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PRESENT AND FUTURE METEOROLOGICAL DROUGHTS OVER CORDEX-CAM USING RegCM4.7

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I. Introduction

Most of CAM (Central America, Caribbean, and Mexico) has become warmer and drier during the last decades[1]. Several authors suggest that droughts over the northwest of the CAM domain, most of Mexico, and northern Central America could become worse at the end of the 21th century [2, 3].

Several investigations have shown that increased spatial resolution in regional models produces an improved simulation of droughts indicators[4], but the overall picture for meteorological drought projections with regional climate model is still incomplete.

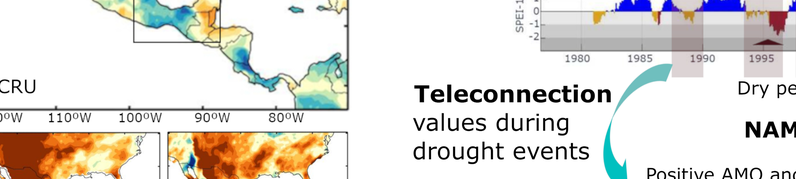
The study of droughts and their present and future assessment is of utmost importance in a warming world for effective drought management.

II. Objectives

- Assess the ability of RegCM4.7 to simulate the temporal variation and spatial patterns of droughts and dry hot spots during the historical period (1981-2010).
- To analyze the projected changes in droughts indices under different scenarios.

III. Datasets and Methodology

Datasets	Spatial Res.	Institution
RegCMv4.7-ERA	0.22°	International Centre for Theoretical Physics (ICTP)
RegCMv4.7-GFDL	0.22°	ICTP
RegCMv4.7-HadGEM2-ES	0.22°	ICTP
RegCMv4.7-MPI-ESM-MR	0.22°	ICTP
CRUv4.5	0.5°	Climatic Research Unit of the University of East Anglia (CRU)
ERAv5-Land	0.1°	Copernicus Climate Change Service (C3S) and European Centre for Medium-Range Weather Forecasts (ECMWF)
Niño 1+2	-	Climate Prediction Center of the National Oceanic and Atmospheric Administration (CPC/NOAA)
ONI	-	CPC/NOAA
PDO	-	CPC/NOAA
AMO	-	CPC/NOAA



Drought event: threshold when the SPI or SPEI index value falls below one negative standard deviation (-1 std) at least during two consecutive months until it turns positive

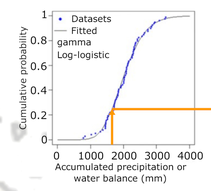
Metrics

Frequency: number of drought events between the number of decades.

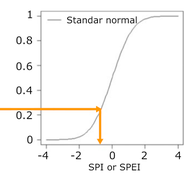
Severity: relation of the sum of the modulus of the SPI-12 or SPEI-12 value over the number of the decades.

Trend: Sen's slope estimator[5] multiplied by 120.

Standardized Precipitation Index (**SPI**)



Standardized Precipitation Evapotranspiration Index (**SPEI**)



Metorological droughts: drought-induced by prolonged meteorological conditions (12 month accumulation period in this work; SPI-12 and SPEI-12)

SPI/SPEI	Climatic moisture categories
≥2.0	Extremely wet
1.51 to 1.99	Severely wet
1.01 to 1.50	Moderately wet
-1.01 to 1.0	Normal
-1.51 to -1.0	Moderate drought
-2.01 to -1.5	Severe drought
≤-2.0	Extreme drought

IV. Results and Conclusions

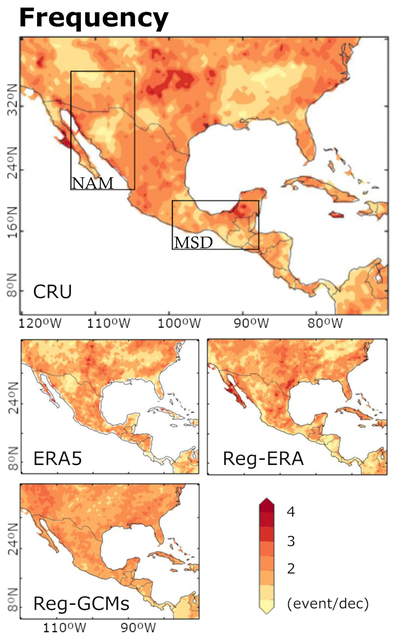
Evaluation (1981-2010)

SPEI-12 → **Spatial patterns**

Similar with **SPI-12**, with smaller metrics values, and smaller bias simulated by Reg-ERA and Reg-GCMs

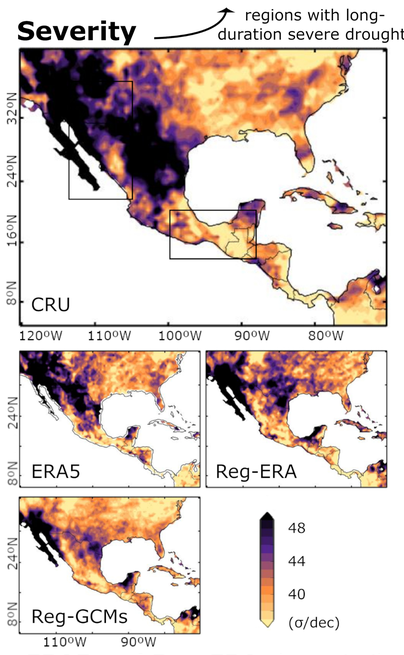
Potential "Dry Hot Spots"
Western United States, the United States-Mexico border region, the NAM, the Yucatan Peninsula, and northern Central America

Frequency



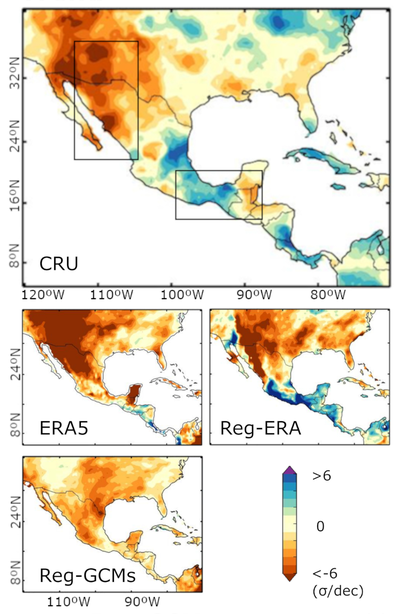
The **large spatial variation in drought** frequency is not well simulated by RegCM

Severity ← regions with long-duration severe droughts



ERA5 and Reg-ERA show similar spatial patterns and similar positive and negative spatial biases relative to CRU

Trend

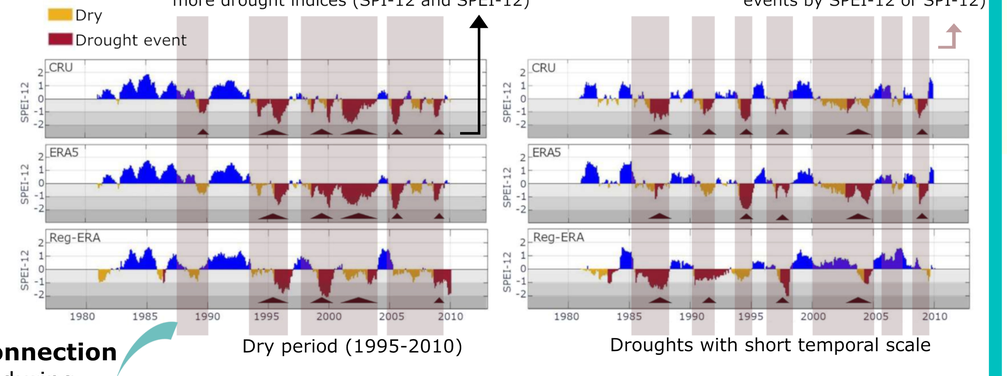


Reg-GCMs mean ensemble underestimates drought severity and trends, mainly over the western side of the domain, and shows difficulties simulating the spatial frequency variation

Temporal series for NAM and MSD

Period when **drought events** coincide in two or more databases (CRU, CHIRPS, GPCP or ERA5), on one or more drought indices (SPI-12 and SPEI-12)

Drought period (the beginning and the end of drought events by SPEI-12 or SPI-12)



Dry period (1995-2010)

Droughts with short temporal scale

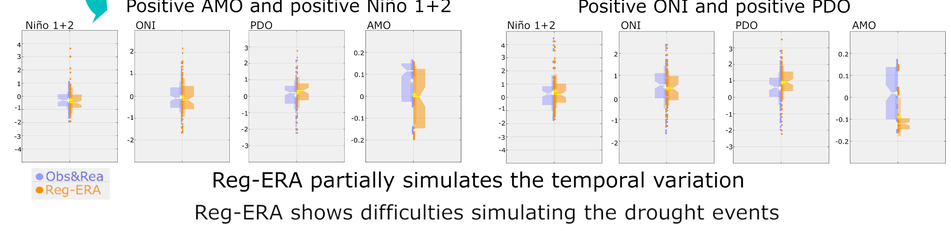
Teleconnection values during drought events

NAM

More droughts during: Positive AMO and positive Niño 1+2

MSD

More droughts during: Positive ONI and positive PDO



Reg-ERA partially simulates the temporal variation

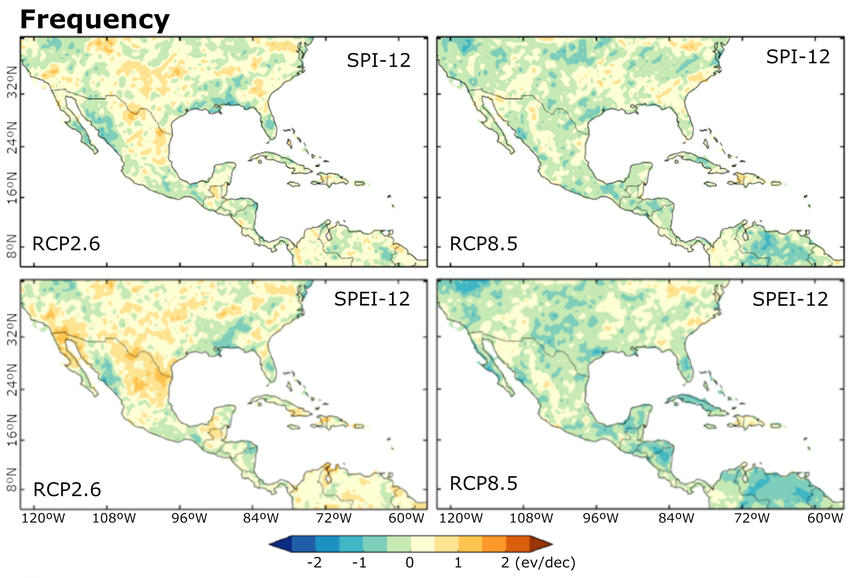
Reg-ERA shows difficulties simulating the drought events during the positive phase of the AMO

Future changes (2071-2100)

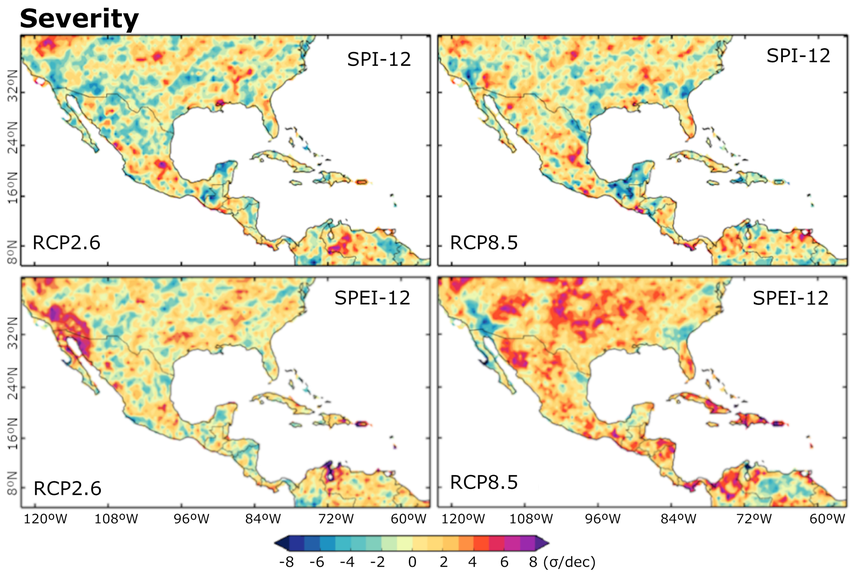
SPI-12 & SPEI-12 → **SPI-12** shows similar future changes with **smaller values**

Differences

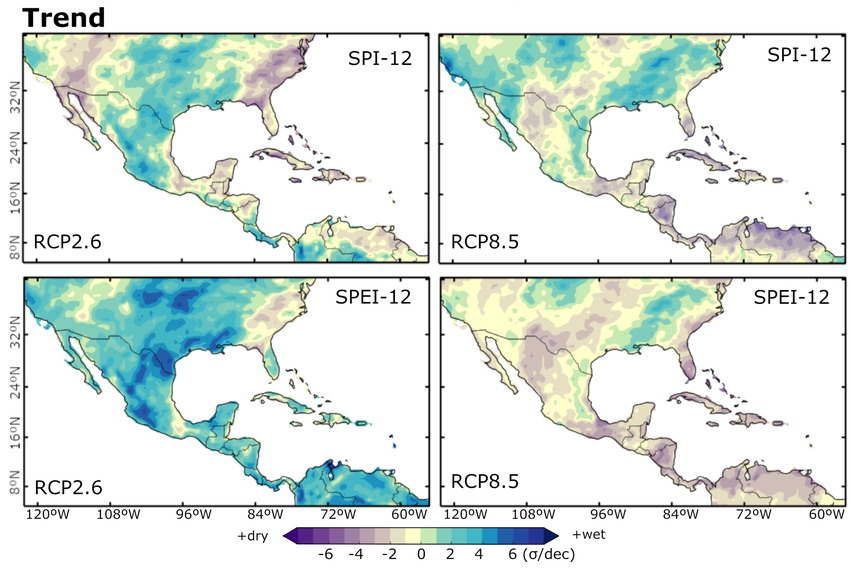
Frequency



Severity



Trend



- Frequent drought events RCP8.5, with SPEI-12 and SPI-12

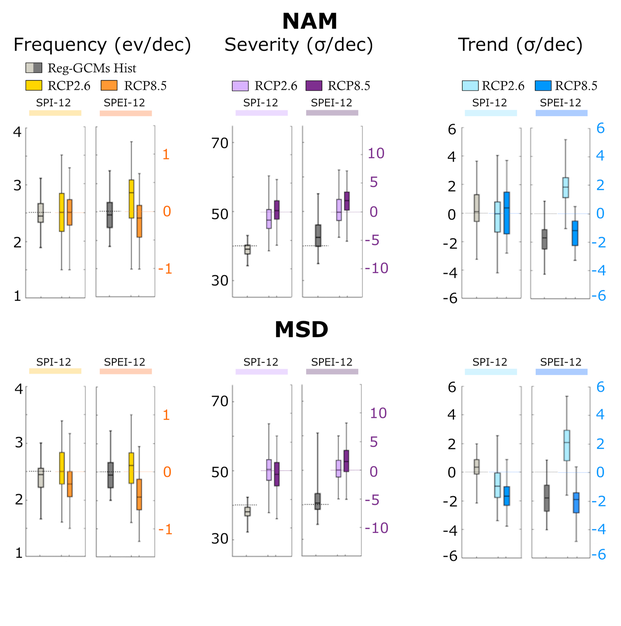
+ Severity RCP8.5 & SPEI-12

> Tendency to drought
RCP8.5 with SPEI-12
RCP2.6 with SPI-12
SPEI-12>SPI-12

Regional future changes vs. historical values

The most significant changes are simulated in the trends over NAM by SPEI-12, and over MSD by SPI-12 and SPEI-12

NAM



MSD

Reg-ERA partially simulates the **spatio-temporal variation** of the drought indicators and capture the inverse drought response between the **NAM and the MSD**, linked to climate teleconnections, but shows difficulties during the **AMO phases**. The model is not able to simulate over **mountain areas**.

The **GCMs** have their own **biases**, and Reg-GCMs cannot reduce them, as shown in the large difference of drought metrics.

Reg-GCMs projects an increase in the severity and negative trends (drier) in many areas of the domain under the RCP8.5 scenario at the end of the century, with small changes in the frequency.

Acknowledgements

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