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Boundary layer schemes in the Regional Climate Model RegCM4.6 Over Central Africa

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1- Abstract

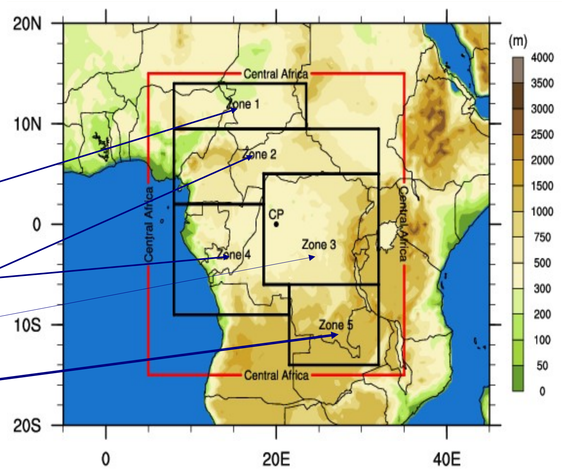
This study examines the performance of two Planetary Boundary Layer (PBL) parameterizations (Holtslag and University of Washington(UW) scheme) in the RegCM4.6 regional climate model for the Central African domain. The results show that the Holtslag scheme is favorable for simulating rainfall in Central Africa mostly during JJA season in zone 3. As far as the wind is concerned, both schemes have a more or less reasonable approach. the simulated total cloud cover can explain the better performance of UW PBL scheme than Holtslag scheme to reproduce surface temperature.

2- Data

- **Model input data of simulation [1] (ERA-Interim reanalysis (ERA-15), Sea surface temperature data (OISST), Topographic data (GLCC)),**
- **Reference and reanalysis data: CHIRPS (0.05°C × ◦0.05°C), GPCP (2.5°C × 2.5°C), UDel (0.5°C × 0.5°C), CRU (0.05°C × 0.05°C), ERA5 (0.25°C × 0.25°C)**
- **Experiments were carried out over a period of 6 years, from January 1, 2001 to December 31, 2006 with 1 year of spin-up**

3- Study area and topography

Figure 1: Topography (m) of the simulation domain encompassing the study area (red box) with its five major climatic zones (black boxes). CP is the central point of the simulation domain.

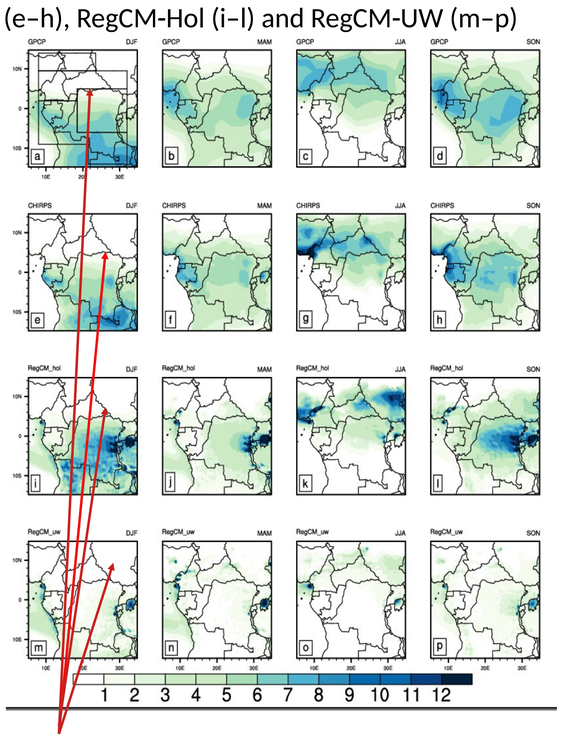


- Sudanian type climate ,
- Humid tropical and dry climate,
- humid tropical climate,
- subtropical climate.

4- Results

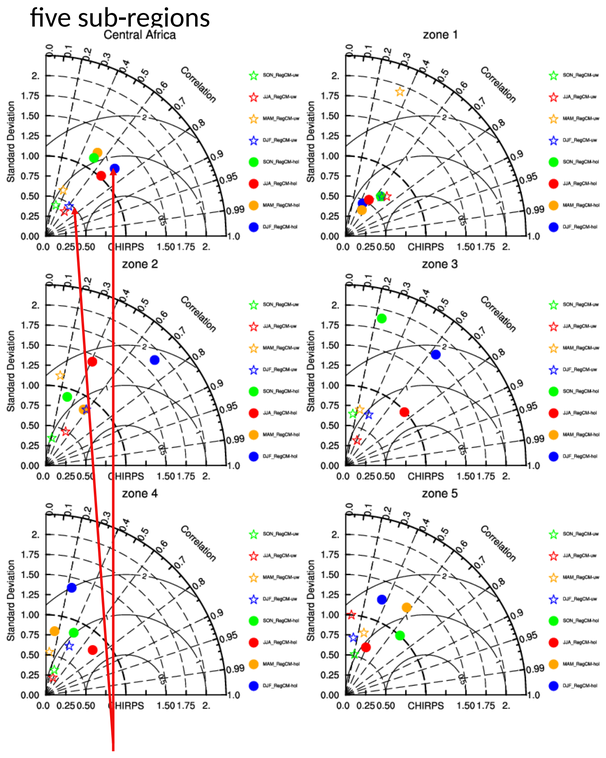
Rainfall climatology

a) Seasonal distributions of rainfall in mm/ day for the period 2002–2006: GPCP (a–d), CHIRPS (e–h), RegCM-Hol (i–l) and RegCM-UW (m–p)



- **The simulated rainfall are quite similar with those of the observations over all seasons, despite the fact that the magni-tude is a bit different and the RegCM-Hol experiment depicts fairly well the precipitation compared to RegCM-UW.**

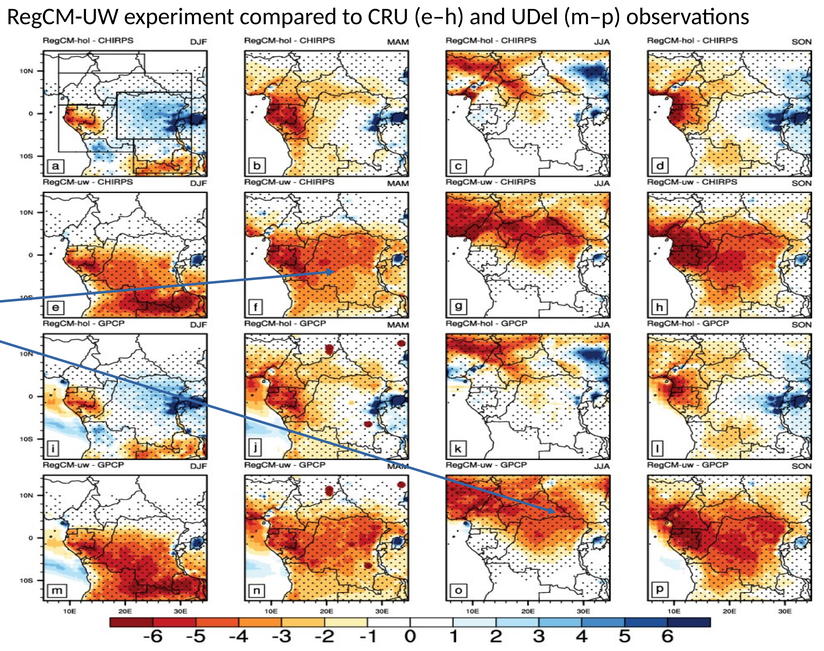
b) Taylor diagram summarizing statistical tools used to evaluate seasonal precipitation over CA and the five sub-regions



- **The comparison the model's performances reveals a big difference between RegCM-Hol and RegCM-UW in terms of standard deviation, PCC and RMSE.**

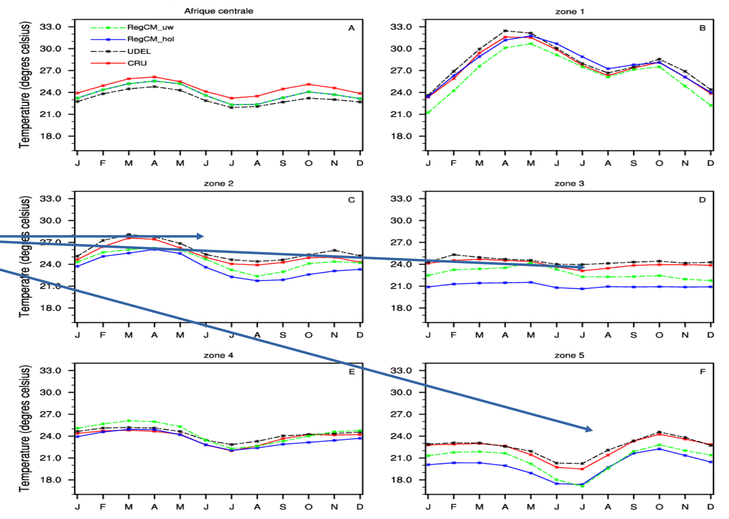
Climatology of near surface temperature

a) Mean seasonal temperature biases for RegCM-Hol experiment compared to CRU (a–d) and Udel (i–l) and RegCM-UW experiment compared to CRU (e–h) and UDel (m–p) observations



- **Both experiments underestimated the temperature over all the seasons, which refers to a cold bias. But the degree of underestimation differs according to the experiments**

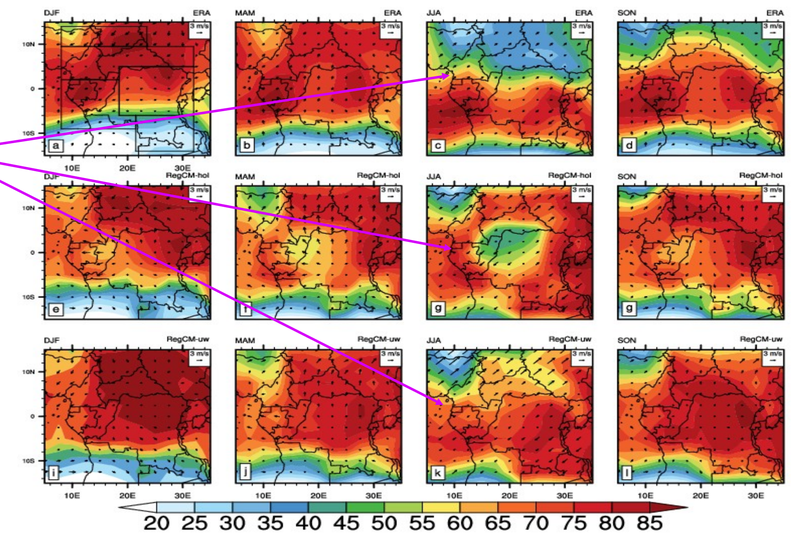
b) Annual cycles of monthly near-surface temperature fromRegCM-Hol and RegCM-UW experiments and both CRU and UDel baseline data for CA and the five sub-regions. Near-surface temperature means are taken over land



- **In zones 2, 3 and 5, the two experiments underestimate temperature against benchmarks throughout the year, but at different intensities**

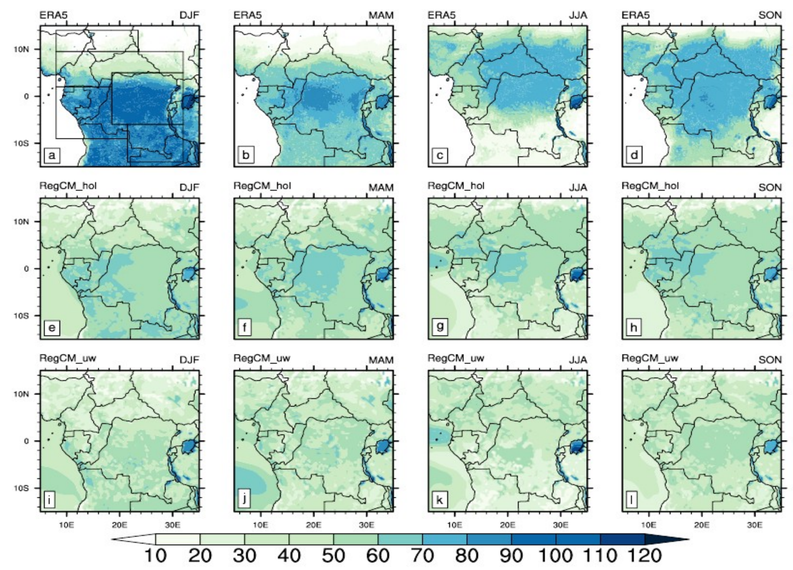
Regional wind circulation and water evaporation

a) Seasonal distribution of surface wind (925 hPa) for the period 2002–2006 and relative humidity in color for ERA-Interim (a–d), RegCM-Hol (e–h) and RegCM-UW (i–l)



- **At 925 hPa the basic structures of relative humidity transport are similar between the models and the reanalysis data. There are important differences between the JJA seasons of ERA-Interim and the experiments where we observe a strong presence of humidity over the entire field of experiments.**

b) Surface water evaporation (mm/day) for 2002–2006 period ERA5 (a–d), RegCM-Hol (e–h) and RegCM-UW (i–l)



- **The seasonal patterns of both experiments are similar over the various sub-regions and strongly underestimate evaporation in various seasons particularly in the southern part of the study domain including zones 3–5**

5- Conclusions

The sensitivity of the regional climate model RegCM4.6 to the choice of Planetary Boundary Layer (PBL) schemes has been investigated in this study. The RegCM-Hol experiment depicts fairly well the precipitation compared to its counterpart RegCM-UW which always tends to an underestimation. The analysis of rainfalls shows that there is no difference with the two RegCM configurations for regions where rainfalls are less than 1 mm/day. Regarding temperatures Generally, statistical analysis of the two experiments shows that RegCM-UW has better results than RegCM-Hol for simulating the near-surface temperature. Tmoreover the RegCM experiments succeed in reproducing the wind direction, while they underestimate relative humidity and overestimate the wind intensity throughout the year.

Acknowledgments

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Reference: this work is a published article in Climate Dynamics, *rdcu.be/cuoFF*