

# Long-term trend pattern in SSTs and atmospheric circulations

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# Outline

1. Introduction
2. Long-term trend pattern in SSTs and atmospheric circulations
3. Numerical Prediction for 2008/09 winter
4. Summary

# 1. Introduction

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2. Long-term trend pattern in SSTs and atmospheric circulations
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# Predictable slow variations of the climate system

Predictable inter-annual variation such as ENSO, IOD,,,,

By CGCM, ENSO and its instantaneous and delayed influence are well predicted

Decadal, inter-decadal, multi-decadal variation such as PDO,AMO,NPGO,,,,,

Basically predictable because of its long time scale compared with that of seasonal prediction

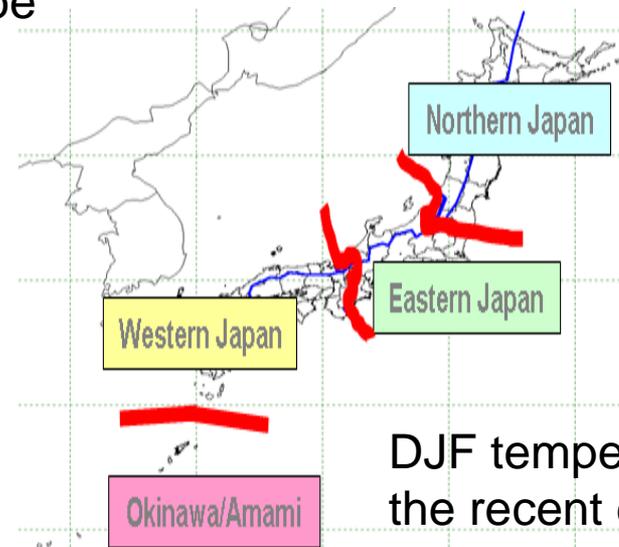
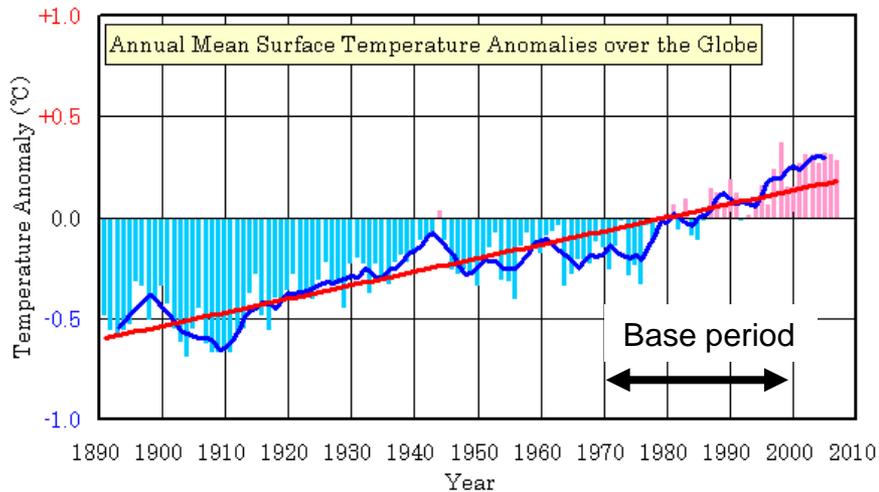
Climate change by anthropogenic external forcing

Difficult to distinguish

- During the coming winter, El Niño and La Niña, which are the dominant predictable inter-annual variation of the climate system, are unlikely to develop
- Heavy weight should be given to decadal variation and climate change as grounds for the coming winter prediction

# Is temperature predication easy considering the apparent global warming trend?

Annual mean TS anomalies over the globe



Not easy

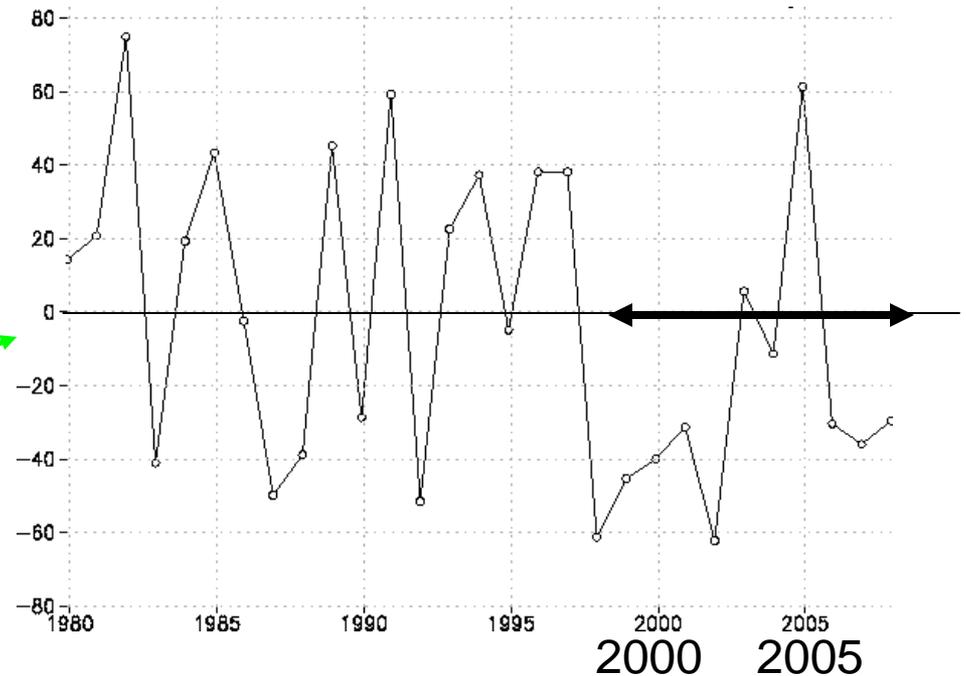
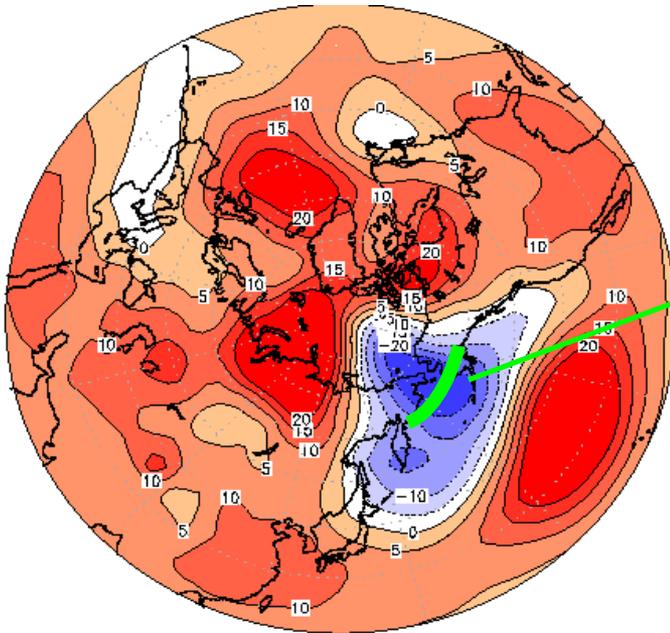
	Temperature anomalies(°C)	Frequency of three categories in 1998/99-2007/08		
		B	N	A
N. Japan	0.1	3	4	3
E. Japan	0.4	1	4	5
W. Japan	0.5	1	6	3
Okinawa/Amami	0.7	0	3	7

B: Below Normal N: Near Normal A: Above Normal

Base period is 1971-2000

# Why is DJF temperature in N. Japan near normal?

The recent decade DJF mean Z500 anomalies (1998/99 – 2007/08)



Base period: 1979-2004

- Climate change including decadal variation is not uniform in space, in time
- It is important to diagnose the current status and its influence

## 2. Long-term trend pattern in SSTs and atmospheric circulations

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# Data and method

## ▪ DATA

### Atmospheric data

JRA-25 (from 1979 to 2004) and JCDAS (2005~)

### SST data

COBE-SST (JMA 2006)

### OLR by ESRL/NOAA

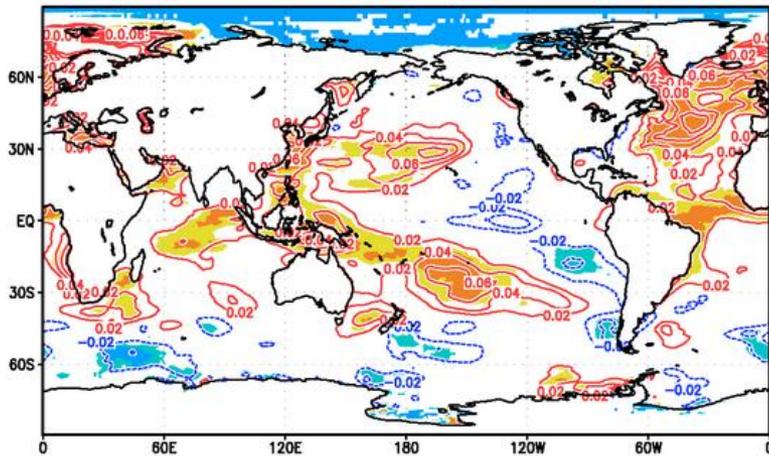
( climatological means were calculated for the period from 1979 to 2004)

- **Linear trend : calculated from 1979 to 2006**
- **Composite analysis: the recent decade (1998/99-2007/08)**
- **DJF**

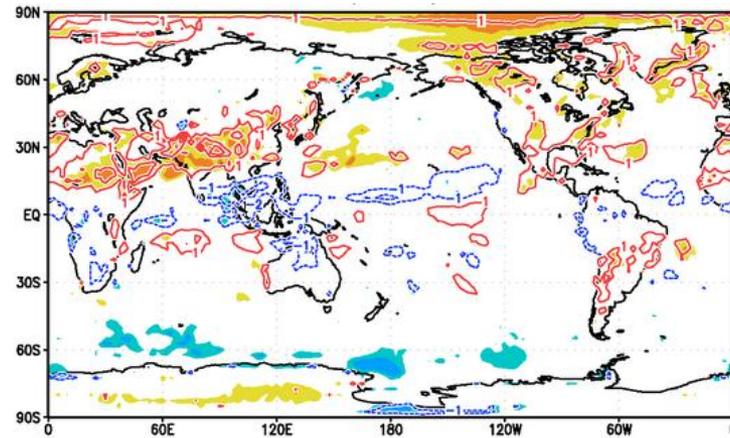
# DJF Oceanic and Atmospheric fields

--linear trend from 1979 to 2006--

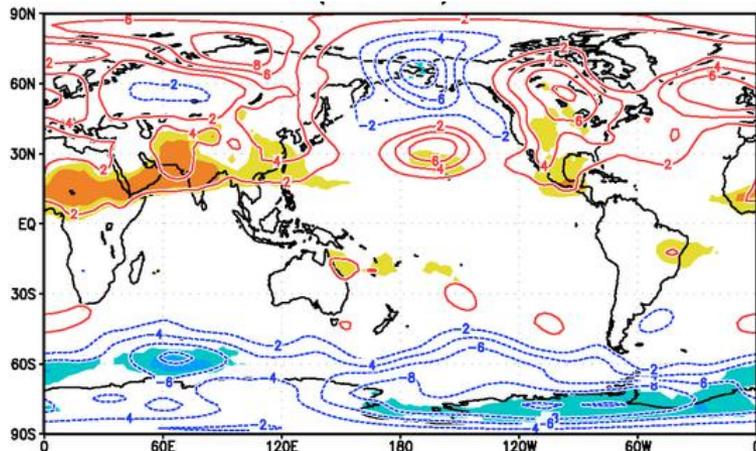
SST °C/10years



OLR W/m<sup>2</sup> /10years



Z500 m/10years

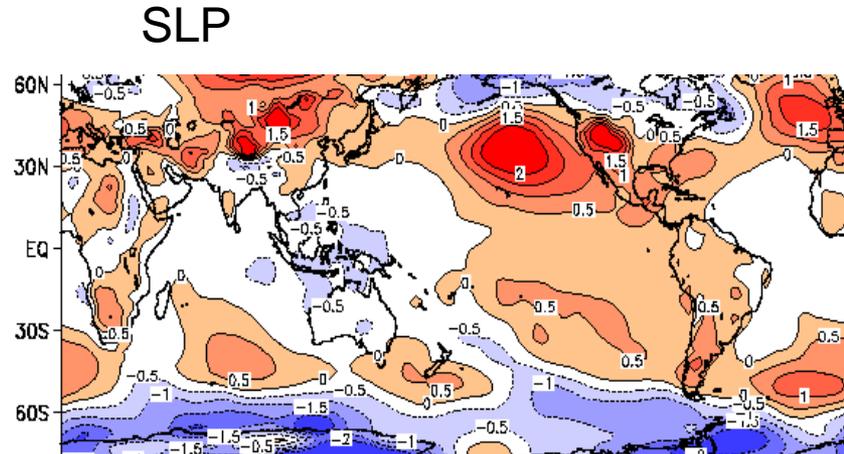
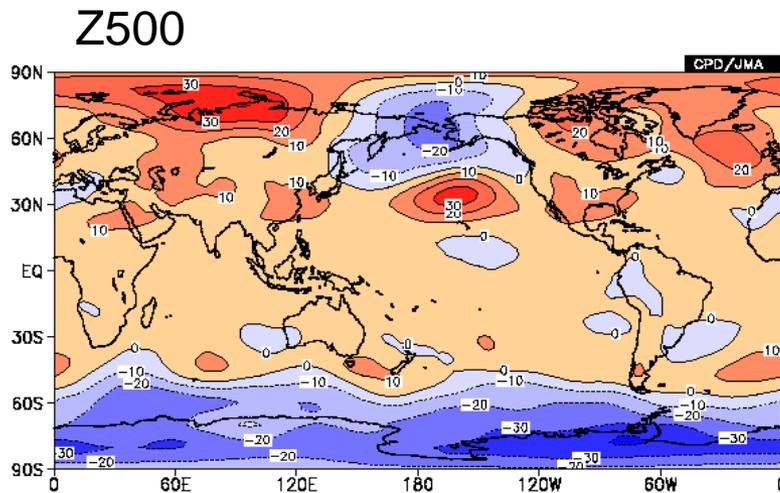
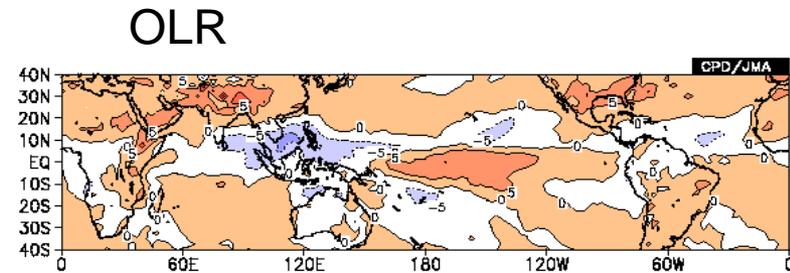
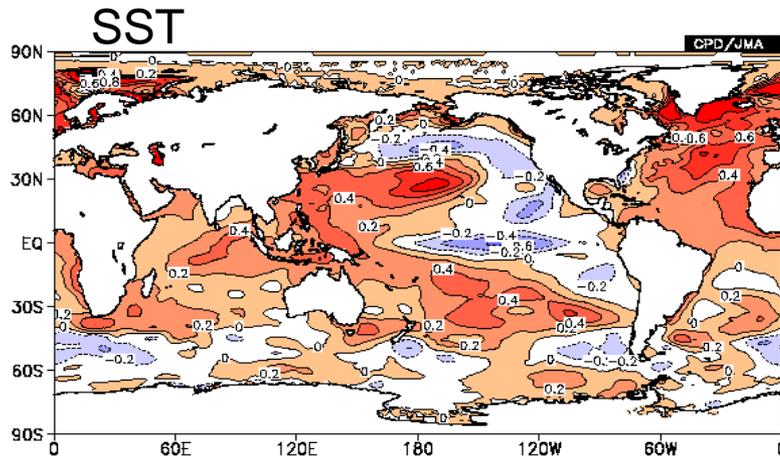


- La Niña like trend in SST
- Active convection over the Maritime Continent
- Negative trend in Z500 over the northern part of the North Pacific

Shade: Statistical significant (90%) by Mann-Kendall rank statistics

# The recent decade DJF mean (1998/99 – 2007/08)

Base period: 1979-2004

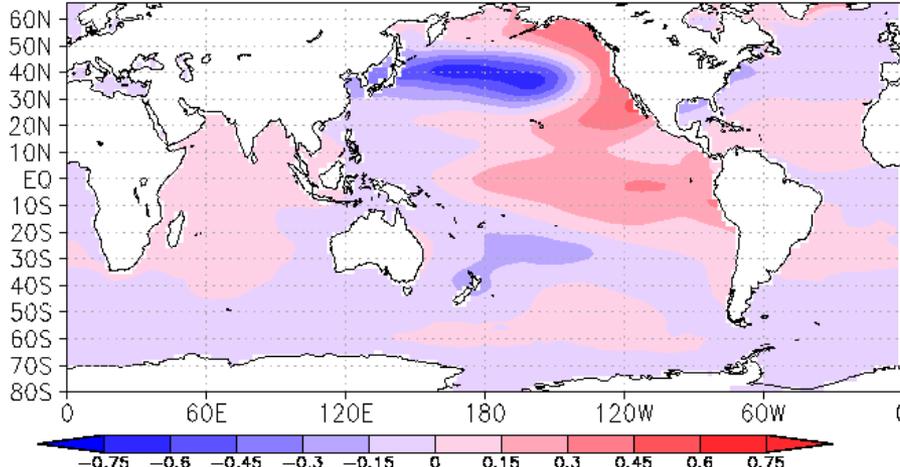


- Linear trend (1979-2006) patterns are clearer in the recent decade winters mean
- Negative Z500 anomalies in the Northern Japan

# Decadal Modes in the North Pacific

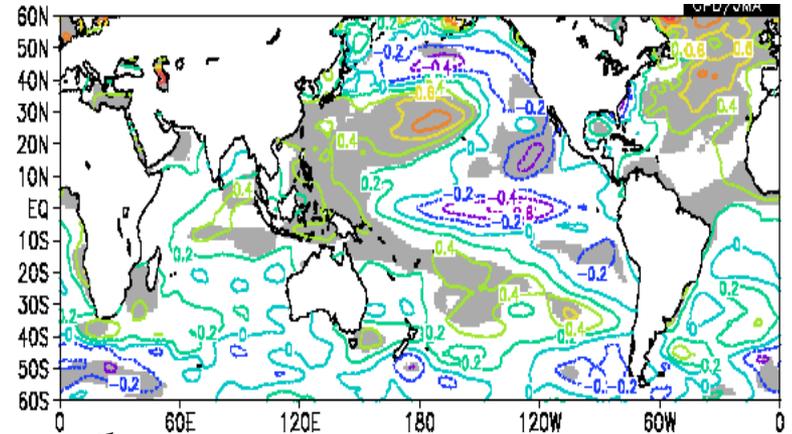
## SST 1<sup>st</sup> Mode: Pacific Decadal Oscillation (PDO)

SST regressd on the PDO index based COBE-SST

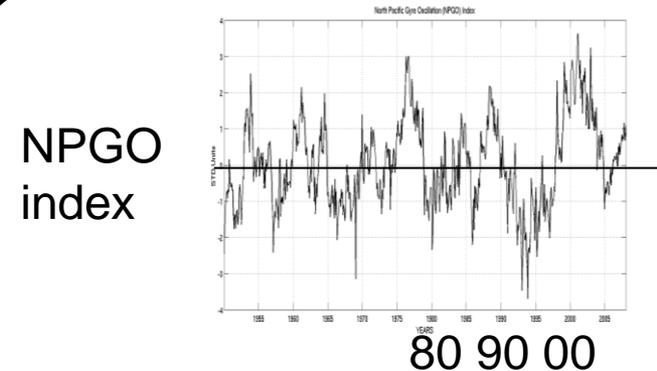


[http://www.data.kishou.go.jp/kaiyou/db/climate/knowledge/pdo/pdo\\_doc.html](http://www.data.kishou.go.jp/kaiyou/db/climate/knowledge/pdo/pdo_doc.html)

## SST: the recent decade DJF mean (1998/99 – 2007/08)



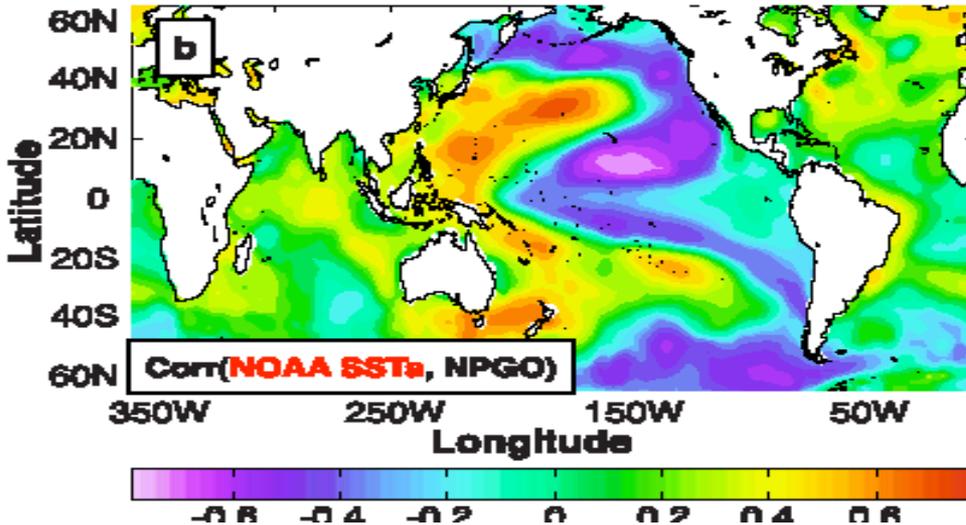
Shade: significant



NPGO index

## SST 2<sup>nd</sup> Mode: North Pacific Gyre Mode (NPGO)

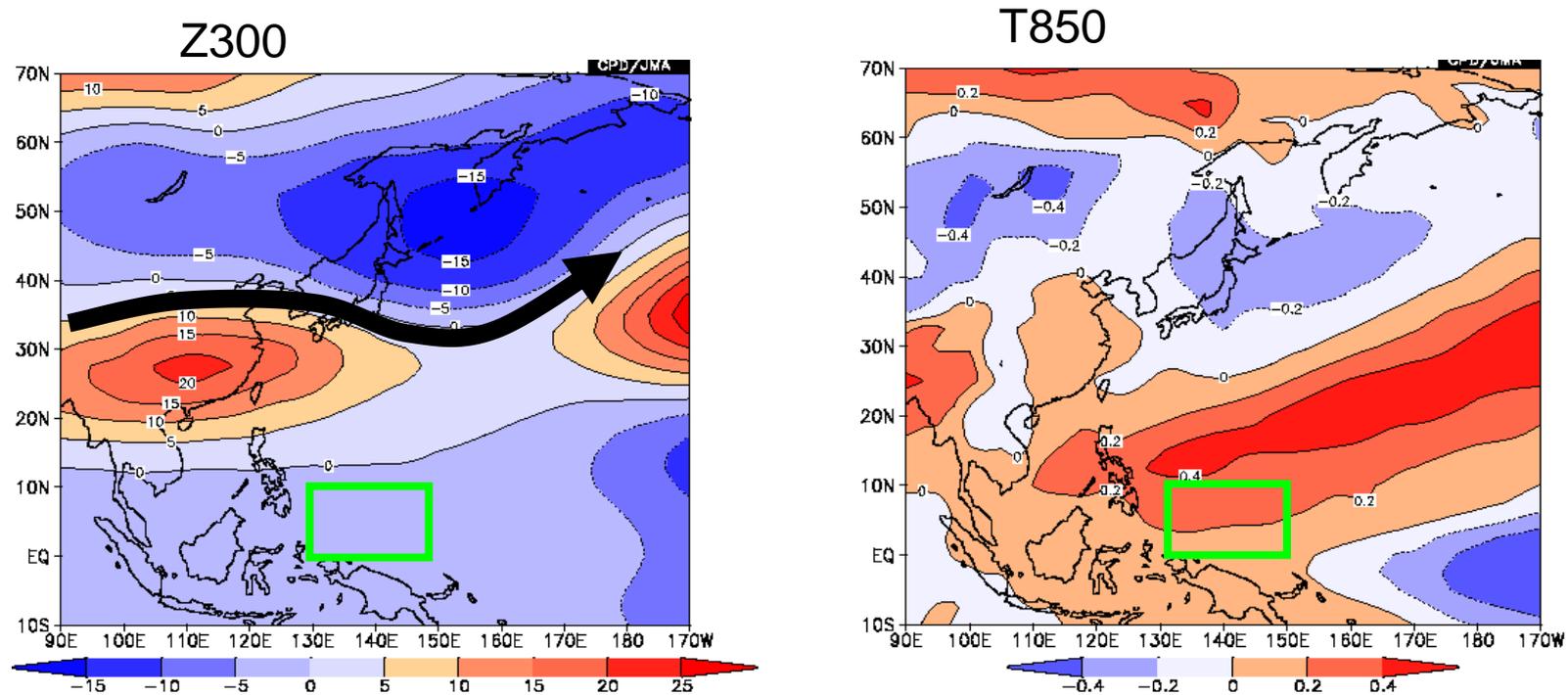
(E. D. Lorenz et al., 2008)



Nakamura et al., 1997, Yasuda and Sakurai, 2006

SST pattern in the recent decade DJF mean resembles the 2<sup>nd</sup> decadal mode in the North Pacific

# SST in the tropical western Pacific and air-temperature (DJF)

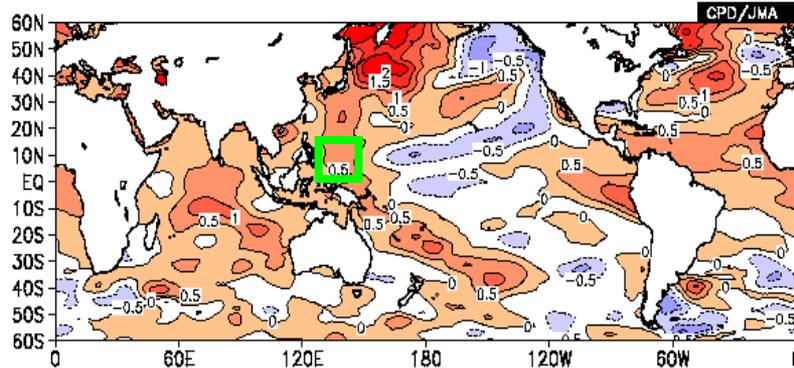


Z300 (left) and T850 (right) anomalies regressed on area averaged (0-10N,130-150E) SST (from 1979 to 2007)

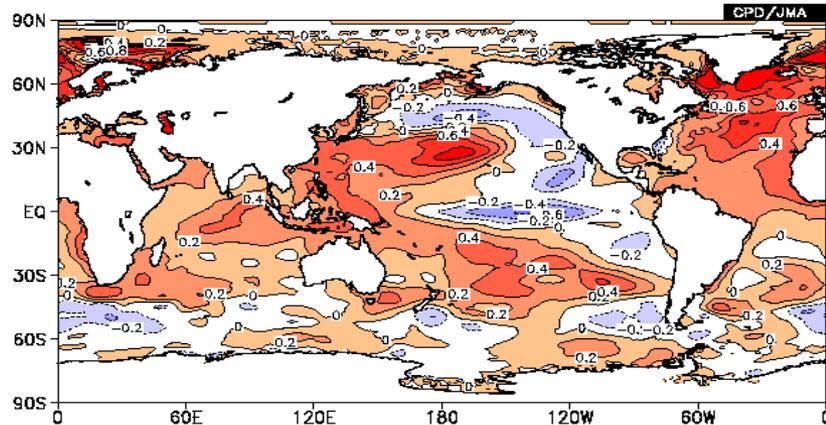
SST anomalies in the tropical western Pacific are negatively correlated with temperature anomalies in Japan through meandering of the sub-tropical jet stream

# SST in Sep. 2008

DATA1 SST t ANOM lat = -60:60 lon = 0:360 level = 1:1  
time = 2008090100:2008090100 cve = 1 MONTH



SST anomaly in  
September 2008



Recent decade winters mean  
SST anomaly(1998/99-2007/08)

SST anomalies pattern in Sep. 2008 resembles that of the recent decade mean  
El Niño is unlikely to develop  
It is natural to consider that the pattern will persist during the coming winter

# 3. Numerical Prediction

1. Introduction

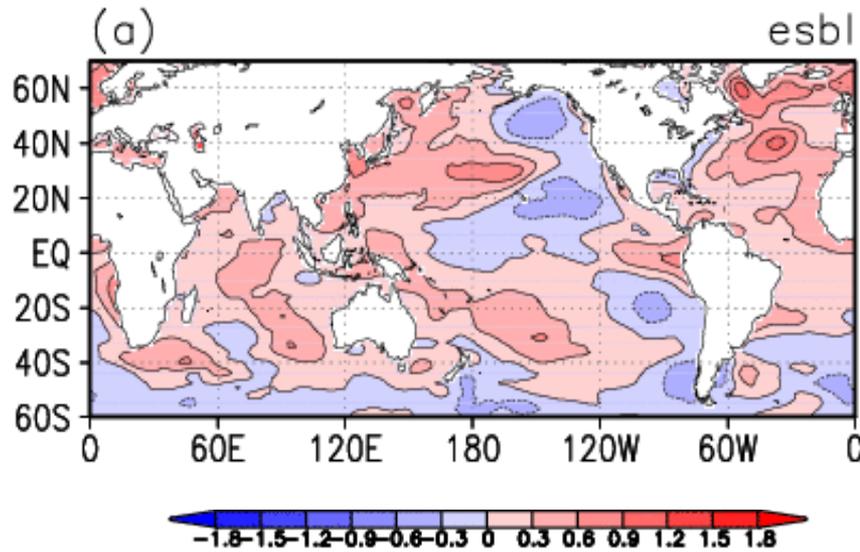
2. Long-term trend pattern in SSTs and atmospheric circulations

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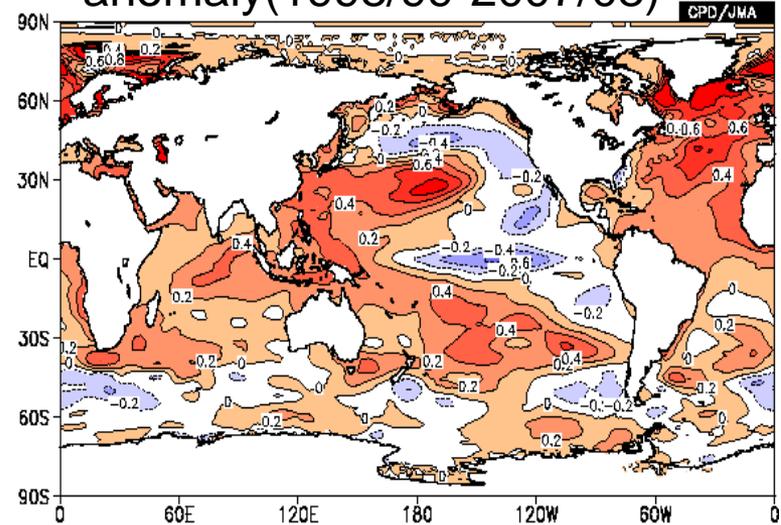
4. Summary

# SST anomalies fed to the model(DJF)

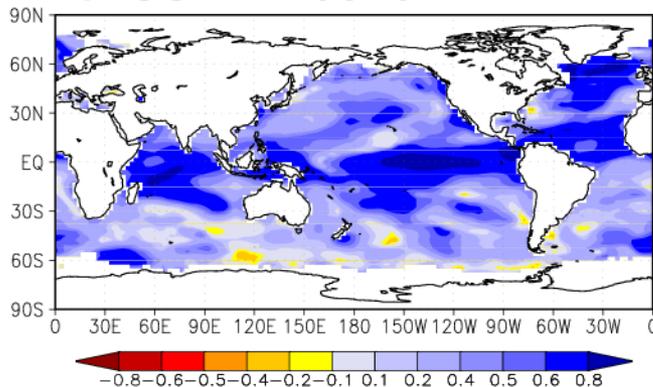
SSTA fed to the model



Recent decade winters mean SST anomaly(1998/99-2007/08)



Prediction skill (ACOR)  
of SST init:0810

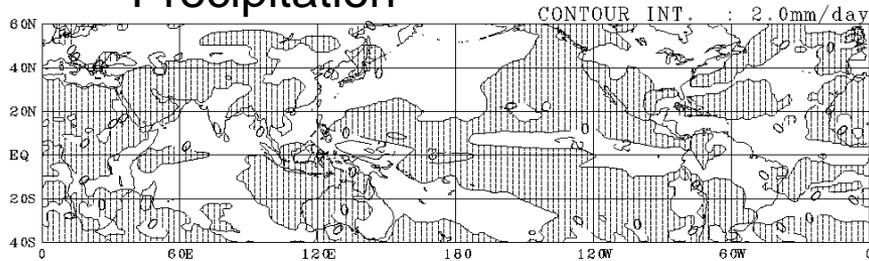


- Not El Niño, Not La Niña
- Negative (Positive) in the central (western) equatorial Pacific. In the Pacific, C shape SST anomaly pattern
- Positive in the Indian Ocean and the North Atlantic.
- Similar pattern and amplitudes to the recent decade DJF mean

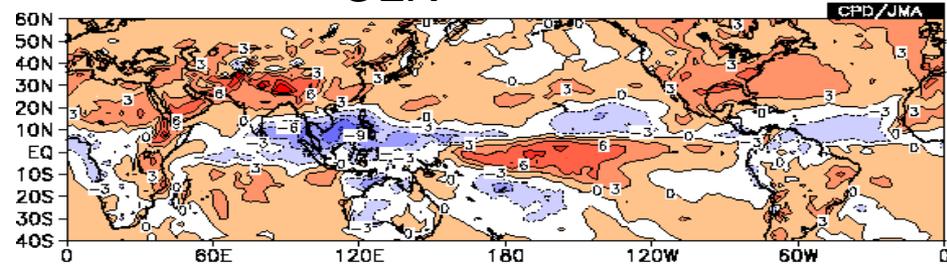
# Tropics and sub-tropics (DJF)

Black and white: numerical prediction, Color: recent decade winters mean

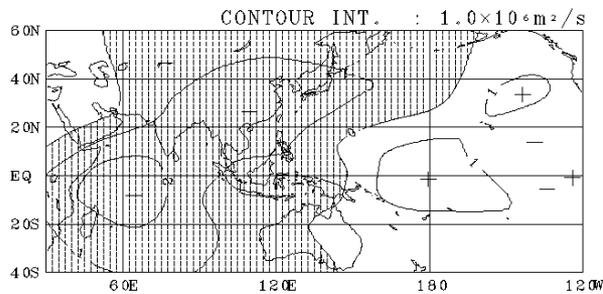
Precipitation



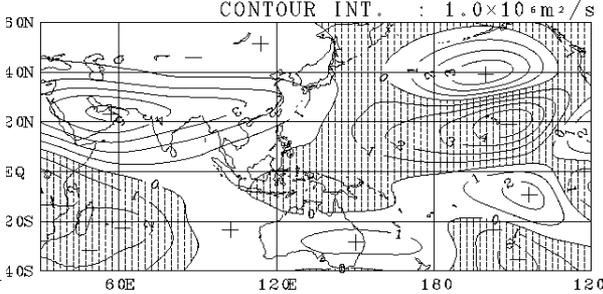
OLR



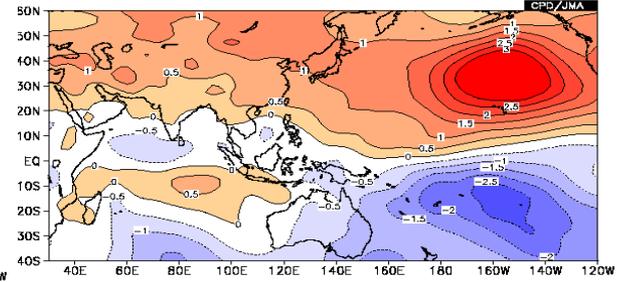
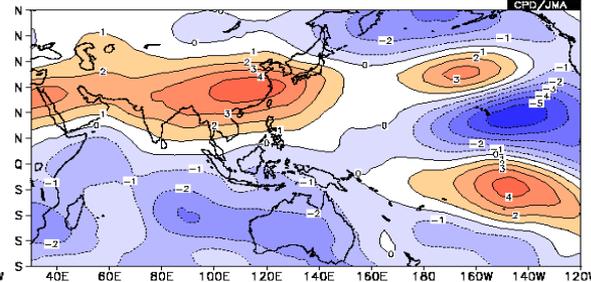
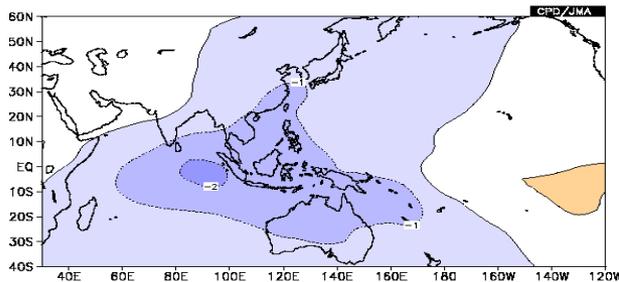
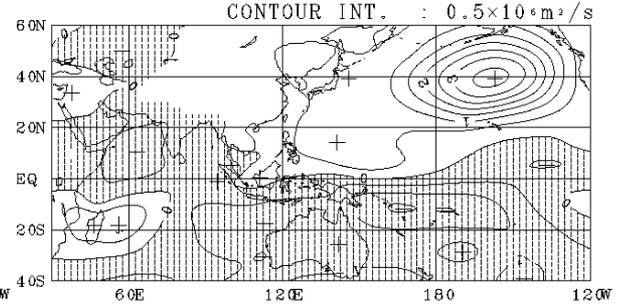
Velocity potential at 200hPa



Stream function at 200hPa



Stream function at 850hPa



In the tropic and the sub-tropics, the predicted circulation anomaly patterns are similar to those of the latest 10 winters mean (rather westward shift). La-Niña like pattern.

# 4. Summary

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# Summary

- In addition to the global warming trend, La Niña like trend is seen in SSTs and atmospheric circulations
- The La Niña like pattern is clearer in the recent decade DJF mean
- The recent decade DJF mean SST anomaly pattern over the globe, including the La Niña like pattern, resembles the secondary dominant decadal mode of SST variation in the Pacific Ocean

- The SST anomaly pattern fed to the numerical model is similar to that of the recent decade DJF mean SST anomaly pattern
- In association with the SST, the predicted ensemble averaged atmospheric circulation anomaly pattern by the model is also similar to that of the recent decade DJF mean circulation anomaly pattern in the tropics and the subtropics
- This result clearly indicates that the greatest signal for the coming winter prediction comes from the long-term trend including decadal variation

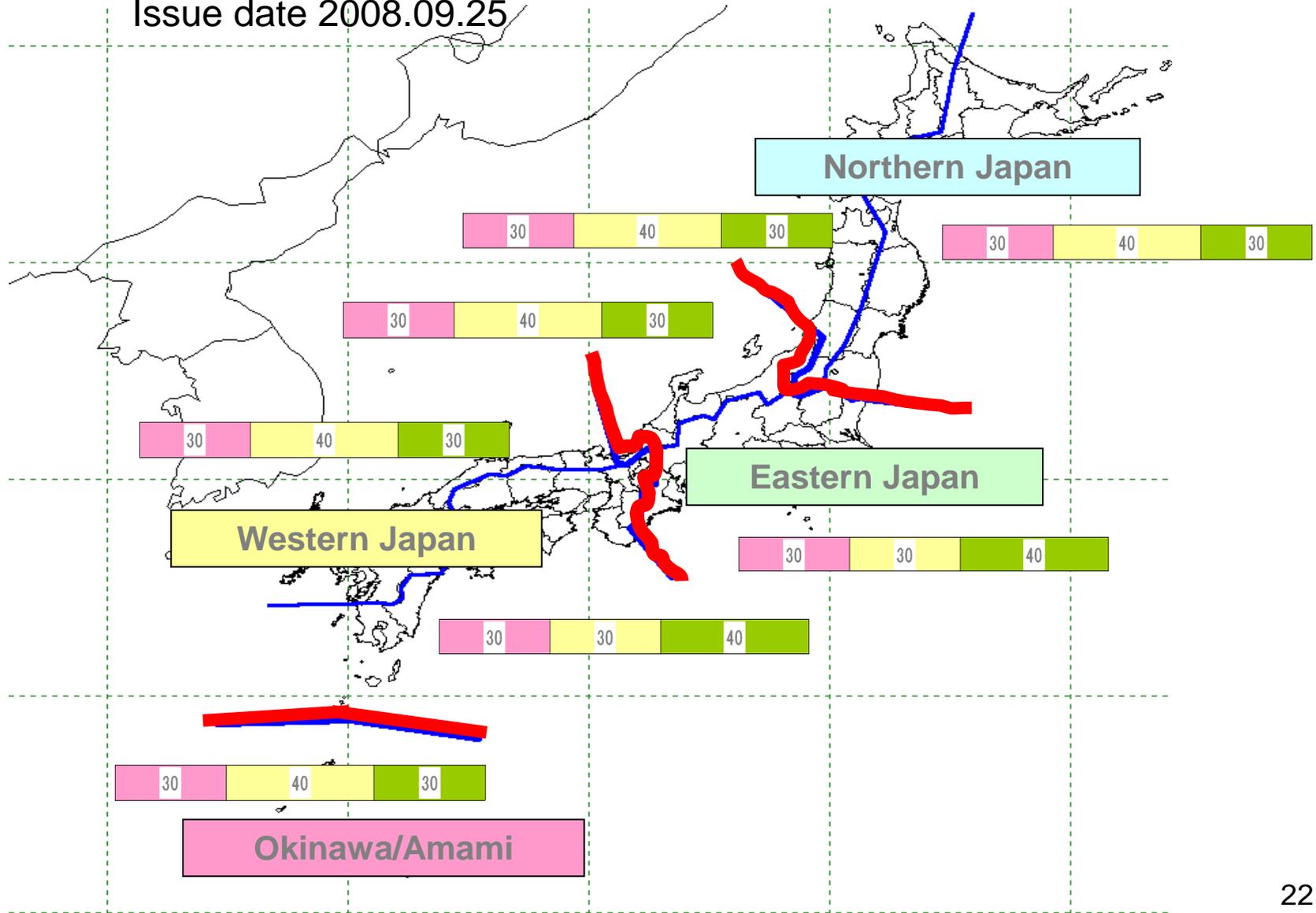
# Implication for the coming winter forecast

- During the coming winter, El Niño and La Niña, which are the dominant predictable inter-annual variation of the climate system, are unlikely to develop
- Thus, heavy weight should be given to the long-term trend pattern( global warming + La Niña like pattern ) and its influence as grounds for the coming winter prediction

# Back up slides

# Probabilities of 2008/09 DJF Precipitation

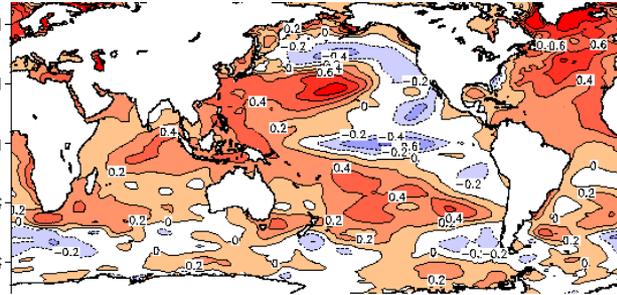
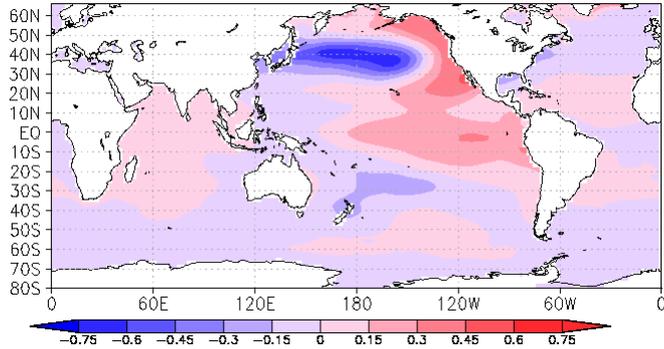
Issue date 2008.09.25



# Decadal Mode in the North Pacific

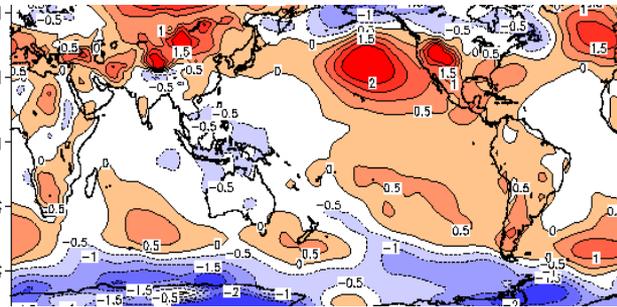
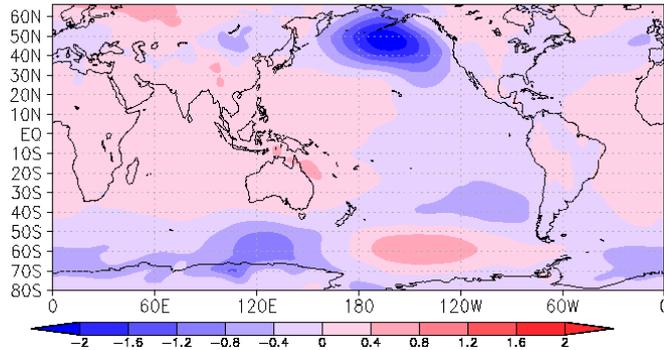
## 1<sup>st</sup> Mode: Pacific Decadal Oscillation (PDO)

SST regressd on the PDO index based COBE-SST

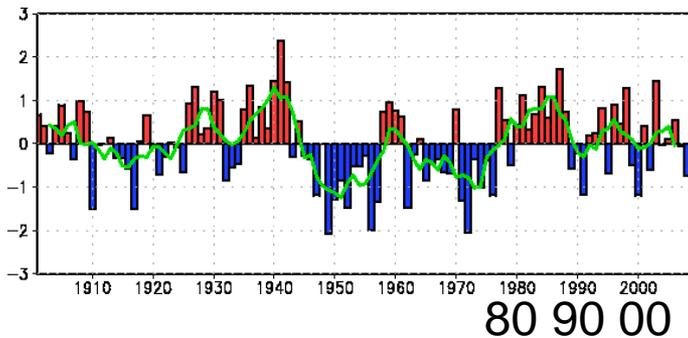


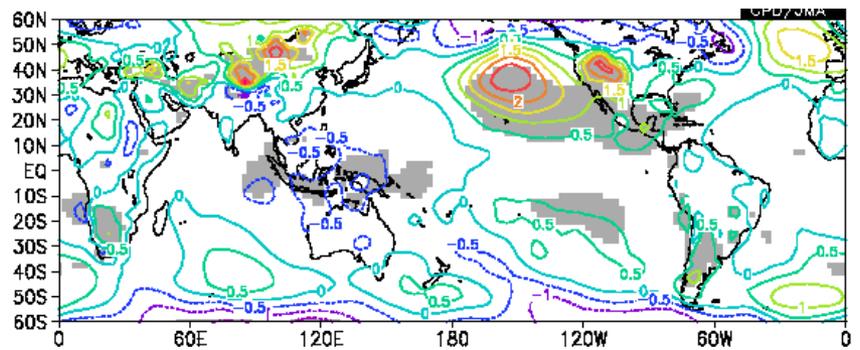
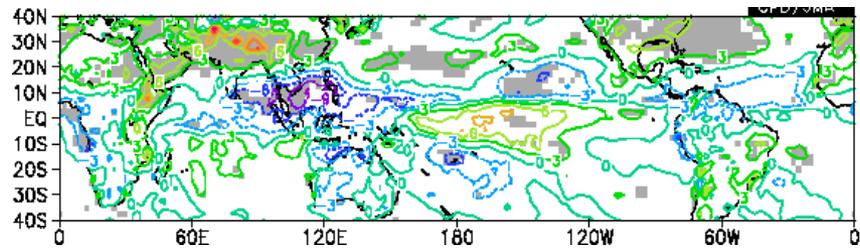
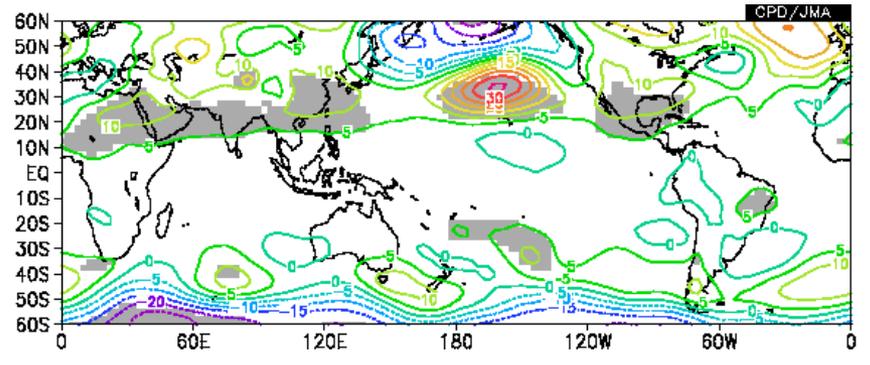
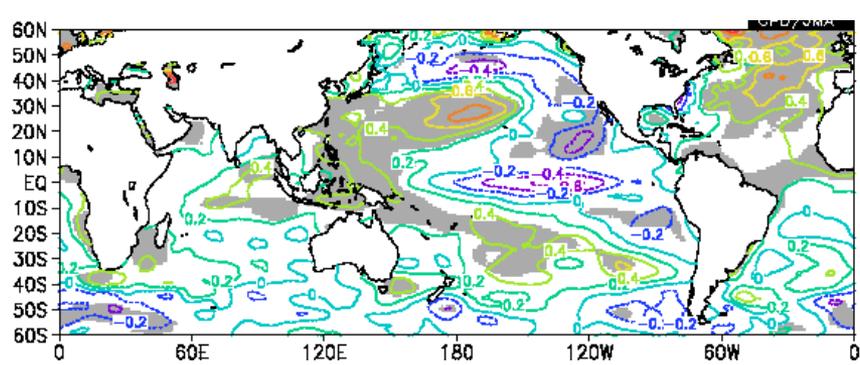
SST

SLP regressd on the PDO index based COBE-SST



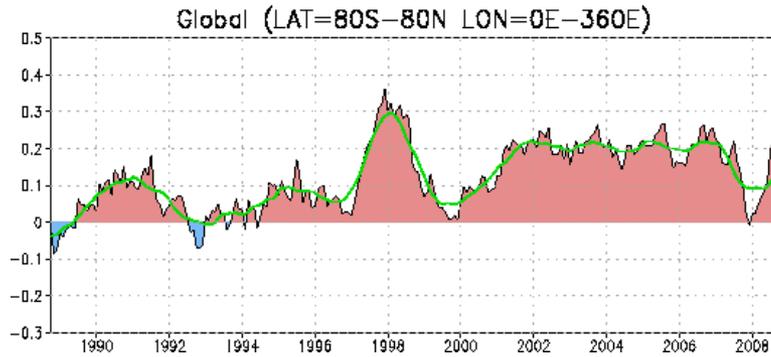
SLP



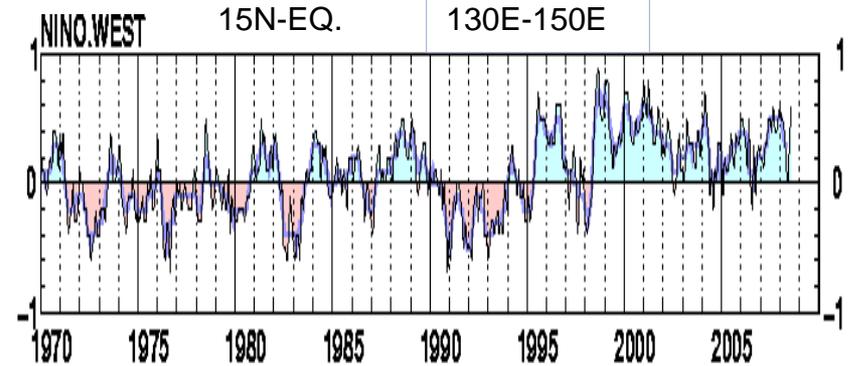


# Time series of area averaged SST anomalies

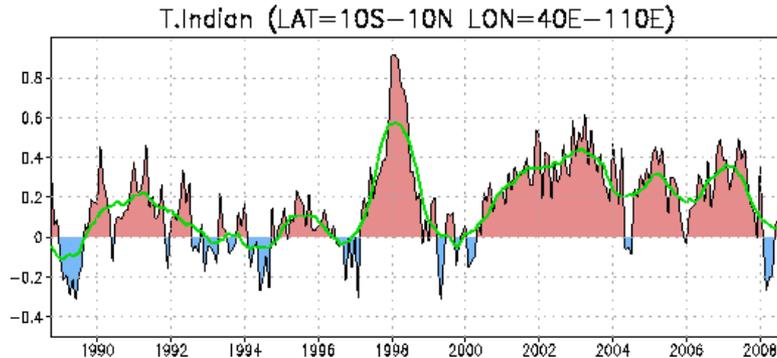
## Global mean



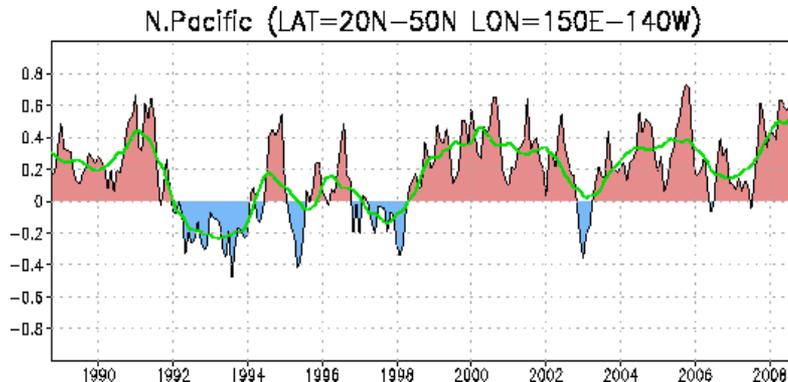
## Tropical western North Pacific



## Tropical Indian Ocean



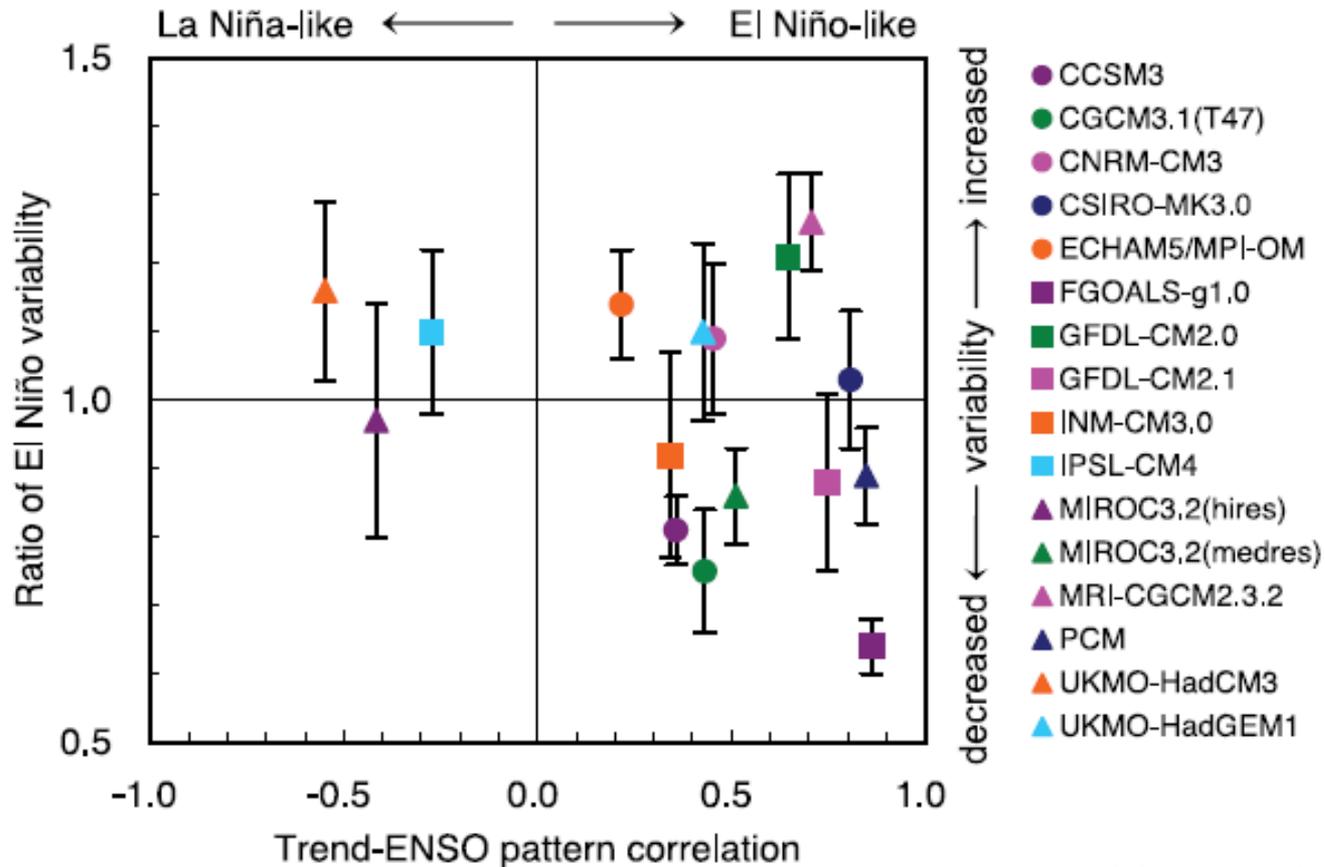
## North Pacific



• Due to the La Niña which had faded in the last spring, the global mean SST anomaly was near normal during the last winter and spring. But, it is rapidly rising in these months.

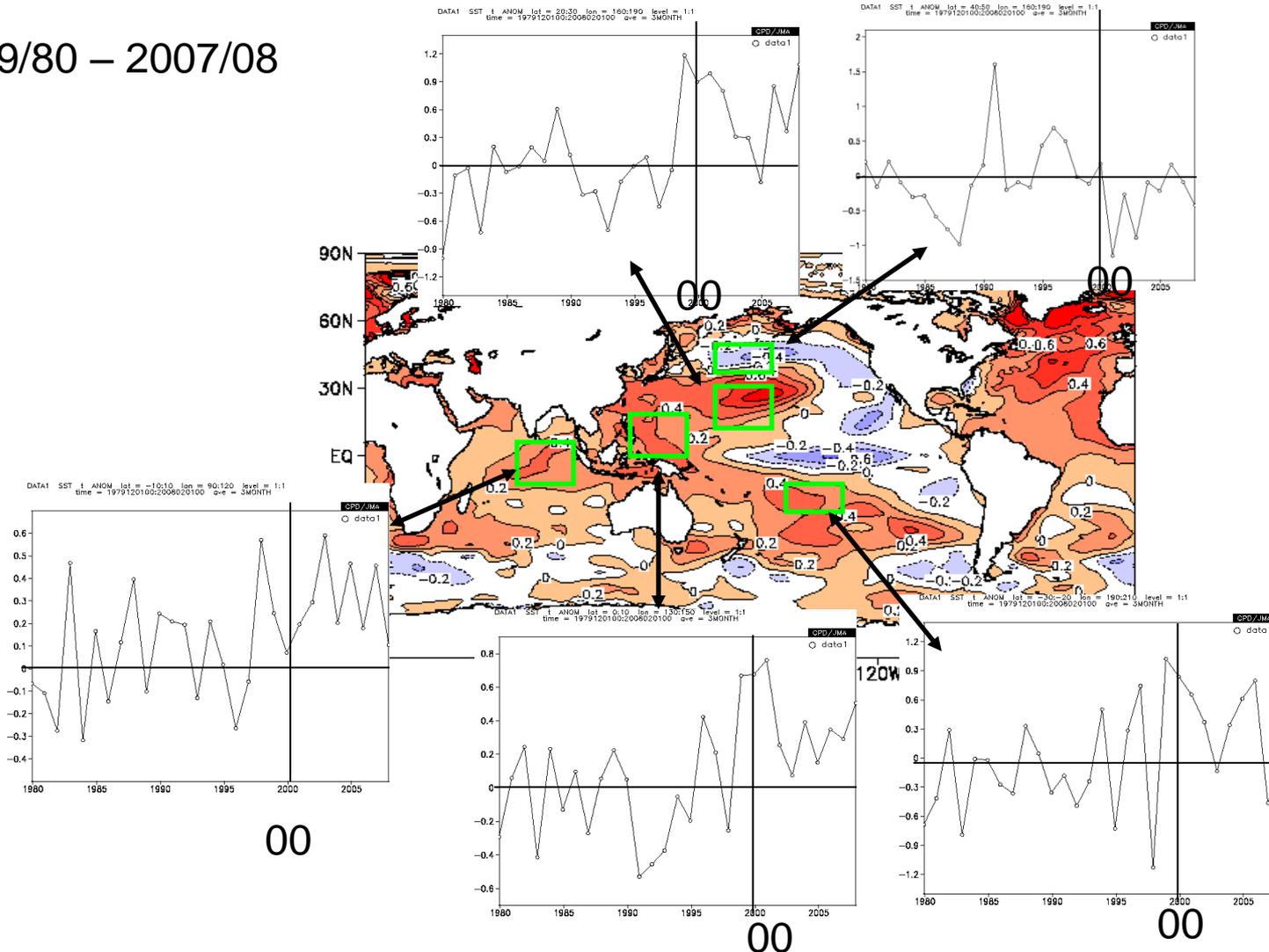
• In the tropical western North Pacific, positive SST anomalies have persisted since 1998.

- The multi-model mean projects a weak shift towards conditions which may be described as ‘El Niño-like’, with SSTs in the central and eastern equatorial Pacific warming more than those in the west.
- Changes in ENSO interannual variability differ from model to model.



# Time series of DJF mean SST

1979/80 – 2007/08

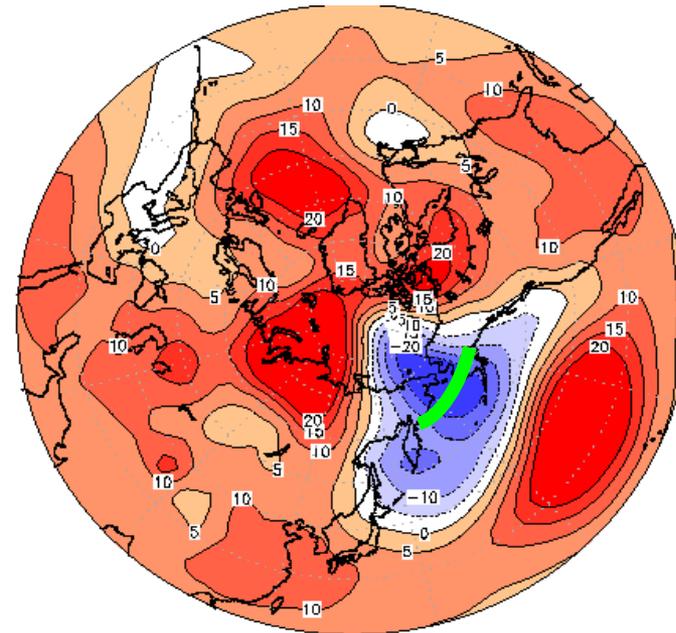
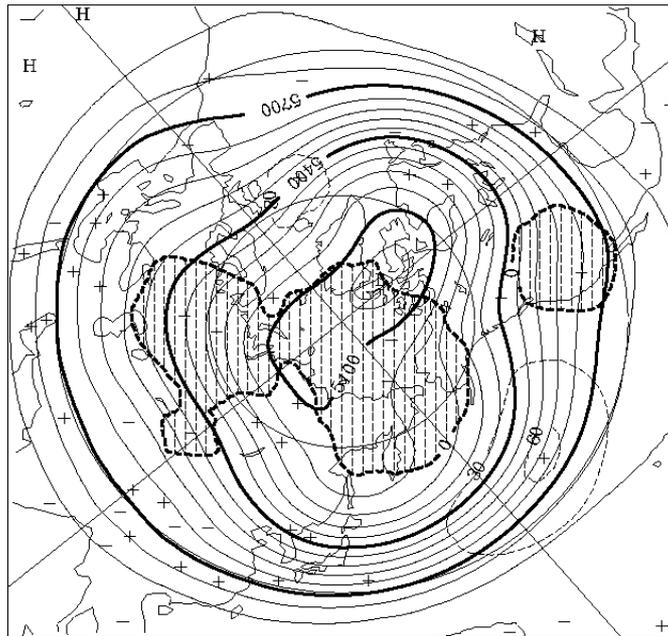


In the tropical western Pacific, positive SST anomalies have persisted since 1998

# Extra-tropics (DJF)

The recent decade DJF mean Z500 anomalies (1998/99 – 2007/08)

Z500 (ensemble mean)



In the extra-tropics, the predicted circulation anomaly patterns are not so similar to those of the latest 10 winters.