Characteristics of climate conditions in Japan in winter 2017/18

20 March 2018

Tokyo Climate Center, Japan Meteorological Agency
http://ds.data.jma.go.jp/tcc/tcc/index.html

1. Climate conditions

A series of extreme cold spells hit Japan and its surrounding areas in winter 2017/18, and cold air consequently prevailed nationwide (Figure 1). The seasonal mean temperature anomaly in western Japan was -1.2°C (Figure 2), which was the lowest for 32 years since the 1985/86 value of -2.1°C.

Some parts of the country intermittently experienced heavy snowfall associated with cold-spell peaks, leading to unprecedented snow depths at some weather stations (Figure 3). Annual snow depth records were equaled or broken at 17 of 321 JMA stations where snow gauges are operated.

2. Primary factors

The primary factors contributing the climate conditions detailed above are illustrated in Figure 4. Figure 5 is as per Figure 4, but for a severe cold-wave event occurring in early February 2018.

- The series of extreme cold spells hitting Japan during this winter period were attributable to a tendency for the subtropical and polar front jet streams to meander southward around the country along with a strengthened northwesterly monsoon.
- The southward meandering of the subtropical jet stream was partly attributable to enhanced convective activity over the Maritime Continent in association with the La Niña event observed from boreal autumn 2017 onward (see the press release Cold Waves and Heavy Snow in Japan from December 2017 dated 23rd February 2018). This meandering was also probably attributable to Rossby wave packet propagation that can be traced back to a persistent upper-level ridge over the North Atlantic.
- The southward meandering of the polar front jet stream occurred partly because the tropospheric polar vortex split and one of the pieces shifted southward over eastern Siberia. This splitting was associated with large meandering of the polar front jet stream over northern Eurasia.
- This meandering over northern Eurasia was attributable to the persistent upper-level ridge over the North Atlantic and possibly to lower-than-normal sea ice extents in the Barents Sea and the Kara Sea as seen in previous studies (e.g., Mori *et al*. 2014).

See also "Seasonal Highlights on the Climate System (December 2017 – February 2018)" on the TCC website.

Note) This summary report is based on analysis and discussion in an ordinary session of the TCC Advisory Panel on Extreme Climatic Events on 5 March 2018. The 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. The current chair is Prof. Hisashi Nakamura from the University of Tokyo. See TCC News No. 28 for more details on the outline and the framework of the Panel.

References

Mori, M., M. Watanabe, H. Shiogama, J. Inoue, and M. Kimoto, 2014: Robust Arctic sea-ice influence on the frequent Eurasian cold winters in past decades. *Nat. Geosci.* **7**, 869–873.

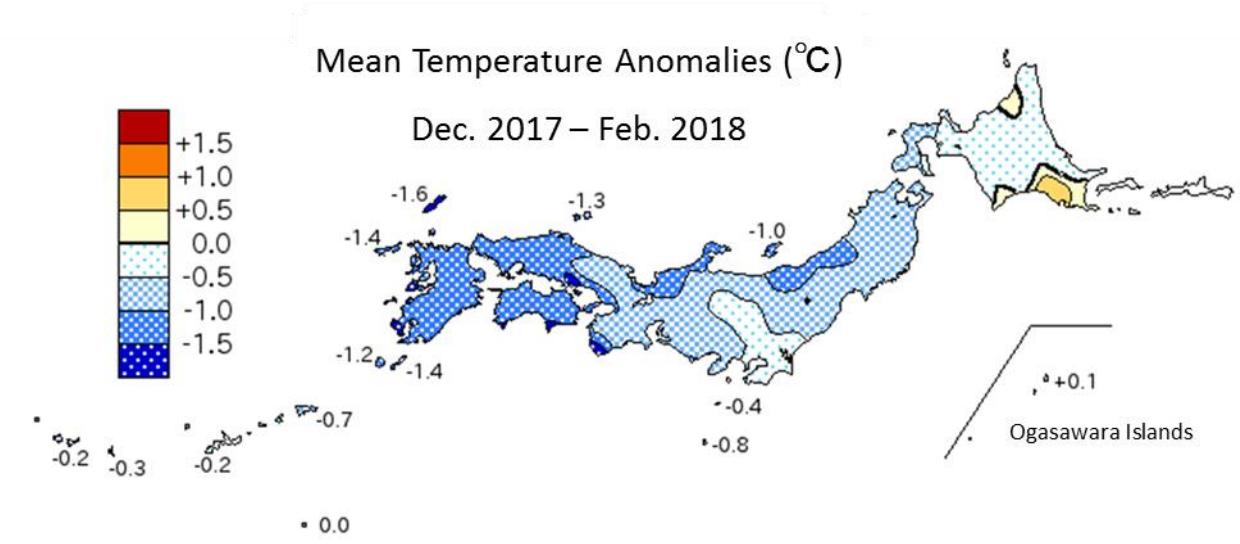

Figure 1. Seasonal mean temperature anomalies for winter 2017/18 (Dec. 2017 – Feb. 2018)

The base period for the normal is 1981– 2010.

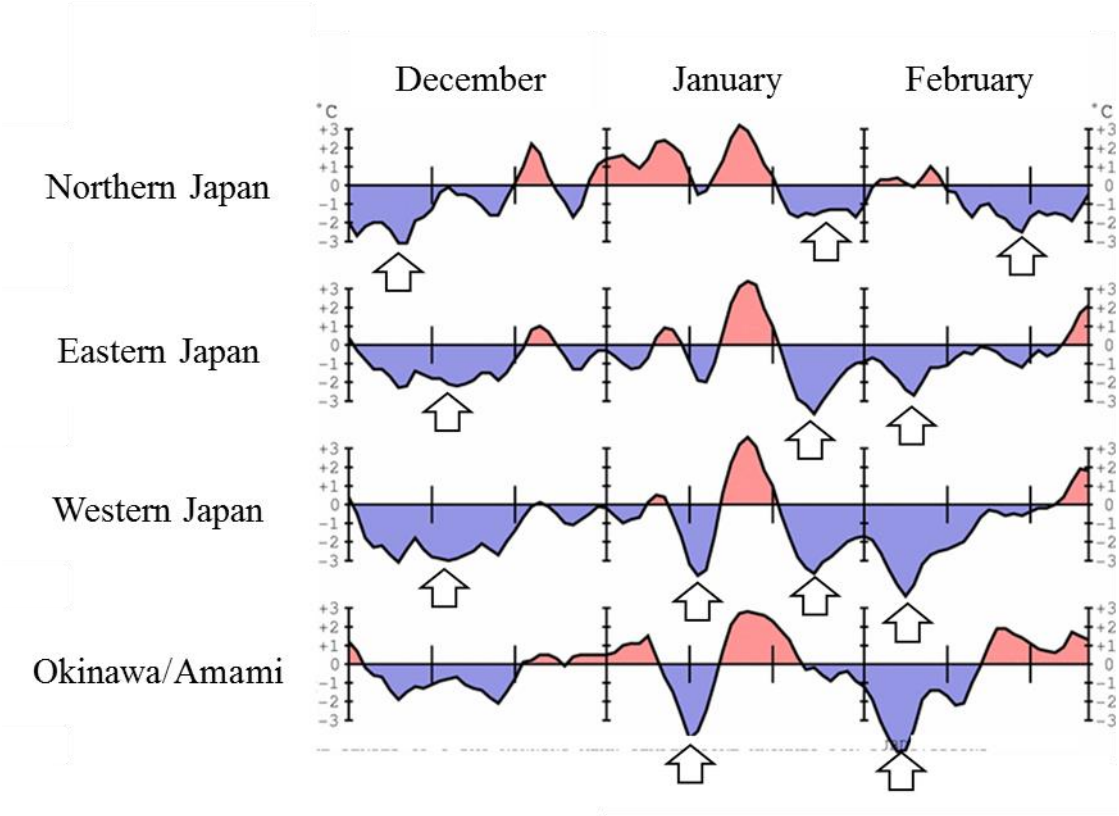

Figure 2. Time-series representations of 5-day running mean temperature anomalies [°C] from December 2017 to February 2018

The base period for the normal is 1981– 2010. Arrows indicate peak low temperatures. For more details of the cold spell in late January, see the press release Cold Spell in Japan from late January 2018 dated 2nd February 2018.

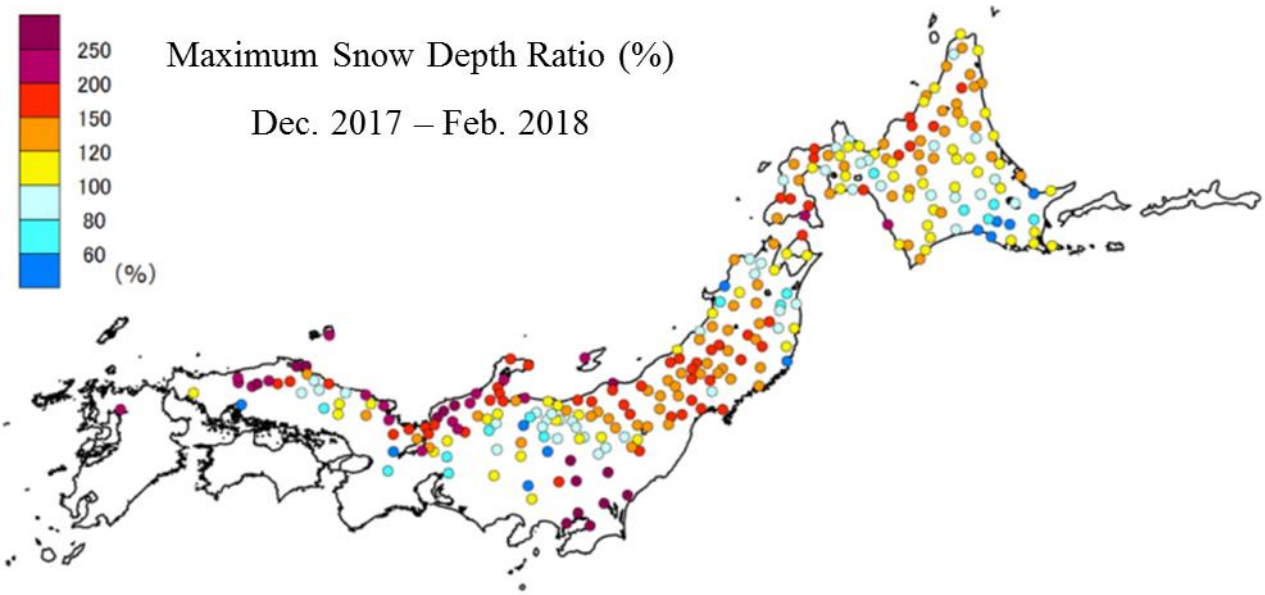

Figure 3. Maximum snow depth ratios to the normal during winter 2017/18

The base period for the normal is 1981– 2010.

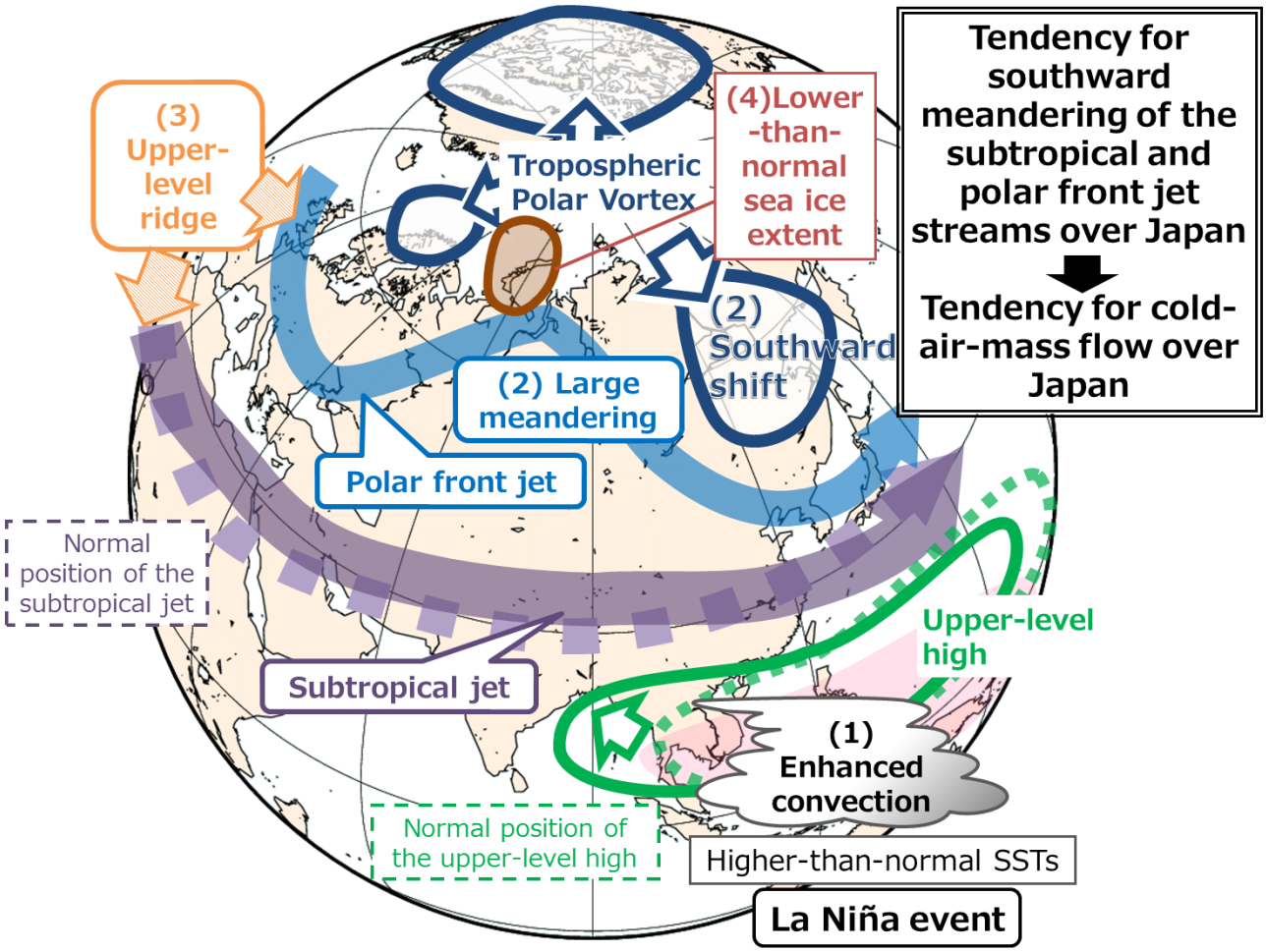

Figure 4. Primary factors contributing to climate conditions in Japan in winter 2017/18

The numbered events in Figure 4 are described in further detail below.

(1) Convective activity was enhanced over the Maritime Continent due to higher-than-normal SSTs in the tropical western Pacific region in association with the La Niña event observed from boreal autumn 2017 onward. This enhanced convection strengthened northwestward expansion of an upper-level high located over the area from the South China Sea to the east of the Philippines, which excited a Rossby wave causing the southward meandering of the subtropical jet stream around Japan.

(2) The tropospheric polar vortex split in association with large meandering of the polar front jet stream over northern Eurasia, which was caused by a blocking high over western Siberia and other influences. One of the polar vortex pieces shifted southward over eastern Siberia, which caused the southward meandering of the polar front jet stream around Japan.

(3) The meandering of the subtropical and the polar front jet streams as mentioned in (1) and (2), respectively, was also caused by Rossby wave packet propagation that can be traced back to the upper-level ridge over the North Atlantic.

(4) Sea ice extents in the Barents Sea and the Kara Sea were lower than normal, which may have caused the meandering of the polar front jet stream over Eurasia.

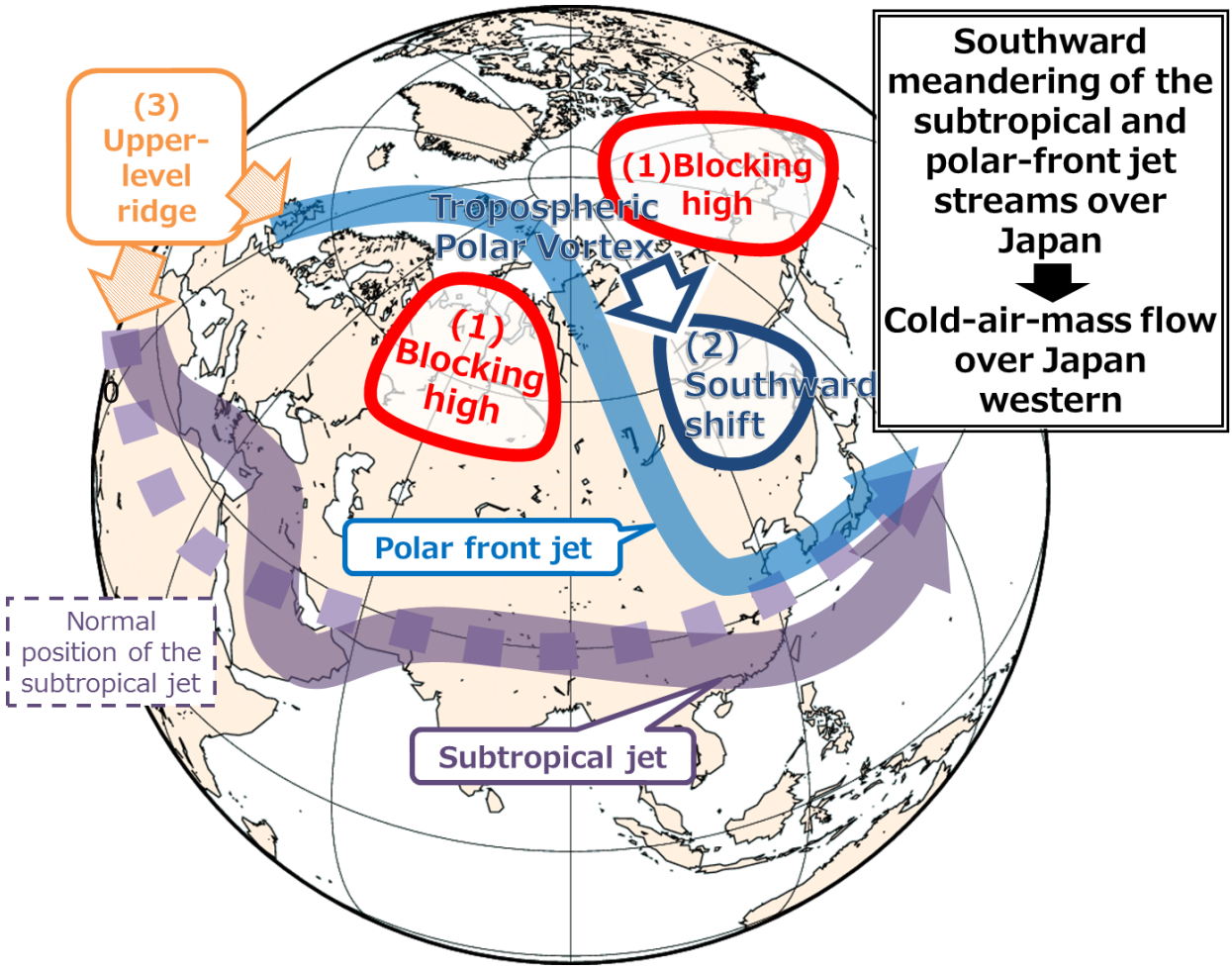

Figure 5. Primary factors behind the severe cold wave hitting Japan in early February 2018

When a severe cold wave hit western and other parts of Japan in early February 2018, the subtropical and polar front jet streams were exhibiting clear meandering over Eurasia. The numbered events in Figure 5 are described in further detail below.

(1) Blocking highs developed over the area from the Bering Sea to its north and over western Siberia.

(2) These highs caused a split in the tropospheric polar vortex, and one of the pieces was pushed toward eastern Siberia in association with the southward meandering of the polar front jet stream around Japan.

(3) The meandering of the subtropical and polar front jet streams was probably caused by Rossby wave packet propagation that can be traced back to the upper-level ridge over the North Atlantic.

Figure 6. 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).