Unseasonable weather conditions in Japan in August 2014

– Summary of analysis by the TCC Advisory Panel on Extreme Climatic Events –

In an extraordinary session held at the Japan Meteorological Agency on 3 September 2014, the TCC Advisory Panel on Extreme Climatic Events[1] issued a statement on primary factors causing the cloudy and rainy conditions observed in Japan in August 2014.

- In August 2014, western Japan experienced record-high precipitation and record-low sunshine durations. From 30 July to 26 August, heavy rainfall events were observed throughout the country.
- These weather conditions were caused by continuous southerly warm moist air flow in association with two typhoons moving northward near or over western Japan from late July to early August and with the southward shift and significant meandering of the jet stream around Japan from mid- to late August. This meandering is considered partially attributable to suppressed Asian monsoon activity in association with above-normal sea surface temperatures in the eastern Pacific and the eastern Indian Ocean as well as tropical intra-seasonal oscillation.[2]

1. Climatic characteristics (Figures 1 and 2, Table 1)

After 30 July 2014, cloudy and rainy conditions were prominent nationwide except in Okinawa/Amami and the Kanto region.

The monthly precipitation ratio to the normal averaged over the Pacific side of western Japan for August 2014 was 301%, which was the highest since 1946 when collection of the area-averaged statistical data referenced here began. Monthly precipitation ratios were also significantly above normal in northern Japan and on the Sea of Japan side of eastern and western Japan. Heavy rain was brought by two typhoons, fronts and moist air flow, resulting in record-high precipitation at observation stations from Hokkaido in the north to Kyushu in the south.

The monthly sunshine duration ratio to the normal averaged over the Pacific side of western Japan was 54%, which was the lowest since 1946. The ratio averaged over the Sea of Japan side of western Japan was 42%, which was the second lowest after 1980, and the figure was also significantly below normal over eastern Japan.

[1] The Advisory Panel, consisting of prominent experts on climate science from universities and research institutes, was established in June 2007 by JMA to investigate extreme climate events based on up-to-date information and findings. See TCC News No. 9 and No. 28.

[2] In the tropics, enhanced and suppressed areas of large-scale cumulus convection appear alternately in cycles of 30 to 60 days.

Table 1 Regional averages and related rankings of monthly precipitation ratios and monthly sunshine duration ratios for August 2014

August		Precipitation ratio (%) 2014		Precipitation ratio (%) Record high	(year)	Sunshine duration ratio (%) 2014		Sunshine duration ratio (%) Record low	(year)
Northern Japan	Sea of Japan side	171	[3]	264	(1981)	94		61	(1998)
	Pacific side	156		222	(1998)	94		58	(1998)
Eastern Japan	Sea of Japan side	234	[3]	279	(1976)	58		49	(1993)
	Pacific side	121		209	(1982)	75		54	(1980)
Western Japan	Sea of Japan side	242	[3]	301	(1980)	42	[2]	41	(1980)
	Pacific side	301	[1]	231	(2004)	54	[1]	57	(1980)
Okinawa and Amami		76		252	(2012)	93		73	(1960)

*The numbers in square brackets indicate the ranking for August 2014 since 1946. Rankings of precipitation ratios and sunshine duration ratios are shown in descending and ascending order, respectively.

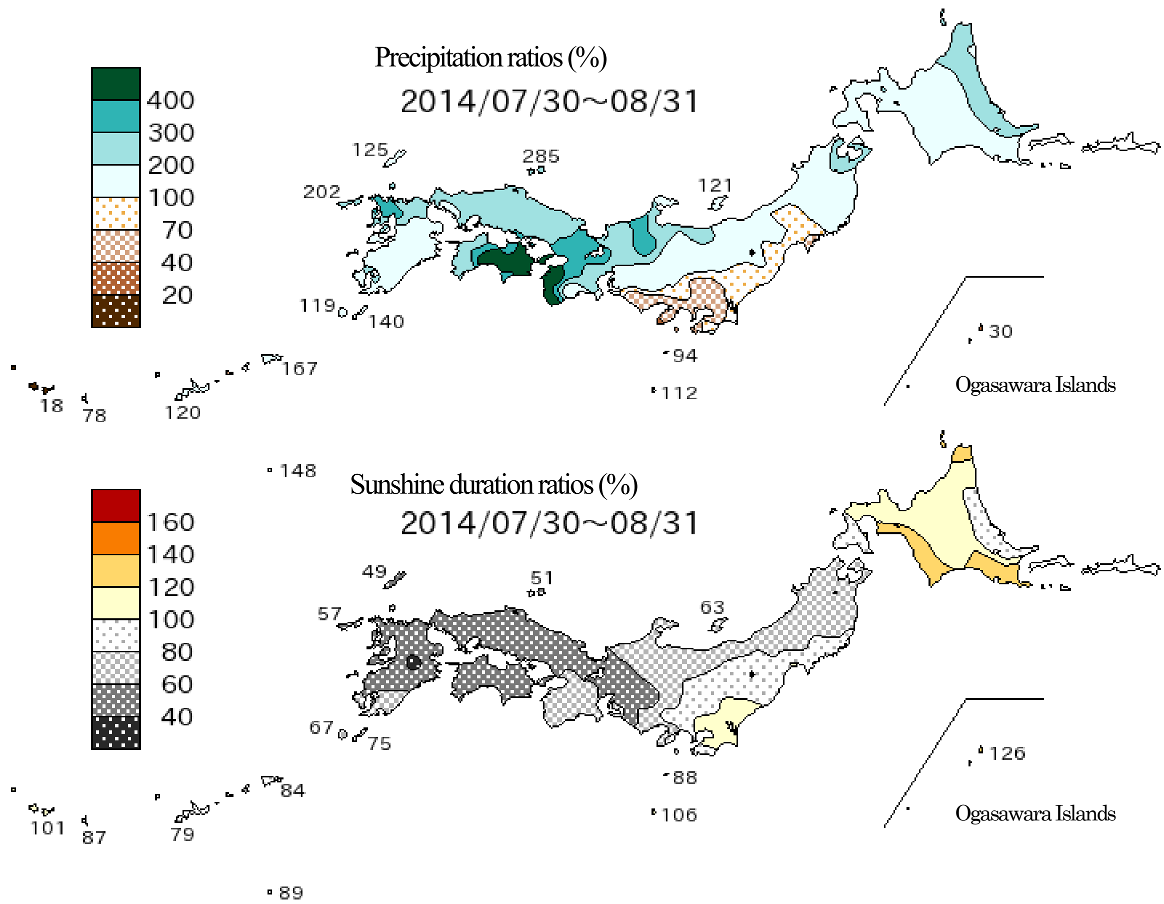


Figure 1 Precipitation ratios and sunshine duration ratios for the period from 30 July to 31 August 2014

The base period for the normal is 1981 – 2010.

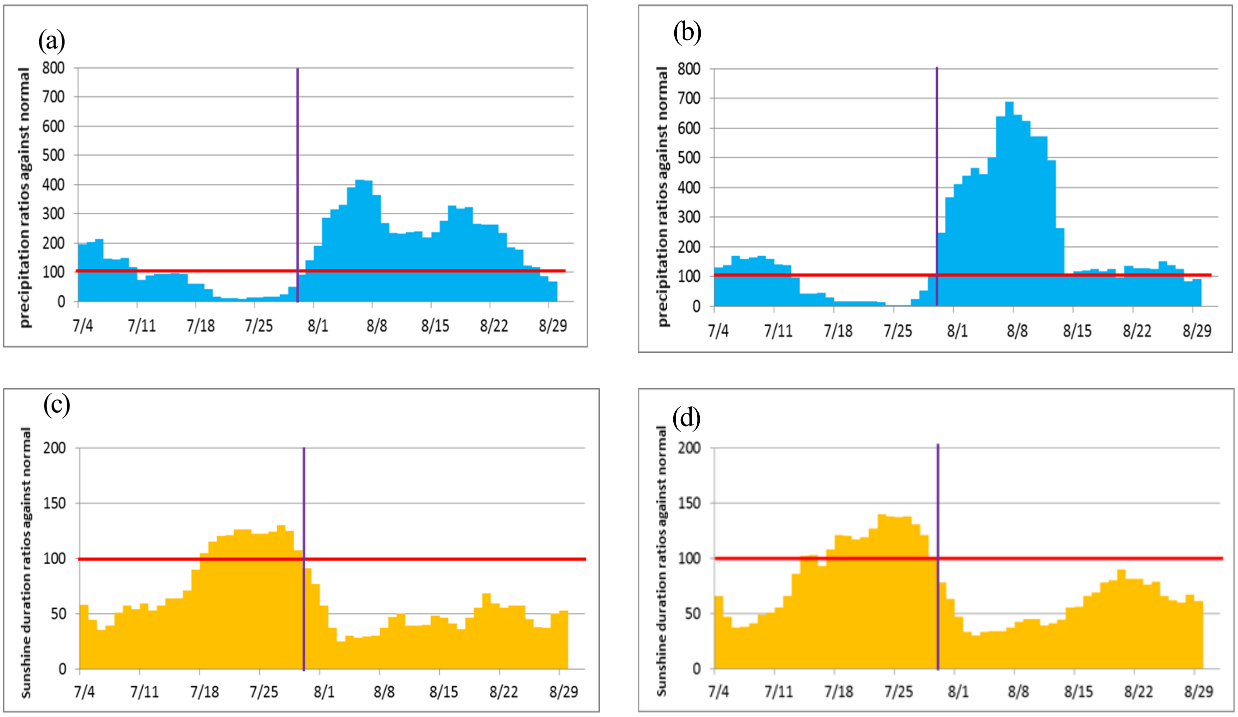


Figure 2 (a) Seven-day running mean precipitation ratios for the Sea of Japan side of western Japan. (b) As per (a), but for the Pacific side of western Japan. (c) As per (a), but for sunshine duration ratios. (d) As per (b), but for sunshine duration ratios. The red horizontal lines indicate the ratio of 100% to the normal. The purple lines indicate 30 July. The base period for the normal is 1981 – 2010.

<u>2. Characteristic atmospheric circulation causing Japan's unseasonable weather conditions (Figure 3)</u>

(1) General characteristics from late July to August 2014

From late July to August 2014, the Pacific High was enhanced to the southeast of mainland Japan and its westward expansion was weaker than normal, which brought continuous southerly warm moist air flow to the country.

From late July to early August 2014, Typhoon Nakri and Typhoon Halong approached Japan in quick succession. After early August, fronts that tended to linger around the nation's mainland brought above-normal precipitation amounts and below-normal sunshine durations over a wide area of western Japan and other parts of the country, and heavy rainfall events were observed nationwide.

(2) Late July to early August 2014

The subtropical jet stream was shifted northward of its normal position around Japan. As a result, Typhoon Nakri did not turn eastward after approaching Japan due to the jet stream's diminished effect. The lasting effects of the typhoon were felt in western and other parts of Japan even after its transformation into an extratropical cyclone.

The Pacific High was enhanced to the southeast of mainland of Japan, which facilitated warm moist air flow over the country along the periphery of the Pacific High. Heightened convective activity around the Philippines is thought to have contributed to the enhanced Pacific High.

(3) Mid- to late August 2014

Typhoon Halong moved slowly northward in the area to the south of western Japan and made landfall over Shikoku on 10 August. After passing over western Japan, it continued northward over the Sea of Japan. In early August, the subtropical jet stream began to shift southward of its normal position around Japan before meandering significantly (i.e., southward meandering to the west of Japan and northward meandering to the east of Japan) toward the middle of the month. In association, fronts tended to linger near the nation's mainland. While the Pacific High was enhanced to the southeast of Japan, its westward expansion was weak. Suppressed cumulus convection over the Asian monsoon region (Southeast Asia and South Asia) in association with the tropical intra-seasonal oscillation is considered to have contributed to the southward shift and meandering of the jet stream.

While convective activity around the Philippines was enhanced during early August, it subsequently became suppressed and continued in this condition. A contributory factor to this situation is considered to be the influence of downward air flow over the western part of the Pacific including the Philippines in association with upward air flow caused by enhanced convective activity in association with above-normal sea surface temperatures in the eastern Pacific and the eastern Indian Ocean. The influence of tropical intra-seasonal oscillations is seen as another contributory factor.

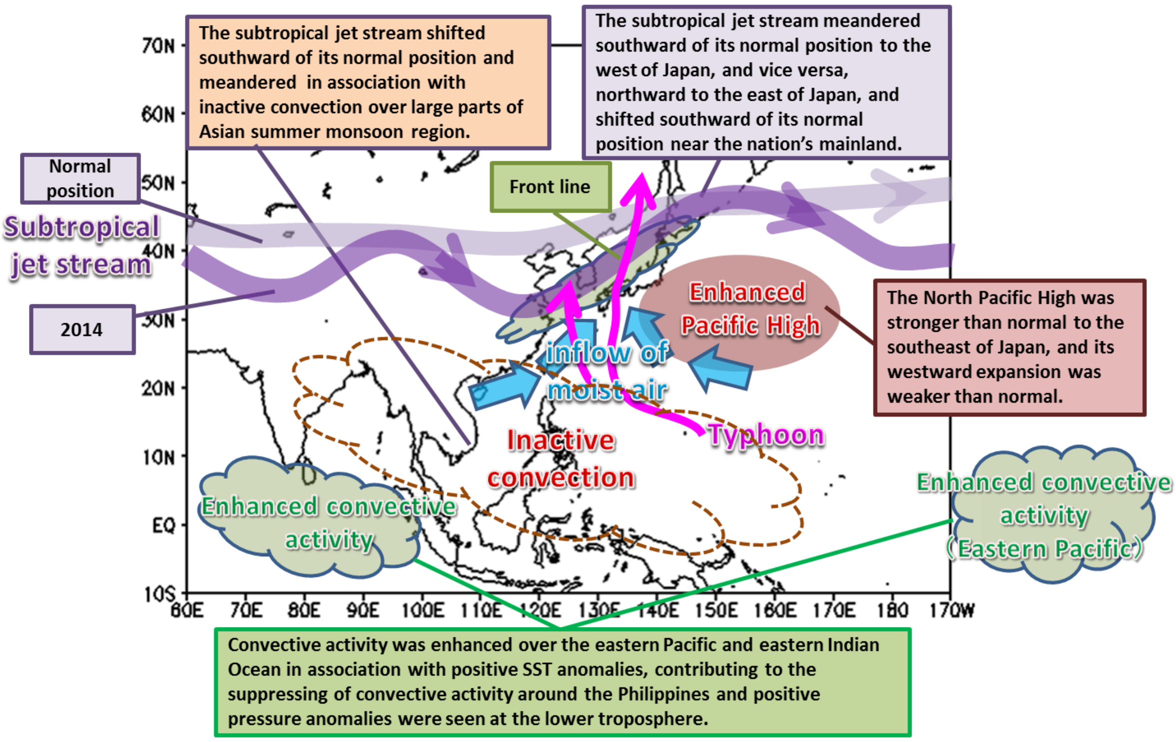


Figure 3 Primary factors contributing to the unseasonable weather conditions of August 2014 in Japan

In association with positive anomalies of lower tropospheric pressure related to suppressed convective activity around the Philippines, southwesterly warm moist air flow in the lower troposphere from the South China Sea to the East China Sea was predominant, while westerly flow from the South China Sea to the Pacific east of the Philippines is seen in normal years. This southwesterly flow is considered to have contributed to the enhancement of warm moist air inflow over Japan.

3. Long-term trends of extreme precipitation events (Figures 4 and 5)

JMA operationally observes precipitation at around 1,300 unmanned regional meteorological observation stations all over Japan (collectively known as the Automated Meteorological Data Acquisition System, or AMeDAS). The annual[3] and monthly (August) numbers of events[4] with precipitation exceeding 50 mm/hour and 80 mm/hour observed at AMeDAS stations are likely to have increased (Figure 4). Data on water vapor presence in Japan based on upper-air observation also show an increasing trend (Figure 5). According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), extreme precipitation events over most mid-latitude land masses will very likely become more intense and more frequent, and the amount of water vapor in the air will likely increase by 5 to 25% by the end of this century as global mean surface temperatures rise.

From the above, it can be inferred that the increasing trend seen in the number of extreme precipitation events may be linked to global warming. As the period covered by observation records is still relatively short, the addition of future data series is expected to allow further clarification regarding the increasing trend's relationship with global warming.

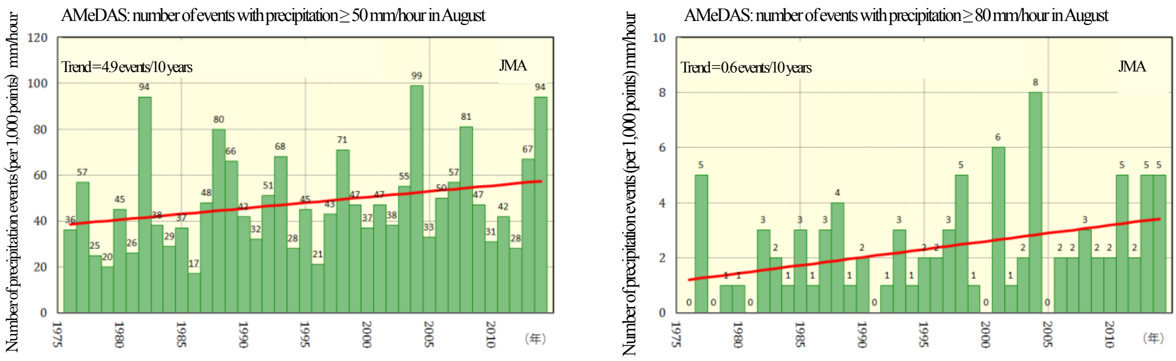


Figure 4 Number of events with precipitation greater than or equal to 50 mm/hour (left) and 80 mm/hour (right) in August from 1976 to 2014 (per 1,000 Automated Meteorological Data Acquisition System (AMeDAS) points)
The green bars indicate values for each year, and the straight red lines indicate the long-term linear trend (statistically significant at a confidence level of 90%).

[3] See Figure 2.2-7 of the Climate Change Monitoring Report 2013 http://www.data.jma.go.jp/cpdinfo/monitor/2013/pdf/ccmr2013_all.pdf.
[4] There were around 800 AMeDAS stations in 1976, gradually increasing to around 1,300 by 2012. To account for these numerical differences, the number of precipitation events is converted to a per-1,000-station basis.

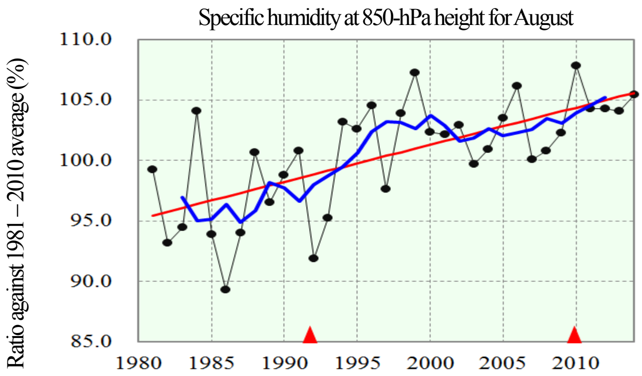


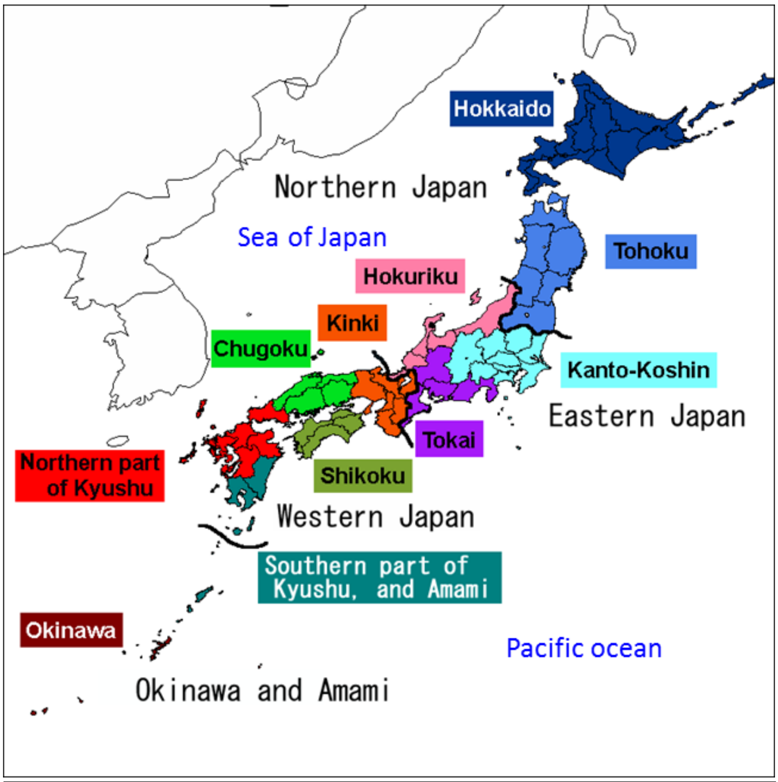
Figure 5 Time-series representations of specific humidity ratios for summer (June – August) at 850 hPa from 1981 to 2014 in Japan

The data are presented as ratios against the baseline (the 1981 – 2010 average).

Note: The term *specific humidity* refers to the mass of water vapor in a unit mass of moist air (g/kg). The data used in this analysis were based on observations made using radiosondes (balloon-borne instrument platforms with a radio-transmitting device) at 13 upper-air observation stations in Japan. The dots show the averages of the data for the 13 stations. The thick blue line indicates the five-year running mean, and the straight red line indicates the long-term linear trend (statistically significant at a confidence level of 95%). The red triangles indicate changes of observation instruments.

4. Outlook

For the coming two weeks, the weather will be changeable in eastern and western Japan, and cloudy/rainy conditions will be more frequent than normal for this time of year on the Pacific side and elsewhere.



Climatological regions of Japan

The country has four divisions (northern, eastern, western Japan and Okinawa/Amami) and eleven subdivisions (Hokkaido, Tohoku, Kanto-koshin, Hokuriku, Tokai, Kinki, Chugoku, Shikoku, northern Kyushu, southern Kyushu and Okinawa).