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

Motohiro TANAKA
Tokyo Climate Center
Japan Meteorological Agency
Contents

- 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
- Comparison with patterns of the past El Niño events in August
- Attribution experiment by Linear Baroclinic Model
- Conclusion - schematic figure -
Overview in August 2015

<table>
<thead>
<tr>
<th>Condition</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer than normal</td>
<td>southeastern Russia and Mongolia, southwestern India</td>
</tr>
<tr>
<td>Colder than normal</td>
<td>southern China to Western Japan</td>
</tr>
<tr>
<td>Wetter than normal</td>
<td>southeastern China to the pacific side of Western Japan</td>
</tr>
<tr>
<td>Dryer than normal</td>
<td>Mongolia, northern China to the Korean peninsula</td>
</tr>
</tbody>
</table>

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.
Contents

- 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
- Comparison with patterns of the past El Niño events in August
- Attribution experiment by Linear Baroclinic Model
- Conclusion - schematic figure -
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

Inactive convection

southward shift

JUN JUL AUG
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** 21 days mean 200 hPa zonal wind anomaly against normal in the Northern Hemisphere for 11th - 31st August.
Contents

- 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
- Comparison with patterns of the past El Niño events in August
- Attribution experiment by Linear Baroclinic Model
- Conclusion - schematic figure -
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.

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

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

† The wave activity flux was calculated with reference to the method of Takaya and Nakamura (2001)
The high-frequency disturbances contributed to increasing the amplitude of ridge and trough.

**500hPa geopotential height anomalies**

**500hPa Eddy feedback by vorticity flux**

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

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)
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

Comparison with patterns of the past El Niño events in August

Attribution experiment by Linear Baroclinic Model

Conclusion - schematic figure -
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.

925hPa WVF anomalies

850hPa Temperature

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
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.

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

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

- 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
- Comparison with patterns of the past El Niño events in August
- Attribution experiment by Linear Baroclinic Model
- Conclusion - schematic figure -
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 $\chi_{200}$ anomalies (bottom left) of El Niño composite and $\chi_{200}$ 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.

Fig.17 $\Psi_{200}$ anomalies (upper left) and observed $\Psi_{200}$ anomalies (upper right) and $\Psi_{850}$ anomalies (bottom left) of El Niño composite and observed $\Psi_{850}$ anomalies (bottom right) in August.
Contents

- 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
- Comparison with patterns of the past El Niño events in August
- Attribution experiment by Linear Baroclinic Model
- Conclusion - schematic figure -
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)
The circulation pattern in August 2015 were similar to the LBM response patterns.

Fig. 18 The response in $\psi_{200}$ anomalies (upper left) and observed $\psi_{200}$ anomalies (upper right) and the response in $\psi_{850}$ anomalies (bottom left) and observed $\psi_{850}$ anomalies (bottom right) in August. † The responses of LBM were removed zonal mean stream function.

Pair of the cyclonic circulation across the equator

Pair of the anti cyclonic circulation across the equator
Due to El Niño event, convective activity was enhanced over the mid - eastern Pacific, contributing to suppress of the convective activity over the Asia monsoon region.

The subtropical jet stream shifted southward of its normal position in association with inactive convection over a large parts of Asian summer monsoon region.

Wave packets propagate over northern Eurasian to East Asia, contributing to southward meandering of the jet stream.
Thank you for your attention...