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Understanding the diversity of the West African Monsoon projected by CORDEX-CORE

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1. Introduction

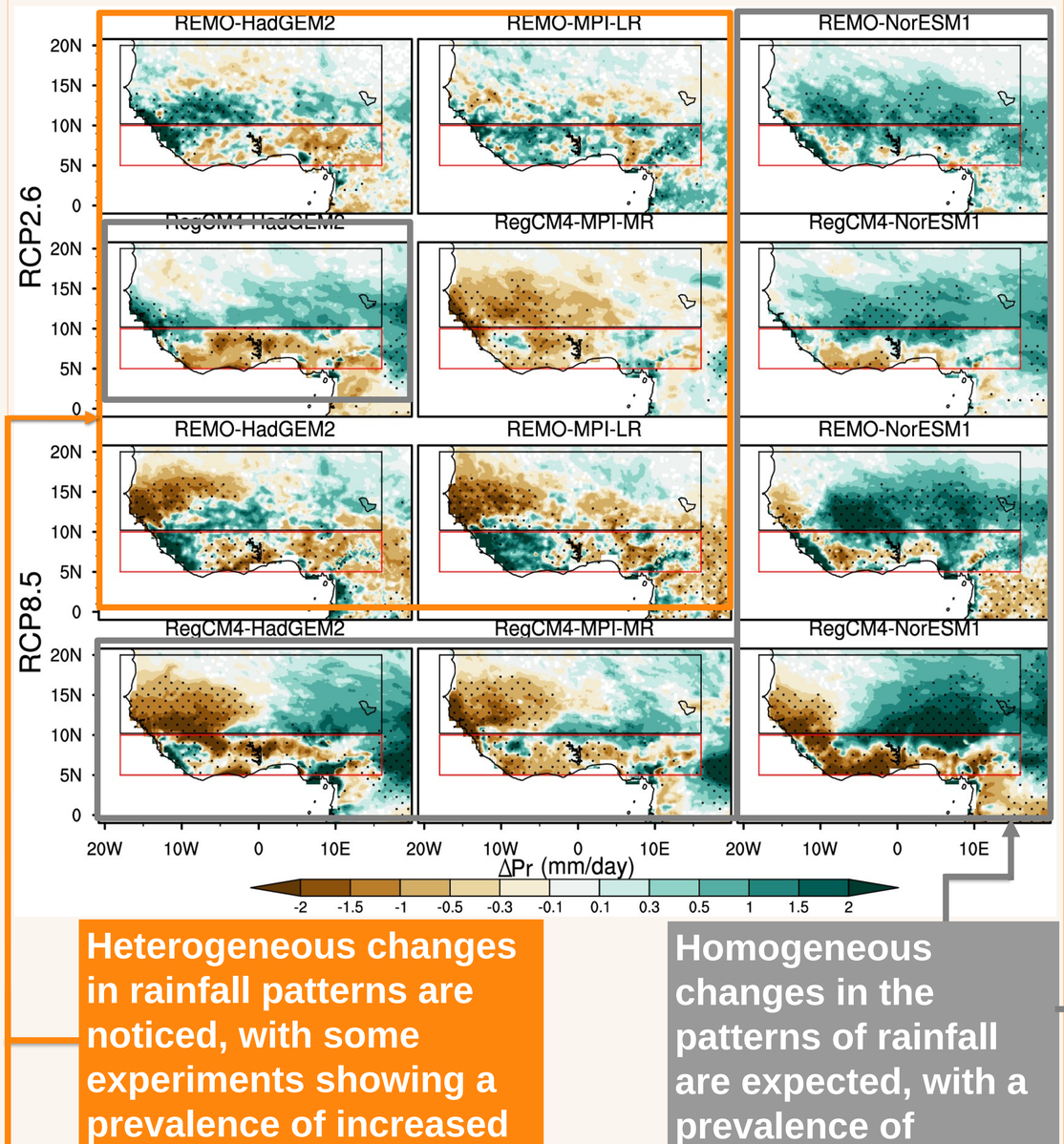
CORDEX-CORE RCMs, forced by three CMIP5 models under the historical, RCPs 2.6 and 8.5 scenarios, exhibit diverse patterns of the West African Monsoon (WAM) rainfall change. These patterns include anticipated homogeneous or increased rainfall over some or all of the Sahel region and heterogeneous or decreased rainfall across West Africa (WA). This study aimed to explore the reasons behind the diversity of rainfall change patterns while taking a step towards assessing the plausibility of the projections.

2. Data

Monthly mean results of dynamical downscaling from REMO- and RegCM4-CMIP5 combination: baseline period (1971-2000); projection periods under RCPs 2.6 and 8.5 scenarios (2070-2099).

3. Results

Diversity in the precipitation change pattern



Heterogeneous changes in rainfall patterns are noticed, with some experiments showing a prevalence of increased (decreased) precipitation.

Homogeneous changes in the patterns of rainfall are expected, with a prevalence of increase in precipitation.

Figure 1: Future (2070-2099) minus historical (1971-2000) mean JAS seasonal rainfall changes (ΔPr, in mm/day) for July-August-September. Results are shown for the REMO (1st and 3rd rows) and RegCM4 (2nd and 4th rows) simulations under RCP2.6 (top two rows) and RCP8.5 (bottom two rows). The stippling highlight the grid points where the change is statistically significant at 95% confidence level using the Student's t-test.

Diversity of physical processes and mechanisms involved in precipitation change patterns

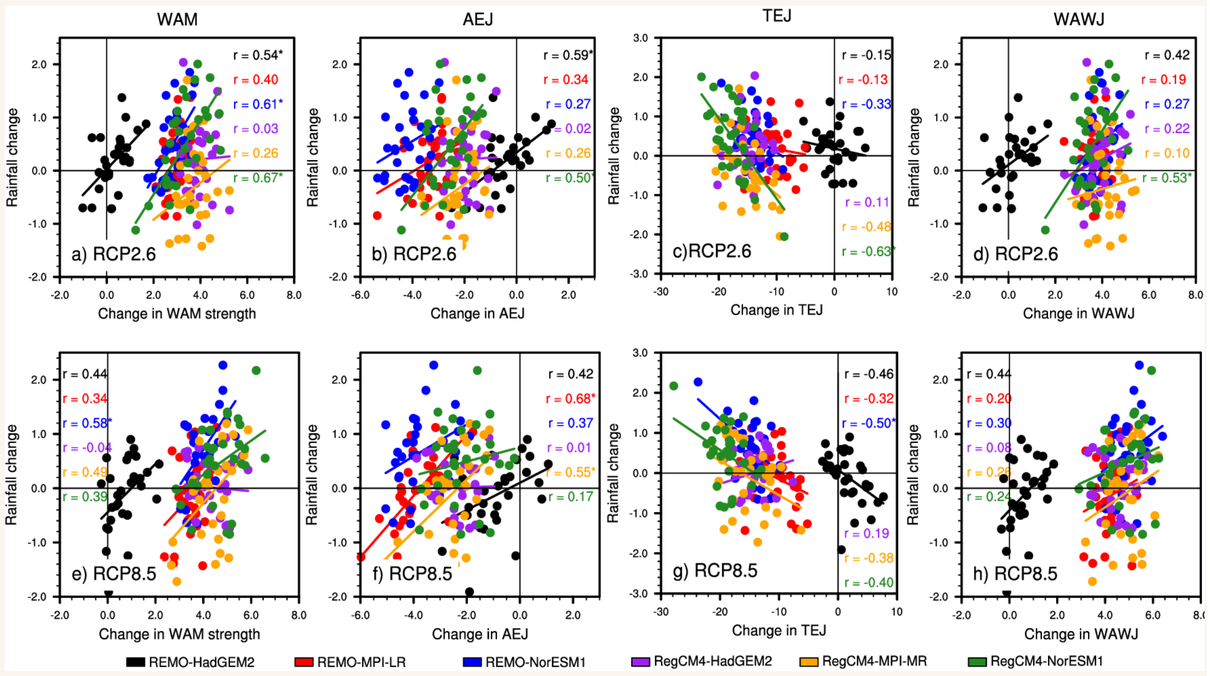


Figure 2: Relationships between the regional mean JAS rainfall change (2070-2099 minus 1971-2000) and regional mean change in WAM features: a–e change in WAM strength, i.e. the intensity of southwesterlies averaged between 1000 and 850 hPa, within longitudes 18°W-16°E and latitudes 5°N-20°N; b–f change in AEJ, i.e. the intensity of easterly wind averaged between 700-600 hPa, within longitudes 18°W-16°E and latitudes 5°N-20°N; c–g change in TEJ, i.e. the intensity of easterly wind averaged at 200 hPa, within longitudes 18°W-16°E and latitudes 5°N-20°N; and d–h change in WAWJ, i.e. the intensity of westerlies averaged between 1000-850 hPa, within longitudes 18°-10°W and latitudes 10°-20°N; under RCP2.6 (1st row) and RCP8.5 (2nd row), for both REMO2015 and RegCM4-v7 experiments.

- ✓ The magnitude of the absolute value of the correlation indicates the extent to which the WAM feature influences the amplitude and sign of rainfall change.
- ✓ The diversity of rainfall change patterns is also correlated with the diversity of physical processes and mechanisms involved, with each experiment featuring some combination of these operating simultaneously.
- ✓ The mechanisms associated with rainfall change patterns depend on the RCM-GCM combination and the level of radiative forcing.
- ✓ The combination of physical processes and mechanisms that operate simultaneously to induce the sign and pattern of rainfall change is also model dependent.

4. Summary and Conclusion

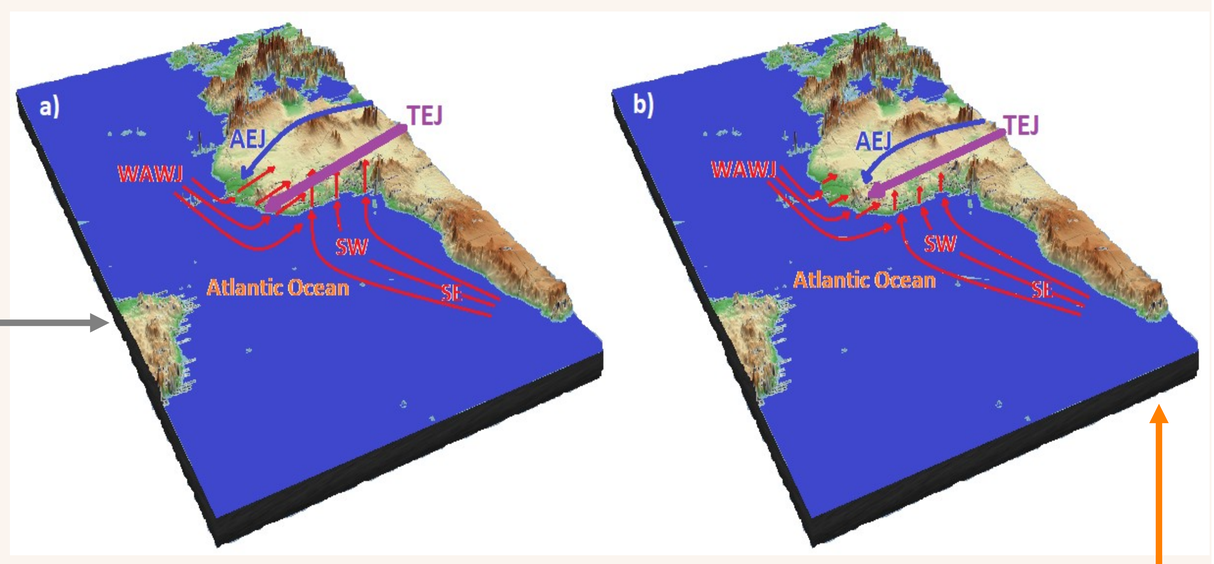


Figure 3: Schematic diagram of mechanisms driving rainfall changes as simulated by RCM experiments (1) projecting increased rainfall over the whole Sahel or central and eastern Sahel on the one hand, then reduced rainfall over the Guinea Coast, on the other hand (a); and (2) those simulating heterogeneous or reduced rainfall over the domain (b). Red arrows show low-level (1000–850 hPa) circulation (SW southwesterlies, SE southeasterlies, WAWJ West African Westerly Jet); the blue arrow shows the mid-tropospheric (700–600 hPa) circulation (AEJ African Easterly Jet), and the purple arrow shows the upper-layer (around 200 hPa) circulation (TEJ Tropical Easterly Jet).

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5. References

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