Seasonal Outlook for winter 2023/24 over Japan

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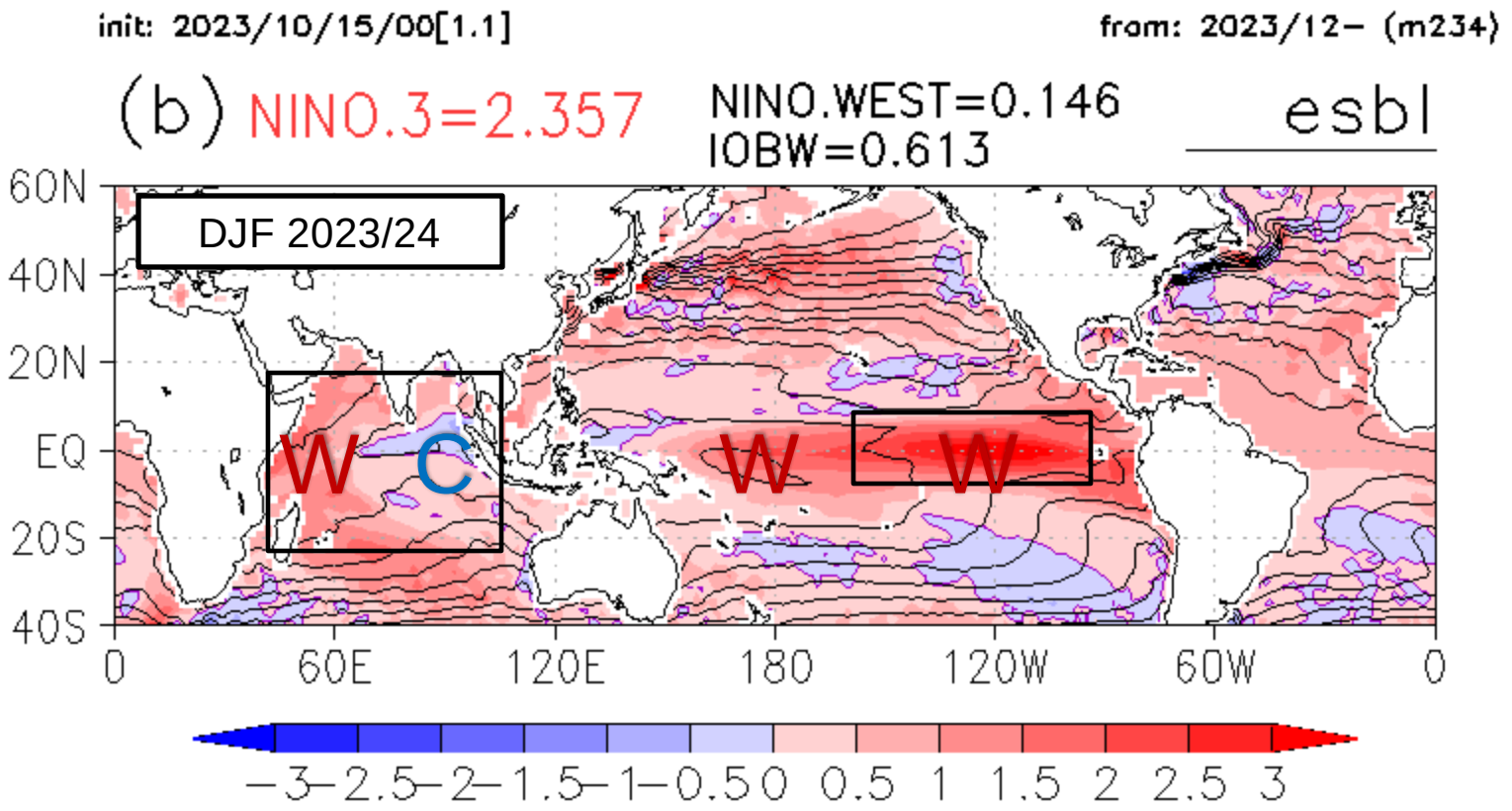
JMA's seasonal outlook

- Basically based on the results of JMA's seasonal ensemble prediction system (JMA/MRI-CPS3) and statistical post-processing
  - Statistical post-processing translates predicted GPVs to probabilities of below-, near-, and above- normal for each area over Japan by using simple regression model.
- Finally decided after adjustment/judgment by forecasters with expertise
  - Considering 30-year (1991-2020) hindcast (i.e. retrospective forecast) verification, meteorological consistency, and so on

JMA's Ensemble Prediction
https://www.data.jma.go.jp/tcc/tcc/products/model/index.html
JMA's Seasonal Outlook
https://www.jma.go.jp/bosai/map.html#contents=season&lang=en

Sea Surface Temperature (SST)

- El Niño event to continue
- Positive IOD-like SST pattern to remain in the Indian Ocean

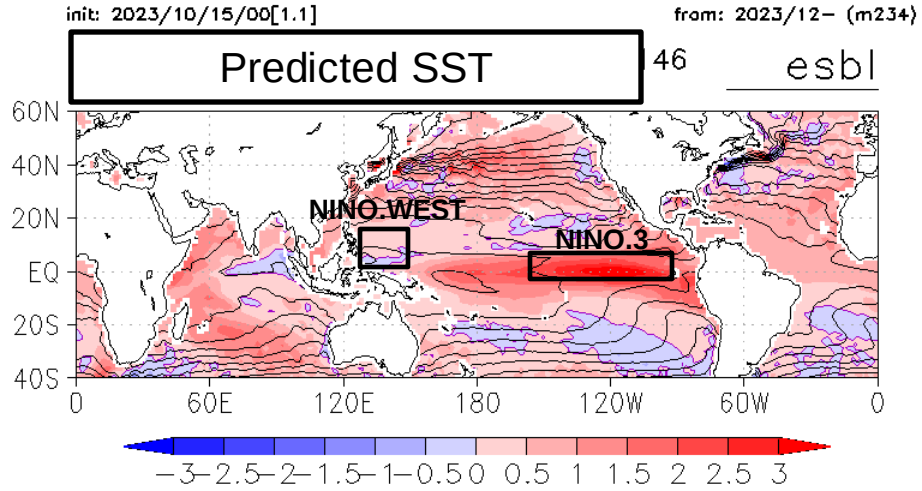


Predicted SST (contour) and anomaly (shading) for DJF.

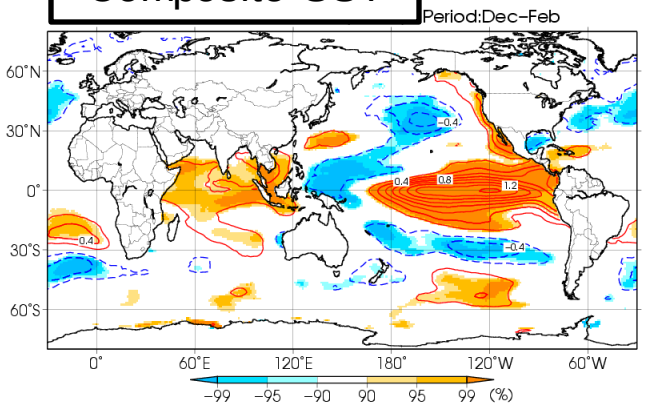
El Niño

- El Niño event to continue through winter
- Central pacific SST to be warmer than typical El Niño

Predicted SST

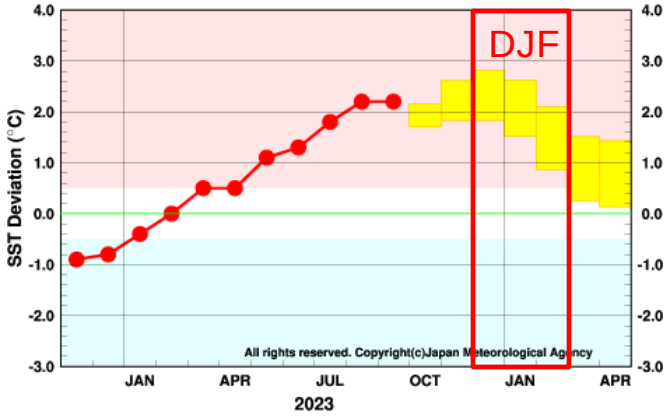


Composite SST

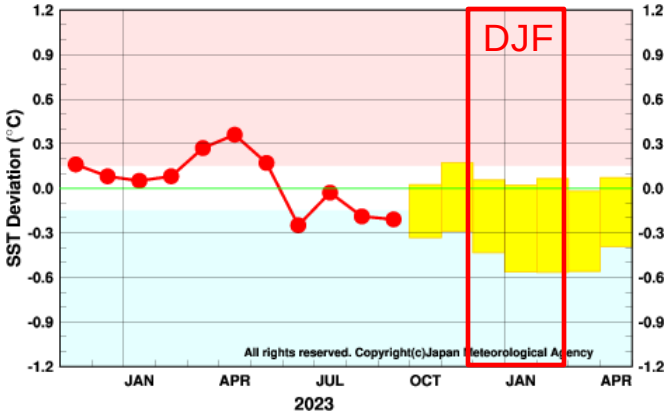


Composite of SST anomalies for El Niño during 1958-2012.

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

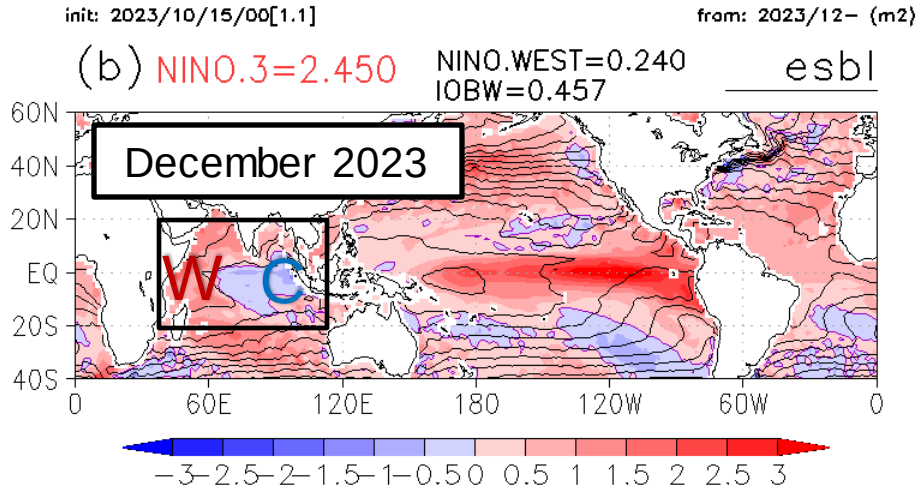


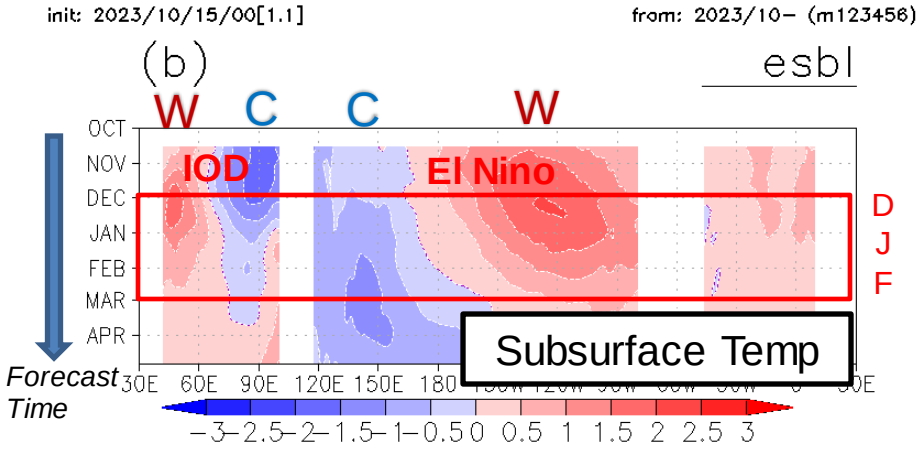
NINO.WEST (15N-EQ, 130E-150E)



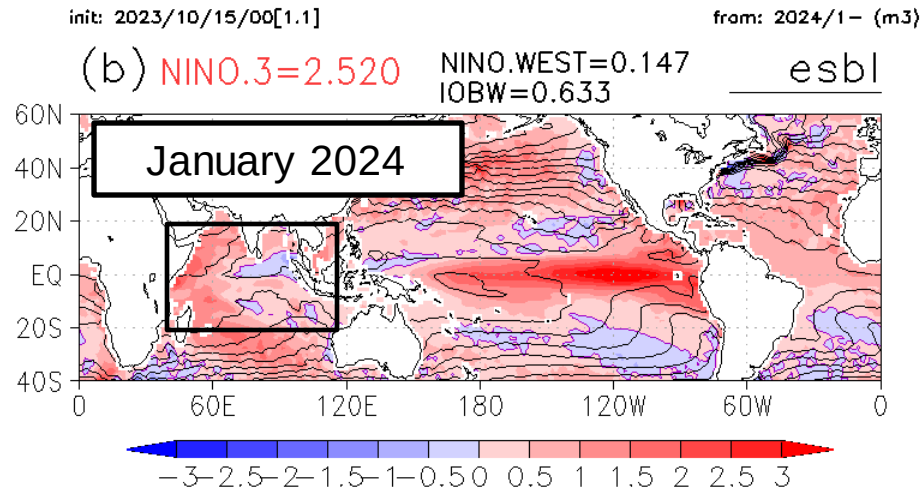
Indian Ocean Dipole (IOD)

➢ Positive IOD-like SST pattern to remain until early winter





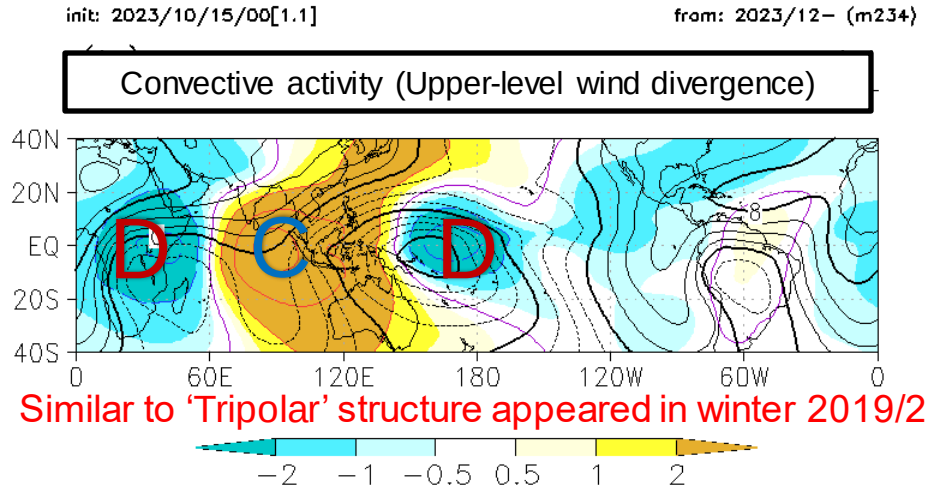
Predicted ocean heat content (vertically averaged temperature in the top 300 m) anomalies along the equator.



Positive IOD-like SST pattern (above-normal over the western Indian Ocean and below-normal over the eastern Indian Ocean) would continue until at least early winter and decay gradually.

Tropical Circulation (Upper Troposphere)

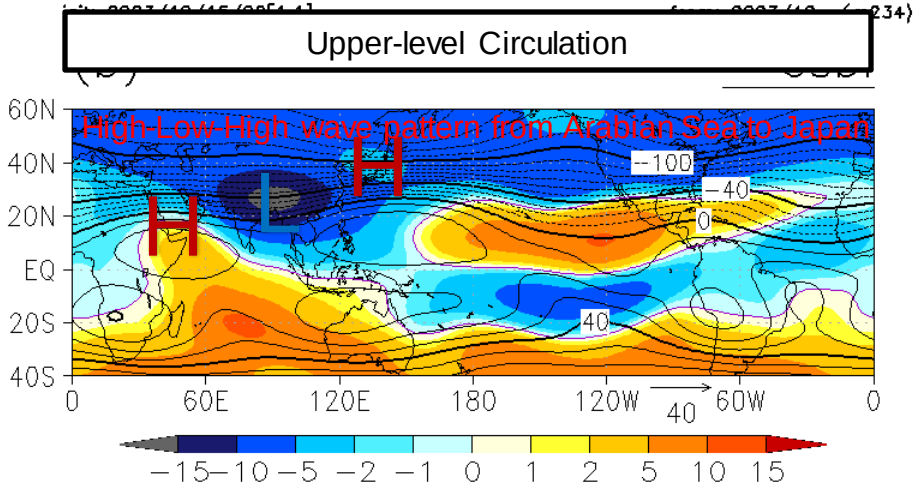
➢ High-Low-High wave pattern along the subtropical jet



Predicted velocity potential (contour) at 200 hPa and anomaly (shading) for DJF.

Corresponding to SST anomalies, convective activities would be

- Enhanced over the western Indian Ocean and the central equatorial Pacific (Divergence anomalies in the upper troposphere wind field)
- Suppressed over the eastern Indian Ocean and the Maritime Continent (Convergence anomalies in the upper troposphere wind field)

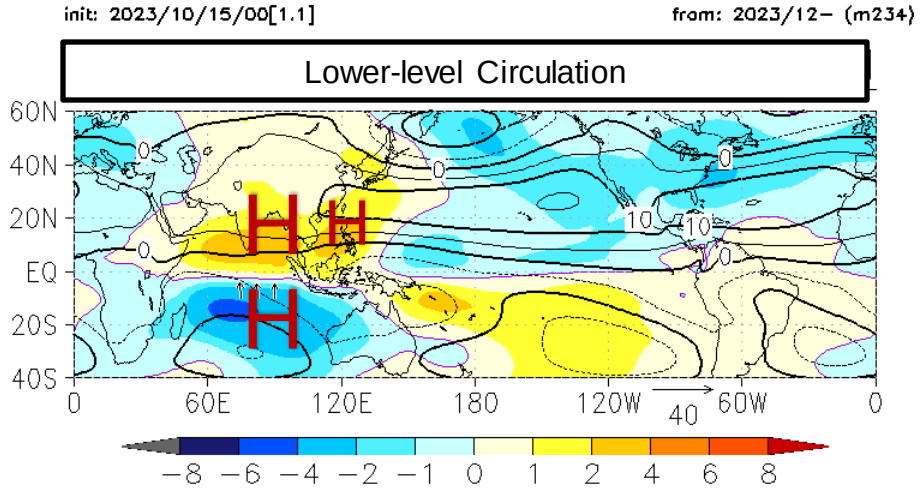


Predicted stream function (contour) at 200 hPa and anomaly (shading) for DJF.

Anomalous convective activities in the Indian Ocean and the Maritime Continent would excite stationary Rossby waves propagating along subtropical jet (STJ), resulting northward meandering of STJ around Japan.

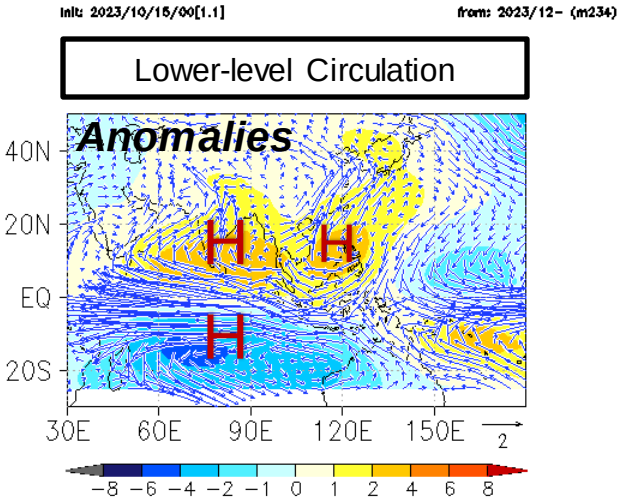
Tropical Circulation (Lower Troposphere)

➢ Southwesterly wind anomalies in the south of Japan

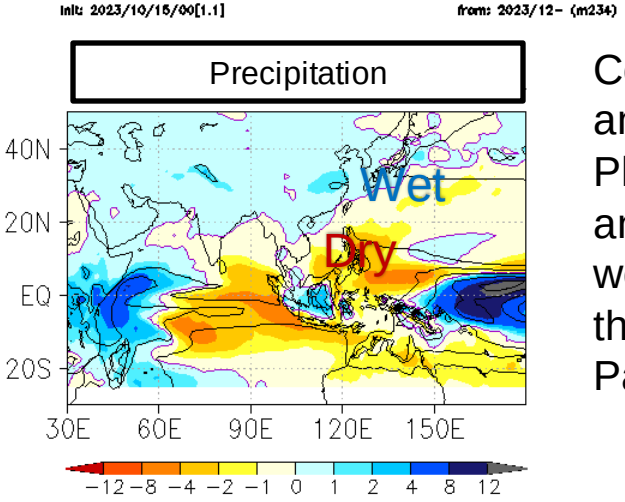


Predicted stream function (contour) at 850 hPa and anomaly (shading) for DJF.

In response to suppressed convective activities over the eastern Indian Ocean and the Maritime Continent, a pair of anti-cyclonic anomalies would be developed at lower level. Anti-cyclonic anomaly in northern hemisphere would extend to the Philippines.



Predicted wind anomaly (vector) at 850 hPa and stream function anomaly (shading) for DJF.

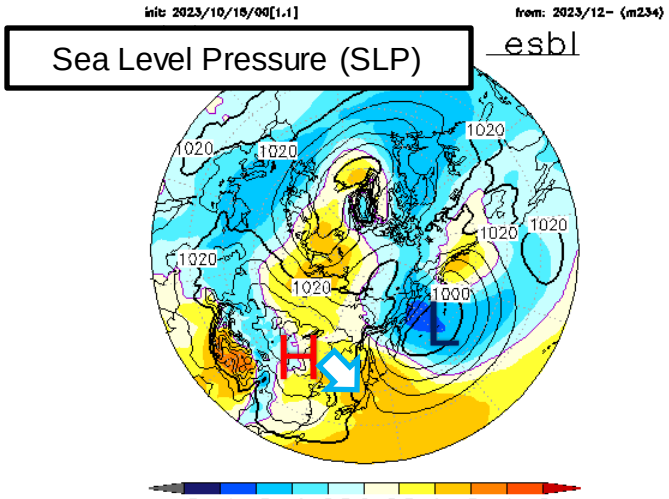


Predicted precipitation anomaly (shading) for DJF.

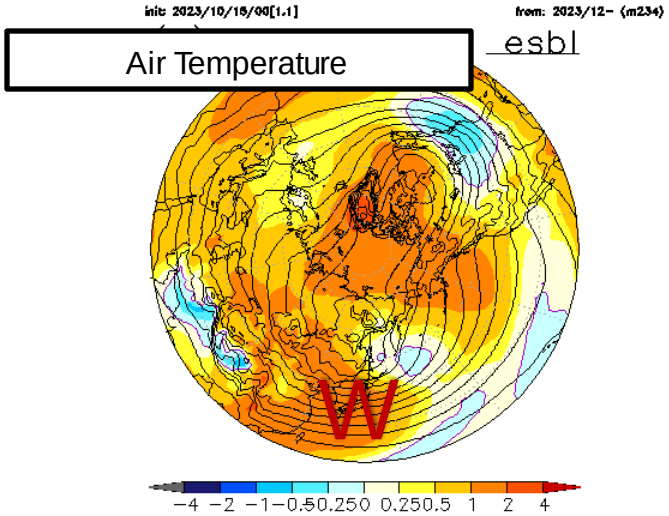
Corresponding to anti-cyclonic anomalies around the Philippines, southwesterly wind anomalies in the south of Japan would be clear, resulting wetter-than-normal conditions on the Pacific side of Japan.

Mid-Latitude Circulation

- Weaker-than-normal East Asian Winter Monsoon
- Warmer-than-normal temperature around Japan



Predicted SLP (contour) and anomaly (shading) for DJF.



Predicted temperature (contour) at 850 hPa and anomaly (shading) for DJF.

- Aleutian Low
  - Stronger than normal around the center
  - Shifted eastward than its normal position
- Siberian High
  - Weaker than normal in the southeastern part

Overall, weaker-than-normal East Asian Winter Monsoon (EAWM) would be expected.

In association with weaker-than-normal Siberian High, Pacific side of eastern/western Japan might be affected by extratropical cyclones mainly in February (not shown).

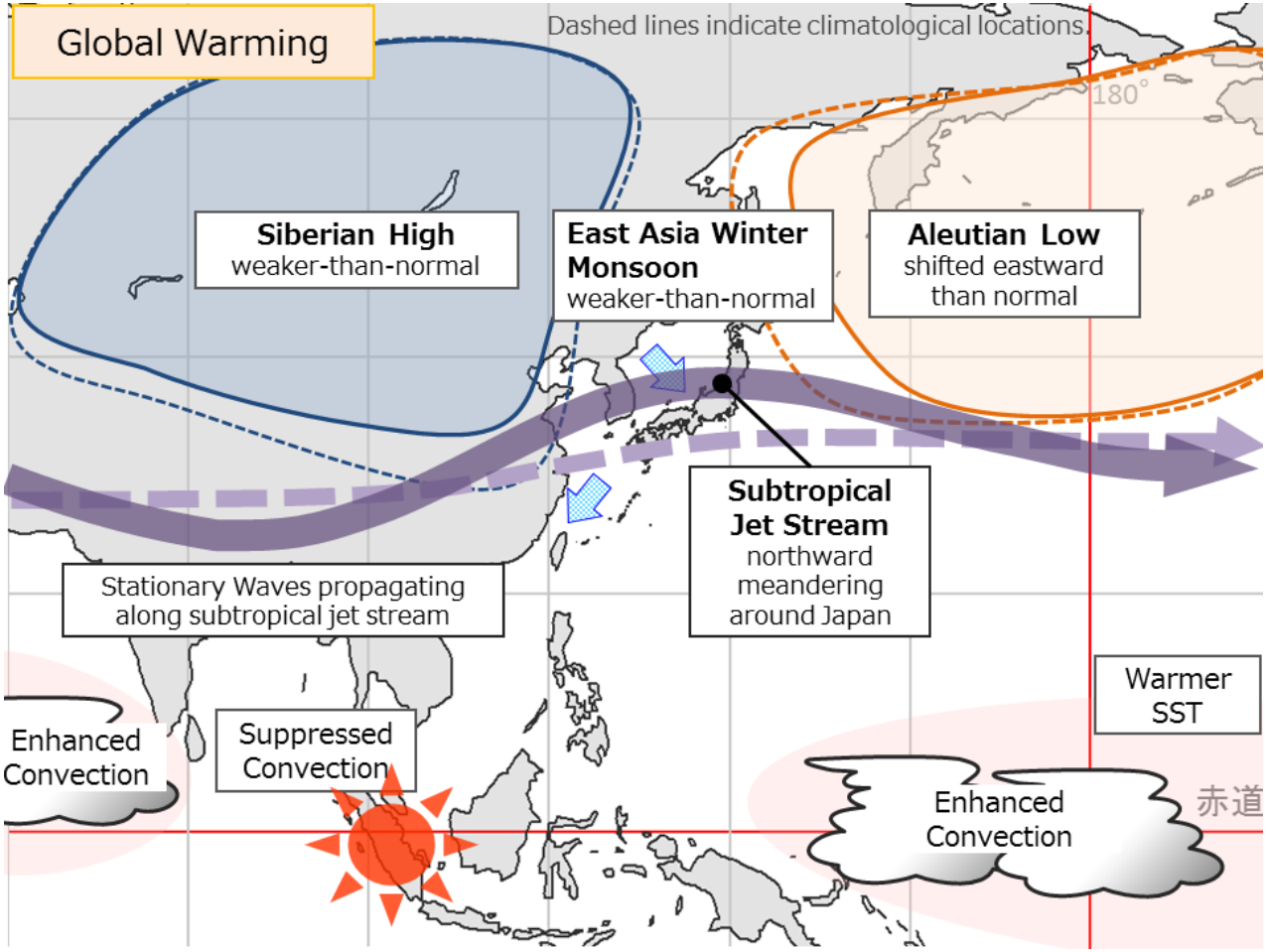
In association with northward meandering of STJ, together with global warming trend, warmer-than-normal temperatures would be expected around Japan.

N.B. Arctic Oscillation (AO) is another major factor for winter climate over Japan; Currently JMA's seasonal prediction model doesn't have enough skill to predict it a few months in advance.

Predicted key factors influencing winter climate over Japan

- ‘Tripolar’ convective activity anomalies in the tropics
- Forced stationary wave with northward shift of STJ around Japan
- Weaker-than-normal EAWM

All these factors would lead to warmer winter over Japan.



Forecaster's assessment using hindcast verification

➢ Forecaster carefully assessed model predictions using 30-year hindcast verification; e.g. how reliable predicted High-Low-High wave pattern is

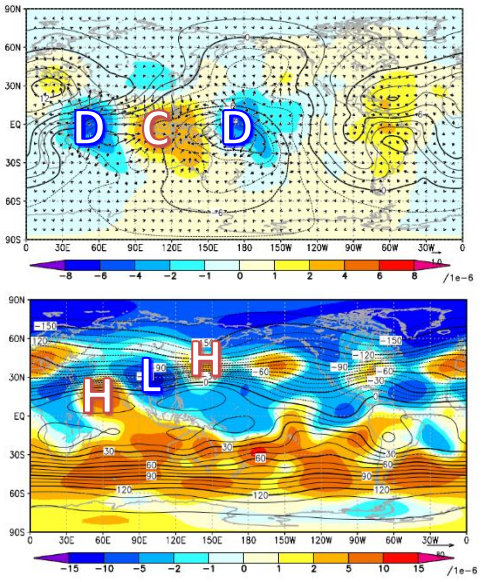
✓ 'Tripolar' convective activity pattern and forced stationary wave train can be predicted well.

case study
2019/20 DJF

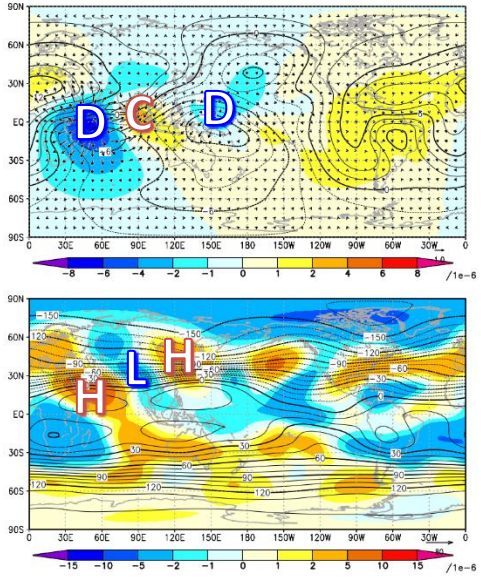
Convective activity

Upper-level Circulation

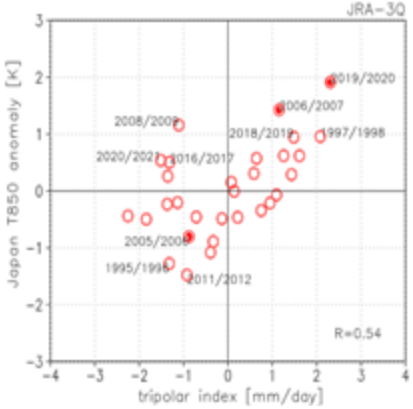
Analysis (JRA-3Q)



Prediction (JMA-MRI/CPS3)



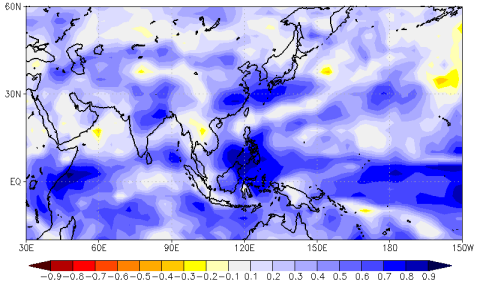
Analysis (JRA-3Q)



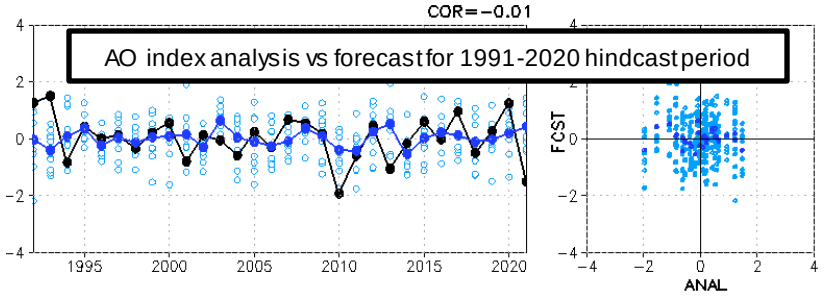
Winter temperature in Japan correlates with tripolar pattern better than tropical western Pacific only.
cf. Kuramochi et al. (2021)

✓ Winter rainfall on Pacfic side of Japan can be predicted relatively well.

Rain
Anomaly Correlation
Calculated from
1991-2020 hindcast

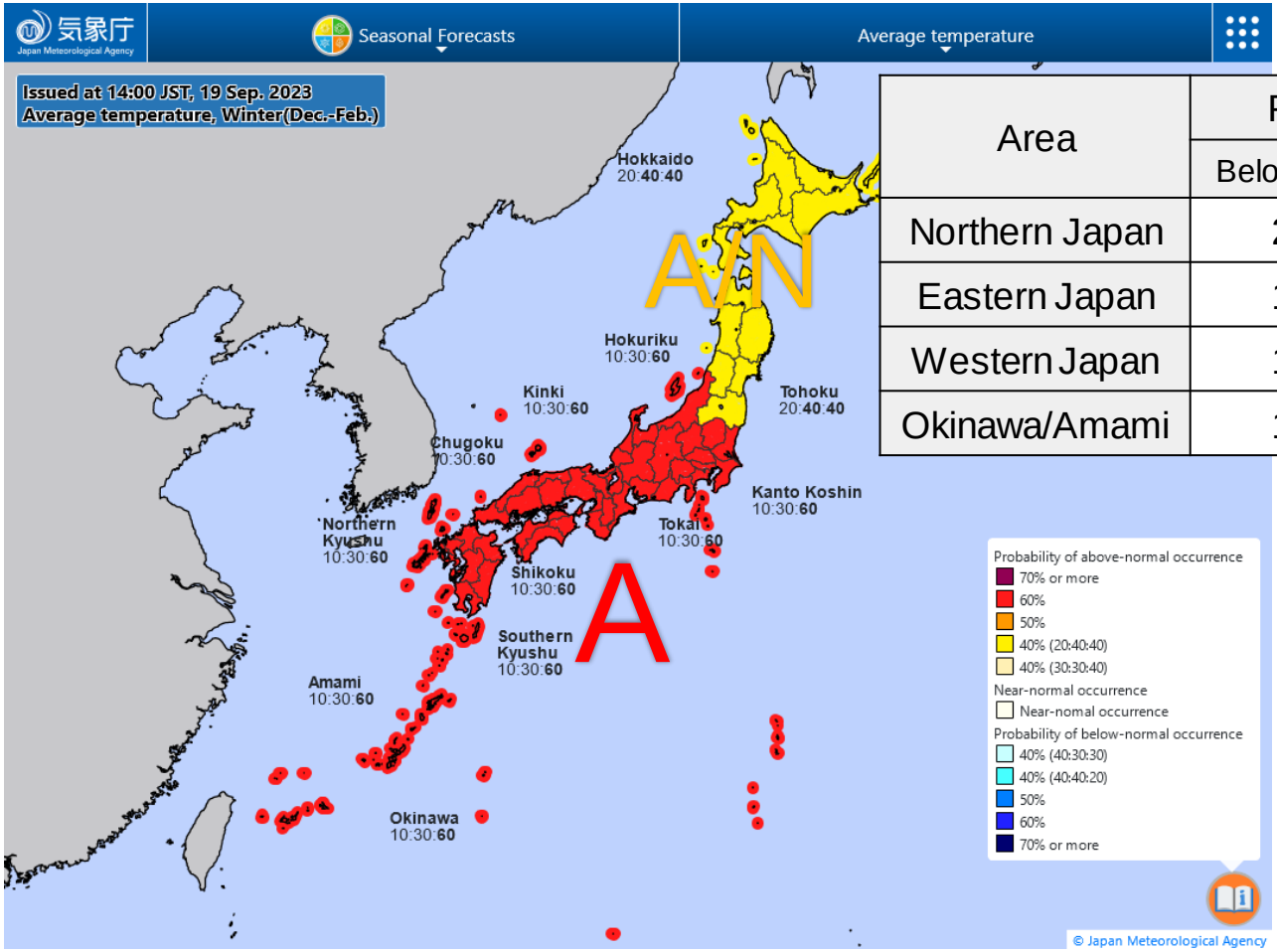


✓ AO cannot be reliably predicted by current model.



Temperature Outlook for winter 2023/24 over Japan

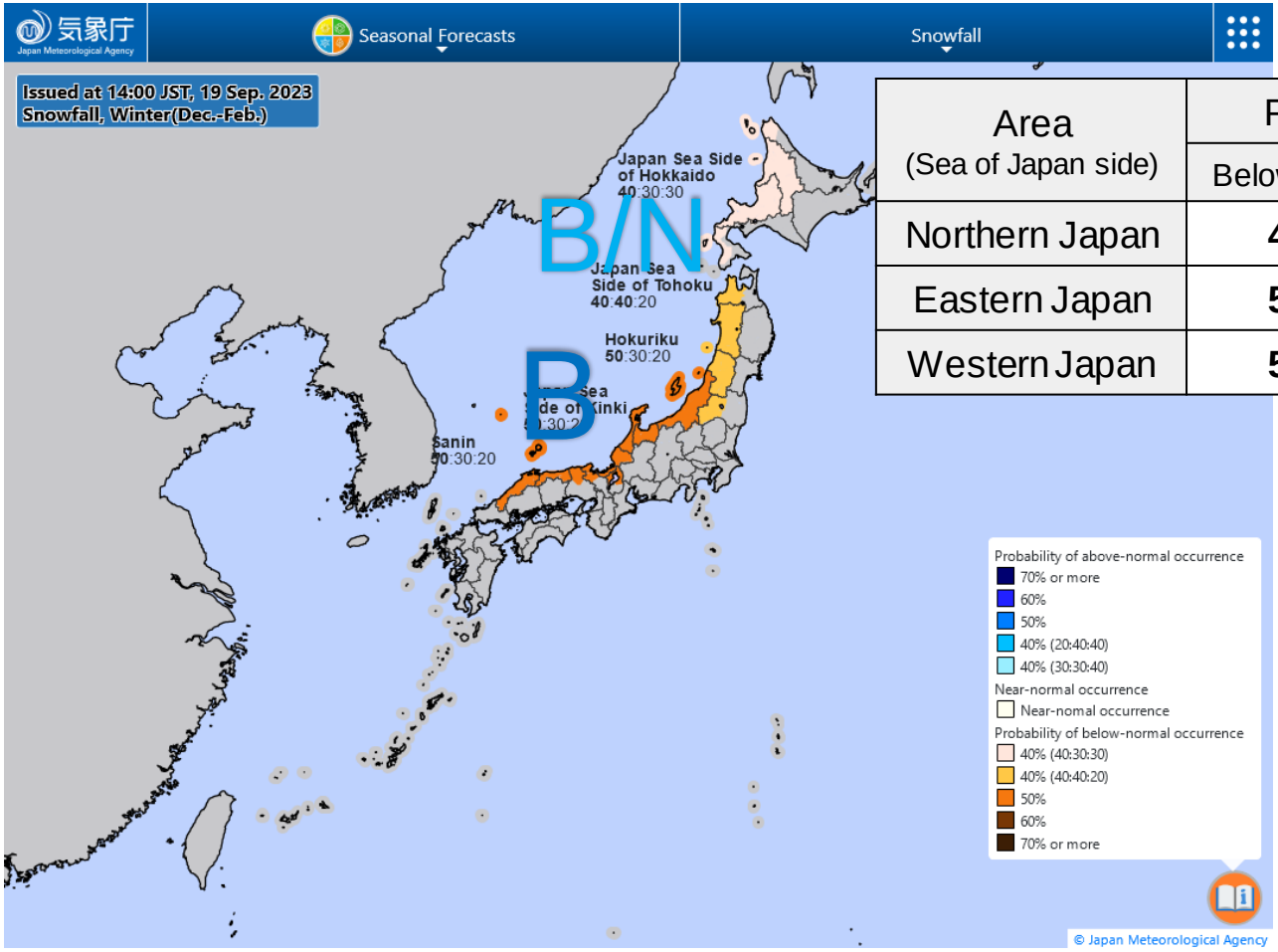
- Above-normal (60%) except for northern Japan
- Near- or Above- normal (40%) in northern Japan; occasionally affected by cold spells



Area	Prob. (%)
	Below Near Above
Northern Japan	20:**40**:**40**
Eastern Japan	10:30:**60**
Western Japan	10:30:**60**
Okinawa/Amami	10:30:**60**

Snowfall Outlook for winter 2023/24 over Japan

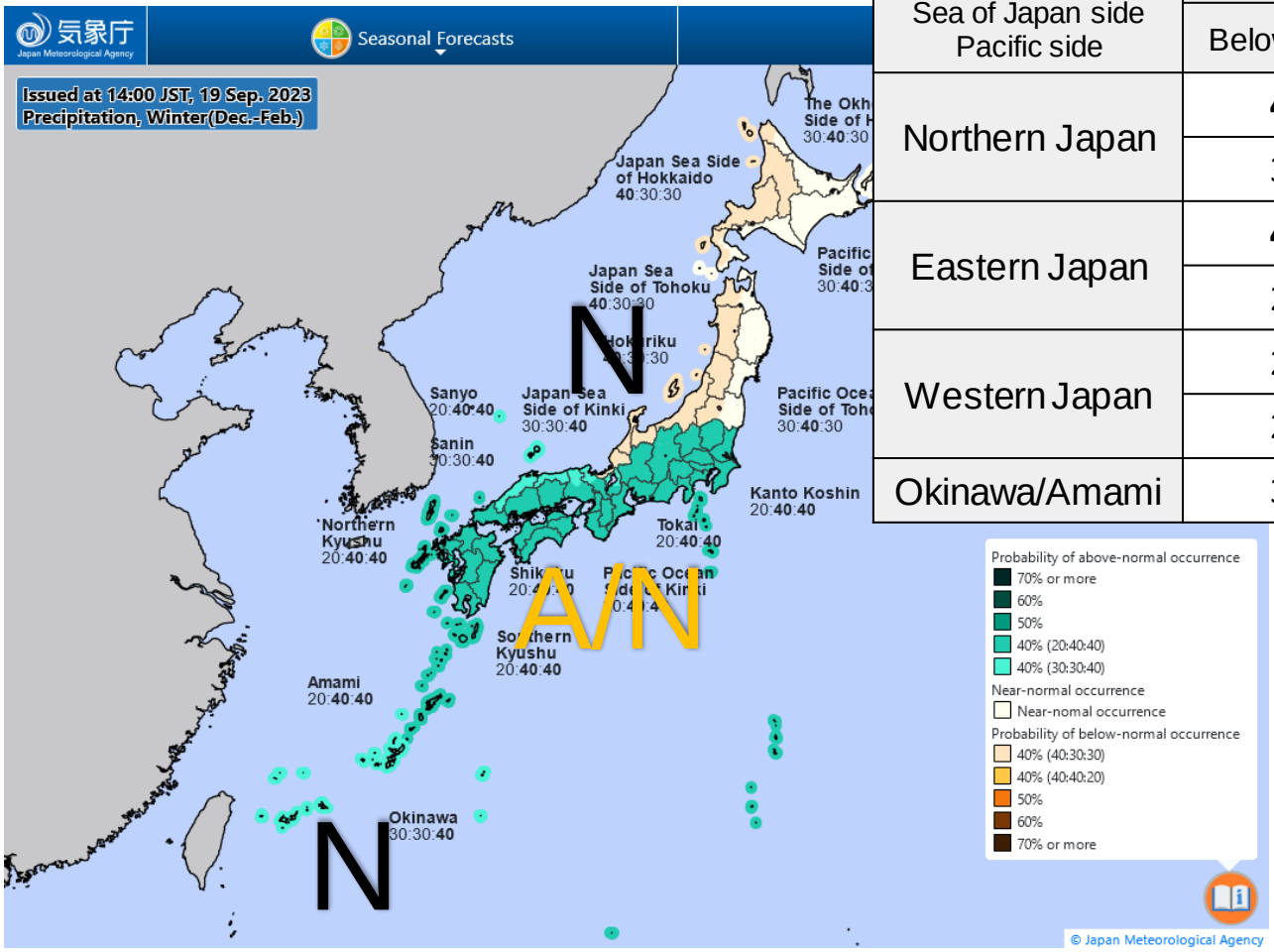
- Below-normal (50%) in eastern and western Japan
- Near- or Below- normal (40%) in northern Japan; occasionally affected by cold spells



Area (Sea of Japan side)	Prob. (%)
	Below Near Above
Northern Japan	**40**:**40**:20
Eastern Japan	**50**:30:20
Western Japan	**50**:30:20

Precipitation Outlook for winter 2023/24 over Japan

- Near- or Above- normal (40%) on the Pacific side of eastern Japan and in western Japan; possibly affected by extratropical cyclones



Area Sea of Japan side Pacific side	Prob. (%) Below Near Above
Northern Japan	**40**:30:30
	30:**40**:30
Eastern Japan	**40**:30:30
	20:**40**:**40**
Western Japan	20:**40**:**40**
	20:**40**:**40**
Okinawa/Amami	30:30:**40**

Summary

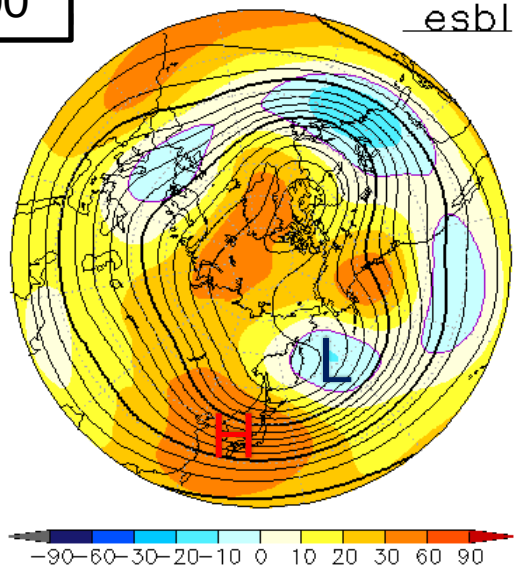
- Atmospheric/Oceanic conditions for winter 2023/24 predicted by JMA/MRI-CPS3
  - Ocean
    - El Niño
    - IOD-like SST pattern
  - Atmosphere
    - ‘Tripolar’ convective activity anomalies in the tropics
    - Stationary wave along STJ with northward shift of STJ around Japan
    - Weaker-than-normal EAWM

- Based on predicted conditions, JMA’s outlook says:
  - Above-normal temperatures (60%) and below-normal snowfall amounts (50%) nationwide except for northern Japan.
  - In northern Japan, temperature and snowfall amount would be equally above- or near-normal (40%) , due to occasional cold spells.

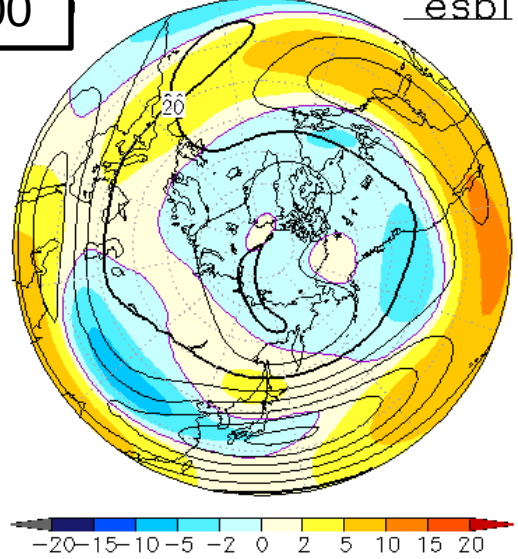
Thank you!

Mid-Latitude Circulation (DJF)

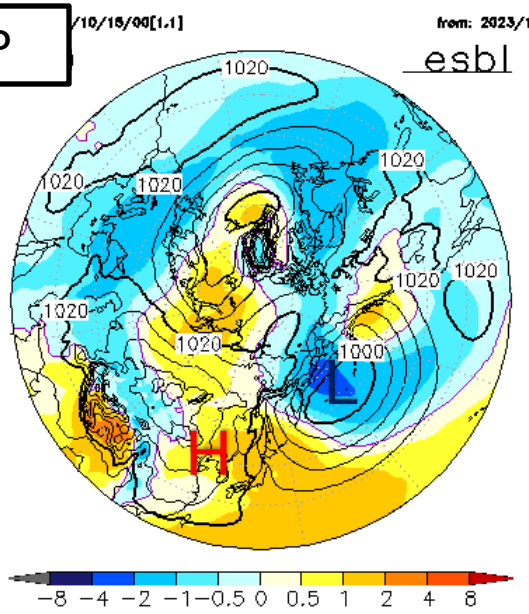
Z500



U200



SLP



Sea Ice