Climate Systems Analysis Group
START/PACOM Centre of Excellence
Regional node for climate modeling

Diagnostic of monthly precipitation from CORDEX simulations over Africa : focus on the annual cycles

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Introduction

General diagnostic of African CORDEX simulations over the historical period.

Regional Climate Models are driven by ERA-interim Reanalysis data (1989-2008).

Objective

Focus on monthly precipitation data

Exploration and diagnostic of the ability of CORDEX Regional Climate Models (RCMs) to reproduce observed annual rainfall features in the African domain.

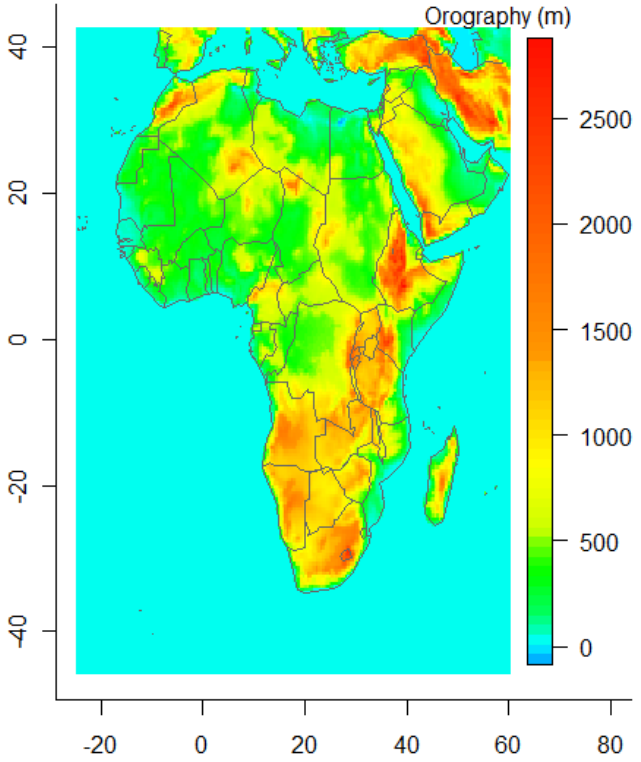
Data

- **8 RCMs monthly precipitation data**

Domain:
24.64°W - 60.28°E
45.76°S - 42.24°N
Resolution: 0.44°

[1] "AFRICA_**CNRM-ARPEGE51**_CTL_ERAINT_MM_50km_1989-2008_pr.nc
[2] "AFRICA_**DMI-HIRHAM**_CTL_ERAINT_MM_50km_1989-2008_pr.nc"
[3] "AFRICA_**IES-CCLM**_CTL_ERAINT_MM_50km_1989-2008_pr.nc"
[4] "AFRICA_**KNMI-RACMO2.2b**_CTL_ERAINT_MM_50km_1989-2008_pr.nc
[5] "AFRICA_**SMHIRCA35**_CTL_ERAINT_MM_50km_1989-2009_pr.nc"
[6] "AFRICA_**UCT-PRECIS**_CTL_ERAINT_MM_50km_1989-2008_pr.nc"
[7] "AFRICA_**UC-WRF311**_CTL_ERAINT_MM_50km-rg_1989-2008_pr.nc"
[8] "AFRICA_**UM-MM5**_CTL_ERAINT_MM_50km-rg_1989-2008_pr.nc"

CORDEX African domain



- **Monthly precipitation data from the Global Precipitation Climatology Centre (GPCC)**

Domain:
24.75°W - 60.75°E
46.25°S - 42.25°N
Resolution: 0.5°

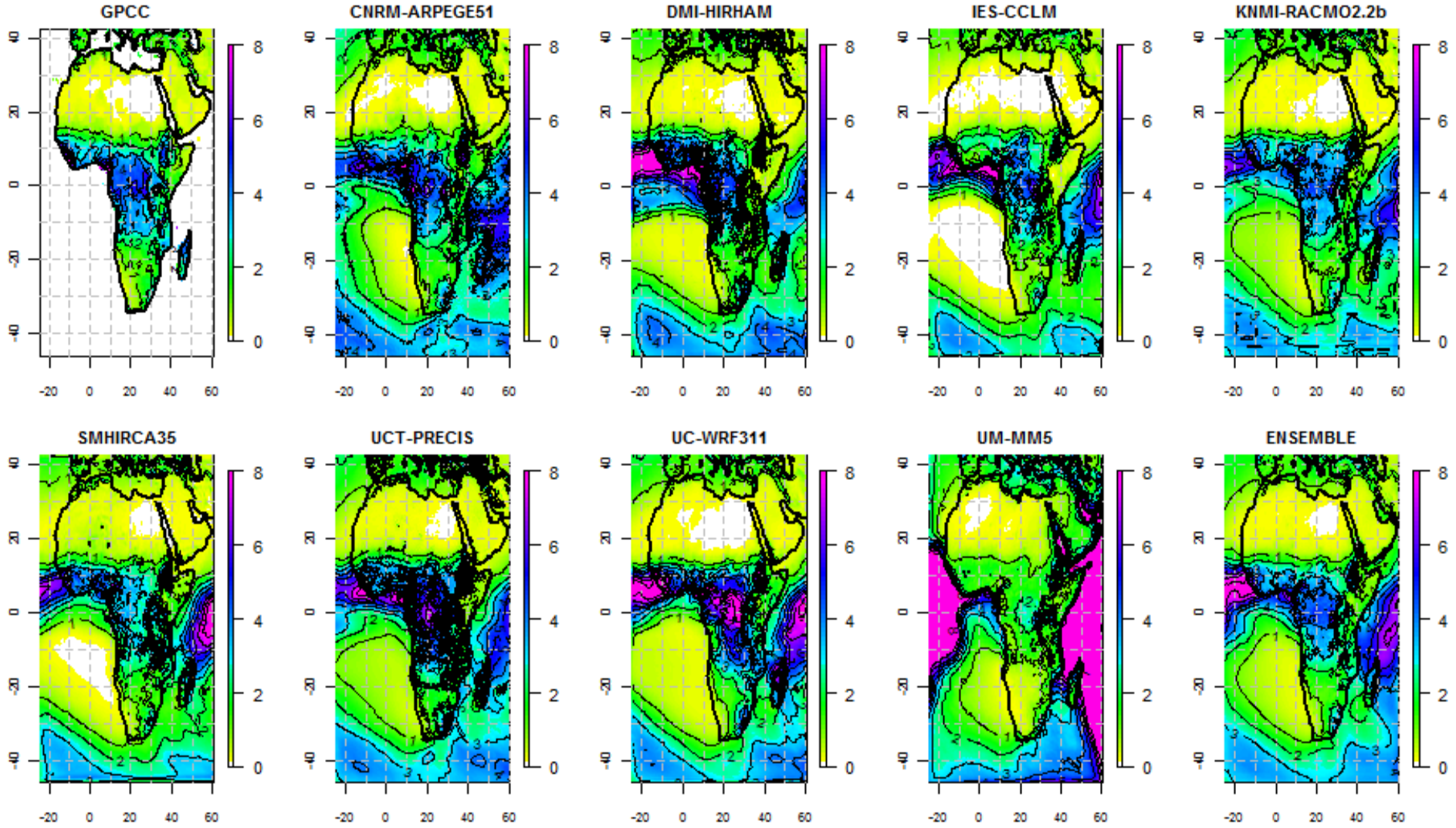
Studied period: 1989-2007

Step 1. Quantification of annual rainfall biases

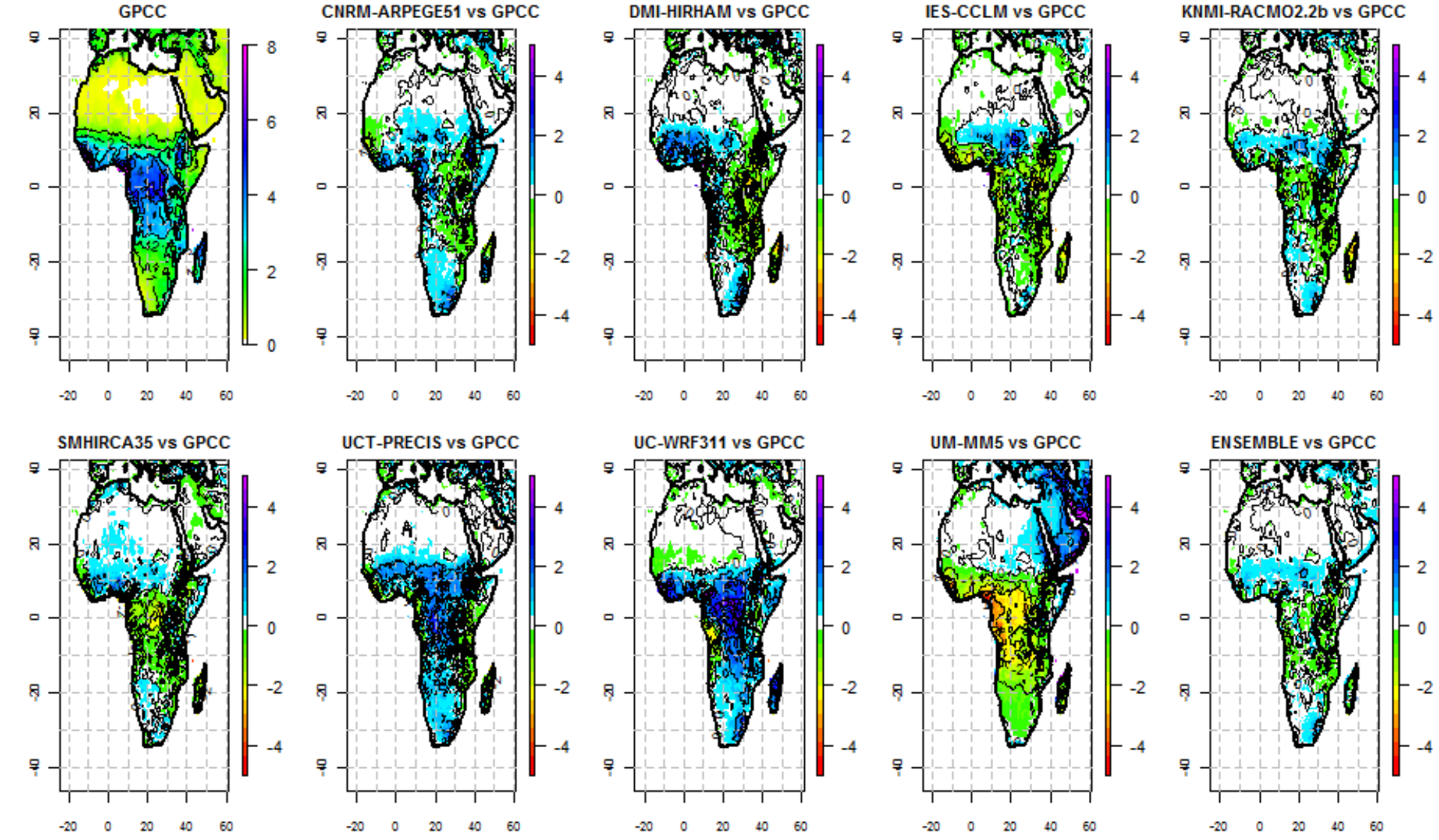
- RCM data are adjusted to the GPCC spatial resolution (0.5º*0.5º) by interpolation.

- Mean annual precipitation from the models is confronted to GPCC data

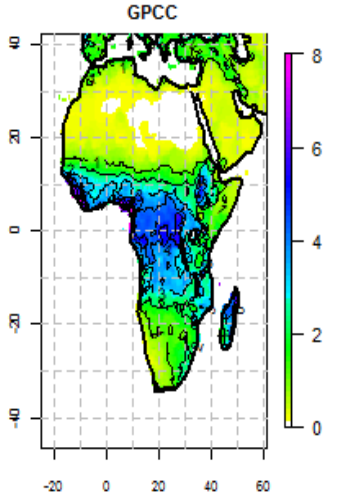
1.1. Annual mean rainfall (mm/day)

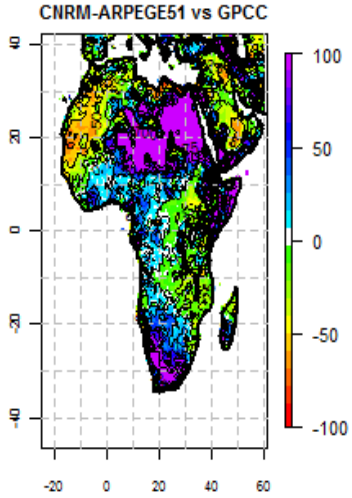


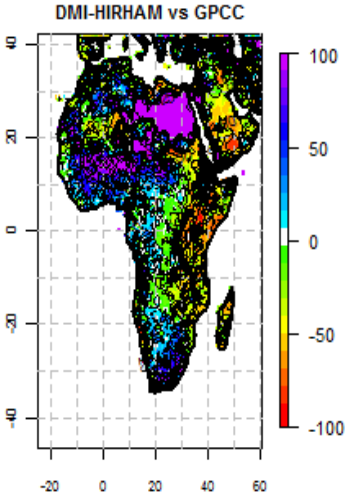
1.2. Annual mean rainfall - RCMs vs GPCC (mm/day)

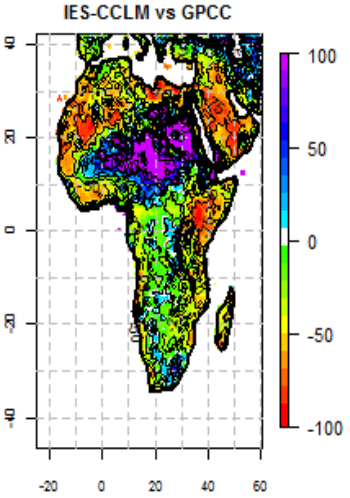


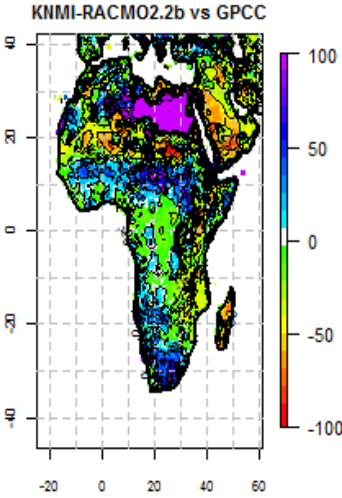
1.3. Annual mean rainfall - RCMs vs GPCC (% of the GPCC normal)

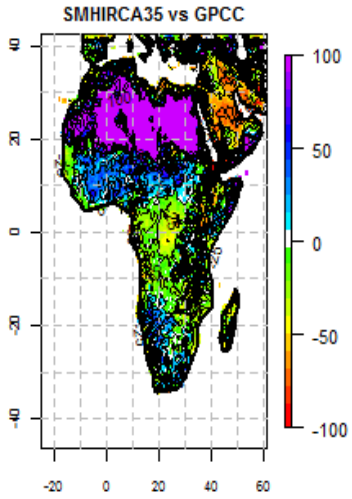


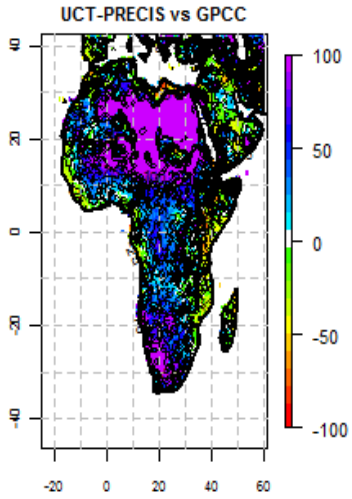


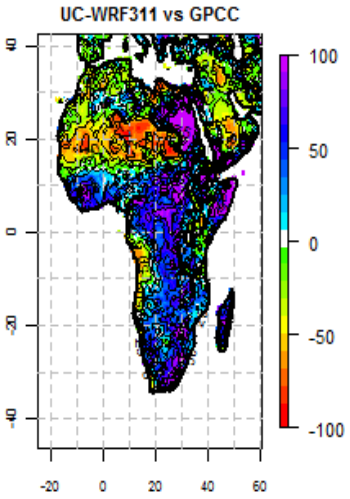


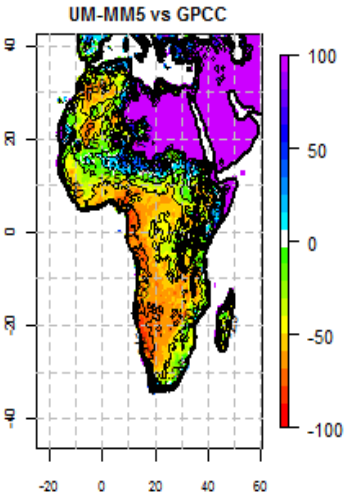


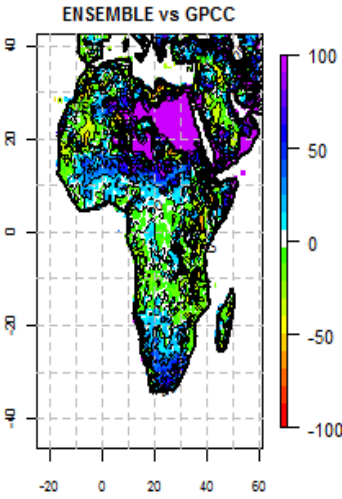






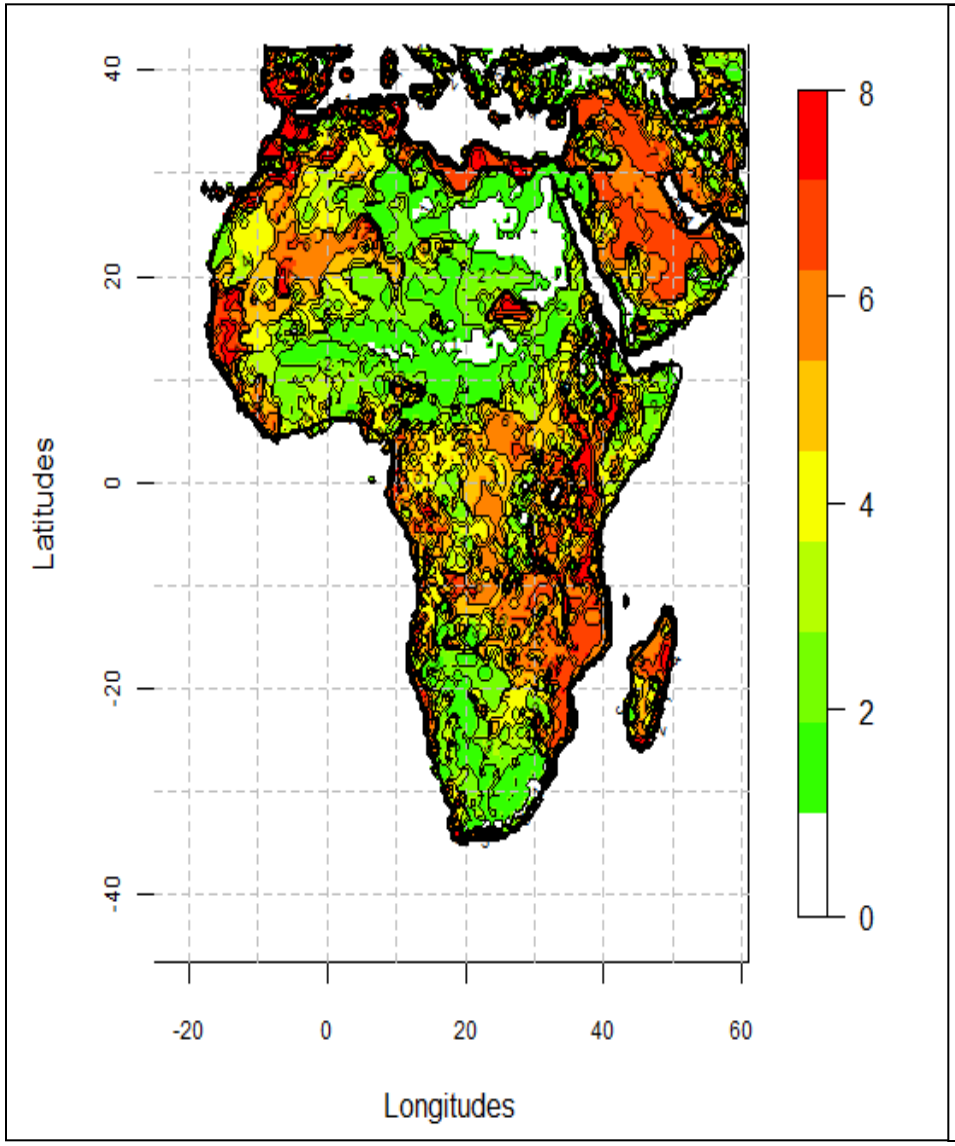




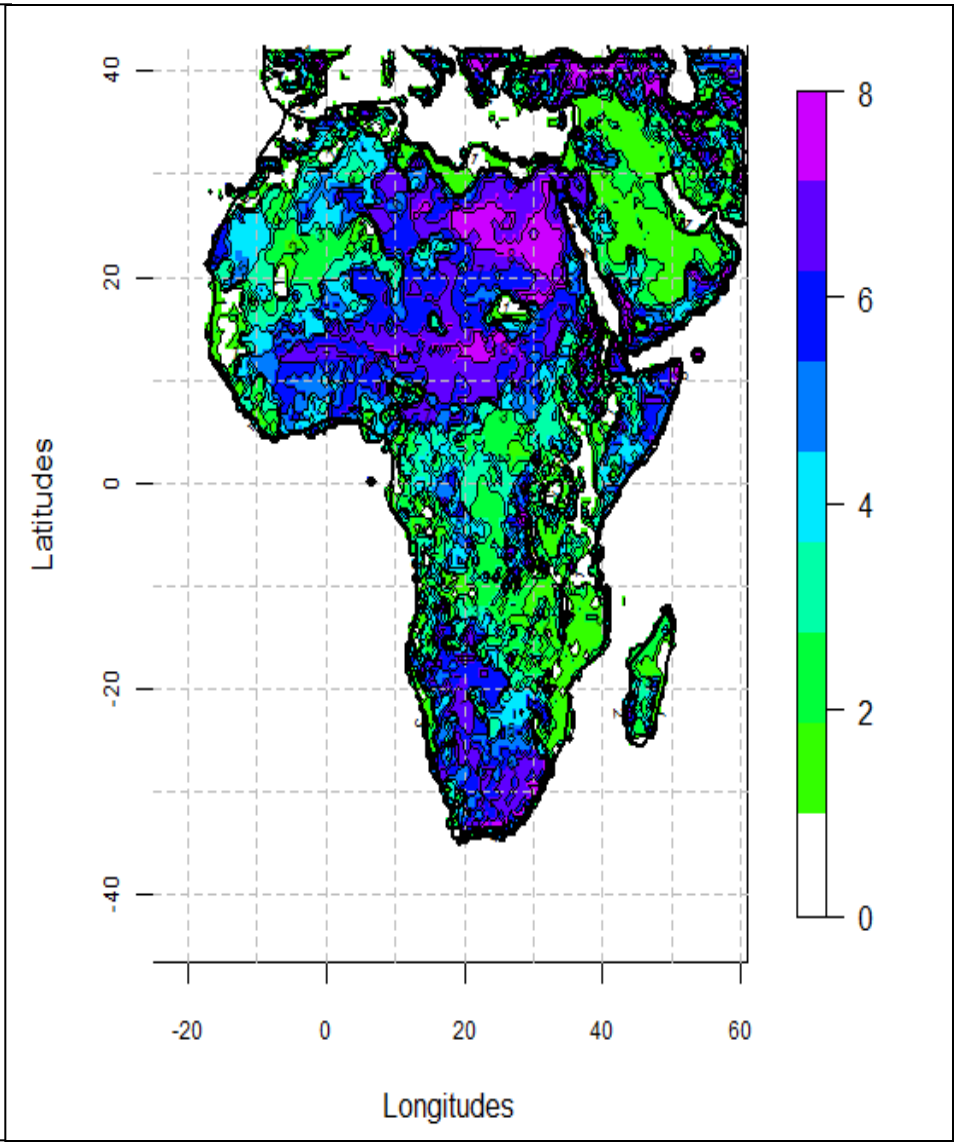


1.4. Annual mean rainfall - RCMs vs GPCC (Dry/wet biases - 8 RCMs)

Dry bias (number of models)



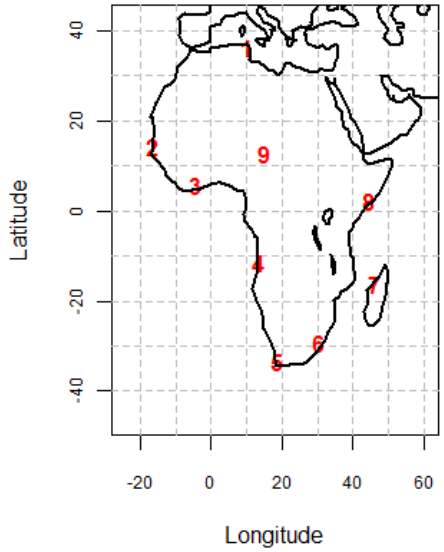
Wet bias (number of models)

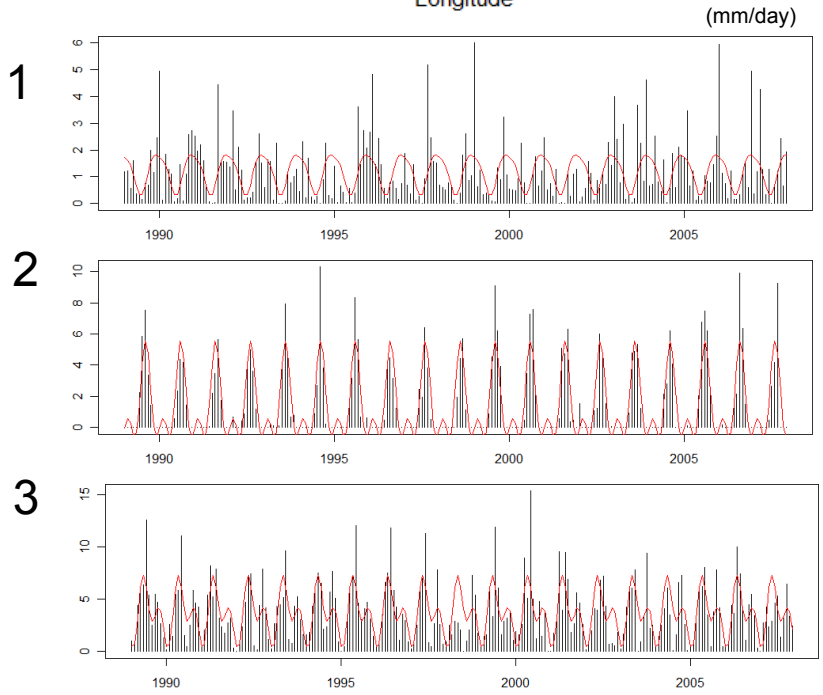


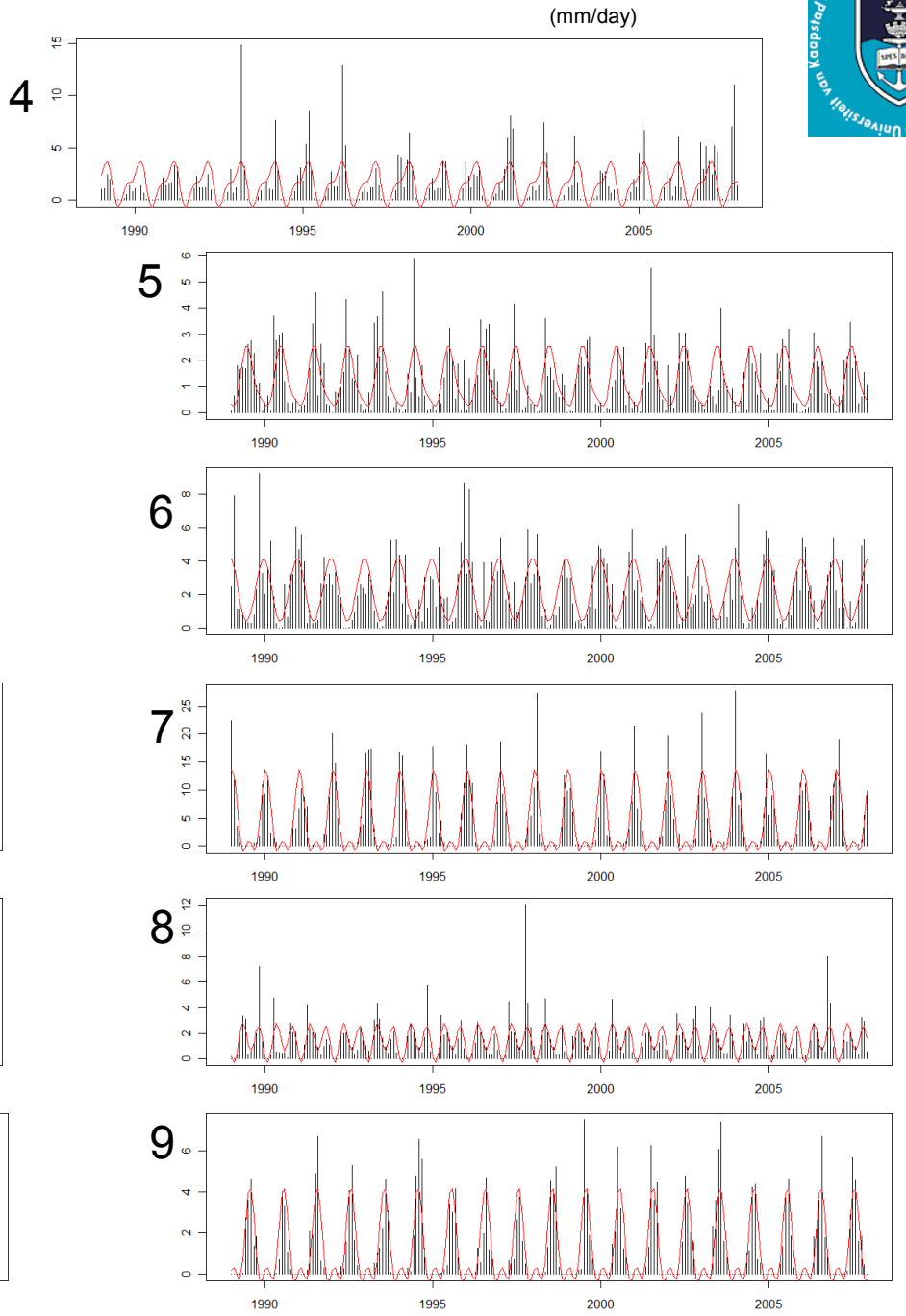
Step 2. Definition of local annual cycles of rainfall

The annual cycles of rainfall are defined by fitting the first four seasonal harmonics to monthly values in both observations and model outputs.

Examples of annual cycles (GPCC- period 1989-2007)



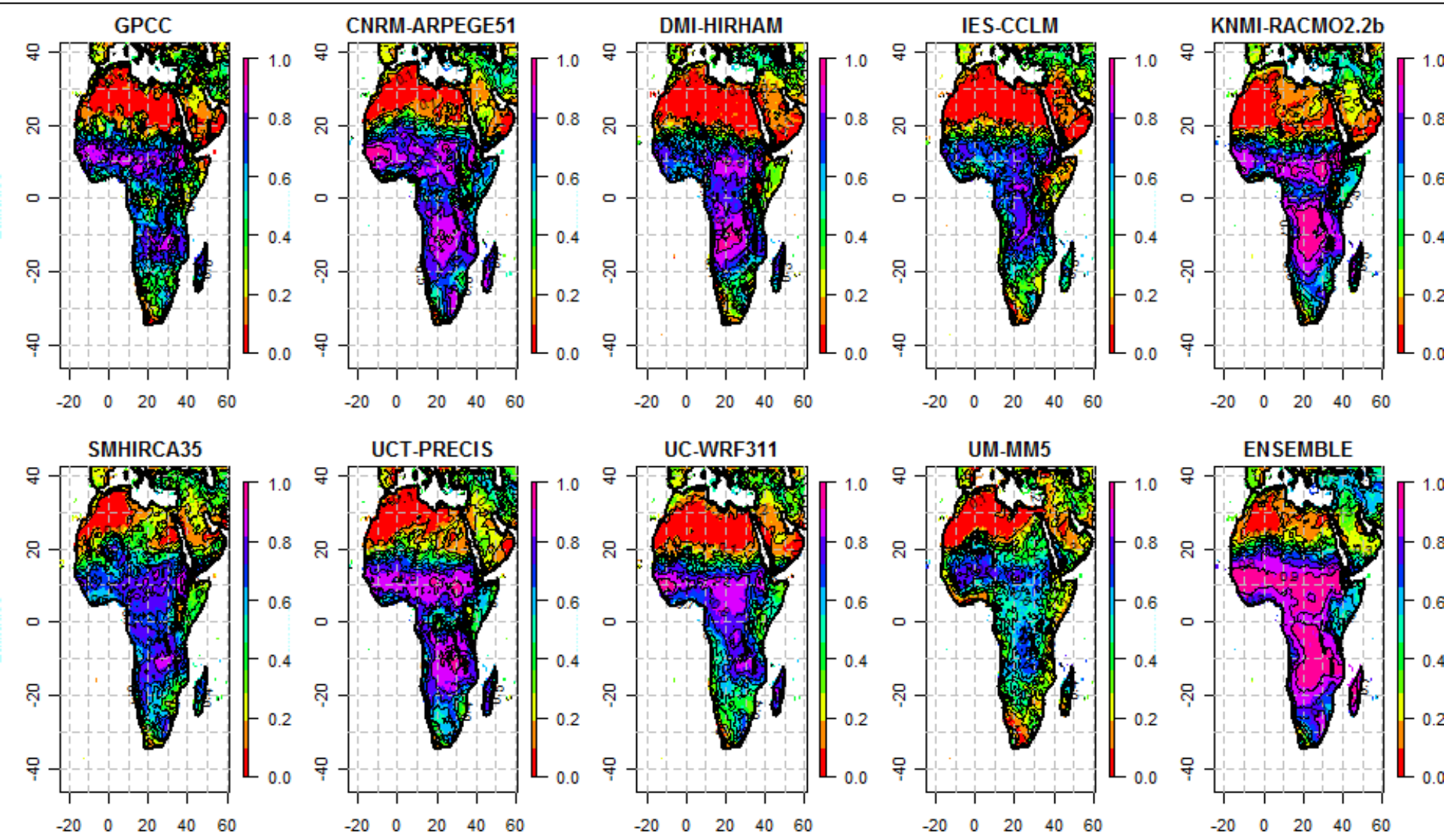




Step 3. Estimation of the annual cycles' significance

The ratio of the seasonal to total variance is computed and mapped in both models and observations.

Total variance explained by the annual cycle (1989-2007)

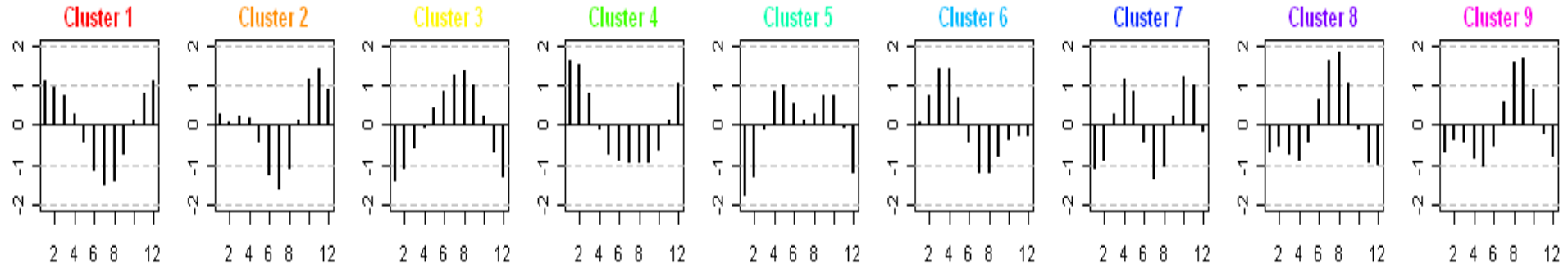


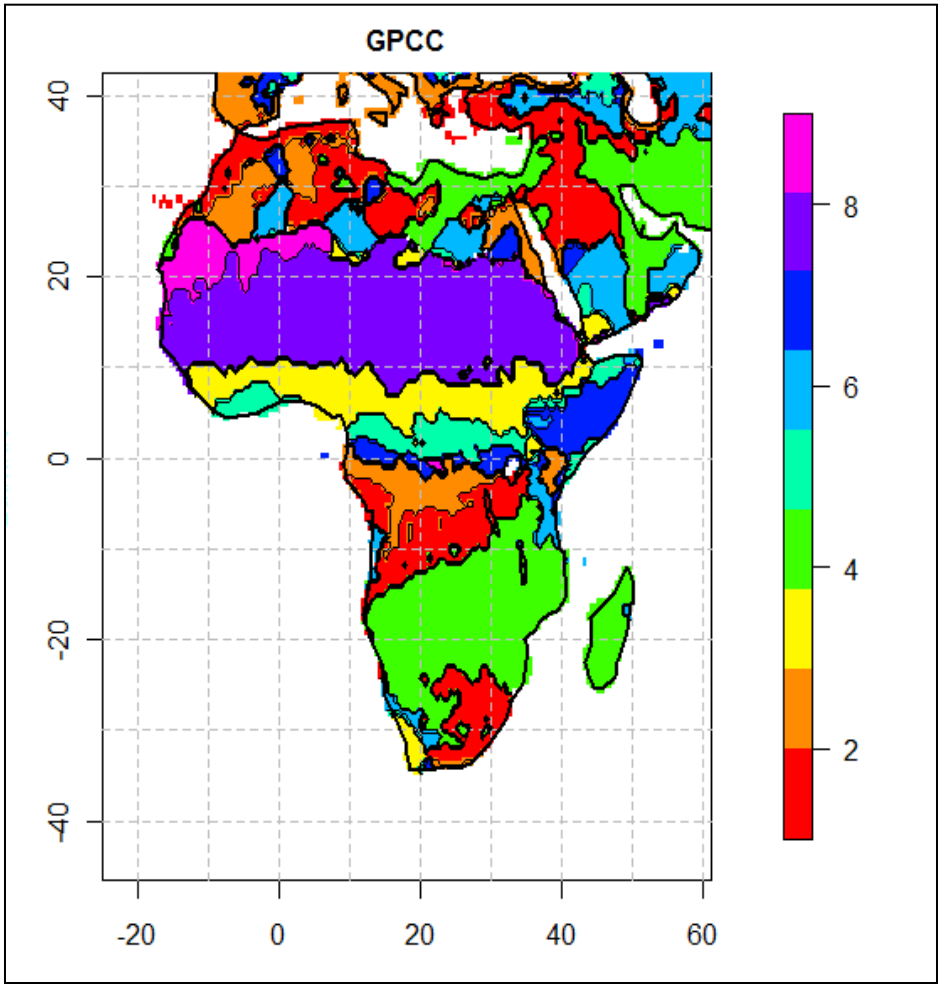
Step 4. Classification of annual cycle shapes

Assessment of similarities and differences in the geographic distribution of the **annual cycle shapes** between the models and observations.

1- We have clustered the **standardized annual cycles** derived from GPCC into **9 classes** using **k-means** method.

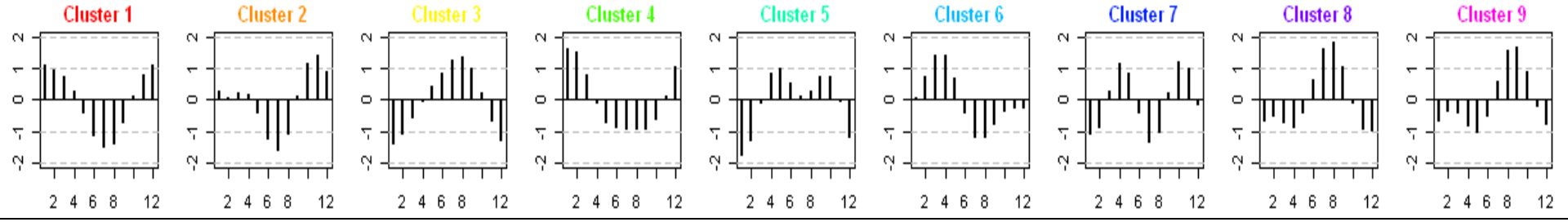
4.1. Classification (GPCC) 9 clusters

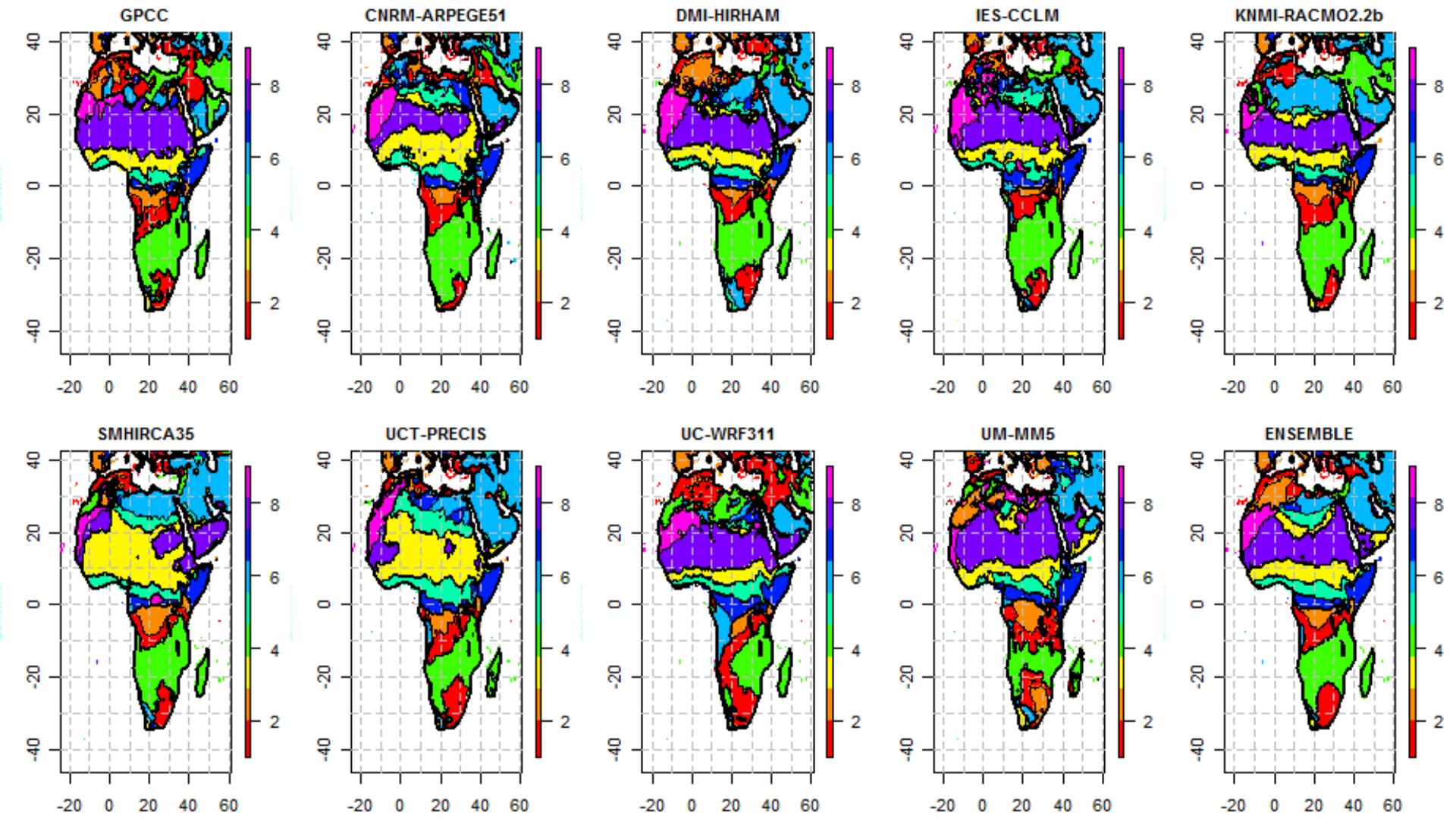




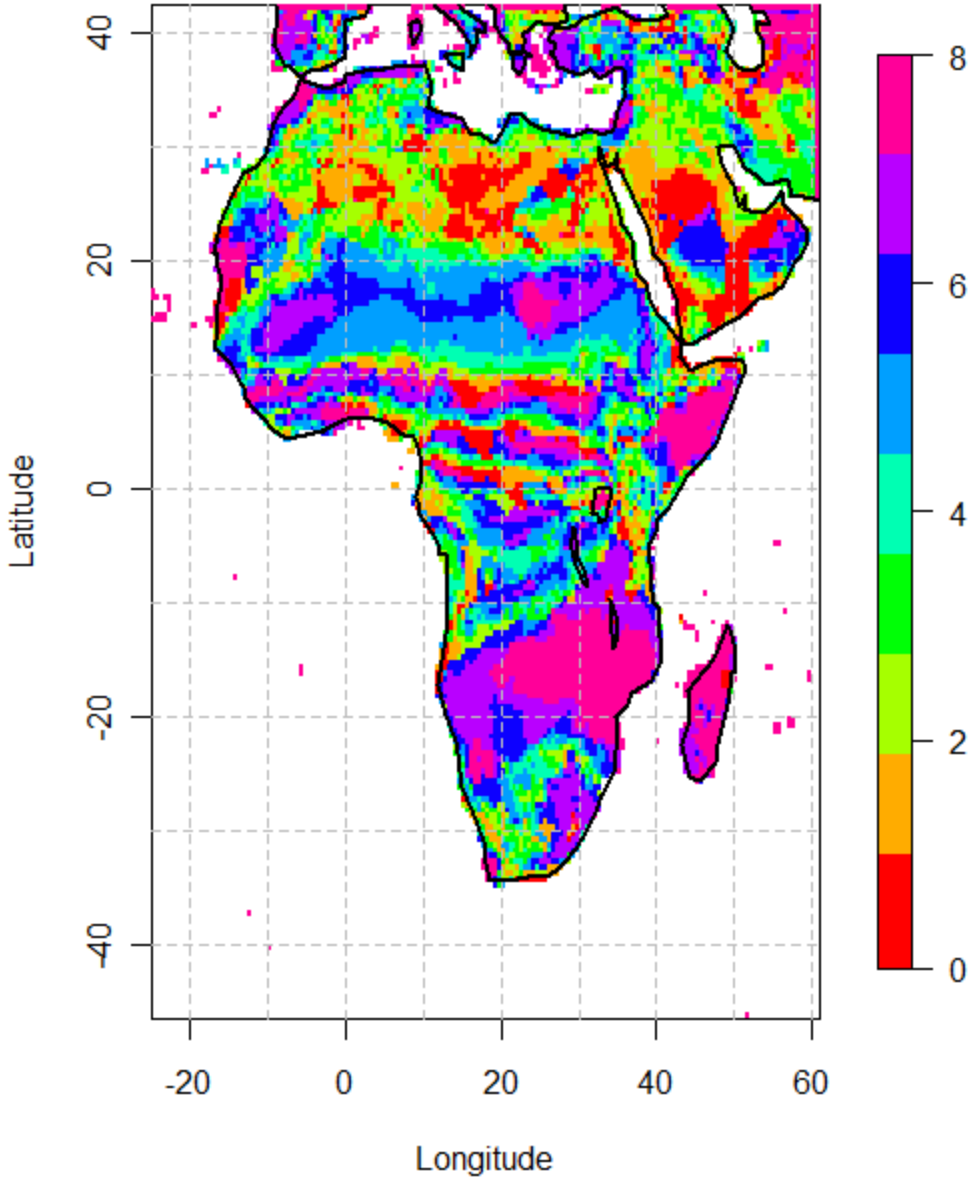
2- We have fitted the standardized annual cycles derived from models to these 9 clusters by applying the **least squares method**.

4.2. Classification (models on the GPCC base)

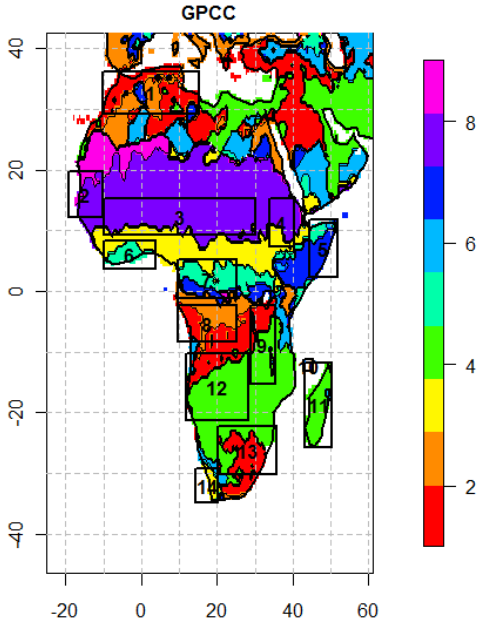


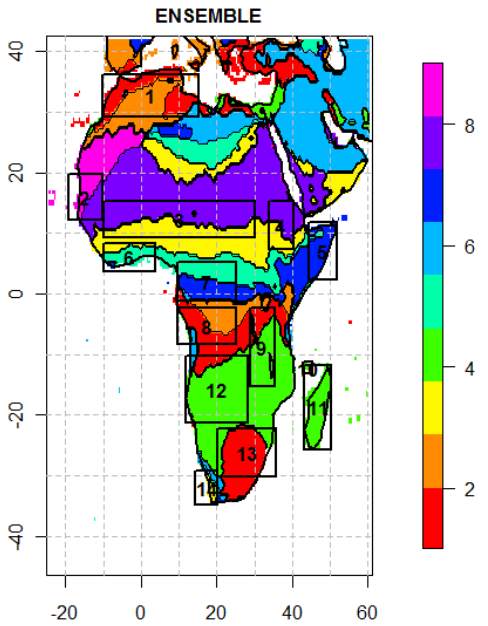


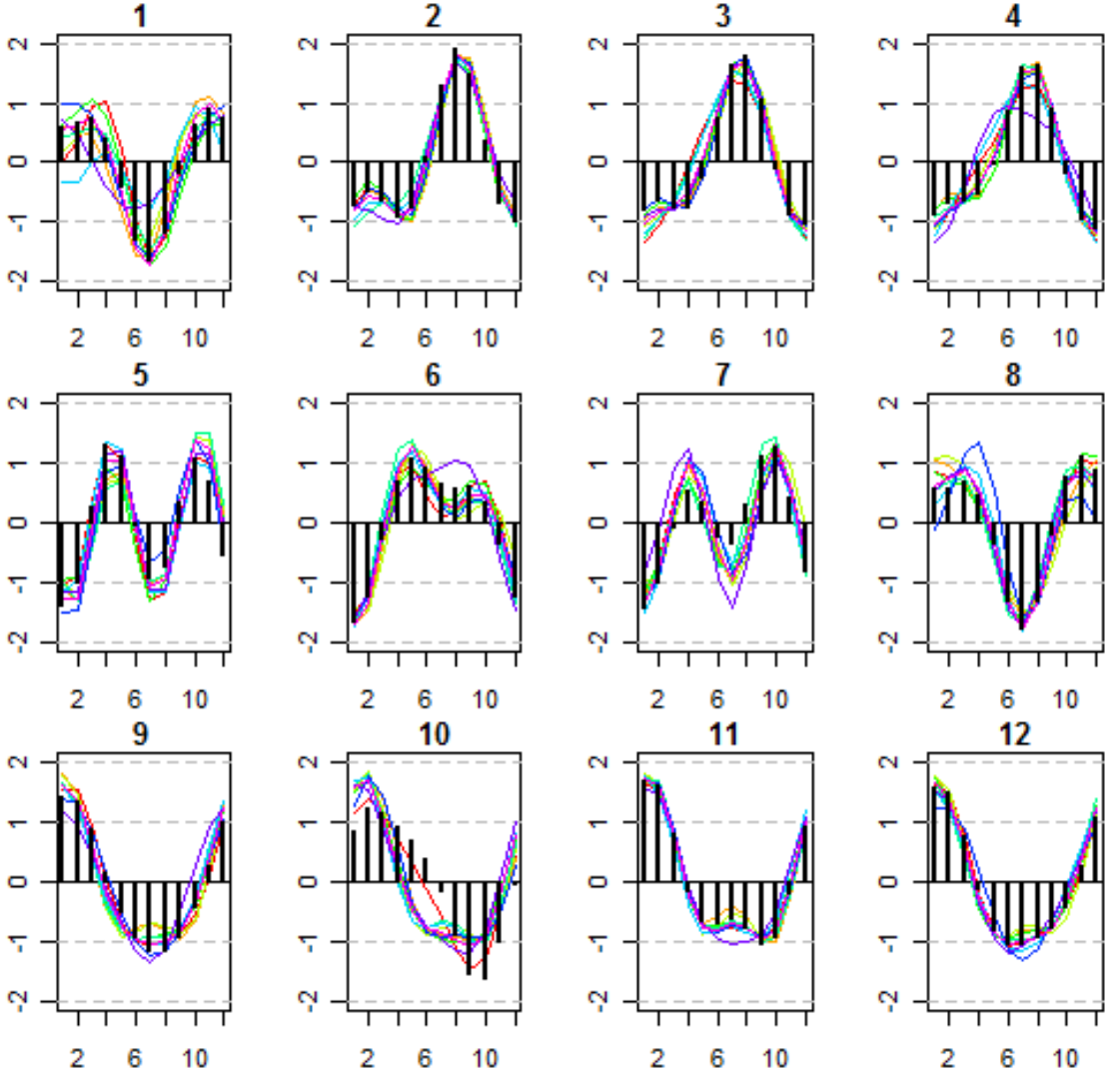
Number of models presenting the same annual cycle (same cluster) as in observations

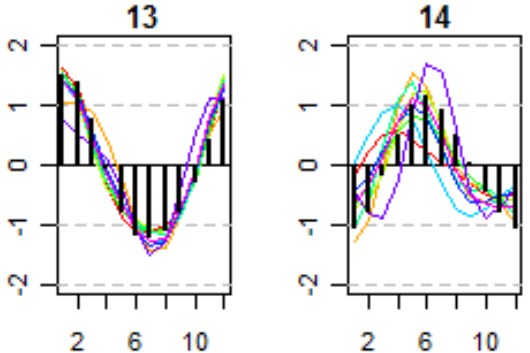


Focus on 14 regions









Barplot = GPCC

Lines = RCMs

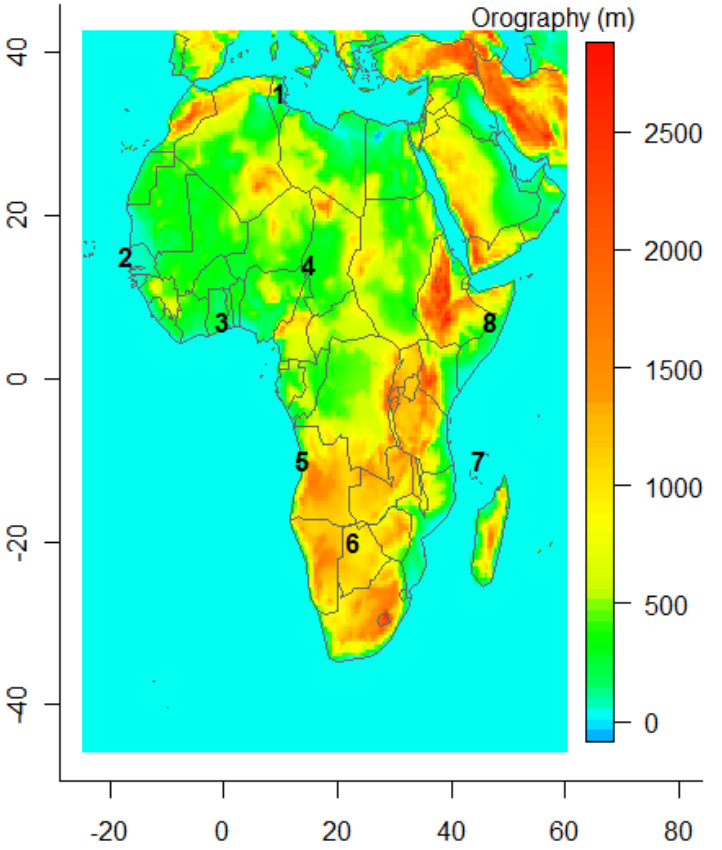
CNRM-ARPEGE51
DMI-HIRHAM
IES-CCLM
KNMI-RACMO2.2b
SMHIRCA35
UCT-PRECIS
UC-WRF311
UM-MM5
ENSEMBLE

Synthesis

Biases in mean annual precipitation and annual cycle shapes

1. Mediterranean and Moroccan coasts
- dry bias in > 6/8 RCMs.
- winter rainfall regimes are correctly reproduced

2. Atlantic coast (from Mauritania to Liberia)
- dry biases specifically for Mauritania and Senegal (> 6/8 RCMs).
- delay in the onset of summer rainfall and shorter rainy season.
- the late summer / early-autumn rainfall domain extends to far to the south



3. Gulf of Guinea (from Ivory Coast to Benin)
- wet biases (~5/8 RCMs)
- the rainy season with 2 peaks is well reproduced by the models but is slightly too long

4. Sahel domain (from Mali to Sudan)
- wet biases for ~6/8 RCMs
- onset of the rainy season is too early in some models (too long rainy season)

5. Atlantic coast from Cameroun to Namibia

- ~6/8 models under-estimate the annual rainfall (dry bias).
- for these models, the onset of the rainfall season is too late and the drier season is too long

6. Southern Africa

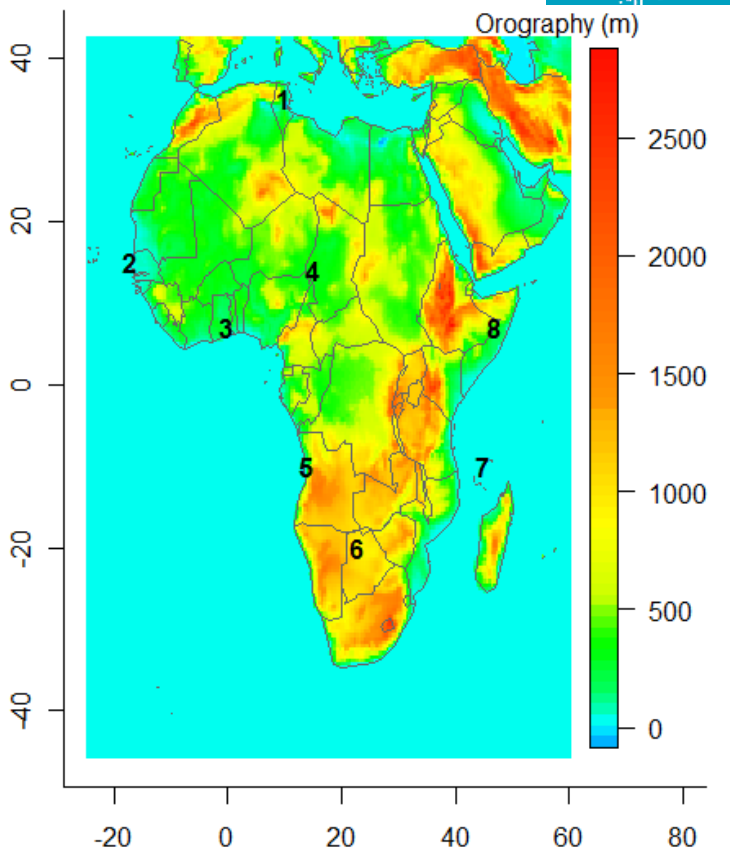
- rainfall is generally over-estimated over the western and southern escarpments
- for South Africa, summer rainfall penetrates too far to the southwest and the winter rainfall domain is reduced

7. Comoros islands

- dry biases for 8/8 RCMs (a dry bias is also noticed over the North of Madagascar and over Mozambique for 6/8 RCMs)
- the onset of the rainy season is synchronic with observations but the duration of the rainy season is too short (the end is too early)

8. Over the Somalia peninsula

- the bi-modal cycle is well reproduced by the RCMs,
- nevertheless, 5/8 models exhibit a wet bias.



Thank you!

References

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