Tokyo Climate Center, Japan Meteorological Agency

TCC News

No. 39 Winter 2015

Contents

State of Global Warming in 2014

~ The year 2014 was the warmest since 1891.~

Global Surface Temperature in 2014

The annual anomaly of the global average surface temperature for 2014 (i.e., the combined average of the near-surface air temperature over land and the SST) was +0.27°C above the 1981 – 2010 average (+0.63°C above the 20th-century average), making it the highest since 1891. The top five warmest years are now 2014 (+0.27°C), 1998 (+0.22°C), 2013 and 2010 (+0.20°C), and 2005 (+0.17°C). On a longer time scale, global average surface temperatures have risen at a rate of about +0.70°C per century since 1891 (Figure 1).

In 2014, the monthly average air temperatures for April, May, June, August, September, October and December, and the seasonal average air temperatures for boreal spring, summer and autumn, were also the highest since 1891.

Warm temperature deviations are seen not only across much of Asia and Europe but also over a wide ocean area, particularly in the North Pacific (Figure 2).

All years this century rank within the warmest 16 since 1891. The recent high temperatures are thought to result from the global warming trend caused by increased concentrations of carbon dioxide and other anthropogenic greenhouse gases. Global temperatures are also affected by inter-annual to decadal natural fluctuations intrinsic to the earth's climate. The highest temperature for 2014 is thought to be associated with the El Niño phenomenon that began in summer 2014.

JMA monitors monthly, seasonal and annual average anomalies of global surface temperature. The results are routinely updated on the following TCC web page:
http://ds.data.jma.go.jp/tcc/tcc/products/gwp/temp/ann_wld.html

(Koji Ishihara, Climate Prediction Division)

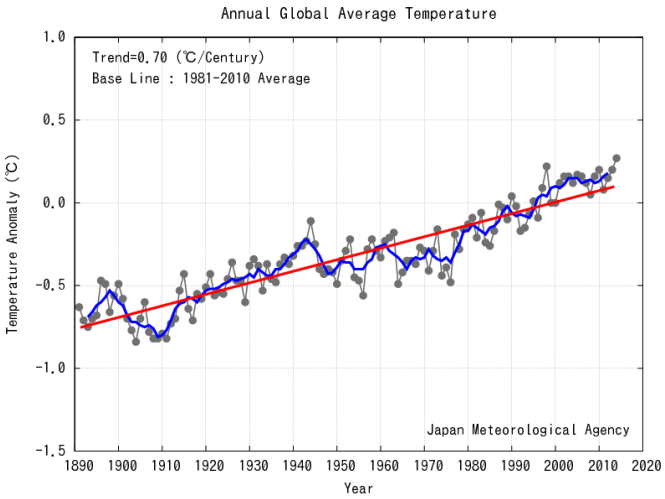


Figure 1 Long-term change in annual mean surface temperature anomalies over the globe
The black line with filled circles indicates anomalies of surface temperature in each year. The blue line indicates five-year running mean, and the red line indicates a long-term linear trend. Anomalies are represented as deviations from the 1981-2010 average.

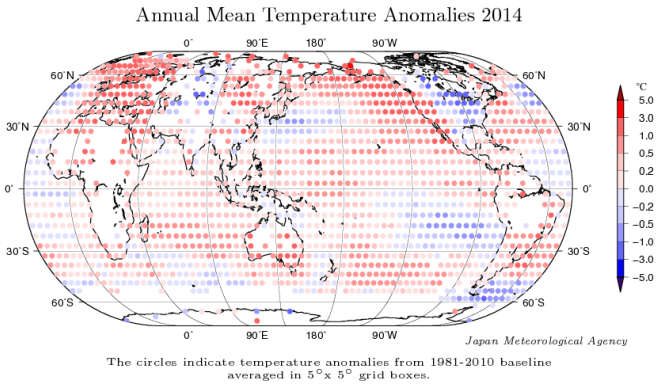


Figure 2 Annual mean temperature anomalies in 2014
The circles indicate anomalies of surface temperature averaged in 5°x5°grid boxes. Anomalies are deviations from the 1981-2010 average.

Ocean Heat Content in 2014

Oceans have a significant impact on the global climate because they cover about 70% of the earth's surface and have high heat capacity. According to the Intergovernmental Panel on Climate Change Fifth Assessment report (IPCC, 2013), more than 60% of the net energy increase in the climate system from 1971 to 2010 is stored in the upper ocean (0 – 700 m), and about 30% is stored below 700 m. Oceanic warming results in sea level rises due to thermal expansion, and impacts marine ecosystems.

It is virtually certain that globally integrated upper ocean (0 – 700 m) heat content (OHC) rose between 1950 and 2014 at a rate of 2.11 × 1022 J per decade as a long-term trend with interannual variations (statistically significant at a confidence level of 99%). Oceans exhibited marked warming from the mid-1990s to the early 2000s. Although the slope has become more moderate, OHC has continued to increase significantly since then. A rise of 0.022°C per decade in the globally averaged upper ocean (0 – 700 m) temperature has accompanied the OHC increase.

These long-term trends can be attributed to global warming caused by increased concentrations of anthropogenic greenhouse gases such as CO2 as well as natural variability.

(Yoshikazu Fukuda, Marine Division)

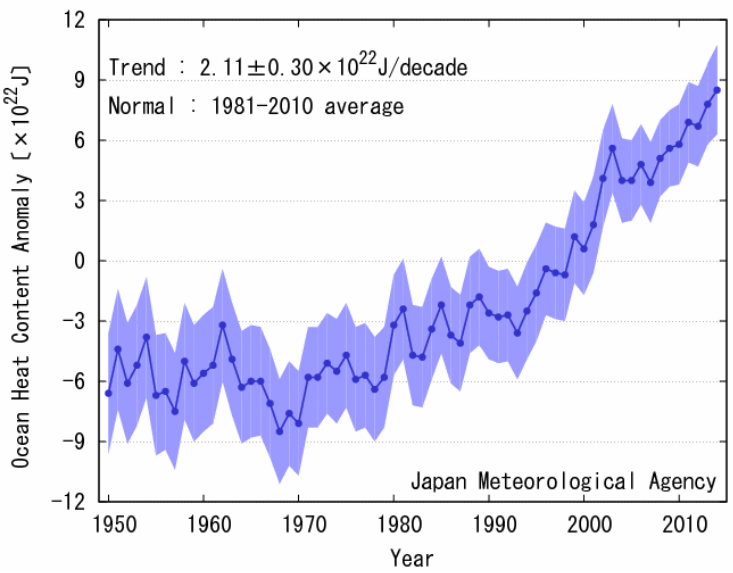


Figure 3 Time series representation of the globally integrated upper (0 – 700 m) ocean heat content anomaly

The 1981 – 2010 average is used as the normal. The solid line with dots shows the annual mean for the global integrals of upper (0 – 700 m) ocean heat content anomalies. The shaded area indicates a 95% confidence level.

Highlights of the Global Climate in 2014

Annual mean temperatures were above normal in many parts of the world, and were below normal in the Philippines, from Western Siberia to Central Asia and from central Canada to the southern USA (Figure 4). Extremely high temperatures were frequently observed from Malaysia to Indonesia, in southern Europe, in western Africa, around northern Madagascar, in western Alaska, from the southwestern USA to northwestern Mexico, around the Caribbean Sea, around southern Brazil and in southern Australia, and extremely low temperatures were frequently observed in the southern part of Western Siberia, in the southern part of Central Asia and around the Midwest of the USA.

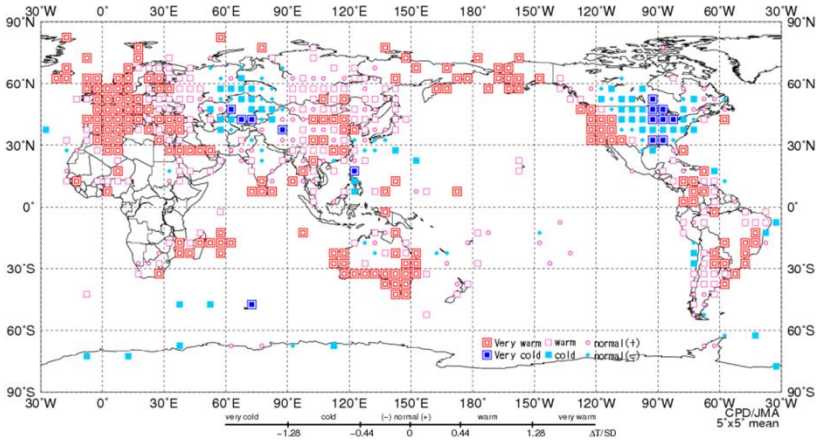


Figure 4 Annual mean temperature anomalies in 2014

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 each category are -1.28, -0.44, 0, +0.44 and +1.28. The normal values and standard deviations are calculated from 1981-2010 statistics. Land areas without graphics represent regions for which the sample size of observation data is insufficient or normal data are unavailable.

Annual precipitation amounts were above normal from Central Siberia to the eastern part of Central Asia, on the southern Scandinavian Peninsula, in southeastern Europe, around the Red Sea, in the northeastern USA, in western Mexico, in the southern part of South America and from Micronesia to the southern Philippines, and were below normal on the southern Arabian Peninsula and in southern Algeria (Figure 5). Extremely heavy precipitation amounts were frequently observed in southeastern and western Europe and around southern Brazil.

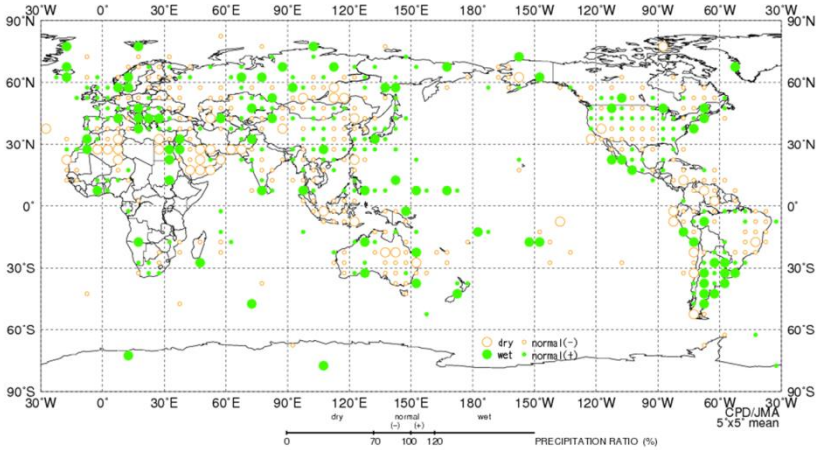


Figure 5 Annual total precipitation amount ratios in 2014
Categories are defined by the annual precipitation ratio to the normal averaged in 5° × 5° grid boxes. The thresholds of each category are 70%, 100% and 120%. Land areas without graphics represent regions for which the sample size of observation data is insufficient or normal data are unavailable.

Major extreme climatic events and weather-related disasters occurring in 2014 are listed below (also see Figure 6).

(1) Torrential rain in Japan (August)
(2) Drought in northeastern and eastern China (June − August)
(3) Low temperatures in the southern part of Western Siberia (July, September – October)
(4) Low temperatures in the southern part of Central Asia (February, October – November)
(5) Typhoon in the Philippines (July)
(6) High temperatures from Malaysia to Indonesia (June – July, October – November)
(7) Torrential rain in India, Nepal and Pakistan (July − September)
(8) Floods and Landslides in northern Afghanistan (April − June)
(9) Heavy precipitation in southeastern Europe (May – June, August – September, December)
(10) High temperatures in southern Europe (February, April, October – November)
(11) Heavy precipitation in western Europe (January – February, May, July – August, November)
(12) High temperatures in western Africa (June – July, November)
(13) High temperatures around northern Madagascar (July – August, October – December)
(14) High temperatures in western Alaska (January, August, November)
(15) Low temperatures around the Midwest of the USA (January – March, July, November)
(16) Drought in California (all year round)
(17) High temperatures from the southwestern USA to northwestern Mexico (all year round)
(18) High temperatures around the Caribbean Sea (June – July, November)
(19) High temperatures (January – February, September – October) and heavy precipitation (June – July, September – October) around southern Brazil
(20) High temperatures in southern Australia (May, September – October)

(Ayako Takeuchi, Tokyo Climate Center)

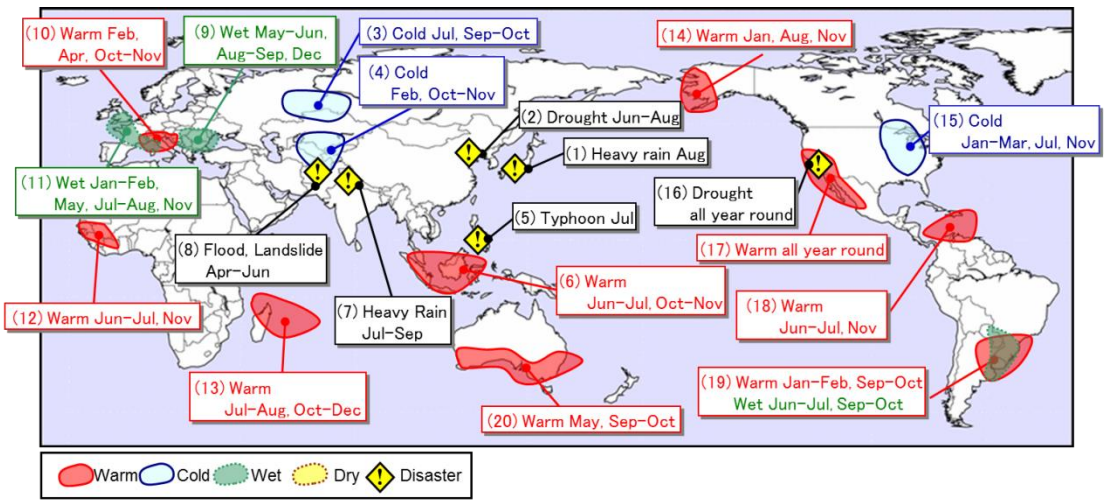


Figure 6 Major extreme climate events and weather-related disasters across the world in 2014
Major extreme climate events and weather-related disasters that occurred during the year are indicated schematically.

Summary of Japan's Climatic Characteristics in 2014

- **Annual mean temperatures were near normal all over Japan. Annual precipitation amounts were above normal in many regions of the country, and were below normal in Okinawa/Amami. Annual sunshine durations were significantly above normal on the Pacific side of northern Japan and eastern Japan, and were below normal in western Japan.**
- **Western Japan experienced cool, wet summer conditions for the first time since 2003.**
- **Hazardous extremely heavy rains were observed in some areas nationwide from late July to August.**
- **Two record-breaking heavy snowfall events hit the Kanto Koushin region in February.**

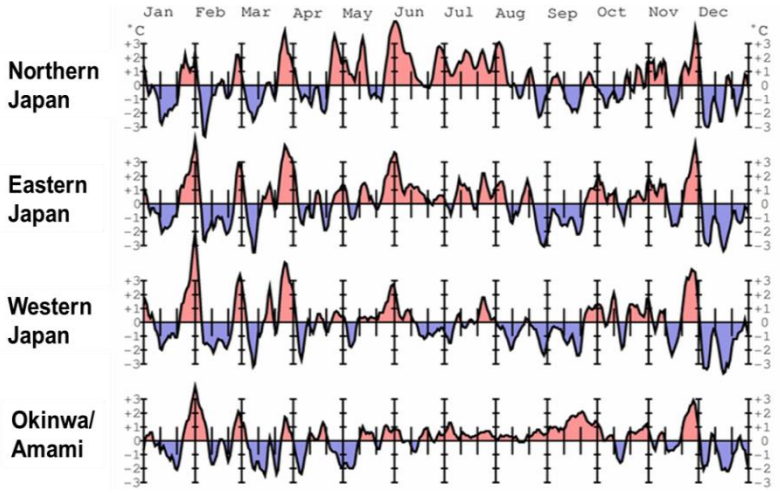


Figure 7 Time series of five-day running mean temperature anomalies for subdivisions (January – December 2014)
The normal is the 1981 – 2010 average.

(1) Annual characteristics

The annual mean temperature over Japan was near normal. Although all regions of the country experienced above-normal temperatures for several months, temperatures fluctuated periodically with largely below-normal temperature periods. Migratory high-pressure systems were dominant and brought sunny weather to northern and eastern Japan mainly in spring and autumn, while a number of typhoons and developed cyclones brought high precipitation amounts there.

(2) Seasonal characteristics

(a) Winter (December 2013 – February 2014)

Although the strength of the winter monsoon was near normal, snowfall amounts were significantly below normal on the Sea of Japan side of Japan. Meanwhile, the Pacific side of eastern Japan was hit by two heavy snowfall events in February, with maximum snow depths significantly exceeding previous records at many stations in the Kanto Koushin region.

(b) Spring (March – May)

Migratory high-pressure systems were dominant over the main islands of Japan, bringing more sunny days than normal to northern, eastern and western Japan and cold air advection to Okinawa/Amami.

(c) Summer (June – August)

The expansion of the Pacific High to western Japan was weaker than normal. This part of Japan experienced cool summer conditions for the first time since 2003, and sunshine durations were the lowest for August since 1946 on the Pacific side of western Japan. Hazardous extremely heavy rains were observed in some areas nationwide due to active fronts and typhoons from late July to August.

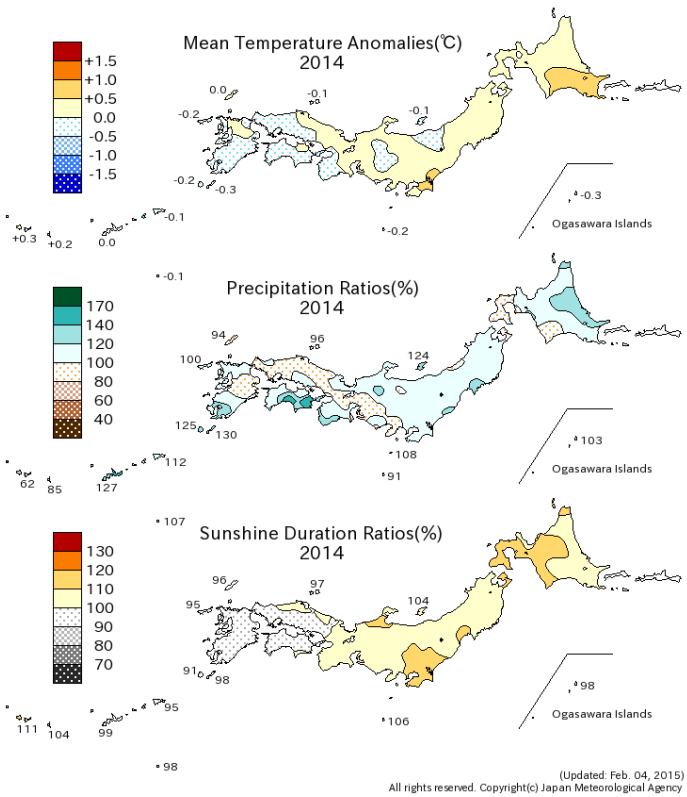


Figure 8 Annual climate anomaly/ratio for Japan in 2014

(d) Autumn (September – November)

Migratory high-pressure systems were dominant over northern Honshu and brought the highest sunshine durations since 1946 to the Sea of Japan side of eastern Japan. The Pacific High covered the Sakishima Islands, bringing hot dry conditions to the area from the second half of summer to the first half of autumn.

(Norihisa Fujikawa, Climate Prediction Division)

TCC Training Seminar on Global Warming Projection Information

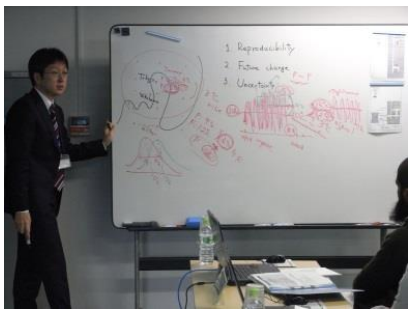
JMA's Tokyo Climate Center (TCC) assists National Meteorological and Hydrological Services (NMHSs) in improving their climate services. The Center's two major activities in this regard involve providing basic climate data and products to NMHSs through its website and assisting with capacity development at NMHSs in the Asia-Pacific region. TCC holds annual training seminars as part of capacity development activities related to its role as an RCC in the WMO RA II area. In addition to running annual training seminars, it arranges expert visits to and hosts visitors from NMHSs to support discussions on cli-mate services and the effective transfer of technology.

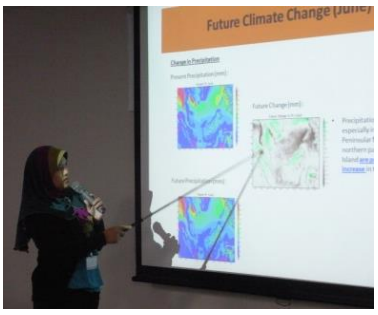
In fiscal year 2014, TCC held the Training Seminar on Global Warming Projection Information from 26 to 30 January 2015 at JMA Headquarters in Tokyo. The event was attended by 13 experts from NMHSs in Bangladesh, Cambodia, Hong Kong (China), Indonesia, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Nepal, the Philippines, Sri Lanka, Thailand and Viet Nam. The seminar focused on enhancing knowledge regarding global warming and related issues, and on improving individual countries' capacity for the generation of global warming projection information. The teaching involved lectures and practical exercises using one of the latest results of global warming projection. The participants generated global warming projection information for their own countries using JMA's JRA-55 reanalysis data and 20-km-resolution MRI-AGCM data produced by JMA's Meteorological Research Institute (MRI) under Theme C of the Program for Risk Information on Climate Change (also known as SOUSEI) – an initiative supported by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT).

At the end of the seminar, all attendees gave presentations on the results of their exercises and engaged in fruitful discussions with the lecturers and other participants. The content of the lectures is available on the TCC website at http://ds.data.jma.go.jp/tcc/tcc/library/library2014.html.

Attendees also listened to lectures by Co-Chairs of IPCC Working Groups at the Symposium "Science on Climate Change and our Future" organized by Japan's Ministry of the Environment. JMA and MEXT were among its co-organizers.

(Atsushi Goto, Tokyo Climate Center)





TCC Activity Report for 2014

In 2014, the Tokyo Climate Center (TCC) continued to support the climate services of NMHSs in Asia-Pacific countries by providing and enhancing data and products, holding training seminars, sending experts and hosting visitors.

1. Highlights of 2014

1.1 Contribution to the Global Framework for Climate Services (GFCS)

At its 15th session held in Doha, Qatar in December 2012, the WMO Regional Association recognized that the implementation of the GFCS depends on the sharing of good practices and lessons learned (including advanced project management capabilities), the development of projects and the improvement of climate services provided by NMHSs. Toward the achievement of these aims, the new Pilot Project for Information Sharing on Climate Services was adopted. TCC plays a leading role in the implementation of the Project, and started collecting information from NMHSs in 2013. Based on the data received, the Center has developed a new dedicated website to support the sharing of information on climate services provided by NMHSs and on their Framework-related activities. The website (http://ds.data.jma.go.jp/tcc/pilot/) was officially launched on 31 March 2014, and is kept updated. RAII Members are encouraged to inform TCC of any updates on their related activities.

The GFCS is intended to enable better management of climate-related risk. As reported in TCC News No. 38, JMA has also developed a new website for climate risk management (CRM) (http://www.data.jma.go.jp/gmd/risk/en/index.html), which is linked to the TCC website. The new website includes information on the following to support CRM activities in Japan:

- Clarification of the basic CRM concept and related processes
- Good practices in CRM conducted by JMA together with partner organizations in the agriculture and apparel/fashion industries

1.2 New provision of "Monthly Discussion on Seasonal Climate Outlooks"

On 25 March 2014, TCC started providing a new product called Monthly Discussion on Seasonal Climate Outlooks on its web page (http://ds.data.jma.go.jp/tcc/tcc/products/model/index.html). This website is intended to assist NMHSs in the Asia-Pacific region in interpreting and assessing products from the Global Producing Center of Long-range Forecasts (GPC) Tokyo for three-month prediction and warm/cold season prediction, and to facilitate understanding of current climate system conditions. (TCC News No.36)

1.3 New Forecast Products in Support of Early Warnings for Extreme Weather Events

Early warnings for extreme events on a sub-seasonal time scale are of great benefit in socio-economic activities such as mitigating the effects of floods and heatwaves and ensuring appropriate food and water supplies. TCC has developed a set of extreme weather warning products for phenomena such as high/low temperatures, heavy precipitation/drought conditions, and strong winds, based on JMA's operational one-month ensemble prediction system (EPS) to support the provision of early warnings for extreme events. The products include maps of the Extreme Forecast Index (EFI), extreme weather warnings based on the EFI, and probabilistic forecasts for extreme conditions together with an EPSgram covering the period up to two weeks ahead. On 28 August 2014, TCC started providing the new forecast products via the TCC website (TCC News No.38).

1.4 Issuance of special reports on extreme events

In its role as a WMO Regional Climate Center (RCC) in RA II, TCC monitors world climate conditions with focus on Asia and the surrounding area. The Center issues reports on extreme climate events and summaries of the Asian summer/winter monsoon on its website at http://ds.data.jma.go.jp/tcc/tcc/products/clisys/reports/index.html.

In August 2014, Japan experienced unseasonable weather. In particular, the western part of the country saw record-high precipitation and record-low sunshine durations. TCC invited members of its Advisory Panel on Extreme Climate Events (TCC News No. 28) to investigate and discuss possible factors related to these unseasonable conditions. Based on its deliberations, the Panel issued a statement on primary factors causing the cloudy and rainy conditions observed. The statement and detailed analysis were issued in Japanese and English on the JMA website, and the English versions were also made available on the TCC website (http://ds.data.jma.go.jp/tcc/tcc/news/press_20140903.pdf).

TCC also closely monitored the extreme events listed below and a number of others, and issued related media releases in Japanese. These are available on the JMA website at http://www.data.jma.go.jp/gmd/cpd/monitor/extreme_world/index.html.

- Extreme cold in northern America in December 2013 and January 2014
- Drought in the southwestern US starting in January 2013

In its role as an RCC in RA II, TCC informed WMO of events in the region to assist in the preparation of the WMO Statement on the Global Climate in 2014.

It is worth noting that the global temperature for 2014 was the highest since 1891 according to TCC's analysis. A preliminary report was issued on 22 December, and the final report was published in February 2015 (TCC News No.39).

1.5 Upgrade of JMA's One-month forecast model in March 2014

TCC provides one-month prediction products via the web based on JMA's Ensemble Prediction System (EPS) for operational one-month forecasting (One-month EPS). On 6 March, JMA implemented a major upgrade of the One-month EPS. Major changes to the new system include increased horizontal resolution of the Atmospheric Global Circulation Model (AGCM), improvement of its boundary conditions, and amendment of the ensemble method (TCC News No.35).

2. Enhancement of data/products/tools on the TCC website

TCC strives to continuously enhance its services in the provision of data, products and tools. In 2014, the following data and products were made available on this site:

30 January:	Upgraded version of ClimatView
10 February:	Updated hindcast gridded data for one-month forecasts
28 February:	JRA-55 data via ITACS
3 March:	Climate products (e.g., analysis charts and indices on the Asian Monsoon) generated using JRA-55 (as opposed to the previous products generated using JRA-25)
25 March:	Monthly Discussion on Seasonal Climate Outlooks
28 August:	Forecast Products in Support of Early Warnings for Extreme Weather Events, including Extreme Forecast Index (EFI) maps

Some of these were made available in response to requests by NMHSs, and are also expected to be useful to other parties. The Center will continue to accommodate requests from NMHSs wherever possible.

3. Capacity development

TCC holds annual training seminars as part of capacity development activities related to its role as an RCC in RA II. In addition to running annual training seminars, it also arranges expert visits to and hosts visitors from NMHSs to support exchanges of views on climate services and the effective transfer of technology.

3.1 Training seminar

TCC holds a training seminar each fiscal year (which runs from April to March). In 2014, preparations were made for the event to be held in January 2015. As the Fifth Assessment Report of the IPCC was issued in November 2014, the Center chose global warming as the subject of the annual event. Details of the training are reported in TCC News No. 39.

3.2 Expert visits and other follow-up activities

In June, a TCC expert visited the Department of Meteorology and Hydrology (DMH) of Myanmar in Nay Pyi Taw to assist with improvements to seasonal prediction services using numerical prediction model outputs and products available on the TCC website. The visit was planned as a follow-up to the TCC training seminar held in 2013, and also provided opportunities for DMH and TCC to discuss future collaboration. (TCC News No.37).

Other follow-up activities to previous TCC training seminars included hosting expert visits at TCC and conducting teleconferences to provide technical support.

4. International meetings

4.1 Regional Climate Outlook Forums

RCCs are expected to actively contribute to discussions in Regional Climate Outlook Forums (RCOFs). In 2014, TCC experts participated in the following RCOFs in Asia:

- Fifth session of the South Asian Climate Outlook Forum (SASCOF-5) held in Pune, India, from 22 to 23 April, and a preceding training workshop on operational seasonal prediction
- Tenth session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II (FOCRA II) held in Beijing, China, from 23 to 25 April
- Second session of the East Asia winter Climate Outlook Forum (EASCOF) held in Tokyo, Japan, from 29 to 31 October (Hosted by JMA; see 4.2 for details.)
- Third session of the ASEAN Climate Outlook Forum (ASEANCOF) held in Singapore from 17 to 19 November

TCC attendees gave presentations on seasonal predictions based on JMA's numerical model and participated in discussions toward the formulation of a consensus statement on regional forecasts.

4.2 EASCOF

From 29 to 31 October, JMA hosted the second session of EASCOF at its headquarters in Tokyo with the attendance of over 30 experts from China, Japan, Mongolia and the Republic of Korea (TCC News No.38). After the session, TCC developed a new dedicated EASCOF website in collaboration with experts from other participating countries to share presentations and reports at EASCOF sessions (http://ds.data.jma.go.jp/tcc/tcc/library/EASCOF/). The new website is linked to the WMO website and the TCC website.

4.3 Other meetings

In 2014, TCC was represented at the 16th session of the WMO Commission for Climatology (CCl-16) (July, Heidelberg, Germany) and the 2nd session of the Intergovernmental Board on Climate Services (IBCS-2) (November, Geneva, Switzerland). In conjunction with CCl-16 and the 35th Meeting of the Joint Scientific Committee of the World Climate Research Programme, the WMO Technical Conference on Climate Services- Building on CLIPS Leg-

acy was held. At this event, TCC made a presentation on support from research for the operational activities of RCCs as well as a poster presentation on JRA-55. TCC experts also participated in the 16th Session of the Commission for Agricultural Meteorology (CAgM-16) (April, Antalya, Turkey), giving two poster presentations on JMA's contribution to improving climate risk management in Japan's agricultural sector and an introduction to JRA-55.

5. Publications

TCC has published its newsletter (TCC News) on a quarterly basis since 2005. The publication is intended to enhance communication and provide information to NMHSs and related communities about recent TCC developments, events and activities as well as details of the Center's reports on the state of the climate, monitoring results and outlooks. In 2014, TCC News No. 35 and No. 38 were issued and made available online by TCC.

Other English-language publications related to the climate, such as Climate Change Monitoring Report 2013 and Annual Report on the Climate System 2013, were also published by TCC on the Web.

6. Staff changes

Ryuji Yamada, who served as a TCC focal point for foreign colleagues for a number of years, moved to the WMO Secretariat in October to work as Programme Manager at the Regional Office for Asia and the South-West Pacific (RAP; part of WMO's Development and Regional Activities Department (DRA)). His position was taken over by Atsushi Goto, who also assumed his responsibilities as a member of the RCC's CCl Expert Team.

7. Plans for 2015

- Contribution to the Global Framework for Climate Services (GFCS)

RCCs are expected to play a major role in the implementation of the GFCS, and TCC plans to further strengthen its activities to lead RA II's contribution to the Framework. Such activities include further assistance to NMHSs for the provision of better climate services, as well as maintenance and updating of the portal site for the Pilot Project for Information Sharing on Climate Services.

- New/upgraded data, products and tool

TCC plans to implement a major upgrade of its Seasonal Ensemble Prediction System for operational three-month and warm/cold season forecasting by the summer of 2015.

Taking advantage of the JRA-55 long-term reanalysis dataset, investigation of ENSO's impact on the global climate is underway. Teleconnection indices (e.g., the Arctic Oscillation Index) are also being developed using JRA-55 to enhance monitoring of atmospheric circulation. TCC plans to make the investigation results and the indices available online in 2015.

TCC further plans to upgrade the Interactive Tool for Analysis of the Climate System (ITACS) to version 5.0 in 2015. The new version will have a renovated Graphical User Interface (GUI) to reduce network traffic and user burdens, and will feature a new function enabling the generation of one-month probabilistic forecasts at station points based on the Model Output Statistics (MOS) technique with 30-year (1981 – 2010) hindcasts. These upgrades are expected to provide ITACS users with a more convenient operational environment and to be more useful in application.

TCC is additionally working on the development of information/products based on the Standard Precipitation Index (SPI) for improved monitoring of drought around the world.

- Capacity development

In the last quarter of the year, TCC will hold its annual training seminar with a dozen invited experts as attendees. The Center will also continue to dispatch experts to NMHSs as necessary and host visitors from NMHSs upon request.

(Teruko Manabe, Tokyo Climate Center)

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.

(Editors: Teruko Manabe, Atsushi Goto and Yasushi Mochizuki)

Tokyo Climate Center (TCC), Japan Meteorological Agency
Address: 1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122, Japan
TCC Website: http://ds.data.jma.go.jp/tcc/tcc/index.html