

# Modulation of Rainfall Predictability in Ecuador: ENSO's Evolving Influence (1981-2018)

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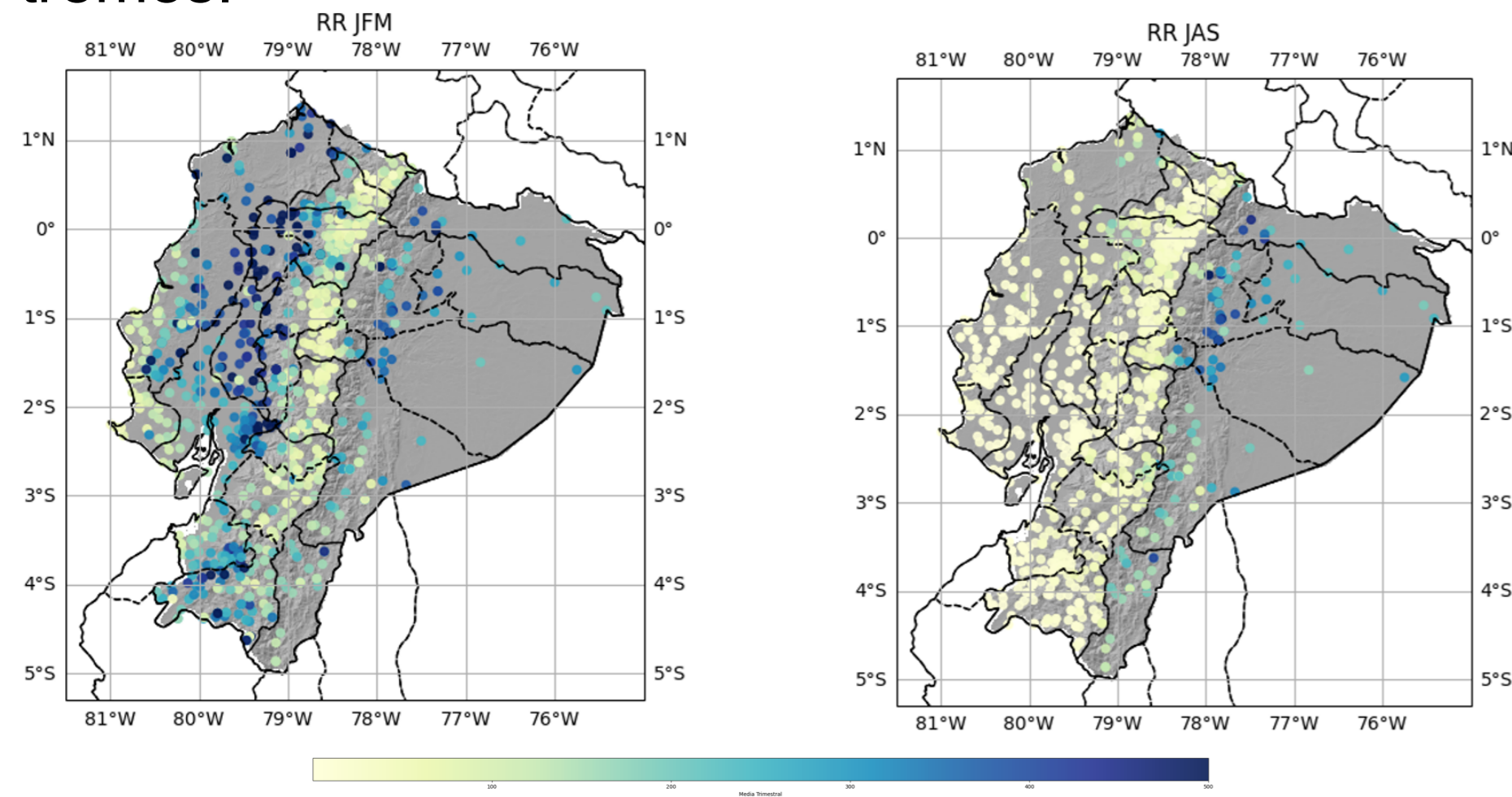
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## 1. Introduction

Ecuador's climate varies across its Coastal, Andean, and Amazon regions, with rainfall patterns heavily influenced by ENSO. This study examines the evolving impact of ENSO on rainfall predictability in 1981-2018, using ground observations and satellite data to analyze changes in precipitation patterns and extremes.



**Figure 1:** Seasonal precipitation means in Ecuador (1981-2018): Left - JFM, Right - JAS. These maps show average rainfall patterns during the wet (JFM) and dry (JAS) seasons.

## 2. Objectives

- Analyze shifts in rainfall patterns between 1981-1999 and 2000-2018.
- Assess how ENSO's influence on rainfall predictability has changed.
- Evaluate correlations between ENSO indices and rainfall indices.

## 3. Methodology

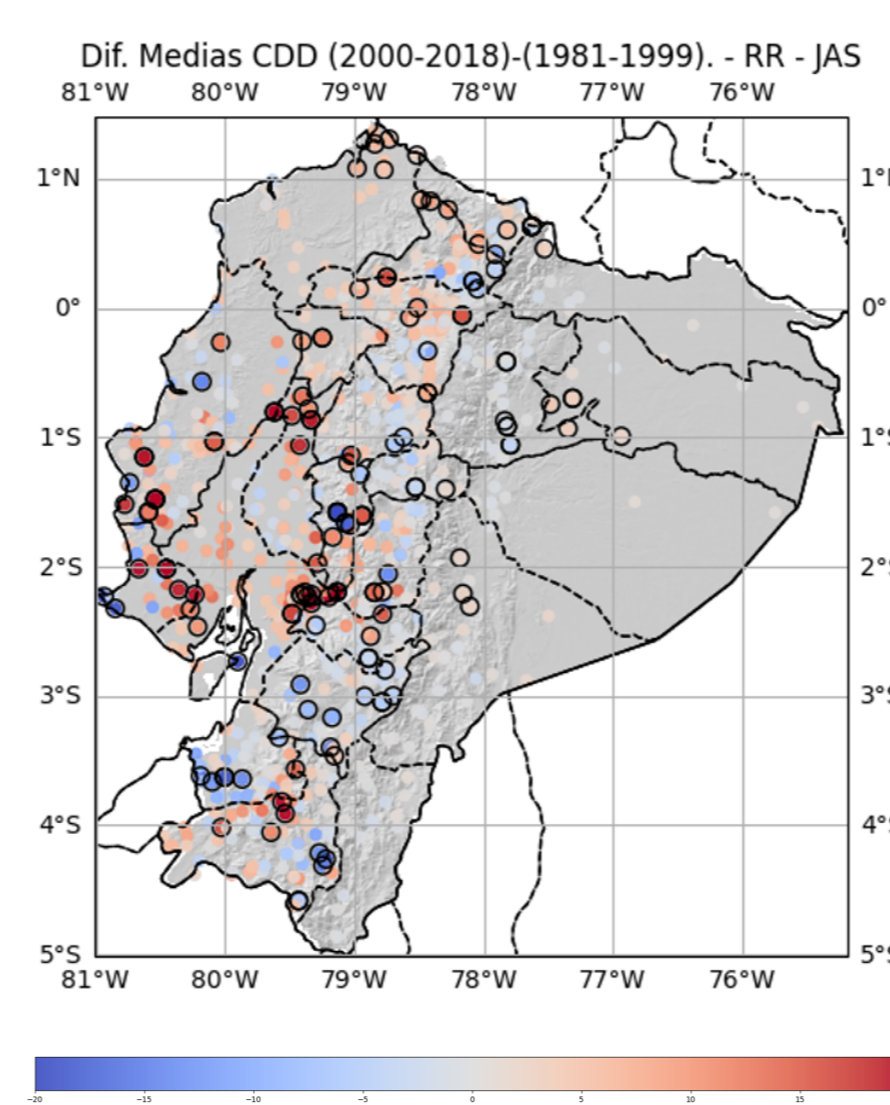
Data from INAMHI (ground observations) and satellite sources (MSWEP, IMERG, CHIRPS) were analyzed. Climatic indices (e.g., Niño 3.4, CDD, CWD, R95p, R99p, Rx1day, Rx5days) and statistical methods (regression, correlation, Monte Carlo statistical significance, EOF analysis) were used to identify patterns of rainfall variability.

## 4. Results

Key findings include:

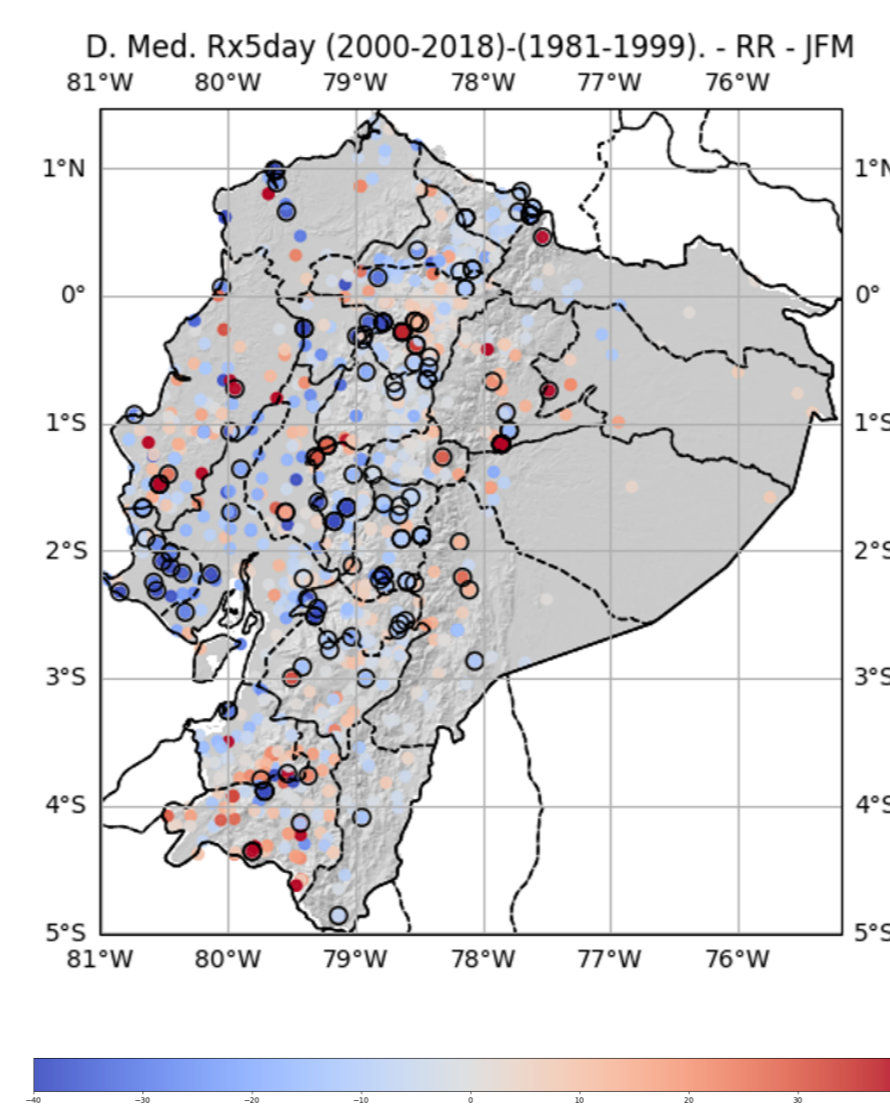
- On dry season (JAS), decreased consecutive dry days (CDD) in the Amazon Andean basins, in-

creased on the Coast (2000-2018).



**Figure 2:** CDD mean differences in Ecuador (2000-2018) - (1981-1999)

- On peak wet season (JFM), reduced extreme rainfall events (R95p, R99p, Rx1day, Rx5days) in 2000-2018.



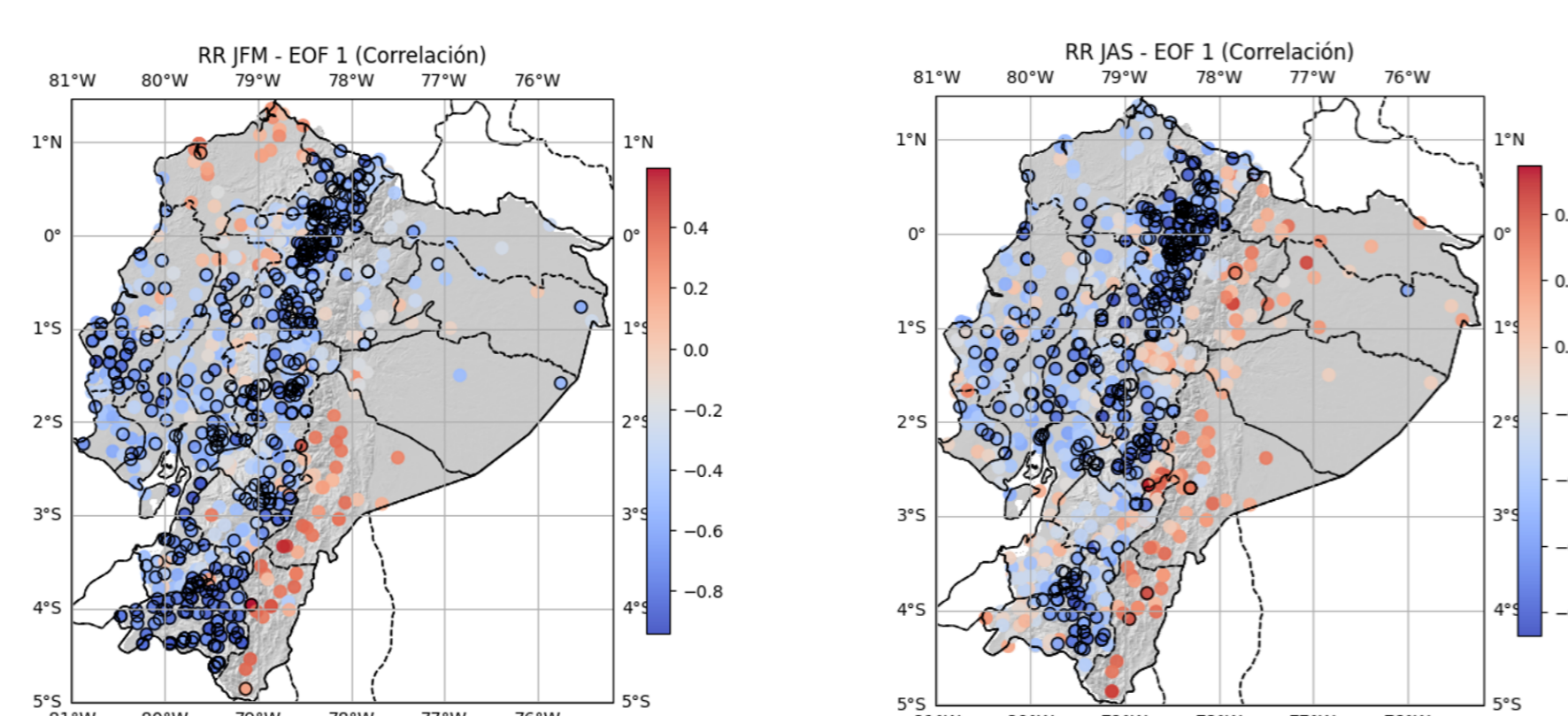
**Figure 3:** Rx5days mean differences in Ecuador (2000-2018) - (1981-1999)

- Shift in ENSO influence from Niño 1+2 to Niño 3.4 and Niño 4.

Índice Climático (PC1)	Periodo	El Niño 4				El Niño 3.4				El Niño 3				El Niño 1+2			
		JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND
Días consecutivos secos (CDD)	1981-1999	-	-	-	1	1	1	-	1	2	1	-	1	2	1	-	1
Días consecutivos húmedos (CWD)		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Días muy húmedos (R95p)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Días extremadamente húmedos (R99p)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Precipitación máxima en 5 días consecutivos (Rx5days)		1,4	1	-	-	1,4	1,4	-	-	2,1	1,4	1	-	2,1	2,1	1	-
Precipitación máxima en 5 días consecutivos (Rx5days)		1	-	-	-	1,4	-	-	-	2,1	1	-	-	2,1	1,4	1,4	-
Días consecutivos secos (CDD)		1	-	-	-	1,4	-	-	-	2,1	1	-	-	2,1	1,4	1,4	-
Días consecutivos húmedos (CWD)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Días muy húmedos (R95p)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Días extremadamente húmedos (R99p)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Precipitación máxima en 5 días consecutivos (Rx5days)	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	
Precipitación máxima en 5 días consecutivos (Rx5days)	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	

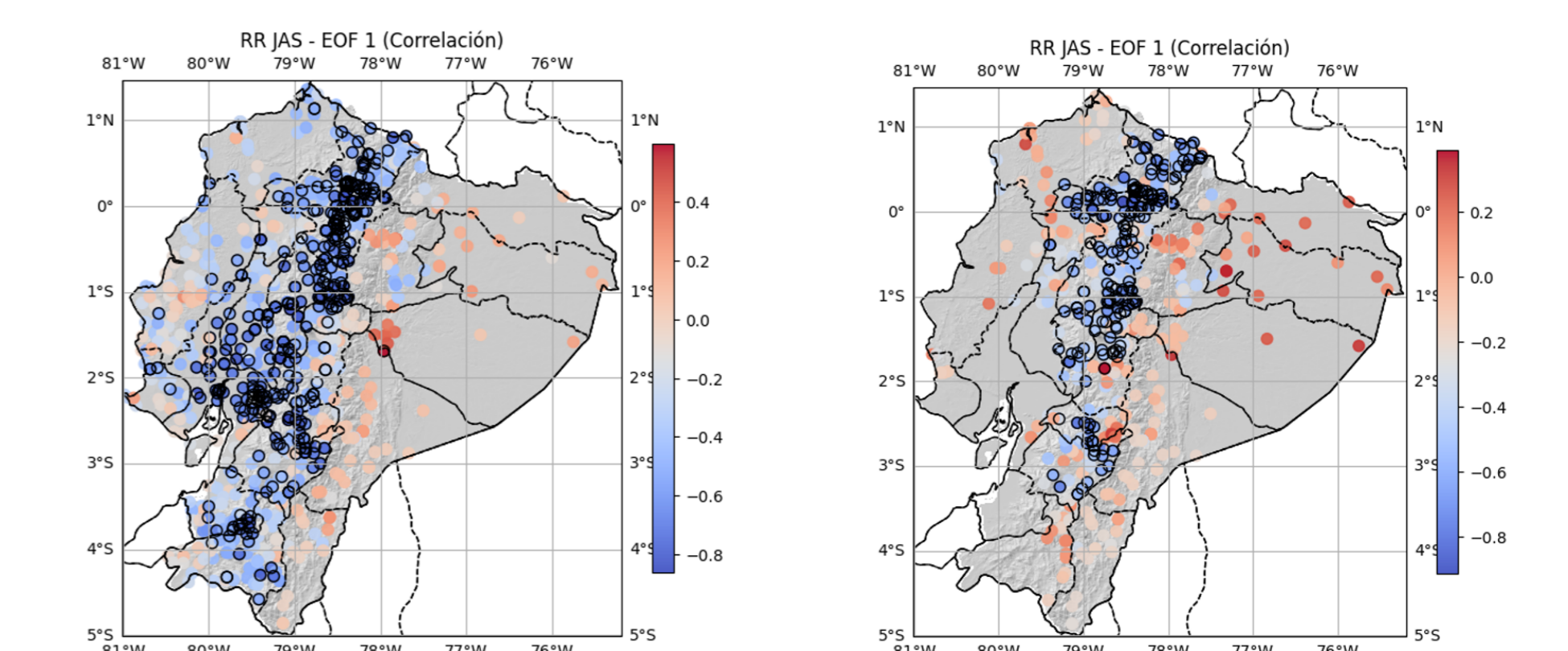
**Figure 4:** Significant Regression and Correlation between El Niño Indices and the PC1 of Climatic Indices from Observation, MSWEP, IMERG, and CHIRPS rainfall data

- On wet (JFM) and dry season (JAS), the significant variability pattern (EOF1) of Consecutive Wet Days (CWD) establishes a decreasing trend when positive anomalies of sea surface temperature (SST) are in the El Niño 3.4 and 4 regions (2000-2018).



**Figure 5:** Seasonal Significant Correlation variability pattern EOF1 for CWD and SST El Niño 3.4 and 4 in Ecuador (1981-2018): Left - JFM, Right - JAS

- During the dry season (JAS), the significant variability pattern (EOF1) of extreme indices (R99p and Rx5days) shows decreasing patterns when positive anomalies of sea surface temperature (SST) are in the El Niño 3.4 and 4 regions (2000-2018).



**Figure 6:** JAS - Significant Correlation variability pattern EOF1 for Rx5days and R99p with SST El Niño 4 and 3.4 respectively in Ecuador (2000-2018): Left - Rx5days JAS EOF1, Right - R99p JAS EOF1

## 5. Conclusions

- ENSO's influence has shifted to Niño 3.4 and 4, altering Ecuador's rainfall patterns.
- Dry season CDD trends vary by region; wet season extreme rainfall has decreased.
- Wet periods and extreme rainfall decline with Niño 3.4 and 4 SST anomalies.
- Updated forecasting models are needed for better climate adaptation.

## 6. References

### References

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