Characteristic and prediction evaluation of the 2017/2018 East Asian winter monsoon

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Japan Meteorological Agency
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Outline

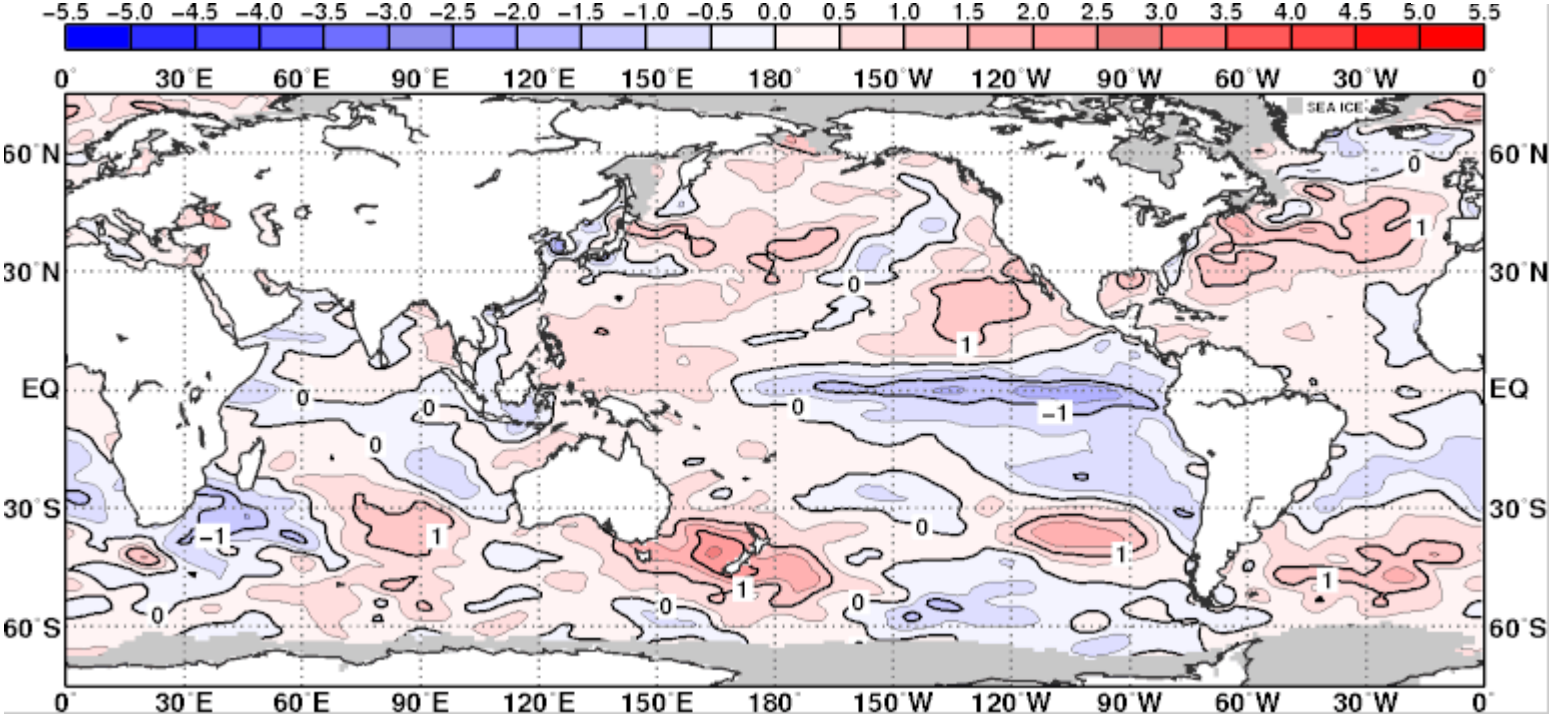
- Characteristics of climate conditions in Japan
- Summary of East Asian winter monsoon
  - The meander of subtropical jet over Asia
  - Predominant Eurasian teleconnection pattern
- Seasonal prediction and evaluation by JMA/MRI-CPS2*
- A issue about zonal mean response over mid-latitude region of tropical convection activities

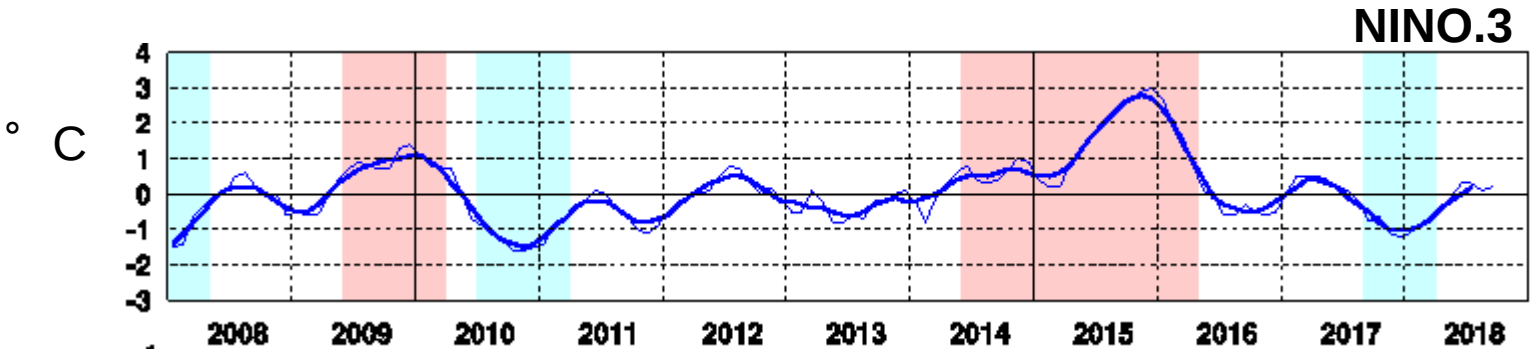
* JMA/MRI-CPS2 :
Japan Meteorological Agency/Meteorological Research Institute-Coupled Prediction System version 2

Weak La Niña conditions developed last winter

SST anomalies for 2017/2018 winter

COBE-SST



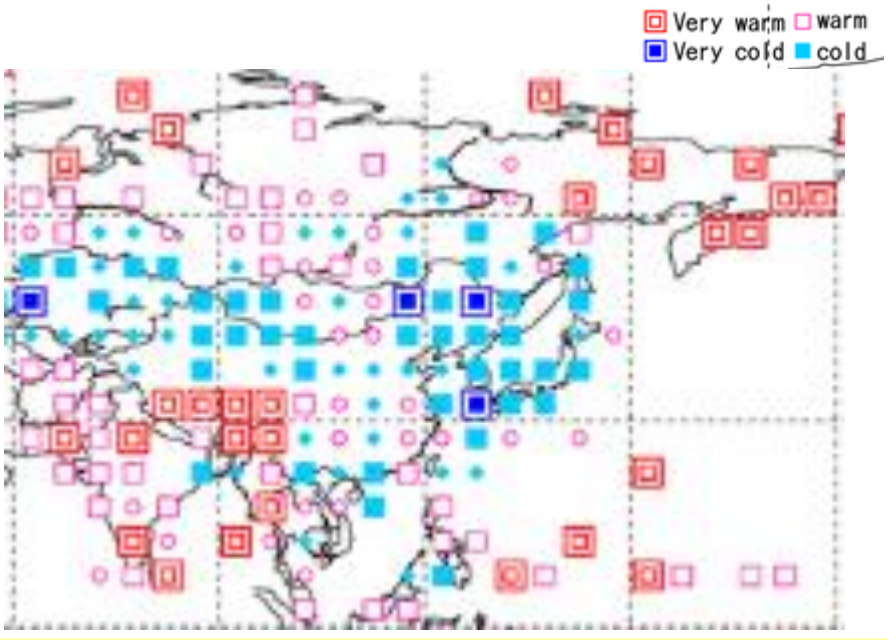


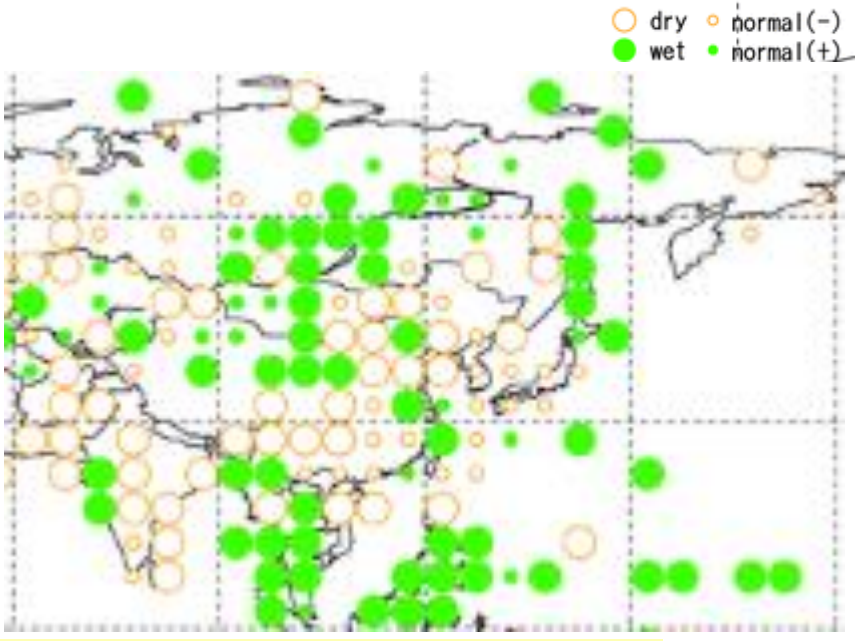
Overview in winter 2017/2018

† Data based on CLIMAT Report

Warmer than normal	Southwestern China Southeastern Russia and Mongolia, Southwestern India
Colder than normal	Most of East Asia, especially Northeast China, the Korean peninsula and Western Japan

Wetter than normal	Midwest China, Western Mongolia and Northern Japan
Dryer than normal	Northeast China and Southern China

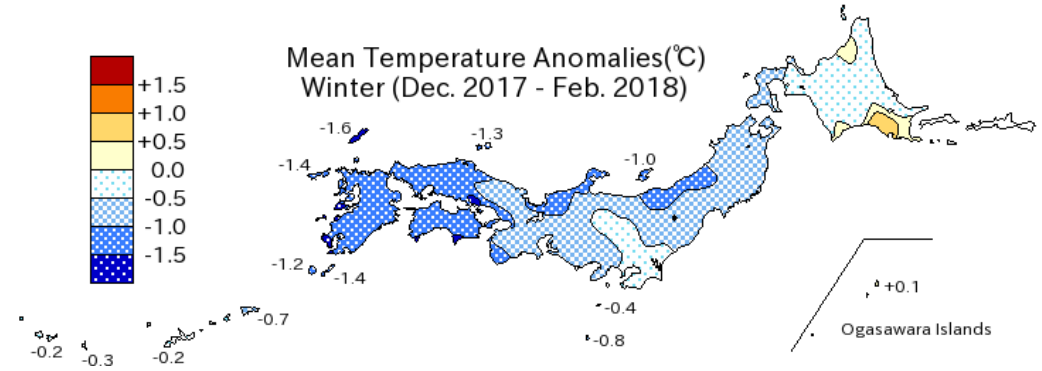


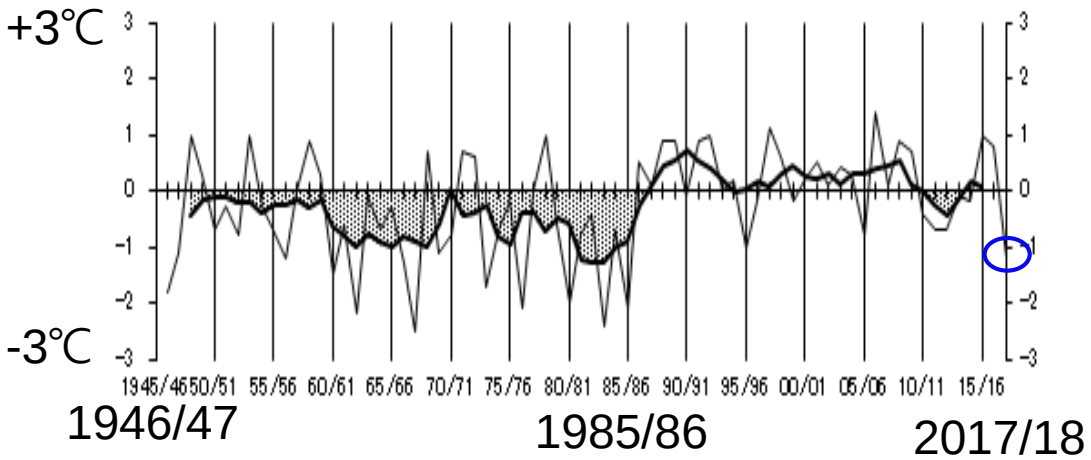


The most of East Asia region experienced cold winter.

The precipitation amount were wetter than normal over Southeast Asia, which were consistent with typical anomaly pattern observed in past La Nina events.

Cold winter over Japan



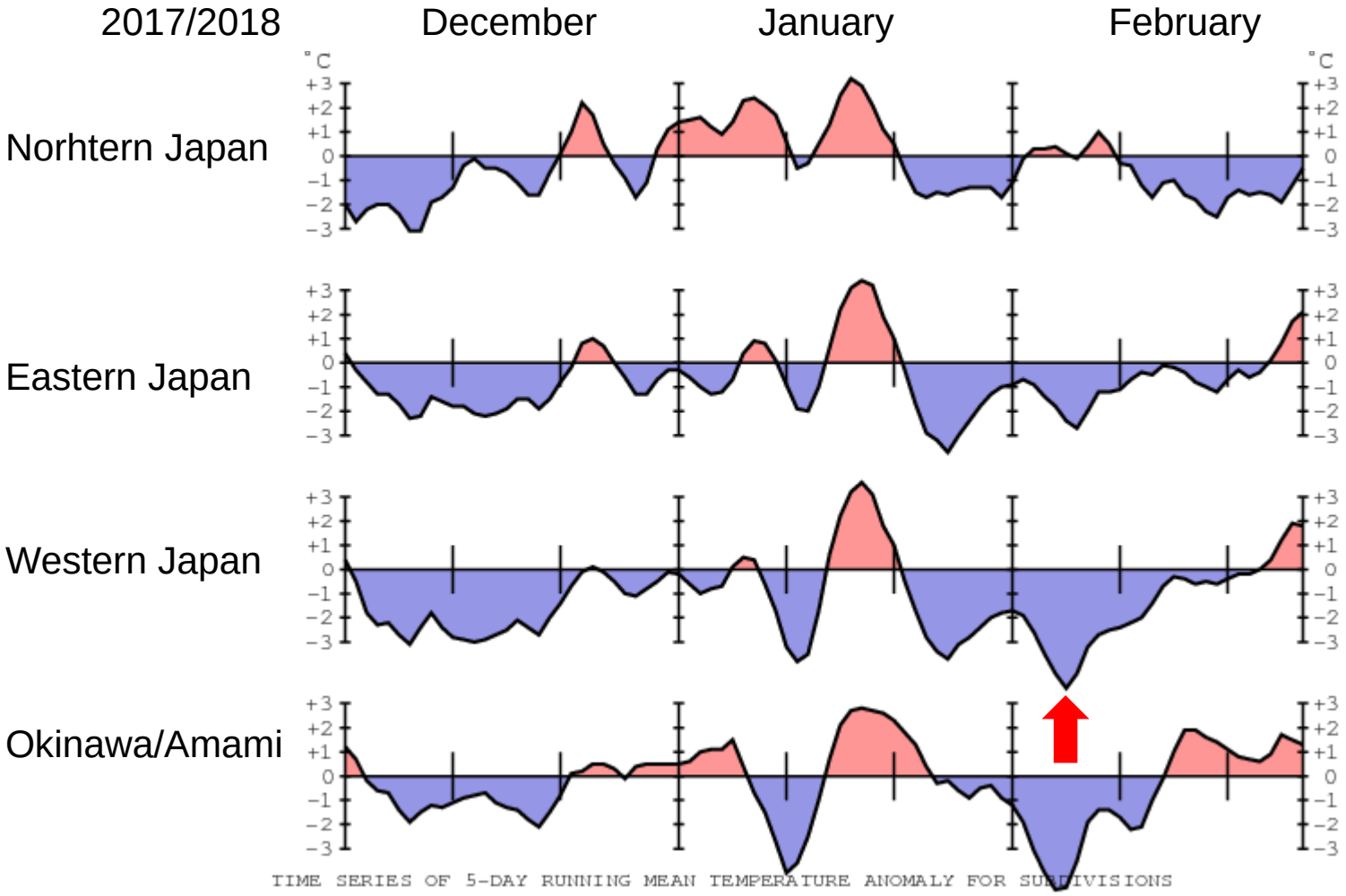


month Sunshine Duration Ratio for Subdivisions(Dec.2017~Feb

	Temperature Anomaly ℃(rank)	Precipitation Ratio %(rank)	Sunshine Duration Ratio %(rank)
Northern Japan	-0.4(-)	105(0)	97(0)
Sea of Japan side		115(+)	90(-)
Pacific side		96(0)	103(0)
Eastern Japan	-0.7(-)	73(-)	109(+)*
Sea of Japan side		124(+)*	99(0)
Pacific side		59(-)	112(+)*
Western Japan	-1.2(-)	83(0)	103(+)
Sea of Japan side		82(-)	100(0)
Pacific side		84(0)	106(+)
Okinawa and Amami	-0.3(-)	82(-)	85(-)

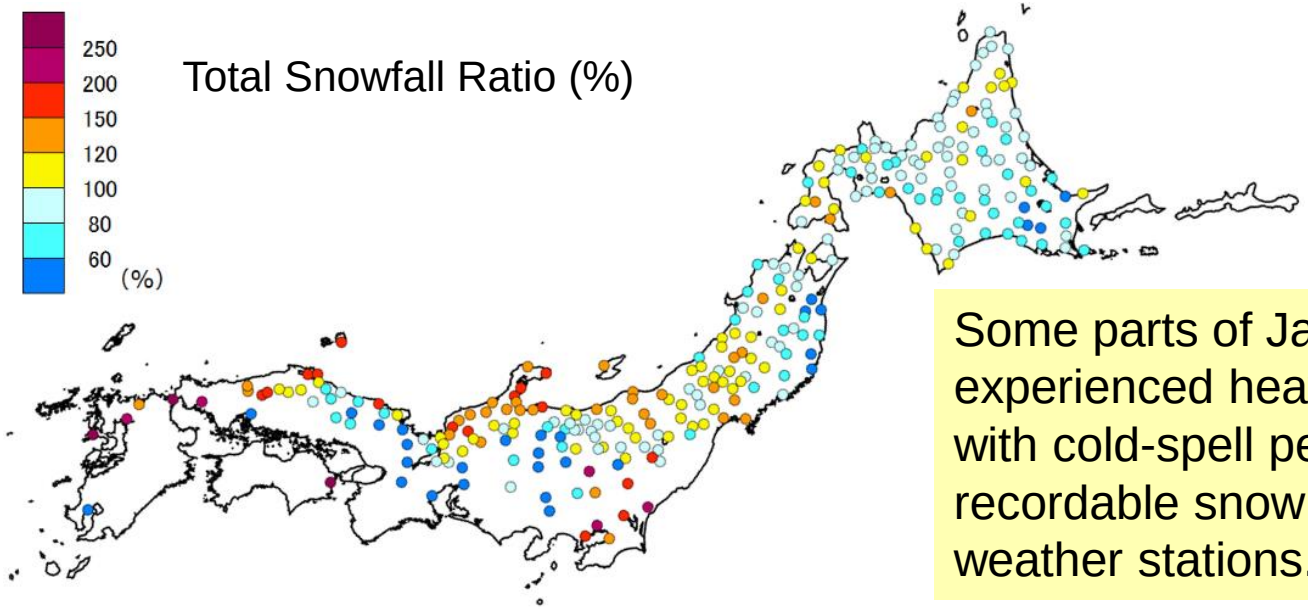
Japan experienced cold winter nationwide last year. The seasonal mean temperature anomaly in Western Japan was -1.2° C, which was the lowest for 32 years since winter 1985/86.

Time-series of temperature anomalies

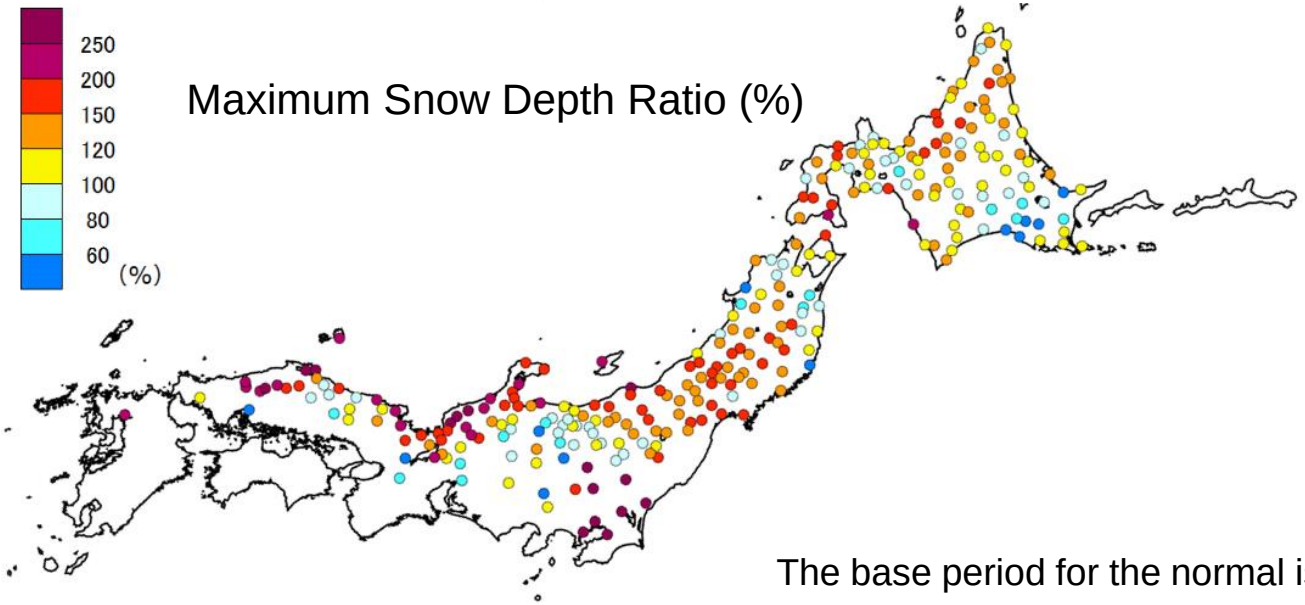


A series of extreme cold spells hit Japan by strong winter monsoon, especially early February.

Observed heavy snow



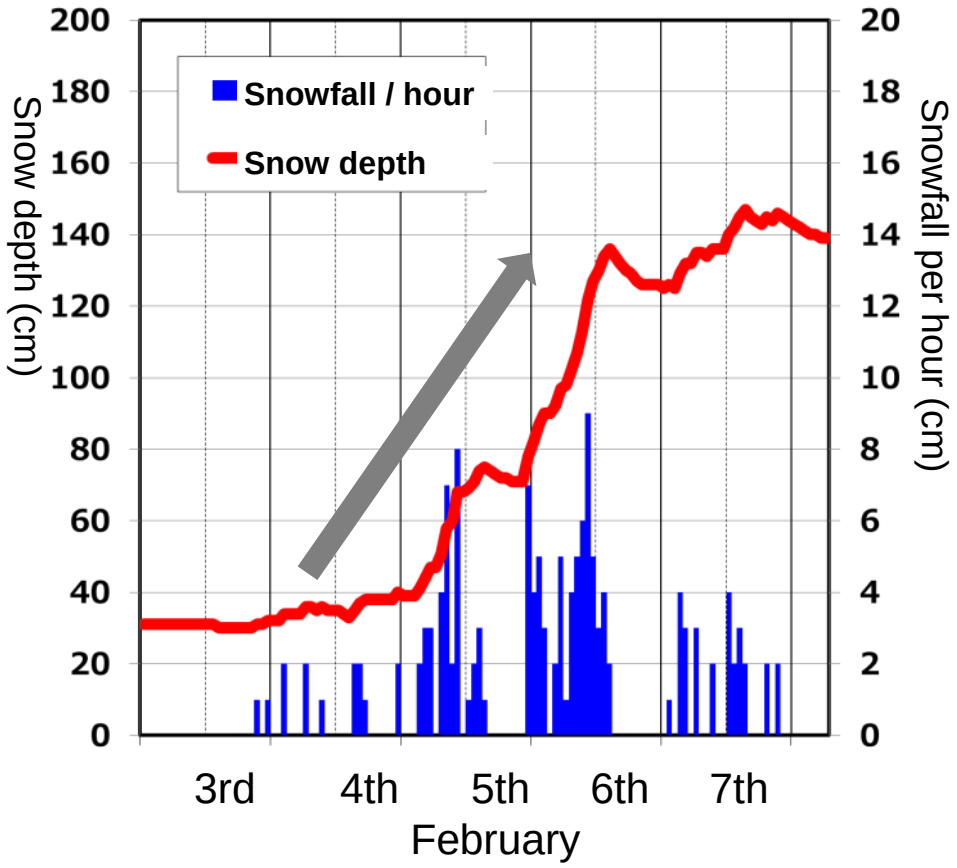
Some parts of Japan intermittently experienced heavy snowfall associated with cold-spell peaks, leading to recordable snow depths at some weather stations.



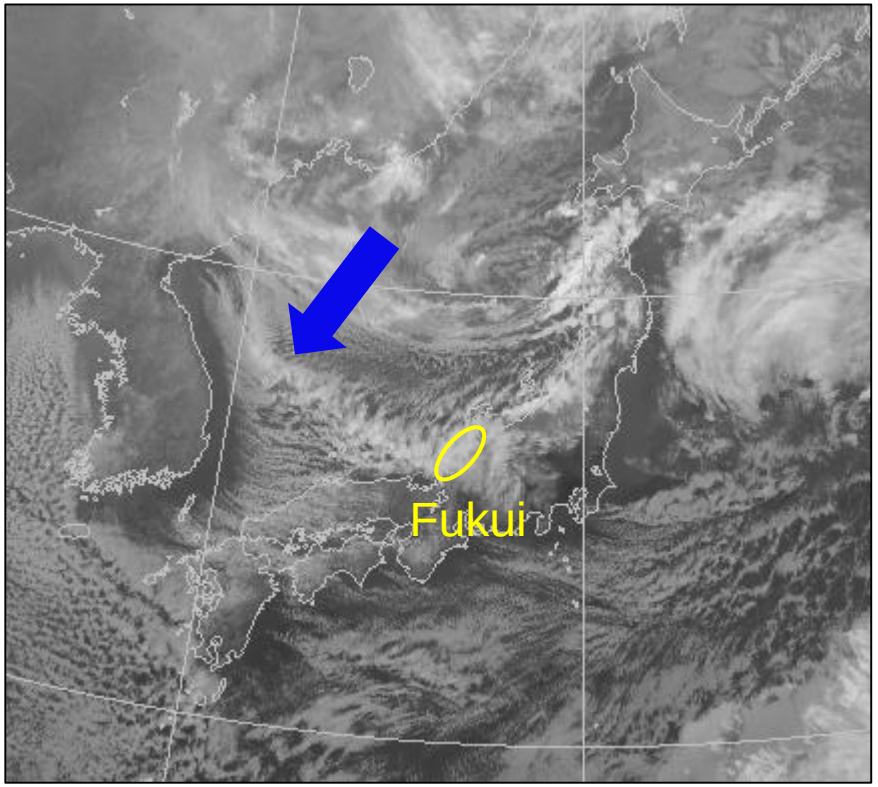
The base period for the normal is 1981– 2010.

Heavy Snow in Fukui

Time-series of snowfall and snow depth



Infrared image on 6th February 2018



Snow clouds due to cold spells were flowing into the sea of Japan side of Eastern Japan.

Disaster by heavy snow

Heavy snow stranded 1,000 vehicles on Fukui Prefecture road

Destroyed agricultural greenhouses

Heavy snow hit much of the Sea of Japan coast on early February 2018 and disrupted transportation. The governor of Fukui prefecture requested the dispatch of the government for disaster relief after about 1,000 vehicles were stranded.
The heavy snow also destroyed many agricultural greenhouses.

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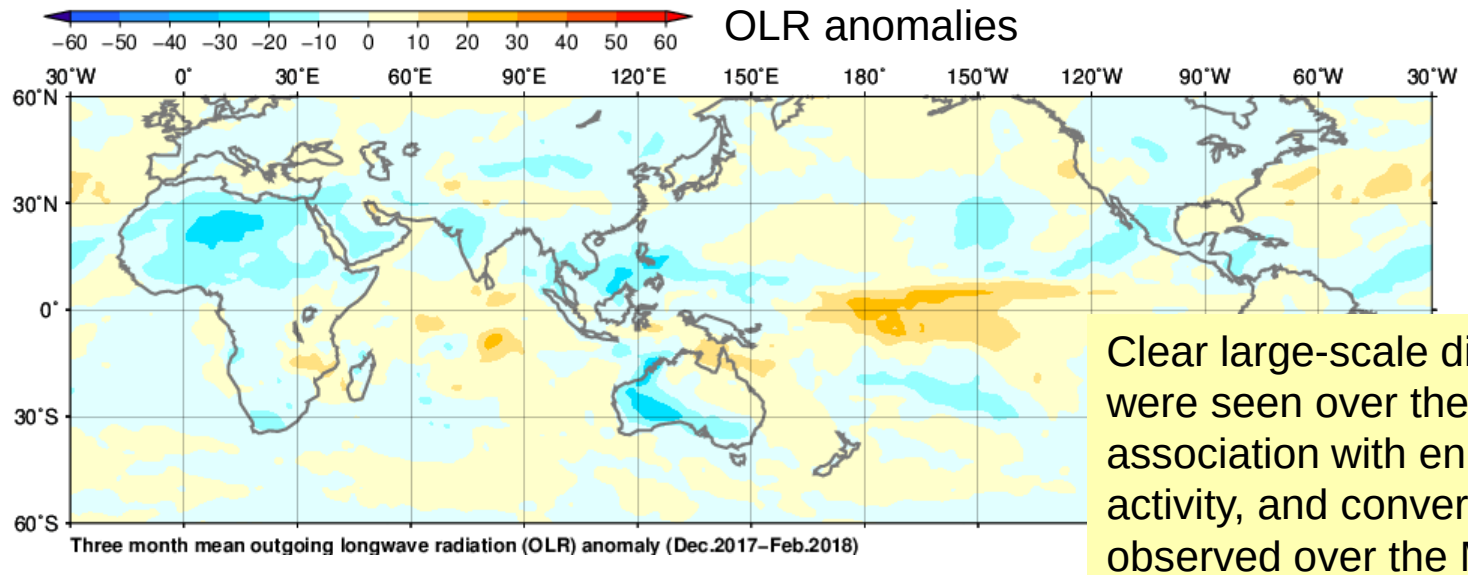
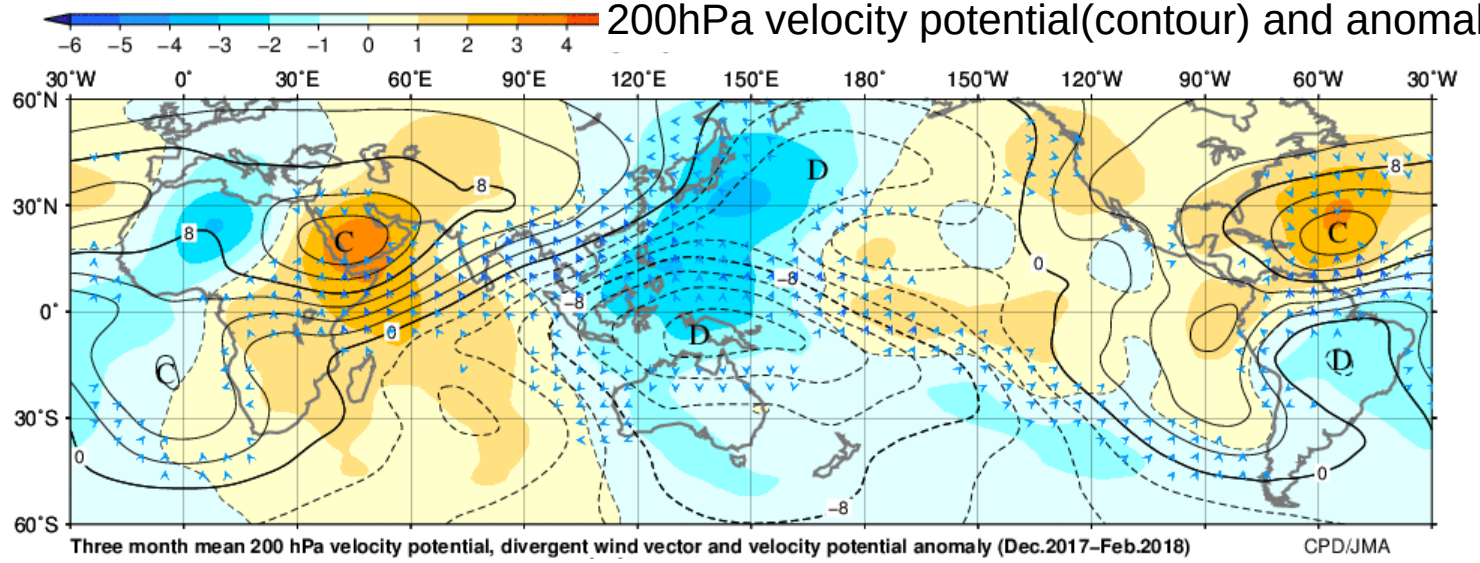
Global circulation in DJF 2017/18



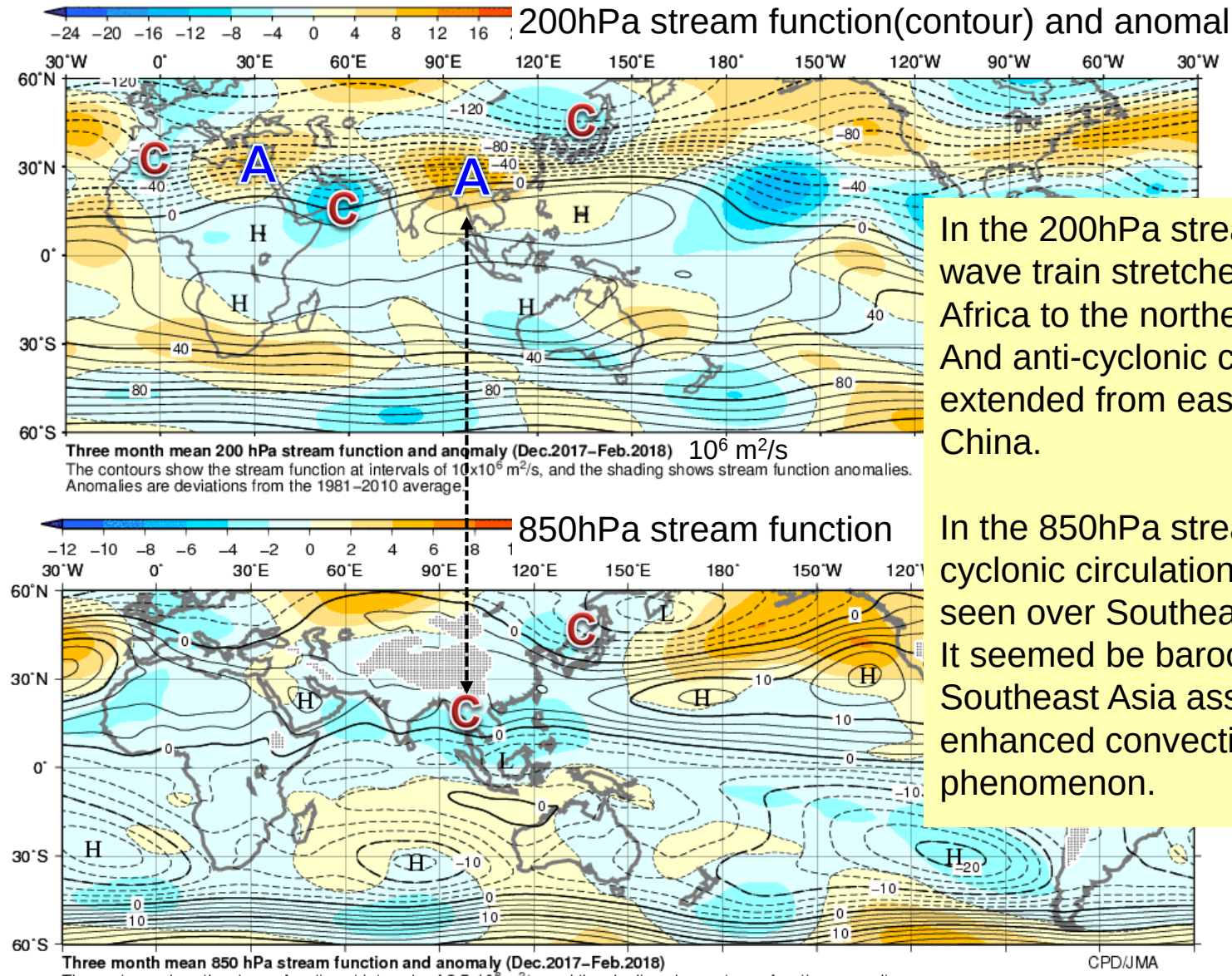
NOAA

Clear large-scale divergent anomalies were seen over the Western Pacific in association with enhanced convective activity, and convergent anomalies were observed over the Middle East.



JRA-55

Response of La Niña over East Asia

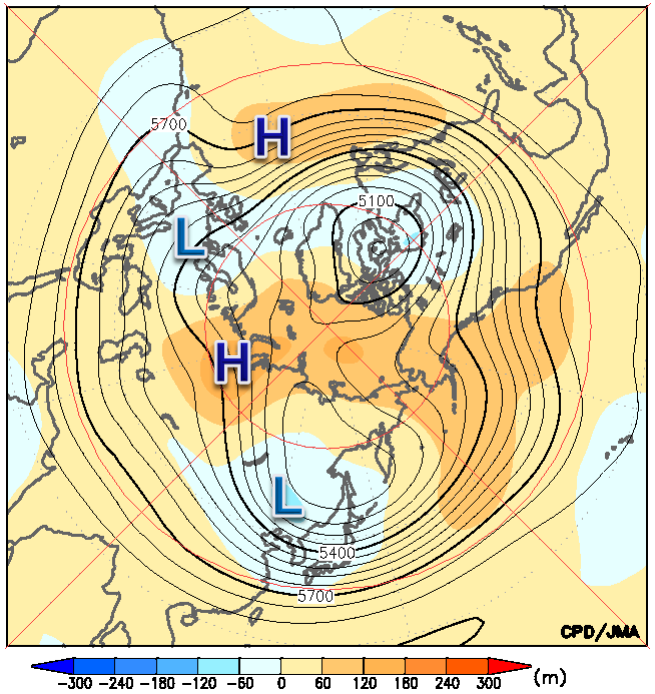


In the 200hPa stream function field, a wave train stretched from Northern Africa to the northern part of East Asia. And anti-cyclonic circulation anomalies extended from eastern India to southern China.

In the 850hPa stream function field, cyclonic circulation anomalies were seen over Southeast Asia.
It seemed be baroclinic structure over Southeast Asia associated with the enhanced convection due to La Niña phenomenon.

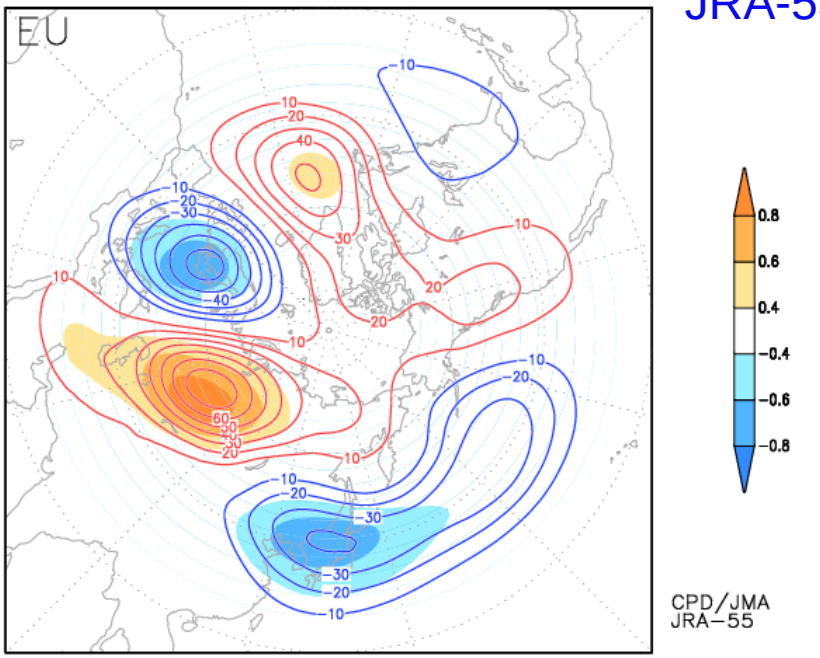
Eurasian teleconnection pattern

Z500 in DJF 2017/18

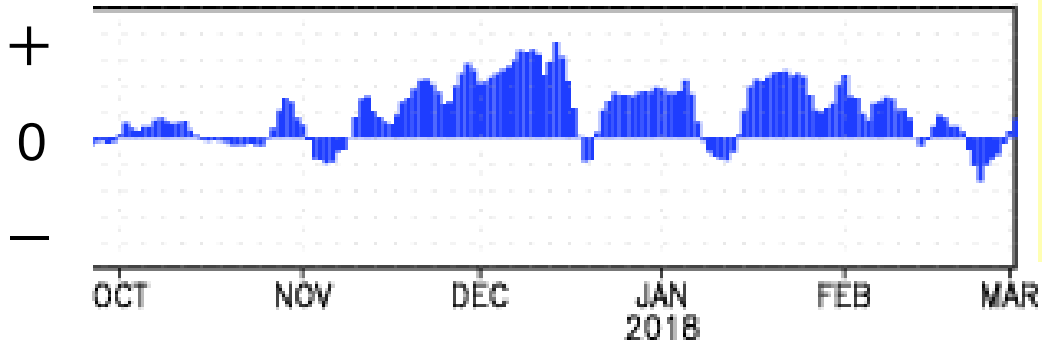


Eurasian teleconnection pattern

JRA-55

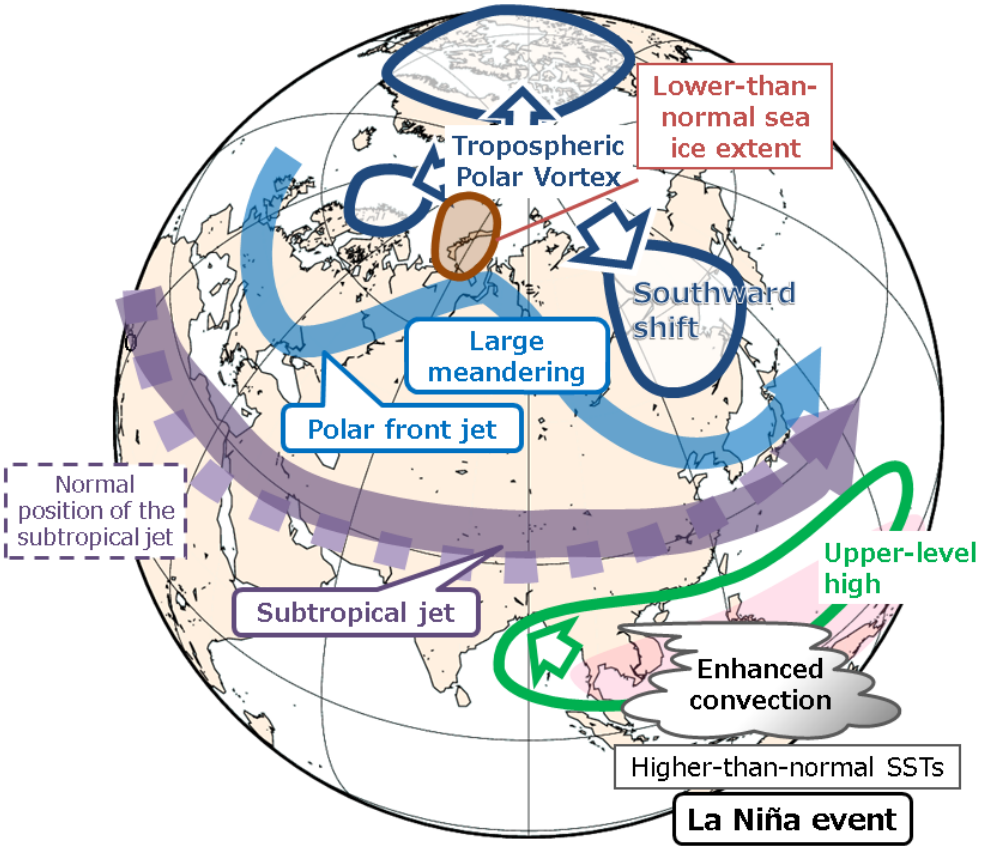


Time-series of EU pattern index



A clear wave train was observed over northern Eurasia, corresponding to the positive Eurasian (EU) teleconnection pattern (Wallace and Gutzler, 1982). It was likely that the cold winter over East Asia was affected with the amplified trough due to the EU pattern.

The primary factors contributing the cold climate



(1) Convective activity was enhanced around the Philippines due to the La Niña event.
(2) This enhanced convection strengthened northwestward expansion of an upper-level high located over Southeast Asia, which excited a Rossby wave causing the southward meandering of the subtropical jet stream around Japan.
(3) The polar vortex split in association with large meandering of the polar front jet stream over northern Eurasia.
(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. (Mori et al, 2014)

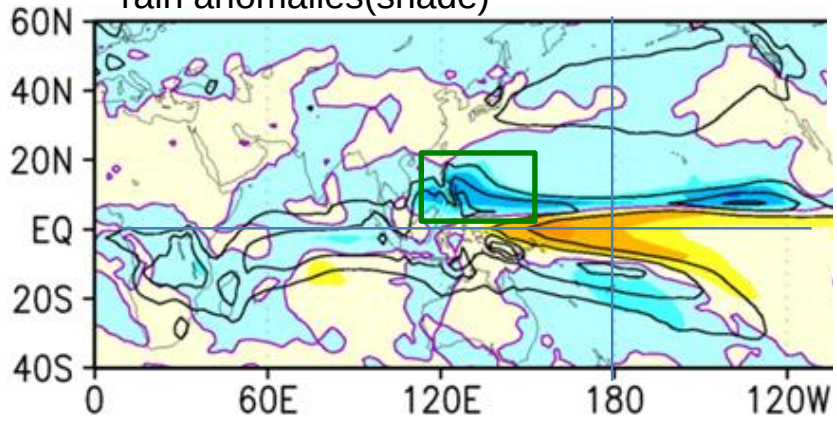
Evaluation of the tropical convection and its effect to the mid-high latitude

Positive rain anomalies around the Philippines(▭) cause the anticyclonic circulation anomalies over southern China and the cyclonic circulation anomalies around Japan.

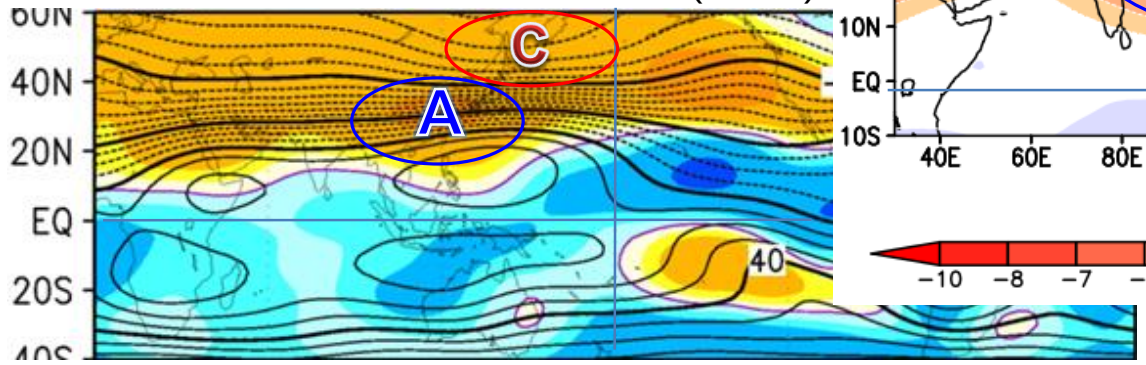
However, it was likely that the zonal mean response of tropical convection were too strong.

Prediction

rain anomalies(shade)

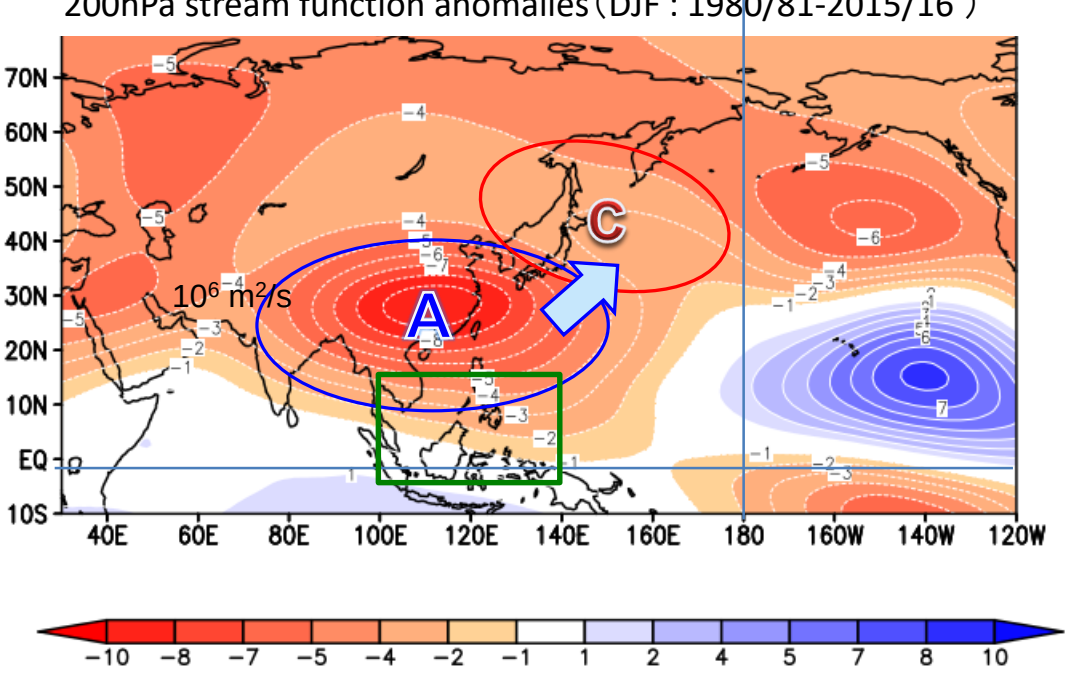


200hPa stream function anomalies(shade)



Analysis(JRA-55)

Regression coefficient
between OLR anomalies(100-140E,0-20N) and
200hPa stream function anomalies（DJF : 1980/81-2015/16 ）



Presented by JMA in EASCOF-5

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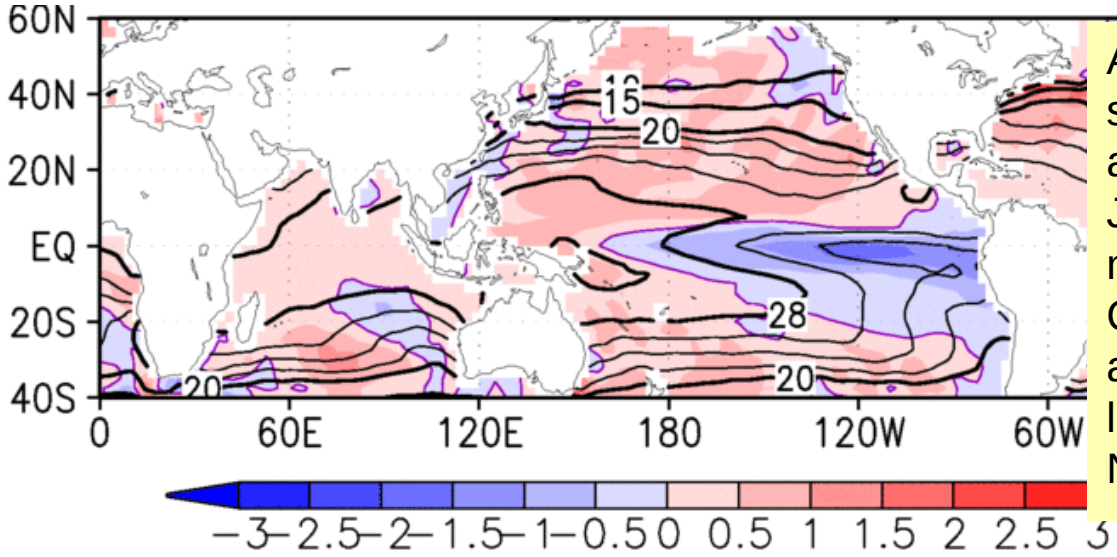
Discussion about ENSO-SST meridional width

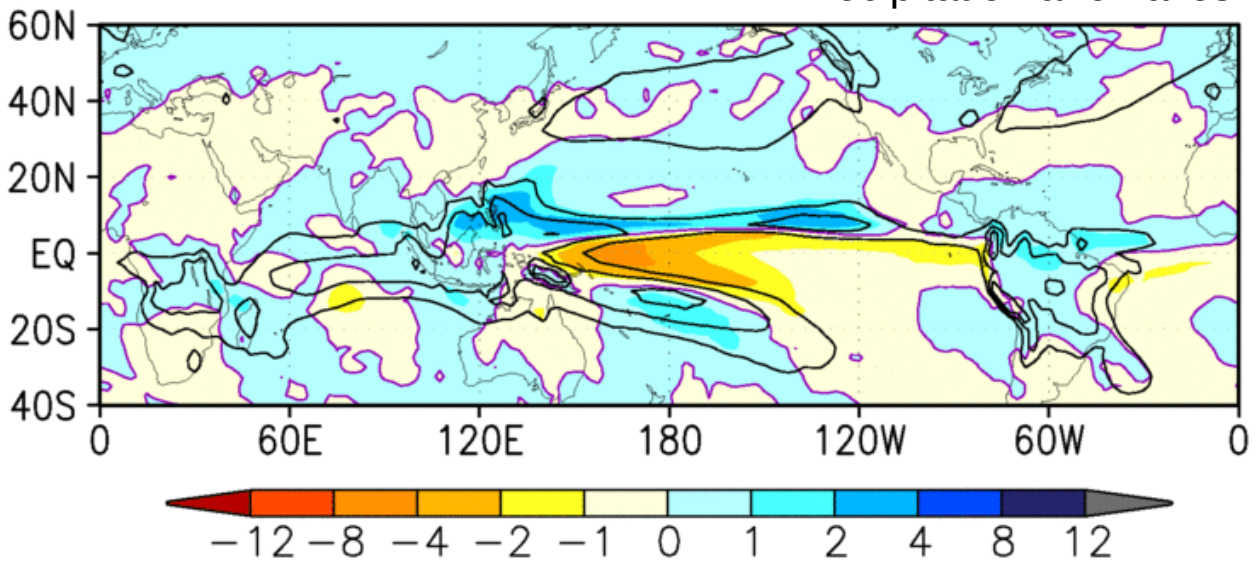
SST anomalies

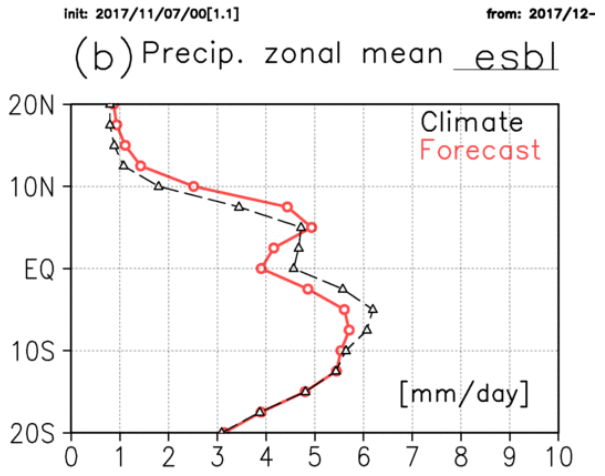
JMA/MRI-CPS2



A systematical narrow bias in the simulated meridional width of the SST anomalies of ENSO has been seen in JMA/MRI-CPS2 and most of CMIP5 models. (Zhang and Jin 2012)
Corresponding to the SST pattern, active convection are predicted over latitudinal band of about 5 – 15N in the North Pacific.

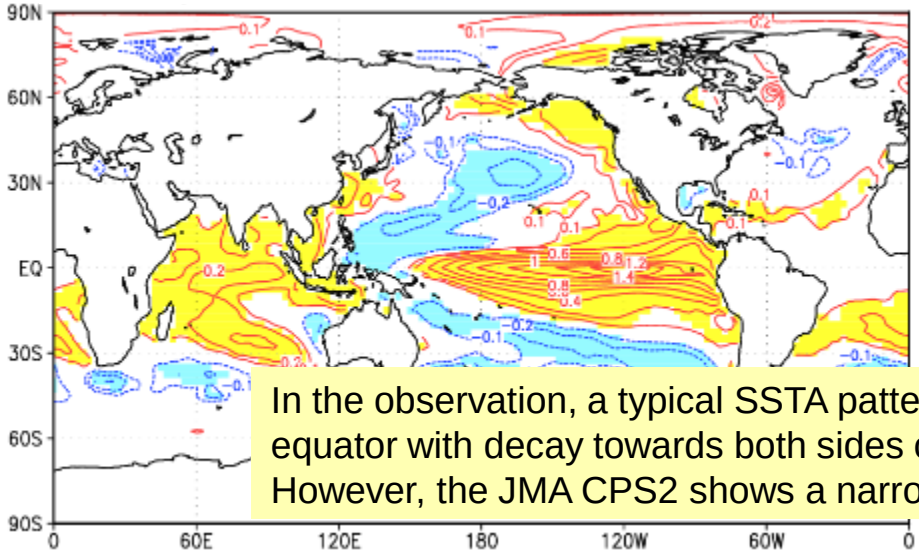
Precipitation anomalies



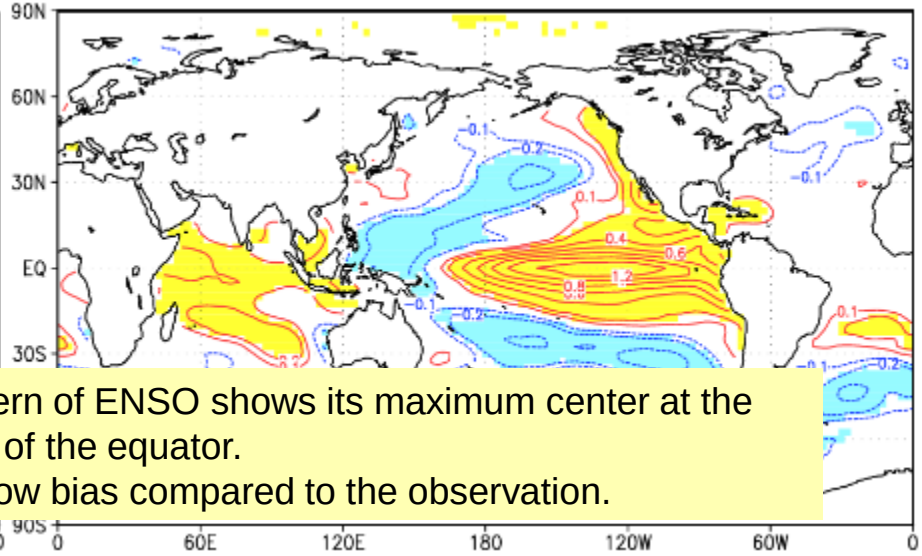


Regression upon the Niño3 SST

SST regressed upon the Nino3 SST CPS2

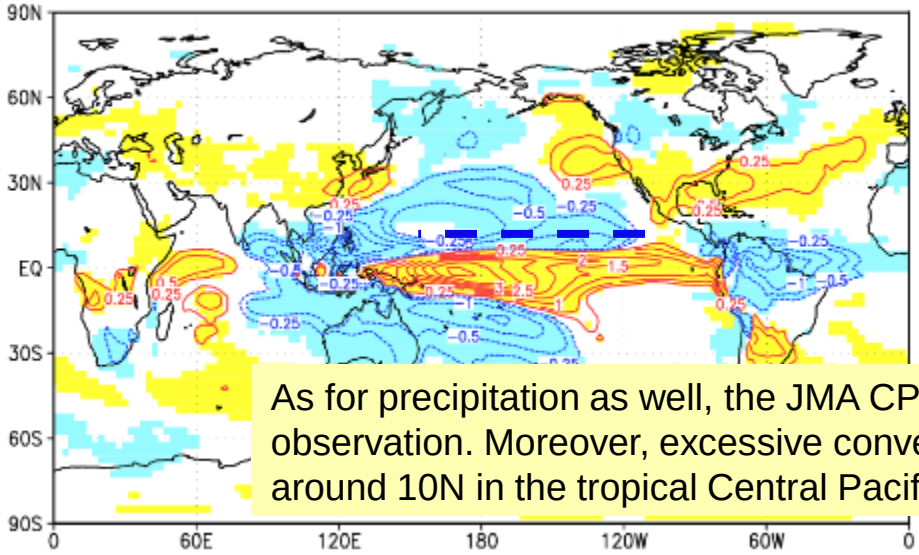


SST regressed upon the Nino3 SST COBE2-SST

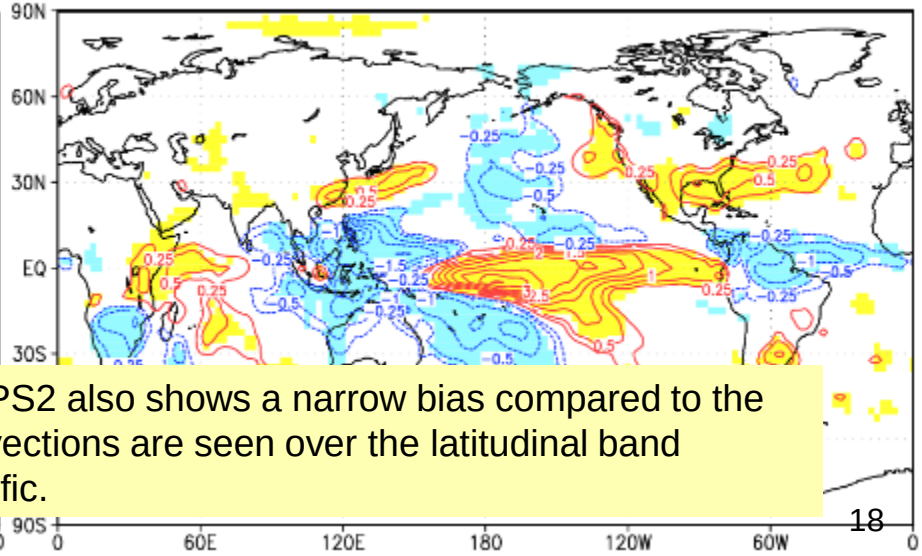


In the observation, a typical SSTA pattern of ENSO shows its maximum center at the equator with decay towards both sides of the equator.
However, the JMA CPS2 shows a narrow bias compared to the observation.

Rain regressed upon the Nino3 SST CPS2



Rain regressed upon the Nino3 SST GPCP v2.2

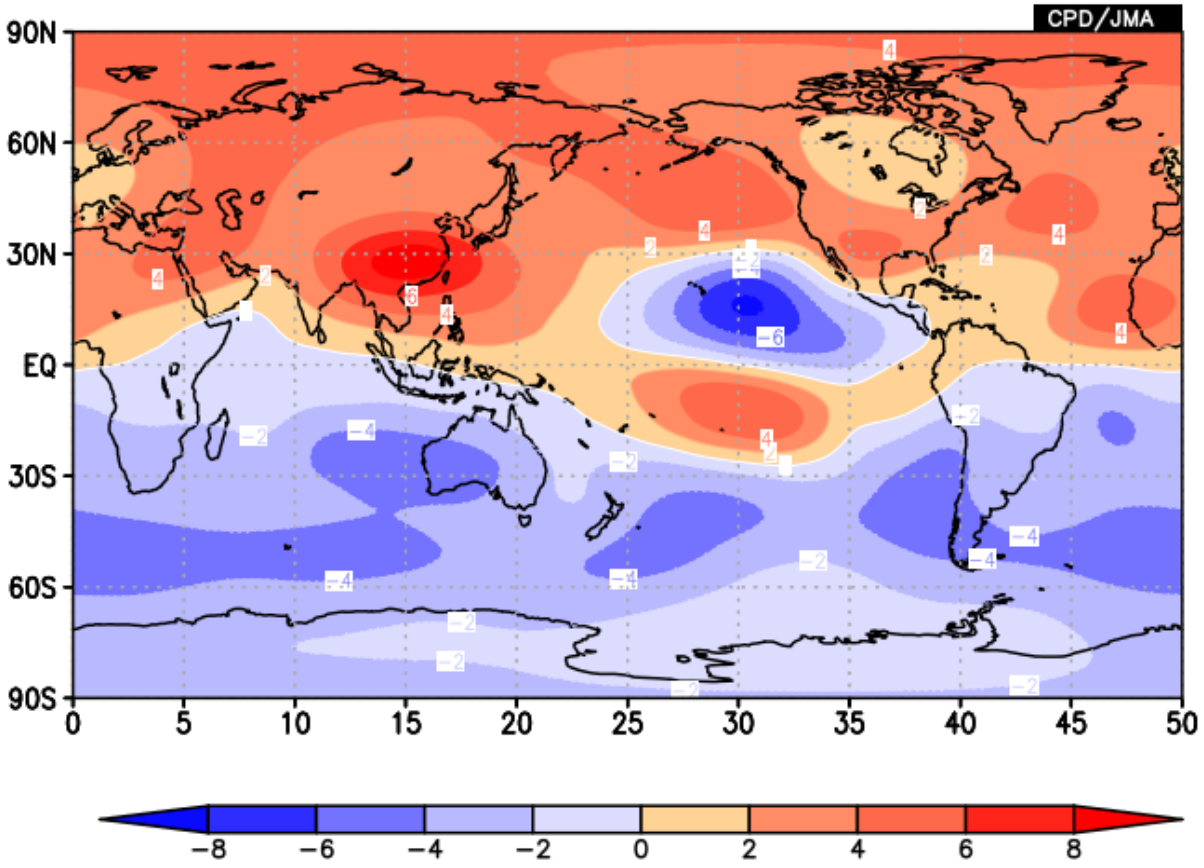


As for precipitation as well, the JMA CPS2 also shows a narrow bias compared to the observation. Moreover, excessive convections are seen over the latitudinal band around 10N in the tropical Central Pacific.

Impacts of latitudinal precipitation bias

200hPa stream function regressed upon the zonal mean precipitation off the equator (5N – 15N)

JRA-55 (DJF,1979 - 2014)

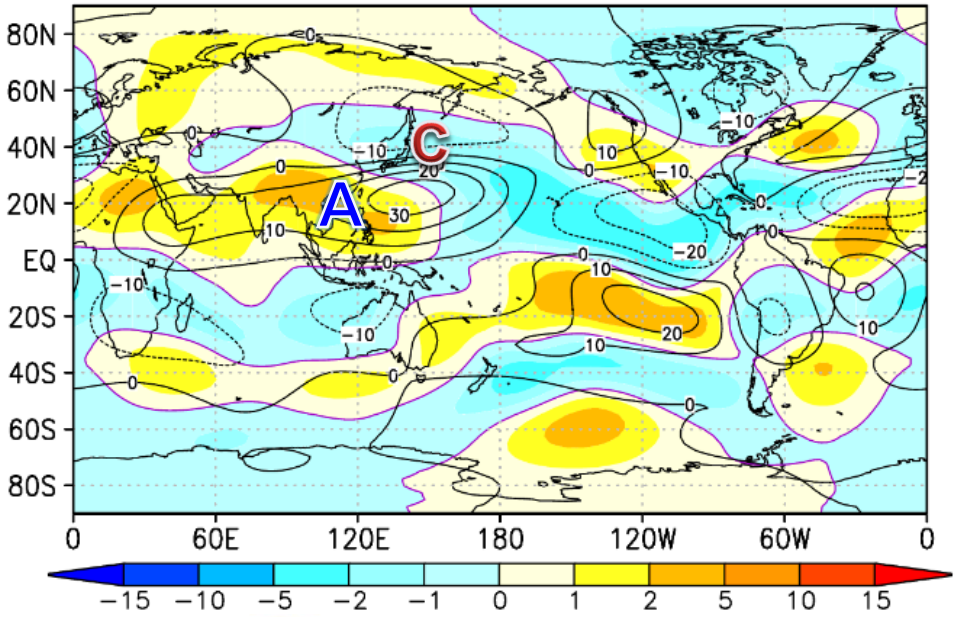


Anticyclonic circulation anomalies extend all over the Northern hemisphere. The zonal mean response to mid-latitude circulation of the JMA-CPS2 seems be stronger than that of observation.

Subtracting the zonal mean

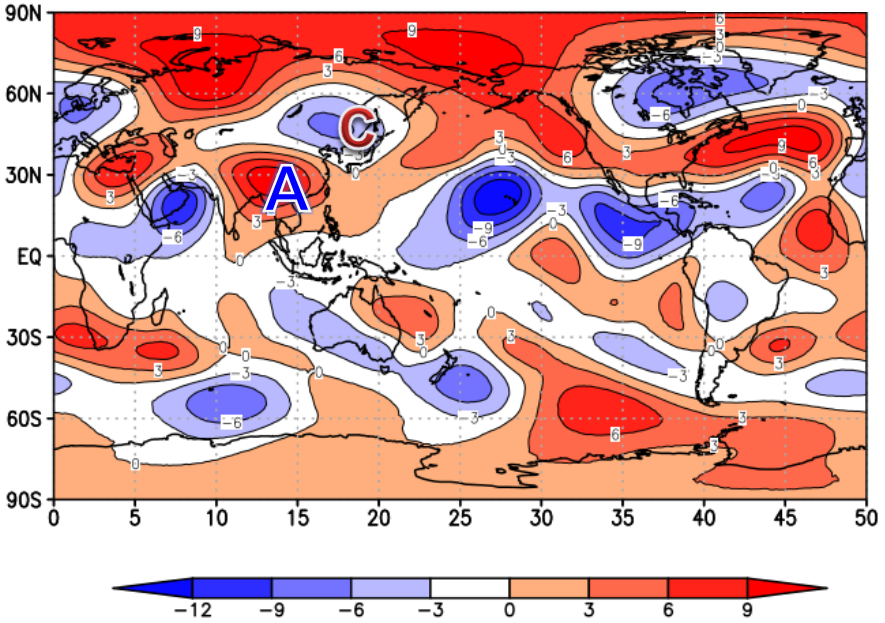
200hPa stream function deviations from the zonal mean

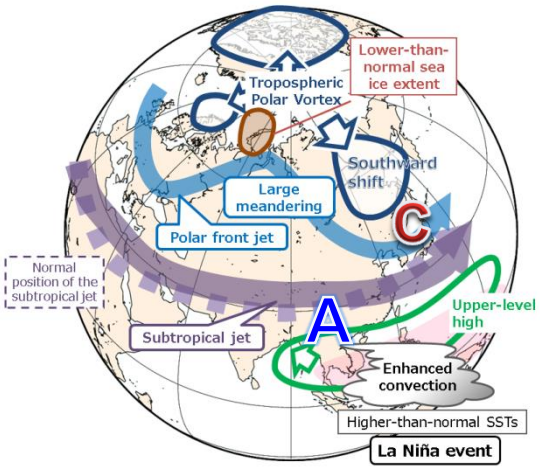
CPS2



200hPa stream function deviations from the zonal mean

JRA-55

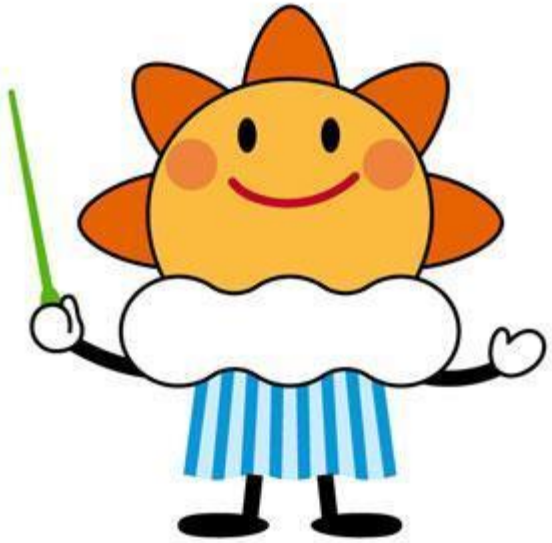




The left figure shows 200hPa stream function anomalies by subtracting the zonal mean component from the original prediction data. The pattern over East Asia are relatively similar to that of analysis.

It was likely that the response of the active convection associated to La Niña were predicted well in JMA/MRI-CPS2.

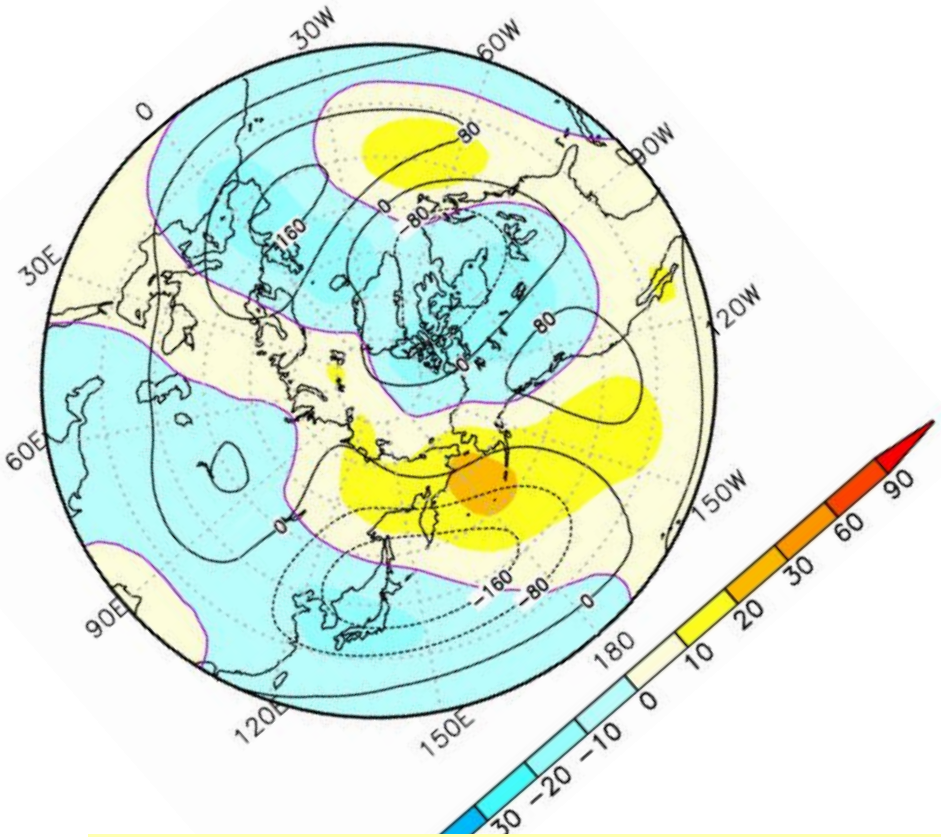
Thank you for your attention !



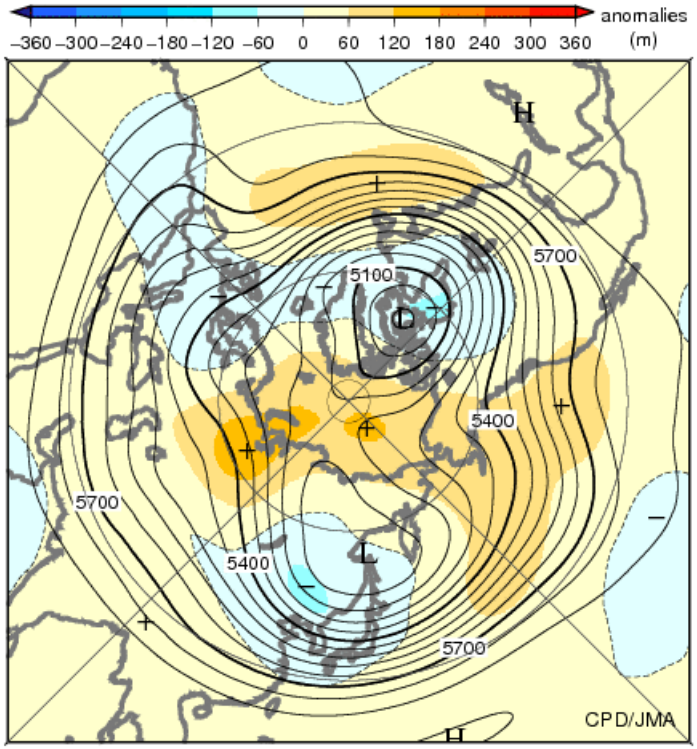
JMA's mascot is named Harerun (in the hope of hare, the Japanese word for “fine weather”), and is designed with elements of sun, cloud and rainfall. Harerun holds a green baton in prayer for a disaster-free, peaceful world. The mascot helps to raise public awareness of meteorological services as well as natural disasters and global environmental issues at various events held at the Meteorological Museum and local offices.

Deviations from the zonal mean

Prediction
(Z500 deviations from the zonal mean)



Analysis (Z500)



Three month mean 500 hPa height and anomaly in the Northern Hemisphere (Dec.2017–Feb.2018)
The contours show height at intervals of 60 m.
The shading indicates height anomalies.
Anomalies are deviations from the 1981–2010 average.

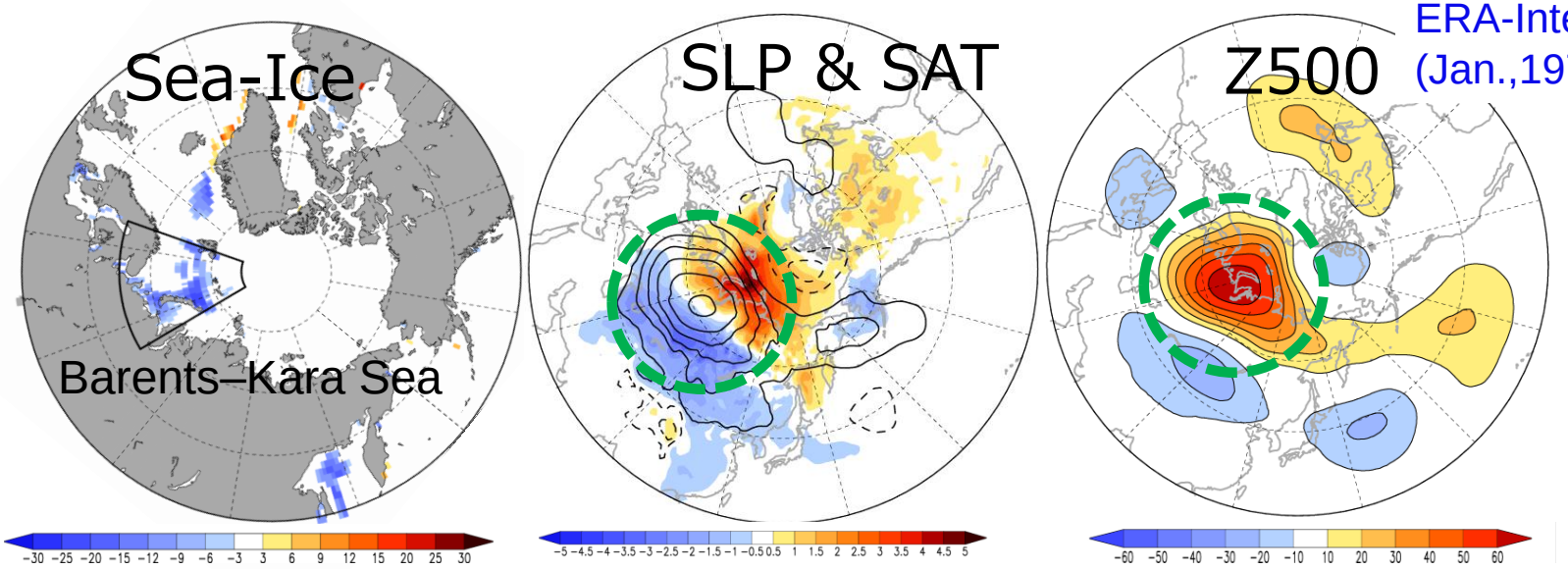
However, the EU teleconnection pattern were not predicted well.

Although the JMA CGCM introduced in June 2015 became able to predict variabilities of the Arctic sea SSTs and sea-ice extents, how to improve the forecast skill for such Eurasian teleconnection still remains a future subject.

Robust Arctic sea-ice influence on the frequent Eurasian cold winters

Sea-ice decline leads to more frequent Eurasian blocking situations, which in turn favour cold-air advection to Eurasia and hence severe winters. (Mori et al, 2014)

ERA-Interim
(Jan.,1979 - 2014)



2017/18 winter