C27-W102A

Evaluation of the CORDEX RCMs over West Africa: Preliminary Results

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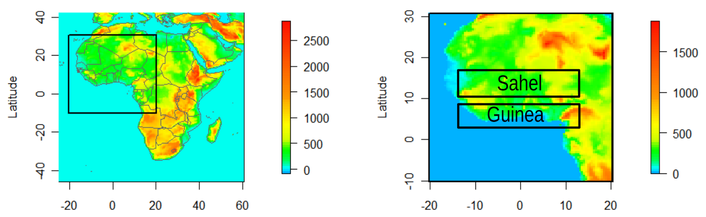
Background

The CORDEX-Africa analysis initiative was developed to investigate the multi-model ensemble of regionally downscaled data for the African continent. In the continuing quest to improve climate model predictions to meet the increasing demand for knowledge on the regional effects of global climate change, it is pertinent to increase our understanding of how the underlying processes of climate are represented in the models we use to make these predictions. Under the CORDEX initiative, long-term global model driven climatologies will be used to downscale climate change scenarios for vulnerable regions such as West Africa and it becomes necessary to investigate how the participating regional models downscale the present climate over such regions. This is essential given that most regional models, when applied over the tropics, often display systematic differences with a land-sea contrast. This study evaluates the performance of a suite of 8 regional climate models (RCMs) in reproducing rainfall and temperature characteristics over West Africa at the annual and seasonal time scales. The ability of models to resolve these cycles correctly is a useful diagnostic metric of their predictive capabilities.

Study Domains: Elevation (m)



West Africa (Longitude: 20.75W- 20.75E, Latitude: 10.7S -30.25N)
Sahel (Longitude: 15.75W -15.75E, Latitude:10.7N-16.25N)
Guinea (Longitude: 15.75W -15.75E, Latitude: 3.7N - 8.25N)

Data and Methods

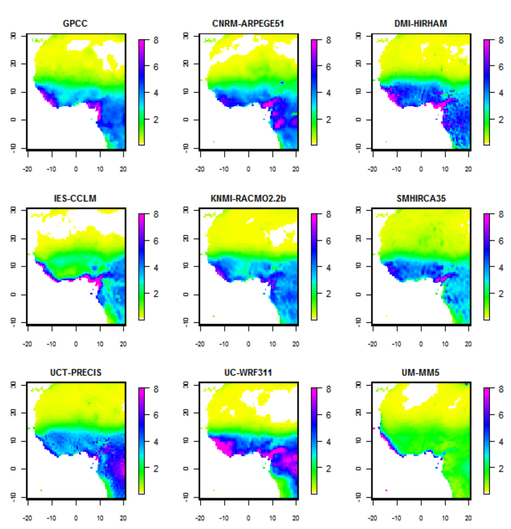
We evaluate 8 RCMs (CNRM-ARPEGE51, DMI-HIRHAM, IES-CCLM, KNMI-RACMO2.2b, SMHIRCA35, UCT-PRECIS, UC-WRF311, UM-MM5) all forced by ERA-interim Reanalysis (1989-2008).

Variables analyzed:
Monthly mean Precipitation and surface (2m) Temperature. The RCM data are interpolated to the GPCC spatial resolution(0.44° by 0.44°).

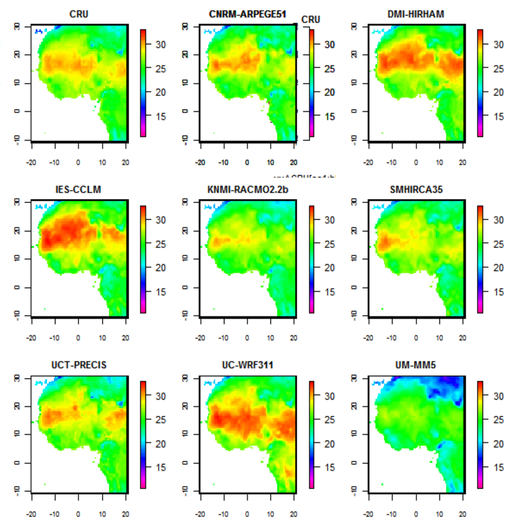
Observations (Gridded products):
Global Precipitation Climatology Centre (GPCC) Monthly Precipitation for the period 1989-2007 and Climate Research Unit (CRU) Monthly Temperature period 1989-2006.

Climatology

Annual Mean Precipitation: GPCC and RCMs (mm/day)

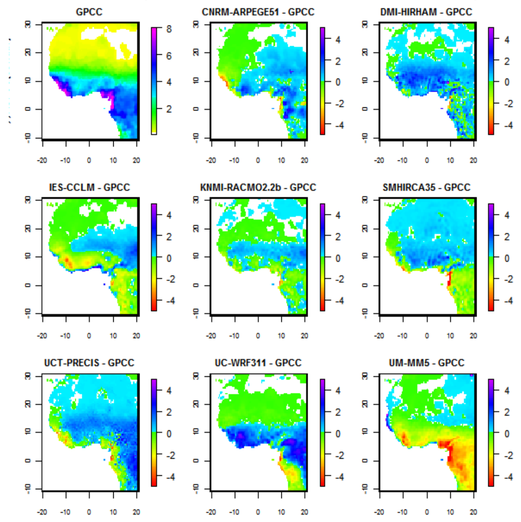


Annual Mean Temperature: CRU and RCMs (°C)

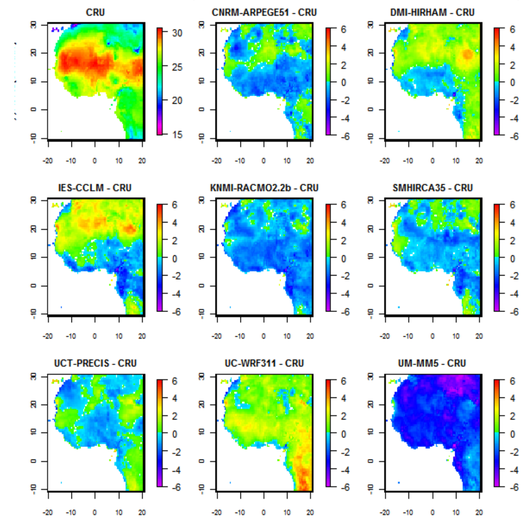


Model Differences

Annual Mean Precipitation difference: GPCC - RCMs (mm/day)

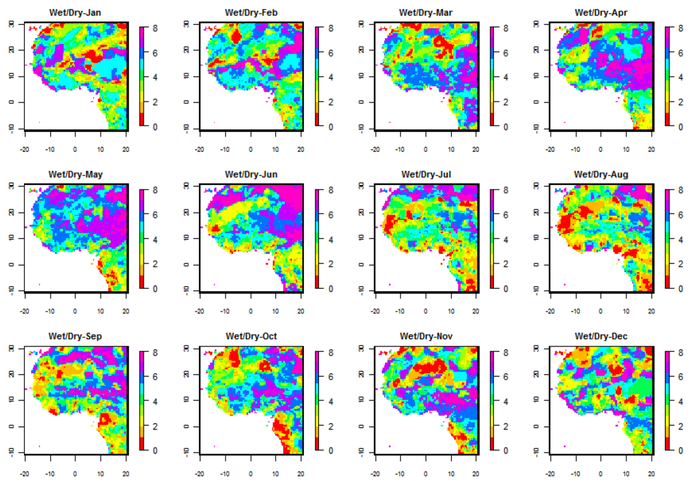


Annual Mean 2m Temperature difference: CRU - RCMs (°C)

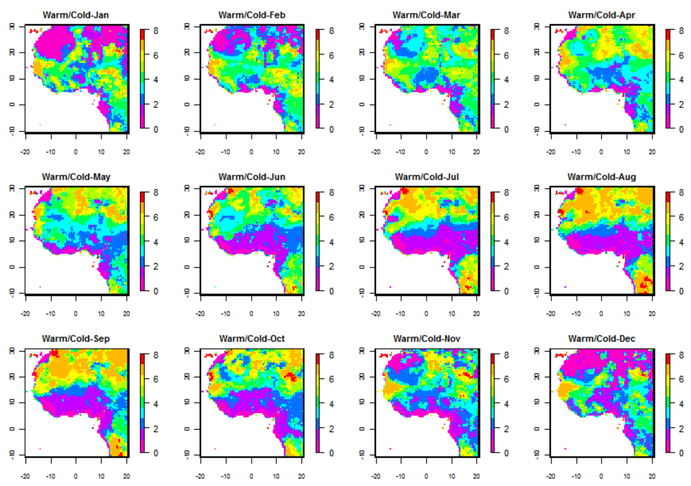


Seasonal Biases

Monthly Mean Precipitation: RCMs-GPCC
(Number of models with wet/dry bias with respect to GPCC)

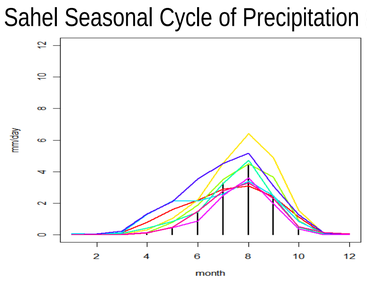


Monthly Mean Temperature: RCMs-CRU
(Number of models with warm/cold bias with respect to CRU)

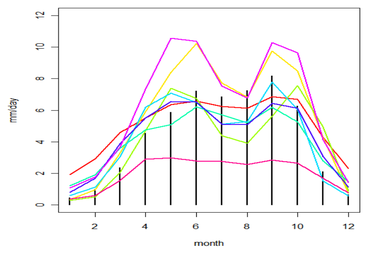


Seasonal Variations

Sahel Seasonal Cycle of Precipitation (mm/day)

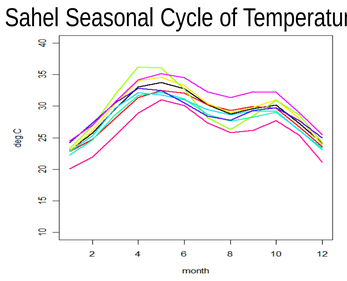


Guinea Seasonal Cycle of Precipitation (mm/day)

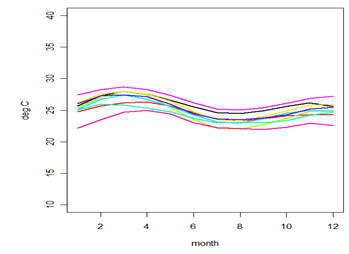


CNRM-ARPEGE51
DMI-HIRHAM
IES-CCLM
KNMI-RACMO2.2b
SMHIRCA35
UCT-PRECIS
UC-WRF311
UM-MM5

Sahel Seasonal Cycle of Temperature (°C)



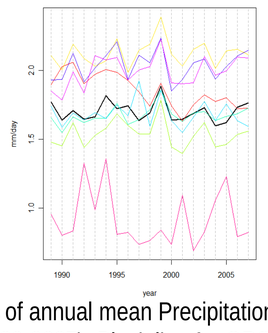
Guinea Seasonal Cycle of Temperature (°C)



Seasonal Cycle of Precipitation (Sahel and Guinea), models represented by colored lines and GPCC as bar plot.

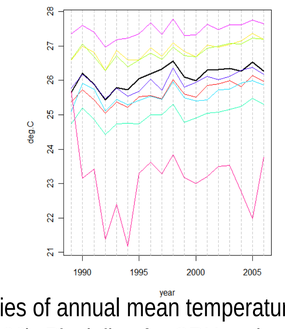
Seasonal Cycle of Temperature (Sahel and Guinea), models represented by colored lines and CRU in black.

Inter-annual Variations



GPCC	cor	p.value
CNRM-ARPEGE51	0.25	0.29
DMI-HIRHAM	0.63	0.02
IES-CCLM	0.76	0
KNMI-RACMO2.2b	0.62	0
SMHIRCA35	0.25	0.3
UCT-PRECIS	0.6	0.01
UC-WRF311	0.56	0.01
UM-MM5	-0.07	0.78

Time series of annual mean Precipitation (mm/day) over the West African Domain (1989-2007). Black line for GPCC and colors for RCMs.
Right: Coefficient of temporal correlation (+ p.value, level of significance) between RCMs and GPCC time series.



CRU	cor	p.value
CNRM-ARPEGE51	0.91	0
DMI-HIRHAM	0.83	0
IES-CCLM	0.81	0
KNMI-RACMO2.2b	0.89	0
SMHIRCA35	0.79	0
UCT-PRECIS	0.82	0
UC-WRF311	0.86	0
UM-MM5	0.2	0.42

Time series of annual mean temperature (C) over the West African Domain (1989-2006). Black line for CRU and colors for RCMs.
Right: Coefficient of temporal correlation (+ p.value, level of significance) between RCMs and CRU time series.

Summary

The RCMs reproduce some aspects but not all details of precipitation in West Africa. There are biases in the mean annual precipitation and annual temperature cycles.

Guinea subdomain:
Wet biases (about 5 out of 8 RCMs). The wet season is well reproduced, with two peaks, but length of season is exaggerated.
Sahel subdomain:
Mainly wet biases (about 6 out of 8 RCMs). Onset of the wet season is too early in some models, leading to extended rain season.

Region specific analytical metrics and atmospheric fields required to fully evaluate model performance.

Acknowledgements
1. A. Favre, CSAG ENGEO Dept. University of Cape Town
2. G. Nikulin, SMHI Sweden
3. CORDEX Modelling Groups