Training Seminar on Application of Seasonal Forecast GPV Data to Seasonal Forecast Products
18 – 21 January 2011
Tokyo, Japan

Atmospheric circulation analysis for seasonal forecasting

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Outline

1. Objectives
2. Climate and atmospheric circulation (December 2010)
3. Impacts of ENSO
4. Appendices

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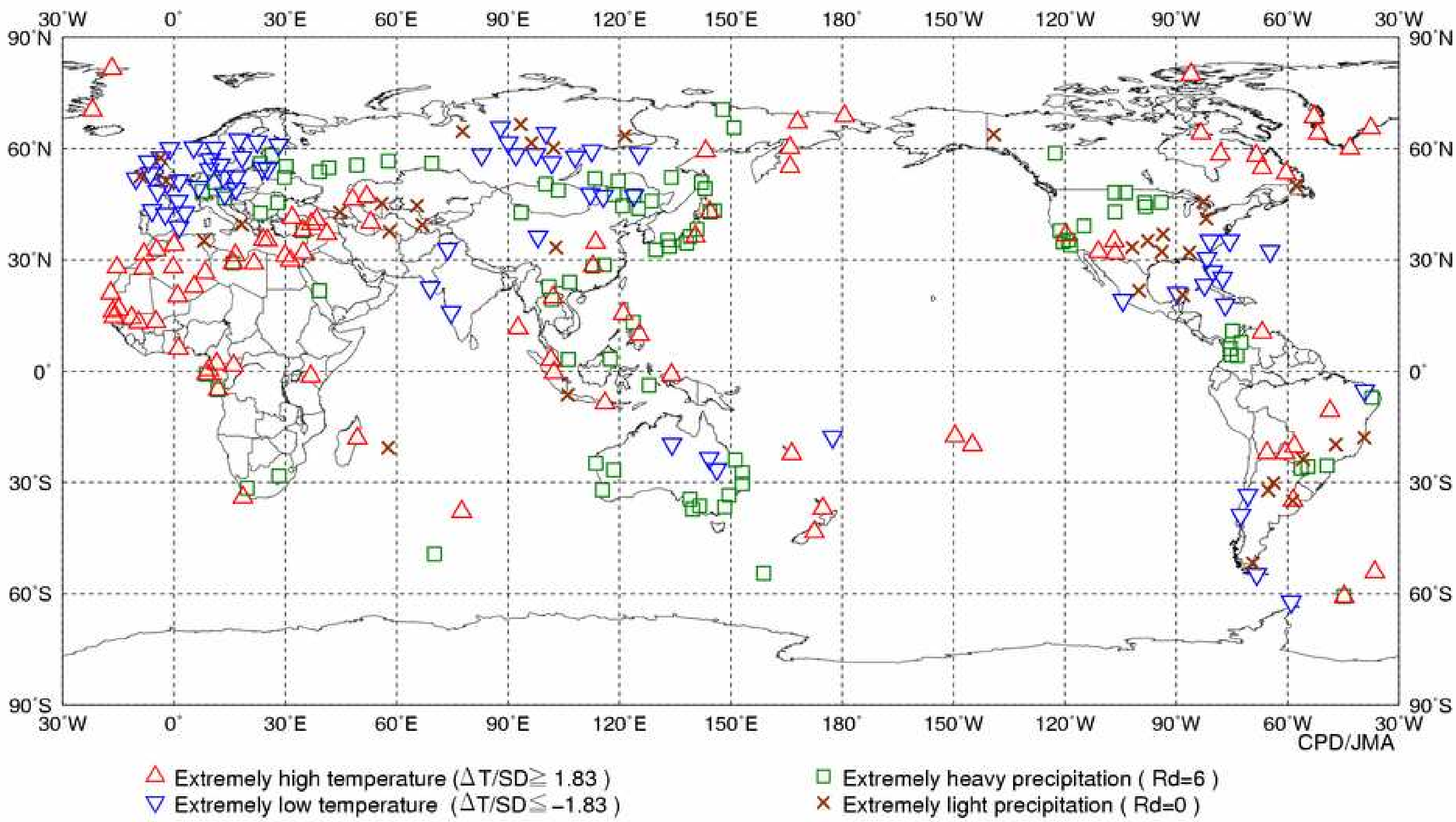
Objectives of atmospheric circulation analysis

- Understand and assess the background of climate, especially extreme climate events, that significantly influences socio-economic sectors.
- Accumulation of findings on atmospheric circulation through operational analysis can contribute to understanding the mechanism of climate system and furthermore to the improvement of seasonal prediction.

1. Objectives
2. Climate and atmospheric circulation (December 2010)
3. Impacts of ENSO
4. Appendices

World climate (December 2010)

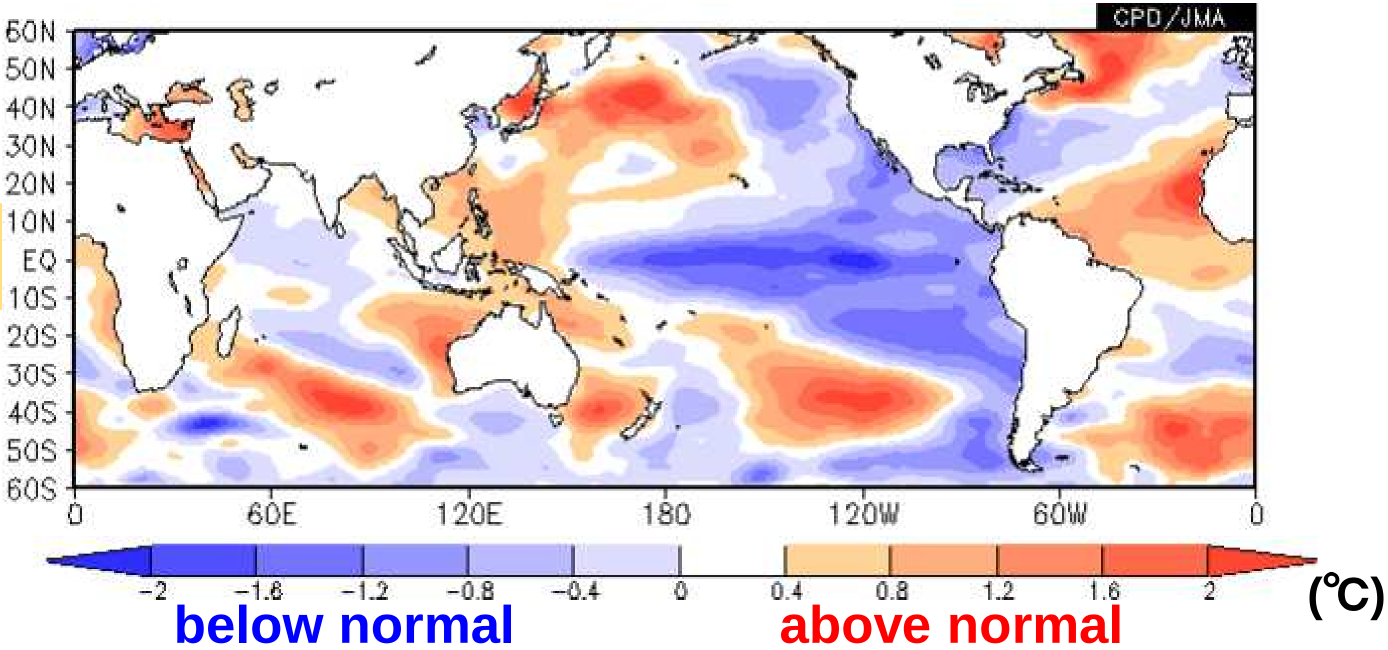


Extremely high/low temperature and extremely heavy/light precipitation (Dec. 2010)

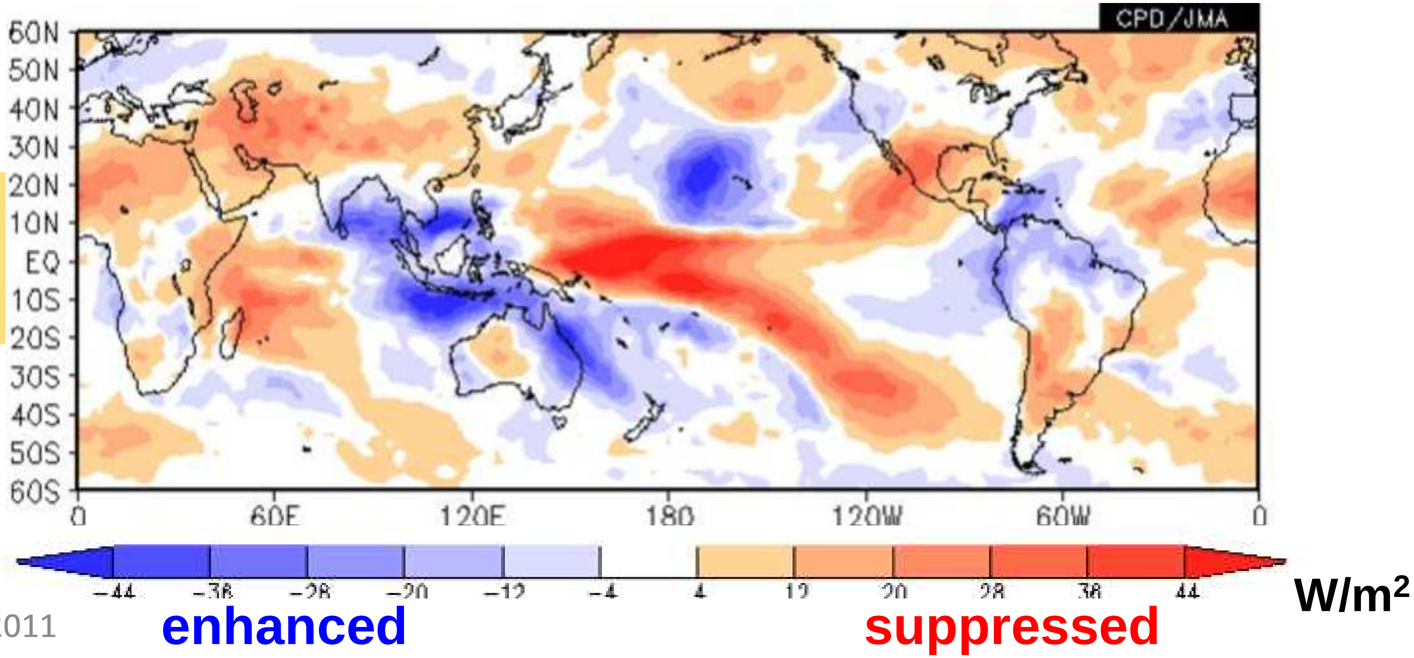
Tropical conditions (December 2010)

A La Niña event occurs, starting in summer 2010.

SST anomaly

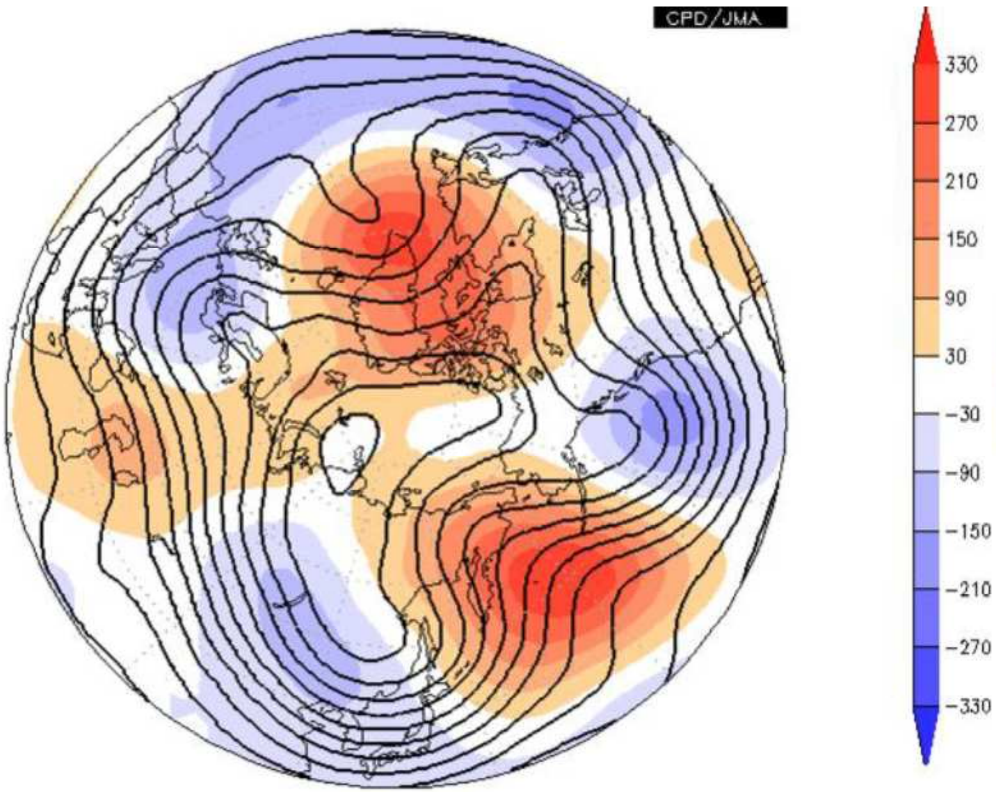


OLR anomaly
(convective activity)

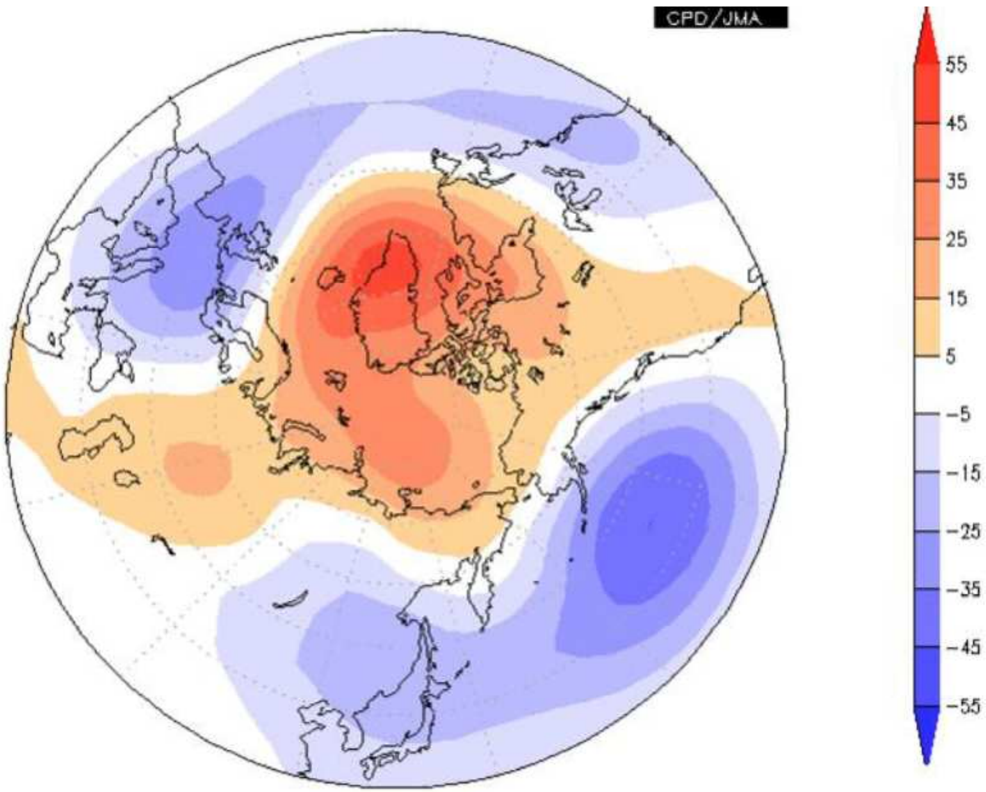


Atmospheric circulation in the N.H.
500-hPa height (December 2010)

The negative Arctic Oscillation (AO) was pronounced.



500-hPa height and anomaly
(Dec. 2010)

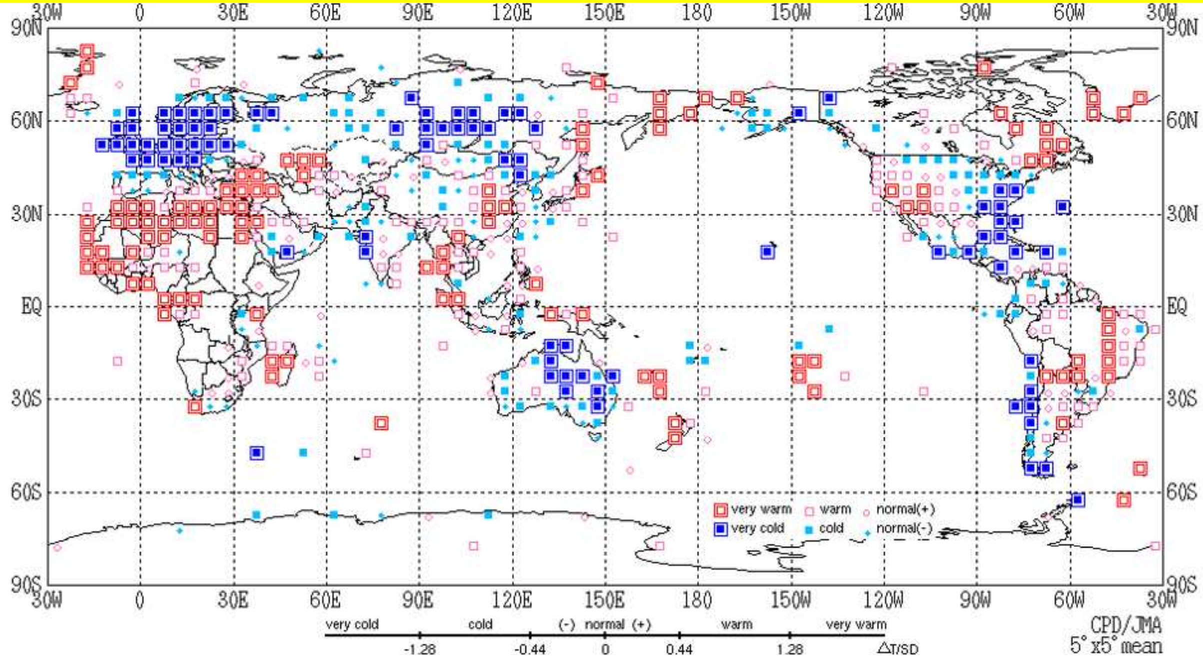


Arctic Oscillation
(negative phase)

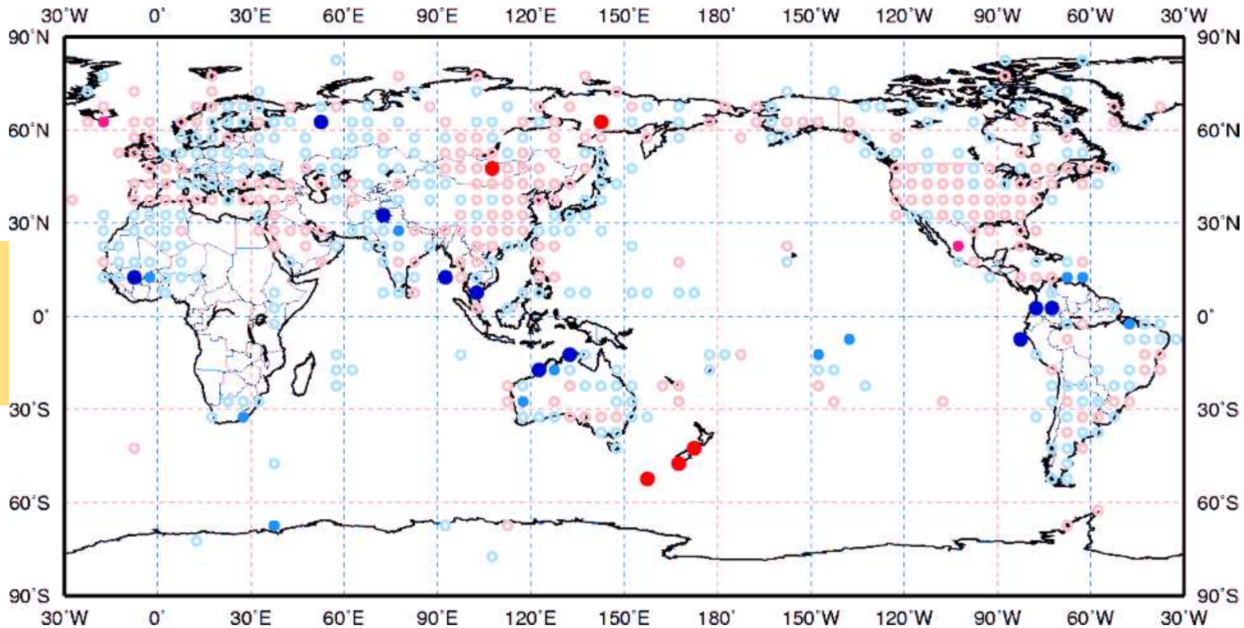
Comparison to past La Niña

Temperature

Temperature
(Dec. 2010)



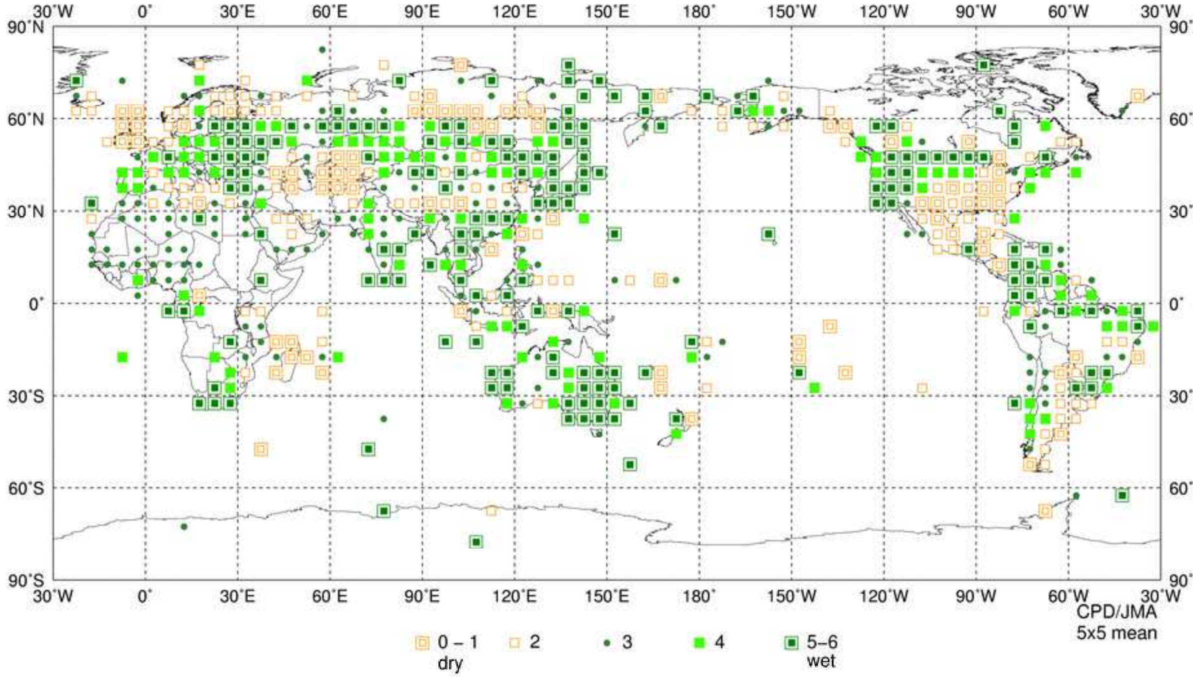
La Niña Composite
(Dec.)



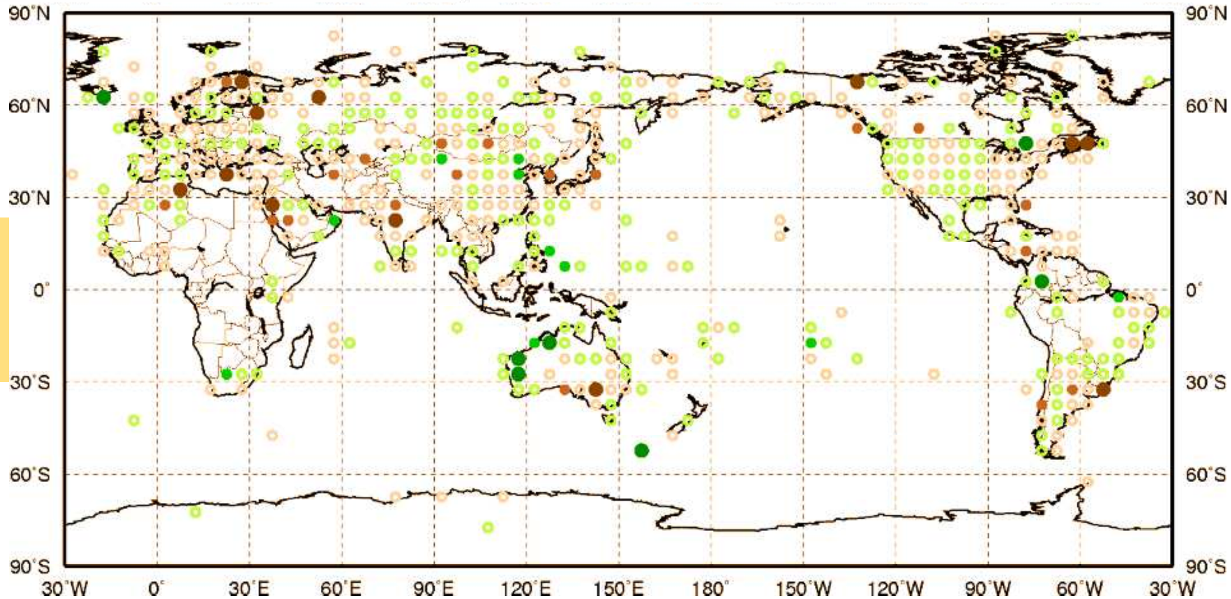
Filled-circle:
statistically significance

Comparison to past La Niña
Precipitation

Temperature
(Dec. 2010)



La Niña Composite
(Dec.)

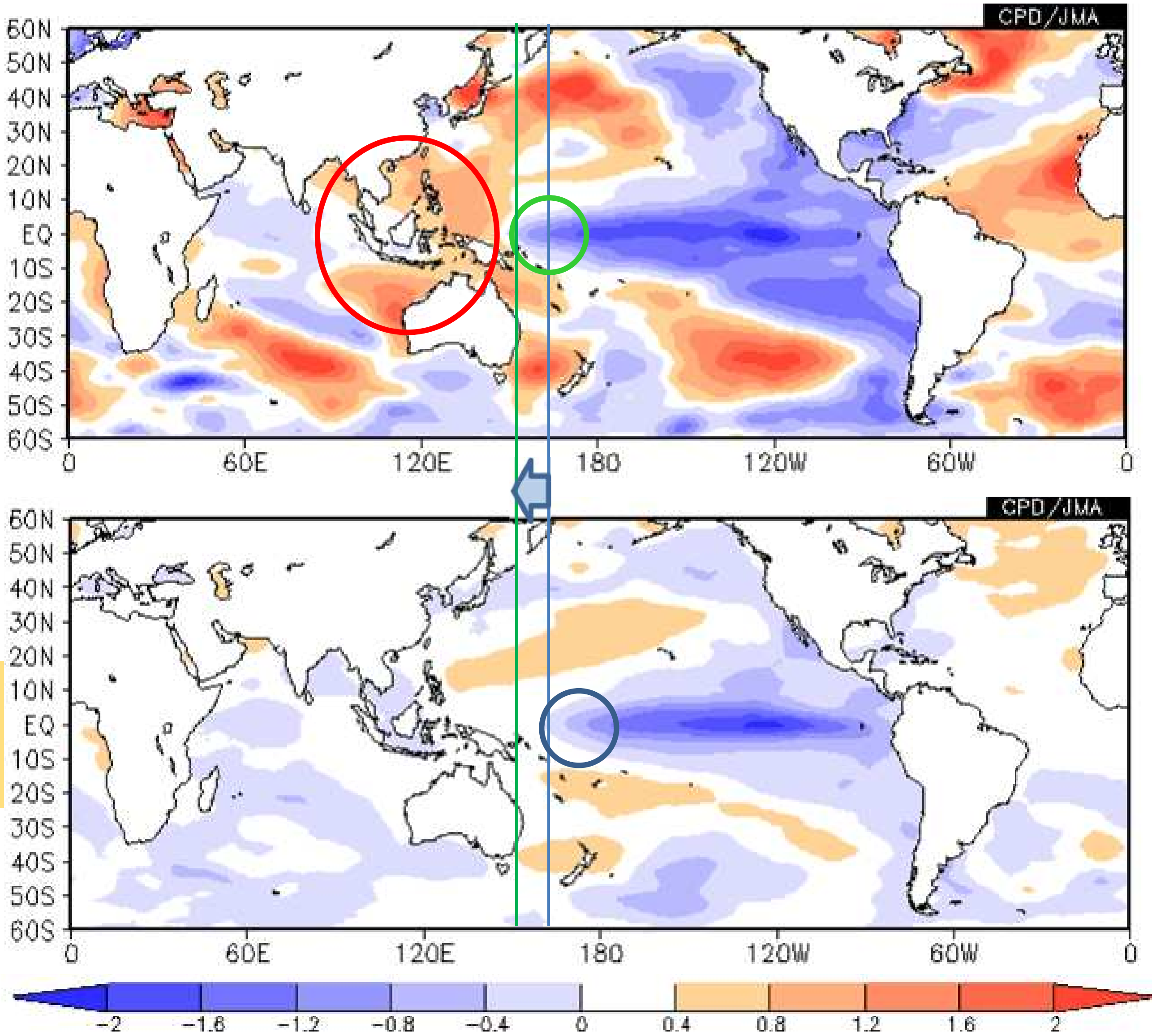


Filled-circle:
statistically significance

Comparison to past La Niña
Sea surface temperature (SST)

SST anomaly
(Dec. 2010)

La Niña Composite
(Dec.)

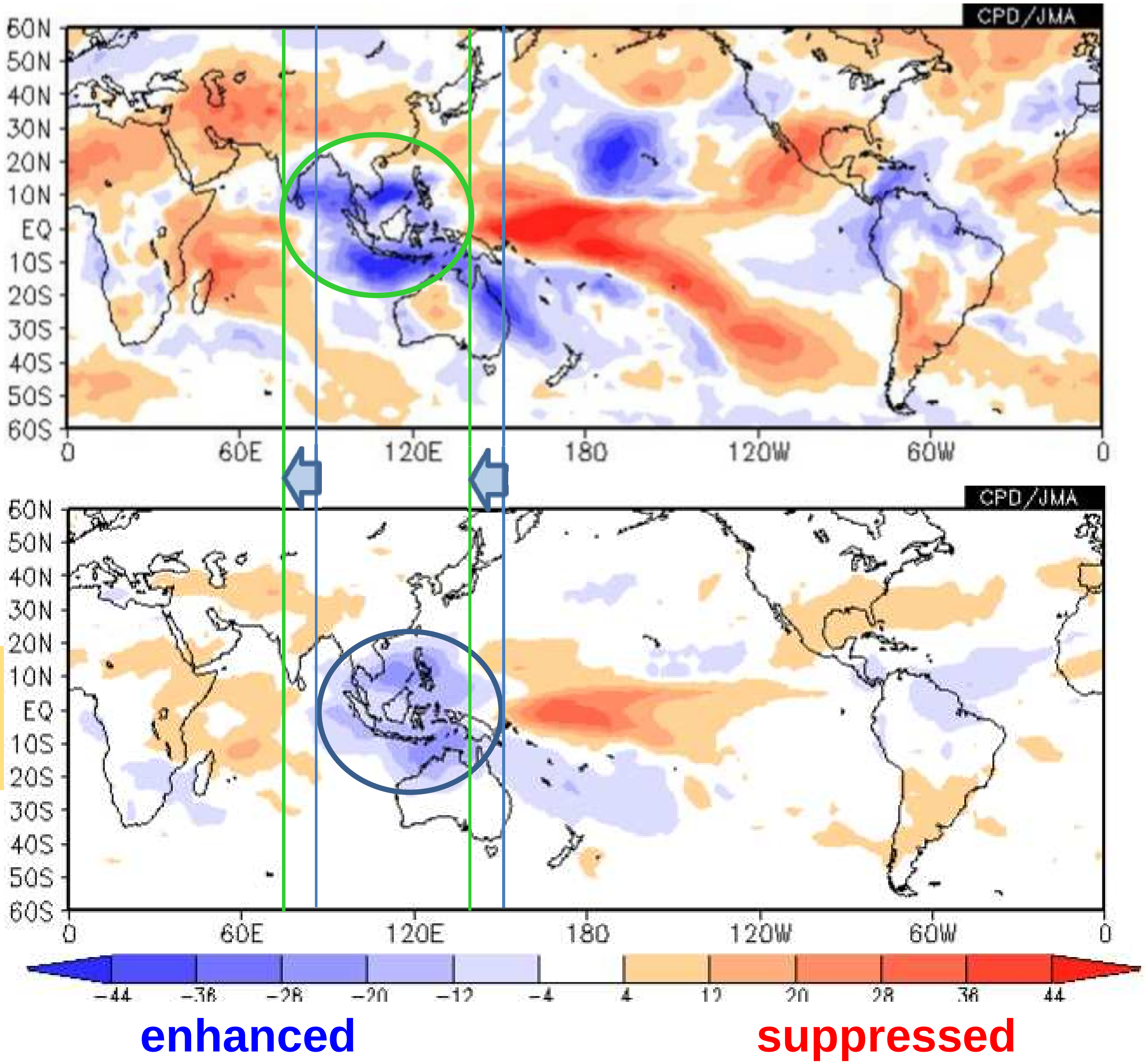


below normal **above normal**

Comparison to past La Niña
Convective Activity

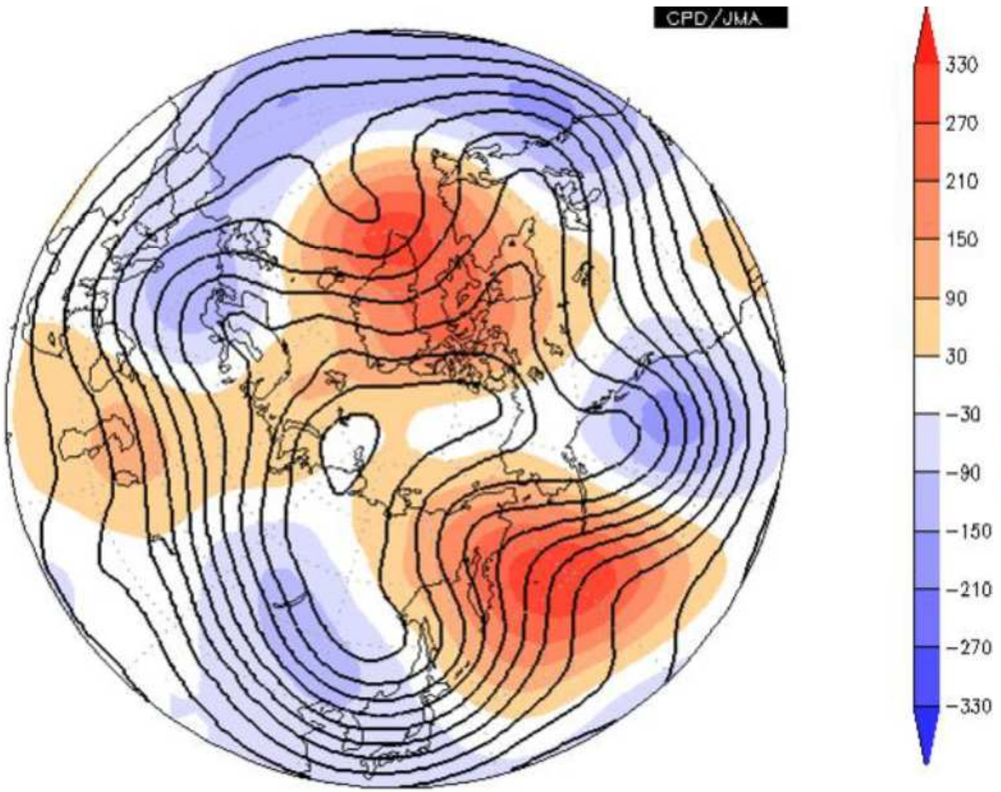
OLR anomaly
(Dec. 2010)

La Niña Composite
(Dec.)

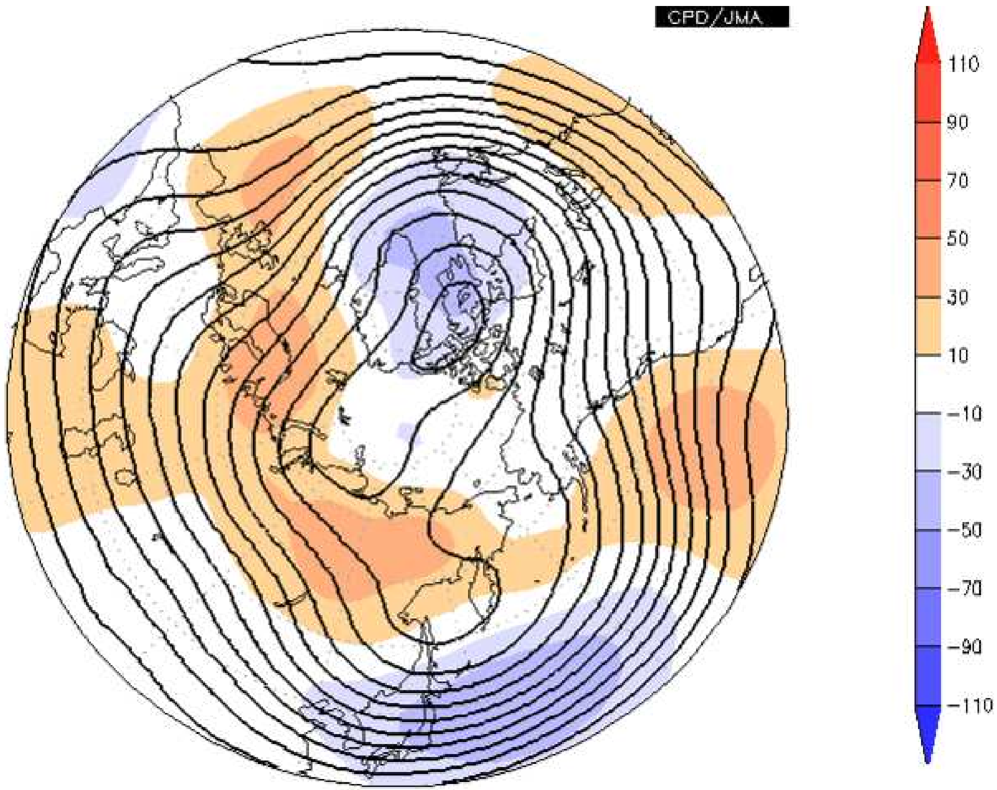


Comparison to past La Niña
500-hPa height in the N.H.

Observed atmospheric circulation results from internal variation (e.g. AO) and external-forced variation (response to ENSO).



500-hPa height and anomaly (Dec. 2010)

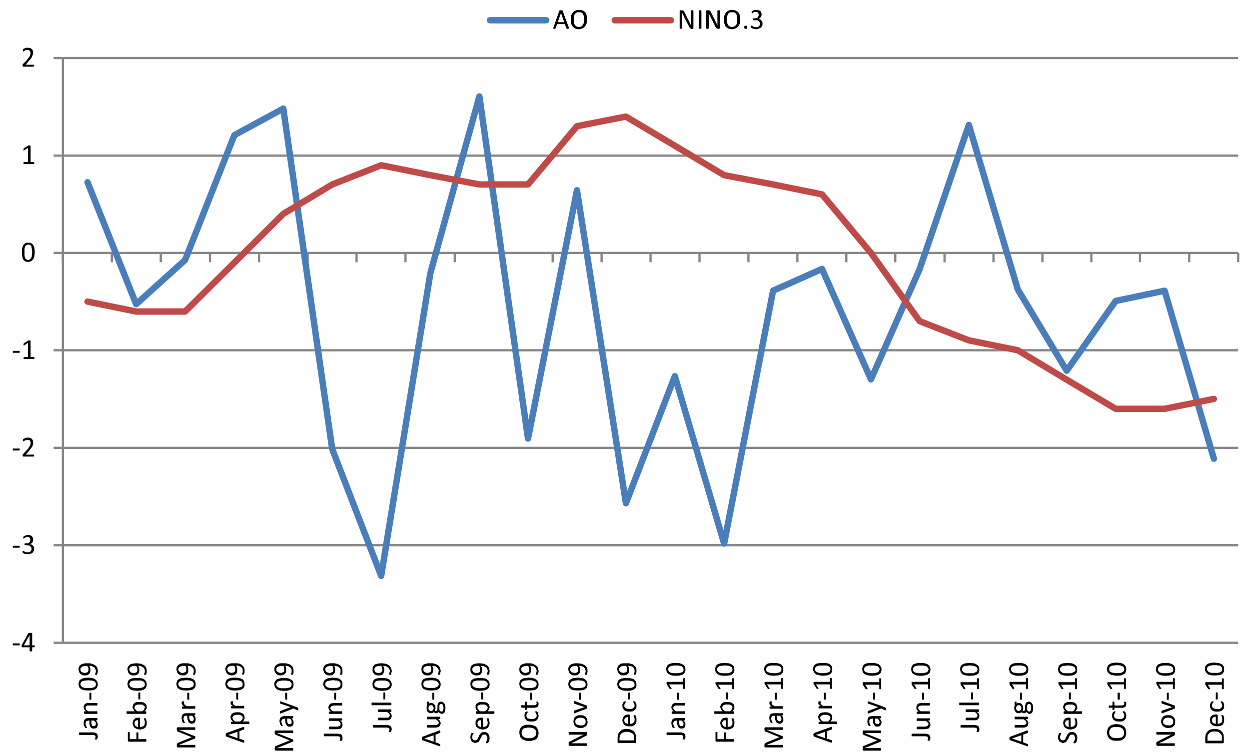


Composite of past La Niña years*

*1984, 1988, 1995, 1998, 1999, 2005, 2007

NINO.3 Index and AO Index

The cyclic period of NINO.3 (oceanographic variation) is longer than that of AO (atmospheric variation).



Time series of NINO.3 SST Index and AO Index
(Jan. 2009 – Dec. 2010)

1. Objectives
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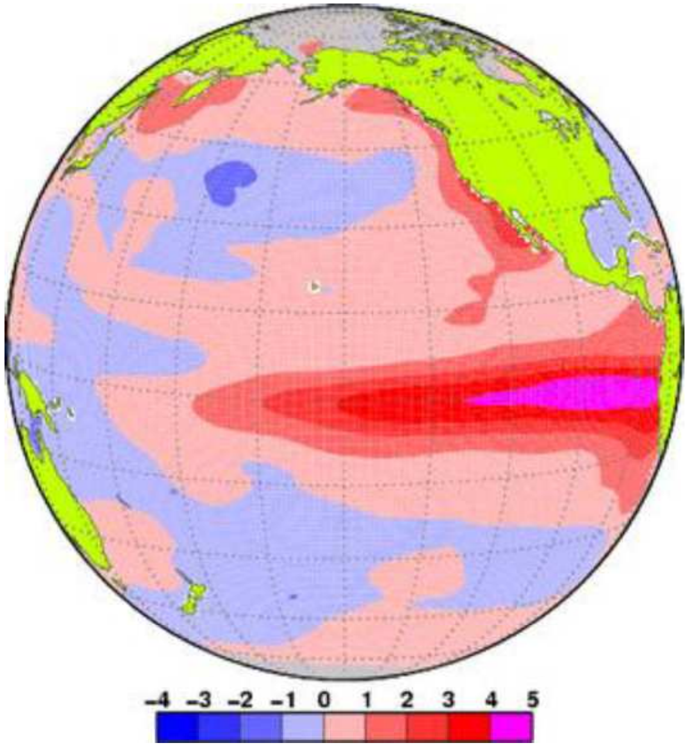
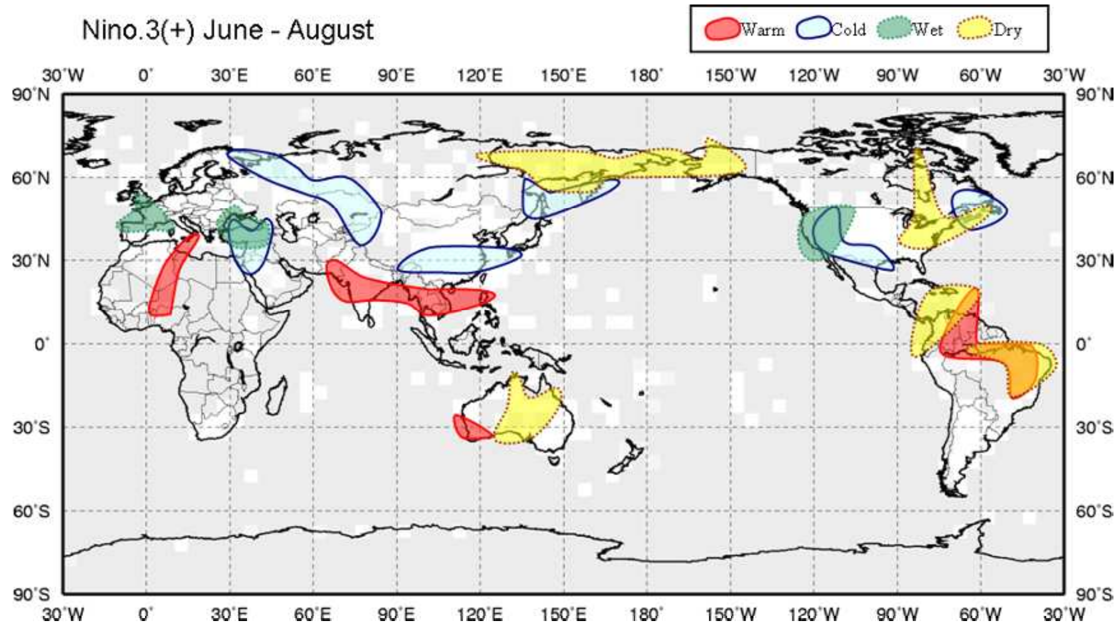
El Niño/La Niña-Southern Oscillation (ENSO)

- ENSO, quasi-periodical and ocean-atmosphere interactive phenomenon, occurs with approximately five-year intervals.
- It has broad, significant impacts on world climate.

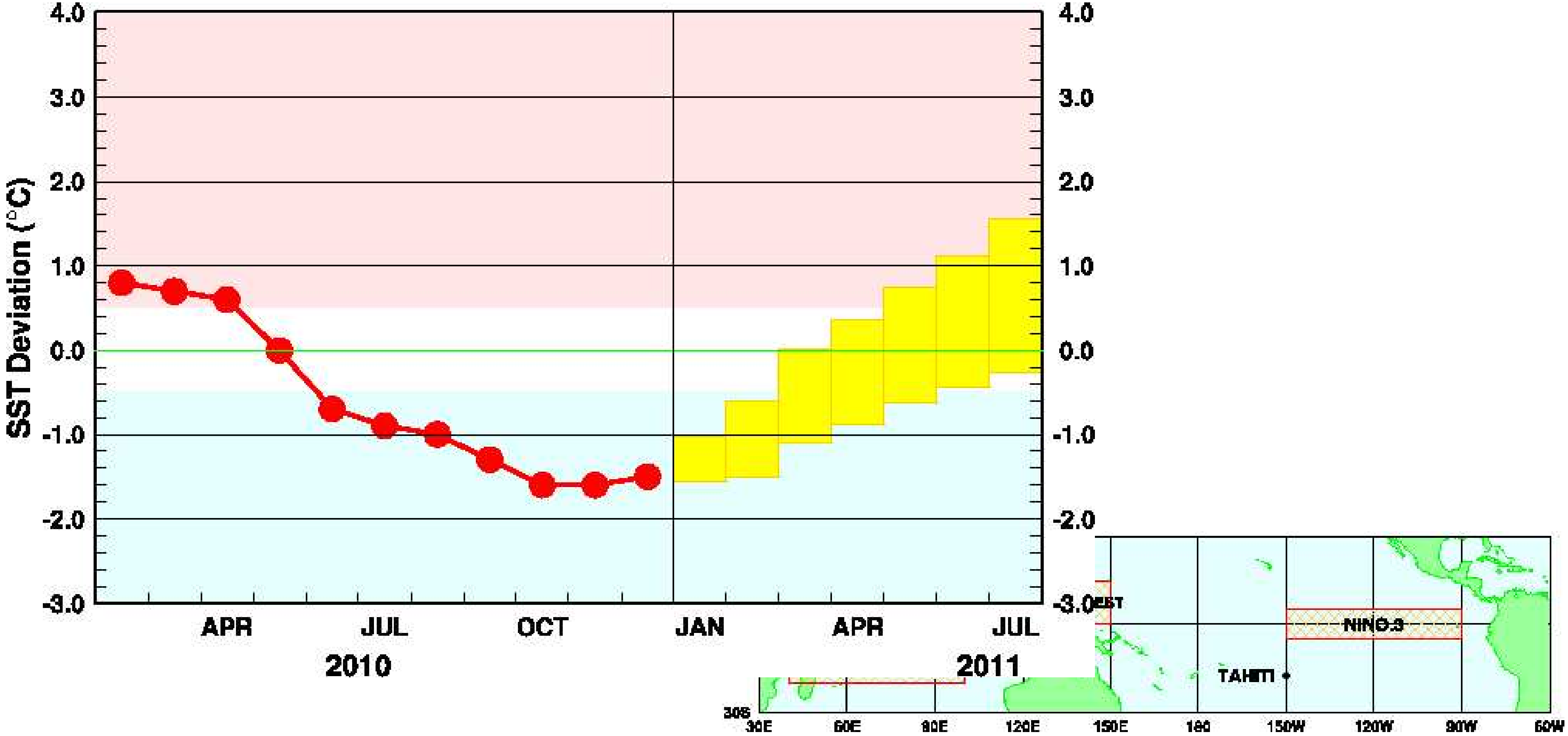


SST anomaly (Nov. 1997)

Climate in El Niño (Jun. – Aug.)



The La Niña event is likely to decay in boreal spring.
(JMA's *El Niño Outlook*, updated 11 January 2011)

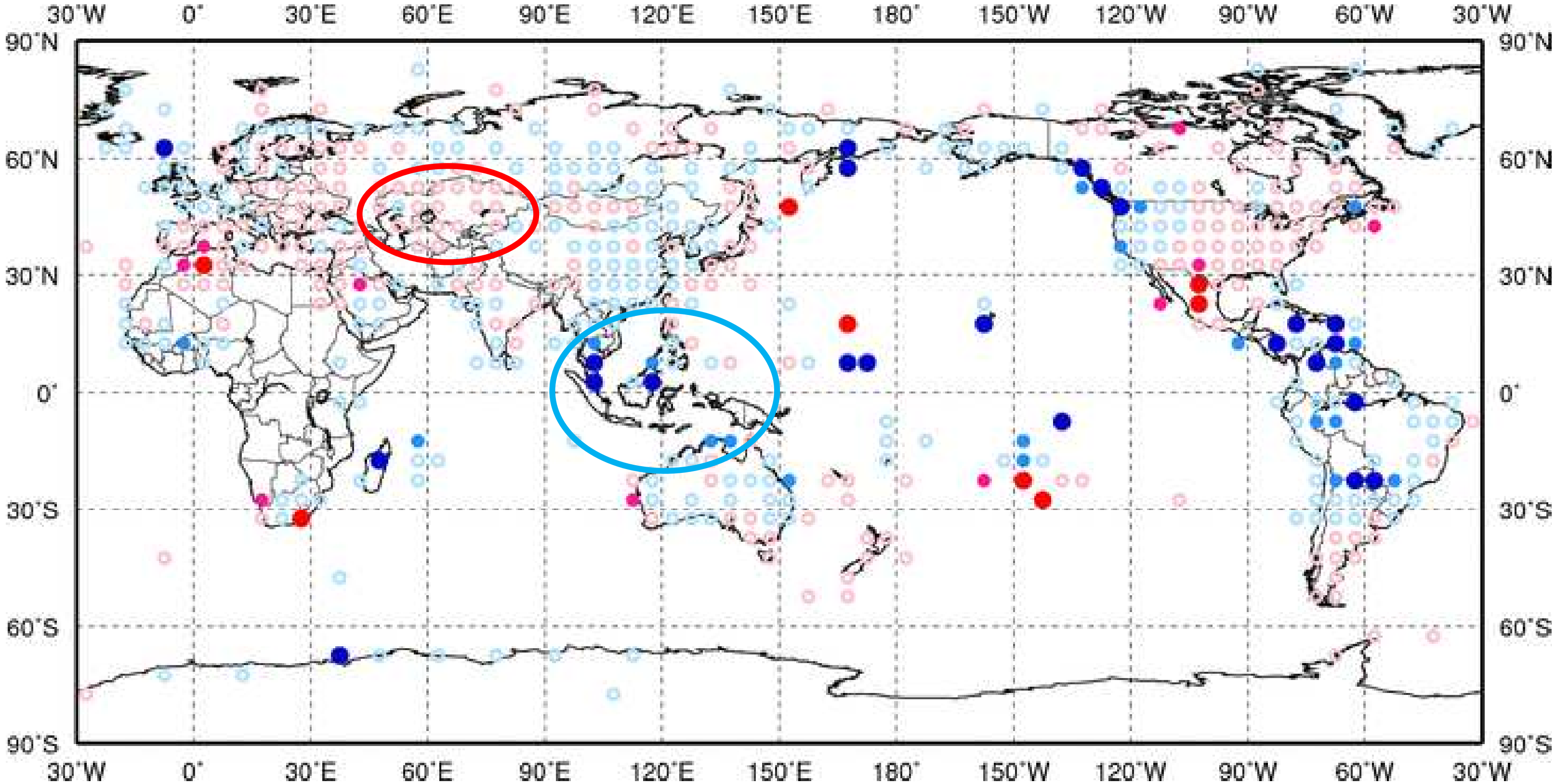


Outlook of the SST deviation for NINO.3 by the JMA's El Niño prediction model.

Red line with closed circle: observed SST deviation.

Yellow boxes: range of predicted SST deviation with 70% probability.

Impacts of La Niña on world climate
Temperature (February - April)



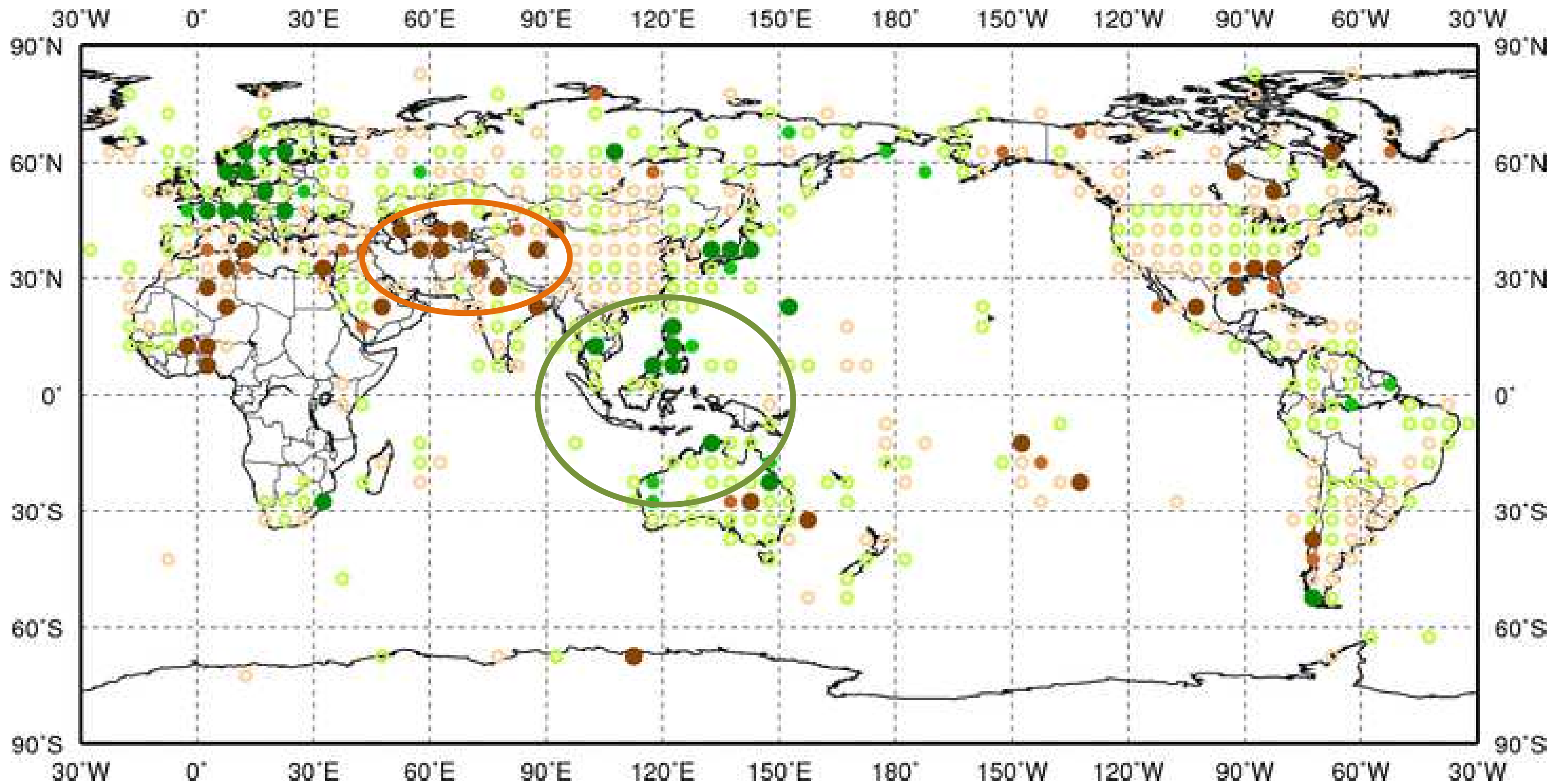
Red: above normal   Blue: below normal

<u>Large filled circle</u>: statistical confidence level is <u>95 % or above</u>.

Small filled circle: statistical confidence level is above 90 % and below 95 %.

<u>Non filled circle</u>: statistical confidence level is <u>below 90 %</u>.

Impacts of La Niña on world climate
Precipitation (February - April)



Red: above normal   Blue: below normal

Large filled circle: statistical confidence level is 95 % or above.

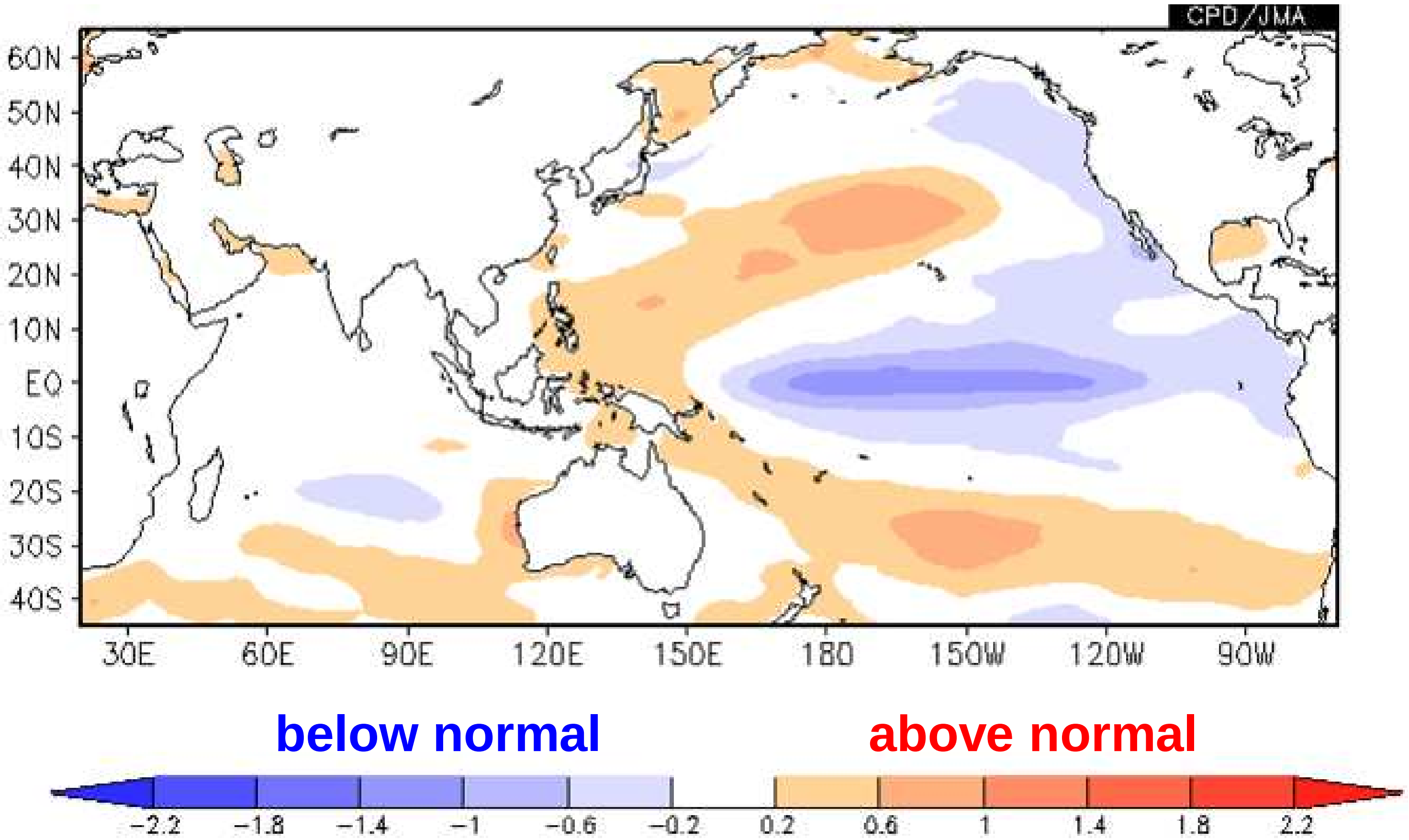
Small filled circle: statistical confidence level is above 90 % and below 95 %.

Non filled circle: statistical confidence level is below 90 %.

- It is important to understand the impacts of ENSO on national and regional climate.
- Furthermore, it is crucial to investigate atmospheric circulation associated with ENSO.

Next, find out characteristic atmospheric circulations in La Niña events.

La Niña composite (Feb. – Apr.)
Sea surface temperature

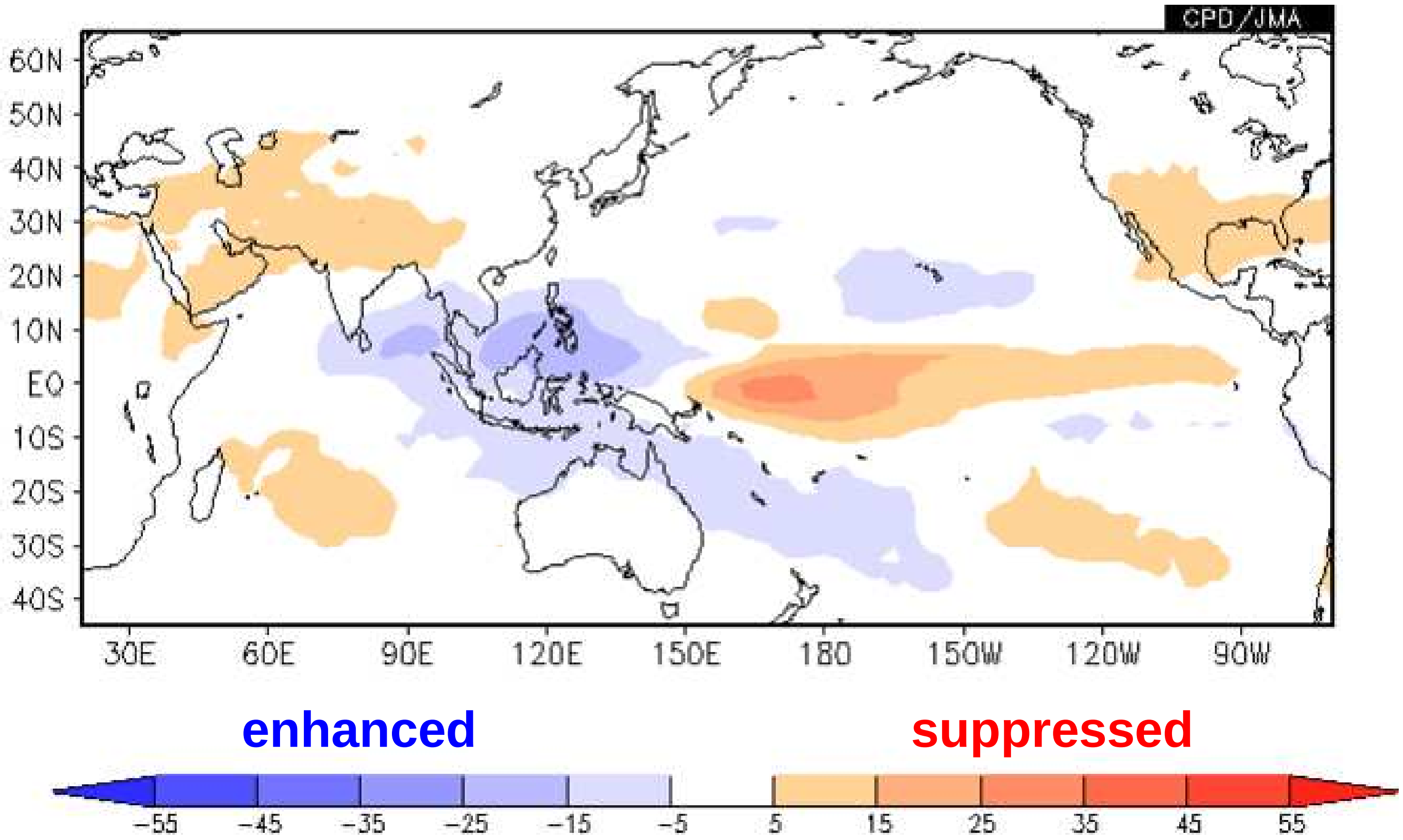


<u>Sea surface temperature (SST) anomaly (degree C)</u>

La Niña years (Feb. – Apr.) : 1985, 1989, 1996, 1999, 2000, 2006, 2008

Climatological normal: 1979 – 2004 average

La Niña composite (Feb. – Apr.)
Convective activity

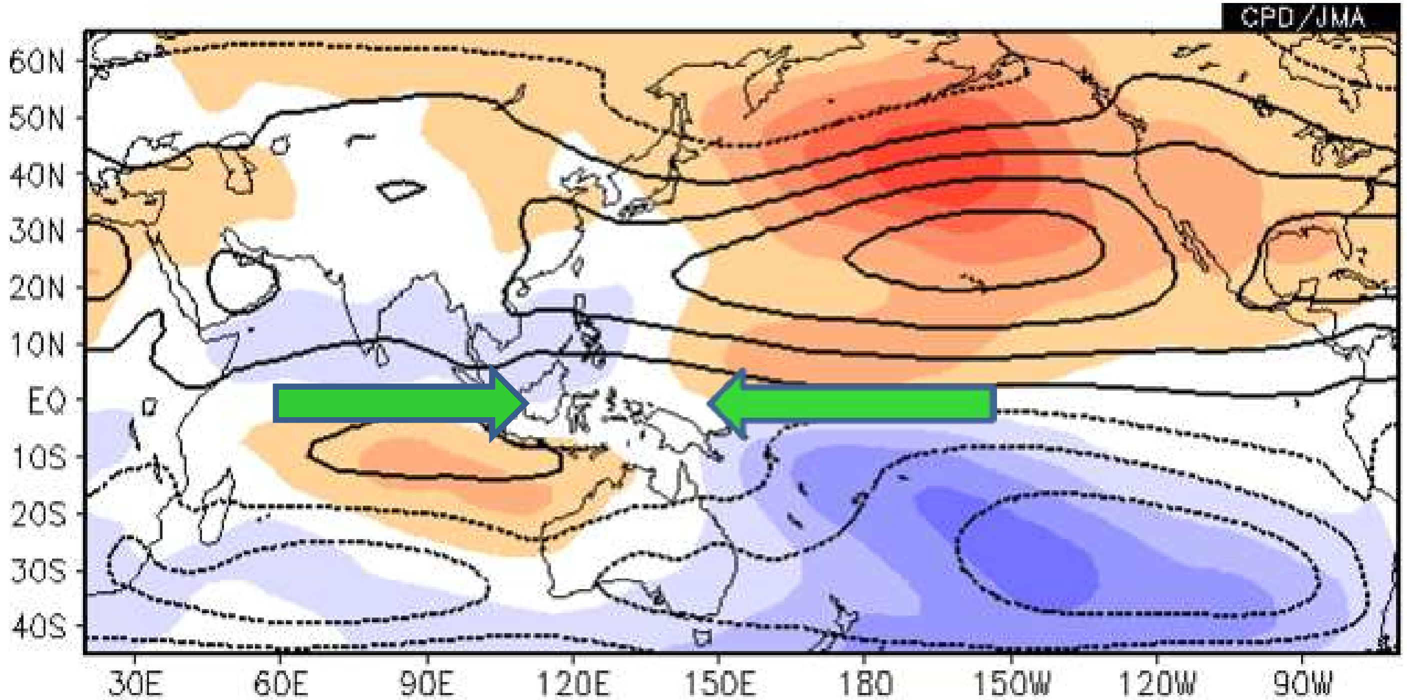


Outgoing longwave radiation (OLR) anomaly (W/m^2)

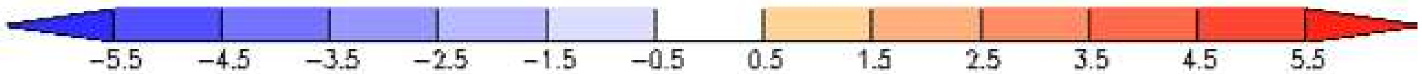
La Niña years (Feb. – Apr.) : 1985, 1989, 1996, 1999, 2000, 2006, 2008

Climatological normal: 1979 – 2004 average

La Niña composite (Feb. – Apr.)
Atmospheric circulation in lower troposphere



N.H. (S.H.): cyclonic (anti-cyclonic) anti-cyclonic (cyclonic)

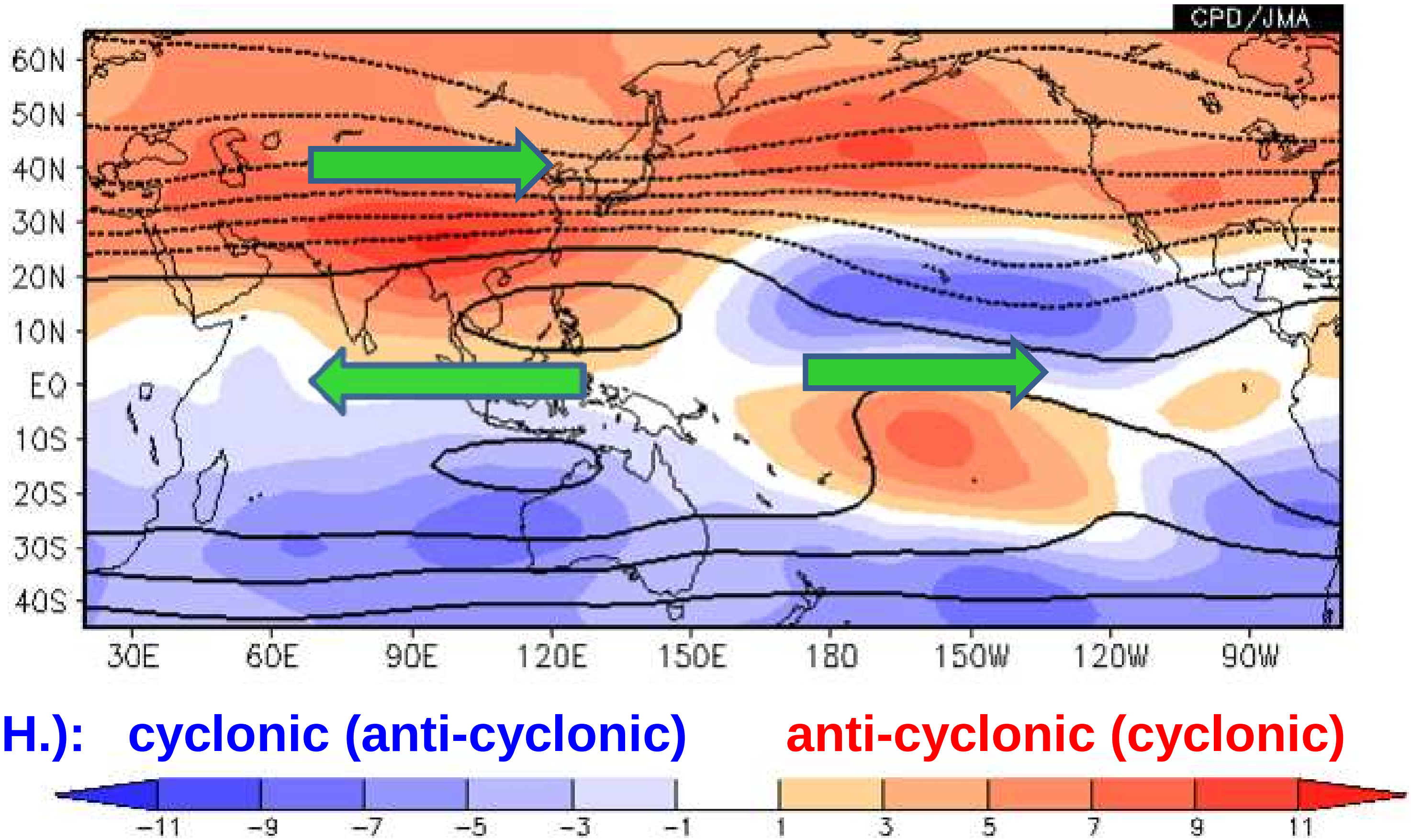


850-hPa stream function (contour) and anomaly (shading) (unit: x$10^6 m^2/s$)

La Niña years (Feb. – Apr.) : 1985, 1989, 1996, 1999, 2000, 2006, 2008

Climatological normal: 1979 – 2004 average

La Niña composite (Feb. – Apr.)
Atmospheric circulation in upper troposphere

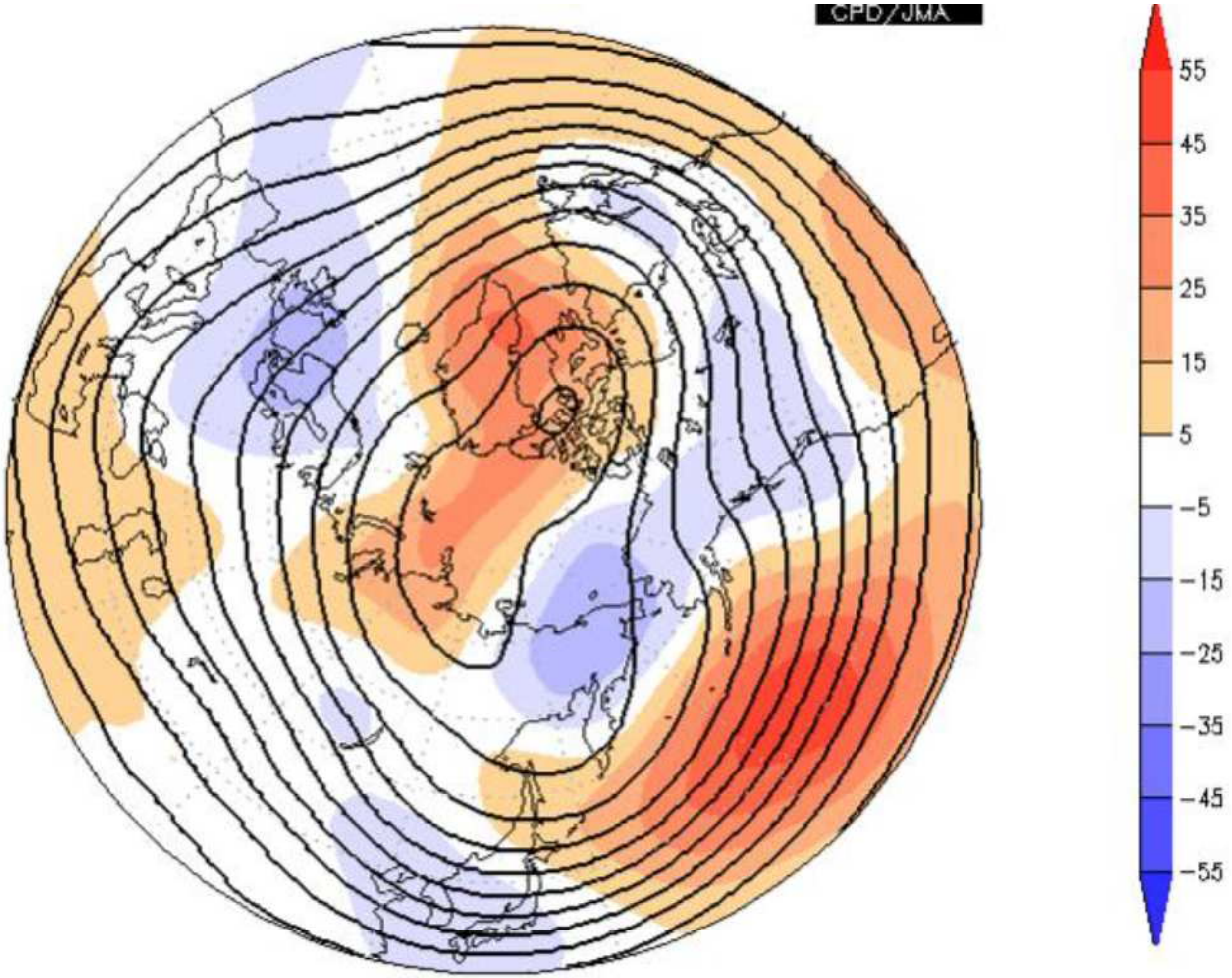


<u>200-hPa stream function (contour) and anomaly (shading) (unit: x$10^6$$m^2$/s)</u>

La Niña years (Feb. – Apr.) : 1985, 1989, 1996, 1999, 2000, 2006, 2008

Climatological normal: 1979 – 2004 average

La Niña composite
500-hPa height in the N.H.



500-hPa height (contour) and anomaly (shading) (unit: m)

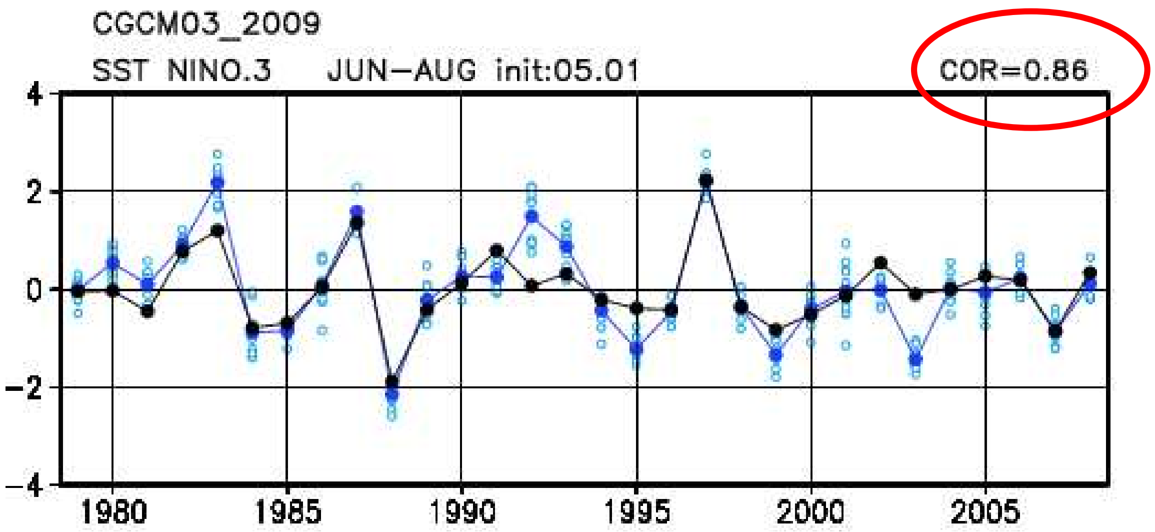
La Niña years (Feb. – Apr.) : 1985, 1989, 1996, 1999, 2000, 2006, 2008

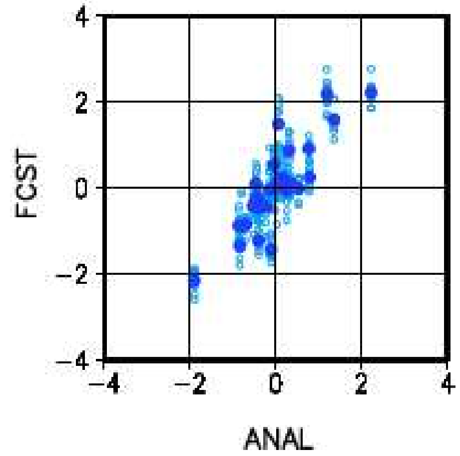
Climatological normal: 1979 – 2004 average

Prediction skill of El Niño/La Niña

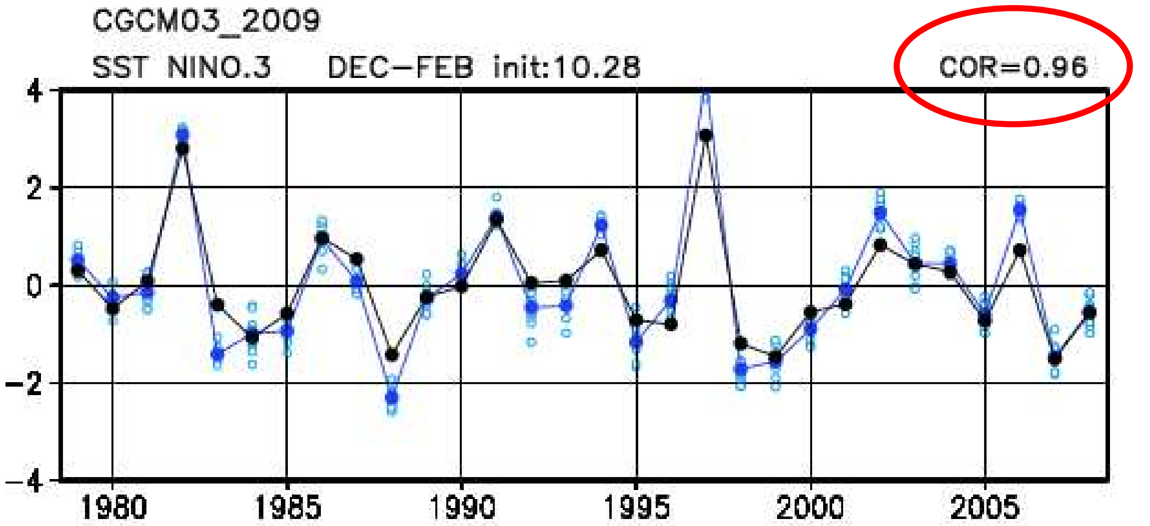
hindcast: 1979 – 2008, Lead-time: one-month

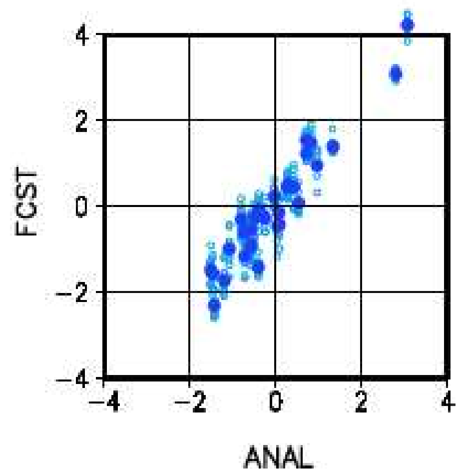
***Index: NINO.3**





Jun. – Aug.





Dec. – Feb.

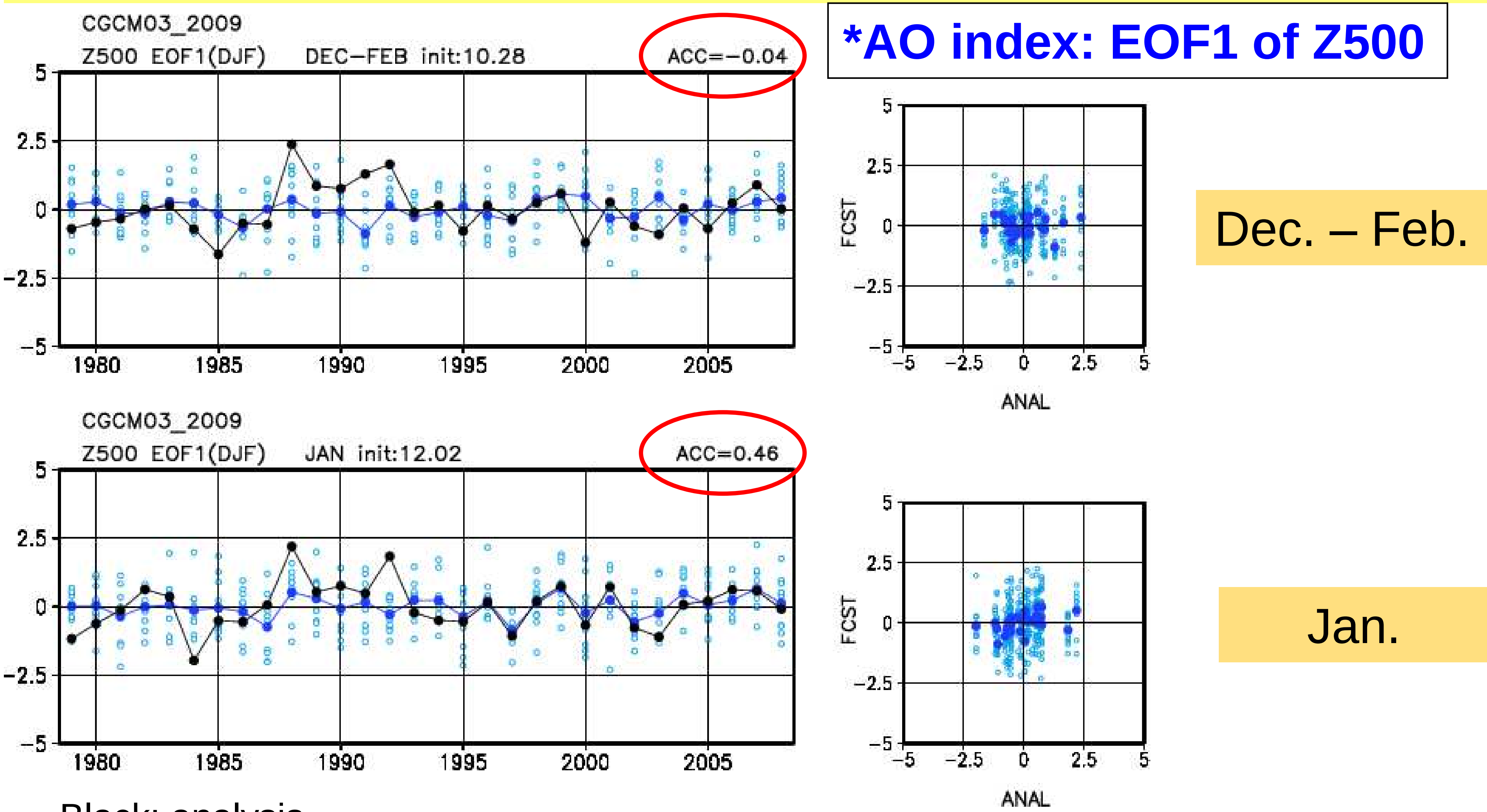
Black: analysis

Blue (filled circle) : ensemble mean, blue (non-filled circles): ensemble members

Prediction skill of AO (Arctic Oscillation)

hindcast: 1979 – 2008, Lead-time: one-month

***AO index: EOF1 of Z500**



Black: analysis

Blue (filled circle) : ensemble mean, blue (non-filled circles): ensemble members

Summary

- ENSO has significant impacts on world climate.
- ENSO cycles are relatively slower than those of internal atmospheric variations.
- Prediction skill for ENSO is significantly high, while that for atmospheric inherent variations is low.

It is very important to focus on ENSO in seasonal forecasting.

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Appendices

Monitoring products

- TCC routinely updates various kinds of monitoring products on climate and climate system.
- Please see Appendix I for more information on monitoring products.

ITACS : Interactive Tool for Analysis of the Climate System

- The ITACS developed by TCC is available on the TCC website.
- Please see Appendix II for more information (function and application)

END

Appendix I

JMA's Climate system monitoring products

Monthly Highlights on Climate System

- This monthly report contains climate in Japan and the world, atmospheric and oceanographic conditions for the previous month,
- issued around 16th every month,
- provided through the TCC website.

http://ds.data.jma.go.jp/tcc/tcc/products/clisys/highlights/index.html

16 November, 2010 *Japan Meteorological Agency*

Monthly Highlights on Climate System (October 2010)

Highlights in October 2010
- Monthly mean temperatures were above normal in the whole Japan.
- Monthly precipitation amounts were extremely heavy around the South China Sea and Indonesia.
- In the 500-hPa height field, a wavy pattern of anomalies was found from the Pacific to North America.
- Convective activities were enhanced from the eastern Indian Ocean to Indonesia and around the South China Sea.
- Remarkably negative SST anomalies were dominant in the equatorial Pacific.

Climate in Japan (Fig. 1):

Due to the large influence of fronts and cyclones, cloudy and rainy weather was dominant compared to the normal. Monthly sunshine durations were below normal in most of Japan. In the latter period of the middle 10 days, Amami region experienced record-breaking heavy rains.

Temperatures were above normal in the first and middle 10 days in the whole Japan, while in the last 10 days they were below normal in Northern and Eastern Japan due to severe cold-air outbreaks.

World Climate (Figs. 2 and 3):

The monthly anomaly of the global average surface temperature in October 2010 (i.e. the average of the near-surface air temperature over land and the SST) was +0.26 °C (10th warmest since 1891) (Fig.2). On a longer time scale, global average surface temperatures have been rising at a rate of about 0.60°C per century. Extreme climate events are the lower troposphere were below normal in eastern and southern China. Zonally-averaged tropospheric air temperature in the middle and high latitudes of the Northern Hemisphere decreased but remained remarkably higher than normal from summer 2010, which was the fifth highest on record for October since 1979.

Tropics (Figs. 6, 7 and 8):

Convective activities were enhanced from the eastern Indian Ocean to Indonesia, from India to the Philippines, around the Caribbean Sea, and in the intertropical convergence zone of Africa, while they were suppressed across the equatorial Pacific (Fig. 6). The active phase of the Madden-Julian Oscillation (MJO) moved eastward around Indonesia early this month (Fig. 7). In the lower troposphere, easterly wind anomalies were dominant from July 2010 (Fig. 7). Corresponding with this, the Southern Oscillation Index (SOI) was +2.8. In the upper troposphere,

16 November, 2010 *Japan Meteorological Agency*

Fig. 4 Monthly mean 500-hPa height and anomaly in the Northern Hemisphere (October 2010)
Contours show heights at an interval of 60 m. Shaded patterns show height anomalies. Base period for the normal is 1979-2004.

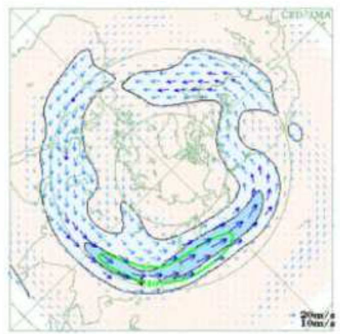


Fig. 5 Monthly mean 200-hPa wind speed and vectors in the Northern Hemisphere (October 2010)
Black lines show wind speeds at an interval of 20 m/s. Blue shading shows values greater than 40 m/s. Green lines show normal wind speeds at an interval of 40 m/s. Base period for the normal is 1979-2004.

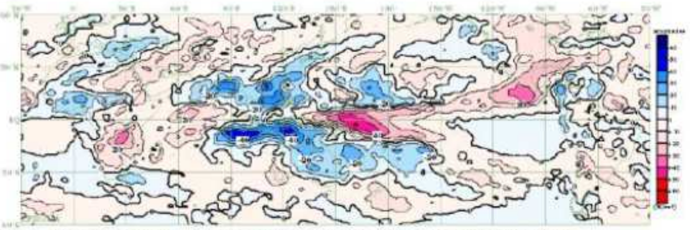


Fig. 6 Monthly mean Outgoing Longwave Radiation (OLR) anomaly (October 2010)
Contour interval is 10 W/m². Base period for the normal is 1979-2004. Original data are provided by courtesy of NOAA.

Annual Report on Climate System

- This annual report contains reports on major climate events (e.g. summary on El Nino/La Nina events, Asian summer monsoon) as well as overviews on climate in Japan and the world, atmospheric and oceanographic conditions,
- issued in March every year,
- provided through the TCC website.

  http://ds.data.jma.go.jp/tcc/tcc/products/clisys/arcs.html

2.7 Summary of the Asian Summer Monsoon in 2009

The figures referred to in this section can be found on pp. 66 – 68.

Observing Asian summer monsoon activity is very important, since fluctuations in convective activities and atmospheric circulation associated with it can influence the summer climate in Asia, including that of Japan. In this section, the characteristics of the Asian summer monsoon from June to September 2009 are described.

2.7.1 Asian summer monsoon activities and atmospheric circulation in summer 2009

Asian summer monsoon activities inferred from the seasonal mean (i.e., from June to September) of Outgoing Longwave Radiation (OLR) were enhanced from the east of the Philippines to the western Pacific (Fig. 2.7.1), and were suppressed over western Indonesia and from India to the area around Taiwan.

Asian summer monsoon activities were generally suppressed throughout the season except in the West North Pacific Monsoon (WNPM) region (Table 2.7.1). In the lower troposphere, monsoon circulation was stronger than normal over the eastern Indian Ocean, though its northward penetration was weaker than normal (Fig. 2.7.2a). Cyclonic circulation anomalies were observed around the Philippines, indicating that the monsoon trough was deeper than normal and

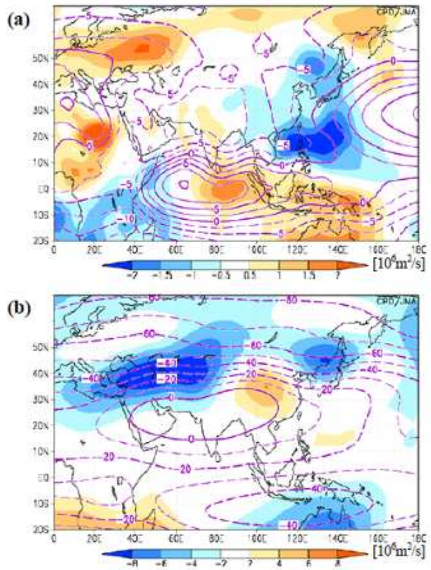


Fig. 2.7.2 Four-month mean stream function and its anomaly for June – September 2009

(a) The contours indicate the 850-hPa stream function (m^2/s) at intervals of $2.5 \times 10^6\ m^2/s$, and the color shading indicates 850-hPa stream function anomalies. (b) The contours indicate the 200-hPa stream function (m^2/s) at intervals of $10 \times 10^6\ m^2/s$, and the color shading indicates 200-hPa stream function anomalies.

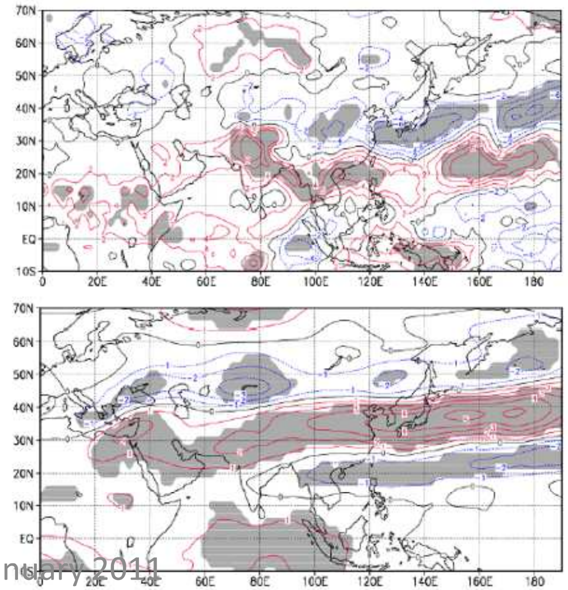


Fig. 4.3.8 Monthly mean linear regression coefficient of OLR (top) and 200 hPa zonal wind (bottom) with part of southward mode score not predicted by NINO.3.

The contour interval is 2 W/m^2 on the left and 1 m/s on the right. The shading shows a 95% confidence level based on F-testing.

El Niño Outlook

- This report contains current condition of and outlook for ENSO,
- issued around 10th every month,
- provided through the TCC website.

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

El Niño Outlook

(January 2011 - July 2011)

Last Updated: **11 January 2011**

- **La Niña conditions are likely to persist during boreal winter and decay in boreal spring.**

[Pacific Ocean]

In December 2010, the SST deviation from a sliding 30-year mean SST averaged over the NINO.3 region was -1.5°C. The five-month running-mean value of the NINO.3 SST deviations was -1.4°C for October. The Southern Oscillation Index for December was +3.0 (Table and Fig.1). In December, negative SST anomalies prevailed over most of the equatorial Pacific, except near Indonesia (Fig.2 and Fig.4). Subsurface temperature anomalies were remarkably positive in the western equatorial Pacific, and were remarkably negative in the central and the eastern parts (Fig.3 and Fig.5). In the equatorial Pacific, convective activities in the western part and near the date line were below normal. Easterly wind anomalies in the lower troposphere prevailed in the western and the central equatorial Pacific (Fig.6, Fig.7 and Fig.8). The oceanic and atmospheric features mentioned above reflect La Niña conditions.

In the equatorial Pacific, persistent easterly anomalies in the lower troposphere maintained the negative subsurface temperature anomalies in the central and the eastern parts. The negative subsurface temperature anomalies will, in turn, keep SSTs below normal.

The JMA's El Niño prediction model predicts that the NINO.3 SST will be below normal during boreal winter, and will gradually become near normal during boreal spring, and will be near or above normal during boreal summer (Fig.9).

Considering all the above, La Niña conditions are likely to persist during boreal winter and decay in boreal spring.

It is likely that the SST in the NINO.WEST will be above normal during boreal winter, and will gradually become near normal during boreal spring and summer (Fig.10).

[Indian Ocean]

The SST averaged over the tropical Indian Ocean (IOBW) region became below normal in December (Fig.1). It is likely that the SST in the IOBW region will be below normal during boreal winter, and near or below normal during boreal spring and summer (Fig.11).

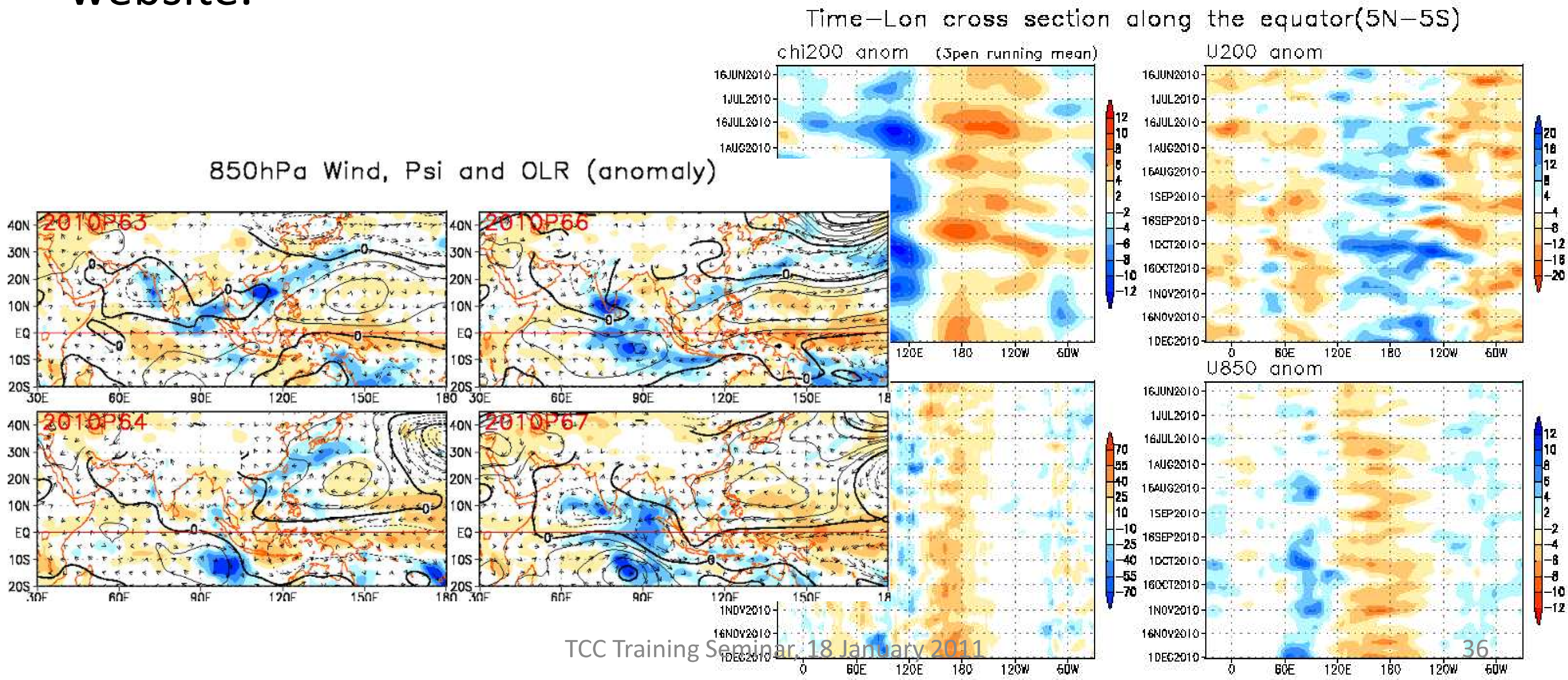
Asian Monsoon Monitoring

- This product contains a variety of analysis products (figures) to assess the current condition of climate system related to Asian,

- provided through the TCC website.

  http://ds.data.jma.go.jp/tcc/tcc/products/clisys/index.html

- In addition to this, ***MJO Monitoring*** is provided through the website.



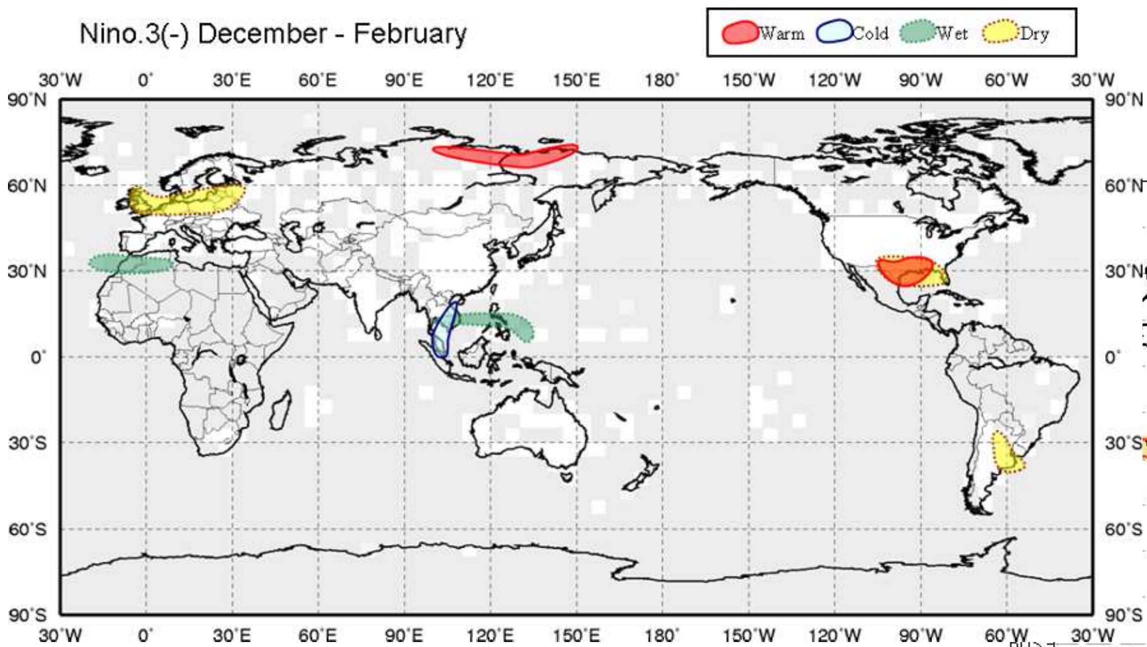
Statistical Research

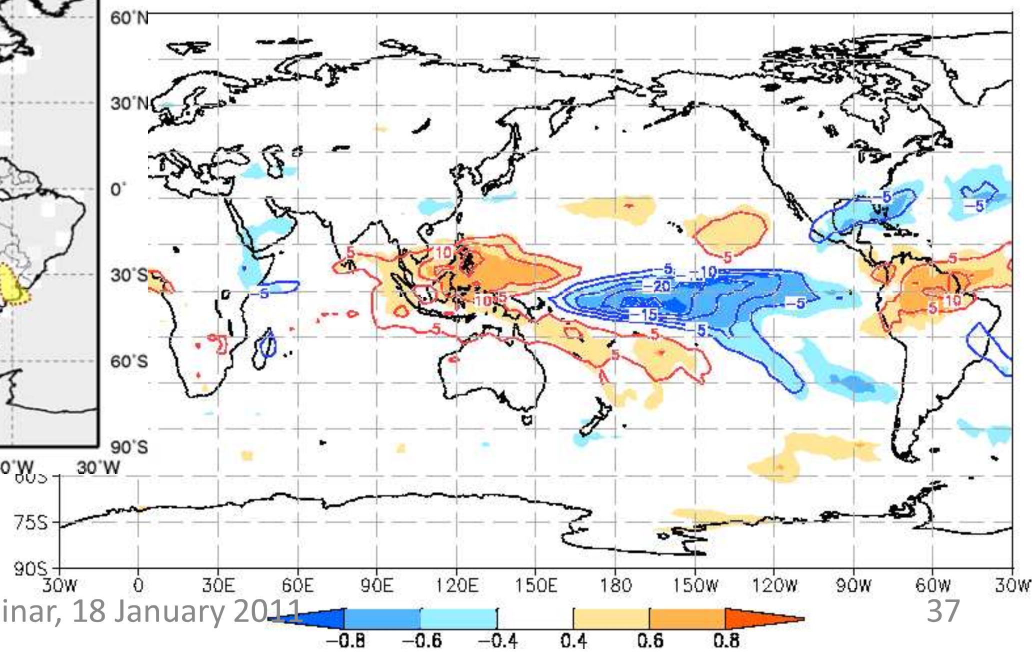
- Regression and correlation analysis between atmospheric circulation and major monitoring indices related to ENSO:

  http://ds.data.jma.go.jp/tcc/tcc/products/clisys/newoceanindex/index.html

- Composite maps of temperature and precipitation in El Nino/La Nina events:

  http://ds.data.jma.go.jp/tcc/tcc/products/climate/ENSO/index.htm

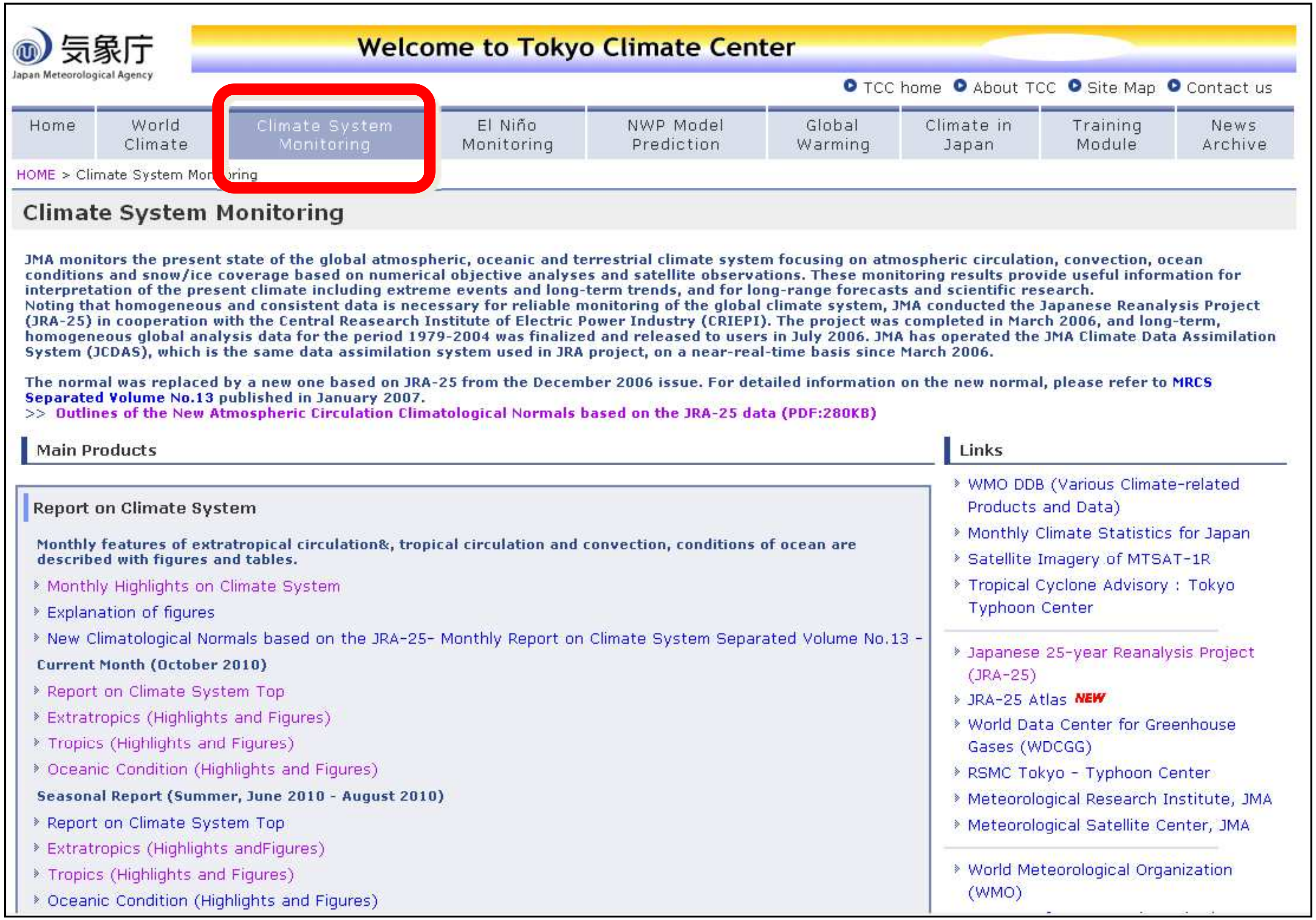




Climate System Monitoring page of the TCC website

- The JMA's climate system monitoring products are provided through the TCC website:

  http://ds.data.jma.go.jp/tcc/tcc/products/clisys/index.html



気象庁 Japan Meteorological Agency

Welcome to Tokyo Climate Center

TCC home | About TCC | Site Map | Contact us

Home | World Climate | Climate System Monitoring | El Niño Monitoring | NWP Model Prediction | Global Warming | Climate in Japan | Training Module | News Archive

HOME > Climate System Monitoring

Climate System Monitoring

JMA monitors the present state of the global atmospheric, oceanic and terrestrial climate system focusing on atmospheric circulation, convection, ocean conditions and snow/ice coverage based on numerical objective analyses and satellite observations. These monitoring results provide useful information for interpretation of the present climate including extreme events and long-term trends, and for long-range forecasts and scientific research.
Noting that homogeneous and consistent data is necessary for reliable monitoring of the global climate system, JMA conducted the Japanese Reanalysis Project (JRA-25) in cooperation with the Central Reasearch Institute of Electric Power Industry (CRIEPI). The project was completed in March 2006, and long-term, homogeneous global analysis data for the period 1979-2004 was finalized and released to users in July 2006. JMA has operated the JMA Climate Data Assimilation System (JCDAS), which is the same data assimilation system used in JRA project, on a near-real-time basis since March 2006.

The normal was replaced by a new one based on JRA-25 from the December 2006 issue. For detailed information on the new normal, please refer to MRCS Separated Volume No.13 published in January 2007.
>> Outlines of the New Atmospheric Circulation Climatological Normals based on the JRA-25 data (PDF:280KB)

Main Products

Report on Climate System

Monthly features of extratropical circulation&, tropical circulation and convection, conditions of ocean are described with figures and tables.

- Monthly Highlights on Climate System
- Explanation of figures
- New Climatological Normals based on the JRA-25- Monthly Report on Climate System Separated Volume No.13 -

Current Month (October 2010)

- Report on Climate System Top
- Extratropics (Highlights and Figures)
- Tropics (Highlights and Figures)
- Oceanic Condition (Highlights and Figures)

Seasonal Report (Summer, June 2010 - August 2010)

- Report on Climate System Top
- Extratropics (Highlights andFigures)
- Tropics (Highlights and Figures)
- Oceanic Condition (Highlights and Figures)

Links

- WMO DDB (Various Climate-related Products and Data)
- Monthly Climate Statistics for Japan
- Satellite Imagery of MTSAT-1R
- Tropical Cyclone Advisory : Tokyo Typhoon Center
- Japanese 25-year Reanalysis Project (JRA-25)
- JRA-25 Atlas NEW
- World Data Center for Greenhouse Gases (WDCGG)
- RSMC Tokyo - Typhoon Center
- Meteorological Research Institute, JMA
- Meteorological Satellite Center, JMA
- World Meteorological Organization (WMO)

Global Surface Climate Monitoring

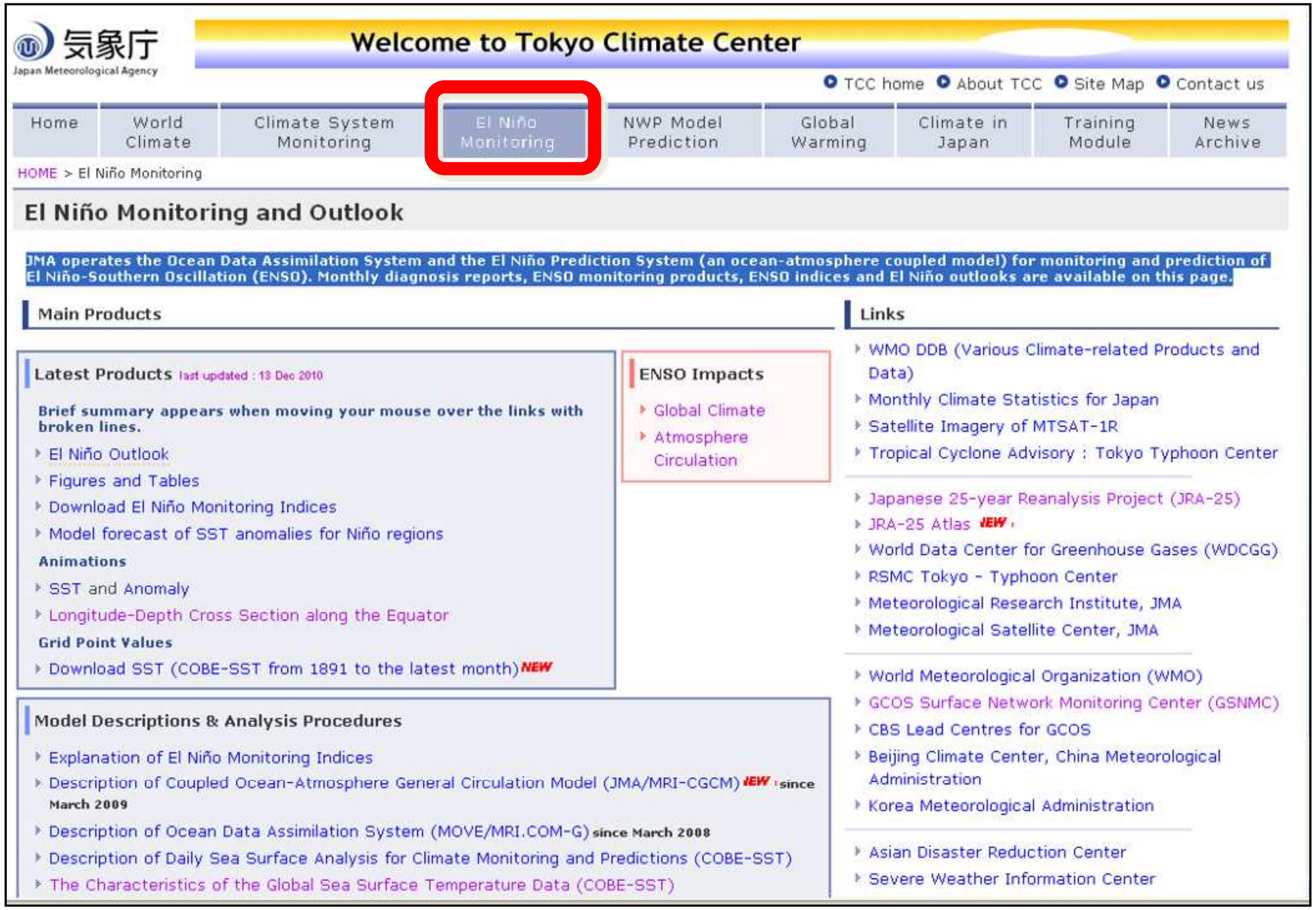
- Weekly, monthly and seasonal monitoring reports on extreme climate events with brief descriptions on disastrous events are available on the TCC website.

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

El Niño Monitoring

- Monthly diagnosis reports, ENSO monitoring products, ENSO indices and El Niño outlooks are available on the TCC website.

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



Go to Appendices

Appendix II

ITACS: Interactive Tool for Analysis of the Climate System

- Functions
- Example charts
- Available datasets
- How to apply for using the ITACS

ITACS : Interactive Tool for Analysis of the Climate System

What is the ITACS?

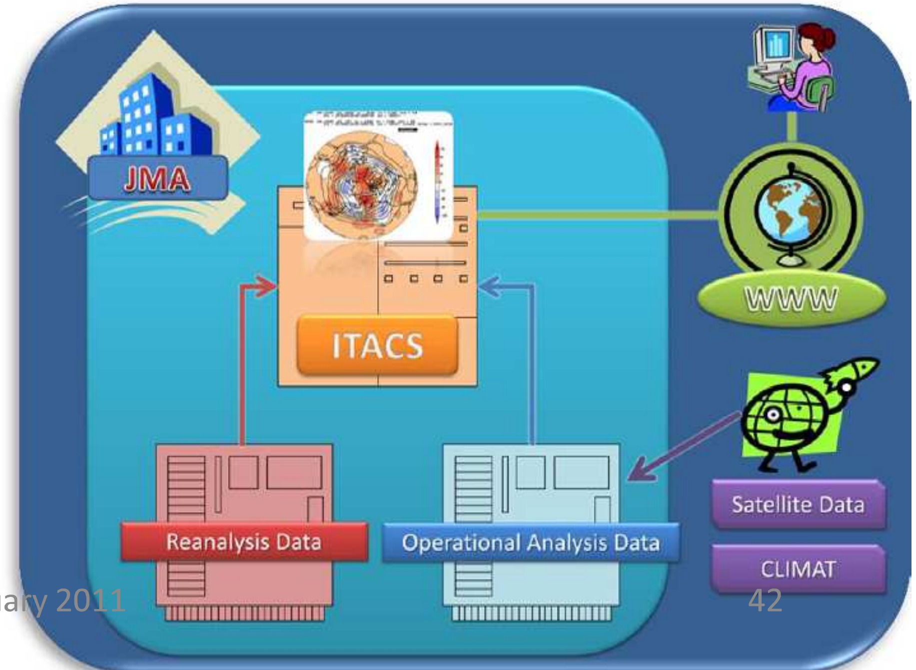
- A web-based application software with various data-sets developed by JMA

Supposed Users of the ITACS

- National Meteorological and Hydrological Services

Usefulness of the ITACS in …

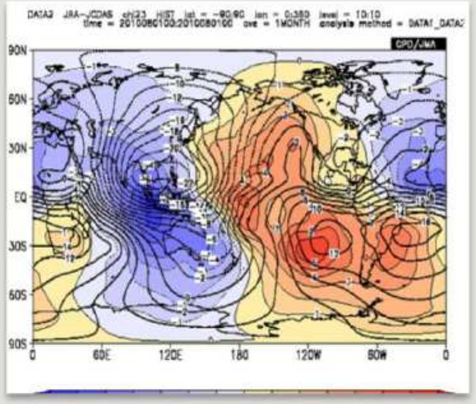
- Monitoring current climate status
- Investigating factors behind climatic condition



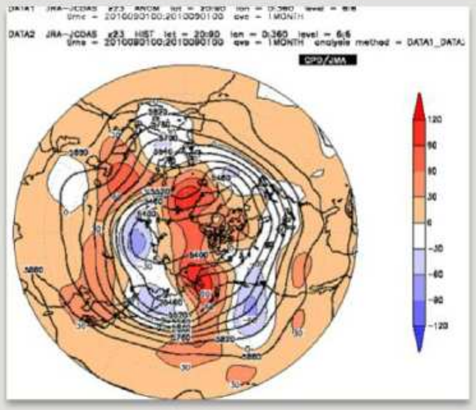
Features of the ITACS

Various Style Charts	Latitude-Longitude map, polar Stereographic map
	Vertical cross section, time-longitude(Latitude) cross section
	Time-series graph
Built-in Statistical Functions	Composite analysis, regression and correlation analysis, significance test
	EOF analysis, SVD analysis
	Fourier analysis, wavelet analysis
Programing Free	Only Internet-accessibility and a web-browser are required
	No Installation

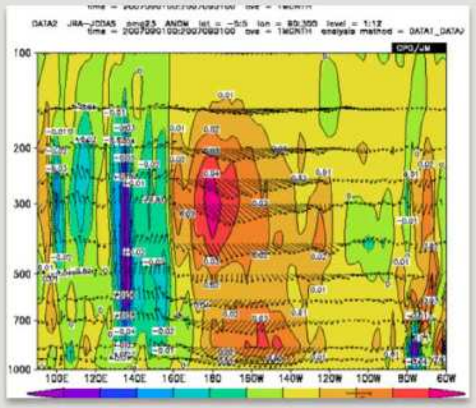
Example Charts



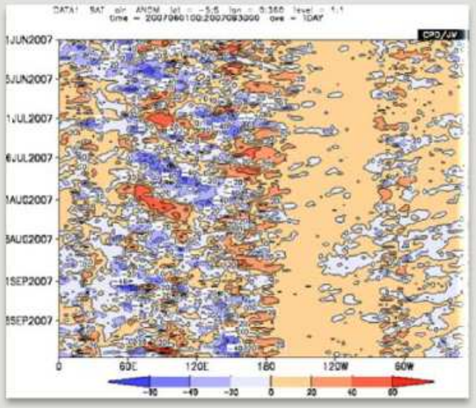
Latitude-Longitude Map



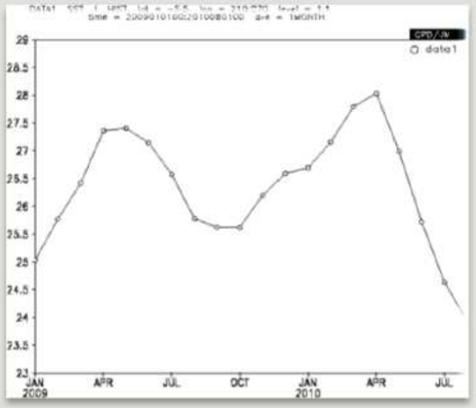
Polar Stereographic Map



Vertical Cross Section

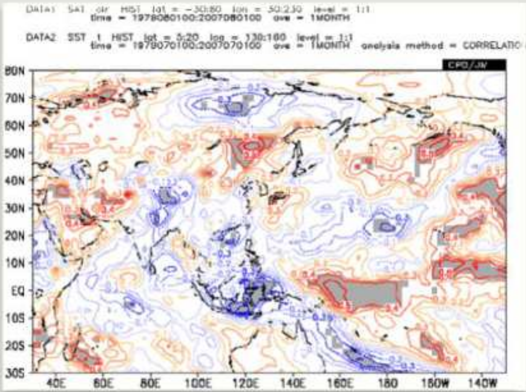


Time-Longitude Cross Section

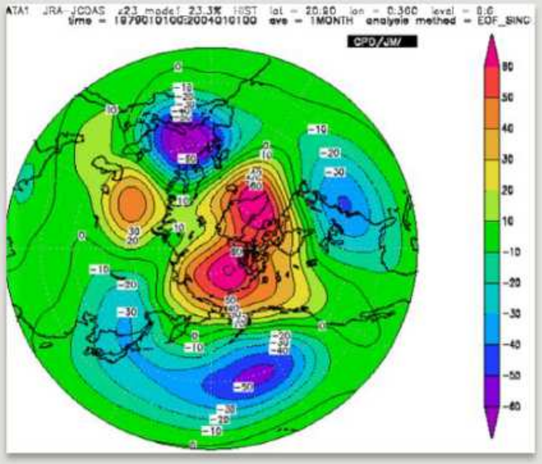


Time-Series Graph

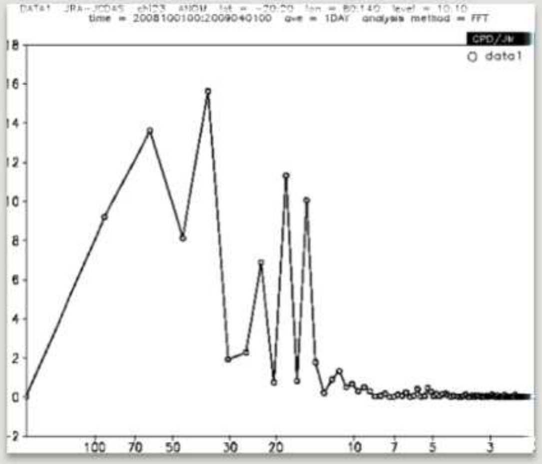
Examples of Statistical Analysis



A Correlation Analysis between SST over East of Philippines and OLR with one-monht Lag



An EOF Analysis on 500hPa Height



A Fourier Analysis on Area-Averaged 200hPa Stream Function

Available Datasets

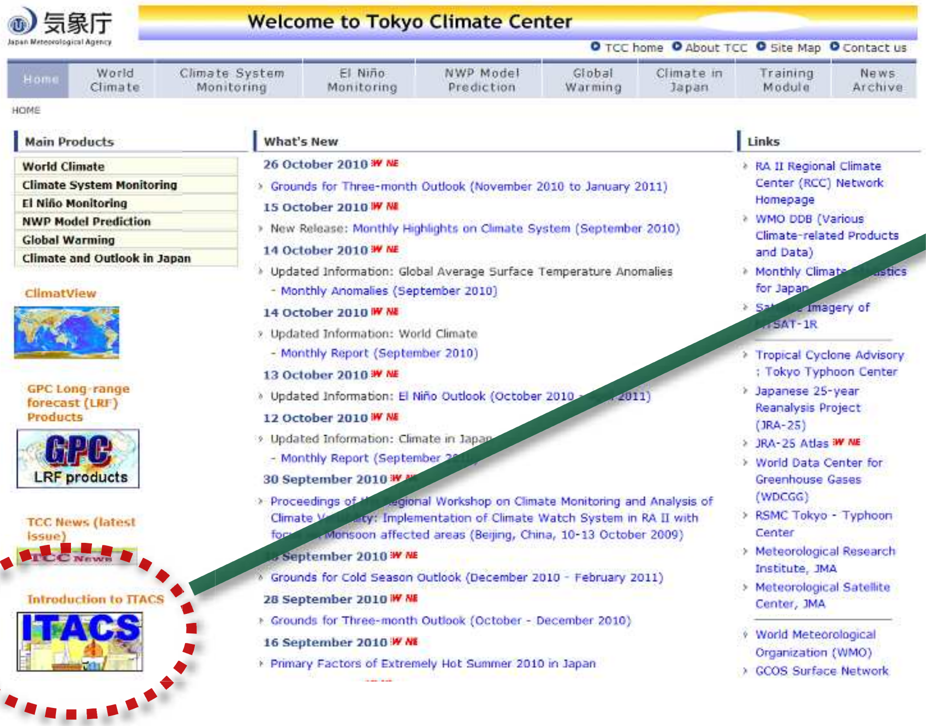
Dataset	Data Description
JRA/JCDAS	Atmospheric Circulation Data by Climate Data Assimilation System of JMA Period for normal : 1979-2004 http://jra.kishou.go.jp/JRA-25/index_en.html
SAT	Outgoing Longwave Radiation (OLR) Derived from observations by polar orbital satellites of NOAA Provided by CPC/NCEP/NOAA Period for normal : 1979-2004
ODAS	Oceanic Circulation Data by Ocean Data Assimilation System of JMA Period for normal : 1987-2006
SST	Sea Surface Temperature Analysis for Climate Monitoring by JMA Period for normal : 1971-2000 http://ds.data.jma.go.jp/tcc/tcc/products/elnino/cobesst_doc.html
INDEX	El Niño Monitoring Indices calculated from monthly Sea Surface Temperature Period for normal : 1971-2000 http://ds.data.jma.go.jp/tcc/tcc/products/elnino/index/Readme.txt
CLIMAT	Monthly World Climate Data from CLIMAT CLIMAT : Messages via the GTS line from WMO members Period for normal : Temperature and Precipitation ,1971-2000 Other elements, 1961-1990 http://ds.data.jma.go.jp/tcc/tcc/products/elnino/index/Readme.txt

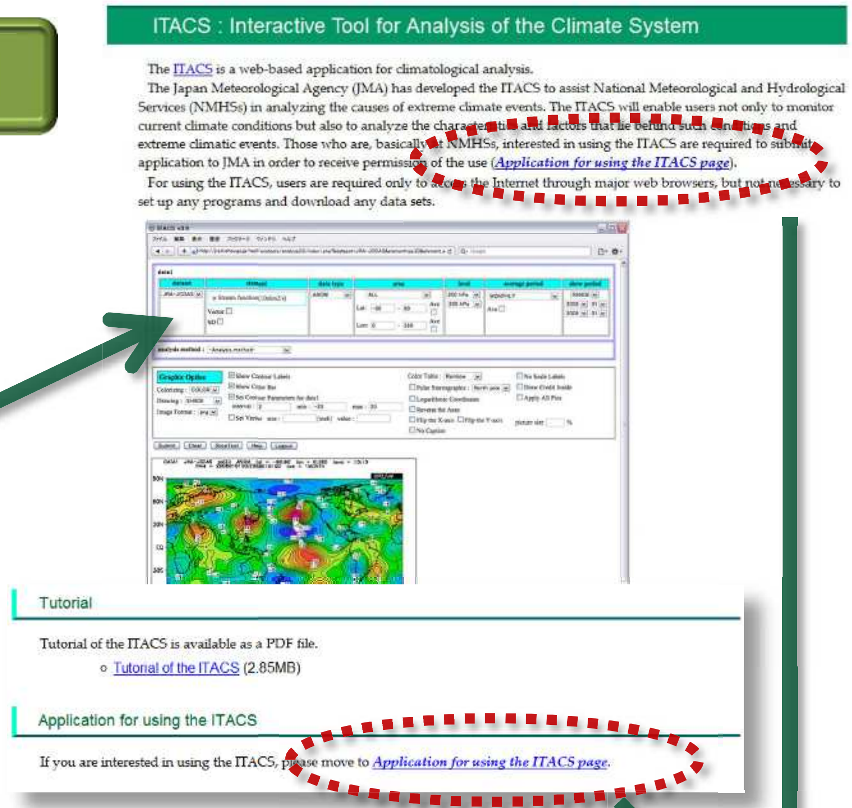
How to obtain an account of the ITACS (1)

Access to the web site of Tokyo Climate Center

Go to the Introduction page of the ITACS

URL http://ds.data.jma.go.jp/tcc/tcc/index.html





Go to the Application Page (next slide)

How to obtain an account of the ITACS (2)

Read Conditions of Use
and, if agree, click "Accept" button

Fill Required Information and
Submit (click "OK")

Application for using the ITACS

Please read the *Conditions of Use* outlined below before applying to JMA to use the ***Interactive Tool for Analysis of the Climate System*** (ITACS). The Japan Meteorological Agency (JMA) will examine applications and, if the application is accepted, issue ID and password.

JMA permits persons at National Meteorological and Hydrological Services to use the ITACS.

Conditions of Use

1. Users should provide user information including name, affiliation, e-mail address and purpose of data use.
2. The use of figures and/or data produced by ITACS for commercial purposes is prohibited.
3. Users should not let any third party use the ID/password information issued, and should keep this information private at all times.
4. The use of ITACS should be duly acknowledged in scientific or techn… …eleases or other communications.
   Sample of citation:
   - The figures and statistical analysis in this … Meteorological Agency.

…ent of inappropriate use, e.g., if a user causes excessive server
The data source used in ITACS should … , the Japan Meteorological Agency will disable the offending ID.
…ublications, press re… …used for more than one year. Those wishing to reactivate IDs should

Disclaimer

Please note that although JMA has taken the utmost care in creating the functions of ITACS, it assumes no responsibility regarding the system's reliability. JMA accepts no responsibility for any damage that may result from the use of ITACS.

JMA reserves the right to change or delete information on this site without prior notice. JMA accepts no responsibility for any inconvenience that may result from such changes or deletion.

Accept | Decline

ITACS User Application

Please fill in the following blanks in English.

Name:(Full name)

Affiliation: Please write an organization name in detail.
(e.g. Climate Prediction Division, Japan Meteorological Agency)
(If you are a retirant or resigned person, please write your former affiliation like former XXXX.)

Address of affiliation: (Country only. e.g. Japan, USA, UK, ... etc.)

E-mail address:
(A specific domain name of your affiliation is required.)

Purpose of use:
Simply giving "study" or "research" is not a acceptable.
(e.g. Reseach of activities of East Asian summer monsoon)

OK

A guidance mail will be sent to the applied address within a few days.

Acceptable characters are followings

```
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
0123456789
;/?:@=+$,-_.!~*( )%
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