News

I Record-high temperatures and low snowfall in winter 2020 (December 2019 – February 2020)

- ○ Winter seasonal mean temperatures were the highest on record since 1946/1947 in eastern and western Japan.
- ○ Winter seasonal snowfall amounts were the lowest on record since 1961/1962 on the Sea of Japan side.
- ○ Winter seasonal sunshine durations were significantly below normal on the Pacific side of eastern Japan, and winter seasonal precipitation amounts were significantly above normal on the Sea of Japan side of western Japan.

I.1 Climate conditions

Winter seasonal mean temperature anomalies in eastern and western Japan were +2.2 and +2.0°C, respectively, which were the highest on record since 1946/1947. At 111 of 153 surface meteorological observation stations nationwide, values were the highest or joint-highest on record. These conditions are attributed to fewer days with typical East Asian Winter Monsoon pressure patterns (featuring the Siberian High and the Aleutian Low) around the nation and weaker-than-normal southward cold-air flow over Japan. The country also experienced significantly lower snowfall than usual in winter 2019/20. On the Sea of Japan side of northern and eastern parts of the country in particular, cumulative snowfall amounts were the lowest for winter since 1961/62, at 44% and 7% of the normal, respectively. Winter seasonal precipitation amounts were significantly below normal on the Sea of Japan side of northern Japan, and were significantly above normal on the Sea of Japan side of western Japan. Winter seasonal sunshine durations were significantly below normal on the Pacific side of eastern Japan in association with periodic low-pressure systems passing over the mainland, and were significantly above normal in Okinawa/Amami due to high-pressure systems and weaker-than-normal cold-air inflow.

I.2 Characteristics of atmospheric circulation

The record-warm climate observed in winter 2019/2020 is primarily attributed to weaker-than-normal Siberian High and Aleutian Low conditions throughout the season, bringing fewer days with typical East Asian Winter Monsoon pressure patterns over and around Japan and consequent weaker-than-normal southward cold-air flow over the country. The synoptic-scale conditions observed nationwide were associated with subtropical jet stream meandering and the positive phase of the Arctic Oscillation (AO) pattern.

The subtropical jet stream meandered northward over and around Japan throughout the season. This may be attributable to southward meandering of the jet stream over southern China in response to suppressed convective activity over and around the Maritime Continent (Figure I.1). Subtropical jet stream meandering was also seen throughout Eurasia. The jet stream shifted northward over the Arabian Peninsula due to enhanced convective activity over the western Indian Ocean, reflecting higher-than-normal sea surface temperatures (SSTs) in the region. From

January 2020 onward, the meander partly originated from the northward meandering of the westerly jet stream over Europe.

In the Indian Ocean, higher-than-normal SSTs in the western part were likely associated with a positive Indian Ocean Dipole mode (IOD)[1] that persisted from summer to autumn 2019. These positive anomalies continued throughout the winter, and negative anomalies in the eastern part continued during December 2019. The suppressed convection observed over the Maritime Continent is considered to be linked to active convection around the equatorial date line, where SSTs were higher than normal.

From January 2020 onward, the positive phase of the AO pattern was dominant in the Northern Hemisphere. In association, a clear polar-front jet stream was observed in northern Eurasia with higher-than-normal temperatures over a broad area from Europe to eastern Siberia (Figure I.2). These conditions were favorable for weakening southward cold-air intrusion from Siberia to Japan. The persistent positive AO observed around March 2020 is considered a factor in the record-high temperatures seen for the month in Japan.

In addition to the above effects from meandering jet streams and a positive AO, a long-term trend of surface air temperature increase due to global warming and exceptionally higher-than-normal tropospheric temperatures throughout the mid-latitudes in the Northern Hemisphere are also considered to have contributed to these extremely warm winter conditions. On a longer time scale, winter surface temperatures worldwide and specifically in Japan have been rising at rates of around 0.79 and 1.19°C per century, respectively. The high tropospheric temperatures observed throughout the mid-latitudes of the Northern Hemisphere are partly attributed to the presence of the clear polar-front jet stream associated with the positive AO, which helped to keep the cold-air mass within the polar region.

Most winter extratropical cyclones in and around Japan took a course over or to the south of the mainland, exerting little or no influence over the northern part of the country. This led to lower snowfall than usual on the nation's Sea of Japan side, especially to the north.

Primary factors behind the record-warm climate conditions observed in winter 2019/2020 are summarized in Figure I.3.

[1] See the Glossary for terms relating to Indian Ocean Dipole mode event. The dipole mode index time series is published on JMA's website.
https://ds.data.jma.go.jp/tcc/tcc/products/elnino/iodevents.html

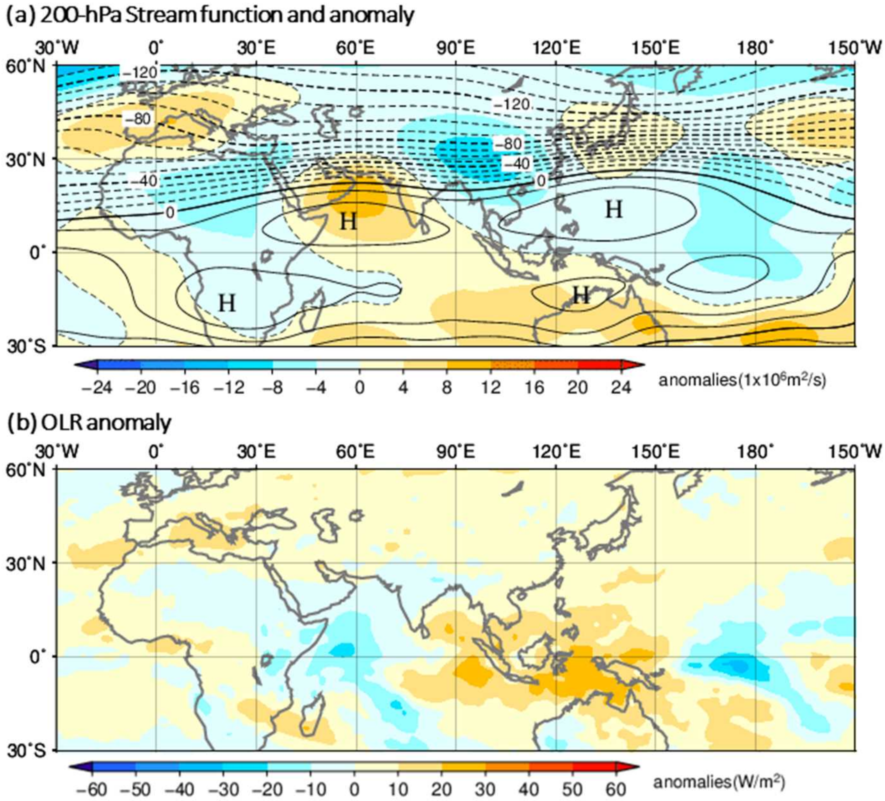

Figure I.1 (a) 200-hPa stream function (contours) and anomaly (shade), (b) outgoing longwave radiation (OLR) anomaly for December 2019 – February 2020

The contours are drawn at intervals of (a) 10 x 10^6 m^2 per s. The base period for the normal is 1981 – 2010.

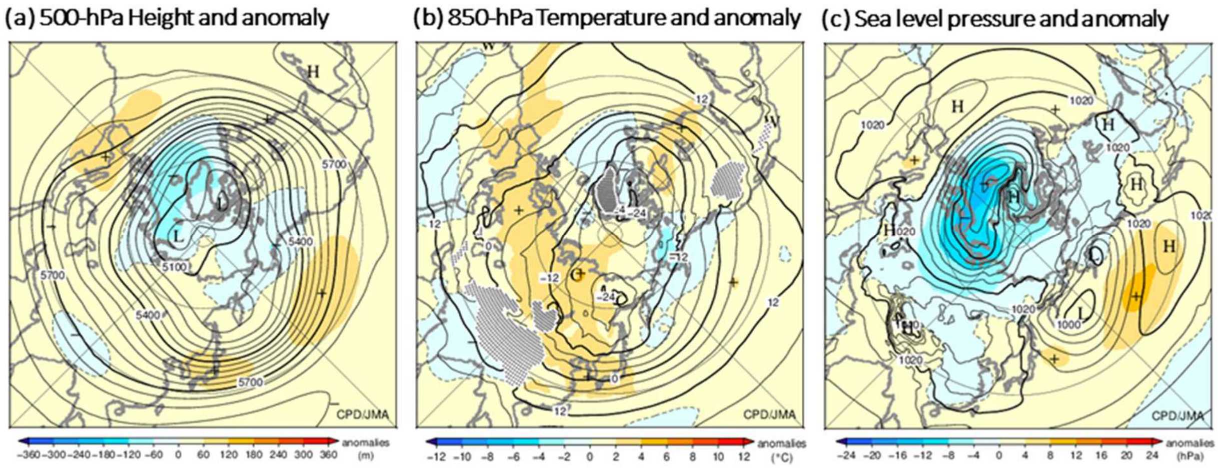

Figure I.2 (a) 500-hPa height (contours) and anomaly (shade), (b) 850-hPa temperature (contours) and anomaly (shade), (c) sea level pressure (contours) and anomaly (shade) for December 2019 – February 2020

The contours are drawn at intervals of (a) 60 m, (b) 4 °C, and (c) 4 hPa. The hatch patterns indicate areas with altitudes exceeding 1,600 m. The base period for the normal is 1981 – 2010.

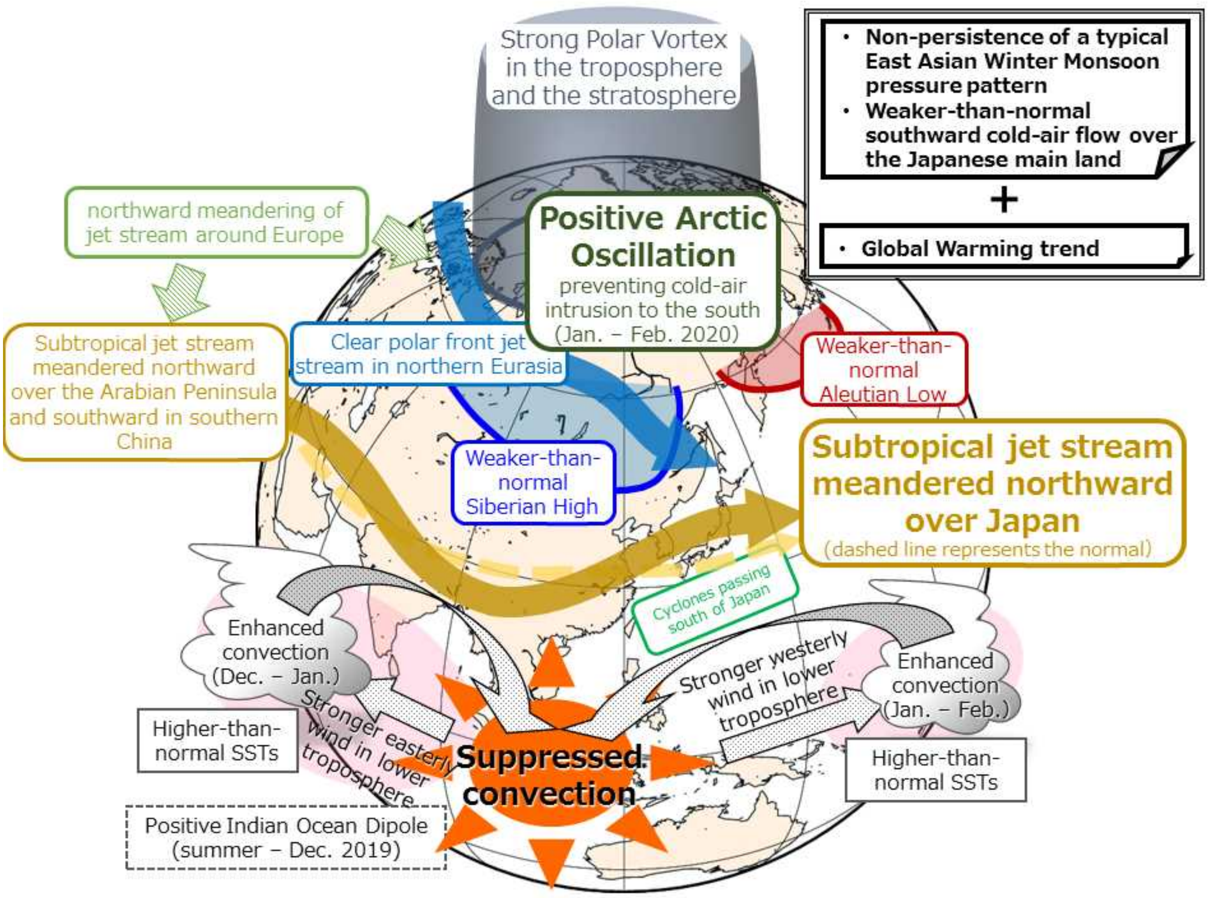

Figure I.3 Large-scale atmospheric circulation associated with the record-warm winter of 2019/2020

II Record-high sea-surface temperatures south of Japan in August 2020

○ Sea surface temperatures south of Japan were much higher than normal in August 2020, and monthly SSTs were the highest since 1982.

JMA monitors sea surface temperatures (SSTs) in the western North Pacific based on satellite, ship and buoy data. Figure II.1, which shows monthly mean SSTs and related anomalies for August 2020, indicates that SSTs south of Japan were much higher than normal, with values exceeding 30°C over wide areas. Figure II.2, which shows area-averaged SSTs for August (and related anomalies), indicates values of 29.8°C (+1.7°C) for the seas off Shikoku and Tokai (Area A in Fig.II.1), 29.3°C (+1.6°C) for the southeastern Kanto region (Area B) and 30.7°C (+2.1°C) for the region east of Okinawa (Area C) in 2020. These were all the highest monthly SSTs since 1982 (the values for 2020 are based on prompt analysis).

In August 2020, the Pacific High was strong over eastern/western Japan and the seas south of Japan, which experienced warm-air coverage and much more solar radiation than usual. These atmospheric conditions and lower typhoon passage over the area are likely factors behind the high SSTs recorded south of Japan.

In January 2021, the National Institute for Environmental Studies (NIES) announced that human-induced climate change had been behind the record-warm northwestern Pacific conditions of August 2020 (Hayashi et al. 2021).

The risk of extreme typhoons approaching Japan rises with higher SSTs around Japan, as such conditions support typhoon development and persistence. As high SSTs also affect socio-economic activity (via effects such as shifting of fishing grounds, aquacultural damage and coral breaching), there is a need for constant monitoring of oceanic variables.

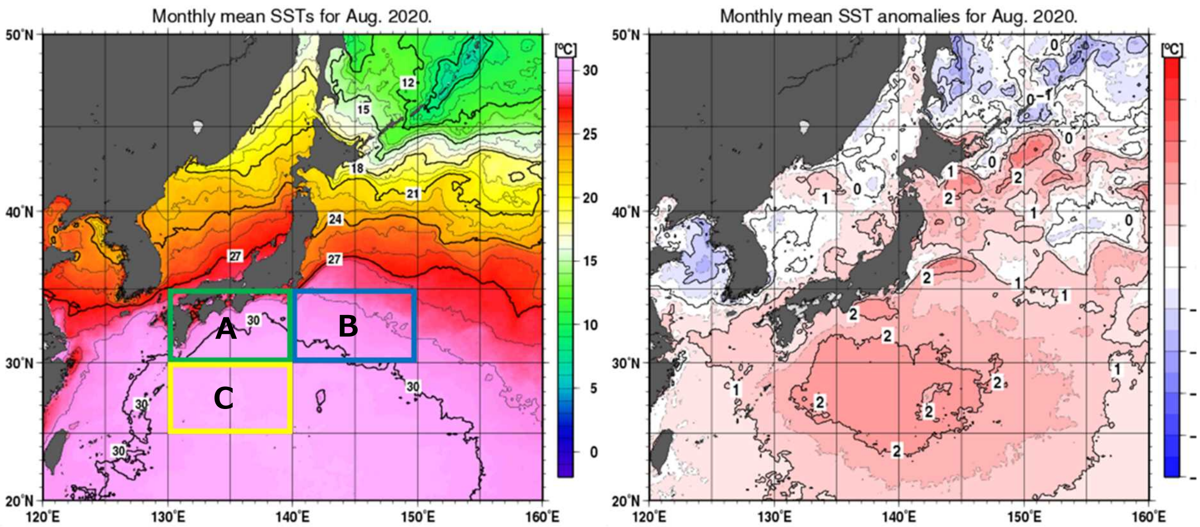

Figure II.1 August mean SSTs (left) and related anomalies (right)

SST anomalies are deviations from the normal for the period 1981 – 2010. SSTs for 2020 are prompt analysis values.

The green, blue and yellow rectangles in the figure on the left indicate averaged areas for the SST time-series representations in Figure II.2.

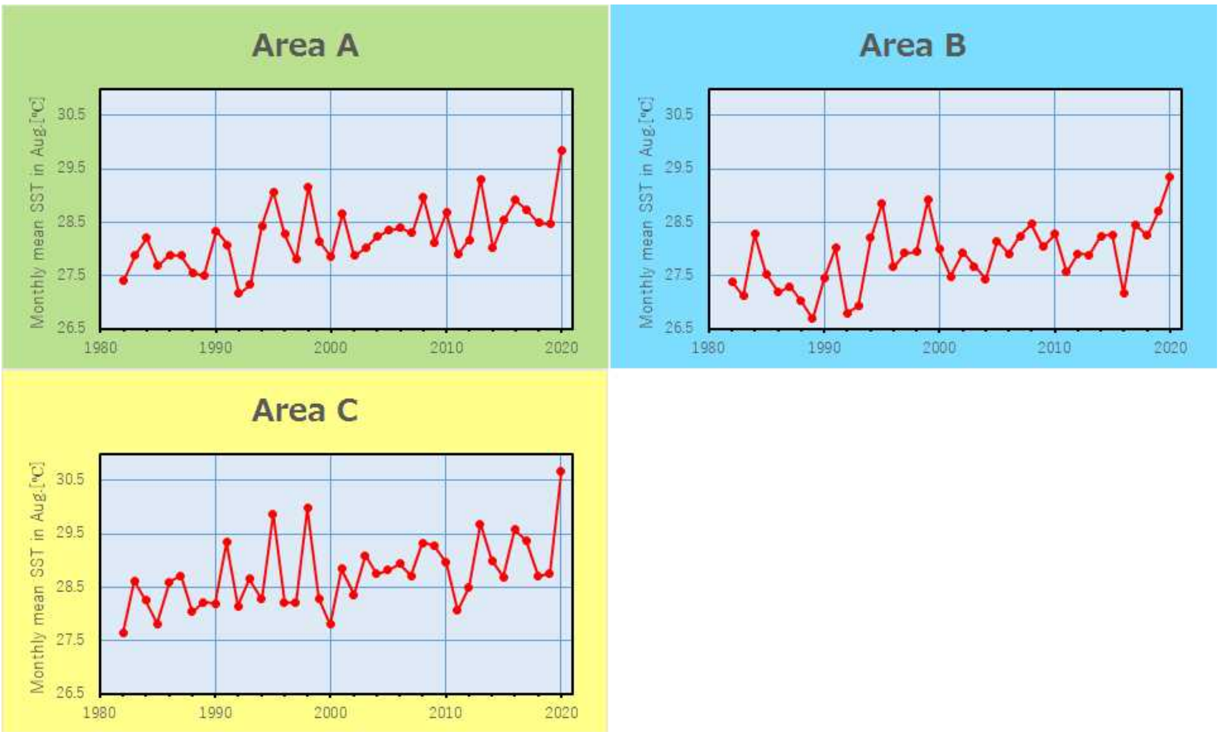

Figure II.2 Mean August sea surface temperatures since 1982 for the rectangle areas shown in Figure II.1

Values for 2020 are based on prompt analysis.