The Abdus Salam International Centre for Theoretical Physics
Physics Without Frontiers

University of Dschang

LABORATORY FOR ENVIRONMENTAL PHYSICS

ICTP Physics Without Frontiers

-SCHOOL ON CLIMATE MODELLING-

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RegCM BIAS CORRECTION

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Ojective

Show that apart of sensitivities studies, there is some bias correction methods to enhance Regional Climate model outputs.

There is two ways to have a better model performance:

1- Conduct several sensitivity analysis

2- Use Bias Correction methods

1- Sensitivity analysis

Sensitivity analysis aims to find suitable parametrizations to have a good model performance.

Among other physical parametrizations in RegCM, we have:

-Convective

-Radiative transfer

-Atmospheric boundary layer

2- Bias Correction methods

Zone 1: Sahelian region

Zone 2: High lands

Zone 3: Congo basin

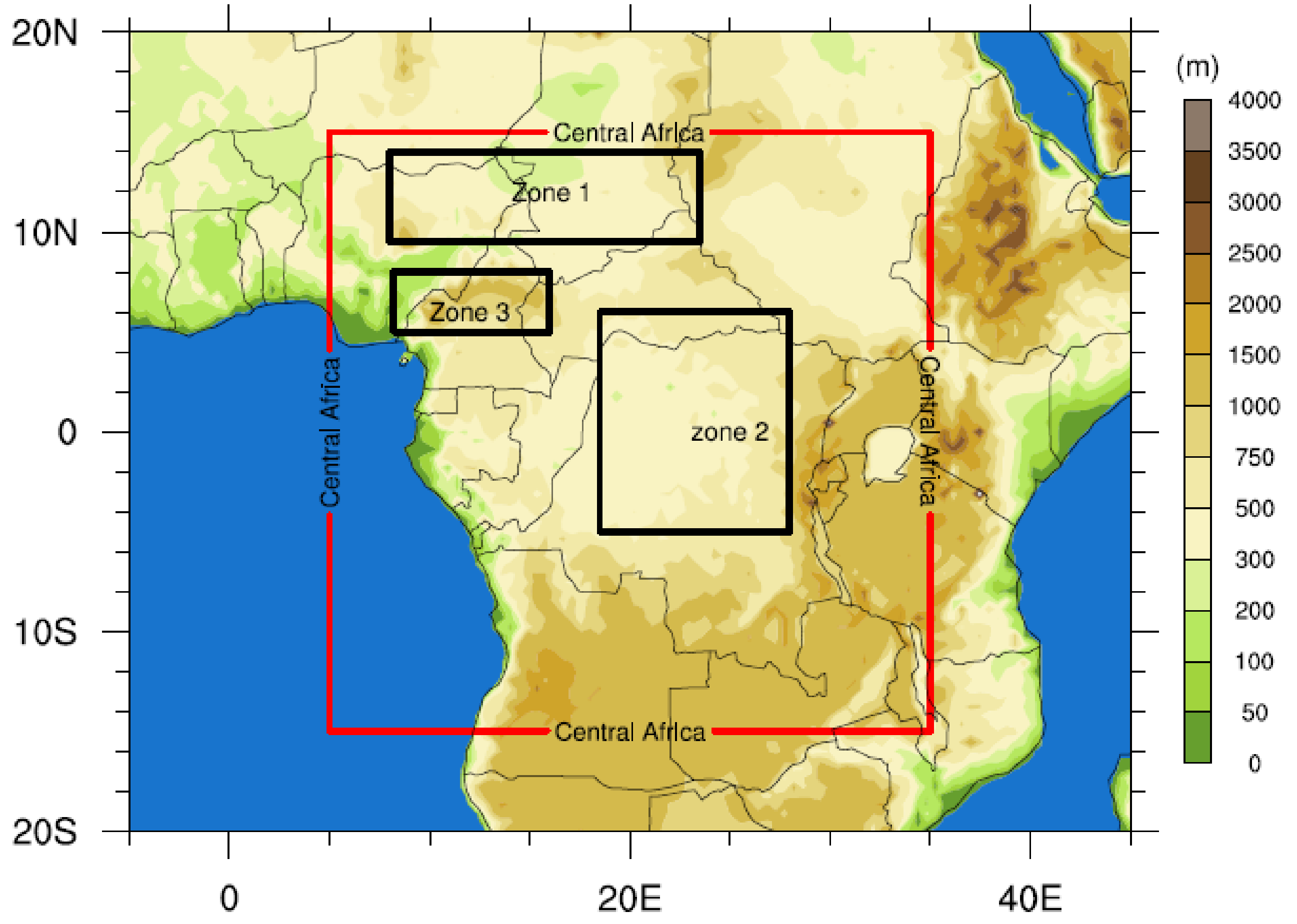


Fig. 1. Topography (m) of the simulation domain encompassing the study area indicated by the red box. The three black boxes indicate the three sub-regions

Two sets of 11 years of simulation (with the first years used as spin-up) are performed:

- The first set (from 1 January 1991, to 1 January 2002) is used as the control while

- the second one (from 1 January 2001 to 1 January 2012) is used as the evaluation period.

Two BC methods:
- Linear Scaling (LS)
- Variance (Va).

The study uses both these BC methods to correct daily biases instead of monthly biases. They have also been adjusted by using seasonal mean instead of monthly mean in performing correction factor

The LS approach (Lenderink et al., 2007) operates with daily correction values based on differences between observed values and simulated values during the control period. The corrected precipitation for the control period $p_c^*(d)$ at day d is given by:

$$p_c^*(d) = p_c(d) * f_{\mathrm{cp}}, \tag{1}$$

where

$$f_{\mathrm{cp}} = \frac{\overline{p}_{\mathrm{obs}}(d)}{\overline{p}_c(d)}, \tag{2}$$

For the evaluation period, the corrected precipitation $p_e^*(d)$ at day d is given as follows:

$$p_e^*(d) = p_e(d) * f_{\mathrm{cp}}. \quad (3)$$

The Va approach corrects both the average and the Va of the chronological series (Delei et al., 2018). Firstly, for control and evaluation periods, precipitation (or temperature) is performed according to the LS method to obtain $P_c^{*1}(d)$ and $P_e^{*1}(d)$ (or $T_c^{*1}(d)$ and $T_e^{*1}(d)$). Secondly, the mean-corrected precipitation (or temperature) is first corrected by subtracting the mean of the corresponding season:

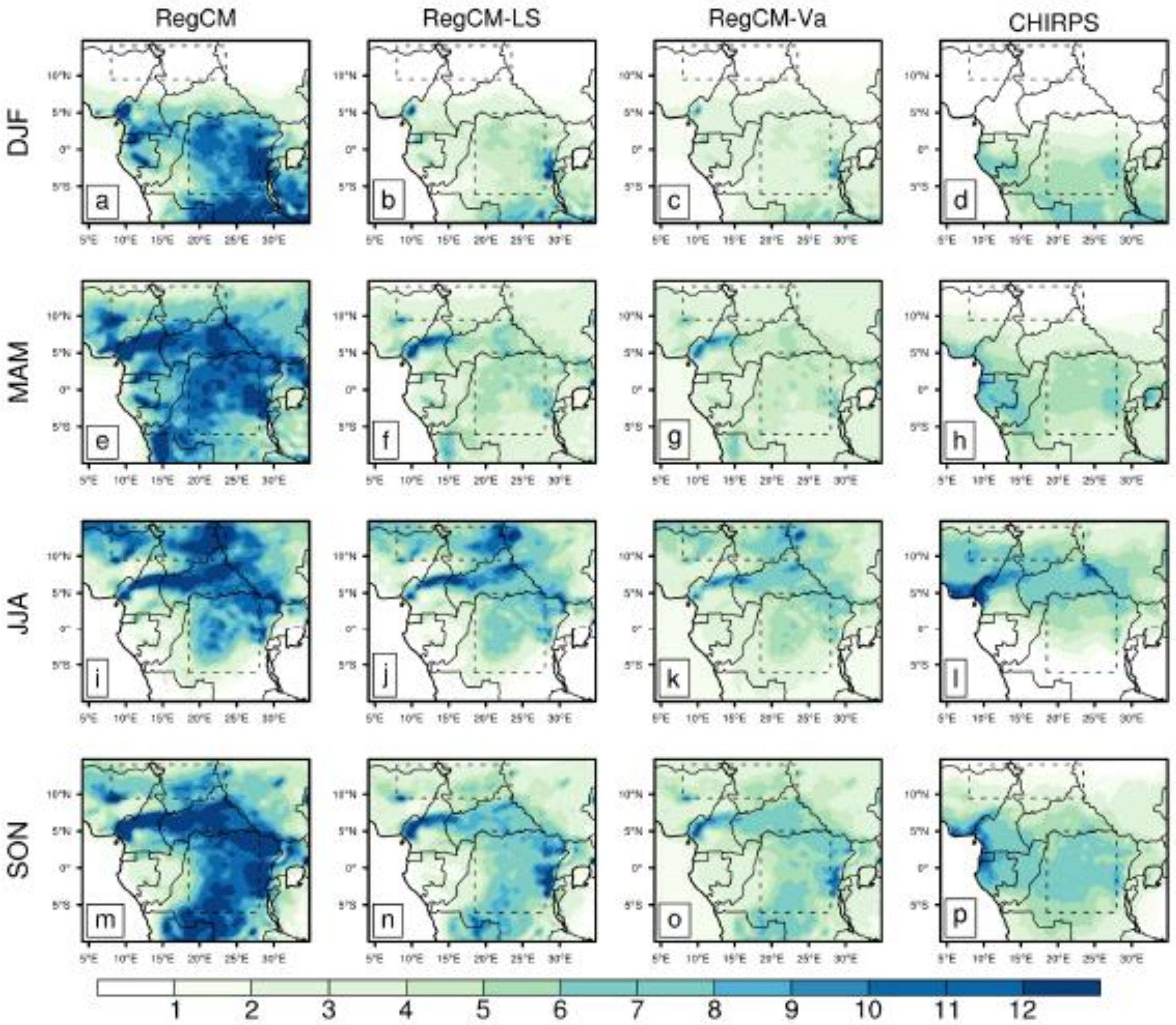
$$P_c^{*2}(d) = P_c^{*1}(d) - \overline{P}_c^{*1}(d), \tag{7}$$

$$P_e^{*2}(d) = P_e^{*1}(d) - \overline{P}_e^{*1}(d). \tag{8}$$

Thirdly, these last values are scaled by the ratio between the observed and control seasonal mean of standard deviation. Finally, obtained values are shifted back using the corrected mean of the first step. Therefore, for control and evaluation periods, corrected precipitations (or temperature) are given by:

$$P_c^{*}(d) = P_c^{*2}(d) * \left(\frac{\overline{\sigma}(P_{\text{obs}})}{\overline{\sigma}\left(P_c^{*2}(d)\right)} \right) + \overline{P}_c^{*1}(d), \tag{9}$$

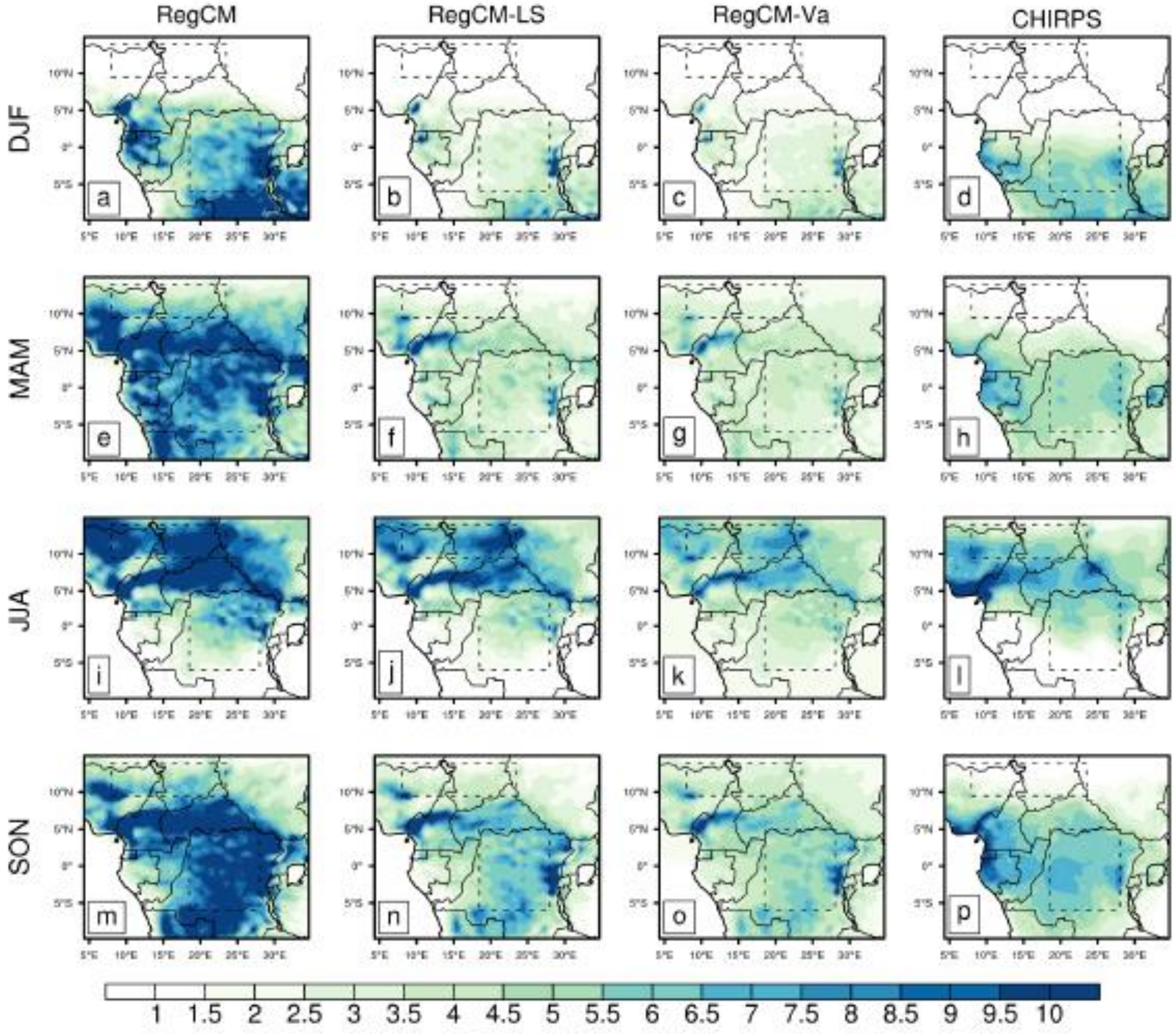
$$P_e^{*}(d) = P_e^{*2}(d) * \left(\frac{\overline{\sigma}(P_{\text{obs}})}{\overline{\sigma}\left(P_c^{*2}(d)\right)} \right) + \overline{P}_e^{*1}(d). \tag{10}$$



Both LS and Va reduced considerably the model biases for the control period

Statistical evaluation shows that Va is better than LS

Fig,12: Seasonal distribution of precipitation (in mm/day) from the model (uncorrected and corrected) and observations for the control period.



As for the control period, the Same result is found for the evaluation period/

Fig,13: Same as in Fig,12, but for the evaluation period.

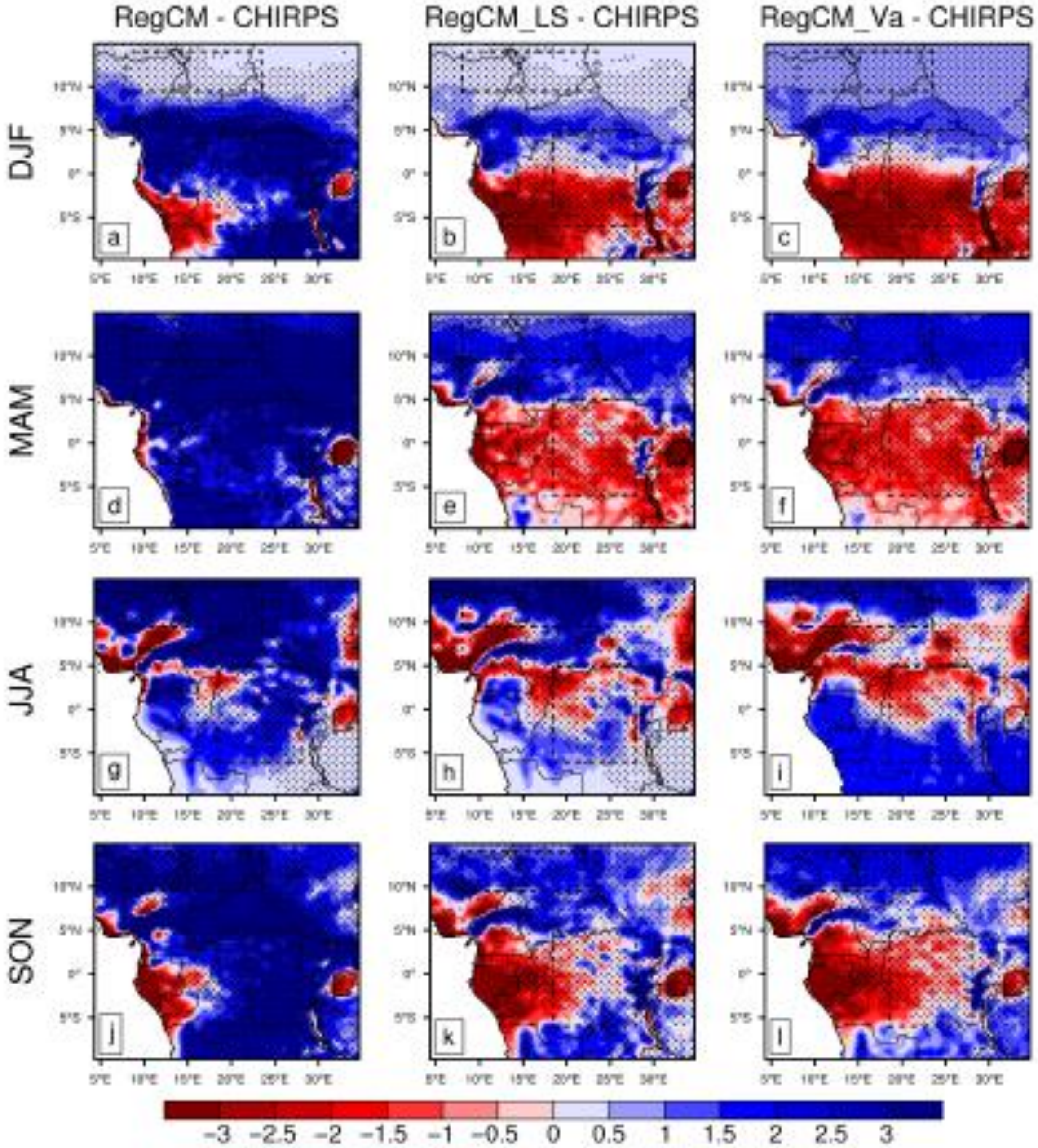


FIGURE 4 Seasonal distribution of precipitation biases (in mm/day) between the model (uncorrected and corrected) and the observations for the evaluation period. The dot shading indicates areas in which the difference between the model (uncorrected or corrected) and observation is statistically significant at the 95% confidence level according to the Student's *t*-test. JJA, June–July–August; LS, Linear Scaling; MAM, March–April–May; SON, September–October–November; Va, Variance.

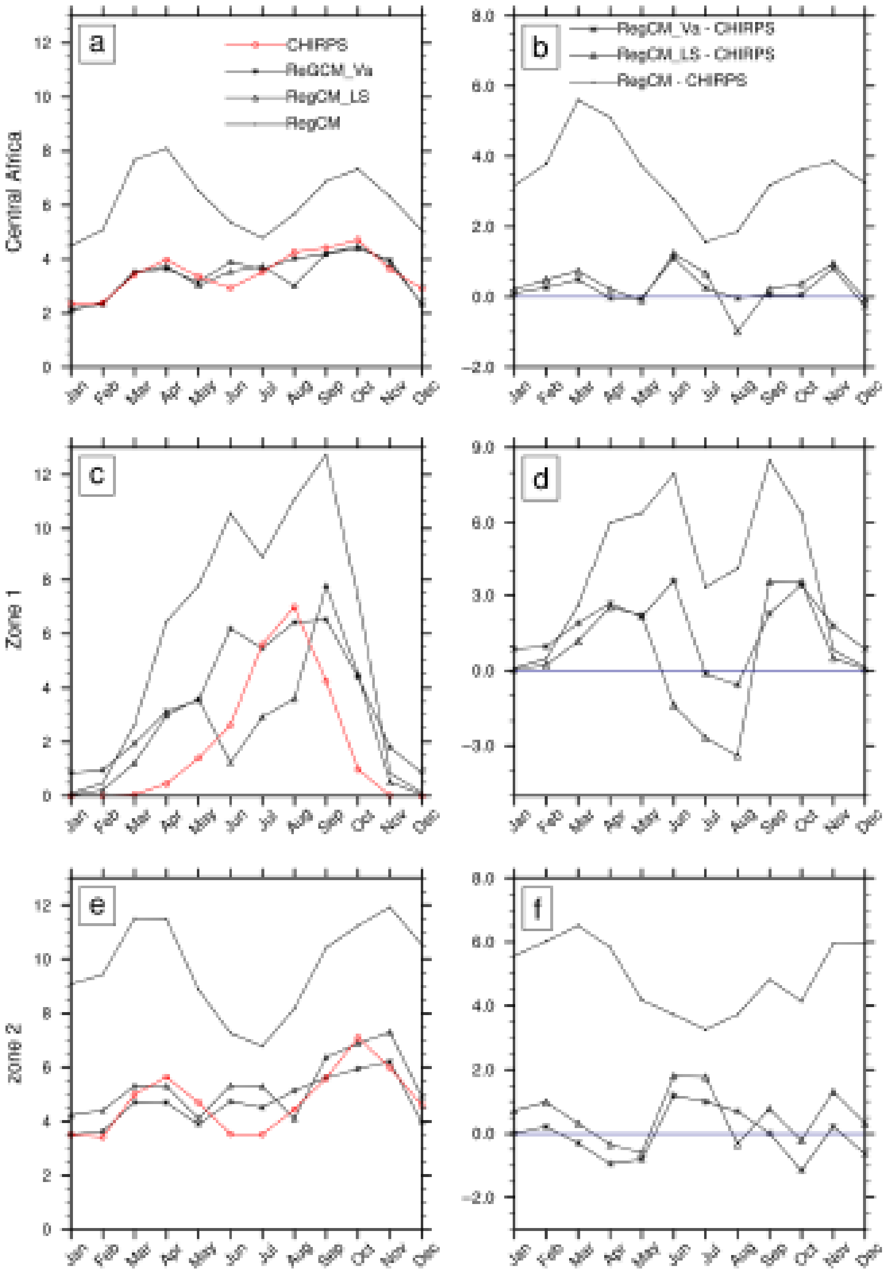


FIGURE 5 Annual cycles of (a, c, e) precipitation and (b, d, f) mean precipitation bias in mm/day from the model (uncorrected and corrected) for the control period. LS, Linear Scaling; Va, Variance.

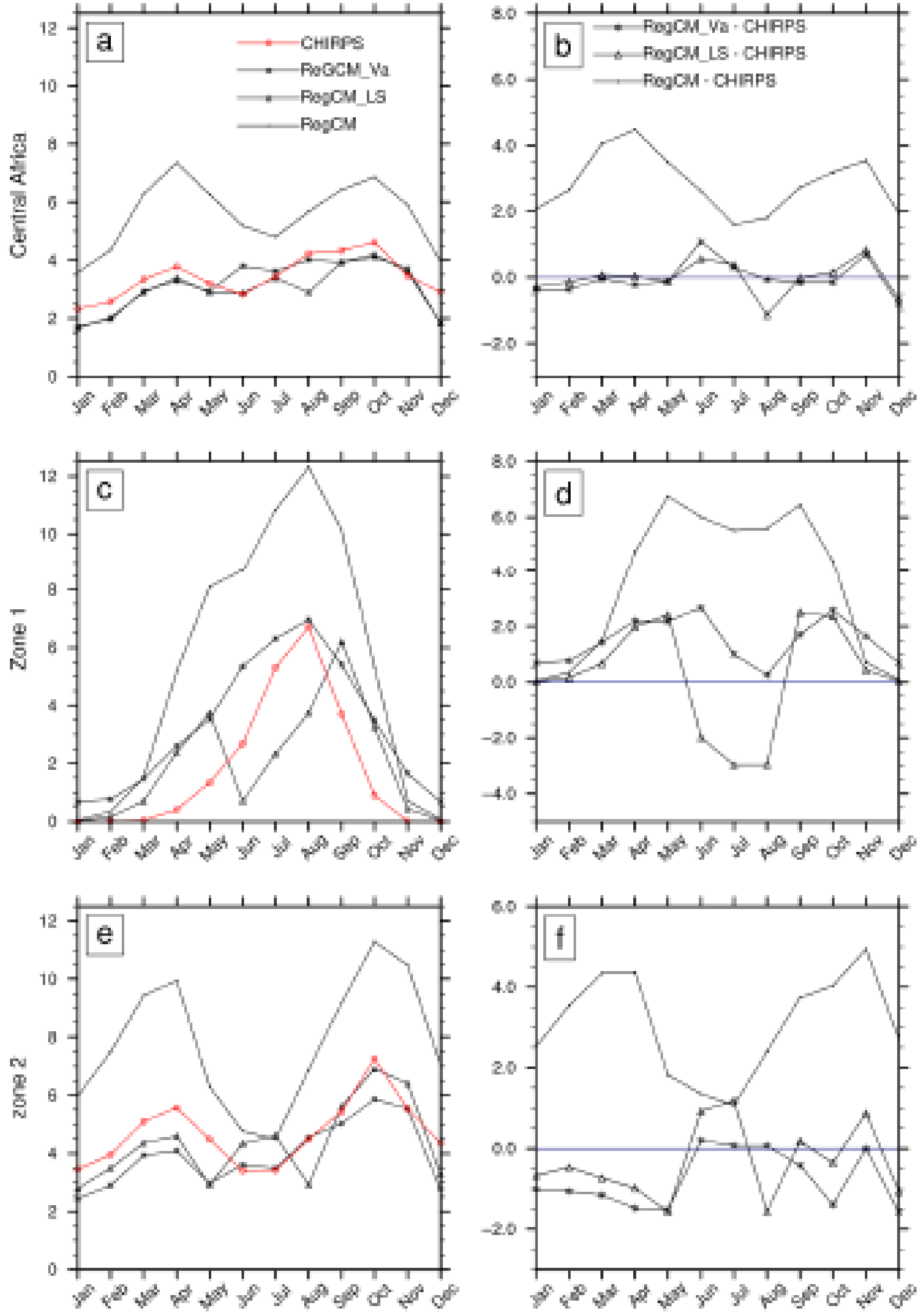


FIGURE 6 Same as Figure 5 but, for the evaluation period. LS, Linear Scaling; Va, Variance.

Overall, the analysis suggests that the Va method is the most suitable for reducing the biases of RegCM4.7 simulations, particularly for precipitation irrespective of regions or seasons.

More information in:

A. J. Komkoua Mbienda, G. M. Guenang, S. Kaissassou, R. S. Tanessong, P. C. Choumbou, F. Giorgi (**2023**): “Enhancement of RegCM4.7-CLM precipitation and temperature by improved bias correction methods over Central Africa”, *Meteorological Applications*, DOI: 10.1002/met.2116

Thank you