気象庁
Japan Meteorological Agency

The 19th Session of the Forum on Regional Climate Monitoring, Assessment, Prediction for Asia (FOCRAII-19)
8-10 May 2023, Nanning China

The Characteristics of 2022/23 Winter Monsoon in Japan

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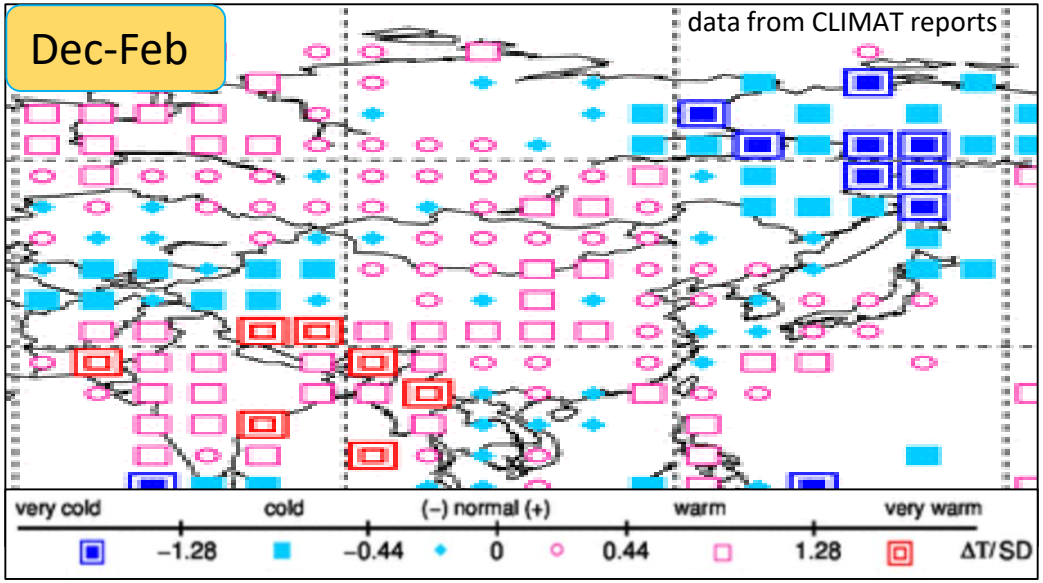
1. Overview of temperature anomalies in 2022/23 winter

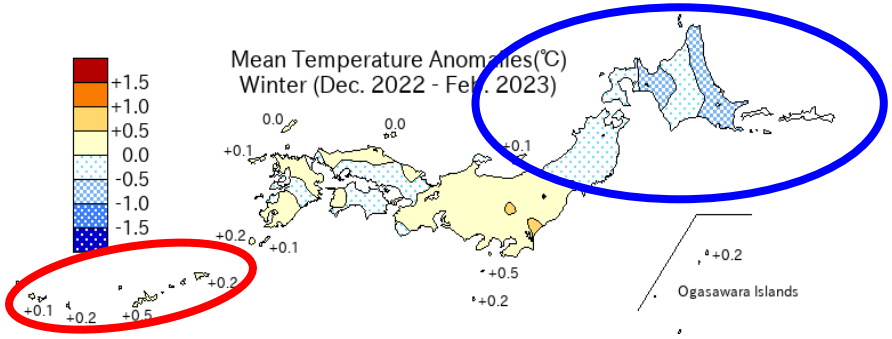
2. Characteristics of circulation at the cold/warm peak

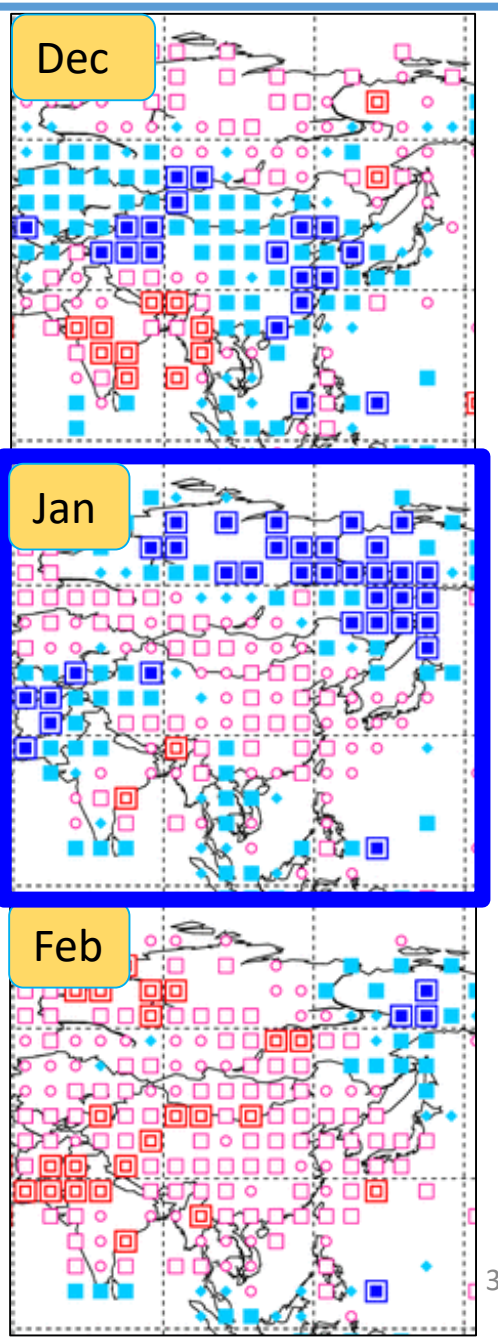
3. Comparison with JMA/MRI-CPS3's forecast

Seasonal mean temperature in Dec 2022 to Feb 2023

Normalized Temperature Anomaly Category [℃]

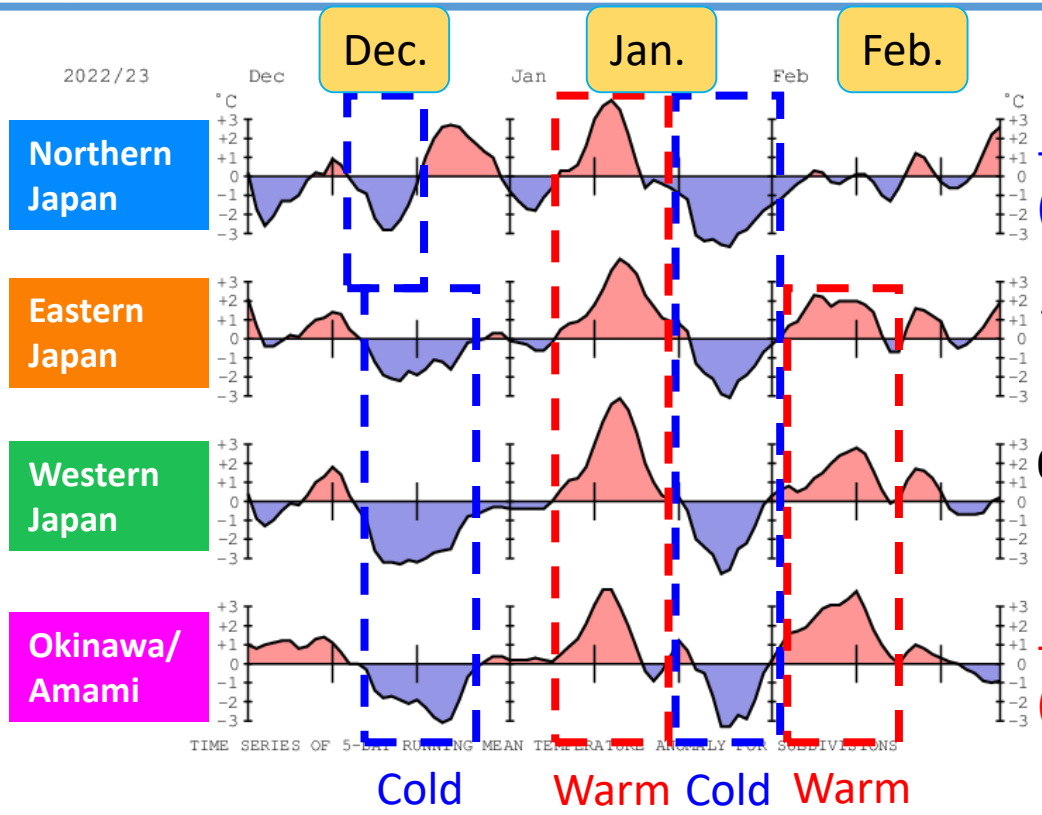


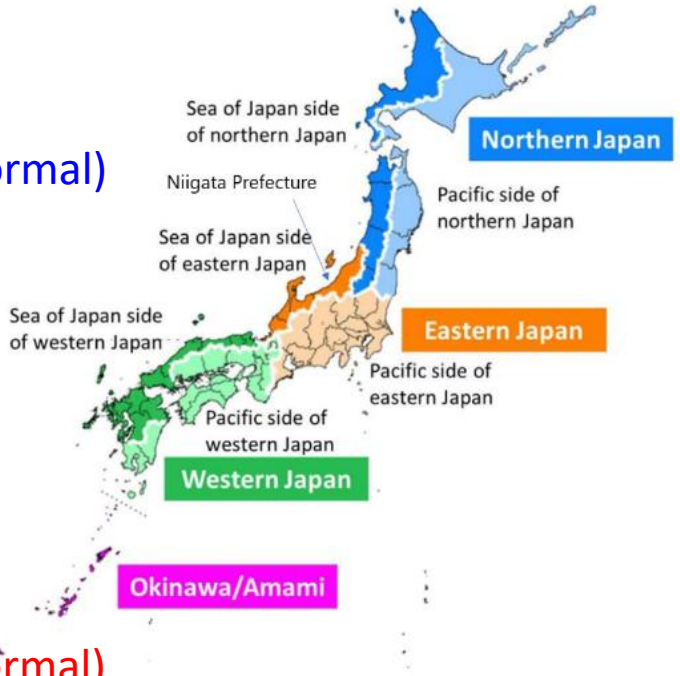




- ✓ Temperature in Eastern Siberia was significantly below normal, particularly in January.
- ✓ Seasonal mean temperature was below normal in northern Japan and above normal in Okinawa/Amami.

Temperature variation during winter 2022/23 in Japan





- Temperature dramatically varied with a cycle of approximately a month in most area of Japan.
  - ✓ Cold: middle Dec. (Northern Japan)
    middle to late Dec. (Eastern/Western Japan and Okinawa/Amami)
  - ✓ Warm: middle Jan. (the most area of Japan)
  - ✓ Cold: late Jan. (the most area of Japan)
  - ✓ Warm: first half of Feb. (Eastern/Western Japan and Okinawa/Amami)

What brought large temperature variability to Japan?

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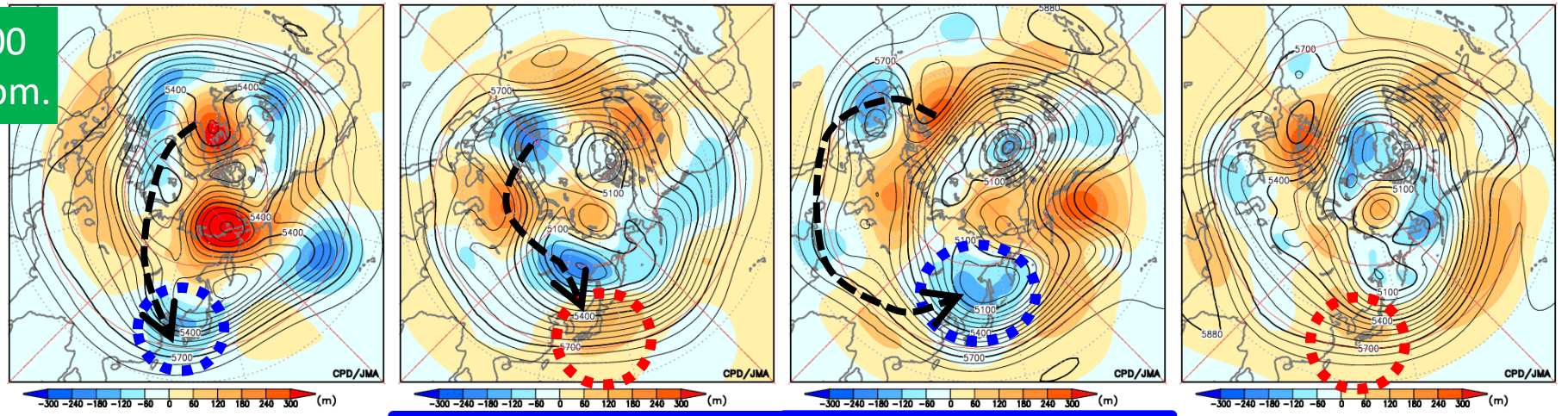
Circulation at Warm/Cold terms in winter 2022/23

middle to late Dec. | middle Jan. | late Jan. | early to middle Feb.

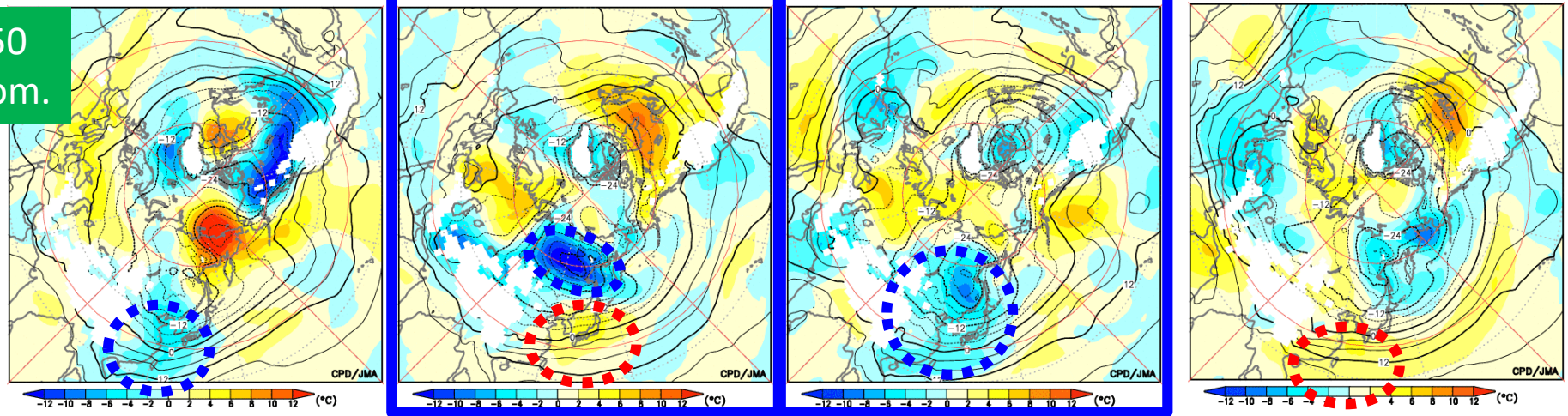
Z500 anom.

16Dec.2022 – 25Dec.2022 | 11Jan.2023 – 20Jan.2023 | 21Jan.2023 – 30Jan.2023 | 06Feb.2023 – 15Feb.2023



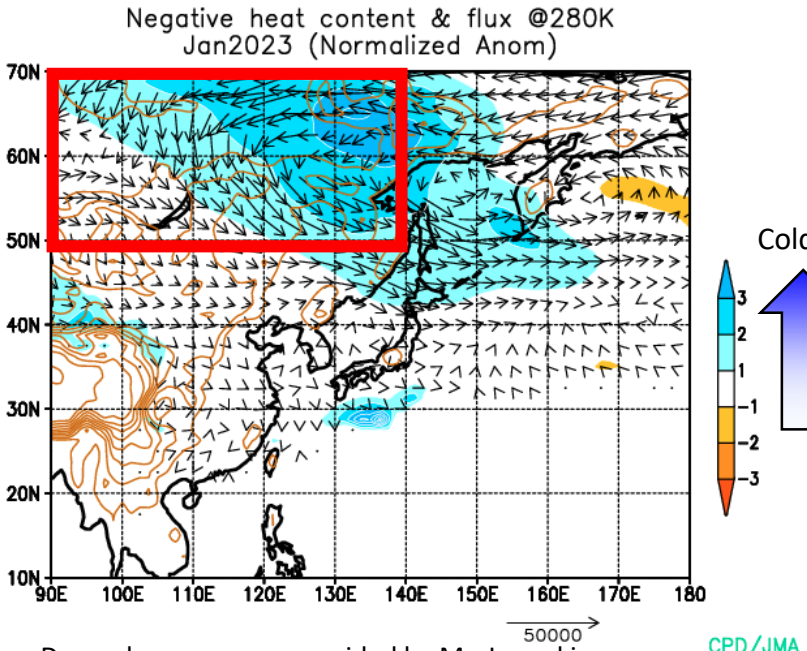
T850 anom.

16Dec.2022 – 25Dec.2022 | 11Jan.2023 – 20Jan.2023 | 21Jan.2023 – 30Jan.2023 | 06Feb.2023 – 15Feb.2023



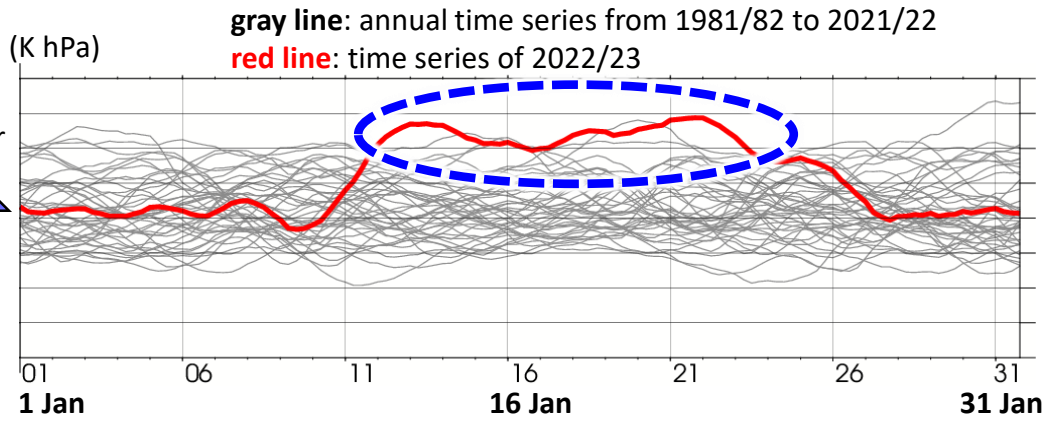
The coldest record of T850 and T700 observed over Tateno (Eastern Japan) in 00 UTC 25 Jan. since Apr. 1957.

Accumulation of strong cold air in north of Japan in middle Jan.

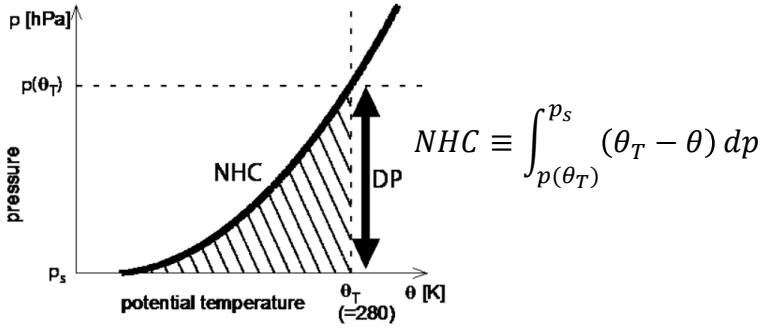


Drawn by a program provided by Mr. Iwasaki.

Negative Heat Content (below 280K)



50–70N, 90–140E
(an area indicated with red frame in the left figure)



Quoted from Iwasaki et al. (2014)

- The Negative Heat Content (Iwasaki et al. 2014) which is an index representing intense of cold air, near Central Siberia in 2023 was remarkable large amount in last 40 years for January.

- In association with part of the polar vortex split and sustained near Siberia, a remarkable cold air was generated and persisted near Siberia especially during mid-Jan.

References

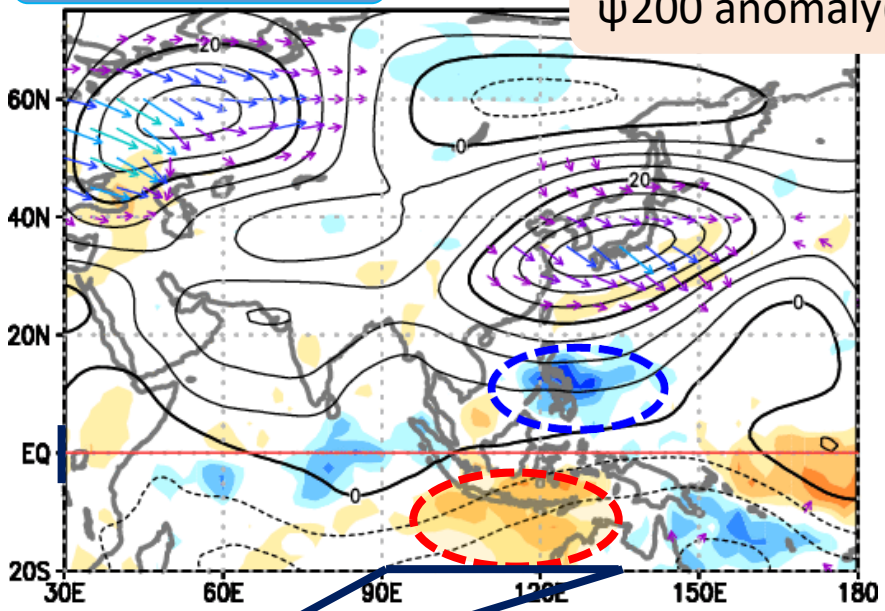
Iwasaki T., T. Shoji, Y. Kanno, M. Sawada, M. Ujiie, and K. Takaya, 2014:
Isentropic analysis of polar cold air mass streams in the northern hemispheric winter. J. Atmos. Sci.

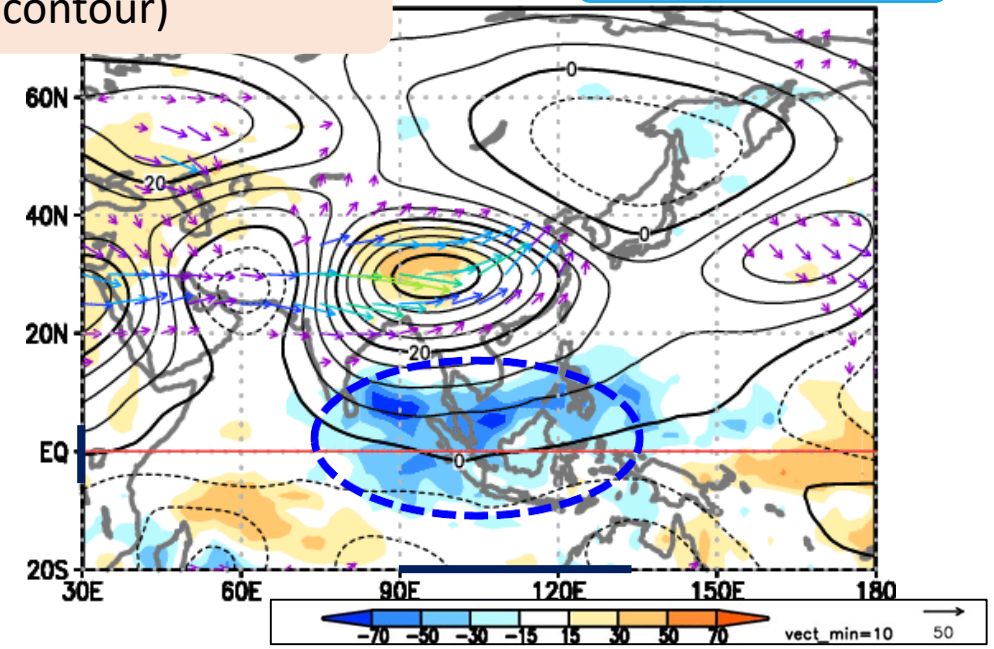
Tropical convection activity in 21 Jan -31 Jan 2023

11 Jan to 20 Jan

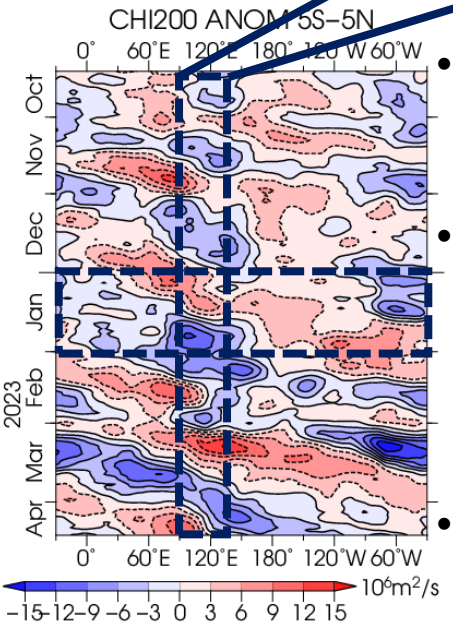
OLR anomaly (color), WAF(vector),
ψ200 anomaly(contour)

21 Jan to 30 Jan





Active <--> Inactive



- Convection active around the Philippines (characteristic of La Niña years) during January.
- With an eastward propagation of the MJO phase in late January, the convection active area extended from the Indian Ocean to the Maritime Continent, which might be supported by high SST over the region in La Niña condition.
- This active convection enforced Rossby wave trains, which propagated near Japan and promoted the southward movement of the polar vortex.

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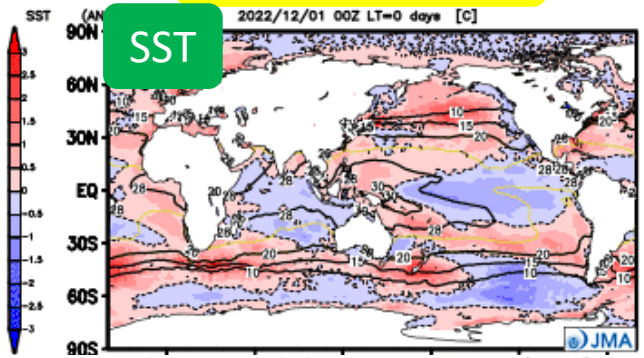
Analysis vs JMA/MRI-CPS3 Forecast for winter 2022/23

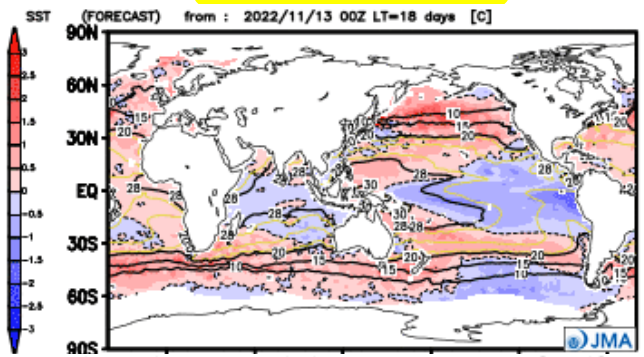
JRA-55 Analysis

CPS3 forecast

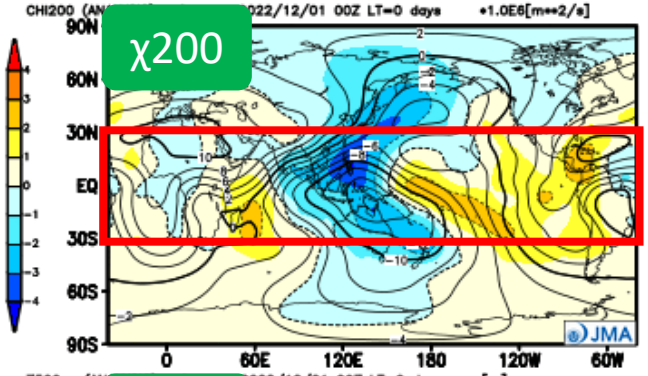
Init: 00UTC 13 Nov 2022

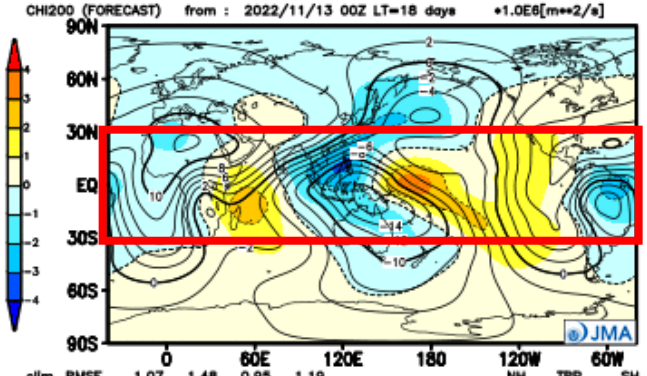
SST



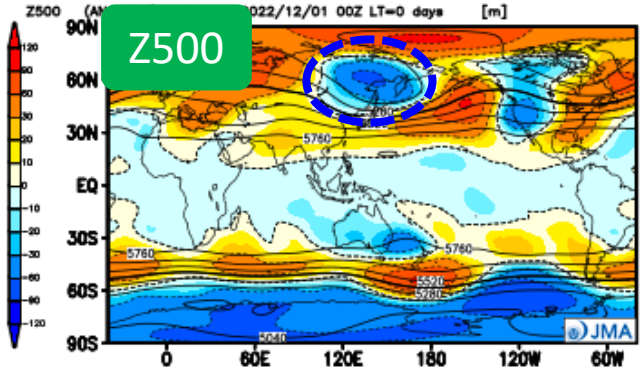


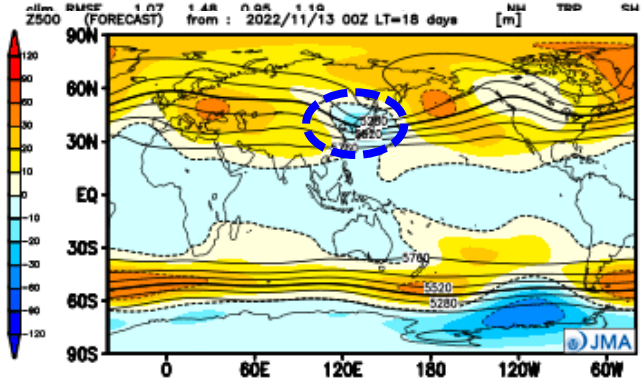
χ200





Z500

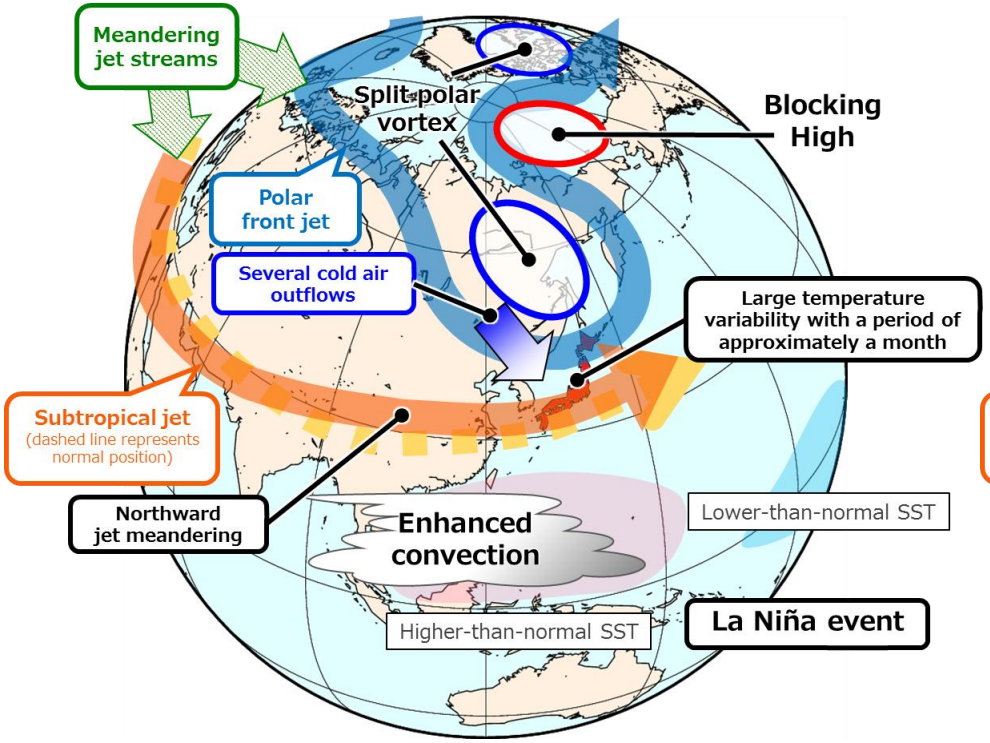




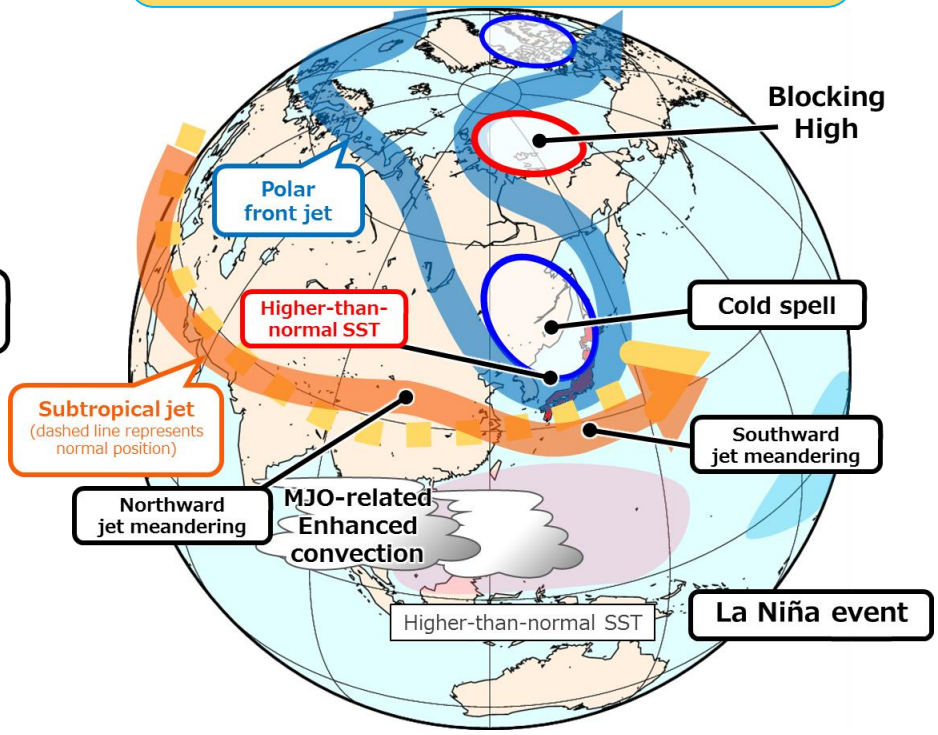
- JMA/MRI-CPS3 (Hirahara et al. 2023) predicted well La Niña-like features of the SST distribution and related tropic convective activities.
- CPS3 also predicted splitting of the polar vortex, but it's position would be predicted to be shifted more southerly than in the JRA-55 analysis.

Summary of winter 2022/23

DJF



late Jan.
(when cold air flowed into Japan)



DJF

- The Polar front jet stream tended to meander SOUTHWARD around Japan.
- The Subtropical jet stream flowed NORTHERLY than normal around Japan.

→ Large temperature variability around Japan with a period of approximately a month in association with meandering of both jet streams.

late Jan.

- MJO-related enhanced convection from the Bay of Bengal to the South China Sea.
- Along the Subtropical jet stream, a ridge around Central China and a trough around Japan were enhanced.
- Cold air trapped near Eastern Siberia flowed into Japan.

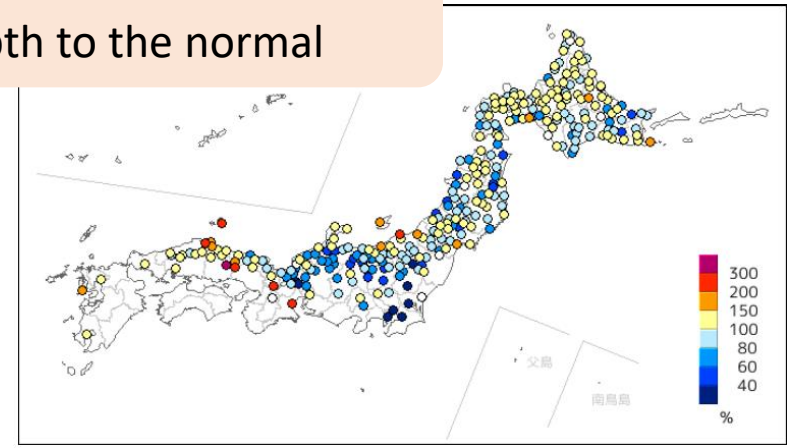
Thank you for your attention!

(谢谢你的关注)

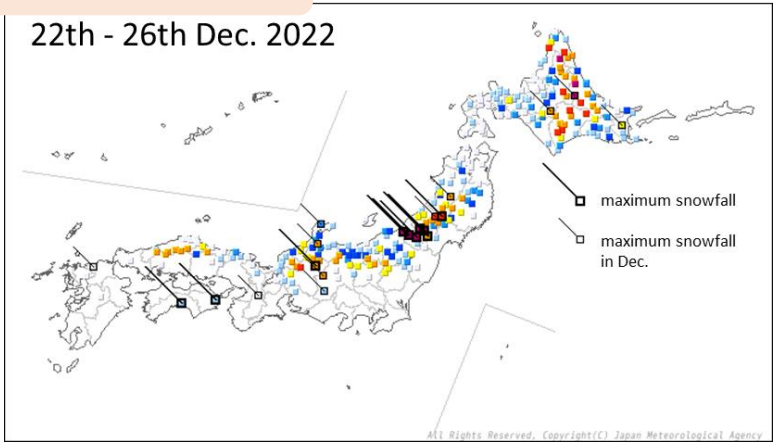
Appendix

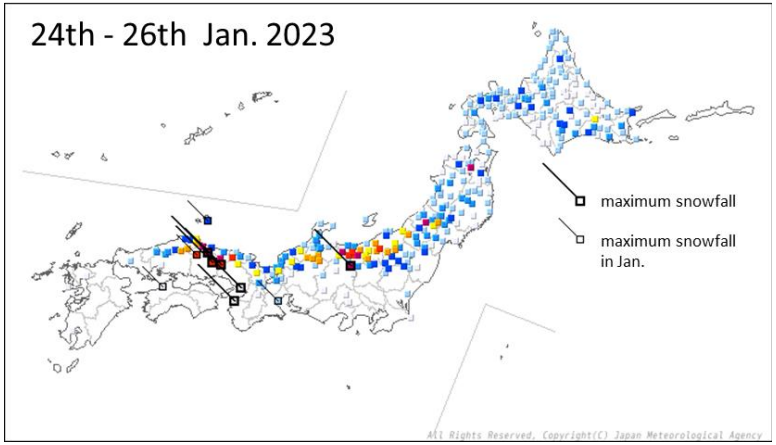
Snowfall amount in Dec 2022 to Feb 2023 in Japan

Ratio of maximum snow depth to the normal



12-hour snowfall





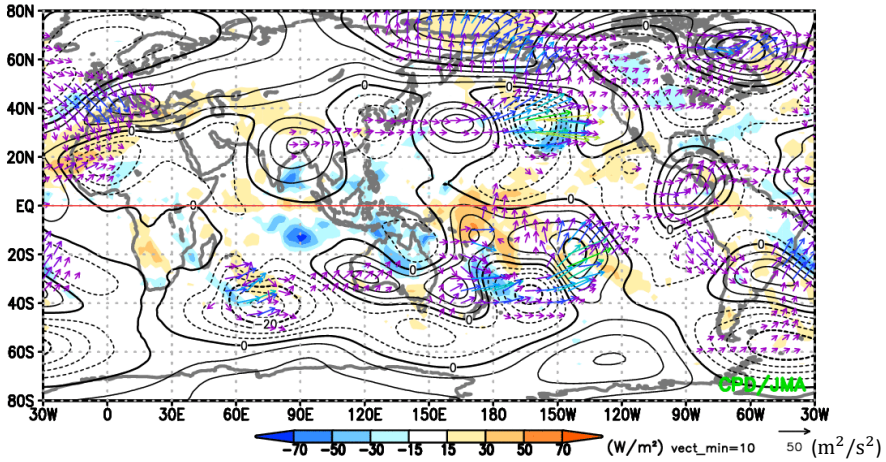
- Heavy snowfall especially on the Sea of Japan side.
- Record-breaking snowfall was also observed in some stations on the Pacific side of Japan.

- Heavy snowfall especially in western Japan.

OLR (color), ψ200 (contour), WAF at 200hPa (vector) winter 2022/23

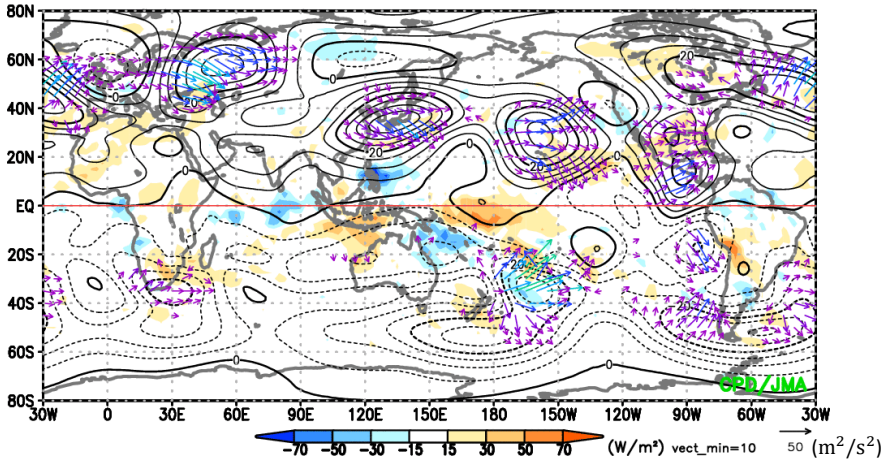
middle to late Dec.

16Dec.2022 – 25Dec.2022



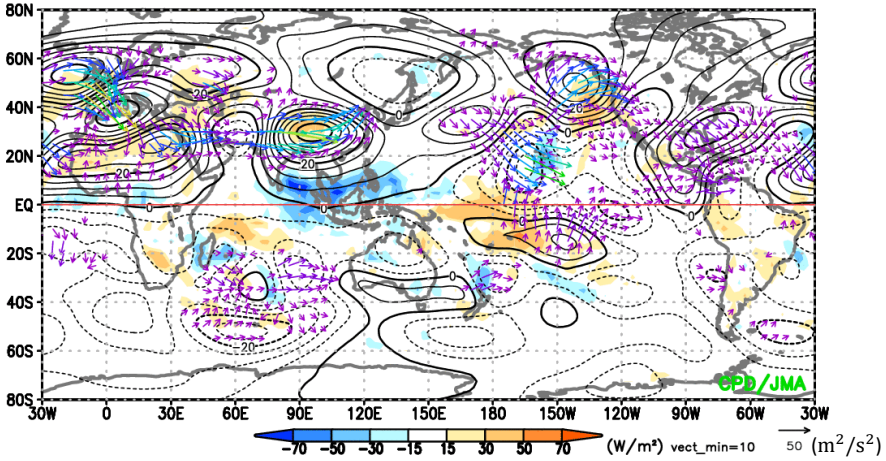
middle Jan.

11Jan.2023 – 20Jan.2023



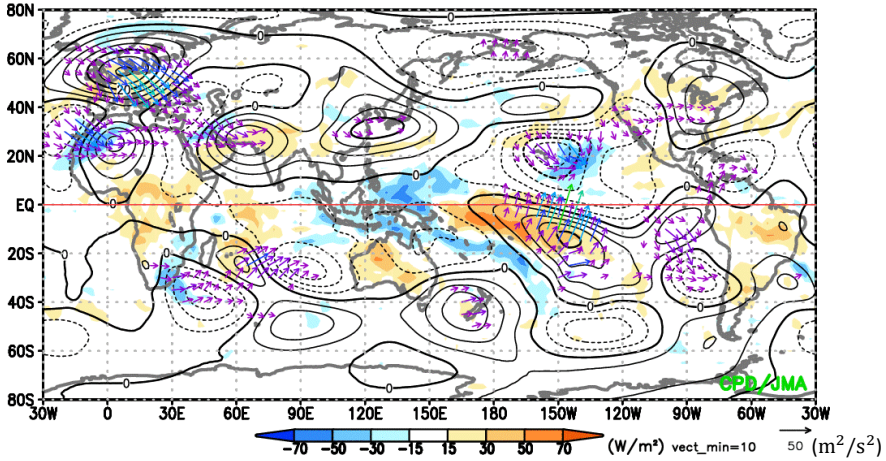
late Jan.

21Jan.2023 – 30Jan.2023



early to middle Feb.

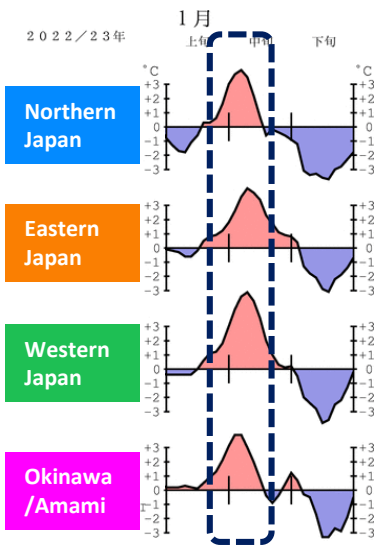
06Feb.2023 – 15Feb.2023



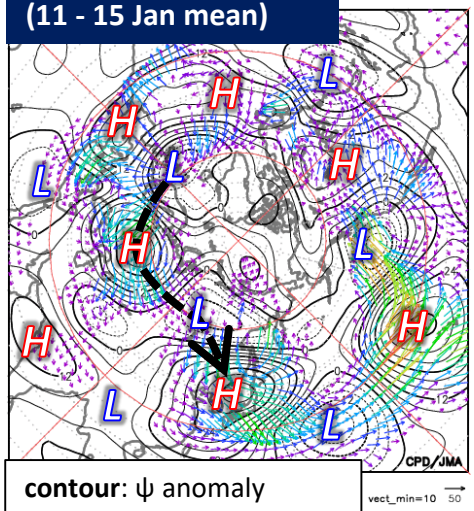
The contour interval is $20 \times 10^6 \mathrm{m}^2/s$ for thick lines and $5 \times 10^6 \mathrm{m}^2/s$ for thin lines.

Circulation field in middle January

contour: analysis
color: anomaly

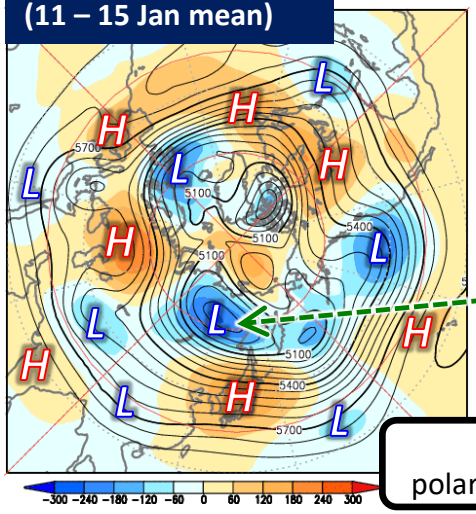


ψ300 anomaly
(11 - 15 Jan mean)

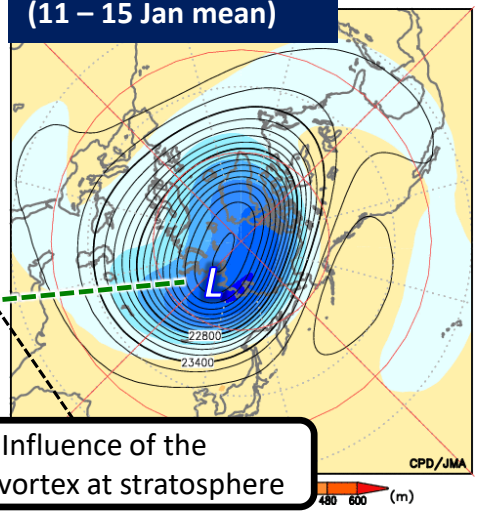


contour: ψ anomaly
vector: Wave Activity Flux

Z500
(11 – 15 Jan mean)

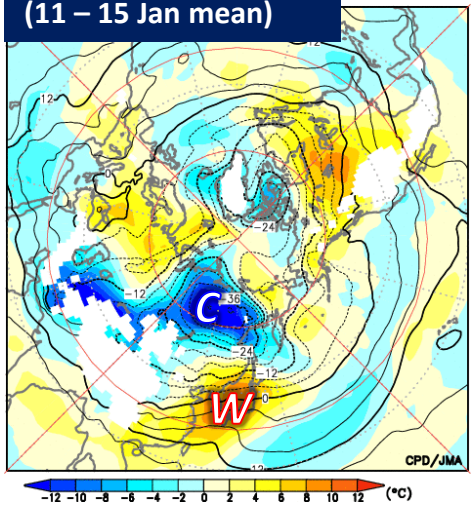


Z30
(11 – 15 Jan mean)

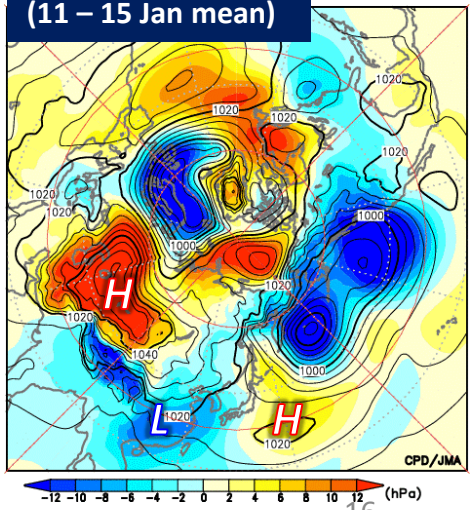


Influence of the
polar vortex at stratosphere

T850
(11 – 15 Jan mean)



SLP
(11 – 15 Jan mean)



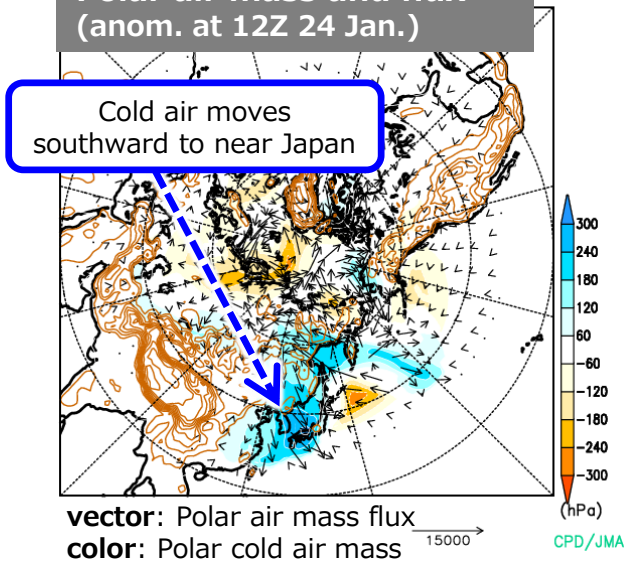
Cold air outflow in late Jan.

gray line: annual time series from 1981/82 to 2021/22
red line: time series in 2022/23

The analysis of polar cold air mass outflow below 280K

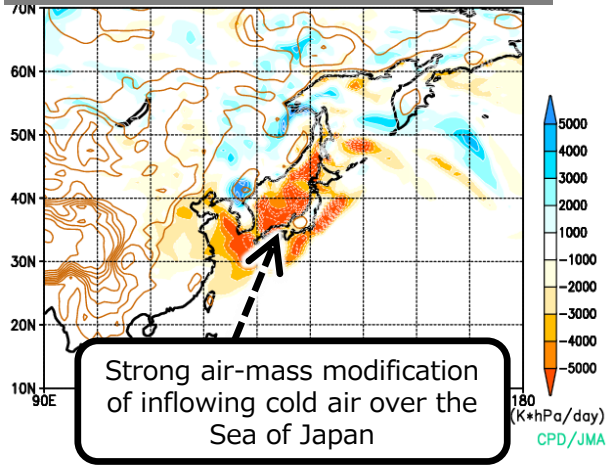
Drawn by a program provided by Mr. Iwasaki.

Polar air mass and flux (anom. at 12Z 24 Jan.)



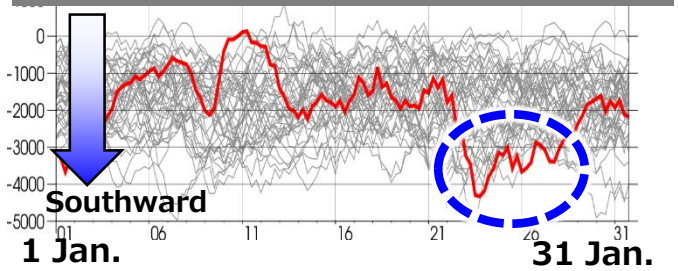
vector: Polar air mass flux
color: Polar cold air mass

Generation and Disappearance Rate of NHC (anom. at 12Z 24 Jan.)



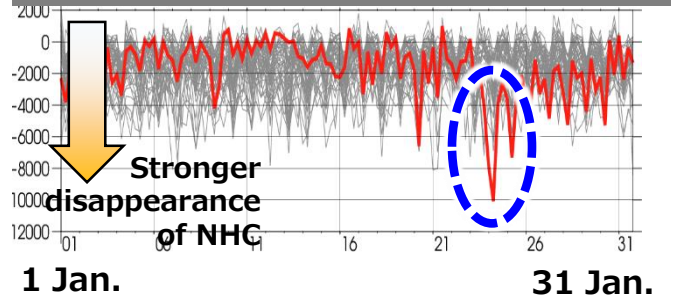
Intensity of cold air outflow via the western route (hPa m/s)

(45N, 90–135E mean southward polar air mass flux)

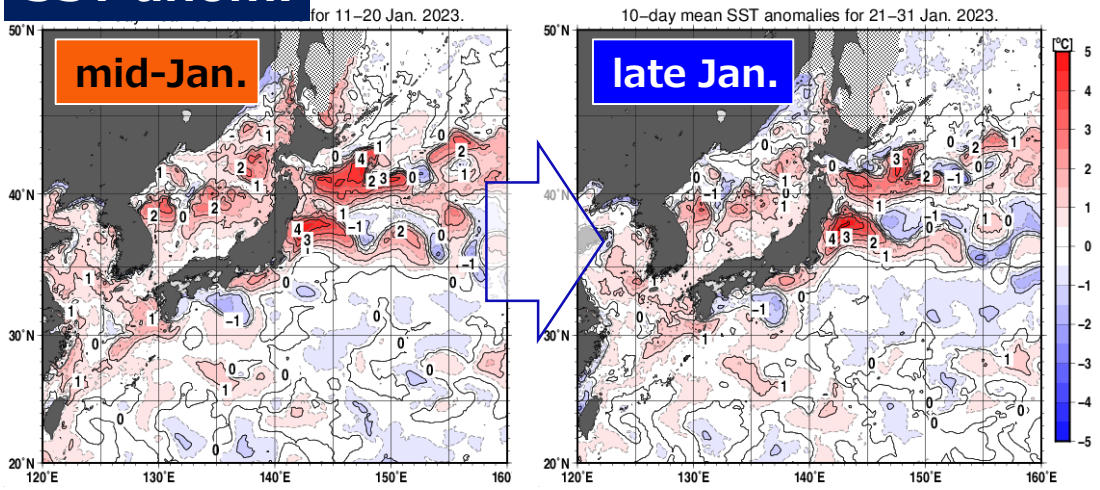


Strength of air mass modification over the Sea of Japan (K hPa/d)

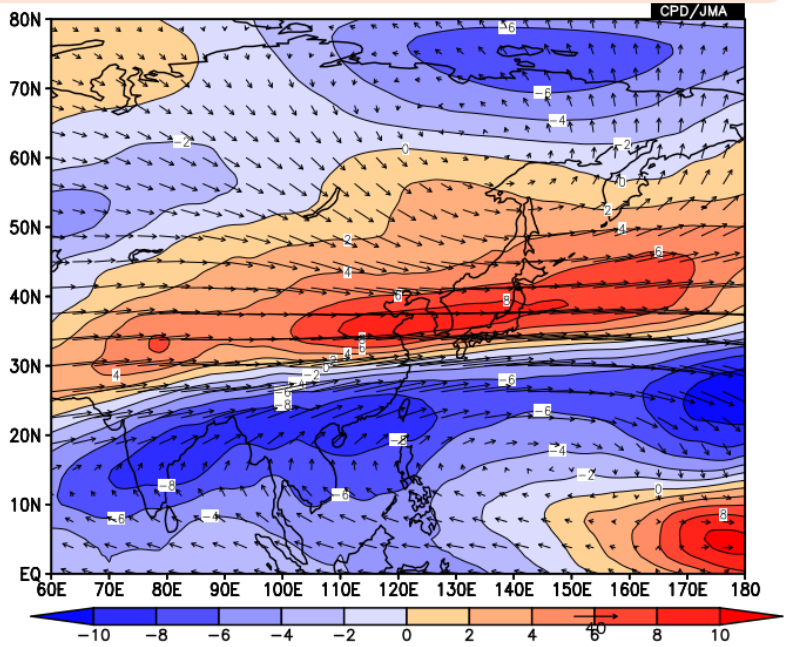
(35–40N, 132.5–140E mean disappearance rate of NHC)



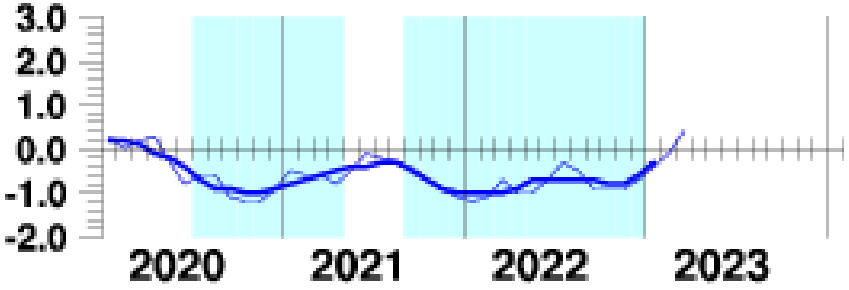
SST anom.

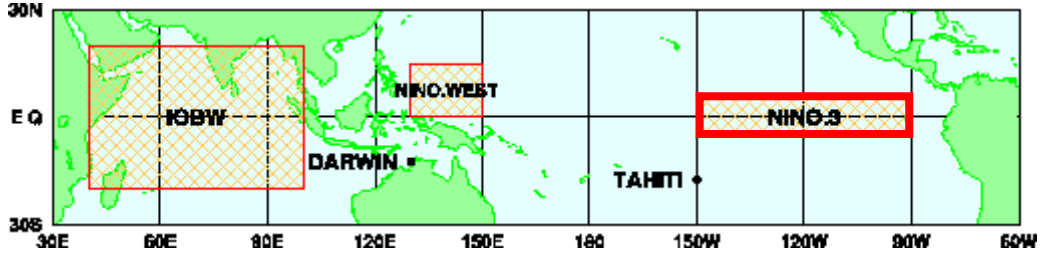


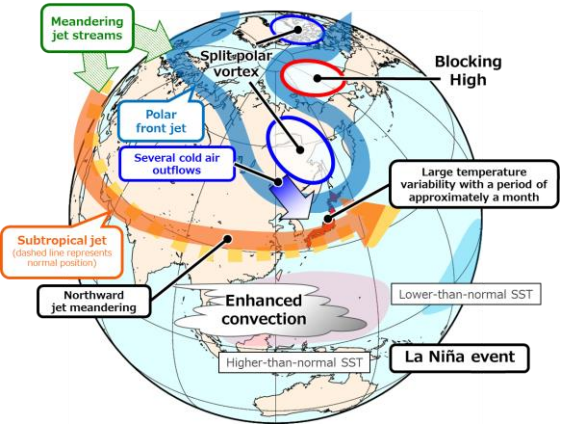
200hPa Horizontal Wind (vector) [m/s]
200hPa U anomaly (color) [m/s]



SST deviation at NINO.3 (5S-5N, 150W-90W)

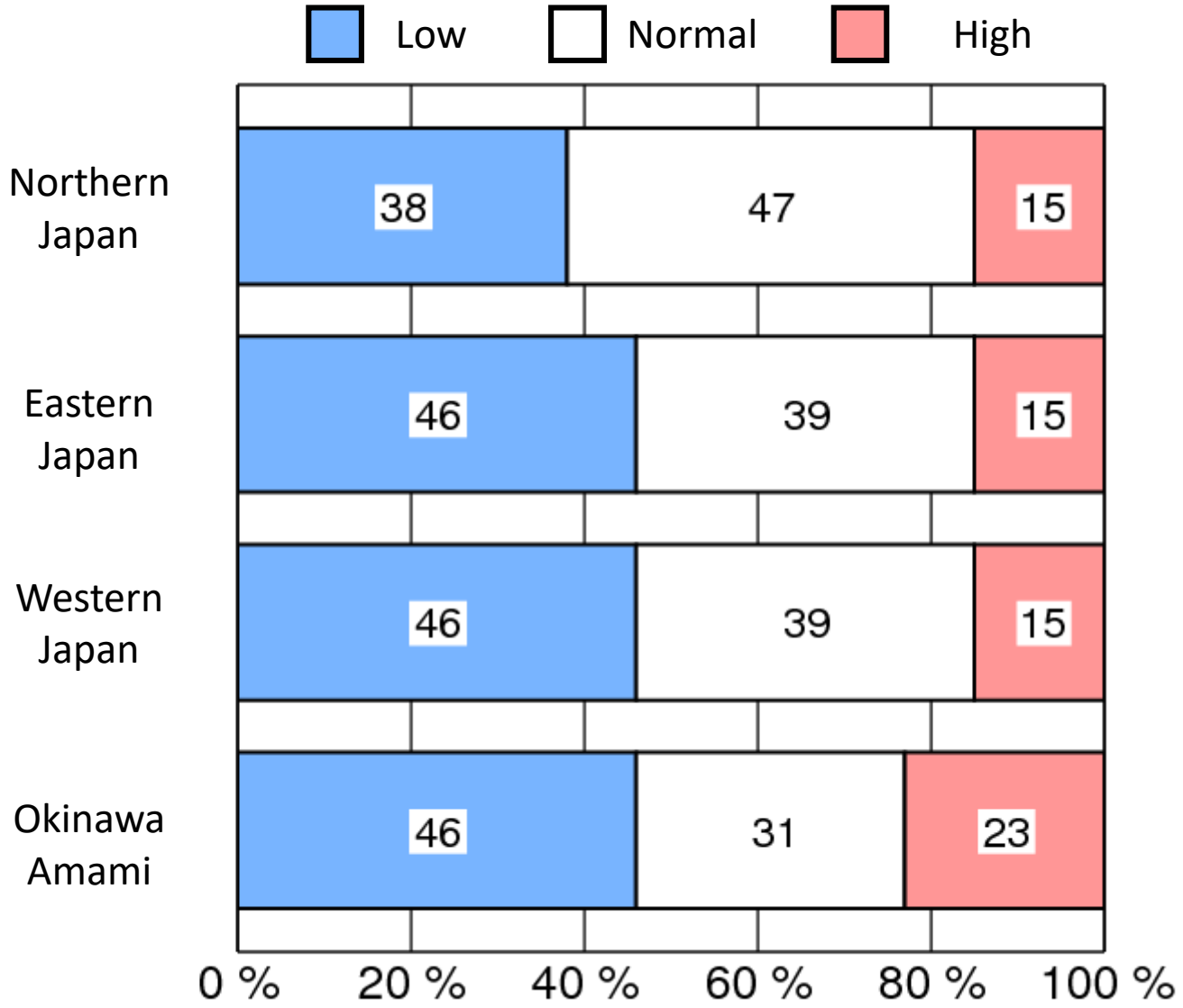






- Subtropical jet stream flowed **NORTHERLY** than normal.
- Polar front jet stream tended to **meander SOUTHWARD** around Japan.
- **La Niña conditions** had persisted from autumn 2021 to early winter 2023.

Percentage of mean temperature rank (winter) in La Niña events (1958-2012).
Due to statistical result of area averaged temperature in past.

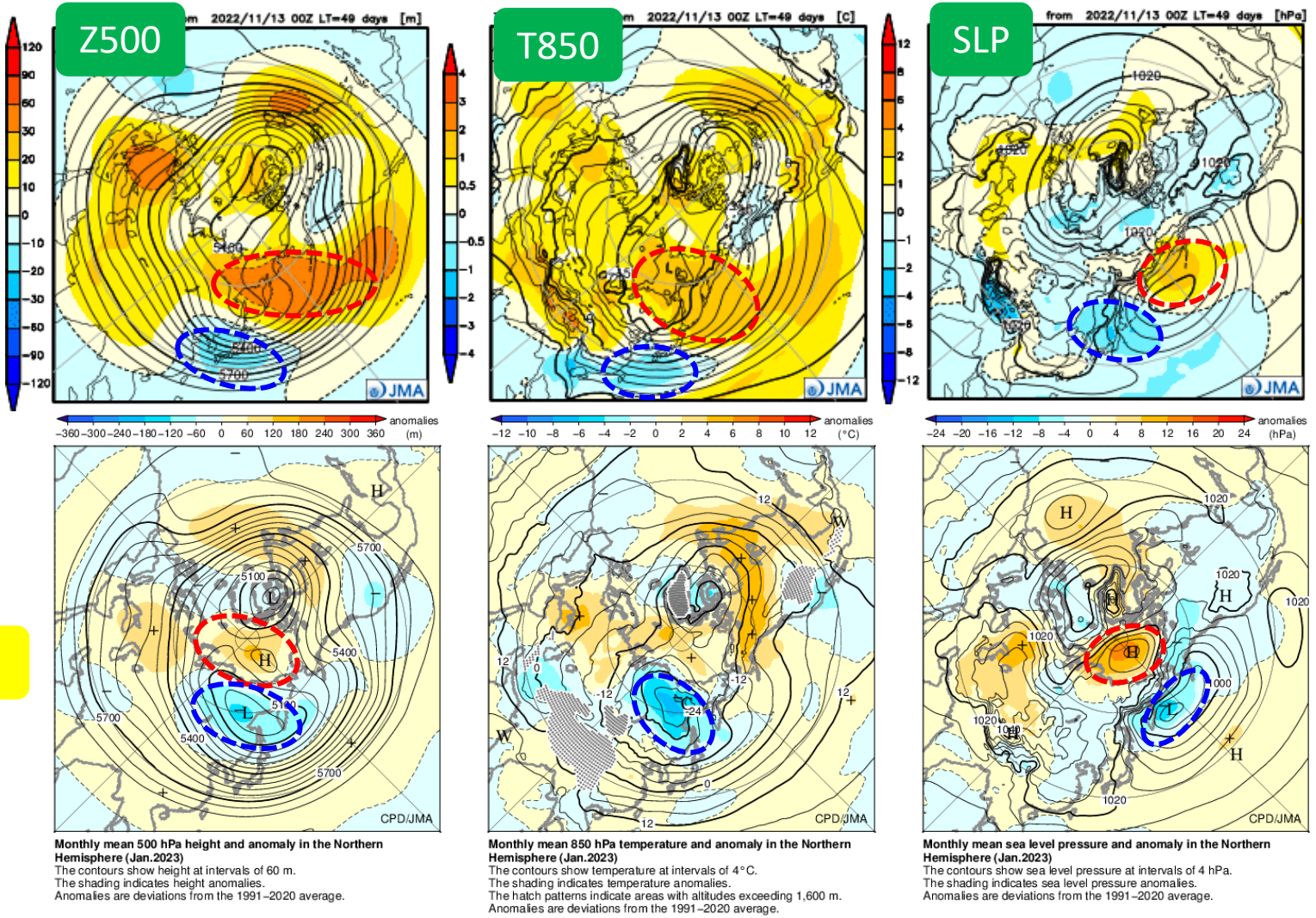


JMA/MRI-CPS3 Forecast vs Analysis for Jan. 2023

Init: 00UTC
13 Nov 2022

CPS3 forecast

JRA-55 Analysis



Monthly mean 500 hPa height and anomaly in the Northern Hemisphere (Jan.2023)
The contours show height at intervals of 60 m.
The shading indicates height anomalies.
Anomalies are deviations from the 1991–2020 average.

Monthly mean 850 hPa temperature and anomaly in the Northern Hemisphere (Jan.2023)
The contours show temperature at intervals of 4°C.
The shading indicates temperature anomalies.
The hatch patterns indicate areas with altitudes exceeding 1,600 m.
Anomalies are deviations from the 1991–2020 average.

Monthly mean sea level pressure and anomaly in the Northern Hemisphere (Jan.2023)
The contours show sea level pressure at intervals of 4 hPa.
The shading indicates sea level pressure anomalies.
Anomalies are deviations from the 1991–2020 average.

- CPS3 predicted the polar vortex splitting.
- However, a blocking high and the polar vortex was predicted southward than JRA-55 analysis.