# Monthly Highlights on the Climate System (July 2016)

Highlights in July 2016
- The monthly anomaly of the global average surface temperature was the highest since 1891.
- In the equatorial Pacific, remarkably positive SST anomalies were observed in the western part, and remarkably negative SST anomalies were observed from the central to eastern parts.
- Convective activity was enhanced over the eastern Indian Ocean and the central part of the equatorial South Pacific, and suppressed over the western equatorial Indian Ocean, the western Pacific and the equatorial North Pacific.
- The westerly jet stream was displaced northward of its normal position from the Korean Peninsula to the Sea of Japan.
- Monthly mean temperatures were significantly above normal in Okinawa/Amami.

## Climate in Japan:

In the first half of the month, heavy rains were often observed in Kyushu due to active Baiu fronts and moist air flow. In the second half of the month, temperatures were below normal and cloudy days were dominant in the Pacific side of Northern and Eastern Japan due to easterly cool and wet winds. In Okinawa/Amami, monthly mean temperatures tied with 2007 and 2003 as the highest for July since 1946 and monthly sunshine durations were above normal.

## World Climate:

The monthly anomaly of the global average surface temperature in July 2016 (i.e., the combined average of the near-surface air temperature over land and the SST) was +0.44 °C (the warmest since 1891) (preliminary value) (Fig. 2). On a longer time scale, global average surface temperatures have risen at a rate of about 0.68 °C per century in July (preliminary value).

Extreme climate events were as follows (Fig. 3).
- Monthly mean temperatures were extremely high from northeastern China to central Mongolia.
- Monthly mean temperatures were extremely high from southwestern Iran to the western Arabian Peninsula.
- Monthly mean temperatures were extremely high in the northern part of South America and monthly precipitation amounts were extremely low in northern Venezuela and eastern Brazil.

## Extratropics:

In the 500-hPa height field (Fig. 4), wave trains were seen over northern Eurasia. Positive height anomalies were seen over and around the Kamchatka Peninsula and negative height anomalies were seen to the east of Japan. The westerly jet stream was displaced northward of its normal position from the Korean Peninsula to the Sea of Japan, and southward to the east of Japan (Fig. 5). The westward extension of the Pacific High was weaker than normal over and around eastern Japan and negative sea level pressure anomalies were seen to the southeast of Japan. In most of the troposphere, especially in mid- to high latitudes of the Northern Hemisphere, zonal mean air temperatures were above normal.

## Tropics:

Convective activity was enhanced over the eastern Indian Ocean and the central part of the equatorial South Pacific. It was suppressed over the western equatorial Indian Ocean, the western Pacific and the equatorial North Pacific (Fig. 6). The active phase of the Madden-Julian Oscillation (MJO) propagated eastward over the area from the Pacific to the Indian Ocean from early to mid-July (Fig. 7). In the lower troposphere, cyclonic circulation anomalies straddling the equator were seen over the Indian Ocean and anticyclonic circulation anomalies were seen over the area from the South China Sea to the seas south of Japan. In the upper troposphere, cyclonic circulation anomalies were seen over the South China Sea (Fig. 8). The Southern Oscillation Index value was +0.6 (Fig. 10).

## Oceanographic Conditions:

In the equatorial Pacific, remarkably positive SST anomalies were observed in the western part, and remarkably negative SST anomalies were observed from the central to eastern parts. The monthly mean SST anomaly in the NINO.3 region was -0.5˚C and the SST deviation from the latest sliding 30-year mean was -0.6˚C. In the North Pacific, remarkably positive SST anomalies were observed in almost the entire region except along 30˚N where negative SST anomalies were observed. In the South Pacific, remarkably positive SST anomalies were observed from the eastern coast of Australia to near 35˚S, 155˚W, from west of Peru to near 5˚S, 170˚E, and from near 55˚S, 115˚W to near 40˚S, 75˚W. In the Indian Ocean, positive SST anomalies were observed in most of the tropical region east of 70˚E, and they were remarkable from the central to eastern parts of the southern tropical Indian Ocean, and in the Bay of Bengal. On the other hand, remarkably negative SST anomalies were observed near the eastern coast of Somalia. In the North Atlantic, remarkably positive SST anomalies were observed from the eastern coast of North America to near 30˚N, 45˚W, and from the northern coast of South America to near 15˚N, 30˚W.

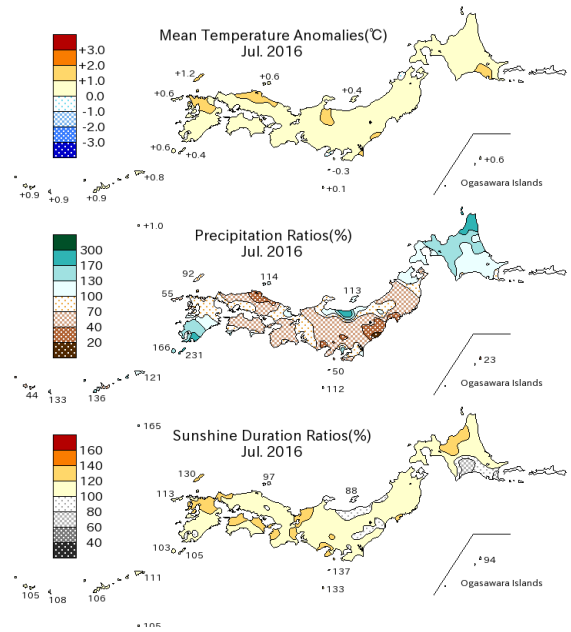


Fig. 1 Monthly climate anomaly / ratio over Japan (July 2016)
Top: temperature anomalies (degree C)
Middle: precipitation ratio (%)
Bottom: sunshine duration ratio (%)
Anomalies are defined as the deviations from the normal (1981-2010 average).

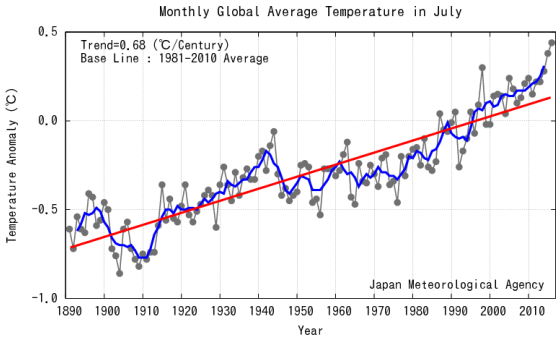


Fig. 2 Long-term change in monthly anomalies of global average surface temperature in July
The thin black line indicates anomalies of the surface temperature in each year. The blue line indicates five-year running mean, and the red line indicates a long-term linear trend. Anomalies are deviations from the 1981-2010 average.

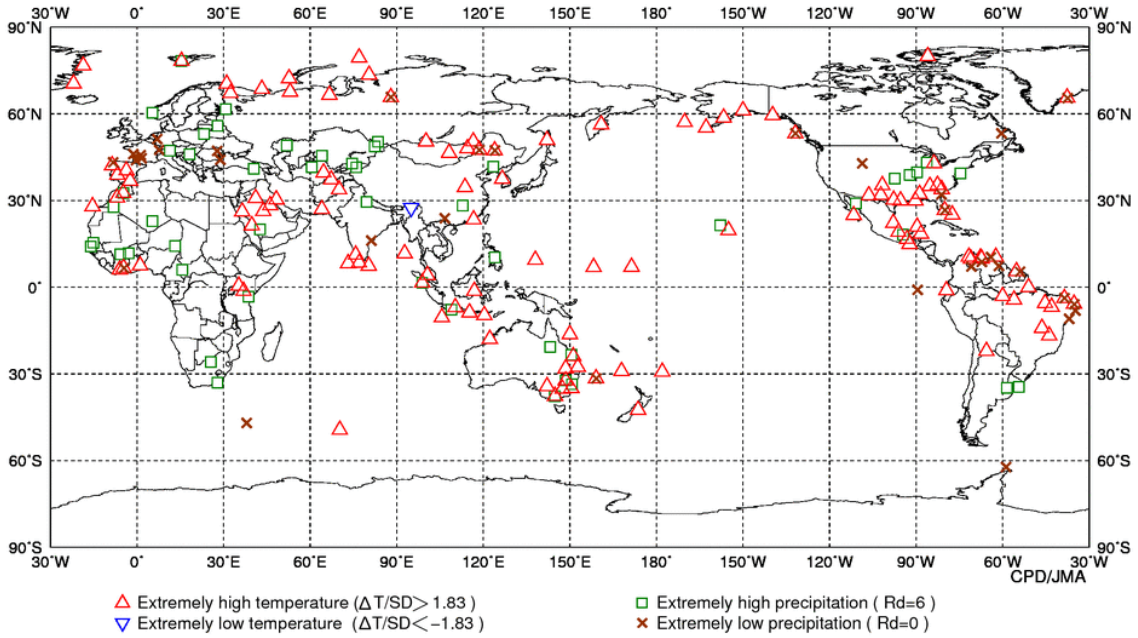


Fig. 3 Distribution of extreme climate events (July 2016)

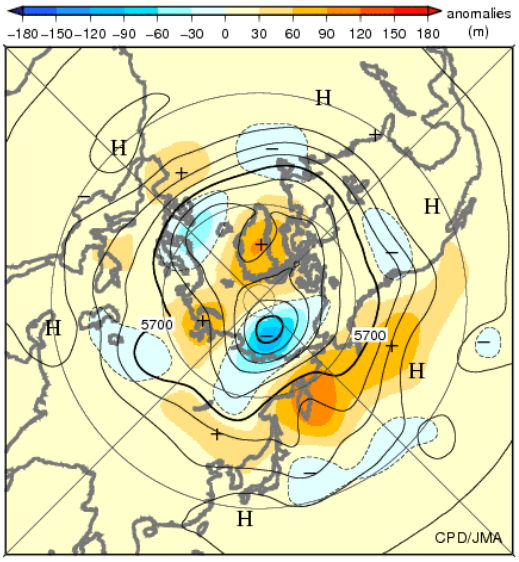


Fig. 4 Monthly mean 500-hPa height and anomaly in the Northern Hemisphere (July 2016)
The contours show heights at intervals of 60 m. The shading indicates height anomalies. The base period for the normal is 1981-2010.

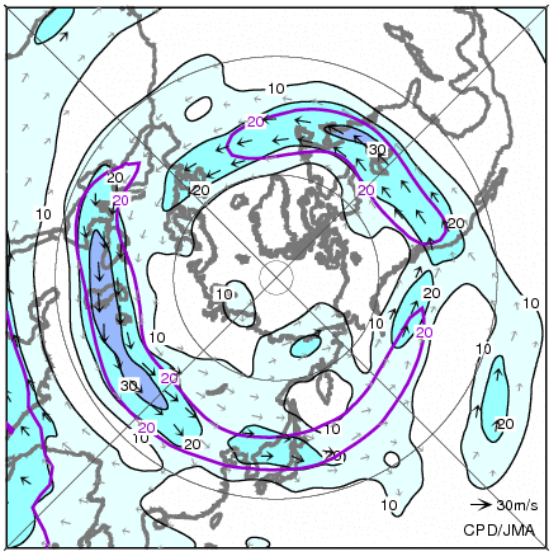


Fig. 5 Monthly mean 200-hPa wind speed and vectors in the Northern Hemisphere (July 2016)
The black lines show wind speeds at intervals of 10 m/s. The purple lines show normal wind speeds at intervals of 20 m/s. The base period for the normal is 1981-2010.

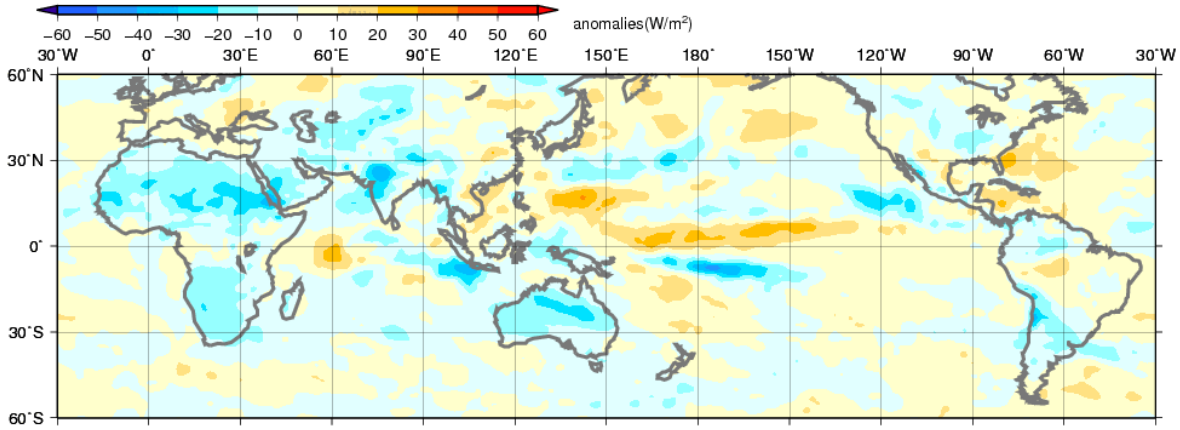


Fig. 6 Monthly mean Outgoing Longwave Radiation (OLR) anomaly (July 2016)
The contour interval is 10 W/m$^2$. The base period for the normal is 1981-2010. Original data provided by NOAA.

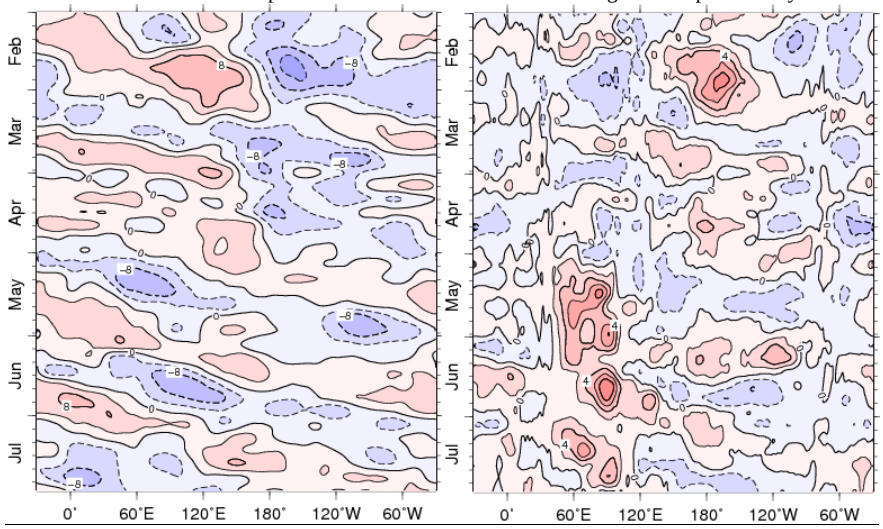


Fig. 7 Time-Longitude cross section (5°N-5°S) of five-day running mean 200-hPa velocity potential anomaly (left) and 850-hPa zonal wind anomaly (right) (February 2016 – July 2016)
The contour intervals are 4x10$^6$ m$^2$/s (left) and 2 m/s (right). The base period for the normal is 1981-2010.

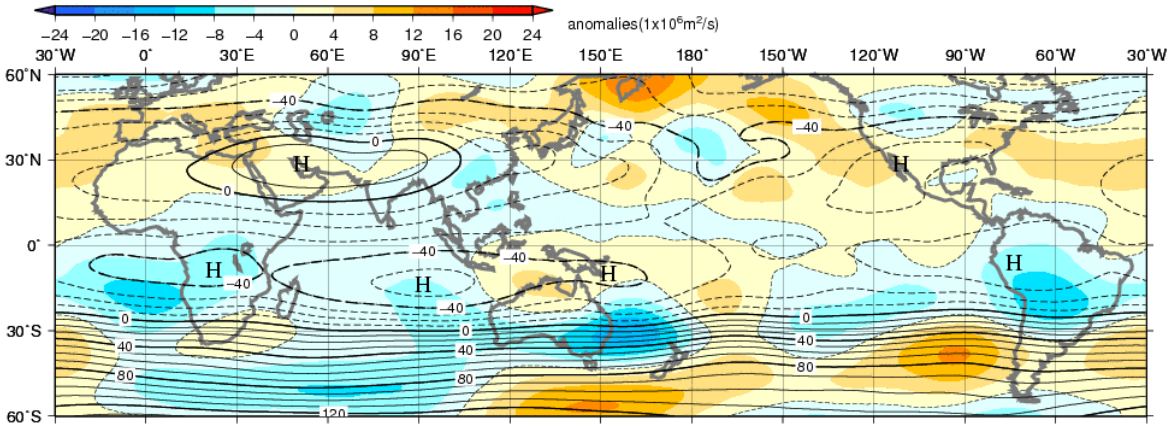


Fig. 8 Monthly mean 200-hPa stream function and anomaly (July 2016)

The contour interval is $10x10^6$ $m^2/s$. The base period for the normal is 1981-2010.

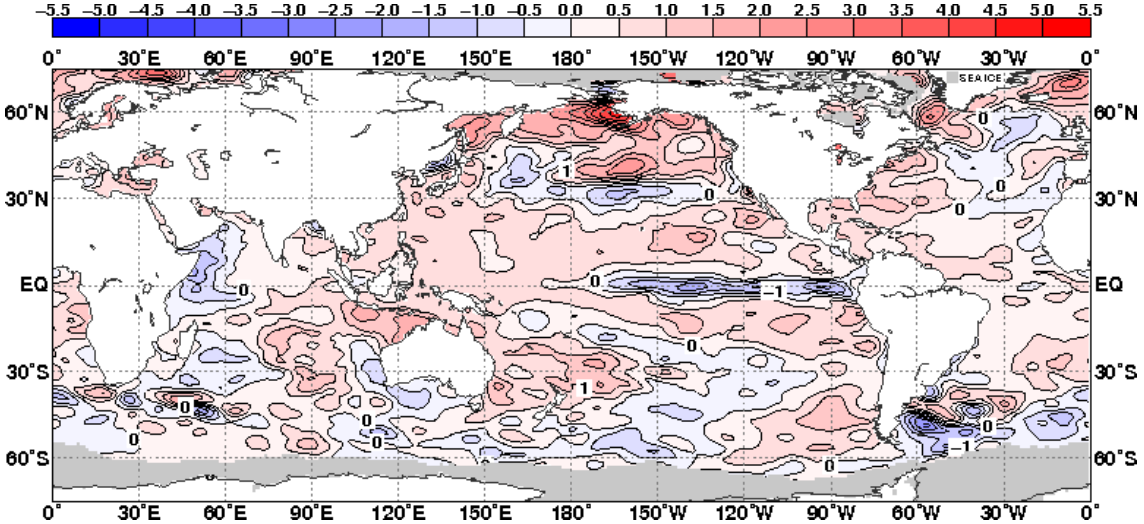


Fig. 9 Monthly mean sea surface temperature anomaly (July 2016)

The contour interval is 0.5 degree C. The base period for the normal is 1981-2010. Maximum coverage with sea ice is shaded in gray.

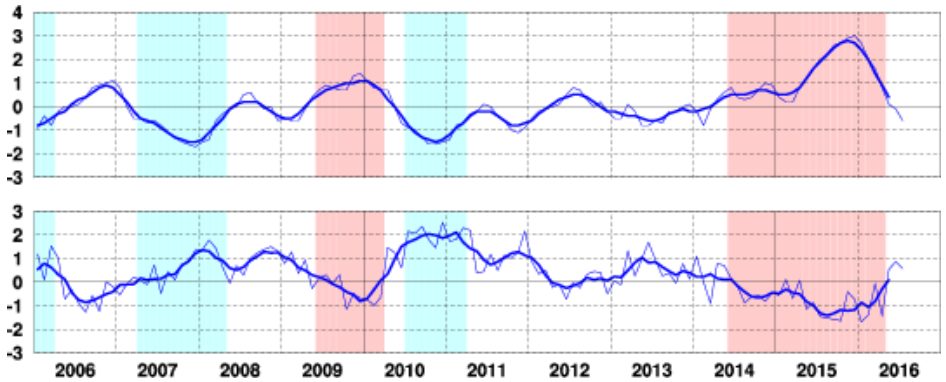


Fig. 10 Time series of monthly mean SST departure (degree C) from the reference value defined as the immediate past 30-year mean SST averaged over the NINO.3 region (upper). Time series of the Southern Oscillation Index with respect to the 1981-2010 base period (lower).

Thin blue lines represent monthly means and thick blue lines five-month running means. Periods of El Niño and La Niña events are shown as red-colored and blue-colored boxes, respectively.

Detailed information on the climate system is available on the Tokyo Climate Center's website.

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

This report is prepared by the Climate Prediction Division, Global Environment and Marine Department, Japan Meteorological Agency.