 on the original global model grids.	• Models: Projections of 9 different global models from the CMIP5-ensemble have been included in both scenario groups • Scenarios: RCP 8.5 (HIGH) and RCP 4.5 (LOW) scenarios have been used. • Scenarios: RCP 8.5 (HIGH) and RCP 4.5 (LOW) • Analysed Data: Daily data available for periods 1961-1990, 2036-2065 and 2071-2100 on the original global model grids.	• Models: Bias corrected projections from 6 GCMs (ECHAM5, ECHAM6, IPSL). The uncorrected projections of all models are part of the CMIP5-ensemble • Scenarios: SRES A2 (HIGH); SRES B2 (LOW) • Analysed Data: Daily data available for periods 1961-1990, 2036-2065 and 2071-2100 on a regular 0.5 degree global model grids.	• Models: Projections of 2 RCMs (REMO and WRF) forced with output of two GCMs of the CMIP5-ensemble (MPI-ESM-LR; EC-EARTH) have been included in both groups. • Scenarios: RCP 8.5 (HIGH); RCP 4.5 and RCP 2.6 (LOW) Runs. • Analysed Data: Data from the RCA-EC-EARTH projection was available in time slices and there is the two REMO projections. • Analysed Data: Daily data available for periods 1961-1990, 2036-2065 and 2071-2100 on a regular 0.5 degree Africa domain with horizontal resolution of 0.44 degree.	

Figure II.1: Description of study domain and extent and coordinates of the 5 zones used in the analysis. The colors in the left map indicate different climate zones as indicated in the legend based on the Koeppen-Geiger classification. The table provides an overview of the different global and regional climate change projections analysed within this study.

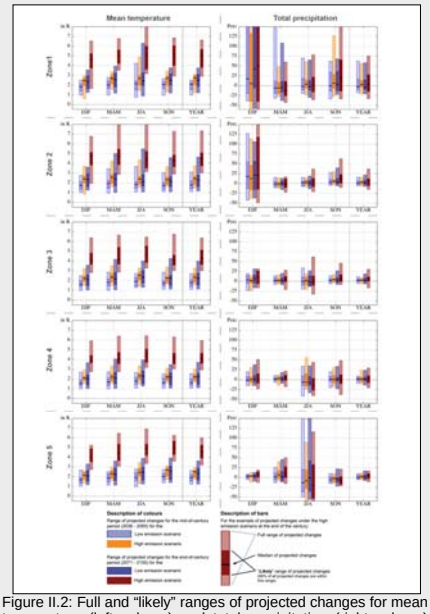


Figure II.2: Full and "likely" ranges of projected changes for mean temperature (left column) and total precipitation (right column) averaged over the five subzones for both scenarios for different time periods.

Summary of major findings

- **The unique ensemble allows to assign likely ranges and robustness measures to projected climate change signals.**
- **A substantial and robust increase in mean temperatures is projected for the future, with increase much stronger under the high emission scenario (Fig II.2).**
- **Annual total precipitation amounts are unlikely to substantially change in the future, but a slight tendency for a precipitation increase is projected (Fig II.2).**
- **If only a sub-ensemble would be considered, projected changes in total precipitation amounts would be different (Fig II.3).**
- **A robust tendency for an increase in the intensity of heavy rainfall events is projected for the future (Fig II.3), but almost no change in their frequency.**

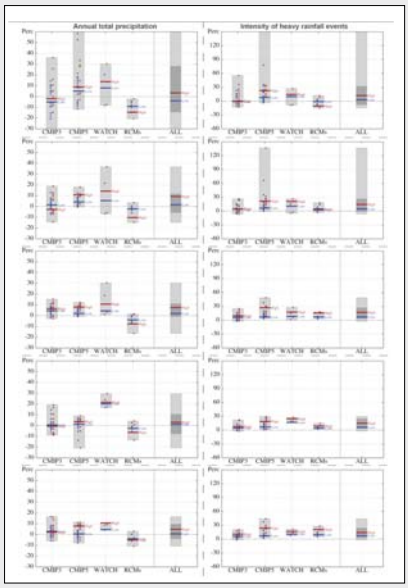


Figure II.3: Sub-ensemble analysis: Full ranges of projected changes in annual total precipitation amounts (left column) and intensity of heavy rainfall events (right column) for the end of the century and averaged over the 5 zones as projected by the different sub-ensembles (left part of respective panel) and for all analysed projections together (right part of respective panel). The Median of the projected changes for the two different scenarios (*low* – blue lines; *high* – red lines) is depicted, as well as the projected changes within each model simulations via the colored crosses (*low* – blue crosses; *high* – red crosses). Finally the *likely* ranges for each scenario are included as dark-grey sub-range. However as they always overlap, they appear as single area only.

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Further information for the studies I) and II) is provided in:

I) Saeed F., Haensler A. & Jacob D. (2013):Representation of extreme precipitation events leads to opposite climate change signals over the Congo basin. Submitted to Atmosphere.
II) Haensler A., Jacob D., Ludwig F. & Kabat P. (2013): Climate change scenarios for the Congo basin. Climate Service Center Report No. 11, Hamburg, Germany, ISSN: 2192-4058