The seesaw response of the intertropical and South Pacific convergence zones to hemispherically asymmetric thermal forcing

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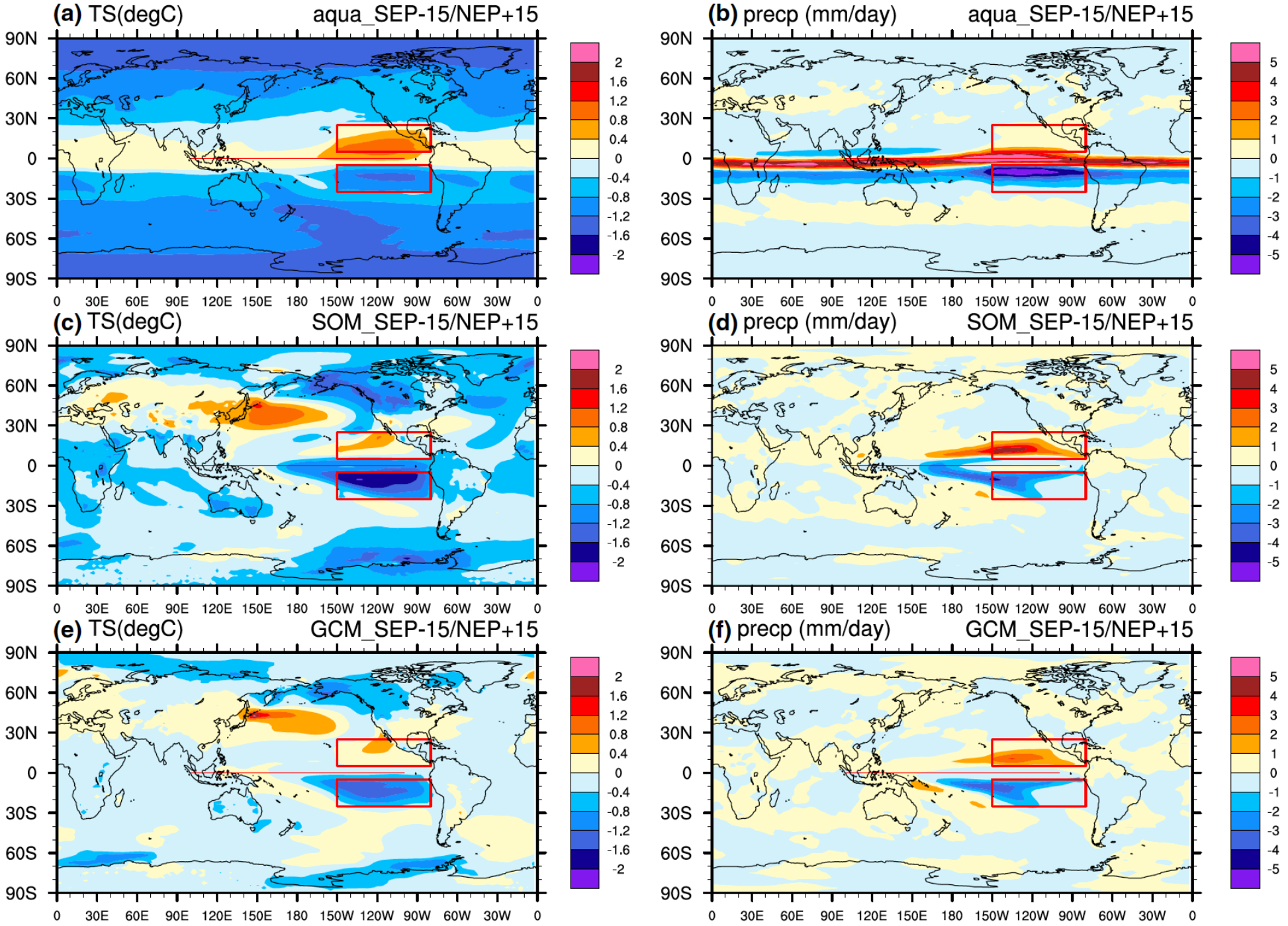
North: 15 W/m^2

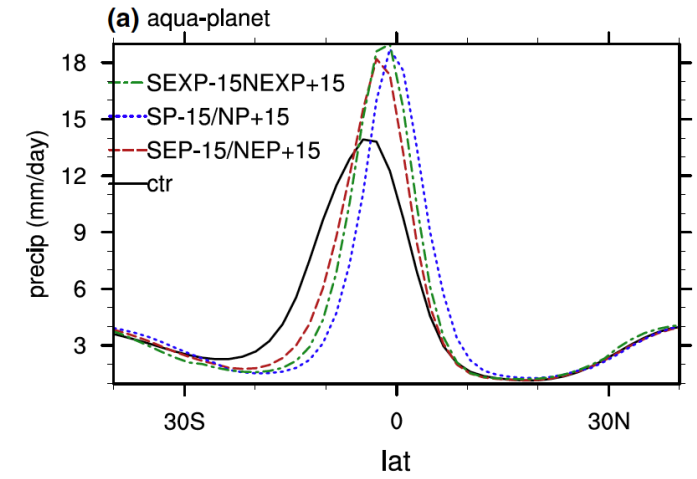
South: -15 W/m^2

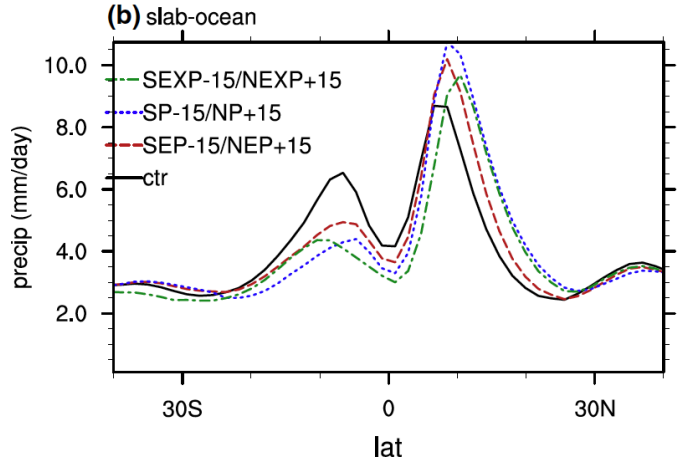


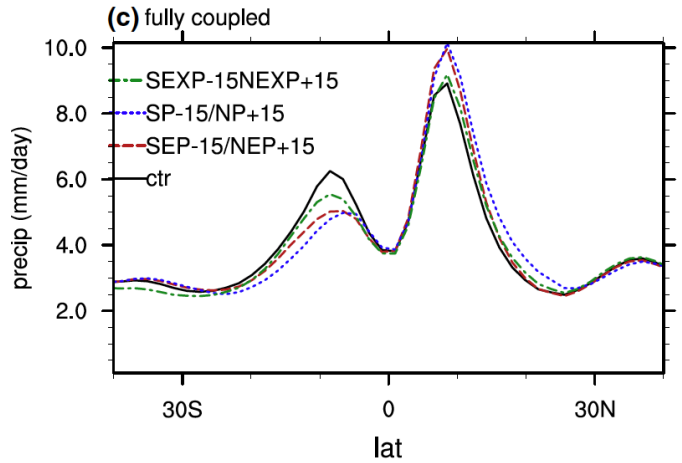
Changes in mean climate in response to an asymmetric thermal forcing imposed in the eastern subtropical Pacific.

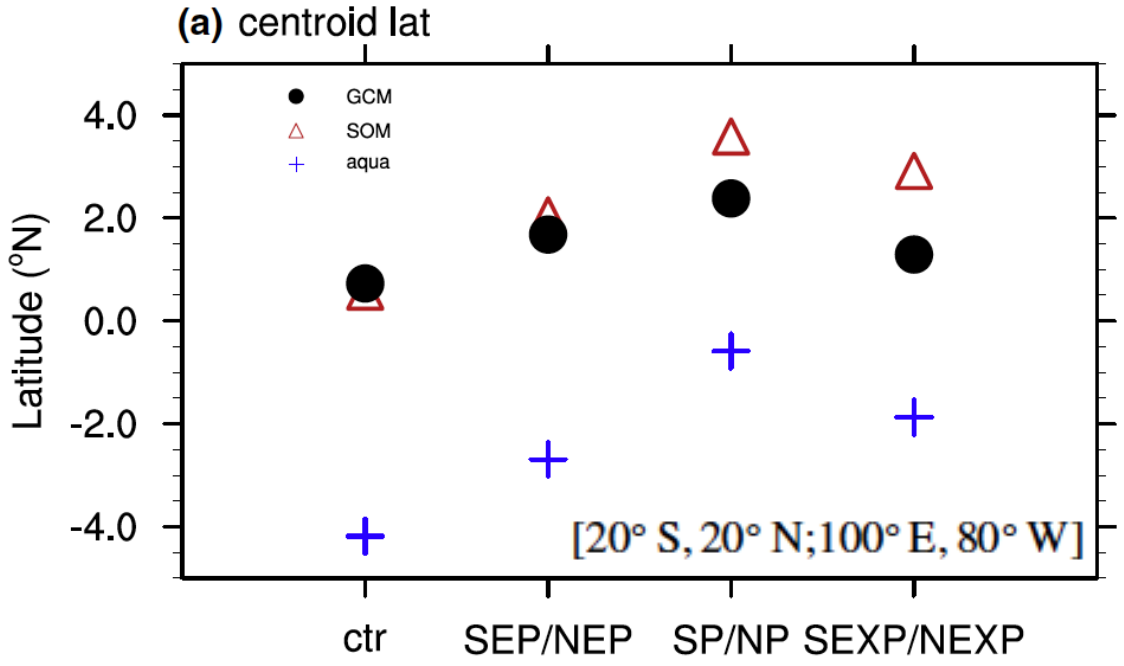
Table 1 A summary of perturbation experiments using different configurations of CESM

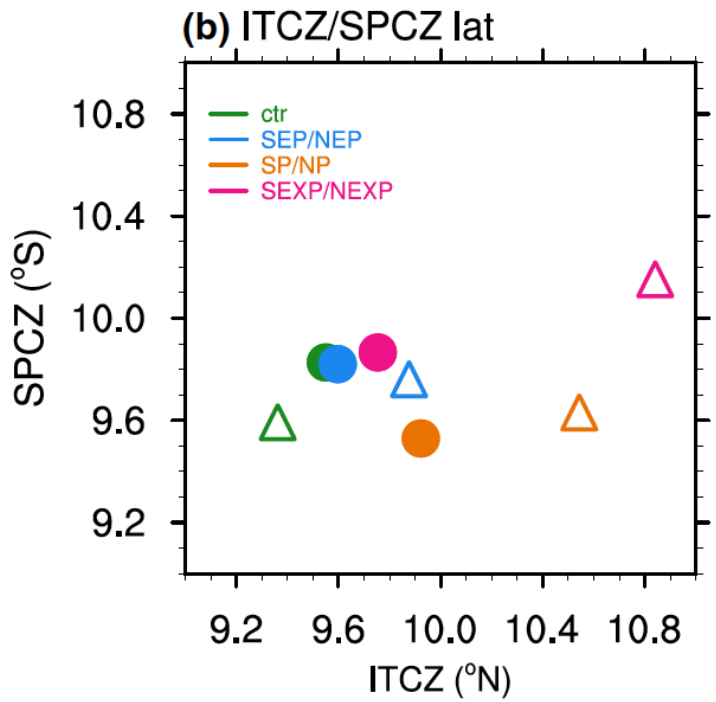
Experiment	Forcing	Simulation length (aqua-planet/slab-ocean/fully coupled)
Main experiments common across different model configurations		
SEP-15/NEP+15	15 W/m^2 added in the northeastern subtropical Pacific [5° N–25° N; 150° W–80° W]; −15 W/m^2 added in the southeastern subtropical Pacific	30/30/100 years
SP-15/NP+15	15 W/m^2 added in the northern subtropical Pacific [5°N–25°N; 100° E–80° W]; −15 W/m^2 added in the southeastern subtropical Pacific [5° S–25° S; 100° E–80° W]	30/30/100 years
SEXP-15/NEXP+15	15 W/m^2 added in the northern subtropical Pacific [30°N–50°N; 100° E–80° W]; −15 W/m^2 added in the southeastern subtropical Pacific [30° S–50° S; 100° E–80° W]	30/30/100 years
Additional fully coupled model runs		
SEP-10	−10 W/m^2 added in the southeastern subtropical Pacific [5° S–25° S; 150° W–80° W]	200 years
SEP-10/NEP+30	30 W/m^2 added in the northeastern subtropical Pacific [5° N–25° N; 150° W–80° W]; −10 W/m^2 added in the southeastern subtropical Pacific	200 years
SEP-12/NEP+40	40 W/m^2 added in the northeastern subtropical Pacific; −12 W/m^2 added in the southeastern subtropical Pacific	200 years
SEP-15/NEP+60	60 W/m^2 added in the northeastern subtropical Pacific; −15 W/m^2 added in the southeastern subtropical Pacific	100 years
SEP+10/NEP-30	−30 W/m^2 added in the northeastern subtropical Pacific; 10 W/m^2 added in the southeastern subtropical Pacific	100 years
SP+10/NP-30	−30 W/m^2 added in the northern subtropical Pacific [5° N–25° N; 100° E–80° W]; 10 W/m^2 added in the southeastern subtropical Pacific [5° S–25° S; 100° E–80° W]	100 years

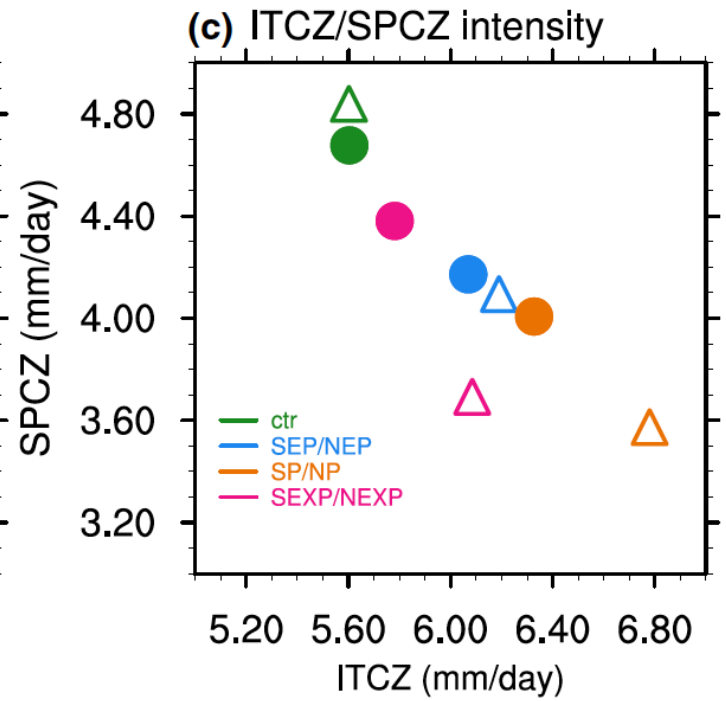

(a) aqua-planet
SEXP-15NEXP+15
SP-15/NP+15
SEP-15/NEP+15
ctr
precip (mm/day)
18
15
12
9
6
3
30S
0
30N
lat


(b) slab-ocean
SEXP-15/NEXP+15
SP-15/NP+15
SEP-15/NEP+15
ctr
precip (mm/day)
10.0
8.0
6.0
4.0
2.0
30S
0
30N
lat

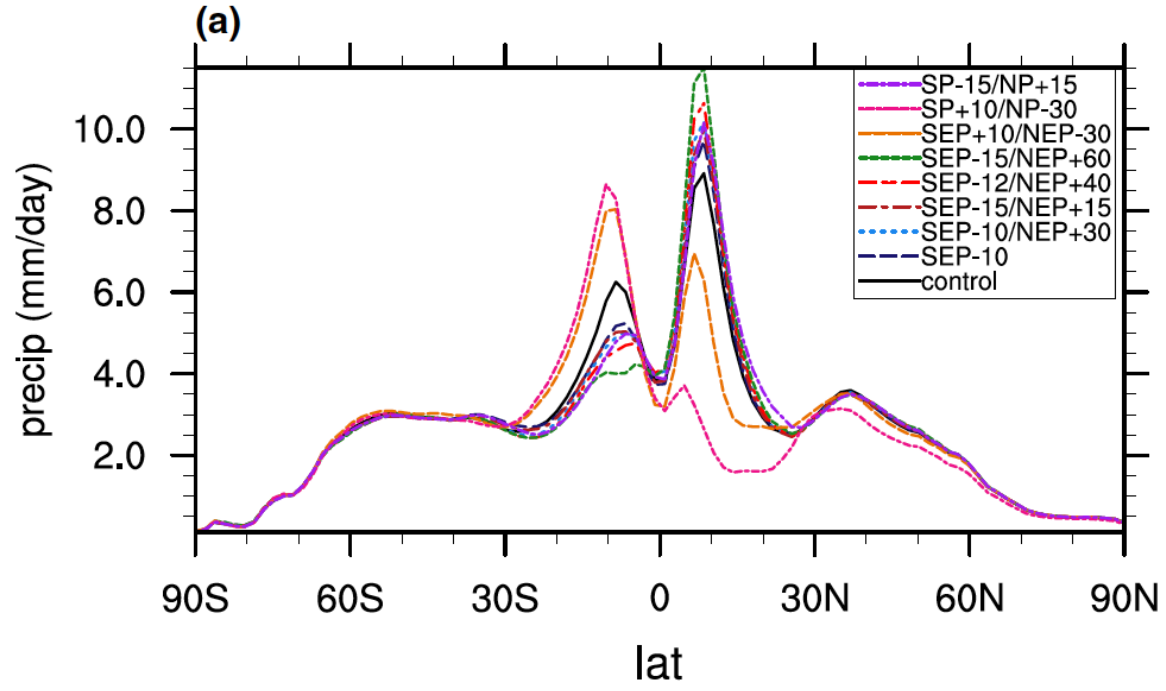

(c) fully coupled
SEXP-15NEXP+15
SP-15/NP+15
SEP-15/NEP+15
ctr
precip (mm/day)
10.0
8.0
6.0
4.0
2.0
30S
0
30N
lat

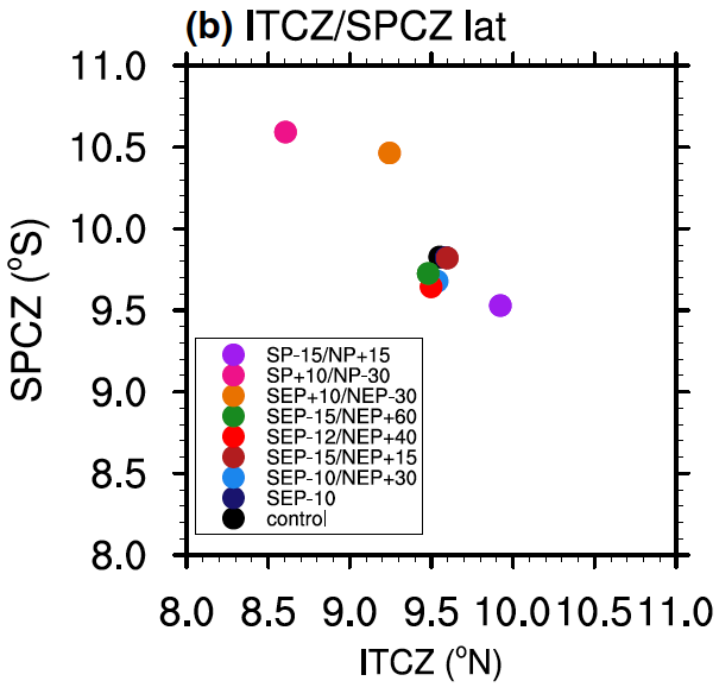

(a) centroid lat
GCM
SOM
aqua
Latitude (°N)
4.0
2.0
0.0
-2.0
-4.0
[20° S, 20° N;100° E, 80° W]
ctr
SEP/NEP
SP/NP
SEXP/NEXP

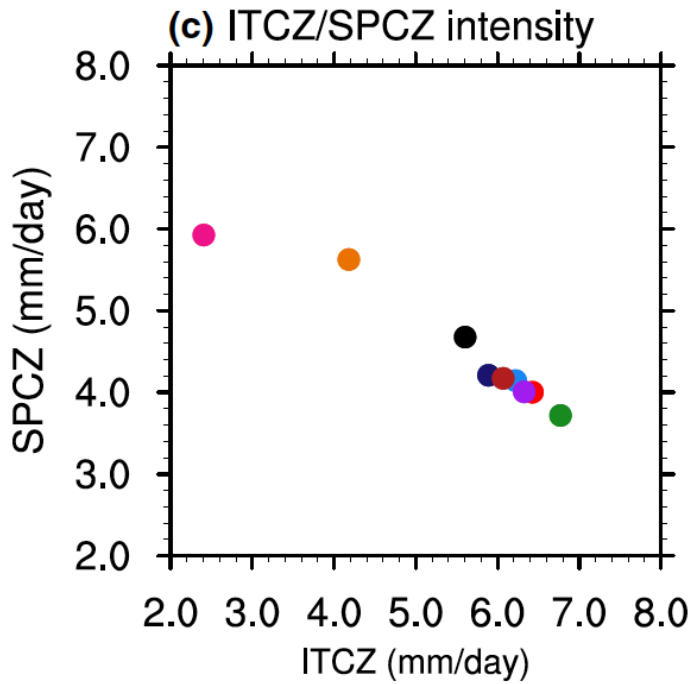

(b) ITCZ/SPCZ lat
ctr
SEP/NEP
SP/NP
SEXP/NEXP
SPCZ (°S)
10.8
10.4
10.0
9.6
9.2
9.2
9.6
10.0
10.4
10.8
ITCZ (°N)

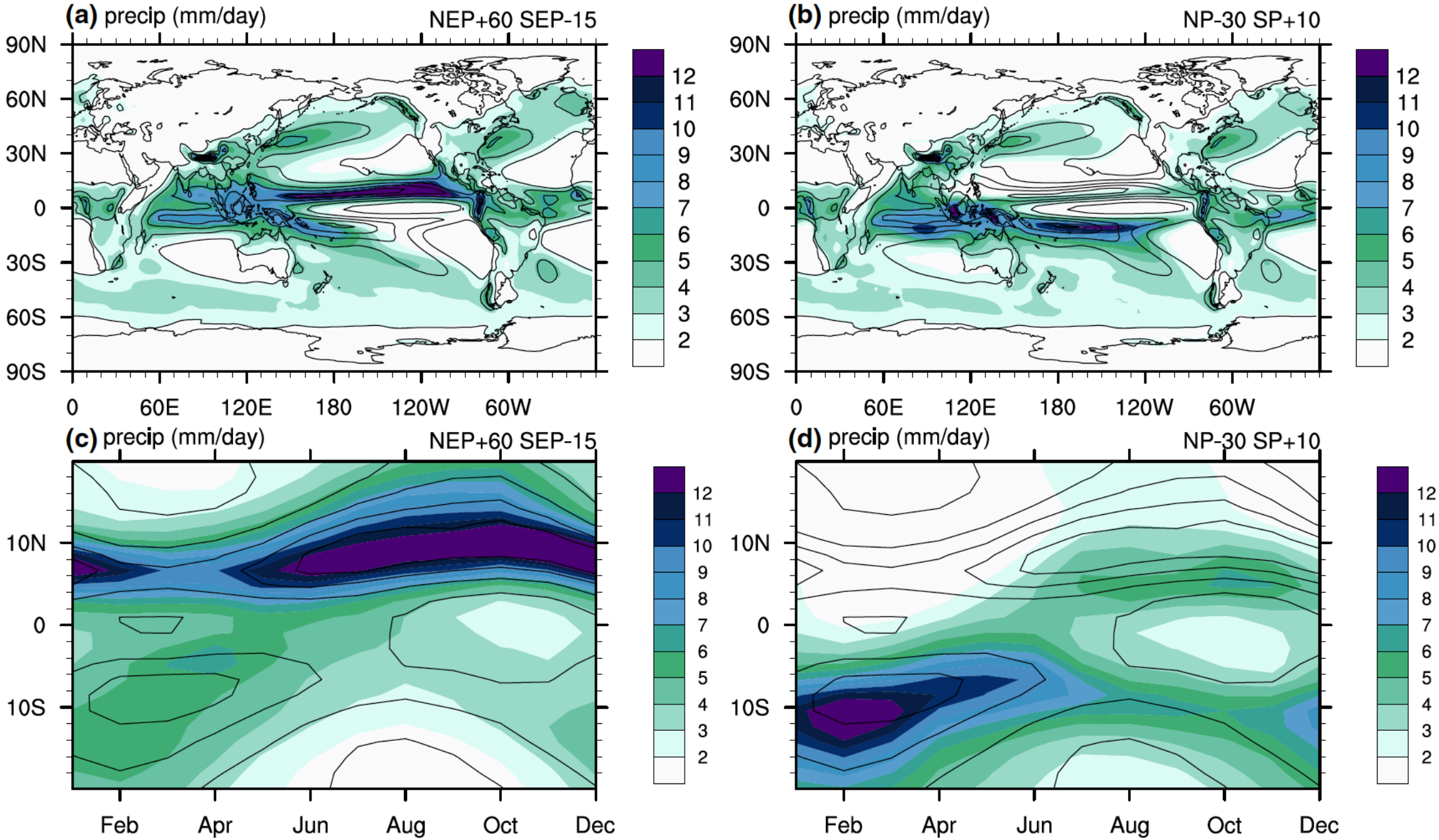

(c) ITCZ/SPCZ intensity
ctr
SEP/NEP
SP/NP
SEXP/NEXP
SPCZ (mm/day)
4.80
4.40
4.00
3.60
3.20
5.20
5.60
6.00
6.40
6.80
ITCZ (mm/day)

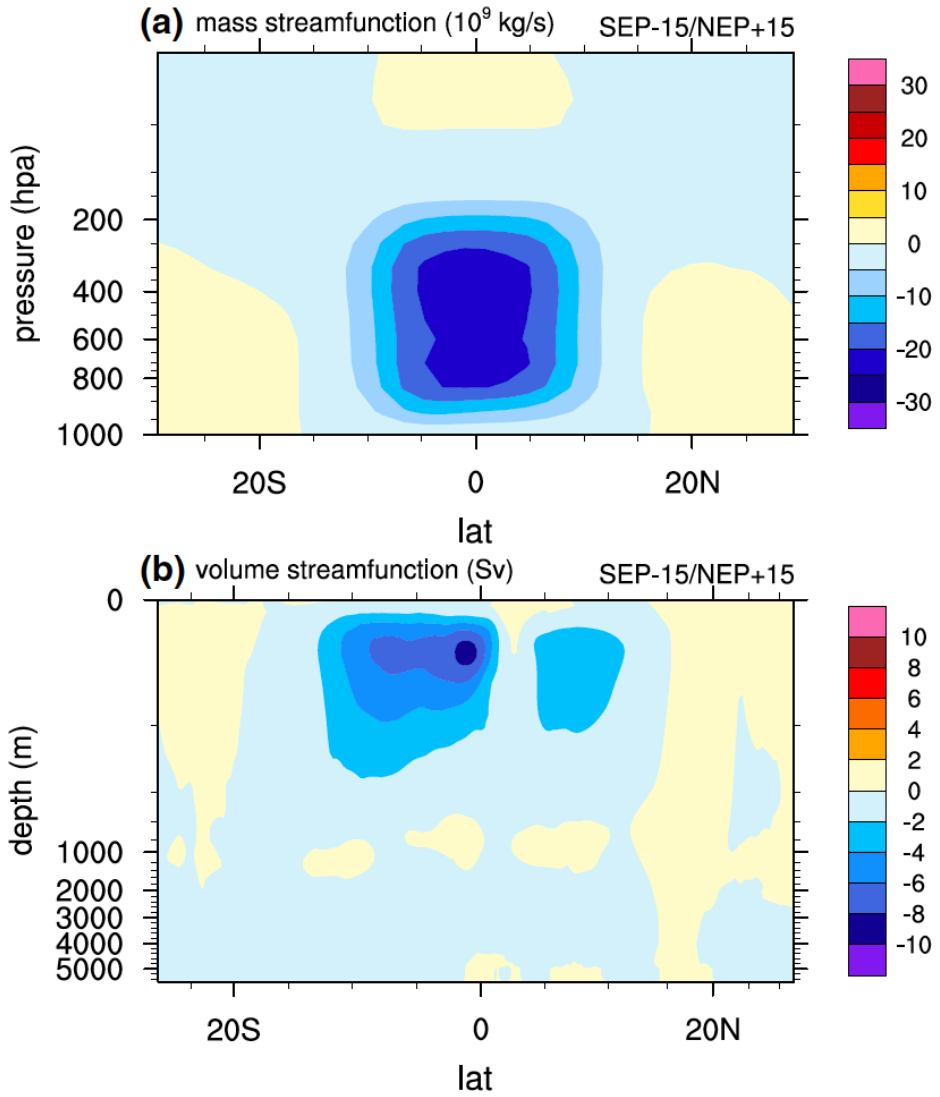
Fully-coupled model:
Tropical Pacific precipitation response
(a) Zonal mean precipitation vs latitude.
(b) Latitudinal position and (c) precipitation intensity of the ITCZ and SPCZ.

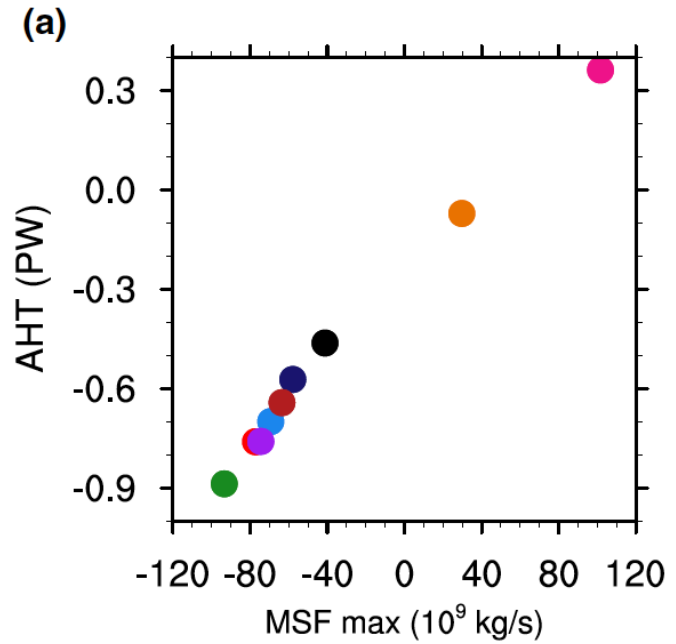


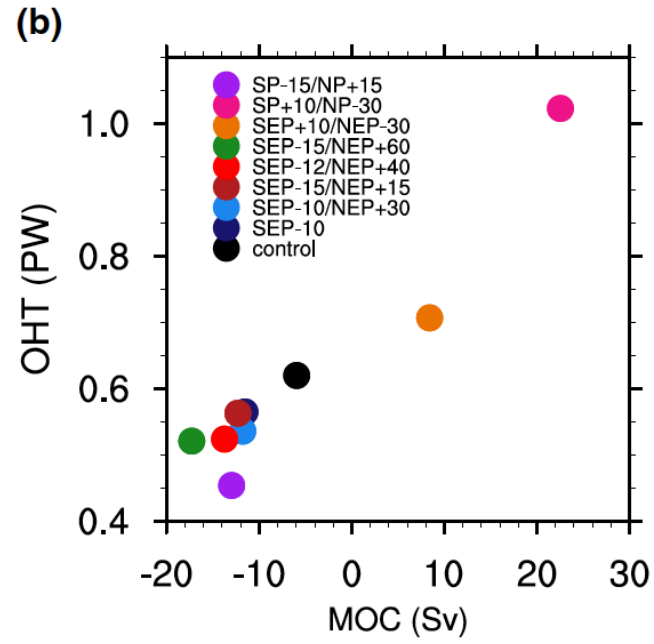


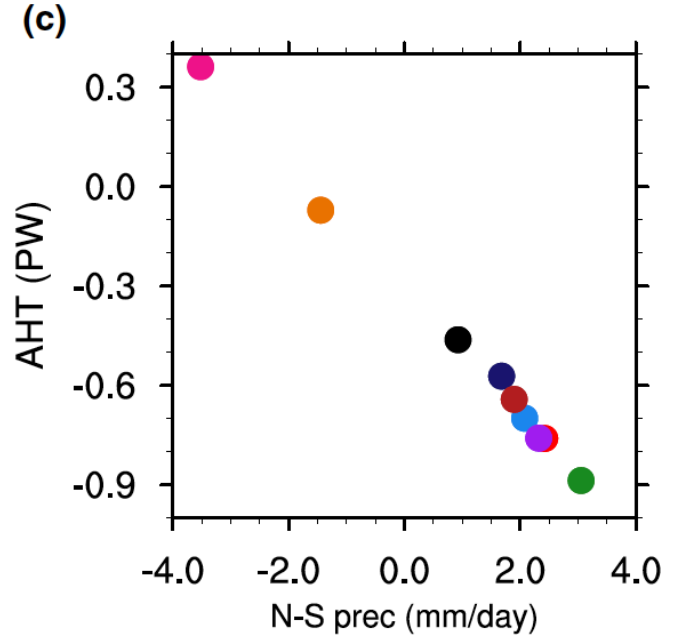


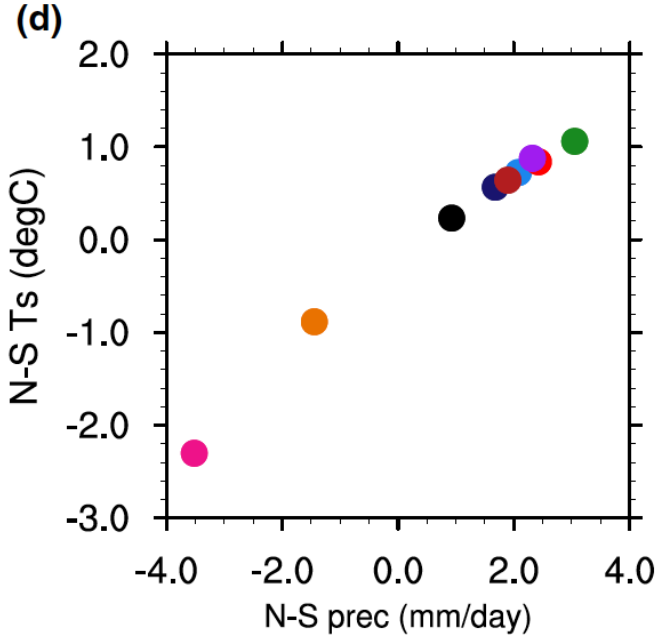

(a) precip (mm/day)
NEP+60 SEP-15
(b) precip (mm/day)
NP-30 SP+10
(c) precip (mm/day)
NEP+60 SEP-15
(d) precip (mm/day)
NP-30 SP+10
90N
60N
30N
0
30S
60S
90S
10N
10S
0
60E
120E
180
120W
60W
Feb
Apr
Jun
Aug
Oct
Dec
12
11
10
9
8
7
6
5
4
3
2

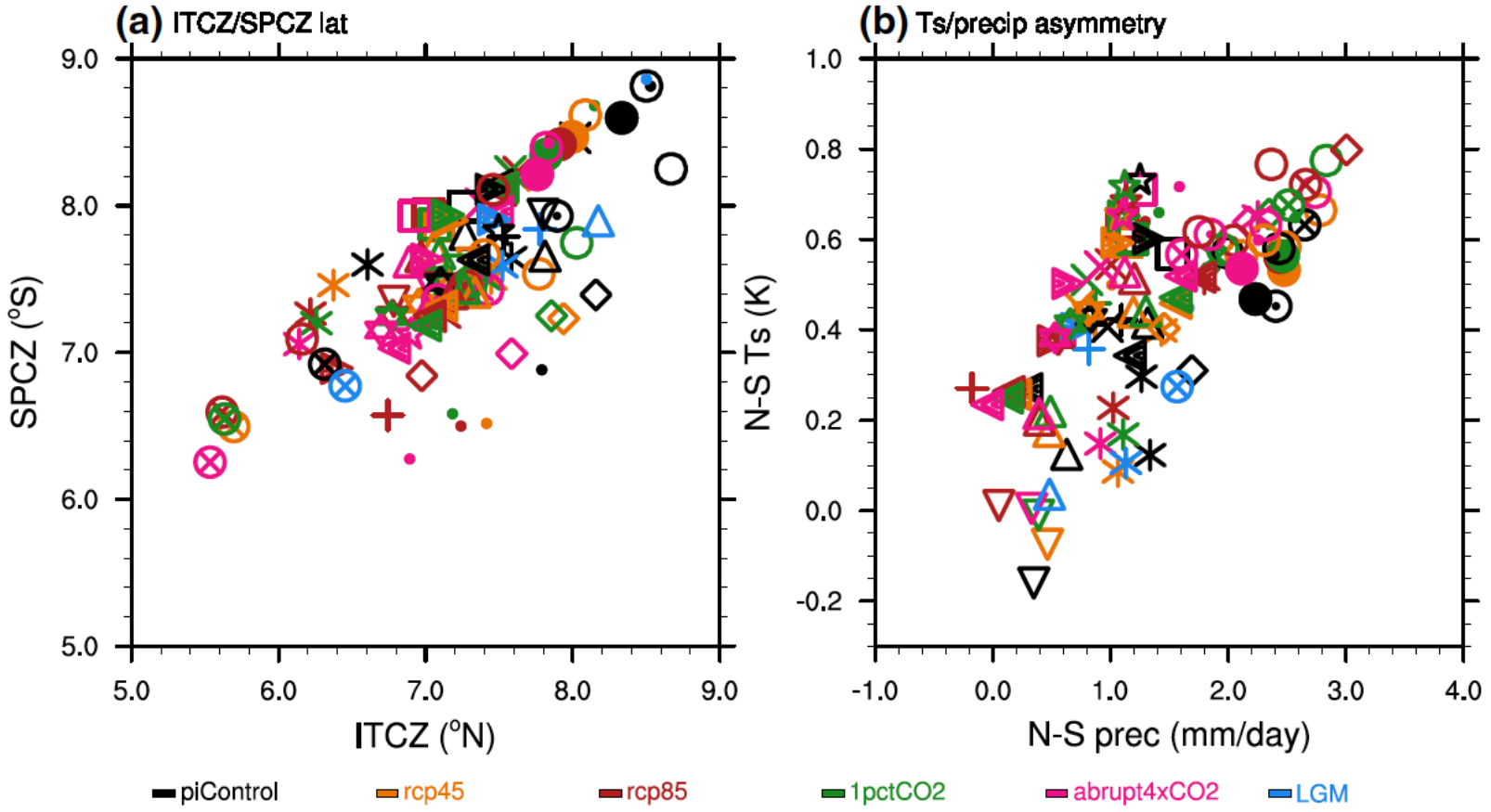

(a) mass streamfunction (10^9 kg/s)
SEP-15/NEP+15
pressure (hpa)
200
400
600
800
1000
20S
0
20N
lat
30
20
10
0
-10
-20
-30
(b) volume streamfunction (Sv)
SEP-15/NEP+15
depth (m)
0
1000
2000
3000
4000
5000
20S
0
20N
lat
10
8
6
4
2
0
-2
-4
-6
-8
-10


(a)
AHT (PW)
0.3
0.0
-0.3
-0.6
-0.9
-120 -80 -40 0 40 80 120
MSF max (10^9 kg/s)


(b)
OHT (PW)
1.0
0.8
0.6
0.4
-20 -10 0 10 20 30
MOC (Sv)
SP-15/NP+15
SP+10/NP-30
SEP+10/NEP-30
SEP-15/NEP+60
SEP-12/NEP+40
SEP-15/NEP+15
SEP-10/NEP+30
SEP-10
control

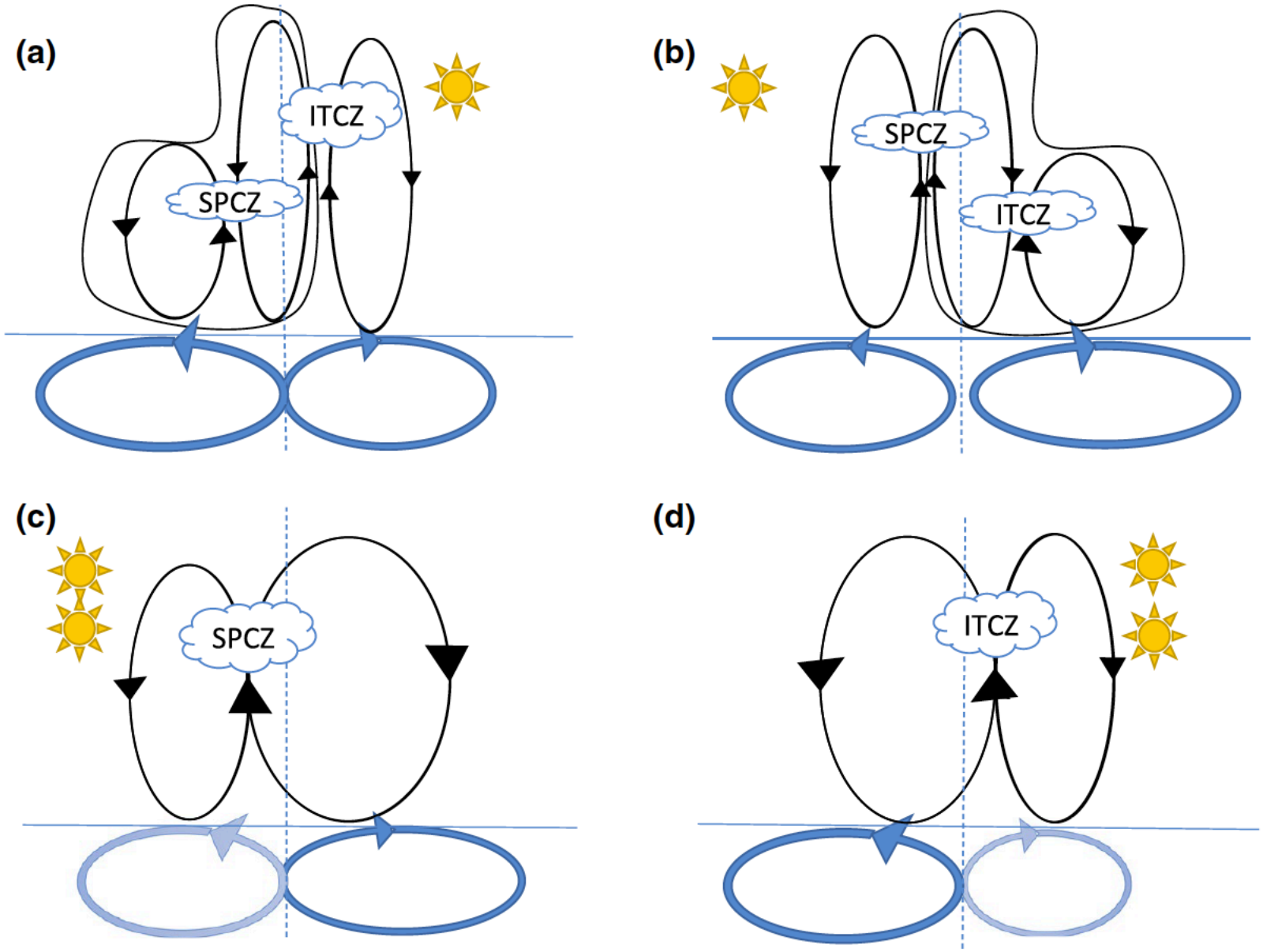

(c)
AHT (PW)
0.3
0.0
-0.3
-0.6
-0.9
-4.0 -2.0 0.0 2.0 4.0
N-S prec (mm/day)


(d)
N-S Ts (degC)
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0 -2.0 0.0 2.0 4.0
N-S prec (mm/day)



Changes in precipitation characteristics across different coupled GCMs and different climate simulations in the CMIP5 dataset: 21 GCMs.

Last Glacial Maximum (LGM), pre-industrial conditions (piControl), 1%/yr increase in CO_2 ($1pctCO_2$), abruptly quadrupled CO_2 ($abrupt4XCO_2$), RCP4.5 (rcp45) and RCP8.5 (rcp85) scenarios



A schematic for the ITCZ-SPCZ seesaw response in the Pacific ocean-atmosphere system summarizing coupled experiments of this study.

Thanks for yout attention!

Zhao, Bowen, and Alexey Fedorov. "The seesaw response of the intertropical and South Pacific convergence zones to hemispherically asymmetric thermal forcing." *Climate Dynamics* 54.3-4 (2020): 1639-1653.