TCC Training Seminar on Climate Analysis Information
26 – 30 November 2012
Tokyo, Japan

Climate System Monitoring
Example analysis of past event

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Outline

Example 1:

Cold winter in East Asia for DJF 2011/2012

Example 2:

Heavy rainfall in southern Asia for Sep. 2012

Procedure

<Analyzing>

Step 1: Surface climate conditions

Assess surface climate conditions and related impacts.

Step 2: Characteristic atmospheric circulation

Identify atmospheric circulation directly contributing to the targeted surface climate conditions.

Step 3: Factor analysis

Investigate the possible factors associated with the identified atmospheric circulation directly contributing to the targeted surface climate conditions.

Example 1

Cold winter in East Asia
for December 2011 – February 2012

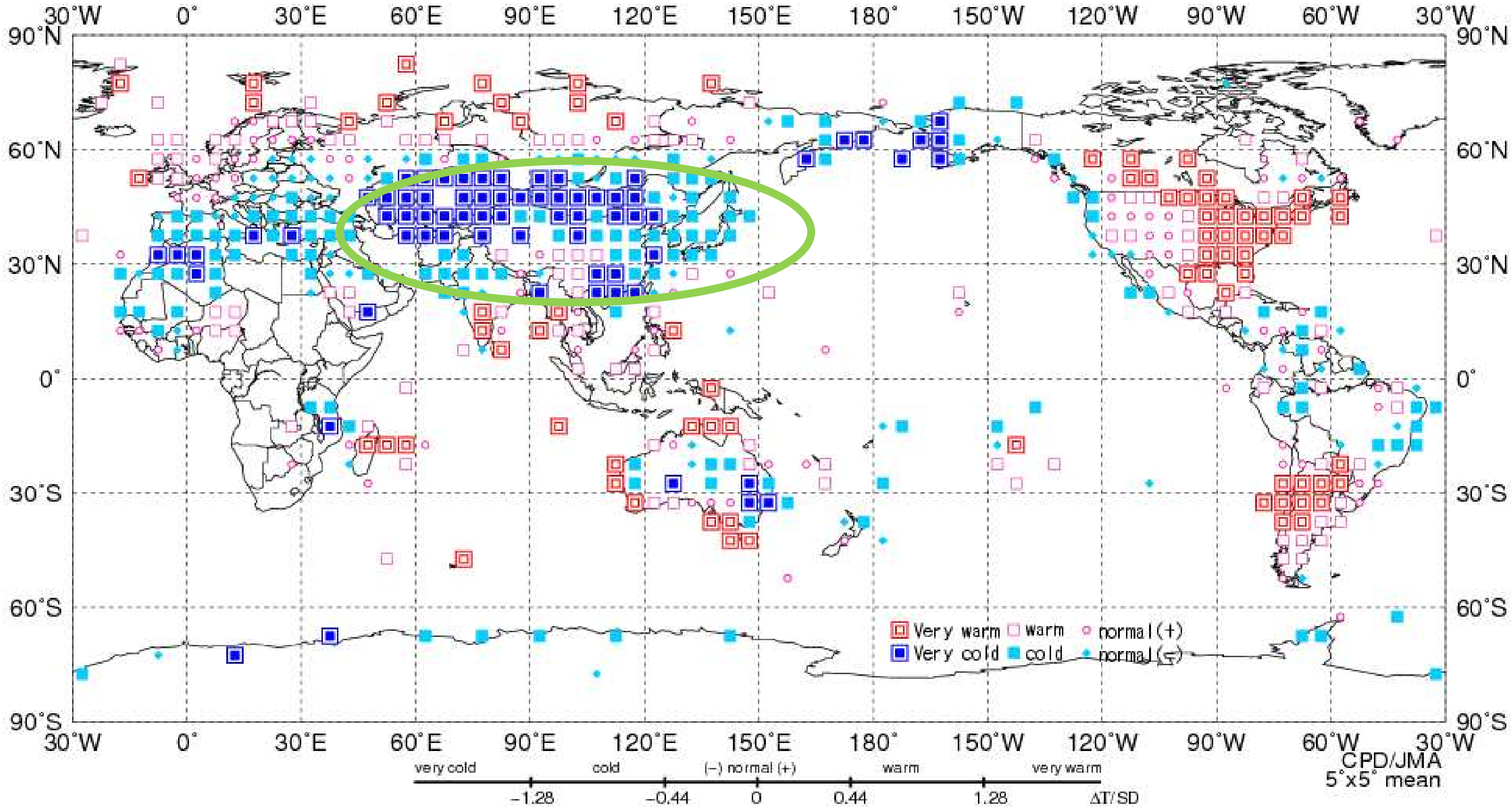
Cold winter in East Asia for DJF 2011/2012

<Step 1>

Surface climate conditions

Seasonal mean temperature anomalies

- East and Central Asia experienced significant cold winter.



Normalized anomalies of three-month mean temperatures (DJF 2011/2012)

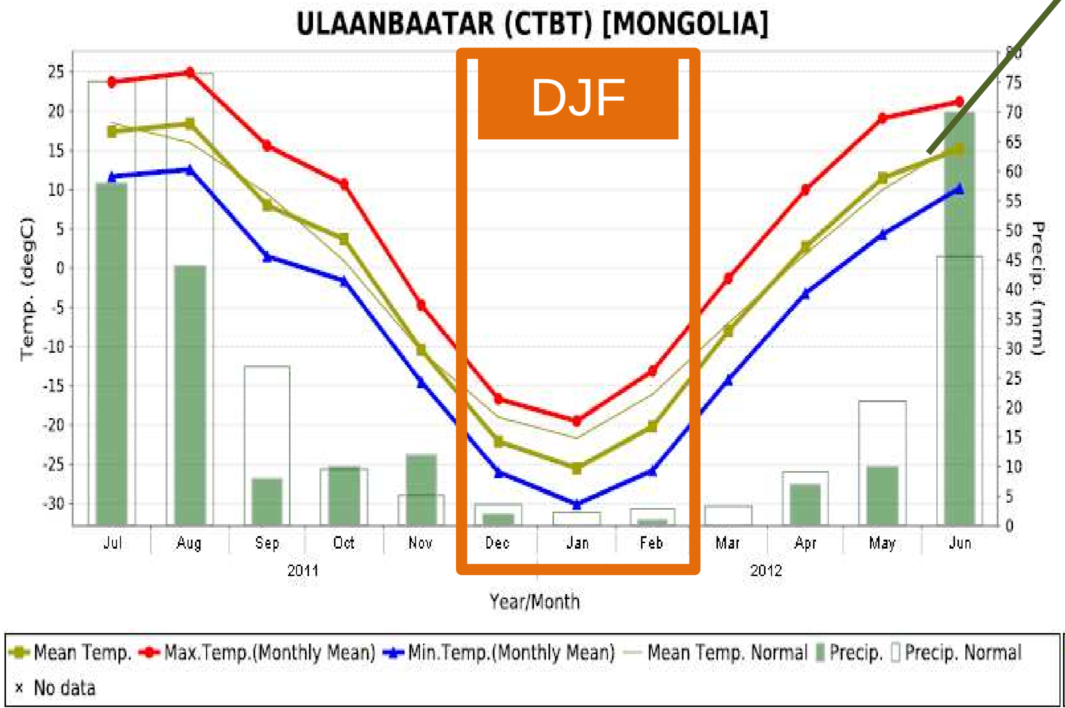
The base period for the normal is 1981 – 2010. Temperature anomalies were normalized by their standard deviations.

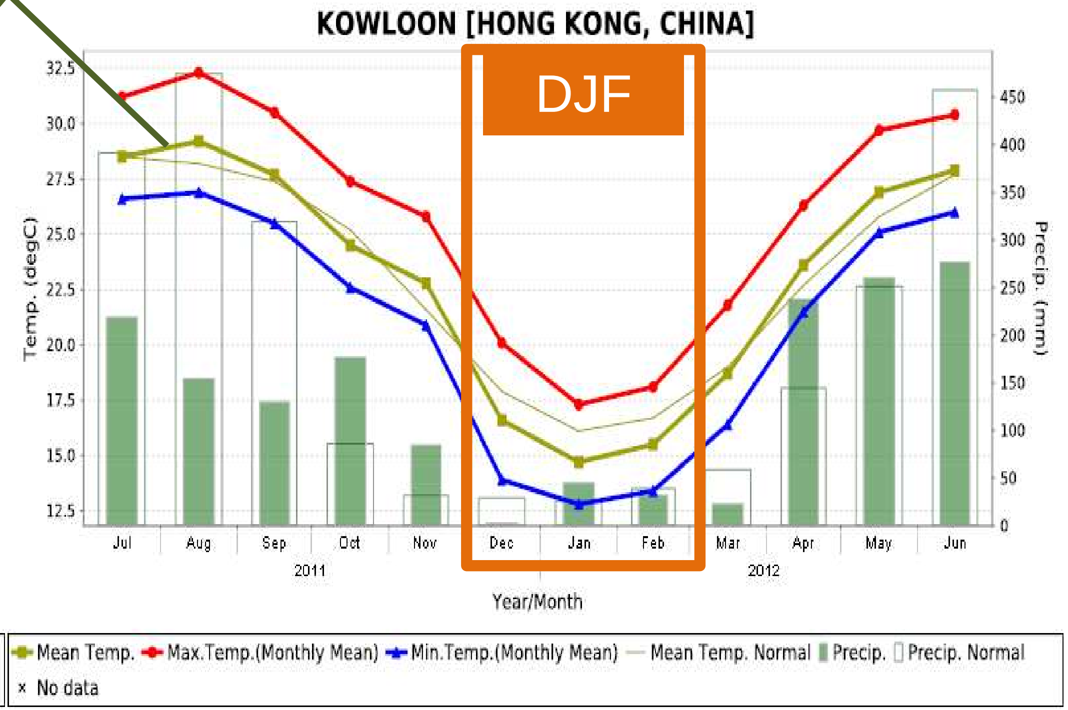
http://ds.data.jma.go.jp/tcc/tcc/products/climate/seasonal.html

Monthly mean temperatures

- Below-normal temperature persisted throughout the season at Ulaanbaatar, Mongolia, and Kowloon, Hong Kong, China.

Monthly mean Temp.
(thick: 2011/2012, thin: normal)





Time series of monthly temperatures and precipitation from July 2011 to June 2012

The base period for the normal is 1981 – 2010.

http://ds.data.jma.go.jp/tcc/tcc/products/climate/seasonal.html

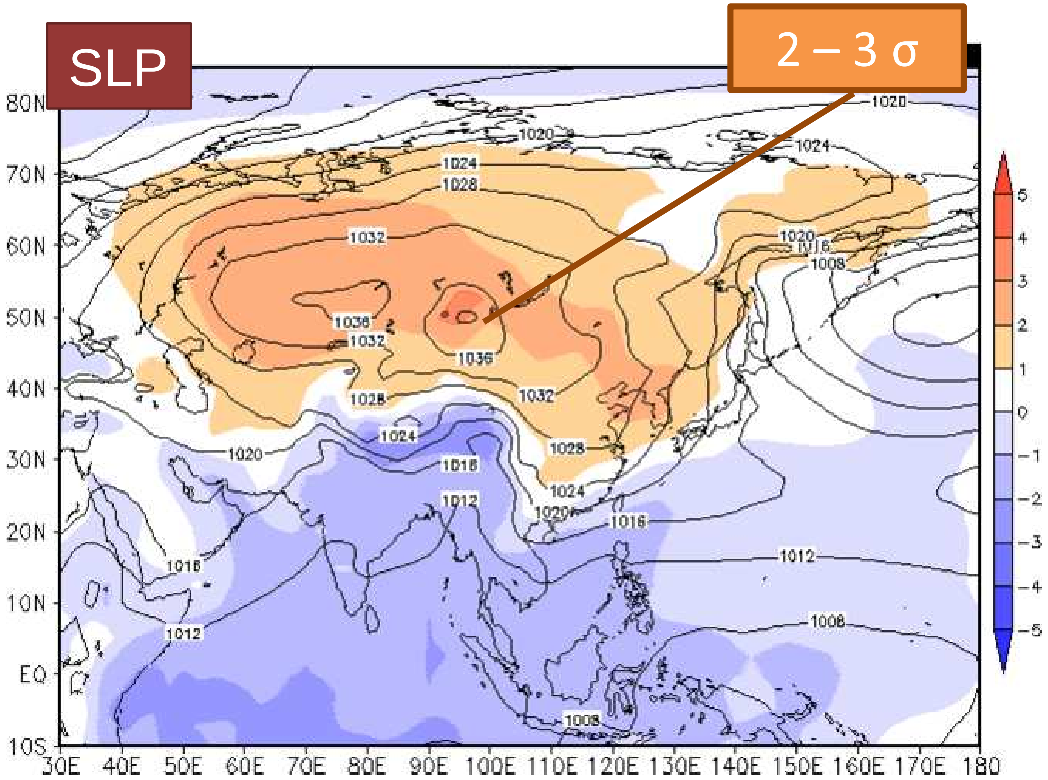
Cold winter in East Asia for DJF 2011/2012

<Step 2>

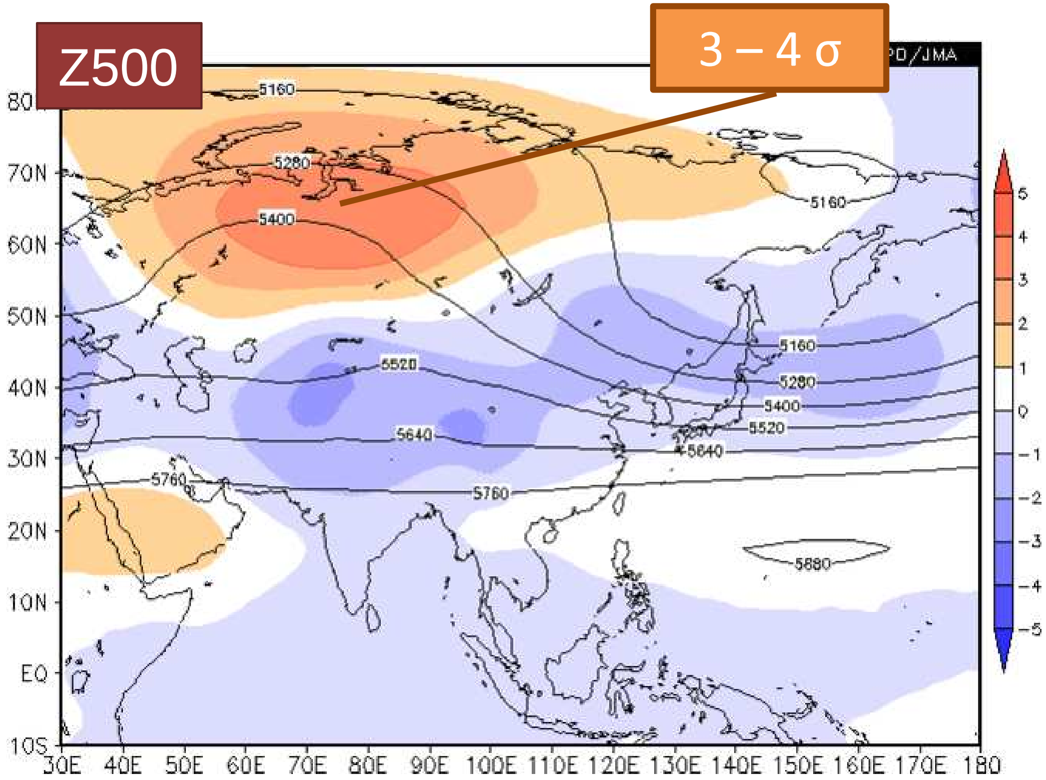
Characteristic atmospheric circulation

Seasonal mean atmospheric circulation

- The Siberian High was significantly enhanced.
- A pronounced ridge was seen over western Siberia.



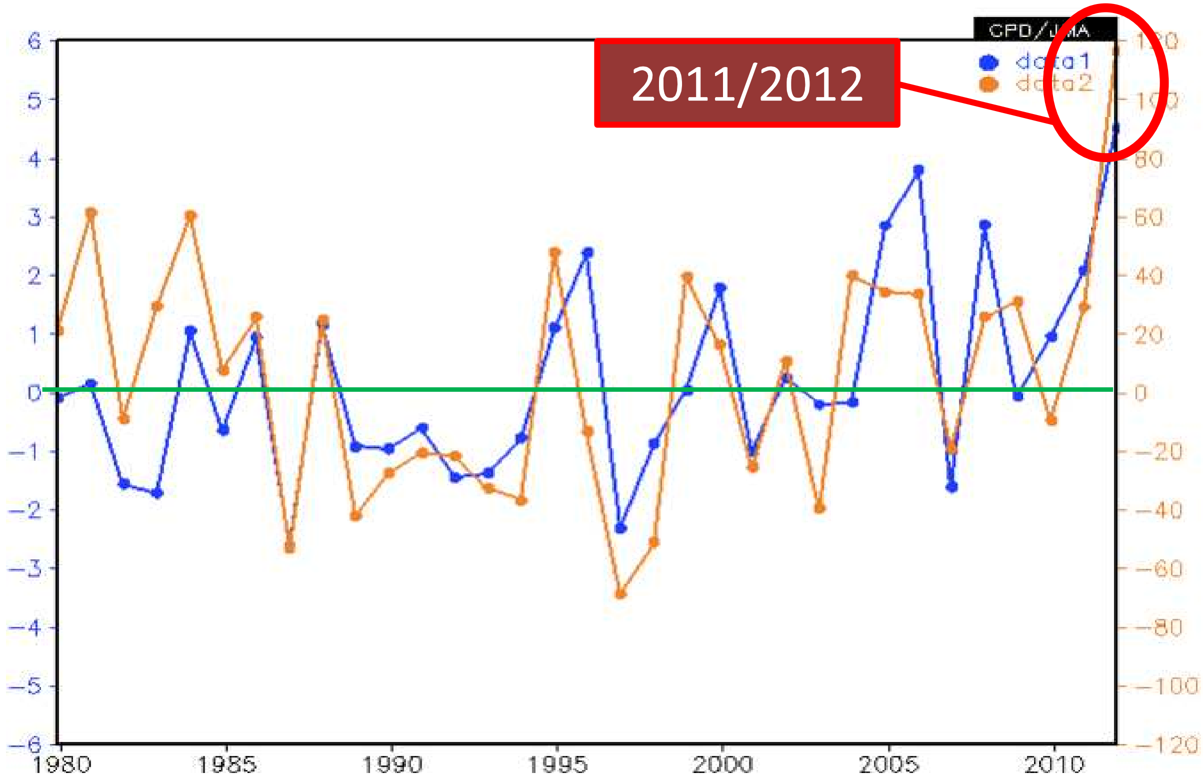
Sea level pressure (contours) and normalized anomalies (shading)

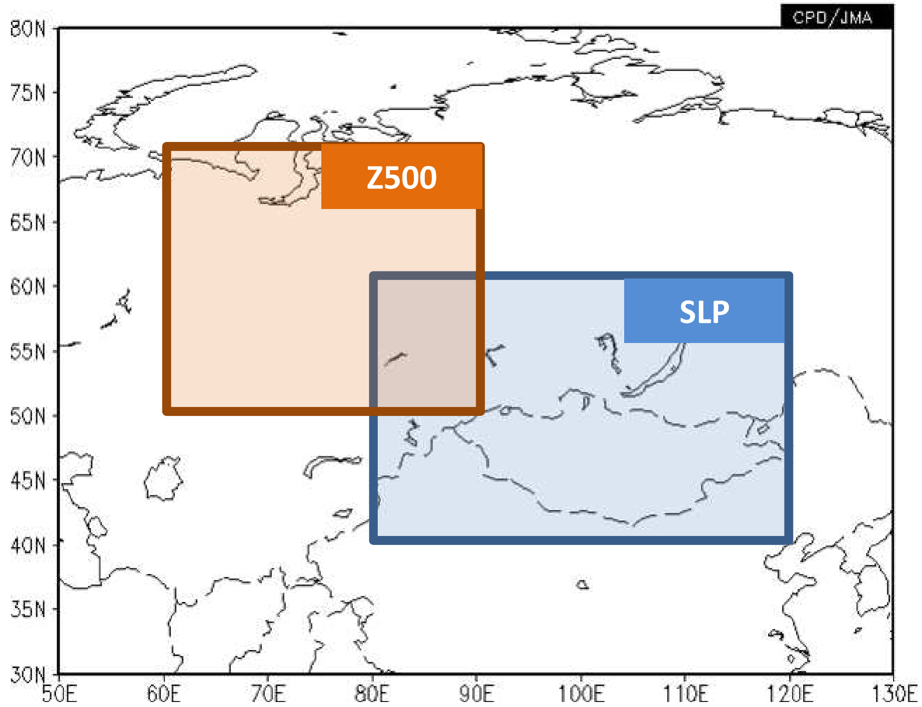


500-hPa height (contours) and normalized anomalies (shading)

Interannual variability

- The Siberian High and the upper-level ridge were at their strongest level since 1979.
- There is close relationship between them in the interannual variability for DJF.

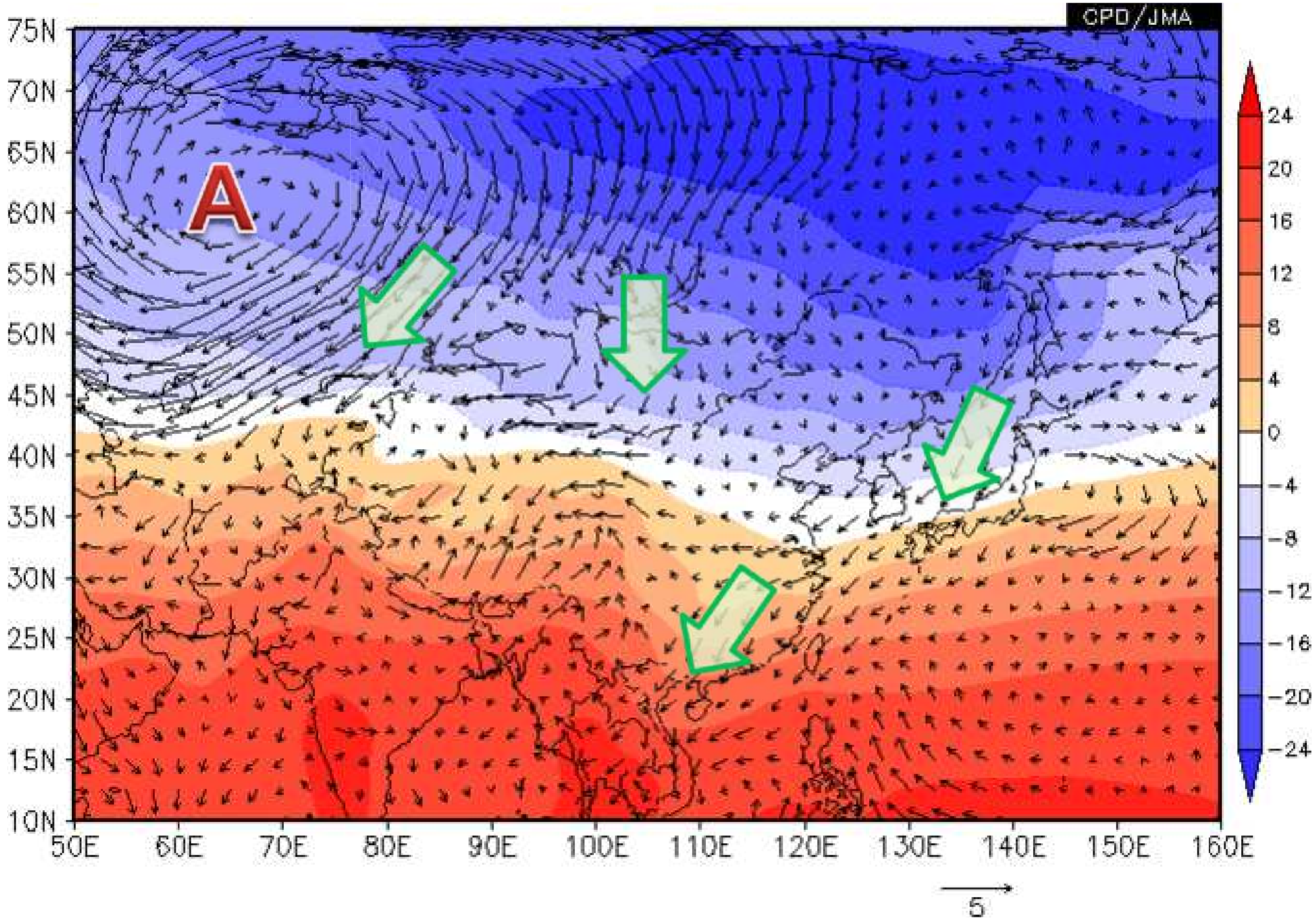




Interannual variability of area-averaged 500-hPa height anomalies (orange: 50 – 70˚N, 60 – 90˚E) and sea level pressure anomalies (blue: 40 – 60˚N, 80 – 120˚E)
The value of correlation coefficient between the two: 0.60 (1979/1980 – 2010/2011)

Enhanced cold-air advection

- Cold-air advection in the lower troposphere was enhanced over most of East and Central Asia, including Mongolia and Hong Kong.



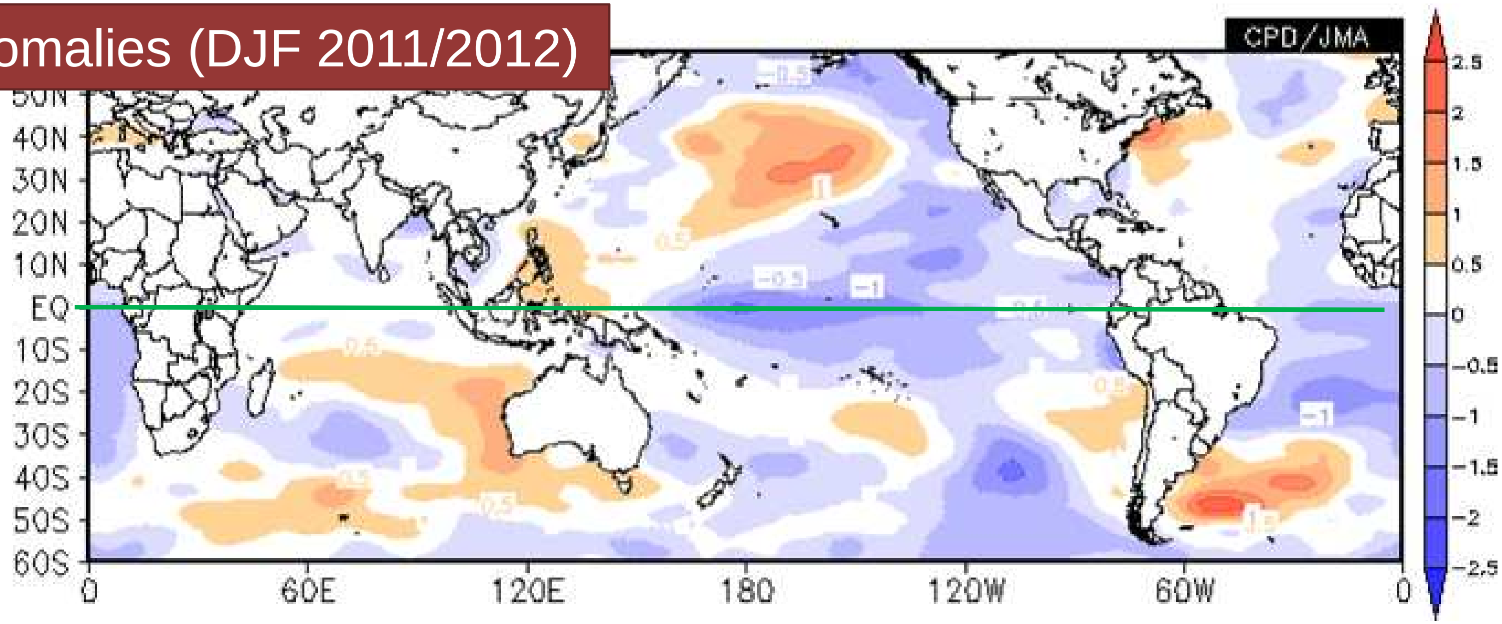
925-hPa wind anomalies (vectors) and normal temperatures (shading)

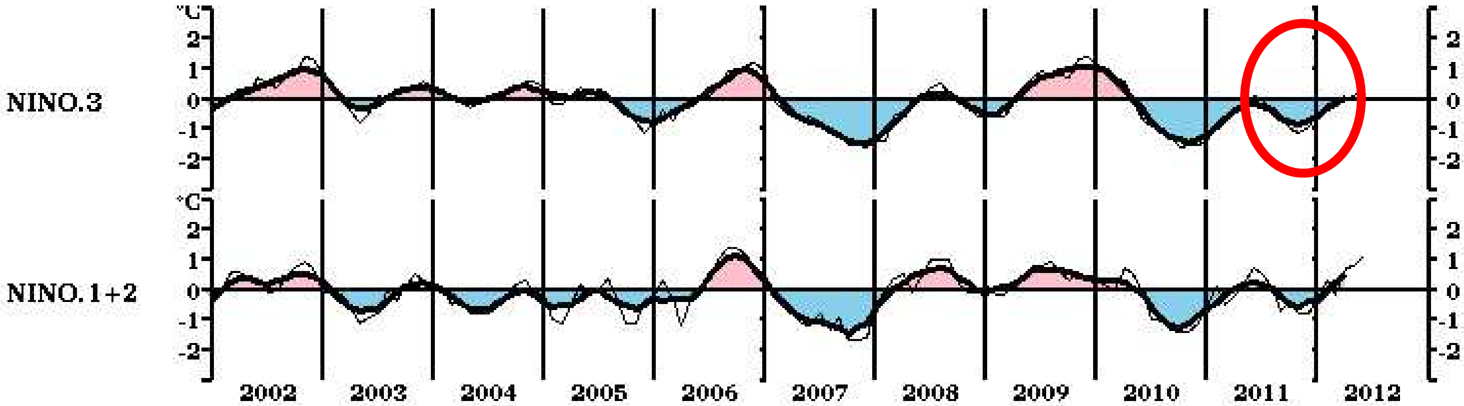
Tropical SST

• La Niña-like conditions were seen in boreal winter 2011/2012.

(NINO.3 SST anomalies did not meet the criteria for JMA's La Niña definition.)

SST anomalies (DJF 2011/2012)



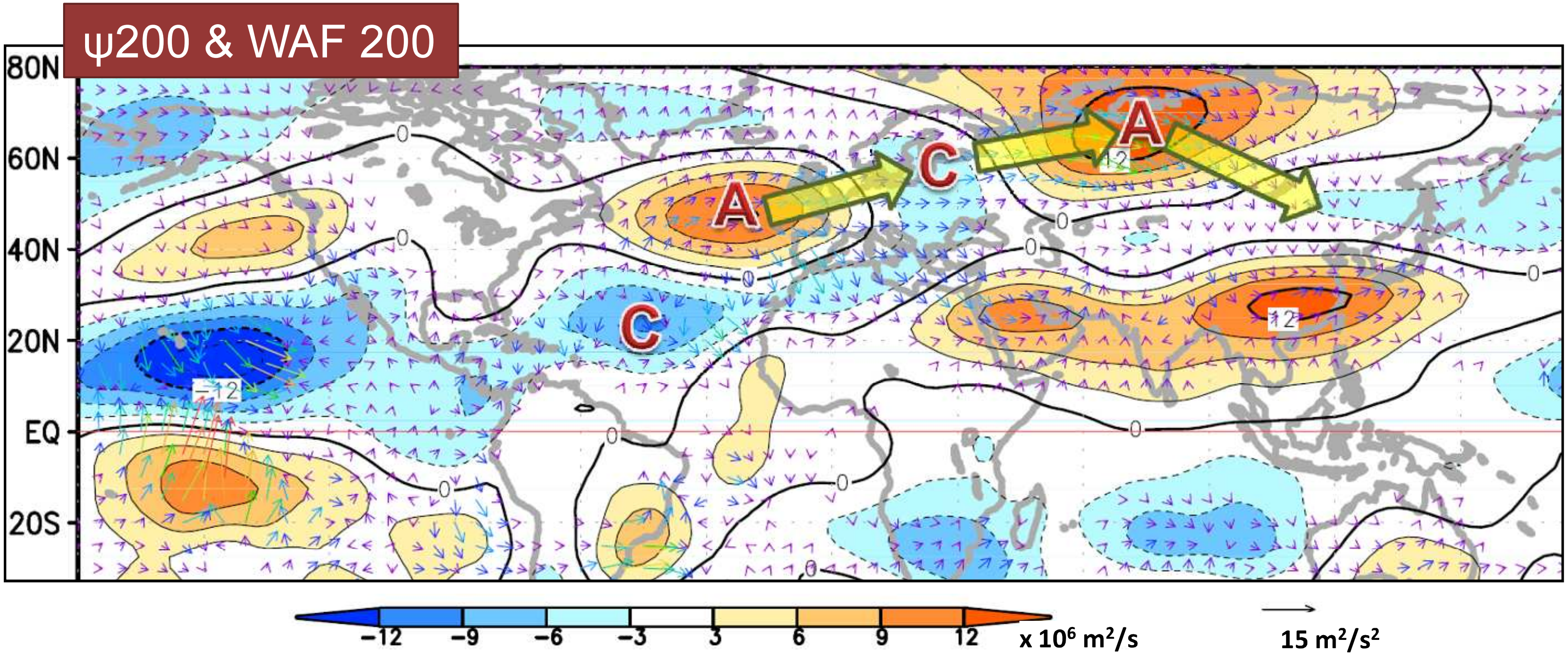


<Step 3>

Factor analysis

Wave trains and upper-level blocking ridge

- Rossby wave trains propagated from the North Atlantic to Eurasia.
- In association, upper-level ridge developed over western Siberia.

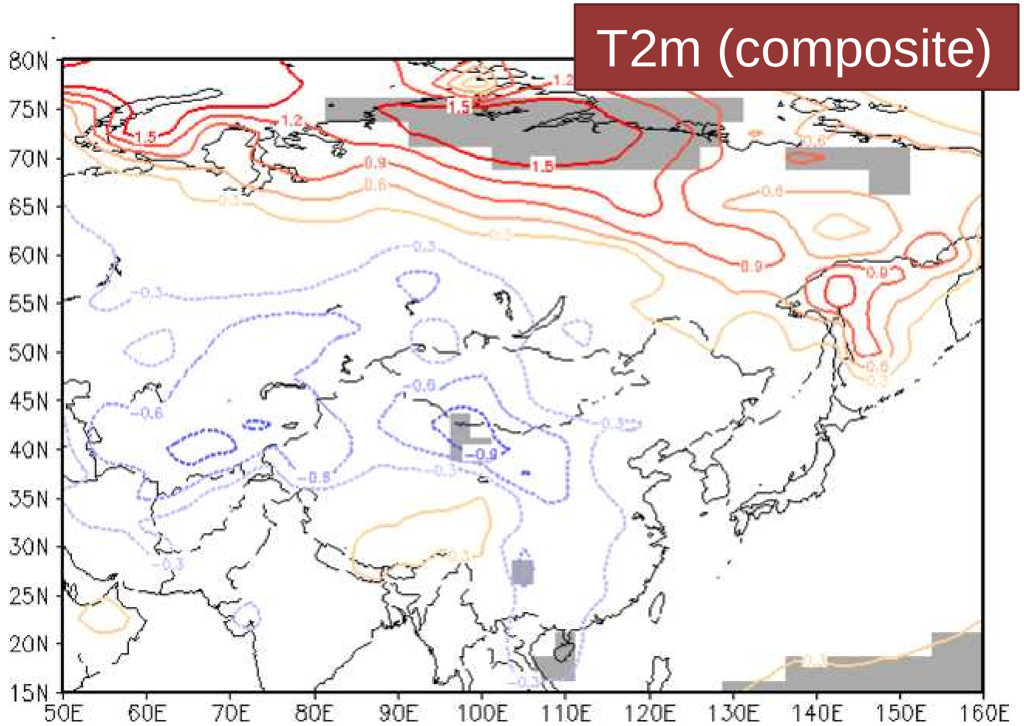


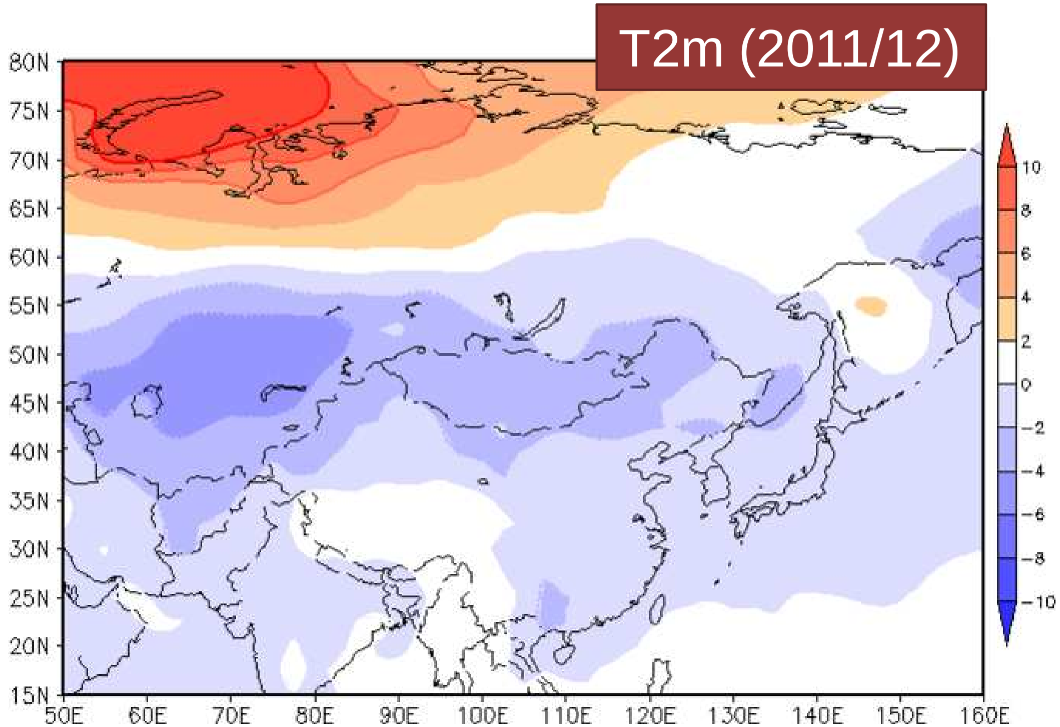
Three-month mean 200-hPa stream function anomalies and wave activity flux for DJF 2011/2012

The contours and shading indicate stream function anomalies at intervals of 3 × 10^6 m^2/s. The warm- (cold)-color shading denotes anticyclonic (cyclonic) circulation anomalies in the Northern Hemisphere, and vice versa in the Southern Hemisphere. The vectors show wave activity flux (unit: m^2/s^2) based on Takaya and Nakamura (2001).

La Niña composite (2m temperature)

- In past La Niña events, temperatures near the surface tended to be below normal near Mongolia and Hong Kong, although statistically significant areas were limited.





La Niña composite (T2m anomaly)

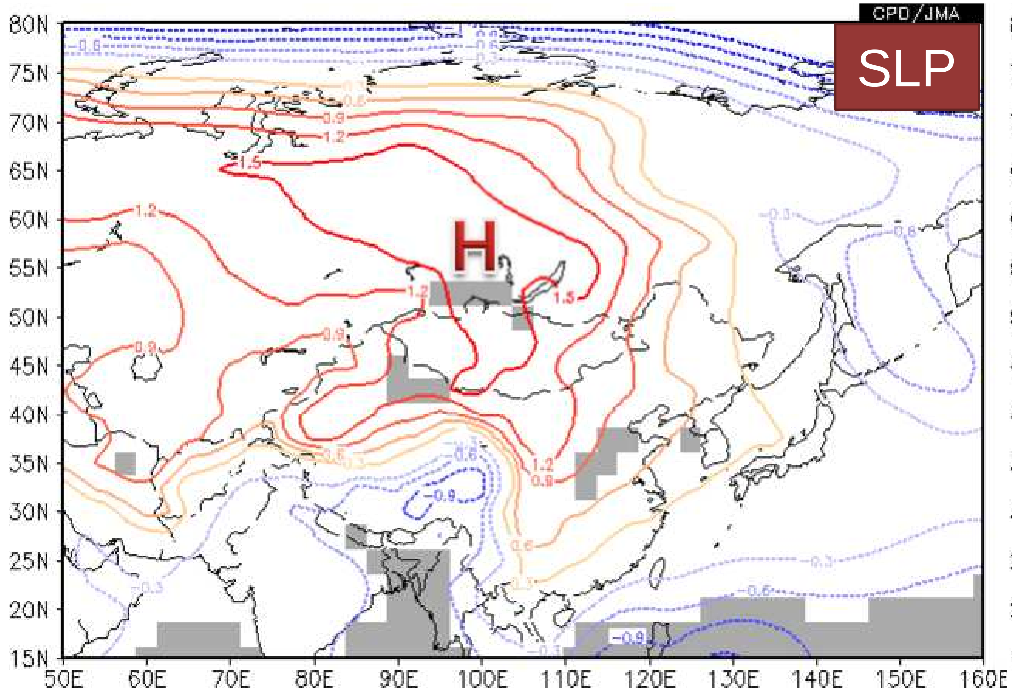
La Niña years: 1984/85, 1988/89, 1995/96, 1998/99, 1999/2000, 2005/6, 2007/8

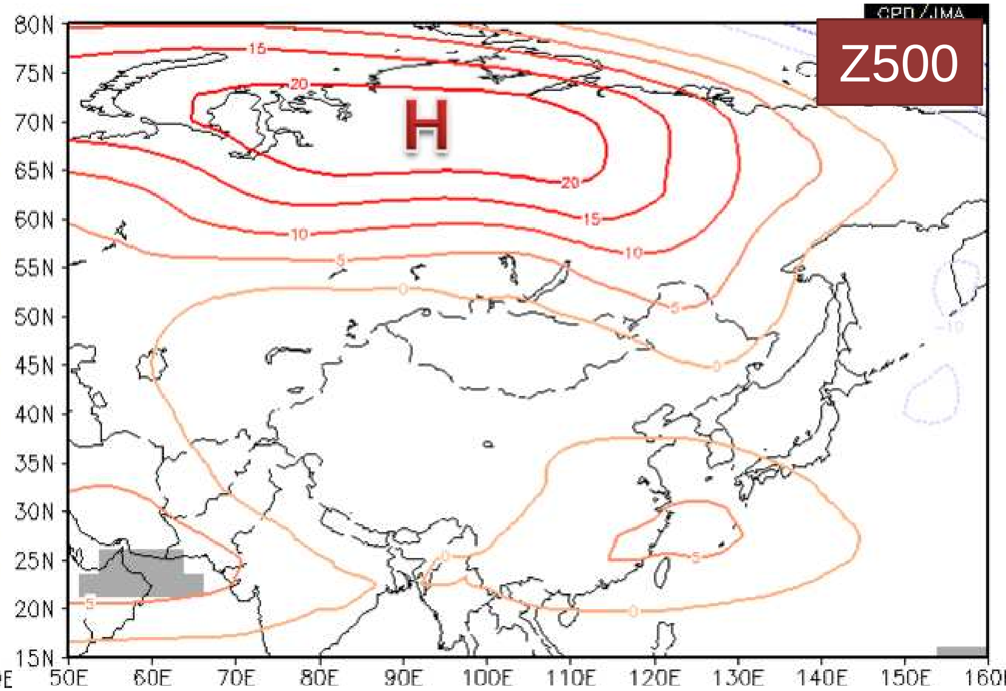
Gray shading: 95 % confidence level

DJF 2011/12 (T2m anomaly)

La Niña composite (SLP and Z500)

• Anomaly pattern seen in the composite maps of SLP and Z500 resemble those seen in DJF 2011/2012.





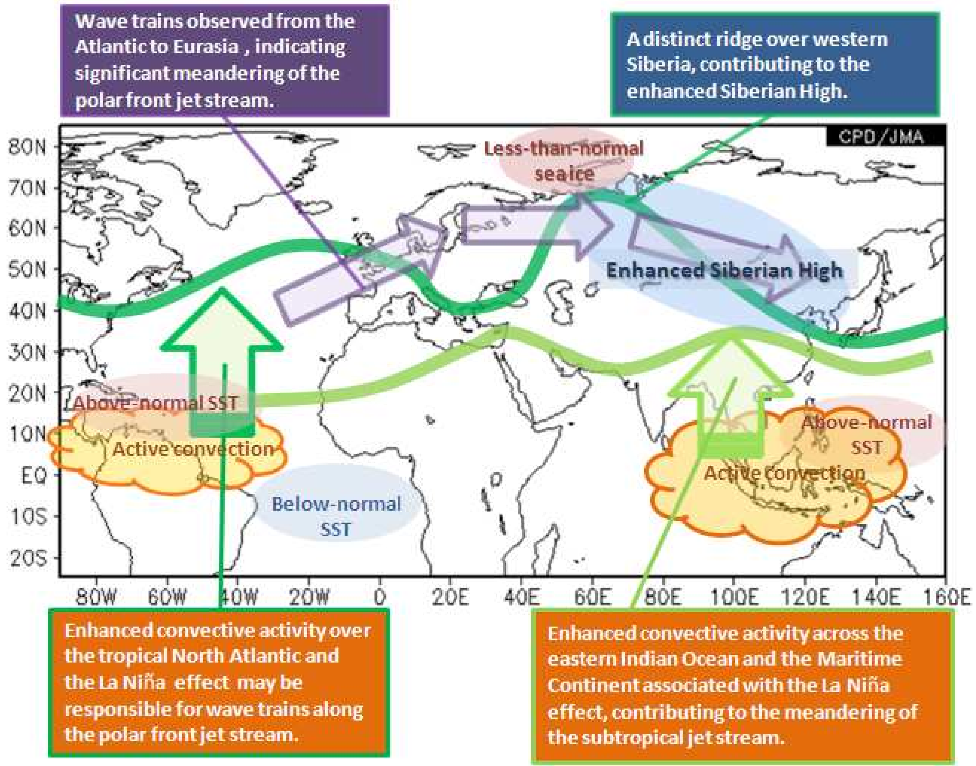
<u>La Niña composite (left: SLP anomaly, right: Z500 anomaly)</u>

La Niña years: 1984/85, 1988/89, 1995/96, 1998/99, 1999/2000, 2005/6, 2007/8

Gray shading: 95 % confidence level

Summary

- East Asia experienced significant cold winter for DJF 2011/2012.
- The enhanced Siberian High that was at its strongest level since 1979 brought cold surges over the regions.
- The amplification of the high was associated with a pronounced blocking ridge over western Siberia.
- The pronounced ridge formed in association with Rossby wave trains propagating from the North Atlantic.
- The amplification of the high can be related to La Niña-like conditions.



Relevant climate analysis information (detailed analysis) is available on the TCC website:

http://ds.data.jma.go.jp/tcc/tcc/products/clisys/ASIA_TCC/report/report20120510.pdf

Example 2

Heavy rainfall in southern Asia for September 2012

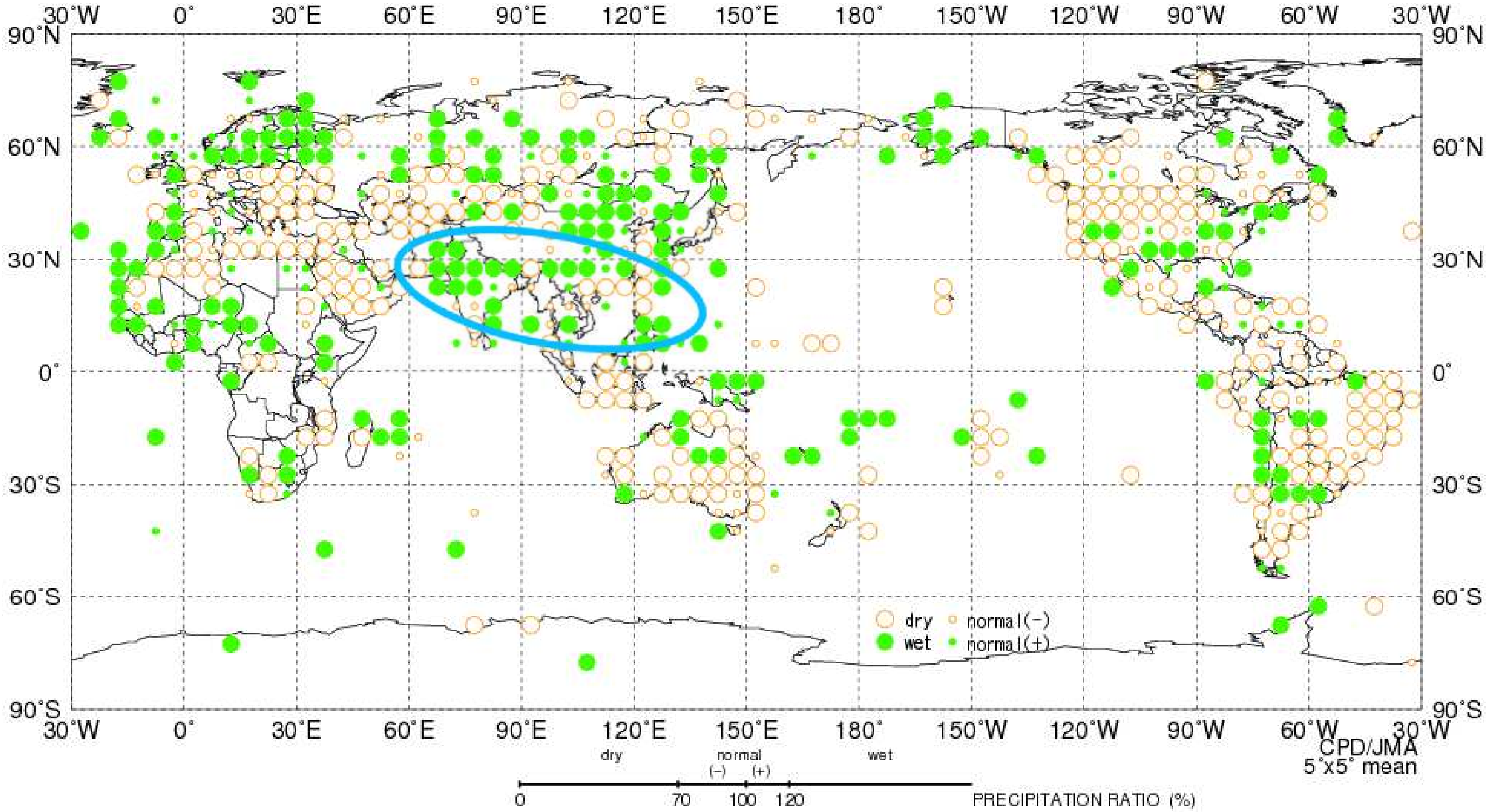
Heavy rainfall in southern Asia for Sep. 2012

<Step 1>

Surface climate conditions

Monthly precipitation ratio

- Many parts of southern Asia experienced above-normal rainfall.

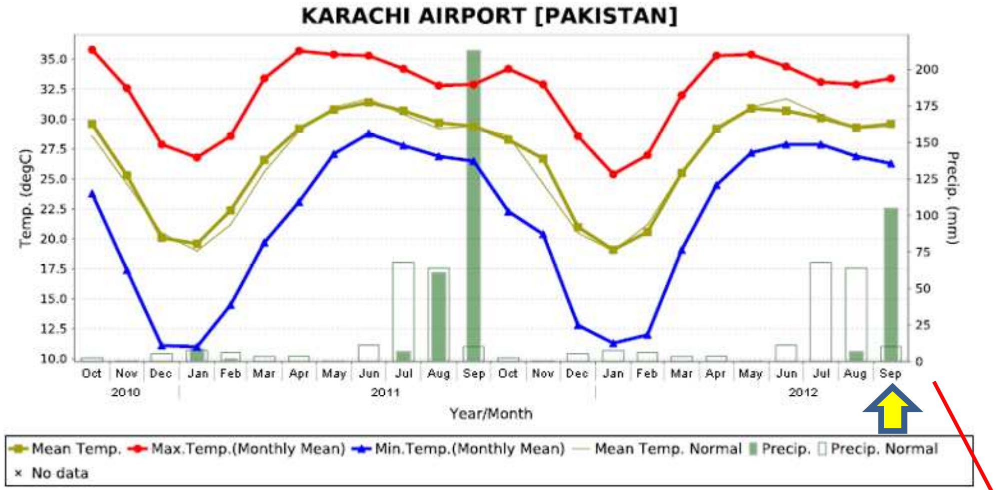


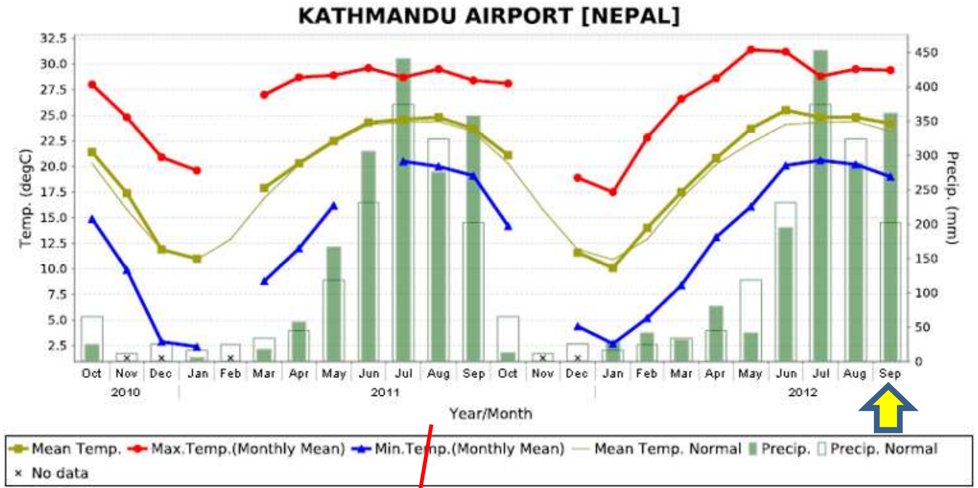
<u>Monthly precipitation ratio (September 2012)</u>

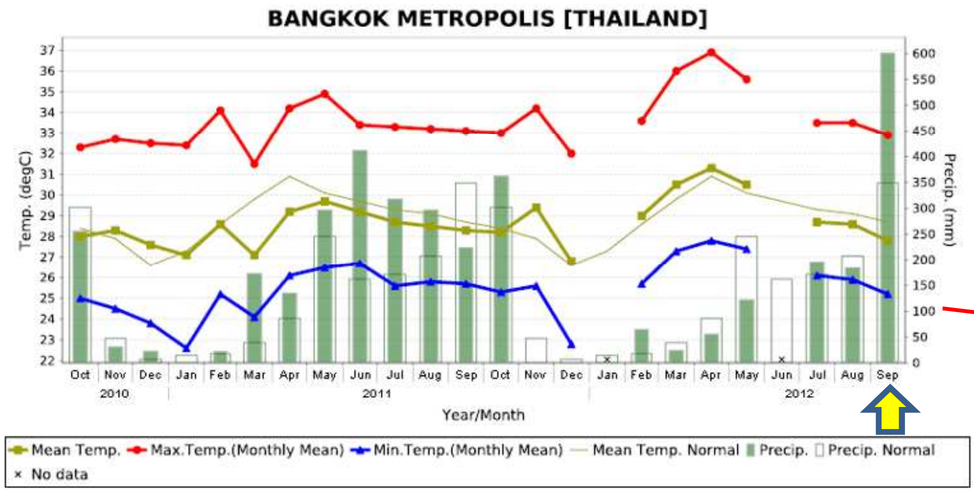
The figure indicates the distribution of categories of the monthly, seasonal or annual precipitation ratio to the normal, averaged in 5˚×5˚ grid boxes. The thresholds of each category are 70%, 100% and 120%. http://ds.data.jma.go.jp/tcc/tcc/products/climate/monthly.html

Monthly precipitation at observatories

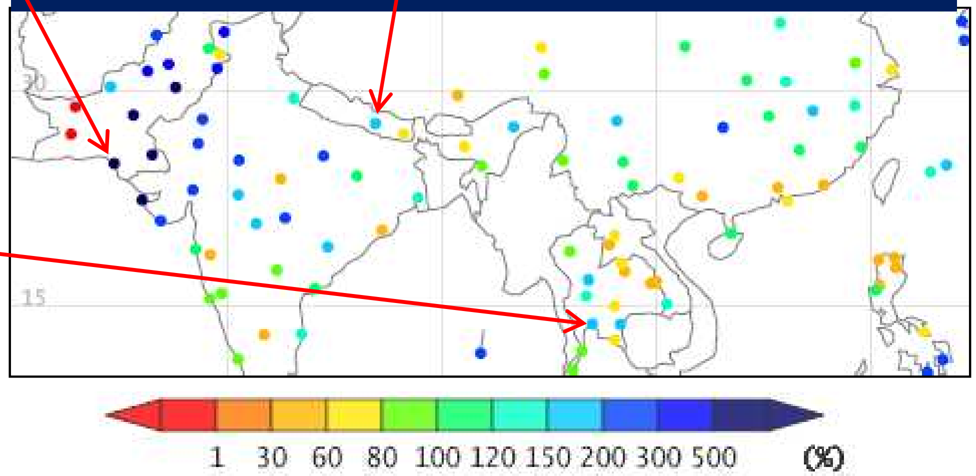
• Heavy precipitation amounts were observed in Pakistan, northern India, Nepal, and Thailand.







Monthly precipitation ratio (Sep. 2012)



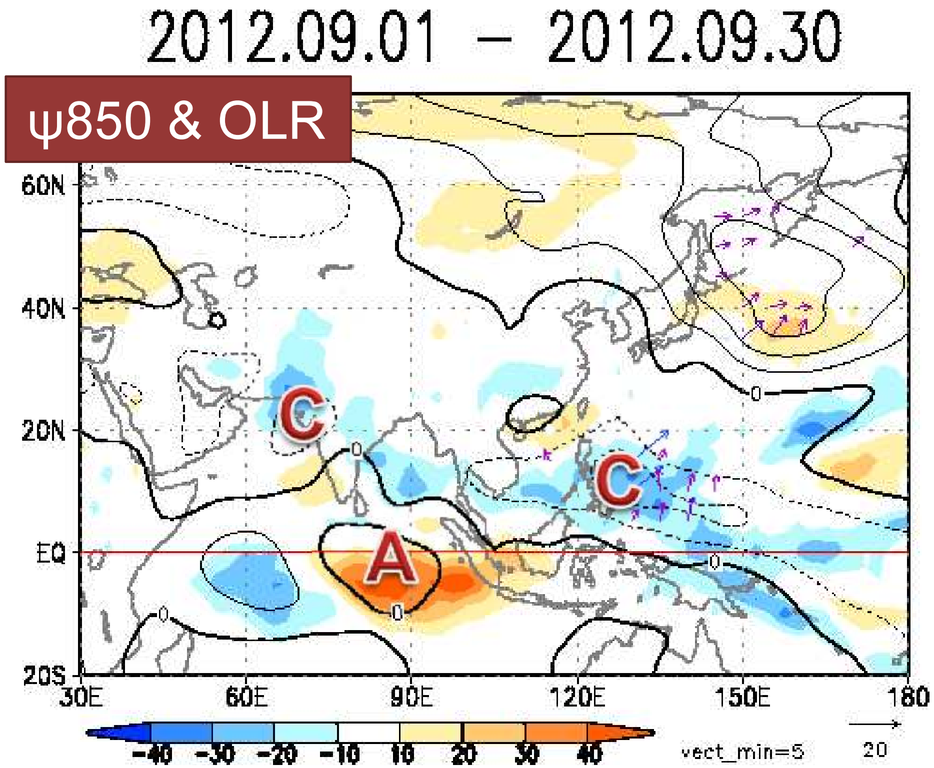
Heavy rainfall in southern Asia for Sep. 2012

<Step 2>

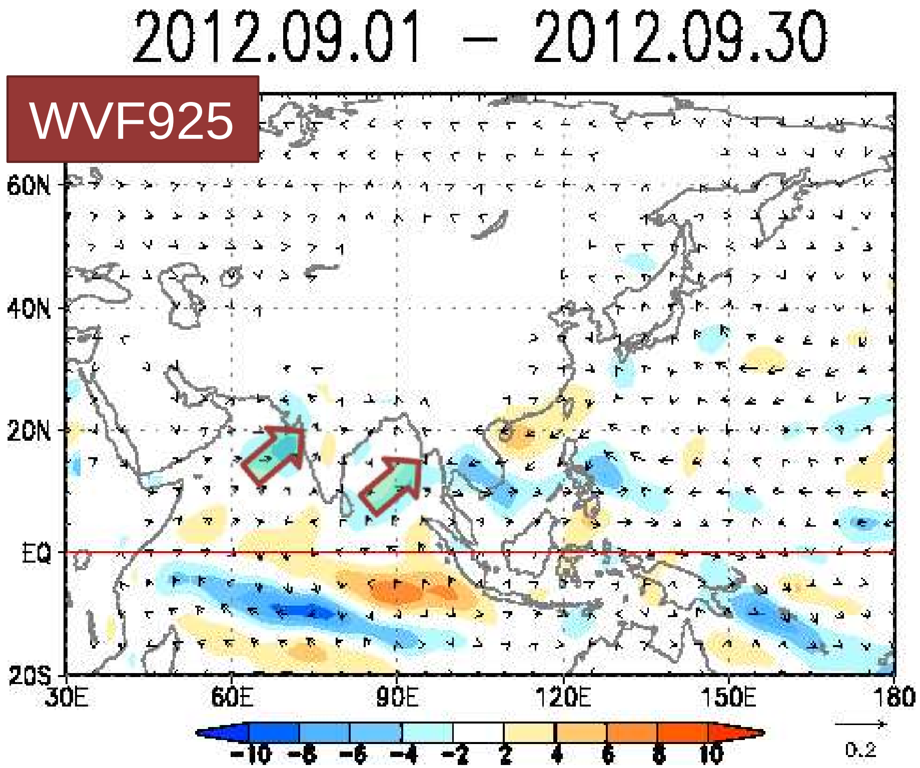
Characteristic atmospheric circulation

Low-level circulation and convection

• Convective activity was enhanced over southern Asia, and southwesterly winds were pronounced over the Arabian Sea and the Bay of Bengal, indicating active southwest monsoon.



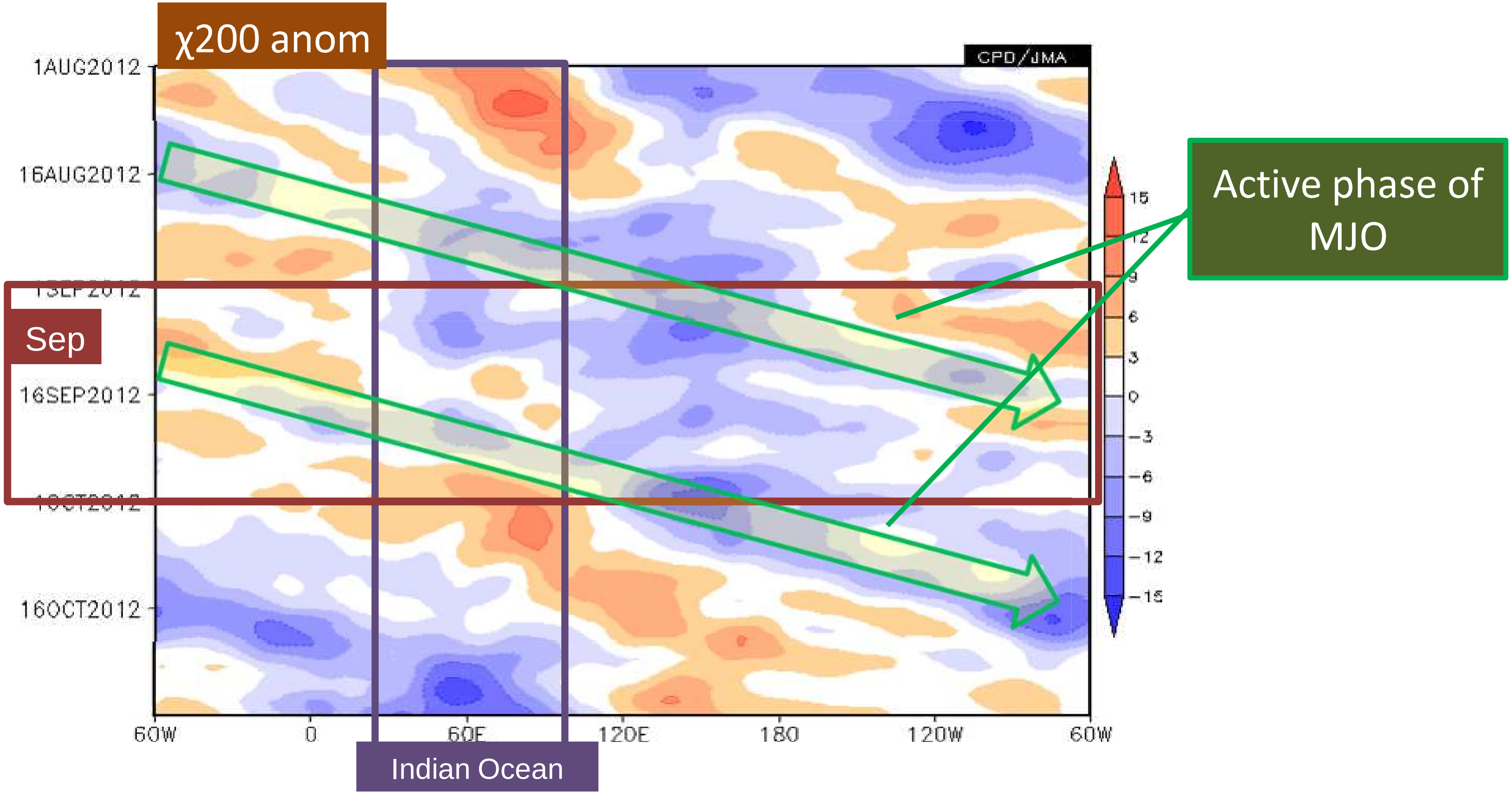
850-hPa stream function anomalies (contours) and OLR anomalies (shading)



925-hPa water vapor flux anomalies (vectors) and convergence/divergence anomalies (cold/warm shading)

MJO

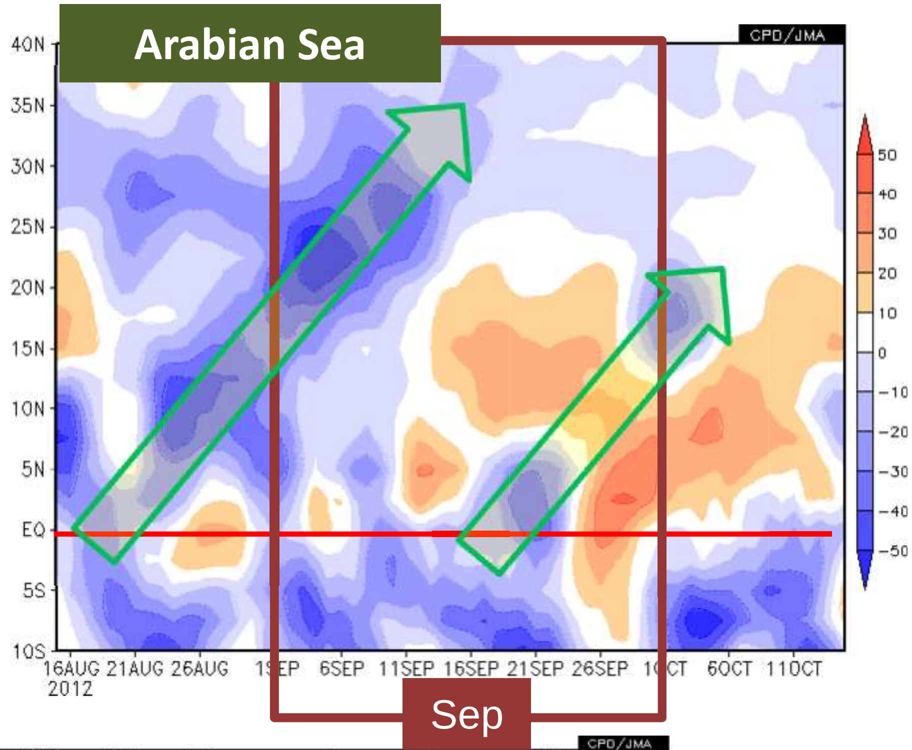
- The active phase of the MJO with a period of 30 days propagated over the equatorial Indian Ocean in the second halves of August and September.

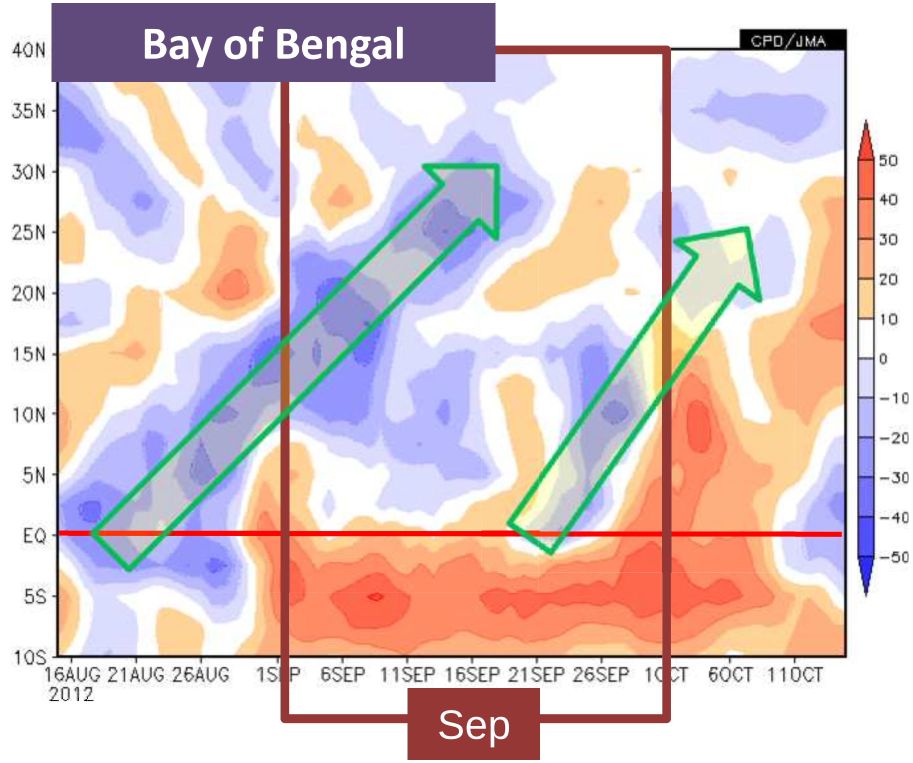


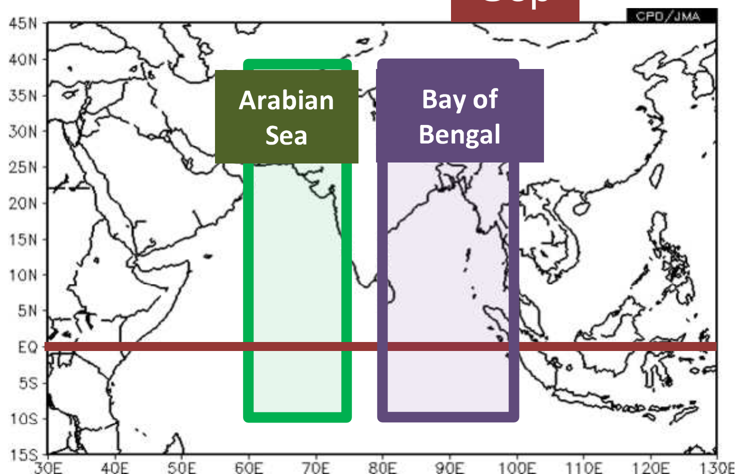
Time-longitude cross section of 200-hPa velocity potential anomalies (shading; five-day running mean) from August to October 2012

Northward propagation of active convection

- Active convection areas moved northward over the Arabian Sea and the Bay of Bengal, originally enhanced by MJO.

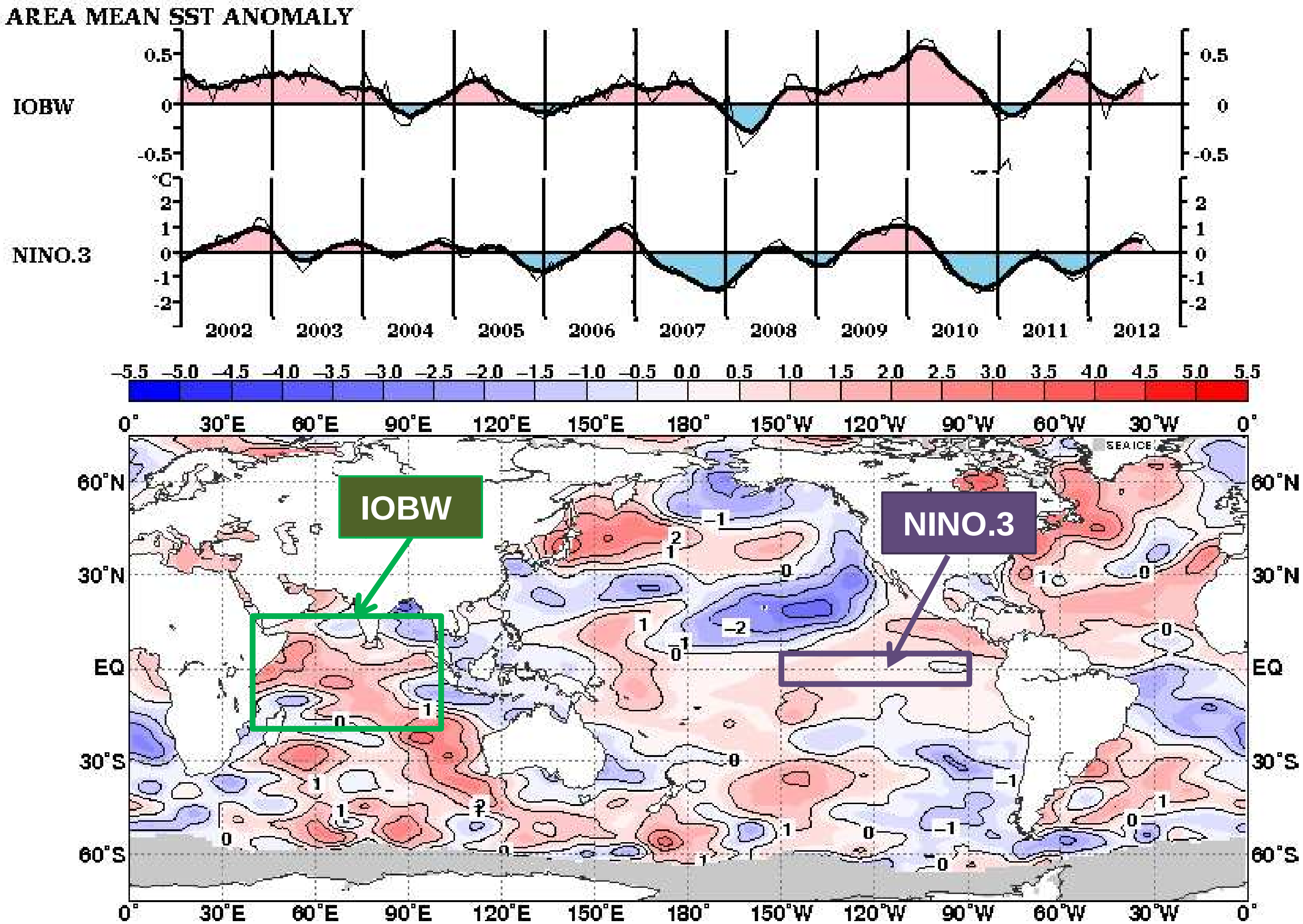






SST

- SSTs were broadly above normal in the tropical Indian Ocean.
- ENSO conditions were almost neutral (weak El Niño-like conditions).



Normalized anomalies of SSTs (Sep. 2012)

IOBW (Indian Ocean Basin Wide): 20˚S – 20˚N, 40 – 100˚E

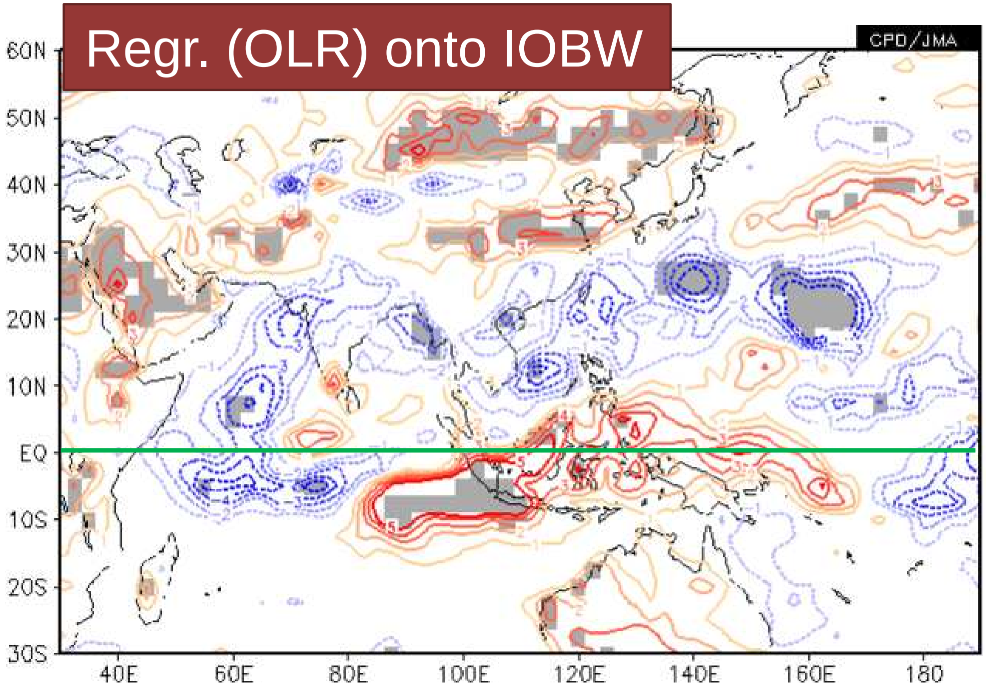
Heavy rainfall in southern Asia for Sep. 2012

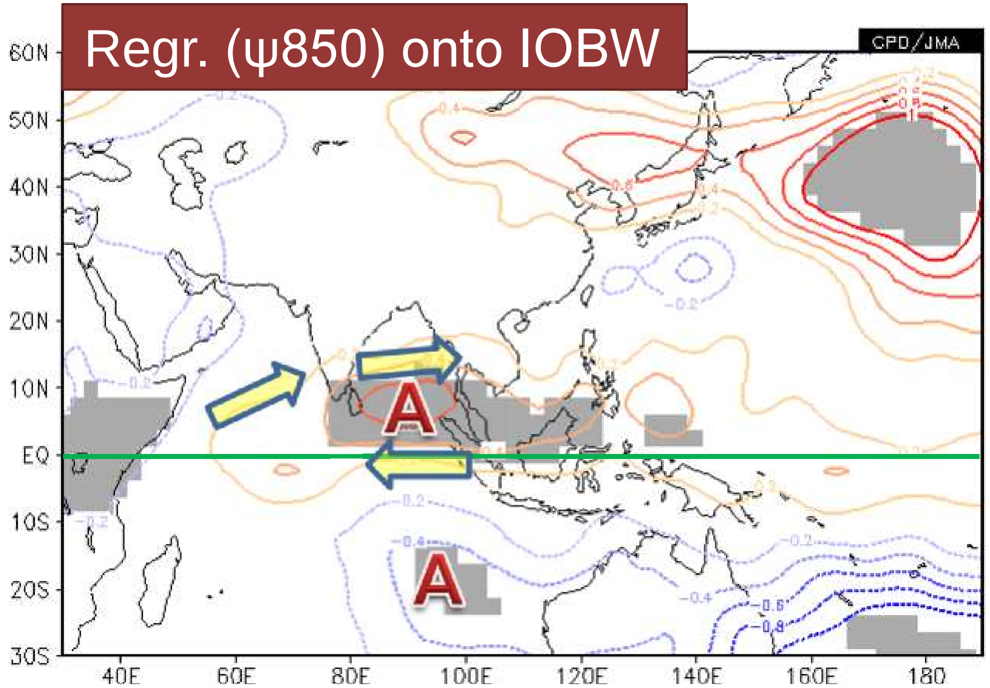
<Step 3>

Factor analysis

Regression to IOBW (September)

• When SSTs warm over the tropical Indian Ocean in September, the southwest monsoon tends to be enhanced in southern Asia.





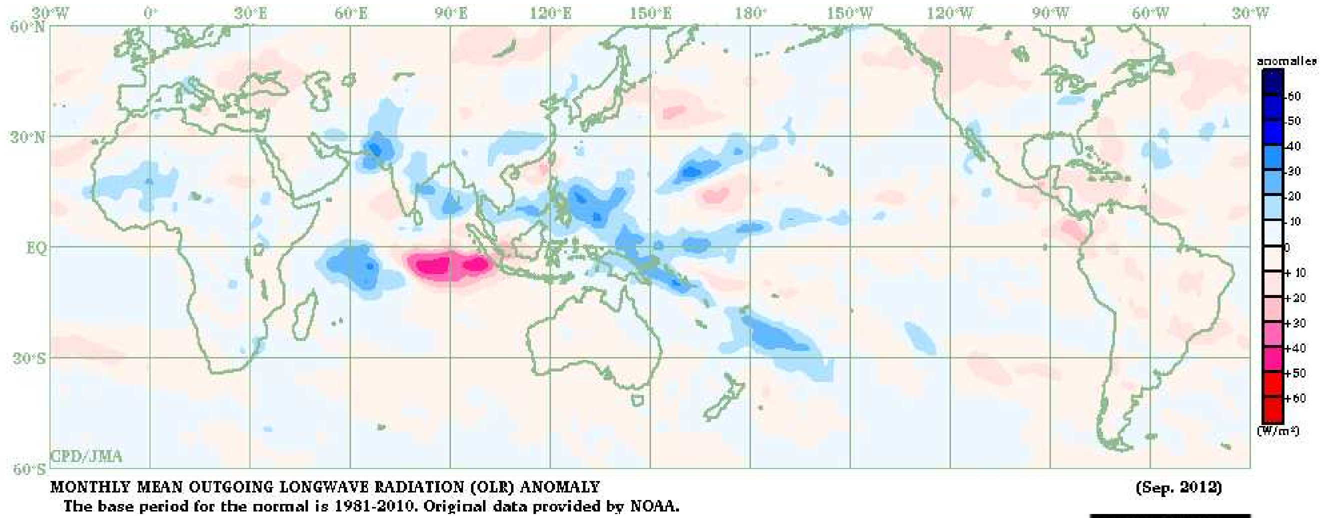
<u>Regression coefficients of OLR (left) and 850-hPa stream function (right) onto a time series of IOBW SST indices for September from 1979 to 2010</u>

The gray shading indicates 95 % confidence level.

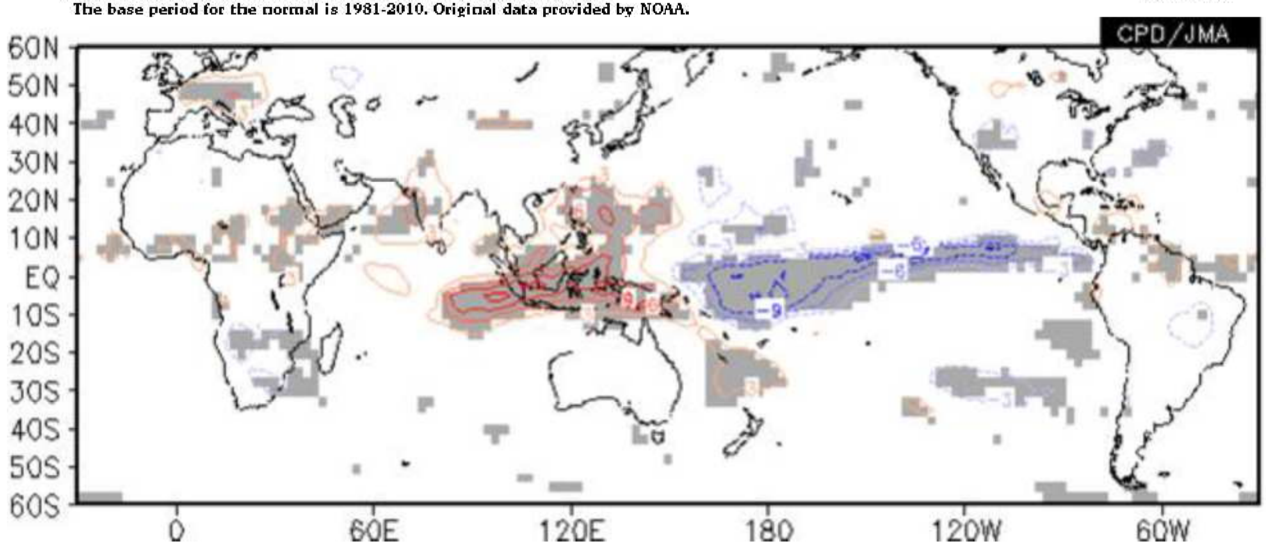
Regression to ENSO (September)

- Anomalous convective activity in September did not resemble that seen in ENSO warm phase.

OLR (Sep. 2012)

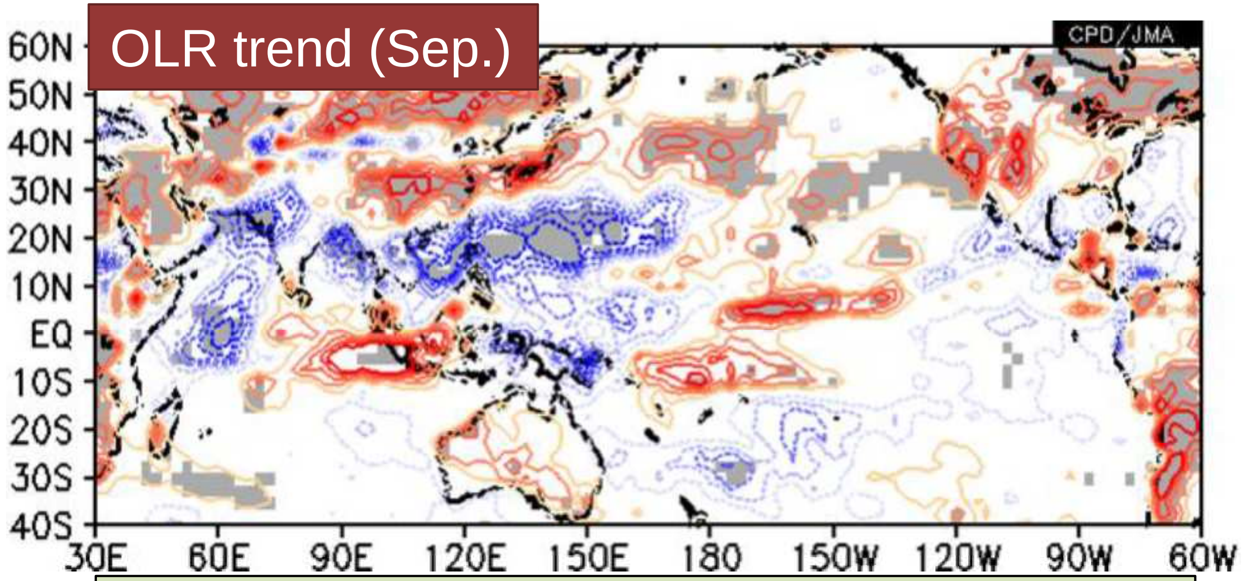


OLR
(regressed on NINO.3)



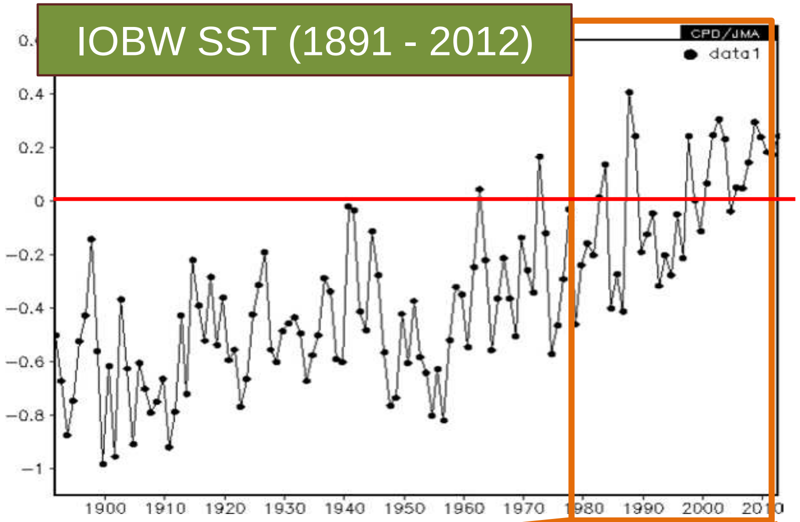
Long-term trends (September)

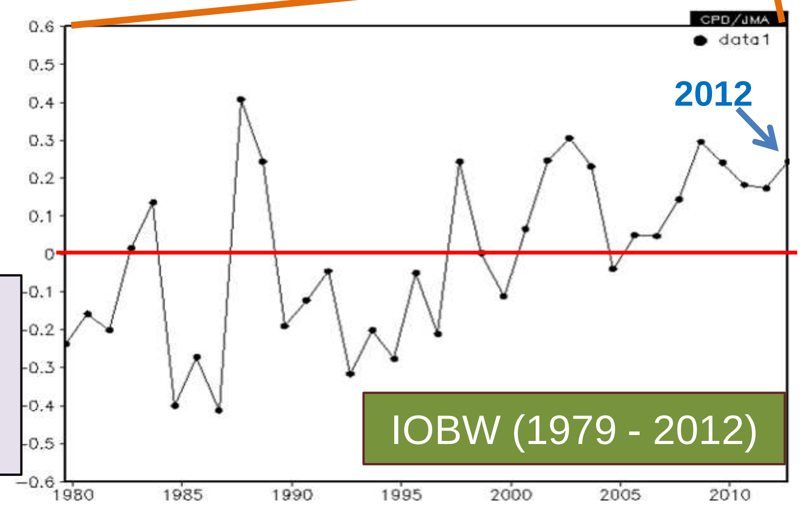
- The southwest-monsoon activity has a strengthening trend.
- An increasing trend is seen in SSTs of the tropical Indian Ocean.



<u>Long-term trend of OLR for Sep. (1979 – 2012)</u>

The gray shading denotes 95 % confidence level.





<u>Interannual variability of IOBW for Sep. (1891 - 2012)</u>

IOBW (Indian Ocean Basin Wide): area-averaged SST anomalies (20˚S – 20˚N, 40 – 100˚E)

Summary

- In September 2012, many parts of southern Asia, including Pakistan, northern India, Nepal and Thailand, experienced heavy rainfall.
- The southwest monsoon in the region was enhanced.
- Intraseasonal oscillation of the monsoon was amplified associated with the MJO.
- Basin-wide SST warming in the tropical Indian Ocean with an increasing trend may contribute to the enhanced southwest monsoon.
- The warming trend of Indian Ocean that can be associated with the strengthening tread of the monsoon in September may be attributable to global warming.

Relevant information and analysis:
Summary of the 2012 Asian summer monsoon is available on the TCC website:
http://ds.data.jma.go.jp/tcc/tcc/products/clisys/ASIA_TCC/report/report20121116a.pdf