Primary Factors of Extremely Hot Summer 2010 in Japan

Kumi Hayashi and Shotaro Tanaka
Tokyo Climate Center
Japan Meteorological Agency

ABSTRACT

1. Temperature for summer (June – August) 2010 in Japan

In summer 2010, Japan experienced record-breaking high temperature. The followings are striking records in connection with this extreme event:

- Three-month mean temperature for June – August in Japan[1] was the highest on record since 1898;
- Three-month mean temperatures for June – August in Northern and Eastern Japan were the highest on record since 1946; and,
- Monthly mean temperatures for August in Northern, Eastern and Western Japan were the highest on record since 1946.

[1] The observatory stations that represent the average temperature of Japan are selected from those deemed to be least influenced by urban heat island.

2. Characteristic atmospheric circulations causing Japan's hot summer and their factors (Figure 1)

On 3 September 2010, the Japan Meteorological Agency (JMA) held an extraordinary meeting of the Advisory Panel on Extreme Climate Events to identify characteristic atmospheric circulations causing the extremely hot summer in Japan and investigate their factors. The Advisory Panel, consisting of prominent climate experts at universities and research institutes, was established in June 2007 by JMA to investigate extreme climate events based on the latest knowledge and findings. In this section, consensus results of the meeting of the Advisory Panel are summarized for the respective atmospheric characters that were identified as main backgrounds for the hottest summer.

(1) Zonally-averaged tropospheric air temperature in the mid-latitudes of the Northern Hemisphere was the highest for June – August since 1979.

As researches so far indicate, it is known that tropospheric air temperatures increase on global scale after El Niño events and then persist higher-than-normal for several months. Examining past La Niña events, there is a tendency that tropospheric air temperature anomalies in the mid-latitudes of the Northern Hemisphere were relatively higher than those in the tropics during the summer when a La Niña event occurred. An El Niño event, which took

place in summer 2009, ended spring (March – May) 2010, and a La Niña event occurred in summer 2010. Therefore, there is a possibility that zonally-averaged tropospheric air temperature in the mid-latitudes of the Northern Hemisphere was extremely high in summer 2010 in the aftermath of the El Niño event and partly due to the effect of the La Niña event.

It can be identified that the zonally-averaged tropospheric air temperature in the mid-latitudes of the Northern Hemisphere has a warming trend. There is a possibility that the warming trend is associated with global warming due to the buildup of anthropogenic greenhouse gases.

(2) Remarkably strong anticyclone persisted over Japan.

In the period from the second half of July to August, the subtropical jet stream near Japan shifted northward from its normal position with a frequent northward meander (ridge of high pressure). Associated with these features of the subtropical jet and extension of the Tibetan High to Japan, quasi-barotropic highs developed and persisted over Japan. It seems that the northward shift of the subtropical jet in the vicinity of Japan was associated with active convections in and around the Indian Ocean. There is a possibility that active convections from the northern South China Sea to northeast off the Philippines were partly responsible for the strength of anticyclones around Japan, especially from the second half of August to early September.

(3) Japan experienced less-than-usual influence of the Okhotsk High (a cool stationary anticyclone).

In June, warm anticyclones frequently covered Japan, particularly its northern parts. In the period from June to the first half of July, the Okhotsk High hardly developed this year, while the Okhotsk High occasionally brings cool air to the Pacific side of Northern and Eastern Japan in normal years. In the second half of July, the Okhotsk High temporarily took place, but Japan experienced little influence of the Okhotsk High due to northward shift of the subtropical jet near Japan and a strong Pacific High to the east of Japan.

3. Conclusion and discussion

The above-mentioned primary factors of the extremely hot summer 2010 in Japan are supported by statistical analyses and researches so far, but those can’t completely explain this extreme event. In order to further understand the extreme event and reveal its dynamical mechanism, it is necessary to investigate other possible factors and perform numerical model experiments.

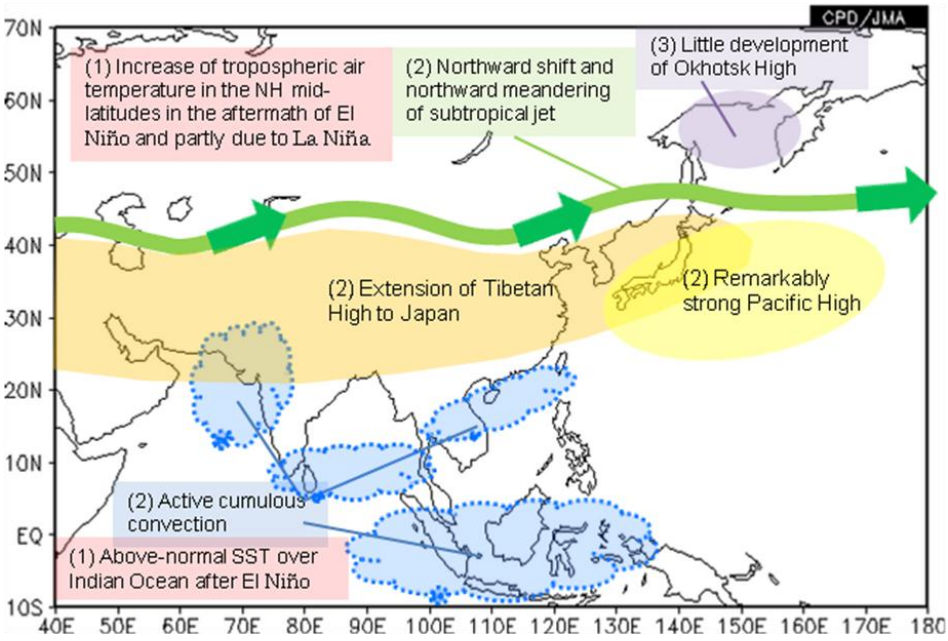

Figure 1 Schematic chart of primary factors of extremely hot summer (June – August) 2010 in Japan.

The numbers of (1), (2) and (3) in this chart correspond to those in Section 2 of the main text, respectively.