Understanding El Nino's influence on East Asian Climate

Sang-Wook Yeh and Seung-Won Hyun
Hanyang University

- El Nino

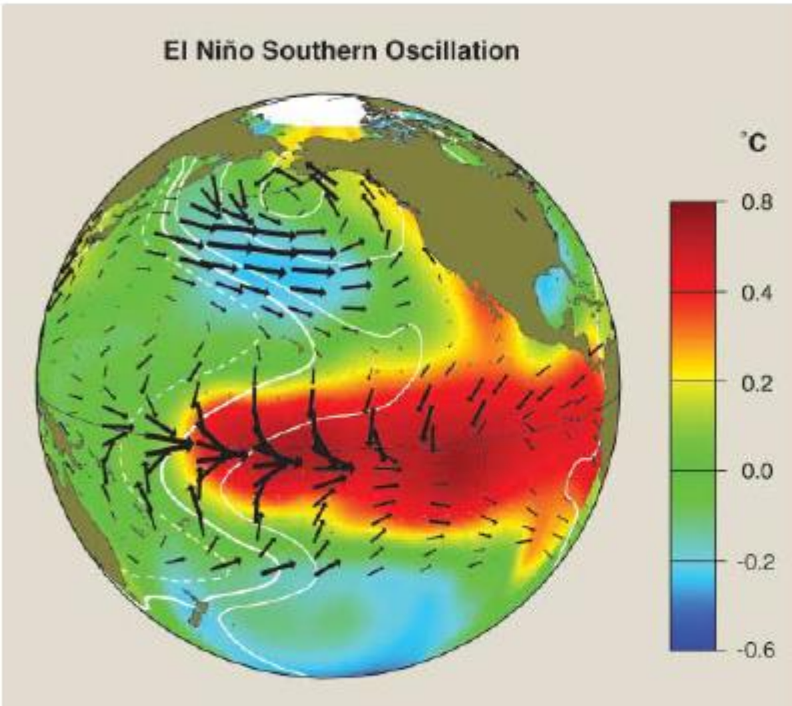


Fig. 1. El Niño anomalies in SST (color shading and scale in °C), surface atmospheric pressure (contours), and surface wind stress (vectors) in the Pacific basin. Pressure contour interval is 0.5 mb, with solid contours positive and dashed contours negative. Wind stress vectors indicate direction and intensity, with the longest vector equivalent to ~1 N m^{-2}. The patterns in this graphic are derived from a linear regression against SST anomalies averaged over 6°N–6°S, 90°W–180° in the eastern and central equatorial Pacific. All quantities scale up or down with the intensity of anomalies in this index region, that is, higher for strong El Niños and lower for weak El Niños. Anomalies of opposite sign apply to La Niña events, although there are some differences in the spatial patterns of El Niño and La Niña that this linear analysis does not capture (*10*, *11*).

McPhaden et al. (2006)

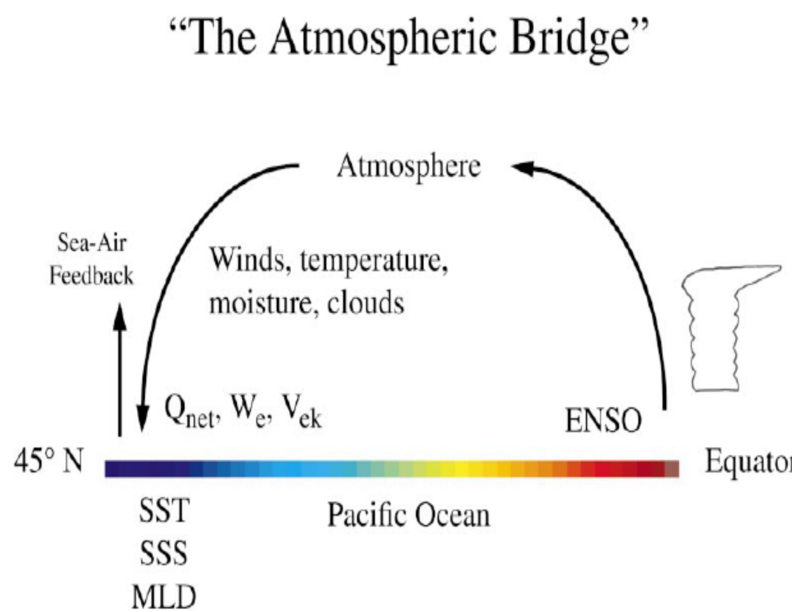
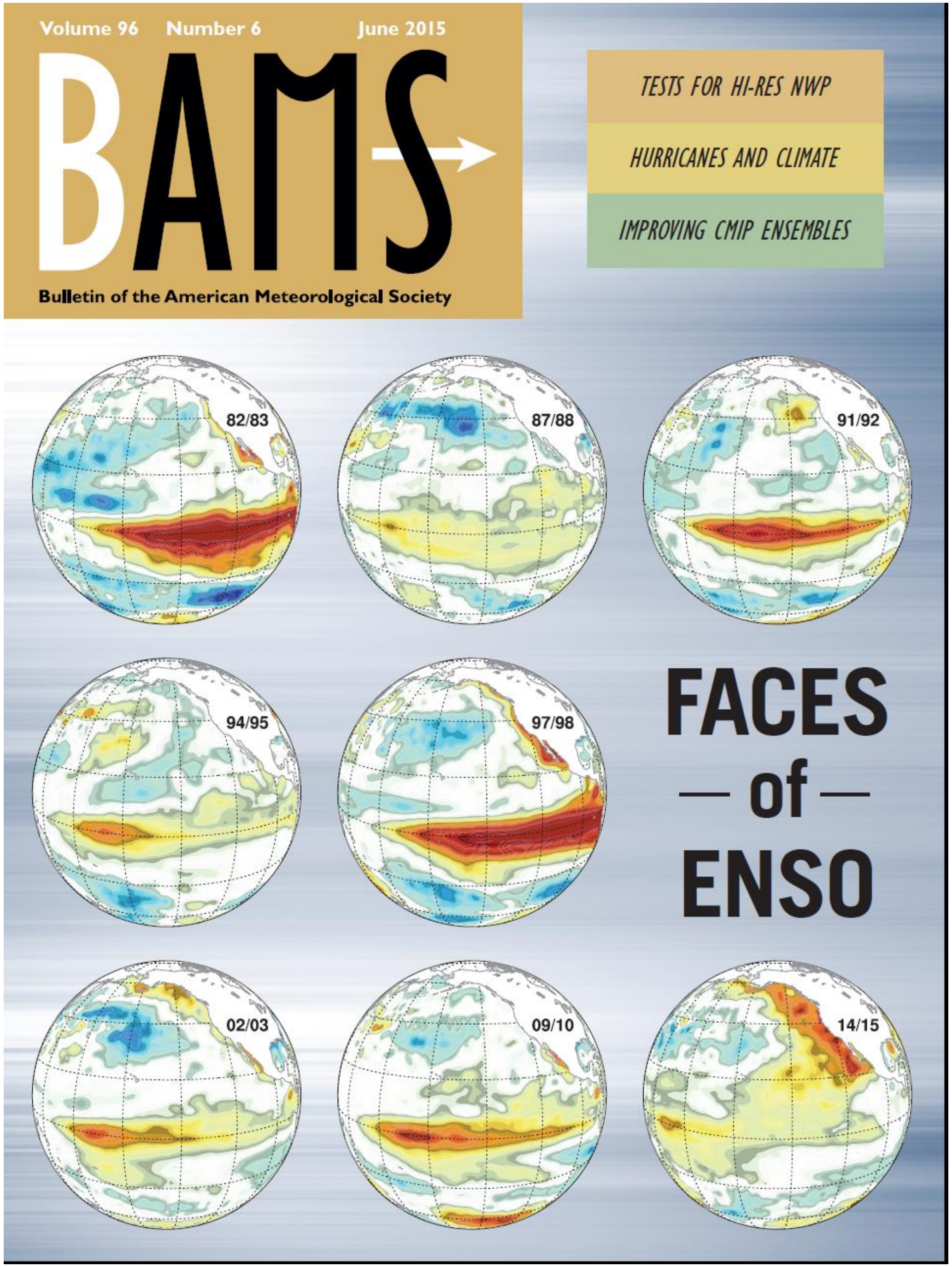


FIG. 1. Schematic of the “atmospheric bridge” between the tropical and North Pacific Oceans. The bridge concept also applies to the Atlantic, Indian, and South Pacific Oceans. The bridge occurs through changes in the Hadley and Walker cells, Rossby waves, and interactions between the quasi-stationary flow and storm tracks (see Trenberth et al. 1998). The Q_{net} is the net surface heat flux; w_e the entrainment rate into the mixed layer from below, which is primarily driven by surface fluxes; SST the sea surface temperature; SSS the sea surface salinity; and MLD the mixed layer depth.

Alexander et al. (2010)

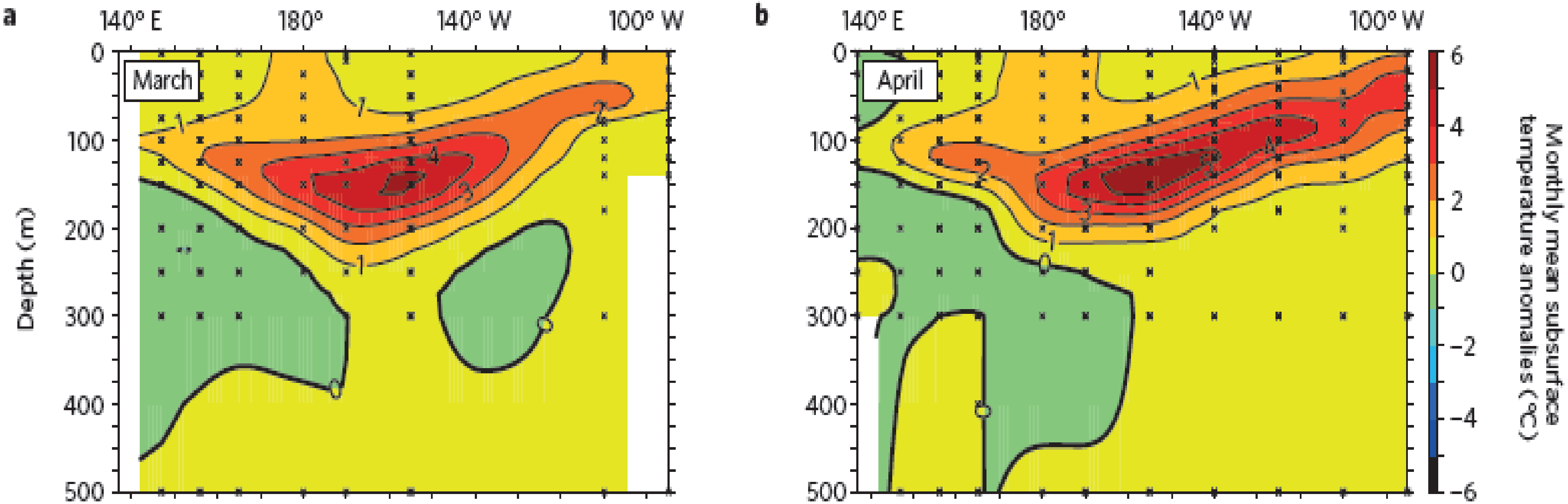


..Improved determination of
ENSO predictability, teleconnections
, and impacts requires a better
understanding of event-to-event
differences in ENSO spatial patterns
and evolution…..
(Capotondi et al., 2015)

• 2014/15 El Nino

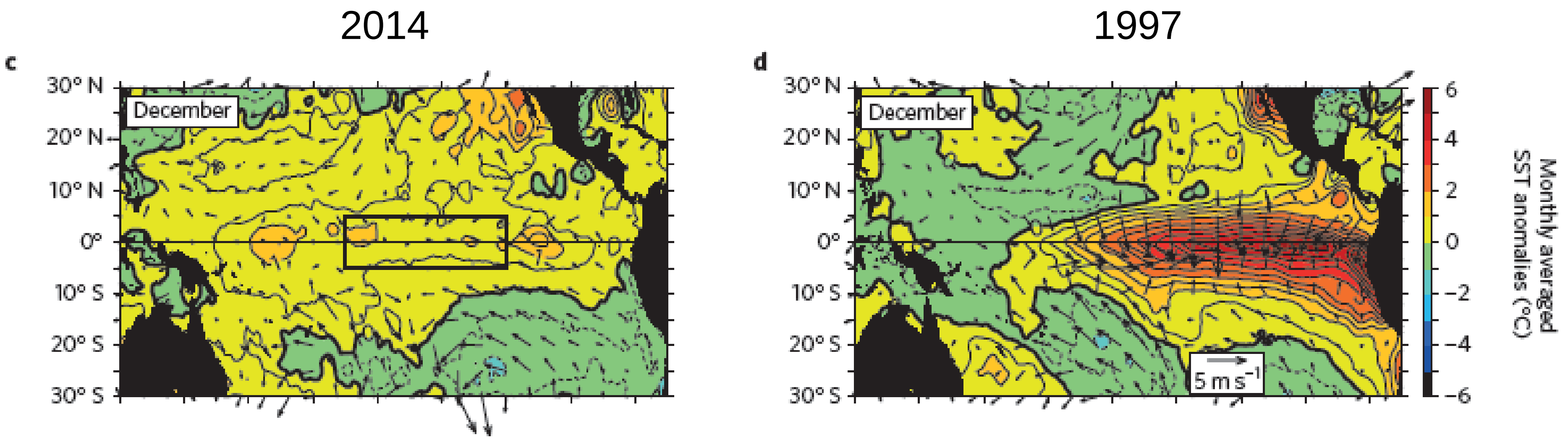
2014

1997



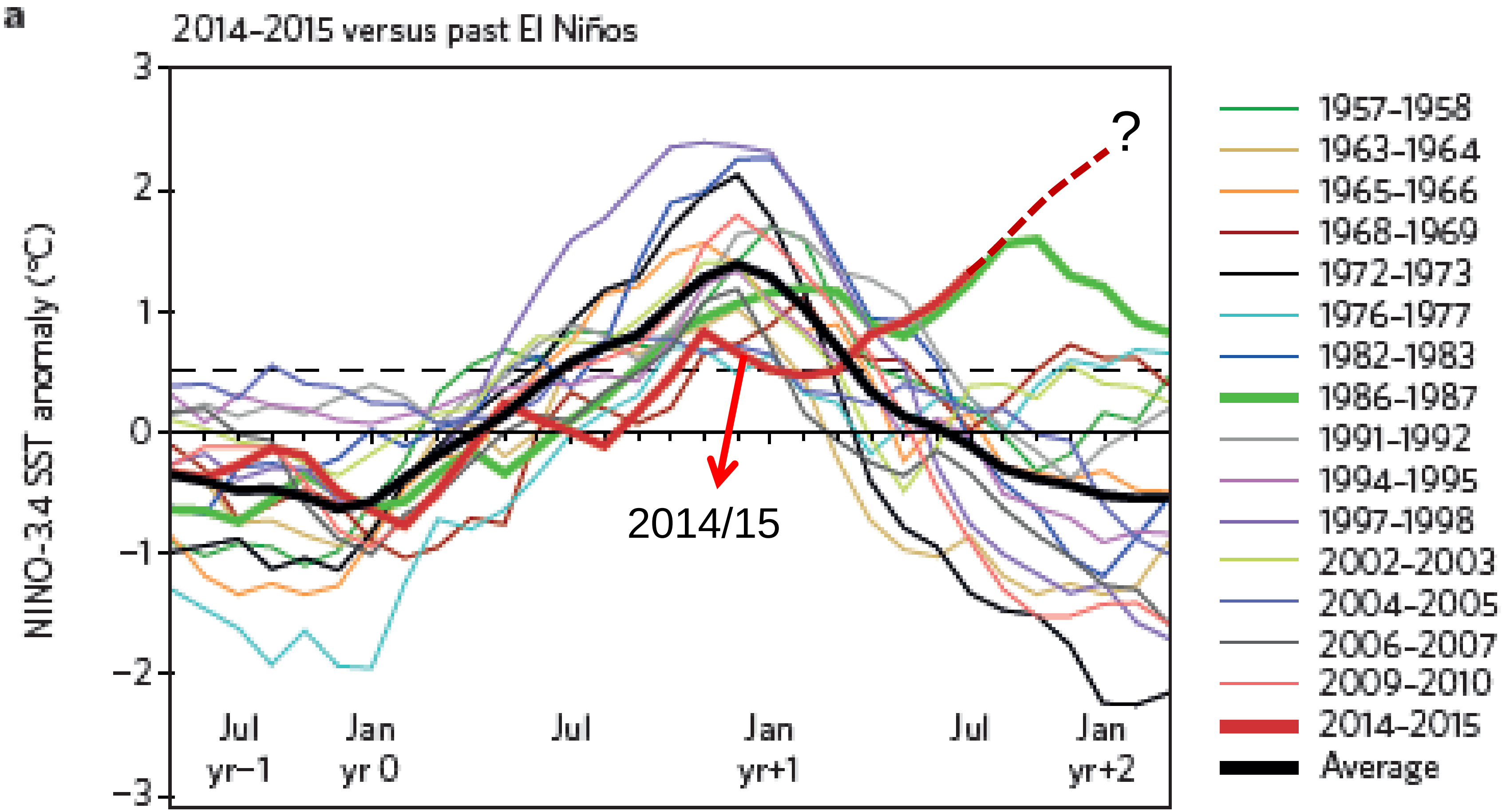
McPhaden et al. (2015)

• 2014/15 El Nino



McPhaden et al. (2015)

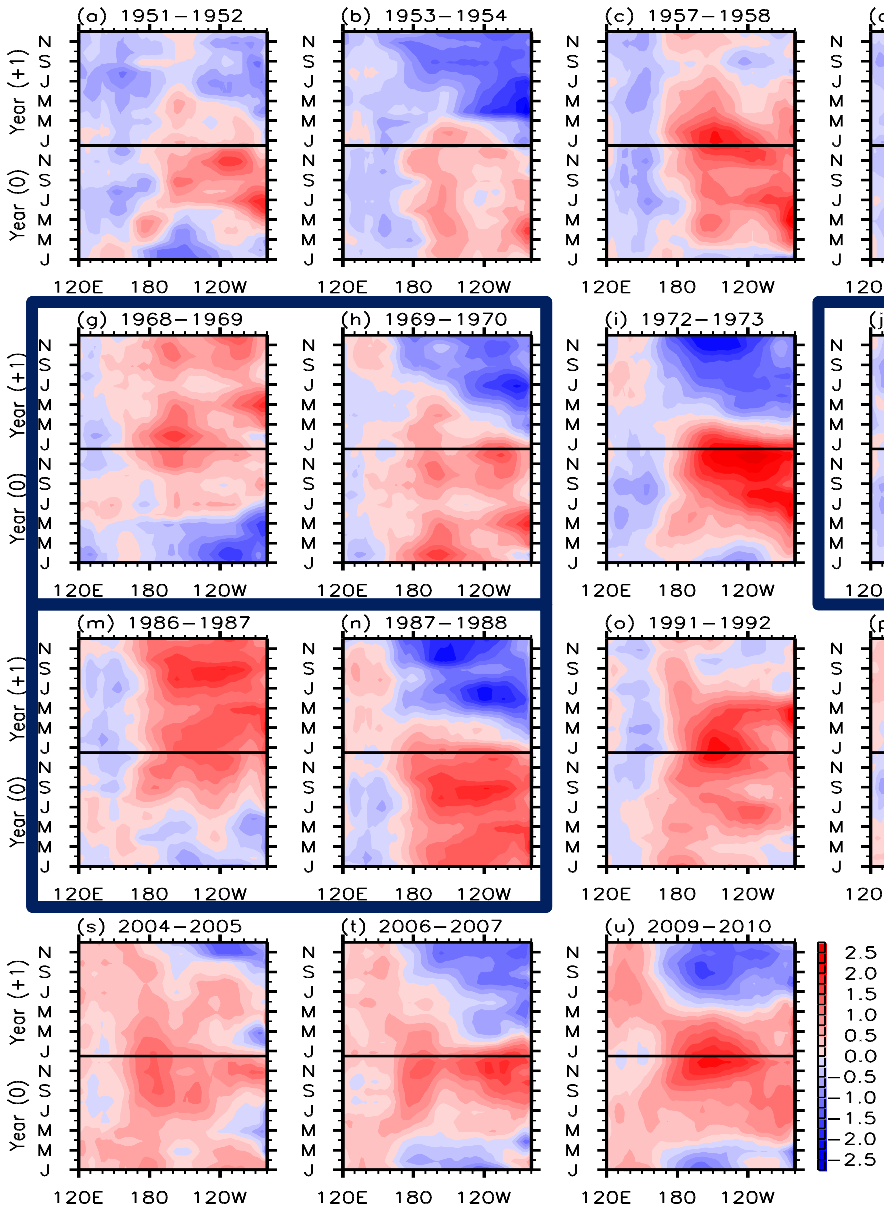
• 2014/15 & 2015/2016 El Nino



McPhaden et al. (2015)

• El Nino's diversity

Equatorial Pacific SST Anomalies during El Ninos



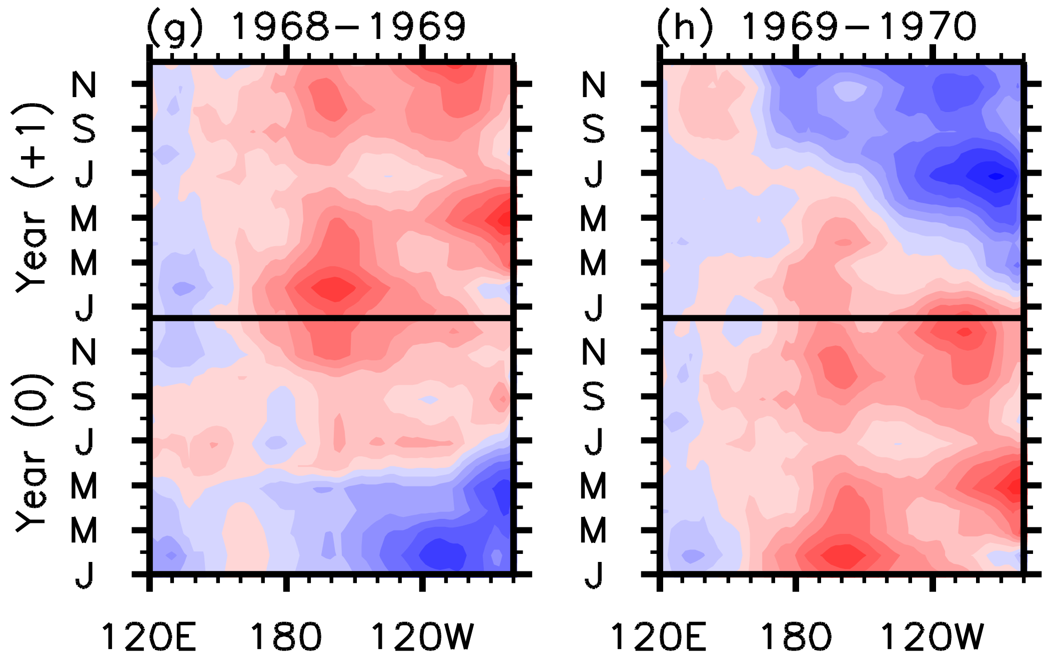
-1968/69, 1969/1970
-1976/77,1977/1978
-1986/87,1987/1988

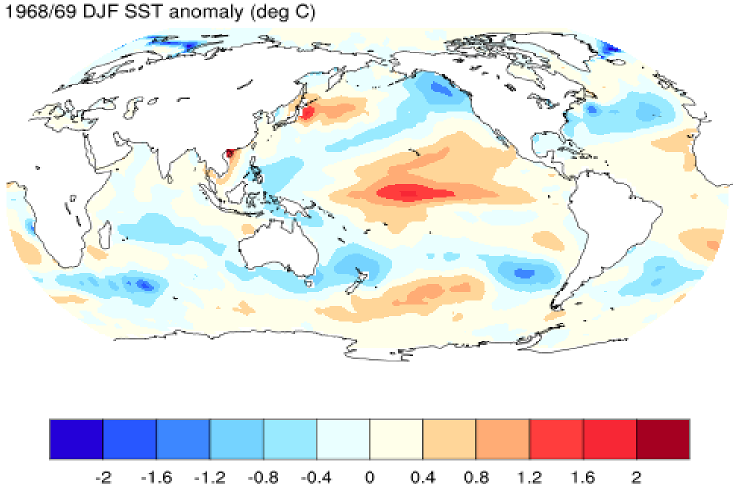
Lee et al., (2015)

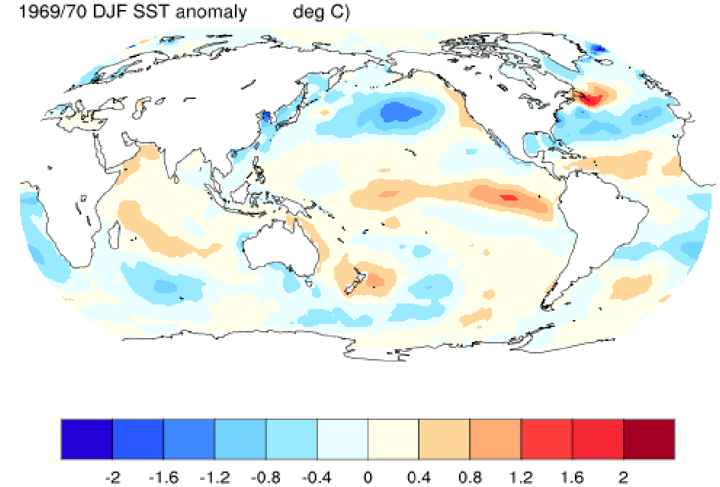
• 1968/69 & 1969/1970 El Nino

1969 1970

1968 1969





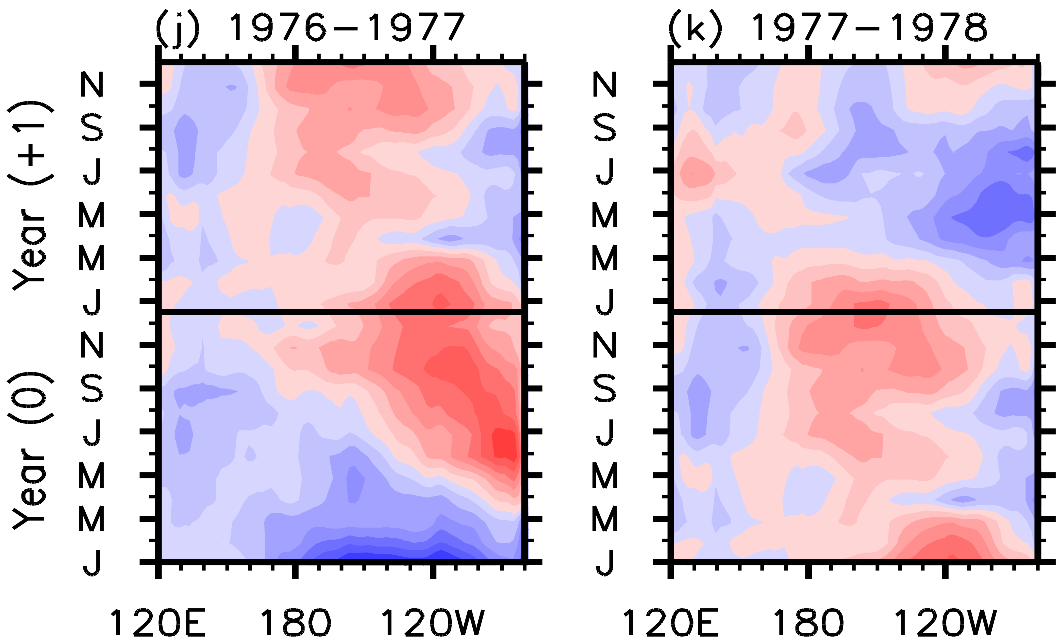


1968D/69JF DJF(Dec.-Jan.-Feb.) 1969D/70JF

• 1976/77 & 1977/1978 El Nino

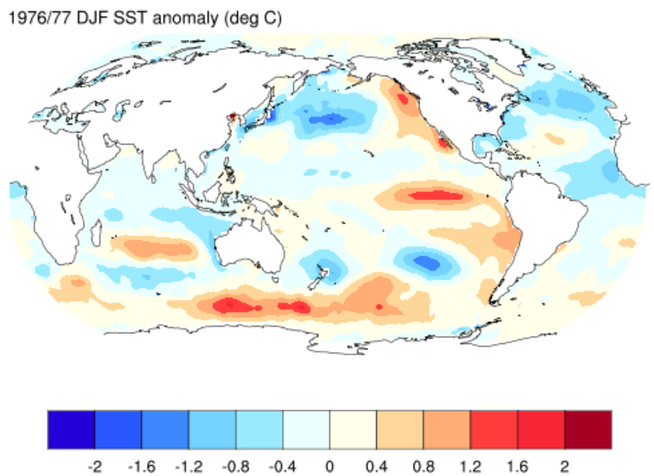
1977

1976

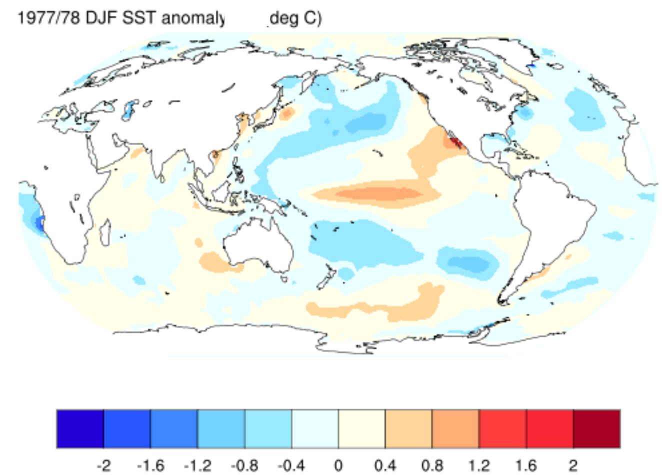


1978

1977



1976D/77JF

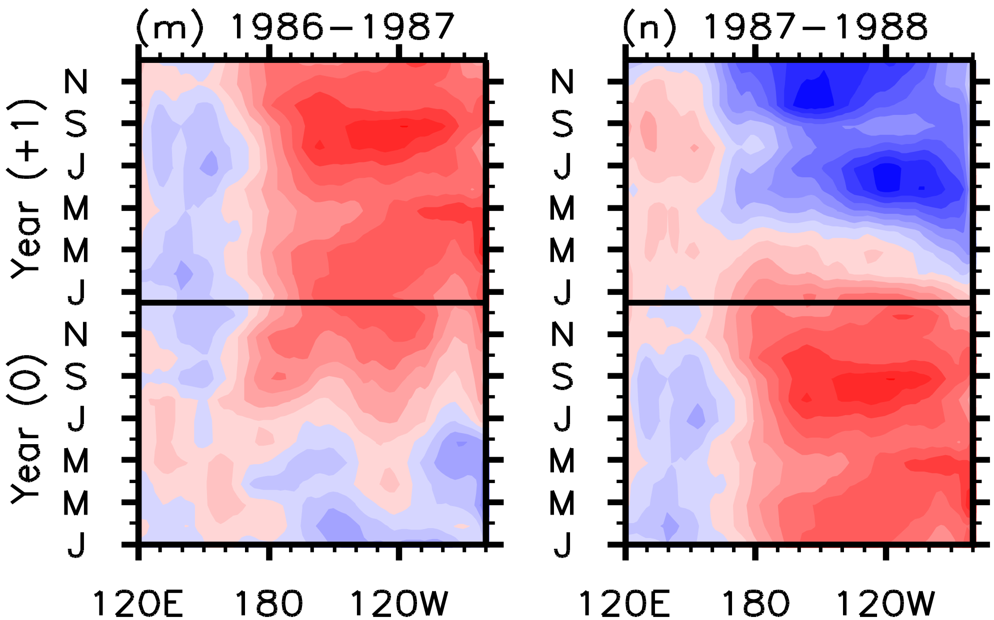


1977D/78JF

• 1986/87 & 1987/1988 El Nino

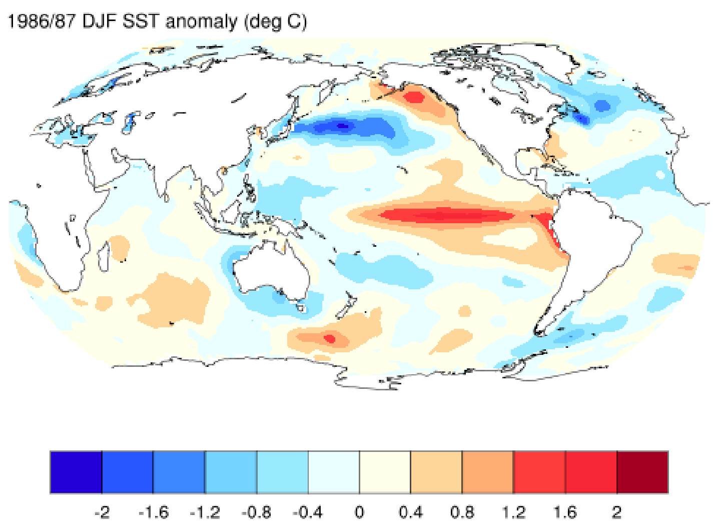
1987

1986

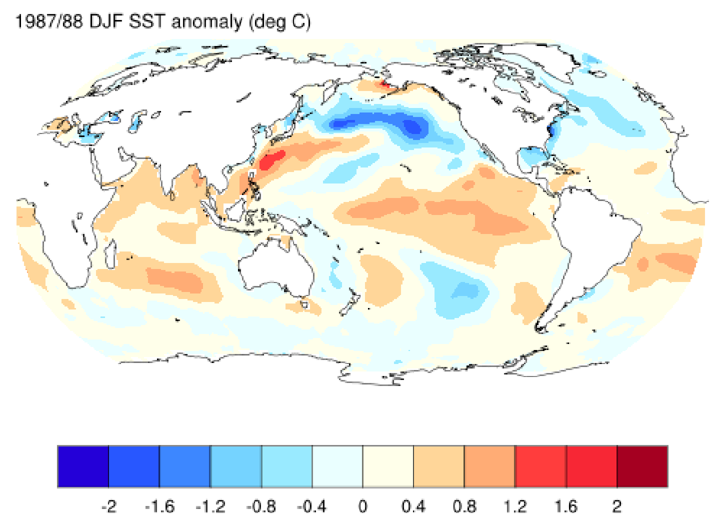


1988

1987

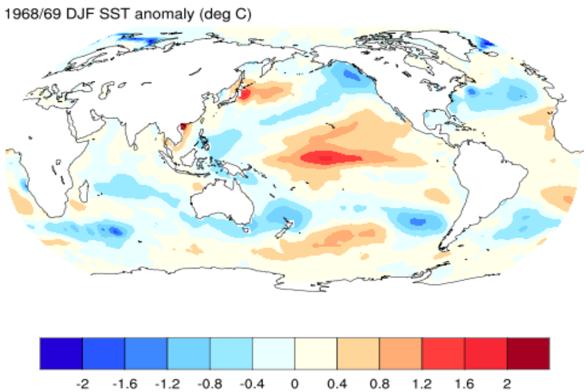


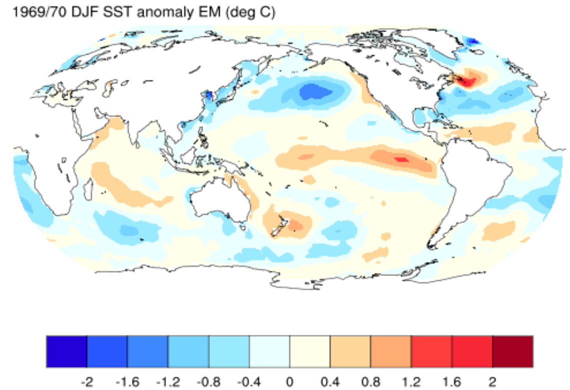
1986D/87JF



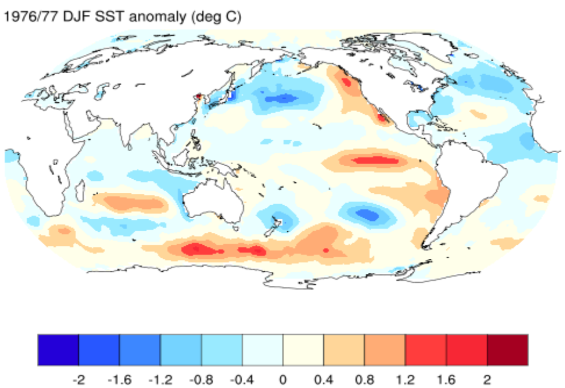
1987D/88JF

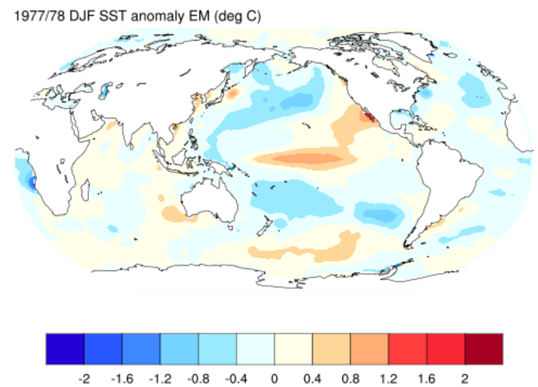
- Two successive El Nino events



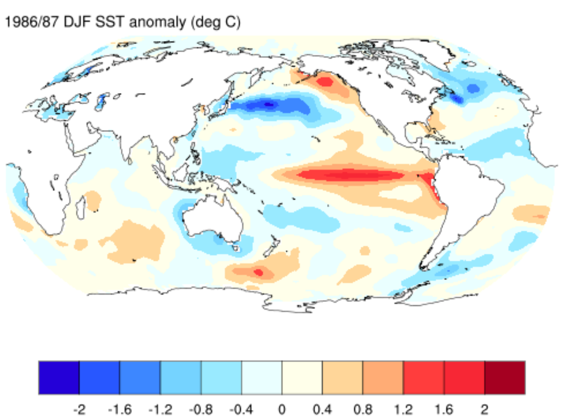


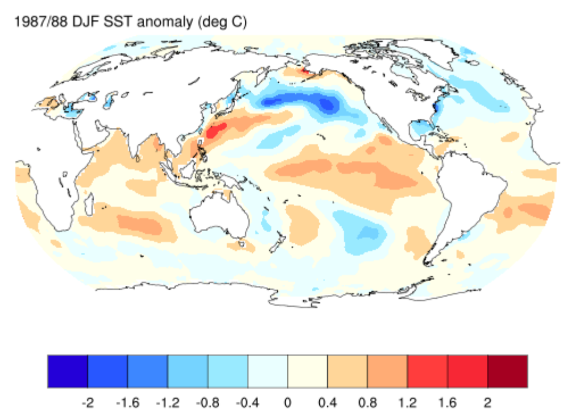
-1968/69, 1969/1970





-1976/77,1977/1978



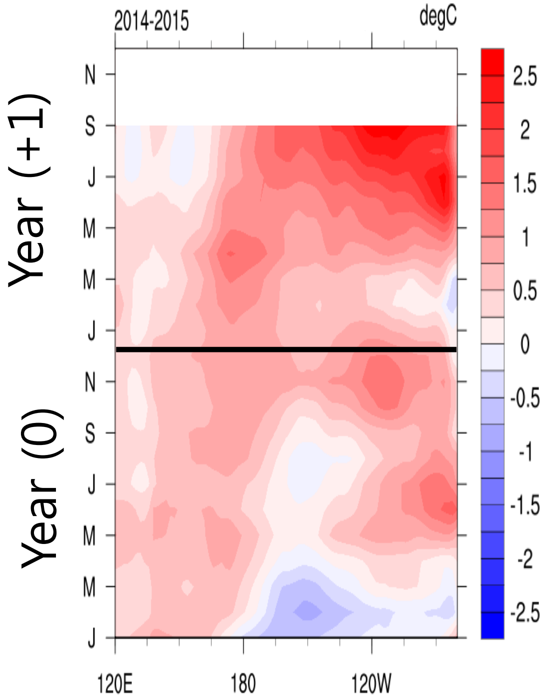


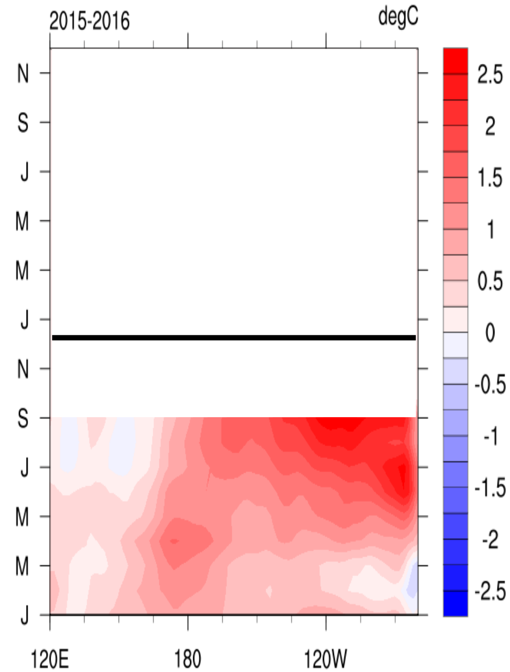
-1986/87,1987/1988

• 2014/15 & 2015/2016 El Nino

2015

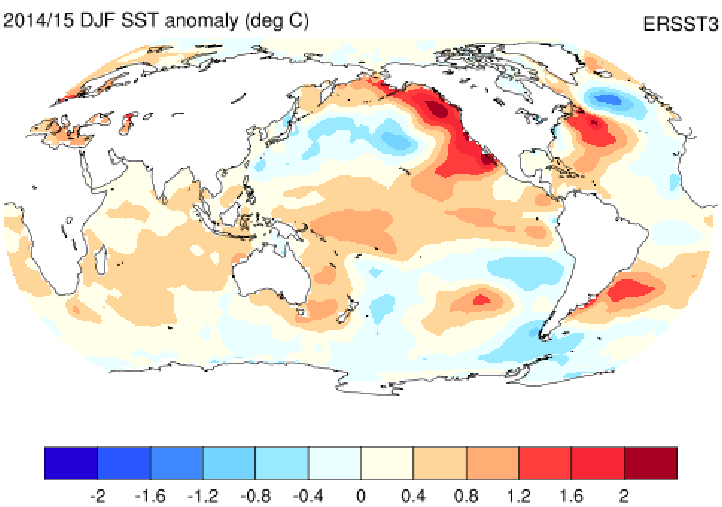
2014





2016

2015

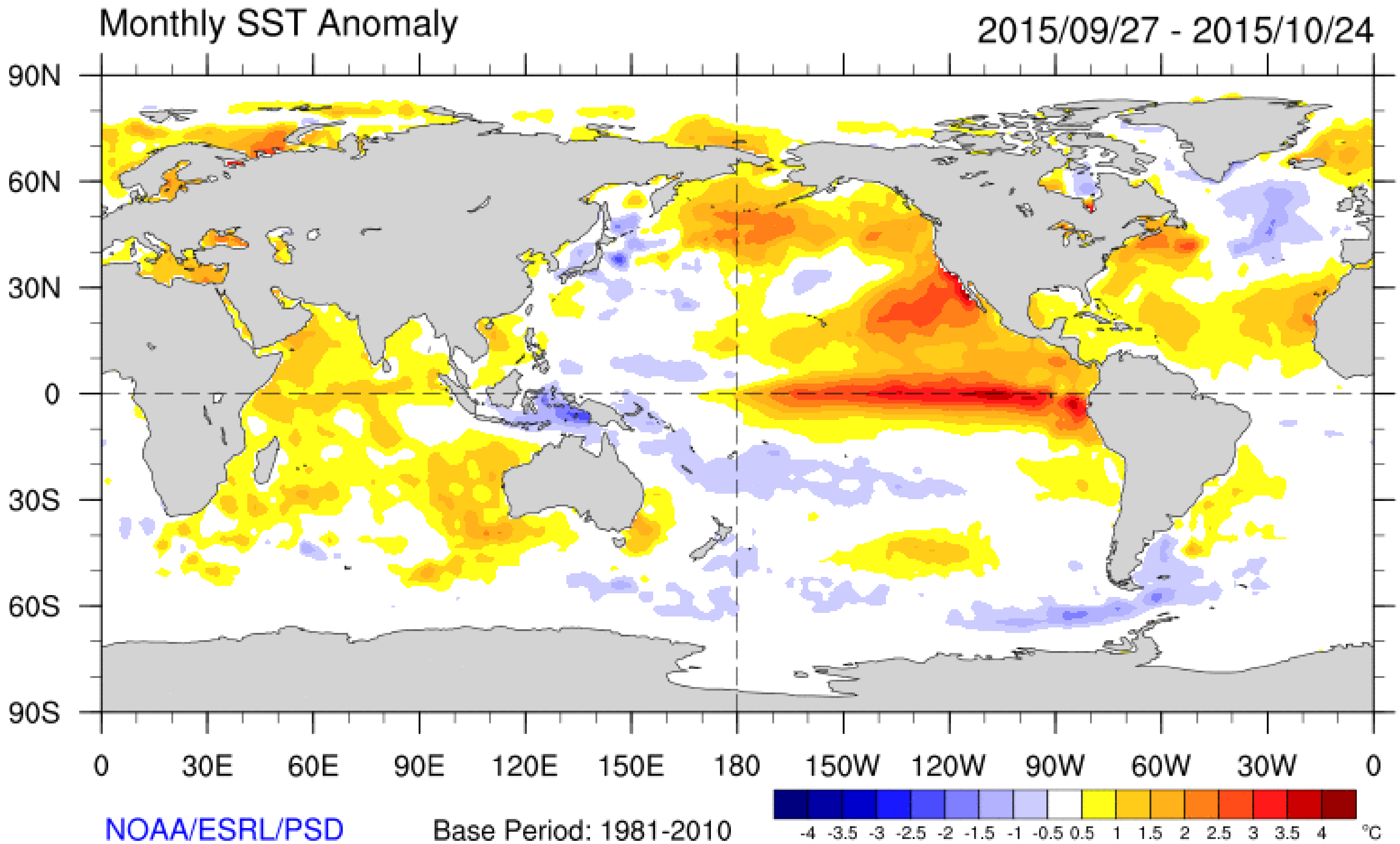


2014D/15JF

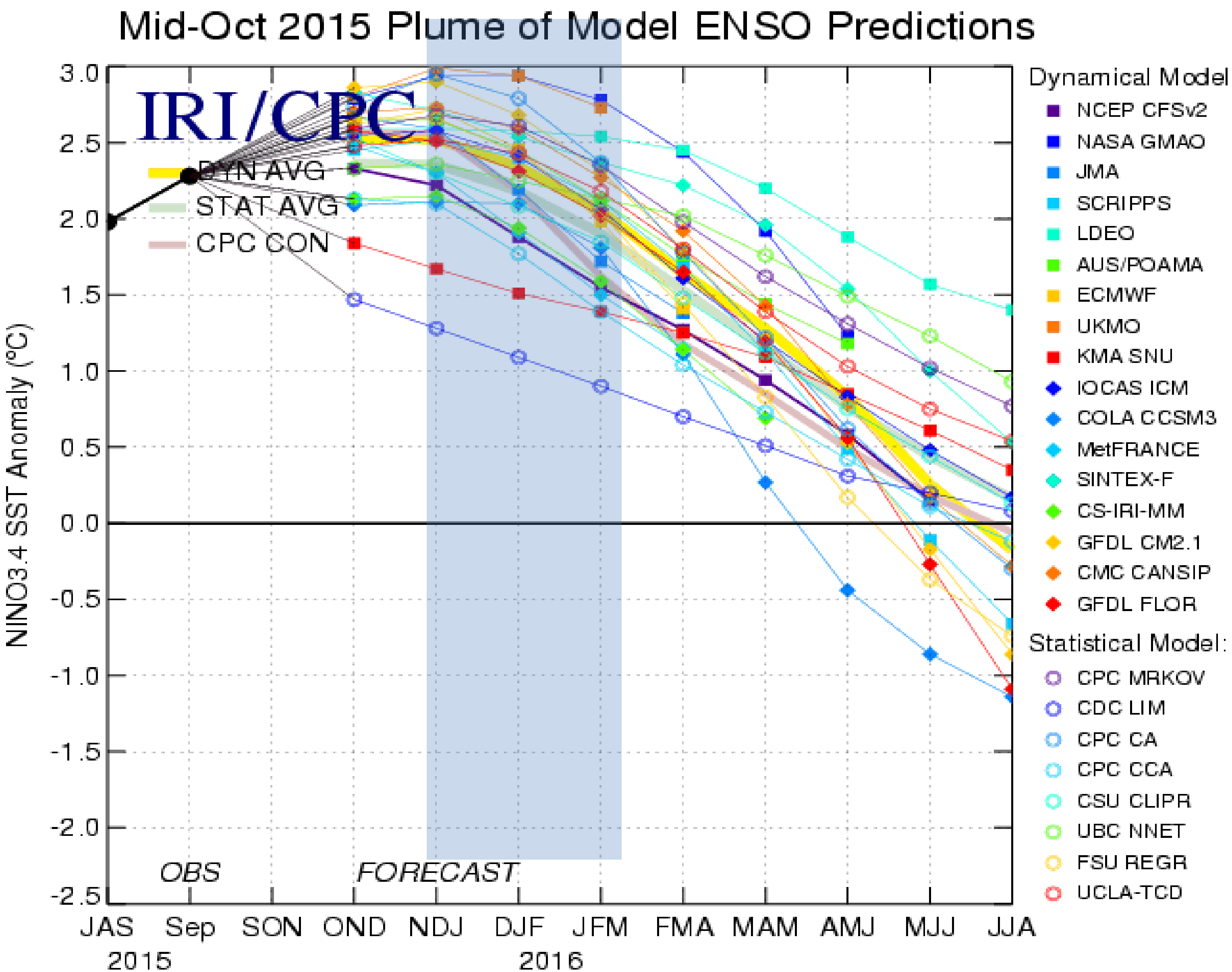
?

2015D/16JF

- Current El Nino



• 2015D/2016JF El Nino's prediction

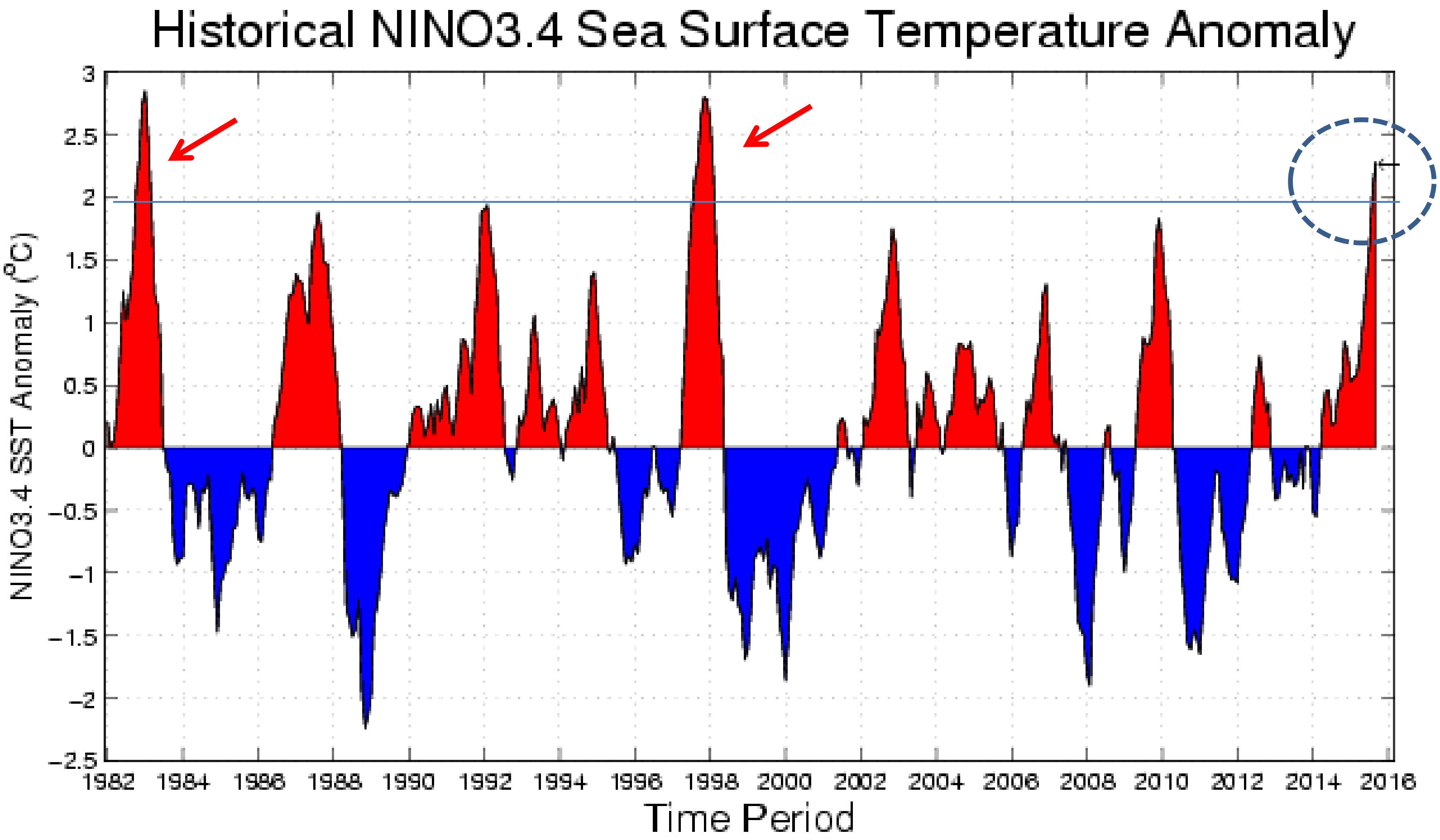


- Conclusion -1

There are three cases of events for 1950-2013 in which two successive El Ninos occurred and the current event will be successive occurrence of El Nino in 2014/15 and 2015/16.

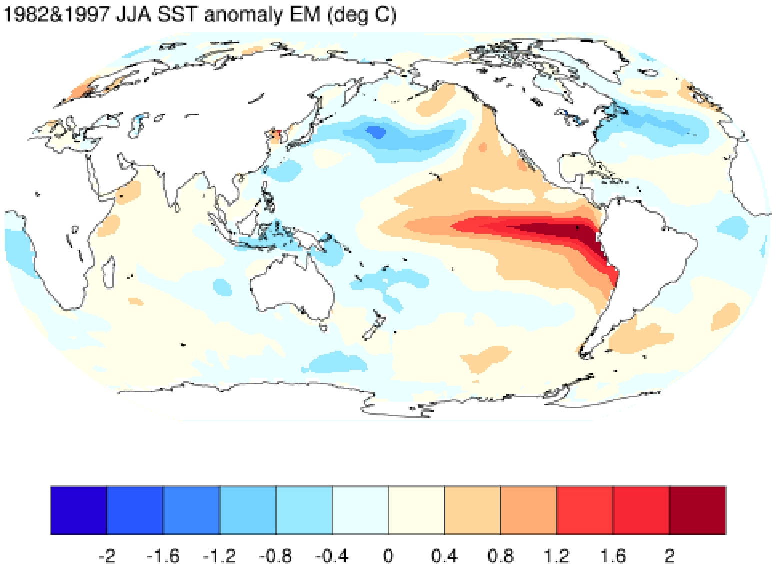
The magnitude of the latter El Nino is weaker than that in the former El Nino event in previous three cases of El Nino events, which is contrast to the current El Nino event.

• Current El Nino

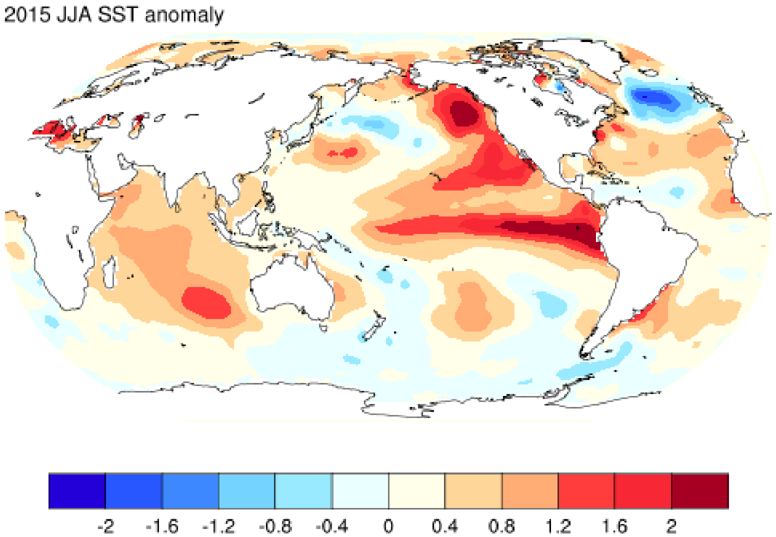


• 1982, 1997 JJA Ensemble Mean & 2015 JJA

1982, 1997 JJA ensemble mean

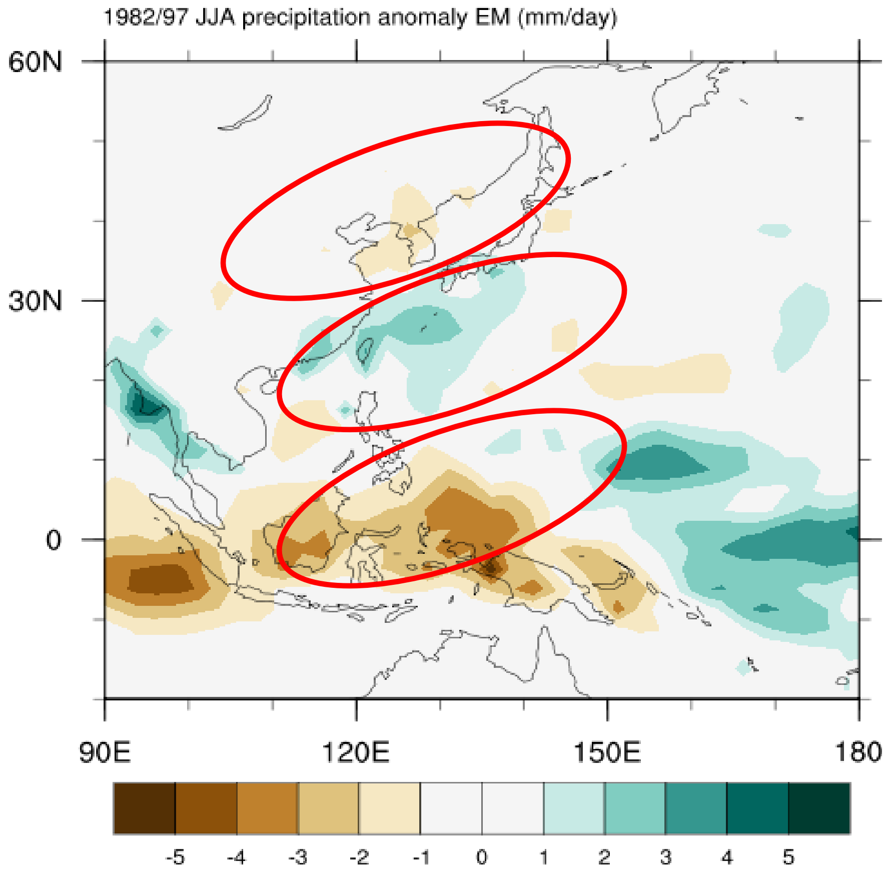


2015 JJA

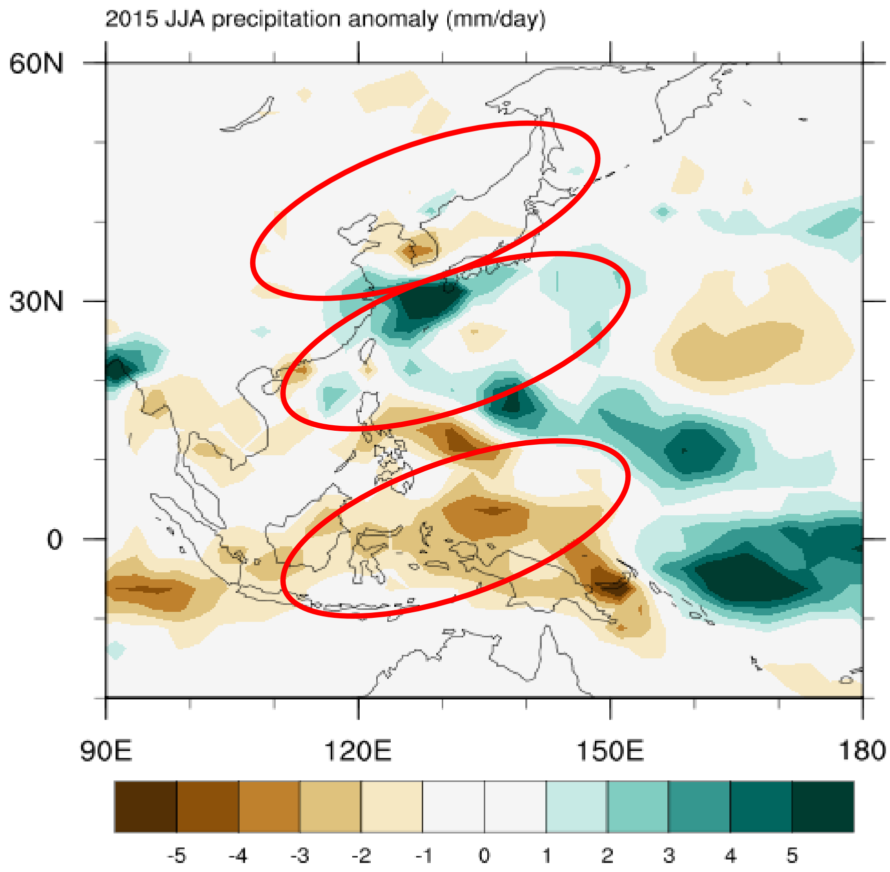


• 1982, 1997 JJA & 2015 JJA: Precipitation

1982, 1997 JJA ensemble mean



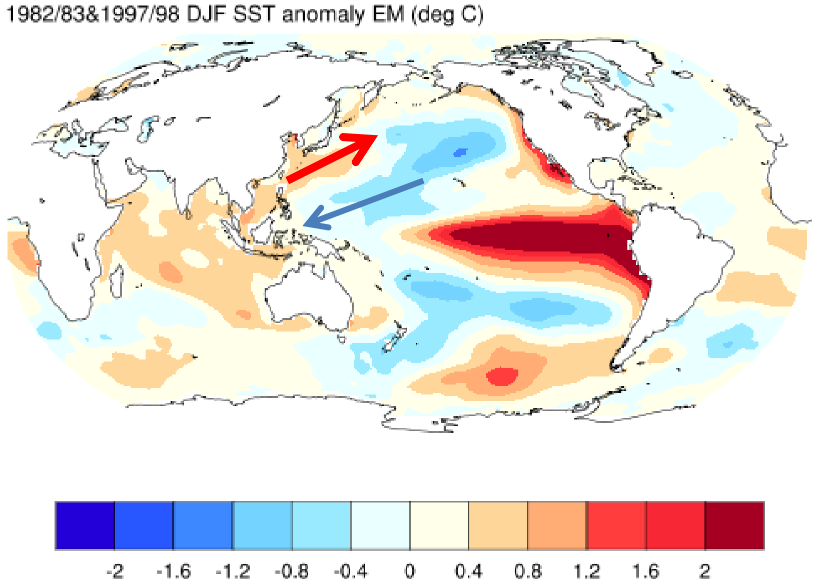
2015 JJA



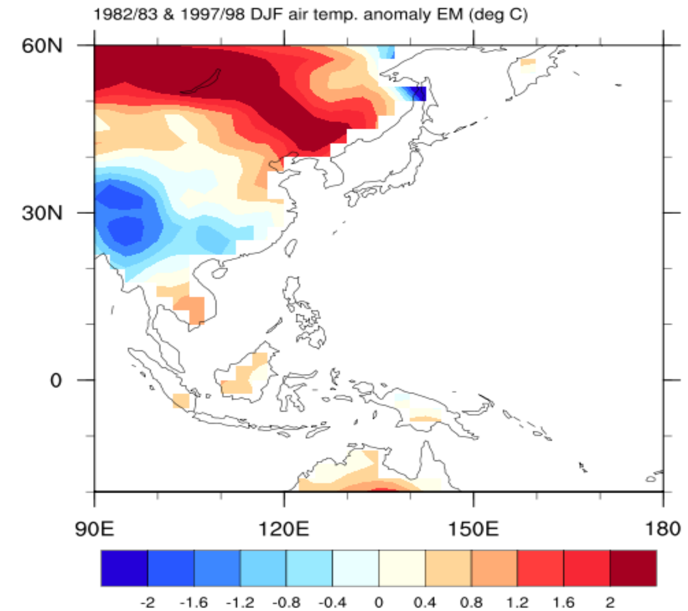
• 1982/83,1997/98 : SST, Air Temp and Precipitation.

1982D/83JF, 1997D/98JF ensemble mean

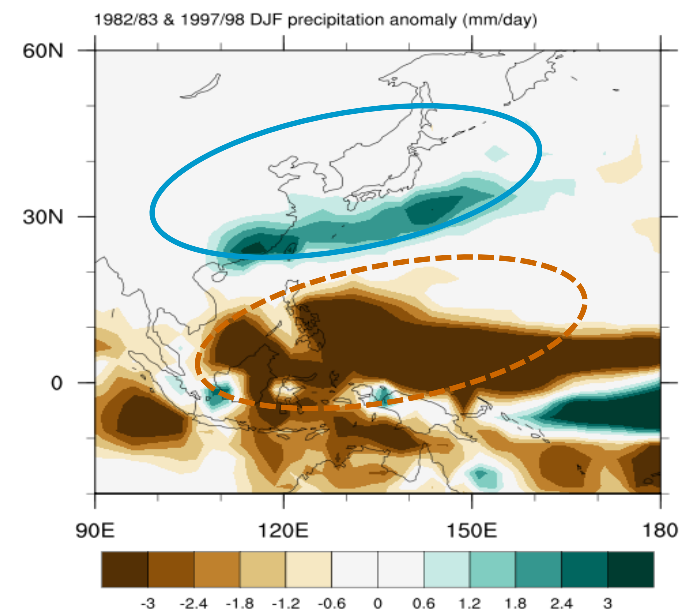
SST



Surface Temp.



Precipitation



- 2015D/16JF : Surface Temp & Precipitation.

Warmer Temp.& Above normal Precipitation

Clim Dyn (2014) 42:957–971
DOI 10.1007/s00382-013-1730-z

Combined effect of El Niño-Southern Oscillation and Pacific Decadal Oscillation on the East Asian winter monsoon

Ji-Won Kim · Sang-Wook Yeh · Eun-Chul Chang

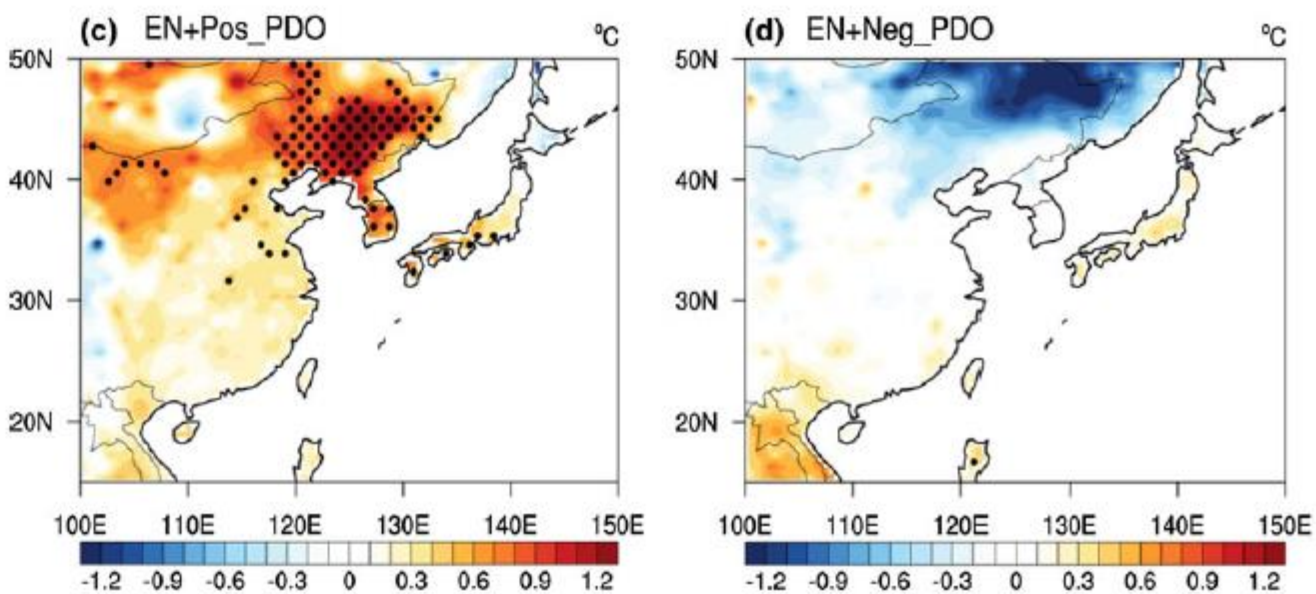


Fig. 4 Conditional composite maps of the DJF surface air temperature (SAT, in °C) anomalies in the East Asian continent for the case of **a** Neu + Pos_PDO, **b** Neu + Neg_PDO, **c** EN + Pos_PDO, **d** EN + Neg_PDO, **e** LN + Pos_PDO, and **f** LN + Neg_PDO. *Areas with black dots* indicate a 90 % confidence level according to a two-tailed student's *t* test

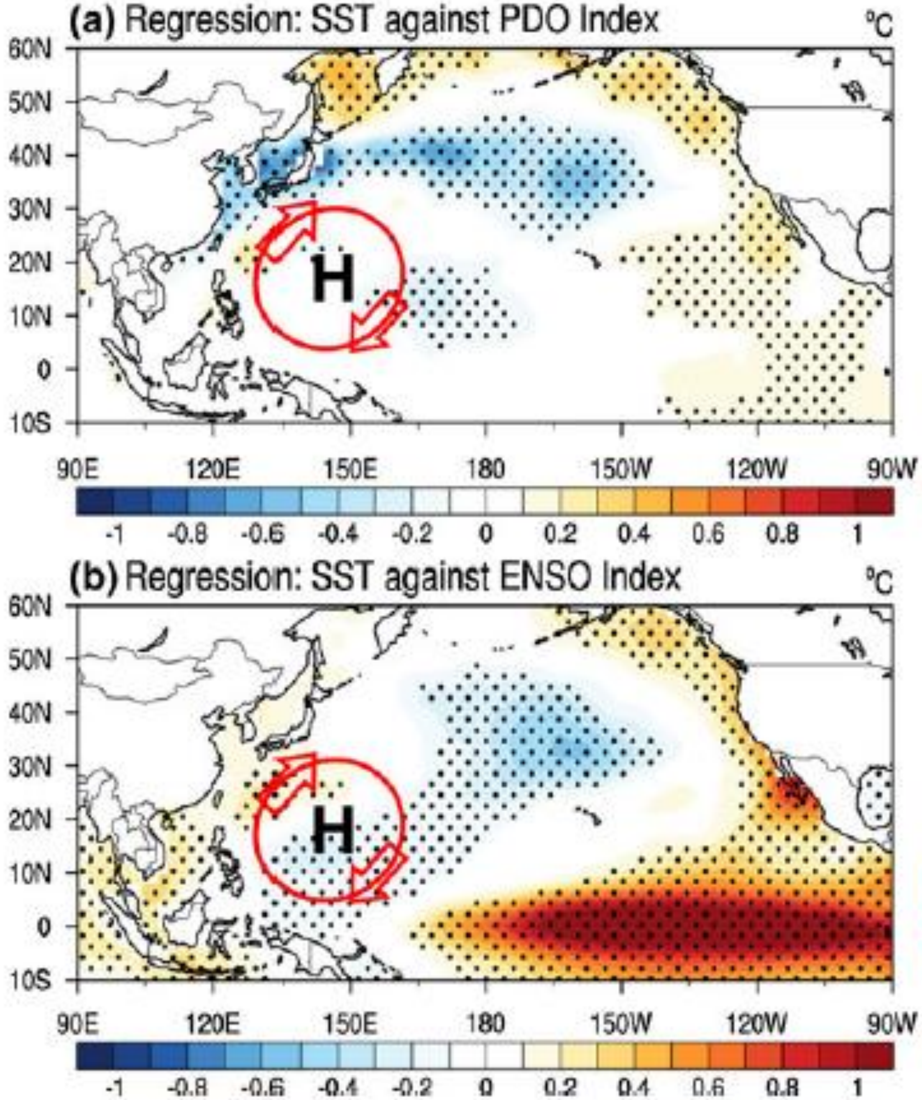
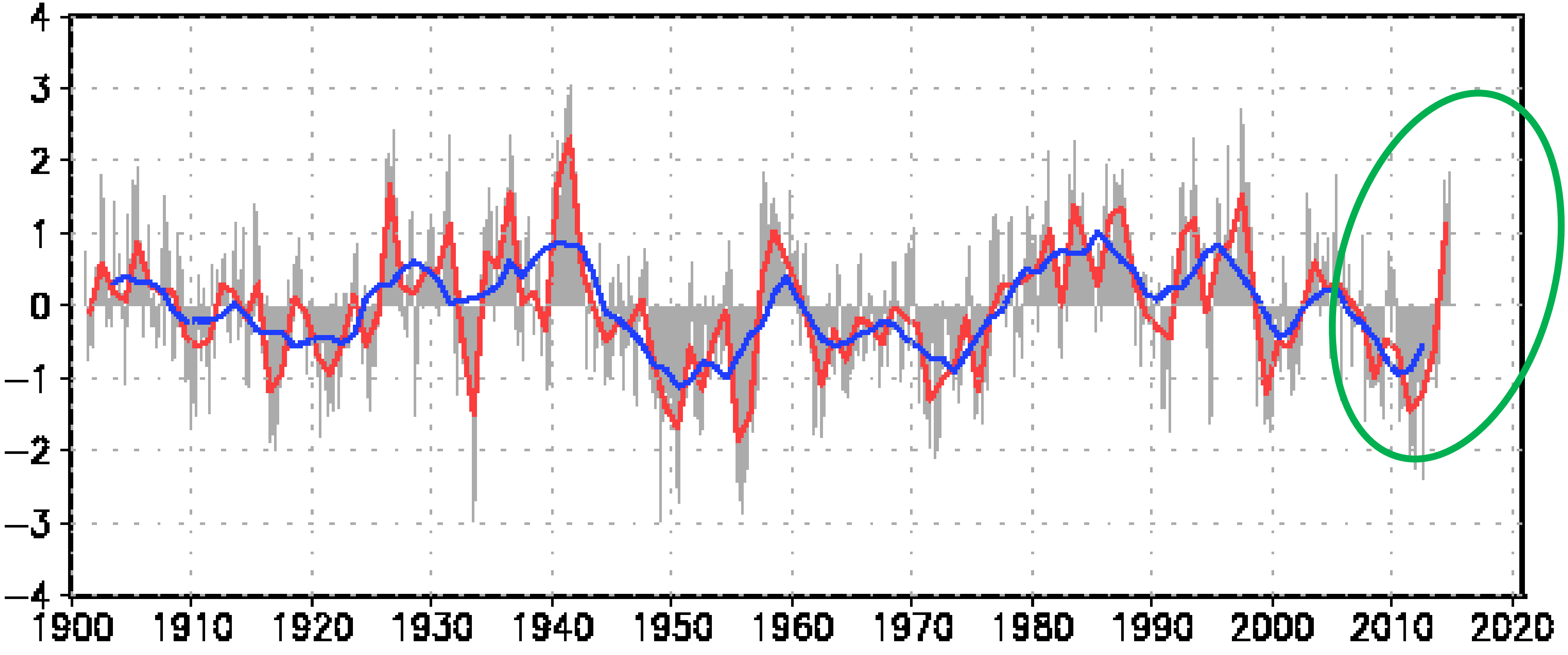


Fig. 6 Regression map of the DJF sea surface temperature (SST, in °C) against the PDO index for the period of 1900–2010. **b** Same as a, but with respect to the ENSO index. *Areas with black dots* indicate a 95 % confidence level according to a two-tailed student's *t* test

Kim et al. (2014)

PDO index

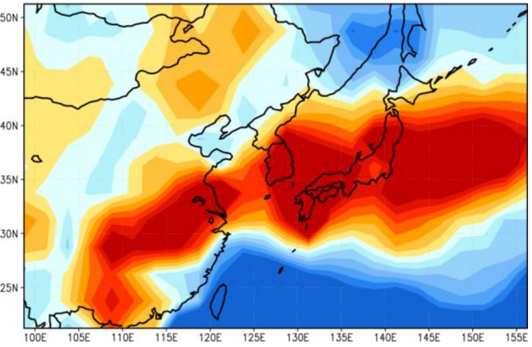


http://ds.data.jma.go.jp/tcc/tcc/products/elnino/decadal/pdo.html

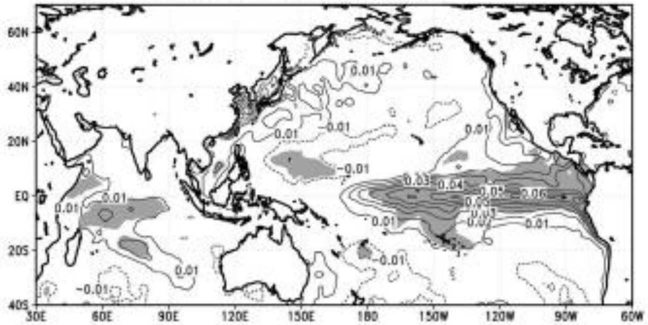
2016 JJA summer

• CMAP EOF1 Precipitation & SST

(a) CMAP EOF 1st mode (17.1%)

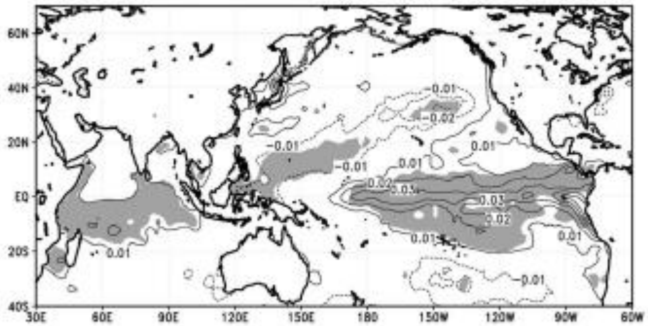


(a) CMAP PC 1st vs. DJF (-1) SST (K)



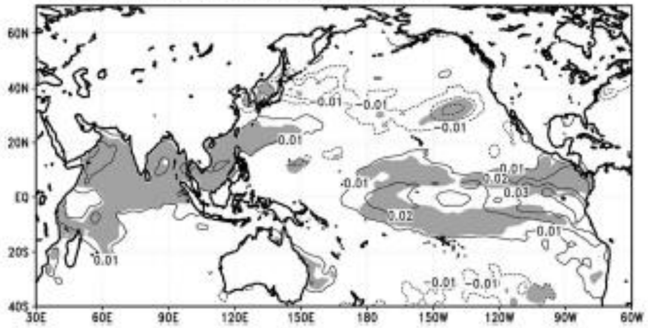
DJF(-1)

(b) CMAP PC 1st vs. MAM (0) SST (K)



MAM(0)

(c) CMAP PC 1st vs. JJA (0) SST (K)



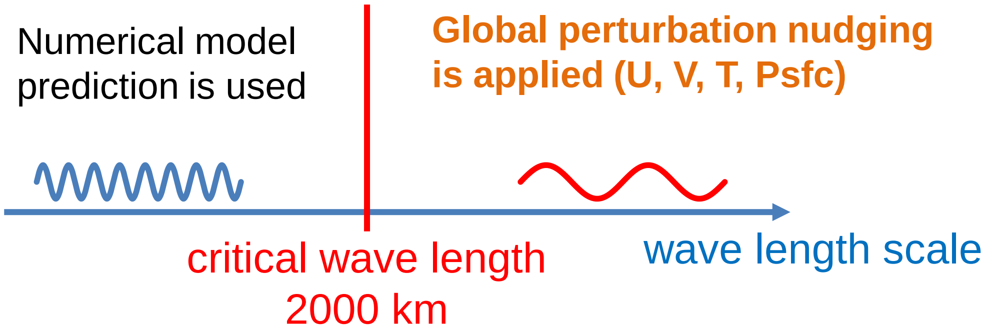
JJA(0)

• A new global atmospheric analysis data (Kim and Hong, 2012)

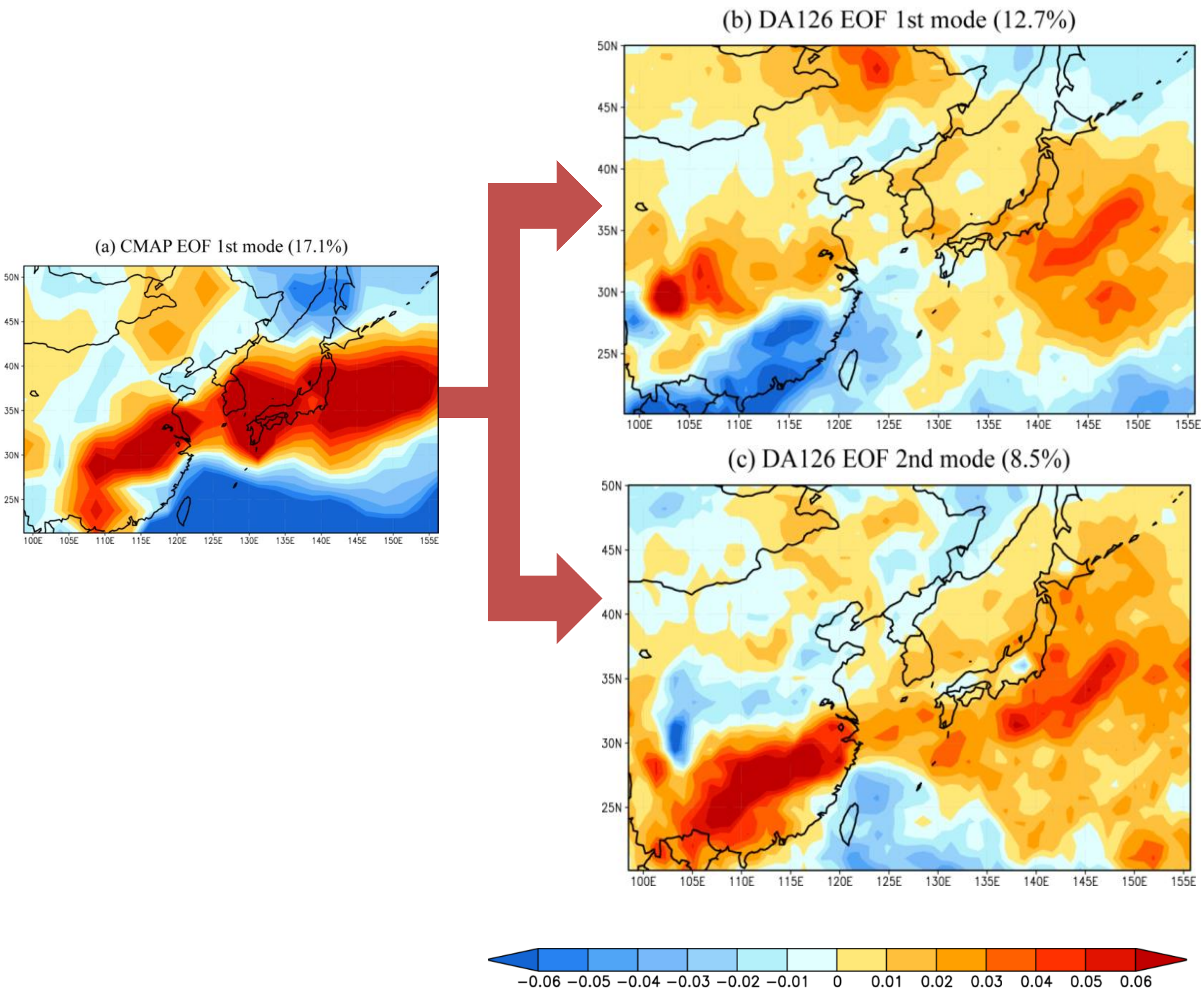
DA126 Kim and Hong (2012)

Resolution	**T126 (1°×1°),** vertical 28 layers
Physics Package	GRIMs physics package v3.0
SST forcing	OISST (1°×1°)
Spectral Nudging	U, V, T, Psfc
Critical wave length for spectral nudging	2000 km
Integration Period	**1980 – 2010 : 31 years**
Nudging forcing	**NCEP-DOE Reanslysis II**

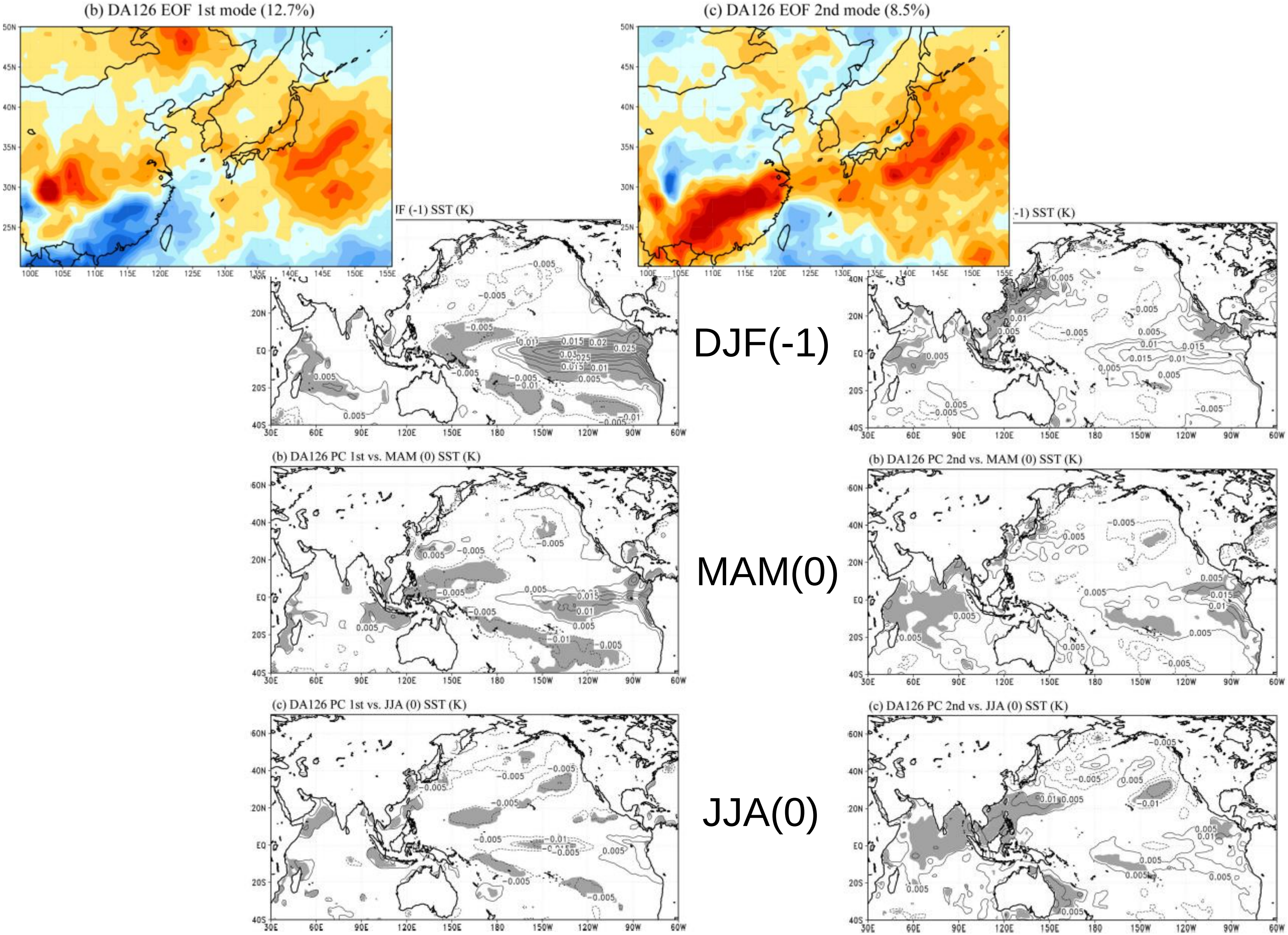
Global downscaling method (Yoshimura and Kanamitsu, 2008)



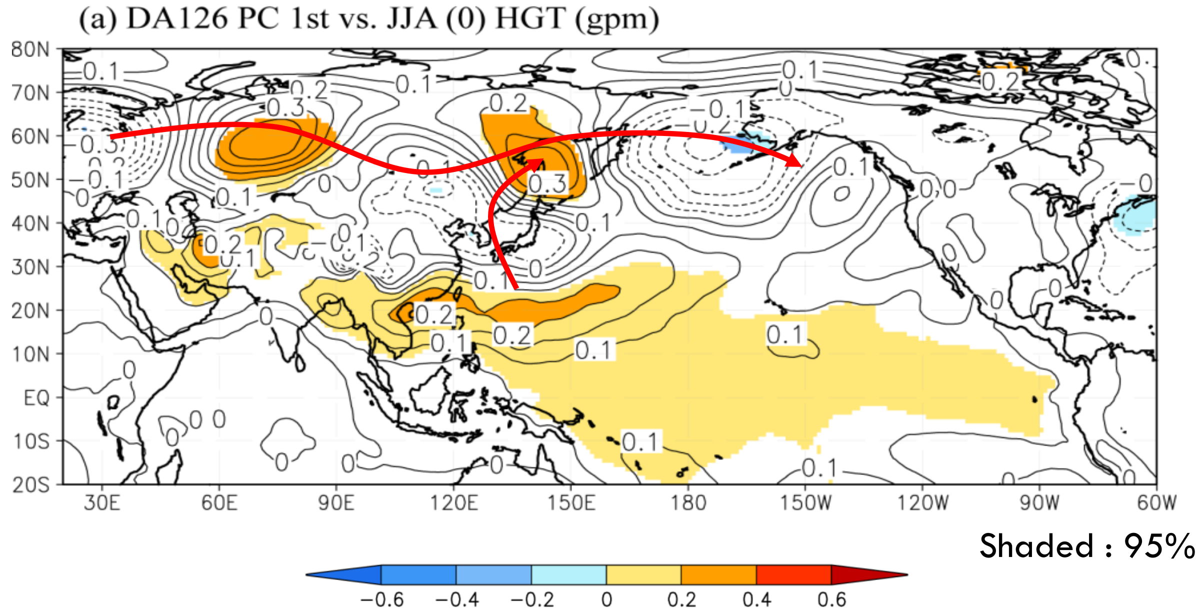
• EOF analysis: JJA precipitation: CMAP & DA126



• DA126 EOF1,2 Precipitation & SST



• DA126 EOF1 PC & Teleconnections



Shaded : 95% significance level

Correlation	vs. PJ index during summer	vs. EU index during summer
DA126 PC 1^{st} mode	0.48	0.62

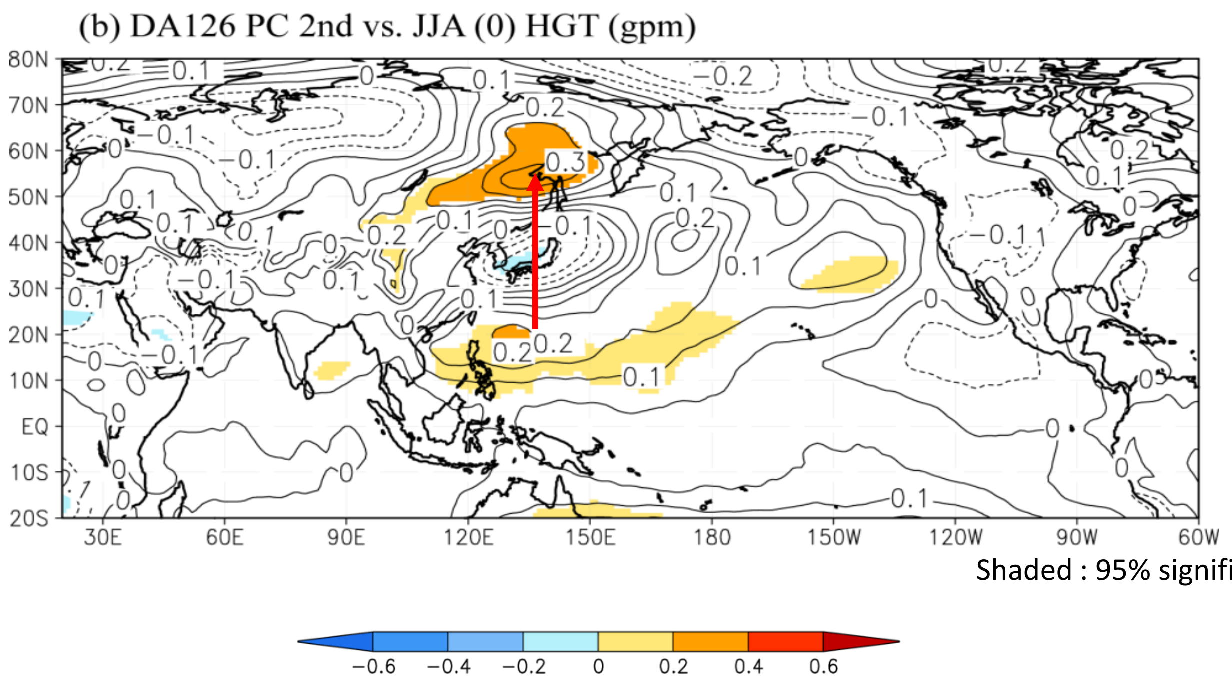
Pacific-Japan (PJ) index (Nitta, 1987)

: differences of the outgoing longwave radiation (OLR) anomaly between [16-20°N, 142-150°E] and [32-38°N, 134-142°E]

EU index (Wallace and Gutzler, 1981)

$$\text{EU index} = -0.25 \times Z^{*}(55°N, 20°E) + 0.5 \times Z^{*}(55°N, 75°E) - 0.25 \times Z^{*}(40°N, 145°E)$$

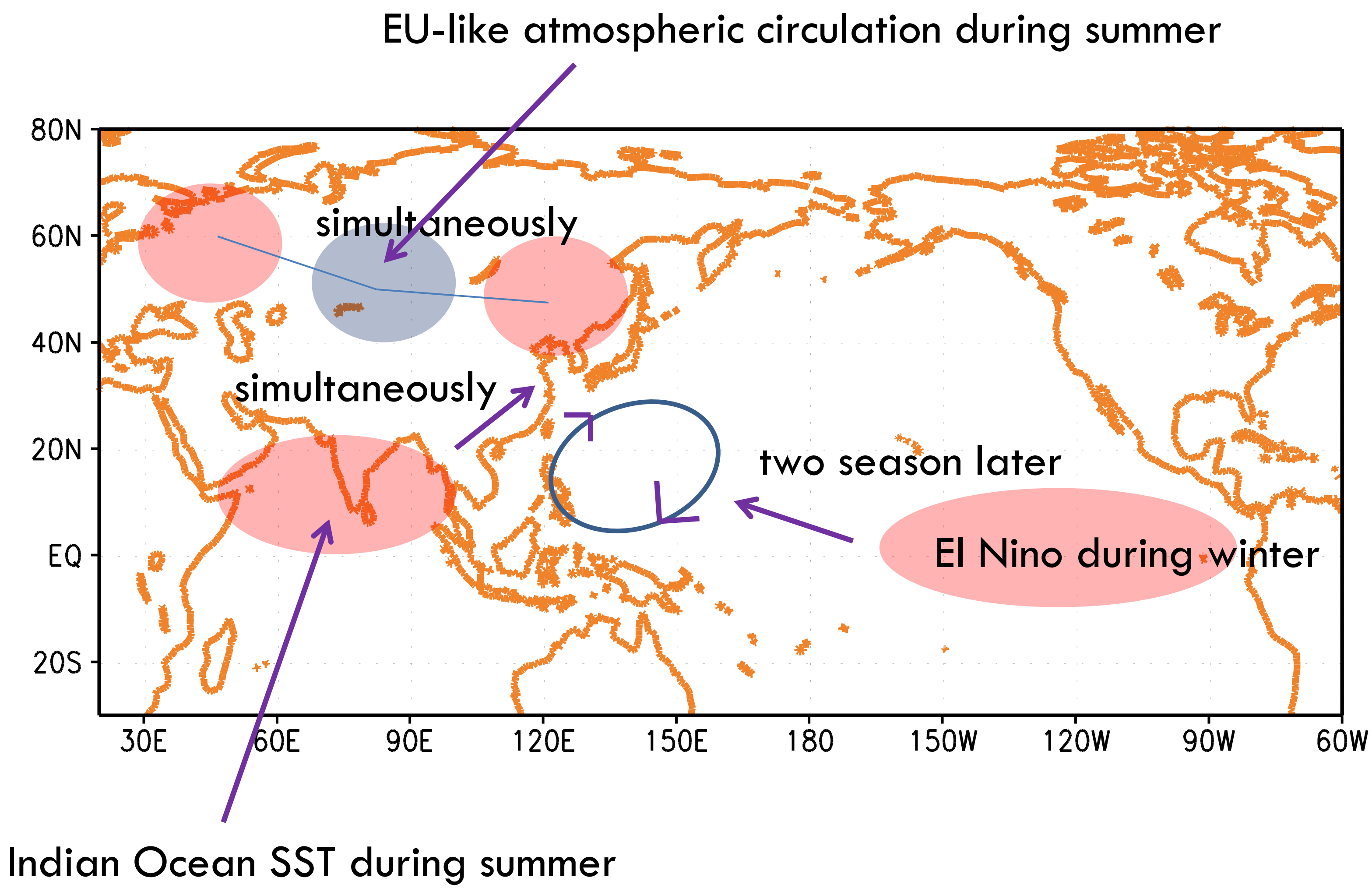
• DA126 EOF2 PC & Teleconnections



Shaded : 95% significance level

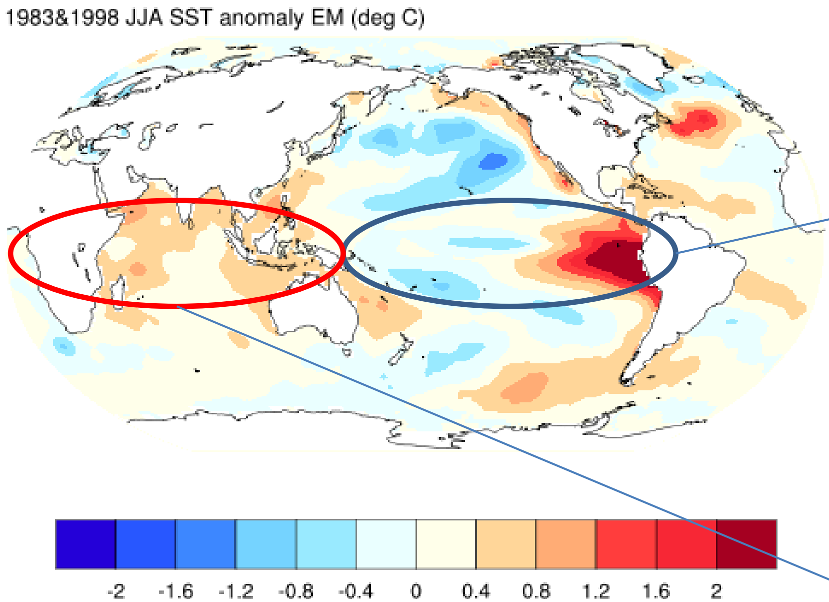
Correlation	vs. PJ index	vs. EU index
DA126 PC 2^{nd} mode	0.39	0.09

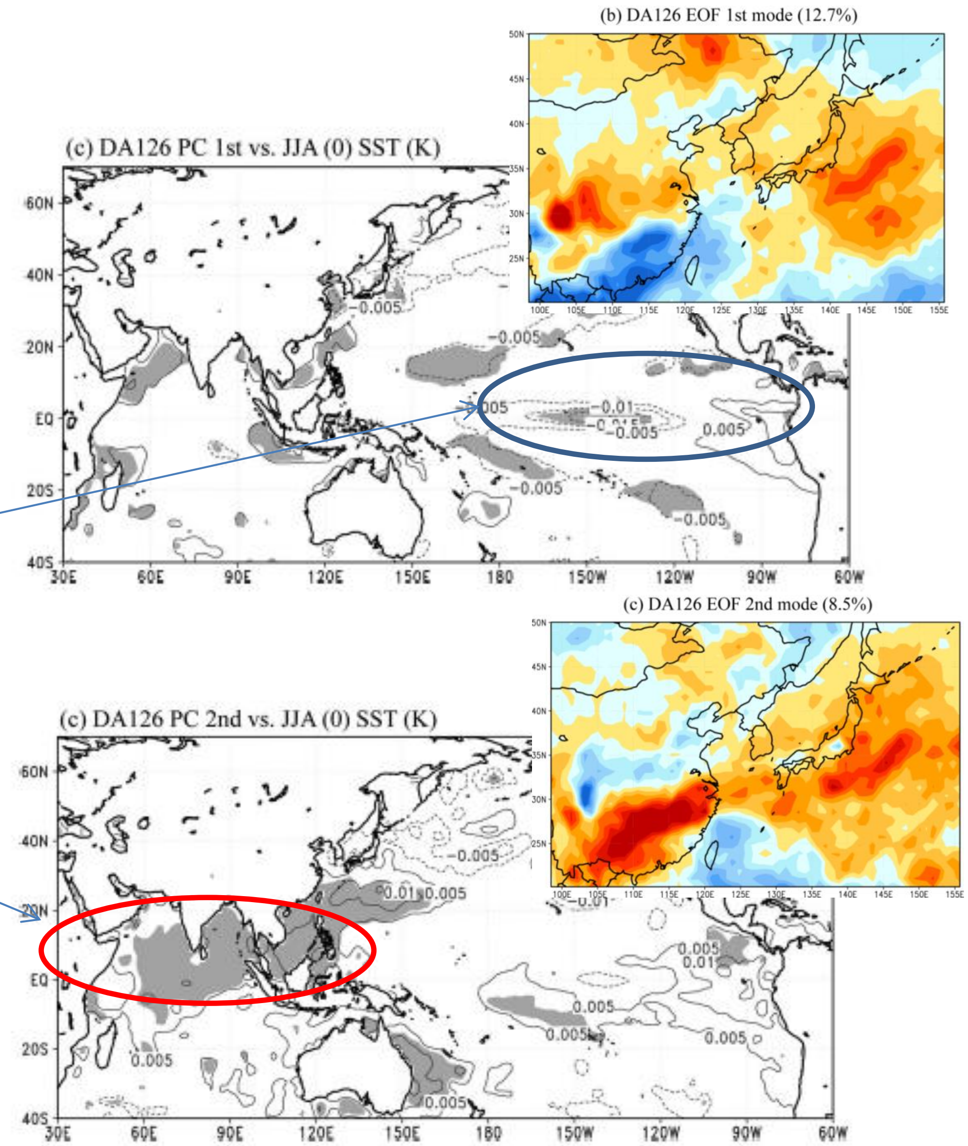
• Teleconnections in relation to summer precipitation



• 1983 JJA, 1998 JJA : SST

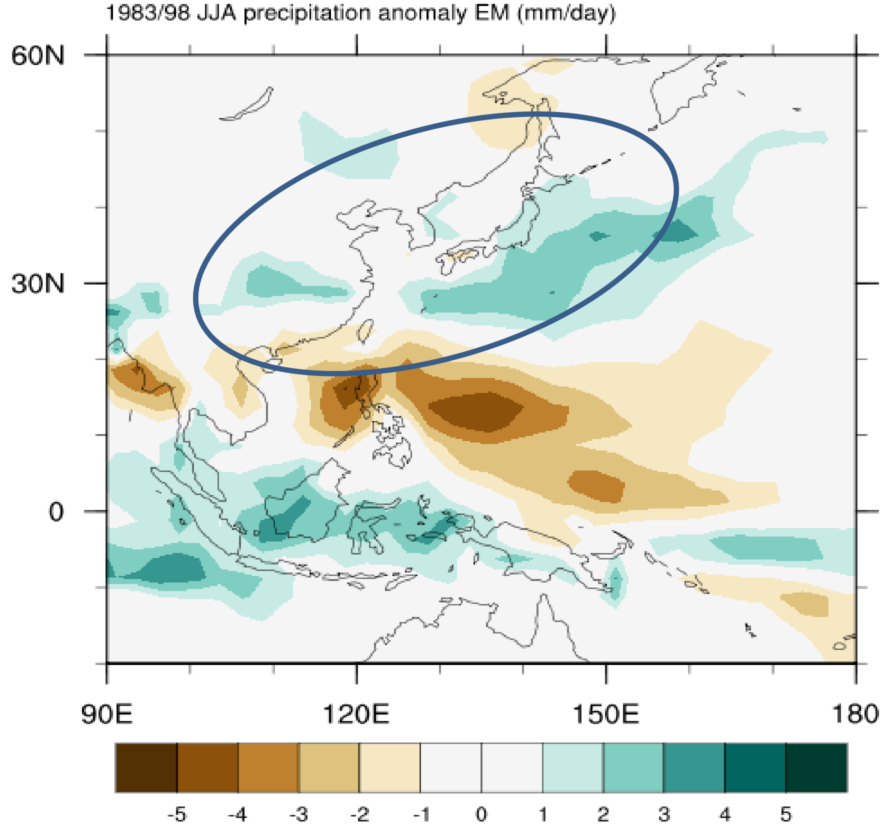
1983 JJA, 1998 JJA ensemble mean





- 1983 JJA, 1998 JJA : Precipitation

1983 JJA, 1998 JJA ensemble mean



- 2016 JJA Precipitation.

: Above normal Precipitation

Thank you

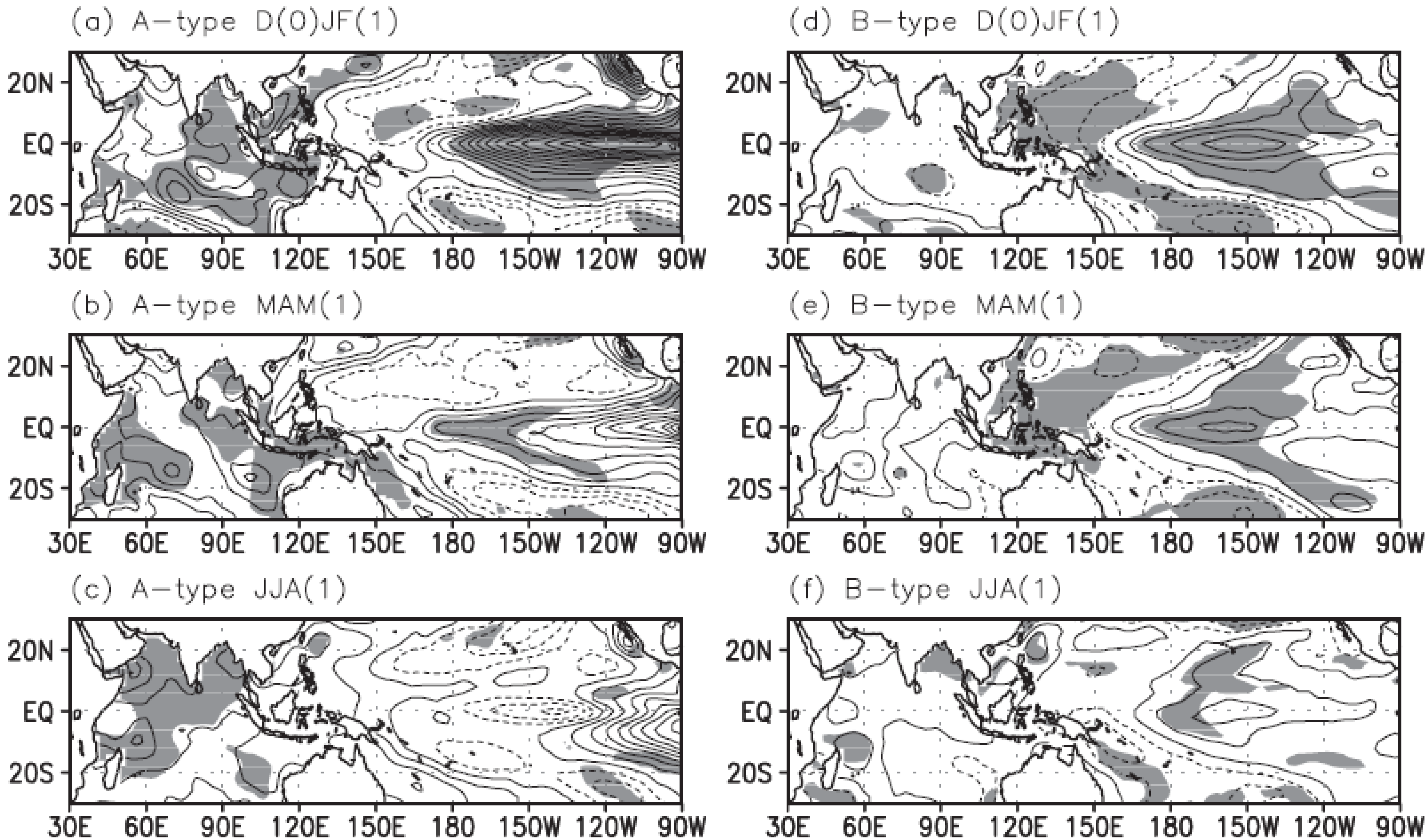


FIG. 3. Composite of seasonal SST anomalies for (a)–(c) A type and (d)–(f) B type from the preceding DJF to the following JJA. Year 0 (year 1) denotes the year before (following year) when strong NEASM occurs (CI: 0.2°C; shading denotes statistical significance at 90% level using a t test).

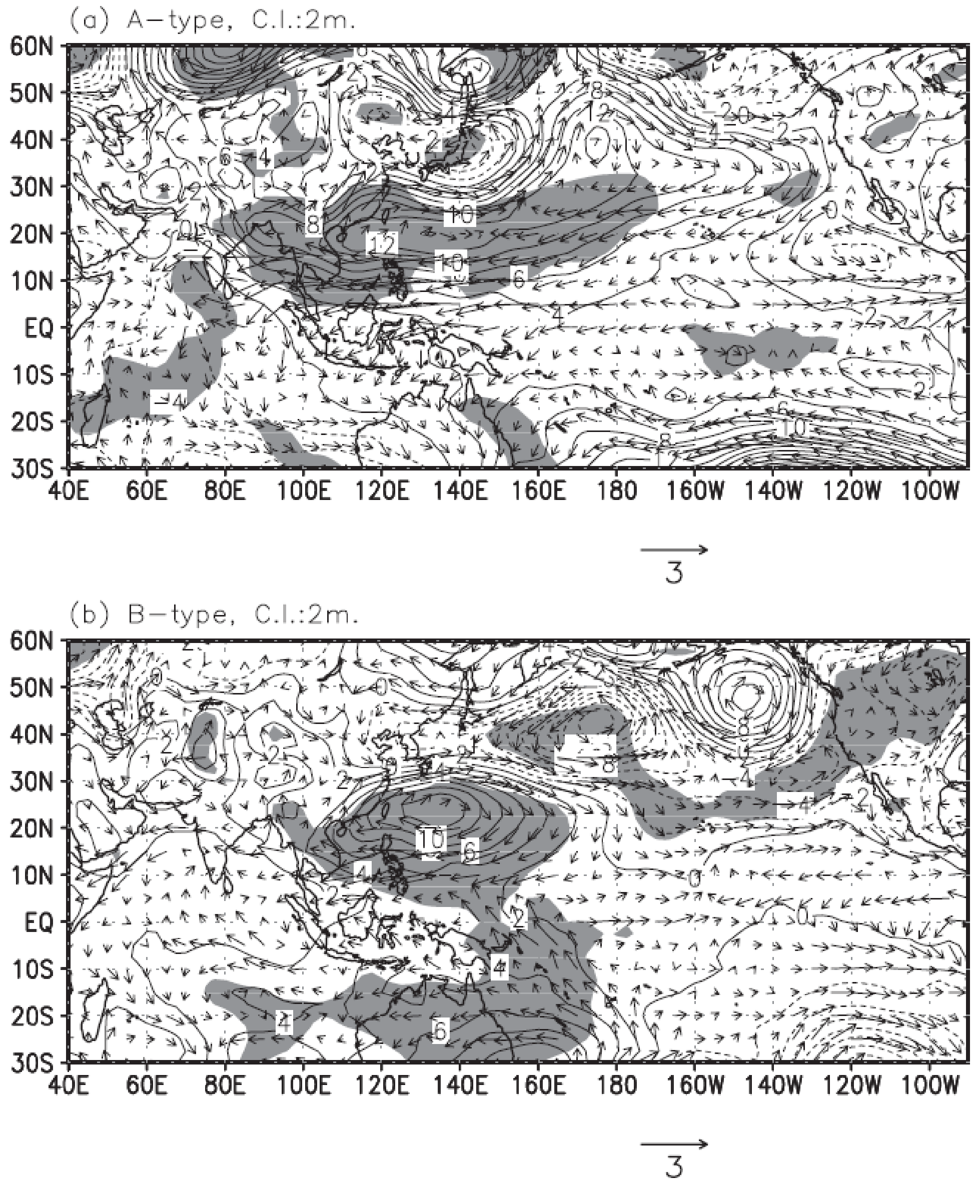


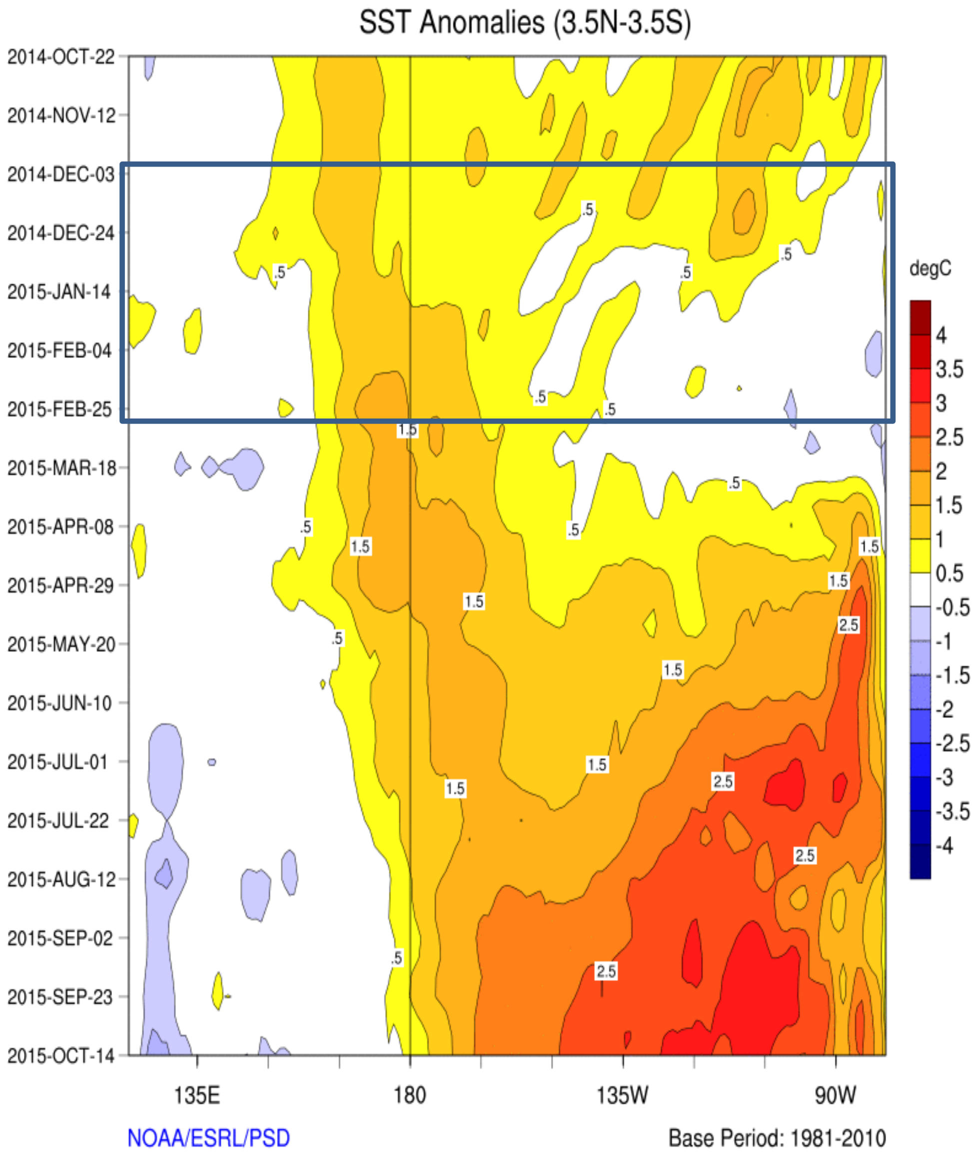
FIG. 6. Composite of anomalous geopotential height and wind anomalies during JJA at 850 hPa for the (a) A type and (b) B type (CI: 2 m and negative contours dashed). The wind scale (m s^{-1}) vector is below the panel; shading denotes statistical significance at 90% level using a t test.

• Question

-A relationship of tropical SSTs to East Asian summer monsoon is stationary?

: Mean state change
: Internal variability
: Global warming

• 2014/15 & 2015/16 El Nino evolution



2014/15 winter

Pacific–East Asian Teleconnection: How Does ENSO Affect East Asian Climate?*

BIN WANG, RENGUANG WU, AND XIOUHUA FU

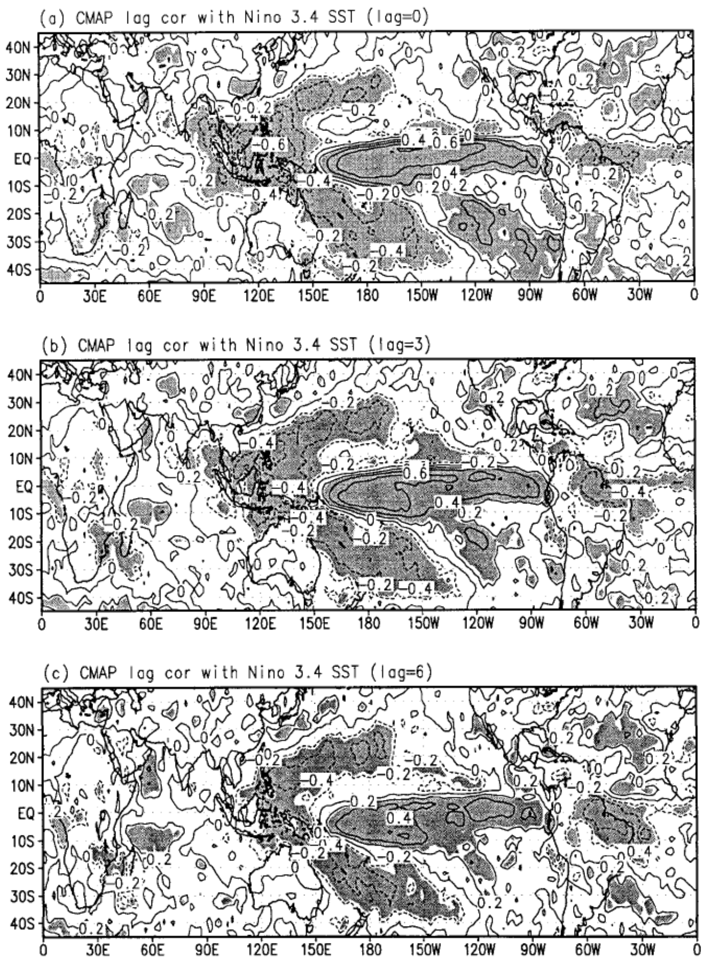


FIG. 1. Correlation maps of the CMAP (Xie and Arkin 1997) rainfall with reference to Niño-3.4 SST (5°S–5°N, 120°–170°W) anomalies (SSTAs) at (a) lag = 0 (simultaneous), (b) lag = +3 (rainfall anomalies lag Niño-3.4 SSTA by 3 months), and (c) lag = +6 (rainfall anomalies lag Niño-3.4 SSTA by 6 months). The data used are 3-month running mean anomalies during 1979–96. The shaded regions denote correlation coefficients significant at 95% confidence level.

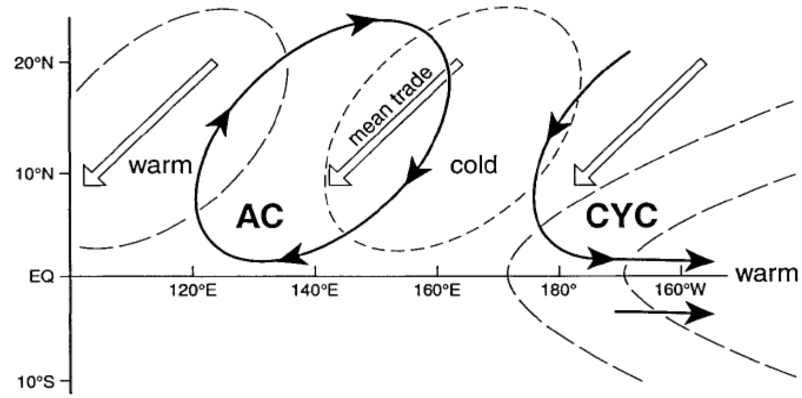


FIG. 16. Schematic diagram showing the air–sea interaction in the western North Pacific that maintains the Philippine Sea anticyclonic anomalies and associated negative SST anomalies in the western North Pacific. The double arrows denote the mean trade winds. The heavy lines with black arrows represent the anomalous winds. The long (short) dashed lines indicate contours of positive (negative) SST anomalies.

Wang et al. (2000)