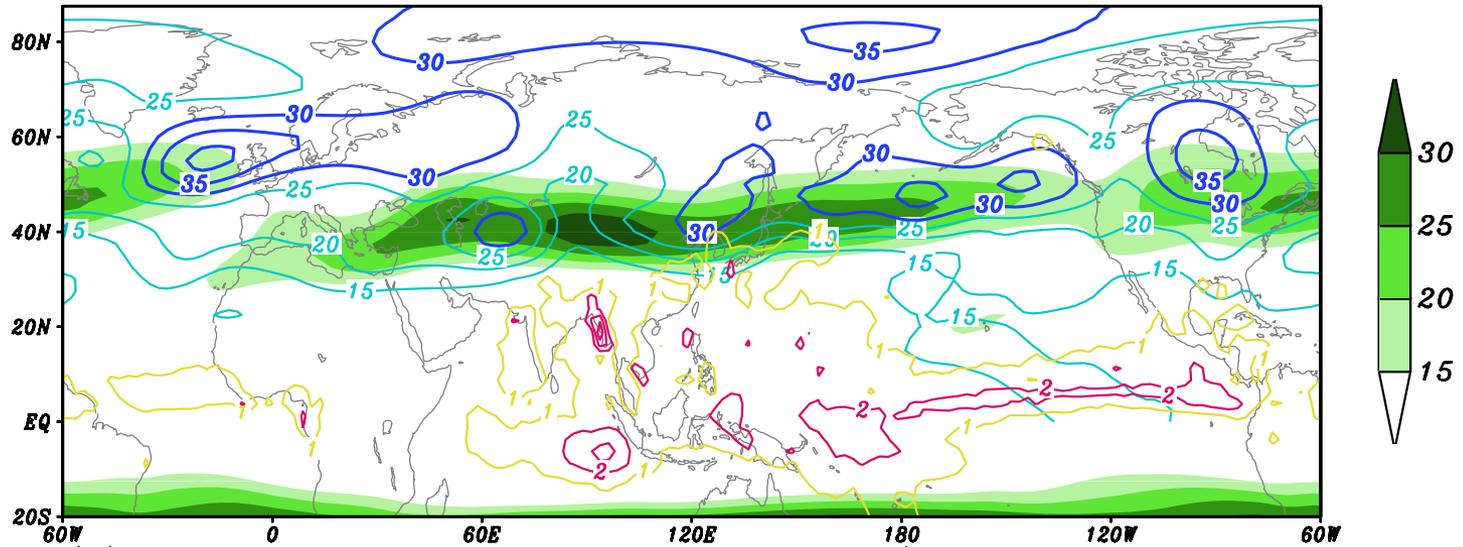




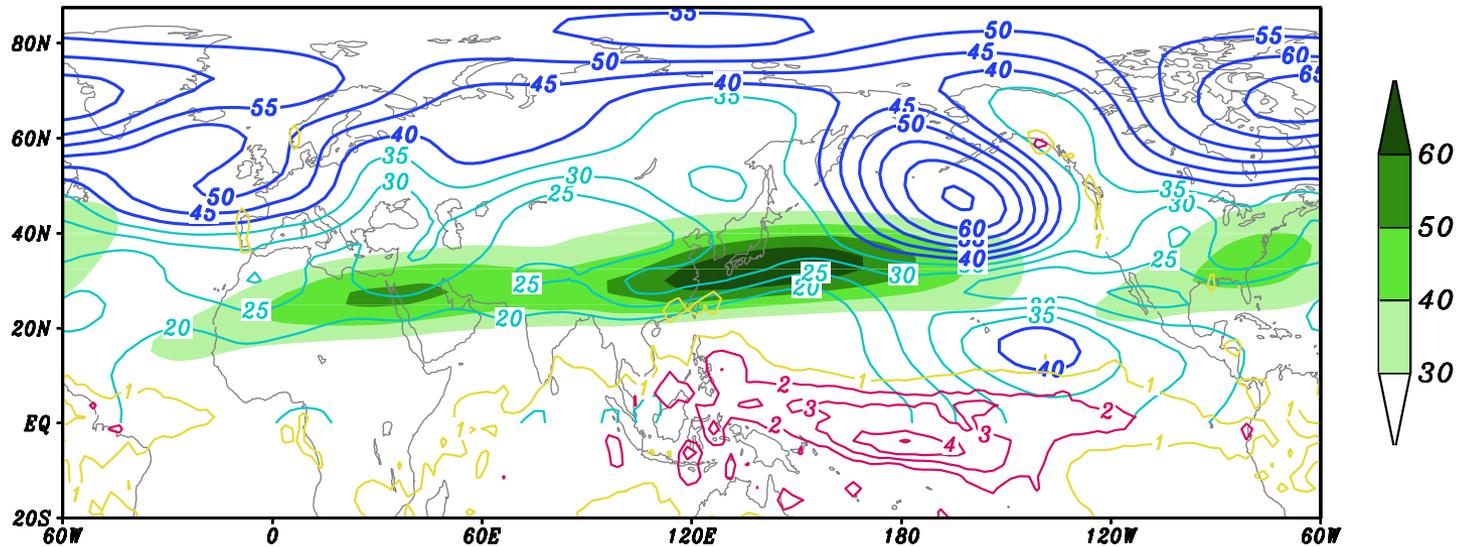
Tropical-extratropical teleconnections in boreal summer: observed interannual variability

Qinghua Ding (U. of Washington), Bin Wang (U. of Hawaii),
John Wallace (U. of Washington), Grant Branstator (NCAR)

(a) JJAS Westerly jet and std of rainfall/GH200



(b) DJFM Westerly jet and std of rainfall/GH200

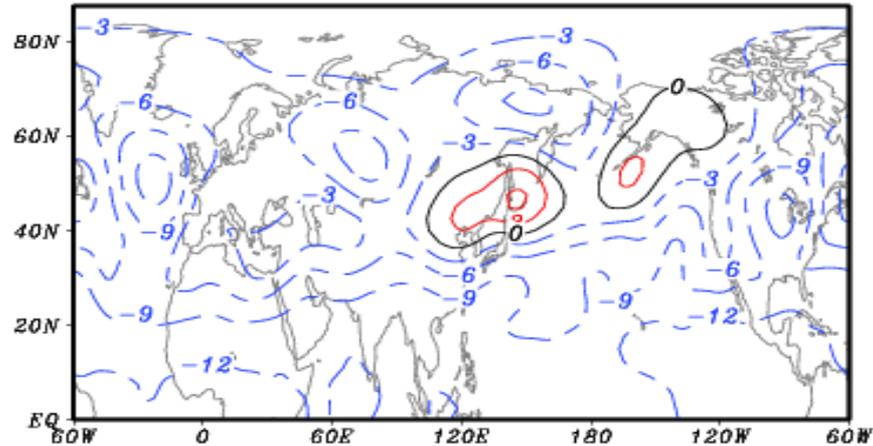


Data (1948-2009)

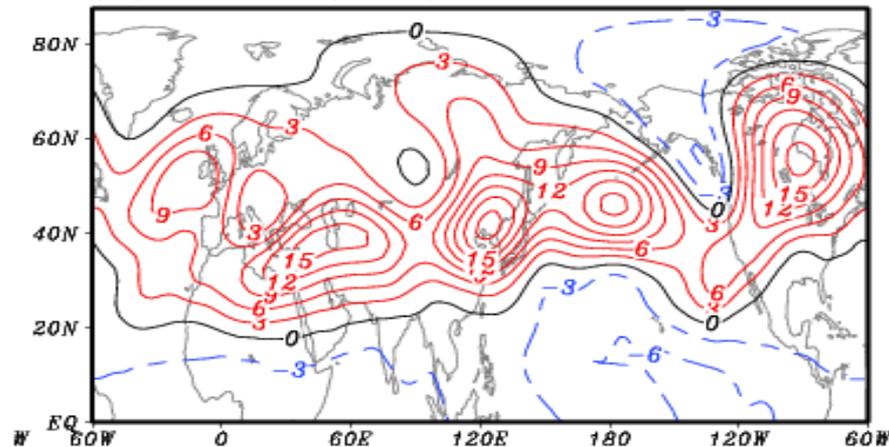
- NCEP/NCAR reanalysis
- NOAA extended reconstructed SST (ERSST3)
- All Indian rainfall index
- The Precipitation REConstruction data set (PREC)
- PREC/L precipitation and CRU surface temperature over land ($0.5^{\circ} \times 0.5^{\circ}$)
- The long-term trend and decadal variations with period longer than 8 years are removed

Z200 (JJAS, 1948-2009)

(a) EOF-1 (21%)



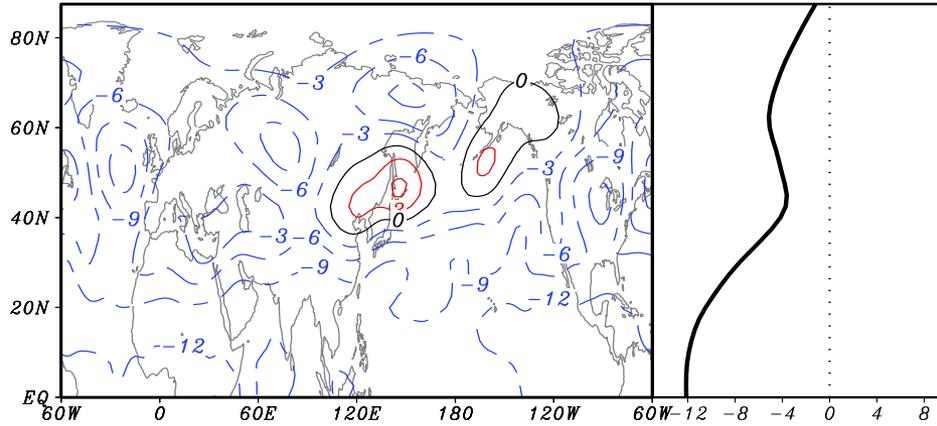
(b) EOF-2 (14%)



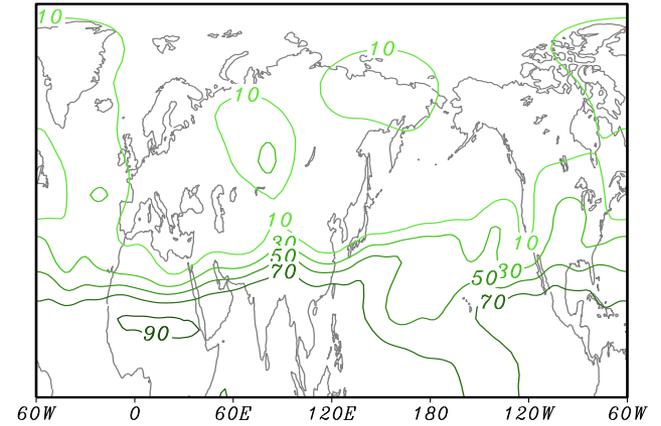
To what extent extratropical circulation variability is related to tropical rainfall?

Local variance explained by EOF1 and EOF2

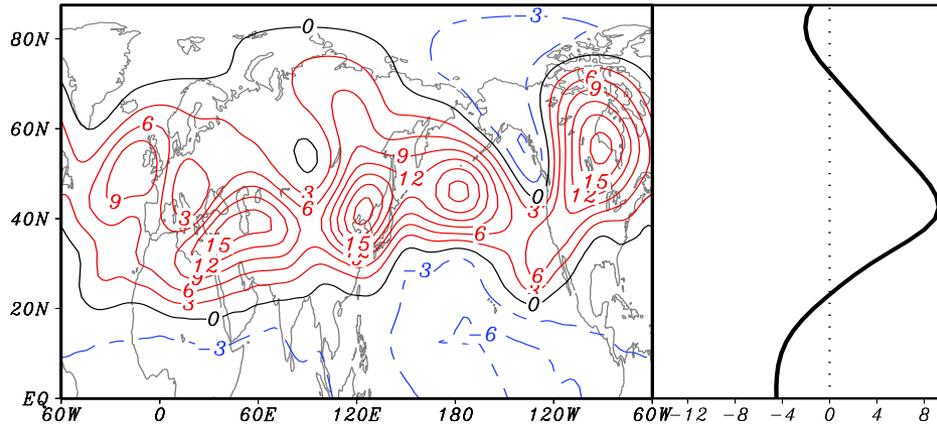
(a) EOF1(21%) and zonal mean component



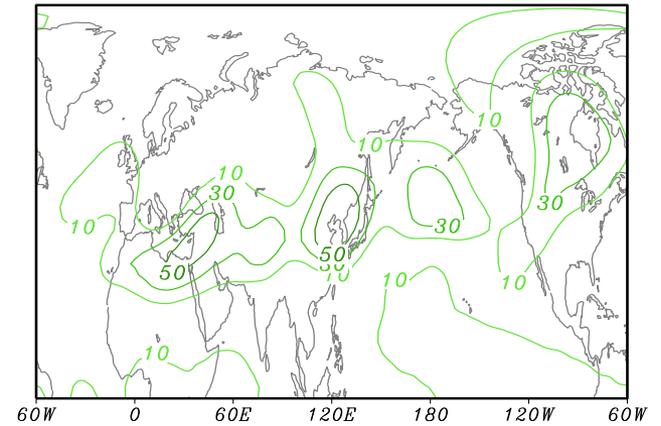
(b) Local variance explained by EOF1

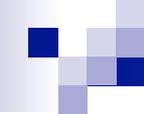


(c) EOF2(14%) and zonal mean component



(d) Local variance explained by EOF2

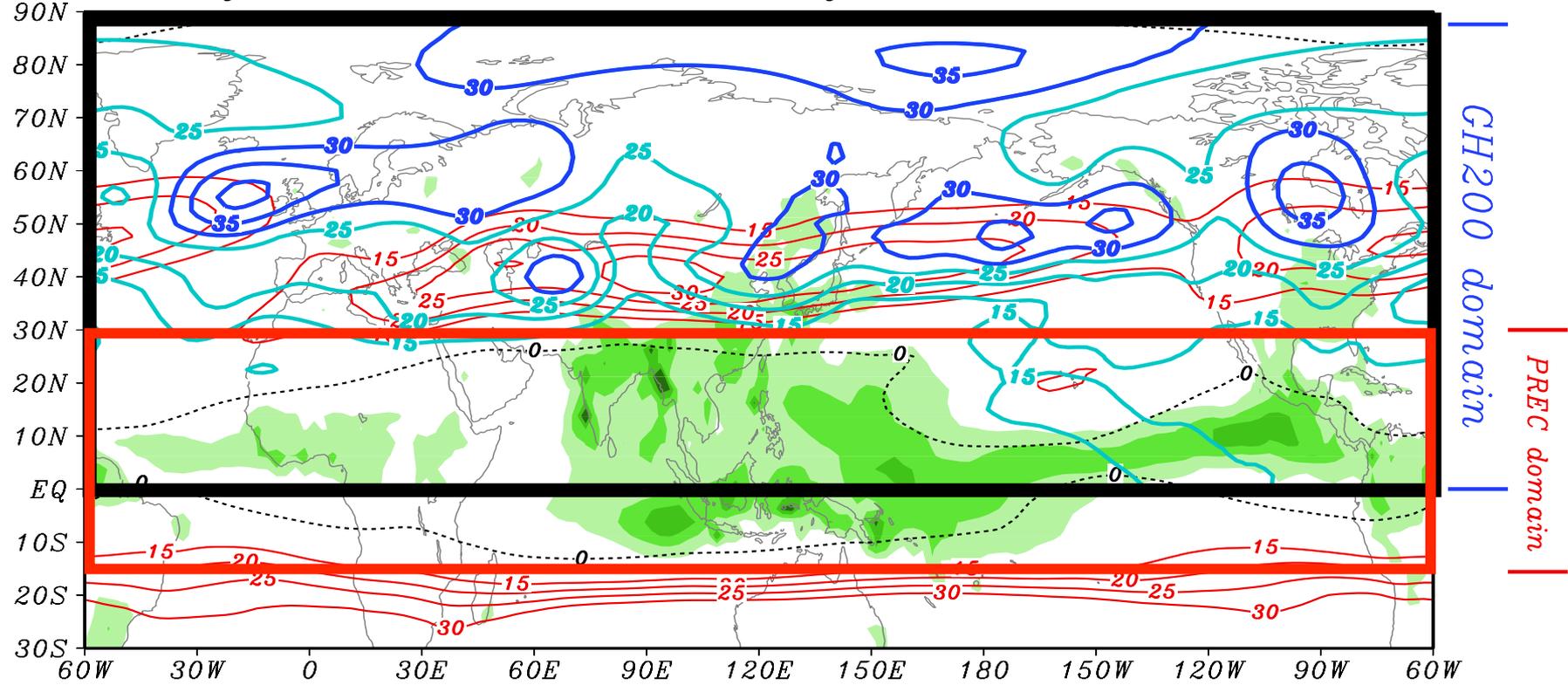




Observed IAV of tropical-extratropical teleconnection (JJAS, 1948-2009)

- What is the dominant coupled pattern between Z200 and tropical rainfall?
- How important are these MCA modes?
- What are the precipitation and temperature anomalies associated with these leading MCA modes?
- How do they relate to tropical SST variations?

Shading: Std of Rainfall(JJAS, 1948-2009), blue curve: Std of Z200(JJAS, 1948-2009)
 Red curve: Climatological 200hPa Jetstream, black dotted line: zero line of zonal wind
Std of 200hPa GH and rainfall



Rainfall

15°S-30°N



Region for SVD analysis

GH200

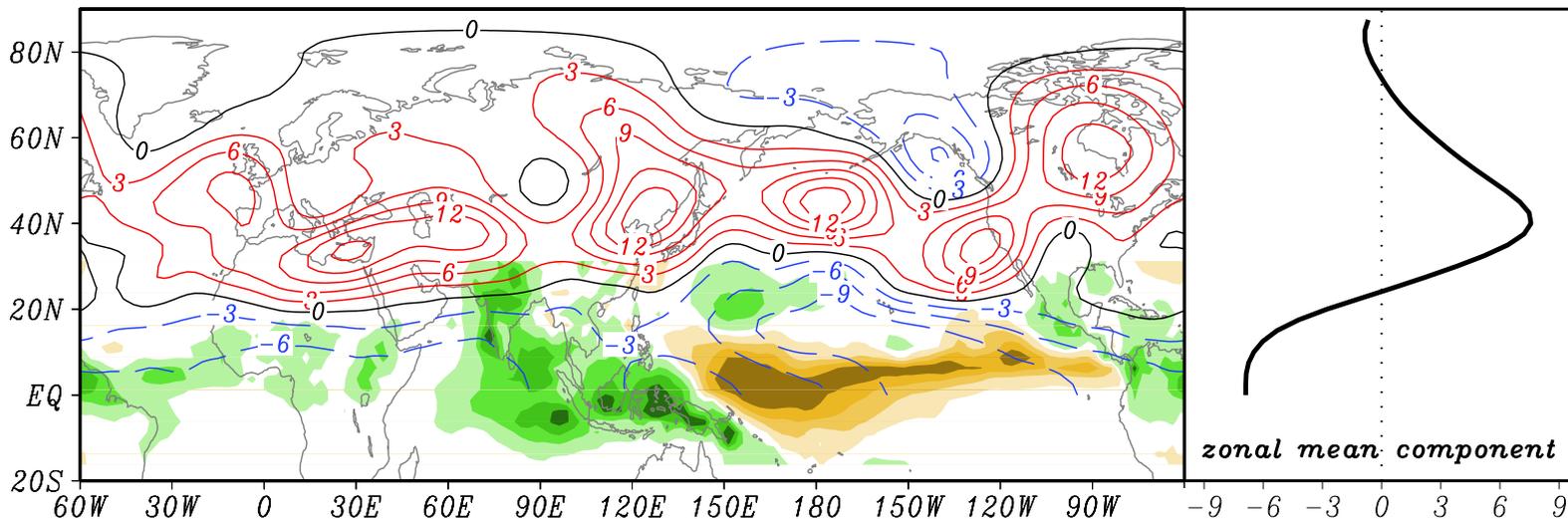
0-87.5°N

MCA analysis between Z200 and rainfall (JJAS, 1948-2009)

(a) M1 (Z200 and PREC) SCF=60% $r=0.80$

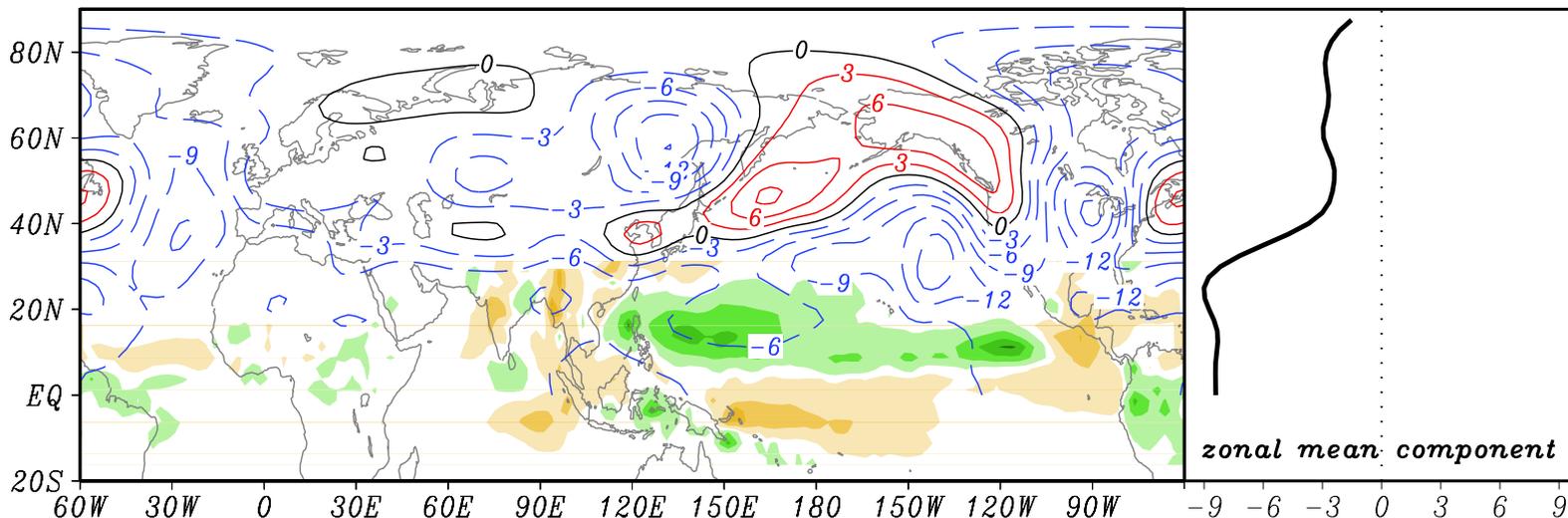
Meridional seesaw

CGT



(b) M2 (Z200 and PREC) SCF=17% $r=0.64$

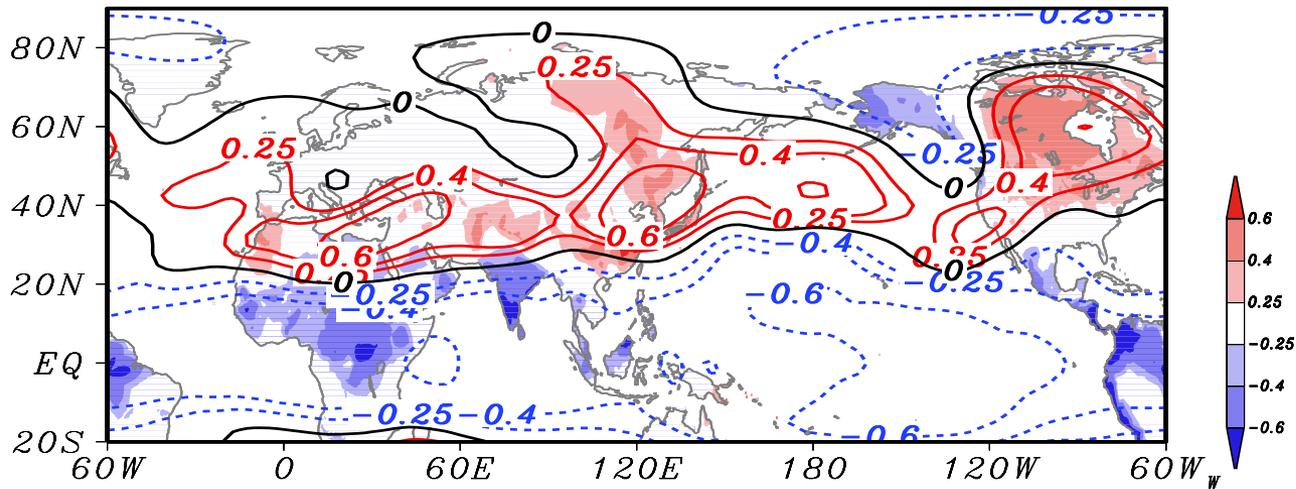
WPNA



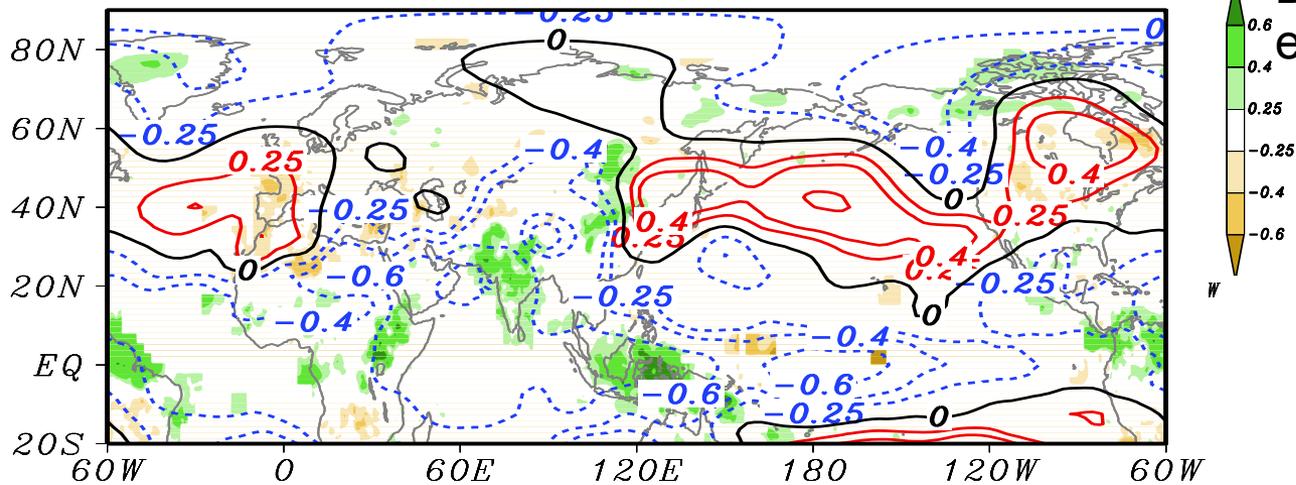
Hemispheric homogeneous

Vertical structure of CGT and related precipitation and surface temperature anomalies

(a) r of M1 with Z200 and temp.

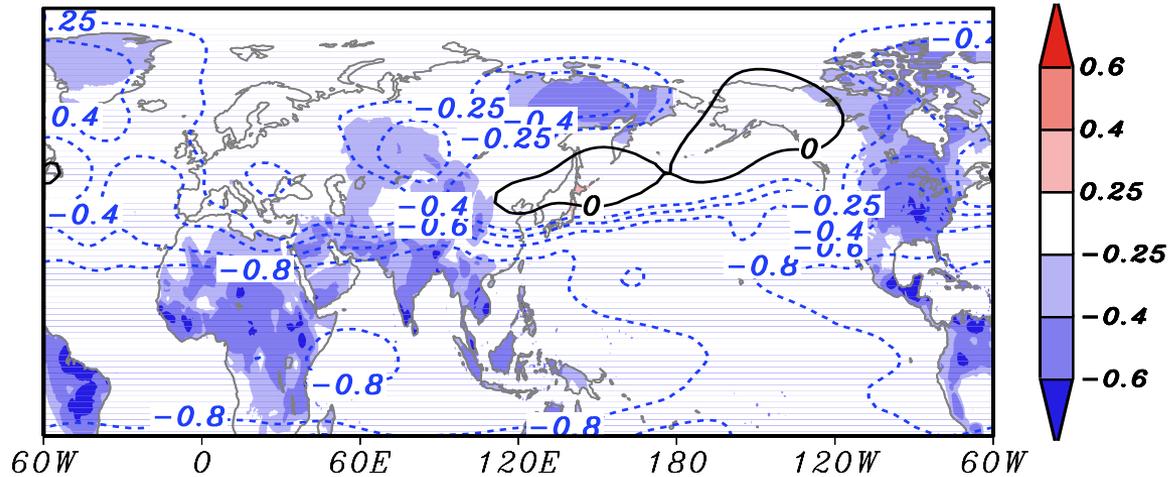


(b) r of M1 with Z700 and rainfall

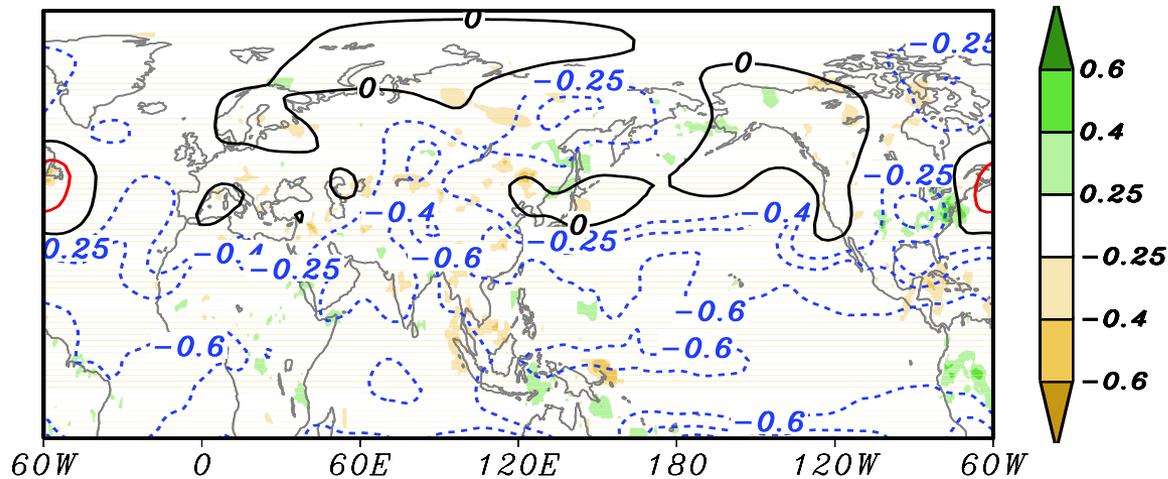


Vertical structure of WPNA and related precipitation and surface temperature anomalies

(c) r of M2 with Z200 and temp.

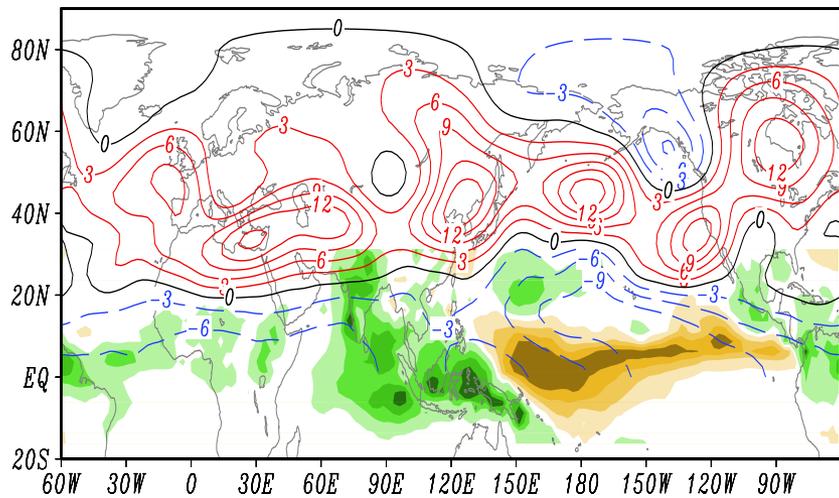


(d) r of M2 with Z700 and rainfall

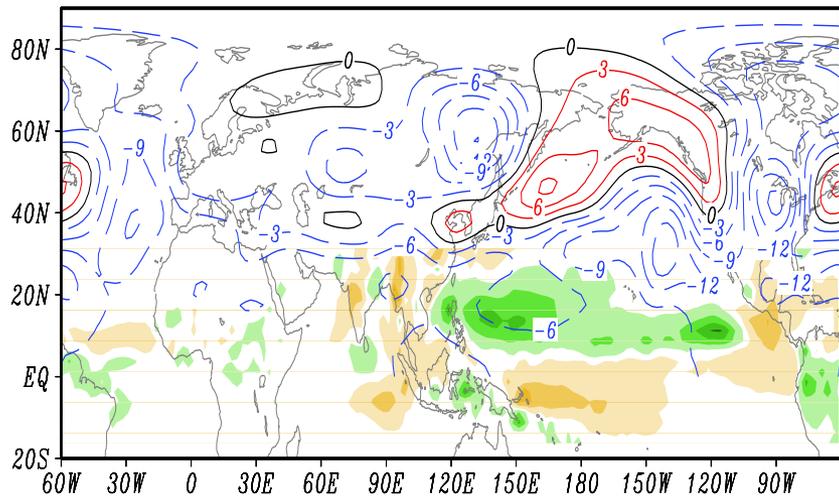


First two SVD/EOF in observation

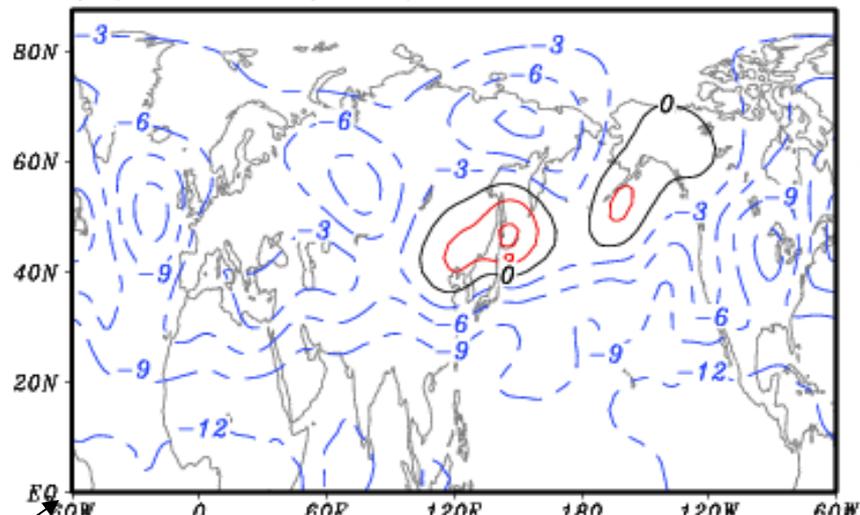
(a) M1 (Z200 and PREC) SCF=60% $r=0.80$



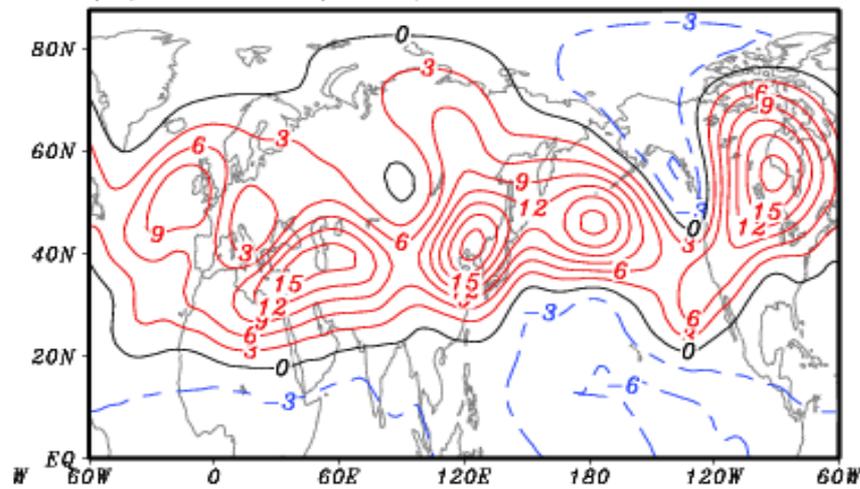
(b) M2 (Z200 and PREC) SCF=17% $r=0.64$



(a) EOF-1 (21%)



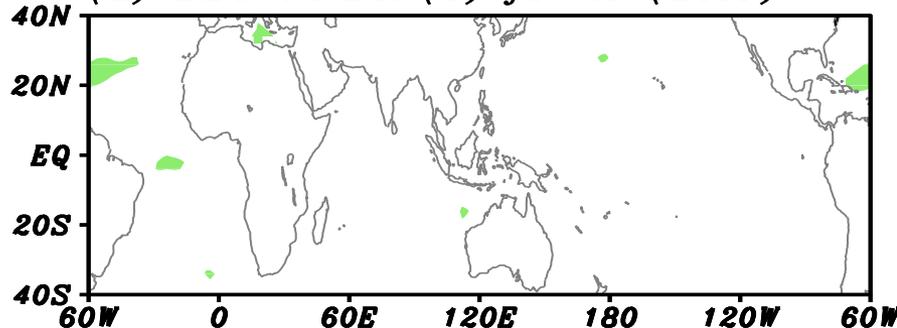
(b) EOF-2 (14%)



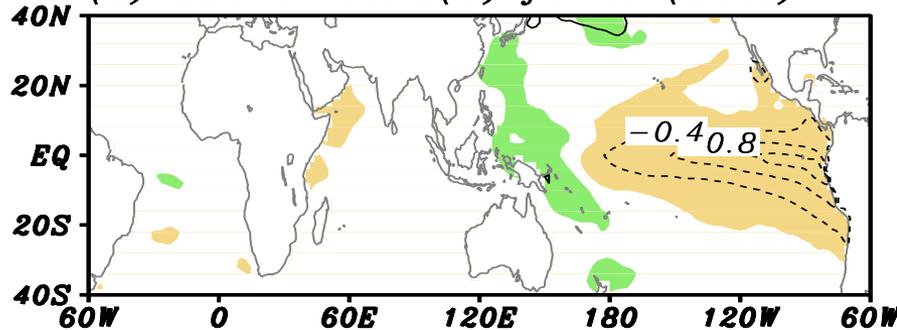
SST corresponding to MCA1 & 2 (DJF(0), JJAS(0),DJF(1) 1948-2009)

M1 - SST

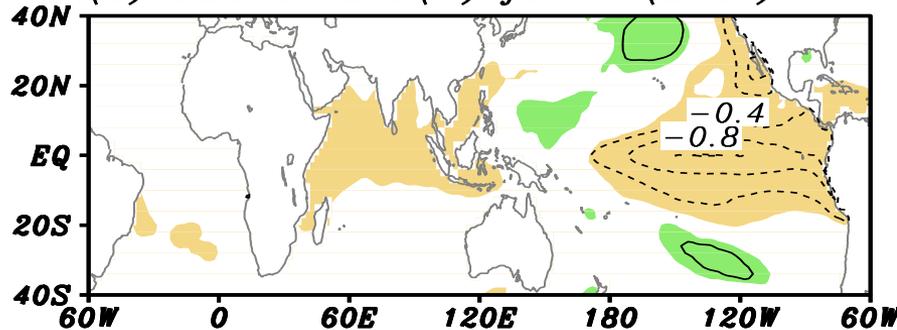
(a) SST in DJF(0) for M1(Z200)



(b) SST in JJAS(0) for M1(Z200)

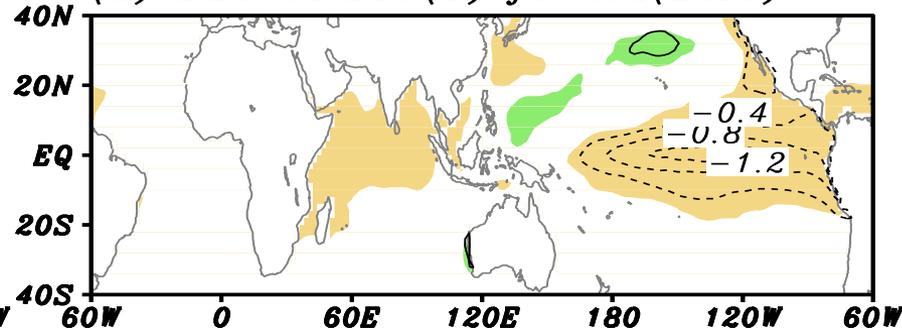


(c) SST in DJF(1) for M1(Z200)

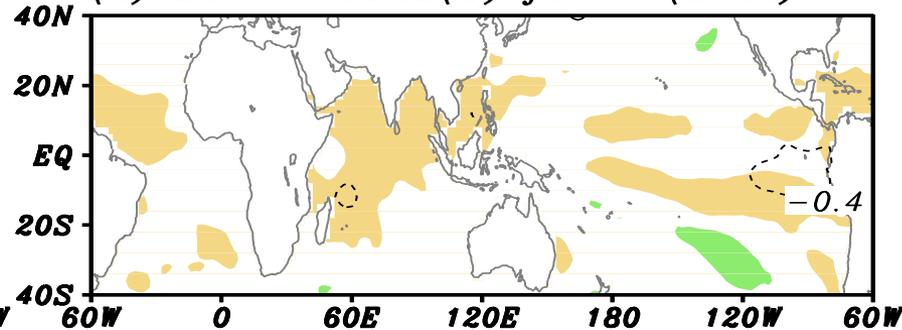


M2 - SST

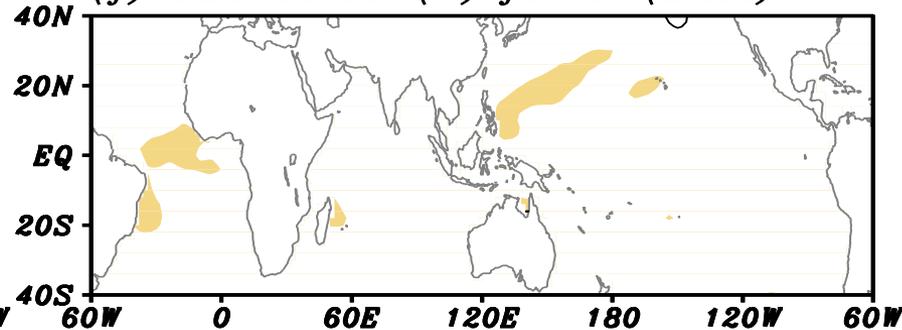
(d) SST in DJF(0) for M2(Z200)



(e) SST in JJAS(0) for M2(Z200)

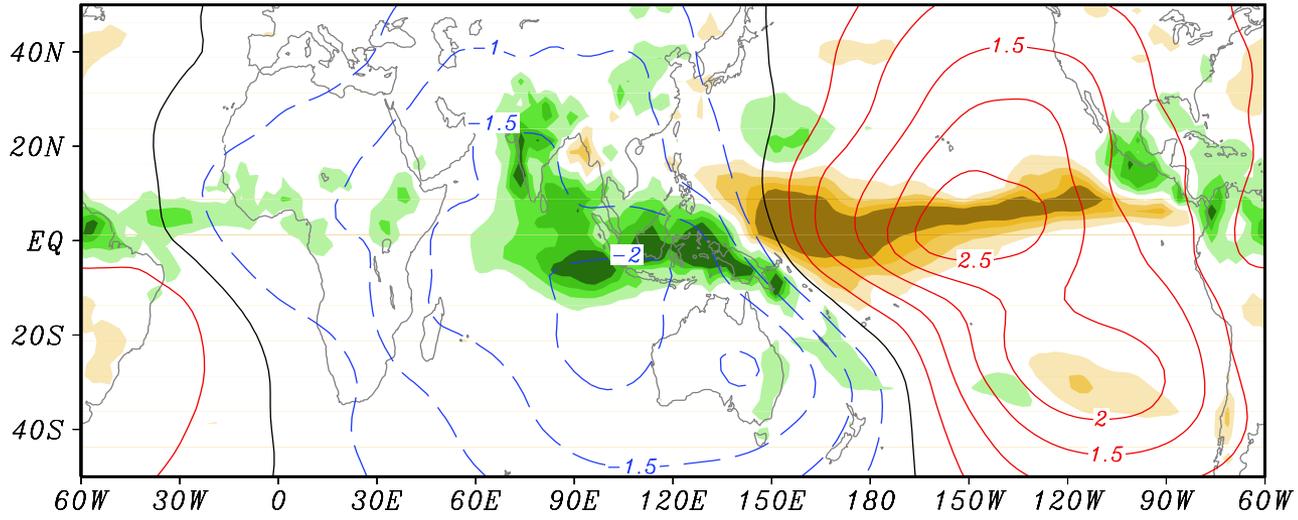


(f) SST in DJF(1) for M2(Z200)



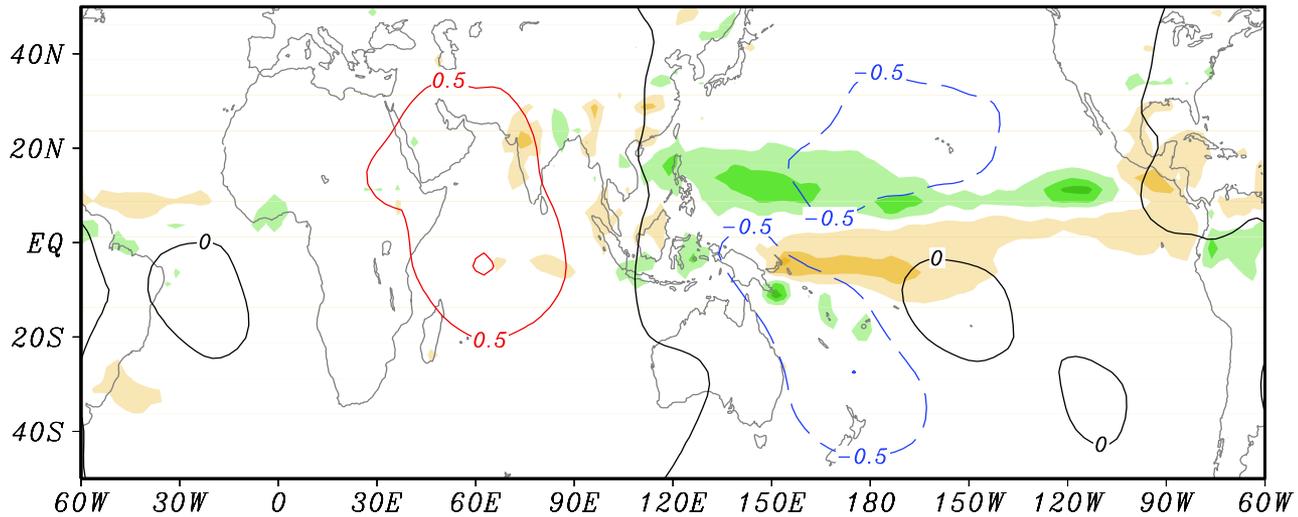
(a) Pre-JJAS rainfall and velocity potential

active

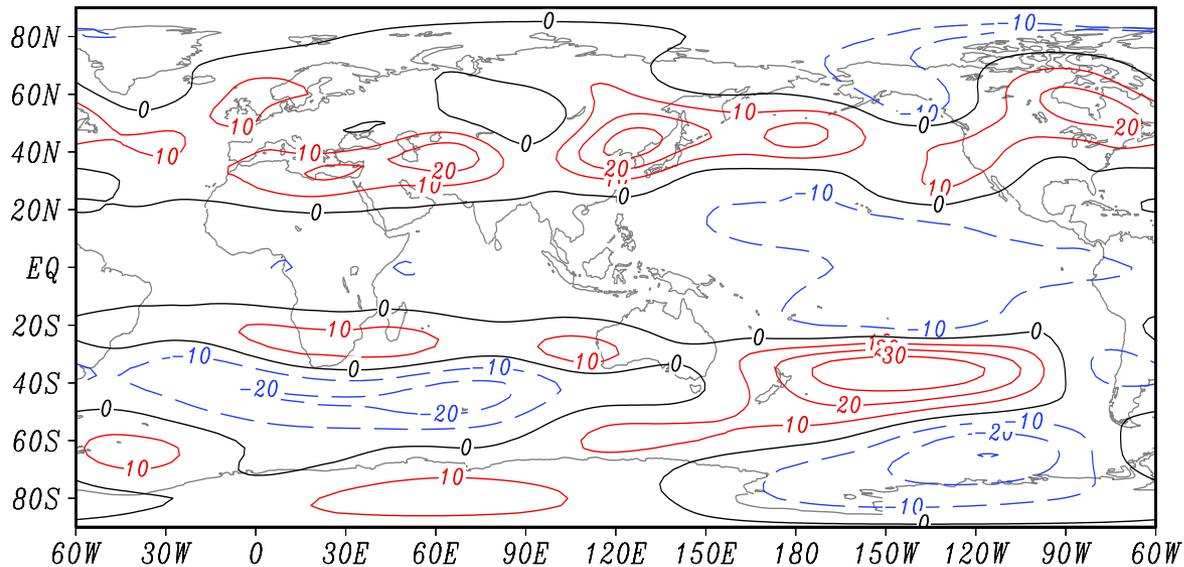


(b) Post-JJAS rainfall and velocity potential

inactive



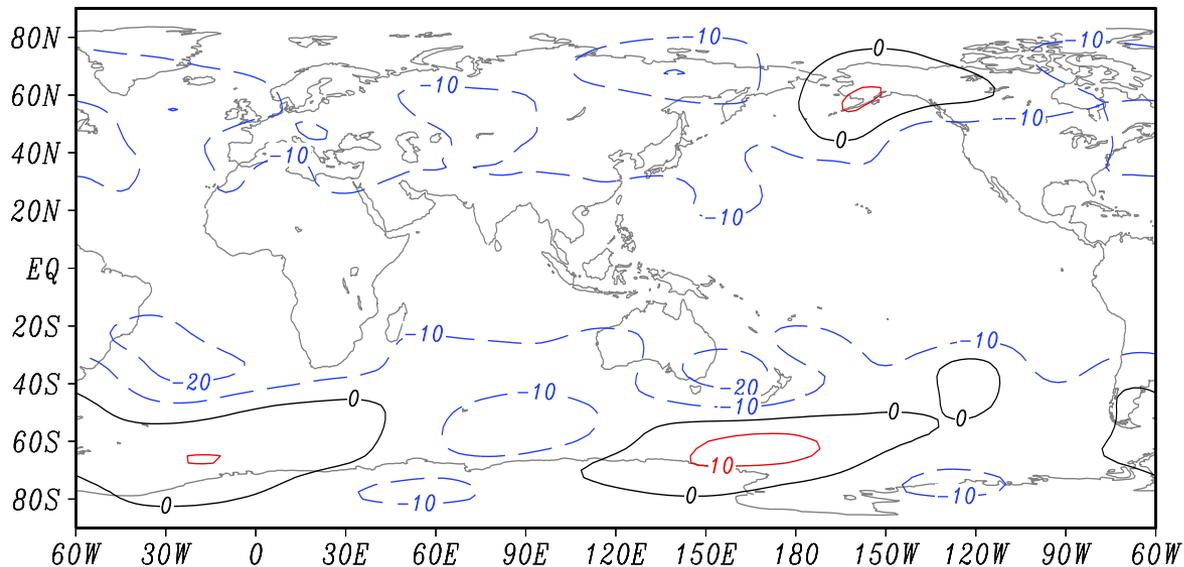
(a) Pre-JJAS geopotential height at 200hPa



Strong

seesaw

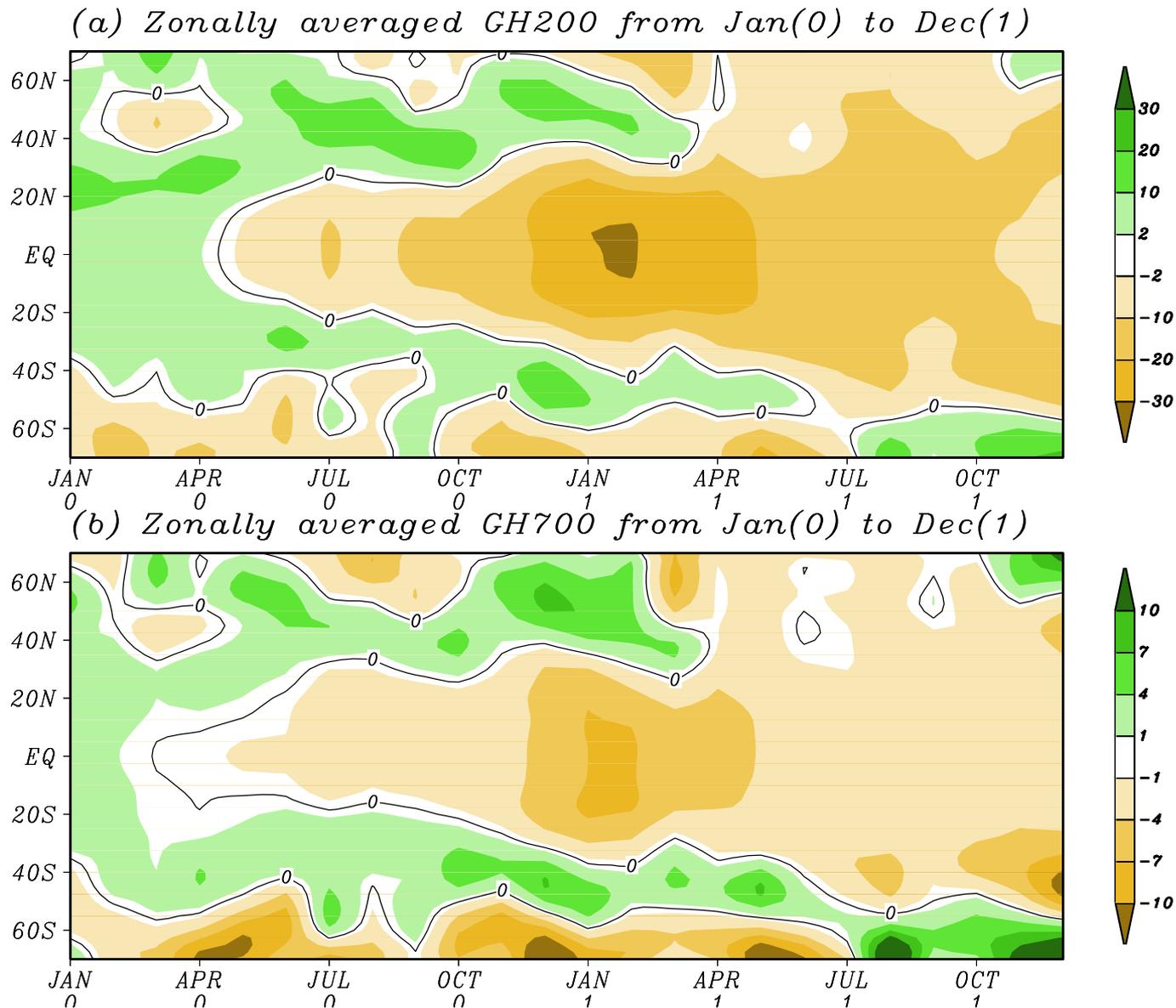
(b) Post-JJAS geopotential height at 200hPa



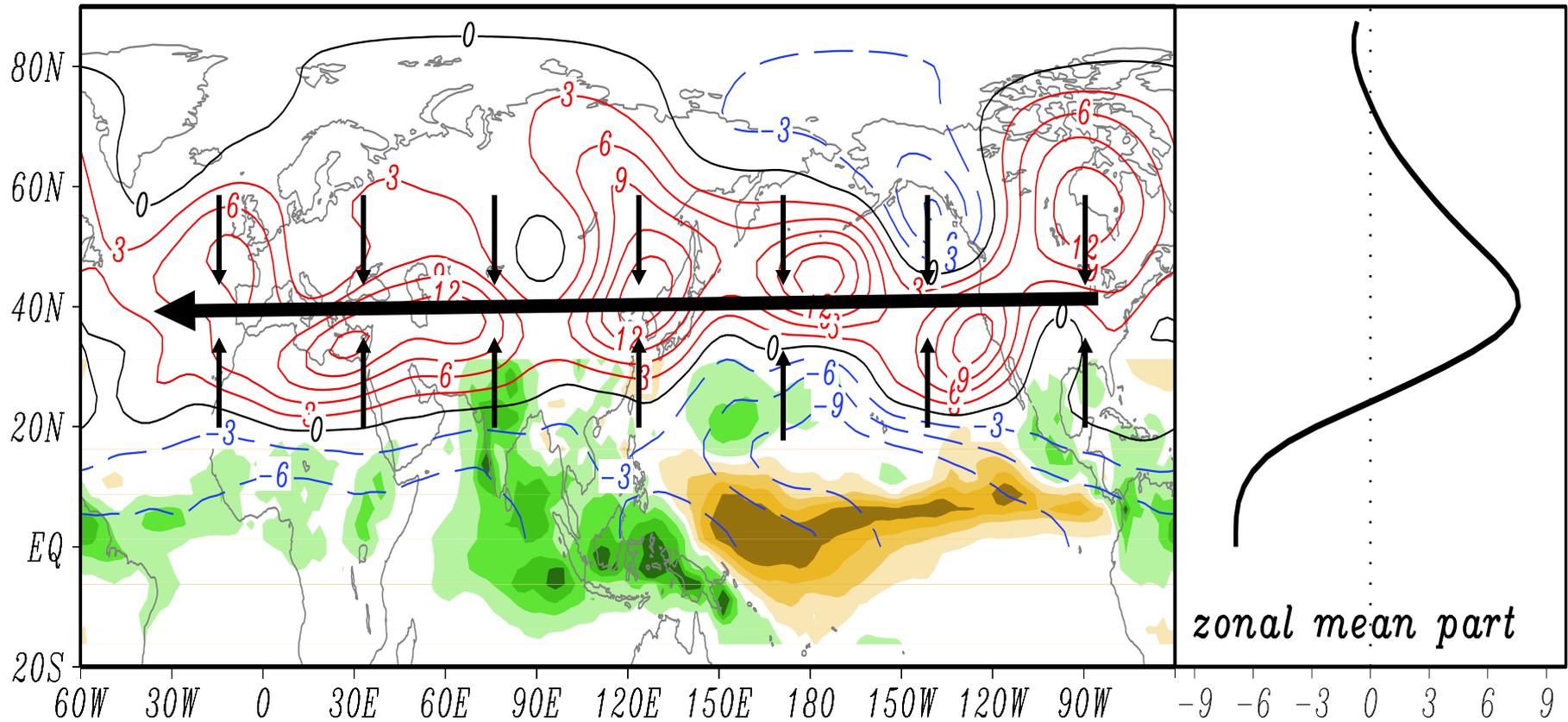
weak

homogeneous

Role of ENSO: Zonally symmetric component

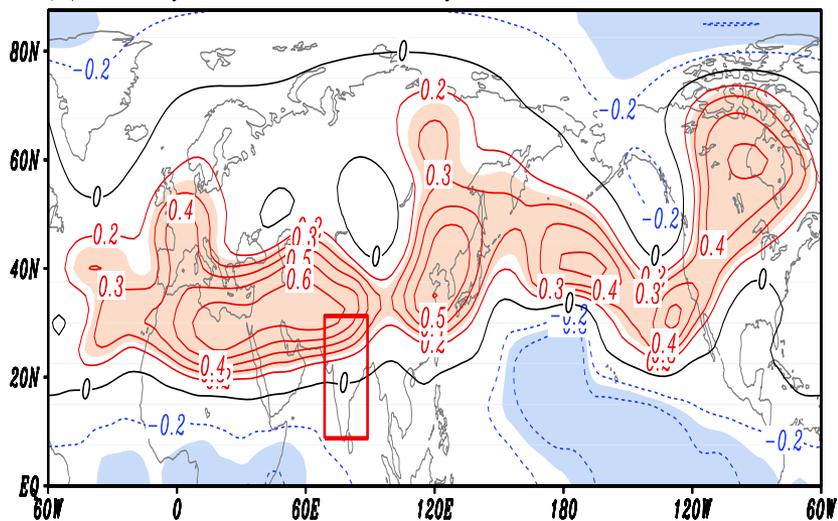


Theory of Seager et al 2003

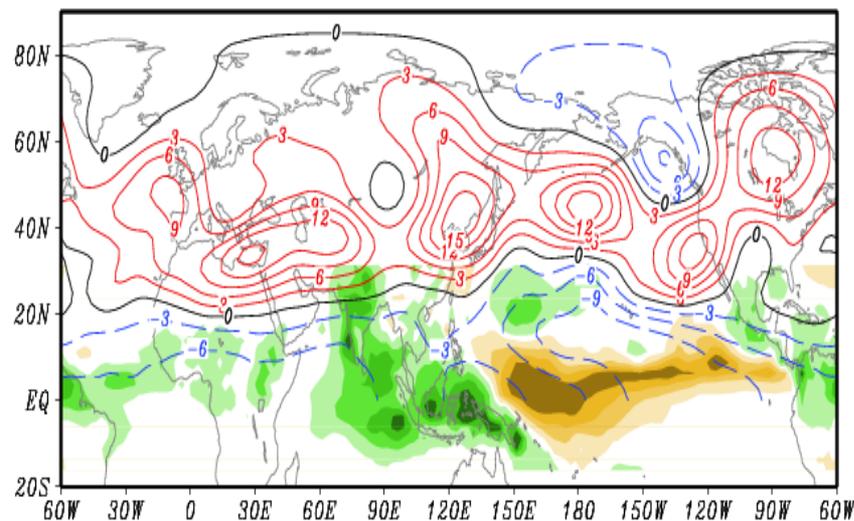


Role of monsoon: Zonally asymmetric component

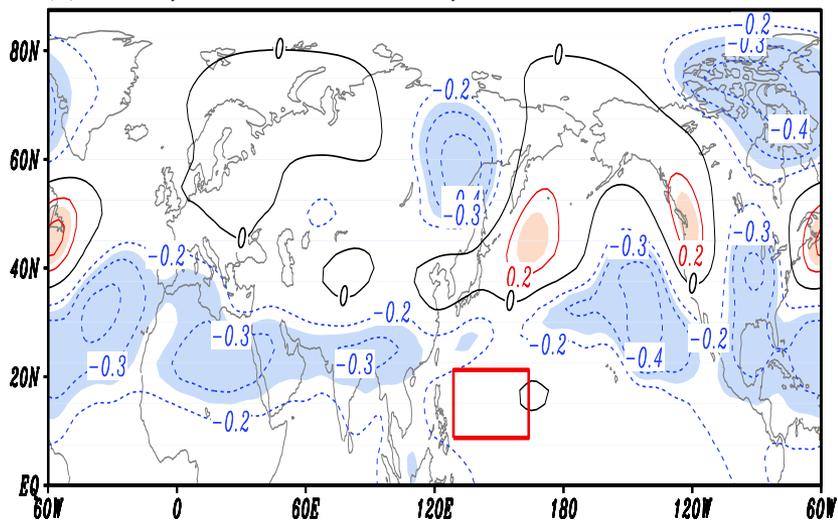
(a) Corr. of GH200 with ISM rainfall



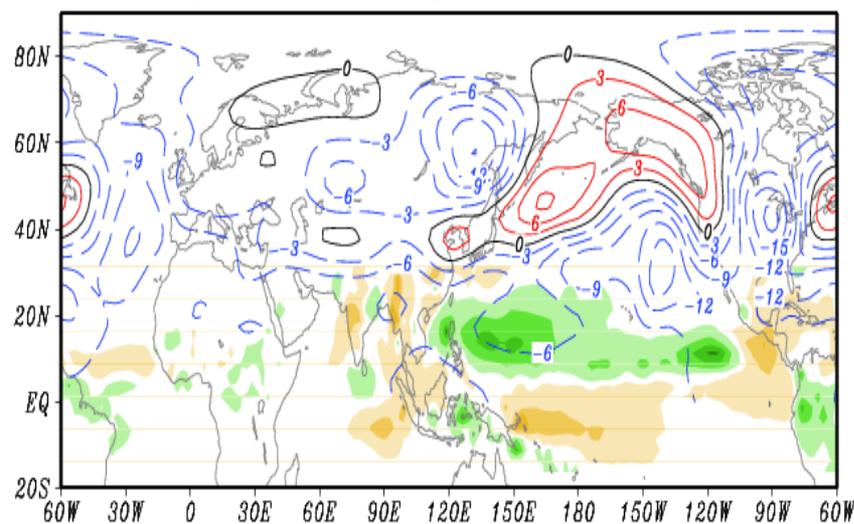
(a)SVD1 (GH200 and rainfall) SCF=60% Corr=0.80



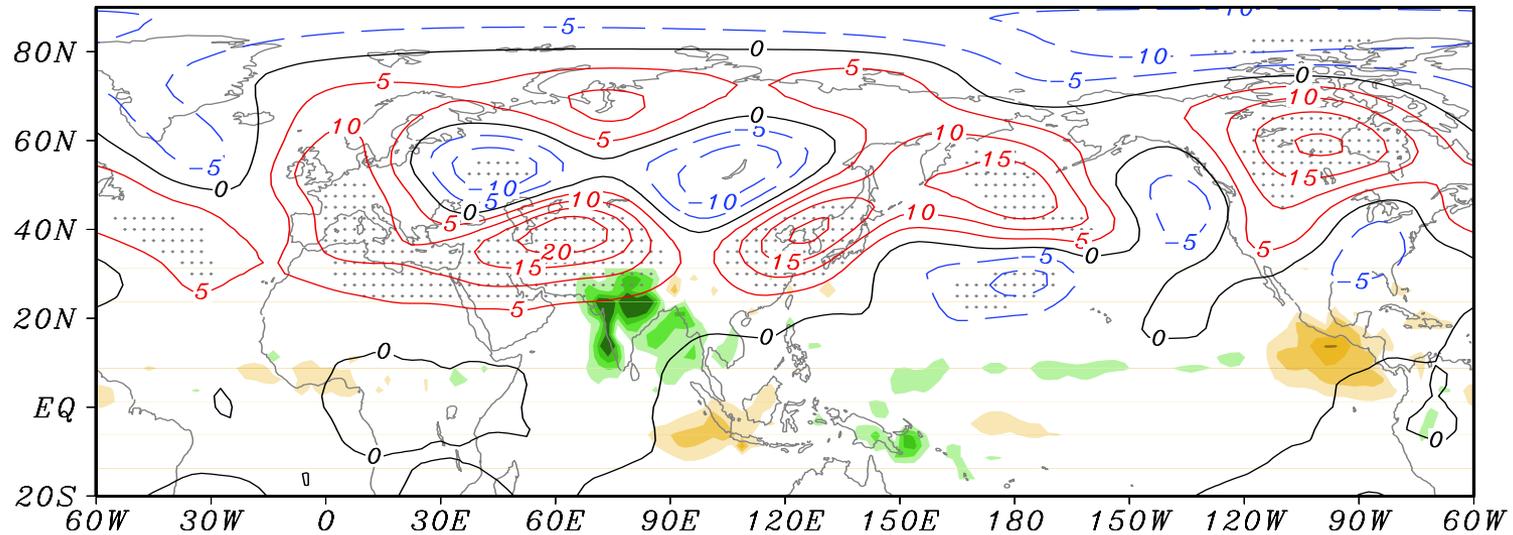
(b) Corr. of GH200 with WNP rainfall



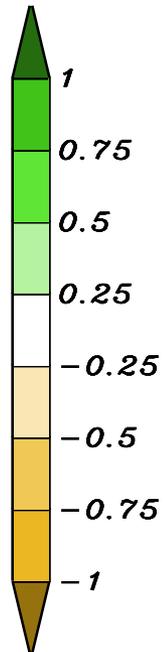
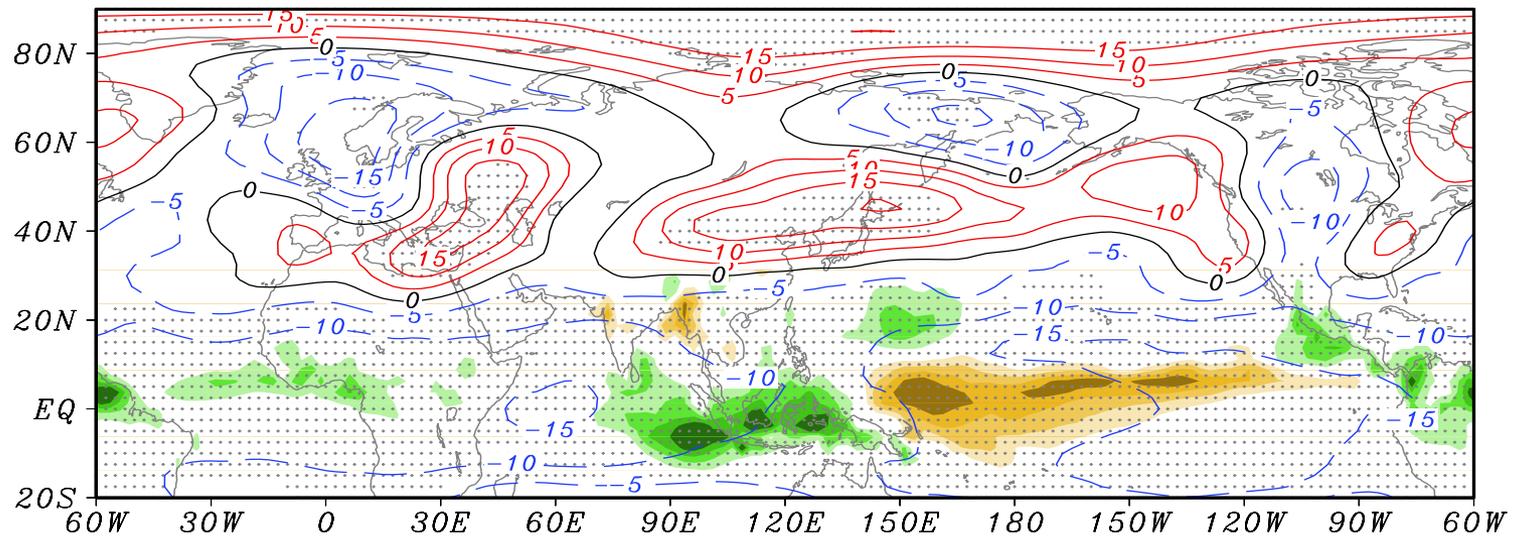
(b)SVD2 (GH200 and rainfall) SCF=17% Corr=0.64



(a) Composite Z200 and PREC for ISM/no ENSO

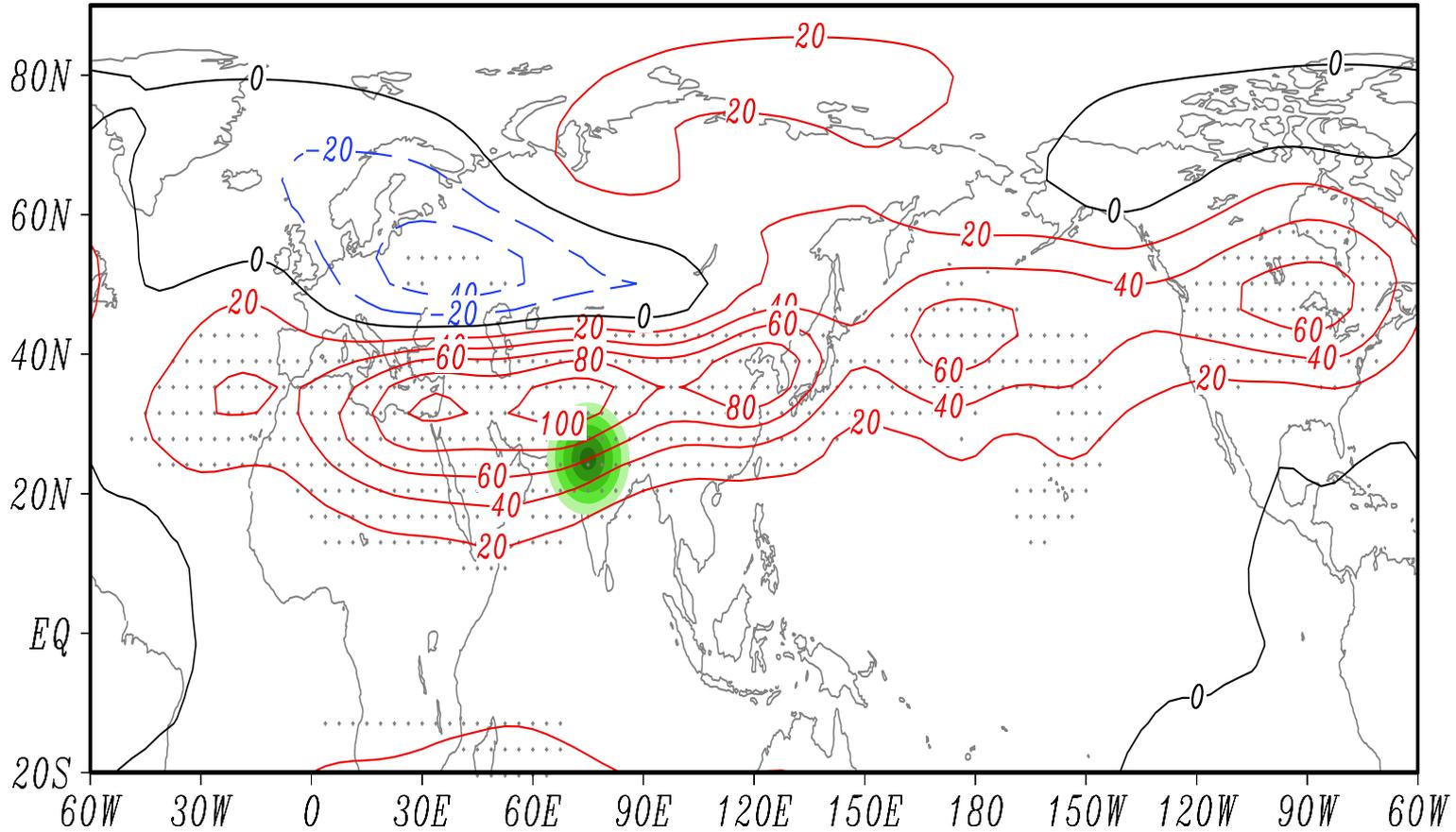


(b) Composite Z200 and PREC for ENSO/no ISM

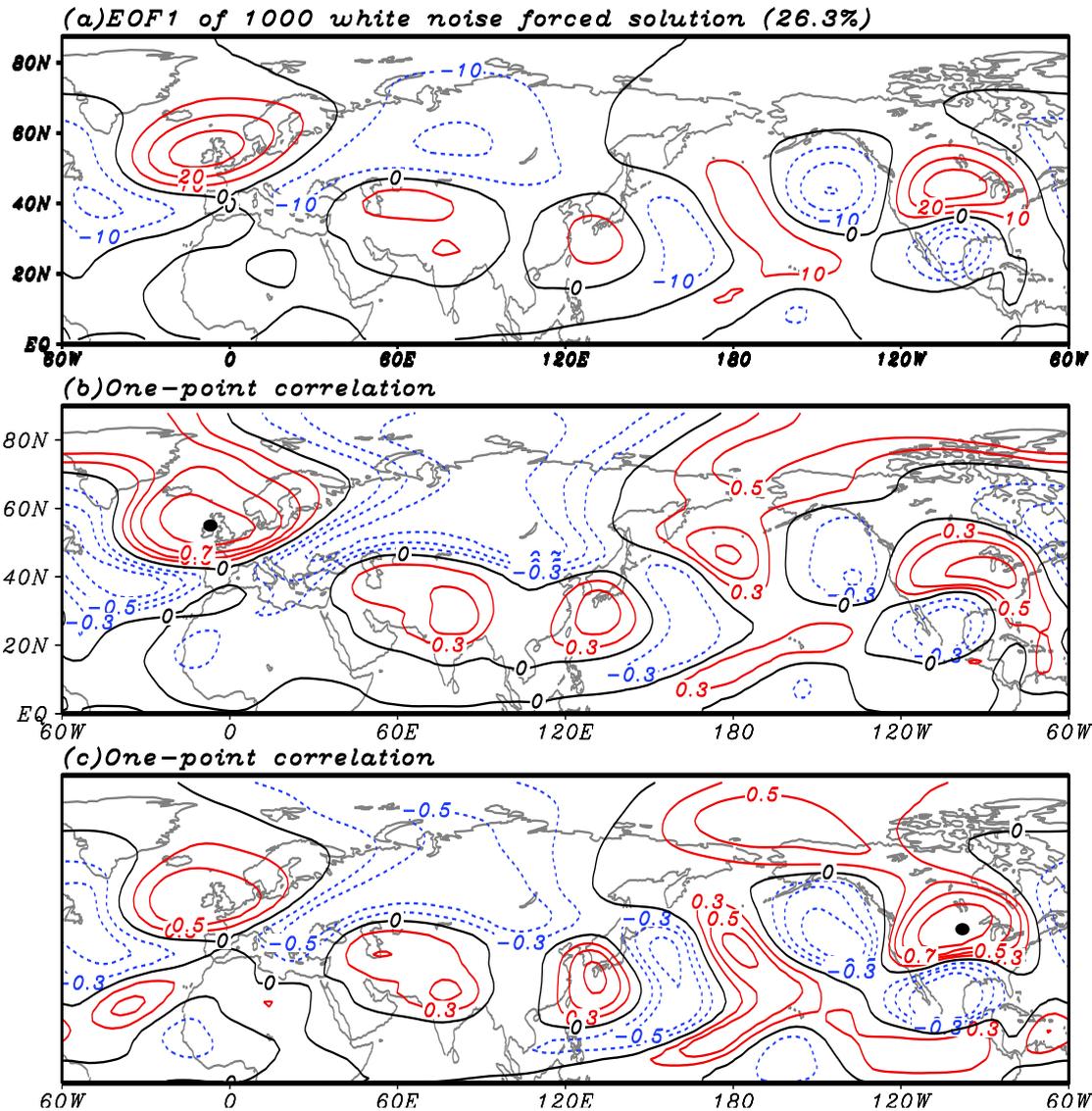


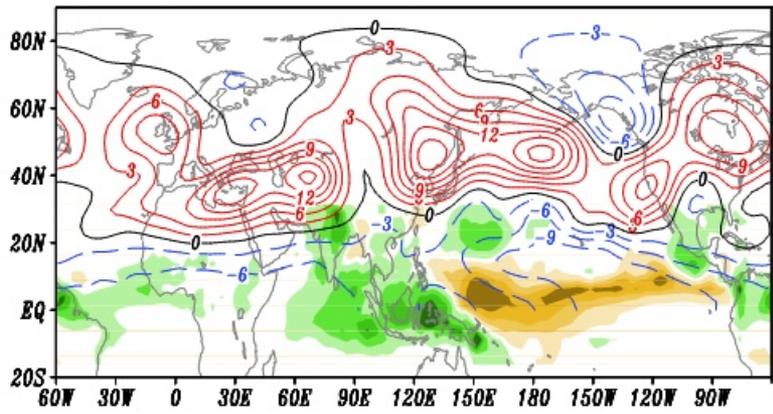
ECHAM response to ISM heating: model show CGT pattern

(a) ISM heating and ECHAM response (JJAS GH200)



Barotropic model response to 1000 white noise forcing

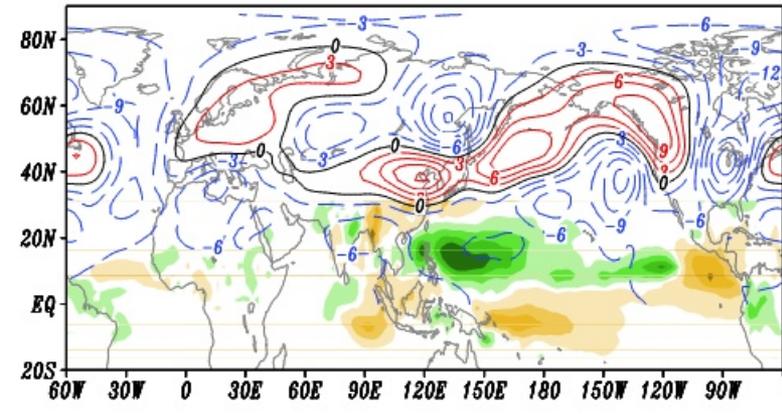




**CGT wave
pattern**
↑
**ISM
anomalies**

**Zonally symmetric
seesaw pattern**
↑
**developing
ENSO
anomalies**

JJA(0)



**WPNA wave
pattern**
↑
**WNPSM
anomalies**

**Hemispheric
uniform pattern**
↑
**decaying
ENSO
anomalies**

JJA(1)