Tokyo Climate Center, Japan Meteorological Agency

TCC News

No. 19 Winter 2010

Contents

Improvements in JMA's Ensemble Prediction System for Long-range Forecasting

JMA will replace its Ensemble Prediction System (EPS) for operational long-range forecasting in February 2010. The main updates are outlined below.

- Introduction of a coupled ocean-atmosphere general circulation model (CGCM) instead of the atmospheric general circulation model (AGCM) used to date
- Change in ensemble techniques and EPS operation
- Provision of new grid point value (GPV) products

The specifications of the current and new EPSs are shown in Table 1(the next page). Forecast performance will be improved, especially with longer lead times and over the tropical region, in association with these updates. As in the past, the date of issuance for long-range forecasts is the 25th of the month or earlier.

1. Change from AGCM to CGCM

The long-range forecasting model will be changed from an AGCM (two-tiered method) to a CGCM (one-tiered method) (Figure1) and unified with the El Niño prediction model in February 2010.

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The CGCM consists of an AGCM and an ocean general circulation model (OGCM), and can represent air-sea interactions more appropriately than the AGCM, which has a spectral triangular 95 (TL95) horizontal resolution (equivalent to a Gaussian grid of nearly 180 km) and 40 unevenly spaced hybrid levels in the vertical resolution. The model top is at the 0.4 hPa level. It is a low-resolution version of JMA's operational AGCM for short- and medium-range forecasting. The OGCM is the Meteorological Research Institute Community Ocean Model (MRI.COM).

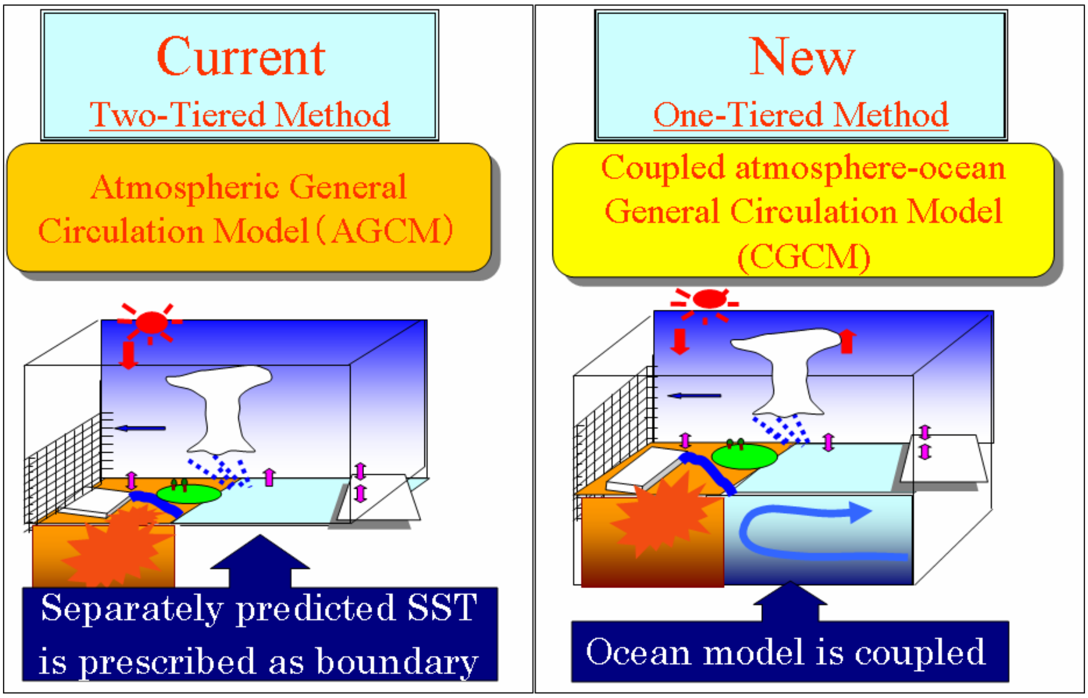

Figure. 1 Improvement of JMA's long-range forecast model

Table 1 Specifications of the current and new EPSs for long-range forecasting in JMA

	Current system (until Jan. 2010)	New system (from Feb. 2010)
	V0703C	JMA/MRI-CGCM
Atmospheric general circulation model (AGCM)	JMA-GSM (based on the JMA/MRI Unified Model)	
Horizontal resolution	TL95 (about 1.875º, Gaussian grid 180 km)	
Vertical layers	40 (model top: 0.4 hPa)	
Ocean general circulation model (OGCM)	---	MRI.COM[*1]
Horizontal resolution		1.0 deg in longitude, 0.3 – 1.0 deg in latitude (75ºS – 75ºN)
Vertical layers		50
Initial conditions		
Atmosphere	JMA Global Analysis	JCDAS[*2] (JMA Climate Data Assimilation System)
Ocean	---	MOVE/MRI.COM-G[*3] (Ocean Data Assimilation)
Land surface	Climatology	
Sea surface temperature (SST)	Two-tiered method; combination of persisted anomaly and prediction using the El Niño prediction model	One-tiered method with flux adjustment
Sea ice distribution	Climatology	
CO_2 concentration	Constant	Trend
Perturbation method	Singular Vector (SV) method	Combination of Breeding of Growing Modes (BGM) and Lagged Average Forecast (LAF) methods
Ensemble size	51	51 (9 BGM & 5-day LAF)
Time integration range	4 months or more, up to 7 months	7 months

System details can be found at:
*1 http://ds.data.jma.go.jp/tcc/tcc/products/elnino/jmamri_cgcm_doc.html
*2 http://jra.kishou.go.jp/JRA-25/index_en.html
*3 http://ds.data.jma.go.jp/tcc/tcc/products/elnino/move_mricom_doc.html

2. Changes in ensemble technique and EPS operation

The new EPS for long-range forecasting is run every five days with nine members, and initial perturbations are estimated for both the atmosphere and the ocean. Atmospheric initial perturbations are obtained using the Breeding of Growing Modes (BGM) method (Toth and Kalnay, 1993, 1997). Oceanic initial perturbations are estimated through the ocean data assimilation system (MOVE/MRI.COM-G) forced by the surface heat and momentum flux associated with the atmospheric initial perturbation fields. The 51-member ensemble is generated using prediction results from six different initial dates (Figure 2).

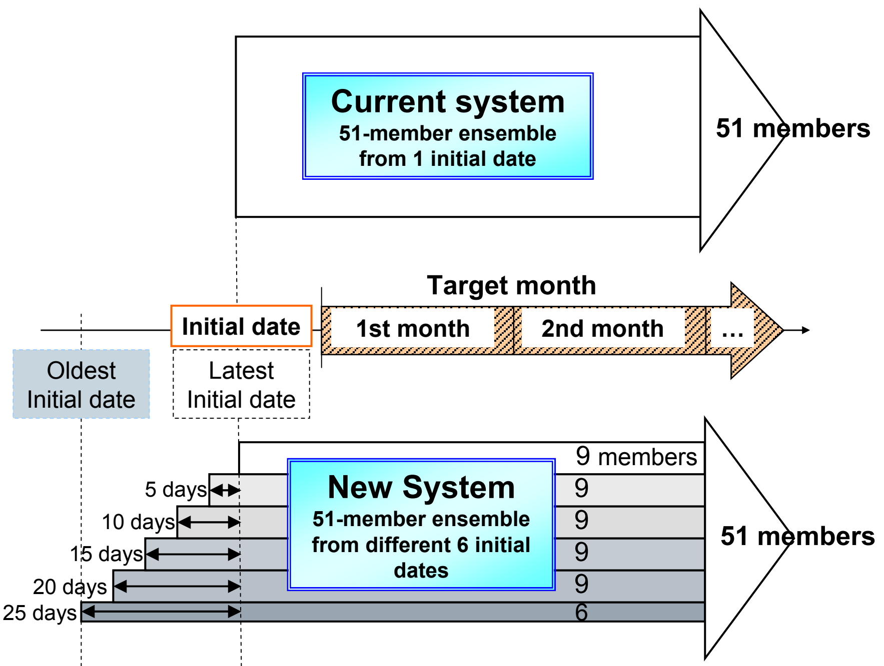

Figure 2 Schema of aggregation for the ensemble members in the current and new systems

3. Provision of new GPV products

TCC will start providing monthly GPV data from individual ensemble members in addition to ensemble mean data. The GPV data of hindcast experiments by the CGCM will also be updated. GPV products (shown in Table 2) are available only to National Meteorological and Hydrological Service (NMHS) users through the Global Producing Centre of Long Range Forecasts (GPC) page on the TCC website.

Table 2 Specifications of GPV products from EPS for long-range forecasting

Parameters	
Ensemble mean*1	U200, V200, Z500, U850, V850, T850, mean sea level pressure, precipitation, 2-m temperature, SST
Individual ensemble members	Z100, Z200, U200, V200, T200, Z300, Z500, U500, V500, T500, Z850, U850, V850, T850, RH850, Q850, mean sea level pressure, precipitation, 2-m temperature, SST
Temporal resolution	1-month mean (ensemble mean & individual ensemble members) 3-month mean (ensemble mean)
Spatial coverage and resolution	Global, 2.5º × 2.5º
Lead time	Between about 0.5 and 5.5 months
Issuance timing	No later than the 25th of each month
Data format	GRIB2*2
Data for calibration	Model normals based on hindcast experiments

*1 Including standard deviation with the exception of SST

*2 Details can be found at http://www.wmo.ch/pages/prog/www/WMOCodes/GRIB.html

4. Improvements in forecast performance

Results from hindcast experiments (Table 3) using the CGCM show that its introduction improves long-range forecast performance, especially with longer lead times and over the tropical region, compared to the AGCM. The data used for verification are JRA-25/JCDAS (Japanese 25-year Reanalysis/JMA Climate Data Assimilation System; Onogi et al., 2007), COBE-SST (Centennial in-situ Observation-Based Estimates of variability of SST and marine meteorological variables; Ishii et al., 2005) and GPCP (Global Precipitation Climatology Project; Adler et al., 2003). The verification results based on hindcast experiments are shown here.

Table 3 Specifications of hindcast experiments for long-range forecasting

		Current system	New system
Model		V0703C (AGCM)	JMA/MRI-CGCM
Target period		All months from 1984 to 2005; 22 years	All months from 1979 to 2008; 30 years
Time integration range		7 months	7 months
Ensemble size (method)		11 (SV)	10 (5 BGM & 15-day LAF)
Initial conditions	Atmosphere	JRA-25*1/JCDAS	
	Ocean	---	MOVE/MRI.COM-G
	Land surface	Climatology	

System details can be found at:

*1 http://jra.kishou.go.jp/JRA-25/index_en.html

Figure 3 shows anomaly correlation coefficients (ACC) of three-month mean SSTs. The CGCM has a high level of forecast skill for tropical SSTs over most of the Indian Ocean and the western tropical Pacific in addition to the ENSO-related region. In particular, improvements in forecast skill for SSTs are significant over the northern tropical Indian Ocean and the western tropical Pacific compared to that of the AGCM.

Figure 4 shows a comparison of ACCs for three-month mean precipitation between the CGCM and the AGCM. Corresponding to the high forecast skill for tropical SSTs, the level of skill for tropical precipitation is also improved. This is partially due to the fact that a realistic relationship between SST and precipitation is reproduced in the CGCM through its physically reasonable air-sea interaction processes, which were not represented in the AGCM.

Figure 5 shows a comparison of ACCs for the three-month mean stream function at 850 hPa (upper) and geopotential height at 500 hPa (lower) between the CGCM and the AGCM. The CGCM also improves the forecast skill for tropical circulation. The level of skill for both fields is improved, especially over the western tropical Pacific.

Figure 6 shows a comparison of relative operating characteristics (ROC) areas in tercile (three-class) probability forecasts (all tercile) for three-month mean surface temperature and precipitation over the tropical region with a one-month lead time. The CGCM improves the level of probabilistic skill for the tercile probability forecasts, especially over the tropical region. Tercile probability forecasts for three-month mean surface temperature and precipitation are made available on the TCC website, and are generated using the Model Output Statistics (MOS) technique based on hindcast experiments.

(Takayuki Tokuhiro, Climate Prediction Division)

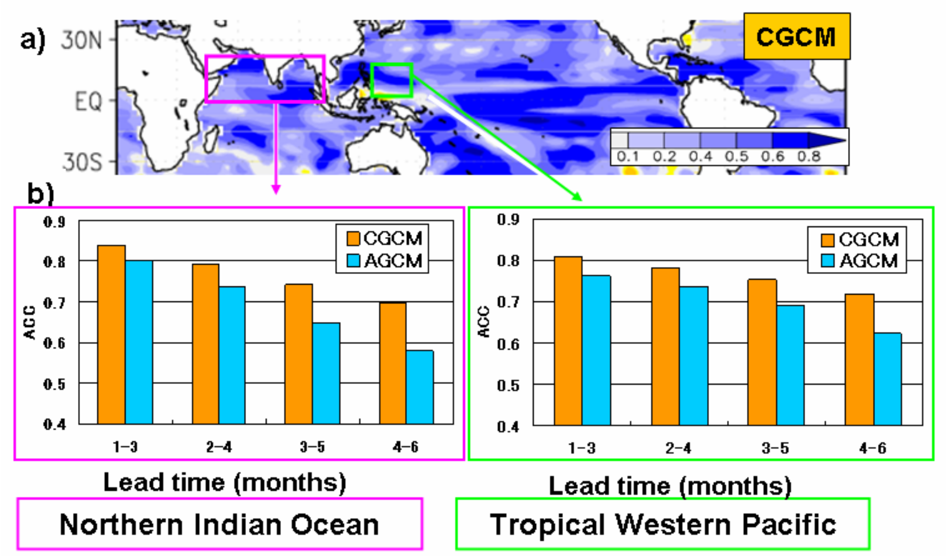

Figure 3 Anomaly correlation coefficients (ACCs) of three-month mean SST

a) ACCs with a four-month lead time for Jun. – Aug. in the CGCM

b) Time series of ACCs (average for 12 initial months) over the northern Indian Ocean (left) and the tropical western Pacific (right). Orange bars represent CGCM ACCs, while blue ones show those of the AGCM. The target years used for verification are 1984 – 2005.

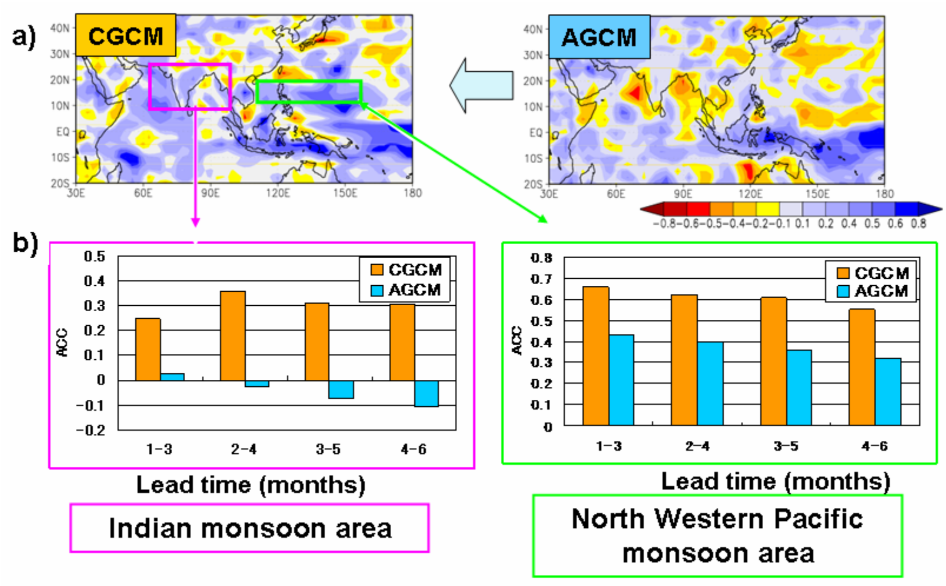

Figure 4 ACCs of three-month mean precipitation

a) As per Fig. 3a), but for CGCM (left) and AGCM (right)

b) As per Fig. 3b), but over the Indian monsoon area (left) and the north western Pacific monsoon area (right)

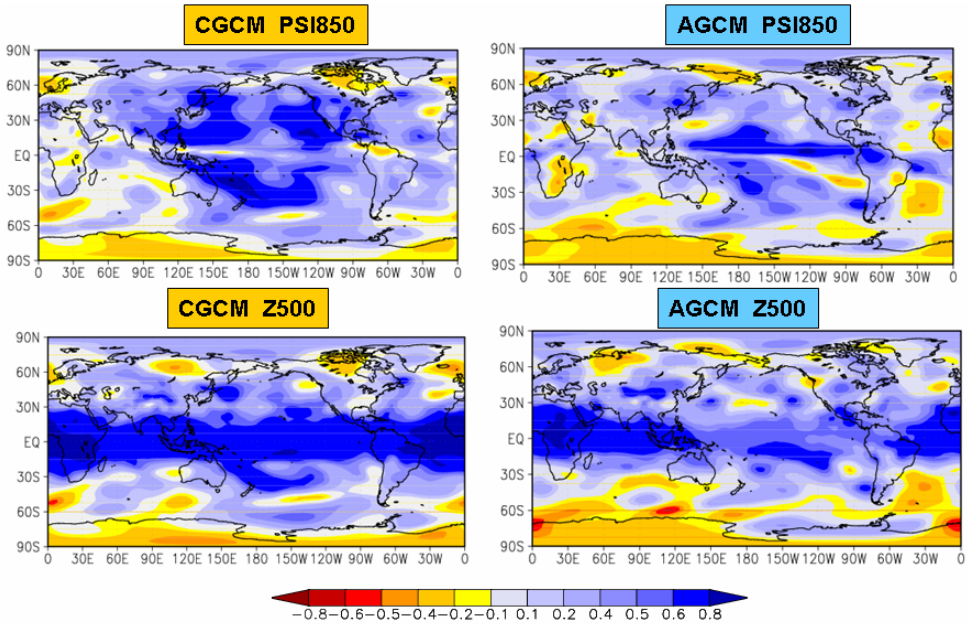

Figure 5 As per Fig. 4a) but for ACCs of stream function at the 850-hPa level (upper) and geopotential height at the 500-hPa level (lower)

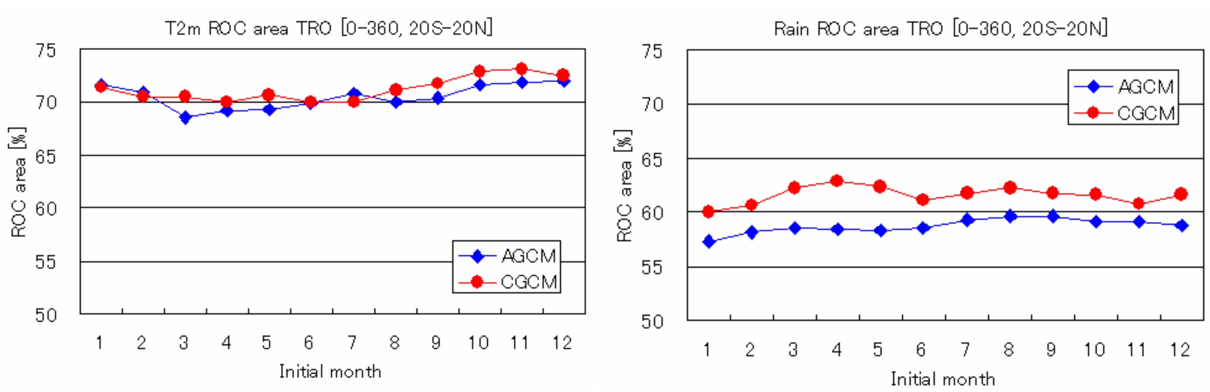

Figure 6 Relative Operating Characteristics (ROC) areas in tercile probability forecasts (all tercile) for three-month mean surface temperature (left) and precipitation (right) over the tropical region with a one-month lead time.
The red and blue lines represent ROC areas with the CGCM and the AGCM, respectively. A value of 50% in the ROC area is the climatological score. The target years used for verification are 1979 – 2008 for the CGCM and 1984 – 2005 for the AGCM.

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Highlight of the Global Climate for 2009

Annual mean temperatures were above normal in most areas of the world except in central Siberia and from Canada to the USA (Figure 7). Extremely high temperatures were frequently observed around low latitudes from 30°S to 30°N, while extremely low temperatures were observed around the central USA in October and December, around China in November and from western Siberia to eastern China in December.

Annual precipitation amounts were above normal in eastern Siberia, from the Philippines to western Indonesia and from Europe to northern Africa, while they were below normal on the Arabian Peninsula, in southern South America and from central to southern Australia (Figure 8). Extremely heavy precipitation amounts were frequently observed in northern Europe, while extremely light precipitation amounts were observed frequently in northern Argentina.

Major extreme climatic events and weather-related disasters in 2009 are as listed below (see also Figure 9):

(1) Low temperatures from western Siberia to eastern China (Dec.)
(2) Low temperatures around China (Nov.)
(3) Heavy precipitation from eastern Mongolia to northern Japan (Dec.)
(4) High temperatures from China to the Middle East (Feb. – Oct.)
(5) Typhoons and torrential rains in the Philippines (May, Sep. – Oct.)
(6) High temperatures from Micronesia to Indonesia (Apr. – Dec.)
(7) Torrential rains in southern India (Sep. – Oct.)
(8) Heavy precipitation in northern Europe (Jul.)
(9) Heavy precipitation from the Aral Sea to northern Africa (Sep.)
(10) Torrential rains in southern Africa (Mar.)
(11) High temperatures around Madagascar (Jan. – Feb., May – Dec.)
(12) Low temperatures around the central USA (Oct., Dec.)
(13) High temperatures from Central America to northern South America (May – Dec.)
(14) Light precipitation around northern Argentina (Jan., Mar. – Apr.)
(15) Heat waves and bushfires in southeastern Australia (Jan. – Feb.)

(Takafumi Umeda, Climate Prediction Division)

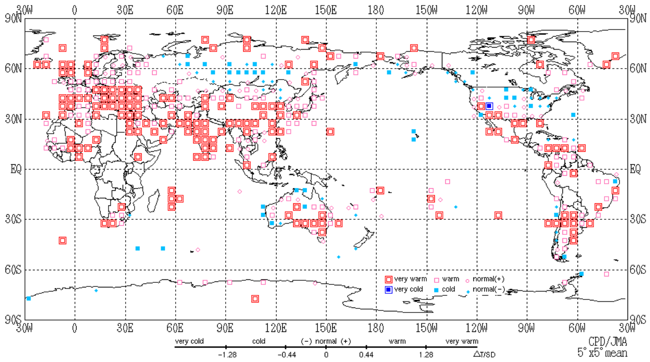


Figure 7 Annual mean temperature anomalies for 2009
Categories are defined by the annual mean temperature anomaly against the normal divided by its standard deviation and averaged in 5° × 5° grid boxes. The thresholds of the categories are -1.28σ, -0.44σ, 0, +0.44σ and +1.28σ, as shown in the legend. The normal values and standard deviations are calculated from 1971 – 2000 statistics. Land areas without marks represent regions where observation data are insufficient or normal data are unavailable.

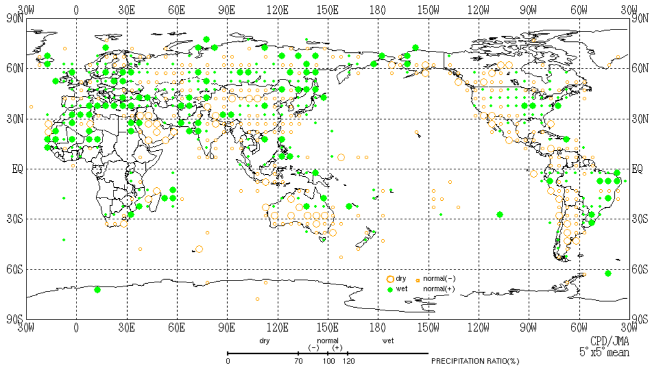


Figure 8 Annual total precipitation amount ratios for 2009
Categories are defined by the annual precipitation ratio to the normal averaged in 5° × 5° grid boxes. The thresholds of the categories are 70%, 100% and 120%, as shown in the legend. Land areas without marks represent regions where observation data are insufficient or normal data are unavailable.

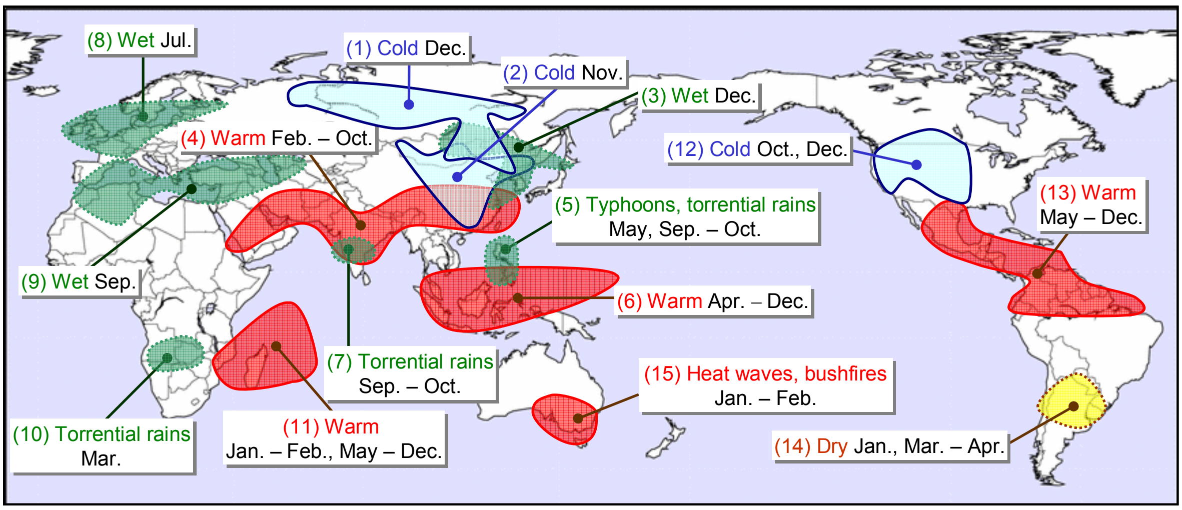


Figure 9 Extreme events and weather-related disasters in 2009
Major extreme climatic events and weather-related disasters occurring during the year are indicated schematically.

Summary of Japan's Climate in 2009

- **Above-normal annual mean temperature nationwide**
- **Light snowfall on the Sea of Japan side**
- **Light precipitation in western Japan and on the Sea of Japan side of eastern Japan from April to June**
- **Repeated and localized heavy rainfall in July and August**
- **Short sunshine duration in northern, eastern and western Japan in July and August**
- **Below-normal incidences of typhoon formation, approach and landfall in Japan**

(1) Annual temperature, precipitation and sunshine duration (Figure 10)

The average surface temperature over Japan (averaged over 17 observatories confirmed as being relatively unaffected by urbanization) in 2009 was 0.56°C above normal (based on the 1971 – 2000 average), and was the seventh highest since 1898. Area-averaged annual mean temperature anomalies were +0.6°C in northern Japan, +0.7°C in eastern Japan, +0.6°C in western Japan and +0.5°C in Okinawa/Amami. Annual precipitation amounts were significantly above normal on the Pacific side of northern Japan, while they were below normal on the Pacific side of western Japan and in Okinawa/Amami and near normal in other areas. Annual sunshine durations were below normal in northern and eastern Japan and on the Sea of Japan side of western Japan. Meanwhile, they were above normal in Okinawa/Amami and near normal on the Pacific side of western Japan.

(2) Seasonal climate features (Figure 11)

As the winter monsoon was much weaker than usual, seasonal mean temperature was above normal nationwide. In particular, they were significantly high in northern and eastern Japan and in Okinawa/Amami. Snowfall amounts were also significantly below normal on the Sea of Japan side. Cyclones periodically passed near mainland Japan, causing above-normal precipitation amounts on the Pacific side. Anticyclones covered the area around Okinawa/Amami, where seasonal sunshine durations and precipitation amounts were significantly above and below normal, respectively.

In spring, seasonal mean temperatures were above normal in northern, eastern and western Japan. In the latter, seasonal precipitation amounts and sunshine durations were significantly below and above normal, respectively, due to the limited influence of cyclones and fronts. In Okinawa/Amami, cloudy or rainy weather was dominant in March and April, but sunny weather was dominant in May.

Cloudy or rainy weather was dominant in mainland Japan during the summer. As a result, seasonal sunshine durations were below normal over northern, eastern and western Japan, while seasonal precipitation amounts were above normal in northern Japan and on the Sea of Japan side of western Japan. In the second half of July and the first half of August, cyclones, fronts and typhoons brought localized heavy rain to many parts of Japan. Seasonal mean temperatures were above normal in Okinawa/Amami due to hot weather dominant in July and August.

In autumn, seasonal mean temperatures were near normal in northern and eastern Japan, and temperatures varied widely. In Okinawa/Amami, seasonal mean temperatures were significantly above normal, and particularly hot weather was dominant in the first half of autumn. In September, monthly precipitation amounts were significantly below normal nationwide. In contrast, they were significantly above normal for western Japan in November due to the frequent passage of cyclones and fronts around the country. In October, Typhoon Melor (0918) made landfall on mainland Japan, bringing heavy rainfall and strong winds.

In the first half of December, temperatures were above normal nationwide and heavy precipitation was brought to the Pacific side of the country by migratory cyclones. In contrast, a strong cold surge brought heavy snowfall to the Sea of Japan side and resulted in low temperatures all over Japan in the second half of the month. Monthly snowfall amounts were above normal on the Sea of Japan side of eastern Japan for the first time in four years.

(Noriaki Watanabe, Climate Prediction Division)

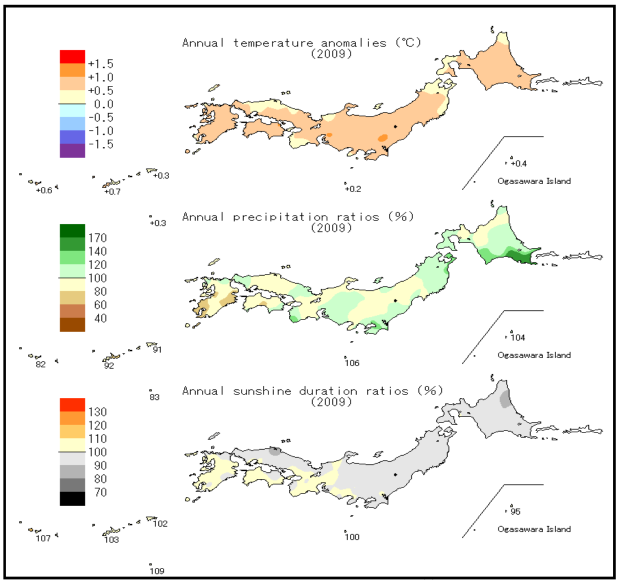


Figure 10 Annual climate anomalies/ratios over Japan in 2009

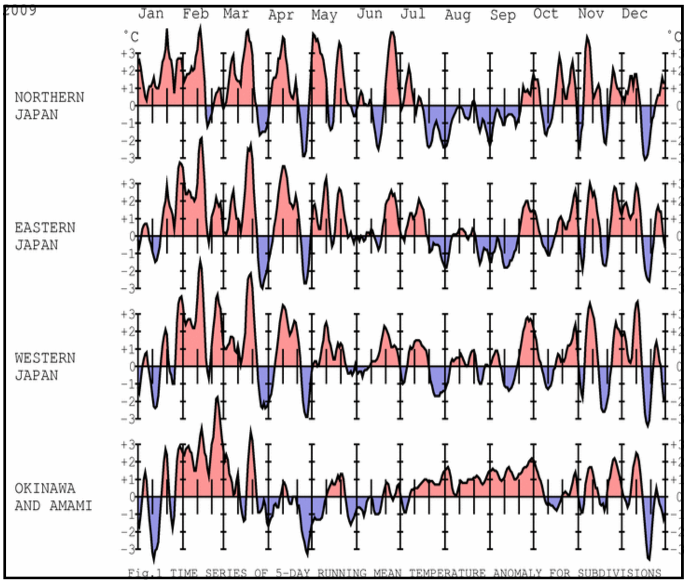


Figure 11 Time series of five-day running mean temperature anomalies for subdivisions
The normal is the 1971 – 2000 average.

TCC Activity Report for 2009

The Tokyo Climate Center (TCC) of the Japan Meteorological Agency (JMA) has prepared the *Activity Report of the Tokyo Climate Center for 2009*, detailing the climate-related activities of TCC in 2009 and its plans for 2010.

1. Designation of TCC as an RCC in RA II

TCC was formally designated as one of the first Regional Climate Centers (RCCs) in Regional Association II (Asia) together with the China Meteorological Administration's Beijing Climate Center (BCC) at the 61st session of the WMO's Executive Council held in Geneva, Switzerland, from 3 to 12 June 2009. TCC and BCC started their operational climate-related activities as RCCs on 1 July. As a result of close cooperation between the two centers, the Regional Climate Center Network in RA II website has been launched at http://www.rccra2.org/detail/index.htm.

Ms. K. Hayashi, Head of TCC, gave a presentation titled "Activity of Regional Climate Centers in Asia" at the World Climate Conference-3 (WCC-3) held in Geneva from 31 August to 4 September 2009, introducing climate-related activities embarked upon by TCC and BCC and future plans being formulated by the RCCs in RA II. The presentation file is available on the WCC-3 website at http://www.wcc3.org/wcc3docs/pdf/I3_Hayashi.pdf.

2. TCC website

TCC operates a website providing climate-related operational data and products as well as presentation materials used in meetings and training events (http://ds.data.jma.go.jp/tcc/tcc/index.htm).

The Center renewed its El Niño Monitoring and Outlook page (http://ds.data.jma.go.jp/tcc/tcc/products/elnino/index.html) and began providing SST monitoring and prediction information in newly defined SST monitoring regions called IOBW (covering the tropical Indian Ocean) and NINO.WEST through the website. On the renewed page, SST deviation diagnosis and six-month outlooks for IOBW and NINO.WEST are available.

The following content has been added to the TCC website:

a) Madden-Julian Oscillation (MJO) information http://ds.data.jma.go.jp/tcc/tcc/products/clisys/mjo/moni_mjo.html

b) Monthly and annual anomalies of JMA's global surface temperature data averaged in 5° x 5° grid boxes http://ds.data.jma.go.jp/tcc/tcc/products/gwp/temp/ann_wld.html

c) Gridded global sea surface temperature data sets (COBE-SST) from 1891 onward http://ds.data.jma.go.jp/tcc/tcc/products/elnino/cobesst/cobe-sst.html

d) Statistical relationships (atmospheric circulations regressed on El Niño monitoring indices) (renewed content) http://ds.data.jma.go.jp/tcc/tcc/products/clisys/newoceanindex/explanation.html

3. Climate information services (monitoring, climate reviews, etc.)

TCC provides a number of regular reports, such as *Monthly Report of Worldwide Extreme Climate Events*, *Monthly Highlights on Climate System*, *El Niño Outlook*, *Global Average Surface Temperature Anomaly* and *Annual Report on Climate System*.

JMA has developed a useful web-based tool for climate diagnosis referred to as ITACS, which stands for Interactive Tool for Analysis of the Climate System. ITACS enables users not only to monitor current climate status but also to analyze the complicated system that lies behind climatic conditions. The system is now available on the TCC website, which is intended for use by National Meteorological and Hydrological Services (NMHSs) and related research institutes. For more details, including information on how to apply, refer to http://jra.kishou.go.jp/itacs-info/tcc/conditions.html.

4. Long-range forecasting (monthly, seasonal, longer-range forecasts issued and disseminated based on model simulations or statistical methods)

JMA improved its one-month ensemble prediction system in March 2008 (see TCC News No. 12 for details). Accordingly, GPV products for one-month forecasts were upgraded in April 2009 with the change of data format from GRIB1 to GRIB2 and the provision of new products (daily GPV data for individual ensemble members and hindcast data) on the TCC website.

5. Training activities

TCC held the Training Seminar on Climate Analysis using Reanalysis Data from December 1 to 4 2009 with 11 invited participants from Asian and Pacific countries (Bangladesh, Indonesia, Laos, Malaysia, Mongolia, Pakistan, Papua New Guinea, the Philippines, Sri Lanka, Thailand and Vietnam). The attendees deepened their knowledge and grasp of practical techniques for climate analysis, in particular learning how to use ITACS through lectures and hands-on exercises (see Article 5).

JMA has run 3-month courses in meteorology for NMHS experts since 1973 as part of the training initiatives provided by the Japan International Cooperation Agency (JICA). The 2009 course was held from September to December with an emphasis on the operational use of numerical weather prediction, satellite meteorology and climate information. In the climate information session, staff members from the Climate Prediction Division gave lectures on climate system monitoring, long-range forecasting, El Niño outlook and global warming projection to four participants from Bhutan, Cambodia, Myanmar and Mongolia.

6. Future plans

In February 2010, JMA will introduce a coupled ocean-atmosphere general circulation model (CGCM) for operational seasonal forecasts, which is expected to improve prediction skill, especially in subtropical areas. GPC (Global Producing Center) Tokyo will start providing products generated using the CGCM (see Article 1).

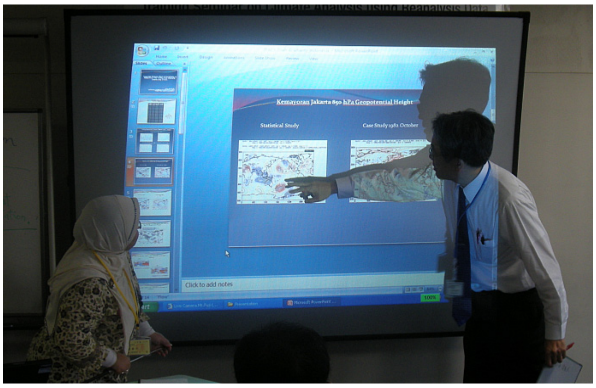
However, TCC recognizes that it is necessary to provide tools and guidance for the handling and interpretation of these products from GPC. In order to facilitate their utilization, TCC plans to hold a training seminar on seasonal prediction in the coming autumn or winter. Furthermore, guidance materials on using the products will be made available on the TCC website, which will help NMHSs generate their own forecast products to meet user requirements. The Center also plans to develop new tools for prediction products within a few years.

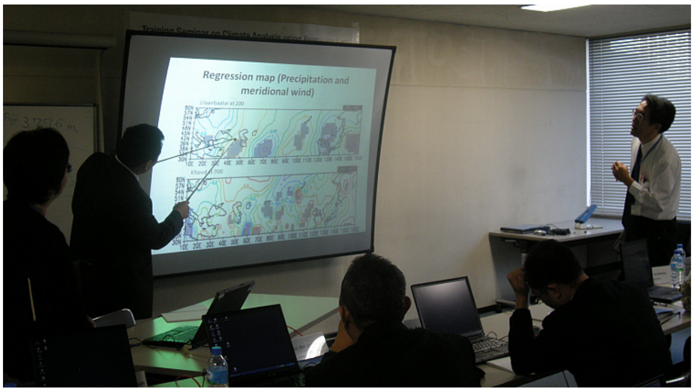
(Kumi Hayashi, Climate Prediction Division)

Training Seminar on Climate Analysis using Re-analysis Data

The Training Seminar on Climate Analysis using Re-analysis Data was held at JMA Headquarters in Tokyo from 1 to 4 December, 2009, as part of the capacity-building activities of the Tokyo Climate Center – one of the Regional Climate Centers in RA II of the World Meteorological Organization (WMO). The purpose of the seminar was to assist NMHSs in enhancing their operational climatic analysis performance. The seminar was attended by 11 participants from 11 countries engaged in operational long-range forecasting at NMHSs in East and Southeast Asia and the Pacific region (Bangladesh, Indonesia, Laos, Malaysia, Mongolia, Pakistan, Papua New Guinea, the Philippines, Sri Lanka, Thailand and Vietnam). The participants learned about the purpose and practical techniques of climate analysis through lectures and exercises using the web-based Interactive Tools for Analysis of the Climate System (ITACS). Developed by JMA, this set of tools enables users not only to monitor current climate conditions but also to analyze the characteristics and factors that lie behind such conditions and extreme climatic events. After a series of lectures and two days of practical exercise using ITACS, each participant gave a presentation on the exercise results focusing on climatic events of their interest. The seminar provided a good opportunity for the participants to deepen their knowledge of climate analysis.

(Kumi Hayashi, Climate Prediction Division)





Any comments or inquiries on this newsletter and/or the TCC website would be much appreciated. Please e-mail to: tcc@climar.kishou.go.jp
(Chief Editor: Kumi Hayashi)

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