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International Centre for Theoretical Physics**



1968-40

Conference on Teleconnections in the Atmosphere and Oceans

17 - 20 November 2008

**Role of Air-Sea Interaction in the Climatological Evolution and ENSO-Related
Variability of the Summer Monsoon over South China Sea and Western Pacific.**

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Role of Air-Sea Interaction in the
Climatological Evolution
and ENSO-Related Variability of the
Summer Monsoon over
South China Sea and Western Pacific

Gabriel Lau



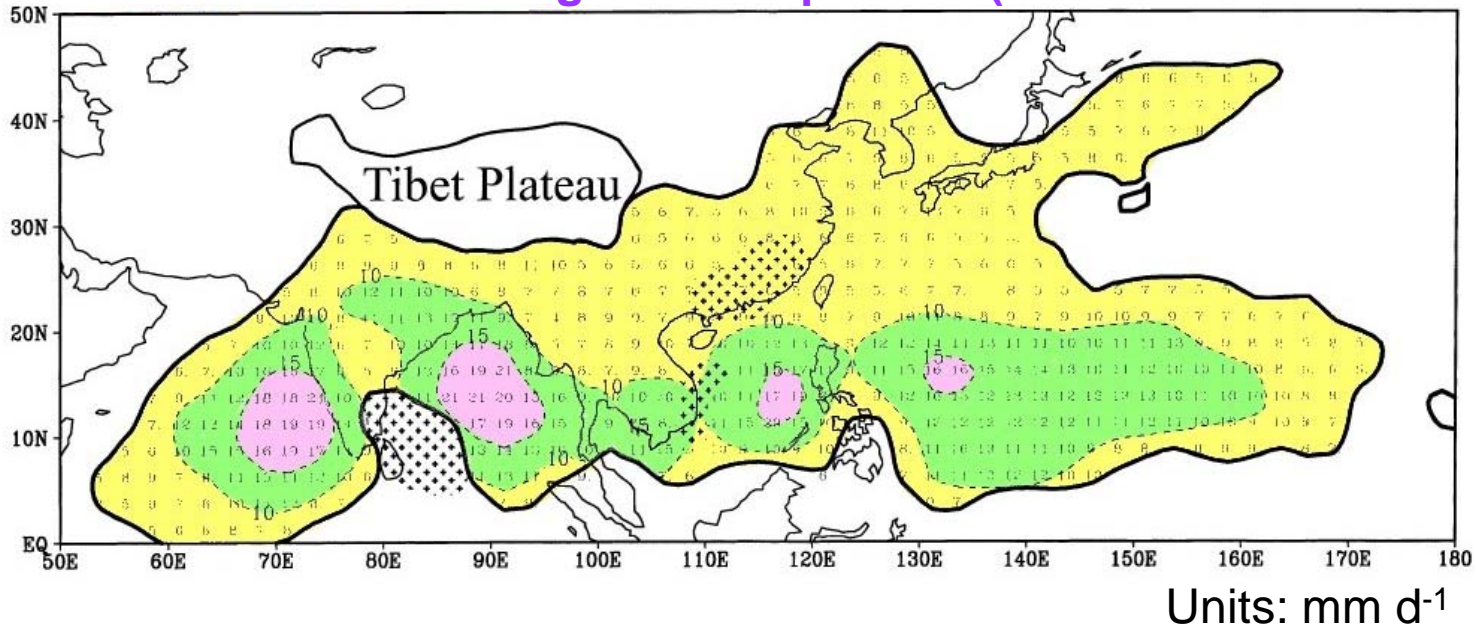
Geophysical Fluid Dynamics Laboratory/NOAA
Princeton University



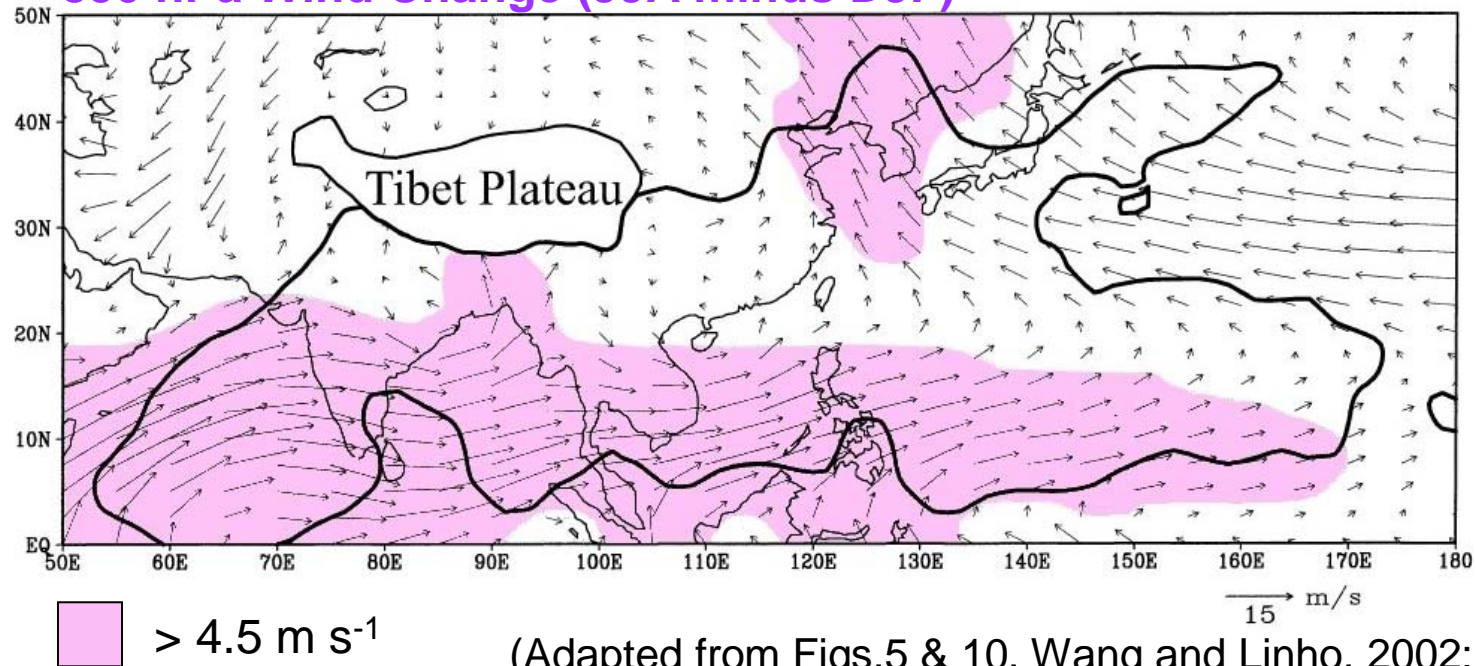
Climatological Evolution



Monsoon Annual Range of Precipitation (Peak Pentad minus Jan)

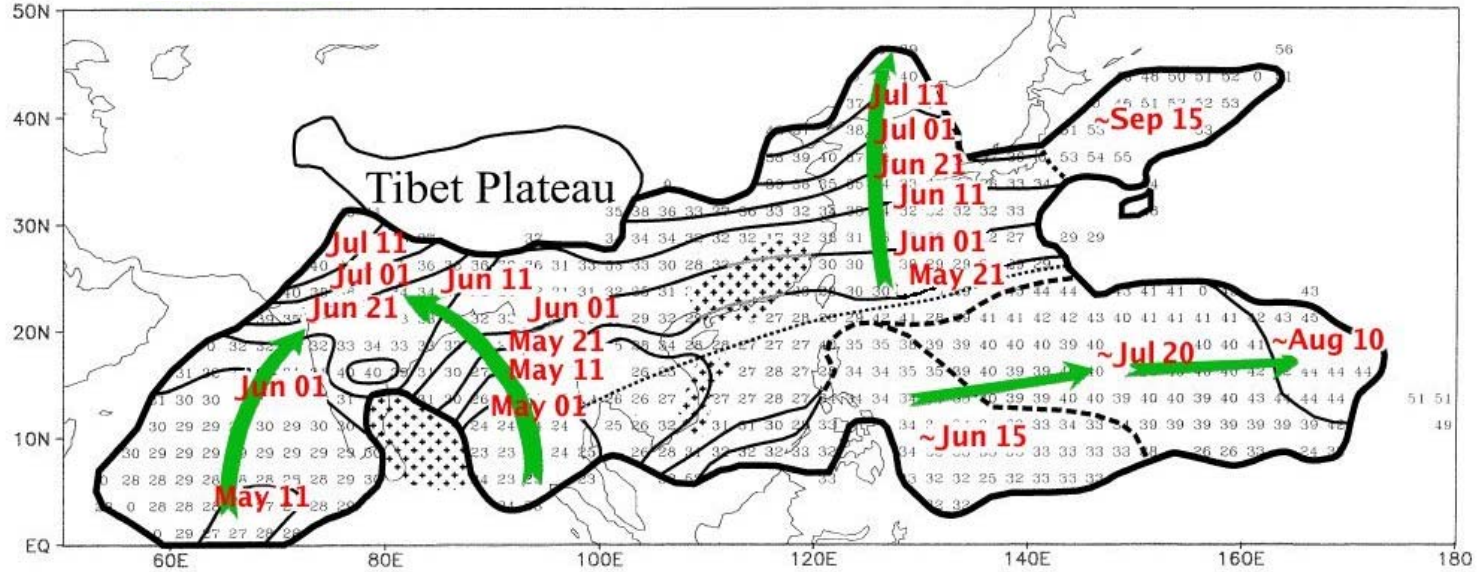


850 hPa Wind Change (JJA minus DJF)

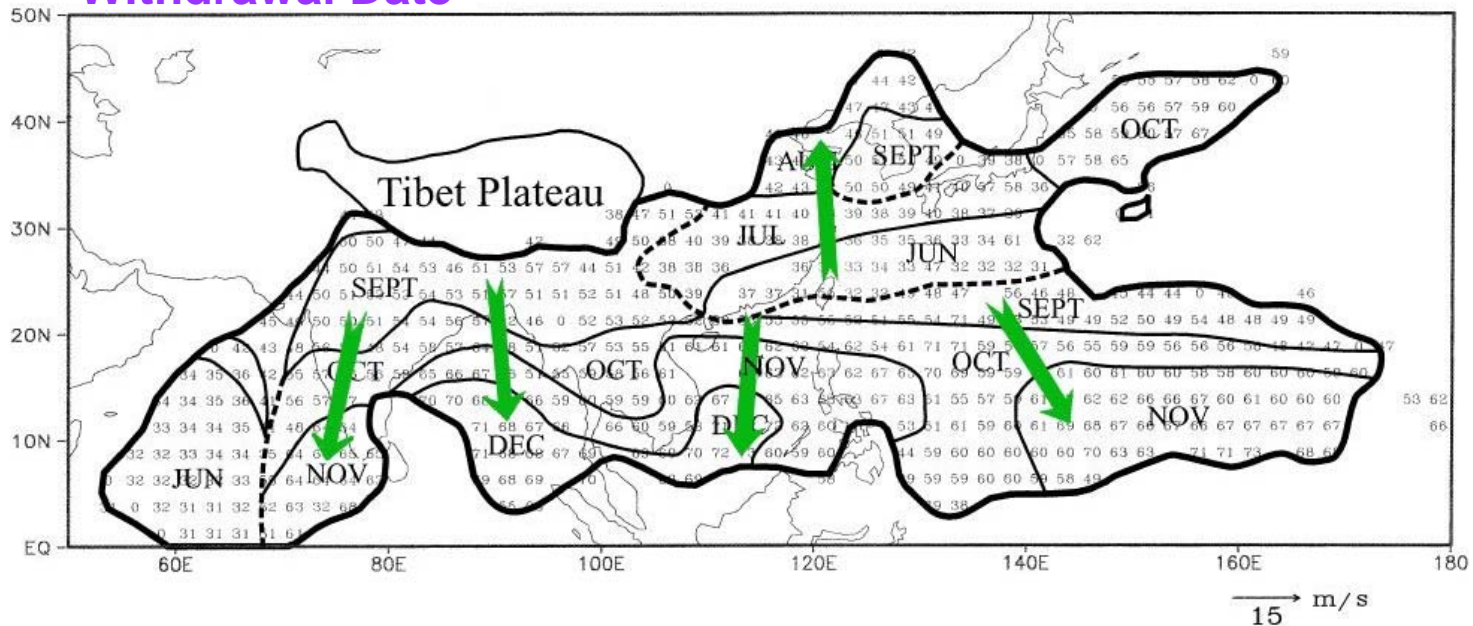


(Adapted from Figs.5 & 10, Wang and Linho, 2002; J.Climate.)

Onset Date

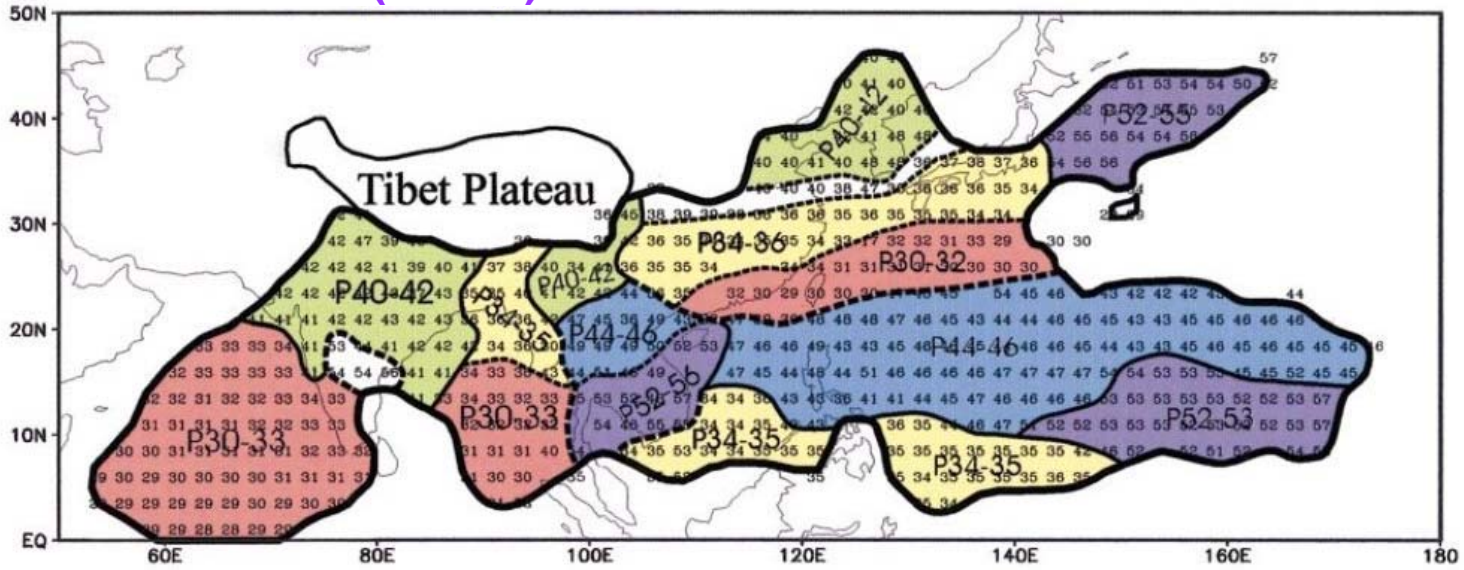


Withdrawal Date

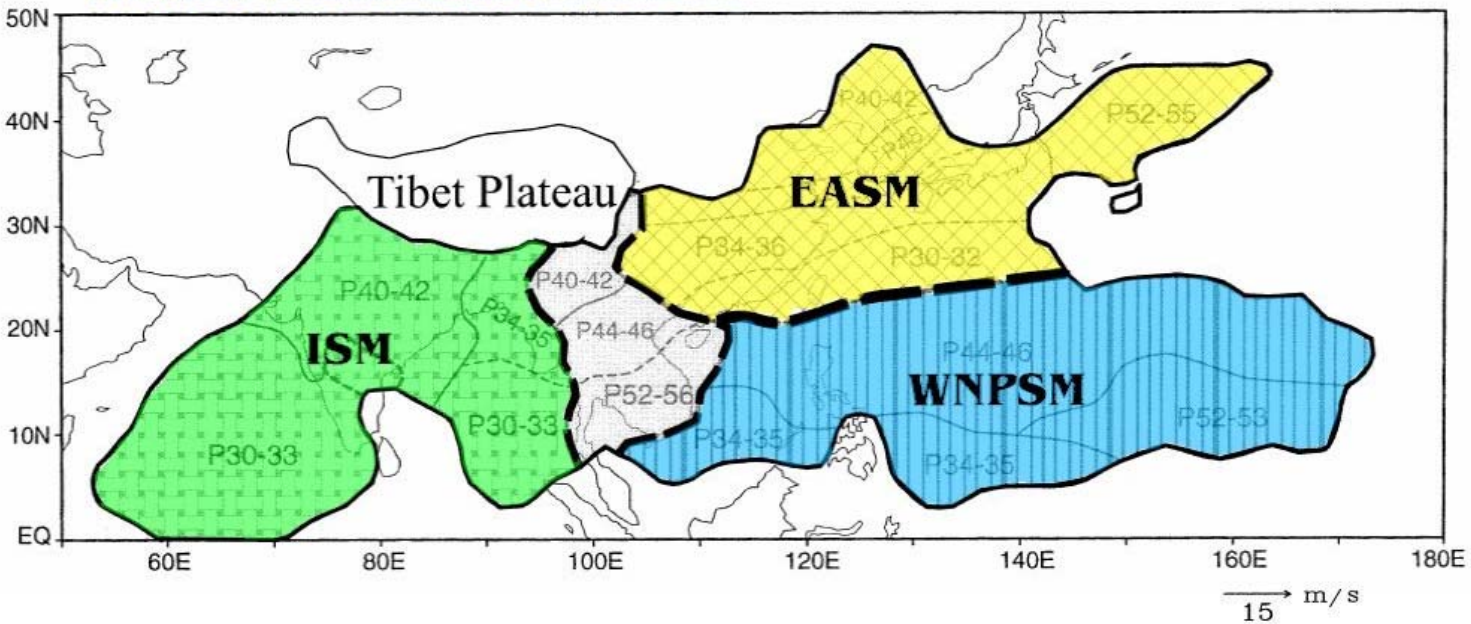


(Adapted from Figs.6 & 8, Wang and Linho, 2002; J.Climate.)

Rainfall Peak (Julian) Pentad



Division of Asian-Pacific Monsoon



(Adapted from Figs.7 & 9, Wang and Linho, 2002; J.Climate.)

MODEL: Geophysical Fluid Dynamics Laboratory (GFDL) Climate Model version 2.1 (CM2.1)

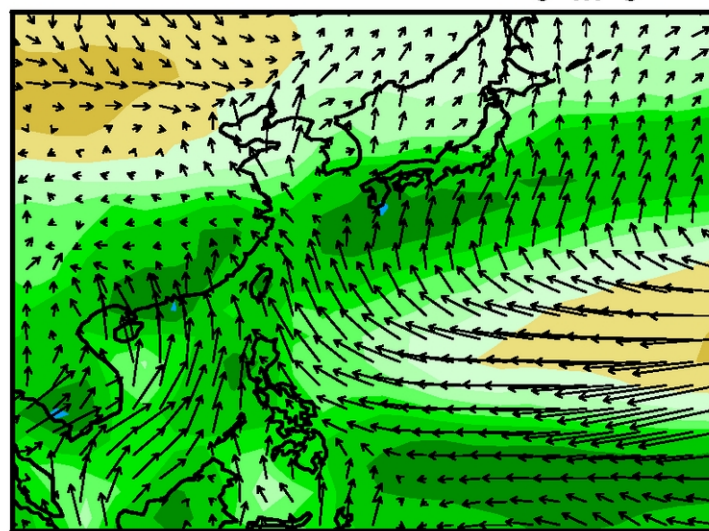
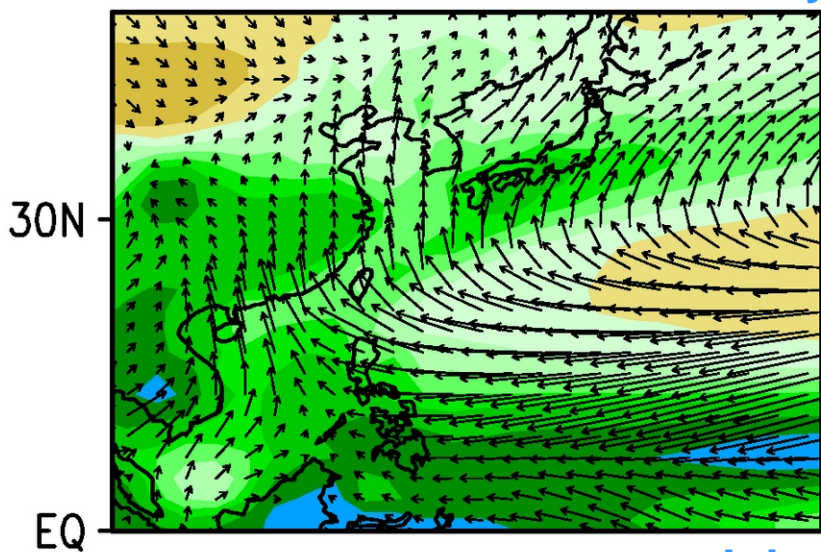
- A coupled ocean-atmosphere-land-ice model (*Delworth et al. 2006*)
- **Fixed 1860 radiative forcings**, including atmospheric trace gases, solar irradiance, and distribution of land cover
- Anthropogenic aerosols are **not** considered.
- A **2000-yr** integration is performed after a 220-yr spinup period.
- Model resolution (atmosphere): **2°** latitude × **2.5°** longitude; **24** vertical levels.

Precipitation / Surface Wind

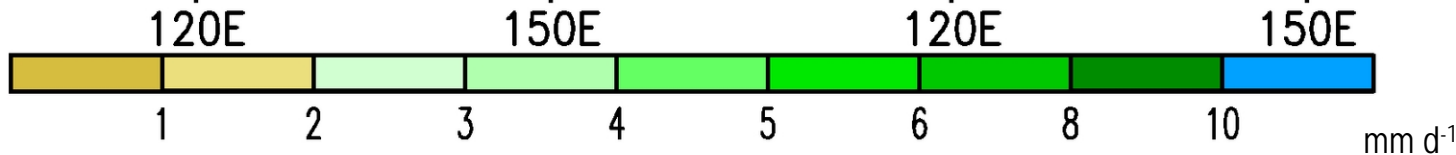
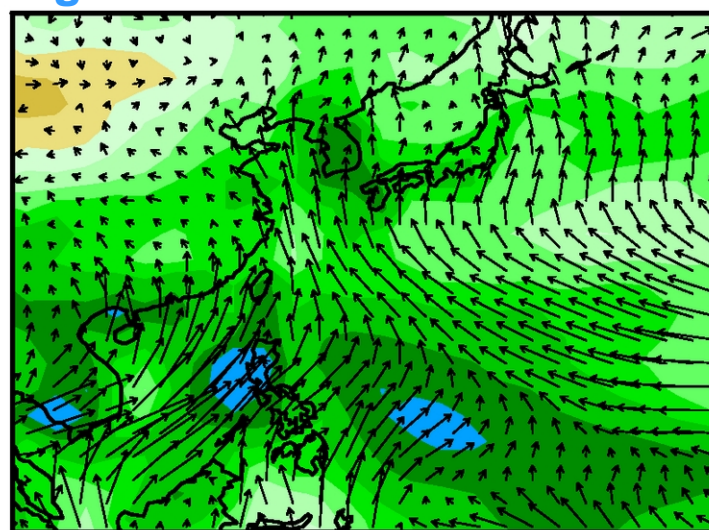
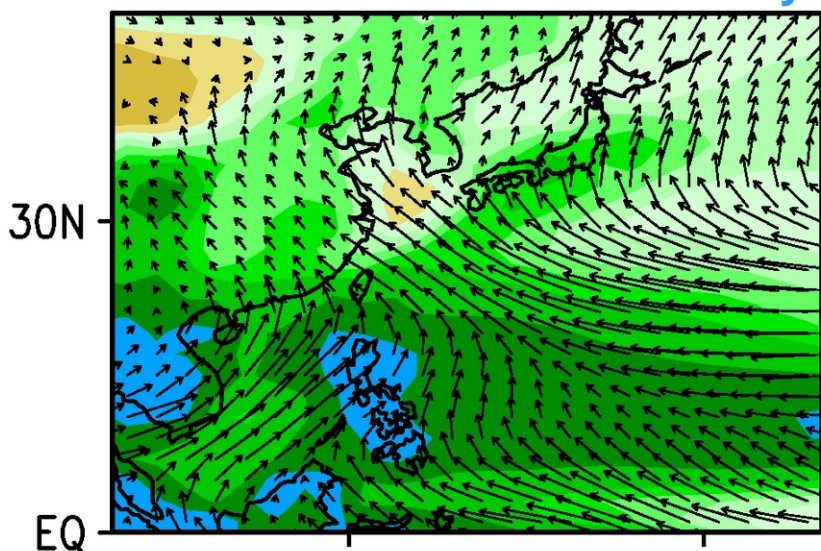
Model

May / June

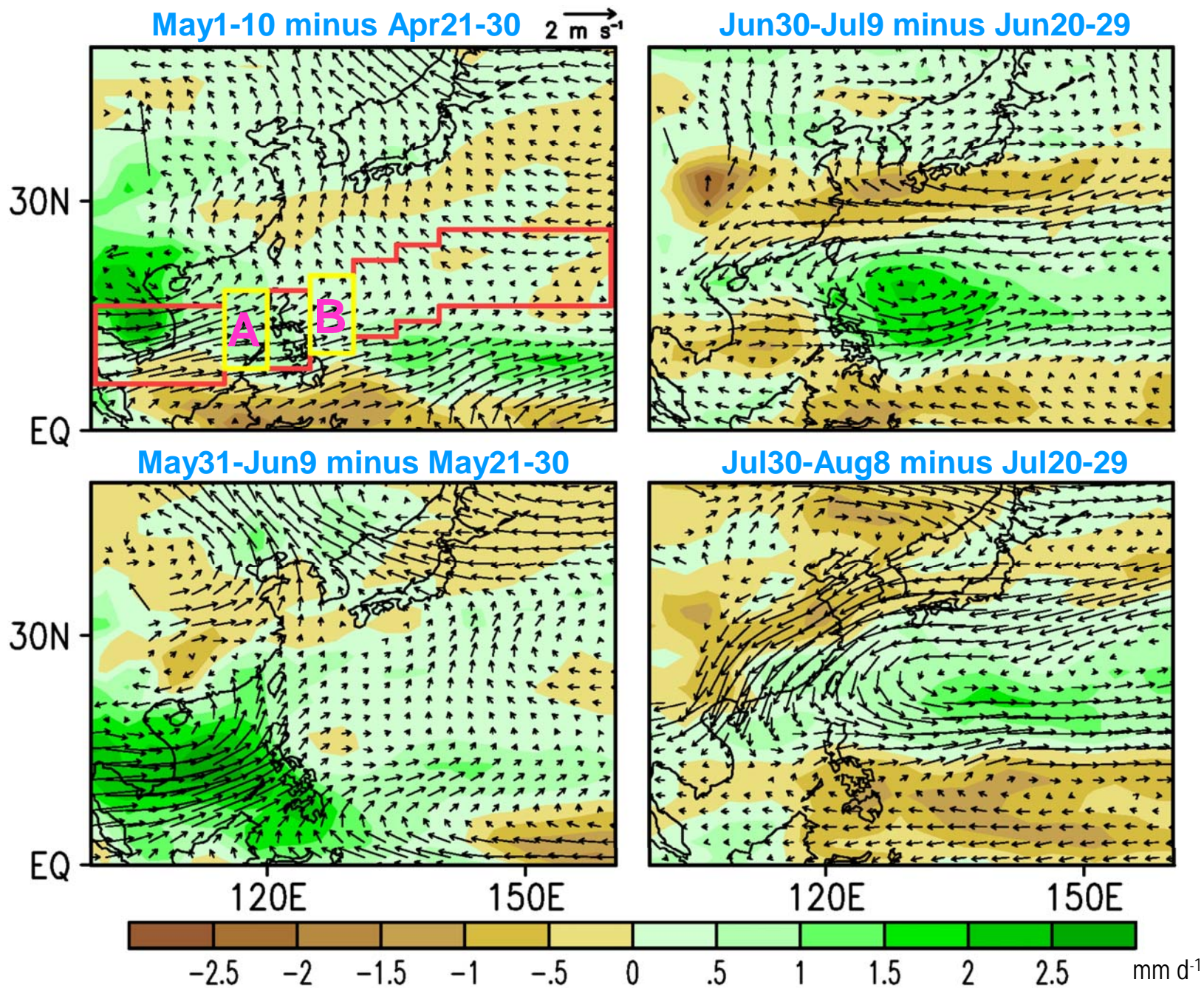
Observation 5 m s^{-1}



July / August

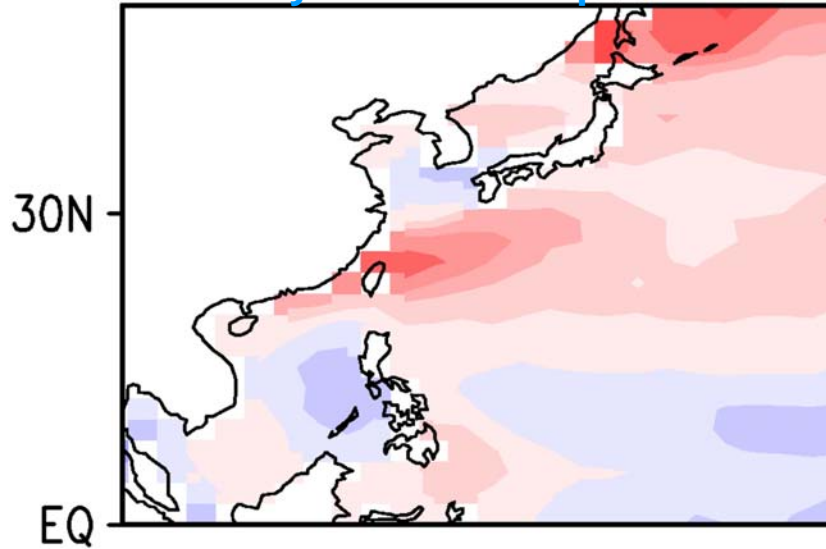


Precipitation / 850mb Wind

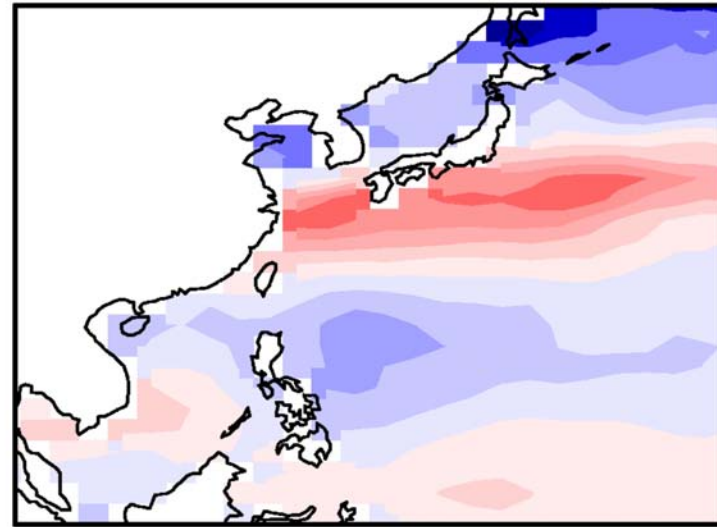


Shortwave Flux

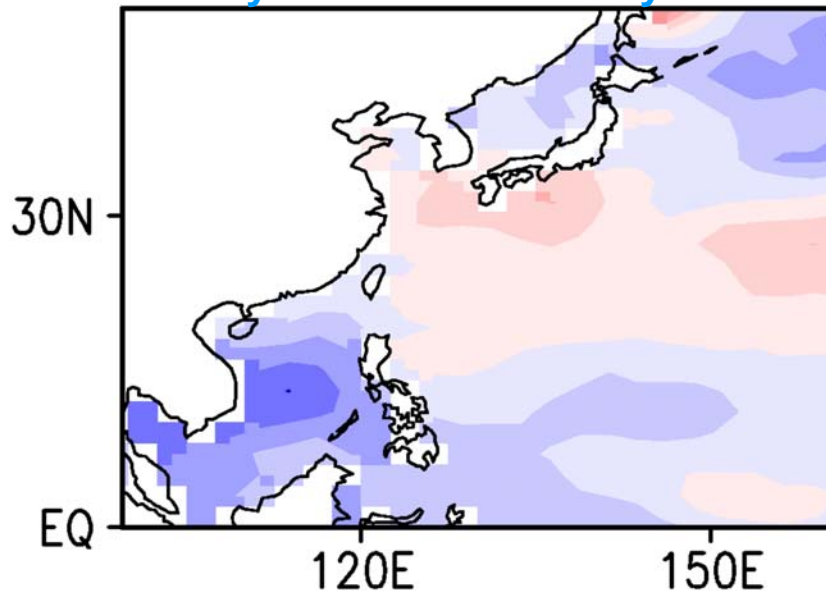
May1-10 minus Apr21-30



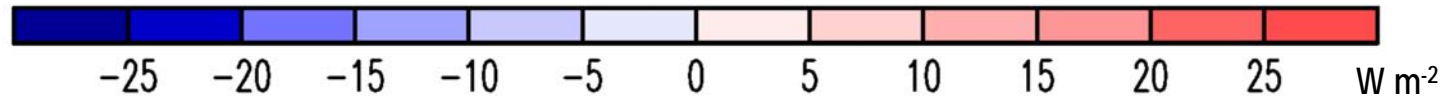
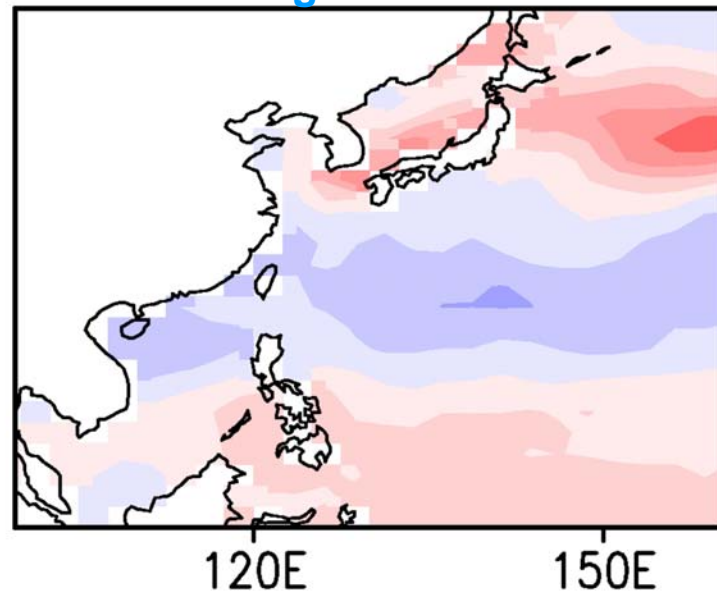
Jun30-Jul9 minus Jun20-29



May31-Jun9 minus May21-30

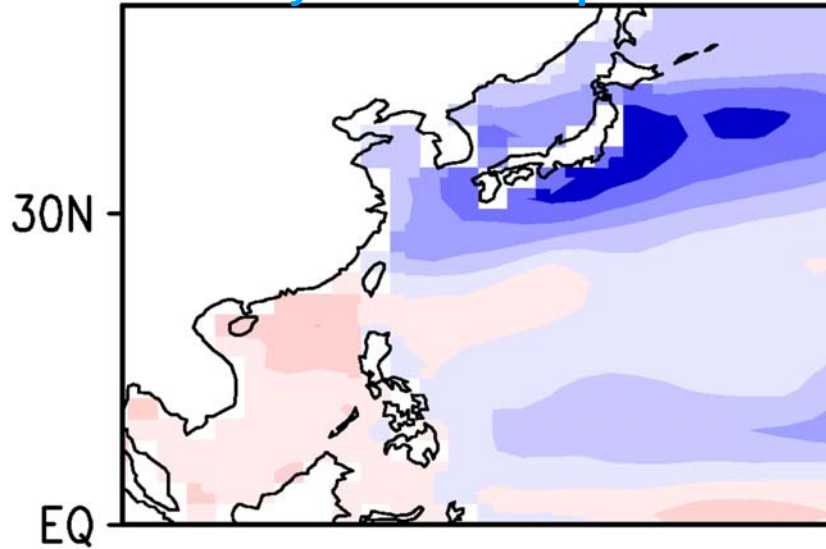


Jul30-Aug8 minus Jul20-29

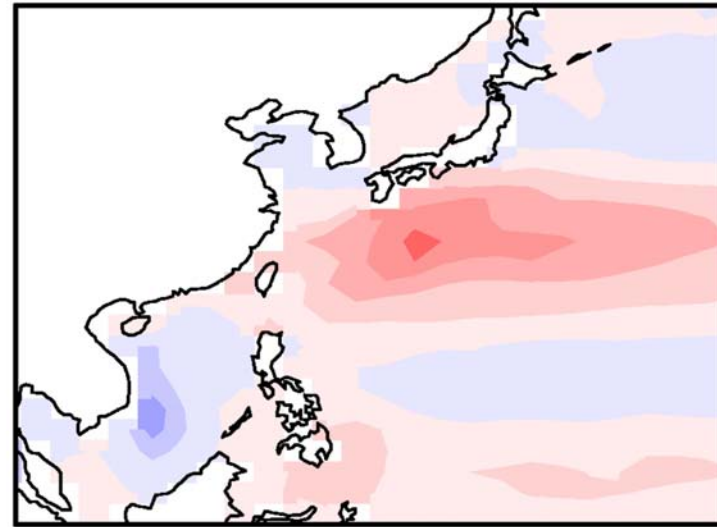


Latent Heat Flux

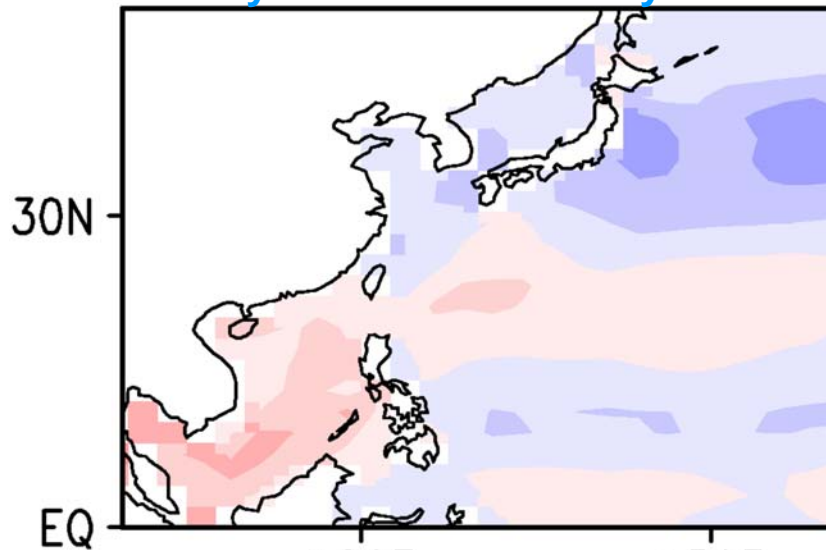
May1-10 minus Apr21-30



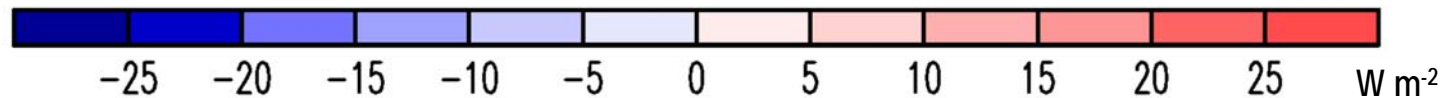
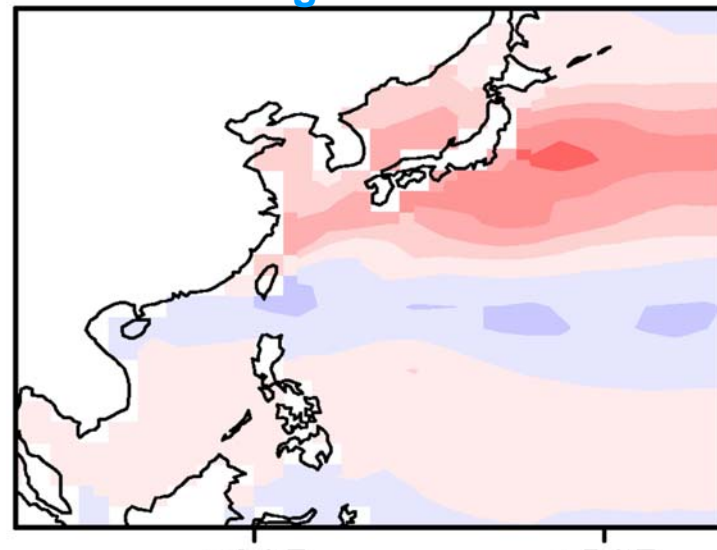
Jun30-Jul9 minus Jun20-29

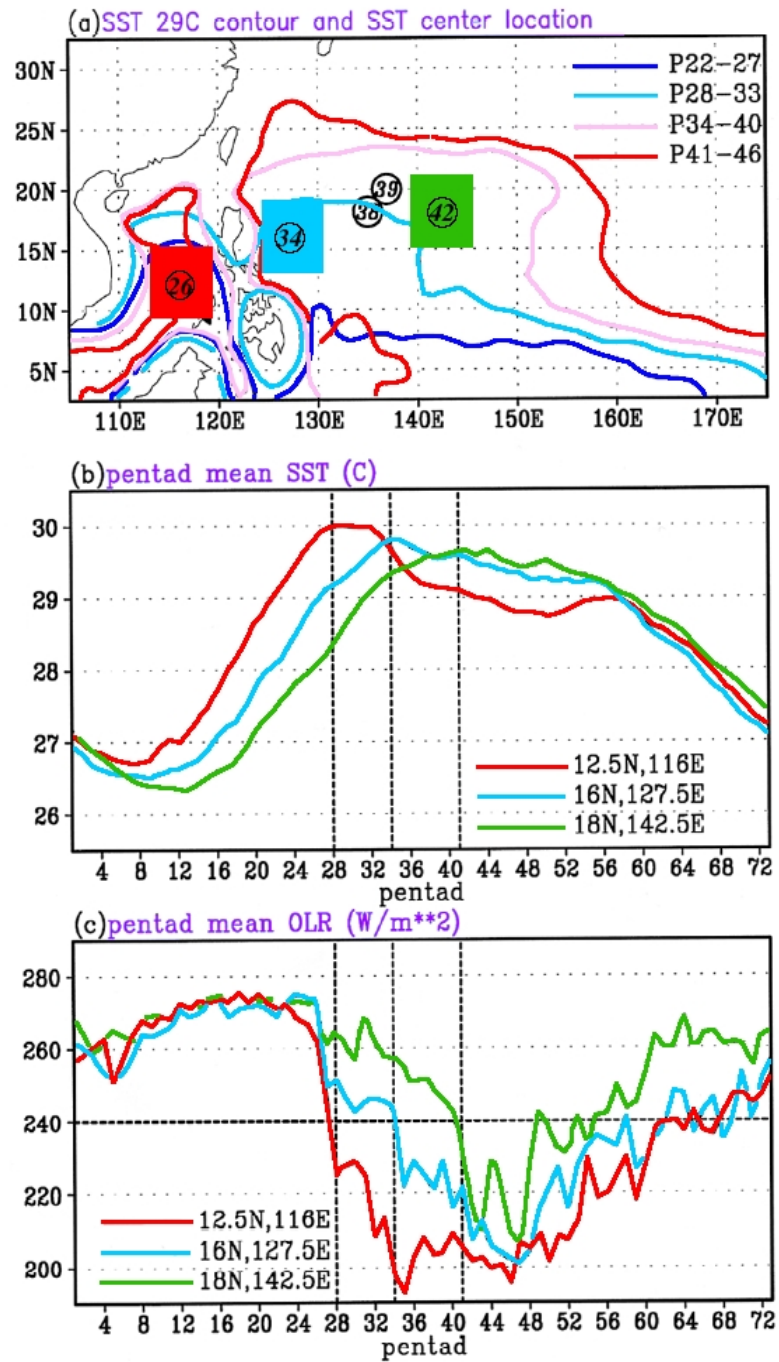


May31-Jun9 minus May21-30



Jul30-Aug8 minus Jul20-29





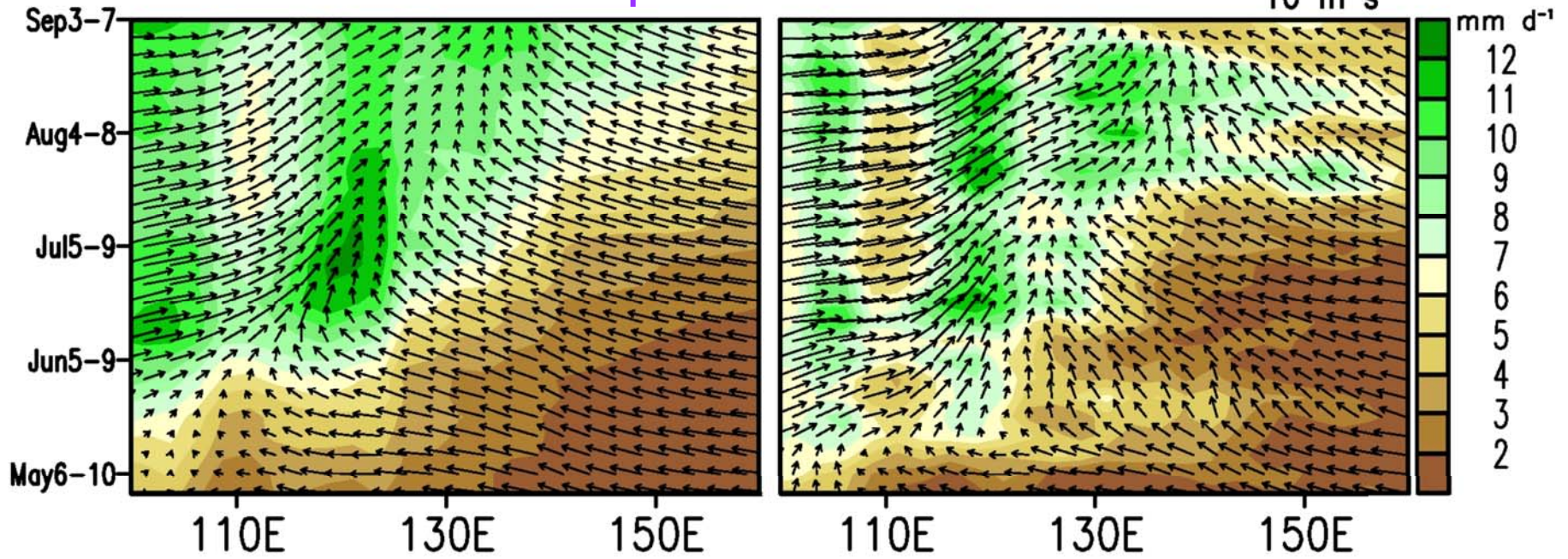
(Adapted from
 Fig.2 of Wu, 2002;
 J. Meteor. Soc. Japan)

Model

Observation

Precipitation / 850mb Wind

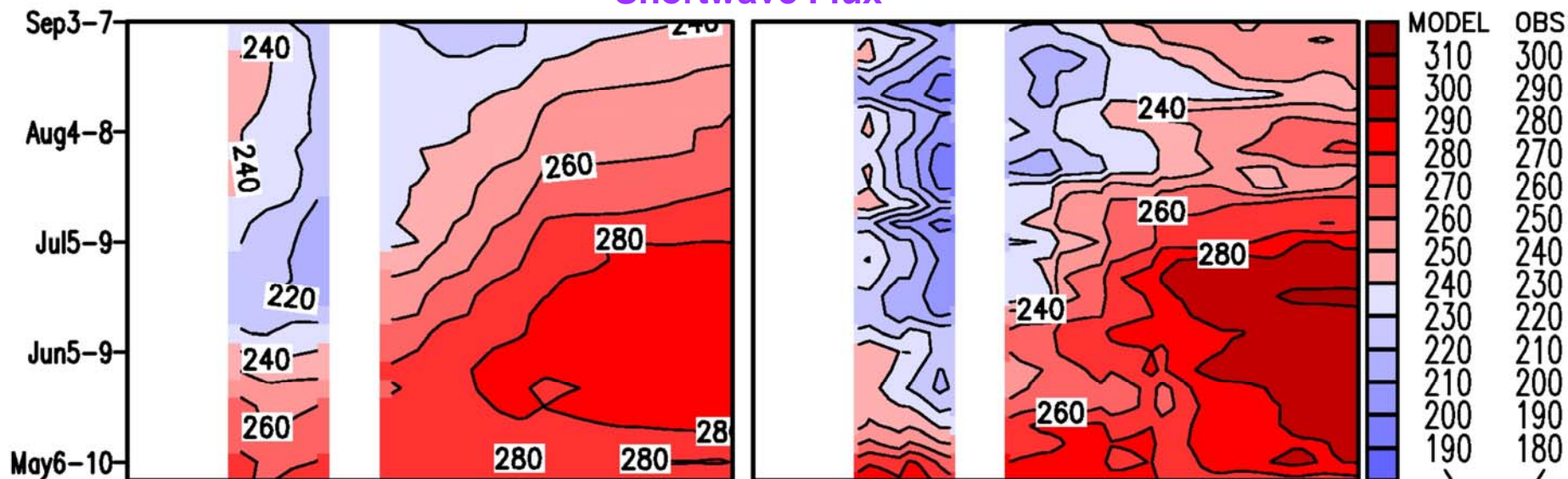
10 $\overrightarrow{\text{m s}^{-1}}$



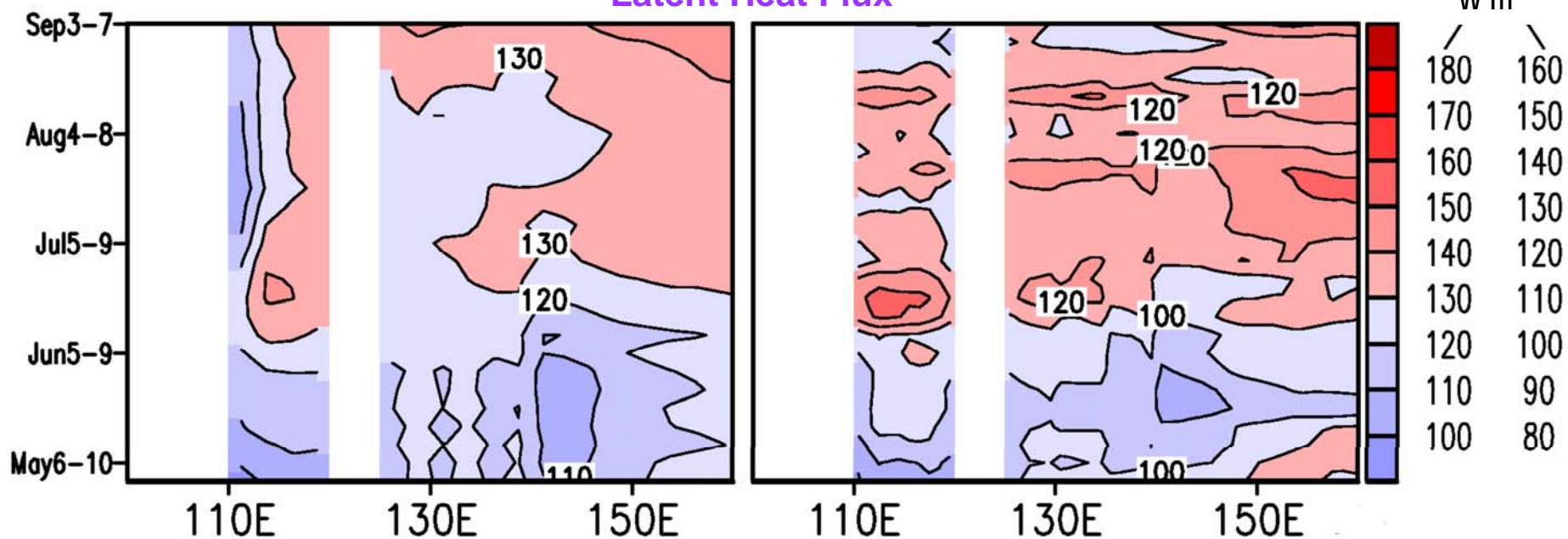
Model

Observation

Shortwave Flux



Latent Heat Flux



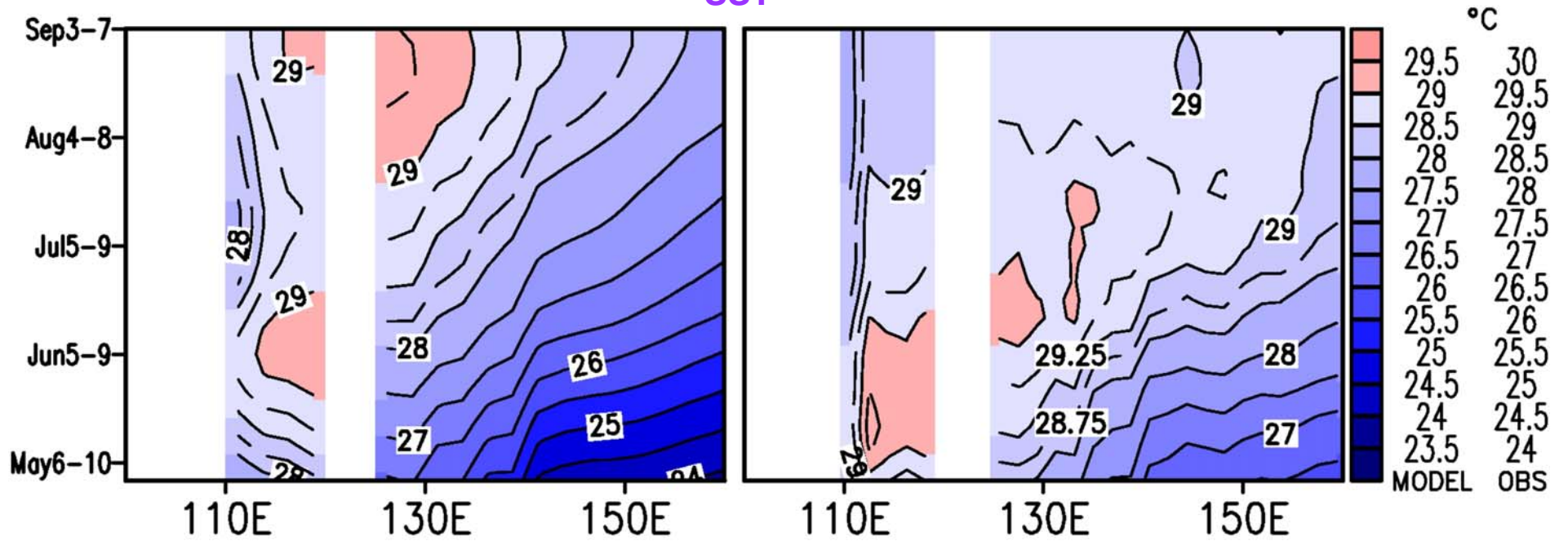
MODEL	OBS
310	300
300	290
290	280
280	270
270	260
260	250
250	240
240	230
230	220
220	210
210	200
200	190
190	180

W m⁻²

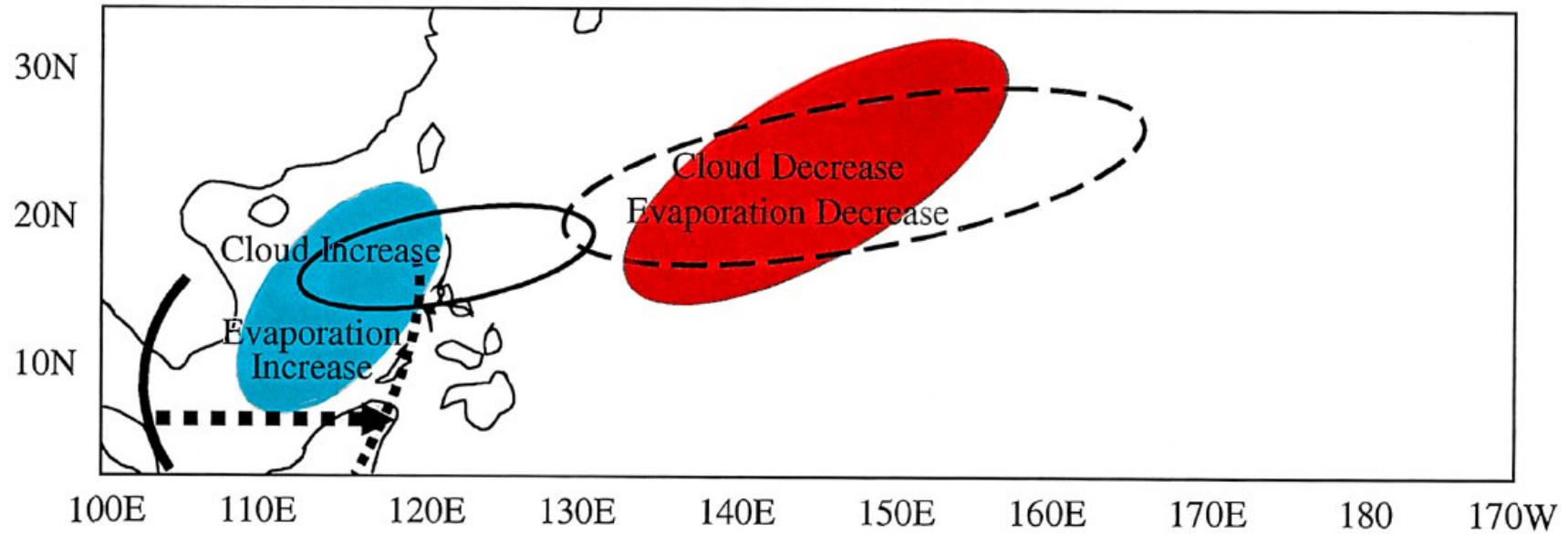
Model

Observation

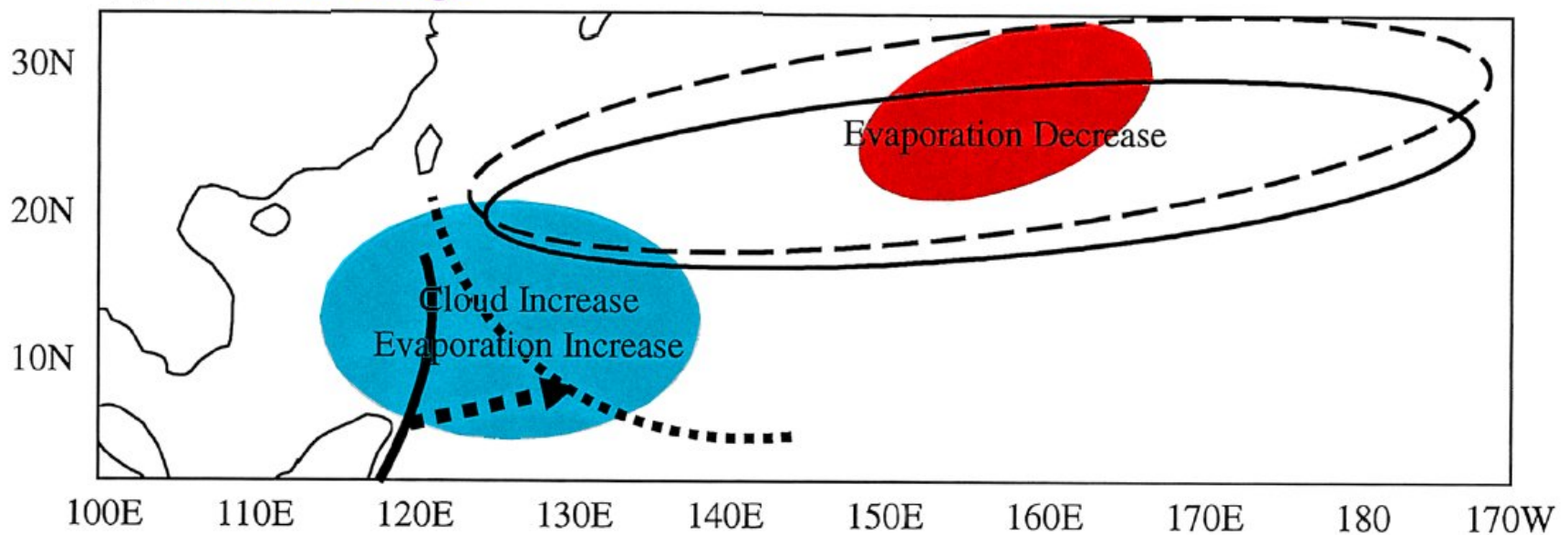
SST



(a) Mid-May Change



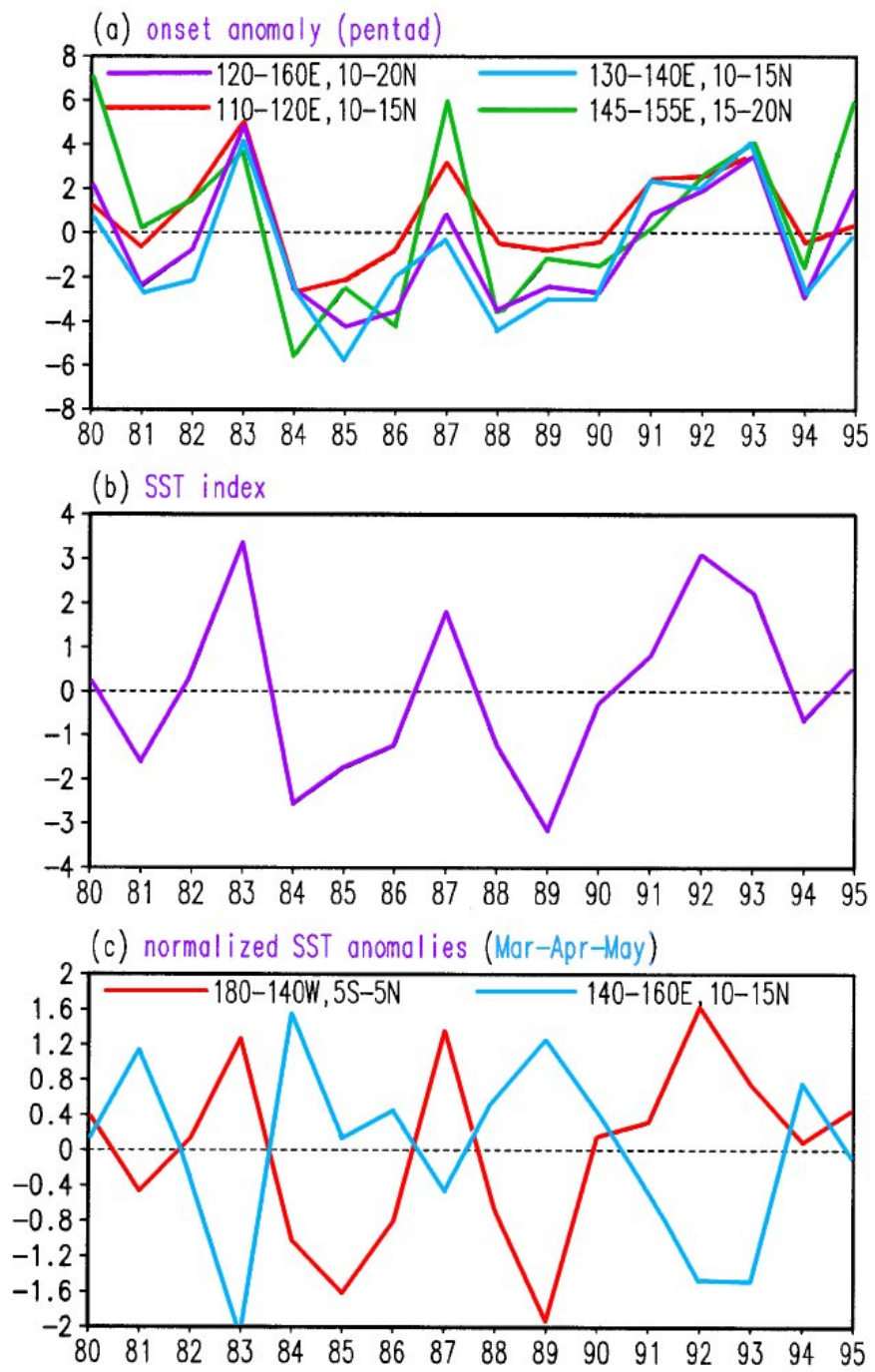
(b) Mid-June Change



(Adapted from Fig. 11 of Wu, 2002; J. Meteor. Soc. Japan)

ENSO-Related Variability

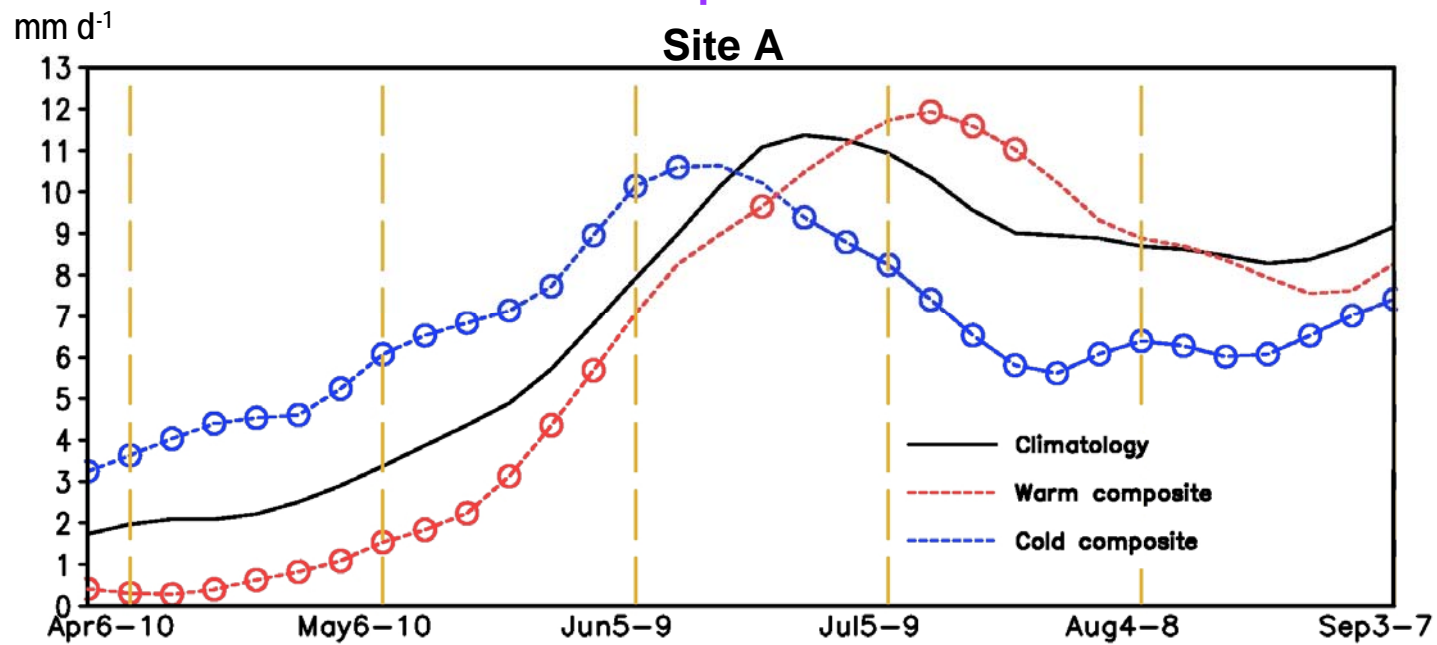




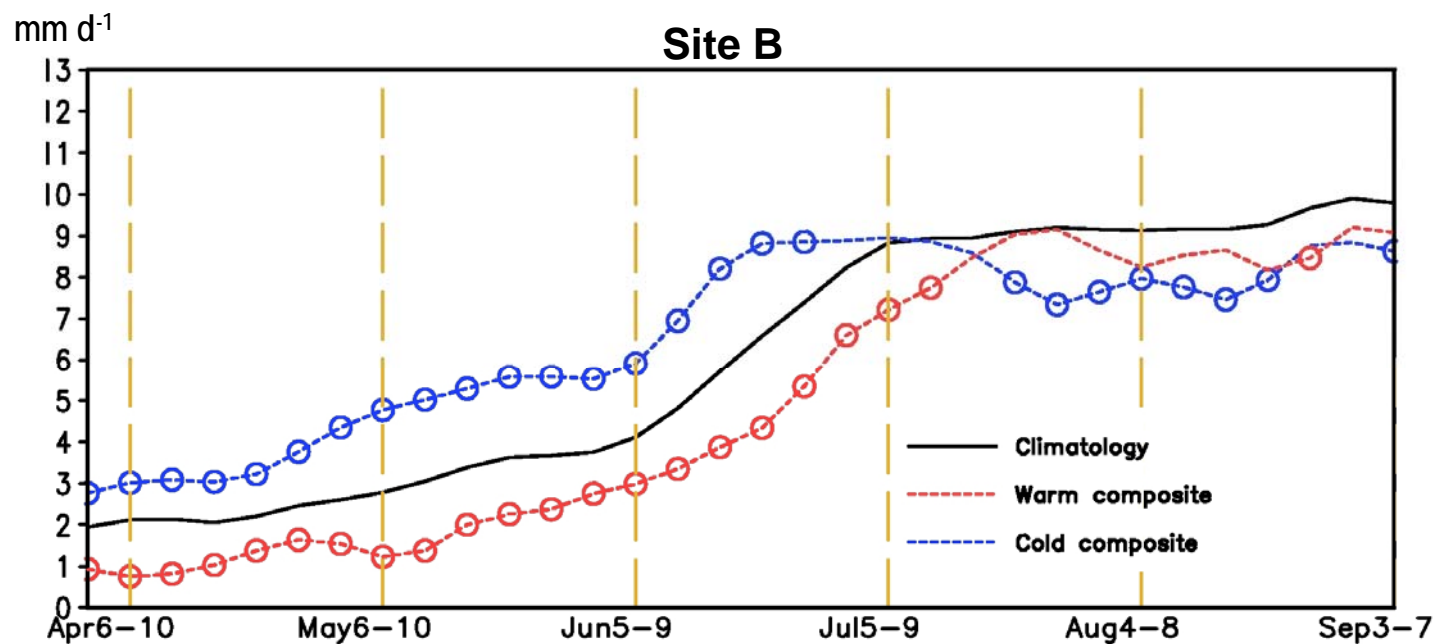
(Adapted from Fig.4, Wu and Wang, 2000; J.Climate.)

Precipitation

Site A



Site B

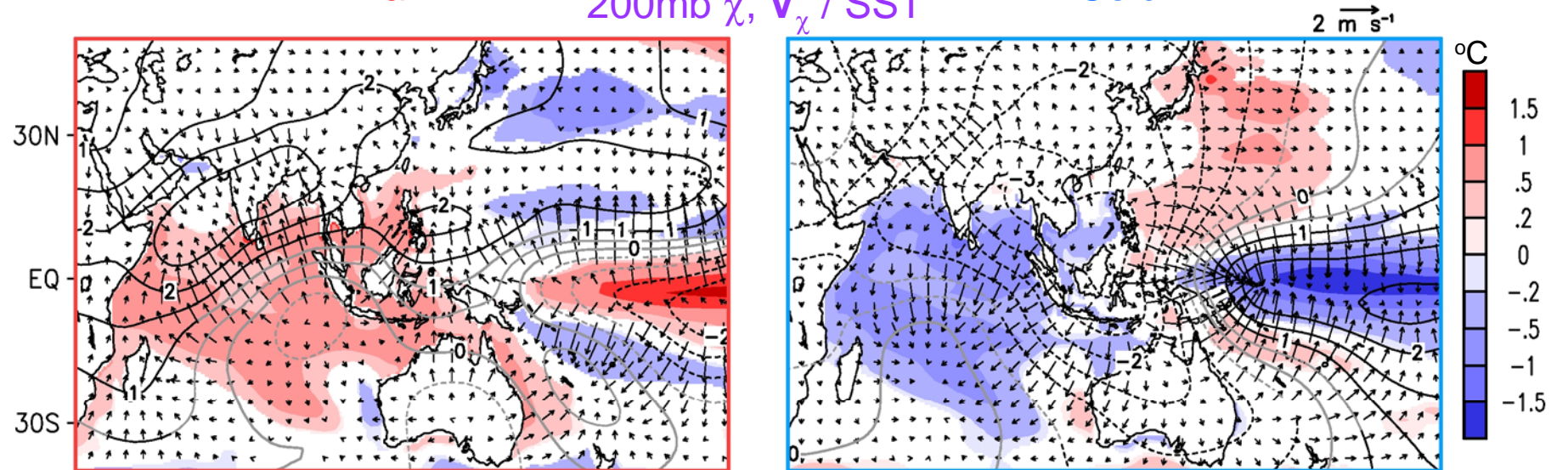


CM2.1
MAY(1)

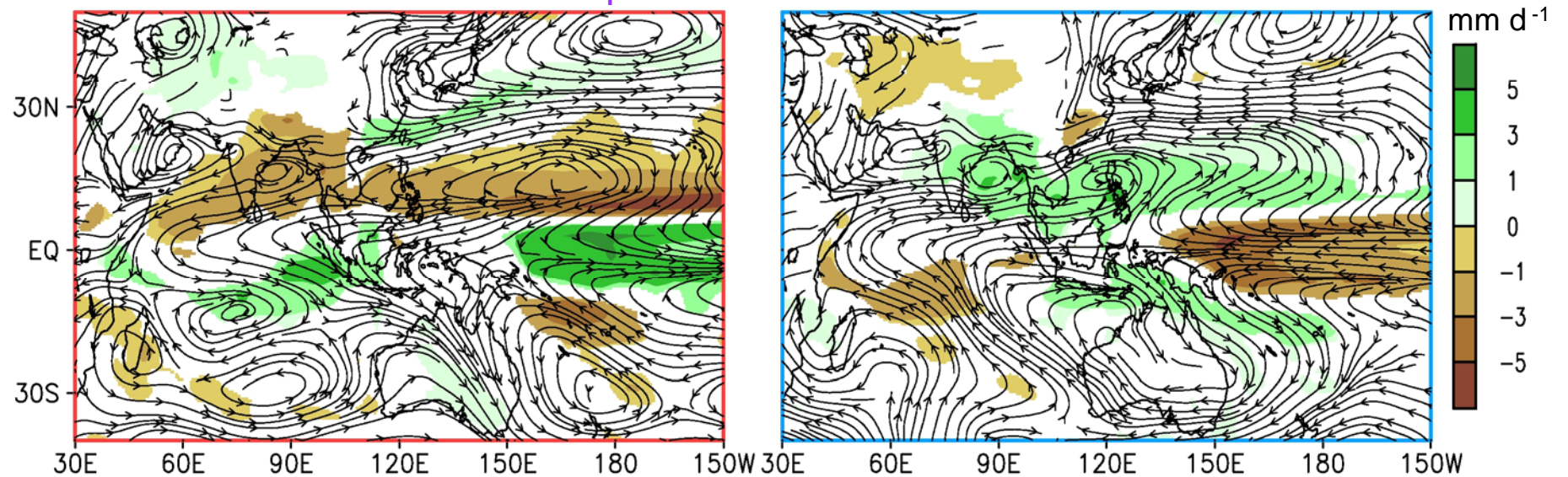
Warm

200mb χ , V_χ / SST

Cold



Precipitation / 850mb Wind

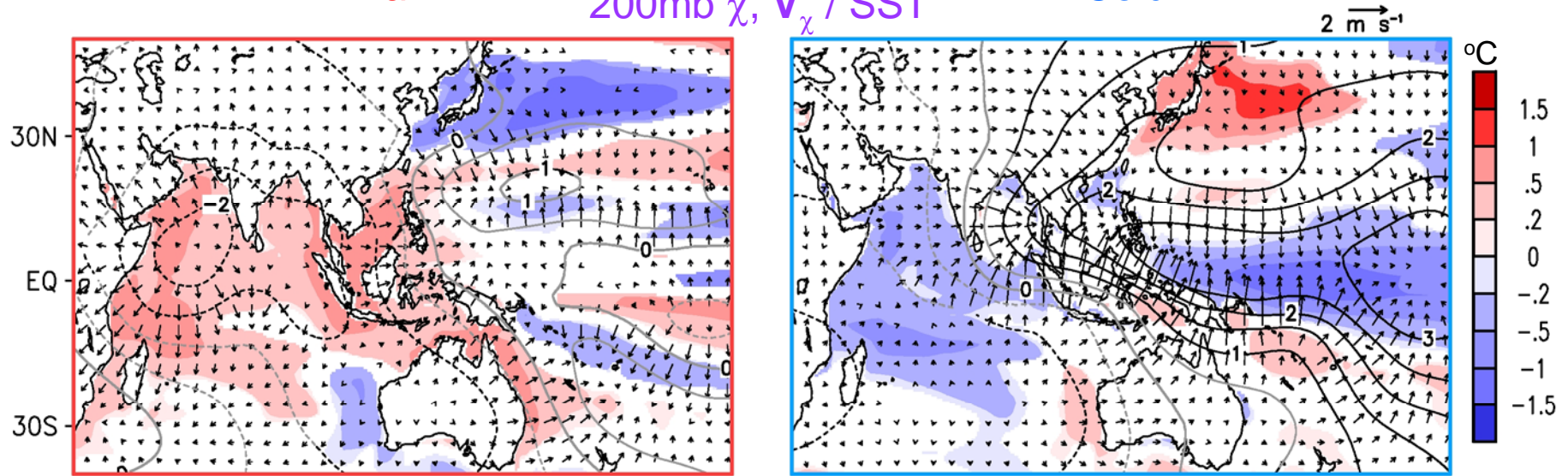


CM2.1
JULY(1)

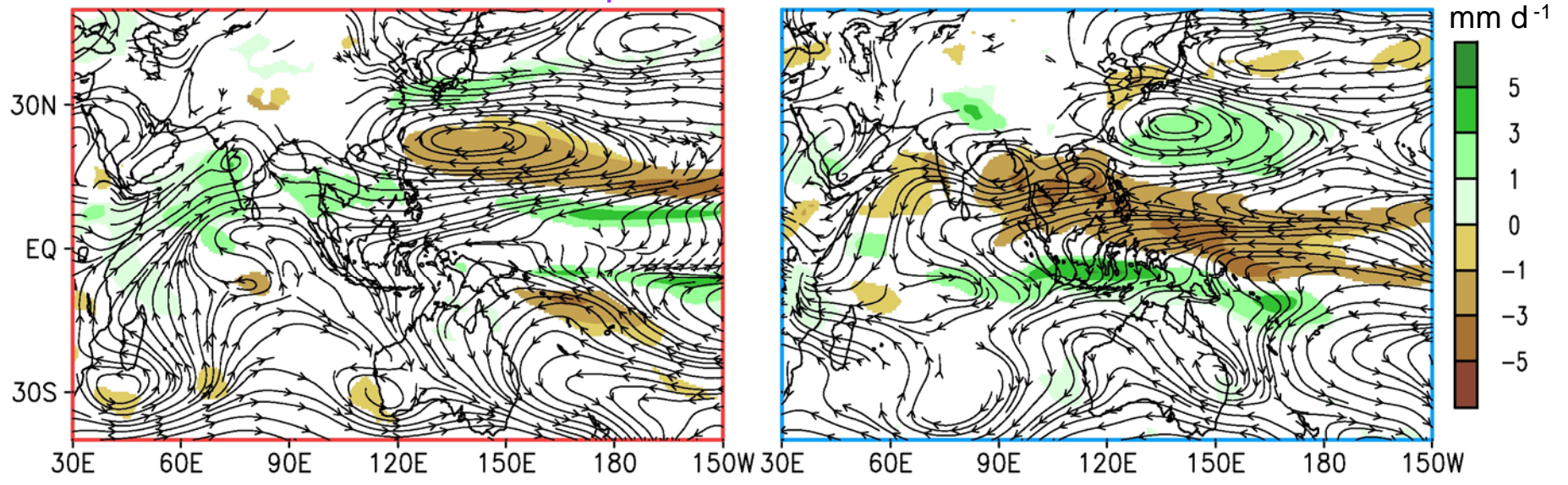
Warm

200mb χ , V_χ / SST

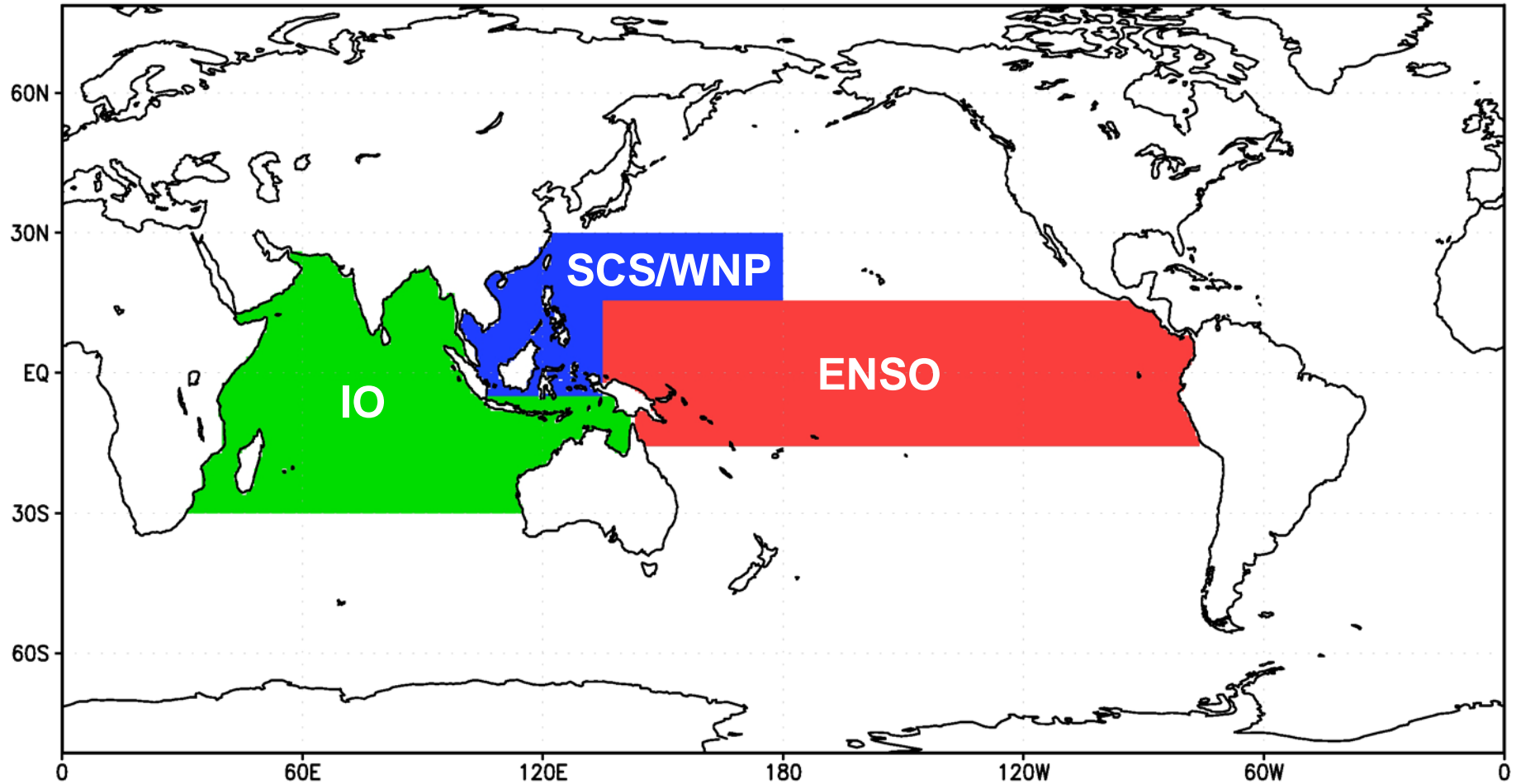
Cold



Precipitation / 850mb Wind



Forcing Domains for SST Sensitivity Experiments



Responses in SST Sensitivity Experiments

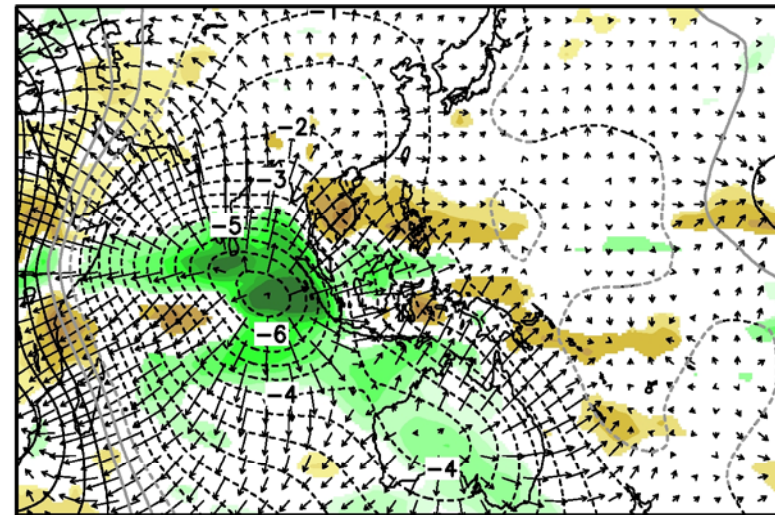
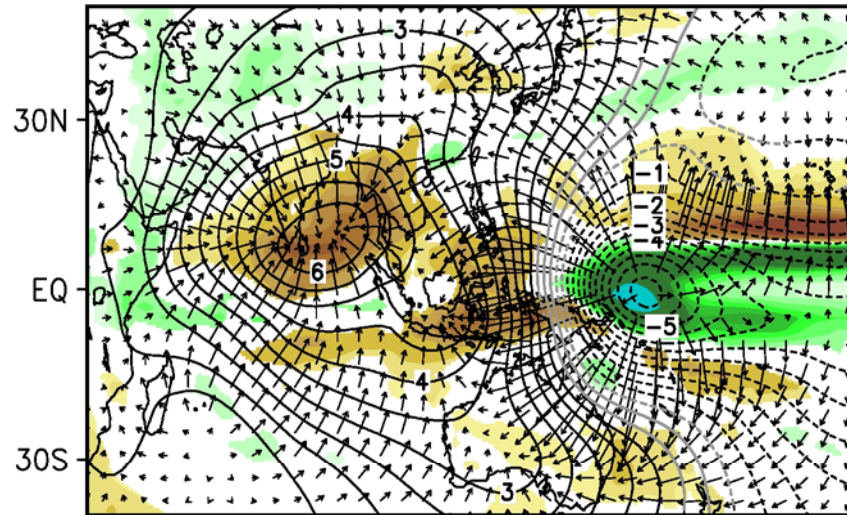
MAY(1) Warm

Precipitation / 200mb χ , V_χ

ENSO

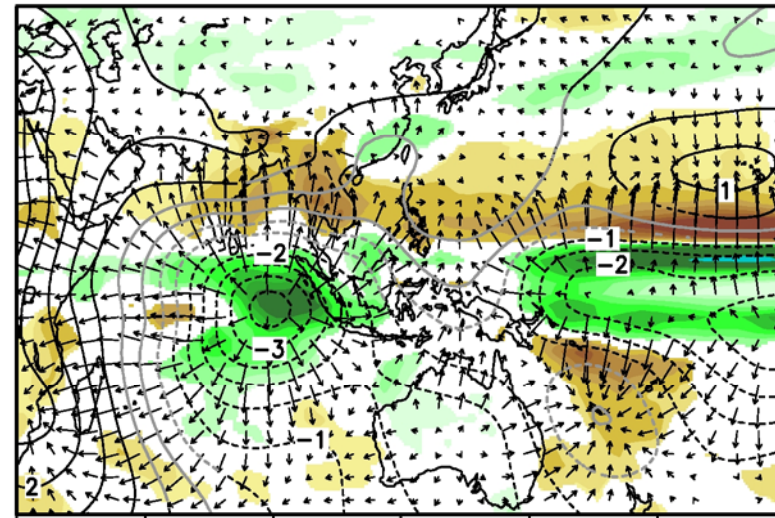
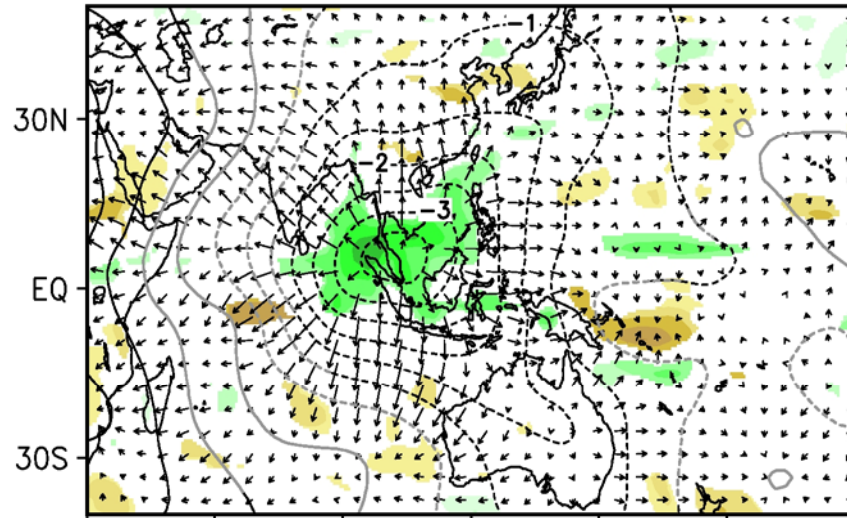
IO

2 m s^{-1}

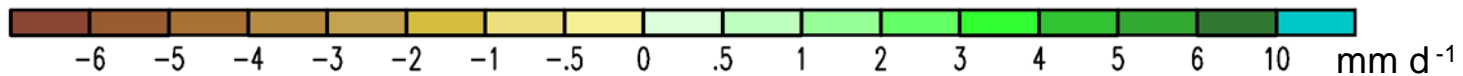


SCS / WP

IO+ENSO+SCS/WP



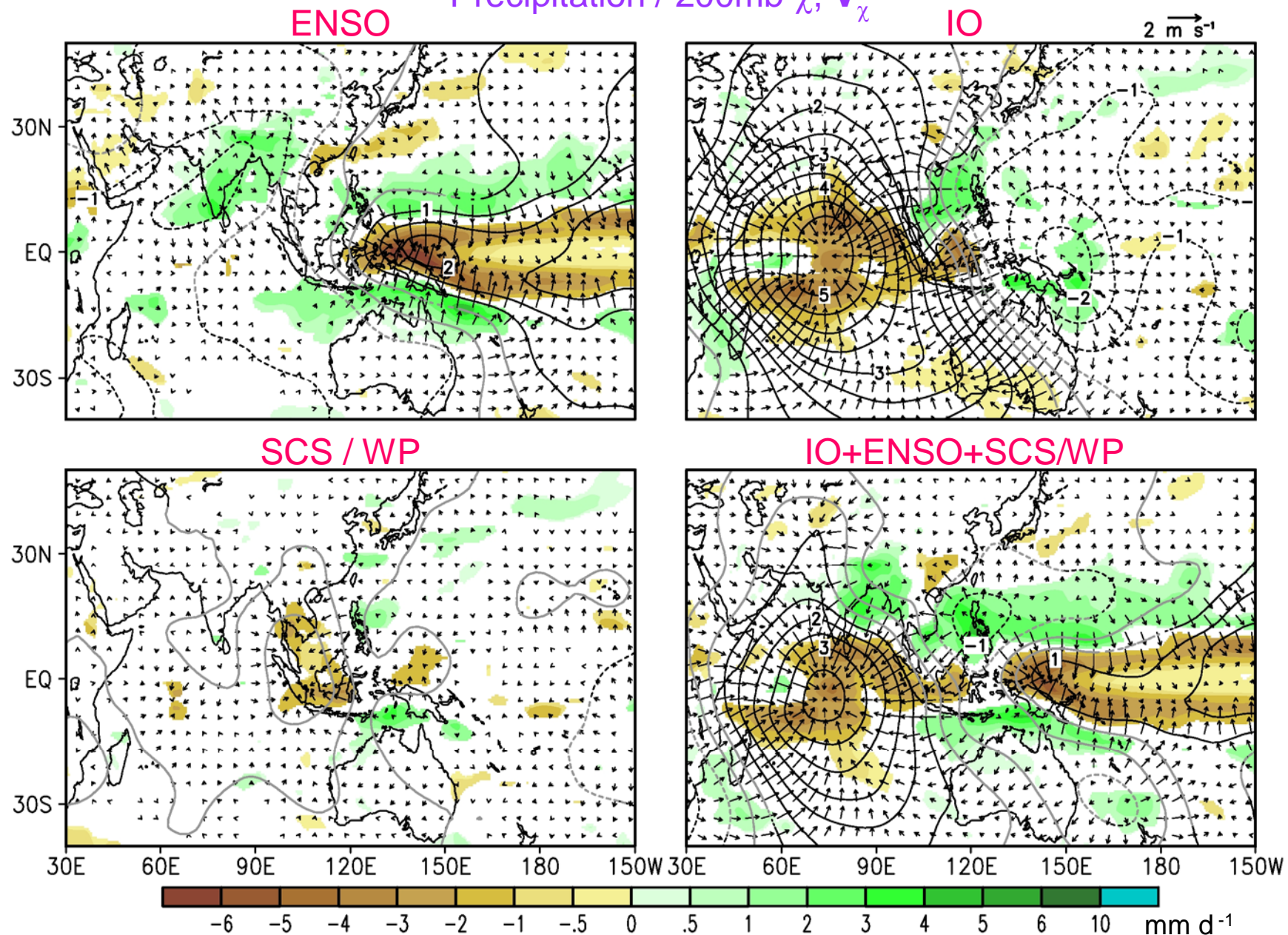
30E 60E 90E 120E 150E 180 150W 30E 60E 90E 120E 150E 180 150W



Responses in SST Sensitivity Experiments

MAY(1) Cold

Precipitation / 200mb χ , V_χ



MAY(1)

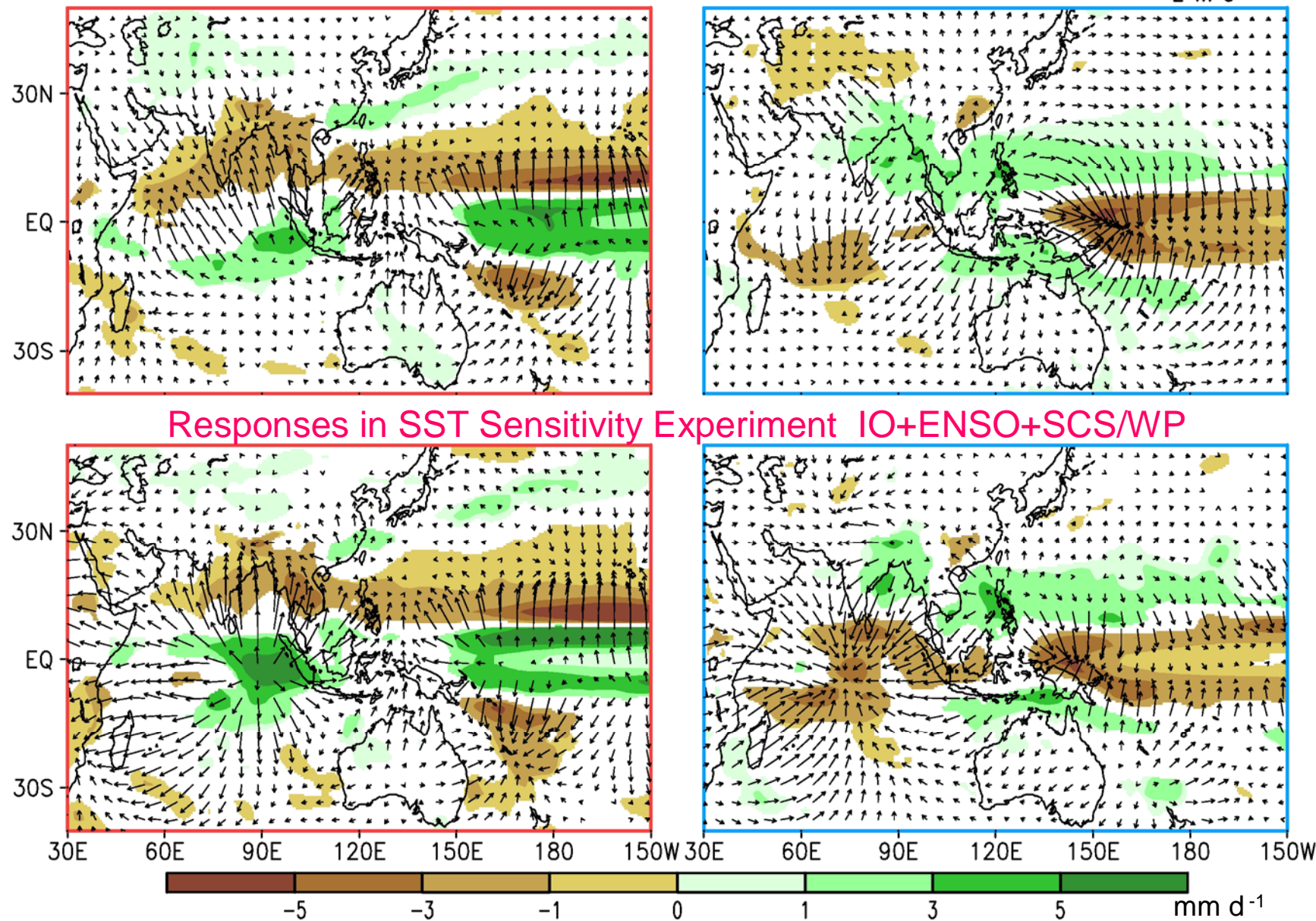
Precipitation / 200mb χ , \mathbf{V}_χ

Warm

Cold

CM2.1

2 m s^{-1}



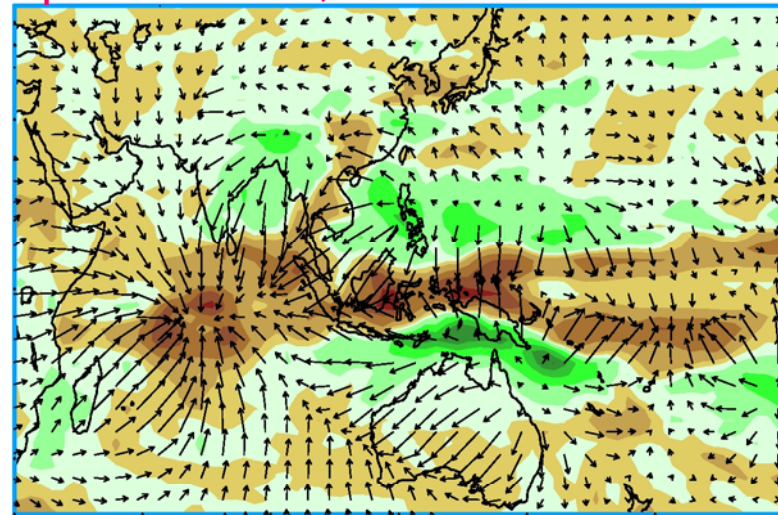
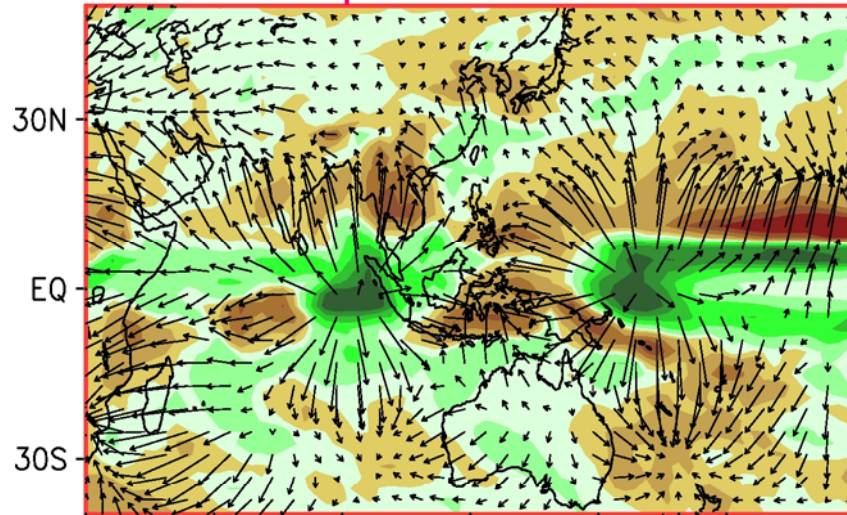
MAY(1)

Warm

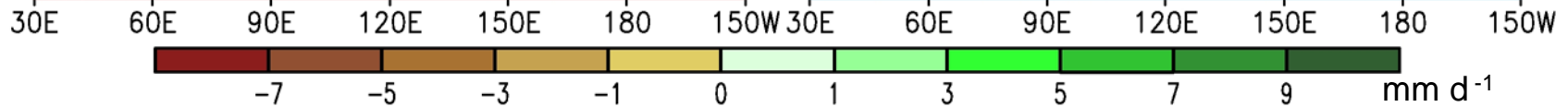
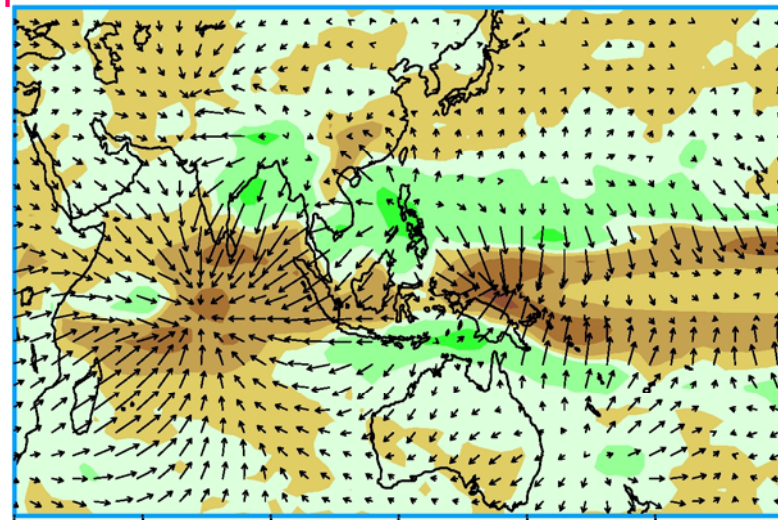
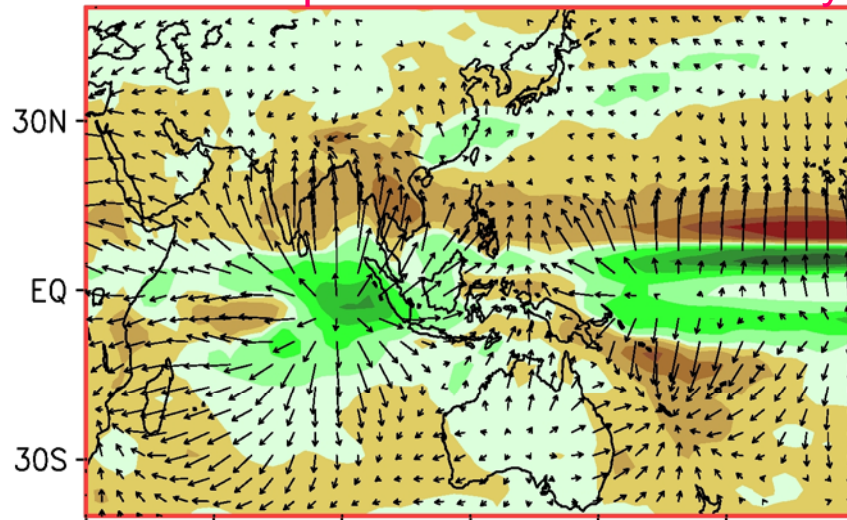
Precipitation / 200mb χ , V_χ

Cold

Sum of Responses in SST Sensitivity Experiments IO, ENSO and SCS/WP



Responses in SST Sensitivity Experiment IO+ENSO+SCS/WP



Responses in SST Sensitivity Experiments

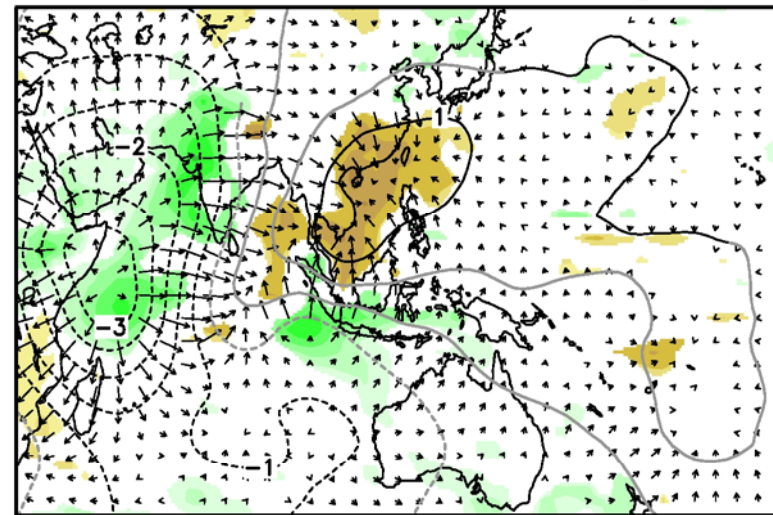
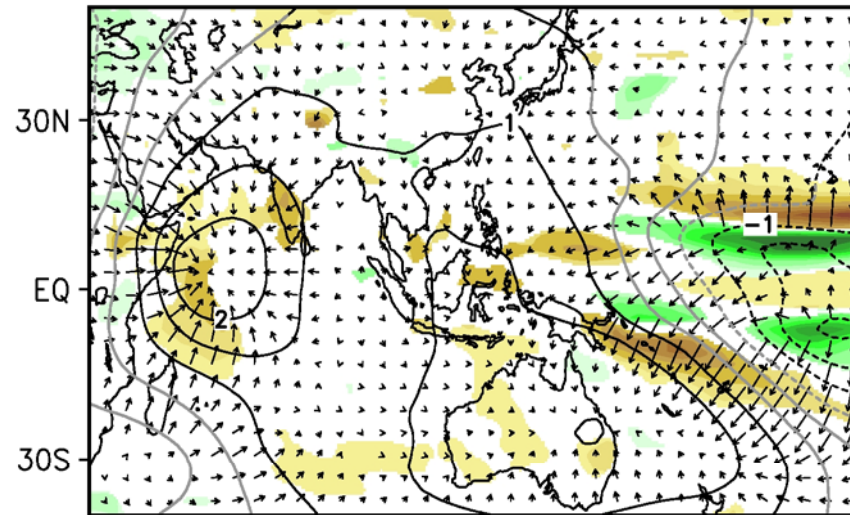
JULY(1) Warm

Precipitation / 200mb χ , V_χ

ENSO

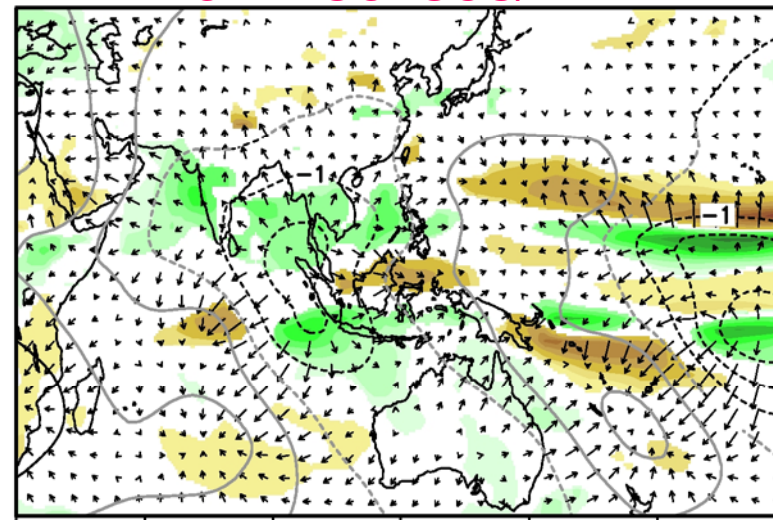
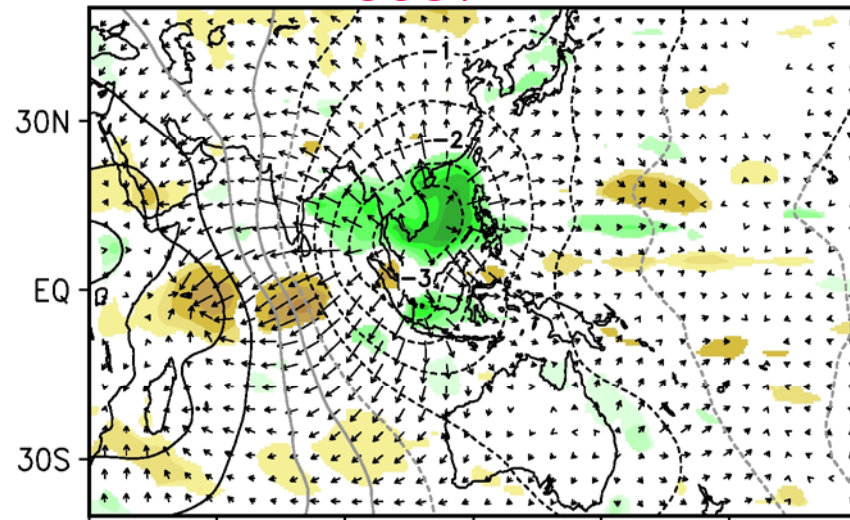
IO

2 $\vec{m\ s^{-1}}$

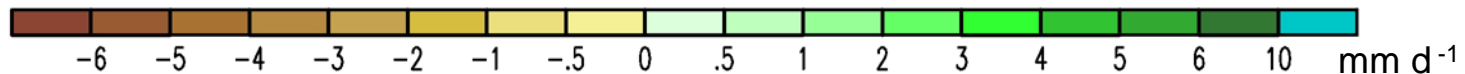


SCS / WP

IO+ENSO+SCS/WP



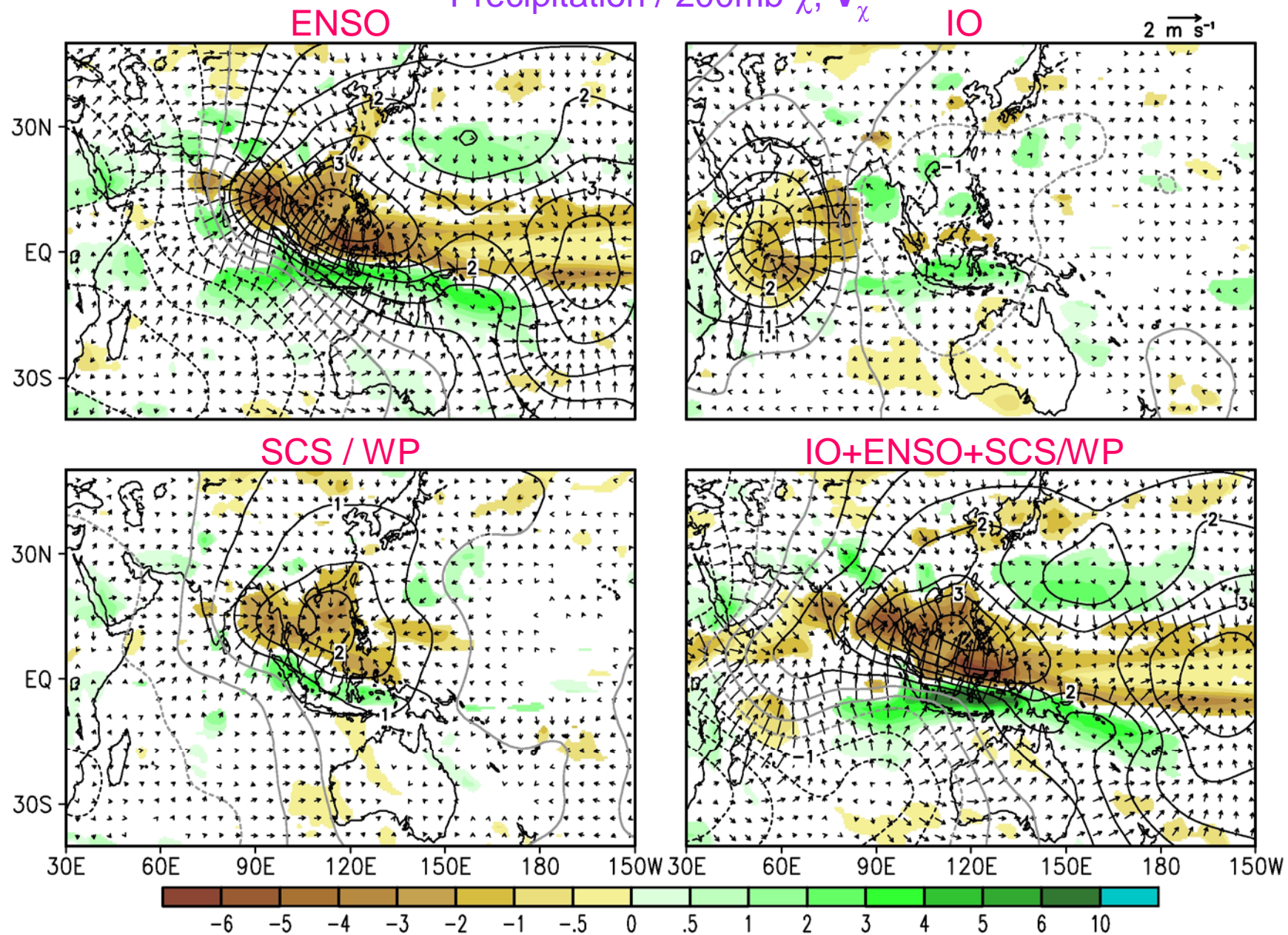
30E 60E 90E 120E 150E 180 150W 30E 60E 90E 120E 150E 180 150W



Responses in SST Sensitivity Experiments

JULY(1) Cold

Precipitation / 200mb χ , V_χ



JULY(1)

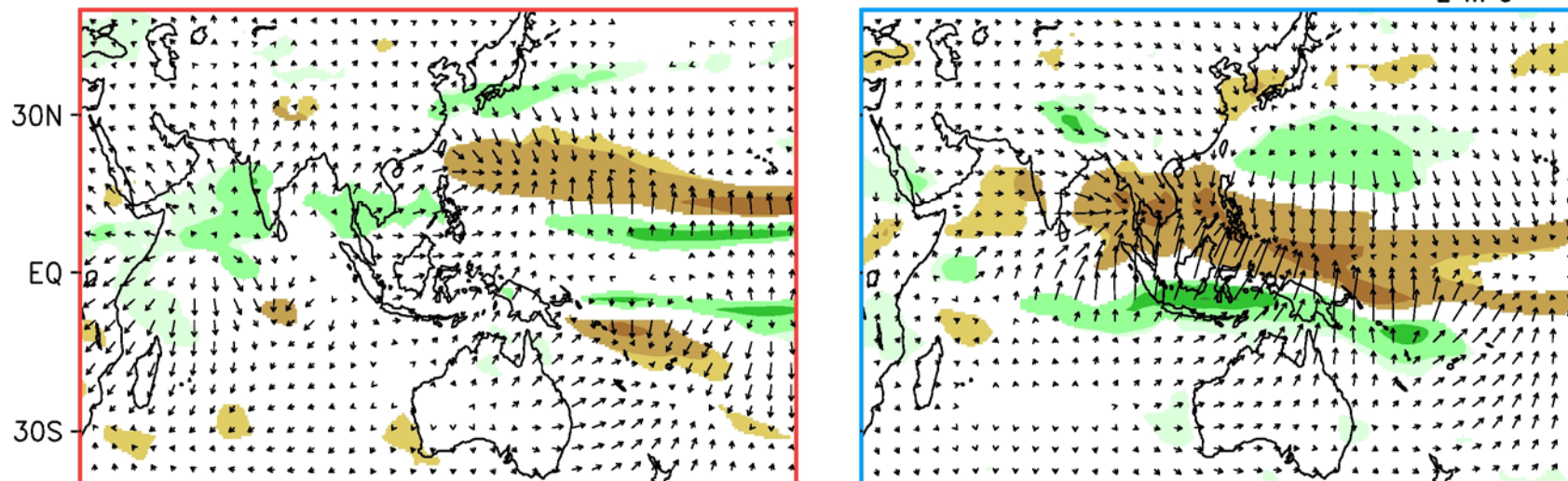
Precipitation / 200mb χ , V_χ

Warm

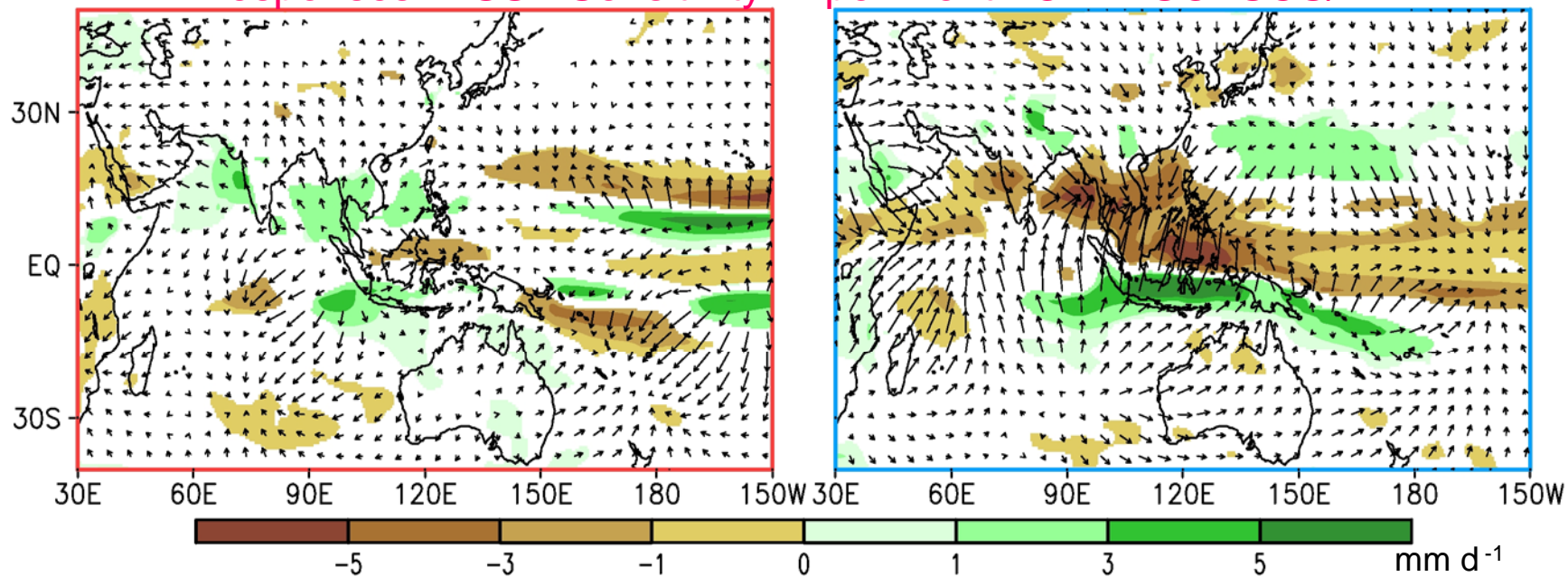
Cold

CM2.1

2 $\vec{m\ s^{-1}}$



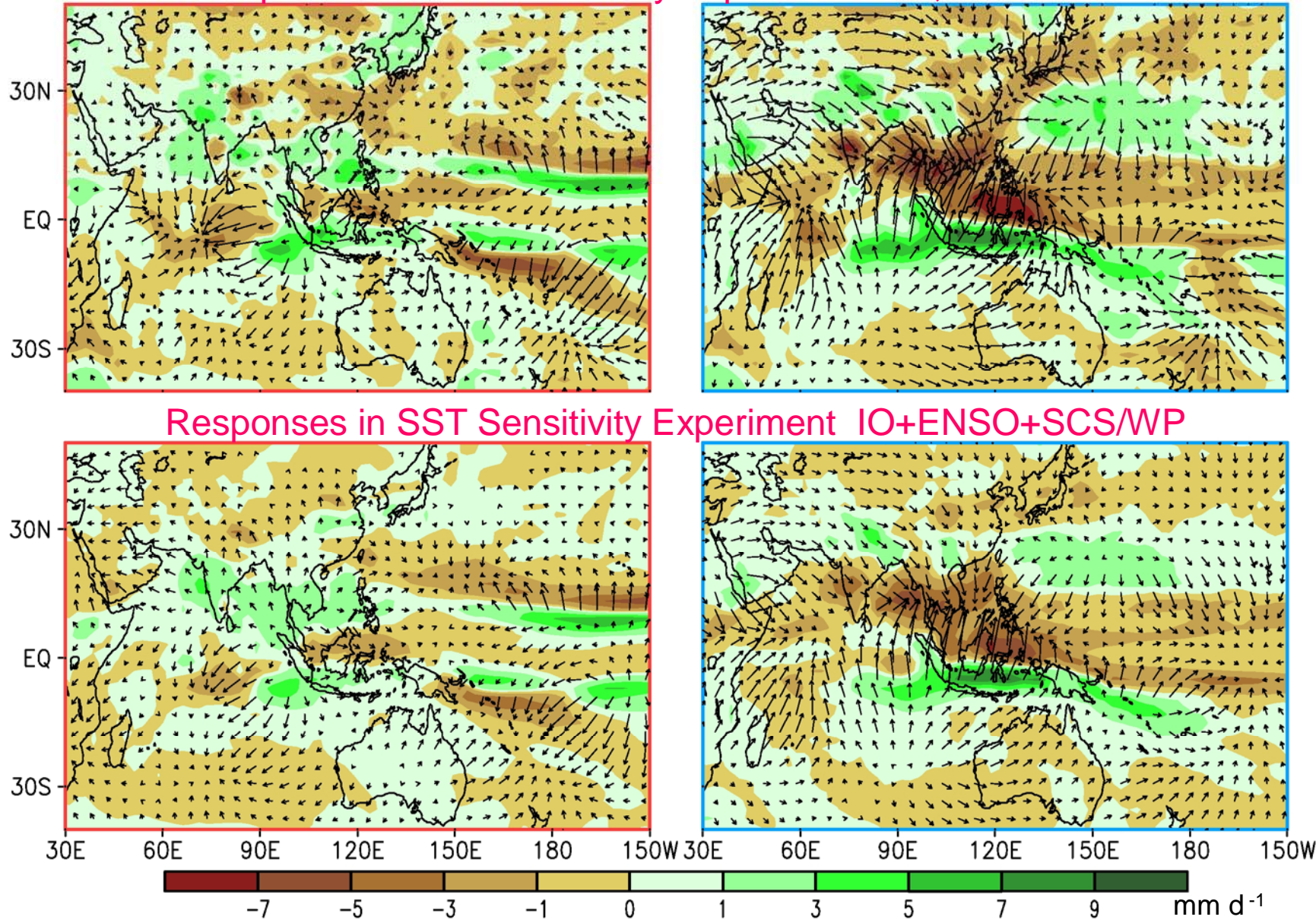
Responses in SST Sensitivity Experiment IO+ENSO+SCS/WP



JULY(1)

Warm Precipitation / 200mb χ , V_χ Cold

Sum of Responses in SST Sensitivity Experiments IO, ENSO and SCS/WP



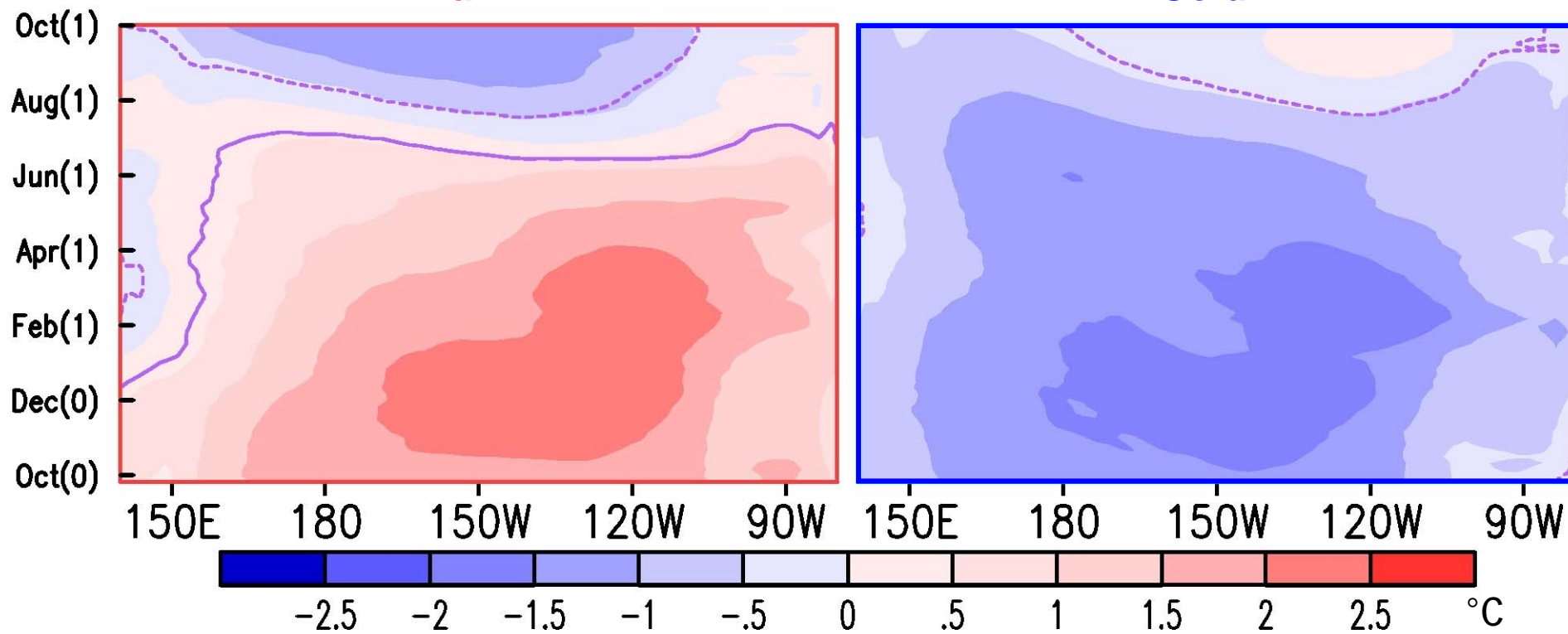
Thank You

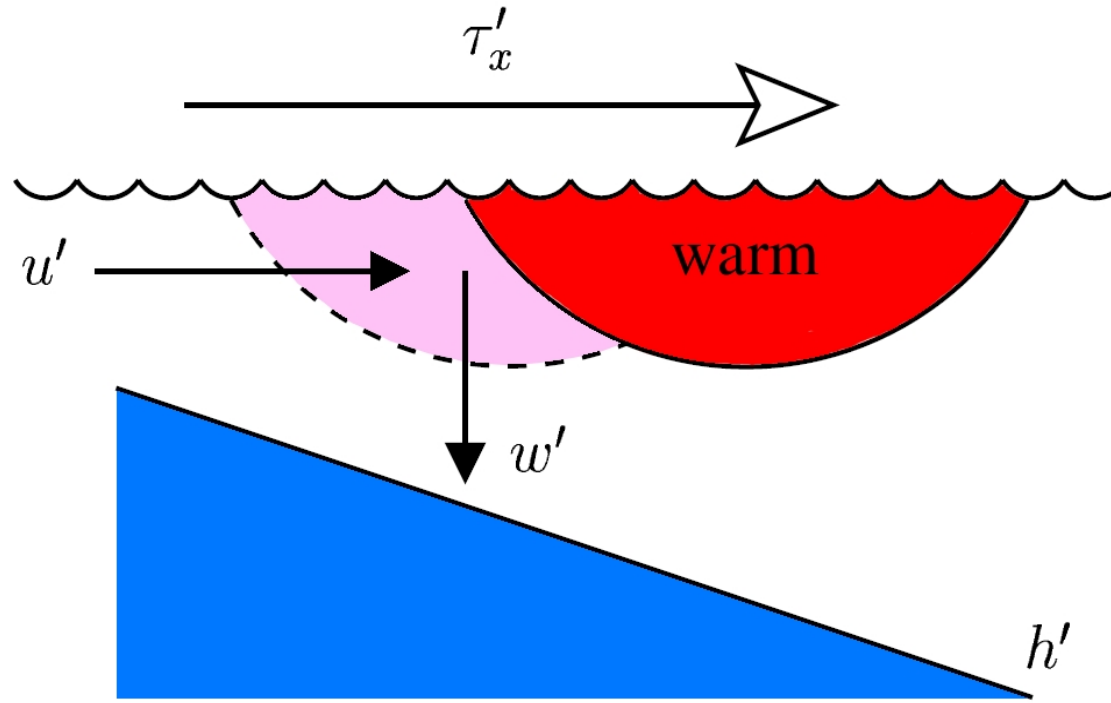


SST 5°S - 5°N

Warm

Cold





Strong Warm events

- $u' > 0, T_x' > 0$
 $\therefore -u'T_x' < 0$
- $w' < 0, T_z' < 0$
 $\therefore -w'T_z' < 0$

Strong Cold events

- $u' < 0, T_x' < 0$
 $\therefore -u'T_x' < 0$
- $w' > 0, T_z' > 0$
 $\therefore -w'T_z' < 0$

(Adapted from Fig.6.2 of Doctoral Thesis of Andrew Wittenberg, Princeton University, 2002)