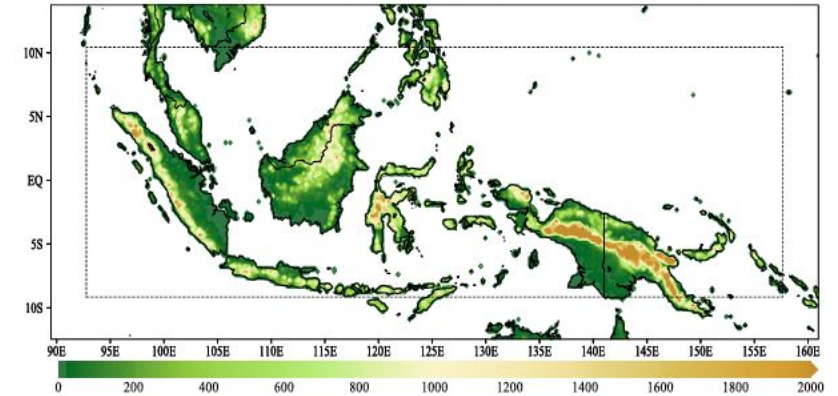


# Deforestation induced land-atmosphere interactions in CESM

Part I: The role of forests in moderating local interannual evapotranspiration variation

Part II: Mean-states dependence of deforestation induced precipitation changes



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# Part I:

## The role of forests in moderating local interannual evapotranspiration variation

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# Introduction

Neutral  
(with prescribed  
climatology SST)

Precipitation &  
evapotranspiration  
decrease

El Nino  
(with prescribed El  
Nino-like SST)

Canopy Evaporation

30.78

25.87

Canopy Transpiration

57.41

Increase

66.52

Ground Evaporation

8.52

9.12

forest's

Lee and Lo, 2021

Unit:  $W/m^2$

evapotranspiration partitioning

# Data & Method

**1981-2014**

## Reanalysis & Observation

- ERA5-Land
- GLEAM
- GPCC

## Events:

The Oceanic Niño Index (ONI)

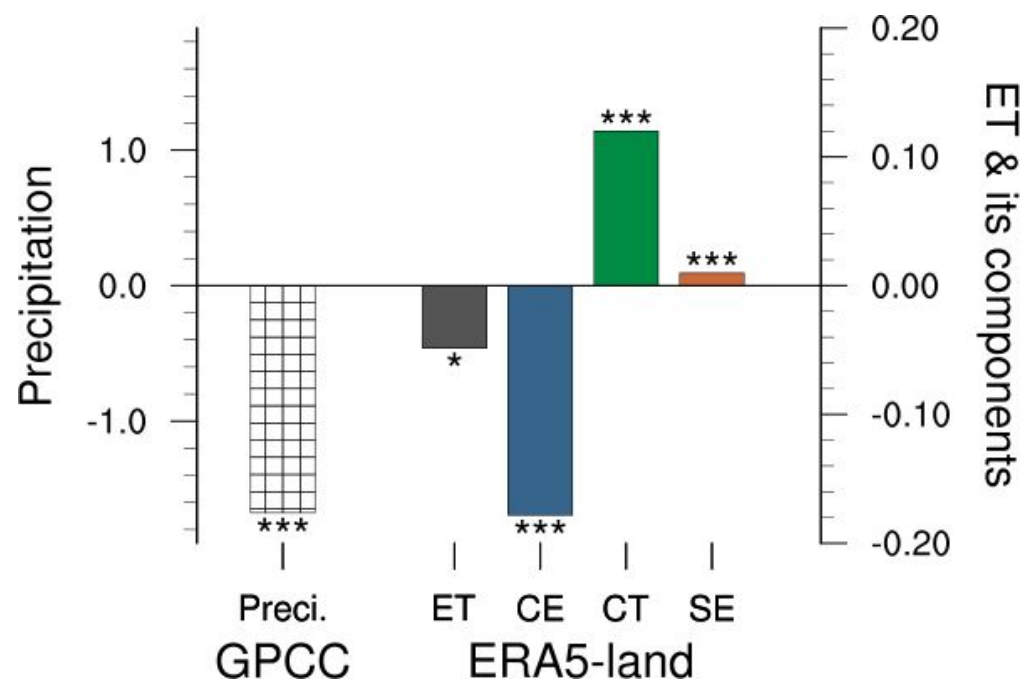
El Niño: the 3-month running averaged NIÑO3.4 SSTA

$\geq 0.5^{\circ}\text{C}$  for five or more consecutive months

La Niña:  $\leq -0.5^{\circ}\text{C}$ .

Difference: El Niño – La Niña  $\square$  interannual variation

# Transpiration's dampening effect



(El Niño – La Niña in the maritime continent)

Unit: mm/day

ET: Evapotranspiration  
CE: canopy evaporation  
CT: canopy transpiration  
SE: soil evaporation

95% significant test(\*)  
99% significant test(\*\*)  
99.9% significant test(\*\*\*)

For Precipitation

(El Niño – La Niña)/Climatology ~ 23.3%

For ET

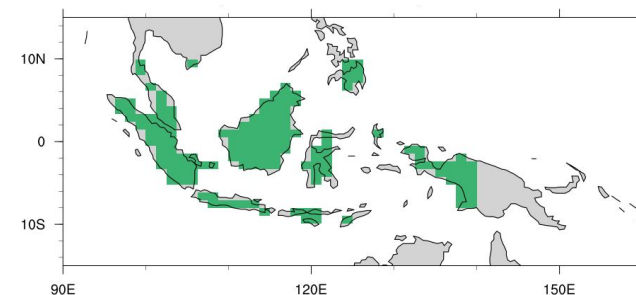
(El Niño – La Niña)/Climatology ~ 1.3% for ERA5  
3.2% for GLEAM

Using CLM to test the role of forest in dampening ET variations

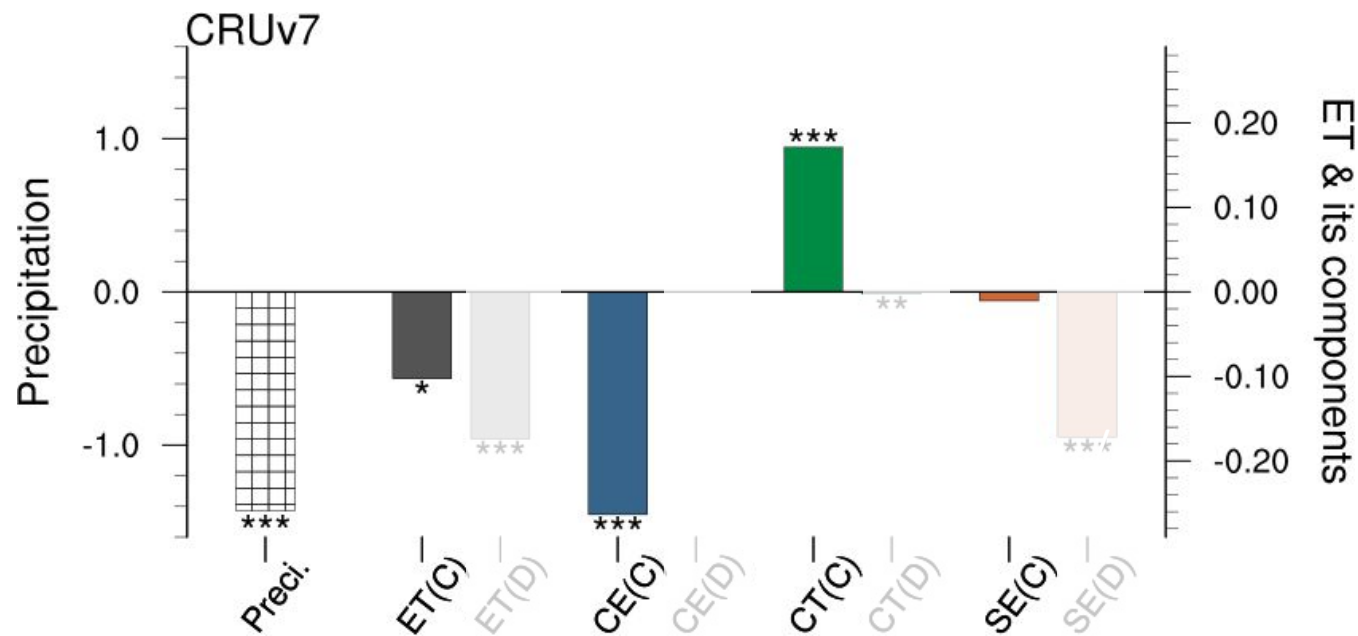
# Simulation I

	Land types	
	<b>Rainforest</b> (control run)	<b>Bare Soil</b> (deforestation run)
<b>Atmospheric forcing</b> (Precipitation, radiation, T, wind, pressure, and Q)	El Niño – La Niña	El Niño – La Niña

1981-2014



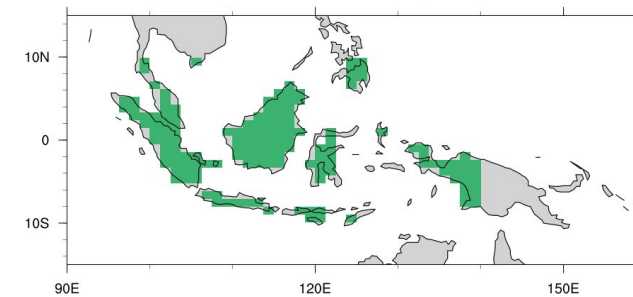
# Deforestation cut down transpiration's dampening effect and the interannual variability of evapotranspiration will be increased



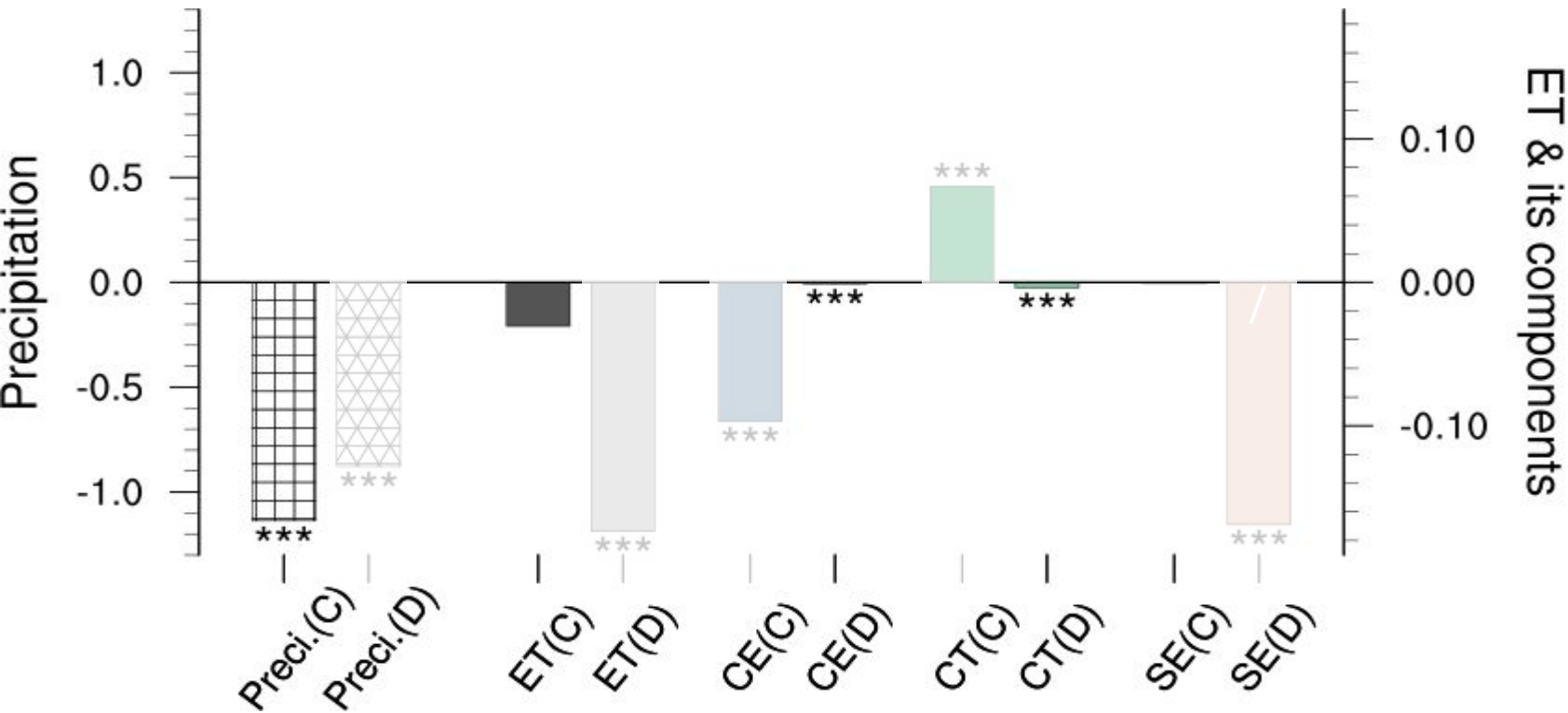


# Simulation II

		Land types	
CESM2 Fully coupled model 40 ensemble (1 year)	Rainforest (control run)	Bare Soil (deforestation)	
	El Niño – La Niña	El Niño – La Niña	



# The interannual variation of evapotranspiration was increased



Take home message:

The compensating effects of canopy transpiration will dampen interannual variation of total evapotranspiration.

After deforestation, evapotranspiration's interannual variability will increase, but **precipitation's interannual variability decreases.**

Unit: mm/day  
 95% significant test(\*)  
 99% significant test(\*\*)  
 99.9% significant test(\*\*\*)

# Part II:

## Mean-states Dependence of Deforestation Induced Precipitation Changes

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LETTER

The role of El Niño in modulating the effects of deforestation in the Maritime Continent

Ting-Hui Lee and Min-Hui Lo

Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan

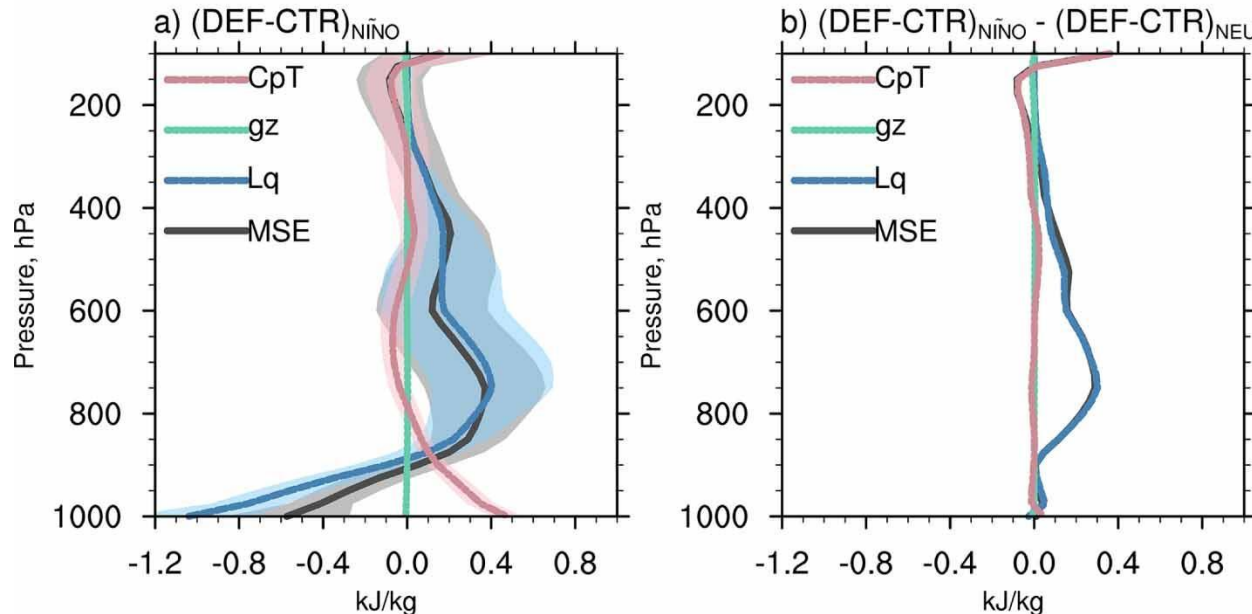
E-mail: [minhuilo@ntu.edu.tw](mailto:minhuilo@ntu.edu.tw)

# Introduction

Variables	Neutral Condition ( $DEF_{Neu} - CTL_{Neu}$ )	El Niño Condition ( $DEF_{Niño} - CTL_{Niño}$ )	Effect of El Niño
Precipitation (P)	Increase ↑ 0.59 mm d <sup>-1</sup>	Increase ↑ 0.79 mm d <sup>-1</sup>	Enhancement ↑ 0.20 mm d <sup>-1</sup>

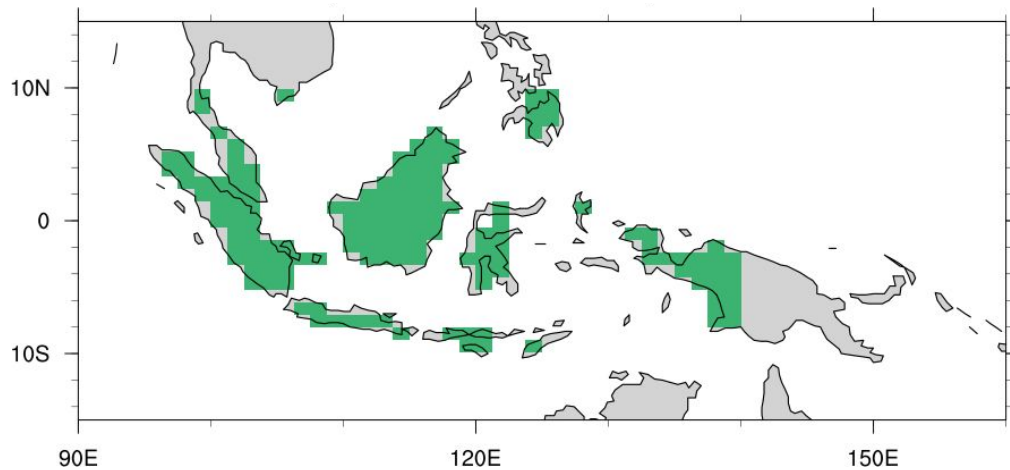
Under the environment of El Niño phase, precipitation increases are significantly greater than neutral phase

Under the environment of El Niño phase, MSE increases in middle troposphere are significantly greater than neutral phase



# Data & Method

## Fully-coupled Simulation



### Experiment

Deforestation experiment conducted by CESM2

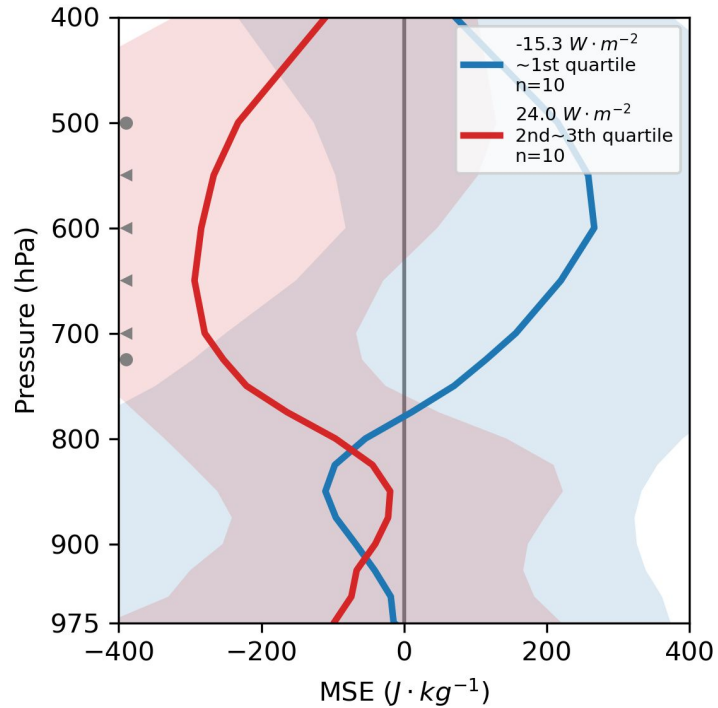
### Ocean Model

Active

### Ensemble member

Macro-perturbation

# Deforestation-induced precipitation increases are greater in "negative-concave" MSE profile mean-state

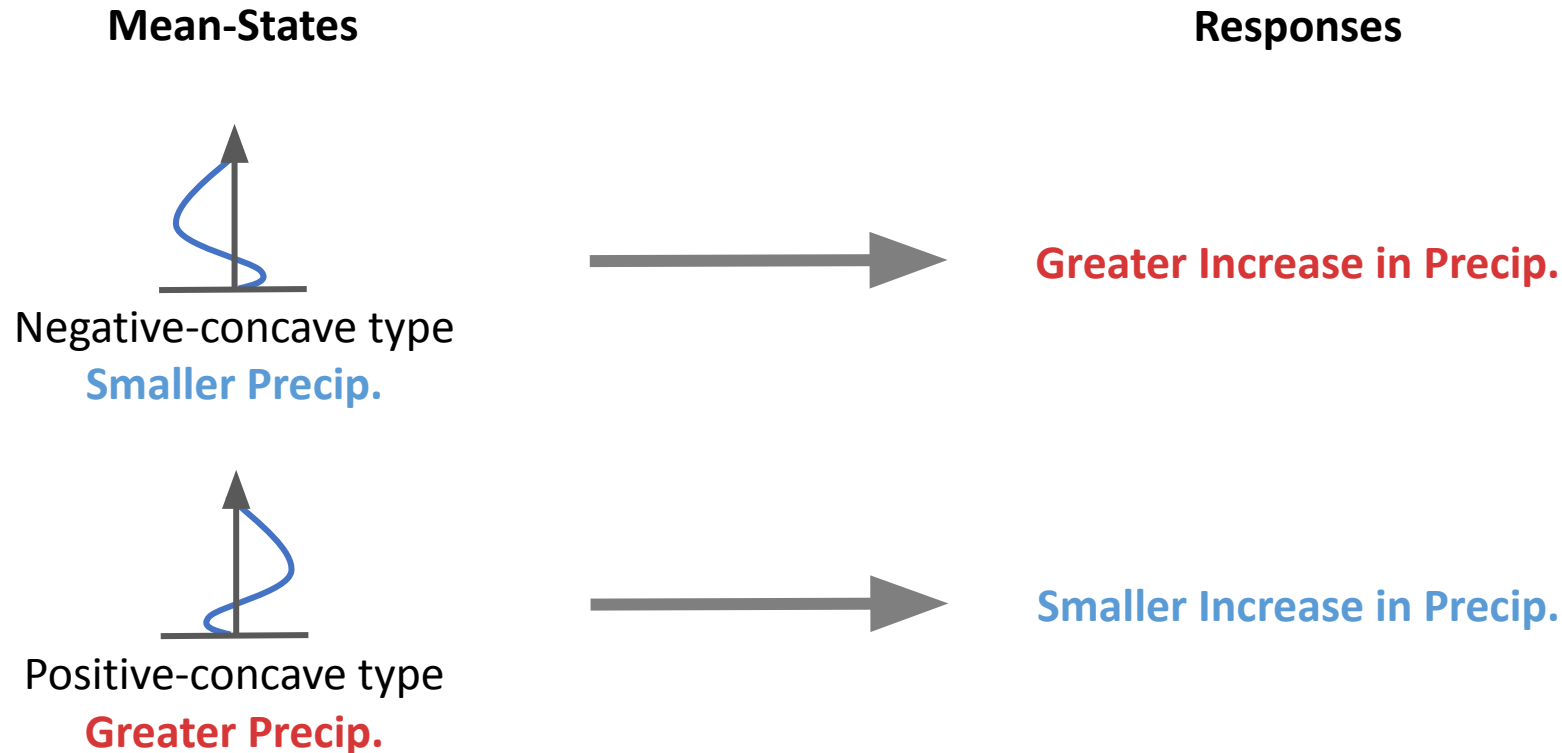


Coupled Model Simulation		
Group	CTL Precipitation	ANO Precipitation (DEF minus CTL)
■	249.6 Wm <sup>-2</sup>	22.1 Wm <sup>-2</sup>
■	280.4 Wm <sup>-2</sup>	-16.8 Wm <sup>-2</sup>

- All events are grouped based on corresponding ANO precipitation, and selected by 4 quartiles.
- For the groups with greater ANO precipitation, the climate state in the CTL tend to be drier. It implies a **negative-feedback** relation between CTL and ANO precipitation.

# Dependency of Precipitation Response on Climate Mean-states

## Negative Feedback of Precipitation after Deforestation in the Maritime Continent



### Take home message

- After deforestation, the group with a negative-concave MSE mean-state tends to cause a stronger increase in precipitation.

# Summary

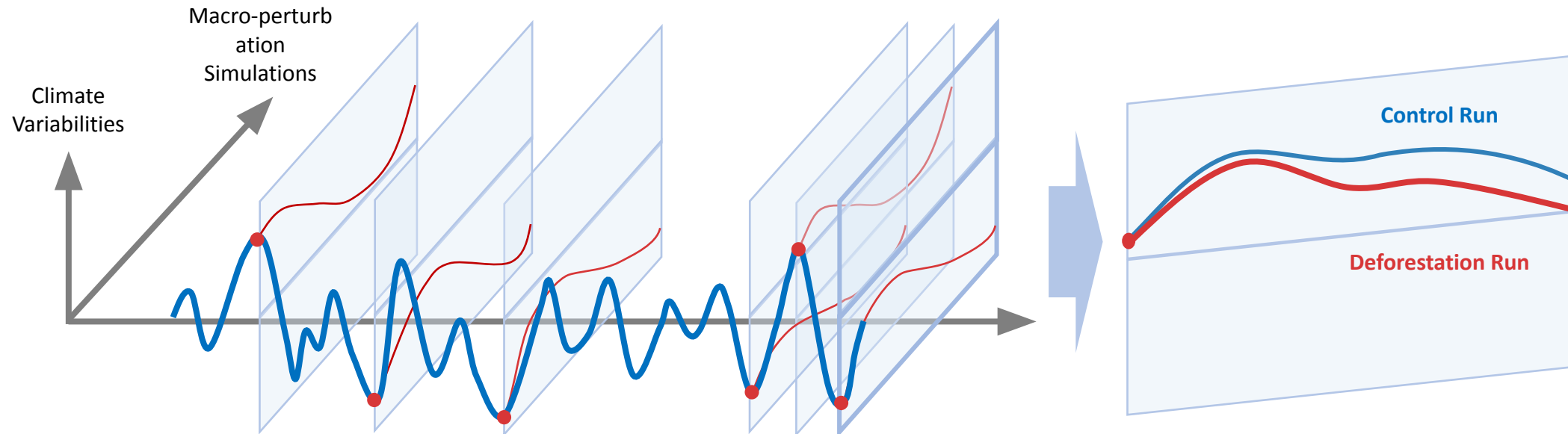
- **Evapotranspiration Variability Amplified**
  - Deforestation disrupts the balance between canopy evaporation and transpiration in tropical forests, amplifying the variation in evapotranspiration and altering local hydrological cycles.
- **Deforestation Affects Climate Variability**
  - Deforestation changes interannual climate variability by increasing precipitation during drier periods, indicating its negative impacts on the local precipitation.



**Thank you for your attention**

# Data & Method

## Part 2: Fully-coupled Simulation



### Cases Selection

Select several years as the samples in CESM2 pi-Control (B1850) dataset

### Experiments

Run control simulation and deforestation simulation based on the different perturbed states

**Macro-perturbation: Different initial condition from different climate mean-states caused by natural variabilities**

### Analysis

Statistical analysis of each case as an independent sample