

Intercomparison of regional climate models and climatic trends in the Central America/Mexico CORDEX domain

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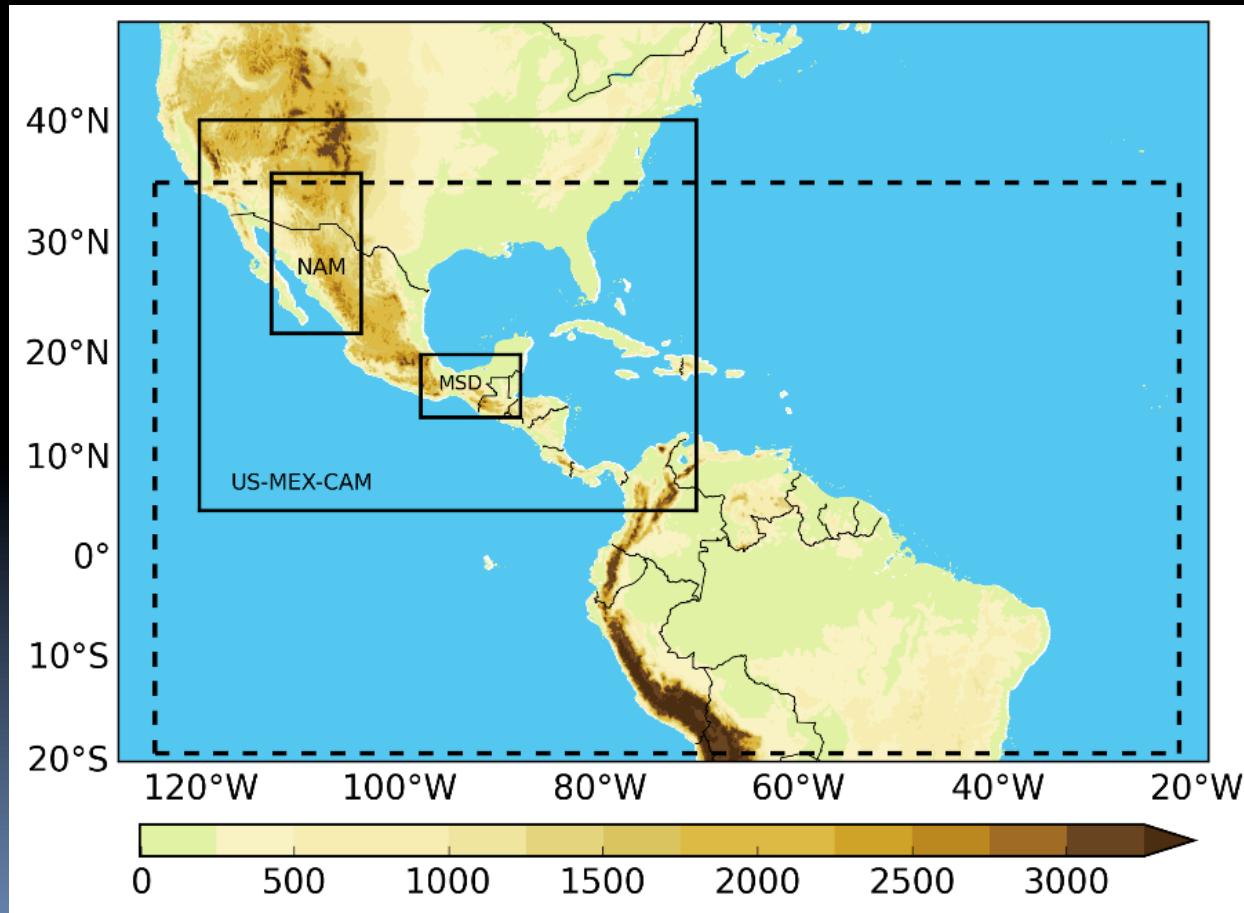


The Abdus Salam
**International Centre
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www.ictp.it

Ninth ICTP Workshop on the Theory
and Use of Regional Climate Models
28 May - 8 June 2018, Trieste, Italy

Objectives

Evaluate 3 RCMs in the CORDEX-CAM domain
and obtain Temp y Precip trends for 1980-2010

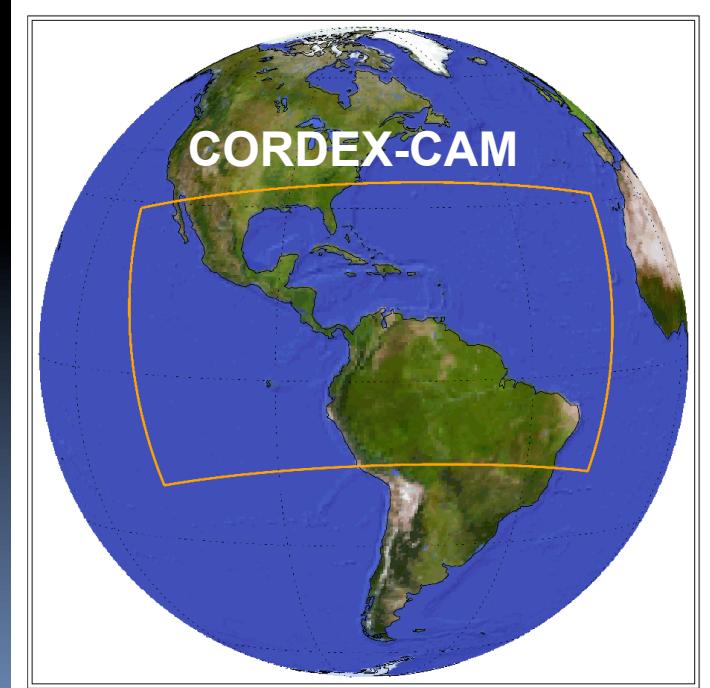
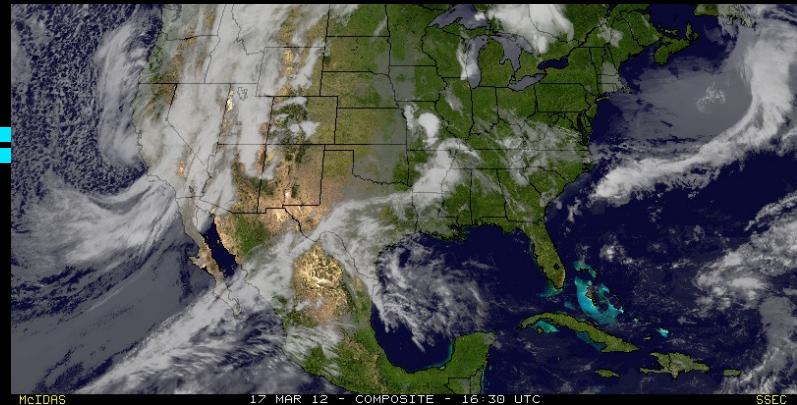


CONTENT

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- 2. Objective, data and methodology**
- 3. Inter-comparison of RCMs**
- 4. Climatic trends**
- 5. Interannual/decadal variability**
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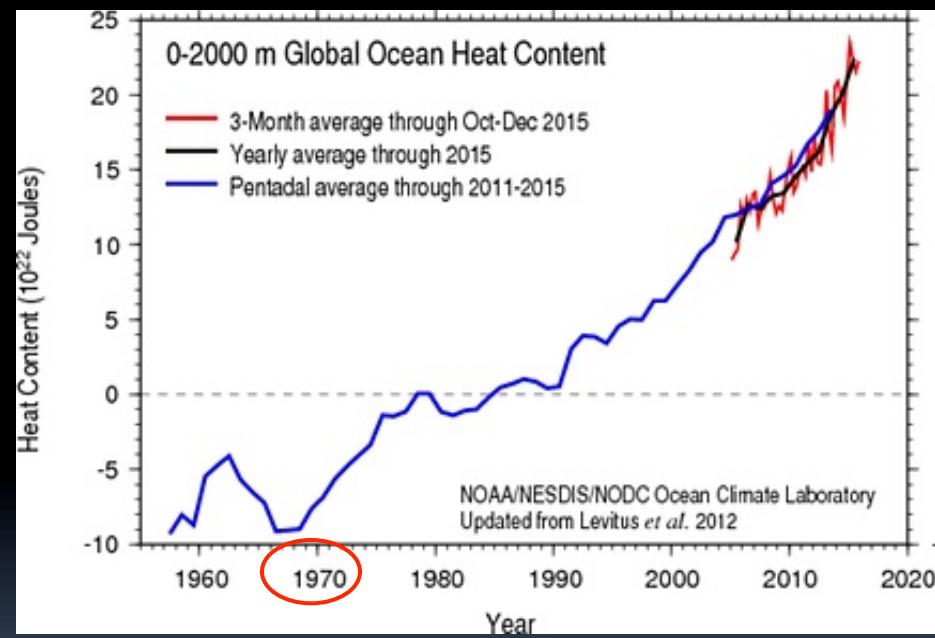
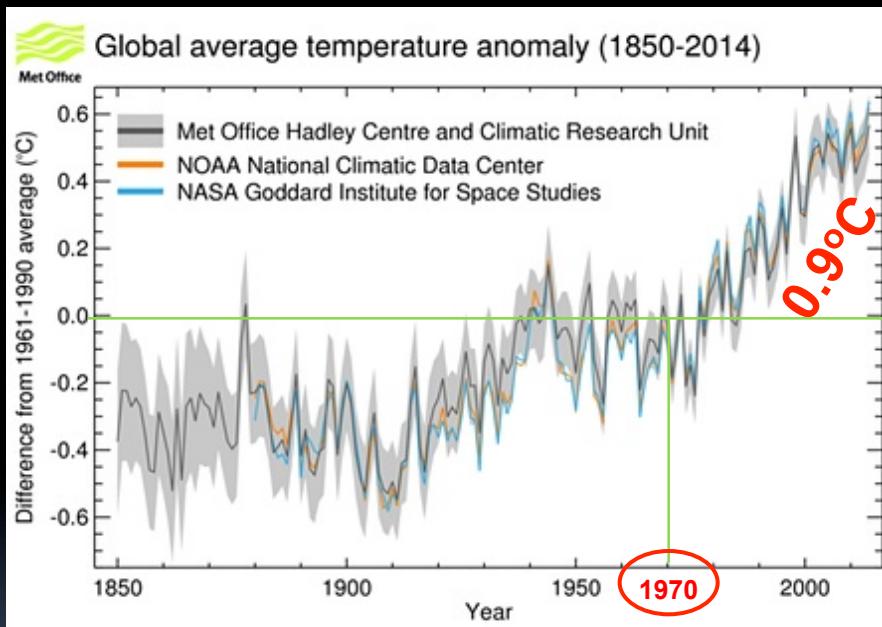


<http://www.cordex.org/>



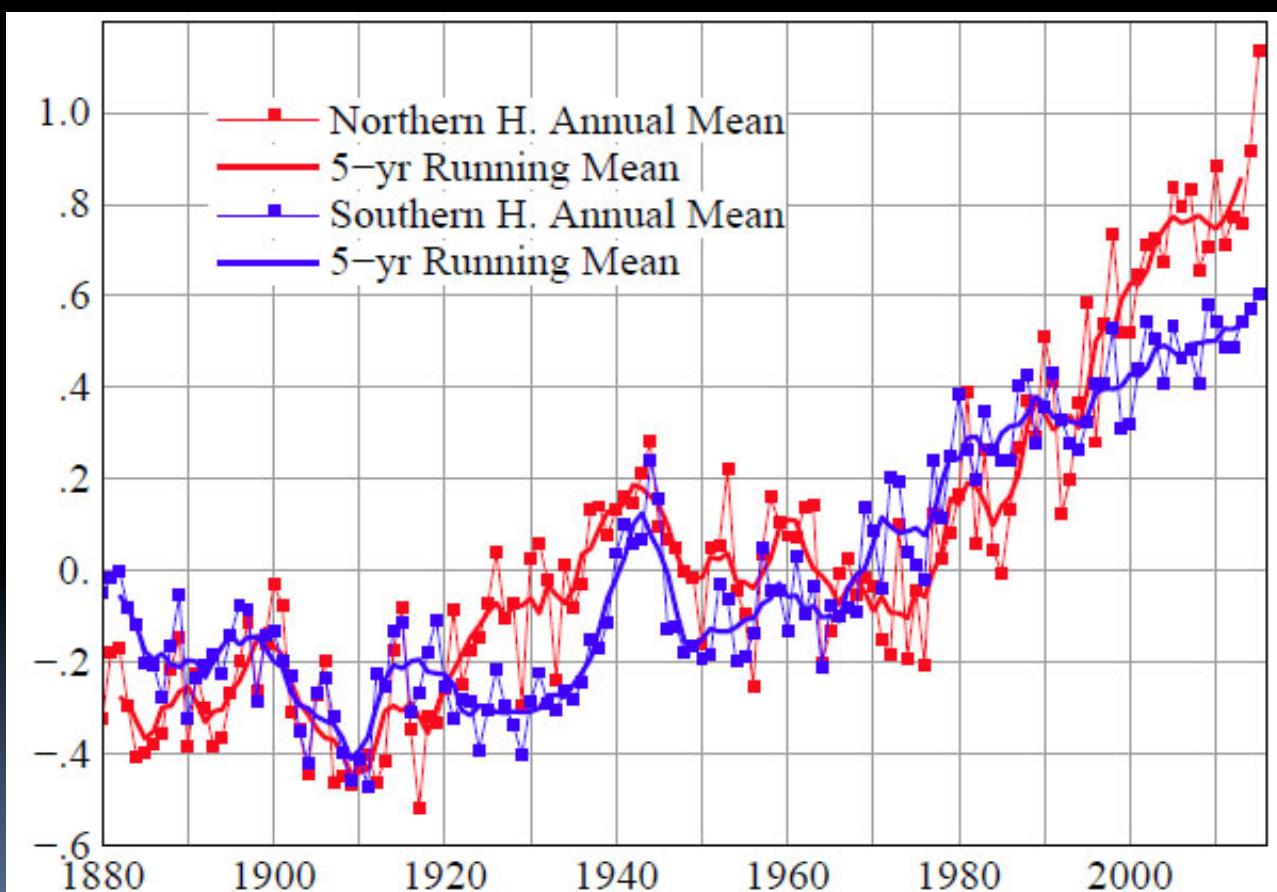
1. Introduction

OBS: Global Air Temperature Anomaly Global Ocean Heat Content



$$Ta_{\text{global}} = 15^{\circ}\text{C}$$

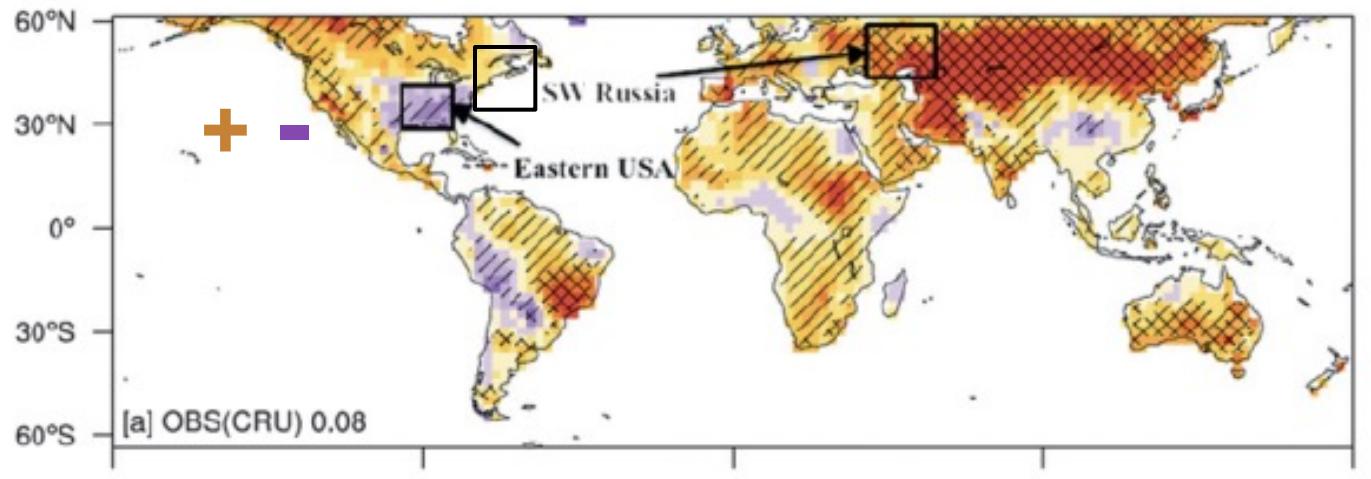
Observations: NH and SH Temperature Change



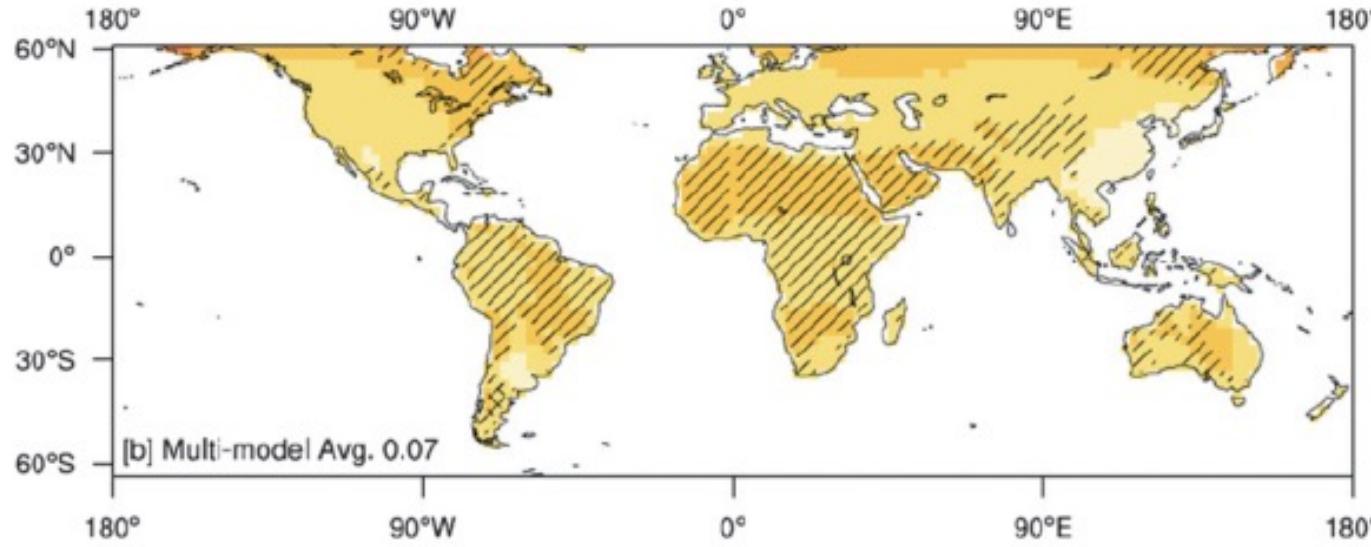
NASA GISS site

Temperature Trends ($^{\circ}\text{C}/\text{decade}$) 1930-2004

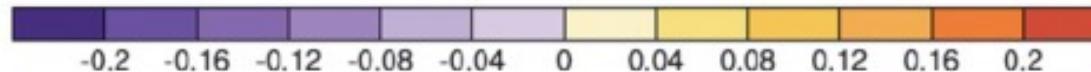
JOURNAL OF CLIMATE



OBS: CRU



CMIP5
ensemble



(Kumar et al. 2013b,
J. Clim, 26, 4168-4185)

Positive Temp trend in the more recent period

1 JUNE 2013

KUMAR ET AL.

3515

JJA

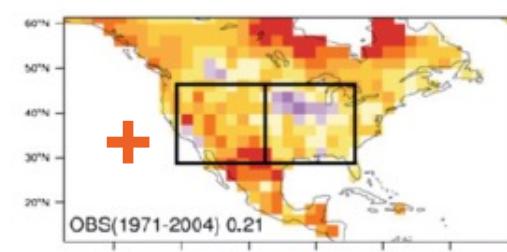
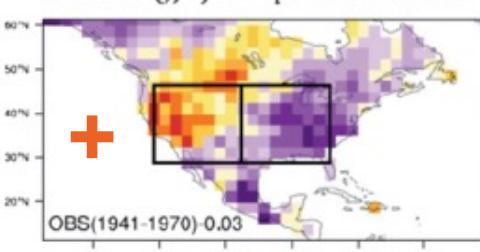
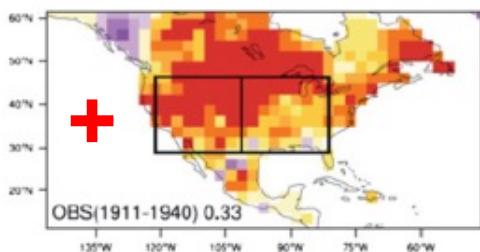
DJF

1911-1940

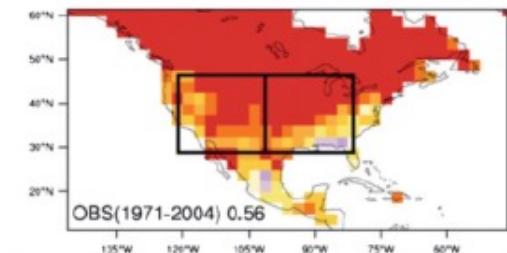
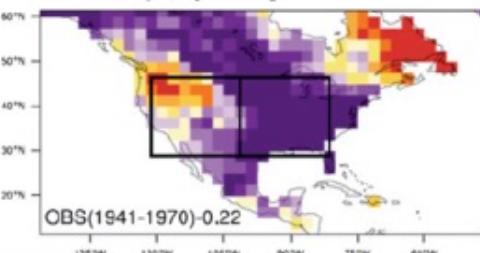
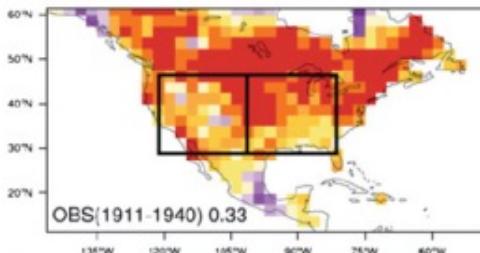
1941-1970

1971-2004

Summer (JJA) Temperature Trend



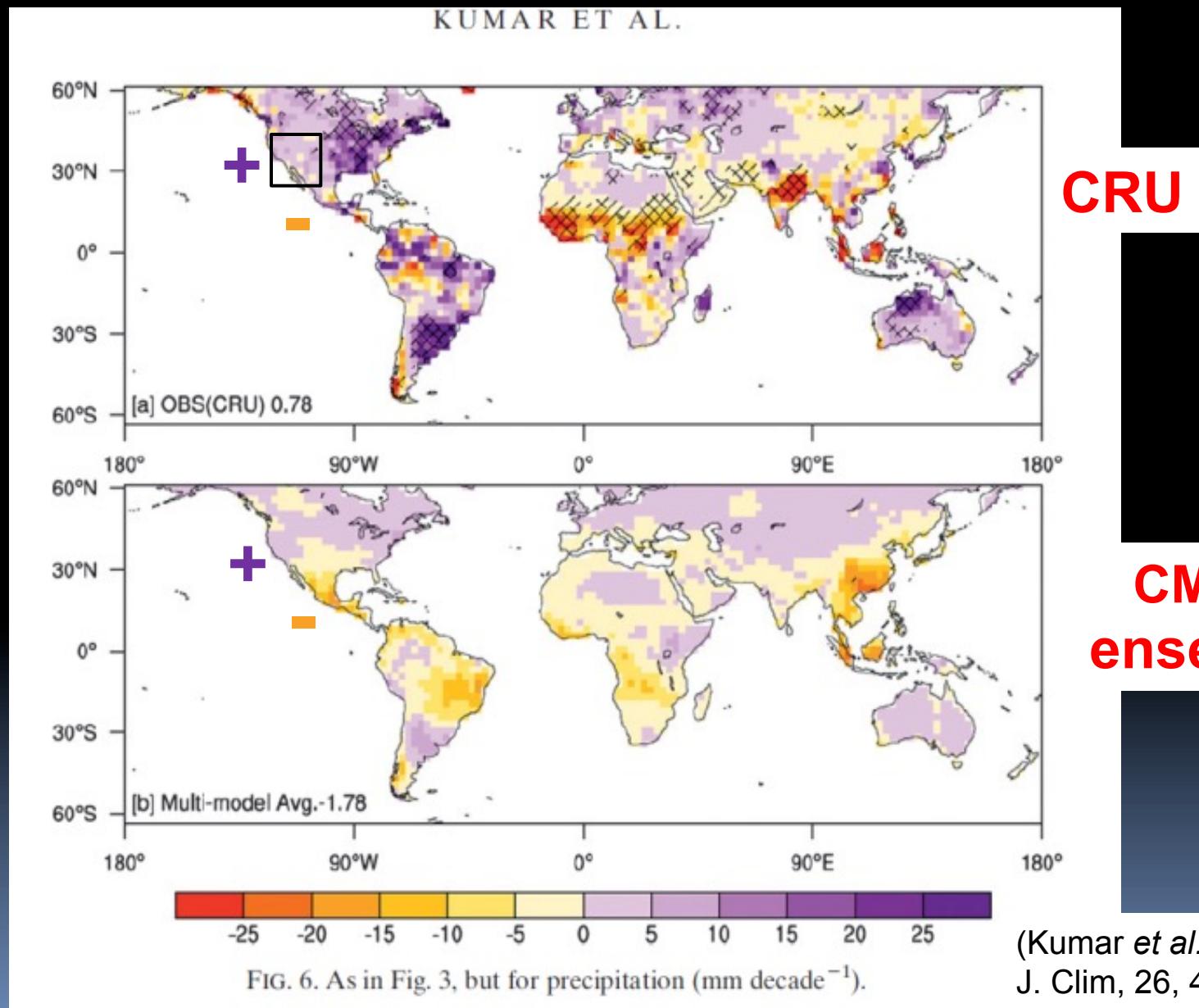
Winter (DJF) Temperature Trend



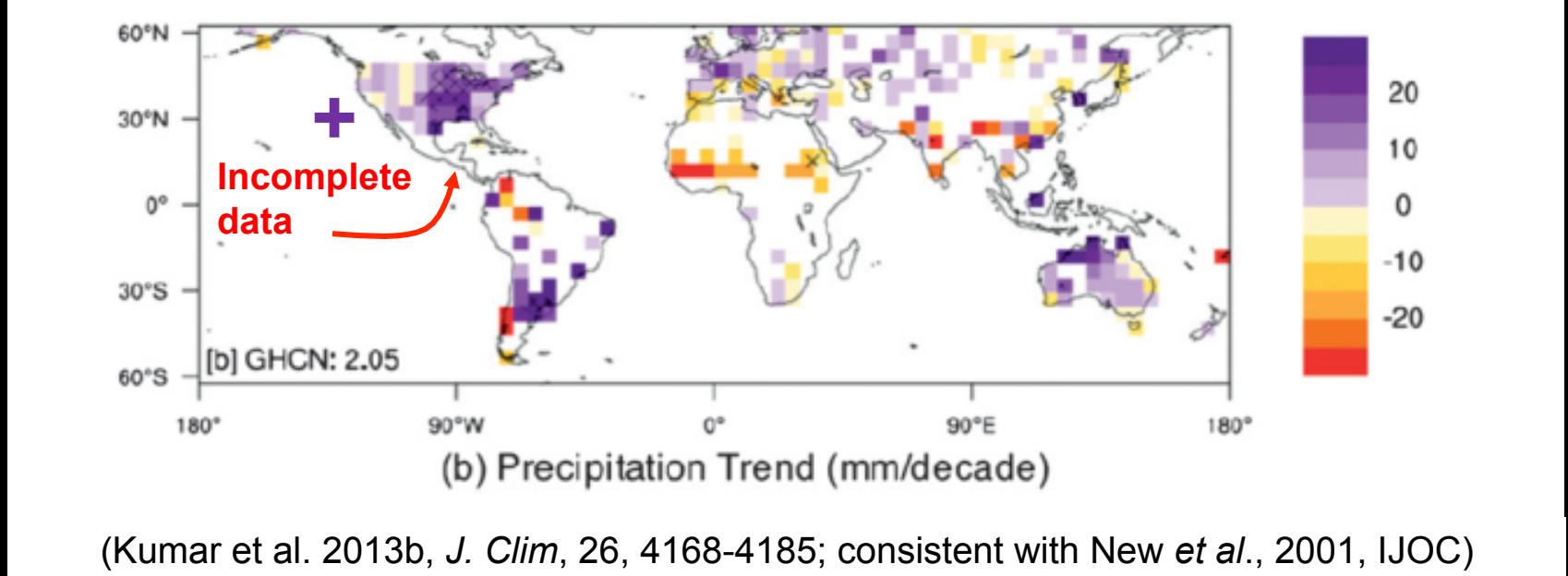
-0.4 -0.32 -0.24 -0.16 -0.08 0 0.08 0.16 0.24 0.32 0.4

FIG. 2. Multidecadal spatial and temporal variability in observed “warming hole.” (top) Summer and (bottom) winter temperature trends for three nonoverlapping 30-yr periods in the twentieth century are shown: (left) 1911–40, (middle) 1941–70, and (right) 1971–2004, in degrees Celsius per decade. The number in each panel represents the North American land-only temperature trend in the corresponding period and the spatial average for the entire region shown in the figure.

Precipitation Trends (mm/decade) 1930-2004



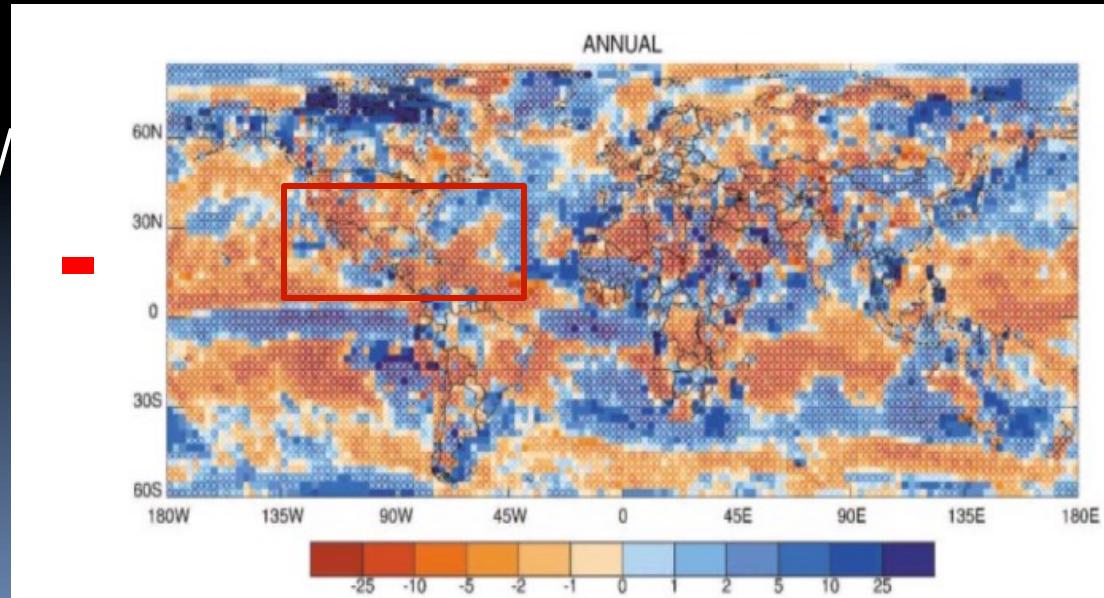
GHCN: Precipitation Trends (mm/decade) 1930-2004



(Kumar et al. 2013b, *J. Clim*, 26, 4168-4185; consistent with New et al., 2001, IJOC)

Obs CMAPrecip Trend (%/decade) 1979-1999:

Negative trend
in the subtropics/tropics
(New et al., 2001)



2. Data and Methodology

Observations	Regional Models	Metrics	Indices
CRU (Temp, Precip)	PRECIS	Dispersion	ENSO
GPCP (Precip)	RCA4	Spatial bias	PDO
	RegCM4.0-Grell	Annual cycles	AMO
	RegCM4.5-Tiedtke	Trends	

RCA4 and RegCM4.0 (CORDEX-CAM):

<https://www.cordex.org/output/esgf-menu.html>

PRECIS: UNAM, Mexico;

RegCM4.5: Universidad de Veracruz, Mexico

Linear trends ($p<0.05$).

Regional trends with
Mann-Kendall trend test and
Sen's slope

Methodology

**ICBC: ERAIN 75
Reanalysis**

Simulation: 1979-2010

Spin up: 1979

Analysis: 1980-2010

Resolution: 50 km

Core: Hydrostatic

Regional Models

PRECIS

RCA4

RegCM4.0-Grell

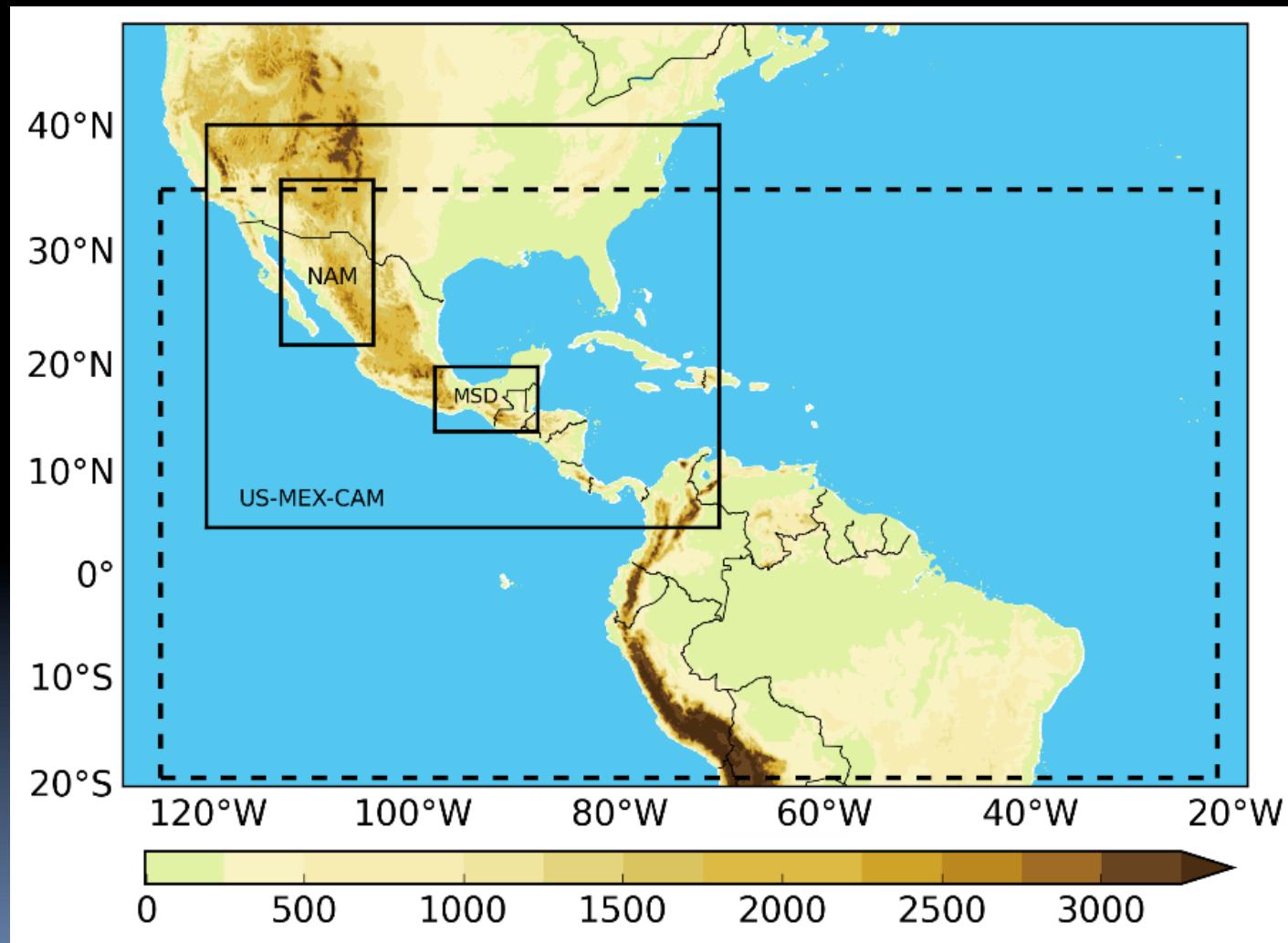
RegCM4.5-Tiedtke

RegCM4 Emanuel → ocean

Physical parameterizations

Physical Options	PRECIS (HadRM3P)	RCA4	RegCM4.0-G (Grell)	RegCM4.5-T (Tiedtke)
Convection-c (continent)	Gregory and Rowntree (1990)	Kain and Fritsch (1990, 1993), Kain (2004)	Grell (1993)	Tiedtke (1989, 1996)
Convection-o (ocean)	Gregory and Rowntree (1990)	Kain and Fritsch (1990, 1993), Kain (2004)	Emanuel (1991)	Emanuel (1991)
Microphysics or moisture scheme	Smith (1990)	Rasch and Kristjánsson (1998)	SUBEX (Pal <i>et al.</i> , 2000)	SUBEX (Pal <i>et al.</i> , 2000)
Land-surface	MOSES2 (Essery <i>et al.</i> , 2003)	Samuelsson <i>et al.</i> , (2006)	BATS (Dickinson <i>et al.</i> , 1993)	BATS (Dickinson <i>et al.</i> , 1993)
Radiation	Edwards and Slingo (1996)	Savijarvi (1990), Sass <i>et al.</i> , (1994)	CCM3 (Kiehl, 1996)	CCM3 (Kiehl, 1996)
Planetary Boundary Layer (PBL)			Holtslag (Holtslag, 1990)	Holtslag (Holtslag, 1990)

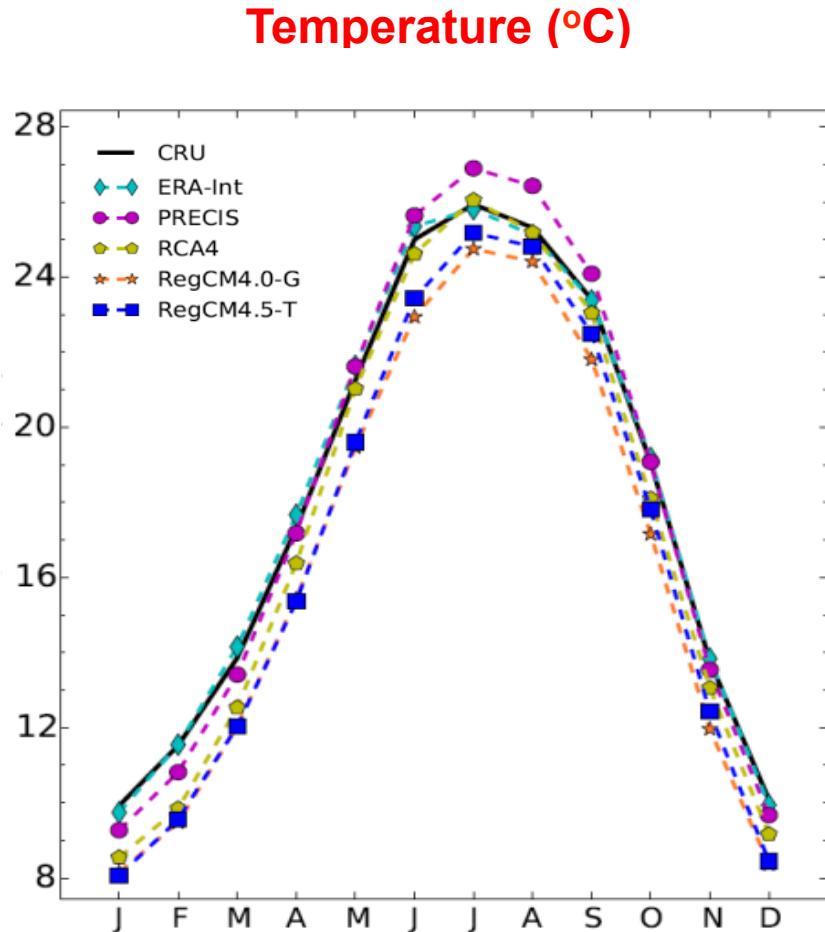
North American monsoon (NAM) and Mid-summer drought (MSD)



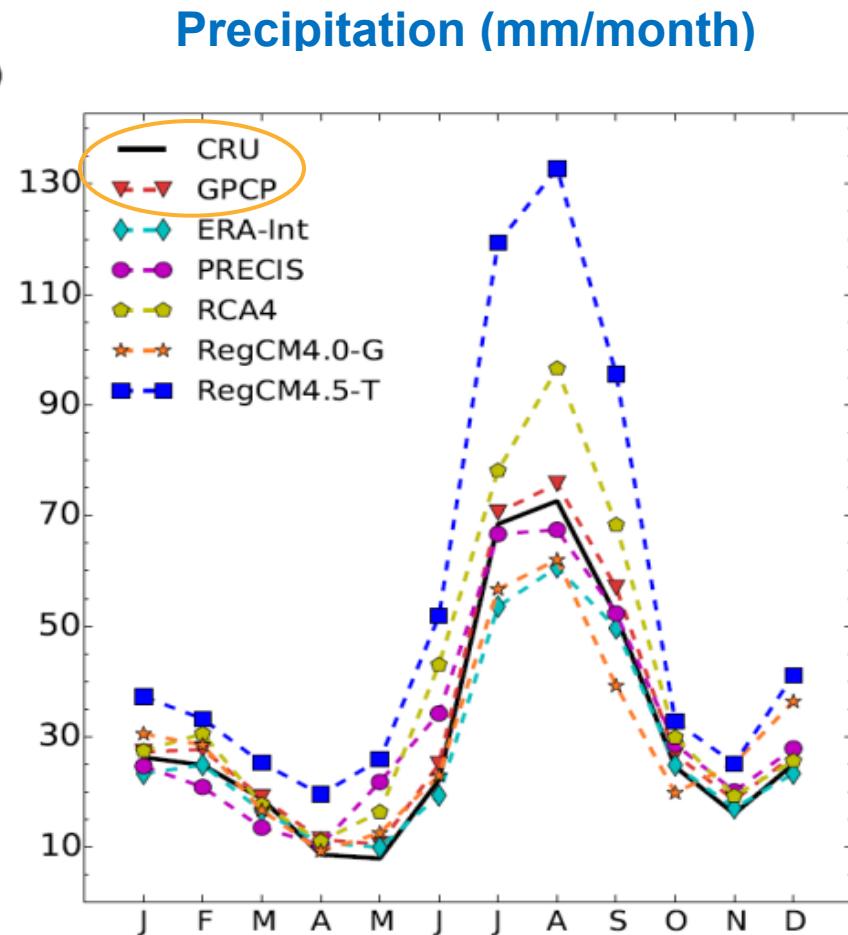
3. Metrics of evaluation (1980-2010)

NAM Region

(a)

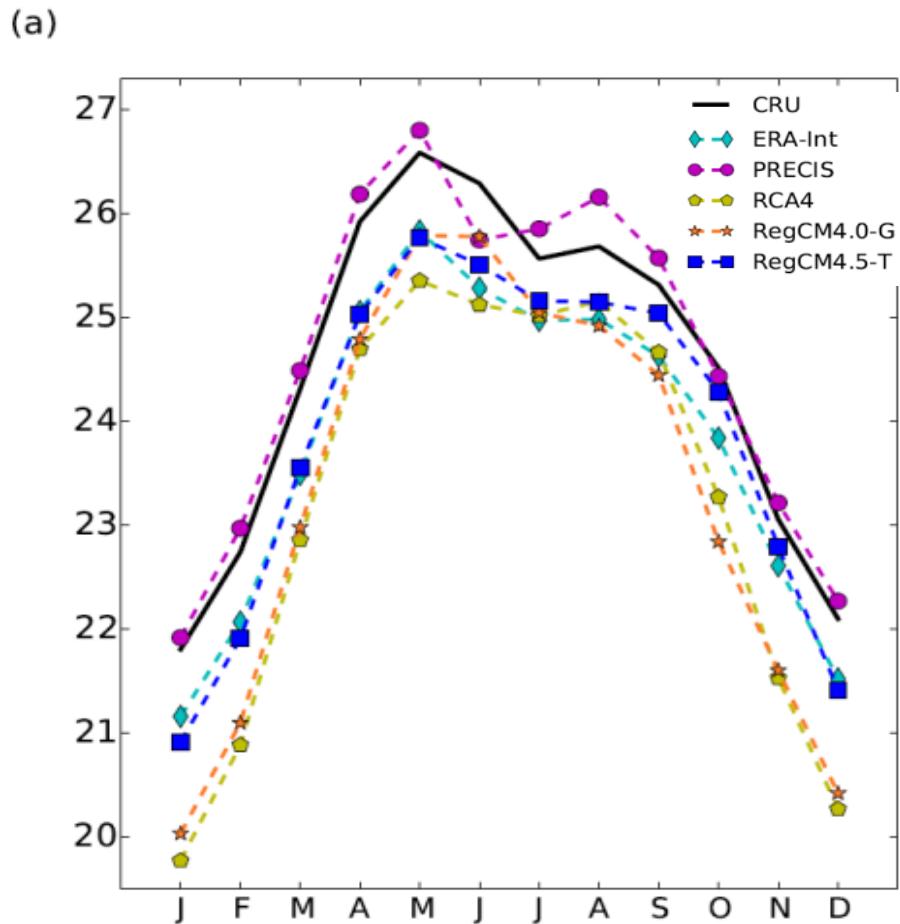


(b)

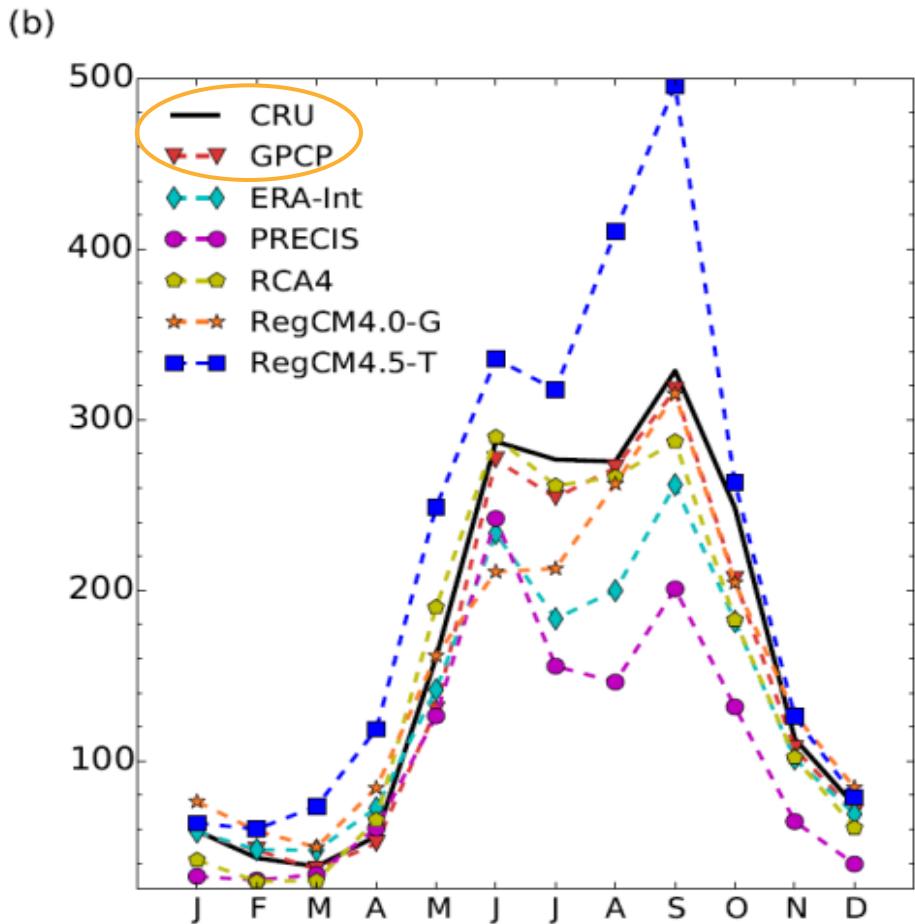


MSD Region

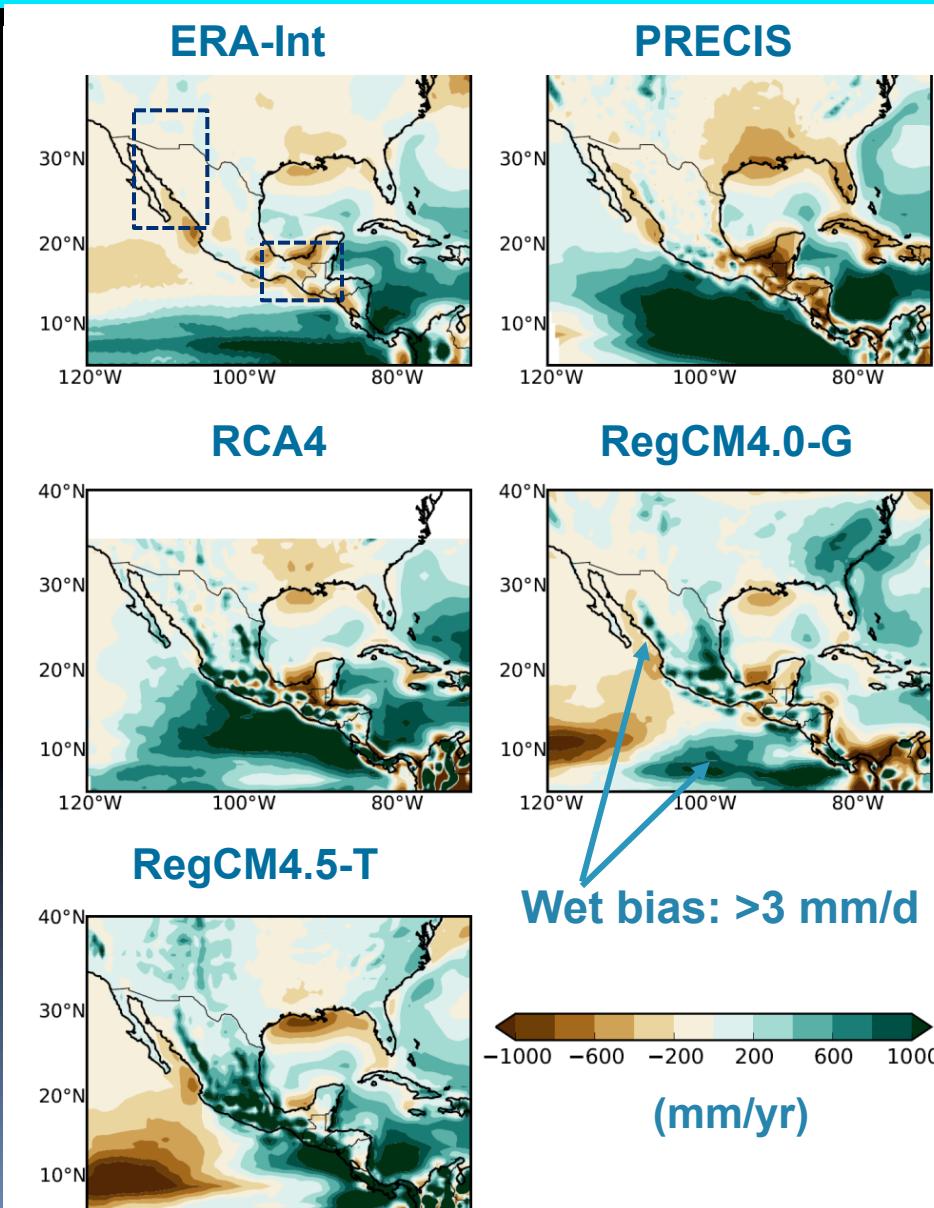
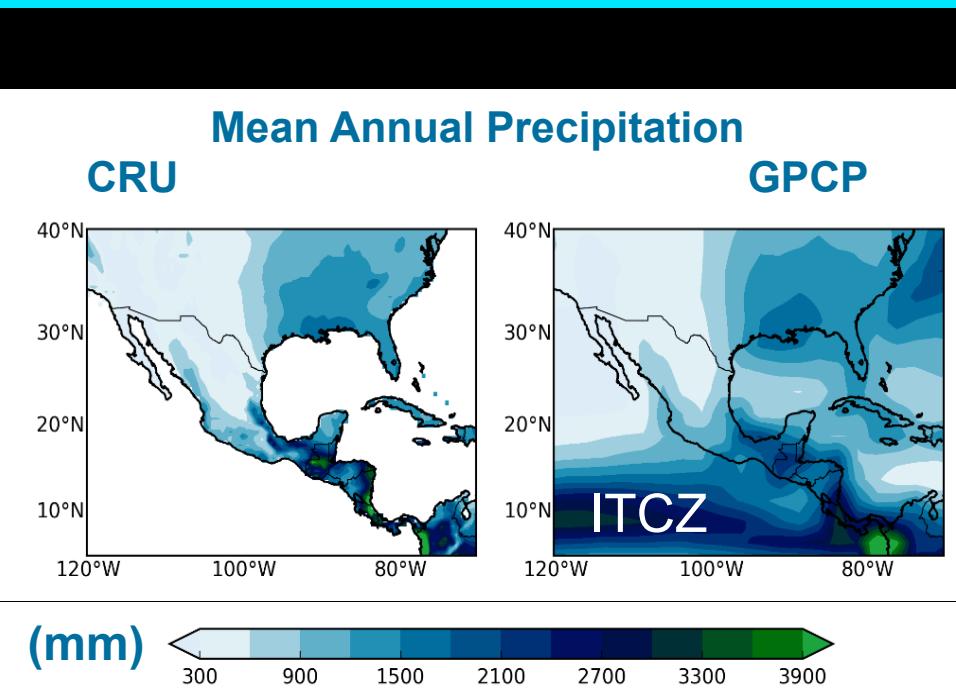
Temperature ($^{\circ}\text{C}$)



Precipitation (mm/month)

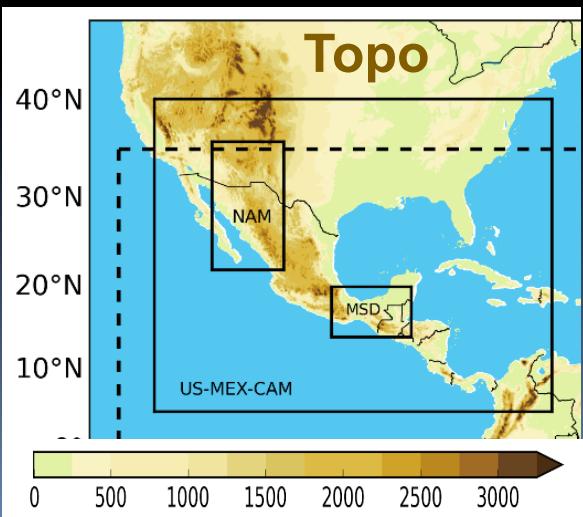
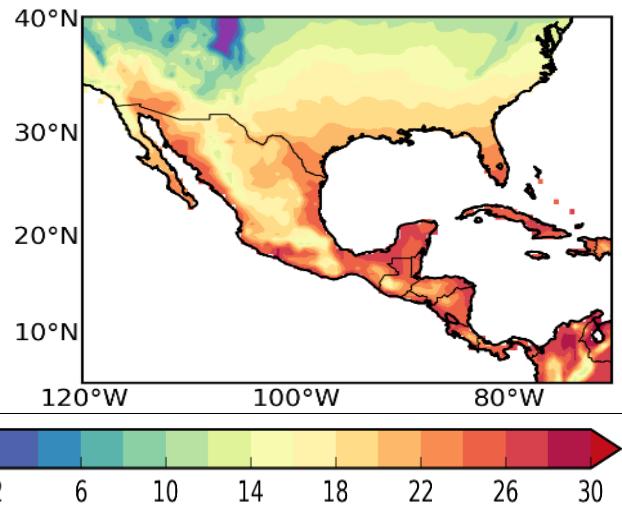


Annual precipitation bias with respect to GPCP (1980-2010)

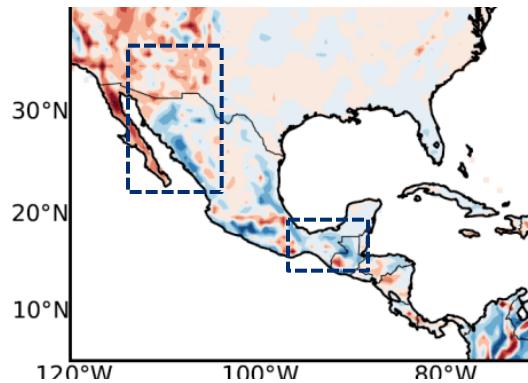


Temperature bias ($^{\circ}\text{C}$) with respect to CRU (1980-2010)

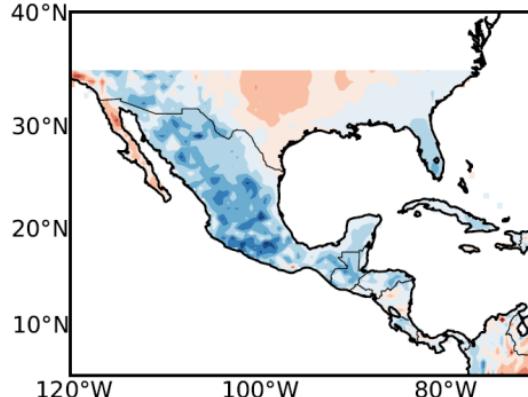
CRU Mean Annual Temperature ($^{\circ}\text{C}$)



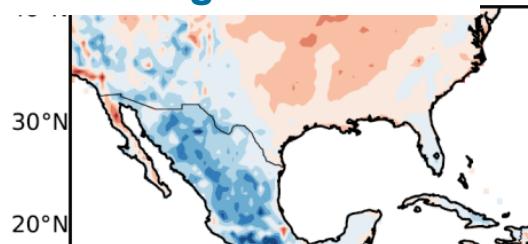
ERA5



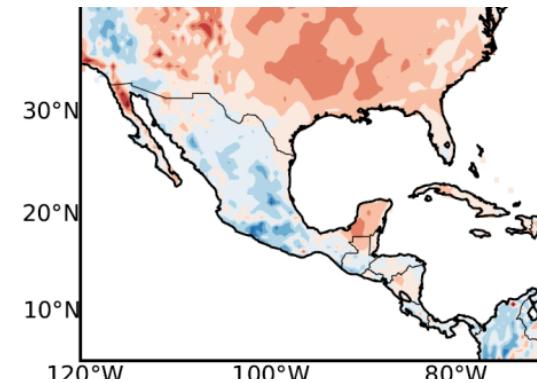
RCA4



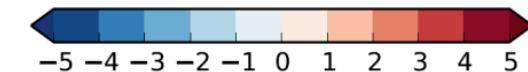
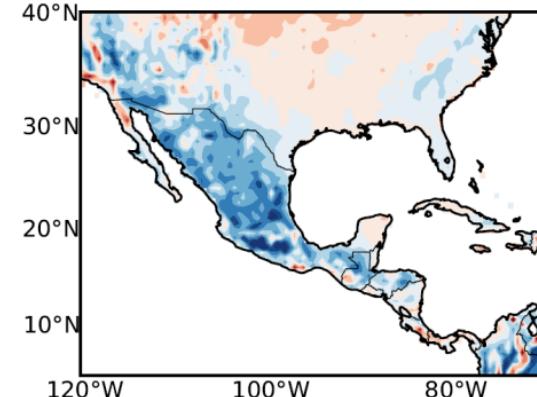
RegCM4.5-T



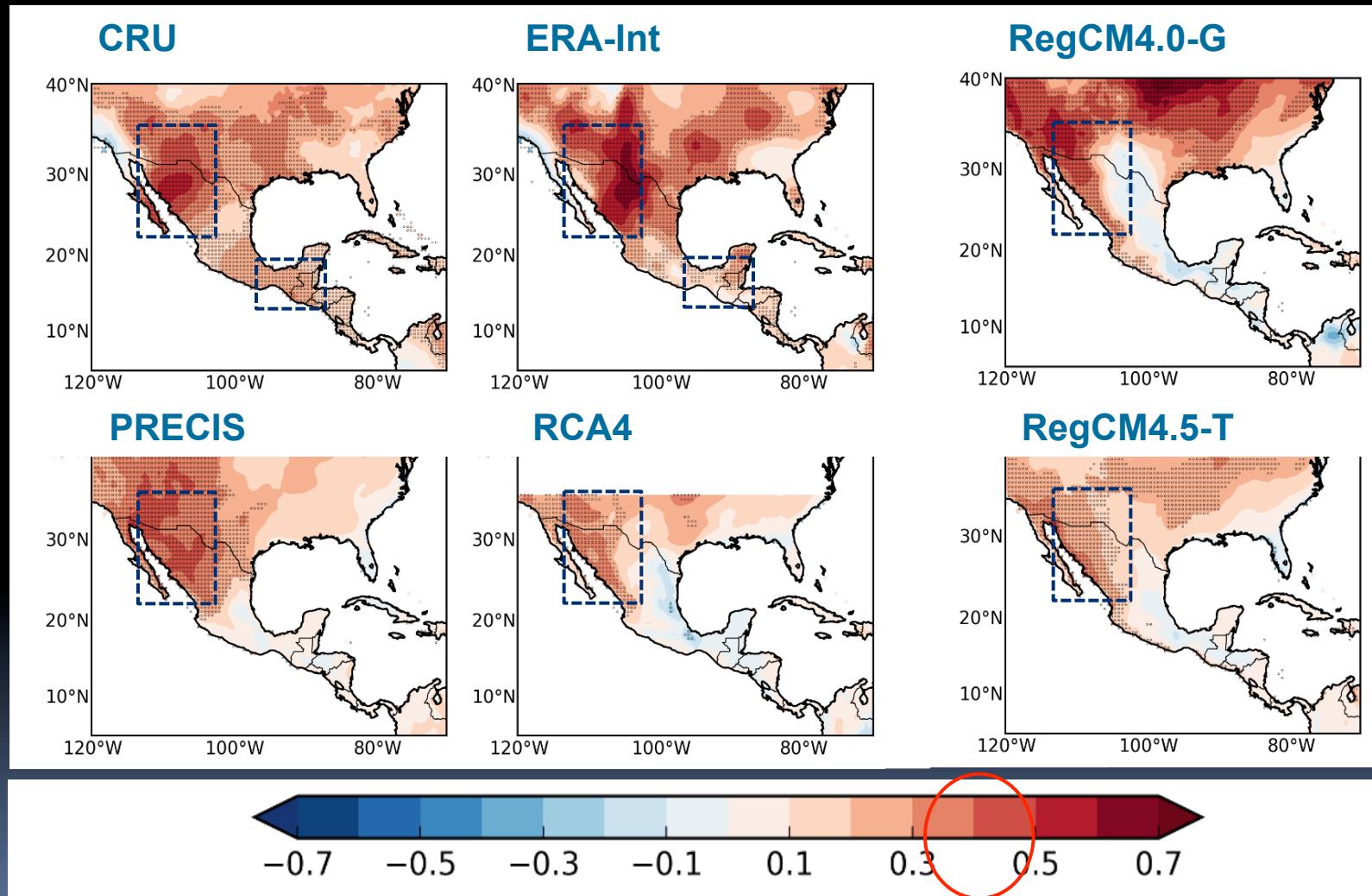
PRECIS



RegCM4-G



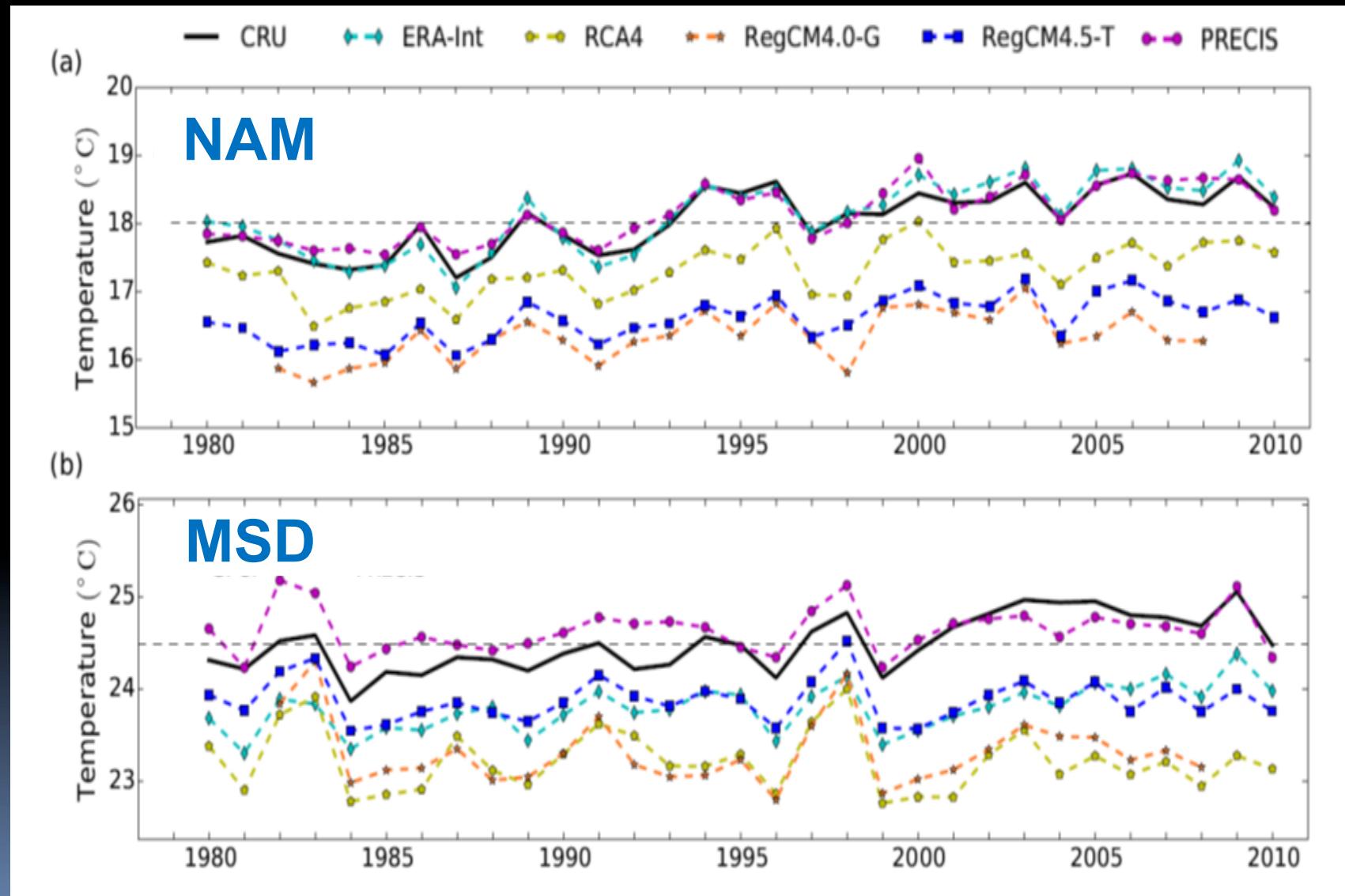
4. Decadal trends of temperature (°C/decade) 1980-2010



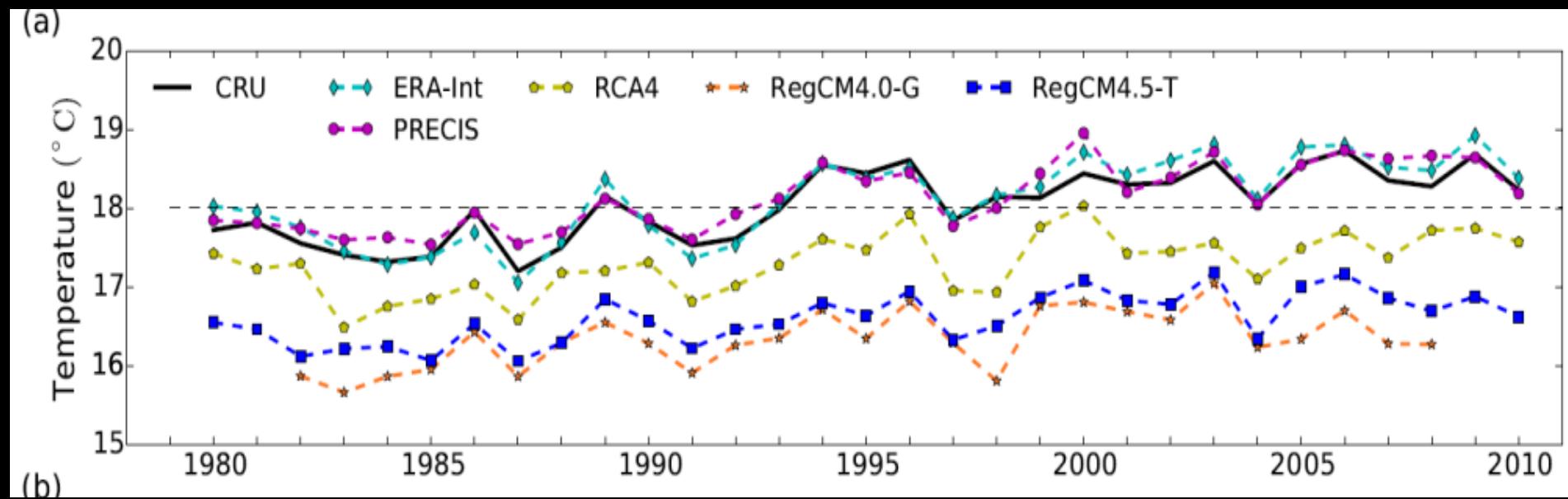
RCMs weak negative trend → wet trend?

Dots: Stat significance at 95%

Mean annual temperature in the NAM and MSD (1980-2010)



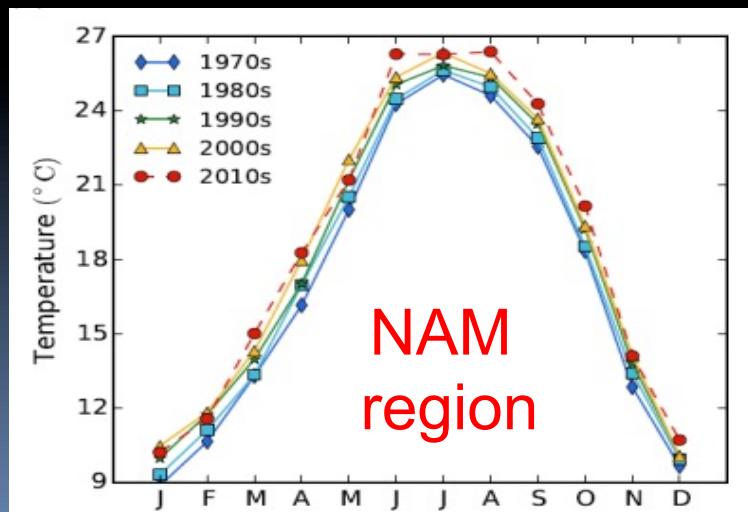
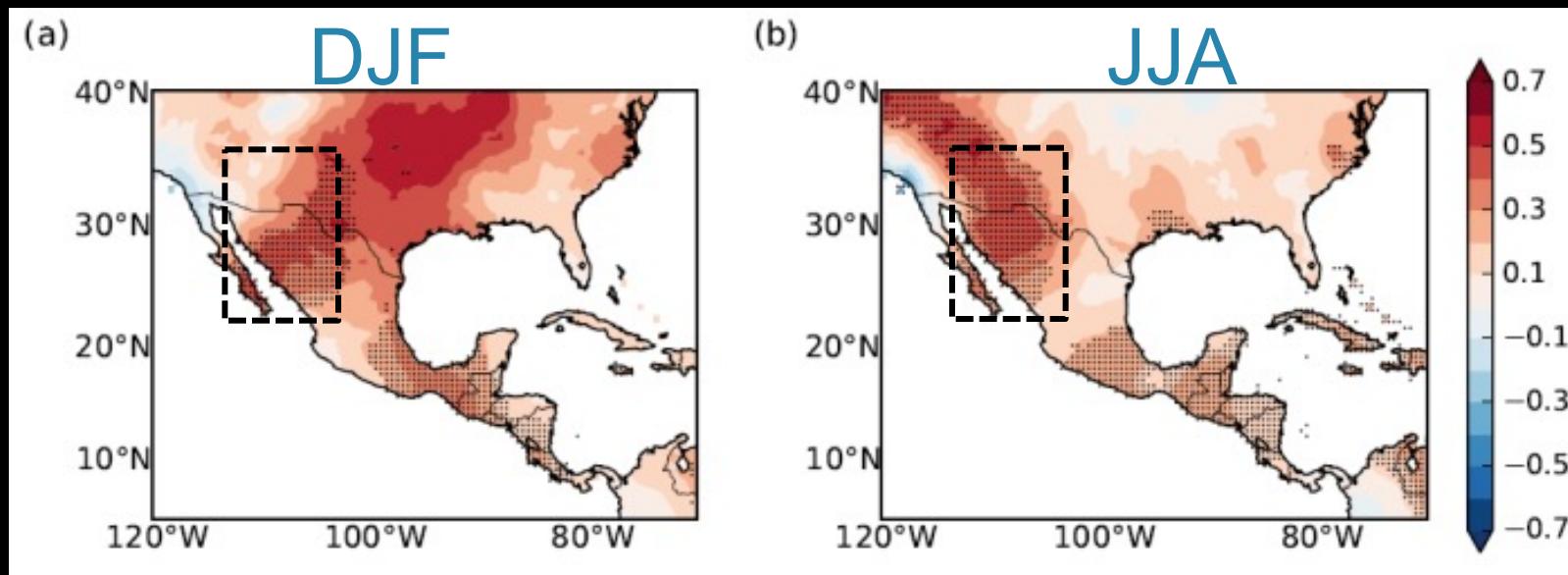
NAM region: Mean annual temperature (1980-2010)



**NAM Observed Temperature Trend:
0.4 $^{\circ}\text{C}/\text{decade}$ significant at the 95% level**

**Detrended temperature variation is not
associated with the AMO, PDO nor ENSO**

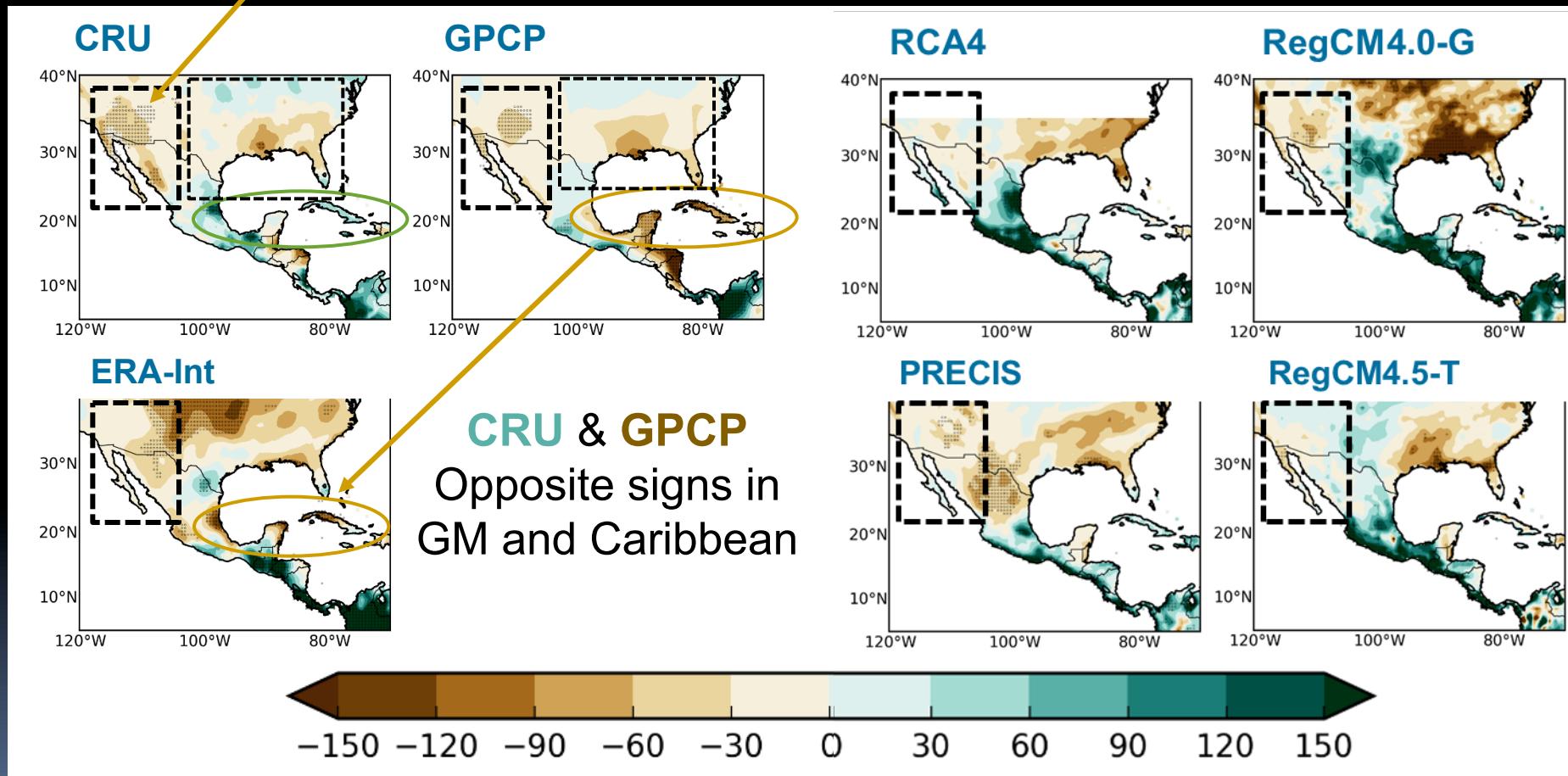
CRU decadal trends of seasonal temperature (°C/decade) 1980-2010



In the NAM region:
Each decade has become
warmer since 1970 to 2015,
especially in JJA
(CRU Temp)

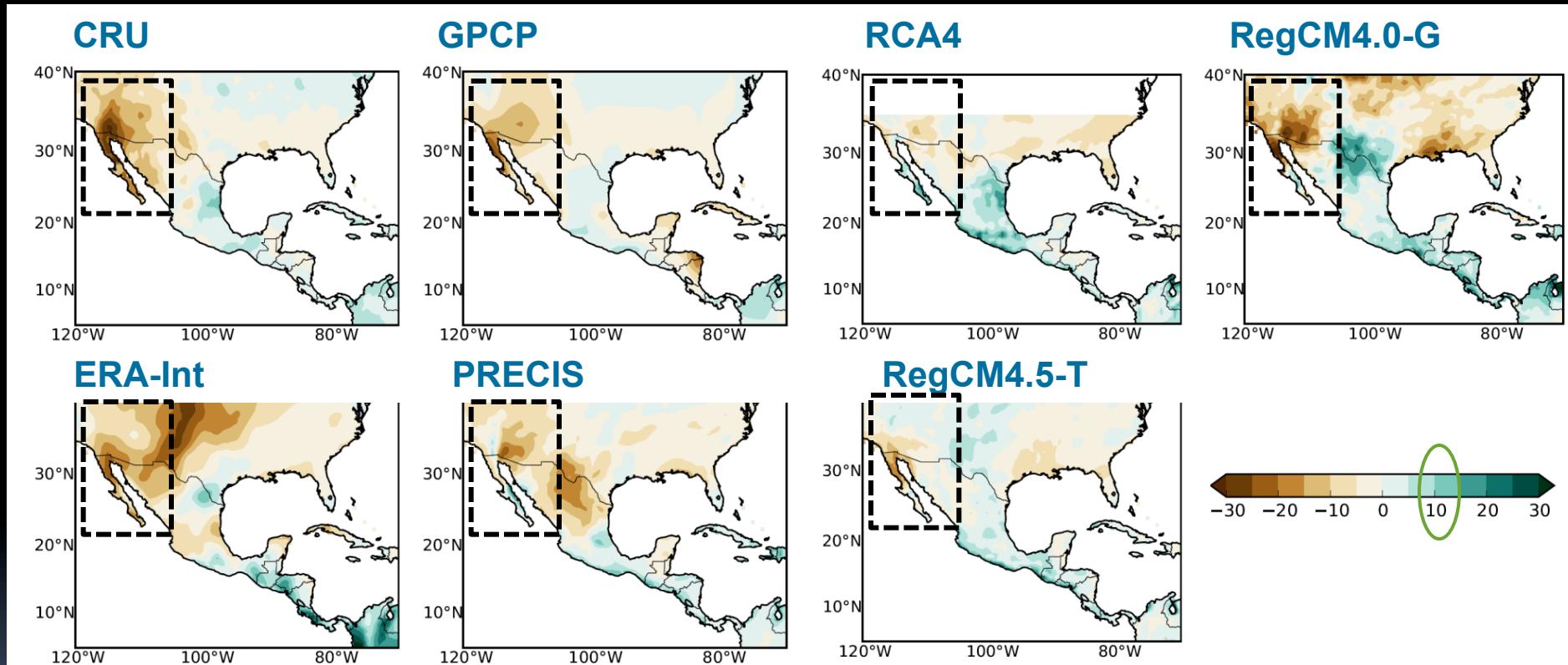
5. Decadal trends of precipitation (mm/decade) 1980-2010

Dots: Stat signif at 95%



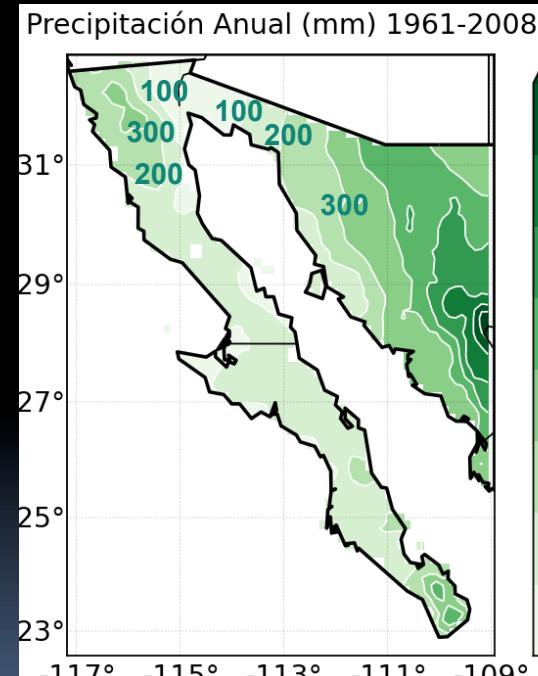
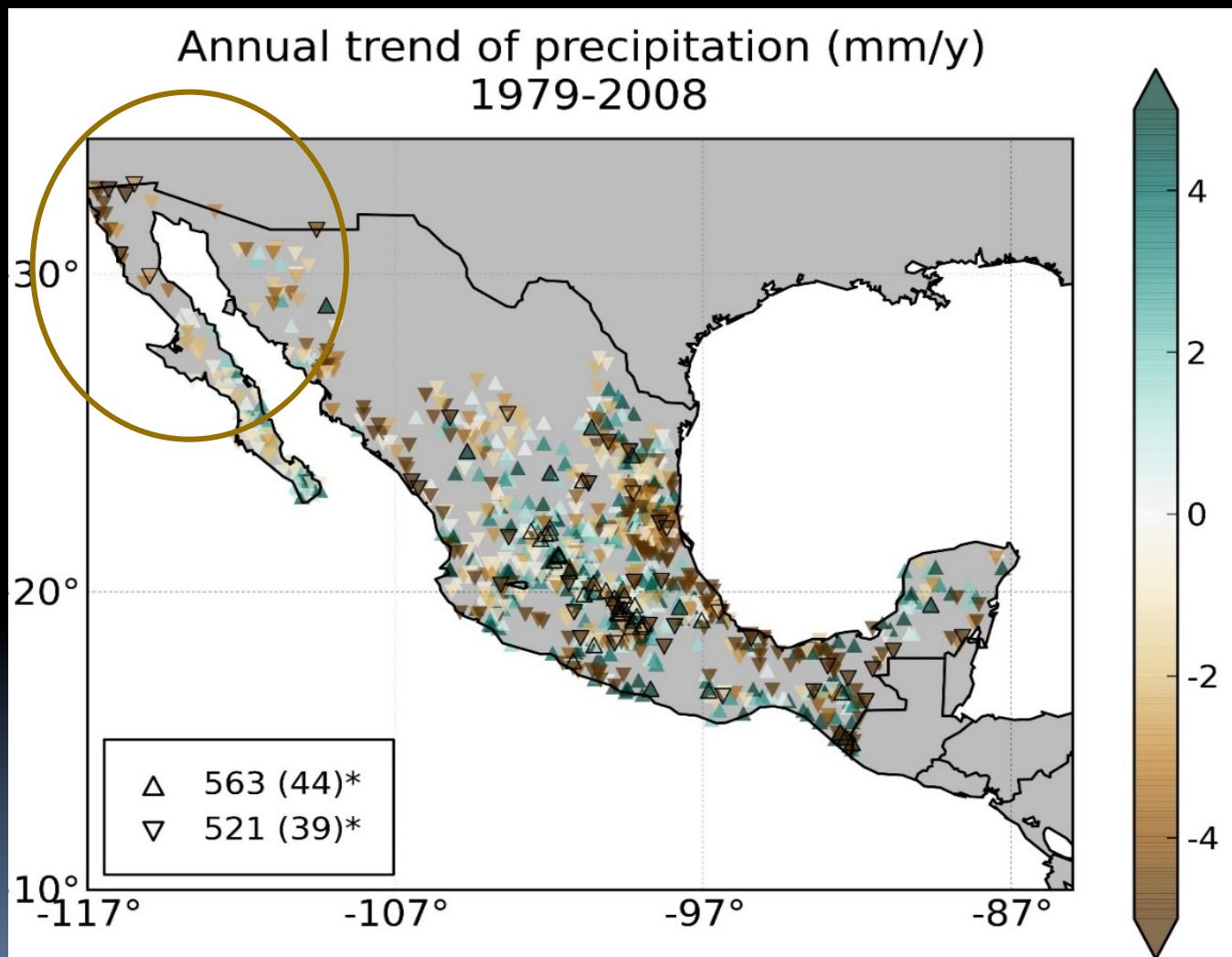
Color scale can be deceiving as in the tropics it rains a lot!

Decadal trends of precipitation (%/decade) 1980-2010

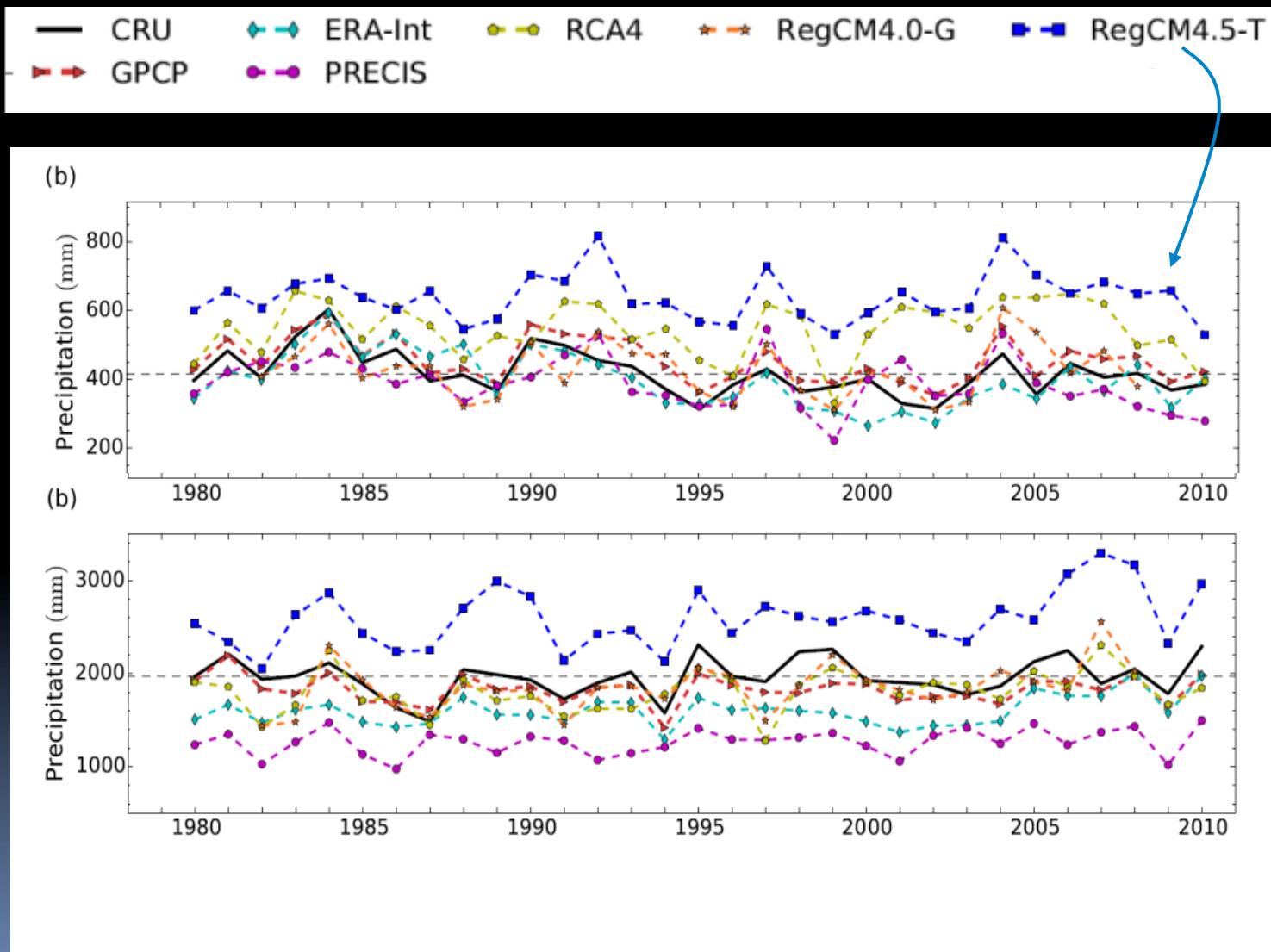


Negative trend in the subtropics is consistent with New *et al.* (2001) for 1979-1999

Annual Precipitation Trends in Mexico (CLICOM data)



Mean annual precipitation in the NAM and the MSD



Correlation with detrended variables (1980-2010)

Region →	NAM		MSD	
Climate Index/Variable	Temp	Precip	Temp	Precip
AMO	-0.09	-0.25	0.32*	0.46**
PDO	0.05	0.16	0.15	-0.15
ENSO	-0.17	0.01	0.59**	-0.49**

MSD region:

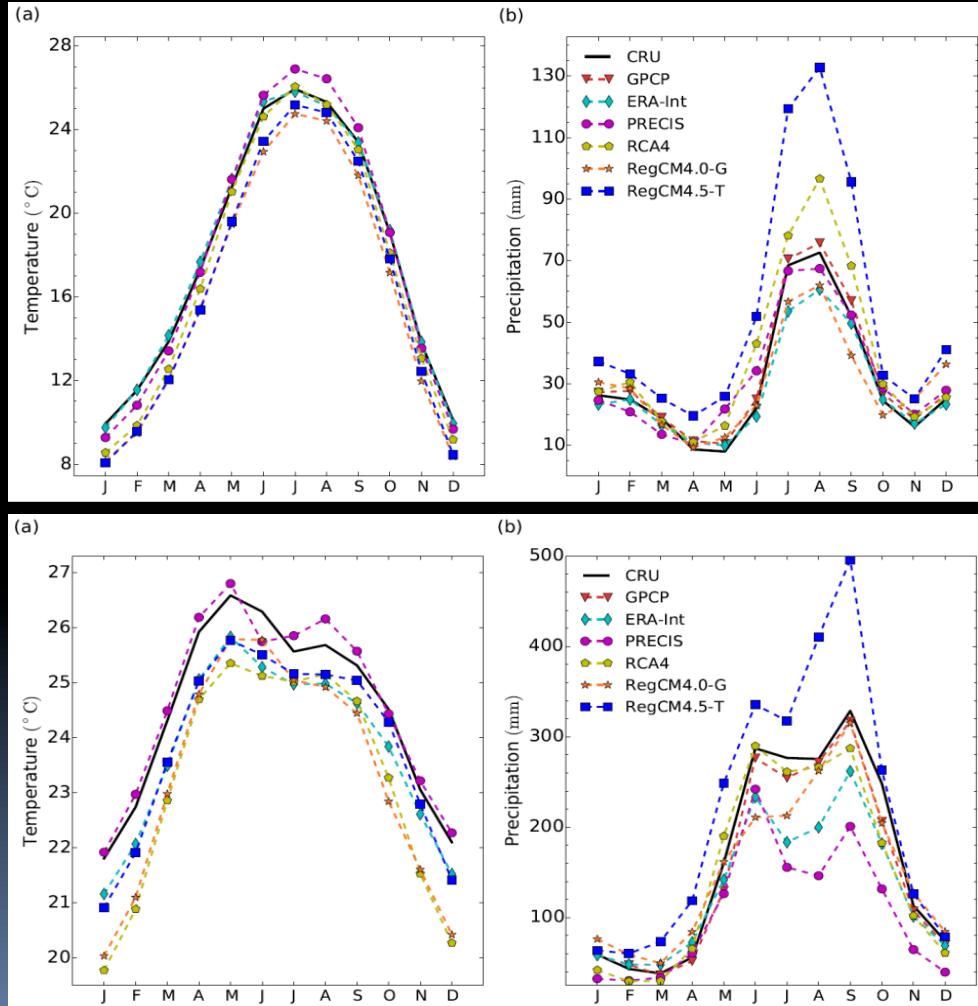
+AMO and El Niño: more Temp
+AMO and La Niña: more Precip →
Warm North Atlantic, cold tropical Pacific

Conclusions

- ❖ **Evaluation:** RCMs capture annual T cycles, but tend to be cooler and drier than observed (exception RegCM4.5). Precis is good at capturing Temp.
- ❖ **Trends:** Observations and RCMs show a warming trend ($0.4^{\circ}\text{C}/\text{decade}$)* in the NAM region that does not appear to be related to PDO, AMO, nor ENSO.
- ❖ Observed negative Precip trend in the subtropics is captured by the RCMs, but large uncertainties in the tropics (too wet)
- ❖ CRU and GPCP show opposite Precip trends over the Gulf of Mexico and the Caribbean region; more uncertainties
- ❖ **Teleconnections:** + AMO and El Niño years are associated with warmer years in the MSD region.
- ❖ + AMO and La Niña conditions favor more rainfall in the MSD region.

This workshop – CORDEX-CAM Group 04

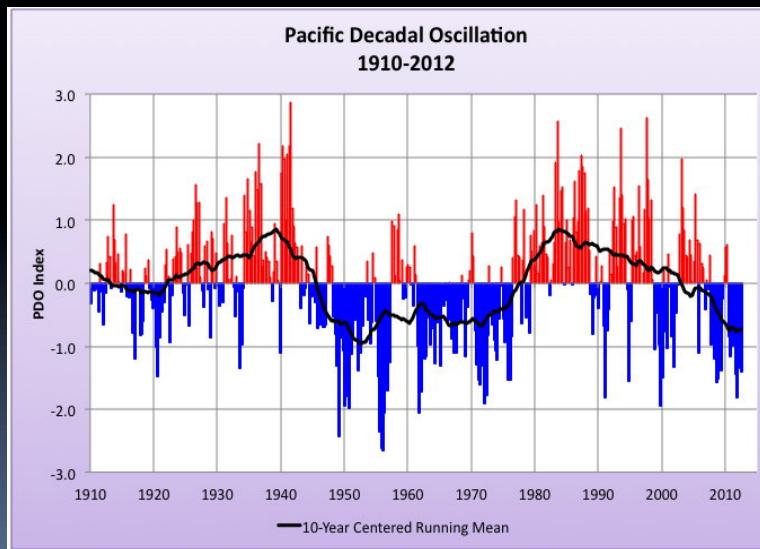
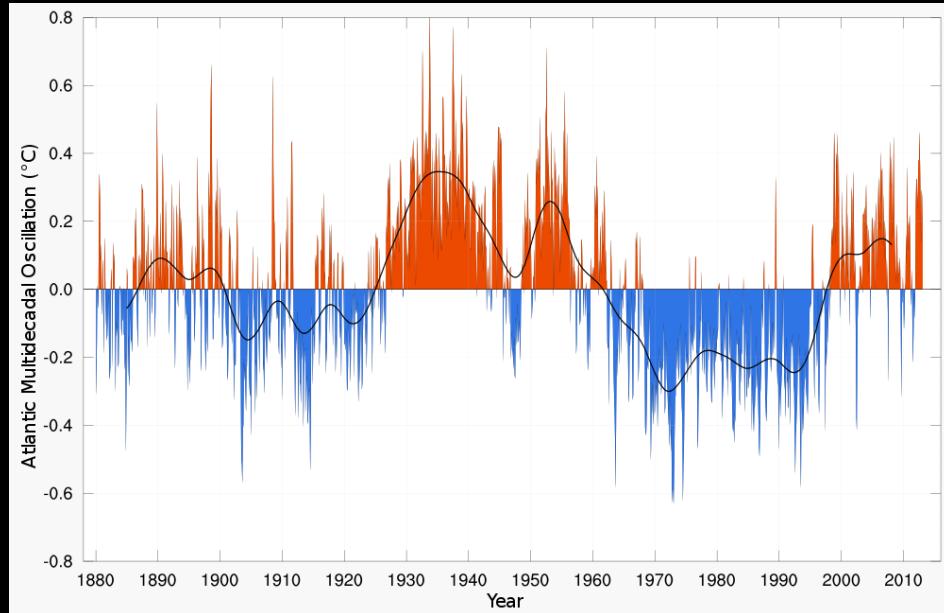
**Analysis: Intercomparison
Models: Add RegCM4.7
Period: 1998-2002
Regions: NAM and MSD**



**Grazie
Gracias!**

**Thank you especially to Filippo,
Graziano and Erika**

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Pacific Decadal Oscillation (PDO)

