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Japan Meteorological Agency

The 9th Session of East Asia winter Climate Outlook Forum (EASCOF-9)
4 November 2021, Seoul, Republic of Korea (Online)

Recent TCC operational activities

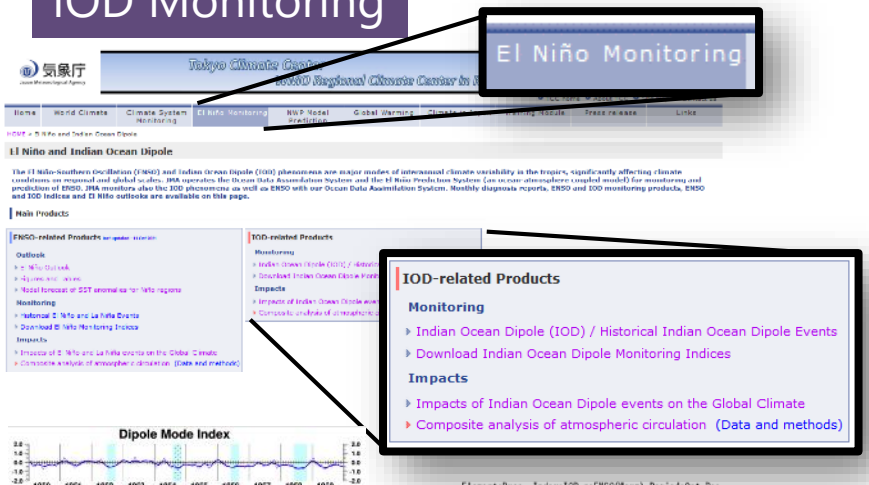
WAKAMATSU Shunya
Tokyo Climate Center, Japan Meteorological Agency

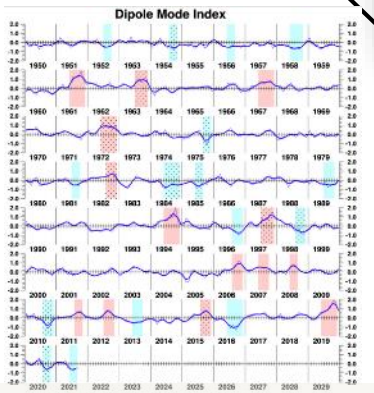
A brief overview of Recent TCC activities

Japan Meteorological Agency

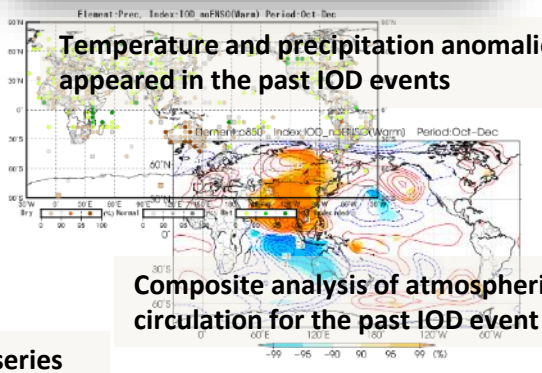
- The Tokyo Climate Center (TCC) provides a variety of climate-related products. Recent improvements are:
  - Launch of Indian Ocean Dipole (IOD) Monitoring website (28 January 2021)
  - Changing the normal period to 1991 – 2020 (19 May 2021)

IOD Monitoring





Dipole Mode Index (DMI) time series



Temperature and precipitation anomalies appeared in the past IOD events

Composite analysis of atmospheric circulation for the past IOD event

New climate normals

From May 19 2021 onward, TCC products (other than those of WMC Tokyo for long-range forecasting) has been based on the 1991 – 2020 normal period.

In early 2022, WMC Tokyo GPV products for long-range forecasting will follow.

More detailed information is available in our TCC news:
https://ds.data.jma.go.jp/tcc/tcc/news/tccnews63.pdf
https://ds.data.jma.go.jp/tcc/tcc/news/tccnews65.pdf

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The 9th Session of East Asia winter Climate Outlook Forum (EASCOF-9)
4 November 2021, Seoul, Republic of Korea (Online)

Climate characteristics and factors behind record-heavy rain in Japan in August 2021

SATO Hirotaka,
Tokyo Climate Center, Japan Meteorological Agency

Outline

I. Record-heavy rain in mid-August in Japan
   - Based on the discussion by the JMA Advisory Panel on Extreme Climate Events*
   - See also the TCC/JMA's press release about this event https://ds.data.jma.go.jp/tcc/tcc/news/press_20210924.pdf

II. Summary

III. The situation so far this autumn (if we have time)

*The JMA Advisory Panel on Extreme Climate Events, consisting of prominent experts on climate science from universities and research institutes, was established in June 2007 by JMA to investigate extreme climate events based on up-to-date information and findings. The current chair is Prof. Hisashi Nakamura from the University of Tokyo.

2021 Summer Monsoon in East Asia

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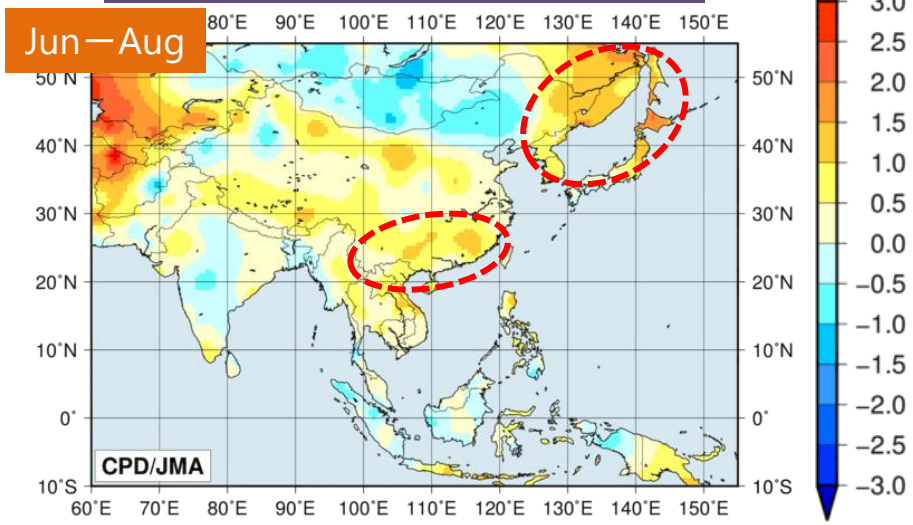
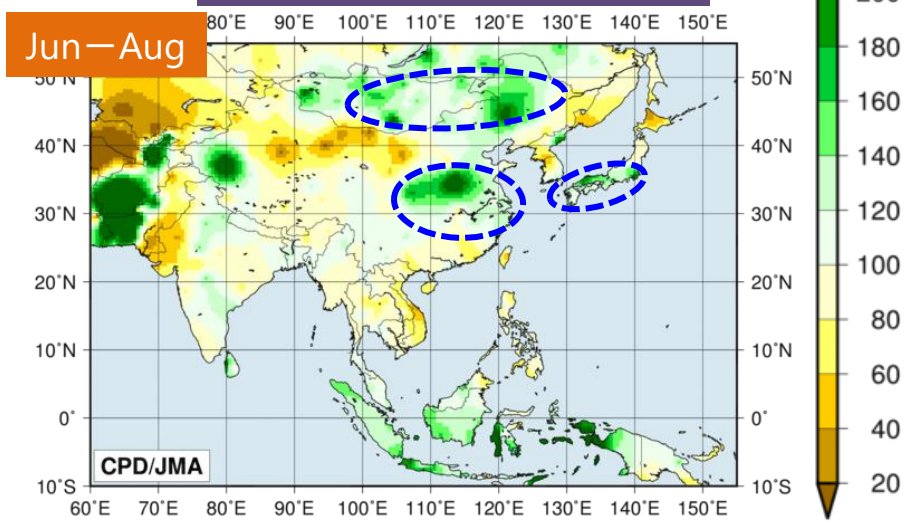
Temperature Anomaly [°C]



Precipitation Ratio [%]

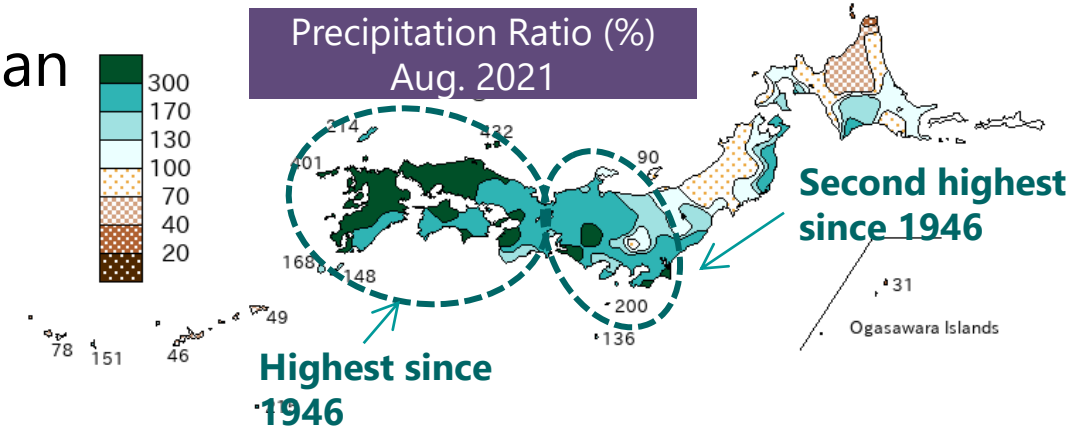


Based on CLIMAT reports. The baseline period for climatological normal is 1991-2020.

- **Warm**:
  - Northern Japan to the Korean Peninsula: extremely warm in July
  - Southern China: through the season
- **Wet**:
  - Japan: extremely wet in August　Today's topic
  - Central China: extremely wet in July and August
  - Central Mongolia and northeastern China: extremely wet in June and August

Persistent Heavy Rainfall in August

- Extremely wet August in western and eastern Japan due to persistent heavy rainfall resulting from a highly active stationary front over the country.



Surface Analysis

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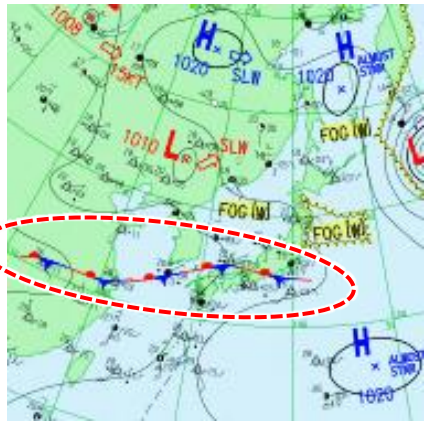

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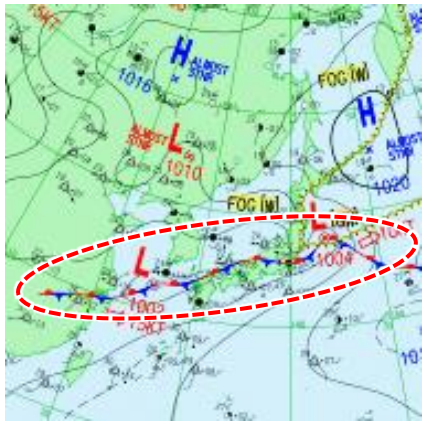

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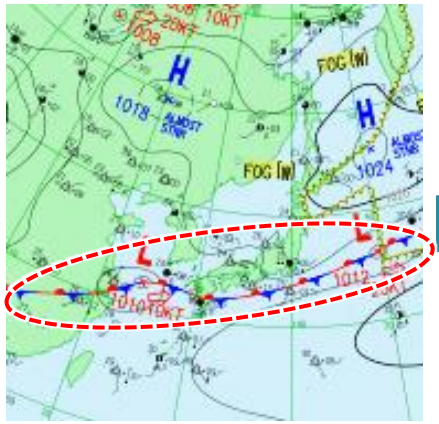
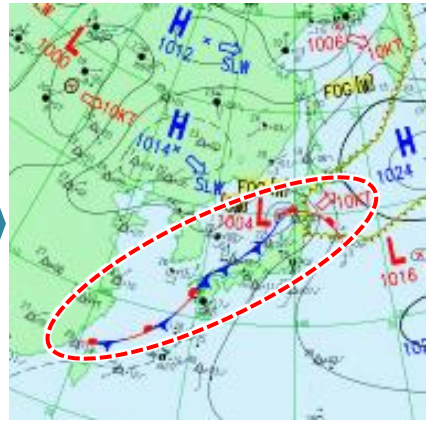


00UTC 18 Aug. 2021



Persistent Heavy Rainfall in August

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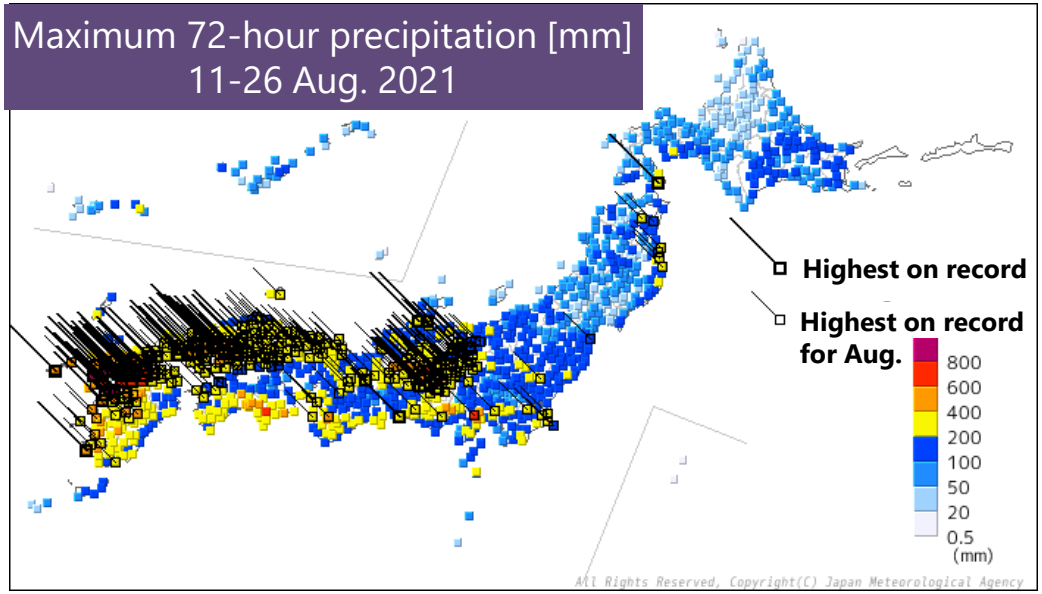
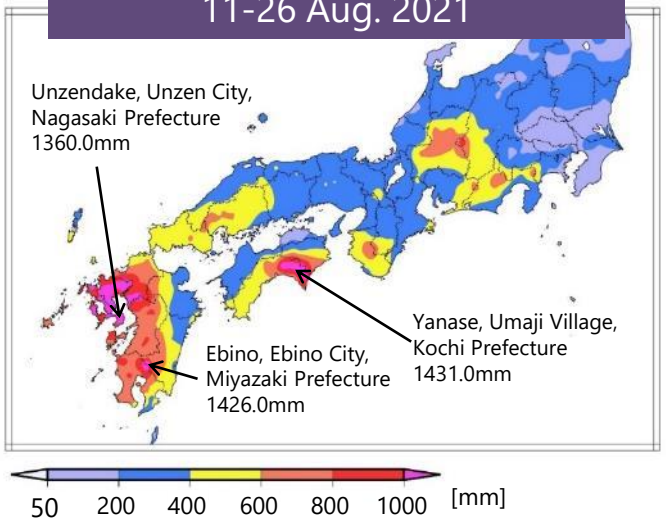
- Record-breaking heavy rainfall widely and persistently from western to eastern Japan from mid- to late August
  - 24- to 72 hour precipitation records were widely broken from western to eastern Japan
  - 8-day (from 12 to 19 Aug. 2021) precipitation amounts over the whole of Japan was higher than that for any 8 days since 1982.
- Damage
  - Deaths: 13, Injured People: 16

According to FDMA, Japan (as of 1 Oct. 2021)
https://www.fdma.go.jp/disaster/info/items/968a37dfa02f32fc036aae1d555f5a5cf0ce292e.pdf

Maximum 72-hour precipitation [mm]
11-26 Aug. 2021



Total Precipitation Amounts [mm]
11-26 Aug. 2021



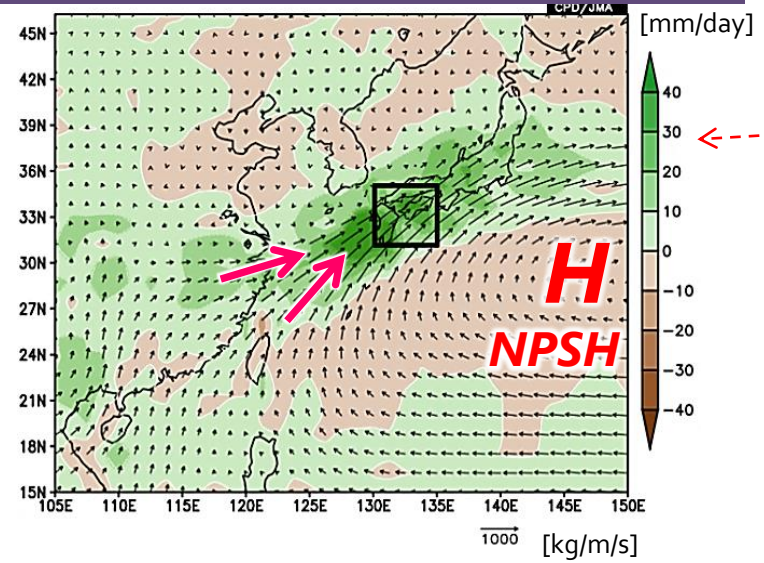
Vast Amounts of Moisture Inflow

- Two major moisture inflows to Japan
  1. From the south along the margin of the NPSH (North Pacific Subtropical High)
  2. From the west, namely continental China

→What conditions of the atmos. circulation?

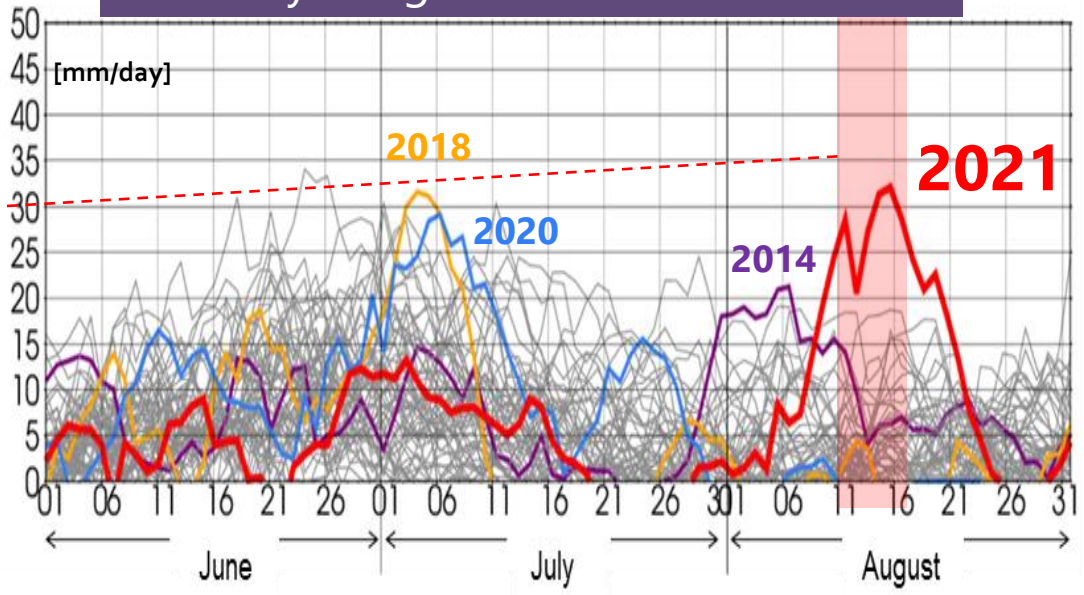
- Vast amounts of moisture flux convergence over Japan

Vertically integrated moisture flux and its horizontal convergence



Period: 11 - 17 Aug. 2021

Vertically integrated moisture flux conv.

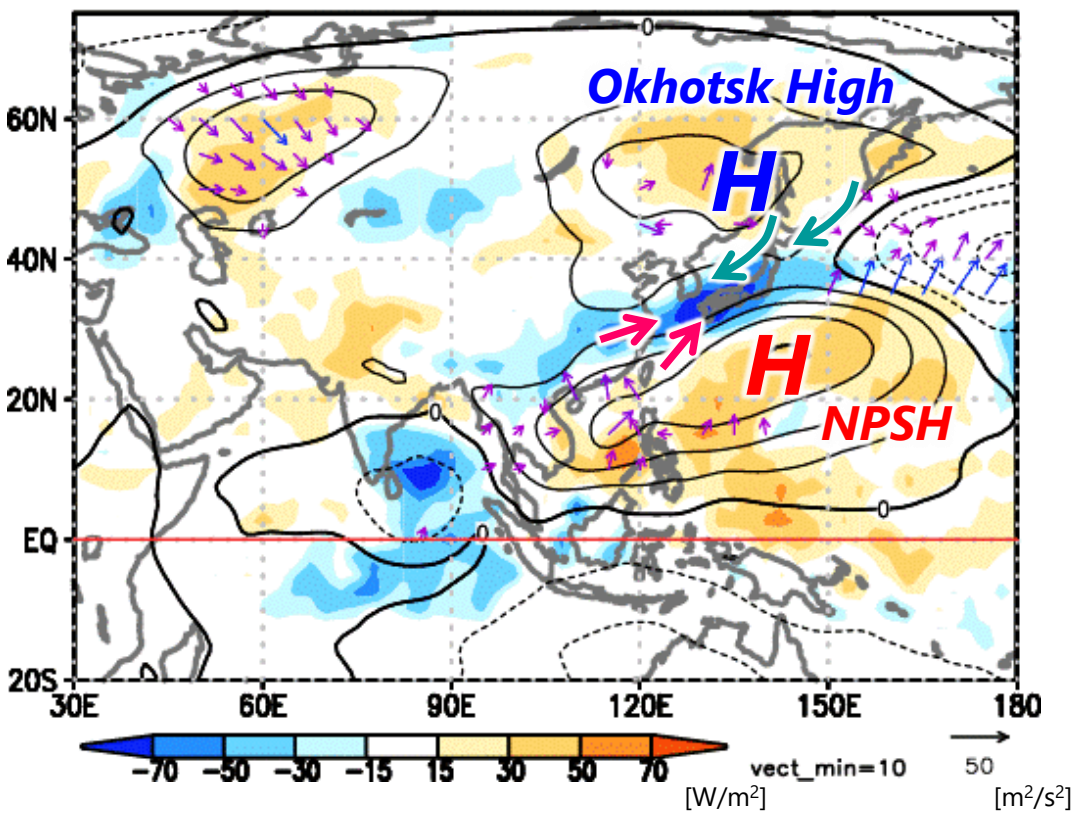


7-day running mean of the 1000-300hPa vertically integrated moisture flux convergence in the black thick line-closed area in the left panel from June to August after 1958

Like Early-summer Rainy Season

- The development of the cold Okhotsk High
- The southward-shifted NPSH
- Stationary front over Japan between the Okhotsk High and the NPSH like in early-summer rainy season, Baiu (梅雨), even though in mid-summer
  - Quite unusual situation!

850hPa stream function (ψ) anom. (cont.) and OLR anom. (color) : 11 – 17 Aug. 2021



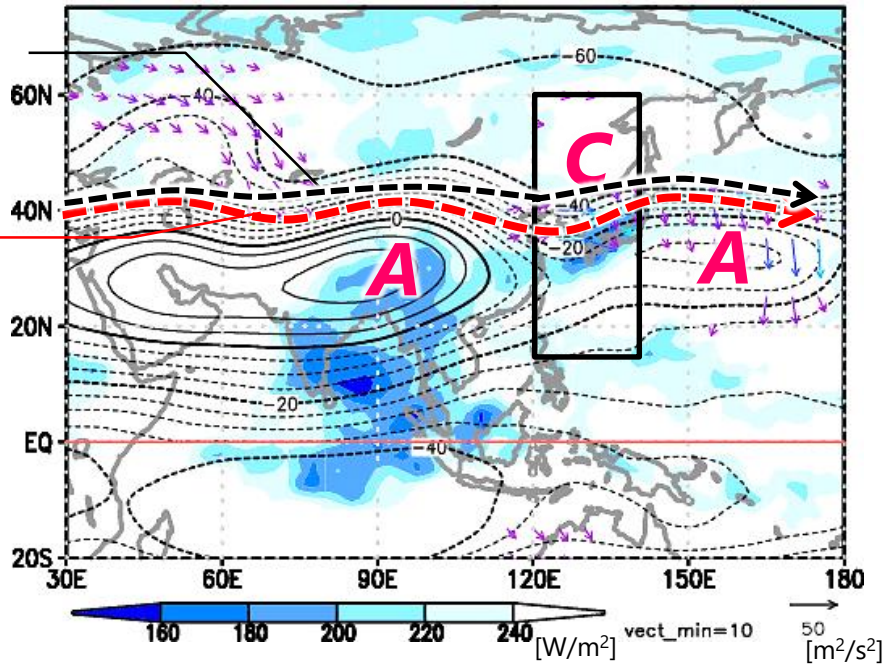
*Vector: Takaya and Nakamura (2001)-wave activity flux

Southward-shifted Subtropical Jet

- Significant <u>southward shift of the Subtropical Jet (STJ)</u>
- Significant <u>southward meandering of the STJ</u> to the west of Japan
  - Relating to the southward shift of the NPSH
  - Favorable for ascent and persistent rainfall

STJ Axis (normal)

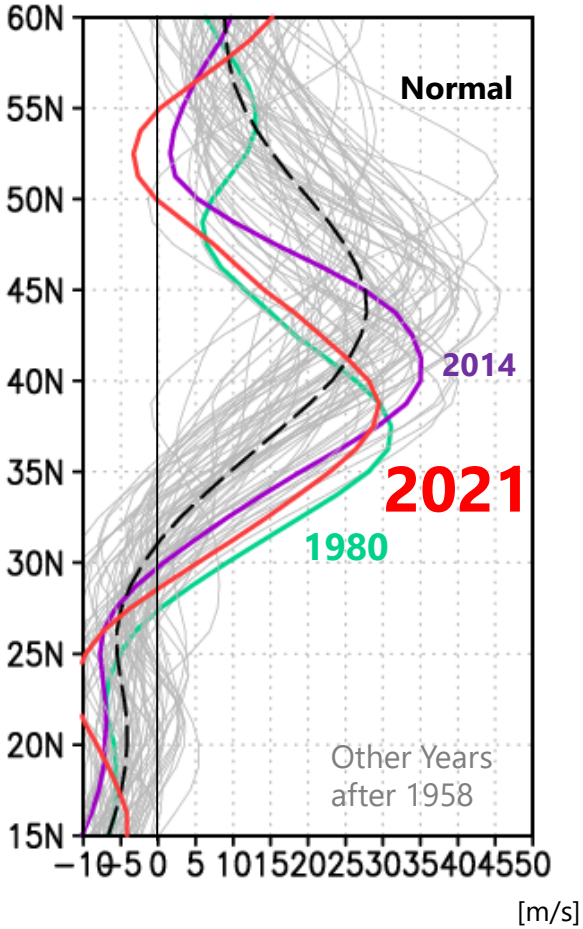
STJ Axis (Aug.2021)



ψ200 (cont.) and OLR (color) : 11 – 20 Aug. 2021

*Vector: Takaya and Nakamura (2001)-wave activity flux

U200 [120-140E] in 11 – 20 Aug. after 1958

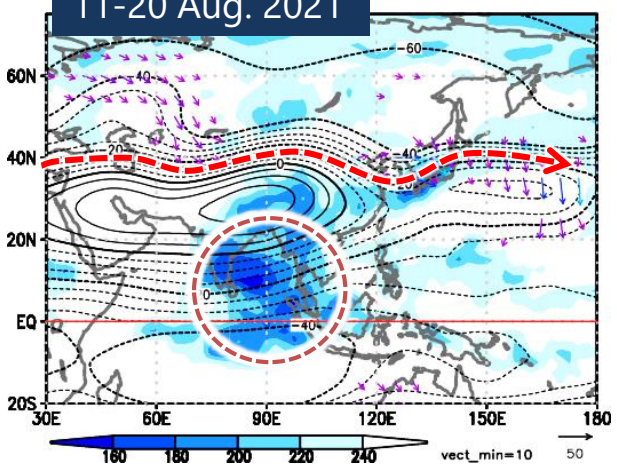


Asian Summer Monoon

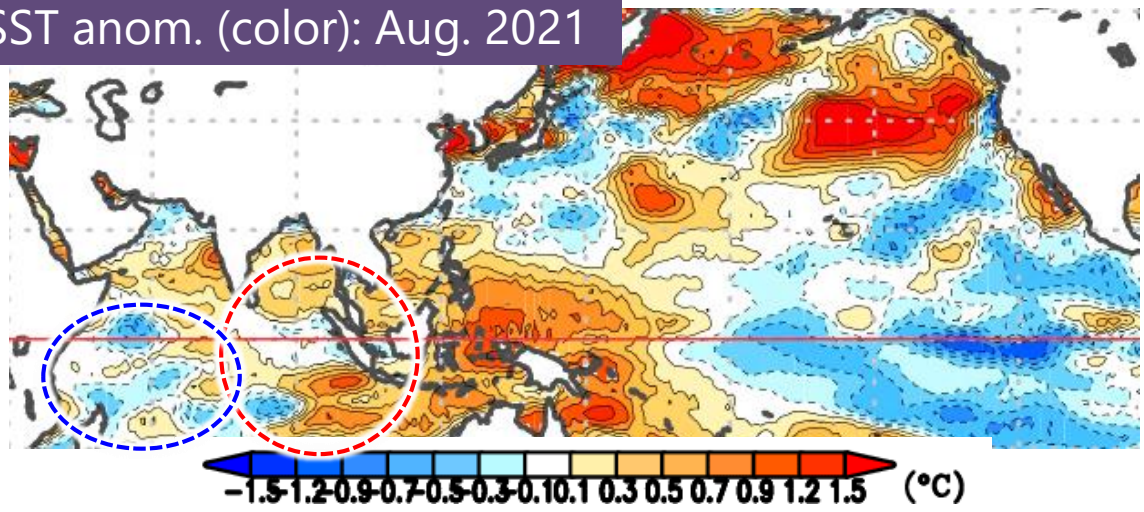
- Southward shift of the whole of the STJ over Eurasia likely affected by:
  - Inactive and southwestward-shifted Asian summer monsoon
  - Negative IOD (Indian Ocean Dipole) condition
    - Warmer : to the southwest of Sumatra
    - Cooler: western tropical Indian Ocean

ψ200 (cont.) , OLR (color)

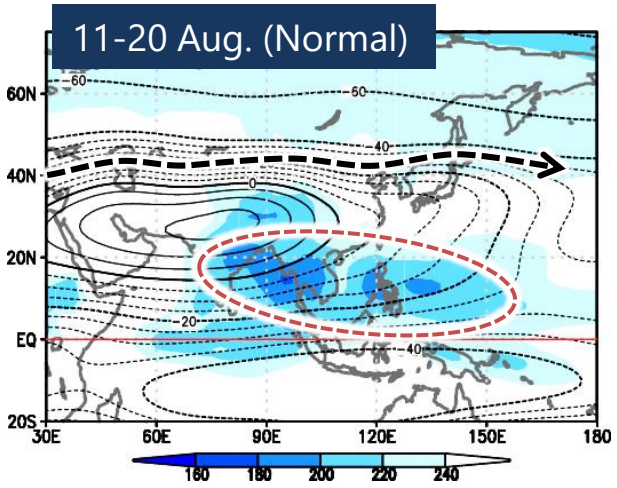
11-20 Aug. 2021



SST anom. (color): Aug. 2021



11-20 Aug. (Normal)



Southward-shifted STJ and upper-level troughs to the west of Japan

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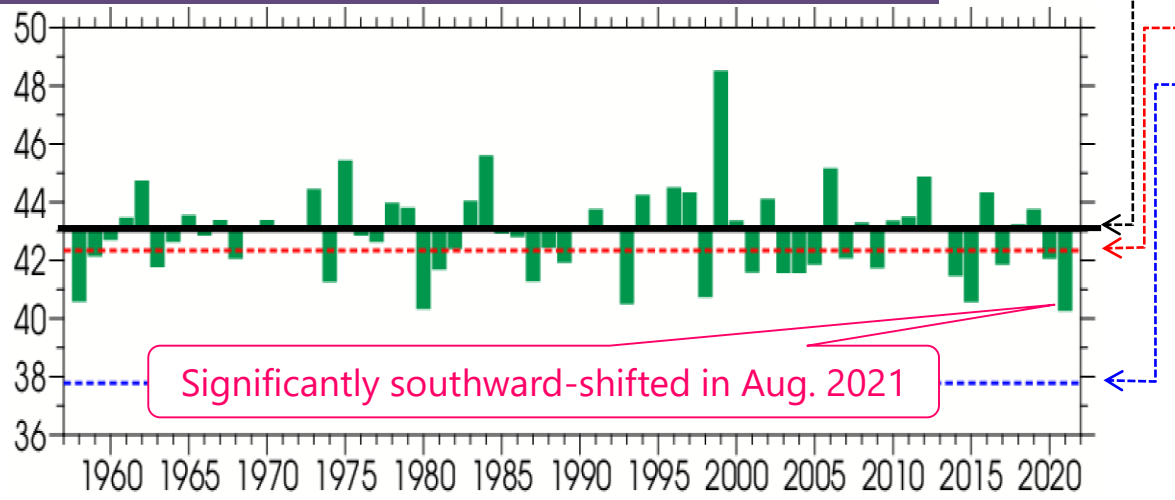
The STJ axis over Eurasia in August after 1958

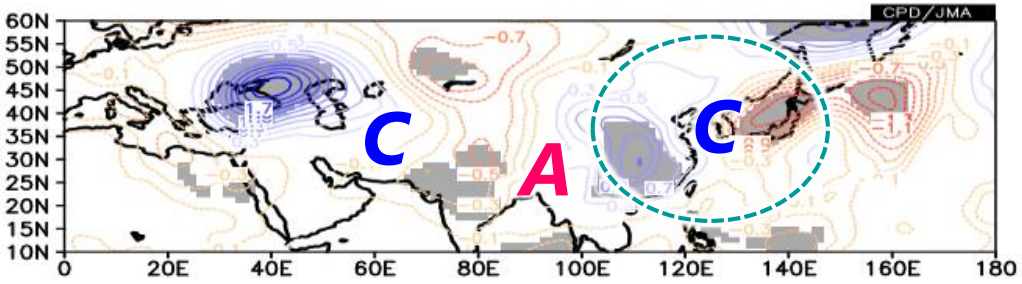


The STJ's axis is defined the latitude at which 40°-120°E averaged u200 have its maximum, where horizontal smoothing was applied to the u200 by extracting components of the zonal wave number $k \leq 2$.

V200 anom. regressed onto the STJ axis index over Eurasia in August
(the above time series)

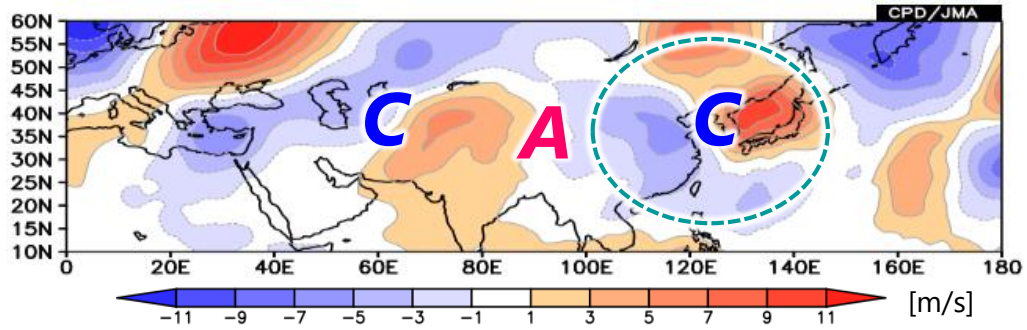
<!> The color tone is reversed to indicate circulation anomalies associated with the southward-shifted STJ

Gray: Confidence level of 95%



The southward-shifted STJs over Eurasia tend to accompany upper-level troughs to the west of Japan

V200 anom. in Aug. 2021



Tropical Convection and NPSH

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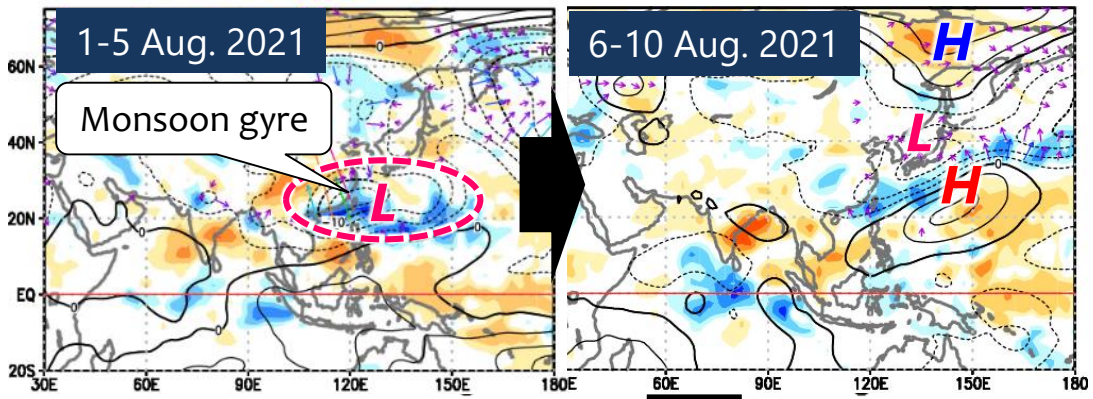
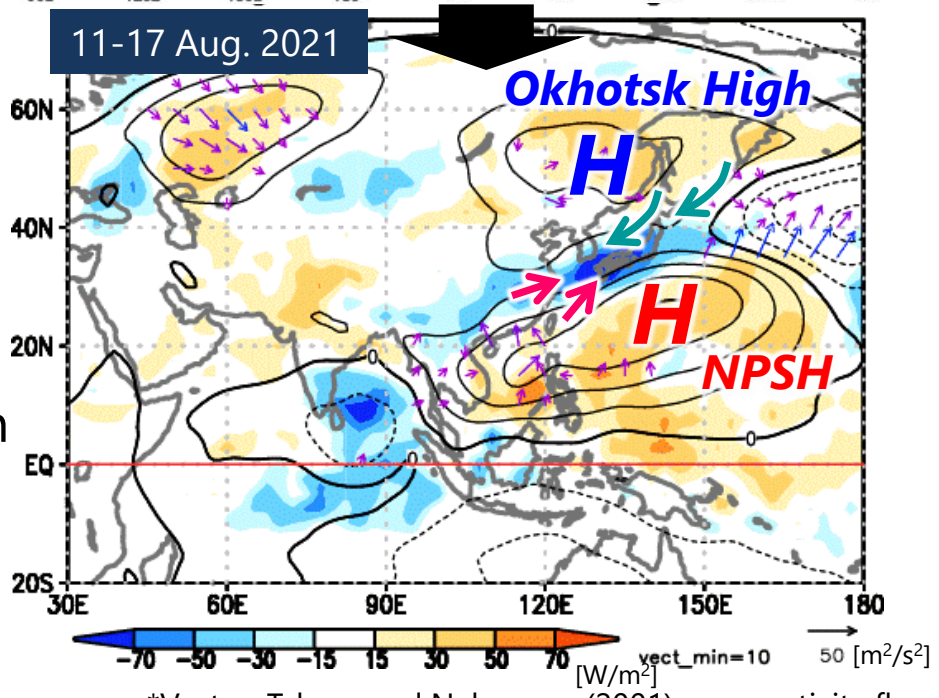
- Low-level cyclonic circulation anomalies (monsoon gyre) prevailed to the south of Japan from the latter half of July to the beginning of August.

ψ850 anom. (cont.) , OLR anom. (color)



- Afterwards, the westward expansion of the NPSH associated with
  - Suppressed convection: the tropical western North Pacific
  - Enhanced convection: the eastern tropical Indian Ocean.
- Phase transition of BSISO (Boreal Summer Intra-Seasonal Oscillation) (Lee et al., 2013)



*Vector: Takaya and Nakamura (2001)-wave activity flux

Summary: Heavy Rainfall in mid-August

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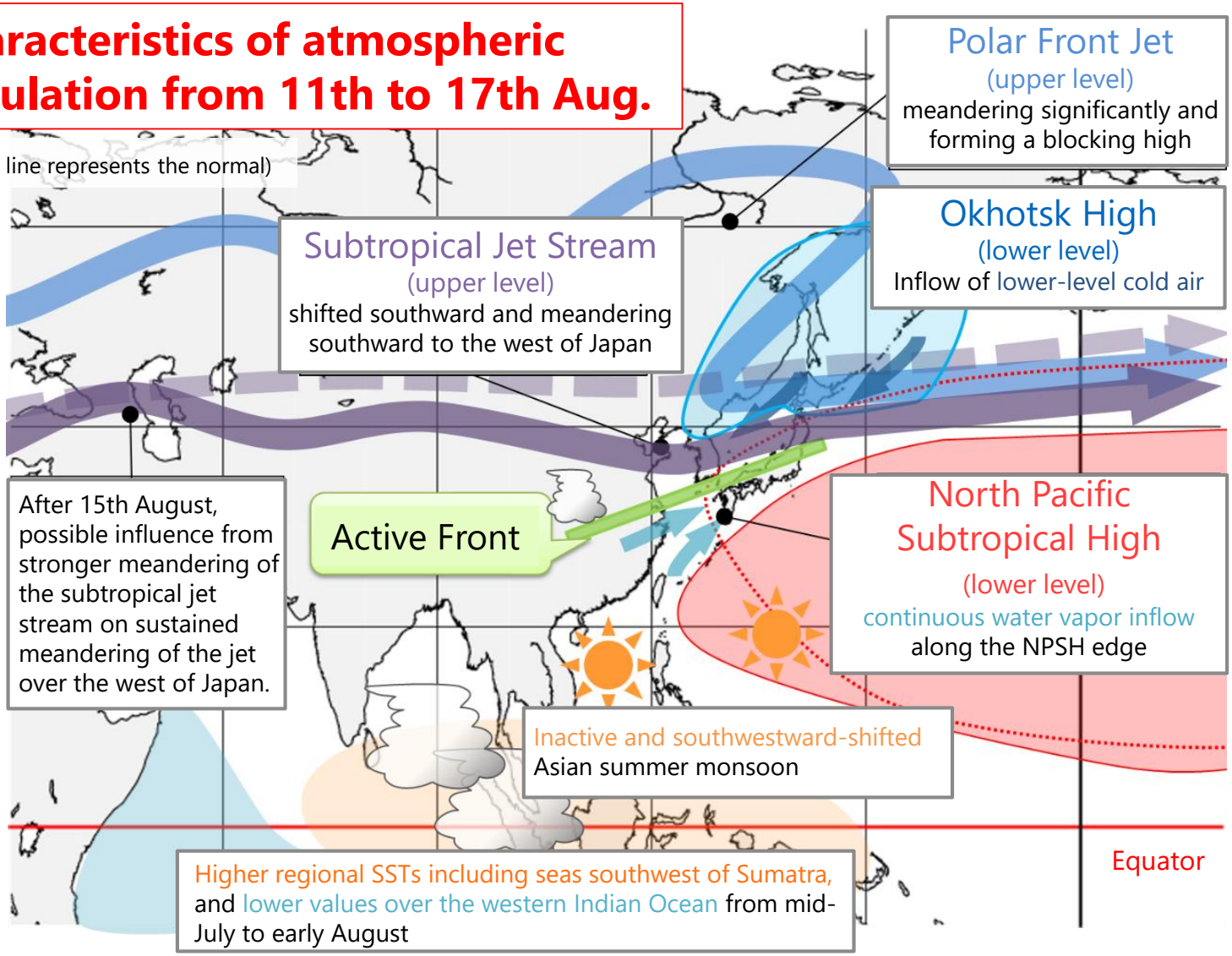
Characteristics of atmospheric circulation from 11th to 17th Aug.

(Dotted line represents the normal)



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   - Based on the discussion by the JMA Advisory Panel on Extreme Climate Events*
   - See also the TCC/JMA's press release about this event
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II. Summary

III. The situation so far this autumn (if we have time)

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Recent La Niña-like Condition

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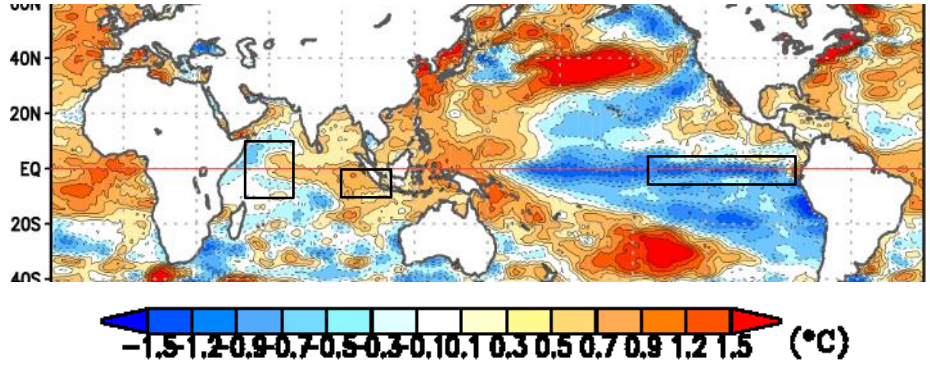
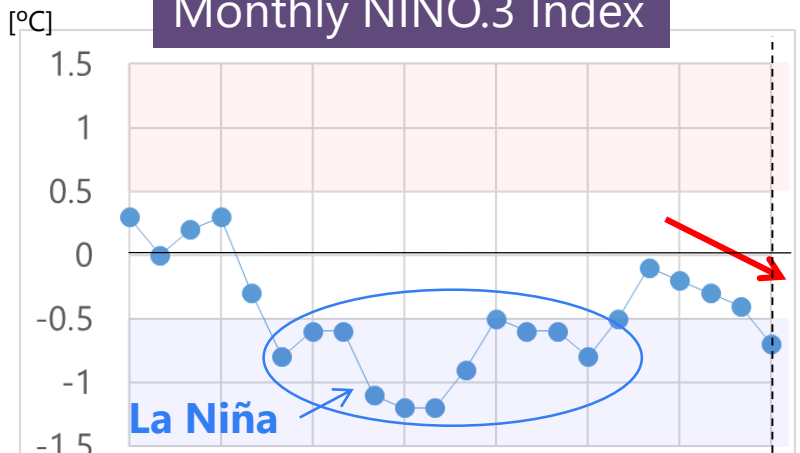
SST anomalies (Sep. – Oct. 2021)

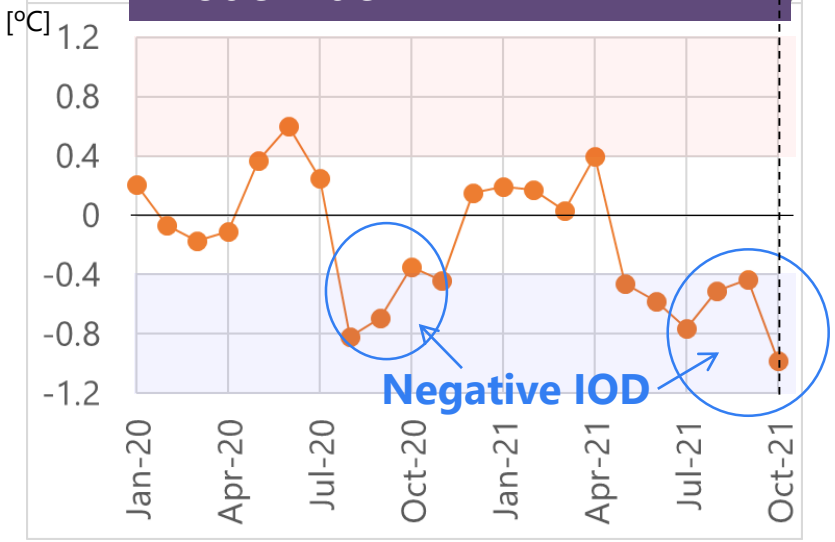


- La Niña-like conditions have been evolving since this autumn (but not meeting the JMA's criteria of La Niña yet).
- The negative IOD episode has remained since this summer.

Monthly NINO.3 Index



Monthly Indian Ocean Dipole Mode Index



NINO.3 [5°S-5°N, 90°-150°W]
Indian Ocean Dipole Mode Index
Difference of are-averaged SST deviations [10°S-10°N, 50°-70°E] minus [EQ-10°S, 90°-110°E]

Recent La Niña-like Condition

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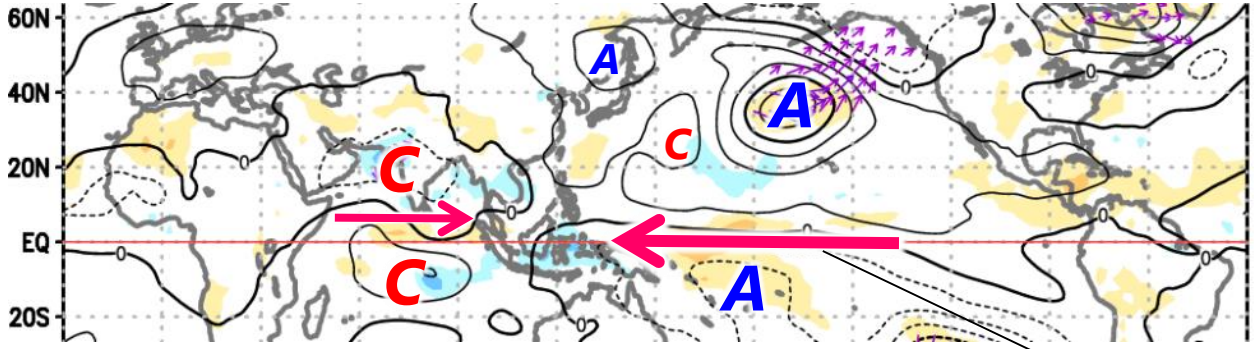
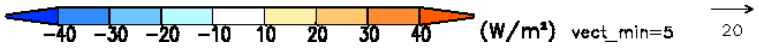
ψ850 anom. (cont.) and OLR anom. (color)
Sep. – Oct. 2021



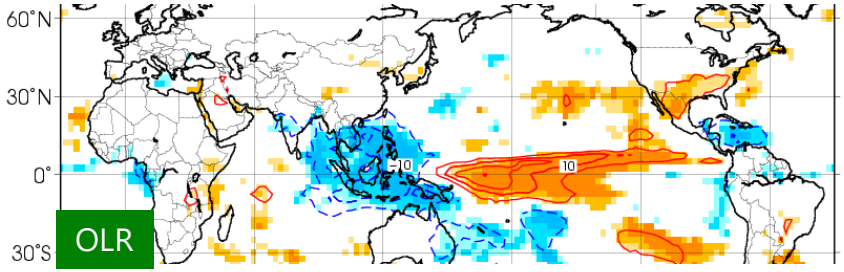


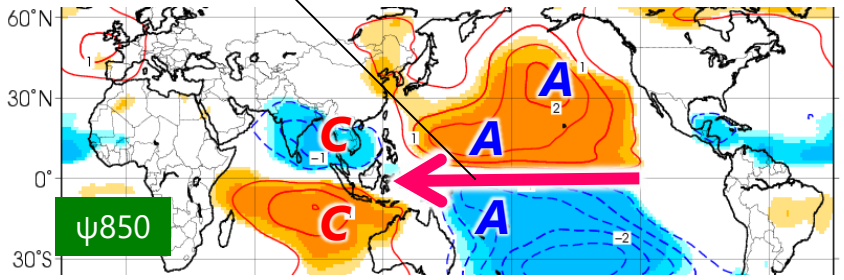
*Vector: Takaya and Nakamura (2001)-wave activity flux

OLR and ψ850 anom. imply the enhanced Walker circulations, which is similar to what were seen in the past La Niña events.

Enhanced Easterlies

La Niña Composites (Sep.-Nov.)





Statistical confidence level −99 −95 −90 90 95 99 (%)

Period: 1958-2012

Summary: Recent Climate Conditions

- La Niña-like conditions have been evolving since this autumn in terms of oceanic and atmospheric circulation in the tropical Pacific.
  - NINO.3 SST index has become more negative i.e. La Niña-like.
  - Also, cooler-than-normal water has prevailed beneath the sea surface from the central to eastern equatorial Pacific (not shown in this presentation).
  - OLR and ψ850 anom. in this autumn imply the enhanced Walker circulations, which is similar to what were seen in the past La Niña.
- The negative IOD episode has remained since this summer.

Reference

- Tokyo Climate Center http://ds.data.jma.go.jp/tcc/tcc/index.html
  - Climate System Monitoring http://ds.data.jma.go.jp/tcc/tcc/products/clisys/index.html
  - El Niño Monitoring http://ds.data.jma.go.jp/tcc/tcc/products/elnino/index.html
  - World Climate http://ds.data.jma.go.jp/tcc/tcc/products/climate/index.html
  - Press release: Climate characteristics and factors behind record-heavy rain in Japan in August 2021 https://ds.data.jma.go.jp/tcc/tcc/news/press_20210924.pdf

- Lee, J.-Y., B. Wang, M. C. Wheeler, X. Fu, D. E. Waliser and I.-S. Kang, 2013: Real-time multivariate indices for the boreal summer intraseasonal oscillation over the Asian summer monsoon region. *Clim Dyn*. **40**, 493-509.
- Takaya, K., and H. Nakamura, 2001: A Formulation of a Phase-Independent Wave-Activity Flux for Stationary and Migratory Quasigeostrophic Eddies on a Zonally Varying Basic Flow. *J. Atmos. Sci*., **58**, 608–627.