





Impact of tropical eastern Pacific warming bias on Caribbean climate

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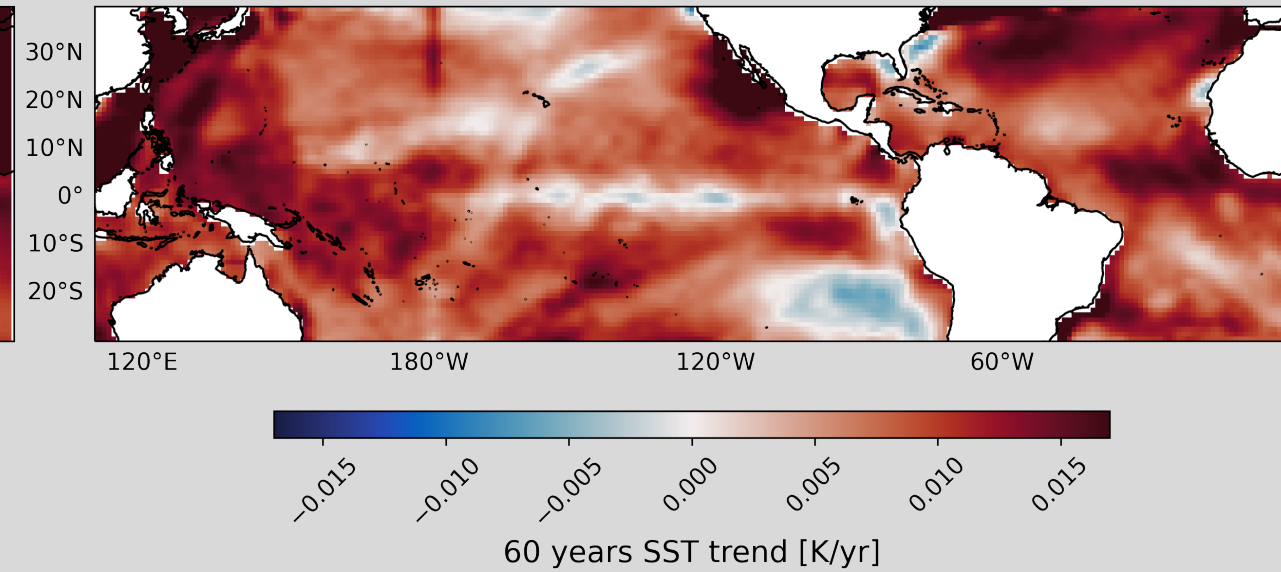
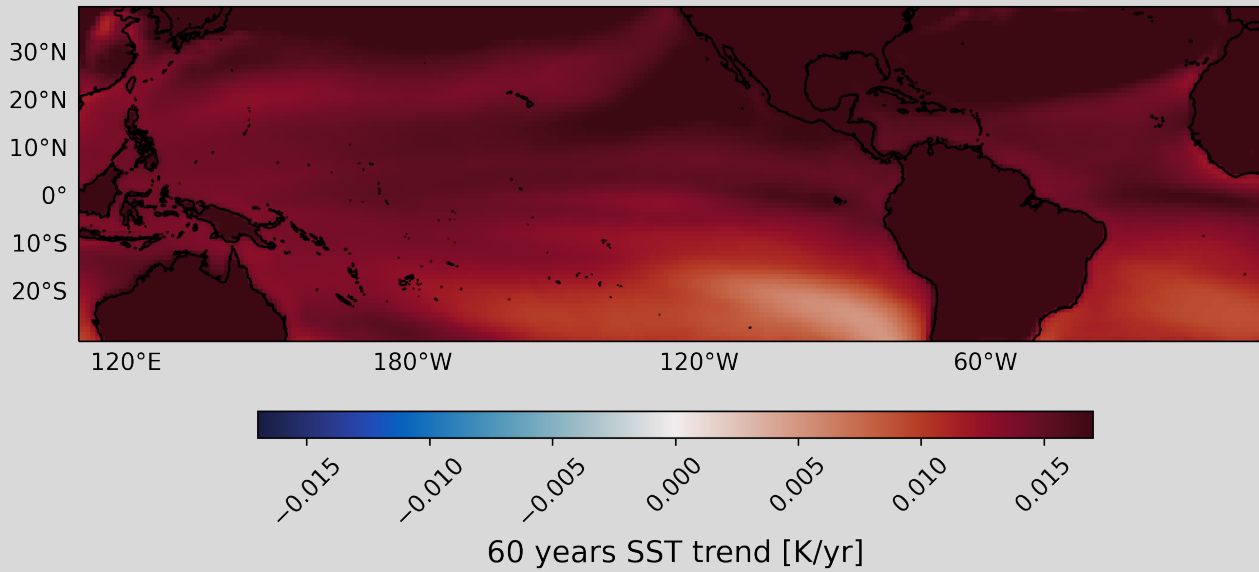


CMIP6

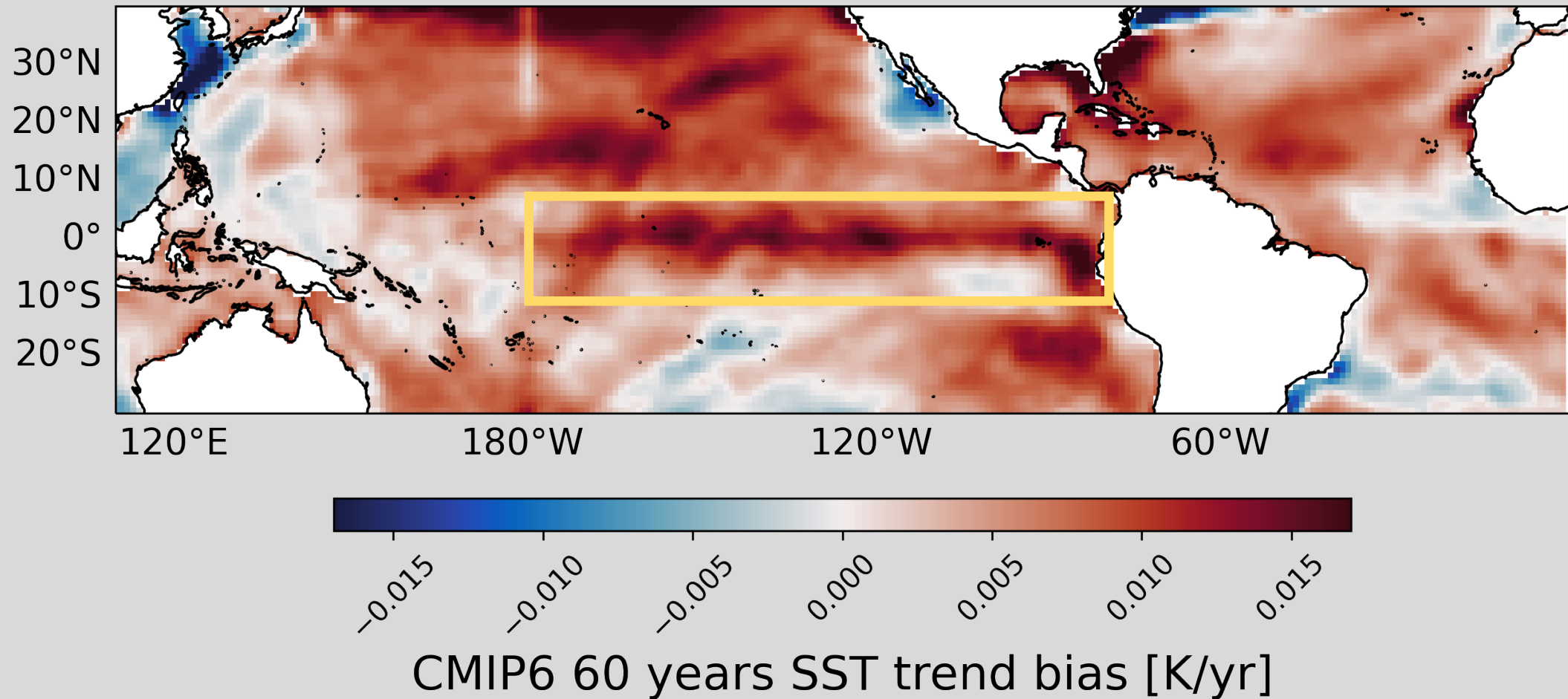
OBSERVATIONS

1961 – 2020 SST trend mmmean CMIP6

1961 – 2020 SST trend Hadley Centre



1961 – 2020 **CMIP6 SST trend bias** (32 CMIP6 mmean - Hadl obs.)





Persistent Discrepancies between Observations and Simulations in the Tropical Pacific

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The eastward shift of the Walker Circulation in response to global warming and its relationship to ENSO variability

Are Simulated and Observed Twentieth Century Tropical

North Pacific Upper-Ocean Cold Temperature Biases in CMIP6 Simulations and the Role of Regional Vertical Mixing

YUCHAO ZHU

Strengthening the
temperatures
greenhouse

Systematic
patterns of re

Pattern Recognition Methods
Climate

DAVID S. BATTISTI

Exploration of Atmosphere-Only Model Deficiencies in Reproducing the 1992–2011 Pacific Trade Wind Acceleration

Peter van Rensch¹ , Shayne McGregor^{1,2} , and Dietmar Dommenget^{1,2}

2011 Pacific trade wind acceleration

Peter van Rensch¹, Shayne McGregor^{1,2}, Dietmar Dommenget^{1,2}

Biases of Walker
related SST anomaly
coupled models

³, Nathaniel C. Johnson^{4,5}, Hailong Liu^{1,2}, Yadi Li^{1,2},
Yan Li^{1,6*}

MODELS



OBSERVATIONS

**EL NIÑO** (the boy)

Eastward migration Walker cell

**LA NIÑA** (the girl)

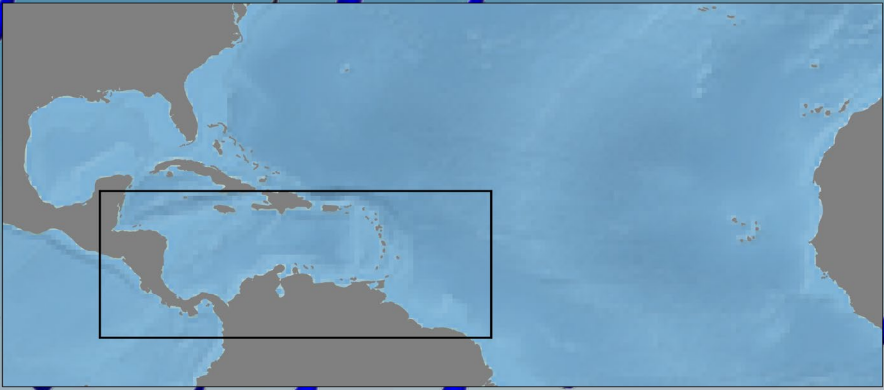
Westward migration Walker cell



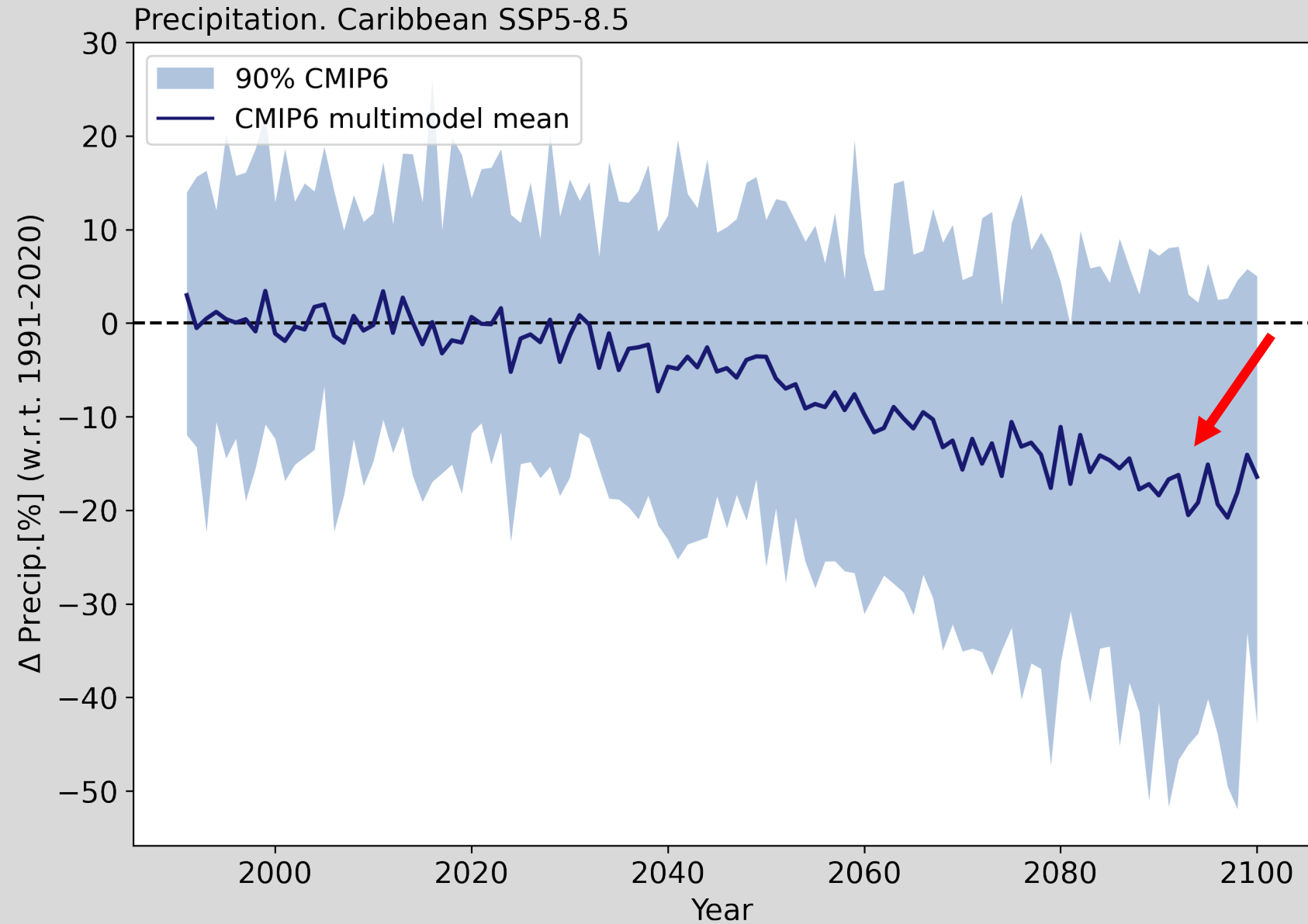
What implications does the Pacific warming bias have on climate projections?



35°N
30°N
25°N
20°N
15°N
10°N
5°N



80°W 60°W 40°W 20°W





32 CMIP6 models



-> **Change (Δ):** difference between future and reference periods

$$\Delta = [2071 \text{ to } 2100] - [1991 \text{ to } 2020]$$

-> **Scale variables:** set all the models to the same warming

For every model:

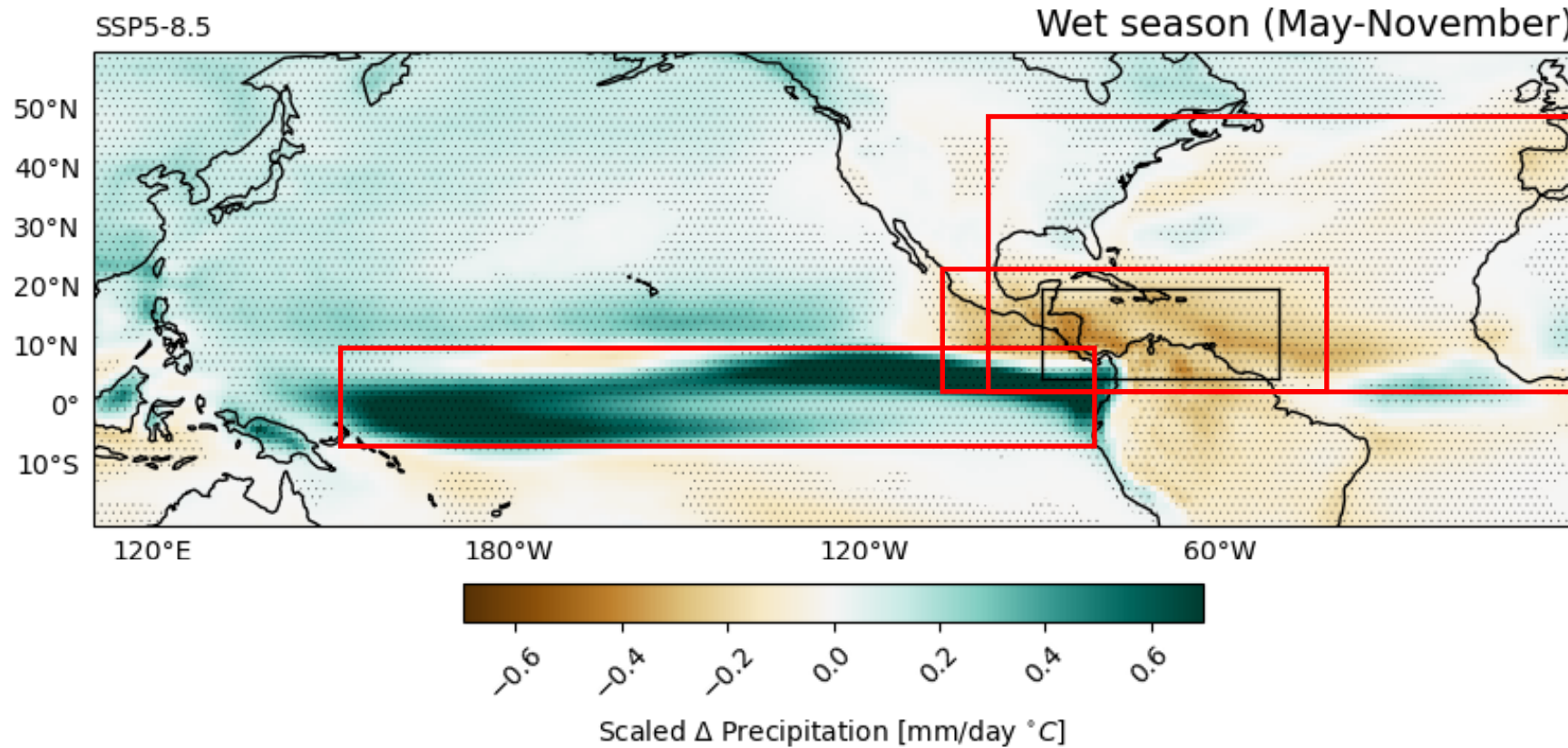
$$\textit{Scaled } \Delta Pr = \frac{\Delta Pr}{\Delta T \text{ } 40^{\circ}N - 40^{\circ}S}$$



Drivers drying

Drivers drying

Scaled Δ Precipitation



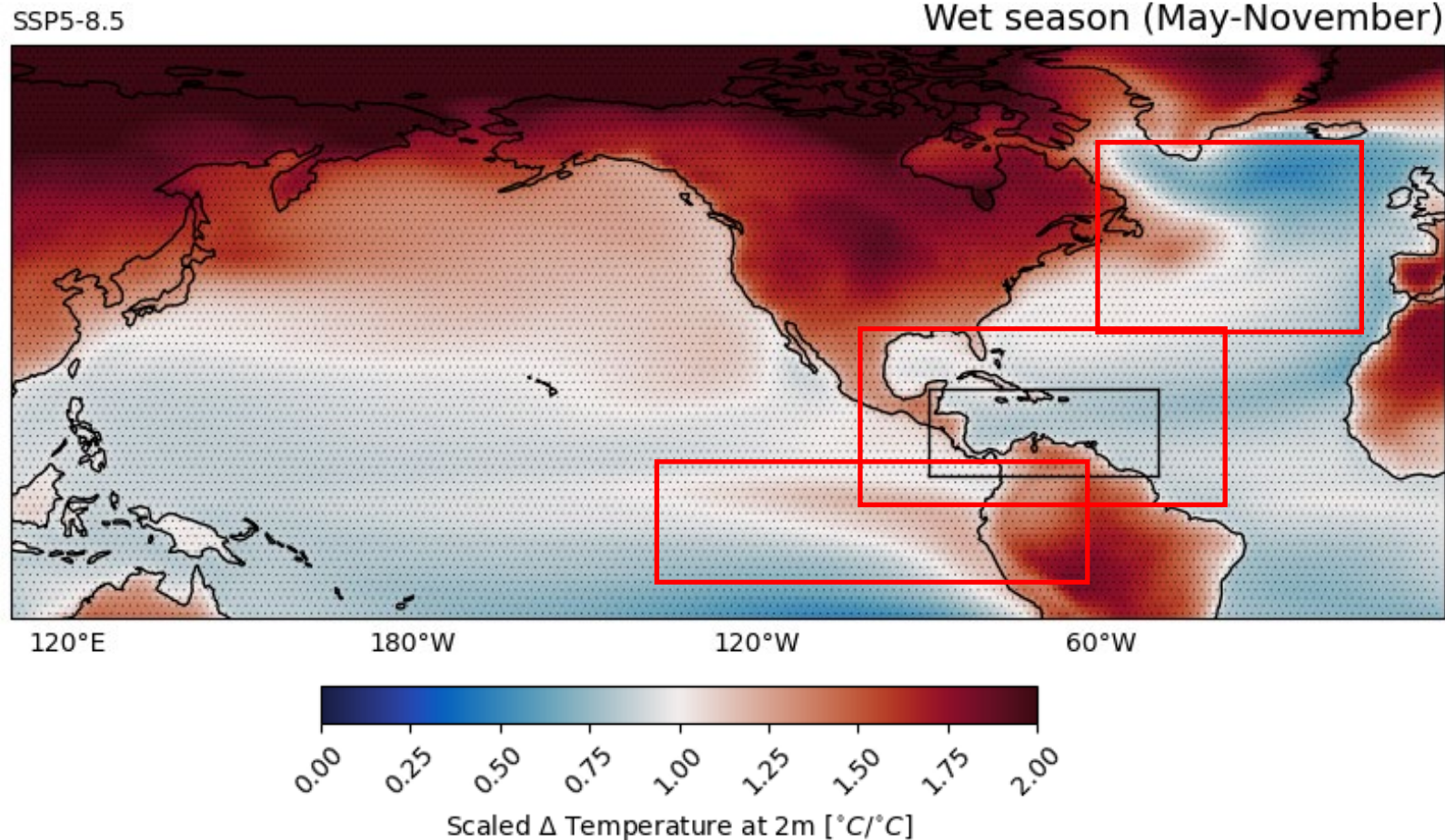
Wet season:

- Deep convection tropics
- Drying subtropical regions
- Strong drying in the Caribbean



Drivers drying

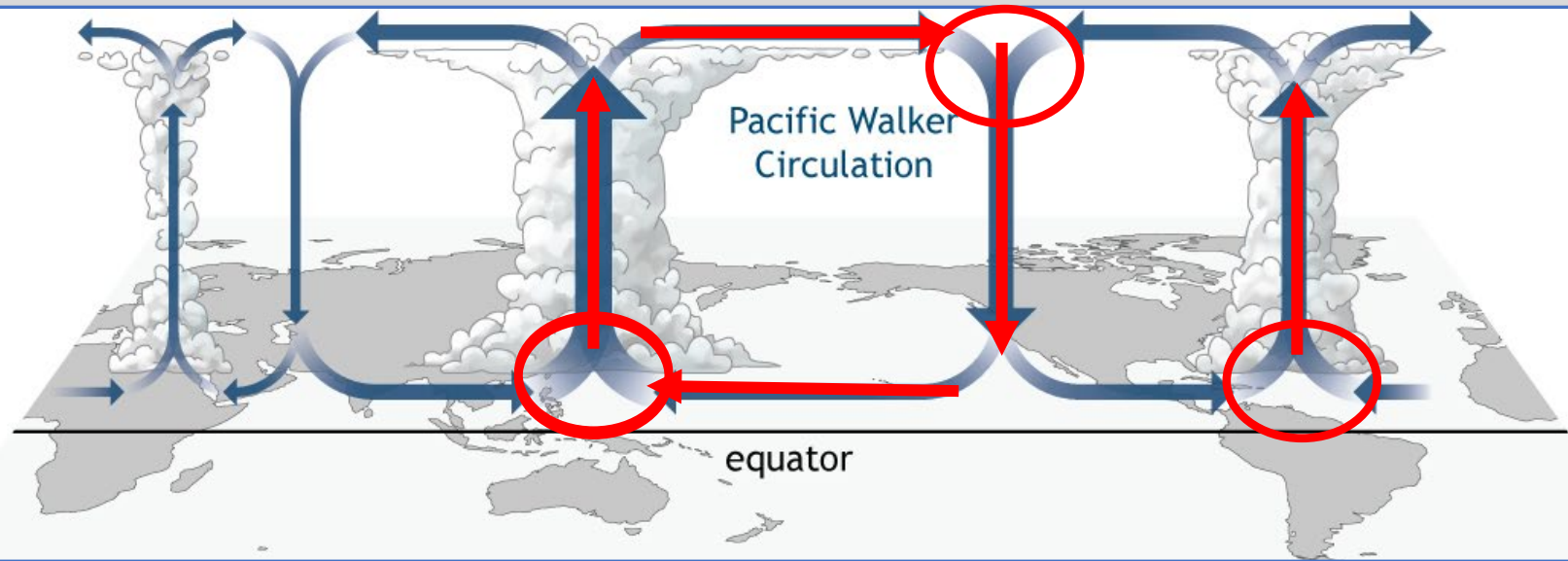
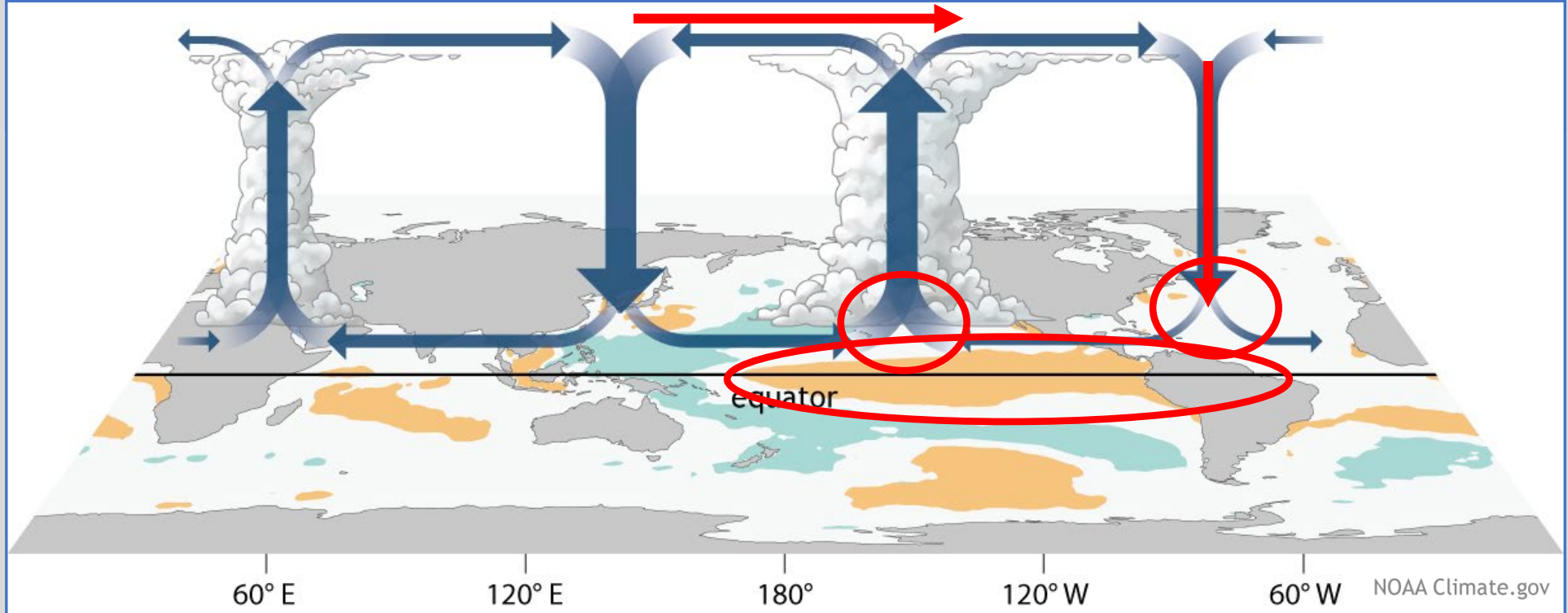
Drivers drying

Scaled Δ Temperature

Wet season:

- El Niño-like warming
- Caribbean-South America ∇T
- AMOC (Atlantic Meridional Overturning circulation) weakening

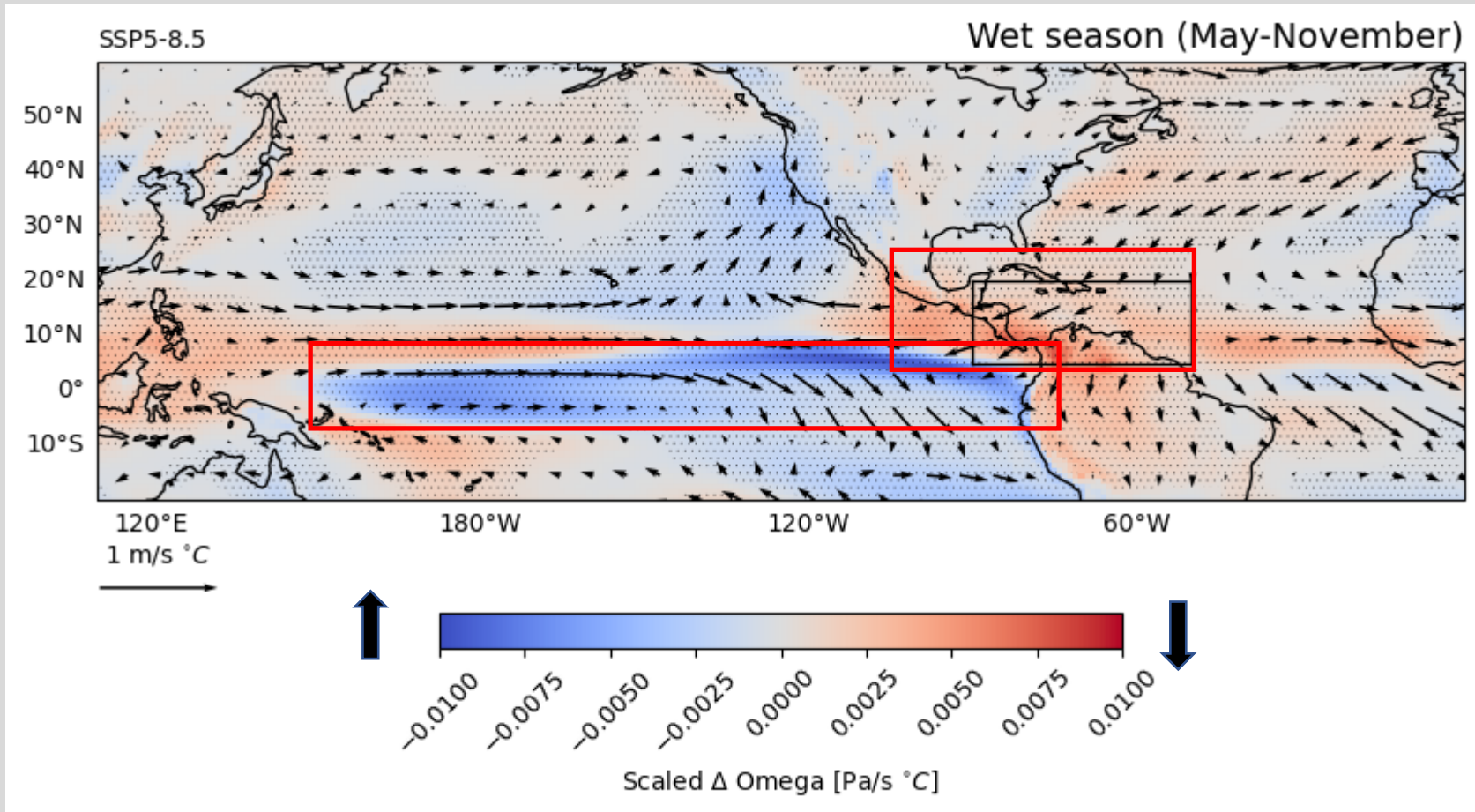
Drivers drying

Normal
circulationEl Niño-like
circulation



Drivers drying

Drivers drying

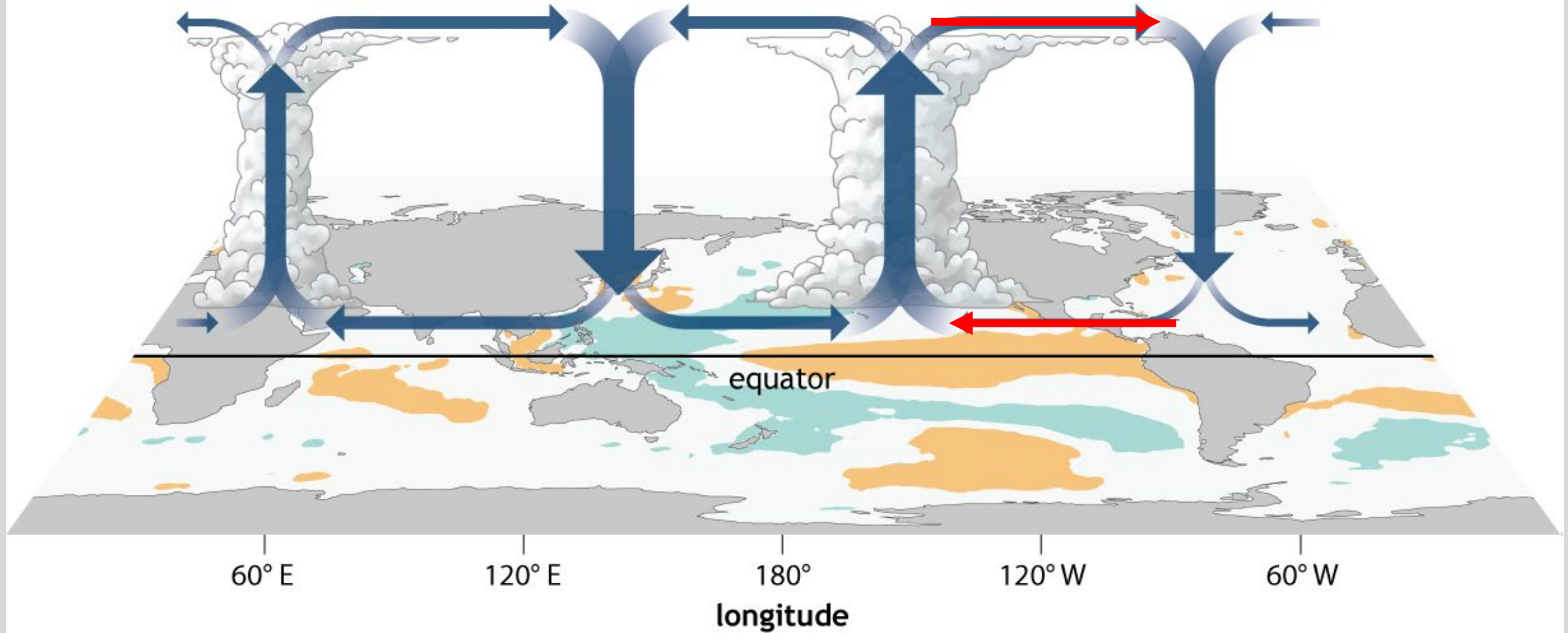
Scaled Δ Omega at 500 hPa and Wind at 850 hPa

Wet season:

- Deep convection in the tropics
- Subsidence in the Caribbean
- Increase trade winds in the Caribbean

Drivers drying

El Niño-like circulation



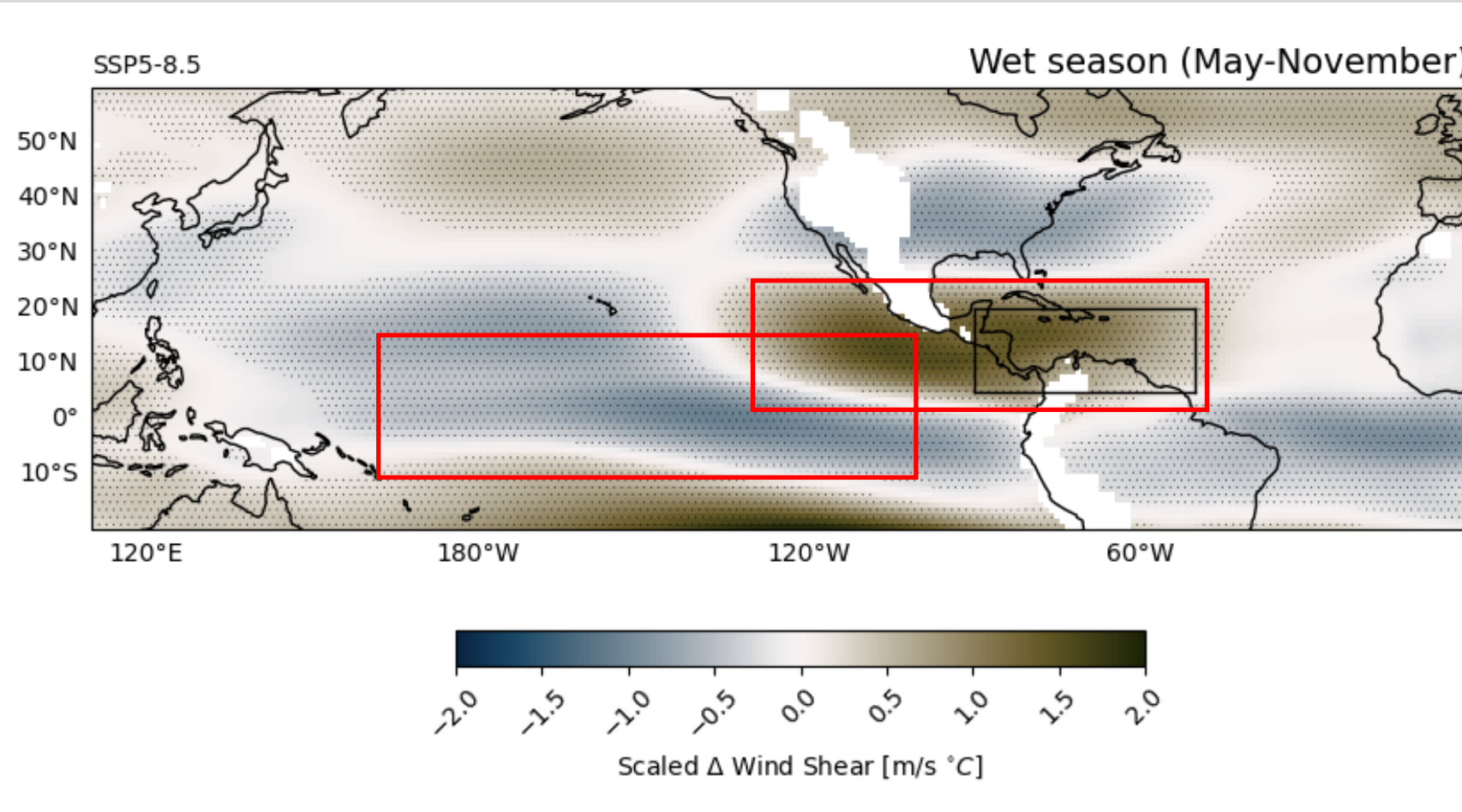


Drivers drying

Drivers drying

Scaled Δ **VWS** (vertical wind shear)

$$VWS = u_{200 \text{ hPa}} - u_{850 \text{ hPa}}$$



Wet season:

- Increase VWS Caribbean
- Decrease VWS east tropical Pacific



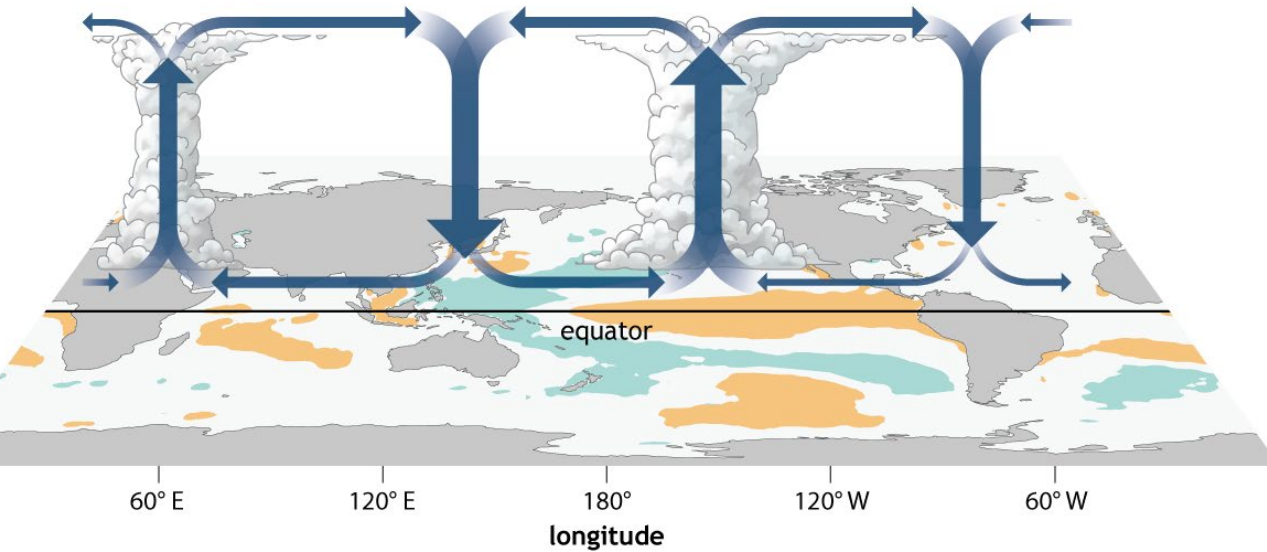
Drivers drying

Drivers drying

CMIP6

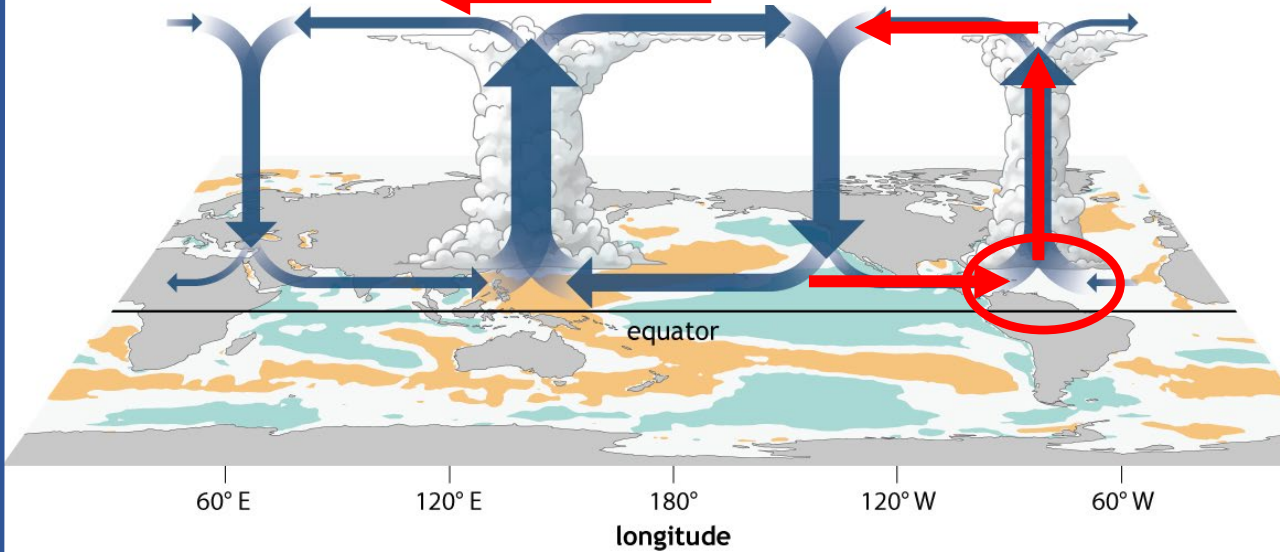
OBSERVATIONS

El Niño-like circulation



NOAA Climate.gov

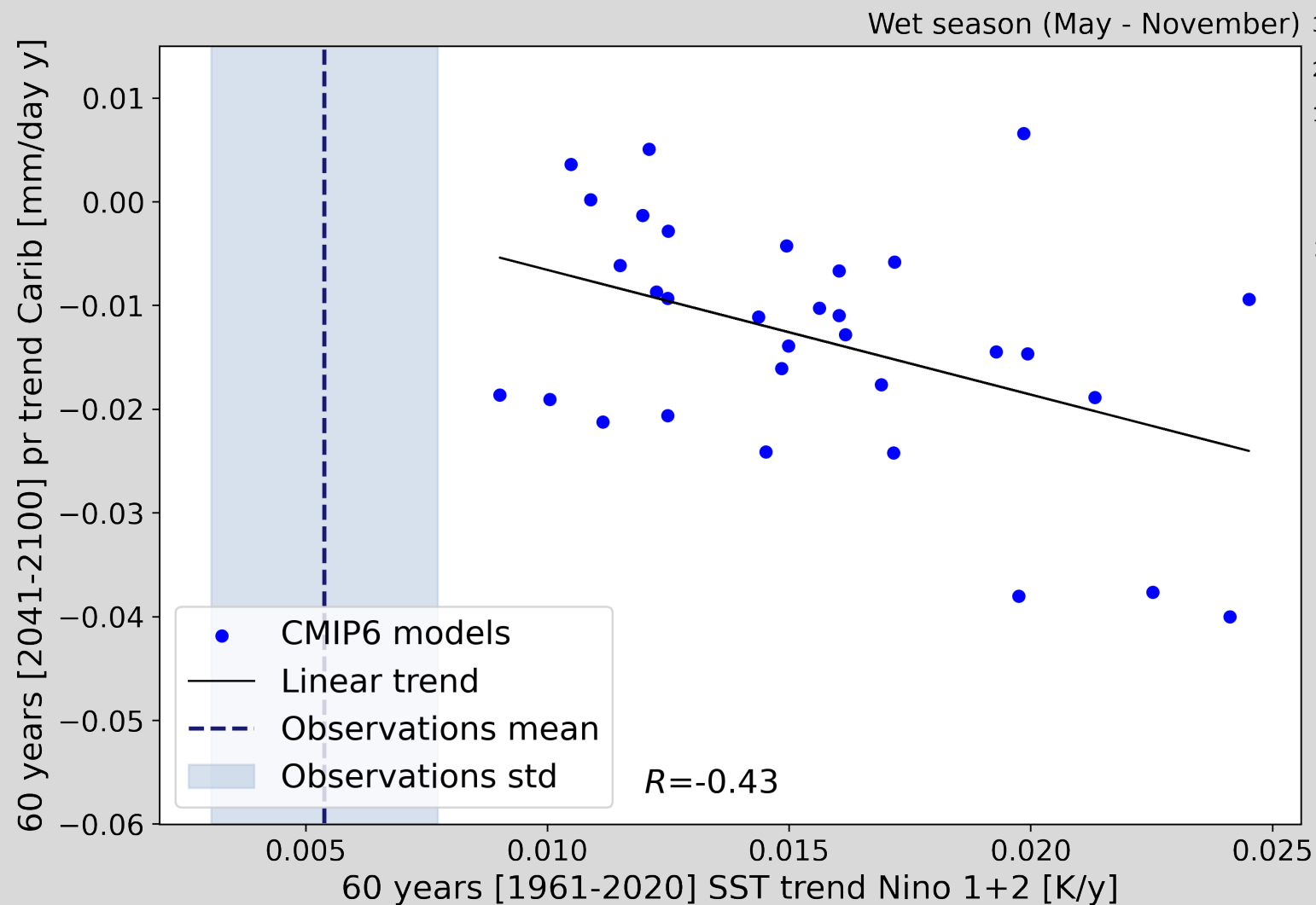
La Niña-like circulation



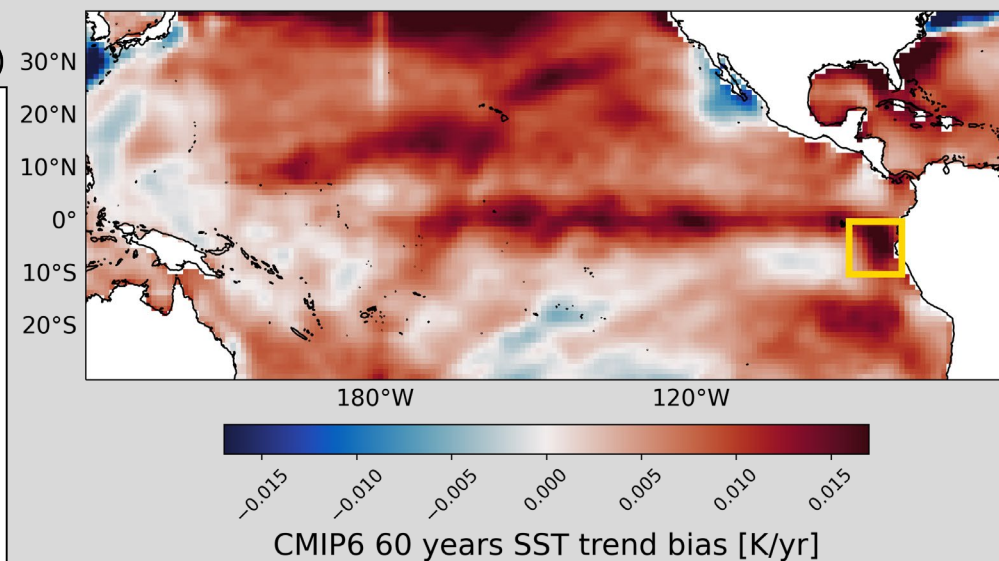
NOAA Climate.gov

First attempt to constrain climate projections

Emergent constraint analysis



CMIP6 60 years [1961-2020] SST trend bias





- **Mismatch observed and modeled Pacific SST trends.**
- Discussion whether is caused by **internal variability** or **model biases**.

- **Drivers Pacific SST bias**

- Vertical mixing
- Cloud-albedo
- Advection of s
- ...

Seager et al., (2022)

observed trend; (iii) taken together, the observed SST and thermocline trends are extremely likely (in IPCC usage) to be outside the range of internal variability in the models. Only

- **CMIP6 project a drying in the Caribbean** at the end of the century.
- **Drivers Caribbean drying** (wet season)
 - Eastward shift **Walker circulation**
 - AMOC weakening
 - Temperature gradients

- The Caribbean is likely to experience wetter conditions than the ones projected by CMIP6 models.

A satellite map of the Pacific Ocean, showing the Americas on the left and Asia/Australia on the right. The text "Thank you for your attention" is overlaid in the center in white. The ocean is a deep blue, and the landmasses are green and brown.

**Thank you
for your attention**