Future changes in extreme rainfall events on the Caribbean slope of Costa Rica, Central America, based on CORDEX-CORE models.

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Introduction

Regional Climate Models (RCMs) better simulate local changes in atmospheric circulation in areas with complex orography such as Central America [1]. Specifically in the study region (Caribbean slope of Costa Rica), no specific works focused on extreme precipitation were found. The high-resolution RCMs of the recent project integrated in CORDEX-CORE [2] over Central America, Mexico and the Caribbean (CAM), have shown improvements by including ocean-atmosphere interactions leading to a better representation of key circulation patterns in the region [1,4]. CORDEX-CORE models [2] provide a comparable set of high-resolution projections, which is approximately 22km for CAM-22.

Data and Methodology

3 RCMs (RegCM4-7, REMO2015 and CRCM5) driven by 3 different Global Climate Models (GCM) were selected.

Monthly and extreme monthly rainfall (25^{th} and 75^{th} percentile) in the historical experiment (1985-2005) and the RCP8.5 scenario for 2-time horizons: 2040-2069 and 2070-2099 were analysed. The study area was delimited to the Caribbean slope of Costa Rica and the outputs were interpolated to a common 0.25° by 0.25° grid. Validation was performed using quality database of 28 weather stations. This research is focused in 2 months that presented opposite and significant behaviours in the trend analysis: September (negative) and December (positive) [3] (Fig. 1).

Figure 1. Delimitation of the RCMs. Solid black line (CORDEX-CAM region), and the solid red line (the cut made for the RCMs).

Results

The validation results for September (December) show, in general, an overestimation (underestimation) of monthly rainfall. Regarding extreme rainfall, the 25th (75th) percentile in September (December) exacerbates the error found in the mean value (Fig. 2 and 4).

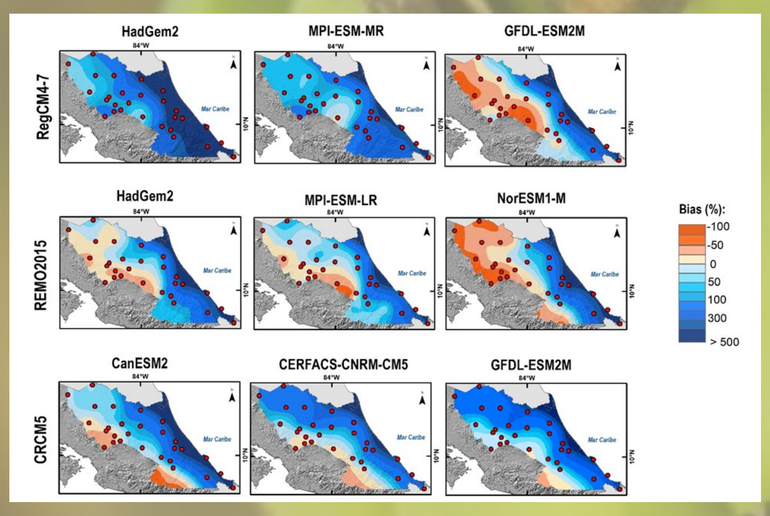

Figure 2. Percentage bias (%), 25th percentile in September precipitation by RGM.

For September and December, most of the models project increases of mean rainfall to the east-southeast whereas more inter-model variability is presented to the west-northwest for the near future period. For September, the increases or decreases deepen, while for December, the decrease deepens in most models (5) for the second horizon with respect to the first. In September, near future changes of the 25th percentile (Fig. 3) is positive in almost all the study region according to 5 RCMs, negative for 2 RCMs and spatial heterogeneous for the rest. In December, near future changes for the 75th percentile is negative according to most of the RCMs, which present deepening of the decrease in rainfall in the second horizon (Fig. 5).

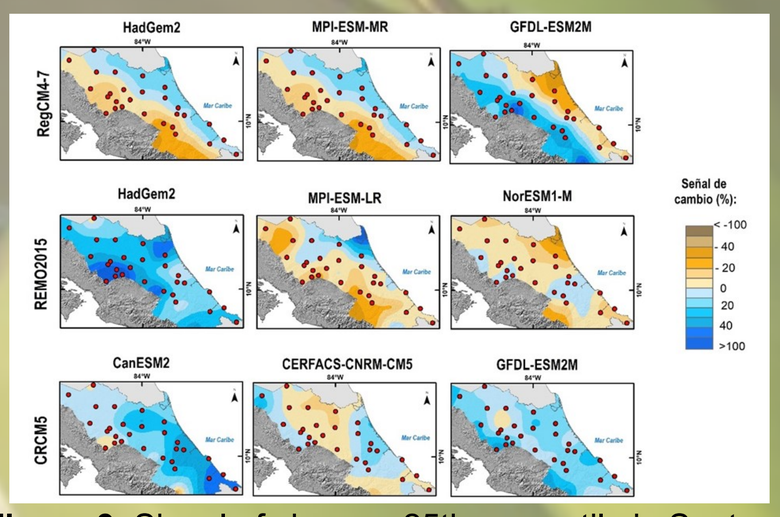

Figure 3. Signal of change, 25th percentile in September, 2040-2069.

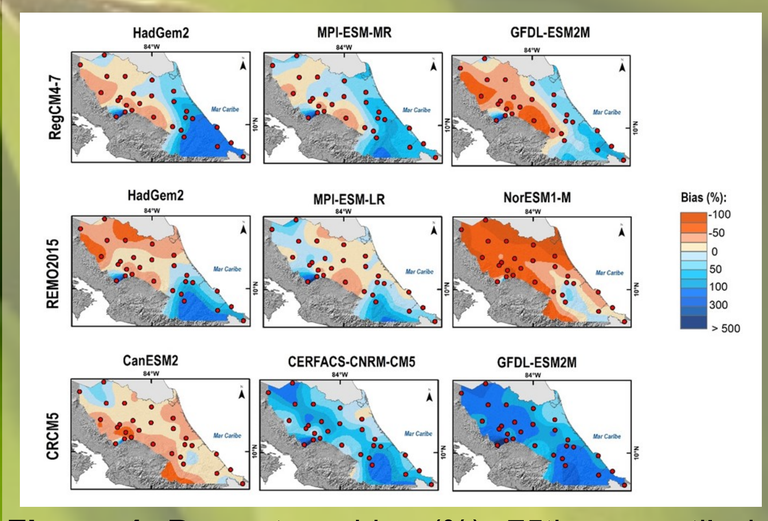

Figure 4. Percentage bias (%), 75th percentile in December precipitation by RGM.

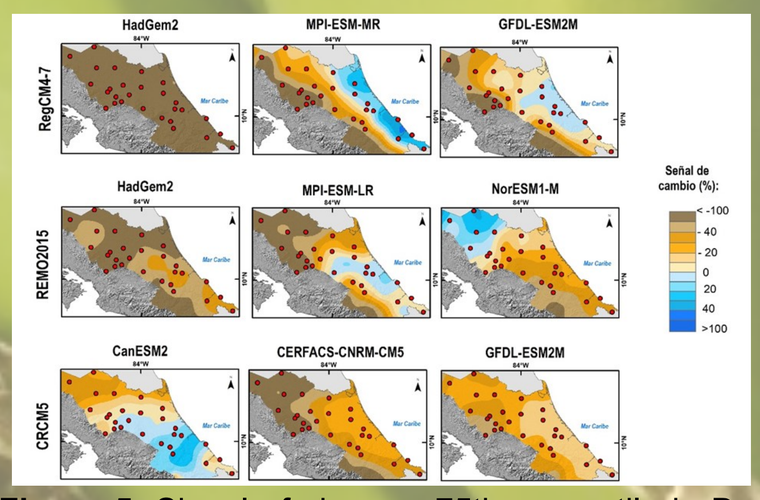

Figure 5. Signal of change, 75th percentile in December, 2070-2099.

Conclusions

- The overestimation behavior is more homogeneous in September for all models, while in December there is more variability between underestimation and overestimation.
- The signal of future change is lower than the bias analysed during the validation stage, indicating the high uncertainty involved in the projections.
- It is difficult to indicate whether rainfall increases or decreases according to the projections for each selected month, as there is little agreement between the results. However, in September, there are slightly clearer (increasing) signals than those seen in December (hybrid). This is consistent with IPCC (2023) in its analysis for the Central American region: the literature is limited and the RCMs project inconsistent changes in the region.

References

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