# The ongoing El Niño event and its impact over East Asia in August 2015

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- Overview of East Asia in August 2015
- Factors contributing to anomalous condition, especially seen in mid to last August
  - Southward shift of the jet stream associated with suppressed convective activity over Asian monsoon region
  - Pronounced meandering of the jet stream to the west of Japan
  - Stagnation of a front and sustained the southwesterly moist air flow to the front
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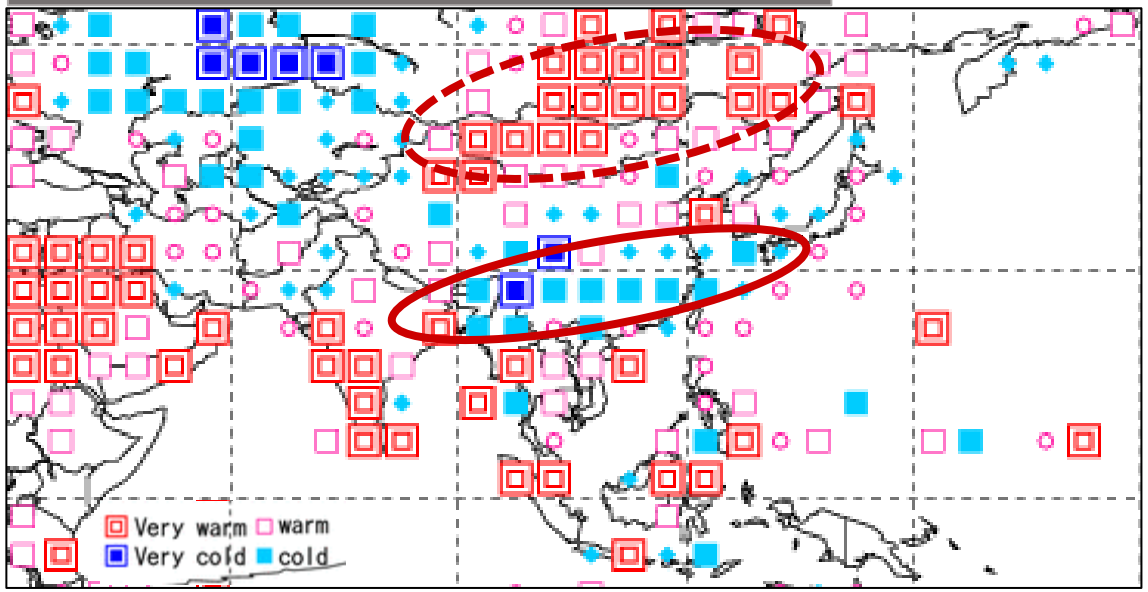
- Attribution experiment by Linear Baroclinic Model
- Conclusion - schematic figure -

# Overview in August 2015

| | |
|---|---|
| **Warmer than normal** | southeastern Russia and Mongolia, southwestern India |
| **Colder than normal** | southern China to Western Japan |

| | |
|---|---|
| **Wetter than normal** | southeastern China to the pacific side of Western Japan |
| **Dryer than normal** | Mongolia, northern China to the Korean peninsula |

Surface Temperature Anomalies




Precipitation Ratio against normal

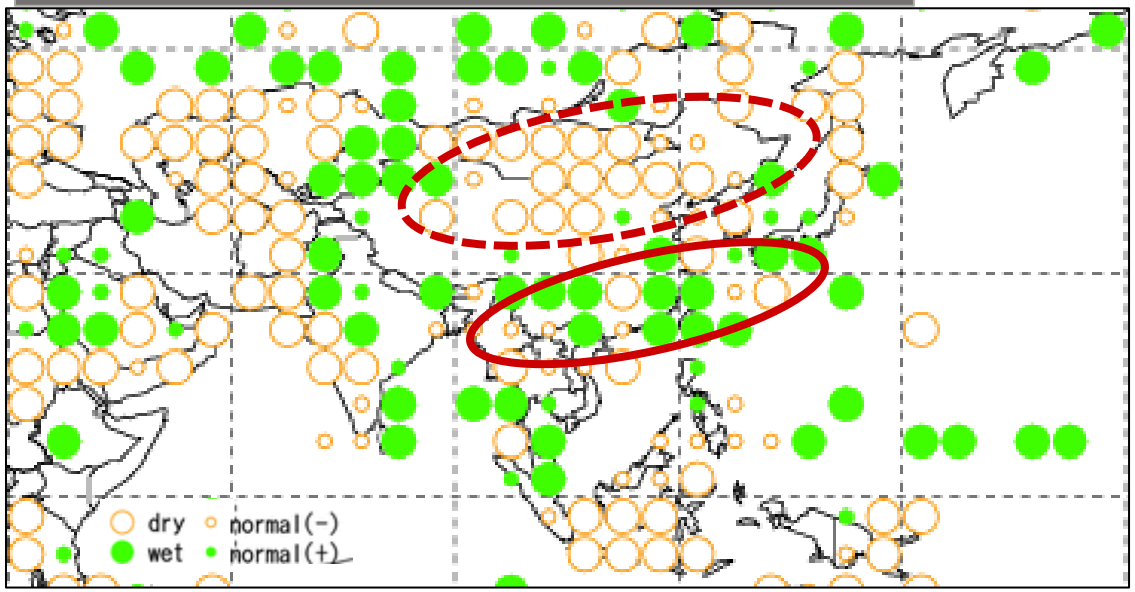



**Fig.1 Normalized monthly mean temperature anomalies and precipitation ratios against normal, both averaged in 5°x5° grid boxes for August 2015**

† Data based on CLIMAT Report

# Characteristics of the Atmospheric Circulation for August 2015

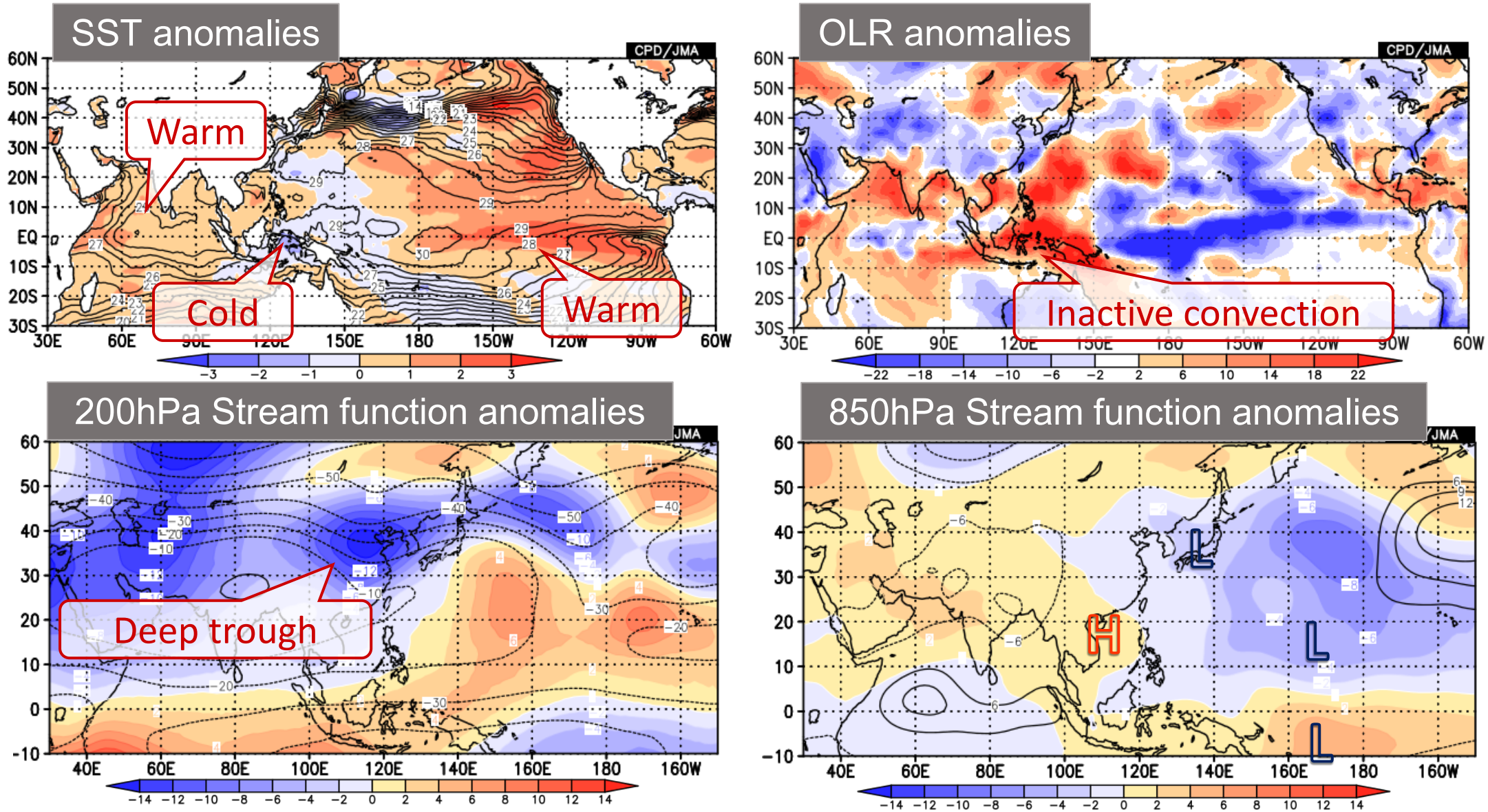



**Fig.2 Oceanic conditions, convective activities and atmospheric circulations for August 2015**

† Data used for this investigation is JRA-55, OLR( provided by NOAA) and COBE-SST.

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# Time series of convective activity of Asian monsoon and the jet stream

○In mid to late August, the convective activities were inactive in and around the whole Asian monsoon region.
○In association with inactive convection, a subtropical Jetstream was shifted southward over East Asia.

SAMOI-A(Monsoon Activity)

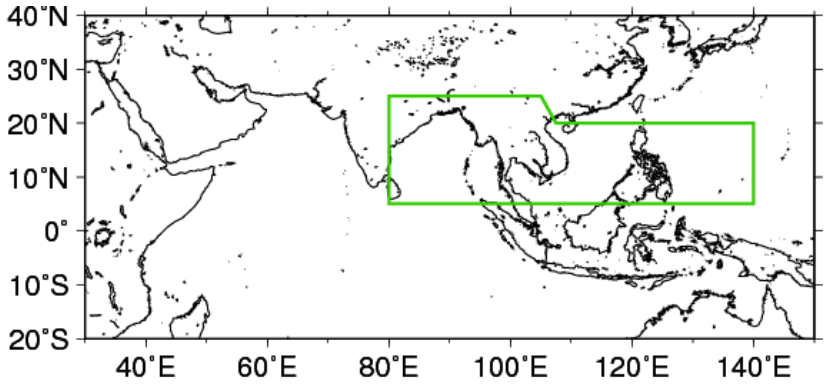
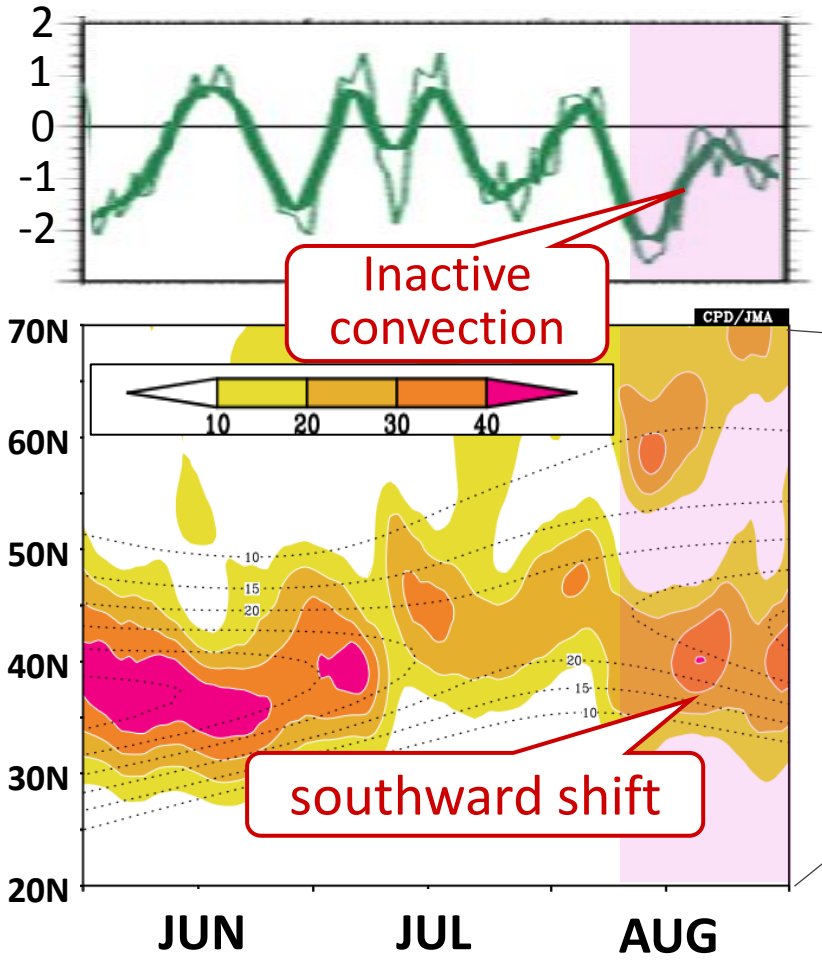



Fig.3 Time series of SAMOI-A index




**11th - 31st August**

200 hPa zonal wind (5day running mean)

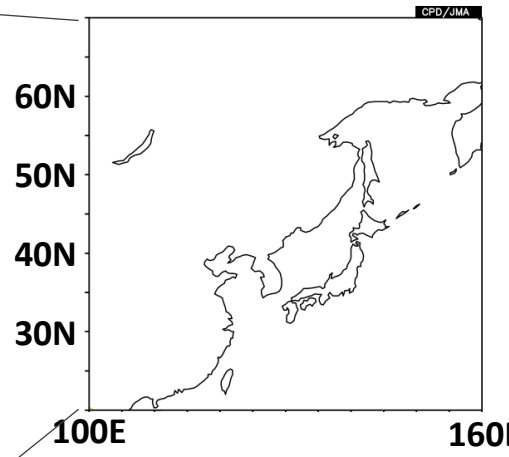



Fig.4 Time-latitude cross section of 200hPa zonal wind averaged in the longitude 100E – 160E

# Southward shift of the jet stream

○The jet stream shifted southward from southern China to Japanese islands.

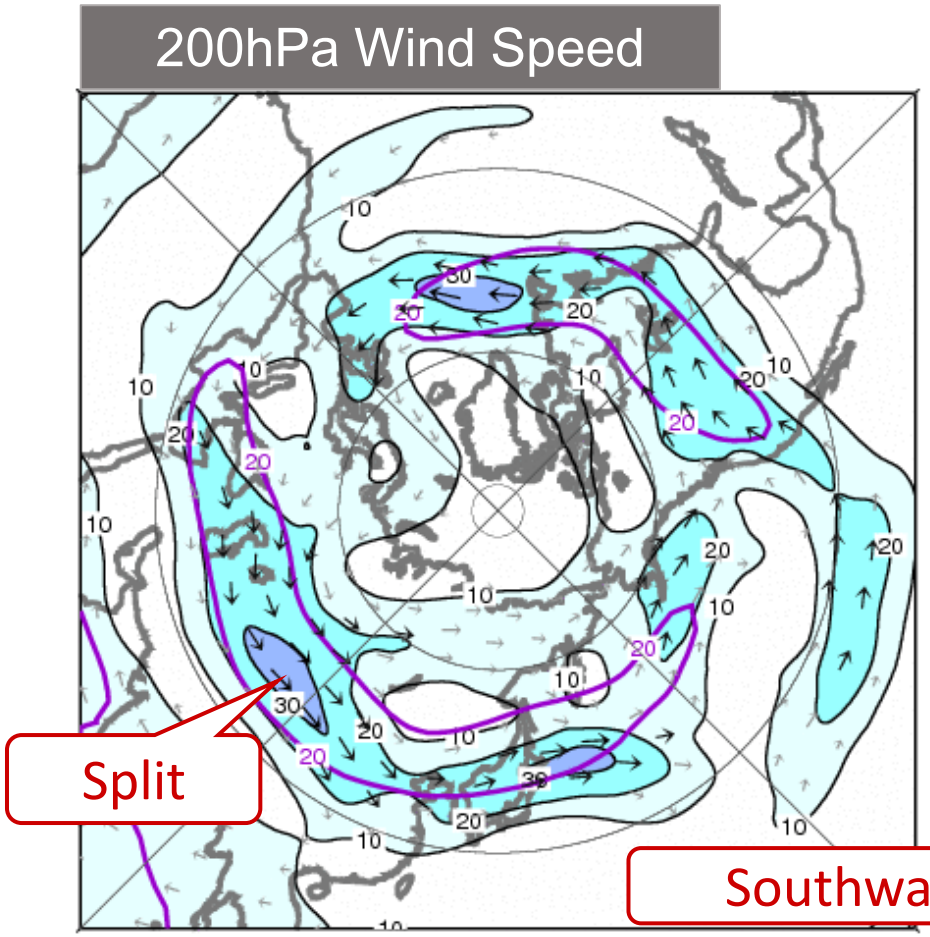



Fig.6 Monthly mean 200 hPa wind speed and vector in the Northern Hemisphere in August. The purple lines show its normal

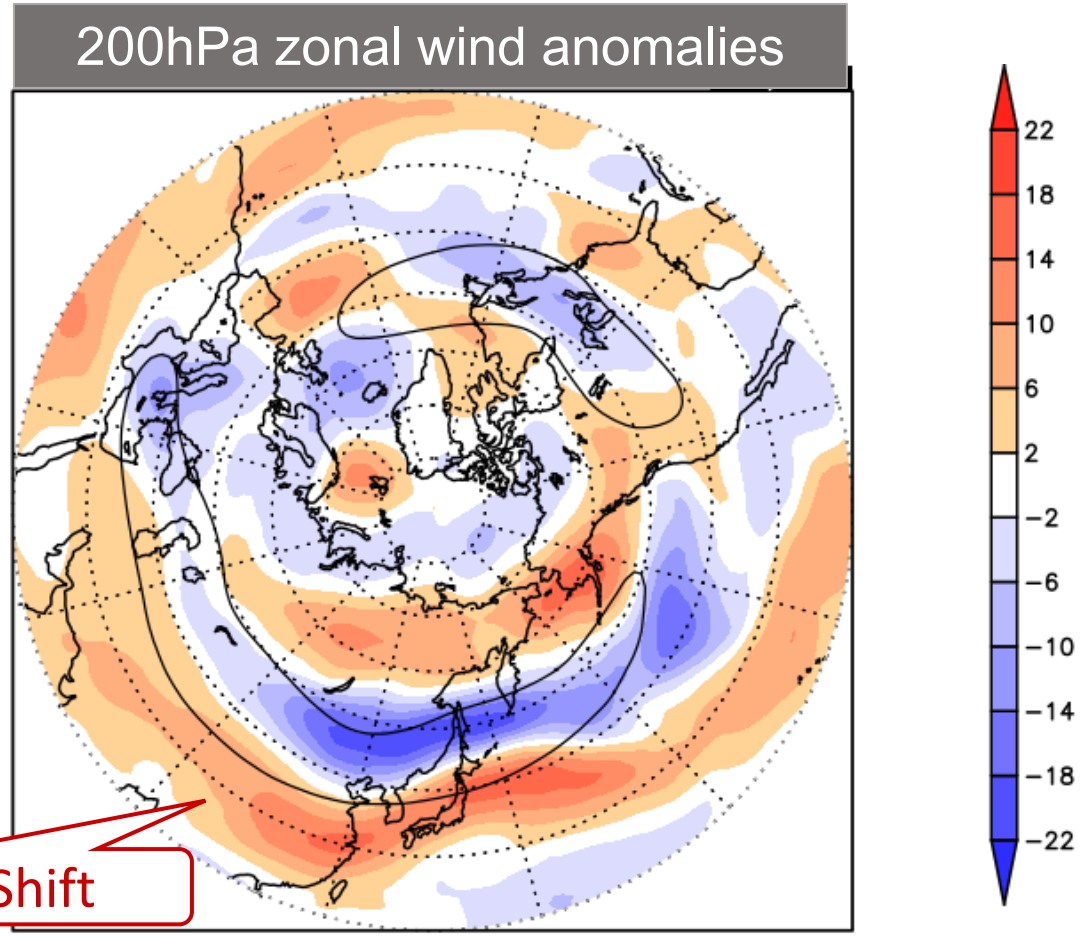



Fig.7 21days mean 200 hPa Zonal wind anomaly against normal in the Northern Hemisphere for 11th - 31st August

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# Wave train over northern Eurasia

○Pronounced wave train was seen over the area from the Atlantic to northern Eurasia.
○Blocking high over eastern Siberia and the deep trough to the west to Japan was observed.

500hPa geopotential height anomalies

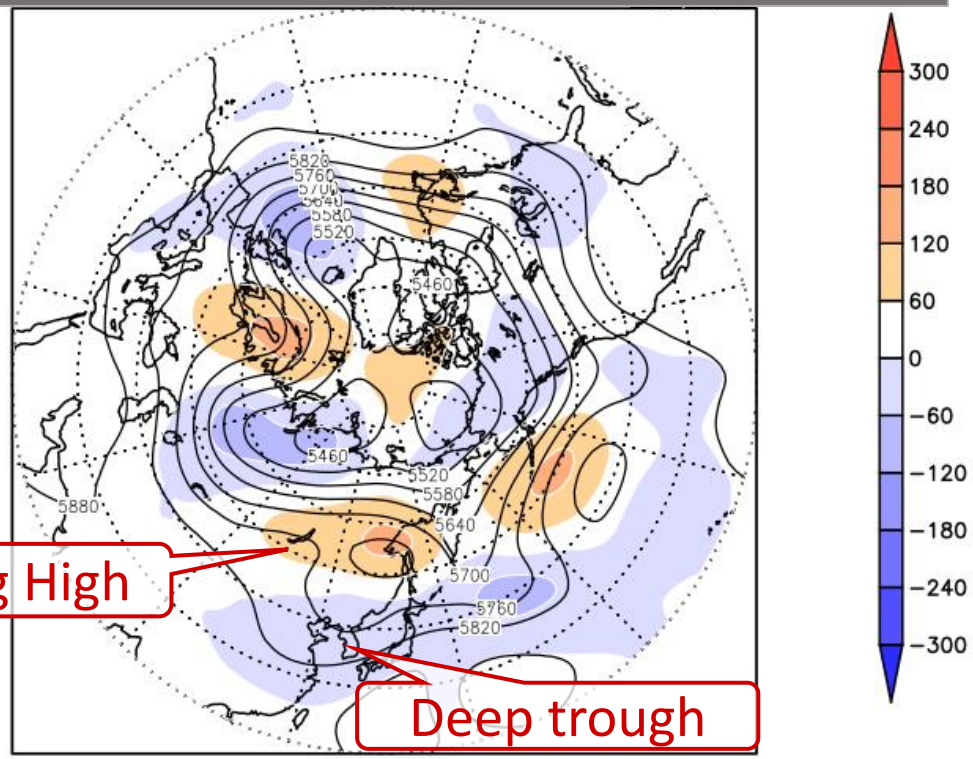


**Fig.8 21-days mean 500 hPa geopotential height anomalies(shade) and observation(contour) for 11th – 31st August 2015**

Ψ300 anomalies & WAF

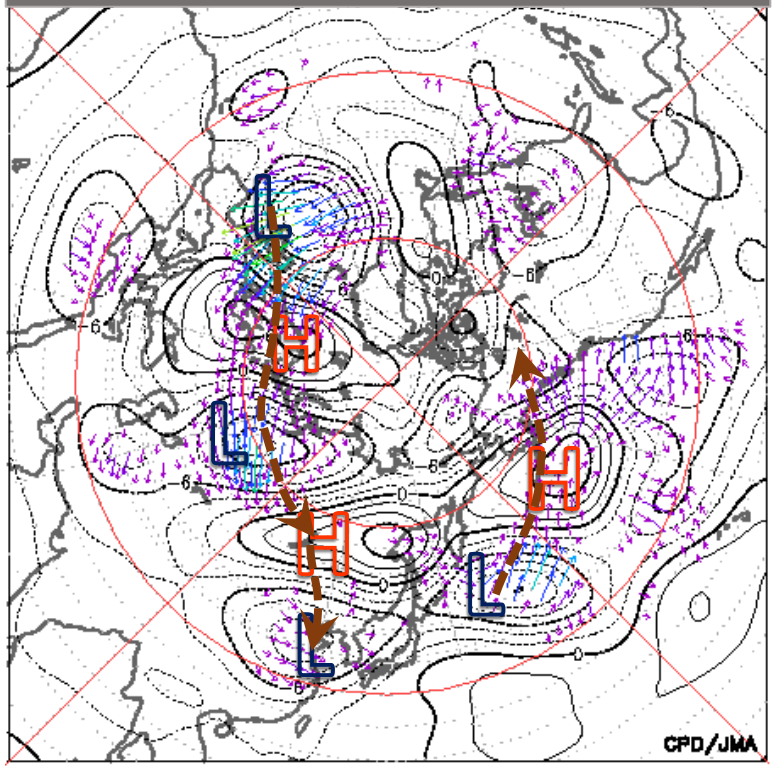


**Fig.9 21-days mean 300 hPa stream function (contour) and wave activity flux(vector) for 11th – 31st August 2015**

† The wave activiy flux was calculated with reference to the method of Takaya and Nakamura (2001)

# Feedback impact of disturbance

○The high-frequency disturbances contributed to increasing the amplitude of ridge and trough.

500hPa geopotential height anomalies

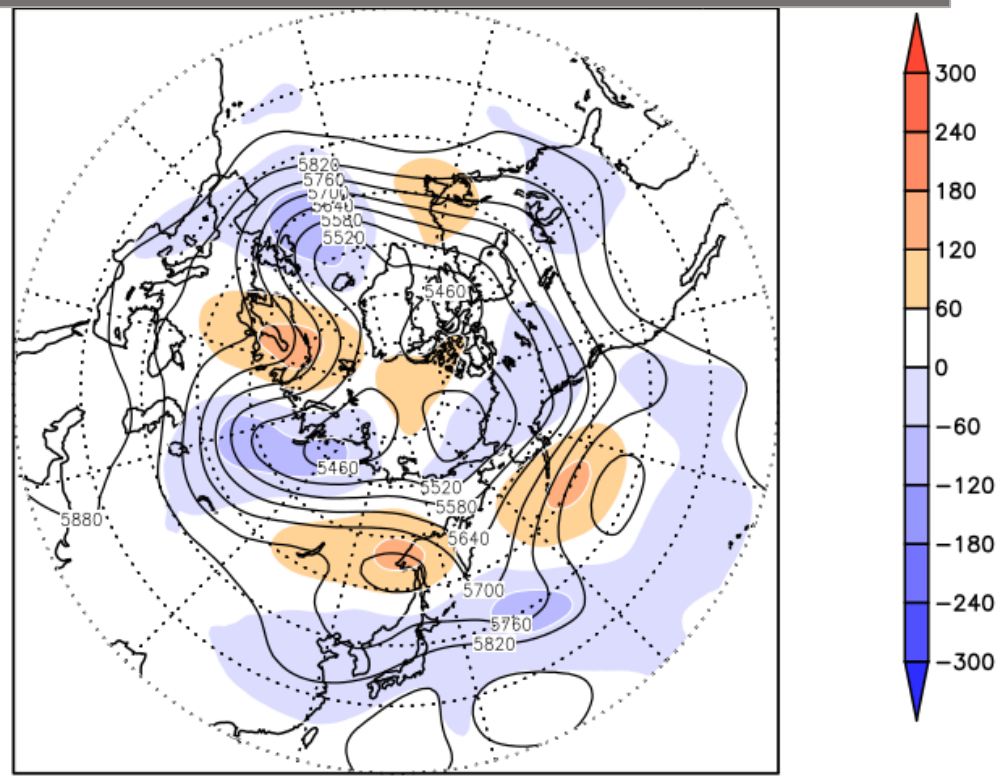


Fig.8 21-days mean 500 hPa geopotential height anomalies(shade) and observed(contour) for 11th – 31st August 2015

500hPa Eddy feedback by vorticity flux

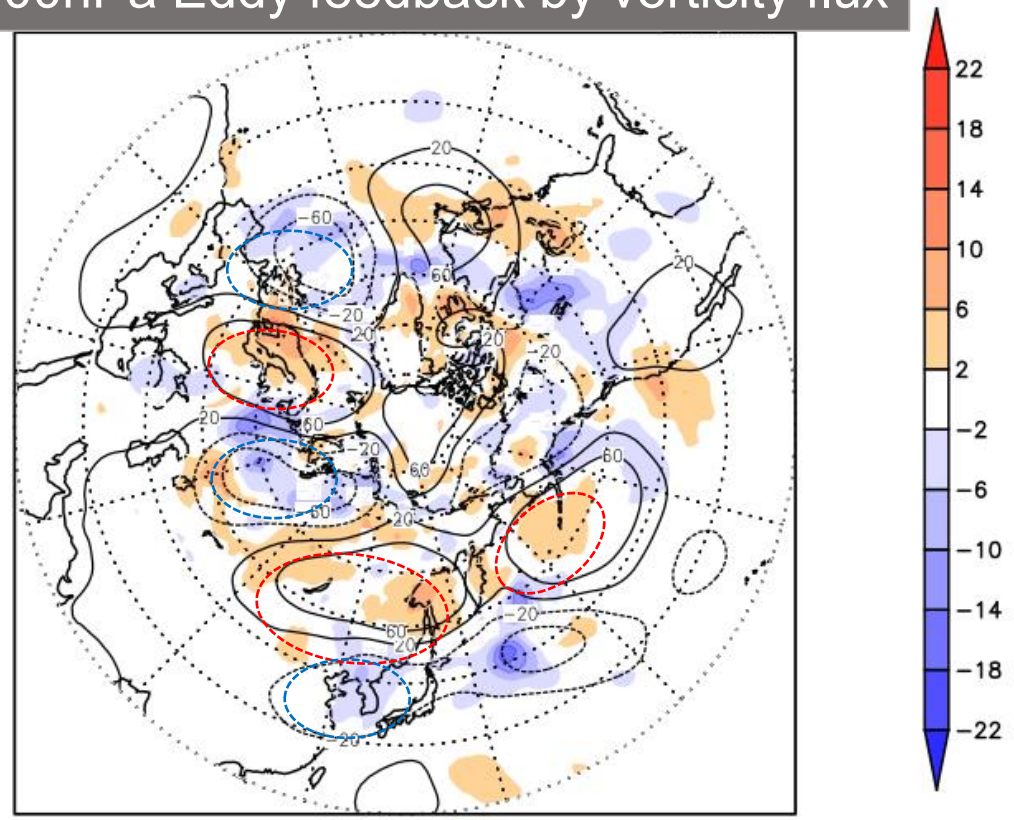


Fig.10 21-days mean 500 hPa height change rate by vorticity flux divergence(shade) and geopotential height anomalies(contour) for 11th – 31st August 2015

# A possible source of wave packet

○Wave packets propagated from the tropical central Pacific through the Atlantic and Europe to East Asia.
○Active convection over the central – eastern tropical Pacific may have partly contributed to the wave packet propagation.

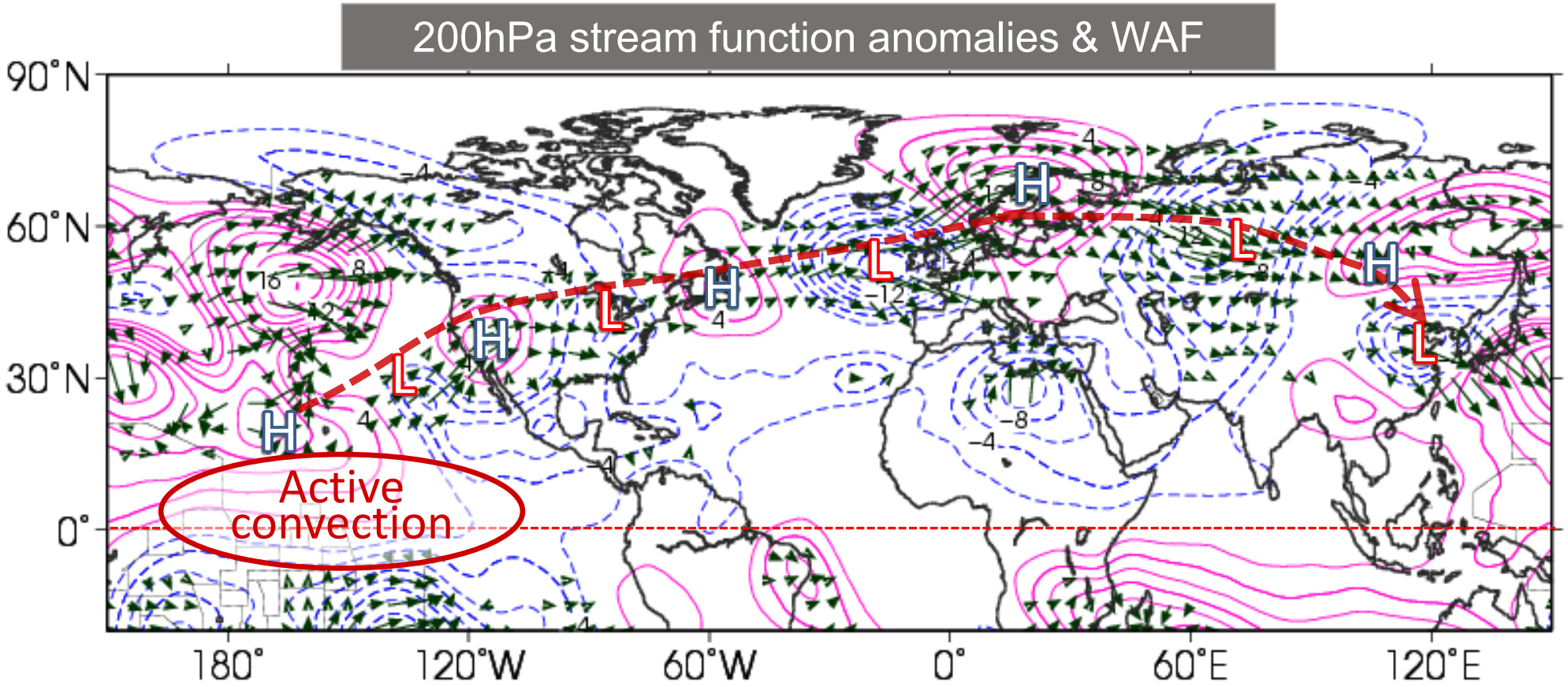


**Fig.11 21-days mean 200 hPa Stream Function (contour) and Wave Activity Flux(vector) for 11th – 31st August 2015**

# How was Rossby Wave Guide?

○The northern Wave Guide was clear over northern Eurasia.
○The Rossby Wave packets easy to propagate to East Asia.

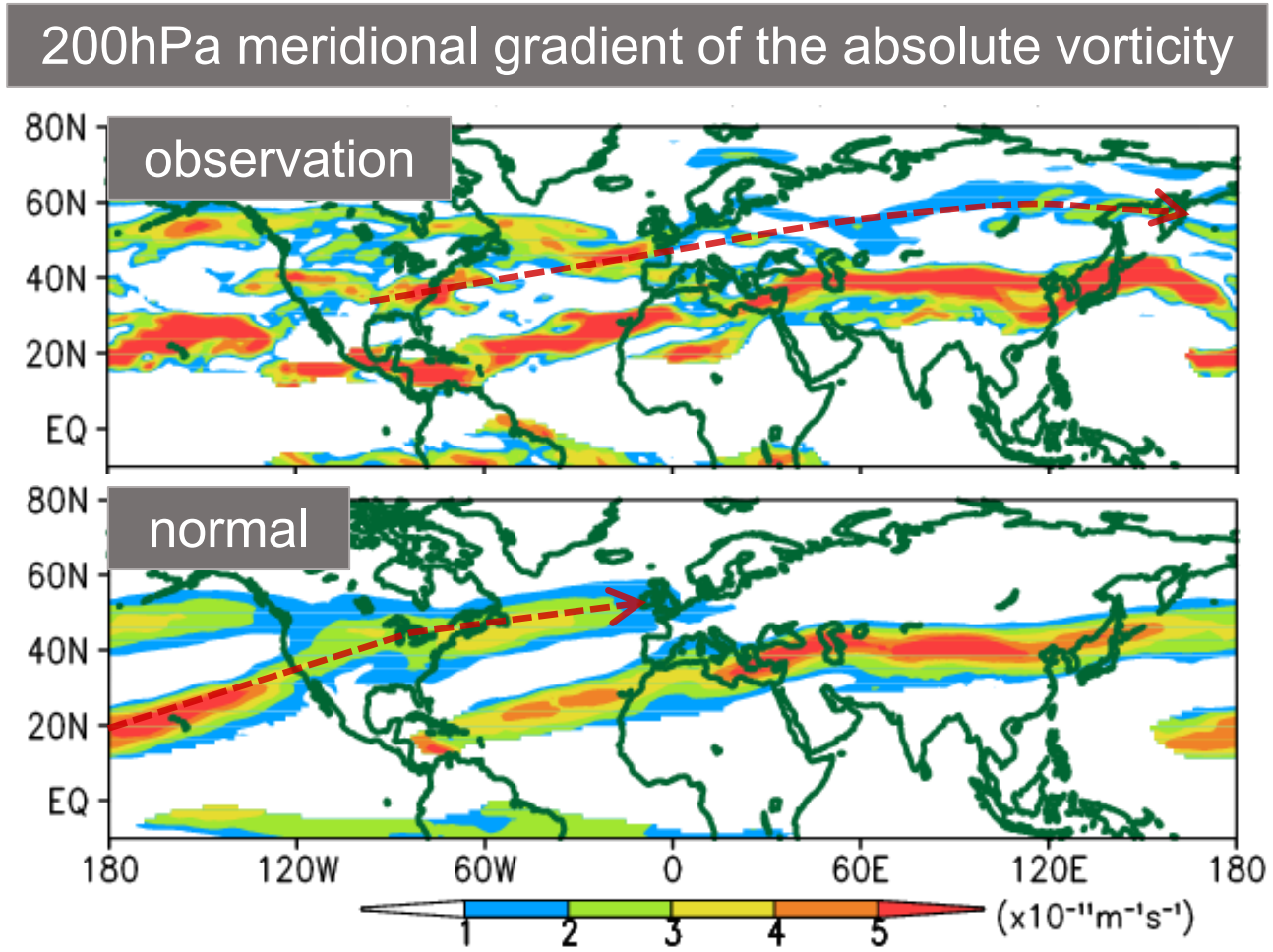


**Fig.12 21-days mean 200 hPa meridional gradient of the absolute vorticity for 11th – 31st August 2015**

† meridional gradient of the absolute vorticity was calculated with reference to the method of Hoskins and Ambrizzi（1993）

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# Water Vapor distribution of lower troposphere and Frontal zone

○Southwesterly warm moist air flow from the South China Sea and the East China Sea was dominant in relation to the subtropical high enhanced south of Japan.
○The frontal zone was located southeastern China to the western part of Japanese mainland.

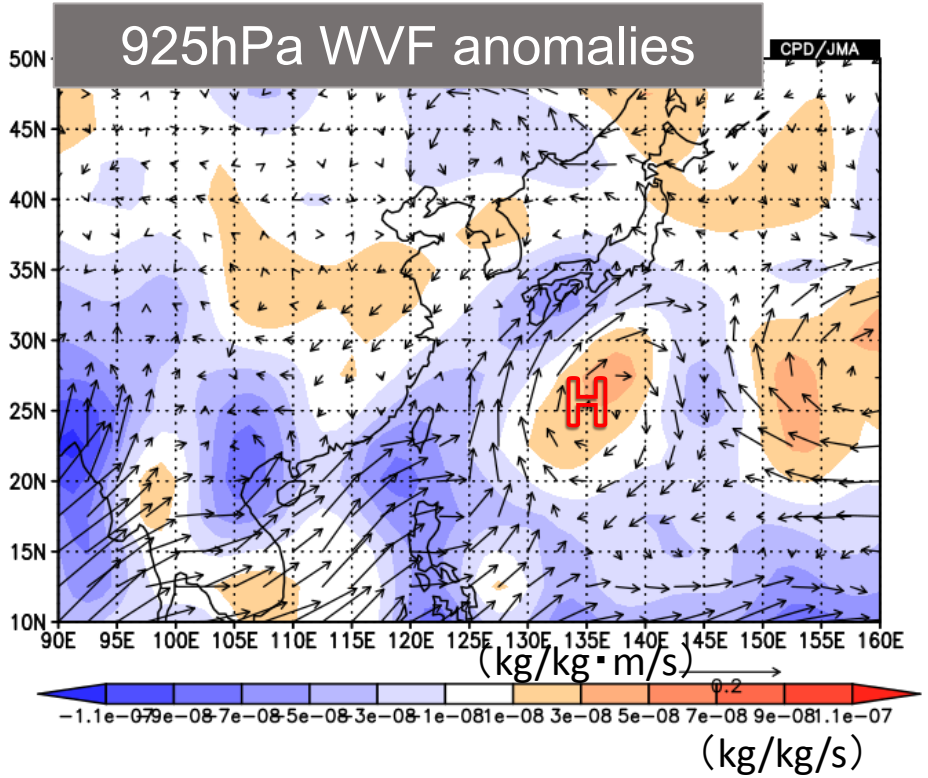


**Fig.13 21-days mean 925 hPa Water Vapor Flux anomalies(vector) and its divergence anomalies(shade) for 11th – 31st August 2015**

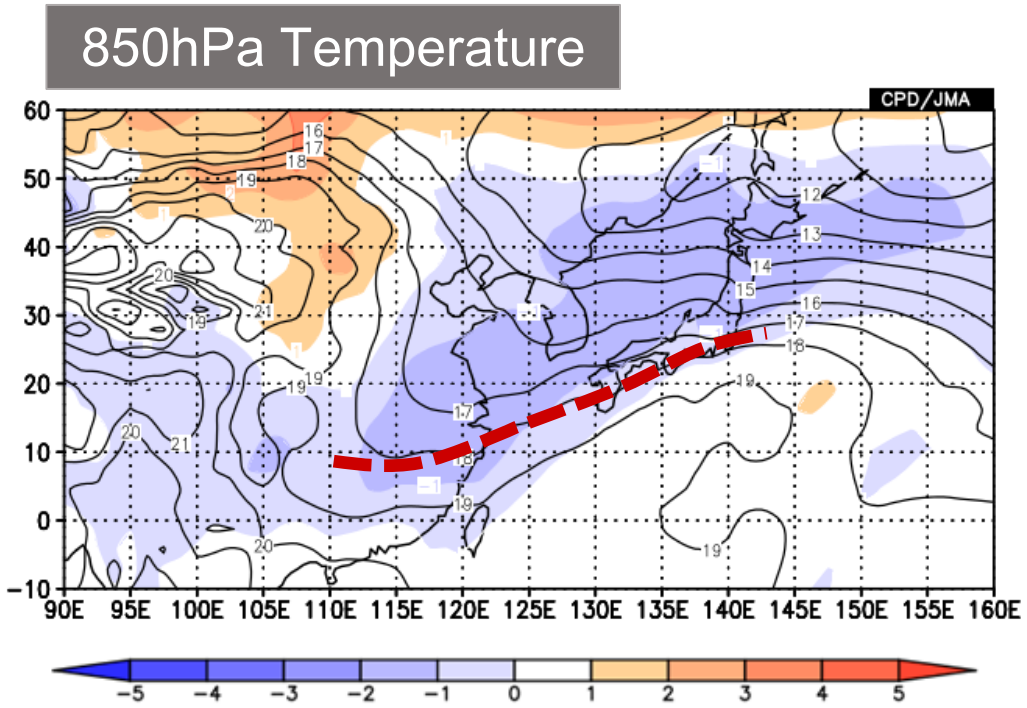


**Fig.14 21-days mean 850 hPa Temperature anomalies(shade) and observation(contour) for 11th – 31st August 2015**

# Transition of frontal zone

○The frontal zone located in 30N-35N over East Asia during mid-last August.
○The location of frontal zone is associated with that of jet stream.

200 hPa zonal wind
(5day running mean)

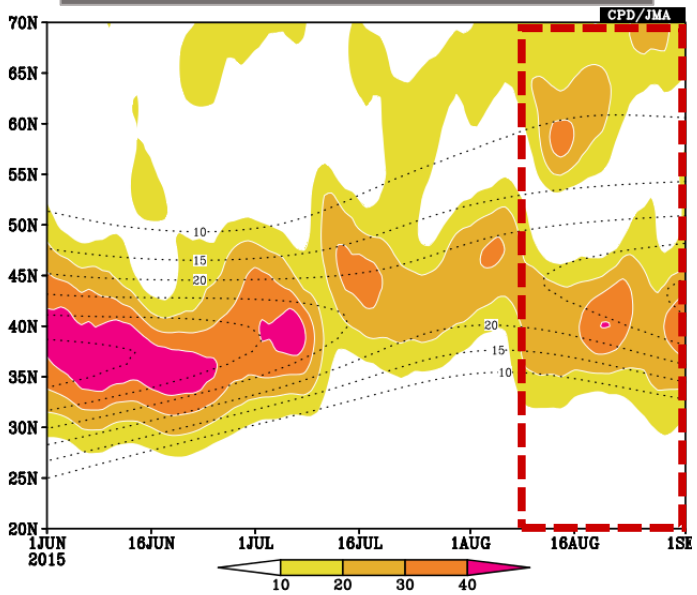


Fig.4 Time-latitude cross section of 200hPa zonal wind averaged in the longitude 100E – 160E

925hPa meridional gradient of EPT

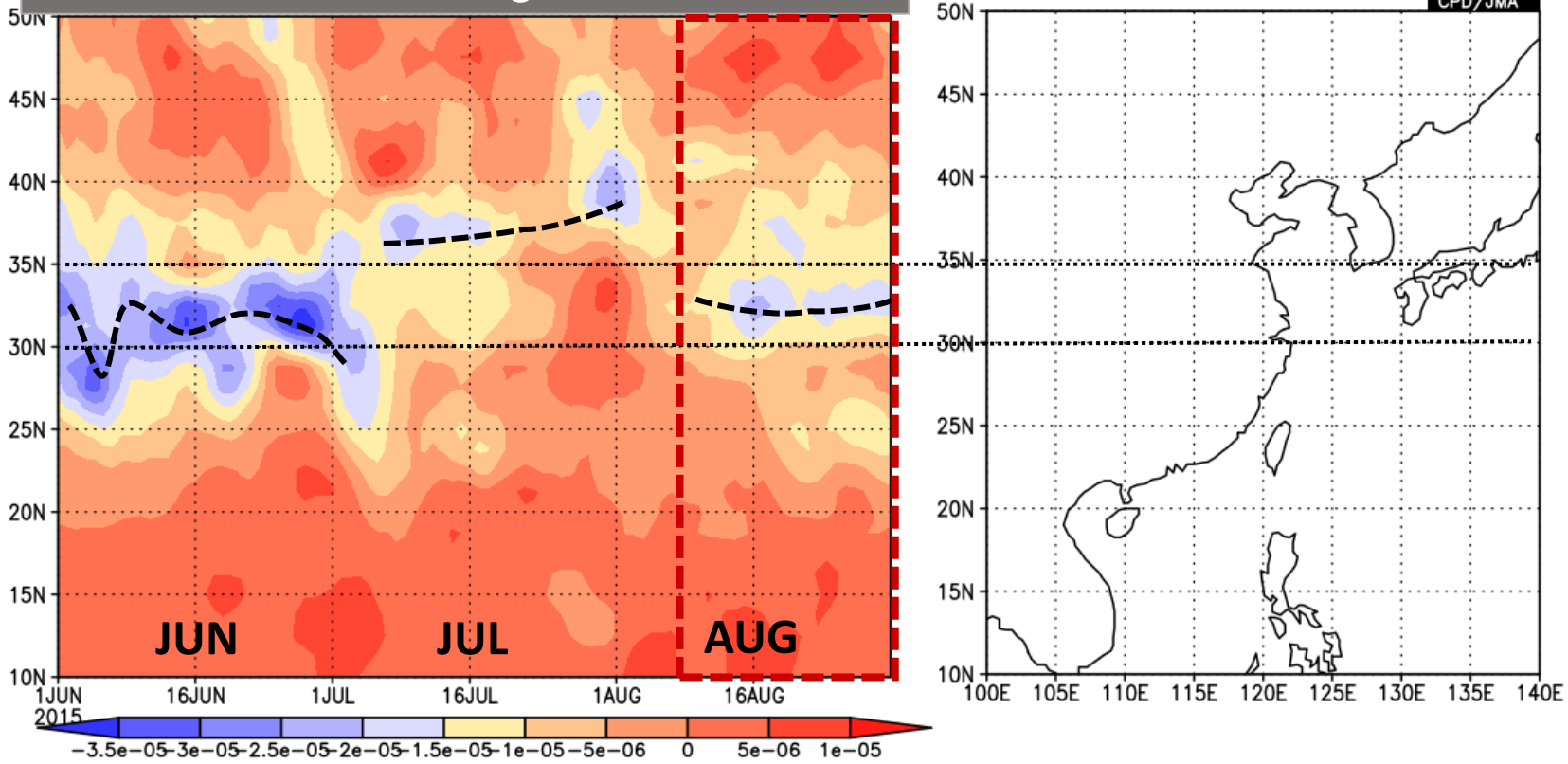


Fig.15 925 hPa time-latitude cross-section of meridional gradient of Equivalent Potential Temperature (5days-running mean) averaged 100E-140E

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# Comparison with pattern of the past El Niño events in August

○The SST patterns of tropical ocean in August 2015 were similar to the El Niño composite patterns.
○The convergence/divergence pattern in August 2015 were also similar to the El Niño composite patterns.

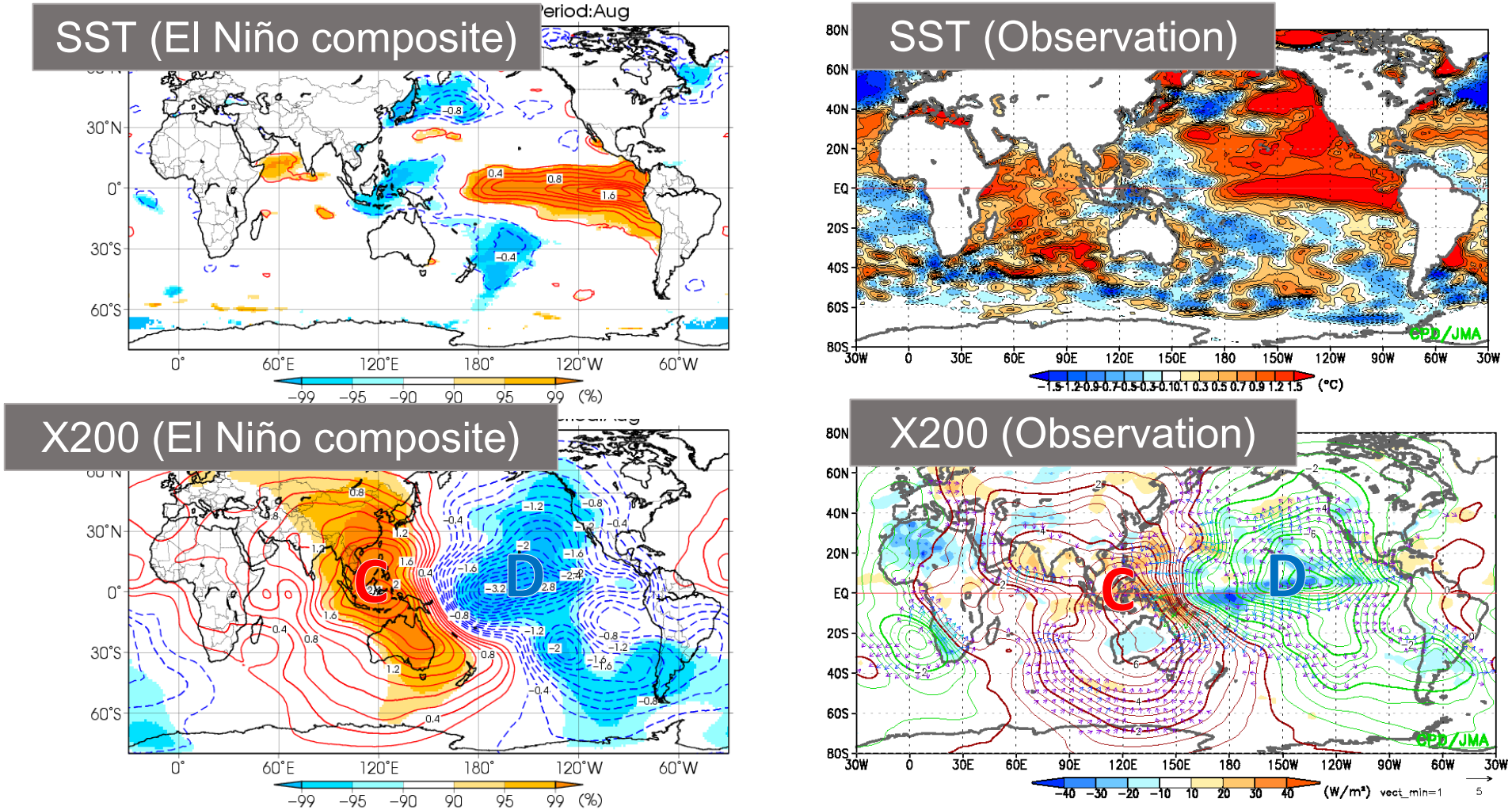
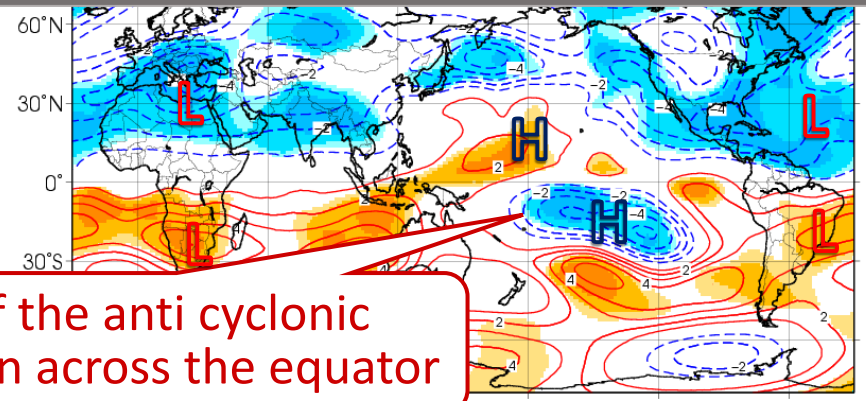



**Fig.16 SST anomalies (upper left) and observed SST anomalies (upper right) and χ200 anomalies (bottom left) of El Niño composite and χ200 anomalies (bottom right) in August.**

# Comparison with pattern of the past El Niño events in August

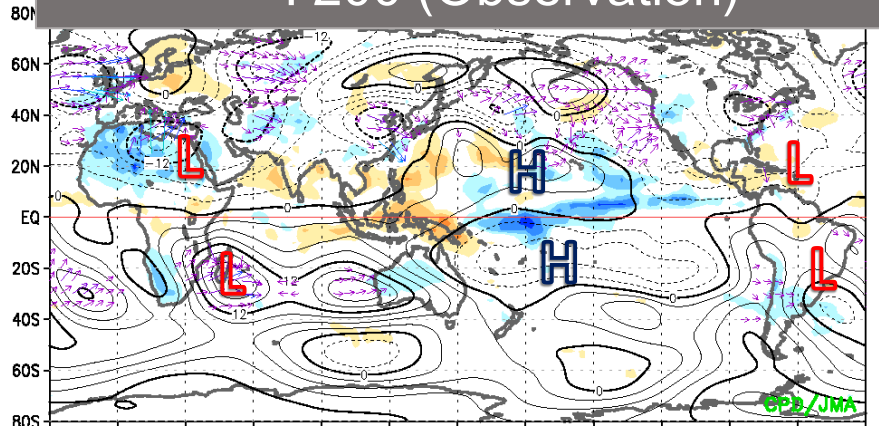
○The circulation pattern in August 2015 were similar to El Niño composite patterns.
○There are Tri-pole pattern and the pair of circulation straddling the equator.

Ψ200 (El Niño composite)

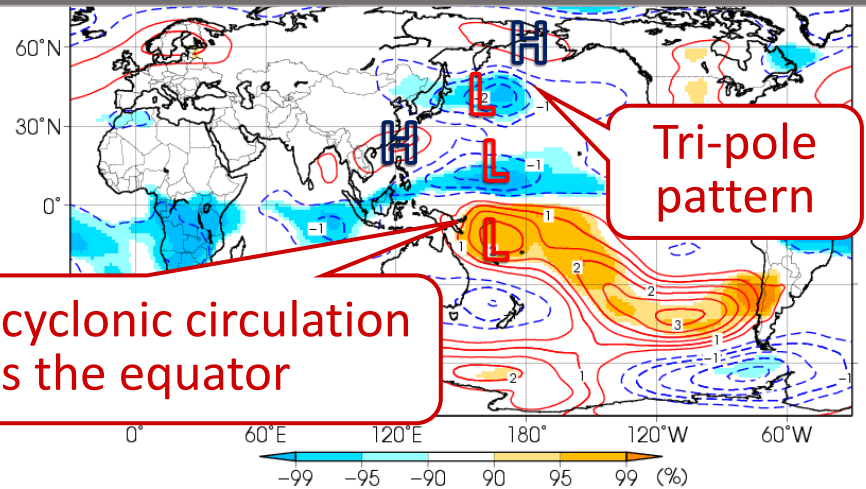



Pair of the anti cyclonic circulation across the equator

Ψ200 (Observation)




Ψ850 (El Niño composite)




Tri-pole pattern

Pair of the cyclonic circulation across the equator

Ψ850 (Observation)

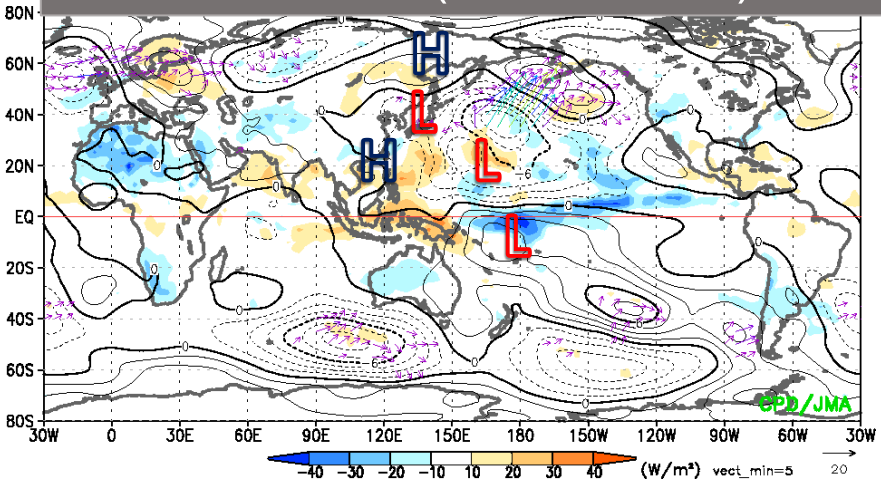



**Fig.17 Ψ200 anomalies(upper left) and observed Ψ200 anomalies (upper right) and Ψ850 anomalies (bottom left) of El Niño composite and observed Ψ850 anomalies (bottom right) in August.**

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# Attribution experiment by Linear Baroclinic Model (LBM)

○The convergence/divergence pattern in August 2015 were similar to the LBM response pattern.

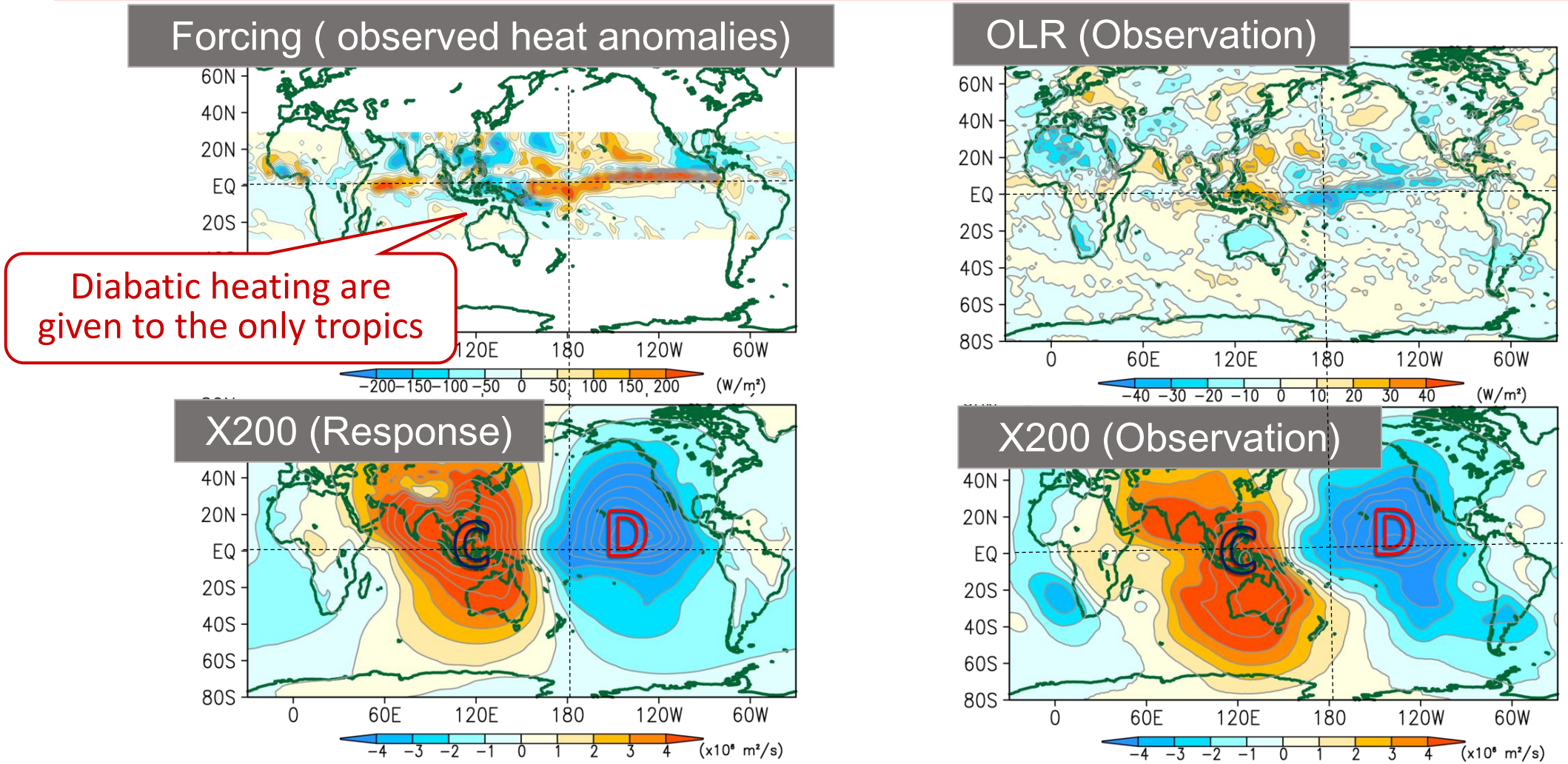



**Fig.18 The given heat anomalies(upper left) and observed OLR anomalies (upper right) and the response in X200 anomalies (bottom left) and observed X200 anomalies (bottom right) in August.**

† The LBM experiment was conducted with reference to the method of Watanabe and Kimoto（2000）

# Attribution experiment by Linear Baroclinic Model (LBM)

○The circulation pattern in August 2015 were similar to the LBM response patterns.

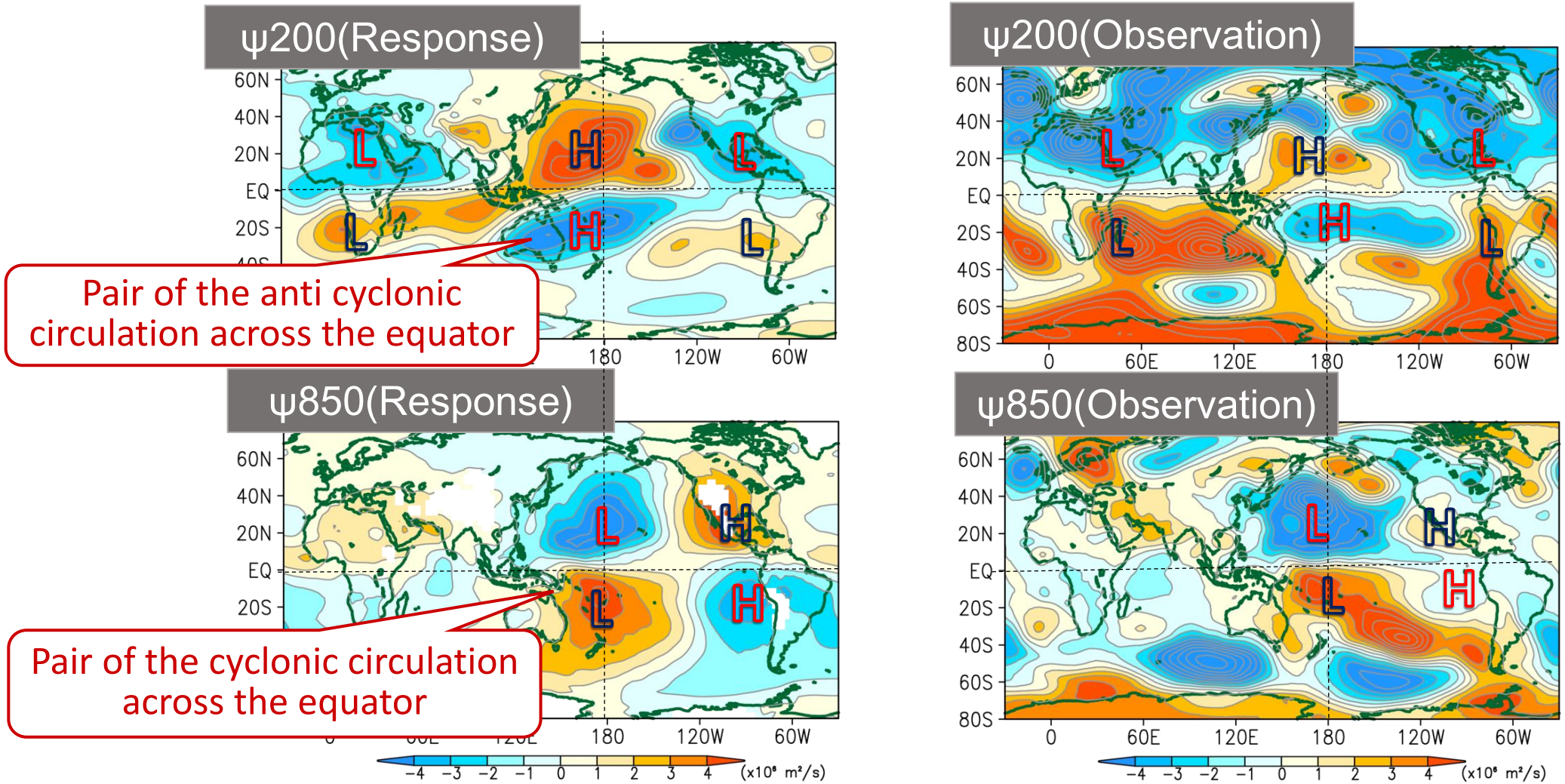
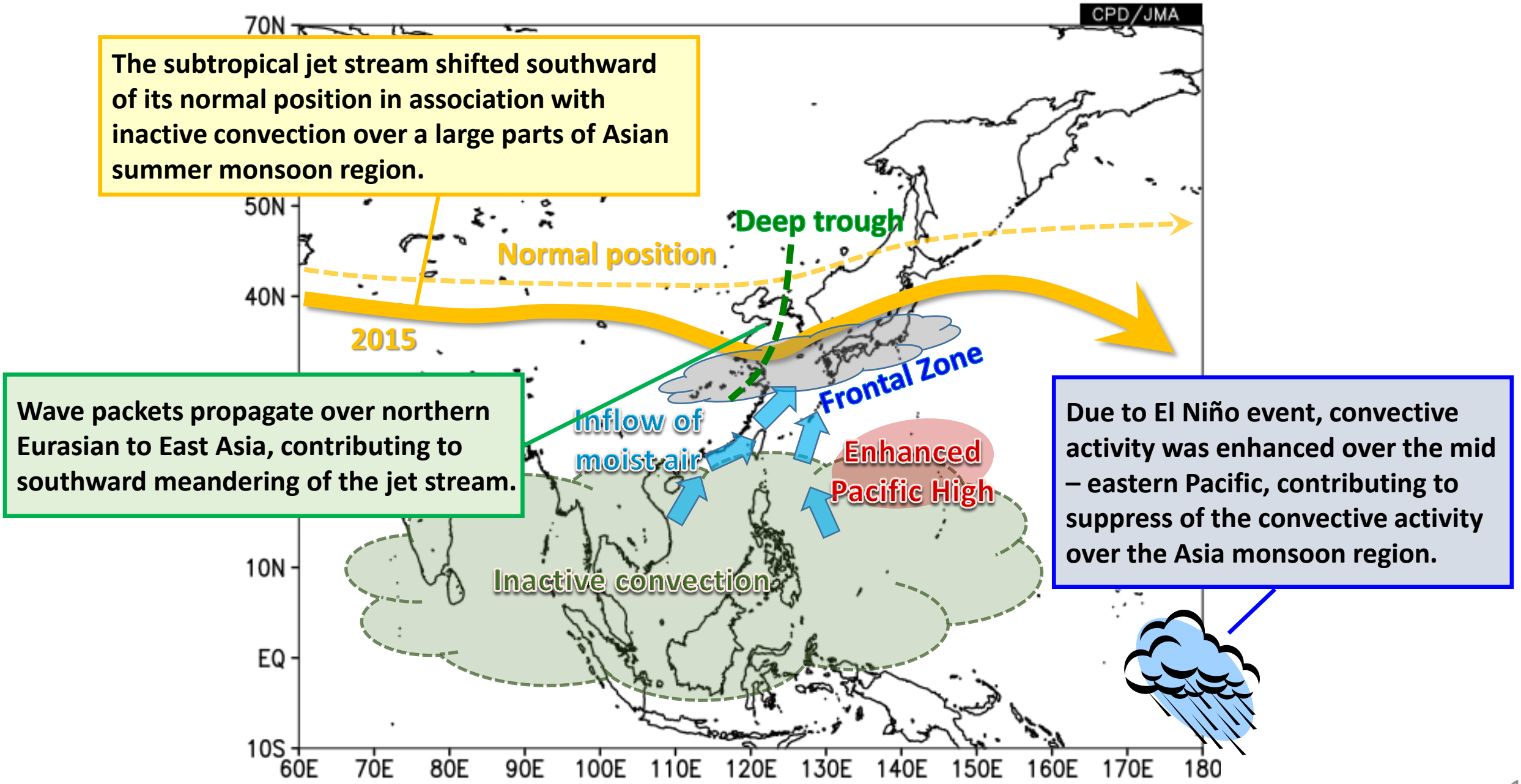



**Fig.18 The response in Ψ200 anomalies(upper left) and observed Ψ200 anomalies (upper right) and the response in Ψ850 anomalies (bottom left) and observed Ψ850 anomalies (bottom right) in August.**

† The responses of LBM were removed zonal mean stream function.

# Conclusion - schematic figure -



# Thank you for your attention…