

Characteristics of East Asian summer monsoon 2014

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Outline

(Part I)

Overview of East Asian summer monsoon 2014
and associated atmospheric circulations

(Part II)

Case Study : Extremely wet August in western
Japan and associated atmospheric circulations

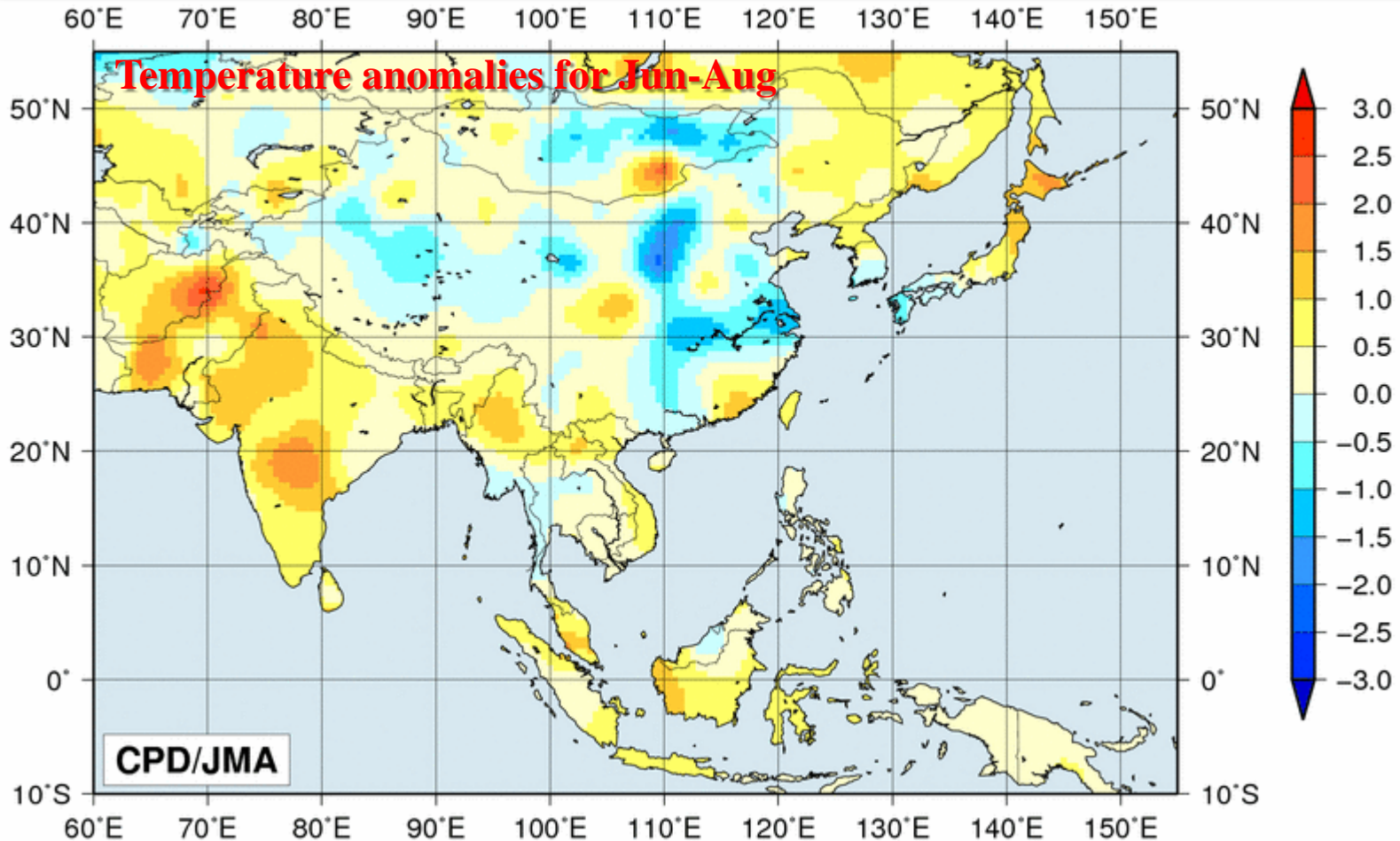
Part I

**Overview of East Asian summer
monsoon 2014 and associated
atmospheric circulations**

3-month mean surface temperatures for Jun-Aug

Warmer than normal: northern Japan, northeastern China, southeastern China, and southeastern Mongolia

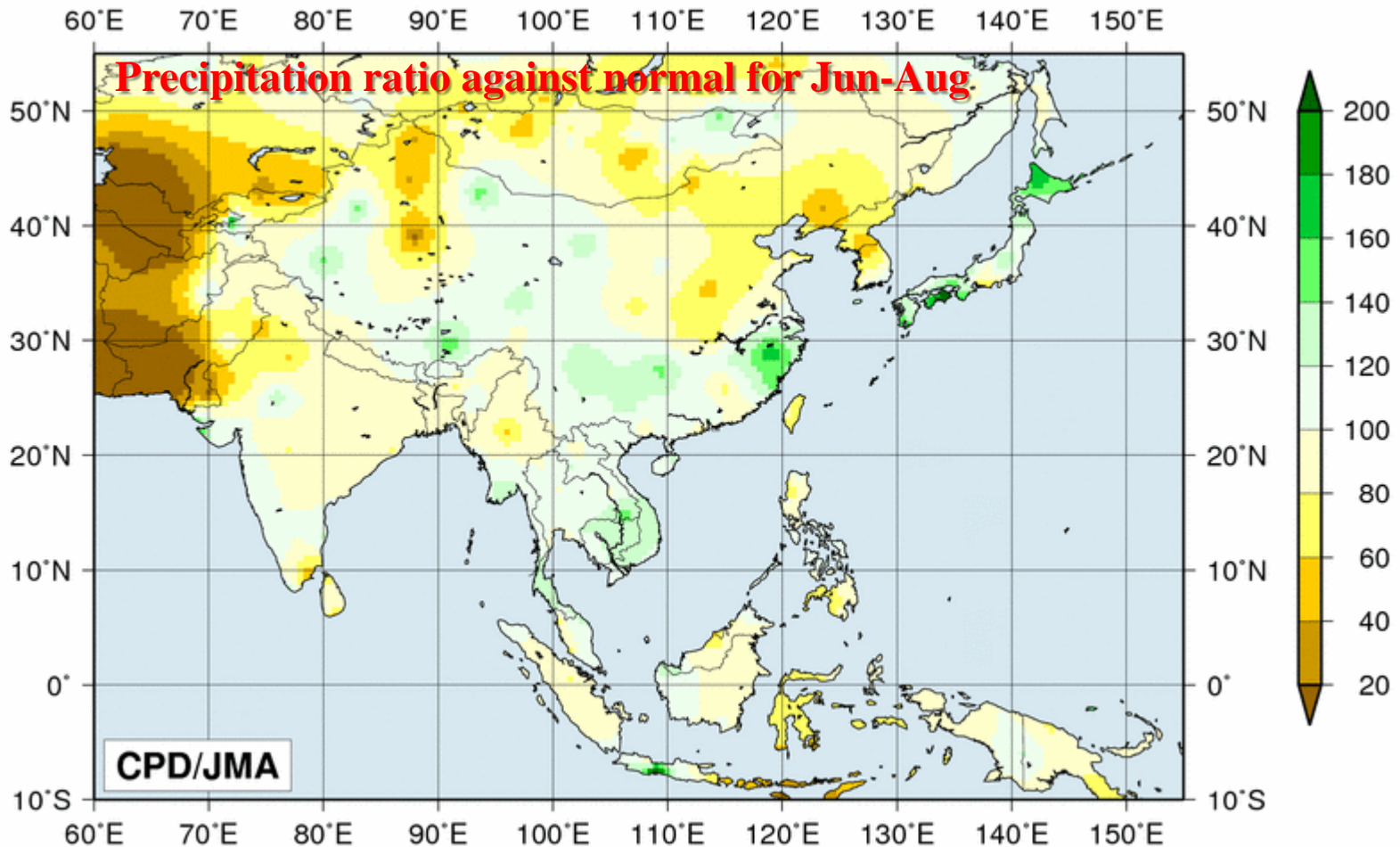
Cooler than normal: western Japan, eastern China and northern Mongolia



3-month precipitation amounts for Jun-Aug

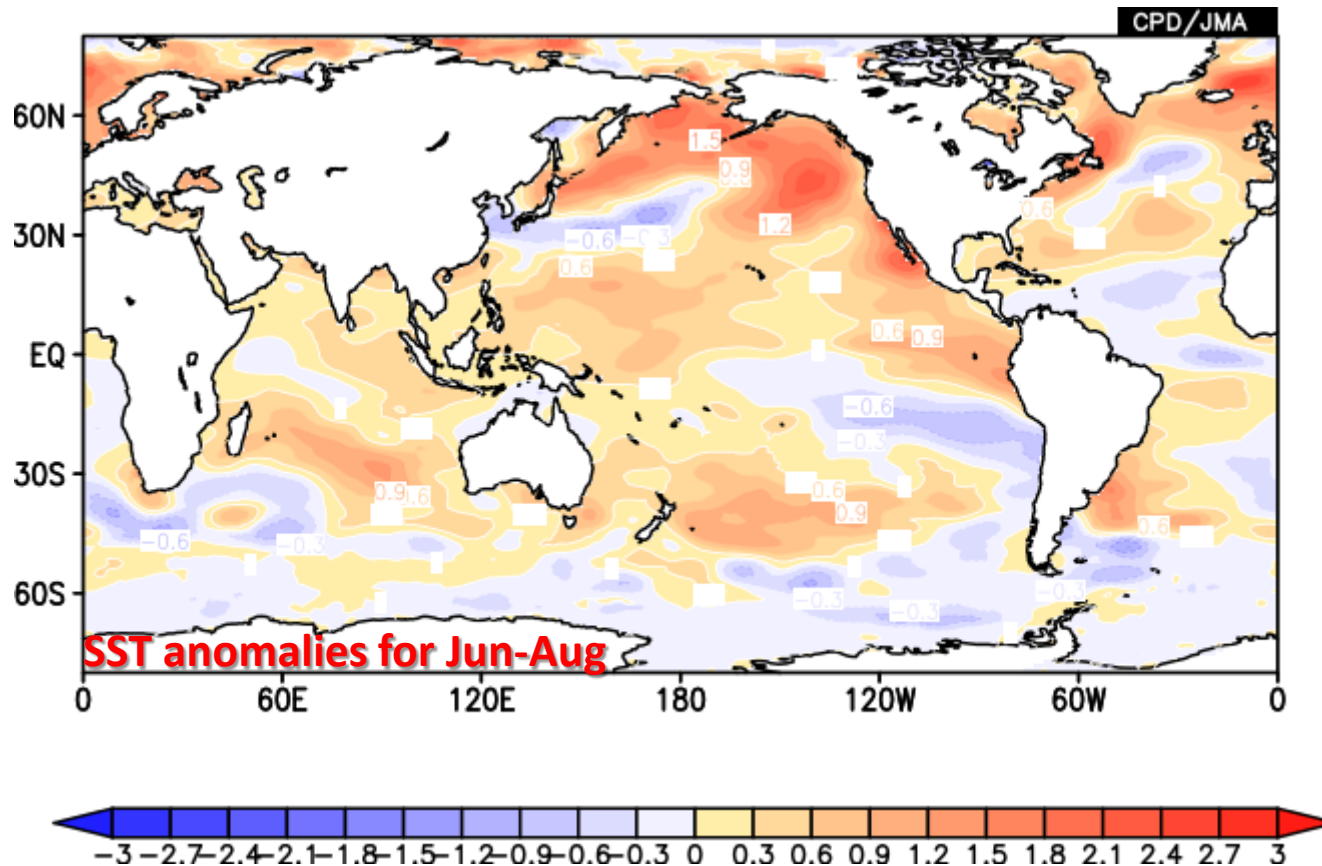
Wetter than normal: northern Japan, western Japan, and southern China

Drier than normal: northeastern China, western and central parts of Mongolia



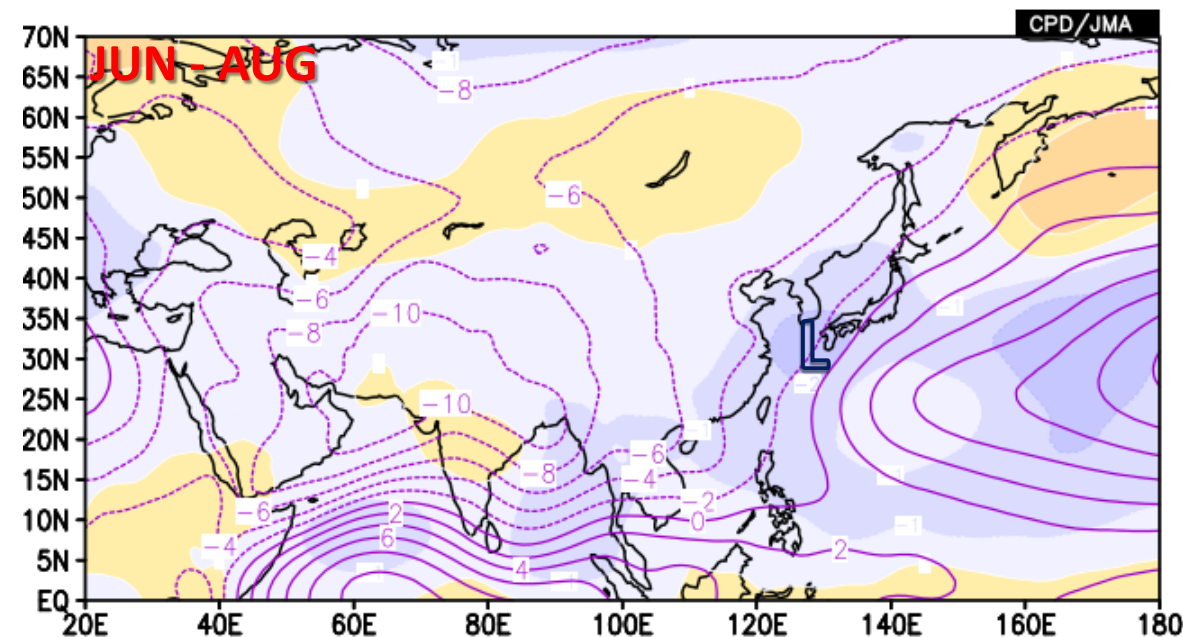
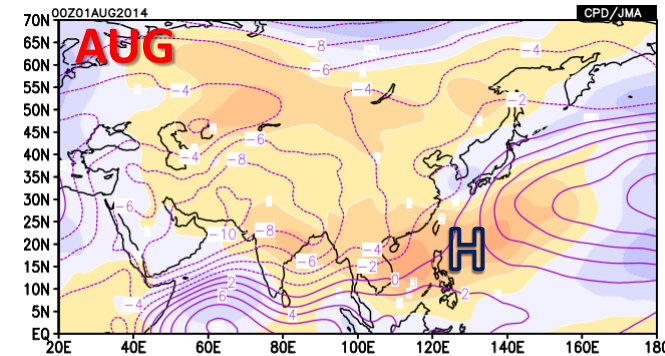
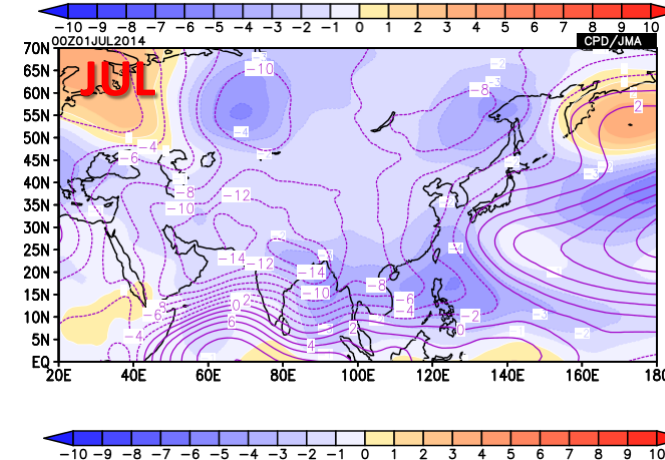
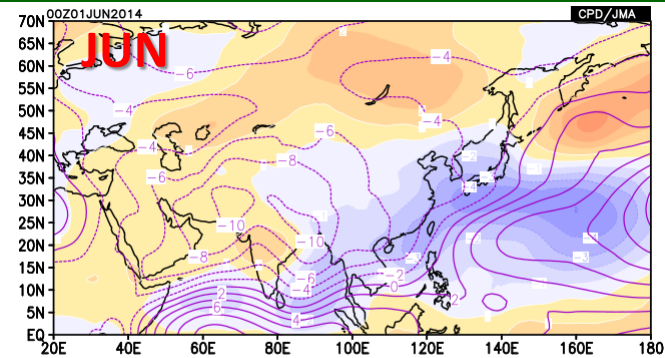
3-month mean global SST for Jun-Aug

- Warm anomalies extend in the western and eastern parts of the equatorial Pacific
- In the Indian Ocean, cold anomalies observed in the west, warm anomalies in the east (pattern of negative IOD)
- Globally, warm anomalies were dominant throughout the season (For each of the three months, global mean SST was the highest since 1891 by a wide margin)



Stream function at 850hPa

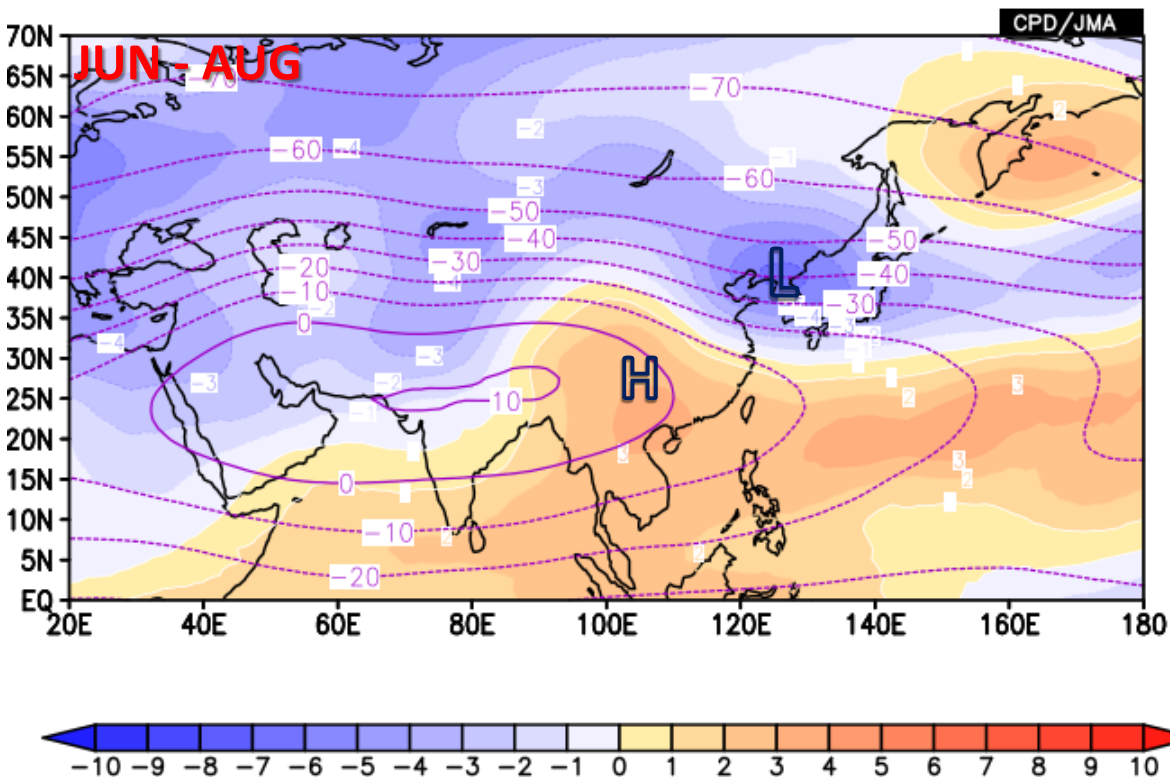
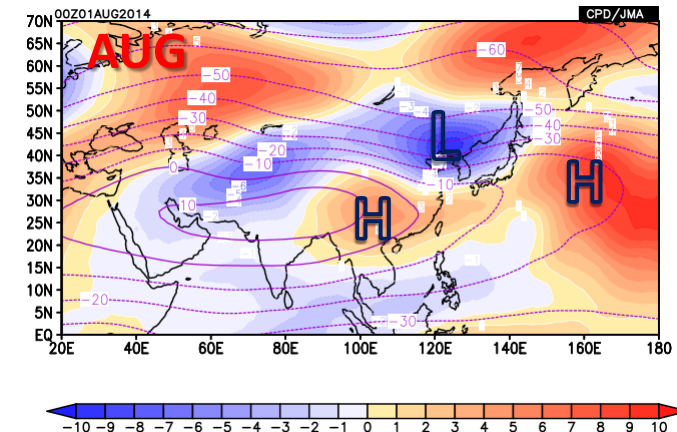
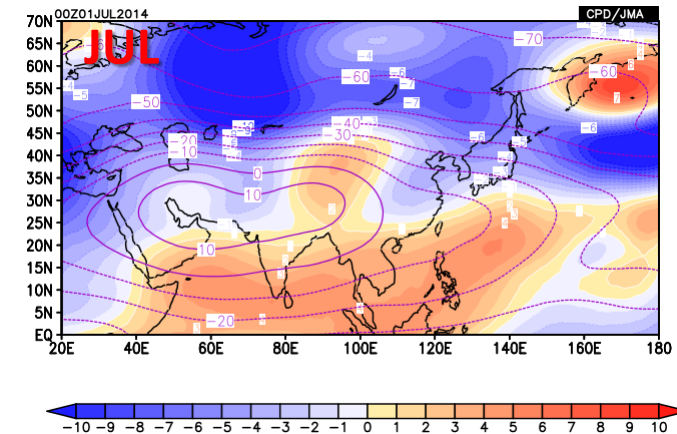
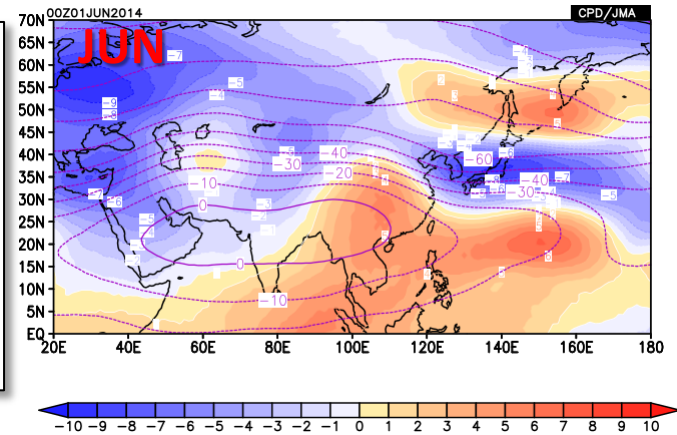
- For the three month mean, cyclonic circulation anomalies are seen around western Japan
- In August, anti-cyclonic circulation anomalies were prominent south of Japan and around the Philippines



Stream function (contour) and anomaly (shade) at 850hPa for the three months of Jun-Aug (above) and for individual months (right)

Stream function at 200hPa

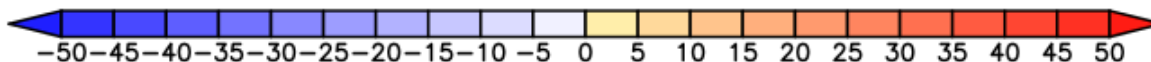
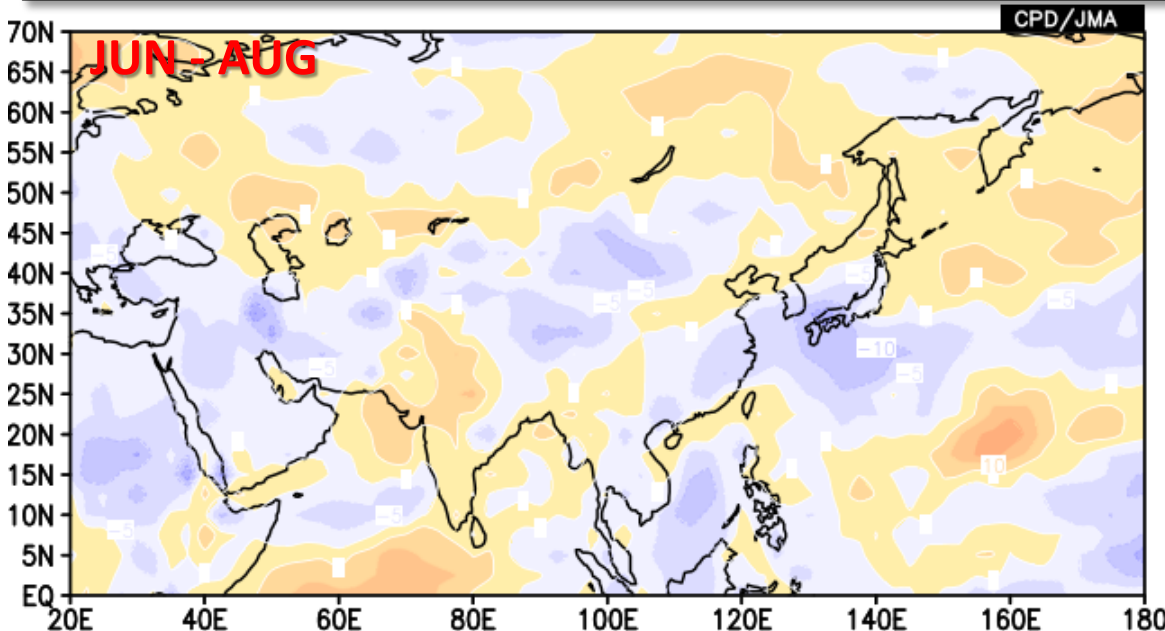
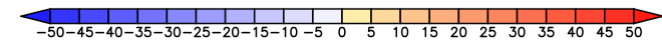
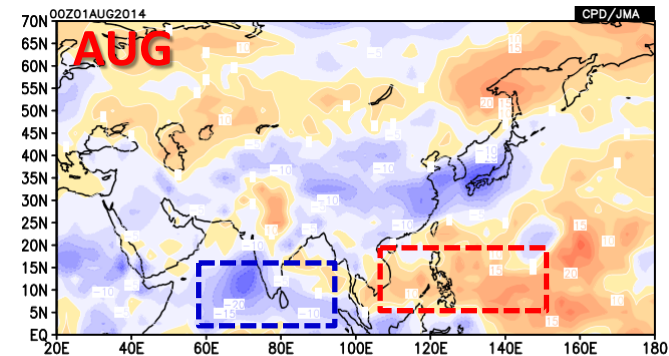
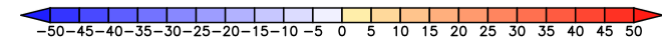
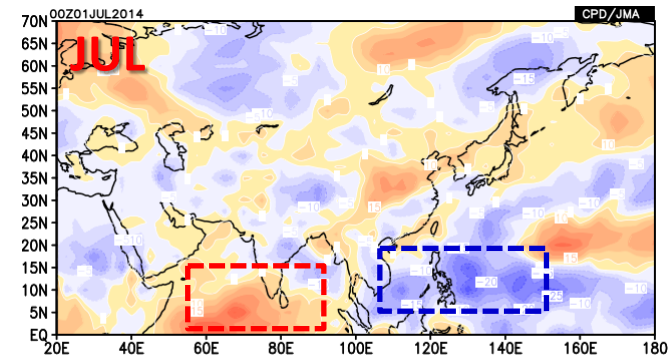
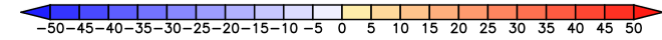
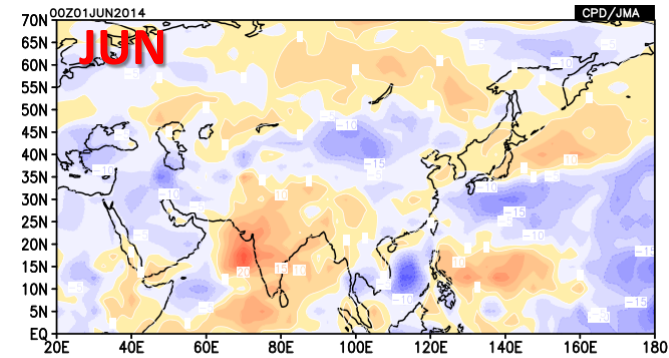
- The three month mean featured anti-cyclonic circulation anomalies in southern China, cyclonic anomalies from eastern China to western Japan
- In August, a tri-pole pattern of anti-cyclonic anomalies in southern China and north Pacific, with cyclonic anomalies centered in eastern China



Stream function (contour) and anomaly (shade) at 200hPa for the three months of Jun-Aug (above) and for individual months (right)

Convective activity (OLR)

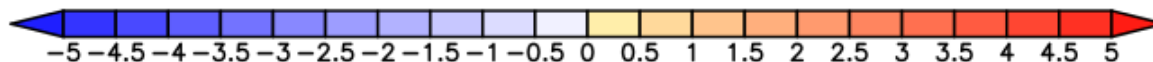
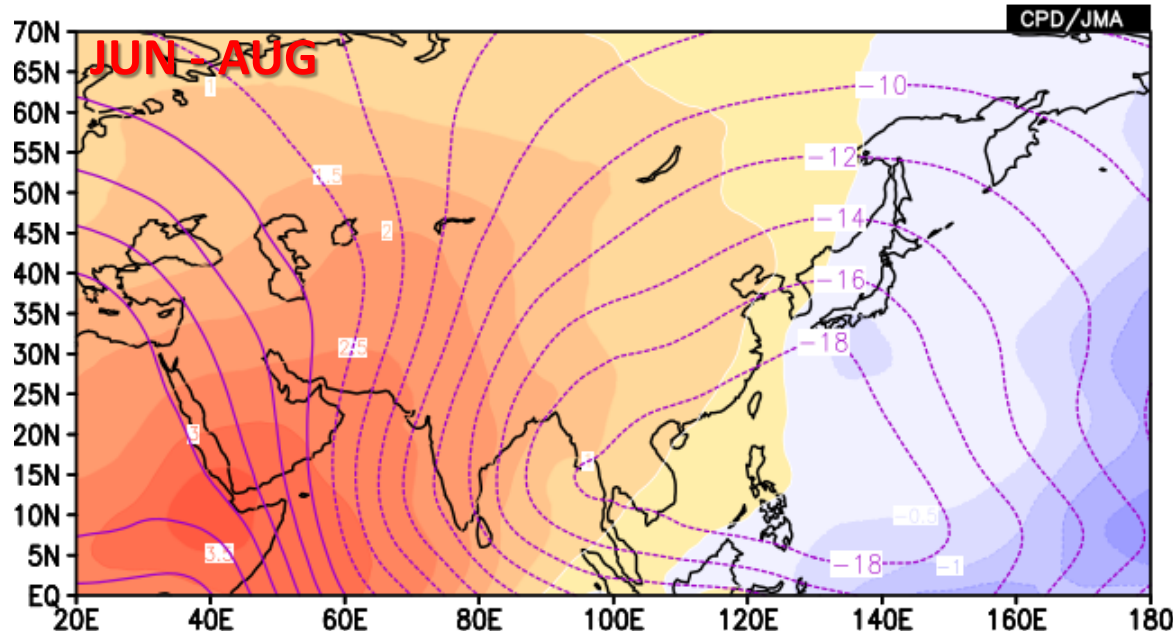
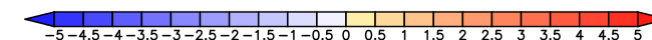
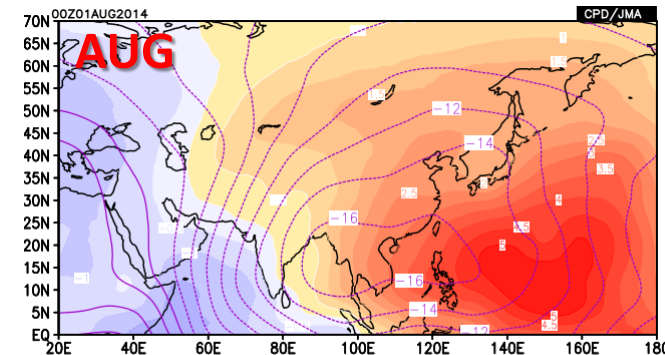
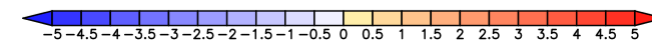
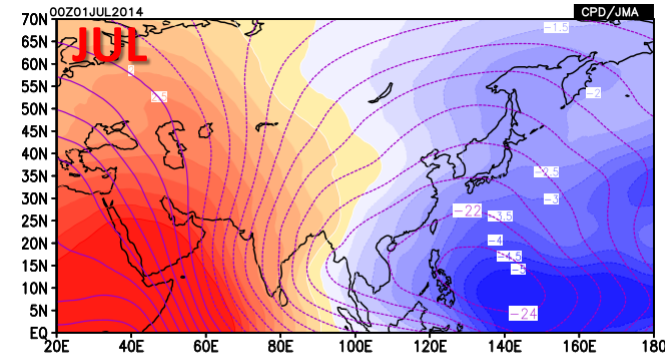
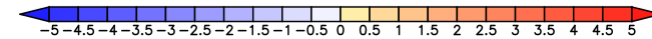
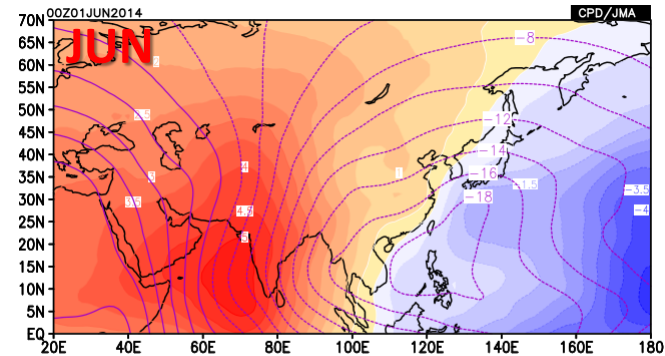
- Enhanced convective activity was seen from eastern China to western Japan, most remarkably in August
- In the tropics, a seesaw-like convection phase shift from July to August between the Indian Ocean and the western Pacific



OLR anomaly for the three months of Jun-Aug (above) and for individual months (right)

Velocity potential at 200hPa

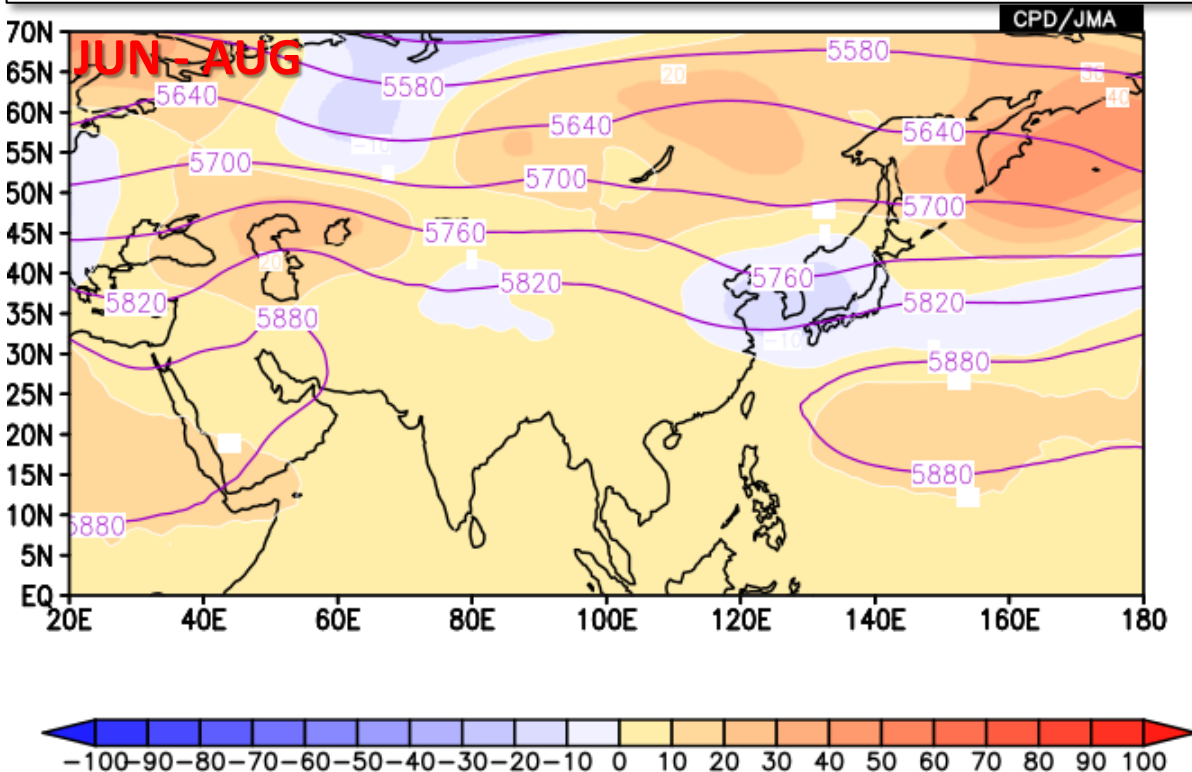
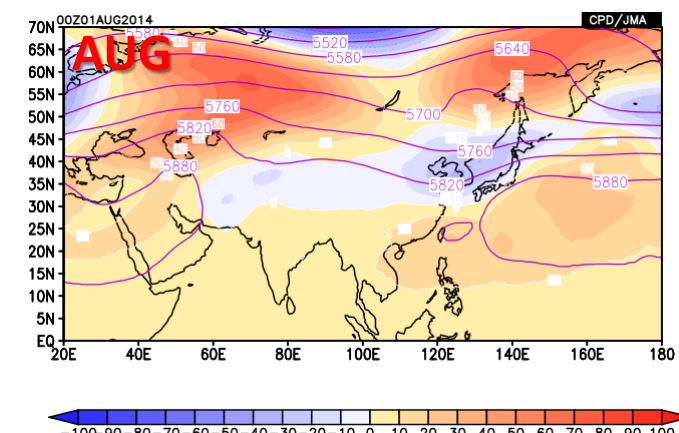
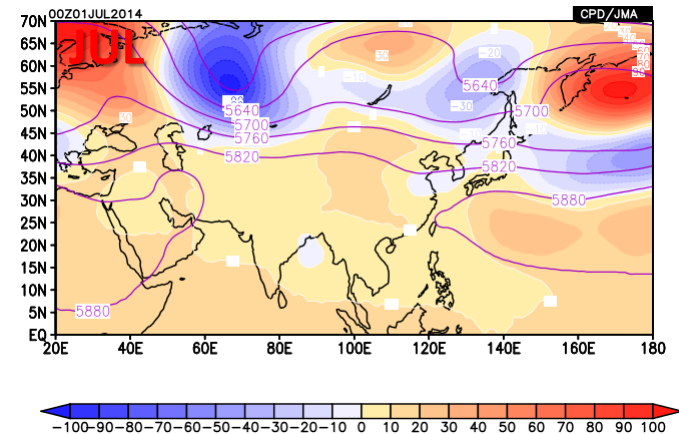
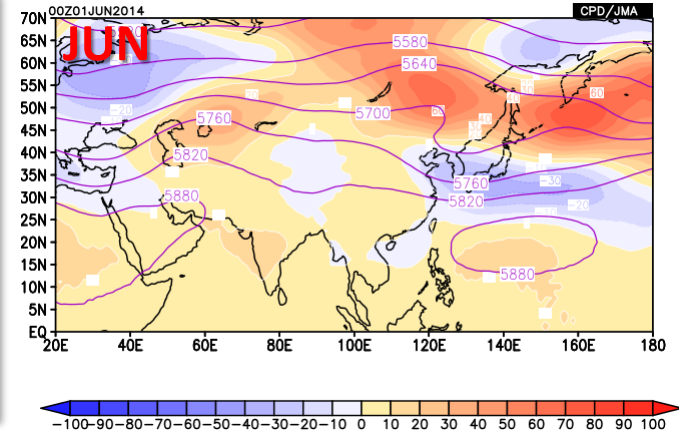
- For the three month mean, convergence anomalies were dominant in the western Indian Ocean
- In August, convection over the western Pacific was significantly suppressed, in stark contrast to the previous month



Velocity potential (contour) and anomaly (shade) at 200hPa for the three months of Jun-Aug (above) and for individual months (right)

Geopotential height at 500hPa

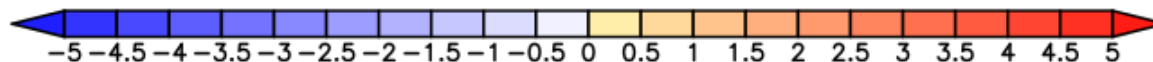
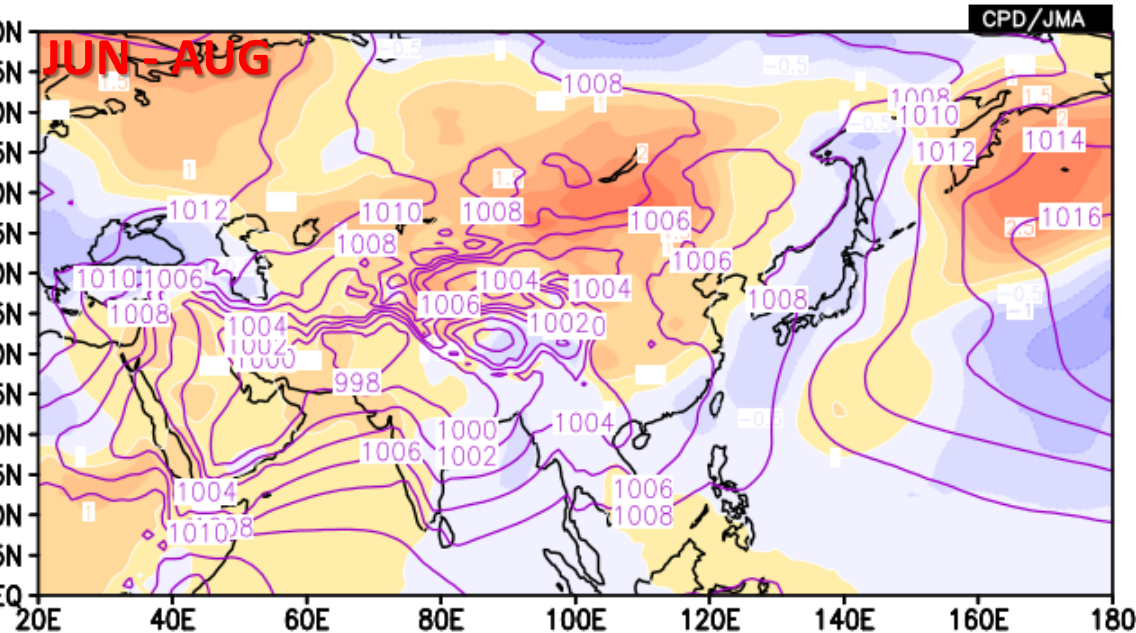
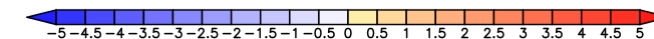
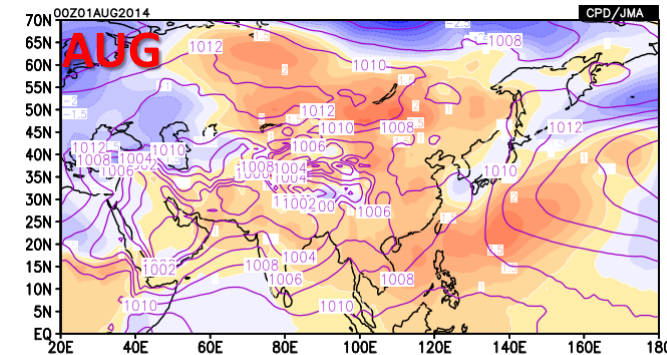
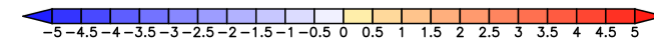
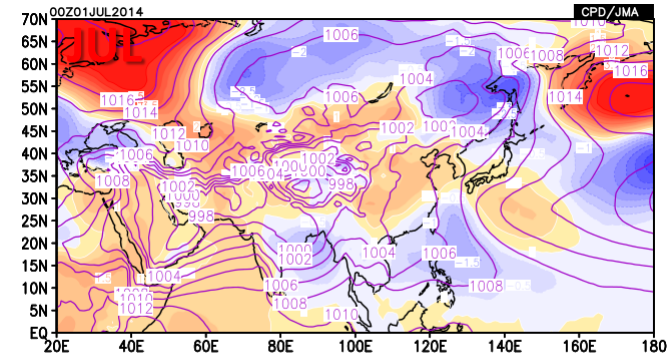
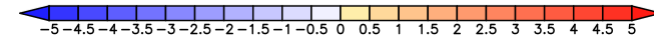
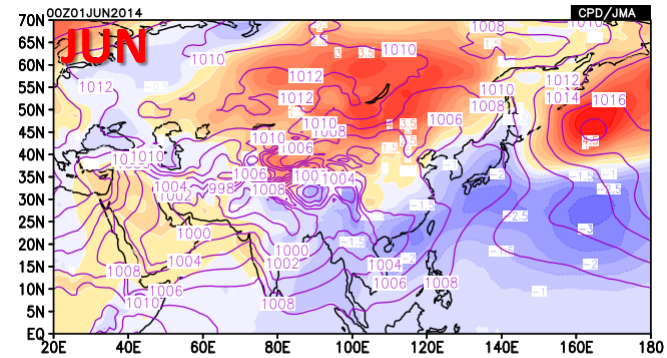
- The three month mean featured troughs extending from eastern China through to Japan, while the Pacific High was strong south of Japan
- In August, negative anomalies around the Korean Peninsula and positive anomalies just southeast of Japan, indicating intensified moist air flow into western Japan



Geopotential height (contour) and anomaly (shade) at 500hPa for the three months of Jun-Aug (above) and for individual months (right)

Sea level pressure

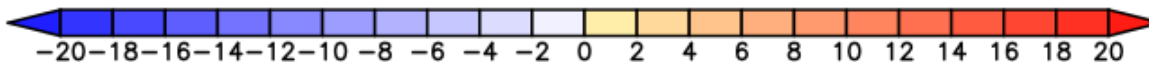
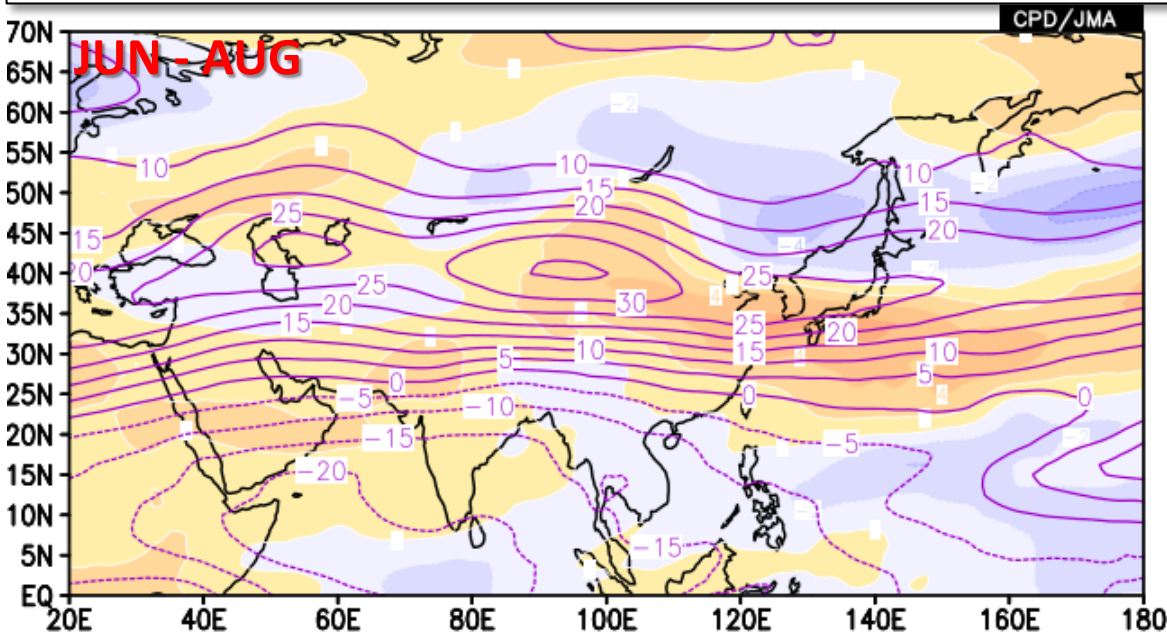
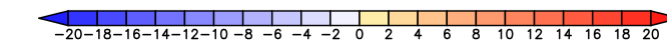
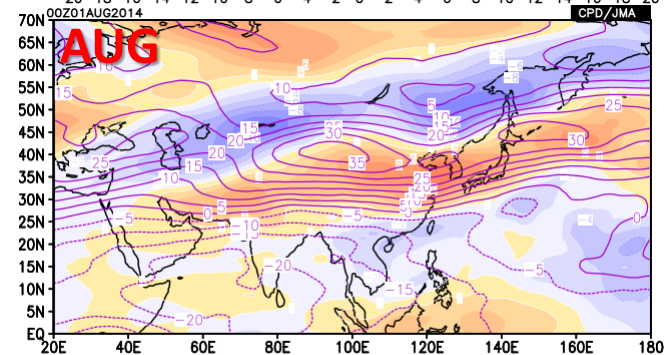
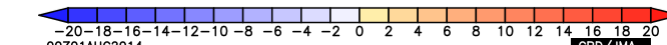
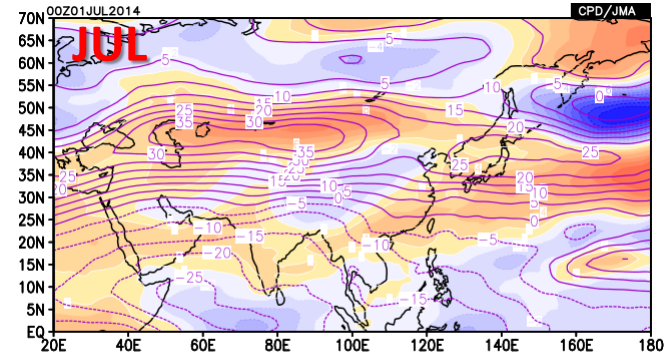
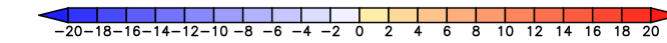
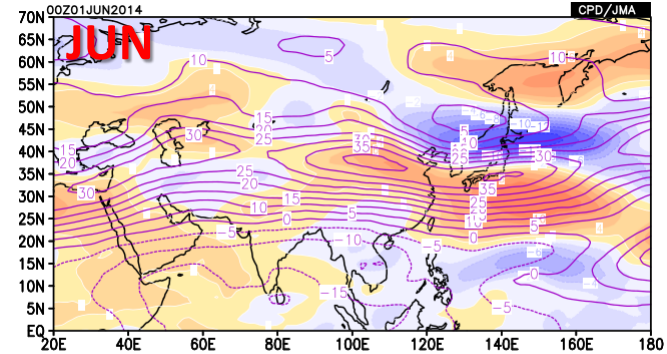
- The three month mean featured an overall pattern of positive anomalies over land with negative anomalies over ocean, suggesting below-average summer monsoon activity



Sea level pressure (contour) and anomaly (shade) for the three months of Jun-Aug (above) and for individual months (right)

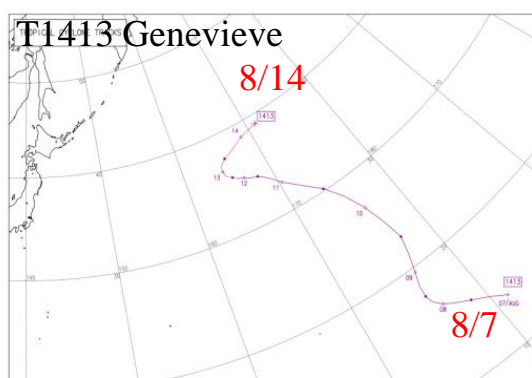
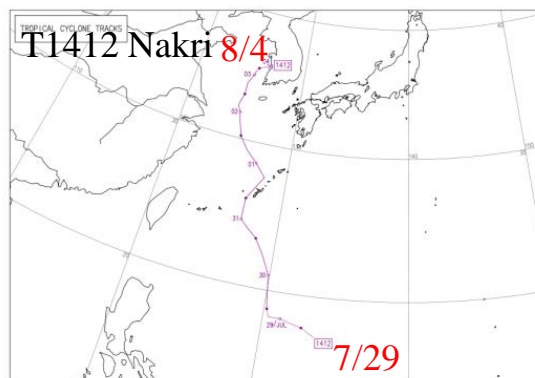
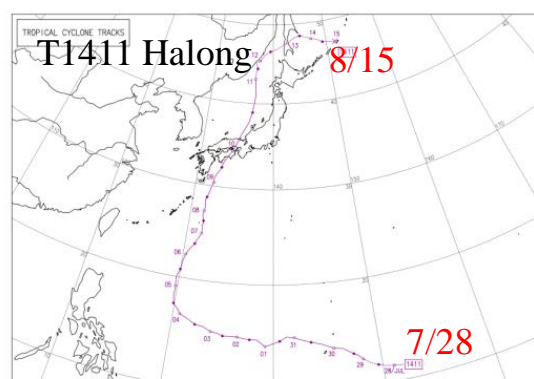
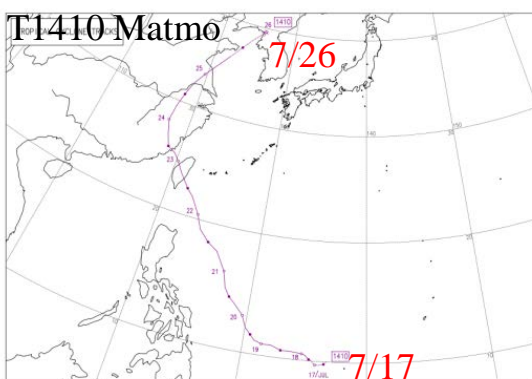
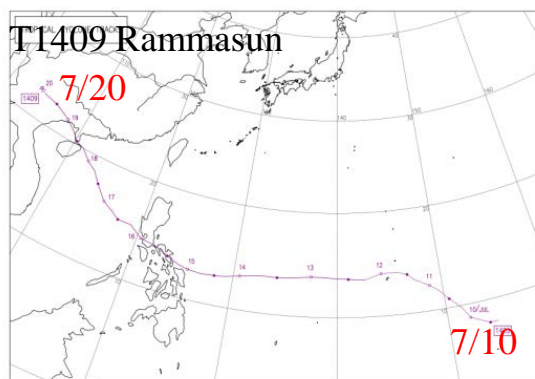
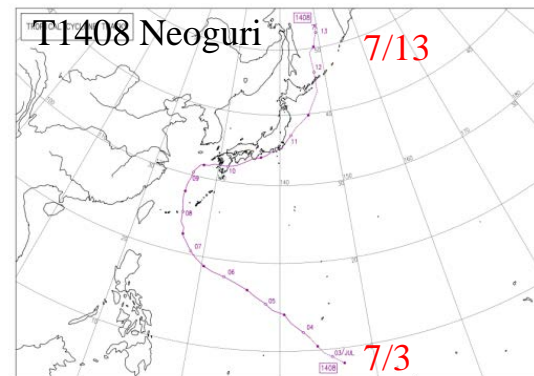
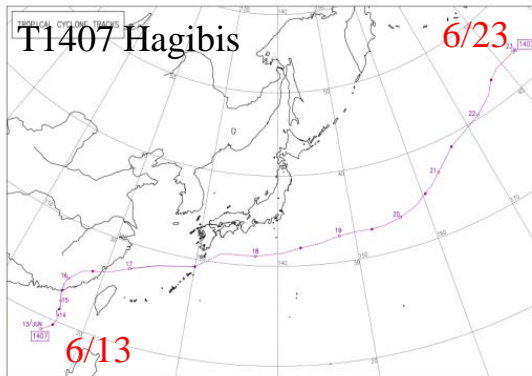
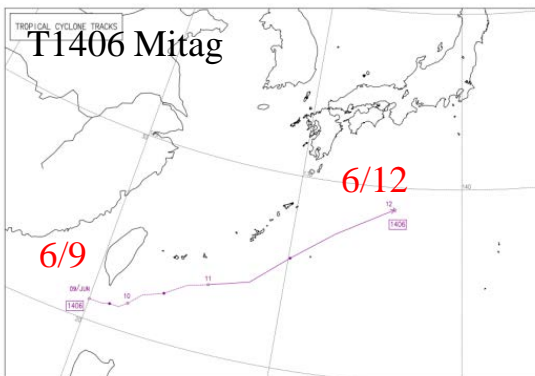
Zonal wind speed at 200hPa

- Overall, the subtropical jet stream was stronger than normal and tended to flow south of its normal position
- In August, the subtropical jet stream meandered significantly southward around eastern China and northward east of Japan



Zonal wind speed (contour) and anomaly (shade) at 200 hPa for the three months of Jun-Aug (above) and for individual months (right)

Tropical cyclones over the western North Pacific



- During the season, 8 tropical cyclones of tropical storm intensity or higher appeared in the western North Pacific (climatological normal: 11.2).
- In August, no tropical cyclone was generated in the western Pacific (T1413 formed in the central Pacific and crossed the dateline)

Part II : Case Study

**Extremely wet August in western Japan
and associated atmospheric circulations**

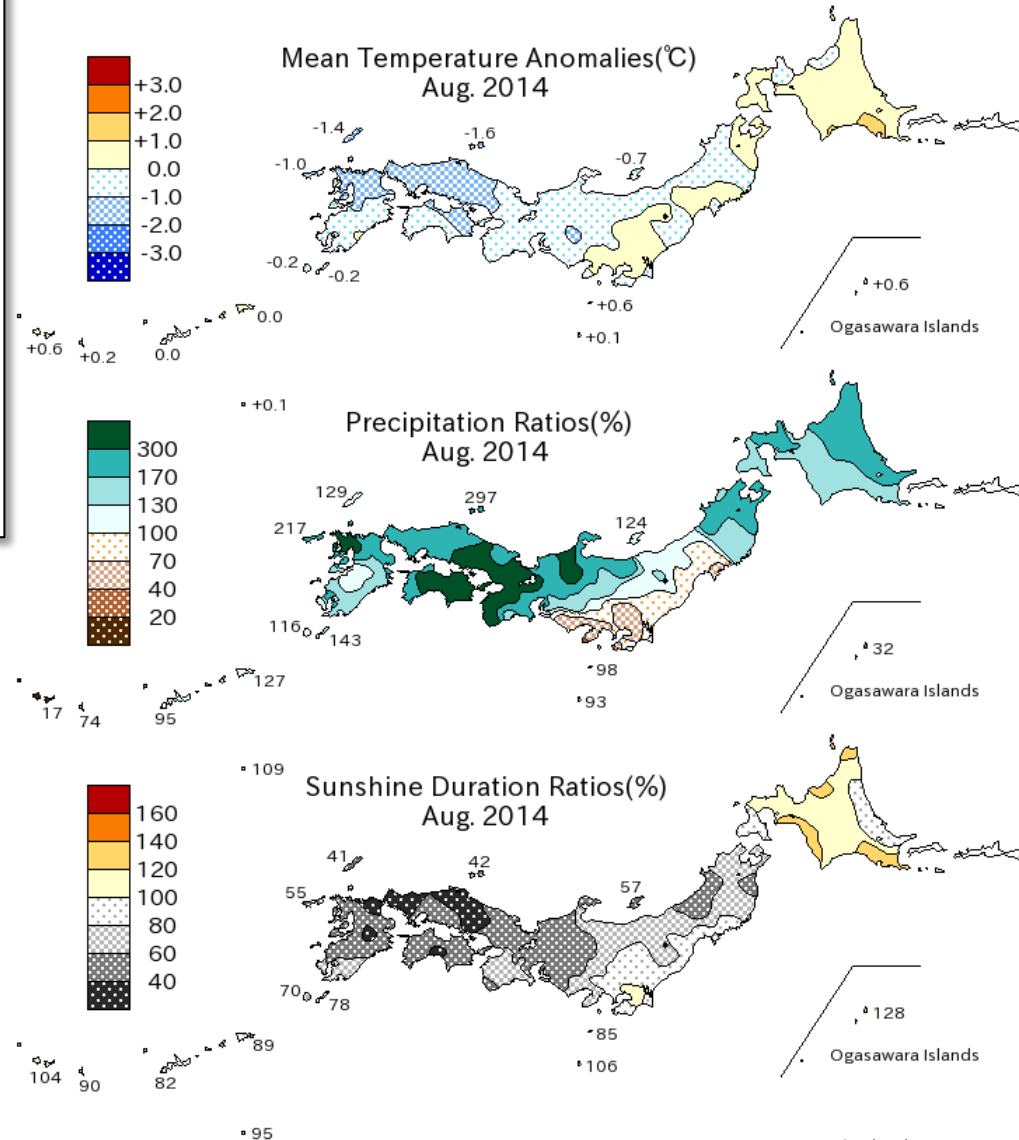
Record-breaking precipitation in August

- From late July towards late August, Japan experienced above-normal rainfall and below-normal sunshine duration nearly nationwide.
- Most markedly, monthly precipitation for August averaged over the Pacific side of western Japan was the highest since 1946 at 301% of normal

Contributing factors are threefold:

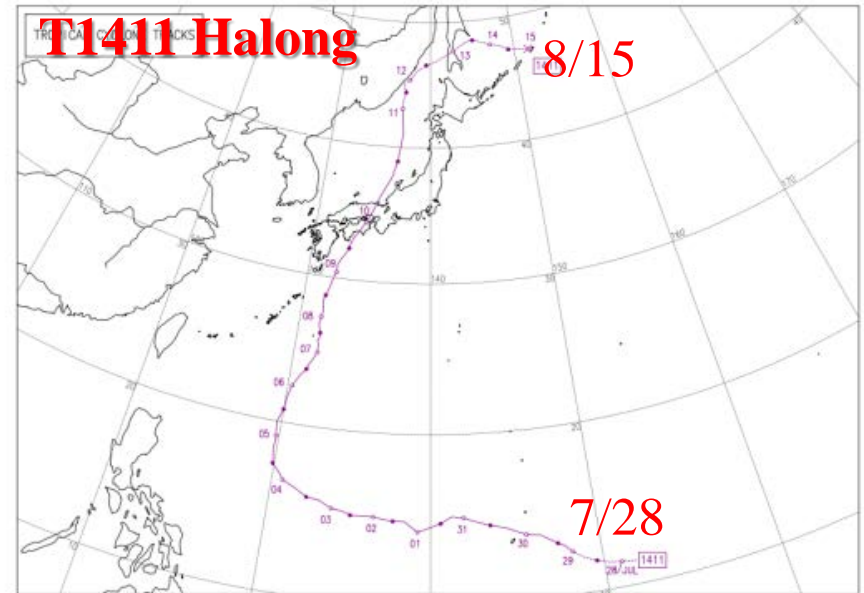
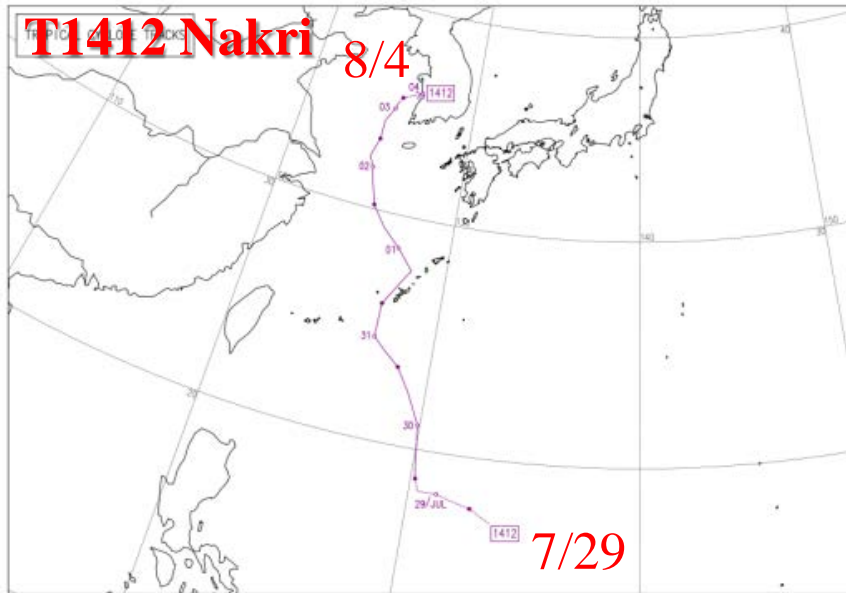
- Two typhoons in early August
- Persistent synoptic-scale front around Japan
- Incessant moist air inflow

TCC Advisory Panel on Extreme Climatic Events



Two typhoons in early August

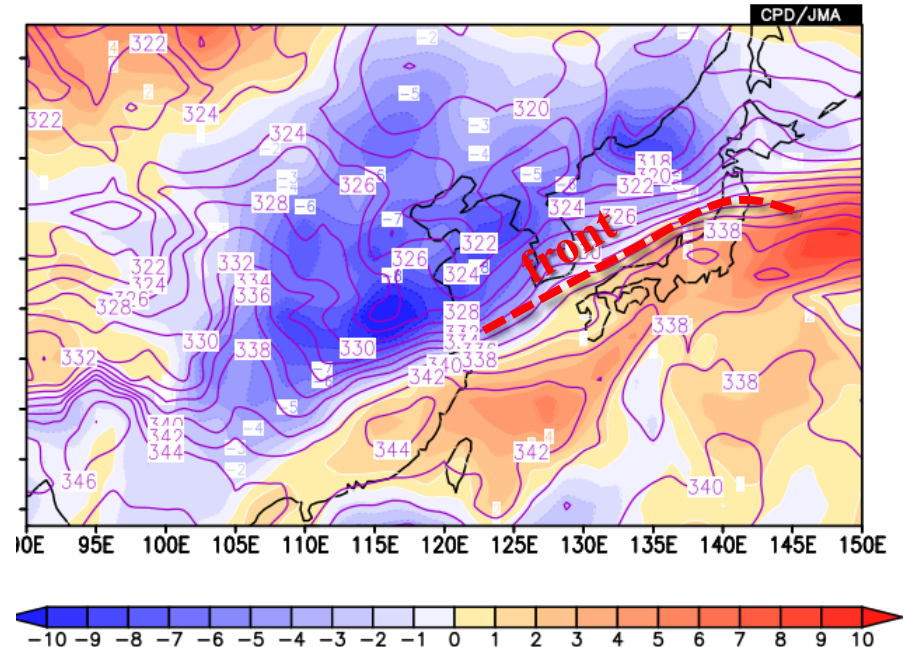
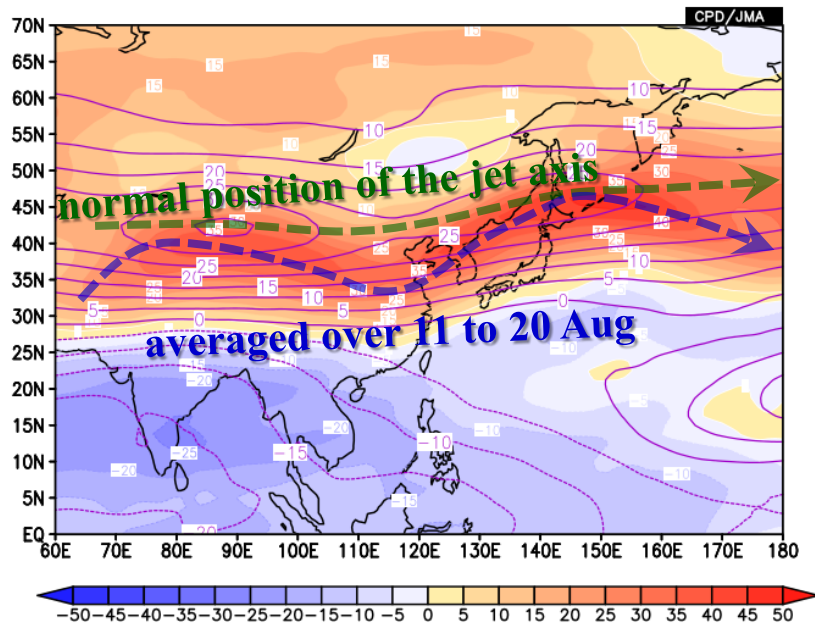
- Typhoon Nakri, followed by Typhoon Halong after a short interval, influenced western Japan early in August
- The two typhoons moved northward at low speed before being accelerated by the subtropical jet stream, thereby influencing western Japan for a longer time than otherwise.



Persistent fronts around Japan

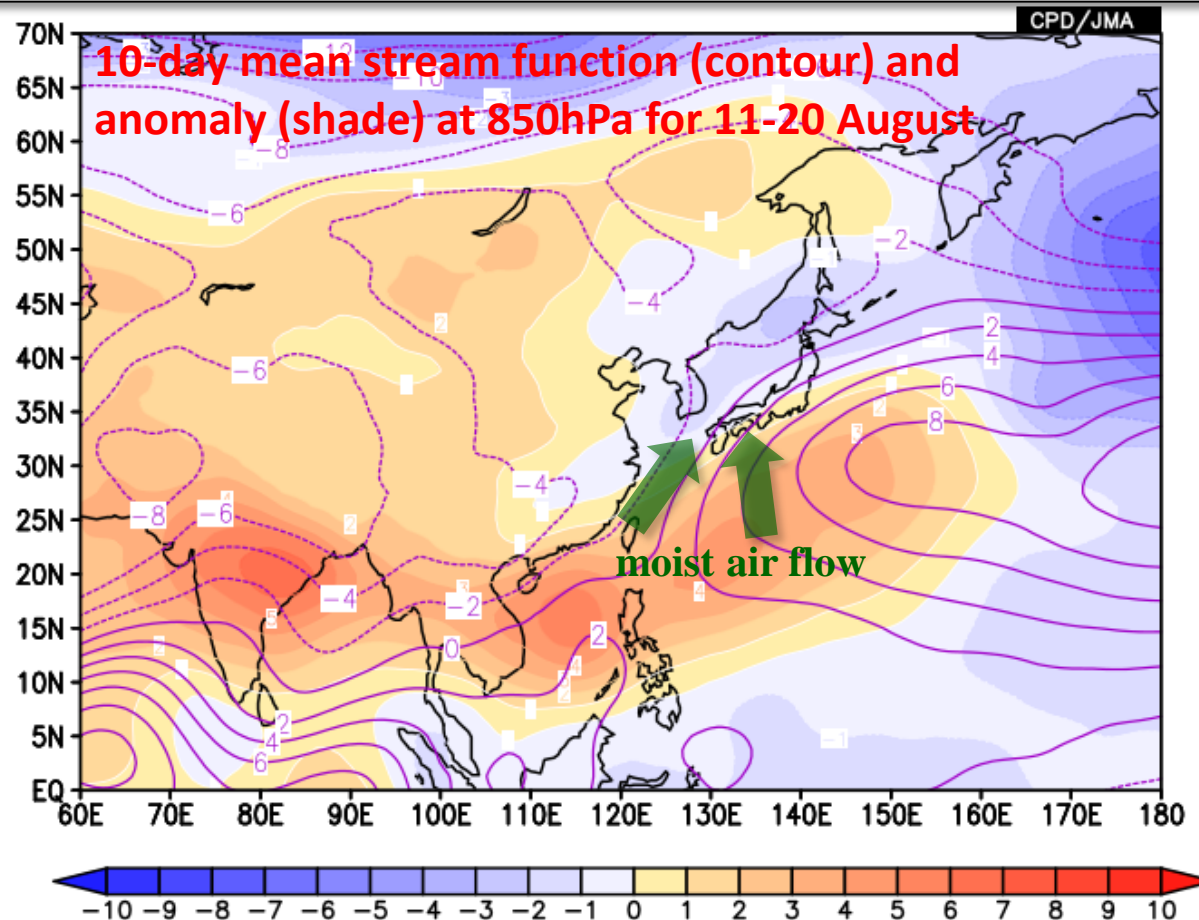
- Synoptic-scale fronts were persistently situated around the mainland of Japan in mid- to late August, likely in relation to the pronounced southward meandering of the subtropical jet stream to the west of Japan.
- The southward meandering of the jet stream was presumably associated with suppressed convection around the Philippines. Wave trains propagated from Europe may have partly contributed.

10-day mean zonal wind speed at 200hPa (shade) for 11-20 August, compared with its normal (contour) 10-day mean equivalent potential temperature (contour) and anomaly (shade) at 850hPa for 11-20 August

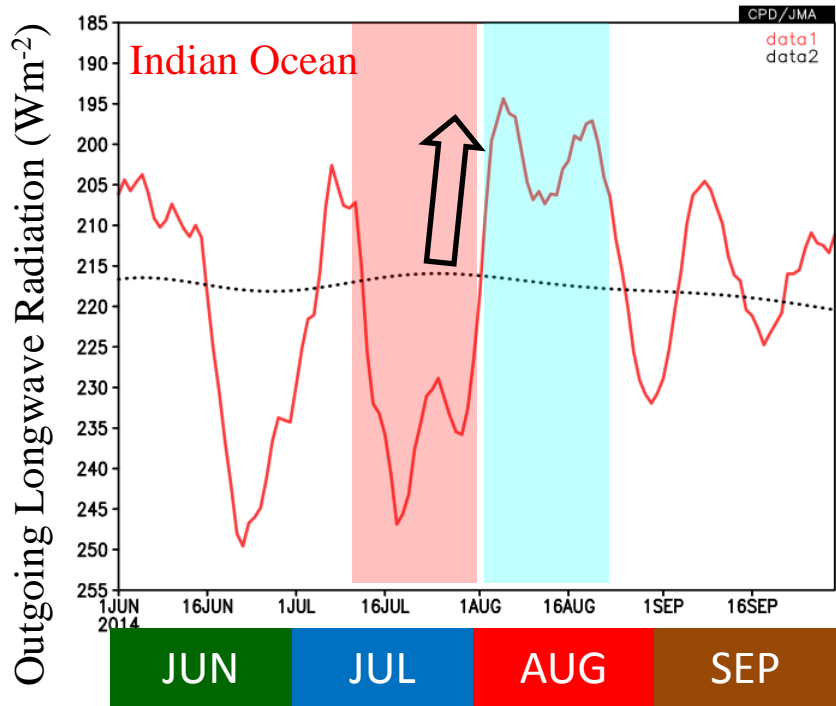


Anti-cyclonic circulation anomalies in the lower troposphere

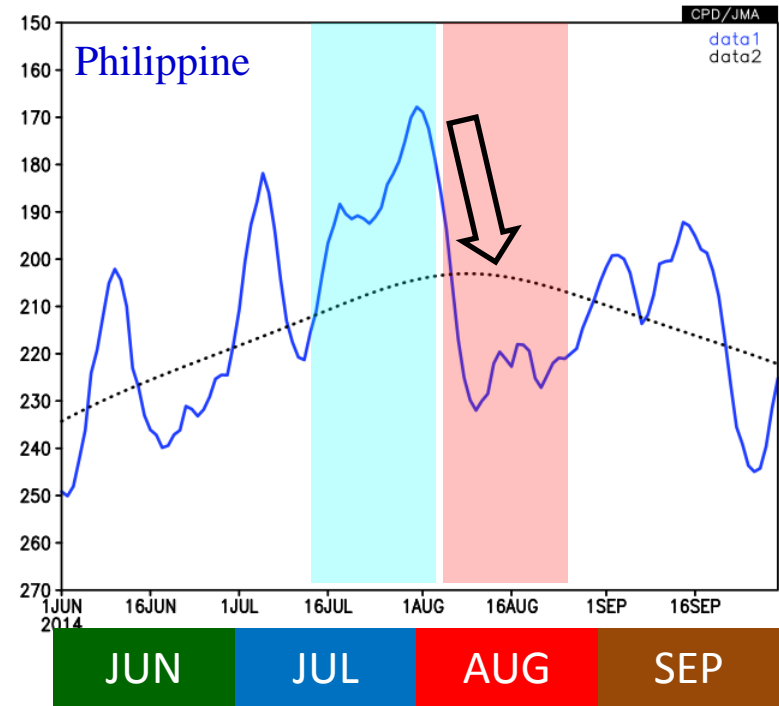
- In mid-August, the Pacific High was amplified to the southeast of Japan
- Coincidentally anti-cyclonic circulation anomalies in the lower-troposphere developed around the Philippines
- These circulation anomalies were conducive to persistent moist air flow into western Japan



Pronounced change in convection distribution early August

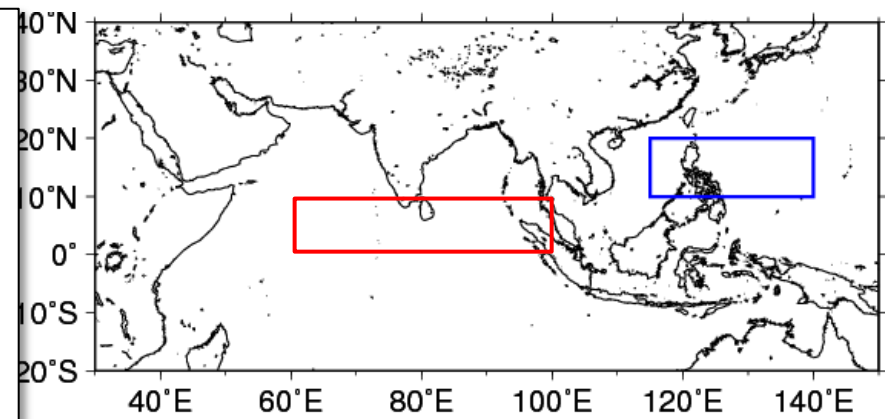


Active ↑
Inactive ↓



7-day running mean OLR averaged over the red (left) and blue (right) boxes in the map below. The dashed lines denote climatological normals.

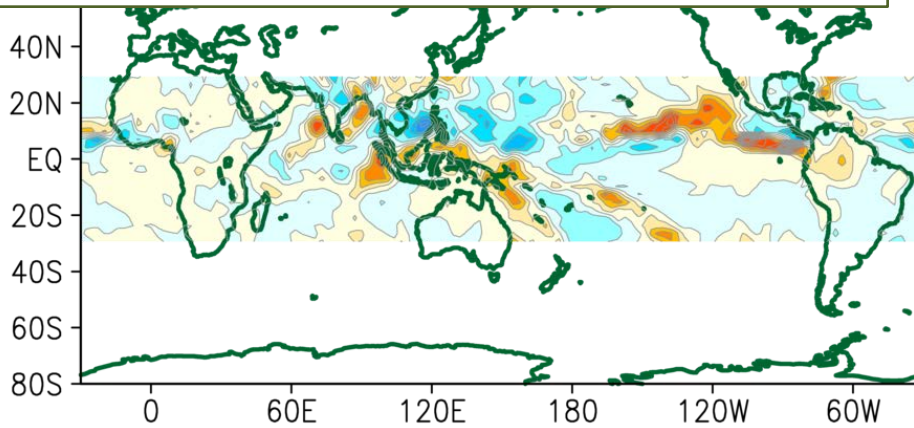
- In early August, convective activity in the equatorial Indian Ocean suddenly switched from suppressed into enhanced phase.
- In phase opposition, convective activity around the Philippine plummeted, presumably contributing to anti-cyclonic circulation anomalies in lower troposphere and southward shift of the subtropical jet stream in east Asia.



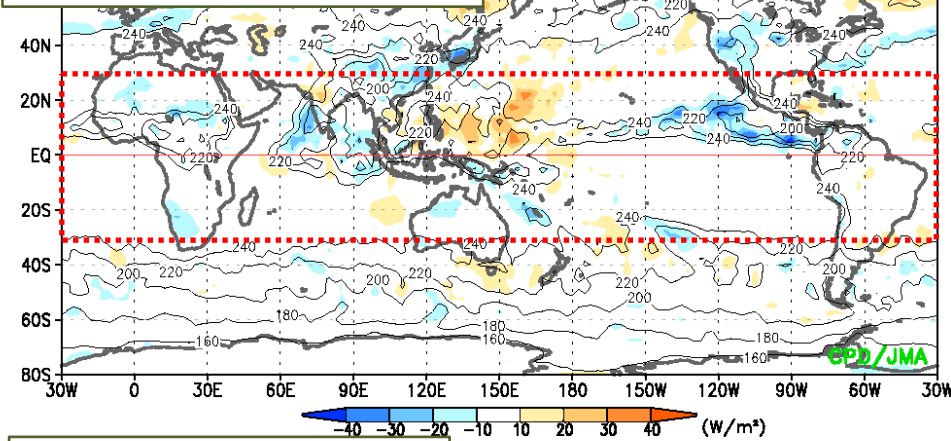
Attribution experiment using Linear Baroclinic Model

Heat anomalies in tropics give rise to a convergence/divergence distribution well resembling observation

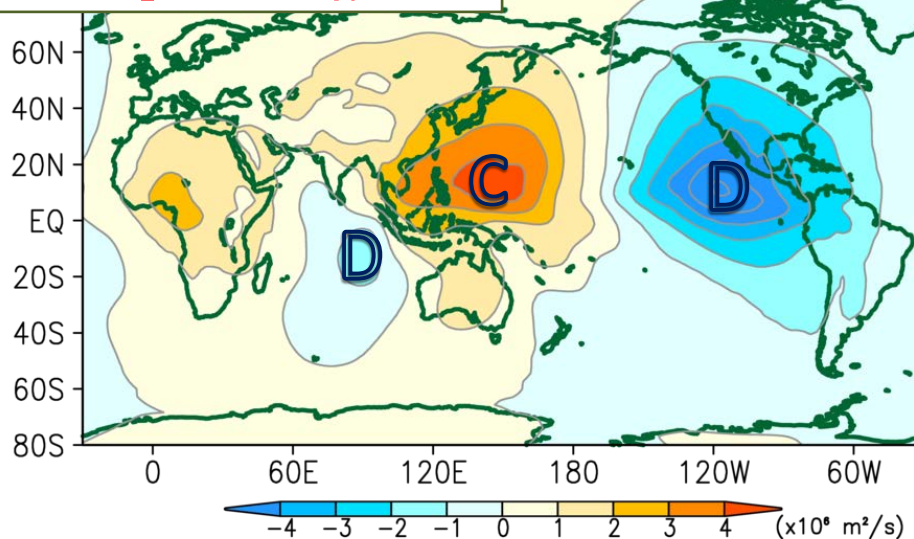
Forcing (observed heat anomaly)



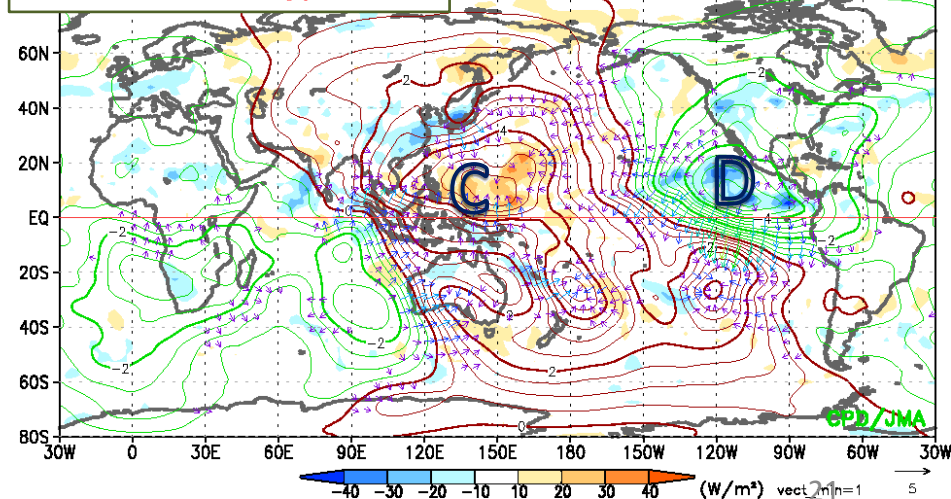
Observed OLR



Response in χ_{200}



Observed χ_{200}

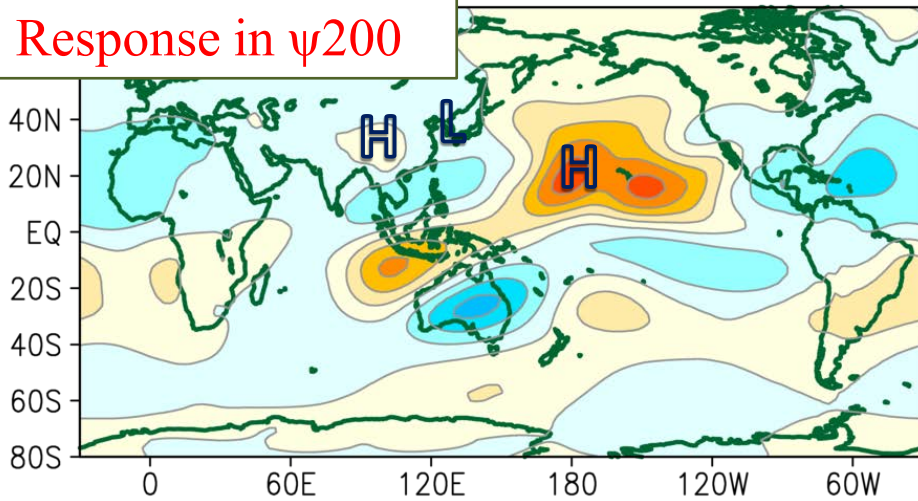


Attribution experiment using Linear Baroclinic Model

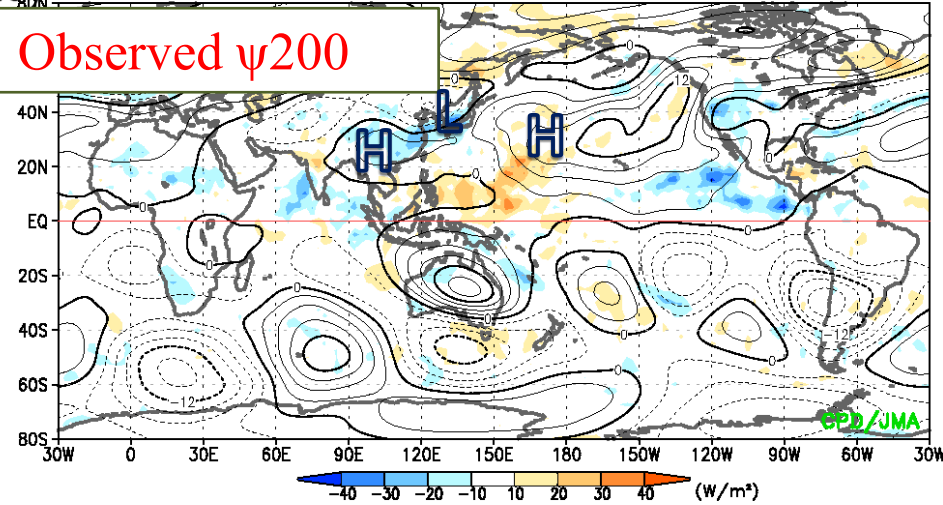
Heat anomalies in tropics also give rise to circulation patterns in good agreement with observation

g.2014

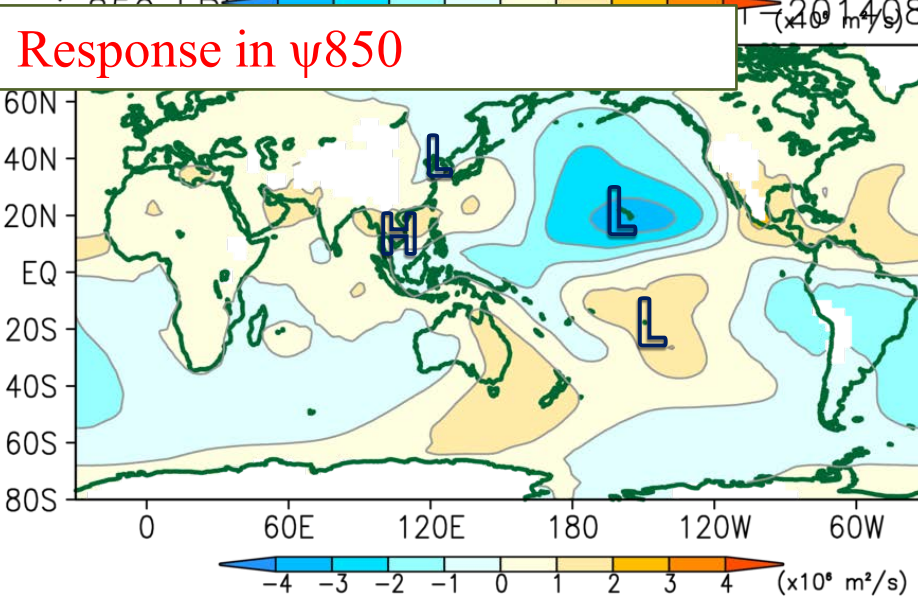
Response in ψ_{200}



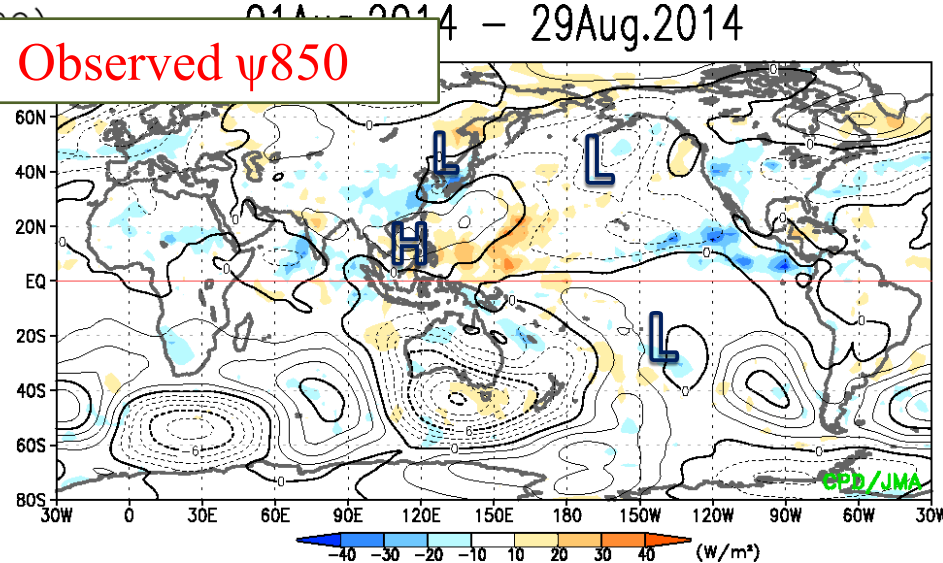
Observed ψ_{200}



Response in ψ_{850}



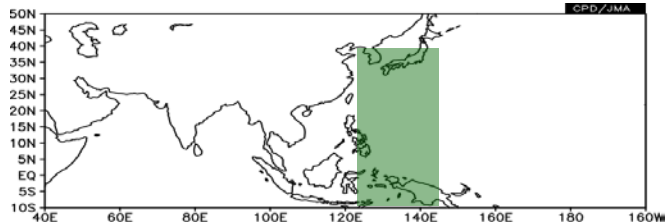
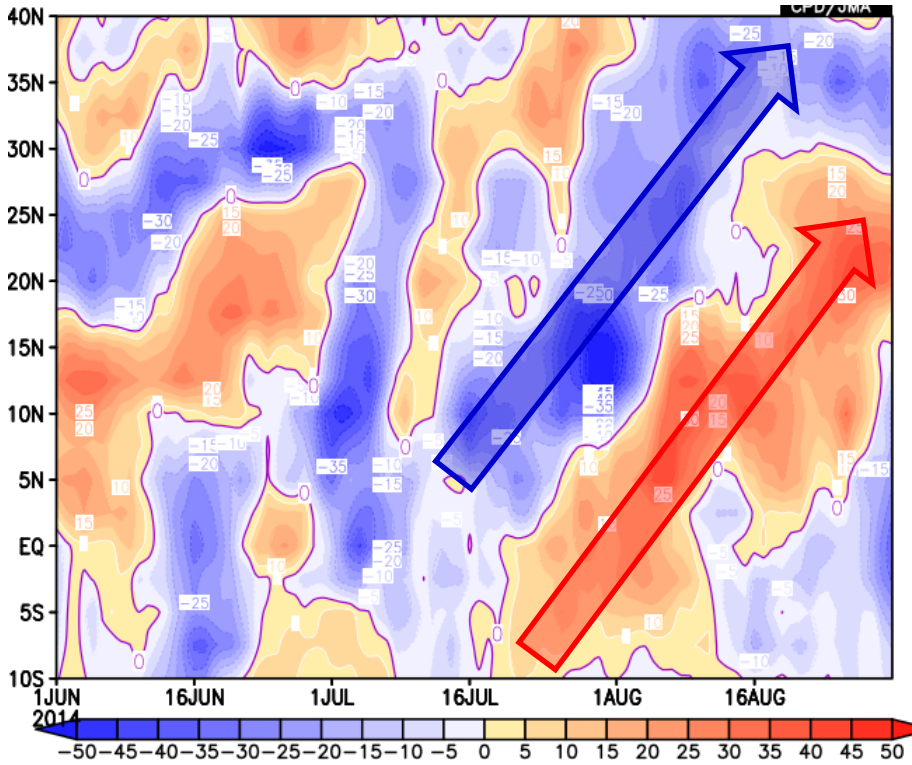
Observed ψ_{850}



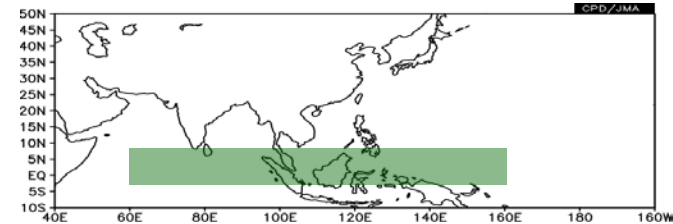
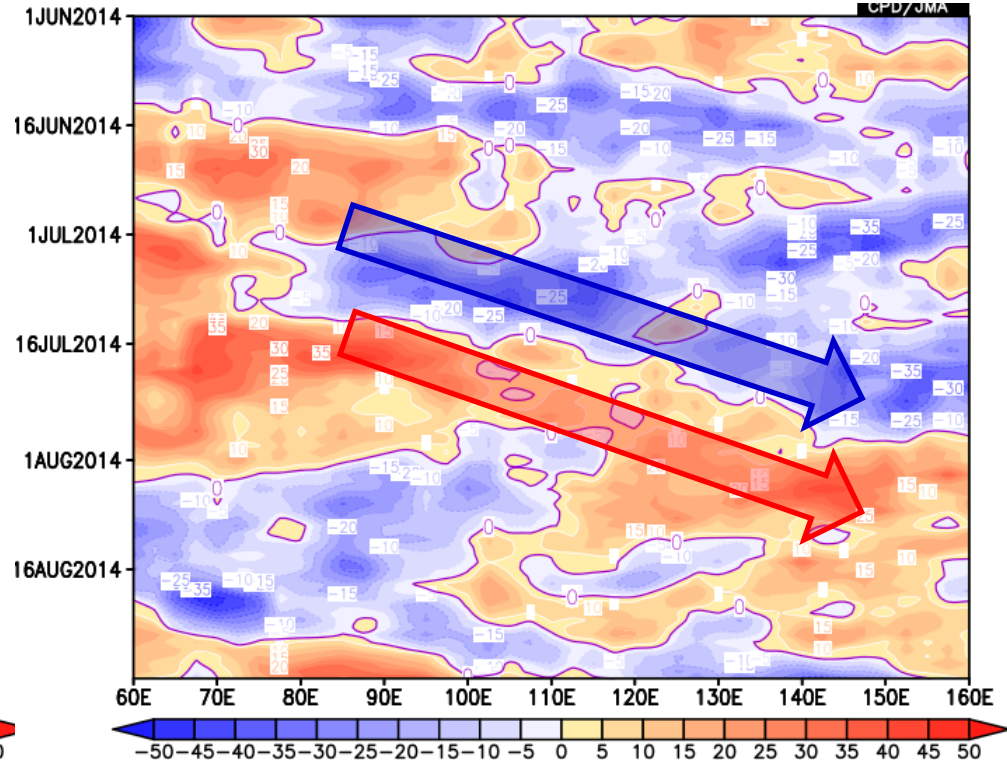
Phase propagation associated with intra-seasonal oscillation

Suppressed convection around the Philippine was associated also with an inactive phase of tropical intra-seasonal oscillation which propagated northward/eastward and coincidentally reached the region around the Philippines.

Time-Latitude OLR anomalies (7-day running mean) for June to September averaged over 125E-145E



Longitude-Time OLR anomalies (7-day running mean) for June to September averaged over 5S-10N



Summary

During the summer monsoon season in 2014,

- Precipitation amounts were above normal in northern and western Japan and southern China, while below normal in northeastern China and parts of Mongolia.
- Warm SST anomalies extended in western and eastern equatorial Pacific and eastern Indian Ocean.
- The subtropical jet stream in east Asia was stronger than normal and tended to flow south of its normal position.
- Early August, pronounced decline in convective activity was observed around the Philippines, in relation to tropical intra-seasonal oscillation.
- In August, western Japan experienced record-breaking heavy rainfall. The southward meandering of the jet stream and the suppressed convection around the Philippines, adding to two typhoons, were related to the extremely wet conditions.