The Interdecadal change of winter climate over China

XiaoJing Jia

ZheJiang University, HangZhou,China

Oct,24,2016 @Valencia,Spain

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Atmospheres

RESEARCH ARTICLE

10.1002/2015JD023583

Key Points:

- A climate shift of the second EOF of SAT over EA is observed in the mid-1980s
- The relationship between SAT-EOF2 and ENSO is significantly increased after 1980
- It is due to the interdecadal change of tropical SST anomalies and the mean flow

Correspondence to:
X. Jia,
jiaxiaojing@zju.edu.cn

Citation:
Jia, X., H. Lin, and J. Ge (2015), The interdecadal change of ENSO impact on wintertime East Asian climate, *J. Geophys. Res. Atmos.*, *120*, doi:10.1002/2015JD023583.

Received 24 APR 2015
Accepted 28 OCT 2015
Accepted article online 2 NOV 2015

The interdecadal change of ENSO impact on wintertime East Asian climate

XiaoJing Jia[1,2], Hai Lin[3], and JingWen Ge[1]

[1]Department of Earth Sciences, ZheJiang University, HangZhou, China, [2]State Key Laboratory of Numerical Modelling for Atmospheric Sciences and Geophysical Fluid Dynamics, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China, [3]Atmospheric Numerical Weather Prediction Research, Environment Canada, Dorval, Québec, Canada

Abstract The interdecadal change in the relationship between the winter mean surface air temperature (SAT) over East Asia (EA) and the El Niño–Southern Oscillation (ENSO) is investigated using both observational data and a simple general circulation model. The positive phase of the first empirical orthogonal function (EOF) of SAT over EA is characterized by significant warming over midlatitude to high-latitude EA and is linked to the Arctic Oscillation. The second EOF (SAT-EOF2) is represented by significant cooling extending from 55°N to the tropics and abnormal warming over high-latitude EA. Focus is given to SAT-EOF2 which has a close relationship with the La Niña-type sea surface temperature (SST) anomalies. A clear shift in SAT-EOF2 is observed in the mid-1980s. The relationships between SAT-EOF2 and ENSO in two subperiods, i.e., 1957 to 1982 (P1) and 1986 to 2010 (P2), are discussed and compared. Results show that the relationship between SAT-EOF2 and ENSO significantly strengthens after the mid-1980s due to stronger SST and precipitation anomalies in P2 than in P1 associated with ENSO in the tropical western Pacific. In the midlatitudes, the Pacific-North American teleconnection pattern is more closely related to ENSO in P2, whereas in P1, the ENSO-related atmospheric circulation anomalies are more similar to a zonally orientated teleconnection pattern. Numerical experiments suggest that the difference in the ENSO-related circulation anomaly in the midlatitudes is likely related to the difference in the climatological mean flows of these two subperiods.

Clim Dyn
DOI 10.1007/s00382-015-2970-x

CrossMark

The interdecadal change of the leading mode of the winter precipitation over China

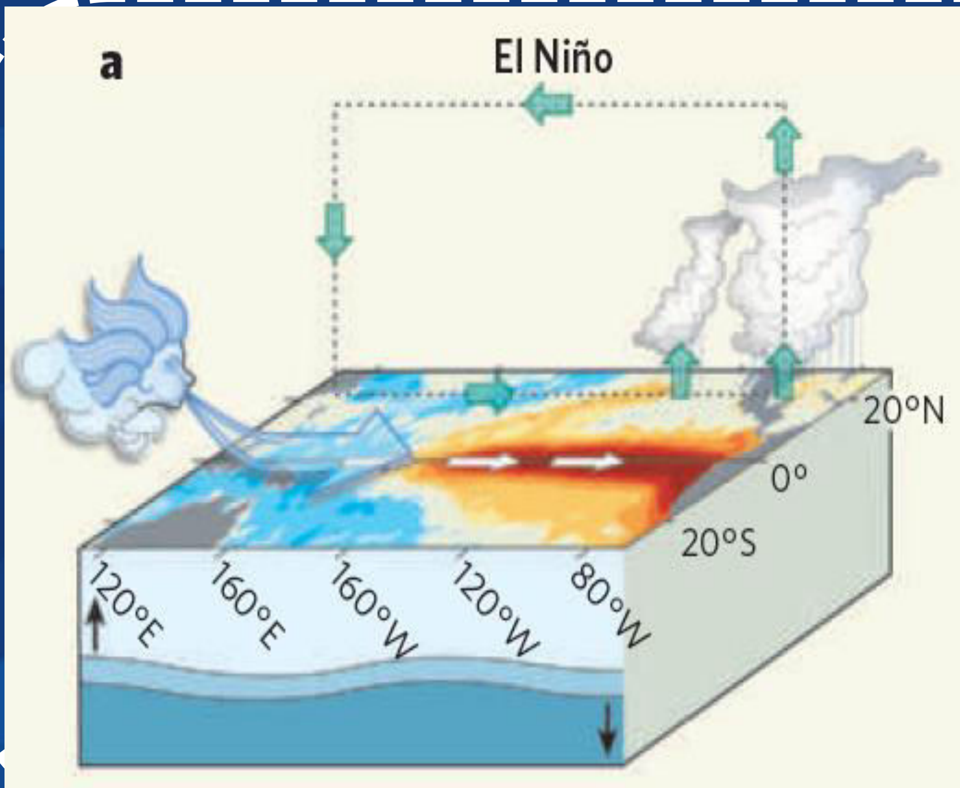
Jingwen Ge[1] · Xiaojing Jia[1,2] · Hai Lin[3]

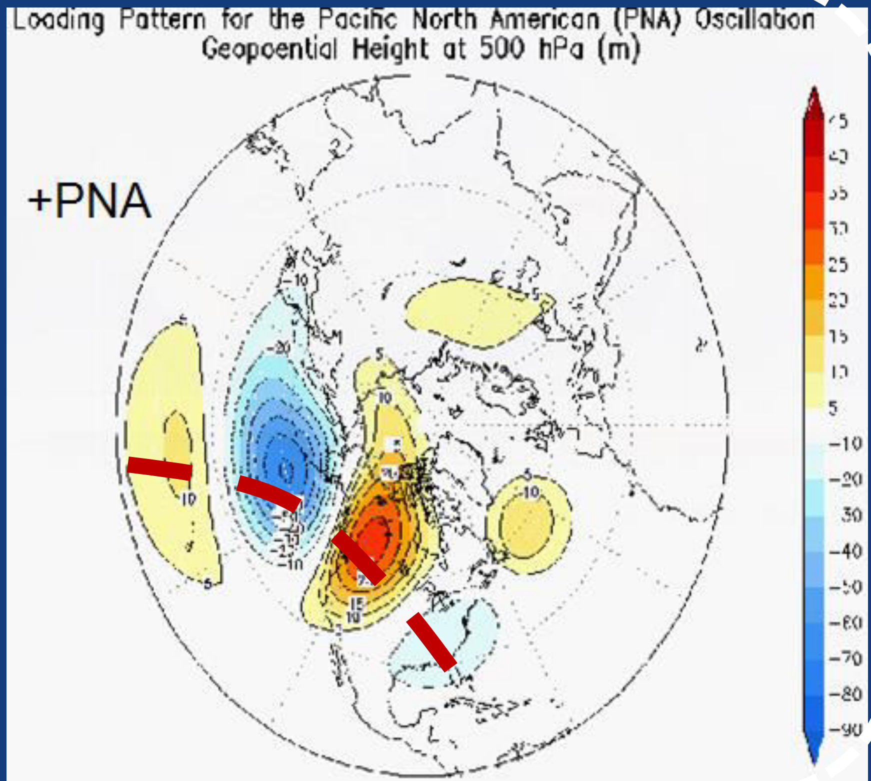
Received: 12 August 2015 / Accepted: 29 December 2015

Abstract The interdecadal change of the leading mode of the mean winter precipitation over China has been investigated using observational data for the period from 1960 to 2012. The leading empirical orthogonal function (EOF) mode (EOF1) of the winter precipitation over China displays a mono-sign pattern over southeastern China, accounting for 49.7 % of the total variance in the precipitation. Both the El Niño-Southern Oscillation (ENSO) and the East Asian winter monsoon (EAWM) can impact EOF1. A positive (negative) EOF1 is accompanied by warm (cold) ENSO events and weak (strong) EAWM, and the latters can cause anomalous southerlies (northerlies) along the coast of southeastern China, accompanied by the transportation of water vapor from the Bay of Bengal and the South China Sea favoring a wet (dry) winter over southeastern China. An abrupt transition of the EOF1 is observed around the mid-1980s. Therefore, the data are divided into two subperiods, i.e., 1960–1987 (P1) and 1988–2009 (P2). Significant differences in the large scale atmospheric circulation and sea surface temperature anomalies associated with EOF1 during these two subperiods are observed. EOF1 is closely related to the mid- to high-latitude atmospheric circulation in P1, while its relationship to the tropics obviously increases during P2. The partial regression analysis results show that the interdecadal change of EOF1 is caused by both the interdecadal changes of the EAWM and ENSO around the mid-1980s. In P1, the lower-level anomalous southerlies along the coastal southeastern China accompanied by water vapor transportation that causes above-average precipitation are related to an anti-cyclonic system centered over the mid-latitude western North Pacific associated with EAWM. In P2, the influence of the EAWM is weaker, and the southerly anomaly over the coastal southeastern China is mainly caused by the anticyclone over Philippines, which is related to the ENSO.

Keywords Interdecadal change · Leading mode · Winter precipitation · EAWM · ENSO

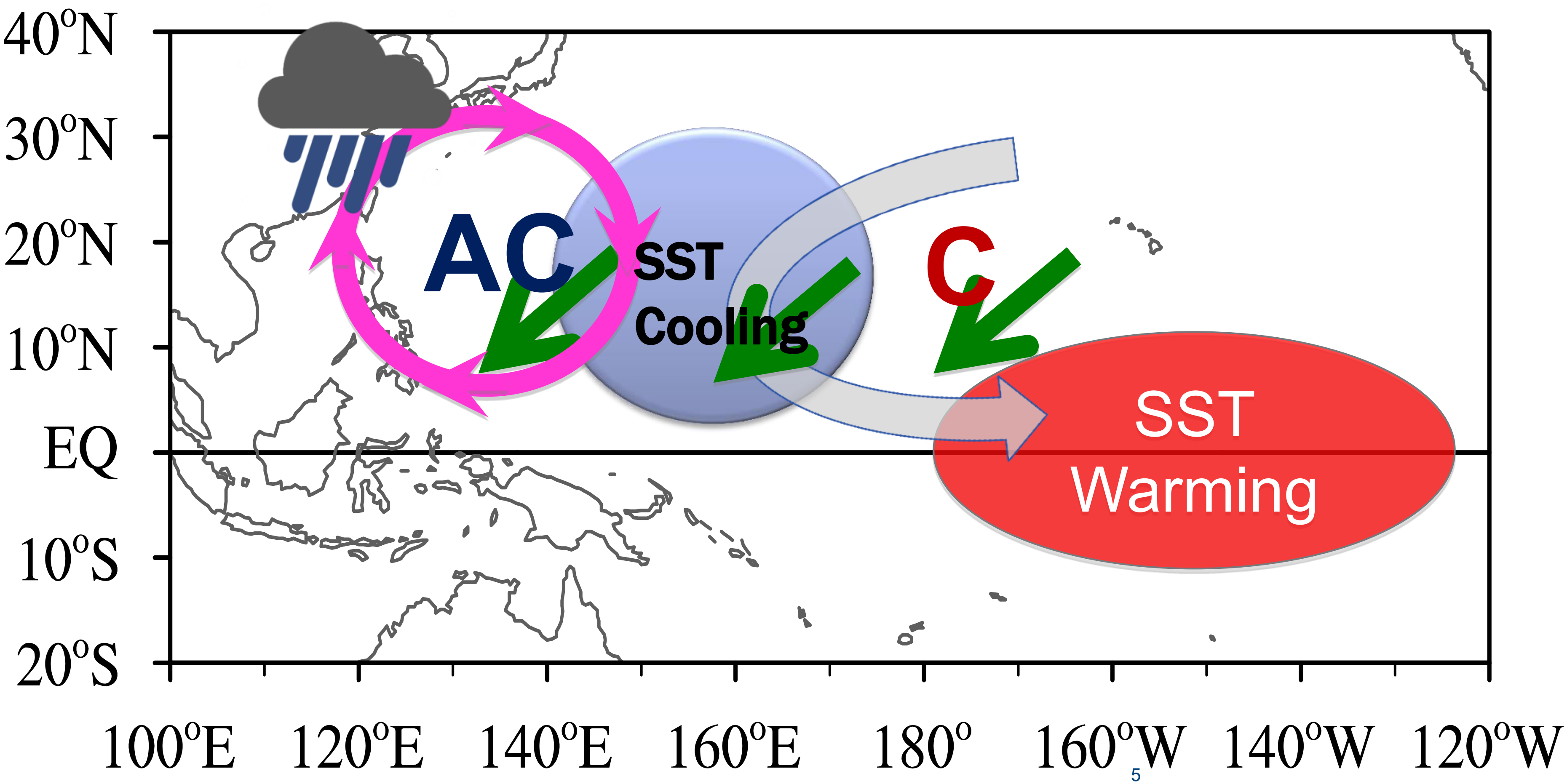
Content


a
El Niño
20°N
0°
20°S
120°E
160°E
160°W
120°W
80°W

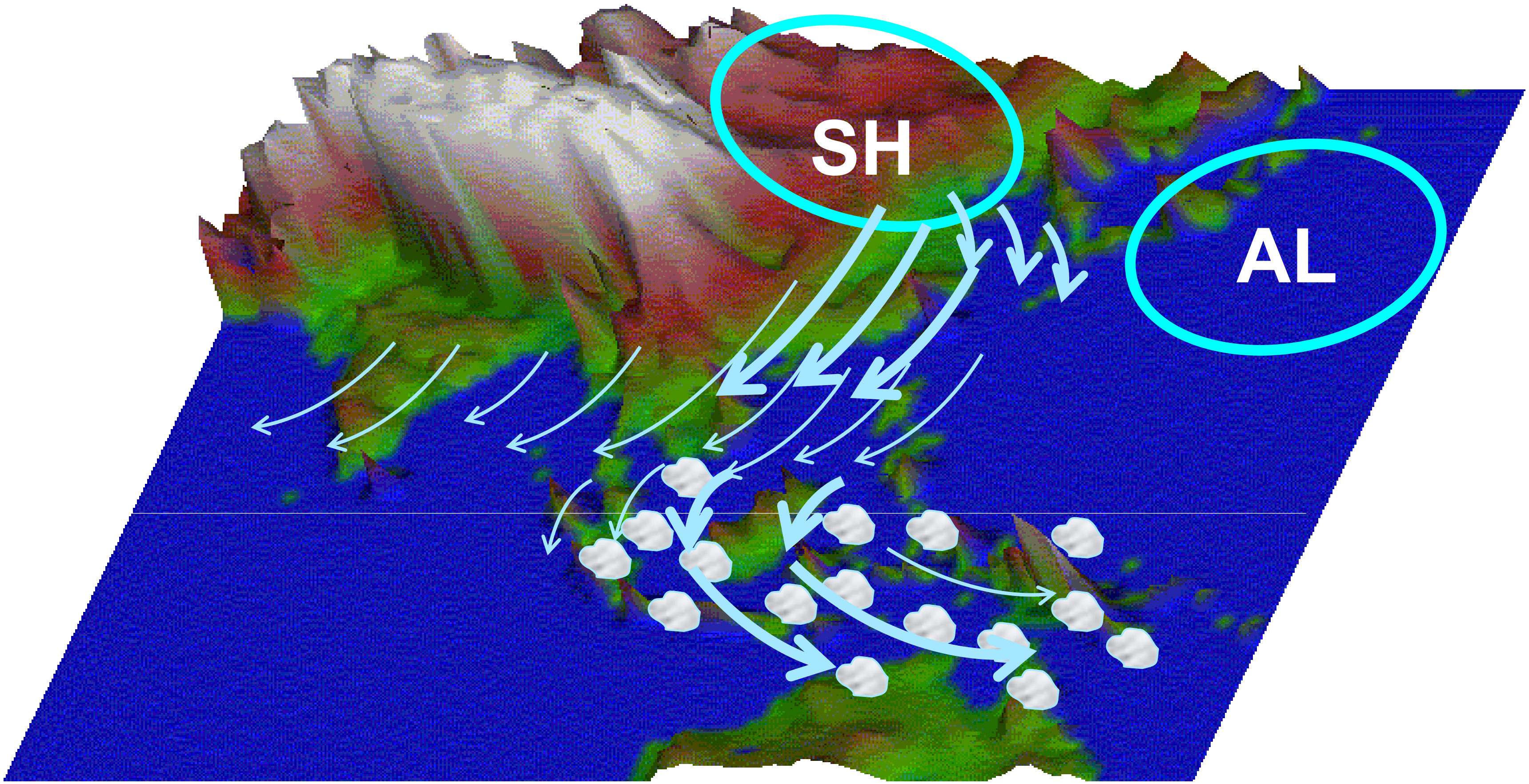

Loading Pattern for the Pacific North American (PNA) Oscillation
Geopoential Height at 500 hPa (m)
+PNA

El Niño-Southern Oscillation

––– Western Pacific Anti-Cyclone (WPAC)



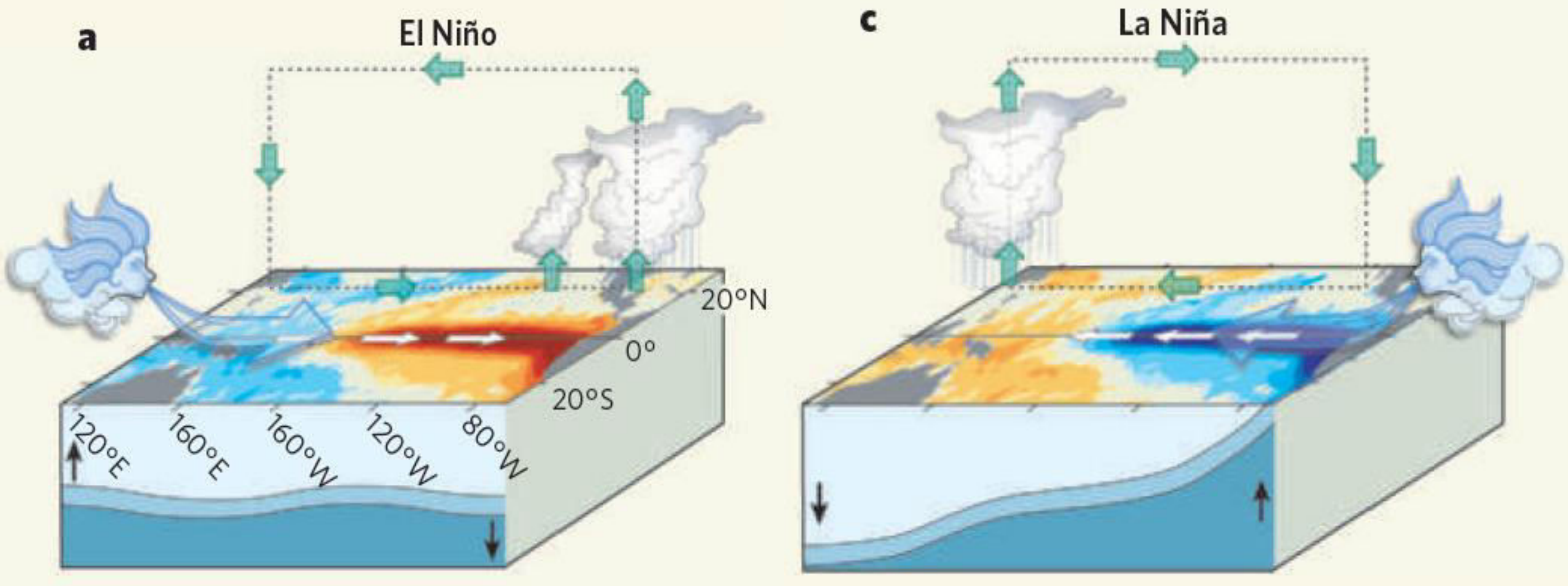
EAWM circulation system:



- The El Niño-Southern Oscillation (ENSO) is regarded as the most important factor that influences the **East Asian winter Monsoon.**

El Niño —— warm and wet

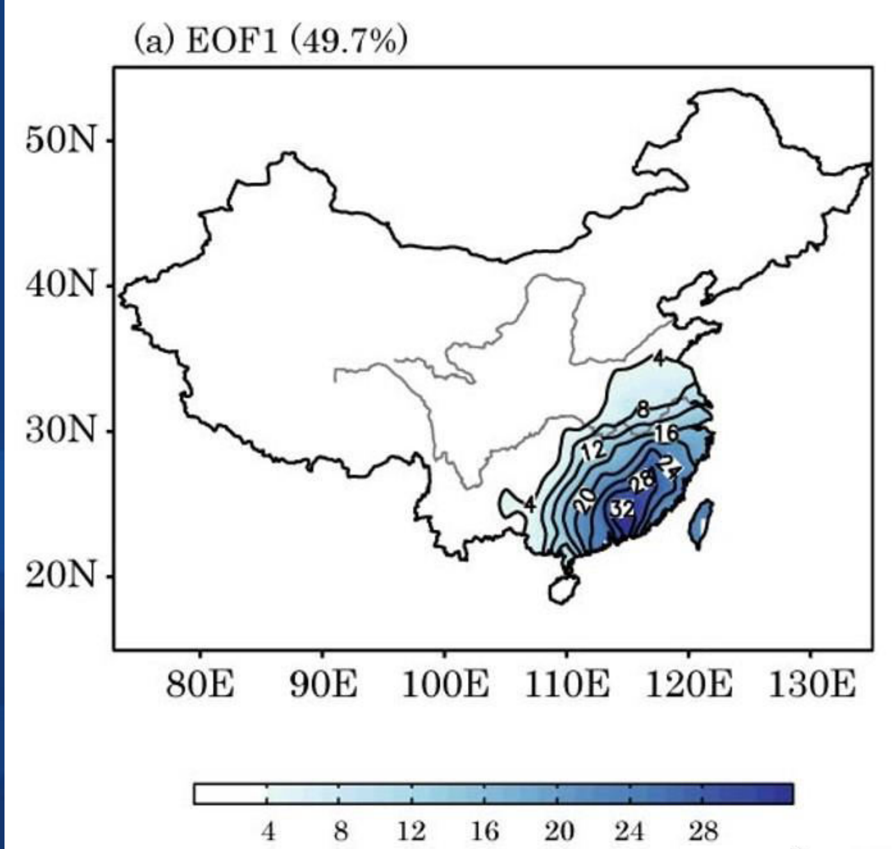
La Niña —— cold and dry

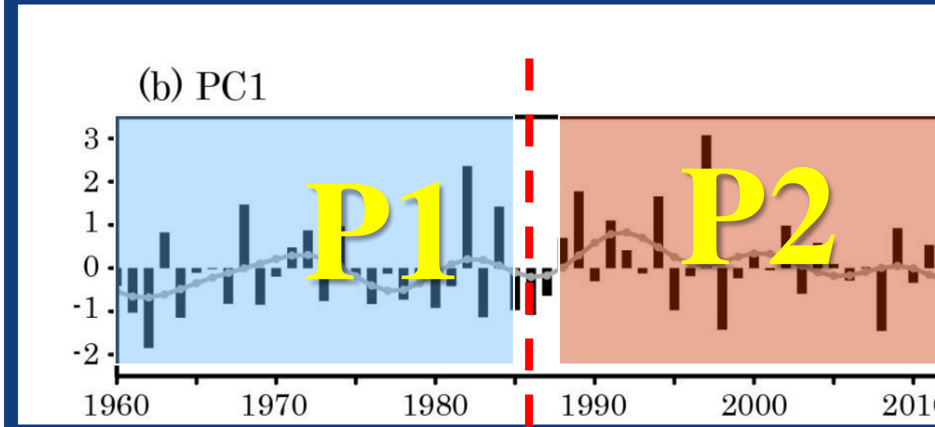


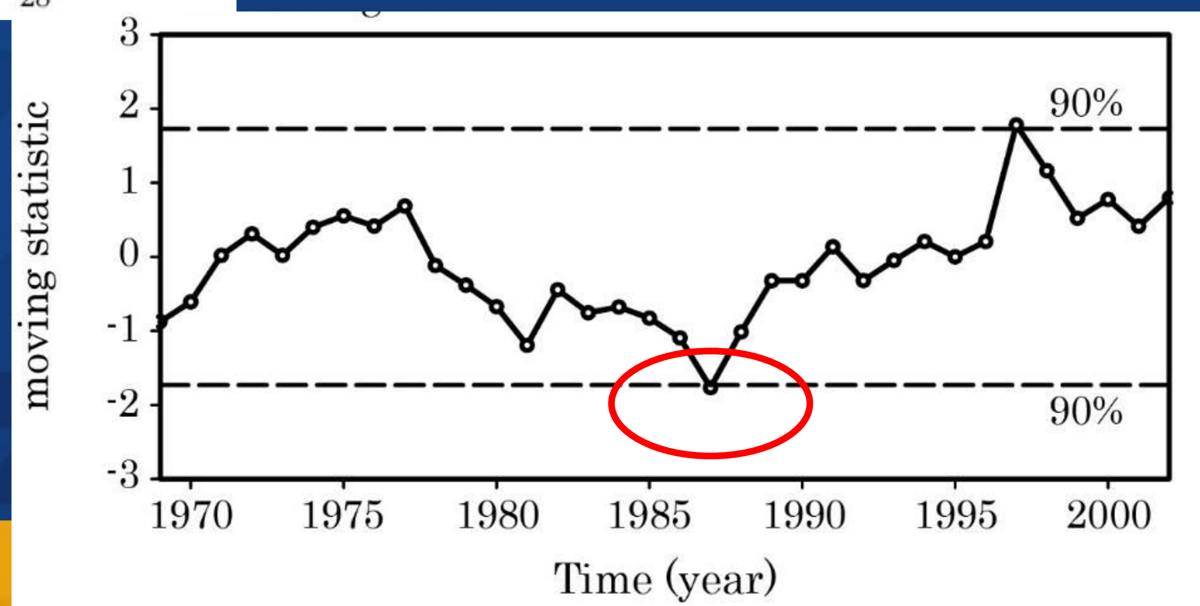
(From Ashok and Yamagata 2009)

Content

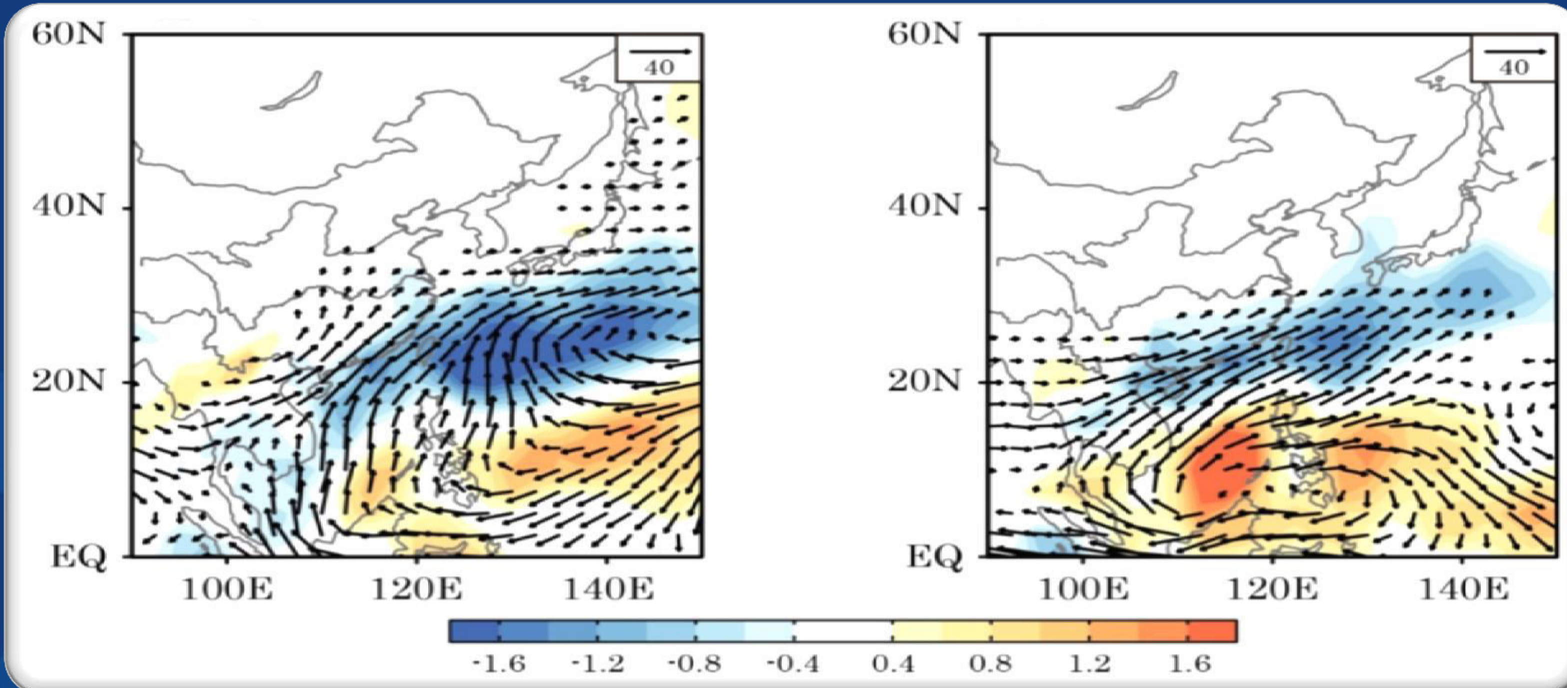
- Background
- The interdecadal change of the winter precipitation over China
- Interdecadal change in the contribution of ENSO and EAWM to the precipitation
- Summary


(a) EOF1 (49.7%)
50N
40N
30N
20N
80E
90E
100E
110E
120E
130E
4
8
12
16
20
24
28
32
4
8
12
16
20
24
28

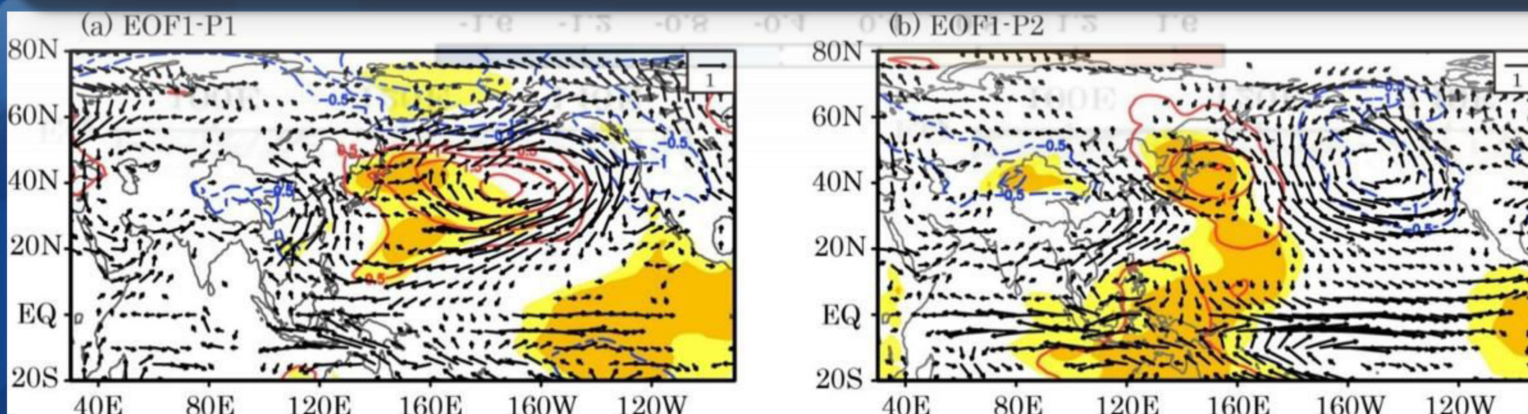

(b) PC1
P1
P2
3
2
1
0
-1
-2
1960
1970
1980
1990
2000
2010


moving statistic
Time (year)
3
2
1
0
-1
-2
-3
90%
90%
1970
1975
1980
1985
1990
1995
2000

Z500



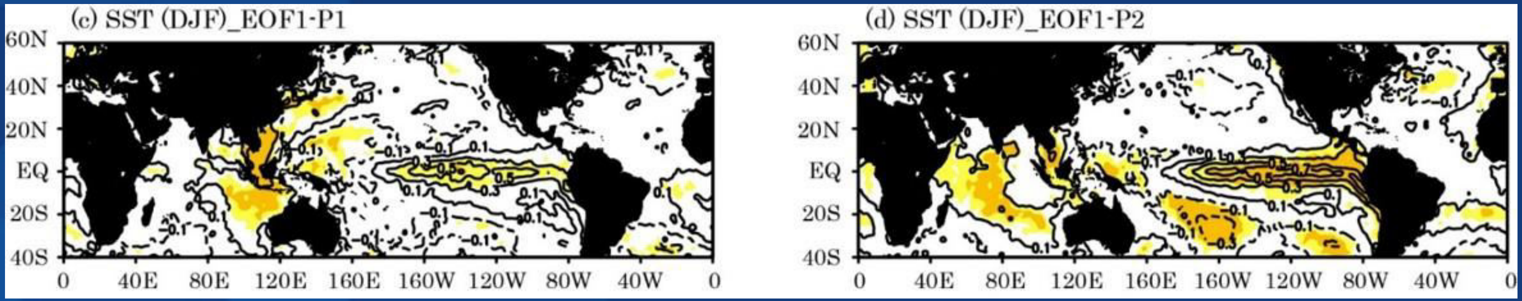
SLP



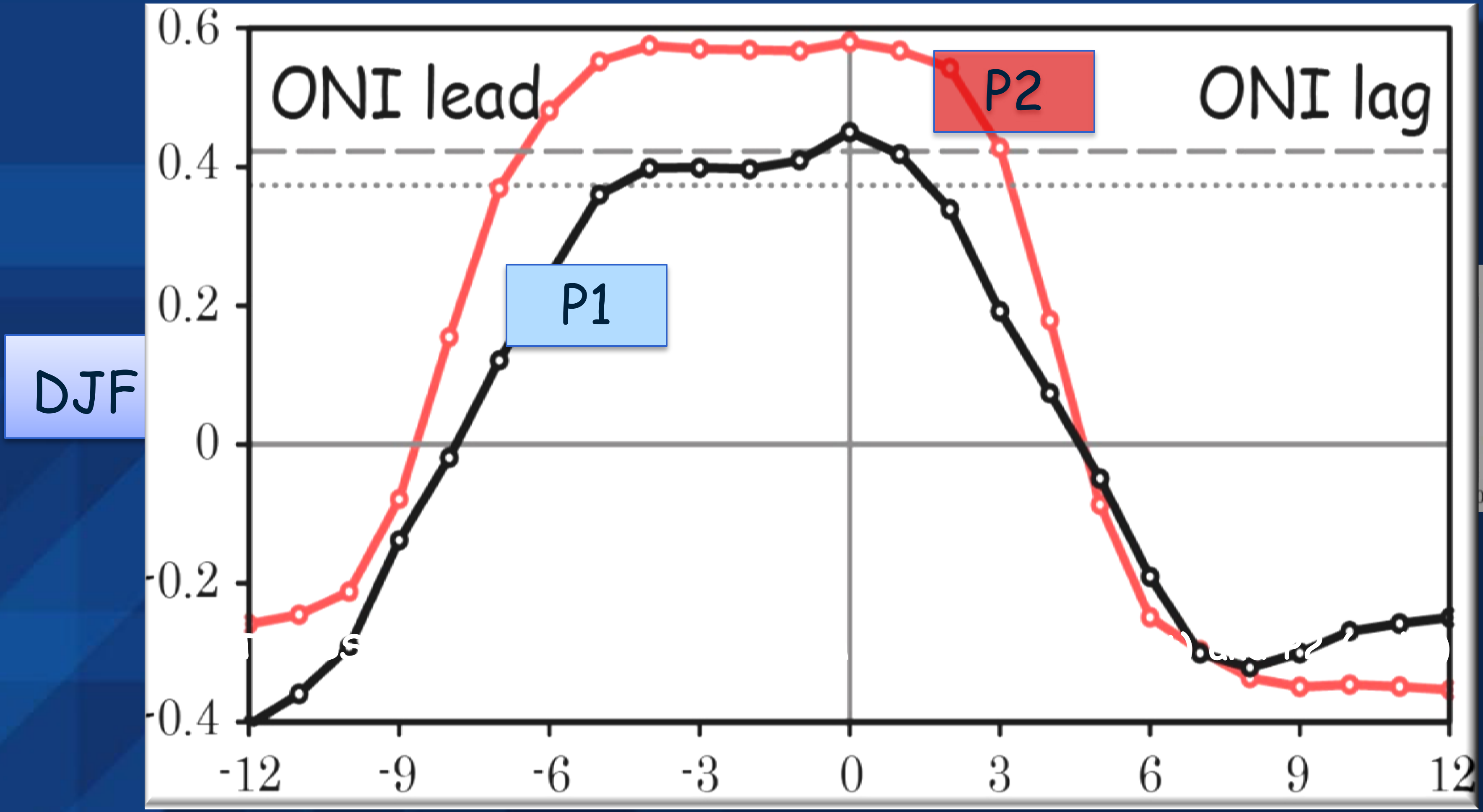
P1

P2

DJF



The SST anomalies associated with EOF1 for P1 (left) and P2 (right).


DJF
ONI lead
ONI lag
P1
P2
0.6
0.4
0.2
0
-0.2
-0.4
-12
-9
-6
-3
0
3
6
9
12

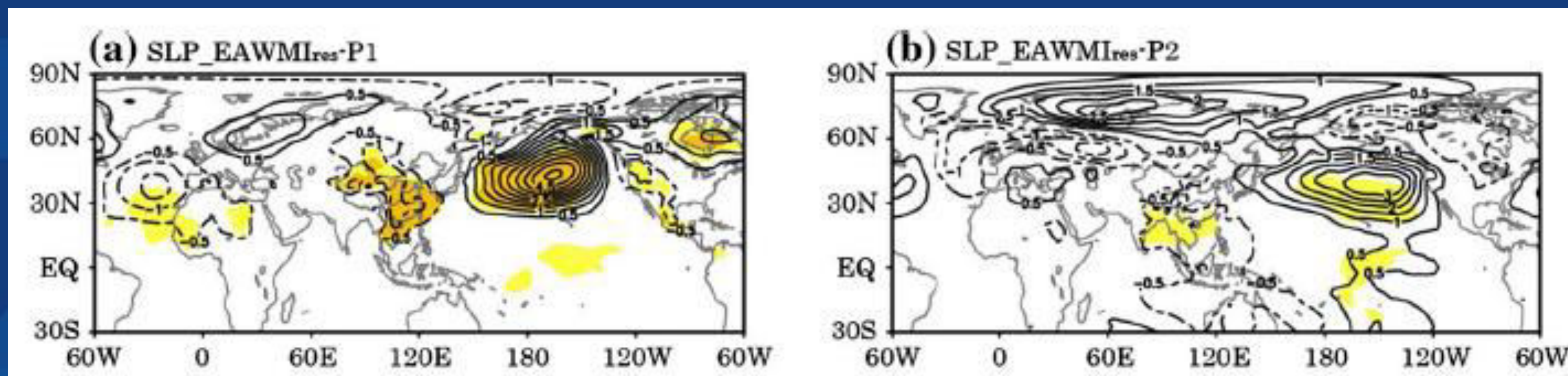
Content

The interdecdal change of ENSO_independent EAWM

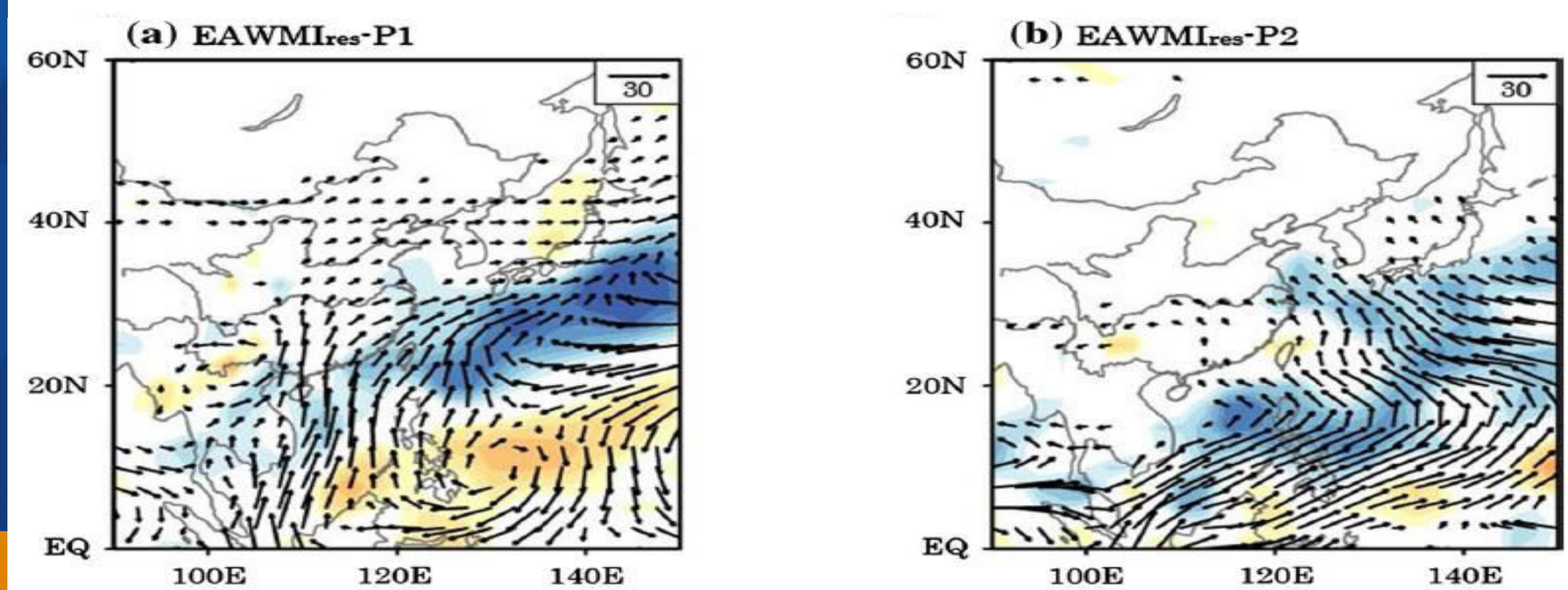
P1

P2

SLP



Moisture transport



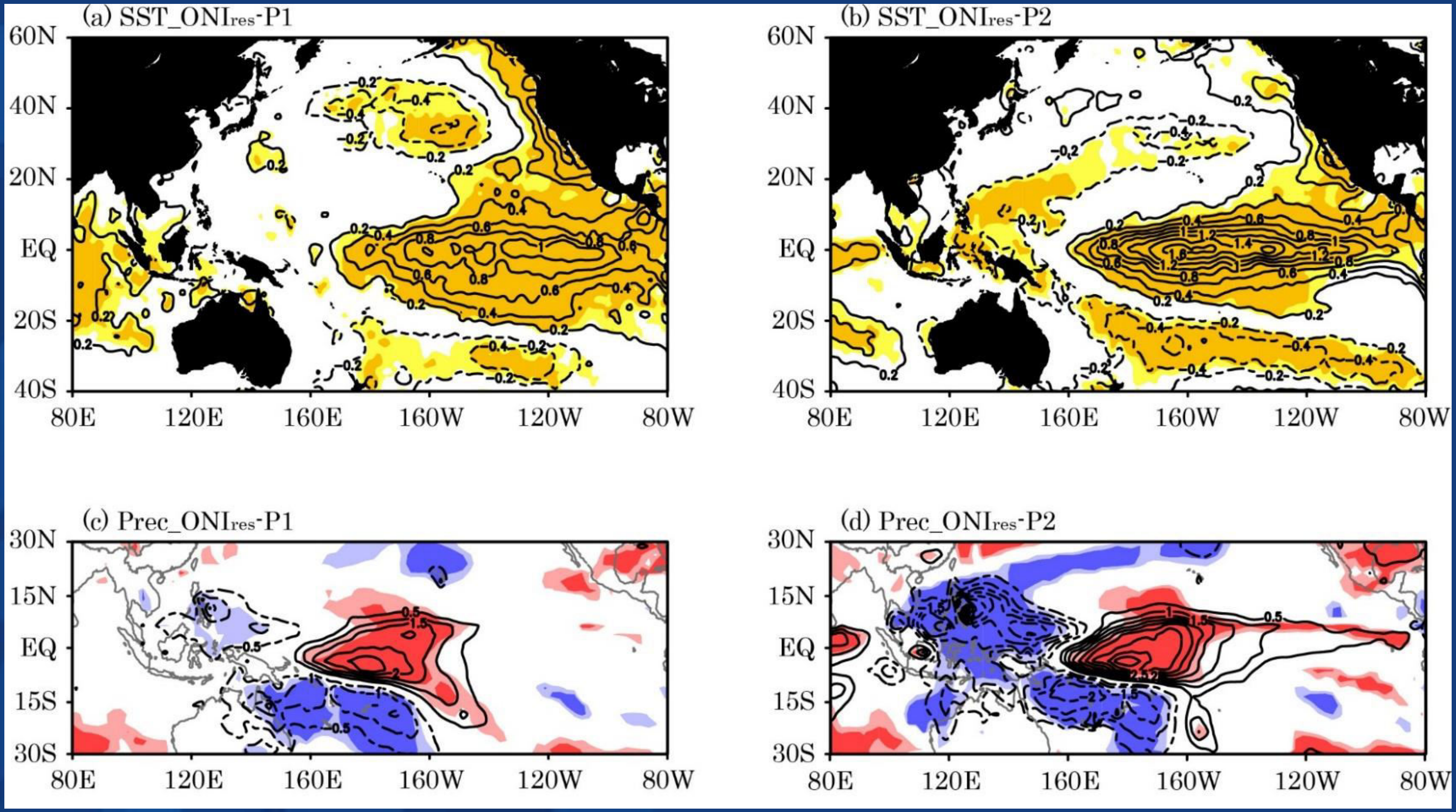
The interdecdal change of EAWM_independent ENSO

P1

P2

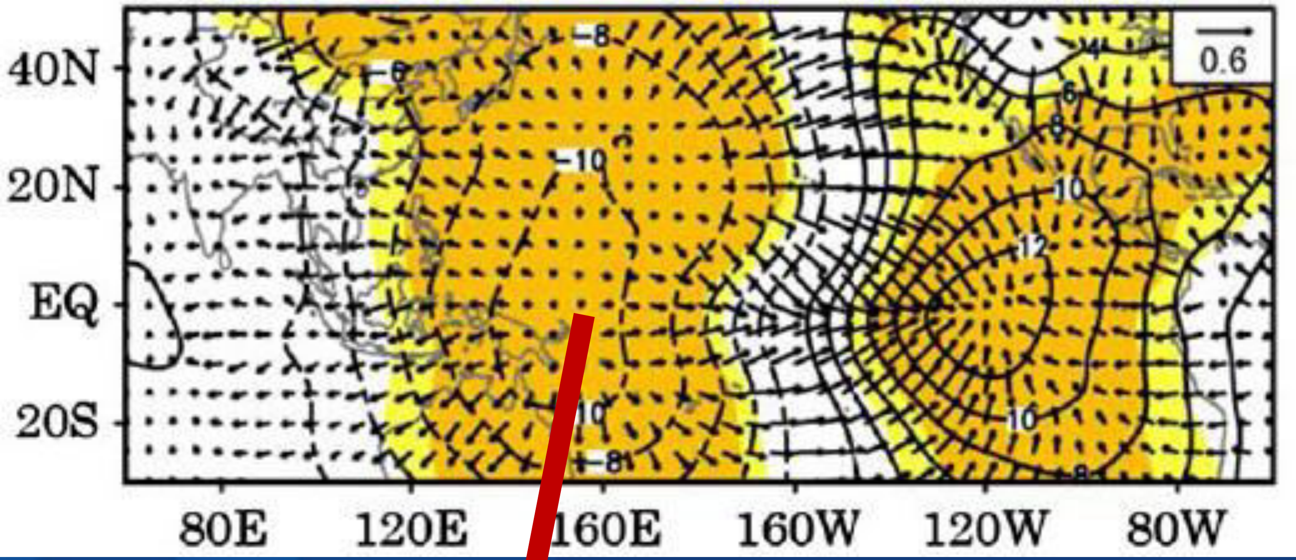
SST

Prec

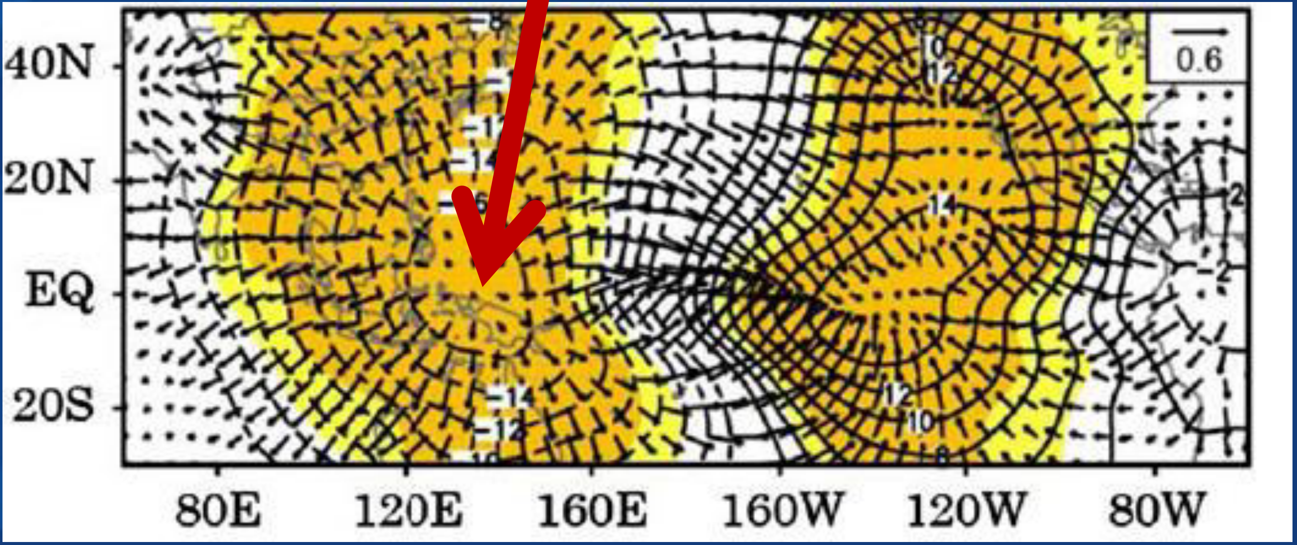


ENSO- covergence wind+VP (850hPa)

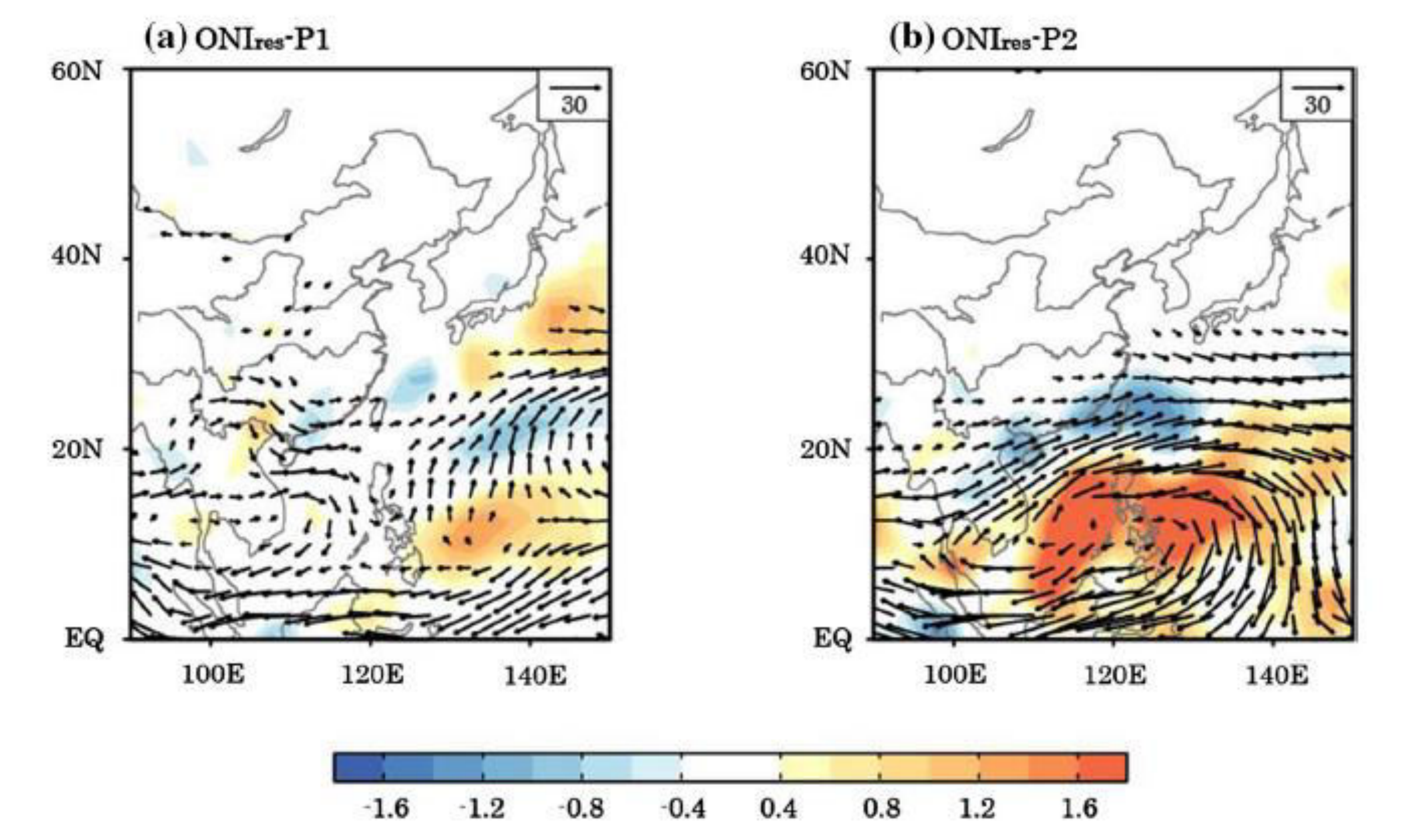
P1



P2



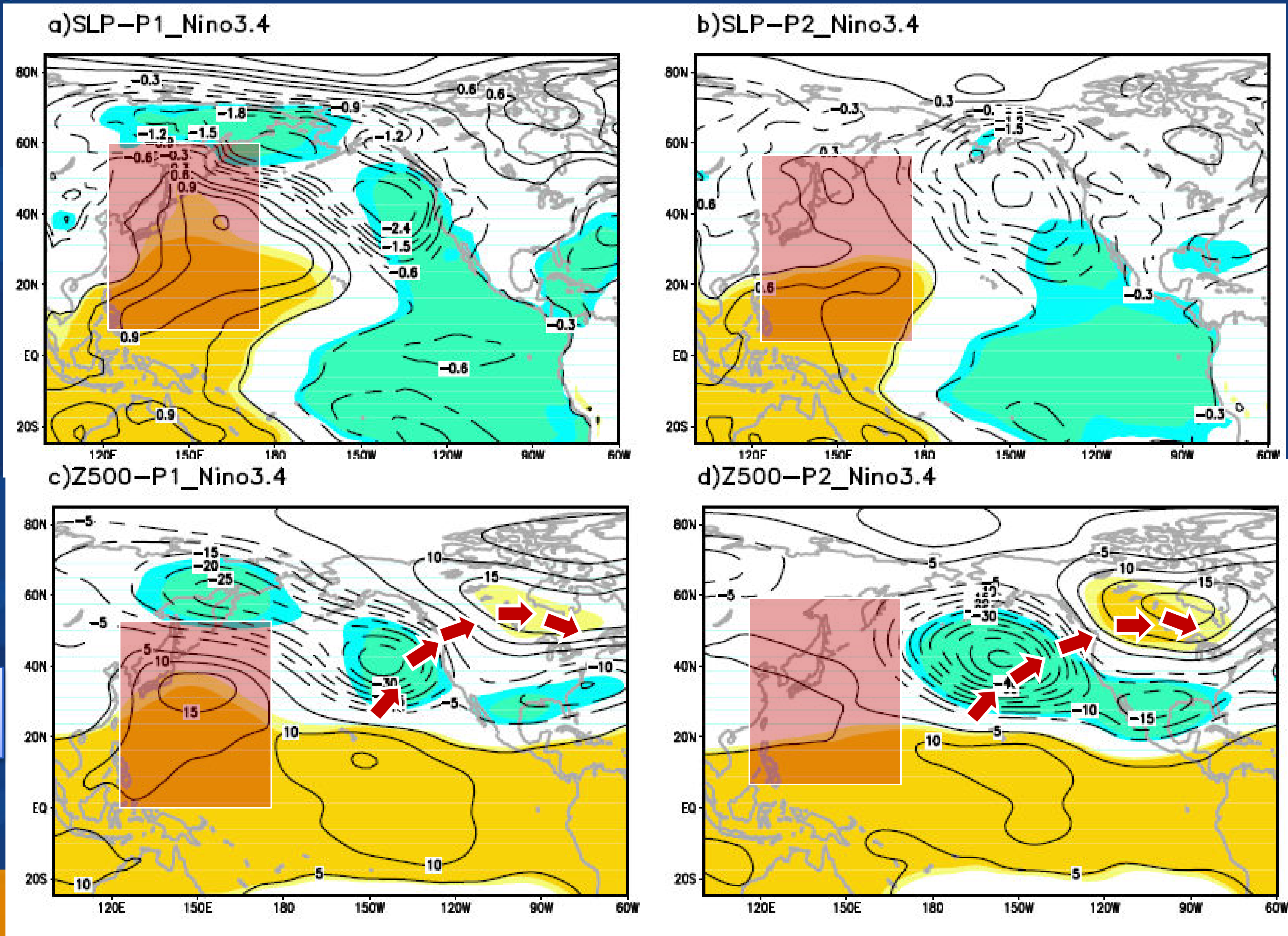
The interdecdal change of EAWM_independent ENSO



ENSO – related anomalies: mid- high latitudes SLP+Z500

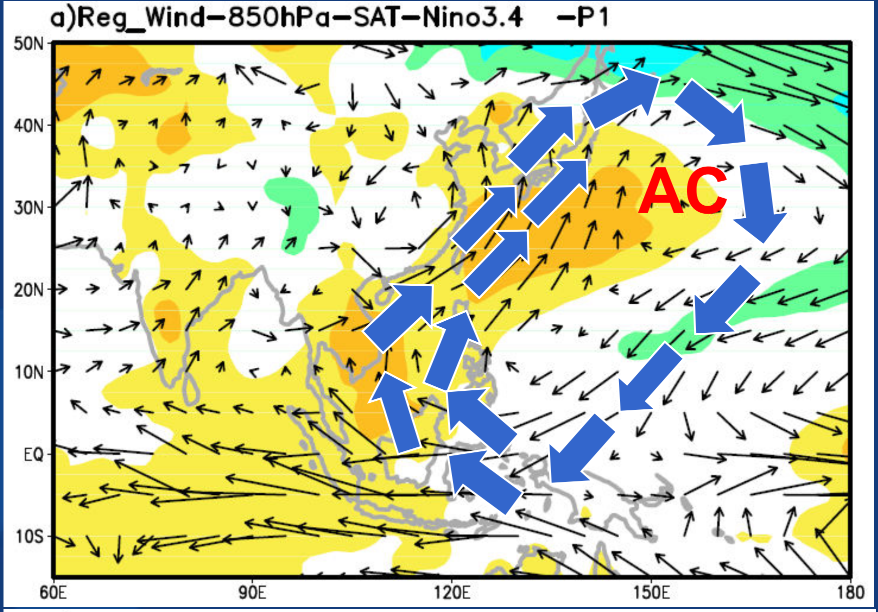
SLP

Z500

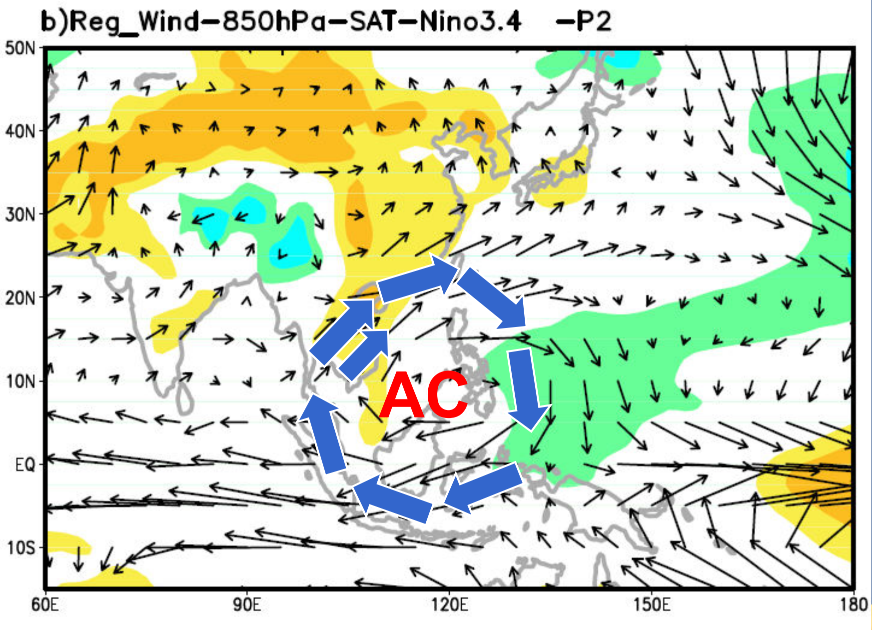


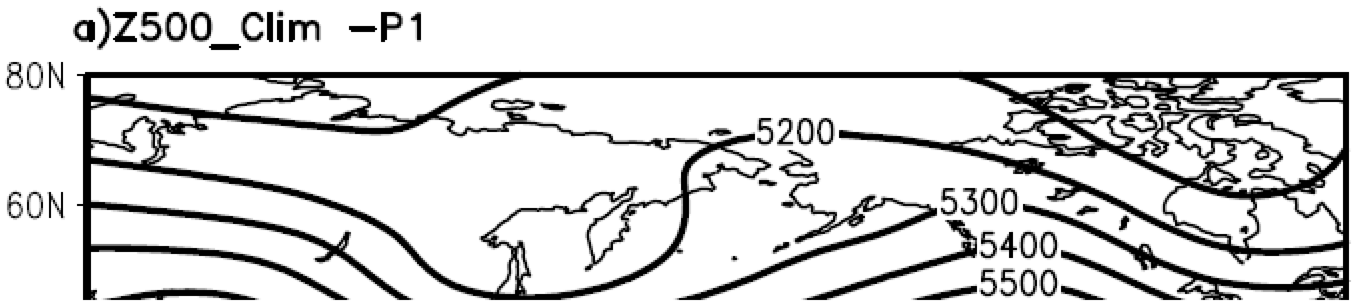
ENSO- covergence wind+SAT (850hPa)

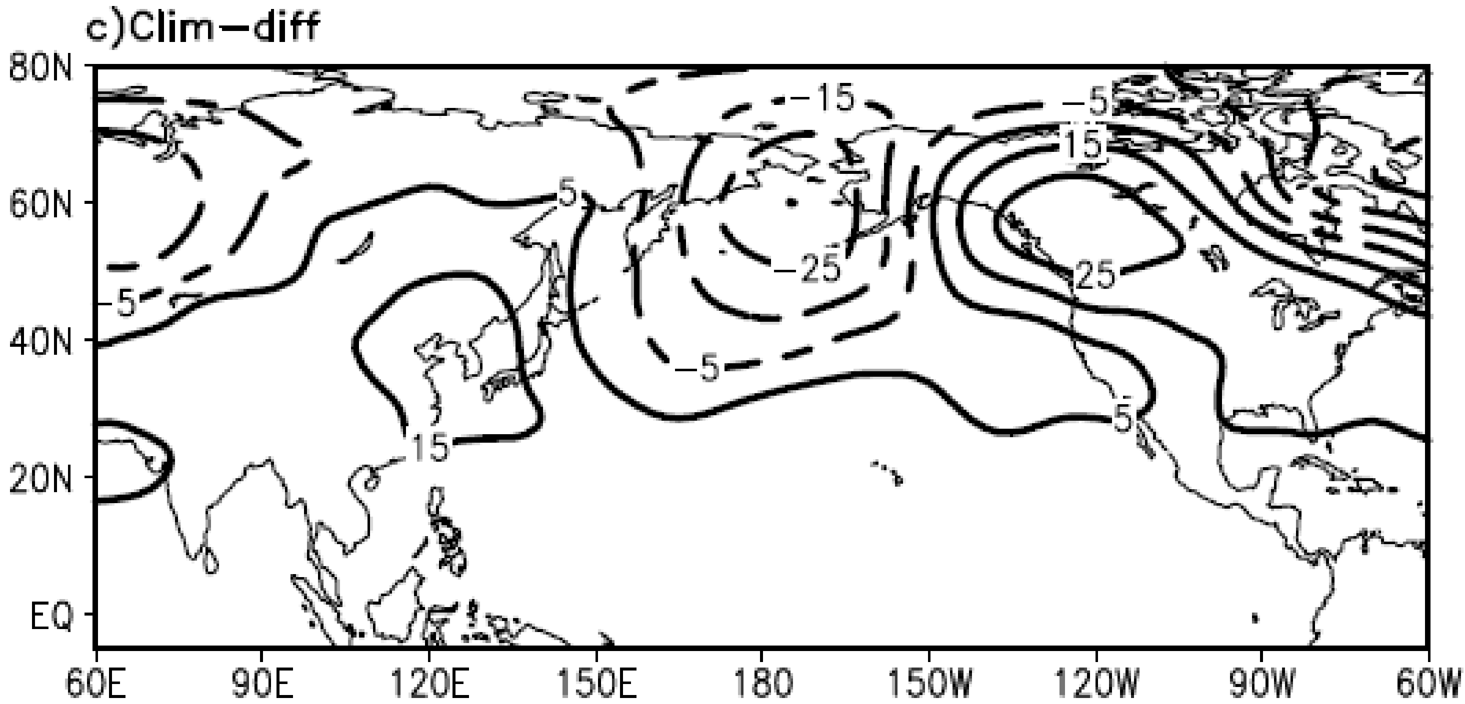
P1

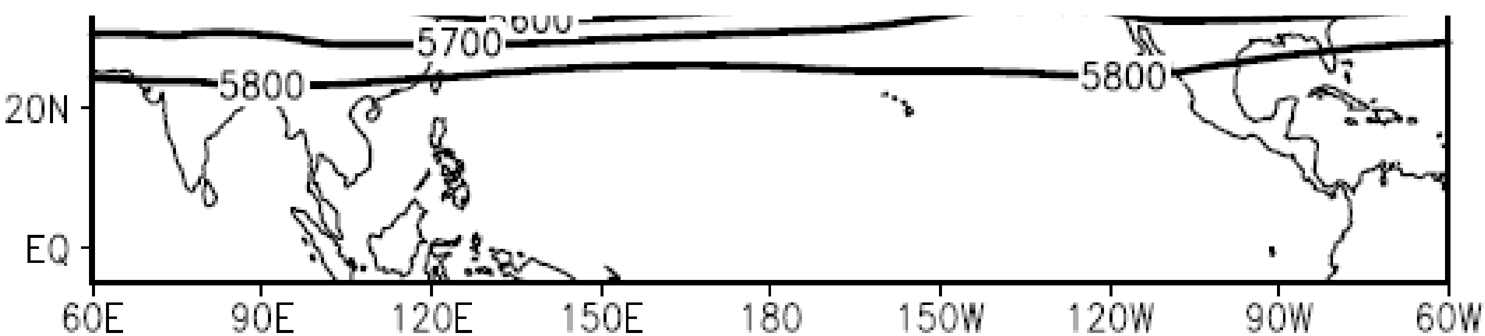


P2




a)Z500_Clim —P1
80N
60N
5200
5300
5400
5500


c)Clim—diff
80N
60N
40N
20N
EQ
60E
90E
120E
150E
180
150W
120W
90W
60W
−15
−5
15
5
−25
25
−5
5
−5
15
5


5700
5800
5800
20N
EQ
60E
90E
120E
150E
180
150W
120W
90W
60W

P1

P2-P1

P2

Simple General Circulation Model (SGCM)

* *Dry, Spectral, Primitive equation model*

-- --*Hall 2000*

**T31,10 equally spaced sigma levels, Global domain*

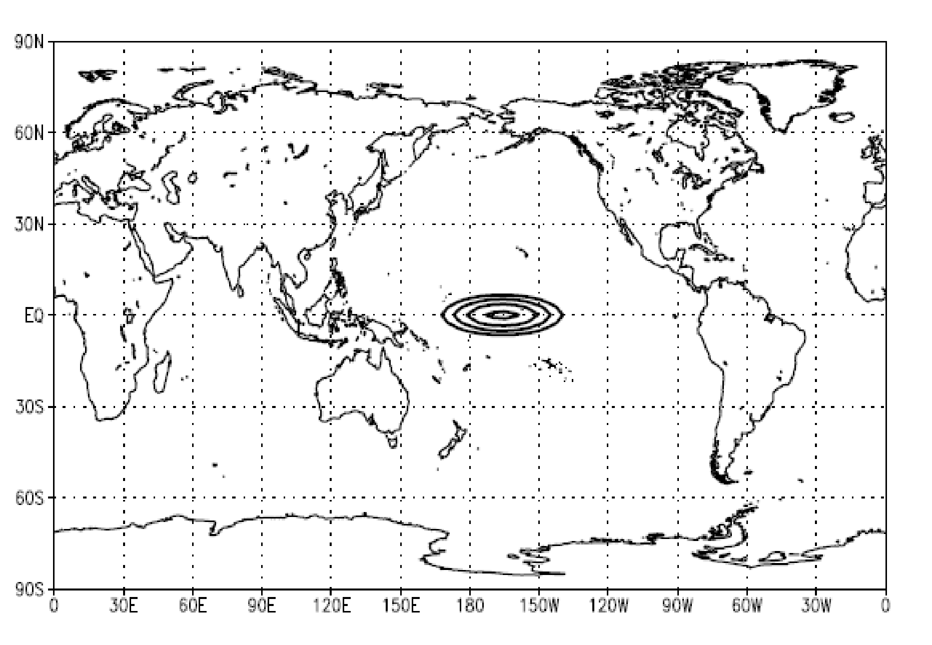
* *Emperical forcings calculated from observed data*

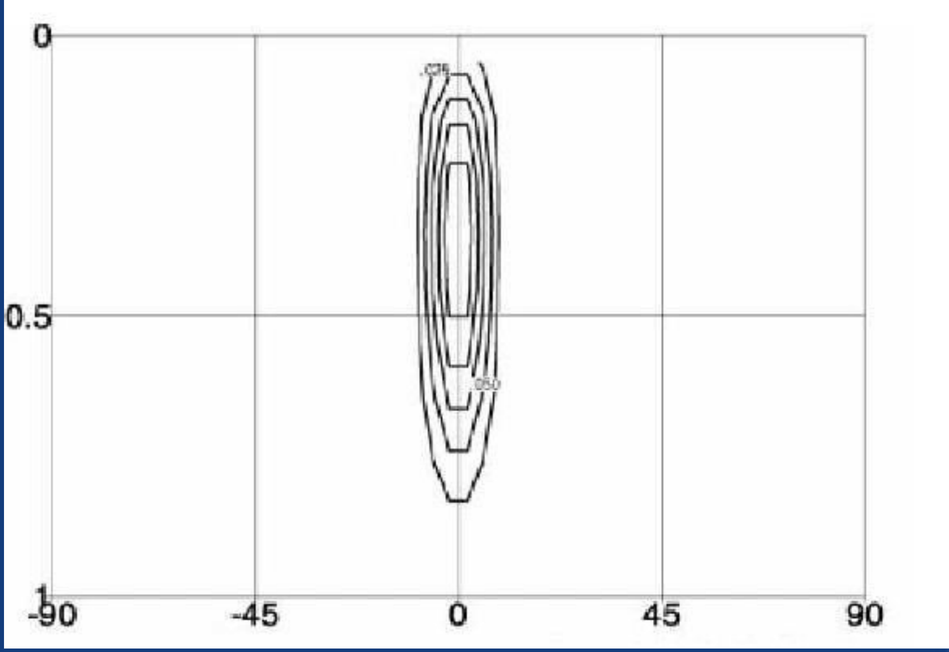
--- *model forcings, use the NCEP/NCAR reanalyses*

--- *forcing includes all processes that cannot be expressed explicitly by the model dynamics, such as the influence of SST, sea ice, diabatic heating and boundary processes such as the orographic forcing.*

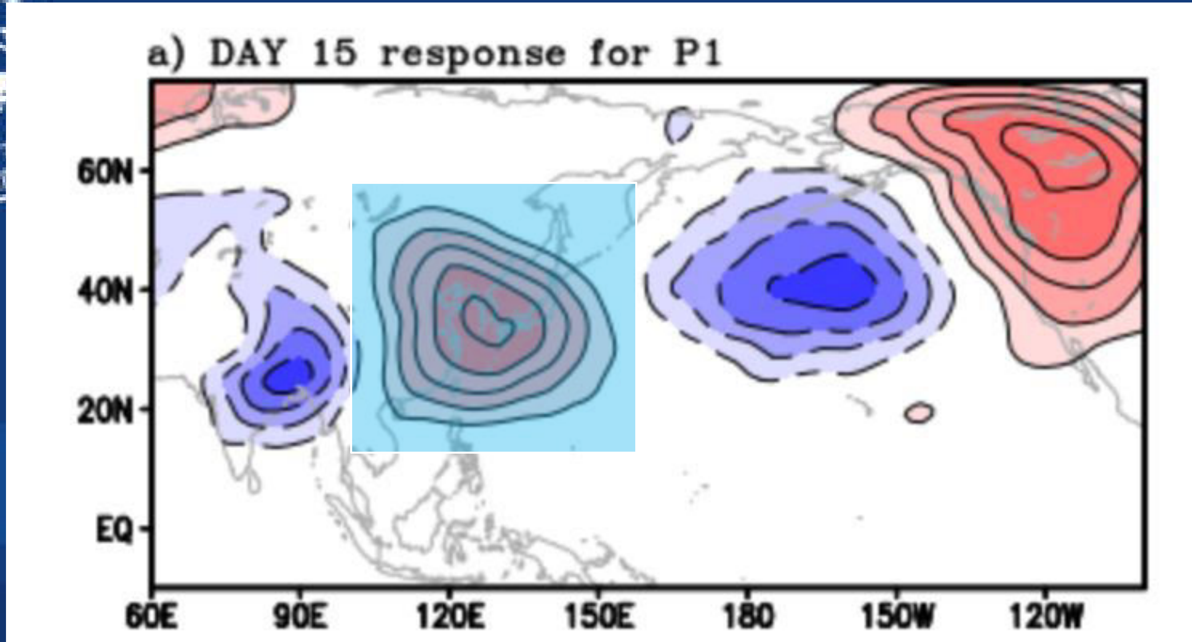
--- *a large number of experiments can be performed.*

Numerical Experiment (SGCM)

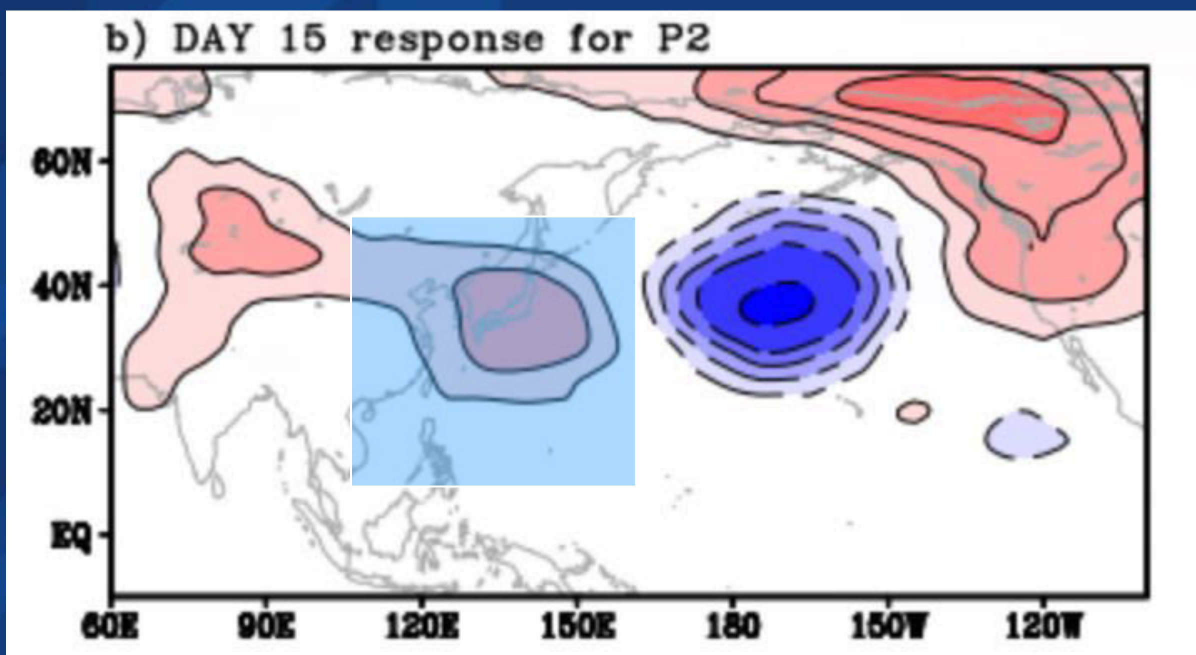




Central peak vertically averaged value: 2^{O}C/day (1cm/day)


a) DAY 15 response for P1
60N
40N
20N
EQ
60E
90E
120E
150E
180
150W
120W

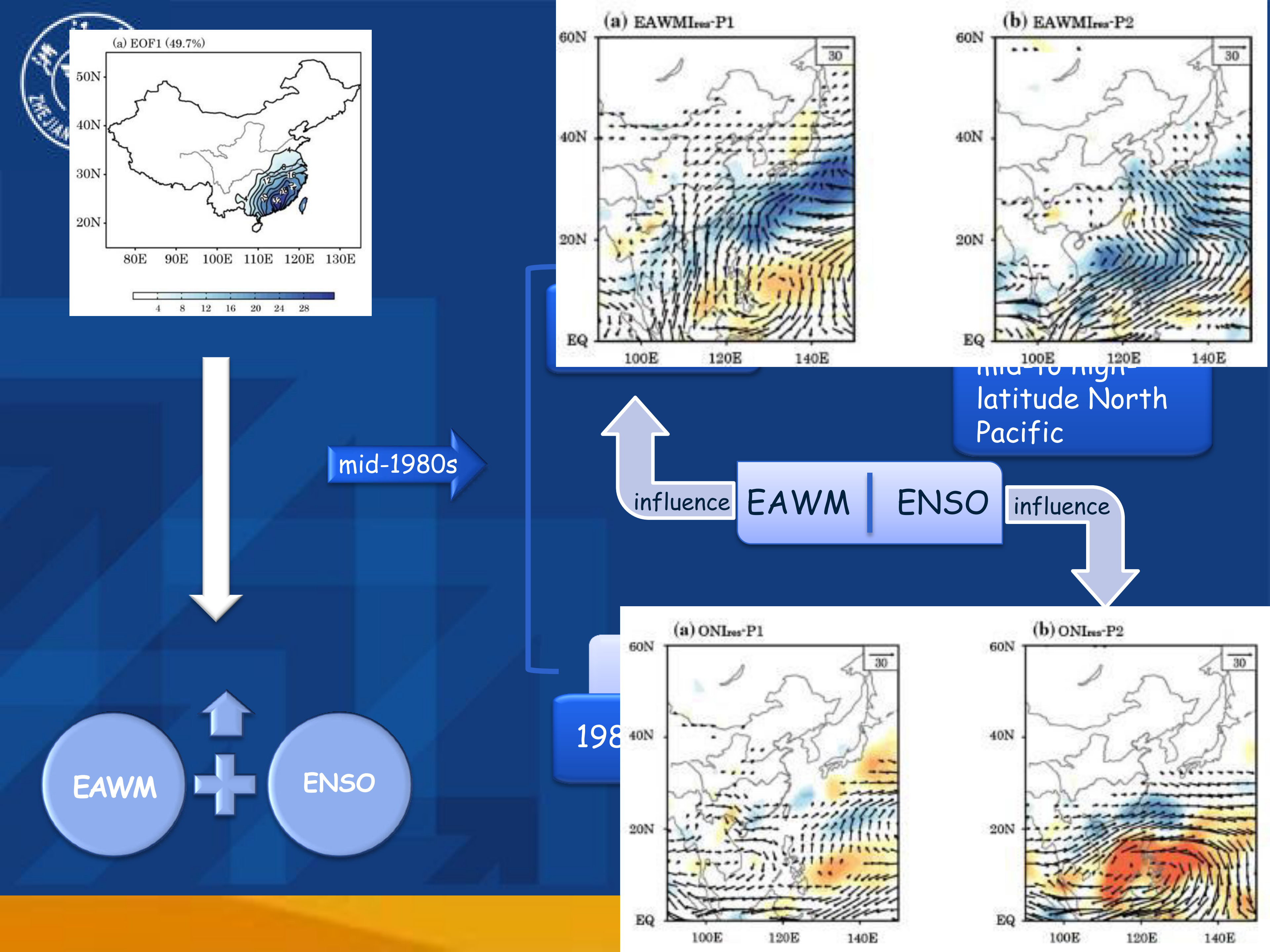
P1


b) DAY 15 response for P2
60N
40N
20N
EQ
60E
90E
120E
150E
180
150W
120W

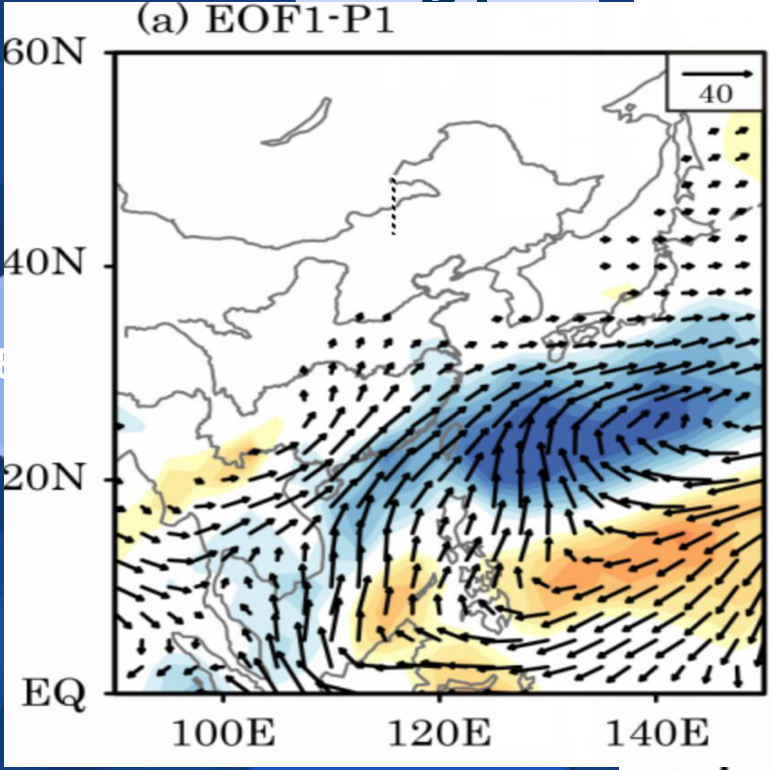
P2

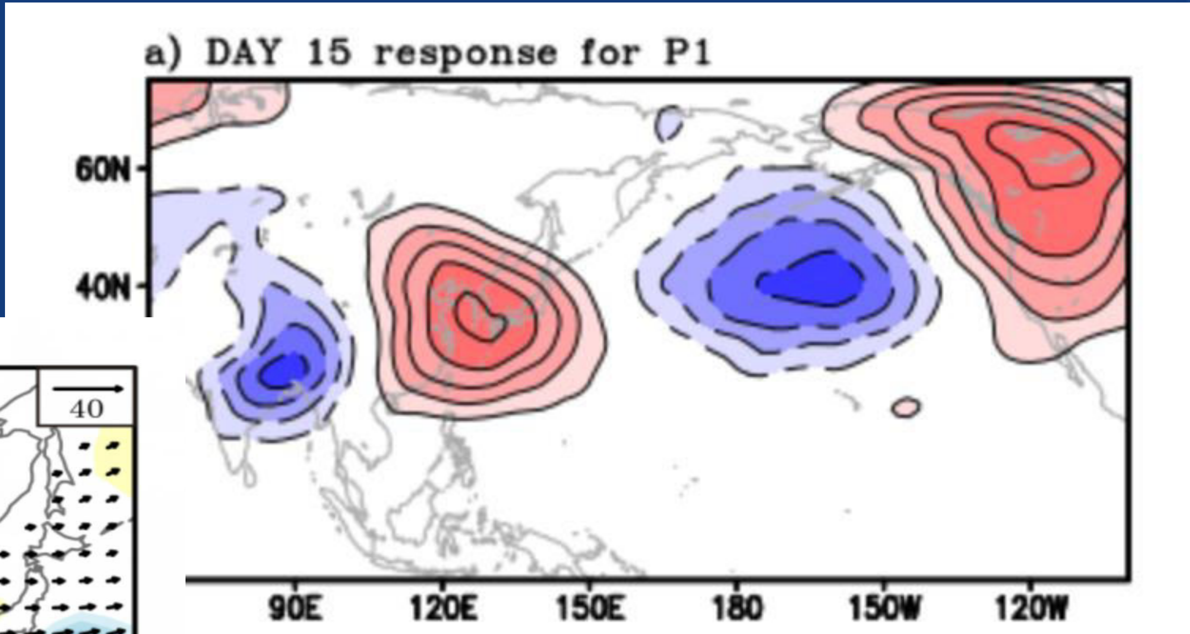
Content

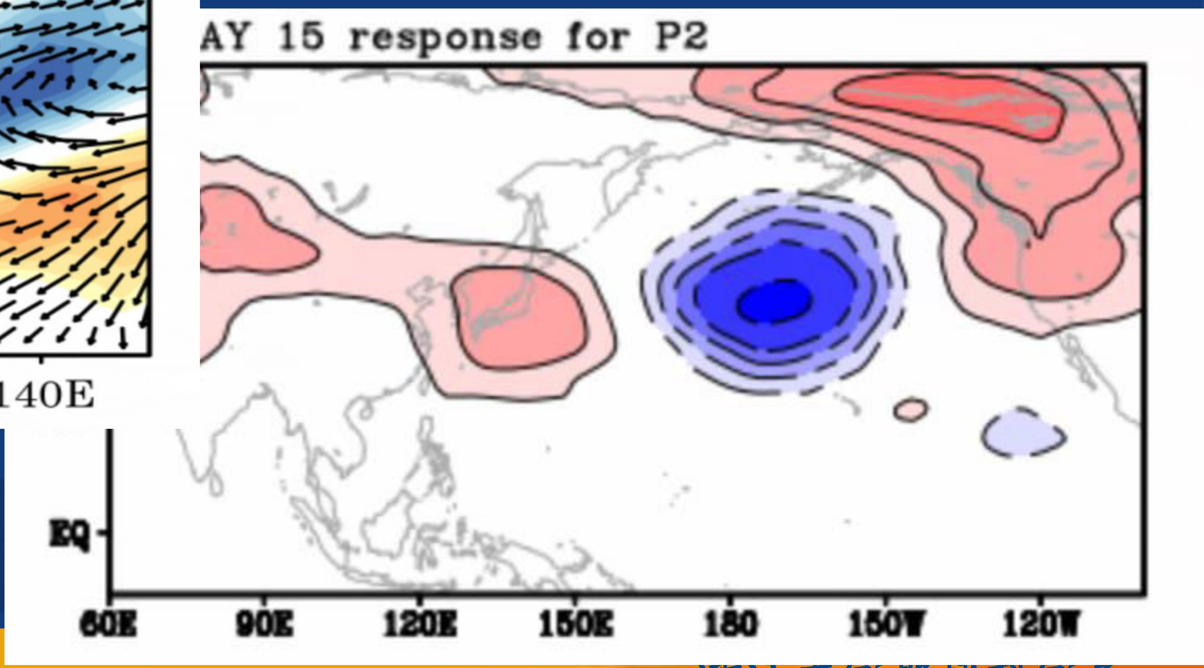
- Background
- The interdecadal change of the winter precipitation over China
- Interdecadal change in the contribution of ENSO and EAWM to the precipitation
- Summary



(a) EOF1 (49.7%)
50N
40N
30N
20N
80E 90E 100E 110E 120E 130E
4 8 12 16 20 24 28
mid-1980s
EAWM
ENSO
(a) EAWMIres-P1
(b) EAWMIres-P2
60N
40N
20N
EQ
100E 120E 140E
30
latitude North
Pacific
influence
EAWM
ENSO
influence
(a) ONIres-P1
(b) ONIres-P2


(a) EOF1-P1
40
60N
40N
20N
EQ
100E
120E
140E


a) DAY 15 response for P1
60N
40N
90E
120E
150E
180
150W
120W


AY 15 response for P2
EQ
60E
90E
120E
150E
180
150W
120W

THANK YOU !