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Comparing Bias Correction Methods for Downscaling Daily Precipitation in Impact Studies over the Sudano-Sahelian Region of Cameroon

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Introduction

The Sudano-Sahelian region of Cameroon is challenged by high rainfall variability and rapid population growth. Due to significant biases and discrepancies in GCMs and RCMs projections, bias correction is crucial to enhance the reliability of future precipitation estimates for climate impact assessments.

Data

1-High-resolution daily rainfall data for Northern Cameroon at 0.01° resolution, based on 418 stations (Knops et Lavarenne, 2024).

2- 10 RCMs from CORDEX-CORE and 10 GCMs from CMIP6 to analyze the historical period (1980–2014) and project the future period (2026–2055), under the SSP5-RCP8.5 scenario.

Methods

-We applied and compared four bias adjustment methods—linear scaling, quantile mapping, CDF-t, and ISIMIP—using the user-friendly ***Ibicus*** toolbox (Spuler et al., 2024), with each method representing a key category of bias correction techniques.

-Extreme precipitation characteristics during the rainy season (dry days, wet days, R10mm, R95p and R1xdays) and seasonal timing (onset and retreat dates) were used to assess climate model performance before and after bias correction for present and future periods.

-Observations and CMIP6 data were regridded to 0.22° resolution using CDO, applying conservative remapping for observations and bilinear interpolation for models.

Results

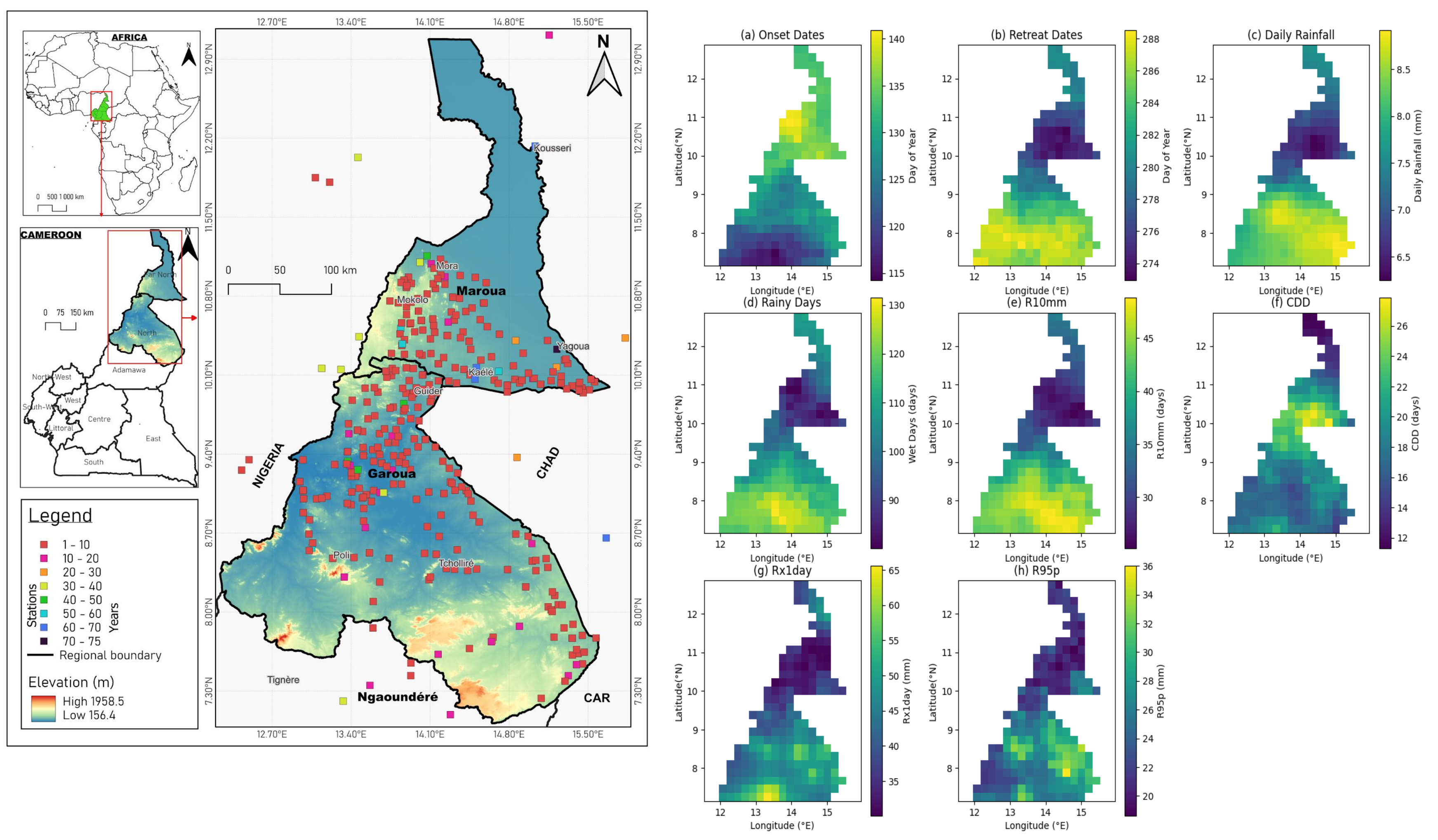

Fig. 1 The study area using gauge station data to analyze spatial patterns of rainy season onset, retreat, and related precipitation metrics.

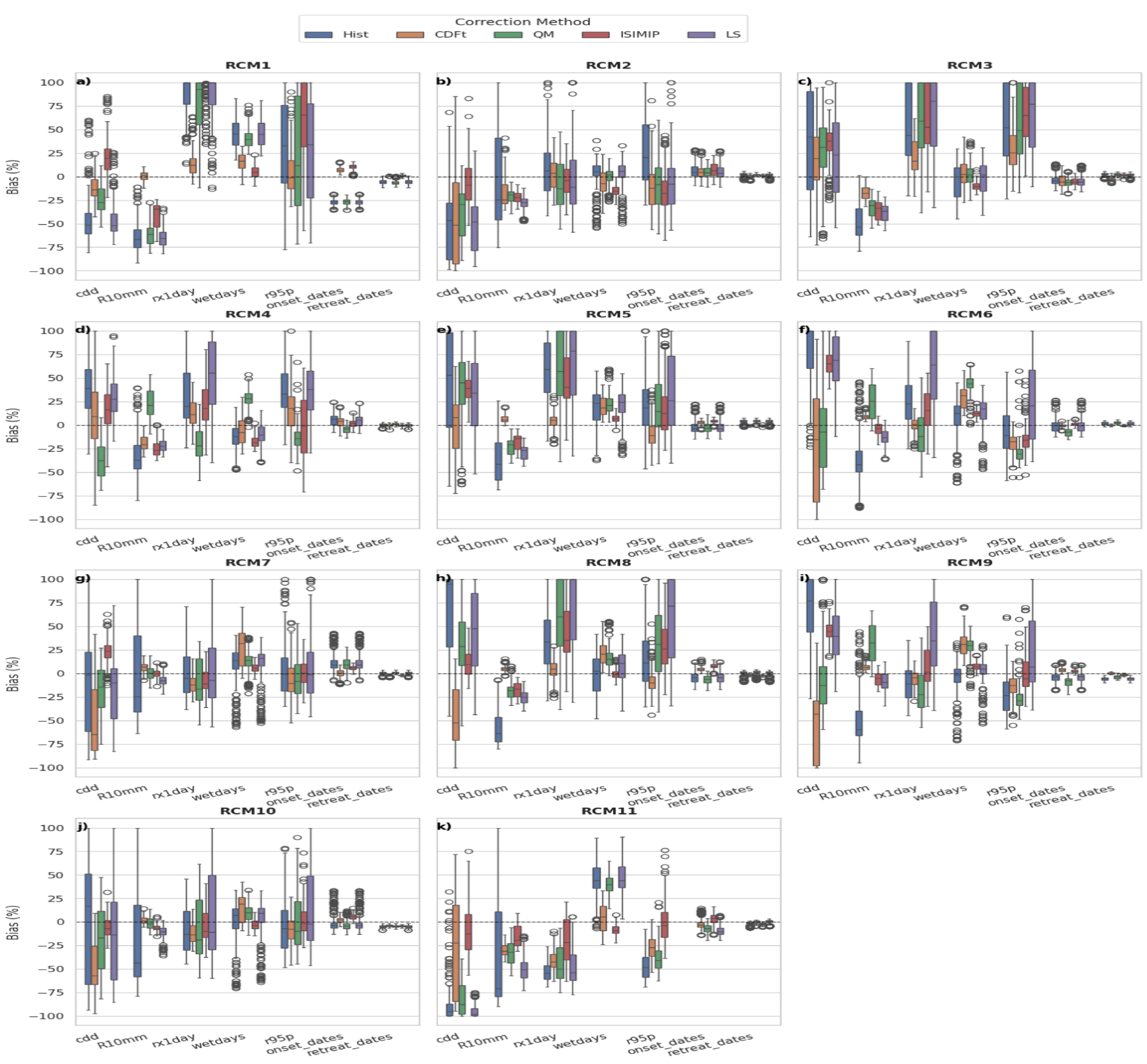

Fig. 2 Distribution of marginal bias of indices across locations before and after bias adjustment for CORDEX-CORE models and ensemble mean compared to observation.

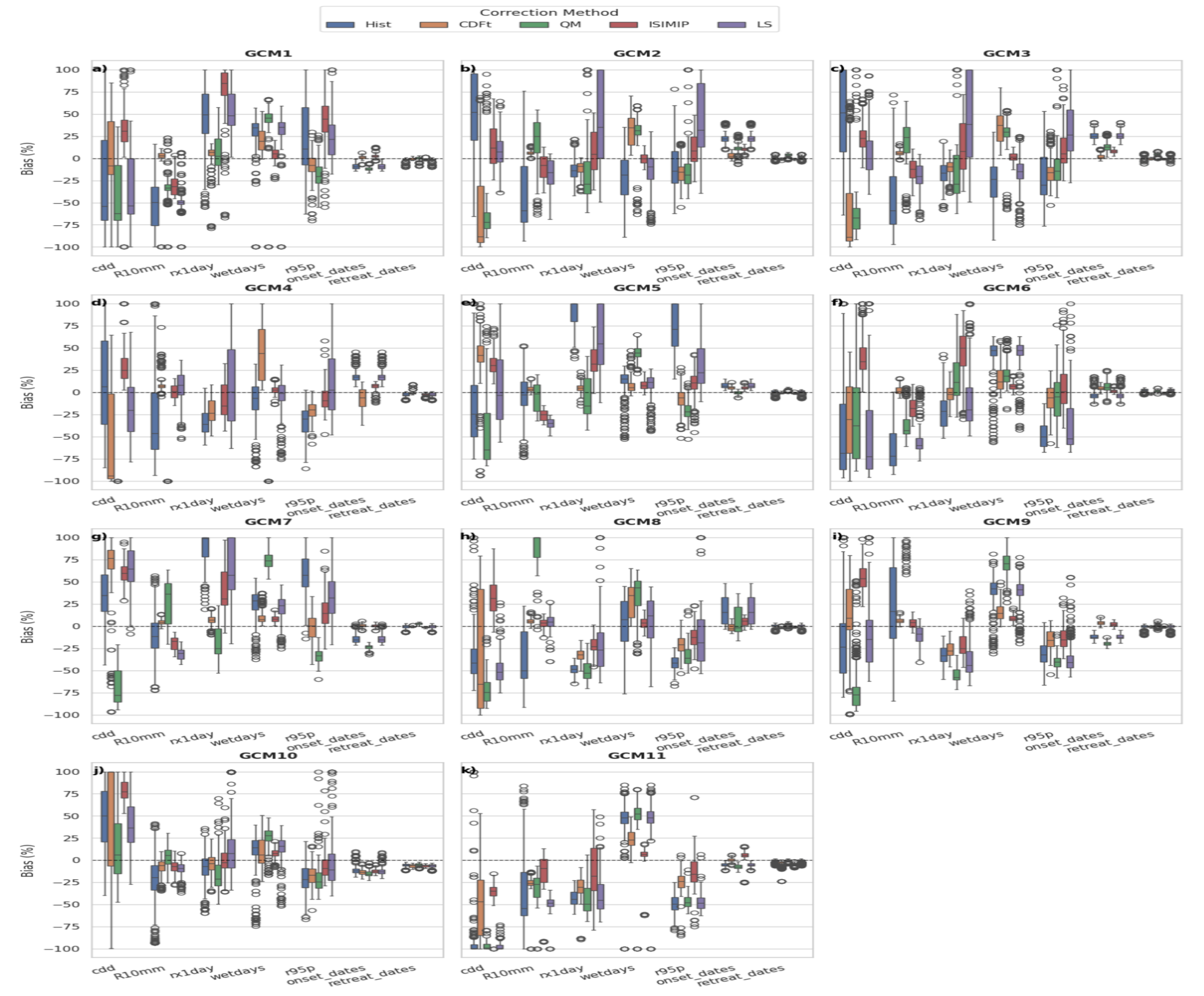

Fig. 3 As Fig. 2, but for the CMIP6 models and their ensemble mean (GCM11).

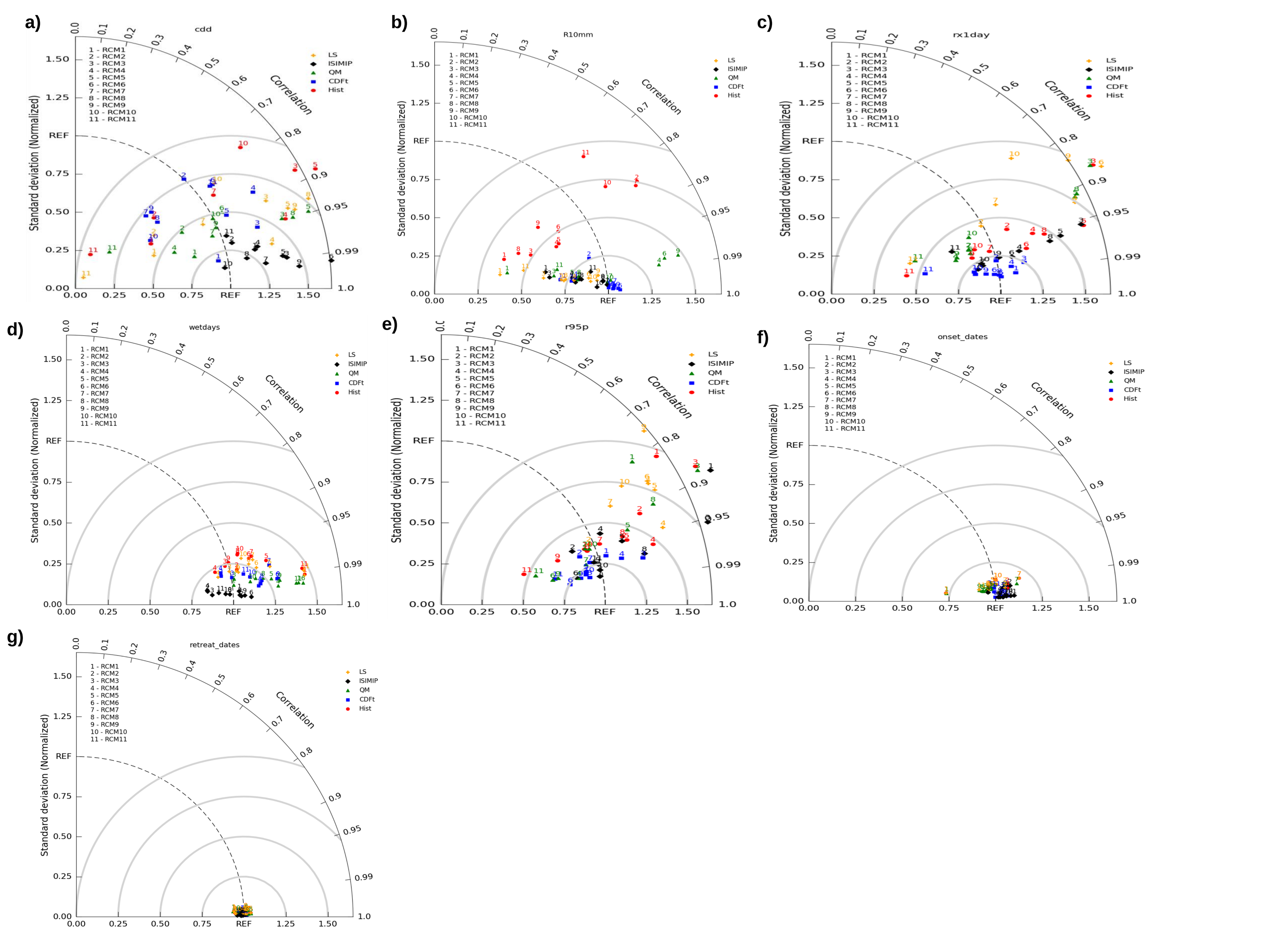

Fig. 4 Taylor diagrams summarize the performance of RCMs by comparing them to observations

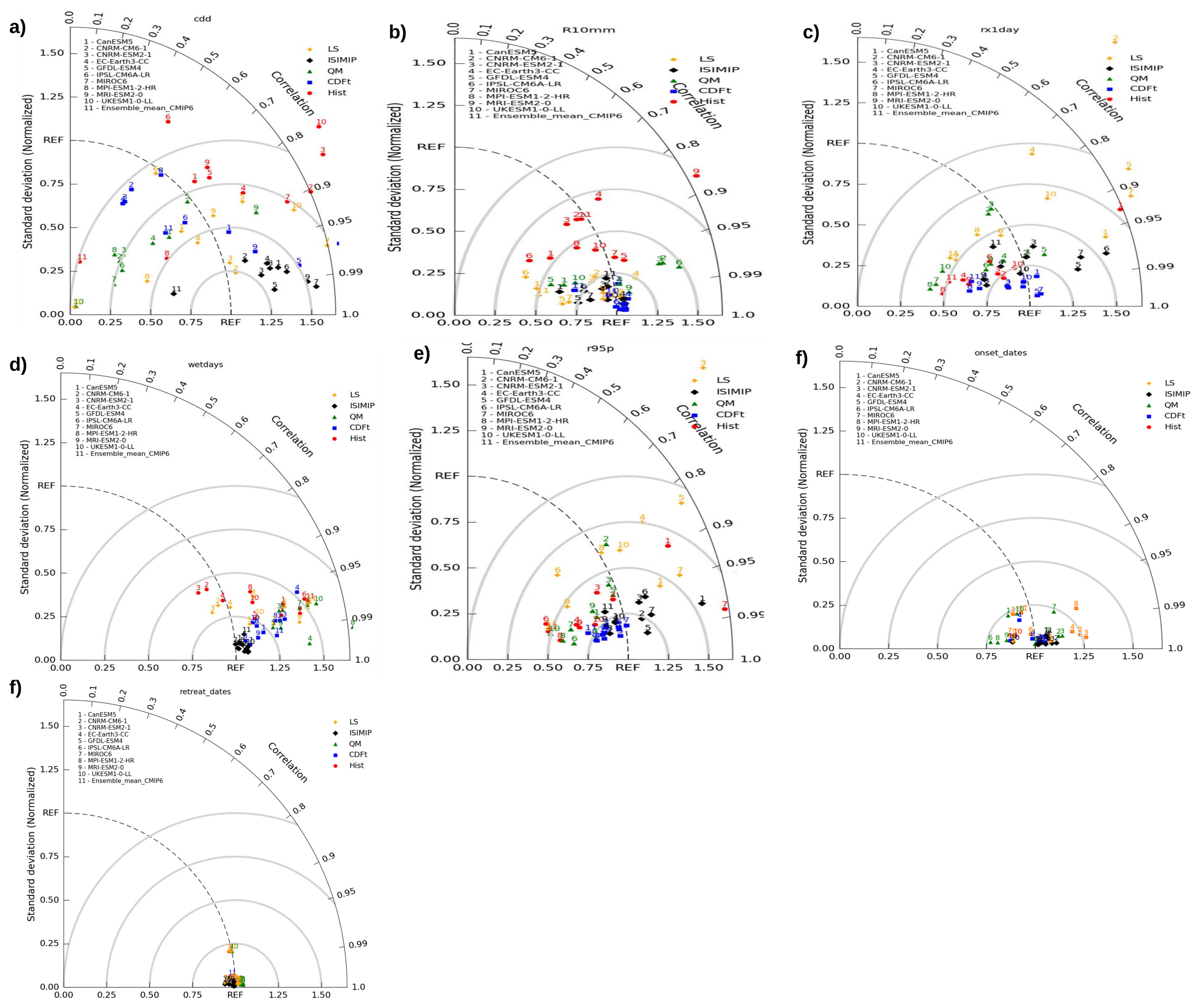

Fig. 5 Taylor diagrams summarize the performance of GCMs by comparing them to observations

Conclusions and future work

we note that :

-a few individual models from CMIP6 and CORDEX-CORE showed closer agreement with observations than their respective ensemble means;

-bias adjustment methods are effective in reducing biases and variabilities, though their effectiveness depends on both the climate models and the precipitation indices considered;

-ISIMIP method performed best in correcting the frequency-based indices while the CDFt method performed best in terms of the intensity.

The future work should also incorporate additional variables relevant to user-specific impact assessments, such as solar radiation. Additionally, this approach may present limitations by disrupting spatial coherence and inter-variable dependencies.

References

Knops, Clara, et Jérémy Lavarenne. 2024. « Northern Cameroon daily interpolated rainfall, 1948-2022, combined dataset obtained via ordinary kriging ». Zenodo. https://doi.org/10.5281/zenodo.11067785.

Spuler, Fiona Raphaela, Jakob Benjamin Wessel, Edward Comyn-Platt, James Varndell, et Chiara Cagnazzo. 2024. « Ibicus: A New Open-Source Python Package and Comprehensive Interface for Statistical Bias Adjustment and Evaluation in Climate Modelling (v1.0.1) ». Geoscientific Model Development 17 (3): 1249-69. https://doi.org/10.5194/gmd-17-1249-2024.