Japan climate conditions in winter 2021/22

29 March 2022

Tokyo Climate Center (TCC), Japan Meteorological Agency (JMA)
https://ds.data.jma.go.jp/tcc/tcc

1. Climate conditions

Strong currents of cold air around Japan caused frequent heavy snowfall over northern to western parts of the country's Sea of Japan side and elsewhere from late December 2021 onward (Figure 1). Winter snowfall amounts were above normal in many locations on the Sea of Japan side, and values exceeded double the normal at some stations in western Japan (Figure 2). Average cumulative snowfall in heavy-snowfall areas[1] was actually significantly below normal in the first half of December, but rose rapidly in the late December to match the climatological normal (Figure 3). The winter maximum snowfall depths were above normal at many stations on the Sea of Japan side and elsewhere (Figure 4), with 12 of 331 stations breaking the annual maximum records. Tsunan in Niigata Prefecture (Figure A1) recorded a value of 419 cm on February 24 (Table 1). The ratio of stations observing top-three record snow depths was the fifth highest since 1985.

Variations in five-day running mean temperatures were relatively low from late December onward, and below-normal temperatures persisted in eastern and western Japan (Figure 5). Average winter temperatures were 0.5°C lower than normal in both eastern and western Japan (Figure 6).

Winter precipitation amounts were below normal in western Japan (Figure 7), especially in February, and seasonal sunshine durations were above normal.

2. Primary factors

The primary factors contributing to these climate conditions are illustrated in Figure 8.

- The polar front jet stream (PFJ) and the subtropical jet stream (STJ) meandered southward around Japan, and the winter low-level pressure pattern typically observed around the country was strengthened. These conditions facilitated four instances of strong cold-air inflow to the region (Figure 9).
- Cold-air inflow triggered significant snowfall on the Sea of Japan side of the country. In late December a strong inflow event (Figure 1) and higher-than-normal sea surface temperatures in the Sea of Japan may have increased the snowfall amount.
- Southward meandering of the PFJ near Japan accompanied the formation of a blocking

[1] As designated under the Act on Special Countermeasures for Heavy Snowfall Areas
https://www.mlit.go.jp/kokudoseisaku/chisei/crd_chisei_tk_000010.html (Japanese)

high over Eastern Siberia in the upper troposphere. Along with the blocking high, the tropospheric polar vortex over the Arctic region split, with partial movement southward to just north of Japan.

- The southward shift of the STJ to the east of Japan was likely influenced by its northward meandering to the west of Japan, which was partly attributable to enhanced convective activity in the area from the Philippines to eastern Indonesia in association with the prevailing La Niña event[2].
- Significant meandering of the jet stream in the area from the North Atlantic to Europe and its downstream extension contributed to sustained meandering of the PFJ and the STJ from Eurasia to Japan.
- Frequent blocking-high formation over Eastern Siberia may have been influenced by significant northward meandering of the PFJ near the Gulf of Alaska. This meandering, associated with a Pacific-North American-like teleconnection pattern, was in turn likely influenced by the distribution of convective activity associated with the La Niña event active in the western tropical Pacific and inactive in the central and eastern tropical Pacific.

See also "Seasonal Highlights on the Climate System (December 2021 – February 2022)" 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 11 March 2022. 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.

[2] The term "La Niña event" here refers to the conditions observed from autumn 2021 onward that did not yet strictly meet the criteria of the phenomenon as of March 2022.

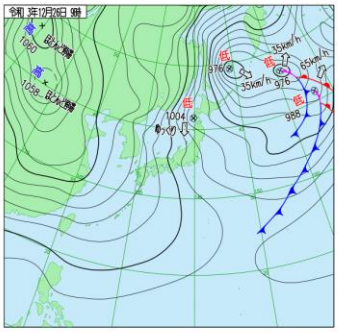
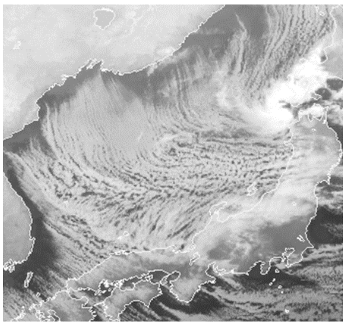
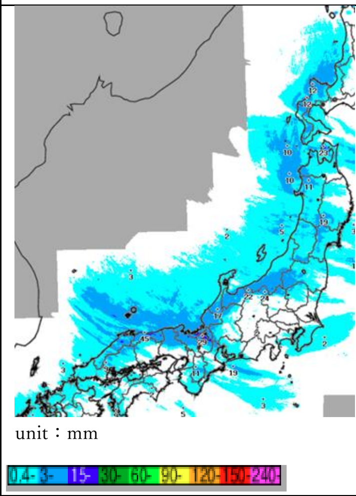
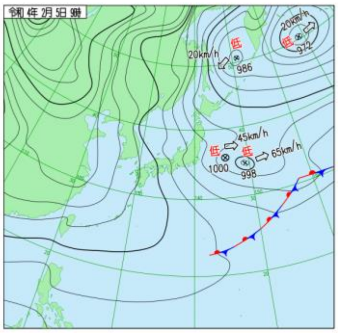
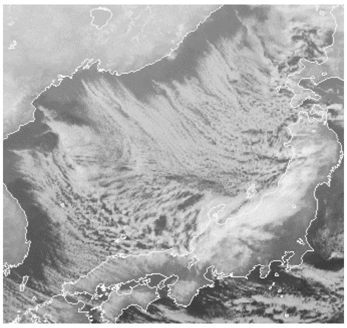
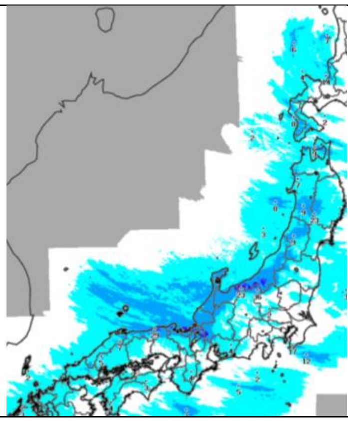
Weather maps	Infrared satellite imagery	6-hour total precipitation amounts (Radar/Raingauge-Analyzed Precipitation)
09 JST on 26th December 2021	09 JST on 26th December 2021	06-12 JST on 26th December 2021
		
09 JST on 5th February 2022	09 JST on 5th February 2022	06-12 JST on 5th February 2022
		

Figure 1. Left: Weather maps; middle: infrared satellite images; right: precipitation distribution for 26 December 2021 and 5 February 2022 (for heavy snowfall on the Sea of Japan side of the country)

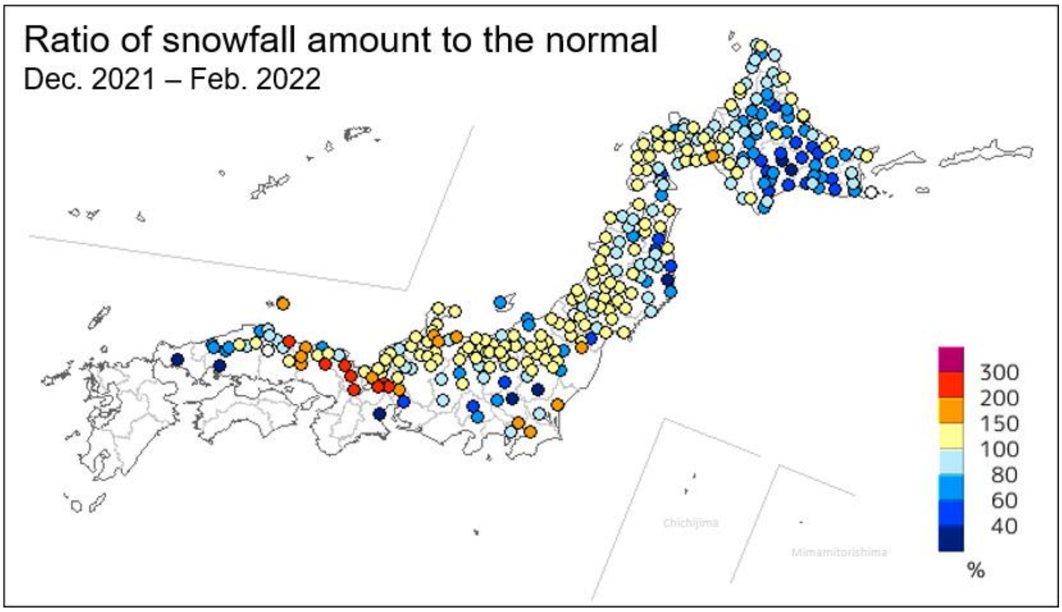


Figure 2. Ratio of snowfall amount for December 2021 – February 2022 to the climatological normal of winter snowfall amount [%]

The base period for the normal is 1991 – 2020. White dots indicate a ratio of 100%. Locations with amounts of 0 cm or normals less than 3 cm are not shown.

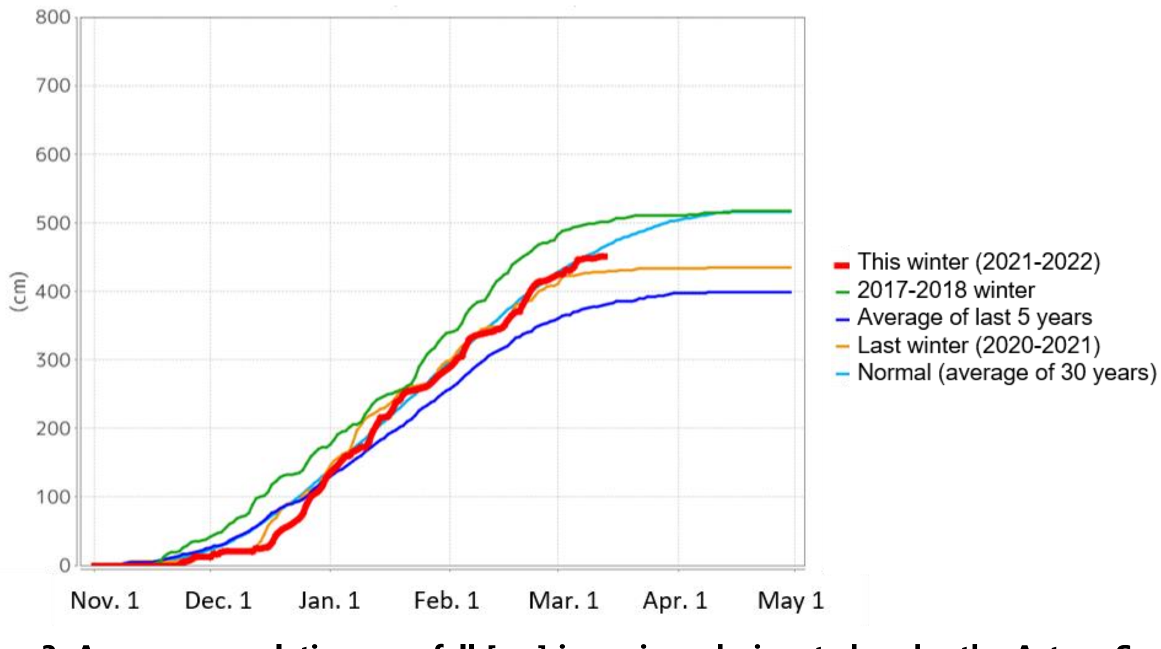


Figure 3. Average cumulative snowfall [cm] in regions designated under the Act on Special Countermeasures for Heavy Snowfall Areas (1 November – 30 April)

Red line: cumulative snowfall for winter 2022 (as of 13 March)

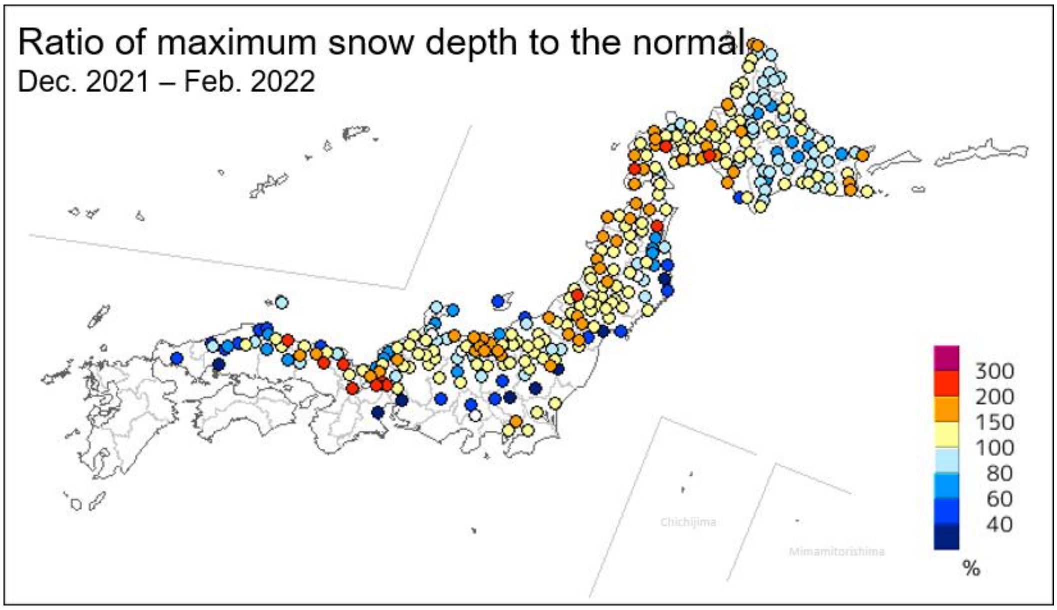


Figure 4. Ratio of maximum snow depth for December 2021 – February 2022 to the climatological normal of winter maximum snow depth [%]
The base period for the normal is 1991 – 2020. The white-filled circles represent that the ratio is 100%. Locations where this winter's amount was 0 cm or the normal value is less than 3 cm are not shown.

Table 1. Record-high annual maximum snow depth locations[3] for December 2021 – February 2022

Prefecture	Location	Observation		Previous record		Start of observation	Description
		cm	date	cm	date		
Hokkaido	Atsuta (厚田)	198	8 February 2022	198	19 February 2012	1981	Joint record-high
Hokkaido	Eniwa Shimamatsu (恵庭島松)	154	23 February 2022	115	5 February 2006	1981	
Hokkaido	Chitose (千歳)	123	23 February 2022	77	28 February 2008	2006	
Hokkaido	Ashibetsu (芦別)	130	14 January 2022	115	6 March 1999	1981	
Hokkaido	Kuromatsunai (黒松内)	214	23 February 2022	204	13 March 1984	1981	
Hokkaido	Abira (安平)	127	23 February 2022	103	6 February 1996	1983	
Hokkaido	Ookishi (大岸)	162	22 February 2022	116	3 March 2021	1983	
Aomori	Noheji (野辺地)	115	17 February 2022	102	27 February 2012	2008	
Gifu	Sekigahara (関ヶ原)	91	7 February 2022	79	9 January 1999	1997	
Niigata	Tsunan (津南)	419	24 February 2022	416	5 February 2006	1989	
Shiga	Maibara (米原)	91	6 February 2022	83	27 December 2005	2001	
Hyogo	Uwano Kougen (兎和野高原)	208	24 February 2022	205	18 February 2012	2005	

[3] Locations among 331 weather/AMeDAS stations where snow depths have been recorded for at least 10 years, either since the start of observation or since an environmental change such as relocation

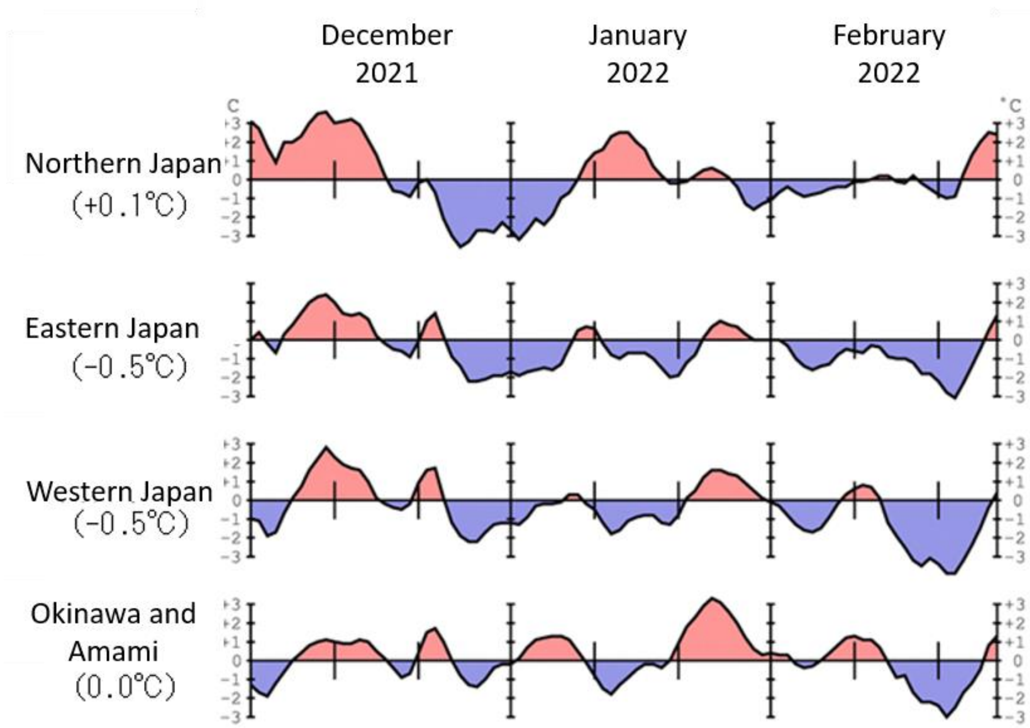


Figure 5. Time-series representations of 5-day running mean temperature anomalies [°C] for December 2021 – February 2022

The base period for the normal is 1991 – 2020. Values in parentheses are winter mean temperature anomalies for each region.

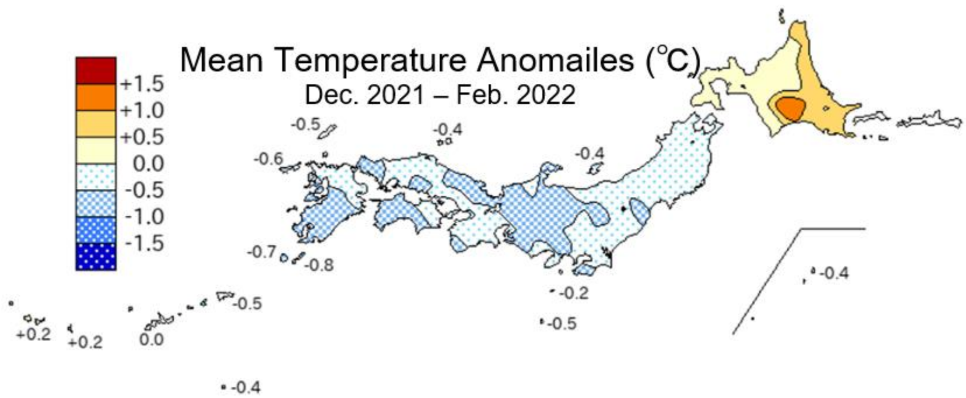


Figure 6. Distribution of mean temperature anomalies [°C] for December 2021 – February 2022

The base period for the normal is 1991 – 2020.

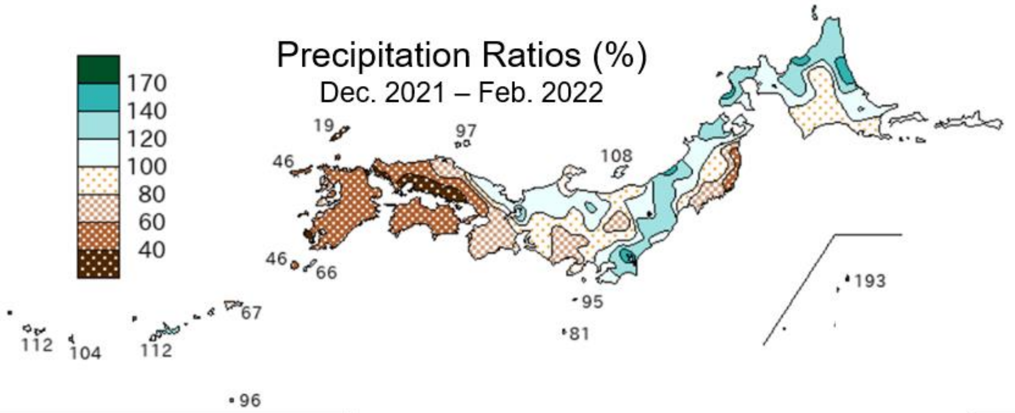


Figure 7. Distribution of precipitation ratios [%] for December 2021 – February 2022
The base period for the normal is 1991 – 2020.

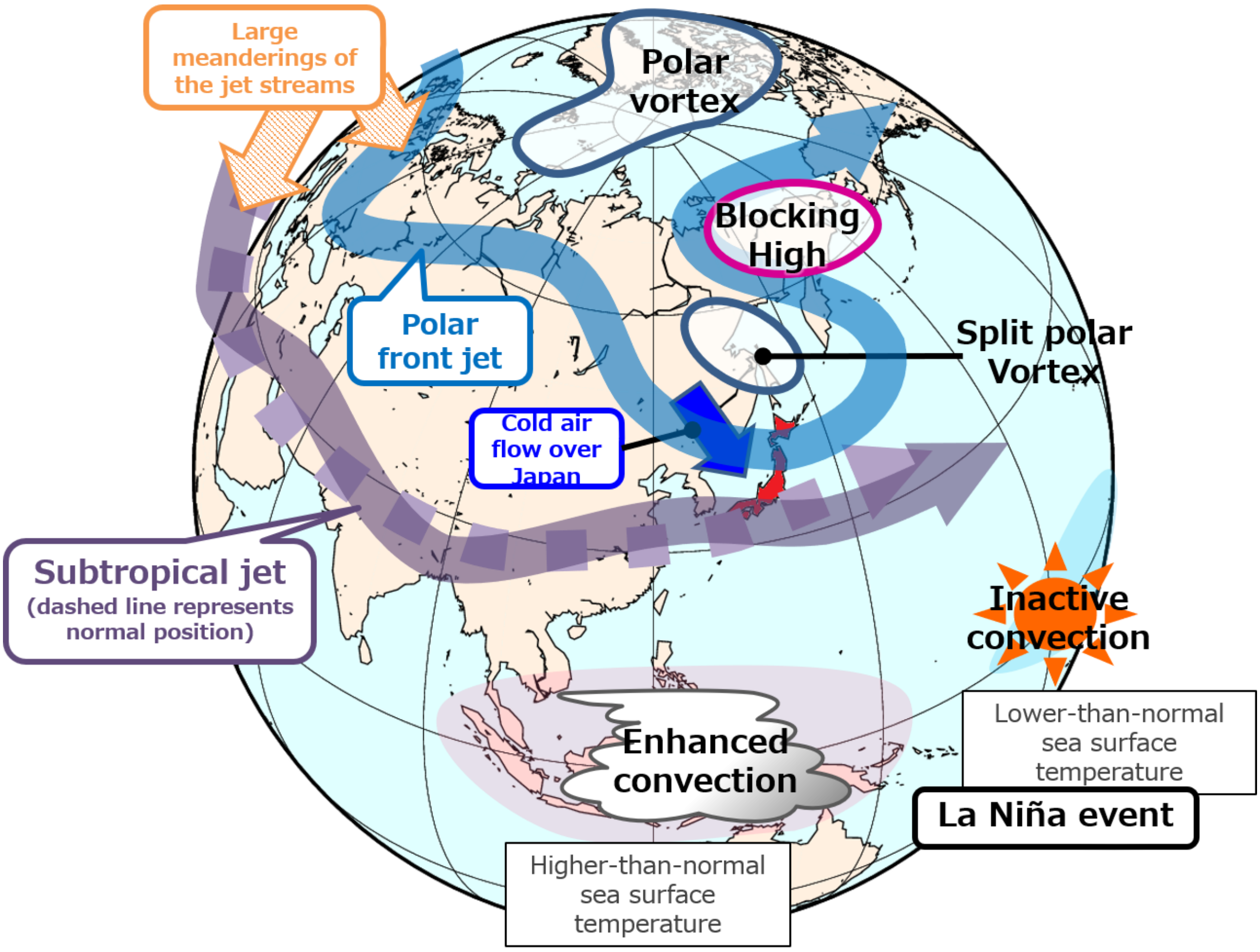


Figure 8. Characteristics of atmospheric circulation from December 2021 to February 2022

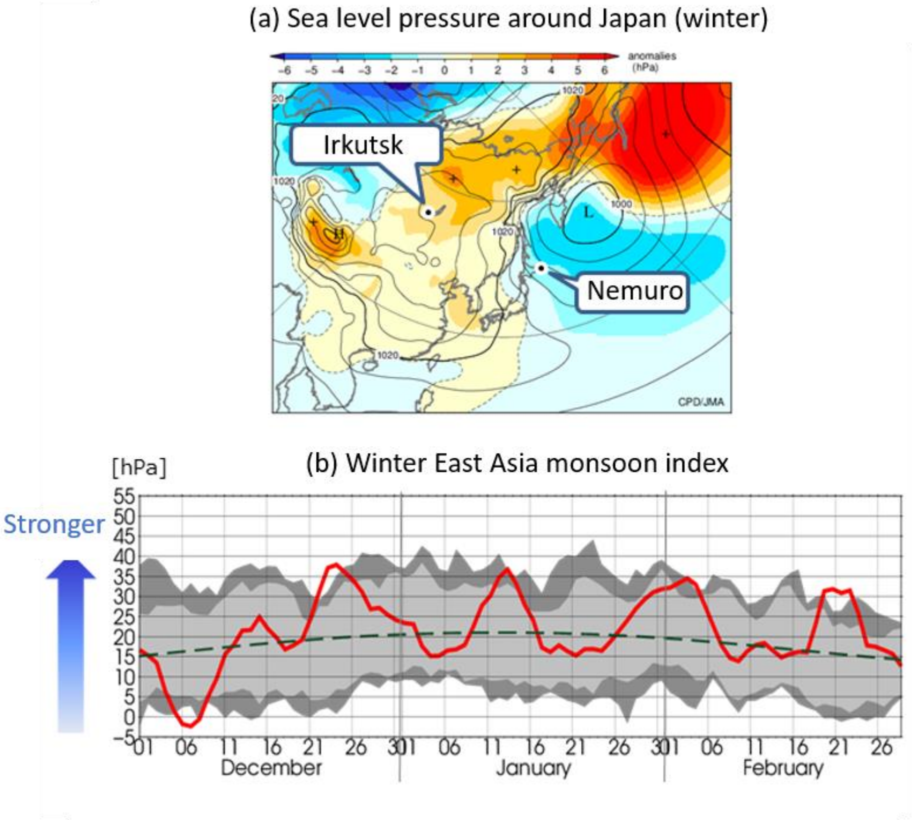


Figure 9. (a) Mean sea level pressure around Japan for winter 2021/22, and (b) winter East Asian monsoon index

(a) Contours indicate sea level pressure, and shading indicates the related anomaly (hPa).

(b) Winter East Asian monsoon index (Hanawa *et al*. 1988; sea level pressure difference between Irkutsk and Nemuro, hPa) from 1 December 2021 to 28 February 2022 (five-day running mean). The red line represents winter 2021/22, the dashed line represents the climatological normal, and shading represents the range of values each year from 1990/91 to 2019/20 (dark shading: 3 – 97%; light shading: 10 – 90%). The larger values for the winter East Asian Monsoon Index indicate a stronger winter pressure pattern around Japan. These data are based on the JRA-55 dataset.

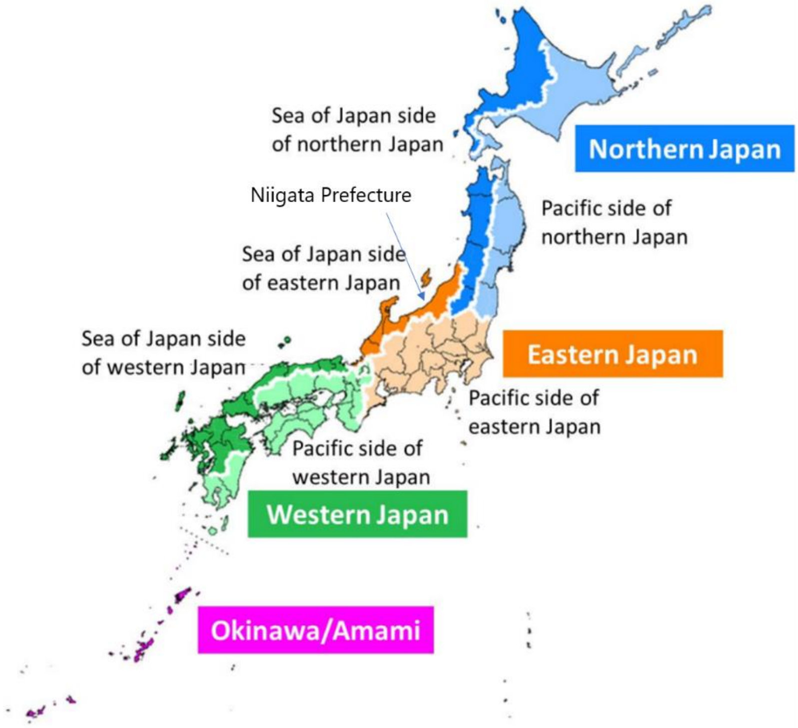


Figure A1. Climatological regions of Japan
JMA's seven regional divisions for climate monitoring and forecasting (the Sea of Japan and Pacific sides of northern, eastern and western Japan, and Okinawa/Amami)

References

Hanawa, K., T. Watanabe, N. Iwasaka, T. Suga and Y. Toba, 1988: Surface Thermal Conditions in the Western North Pacific during the ENSO Events. *J. Meteor. Soc. Japan*, **66**, 445-456.