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Characteristics of 2019 summer monsoon in East Asia

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- Overview of 2019 summer monsoon in East Asia
- Shifted subtropical jet stream in the eastern part of East Asia from early June to late July
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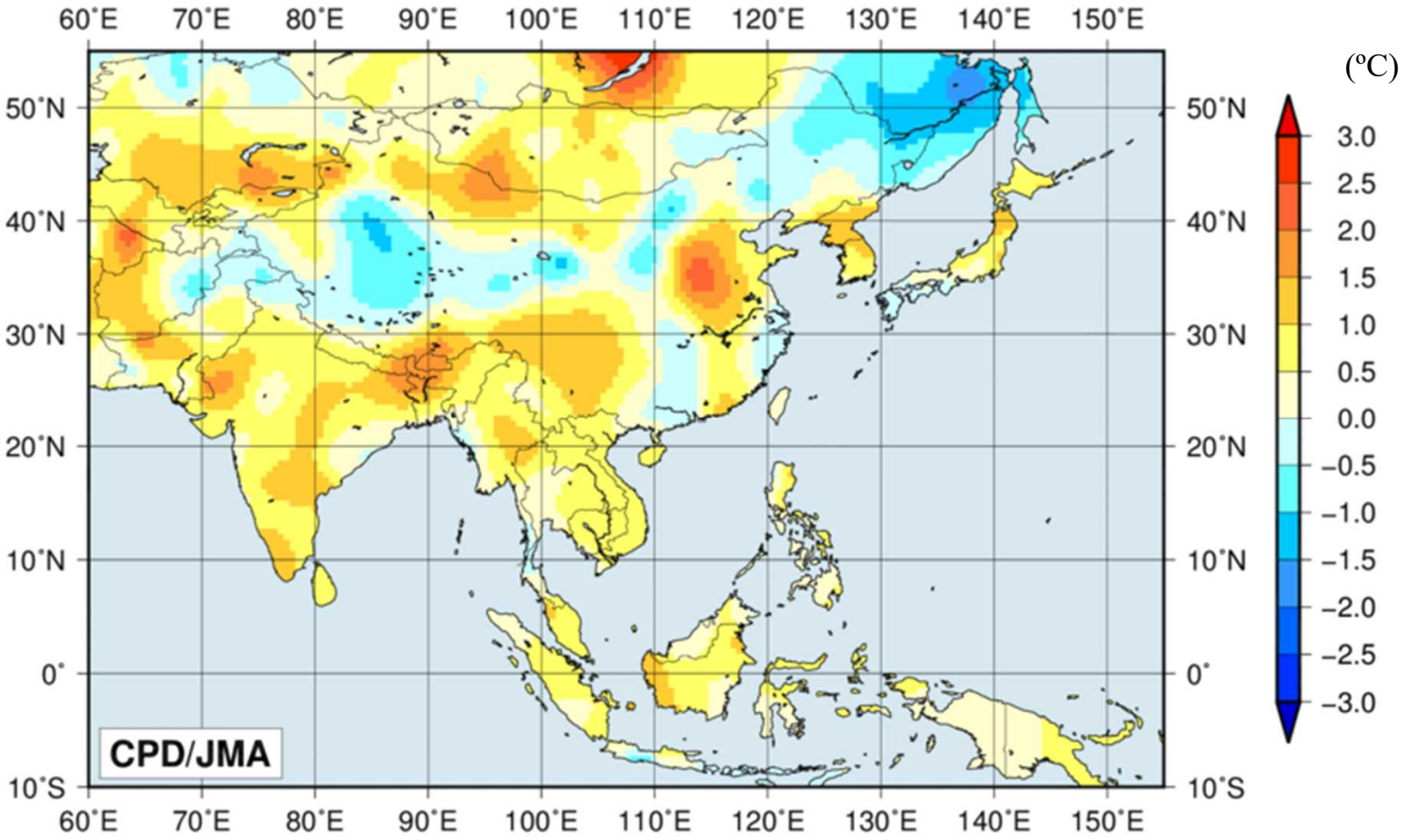
3-month mean surface temperatures for Jun-Aug

Warmer than normal: Japan, Korea, parts of China, and Mongolia
Cooler than normal: parts of China

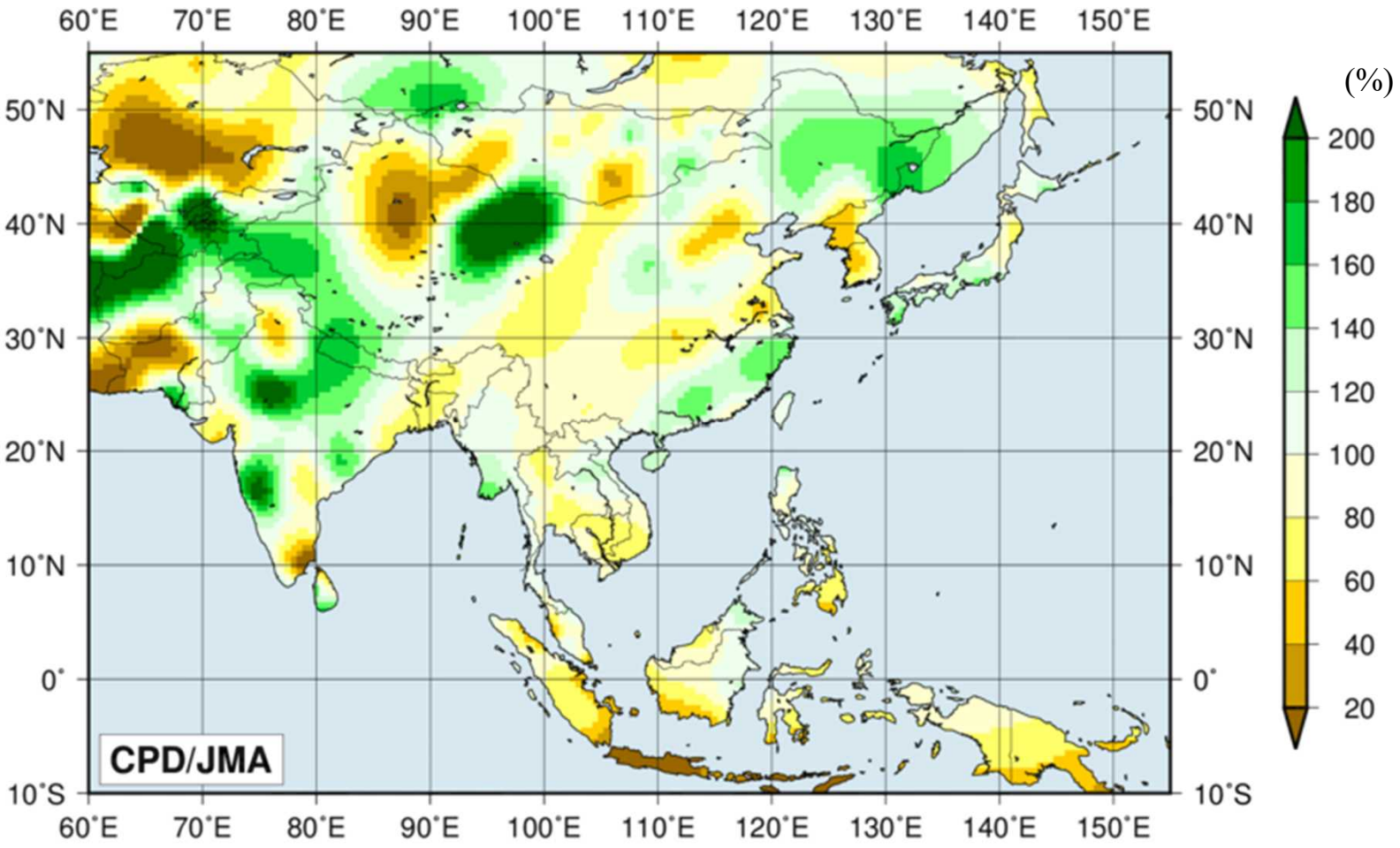


Temperature anomalies for Jun-Aug are based on CLIMAT reports.
Normals are the 30-year average during the period from 1981 to 2010.

3-month precipitation amounts for Jun-Aug

Wetter than normal: from Japan to southern China,
in and around northeastern and northern China

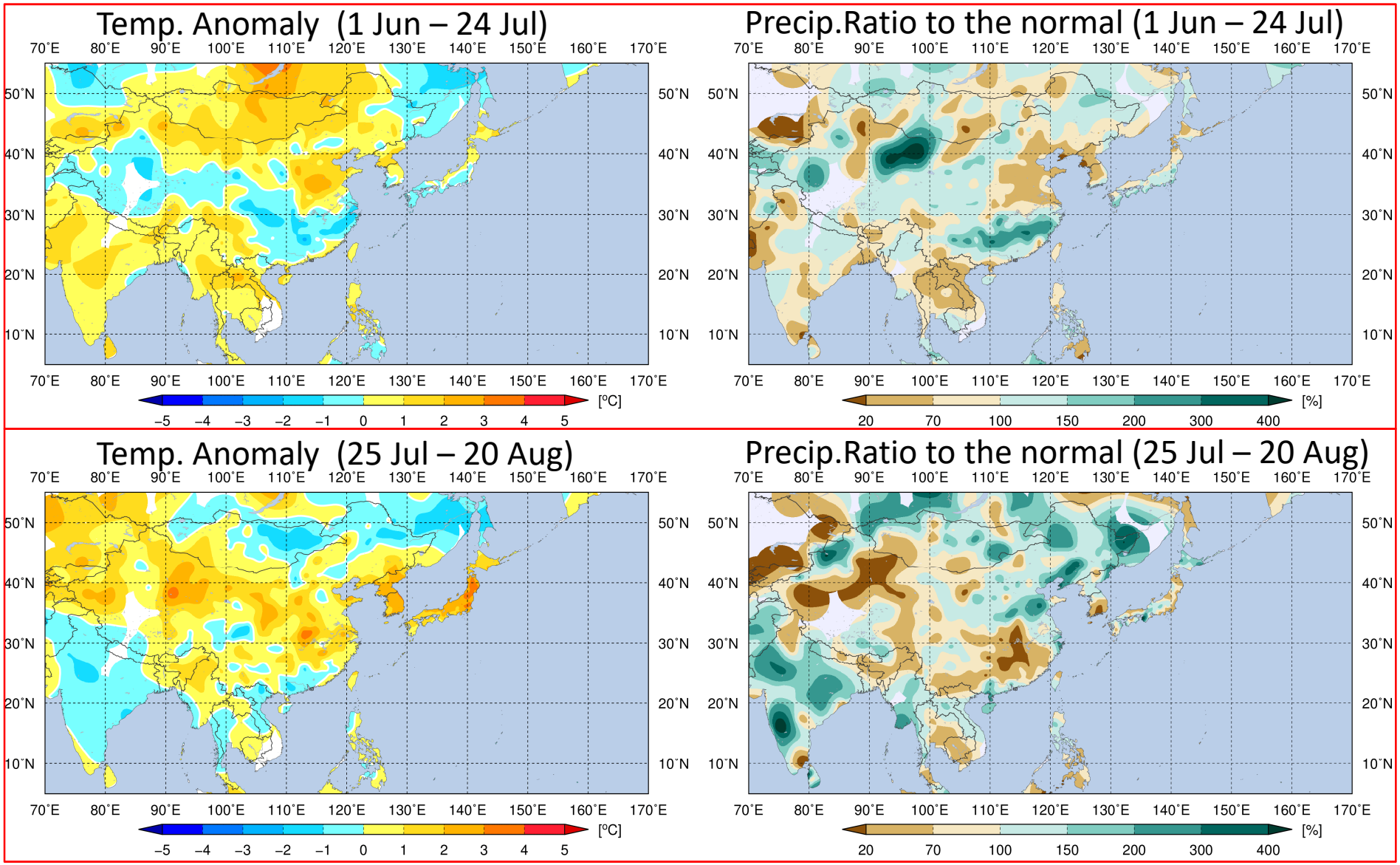
Drier than normal: Korea, in and around central and western China



Precipitation ratios against normal for Jun-Aug are based on CLIMAT reports.
Normals are the 30-year average during the period from 1981 to 2010.

Temp. and Precip. in two periods for 2019 summer

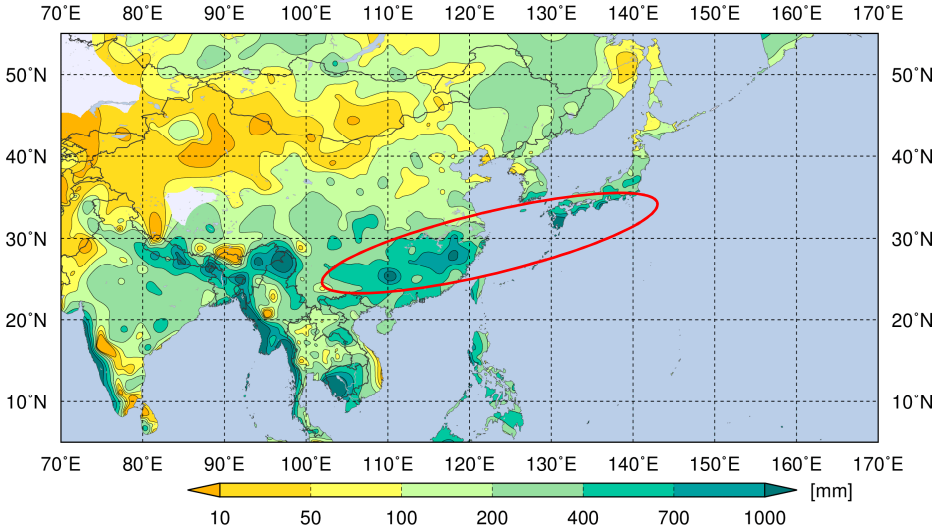
- The pattern of the temp. anomaly and precip. ratio against the normal was different between the period from early June to late July and that from late July to mid-August.



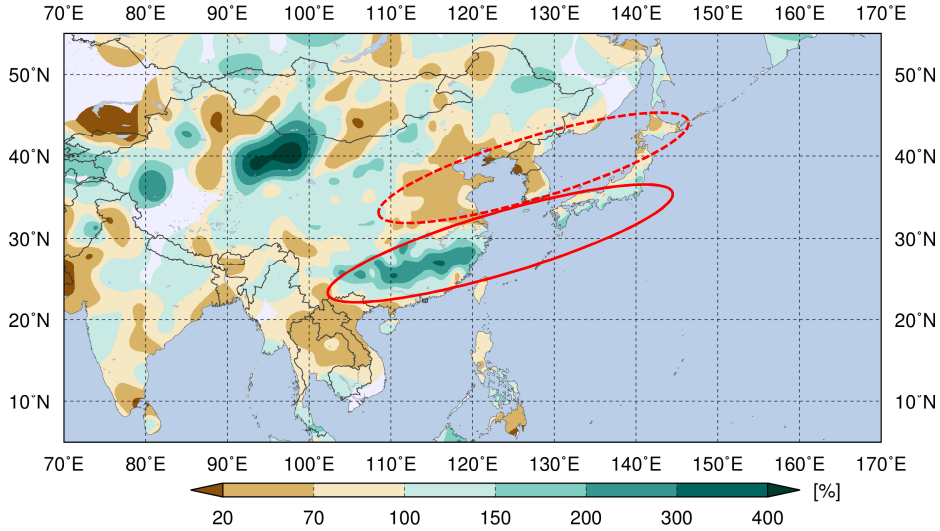
Observations are based on SYNOP reports. Normals are based on CLIMAT reports from 1981 to 2010.

Precipitation for early June to late July 2019

Precip. total (1 Jun – 24 July)

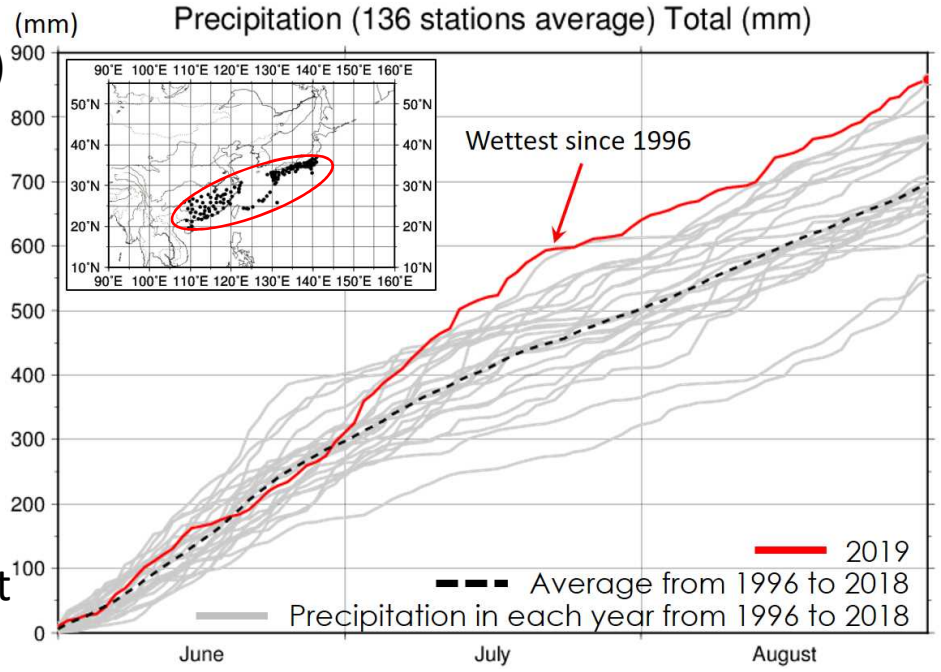


Precip. Ratio to the normal (1 Jun – 24 July)



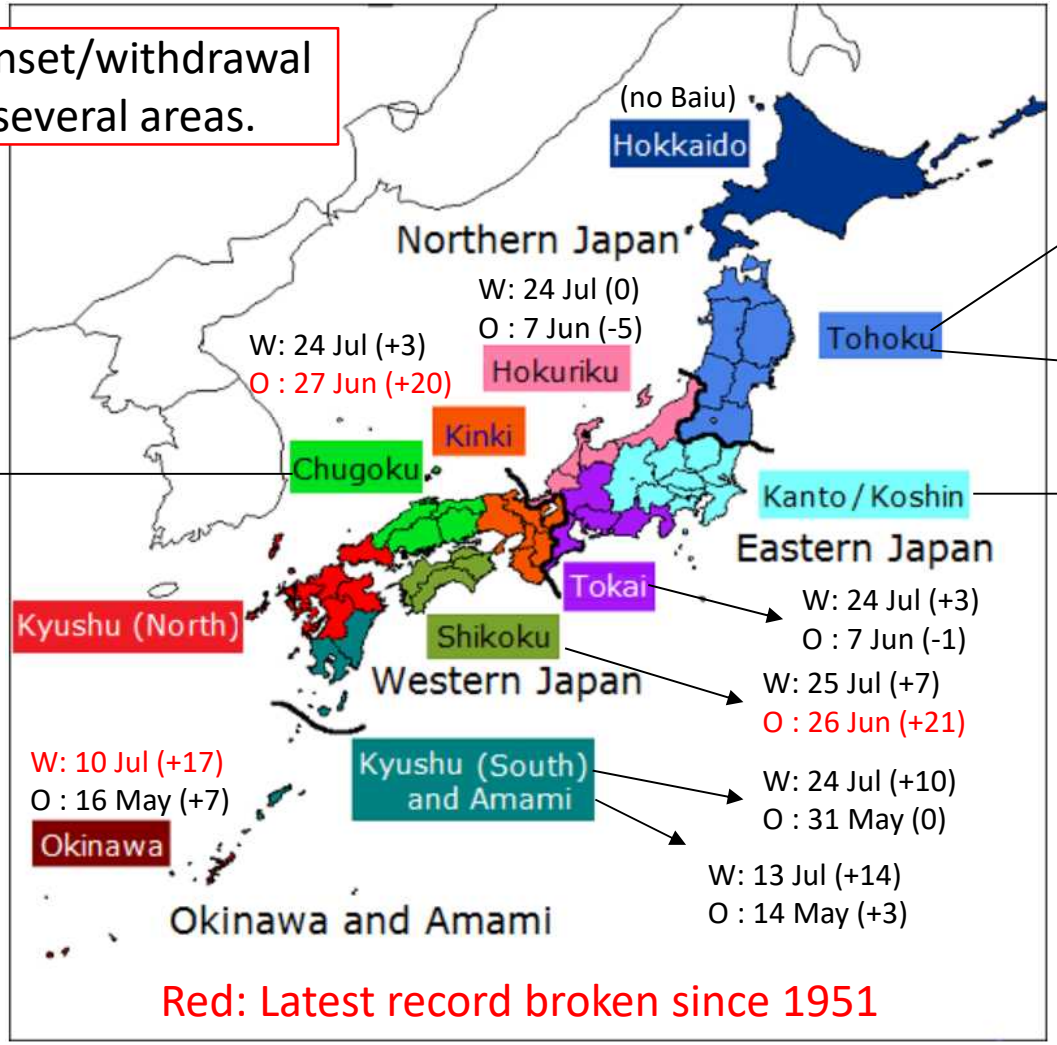
Observations are based on SYNOP reports. Normals are based on CLIMAT reports from 1981 to 2010.

- The precipitation total (from 1 Jun to 24 Jul) were higher than normal from the Pacific side of eastern Japan to southern China, where precip. normals are relatively high.
- On the other hand, the precipitation total were lower than normal from northern Japan to eastern China.
- Estimating from SYNOP reports, the precipitation amount for the period averaged in the former area was the highest since 1996. (right fig.)



Baiu(梅雨 - rainy period) onset/withdrawal in Japan 2019

Latest records of onset/withdrawal were broken in several areas.



(Values in parenthesis shows the days later than normal date of onset/withdrawal.)

- In Japan, the Baiu (a cloudy and rainy period of early summer in Japan) onsets from western Japan to the Okinawa region were almost later than normal.
- The Baiu withdrawals from eastern Japan to the Okinawa region were also almost later than normal.

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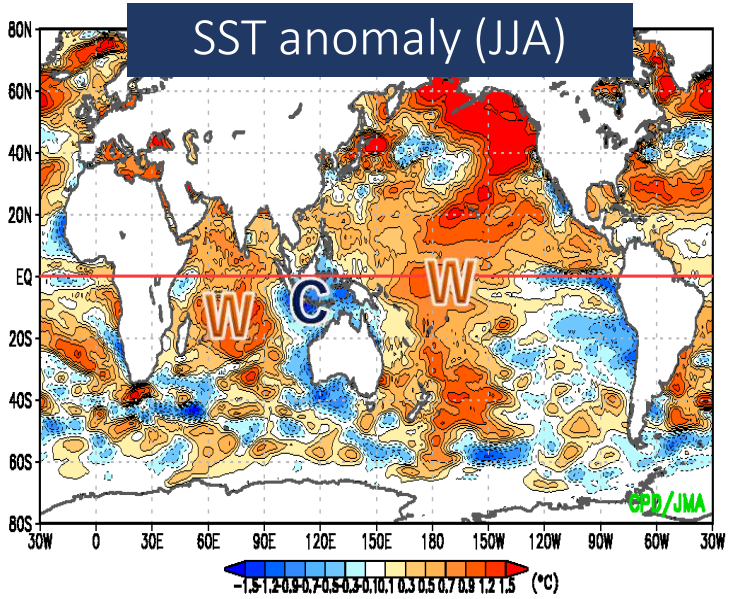
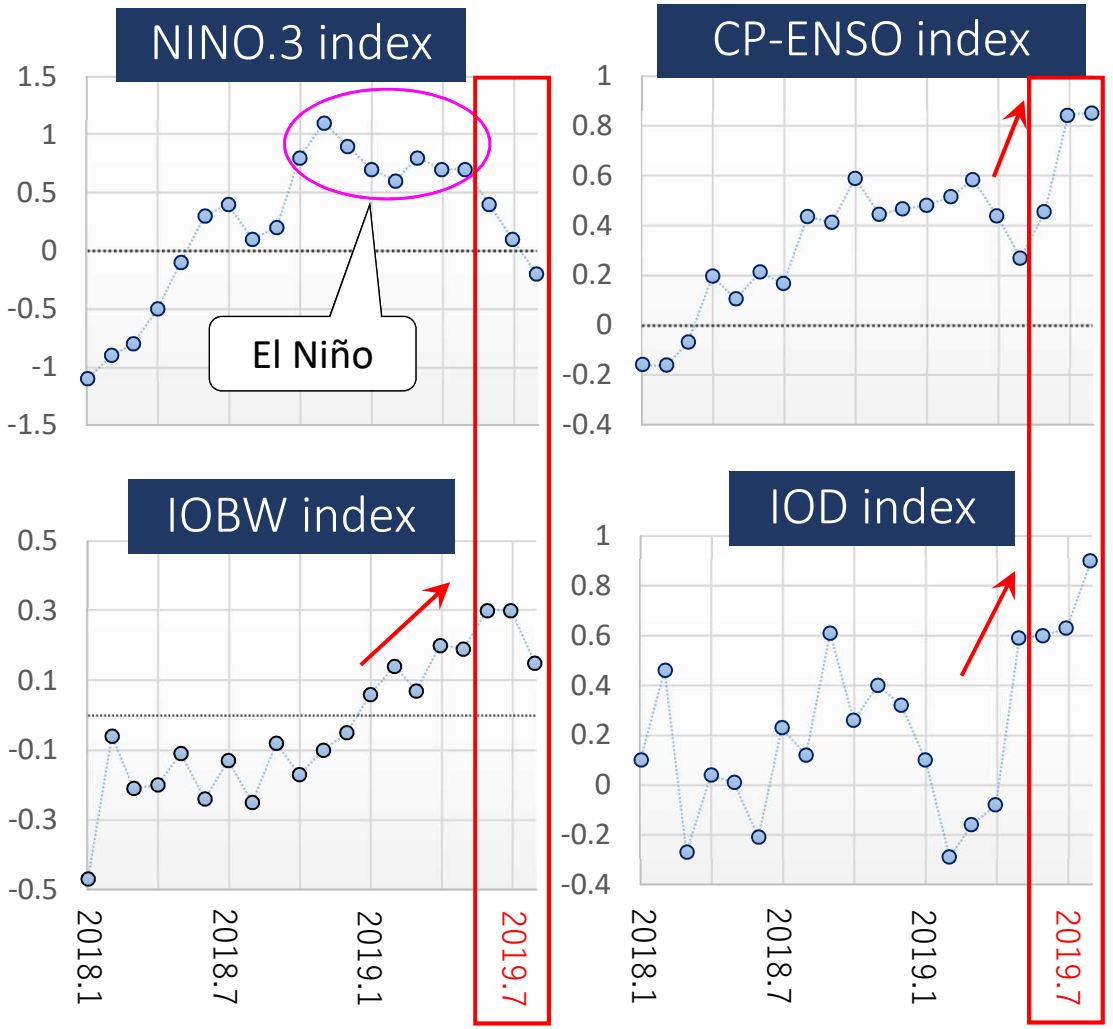
SST in tropical regions and several Indices in JJA 2019

- El Niño event ended in MAM. ENSO-neutral conditions persisted in JJA.
- The area-averaged SST in the tropical Indian Ocean (IOBW) was above normal in JJA.
- The SST in southeastern part of the tropical Indian Ocean was below normal in JJA.





Definition of Indices

NINO.3: SST anomaly averaged over 150W-90W, 5N-5S

IOBW: SST anomaly averaged over 40E-100E, 20N-20S (IO basin wide)

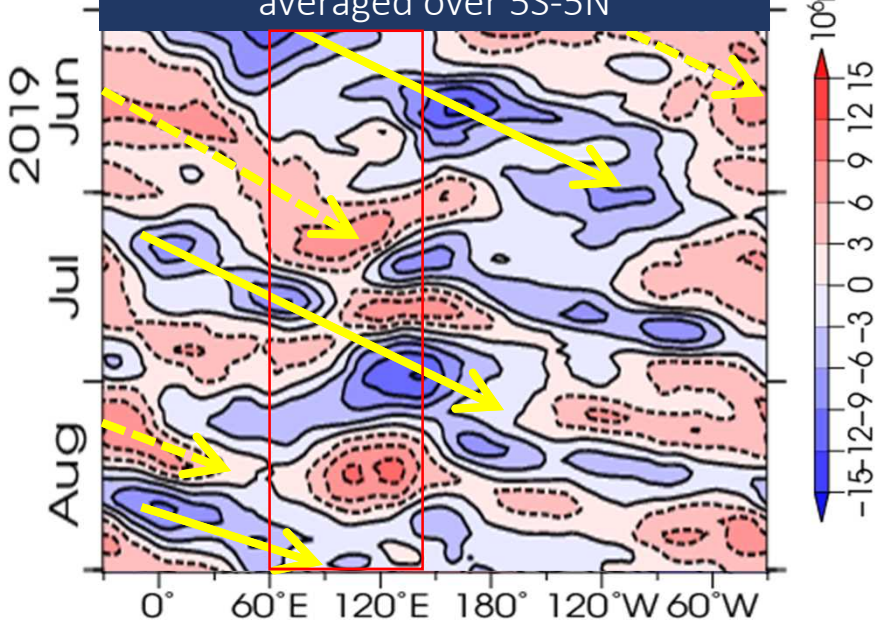
CP-ENSO: based on Ashok et al. (2007)

IOD: difference of two area-averaged SST anomalies as follows:
(50-70E, 10N-10S) – (90-110E, Eq-10S)

Asian Monsoon

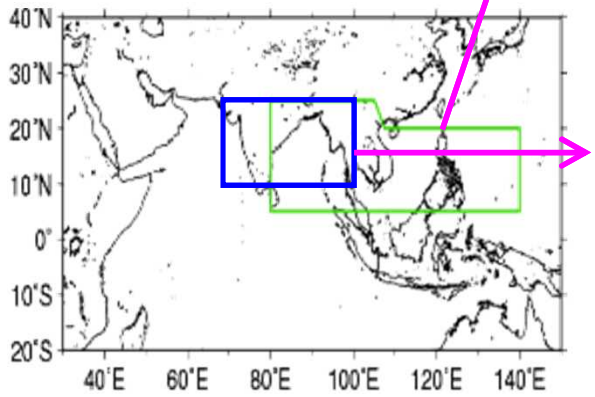
- On average, Asian monsoon (tropical regions) activity was weaker than normal from June to July in association with the El Niño event that ended in MAM and near normal in August.
- The active and suppressed phase of MJO propagated eastward significantly in JJA.

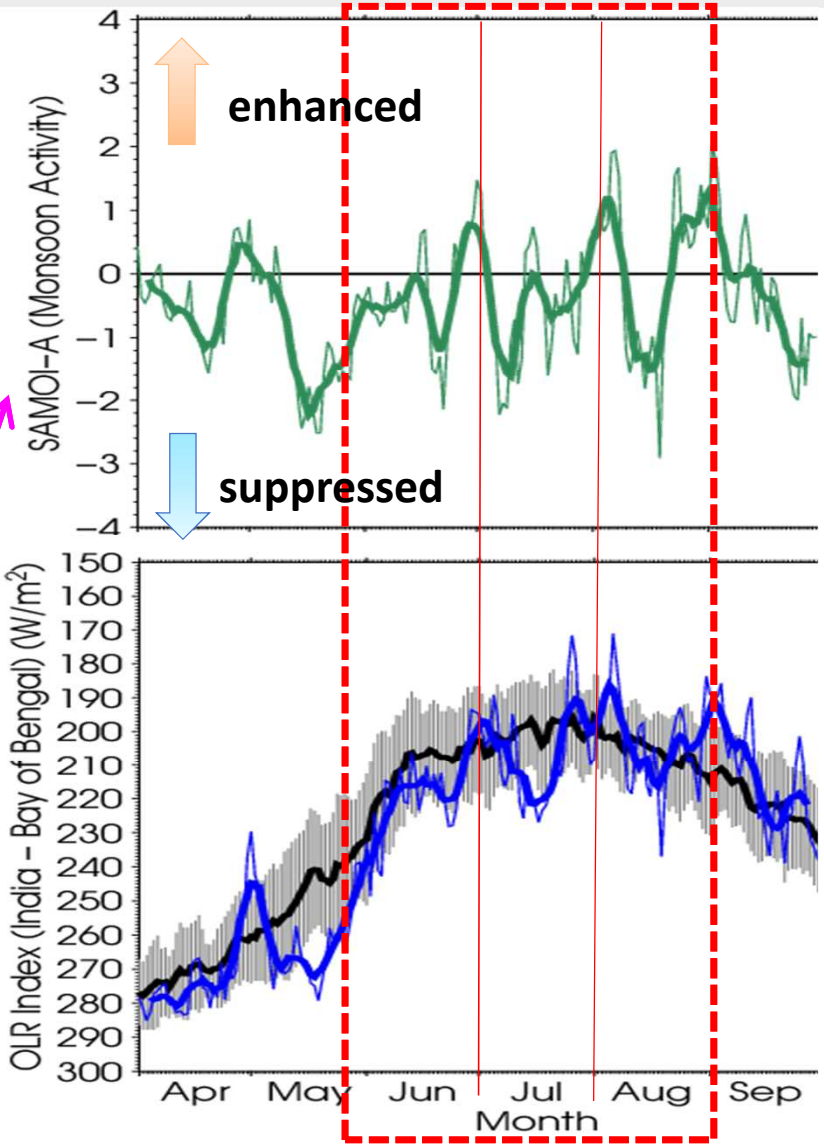
Time-longitude cross sections of 200hPa velocity potential anomaly averaged over 5S-5N



(7-day averaged)

OLR indices are defined as area-averaged OLR anomalies with reverse sign. SAMOI-A is normalized by their standard deviations.
* OLR:
outgoing longwave radiation



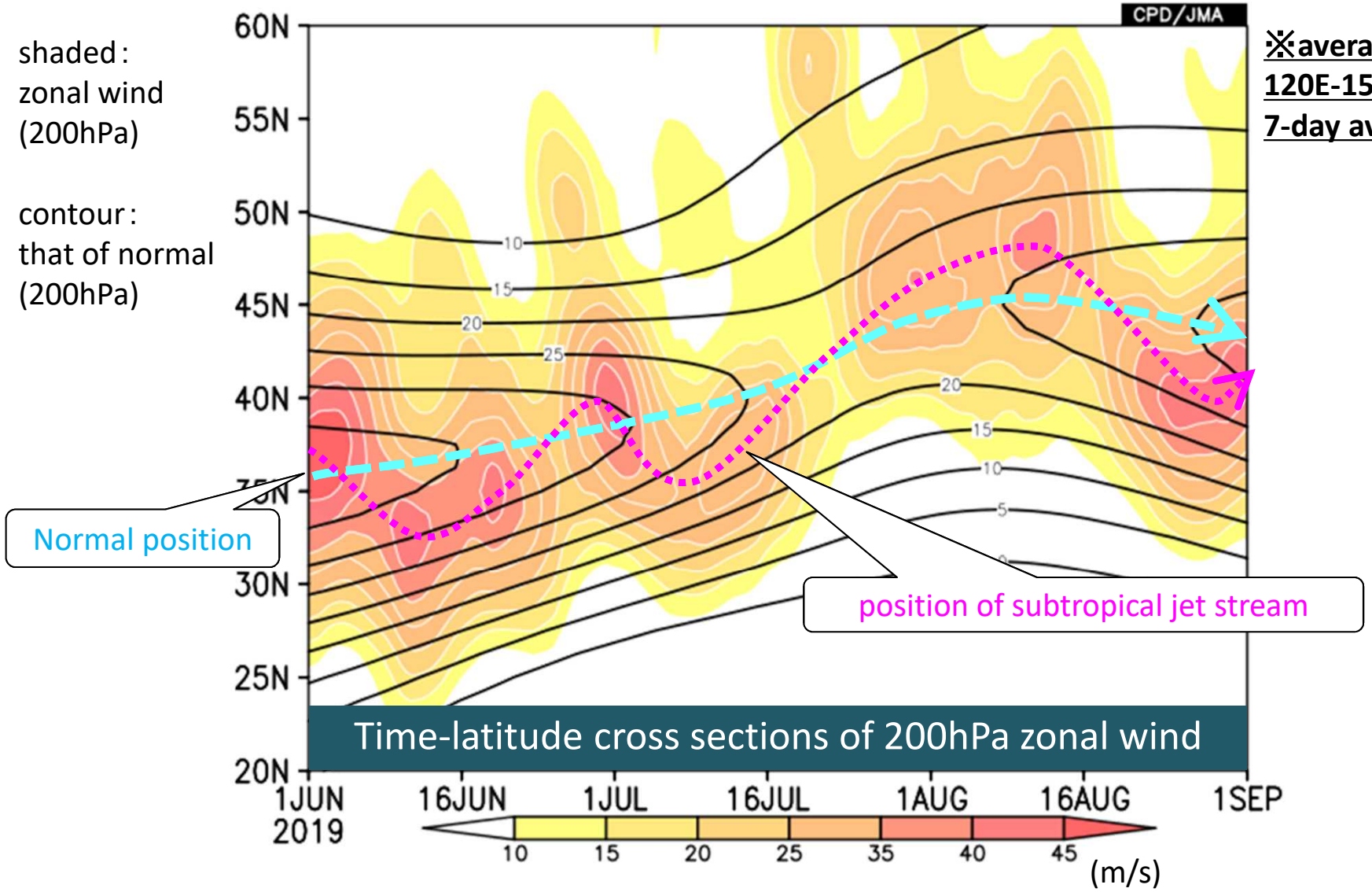


Subtropical jet stream in eastern part of East Asia

- The subtropical jet stream shifted southward until mid-July likely in association with the suppressed Asian monsoon (tropical regions) activity, and shifted northward from late July to mid-August.

shaded:
zonal wind
(200hPa)

contour:
that of normal
(200hPa)



※averaged over 120E-150E, 7-day average

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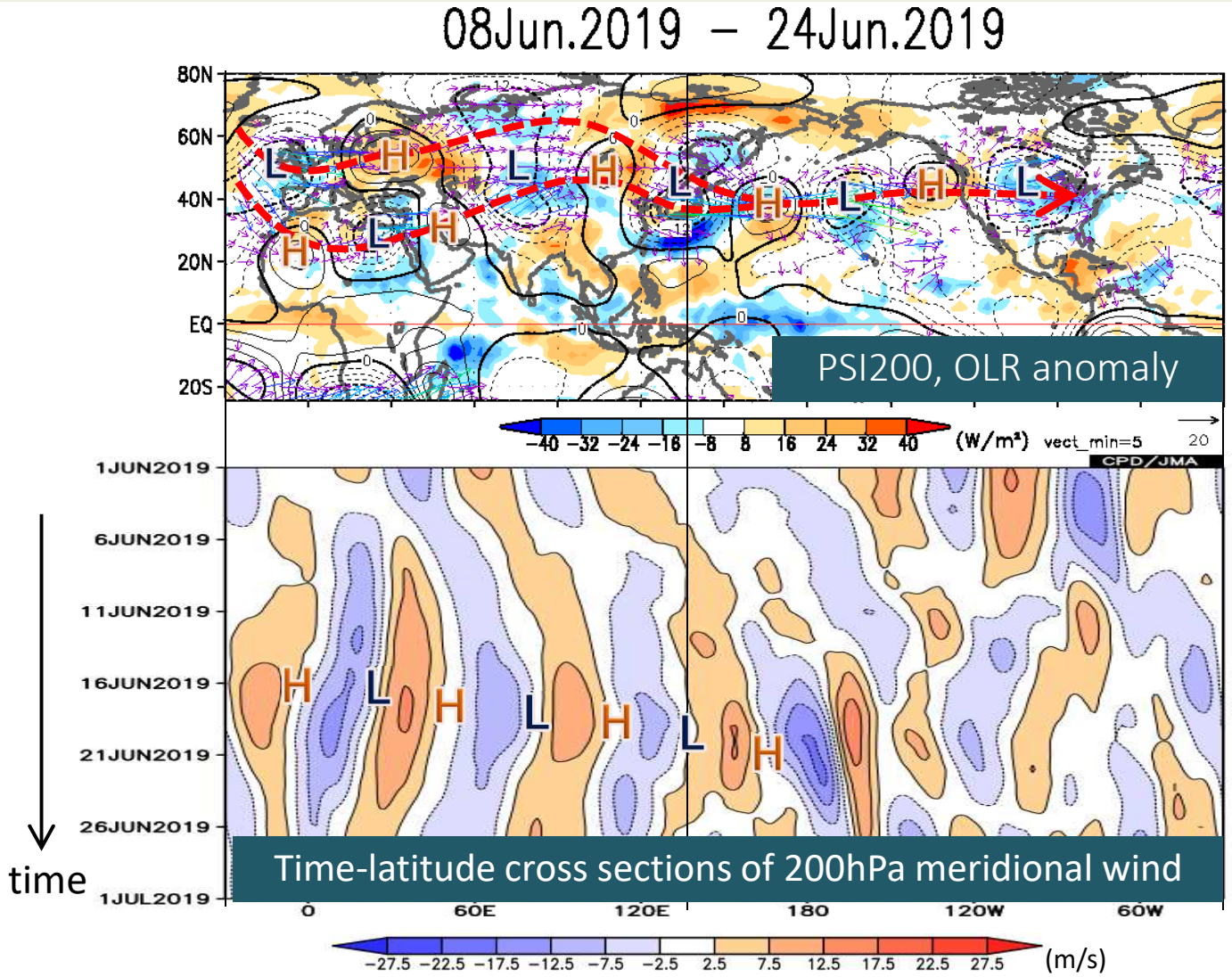
Rossby-wave trains in June

- Rossby-wave trains along jet stream were seen clearly and positions of trough/ride were almost fixed in and around mid-June.
- The subtropical jet stream shifted southward from its normal position in the eastern part of East Asia.



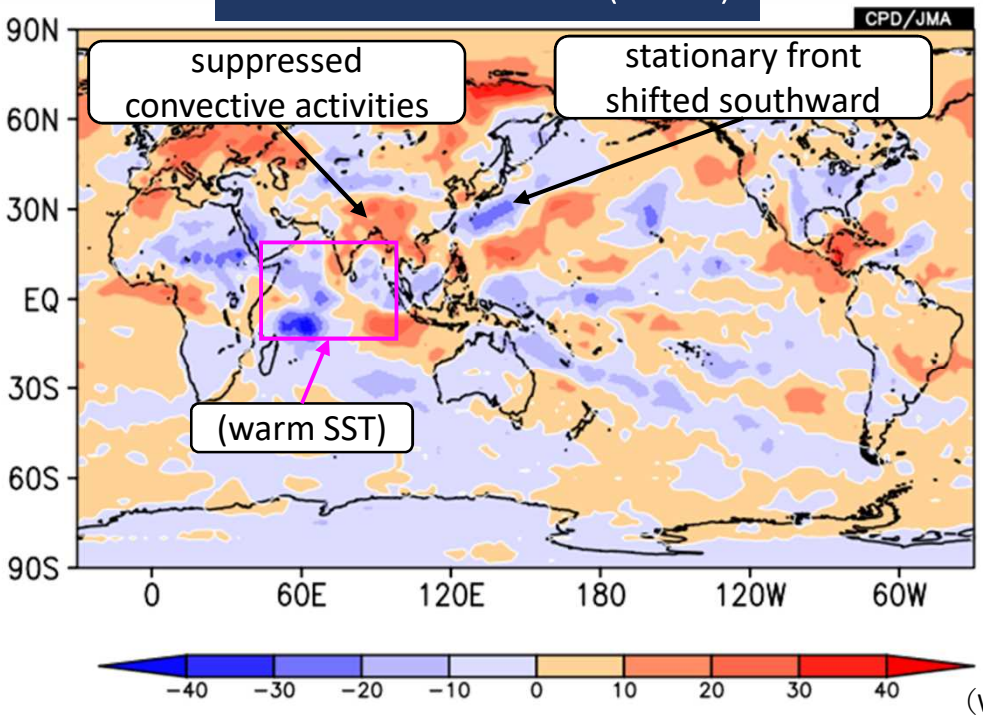
color：OLR anomaly （W/m^2）
contour：stream function anomaly at 200hPa （10^6m^2/s）
vector：wave activity flux （m^2/s^2）

shaded: meridional wind anomaly at 200hPa (7-day averaged, averaged over 20-40N)

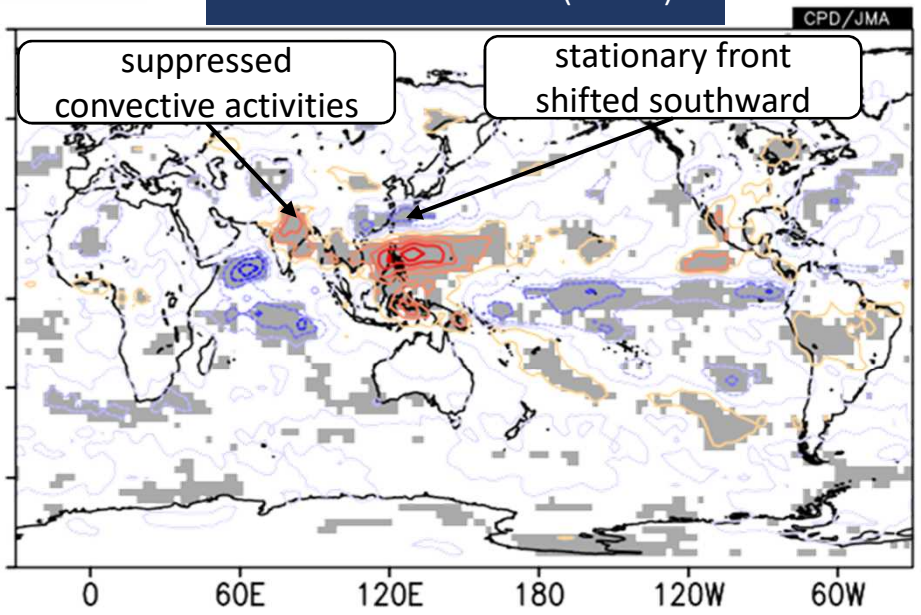
Suppressed activity of Indian monsoon in June

- Regression of OLR onto SST in Indian Ocean (IOBW) in June from 1979 to 2018 show that <u>suppressed convective activities over India in June</u> seems to have associations with the warmer-than-normal SST over Indian Ocean (IOBW), which is consistent with the SST and OLR analysis data in 2019.
- Whereas the results of regressions of OLR onto IOD or CP-ENSO indices are not so consistent with observations.

OLR observation (June)



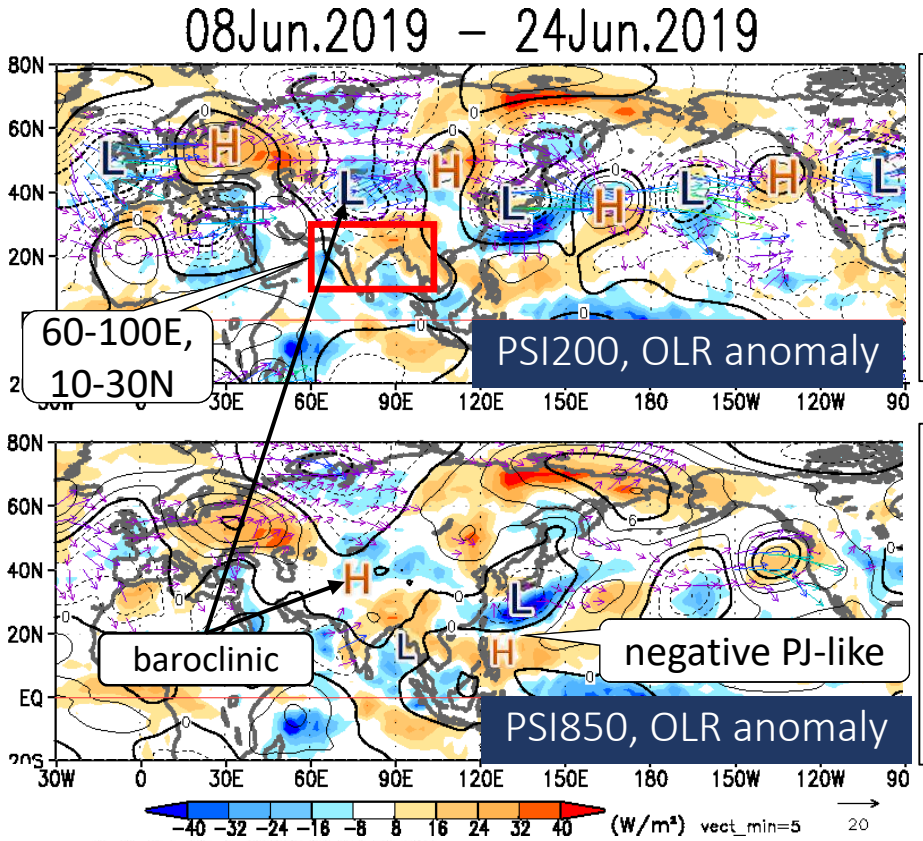
Regression of OLR onto SST-IOBW (June)

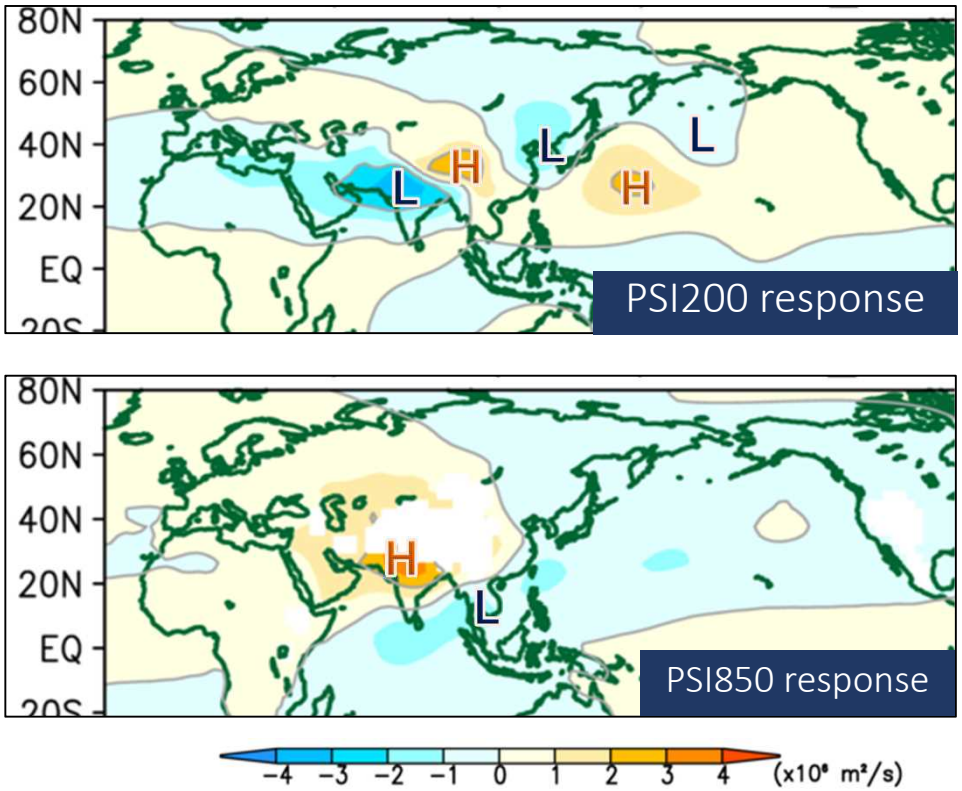


➢ Areas exceeding the significance level (95%, one side) are shaded in gray.

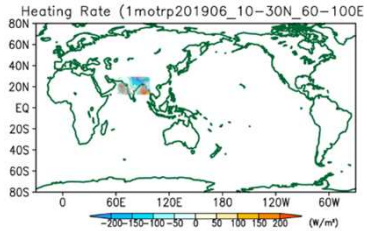
Linear Baroclinic Model (LBM) experiment in June

- We ran Linear Baroclinic Model (LBM, Watanabe and Kimoto 2000) with observed diabatic heat forcings over India in June 2019.
- The result shows that suppressed Indian monsoon activity possibly contributed to Rossby wave trains over East Asia in June 2019.





* Zonal mean values are subtracted from the results.



Adiabatic heating/cooling given running the LBM experiment in June

Summary

- The pattern of the temperature anomaly and precipitation ratio to the normal for 2019 summer was uneven, different between the period from early June to late July and that from late July to mid-August.
- In June, suppressed Indian monsoon activity possibly contributed to the shifted subtropical jet stream in the eastern part of East Asia.

Thank you for your attention…