Tokyo Climate Center, Japan Meteorological Agency

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El Niño Outlook (October 2011 – April 2012)

It is more likely than not that La Niña conditions will develop during the Northern Hemisphere autumn and winter.

El Niño/La Niña

The La Niña event that began in the Northern Hemisphere summer 2010 ended in spring 2011. Recently, ENSO-neutral conditions have persisted during the Northern Hemisphere summer.

In September 2011, the NINO.3 SST deviation was -0.6°C, and SSTs in the central-eastern equatorial Pacific were below normal (Figures 1 and 3 (a)). Positive subsurface temperature anomalies were seen in the western equatorial Pacific, while negative ones were seen in the central-eastern part (Figures 2 and 3 (b)). In the atmosphere over the equatorial Pacific, convective activity was above normal in the western part, and easterly wind anomalies in the lower troposphere were seen over the western-central part. These oceanic and atmospheric characteristics were similar to those of La Niña conditions. According to JMA's El Niño prediction model, the NINO.3 SST will be near normal throughout the prediction period (Figure 4). However, the predicted NINO.3 SST deviation for the Northern Hemisphere autumn and at the beginning of winter was lower than the prediction of the previous month, and the observed value in September (-0.6°C) was near the lower bound of the previous month's prediction.

The above observations and the model prediction suggest it is more likely than not that La Niña conditions will develop during the Northern Hemisphere autumn and winter.

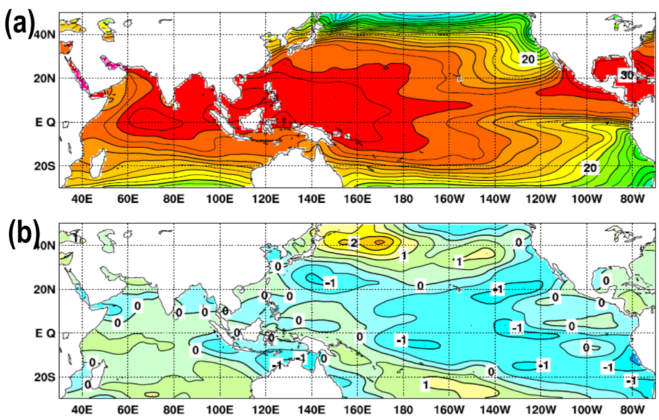


Figure 1 Monthly mean (a) sea surface temperatures (SSTs) and (b) SST anomalies in the Indian and Pacific Ocean areas for September 2011

The contour intervals are 1˚C in (a) and 0.5˚C in (b). The base period for the normal is 1981 – 2010.

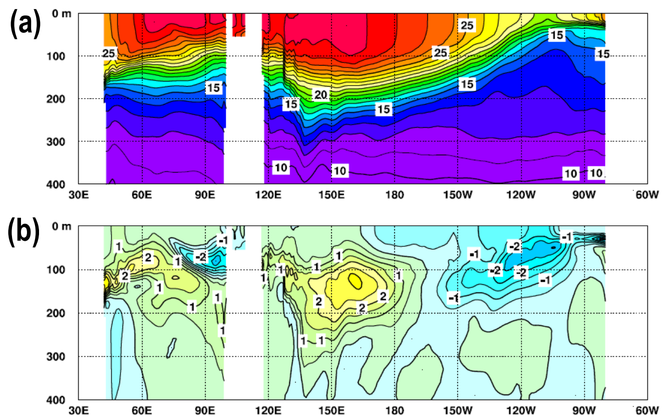


Figure 2 Monthly mean depth-longitude cross sections of (a) temperature and (b) temperature anomalies in the equatorial Indian and Pacific Ocean areas for September 2011

The contour intervals are 1˚C in (a) and 0.5˚C in (b). The base period for the normal is 1981 – 2010.

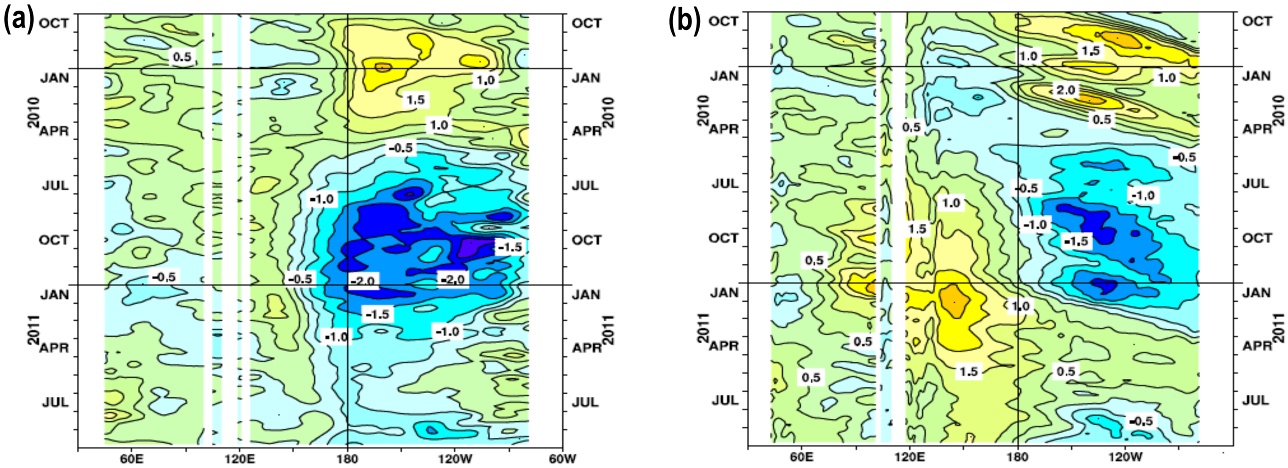


Figure 3 Time-longitude cross sections of (a) SST and (b) ocean heat content (OHC) anomalies along the equator in the Indian and Pacific Ocean areas
OHCs are defined here as vertical averaged temperatures in the top 300 m. The base period for the normal is 1981 – 2010.

<u>**Western Pacific and Indian Ocean**</u>

The SST in the tropical western Pacific (NINO.WEST) region was below normal in September. It is likely that the NINO.WEST SST will become near normal in the months ahead, and that near-normal SST conditions will continue until the Northern Hemisphere winter.

The SST in the tropical Indian Ocean (IOBW) region was near normal in September. It is likely that the IOBW SST will be near normal during the prediction period.

(Ichiro Ishikawa, Climate Prediction Division)

* The SST normals for the NINO.WEST region (Eq. – 15°N, 130°E – 150°E) and the IOBW region (20°S – 20°N, 40°E – 100°E) are defined as linear extrapolations with respect to a sliding 30-year period in order to remove the effects of long-term trends.

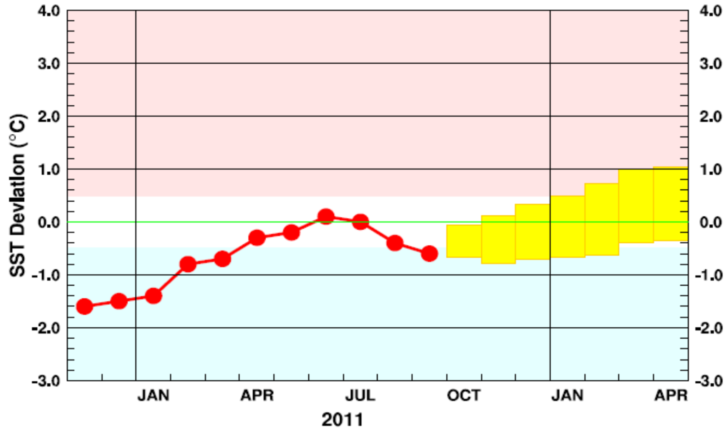


Figure 4 Outlook of NINO.3 SST deviation produced by the El Niño prediction model
This figure shows a time series of monthly NINO.3 SST deviations. The thick line with closed circles shows observed SST deviations, and the boxes show the values produced for the next six months by the El Niño prediction model. Each box denotes the range into which the SST deviation is expected to fall with a probability of 70%.

JMA's Seasonal Numerical Ensemble Prediction for Winter 2011/2012

According to JMA's seasonal ensemble prediction system, active convection from the tropical western Pacific to the tropical Indian Ocean and inactive convection from the central to the eastern part of the tropical Pacific are expected. In association with active convection from the tropical western Pacific to the tropical Indian Ocean, negative anomalies at 500hPa geopotential height are widely predicted over the southern part of the Eurasian Continent. Conversely, in relation to inactive convection from the central to the eastern part of the tropical Pacific, the Aleutian Low is expected to be weaker than normal, suggesting that the northwesterly winter monsoon will be weaker than normal in Northeast Asia.

1. Introduction

This article outlines JMA's dynamical seasonal ensemble prediction for winter 2011/2012 (December 2011 – February 2012, referred to as DJF), which was used as a basis for the Agency's operational cold-season outlook issued on 24 November, 2011. The prediction shown here is based on the seasonal ensemble prediction system of the Atmosphere-Ocean General Circulation Model (AOGCM). Please refer to the column for details of this system.

Section 2 outlines global SST anomaly predictions, and Section 3 describes the circulation fields expected over the tropics and sub-tropics in association with these anomalies. Finally, the circulation fields predicted for the mid- and high latitudes of the Northern Hemisphere are explained in Section 4.

2. SST anomalies (Figure 5)

Figure 5 shows predicted SSTs and their anomalies for DJF. Negative SST anomalies are expected widely in the tropical and subtropical middle and eastern Pacific, indicating La Niña conditions. The current La Niña conditions are expected to decay in the winter-spring season (see also El Niño Outlook in this issue). Meanwhile, positive SST anomalies are predicted from the tropical western Pacific to the tropical Indian Ocean.

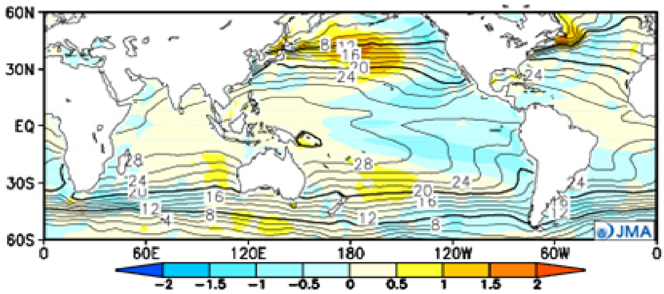


Figure 5 Predicted SSTs (contours) and SST anomalies (shading) for December 2011 – February 2012 (ensemble mean of 51 members)

3. Prediction for the tropics and sub-tropics (Figure 6)

Precipitation (Figure 6 (a)) is expected to be above normal from the western tropical Pacific to the Arabian Sea and the western part of the tropical Indian Ocean, and below normal from the central to the eastern part of the tropical Pacific.

Velocity potential in the upper troposphere (200 hPa) (Figure 6 (b)) is expected to be negative (i.e., more divergent) from the tropical western Pacific to the tropical Indian Ocean, while positive (i.e., more convergent) anomalies are predicted from the central to the eastern part of the tropical Pacific, reflecting precipitation anomaly patterns in the tropics.

It is predicted that the 200-hPa stream function (Figure 6 (c)) will be positive (i.e., anti-cyclonic) over South Asia in association with active convection over the tropical Indian Ocean. This suggests that the sub-tropical jet will tend to shift northward over South Asia and southward over East Asia. Negative (i.e., cyclonic) anomalies of the 200-hPa stream function are predicted over the subtropical North Pacific associated with inactive convection from the central to the eastern part of the tropical Pacific.

It is predicted that the 850-hPa stream function (Figure 6 (d)) will be negative over the northern Indian Ocean in association with active convection over the Indian Ocean. Positive anomalies of the 850-hPa stream function are predicted over the North Pacific in association with inactive convection from the central to the eastern part of the tropical Pacific.

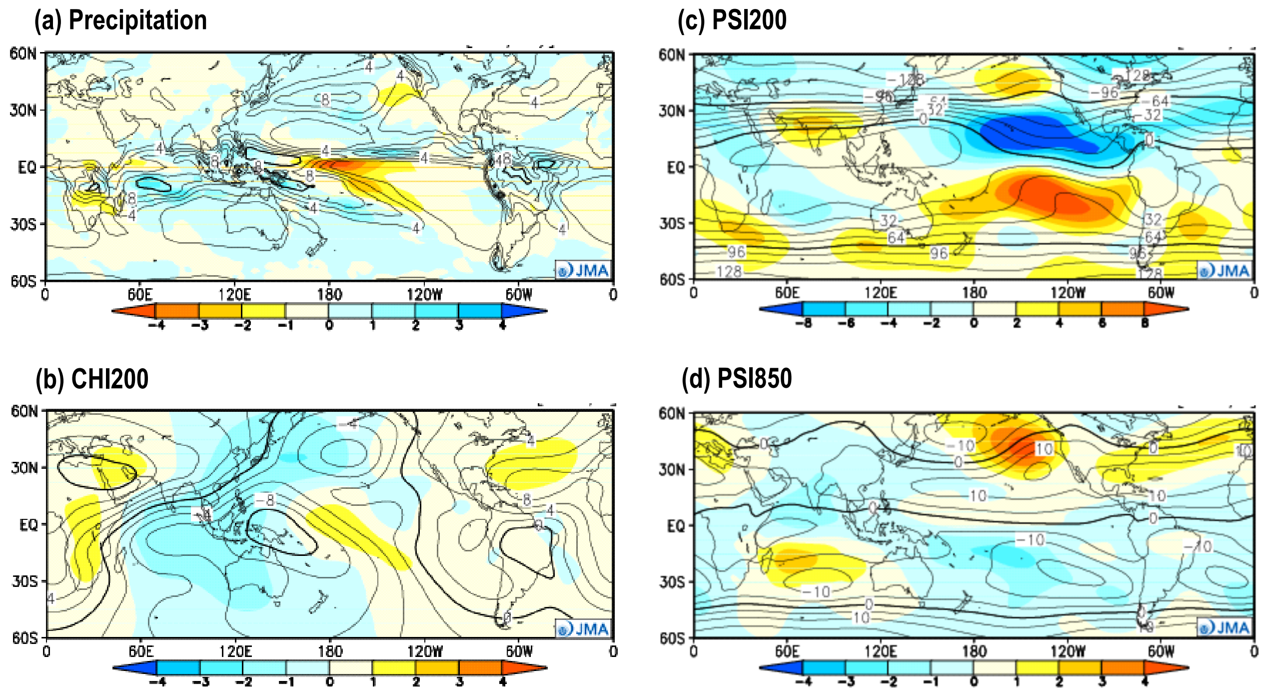


Figure 6 Predicted atmospheric fields from 60°N – 60°S for December 2011 – February 2012 (ensemble mean of 51 members)

(a) Precipitation (contours) and anomaly (shading). The contour interval is 2 mm/day.
(b) Velocity potential at 200 hPa (contours) and anomaly (shading). The contour interval is 2×10^6 m^2/s.
(c) Stream function at 200 hPa (contours) and anomaly (shading). The contour interval is 16×10^6 m^2/s.
(d) Stream function at 850 hPa (contours) and anomaly (shading). The contour interval is 5×10^6 m^2/s.

4. Prediction in the mid- and high latitudes of the Northern Hemisphere (Figure 7)

Positive anomalies of sea level pressure (SLP) and 500-hPa geopotential height are predicted in the North Pacific, suggesting that the Aleutian Low will be weaker than normal. This indicates that the northwesterly winter monsoon over Northeast Asia will also be weaker than normal, while it will be stronger than normal over East Asia, reflecting upper anti-cyclonic anomalies over South Asia (Figure 6 (c)). Negative anomalies of 500-hPa geopotential height (Figure 7b) are widely expected over the southern part of the Eurasian Continent, and this might be attributable to negative anomalies of the 850-hPa stream function over the northern Indian Ocean (Figure 6 (d)), reflecting active convection (Figures 6 (a) and 6 (b)).

(Masayuki Hirai, Climate Prediction Division)

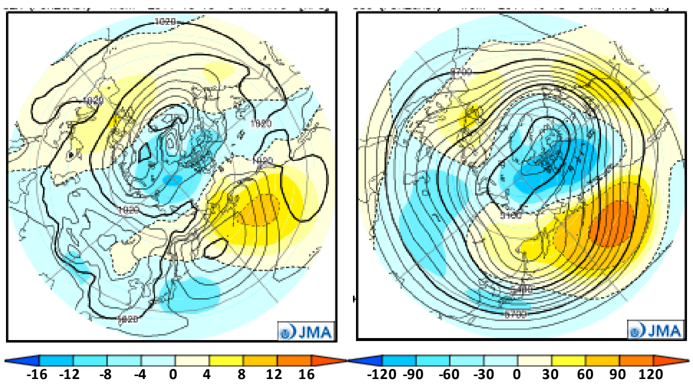


Figure 7 Predicted atmospheric fields from 20°N – 90°N for December 2011 – February 2012 (ensemble mean of 51 members)
(a) Sea level pressure (contours) and anomaly (shaded). The contour interval is 4 hPa.
(b) 500-hPa height (contours) and anomaly (shaded). The contour interval is 60 m.

JMA's Seasonal Ensemble Prediction System

JMA operates a seasonal Ensemble Prediction System (EPS) using the Atmosphere-Ocean General Circulation Model (AOGCM) to make seasonal predictions beyond a one-month time range. The EPS produces perturbed initial conditions by means of a combination of the initial perturbation method and the lagged average forecasting (LAF) method. The prediction consists of 51 members from the latest 6 initial dates (9 members are run every 5 days). Details of the prediction system and verification maps based on 30-year hindcast experiments (1979 – 2008) are available at http://ds.data.jma.go.jp/tcc/tcc/products/model/.

Cold-Season Outlook for Winter 2011/2012 in Japan

For winter 2011/2012, mean temperatures are likely to be above or near normal in northern Japan, and below or near normal in Okinawa and Amami. Cold-season precipitation amounts are likely to be above or near normal on the Pacific side of northern Japan, and below or near normal in Okinawa and Amami.

1. Outlook summary

JMA issued its outlook for the coming winter over Japan in September, and updated it in October. For winter 2011/2012, mean temperatures are predicted to be near or above normal (both with 40% probability) in northern Japan, and near or below normal (both with 40% probability) in Okinawa/Amami.

Cold-season total precipitation is predicted to be near or above normal (both with 40% probability) on the Pacific side of northern Japan, and near or below normal (both with 40% probability) in Okinawa/Amami.

The outlook for cold-season snowfall on the Sea of Japan side of the country shows no significant characteristics.

Category	-	0	+
Northern Japan	20	40	40
Eastern Japan	30	40	30
Western Japan	30	40	30
Okinawa and Amami	40	40	20

(Category ー: below normal, 0 : normal, + : above normal, Unit : %)

Figure 8 Outlook for winter 2011/2012 temperature probability in Japan

2. Outlook background

In September 2011, the NINO.3 SST deviation from a sliding 30-year mean SST was -0.6°C. The five-month running-mean of NINO.3 SST deviations was -0.2°C for July. The Southern Oscillation Index for August was +1.1. These oceanic and atmospheric characteristics were similar to those of La Niña conditions.

According to JMA's El Niño prediction model, the NINO.3 SST will be near normal throughout the prediction period. However, the predicted NINO.3 SST deviation for boreal autumn and the beginning of winter is lower than the prediction of the previous month, and the observed value in September (-0.6°C) was near the lower boundary of the previous month's prediction.

The above results suggest it is more likely than not that La Niña conditions will develop during autumn and winter in the Northern Hemisphere.

Negative SST anomalies are predicted widely in the tropical and subtropical middle and eastern Pacific, while positive anomalies are predicted in the tropical western Pacific and in the tropical Indian Ocean. In relation to this, weak and strong convective activities are predicted in the former and latter areas, respectively.

In relation to the characteristic of convective activity in the middle and eastern Pacific, it is predicted that the 500-hPa geopotential height will be significantly higher than normal in the northeastern Pacific, and that the Aleutian Low will be weaker than normal, suggesting that the northwesterly winter monsoon will be weak over the northern part of Japan.

Conversely, in association with predicted active convection in the tropical western Pacific and the tropical Indian Ocean, an anti-cyclonic circulation anomaly in the upper troposphere (200 hPa) is predicted over South Asia, and the subtropical jet stream is predicted to shift northward over the Asian Continent and southward over Japan, suggesting a strong winter monsoon around the southern part of the country.

The tropospheric thickness temperature averaged over the mid-latitudes of the Northern Hemisphere (30°N – 50°N), which is positively correlated with temperatures over Japan, is predicted to be above normal during this boreal winter.

In the mid- and high latitudes, a neutral phase of the Arctic Oscillation (AO) is predicted. The positive (negative) phase of AO tends to cause weak (strong) winter monsoons and above-normal (below-normal) temperatures in northern Japan. However, the spread among ensemble members is large, and the hindcast (30 years from 1979 to 2008) suggests that the model does not have a sufficient level of skill to predict the AO. Accordingly, there is no specific prediction on the strength of the winter monsoon.

(Koji Ishihara, Climate Prediction Division)

Category		-	0	+
Northern Japan	Sea of Japan side	30	40	30
	Pacific side	20	40	40
Eastern Japan	Sea of Japan side	30	40	30
	Pacific side	30	40	30
Western Japan	Sea of Japan side	30	40	30
	Pacific side	30	40	30
Okinawa and Amami		40	40	20

(Category －: below normal, 0 : normal, + : above normal, Unit : %)

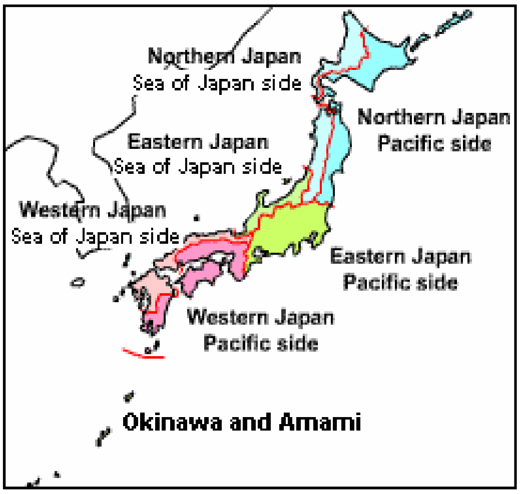


Figure 9 Outlook for winter 2011/2012 precipitation probability in Japan

Summary of the 2011 Asian Summer Monsoon

1. Monsoon activity and atmospheric circulation

Convective activity (inferred from outgoing longwave radiation (OLR)) was enhanced over southern Pakistan, the eastern Arabian Sea, the Bay of Bengal, the Indochina Peninsula, the Philippines and the western Pacific, while it was suppressed over the eastern Indian Ocean and Indonesia (Figure 10). In the upper troposphere, the Tibetan High was pronounced over a broad area (Figure 11 (a)). In the lower troposphere, a prominent monsoon trough was observed stretching from northern India to the Philippines, and westerly/southwesterly winds were stronger than normal over a large area from the Arabian Sea to the Philippines (Figure 11 (b)). These characteristics of convective activity and atmospheric circulation indicate that the Asian summer monsoon was active.

From May to August, equatorial intraseasonal oscillations were observed propagating eastward with a period of less than 30 days (Figure 12). The areas of active convection originally enhanced by these oscillations were seen to propagate northward around India and east of the Philippines (Figure 13). In October, the active phase of a large-amplitude Madden-Julian Oscillation (MJO) propagated eastward from northern South America to the Indian

Ocean (Figure 12), and convective activity over the western Pacific, which tended to be enhanced until September, was suppressed.

(Shotaro Tanaka, Climate Prediction Division)

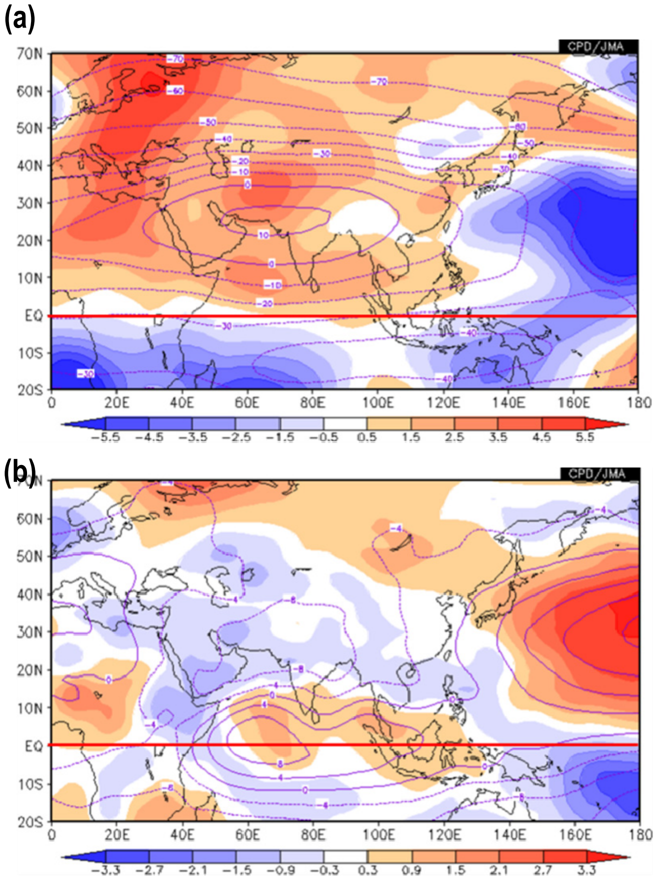


Figure 11 Four-month mean stream function and its anomaly for June – September 2010

(a) The contours indicate the 200-hPa stream function at intervals of 10 × 10^6 m^2/s, and the color shading indicates 200-hPa stream function anomalies from the normal. (b) The contours indicate the 850-hPa stream function at intervals of 4 × 10^6 m^2/s, and the color shading indicates 850-hPa stream function anomalies from the normal. The base period for the normal is 1981 – 2010. In the Northern (Southern) Hemisphere, warm (cold) shading denotes anticyclonic (cyclonic) circulation anomalies.

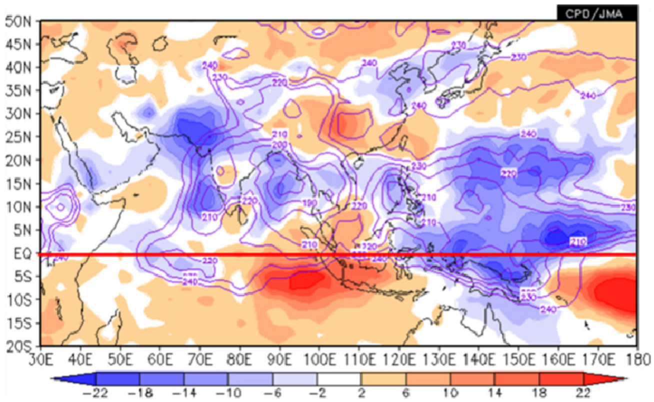


Figure 10 Four-month mean outgoing longwave radiation (OLR) and its anomaly for June – September 2011

The contours indicate OLR at intervals of 10 W/m^2, and the color shading denotes OLR anomalies from the normal (i.e., the 1981 – 2010 average). Negative (cold color) and positive (warm color) OLR anomalies show enhanced and suppressed convection compared to the normal, respectively. Original data provided by NOAA.

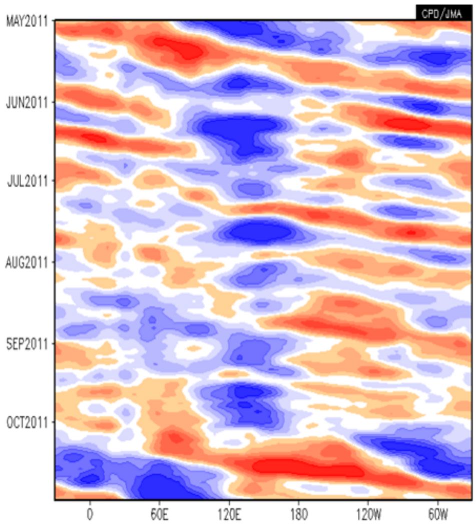


Figure 12 Time-longitude cross section of five-day running mean 200-hPa velocity potential anomaly from May to October 2011 (5ºS – 5ºN mean)

The shading denotes 200-hPa velocity potential anomalies (x 10^6 m^2/s) from the normal (i.e., the 1981 – 2010 average). The cold (warm) shading indicates large-scale divergence (convergence) anomalies.

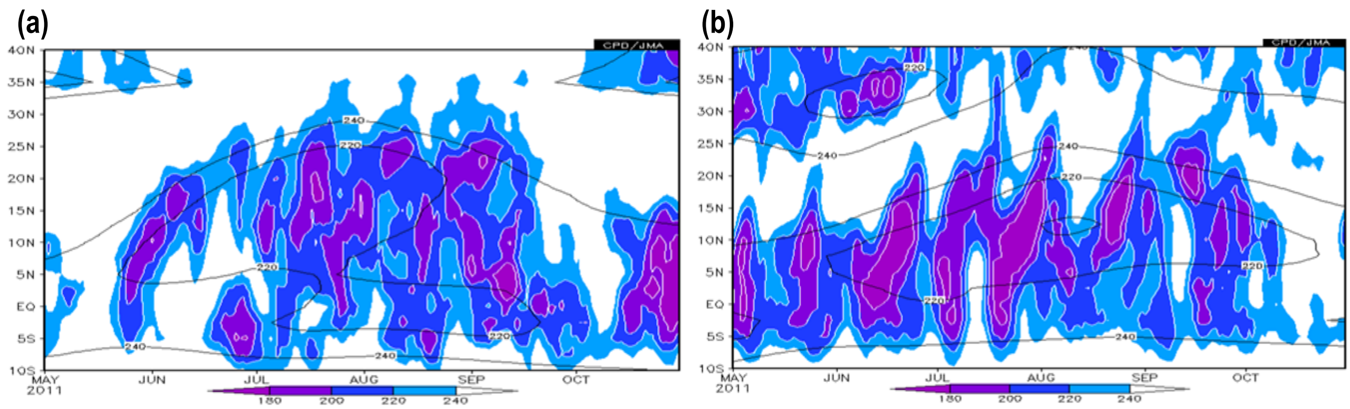


Figure 13 Latitude-time cross section of five-day running mean OLR from May to October 2011 ((a) India (65º – 85ºE mean), (b) area east of the Philippines (125º – 145ºE mean))

The thick black lines indicate the climatological mean OLR (W/m^2) for the period from 1981 to 2010, and the shading denotes the OLR for 2011.

2. Precipitation and temperature

Four-month total precipitation amounts based on CLIMAT reports during the monsoon season (June – September) were above 200% of the normal around southern Pakistan, and below 60% of the normal around Java Island (Figure 14). They were mostly consistent with the distribution of OLR anomalies (Figure 10).

Four-month mean temperatures for the same period were higher than normal from Pakistan to northern China, around southern China and around Japan, and lower than normal around northern India, in most parts of the Indochina Peninsula and in eastern China (Figure 15).

It was reported that heavy rains caused at least 175 fatalities in southern China in June, and more than 70 fatalities in Korea from 26 July to 29 July. Floods that began in August are also reported to have caused more than 460 fatalities in Sindh, Pakistan.

Precipitation over the Indochina Peninsula continued to be above normal from June to September, causing floods over a wide area in the Chao Phraya River and Mekong River basins. This flooding caused serious damage over the Indochina Peninsula, especially in Thailand.

3. Tropical cyclones

During the monsoon season, 17 tropical cyclones (TCs) of tropical storm (TS) intensity or higher formed over the western North Pacific (Table 1). The number of formations was almost the same as the 1981 – 2010 average of 16.0. A total of 7 of the 17 TCs passed around the South China Sea and approached or hit southern China or Vietnam. Three of them hit the main islands of Japan.

Severe tropical storm Nock-ten caused more than 70 fatalities and Typhoon Nesat caused more than 80 fatalities in the Philippines. Severe Tropical Storm Talas caused 78 fatalities and Typhoon Roke caused 17 fatalities in Japan (as of 2 November 2011).

Note: Disaster information is based on reports by governmental organizations (China, Korea, the Philippines and Japan) and UN organizations (IRIN).

(Hitomi Saitou, Climate Prediction Division)

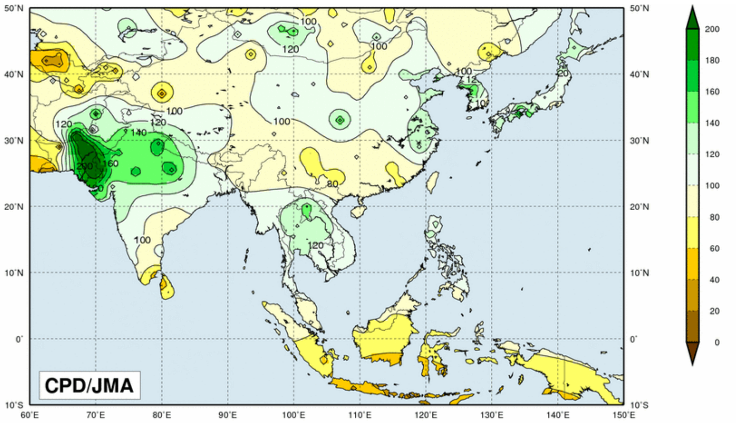


Figure 14 Four-month precipitation ratios (%) from June to September 2011

The base period for the normal is 1981 – 2010.

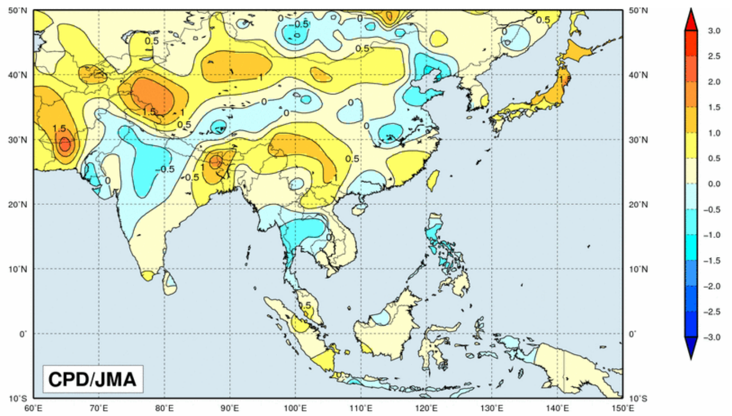


Figure 15 Four-month mean temperature anomalies (°C) from June to September 2011

The base period for the normal is 1981 – 2010.

Table 1 Tropical cyclones forming over the western North Pacific from June to September 2011

Number ID	Name	Date (UTC)	Category[1)]	Maximum wind[2)] (knots)
T1103	Sarika	6/9 – 6/11	TS	40
T1104	Haima	6/21 – 6/24	TS	40
T1105	Meari	6/22 – 6/27	STS	60
T1106	Ma-on	7/12 – 7/24	TY	95
T1107	Tokage	7/15 – 7/15	TS	35
T1108	Nock-ten	7/26 – 7/30	STS	50
T1109	Muifa	7/28 – 8/8	TY	95
T1110	Merbok	8/3 – 8/9	STS	50
T1111	Nanmadol	8/23 – 8/30	TY	100
T1112	Talas	8/25 – 9/5	STS	50
T1113	Noru	9/3 – 9/6	TS	40
T1114	Kulap	9/7 – 9/8	TS	35
T1115	Roke	9/13 – 9/22	TY	85
T1116	Sonca	9/15 – 9/20	TY	70
T1117	Nesat	9/24 – 9/30	TY	80
T1118	Haitang	9/25 – 9/26	TS	35
T1119	Nalgae	9/27 – 10/4	TY	95

Note: Based on information from the RSMC Tokyo-Typhoon Center.
1) Intensity classification for tropical cyclones
TS: tropical storm, STS: severe tropical storm, TY: typhoon
2) Estimated maximum 10-minute mean wind

Status of the Antarctic Ozone Hole in 2011

The Antarctic ozone hole developed significantly in 2011, as in previous years.

The Antarctic ozone hole has appeared for the last 30 years from late winter to early summer (August – December), peaking in September or early October. Its scale is generally represented by the area in which the total ozone column is equal to or less than 220 m atm-cm.

According to JMA's analysis of Aura OMI data, the ozone hole in 2011 appeared in August and expanded to reach a maximum area of 25.5 million km^2 on 12 September. This was 1.8 times as large as the Antarctic Continent (Figure 16 (upper left)), and was almost the same as the average size of 25.2 million km^2 seen over the last ten years. The size of the annual maximum ozone hole area is still large from a long-term point of view (Figure 16 (upper right)). The five spherical images in Figure 16 (bottom) indicate total ozone column distributions in the Southern Hemisphere, with the ozone hole shown in gray.

Antarctic ozone is expected to return to pre-1980 levels in the late 21st century according to *WMO/UNEP Scientific Assessment of Ozone Depletion: 2010*. It is necessary to continue close observation of the ozone layer in order to assess its recovery and the shrinkage of the ozone hole.

(Masaki Adachi, Ozone Layer Monitoring Office, Atmospheric Environment Division)

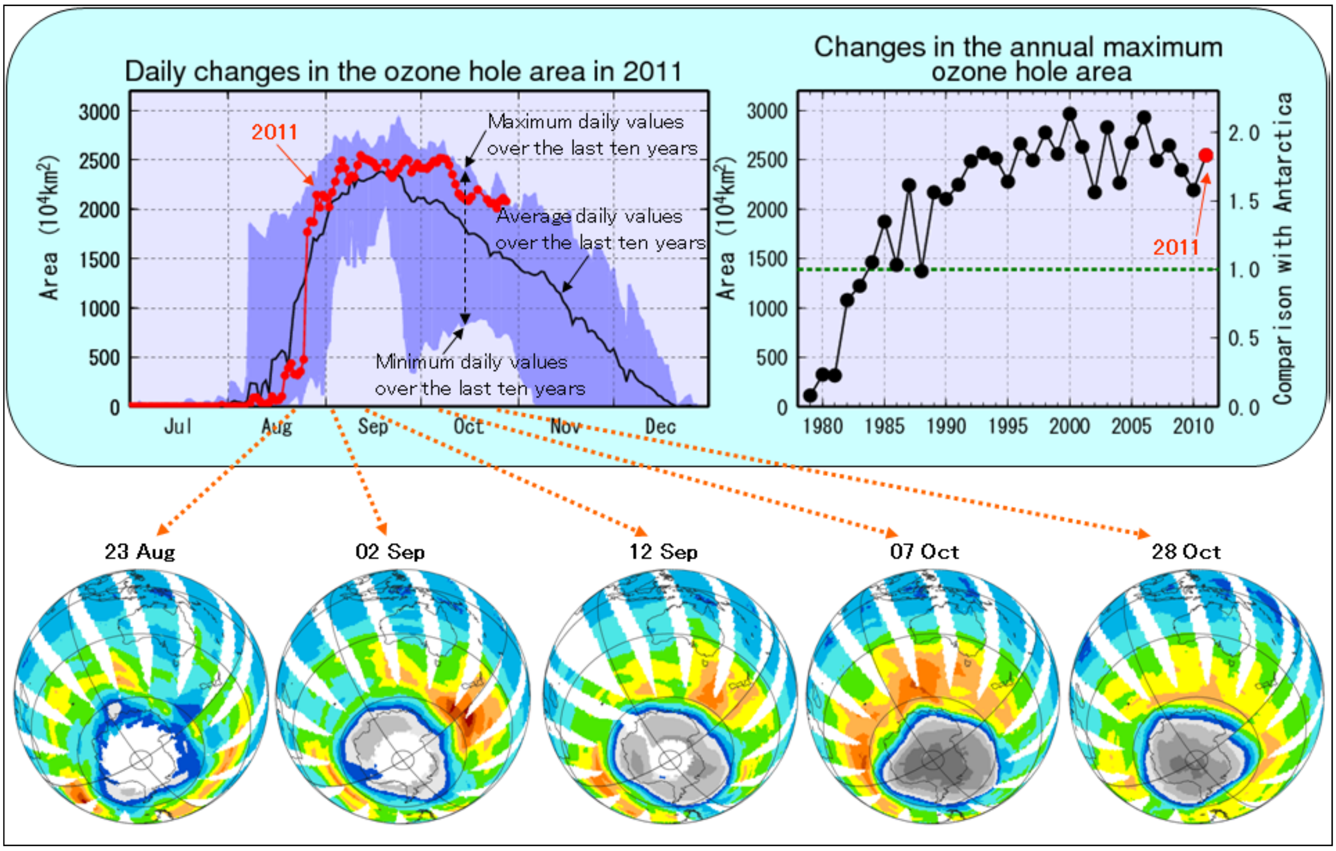


Figure 16 Daily changes in the Antarctic ozone hole area in 2011 (upper left), changes in its annual maximum area since 1979 (upper right), and total ozone distributions in the Southern Hemisphere on the dates indicated (bottom)
The Antarctic ozone hole is shown in gray in the spherical images at the bottom. These figures were produced from TOMS and OMI data provided by NASA (the National Aeronautics and Space Administration).

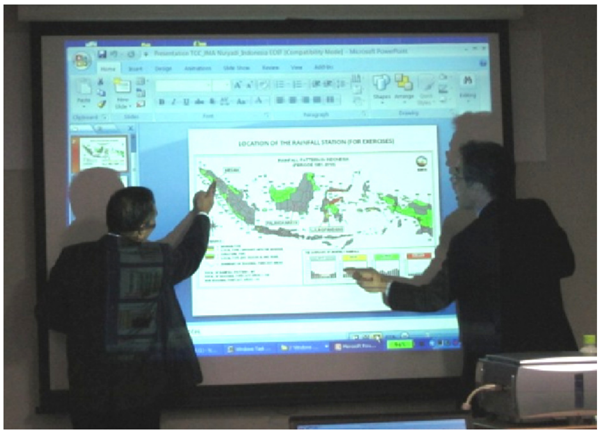
TCC Training Seminar on One-month Forecast Products/Twelfth Joint Meeting for the Seasonal Prediction of the East Asian Winter Monsoon

TCC holds an annual training seminar as part of capacity-building activities related to its role as one of the Regional Climate Centers in WMO RA II. In fiscal 2011, the Training Seminar on One-month Forecast Products took place from 7 to 9 November at JMA Headquarters in Tokyo. The event was attended by 13 experts from NMHSs in Bangladesh, Cambodia, Hong Kong, Indonesia, Lao Democratic People's Republic, Malaysia, Mongolia, Myanmar, Pakistan, the Philippines, Sri Lanka, Thailand and Viet Nam. Through lectures and exercises, the participants learned how to produce one-month forecasts using guidance and gridded model outputs. After attending a series of lectures and engaging in practical exercises, individual participants gave presentations on the exercise results of statistical guidance relating to one-month forecasting for each country. The presentations given by lecturers are available on the TCC web site (http://ds.data.jma.go.jp/tcc/tcc/library/library2011.html).

The Twelfth Joint Meeting for Seasonal Prediction of the East Asian Winter Monsoon was held on 10 and 11 November 2011 at the same venue as the seminar. This event has been held in autumn every year since 2000 based on close collaboration among the China Meteorological Administration, the Korea Meteorological Administration and JMA, and has recently also been joined by Mongolia's National Agency for Meteorology and Environment Monitoring. The meeting was attended by more than 30 people including the participants in the training seminar, and provided a good opportunity for attendees to discuss the recent understanding of phenomena related to seasonal prediction on the East Asian winter monsoon and the seasonal outlook for the coming winter. A summary report of the meeting will be made available on the TCC web site.

(Teruko Manabe, Tokyo Climate Center)

Lecture on JMA ensemble prediction system for seasonal prediction



Presentation by a participant on one-month forecast in his country

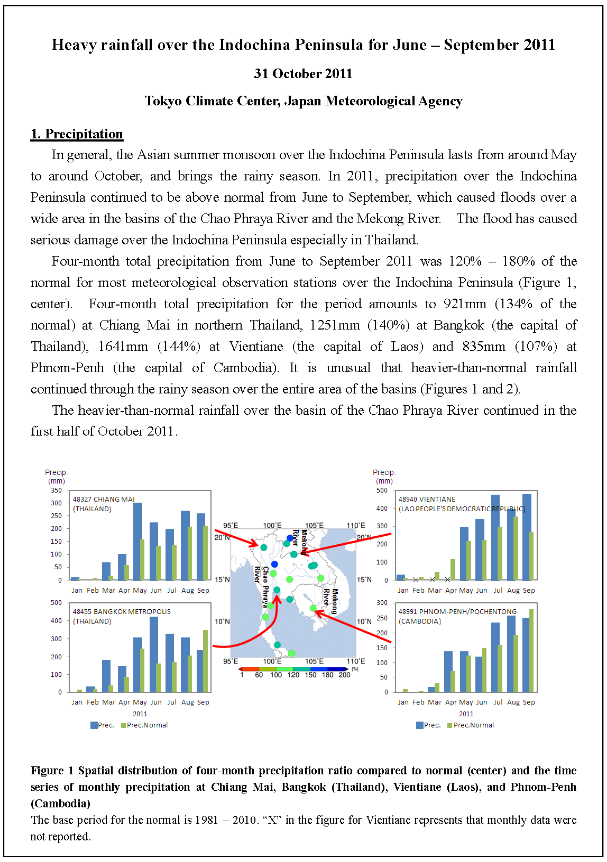
Scene at the exercise session

Group photo taken at the opening session of the Twelfth Joint Meeting for the Seasonal Prediction of the East Asian Winter Monsoon, 10 November 2011

Issuance of TCC Report Detailing Heavy Rainfall over the Indochina Peninsula

Heavy monsoon rains have recently caused widespread flooding in Thailand and other areas of the Indochina Peninsula. On 31 October, 2011, TCC issued a report entitled "Heavy rainfall over the Indochina Peninsula for June – September 2011" (http://ds.data.jma.go.jp/tcc/tcc/news/Heavy_rainfall_over_the_Indochina_Peninsula.pdf) to provide a brief summary of the situation. The Center also provided NMHSs in the affected areas with supplementary commentary on the situation as well as information on how to prepare the figures using web-based tools available on the TCC web site, such as ClimatView (http://ds.data.jma.go.jp/gmd/tcc/climatview/) and ITACS (http://extreme.kishou.go.jp/tool/itacs-tcc2011/). TCC remains committed to its efforts to assist NMHSs, and plans to continue and expand its involvement in such activities.

(Teruko Manabe, Tokyo Climate Center)



Heavy rainfall over the Indochina Peninsula for June – September 2011

31 October 2011

Tokyo Climate Center, Japan Meteorological Agency

1. Precipitation

In general, the Asian summer monsoon over the Indochina Peninsula lasts from around May to around October, and brings the rainy season. In 2011, precipitation over the Indochina Peninsula continued to be above normal from June to September, which caused floods over a wide area in the basins of the Chao Phraya River and the Mekong River. The flood has caused serious damage over the Indochina Peninsula especially in Thailand.

Four-month total precipitation from June to September 2011 was 120% – 180% of the normal for most meteorological observation stations over the Indochina Peninsula (Figure 1, center). Four-month total precipitation for the period amounts to 921mm (134% of the normal) at Chiang Mai in northern Thailand, 1251mm (140%) at Bangkok (the capital of Thailand), 1641mm (144%) at Vientiane (the capital of Laos) and 835mm (107%) at Phnom-Penh (the capital of Cambodia). It is unusual that heavier-than-normal rainfall continued through the rainy season over the entire area of the basins (Figures 1 and 2).

The heavier-than-normal rainfall over the basin of the Chao Phraya River continued in the first half of October 2011.

Figure 1 Spatial distribution of four-month precipitation ratio compared to normal (center) and the time series of monthly precipitation at Chiang Mai, Bangkok (Thailand), Vientiane (Laos), and Phnom-Penh (Cambodia)

The base period for the normal is 1981 – 2010. "X" in the figure for Vientiane represents that monthly data were not reported.

Any comments or inquiry on this newsletter and/or the TCC website would be much appreciated. Please e-mail to tcc@met.kishou.go.jp.
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