Consecutive extreme flooding and heat wave in Japan (2018): Are they becoming a norm?

Simon 世宇 Wang
Professor of climate
Utah State University

SCIENTIFIC AMERICAN

Searing Summer Heat Follows Killer Floods in Japan

The extreme weather has planners concerned about conditions during the 2020 Tokyo Olympics

By Nathanial Gronewold, E&E News on July 25, 2018

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Business

Japan's Floods, Heatwave Kill More Than 300 in July

THE ASSOCIATED PRESS (KEN MORITSUGU)

July 30, 2018, 10:42 PM MDT *Updated on July 30, 2018, 11:50 PM MDT*

Floods in Japan

As of July 8, 1456 GMT

followed by heat waves

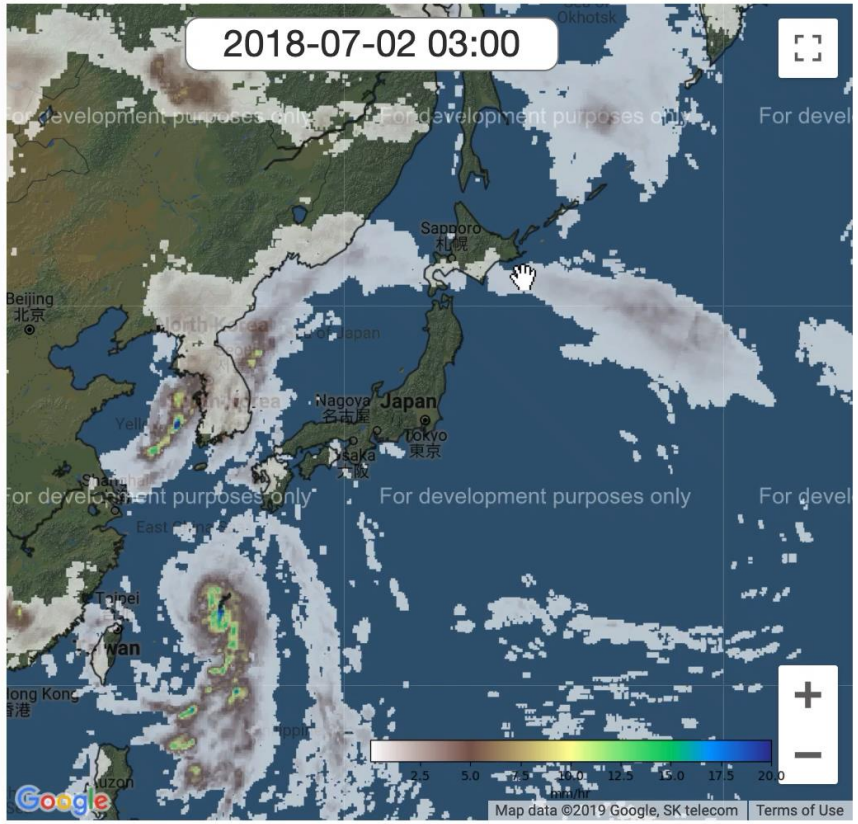
Floods in Japan

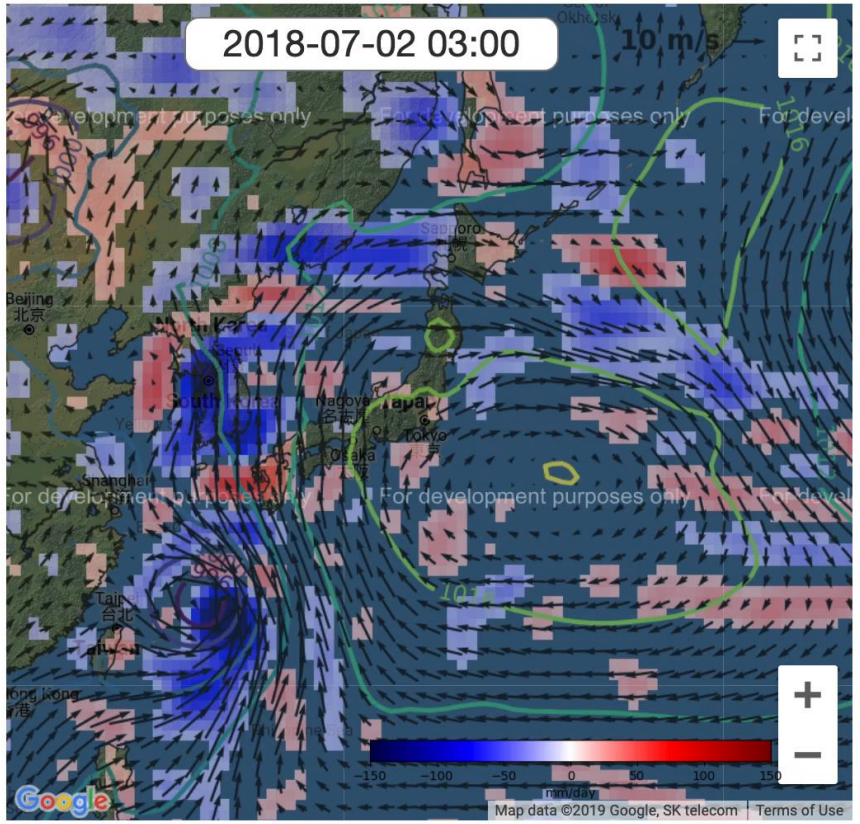
As of July 8, 1456 GMT

H30.07 WESTERN JAPAN HEAVY RAINFALL

GSMaP Precipitation (shade:left), JRA55 Column Integrated Water Vapor Divergence (shade:right), JRA55 Wind@900mb (vector:right), JRA Mean Sea Level Pressure (contour:right)

Rate: 900ms Opacity: 63%





Okayama

Hiroshima

100 km

Alert level

http://hydro.iis.u-tokyo.ac.jp/~hjkim/FLOOD.H30WJ/app/

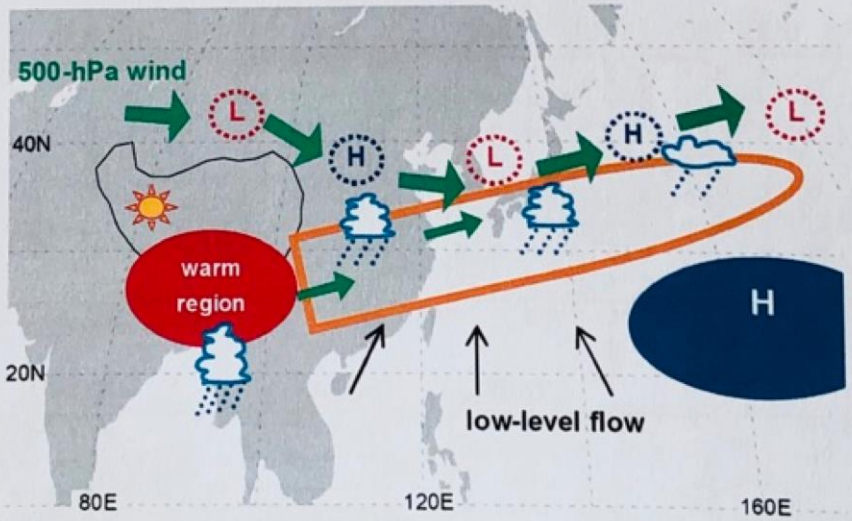
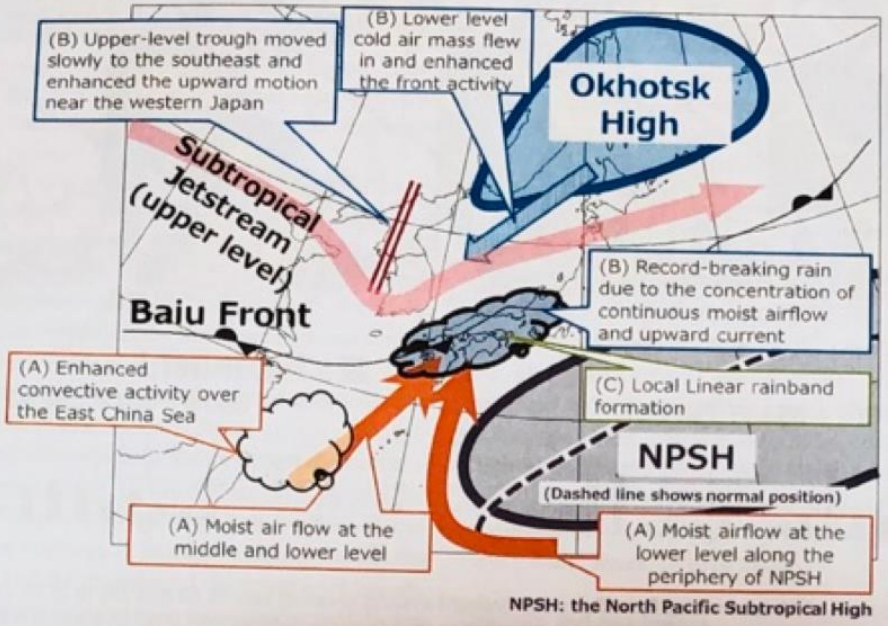


FIG. 15. Schematic diagram describing factors that bring meiyu-baiu in early summer East Asia. Midtropospheric winds (green arrows) advect warm air from the warm region over the south flank of the Tibetan Plateau (red oval; thin black line is the 3000-m contour of topography) associated with the heated surface of the Plateau and monsoon convection to the south. The warm a… motion along the jet strea…) in the presence of con… rt (black arrows) between a heat low over the continent and an oceanic high over the North Pacific (light blue oval with "H"). The jet stream (thick green arrows) steers transient weather disturbances from midlatitudes (blue and red dotted circles with "H" and "L") eastward, increasing

Sampe, T., and S.-P. Xie (2010)

with many local line-shaped precipitation systems … disaster areas in western Japan were also characterized by unusual



optic-scale motion factors that contributed to the record rainfall from western Japan to the Tokai region. From TCC, JMA (2018)

What do we *not* know?

2019 in review

Flood and heatwave in Japan 2018 and future increase of c

Hyungjun Kim, the University of Tokyo, Tokyo, Japan*

Gavin D. Madakumbura, University of California, Los Angele

Simon Wang, Utah State University, Logan, Utah

Hideo Shiogama, National Institute for Environmental Studie

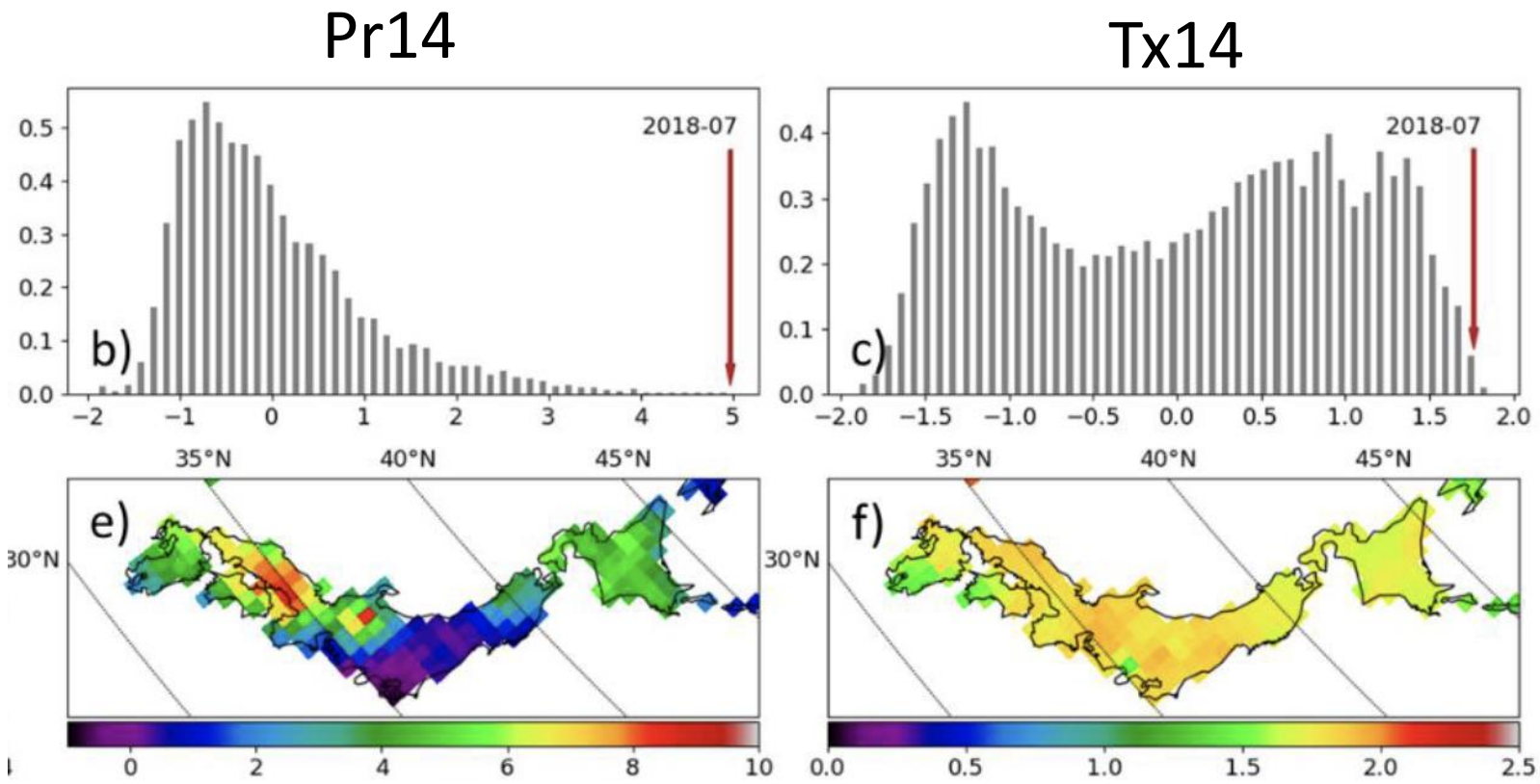
Erich Fisher, ETH Zurich, Zurich, Switzerland

Nobuyuki Utsumi, the University of Tokyo, Tokyo, Japan

Jin-Ho Yoon, Gwangju Institute of Science and Technology, G

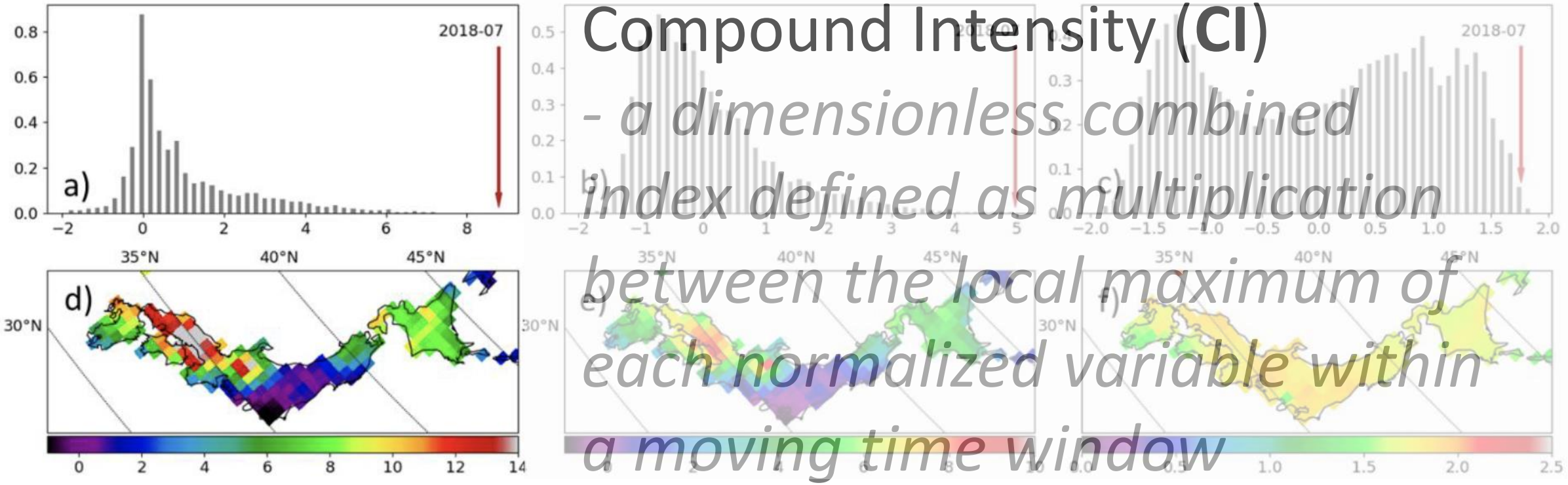
(1) Quantitative attribution

normalized precip and Tmax: *14-day running sum precip (Pr14) and mean Tmax (Tx14)*



(1) Quantitative attribution

CI28

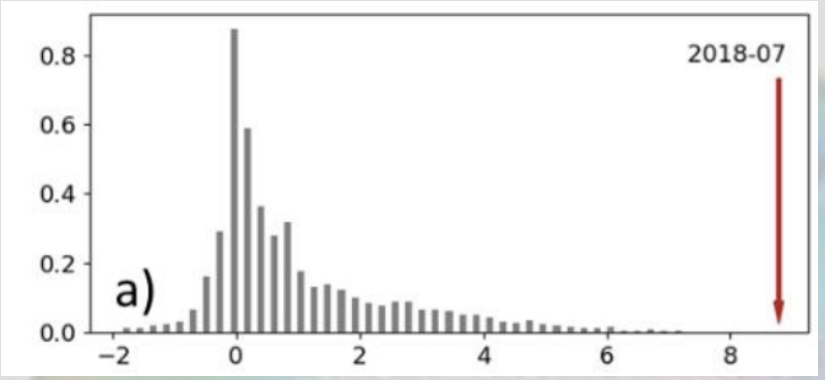


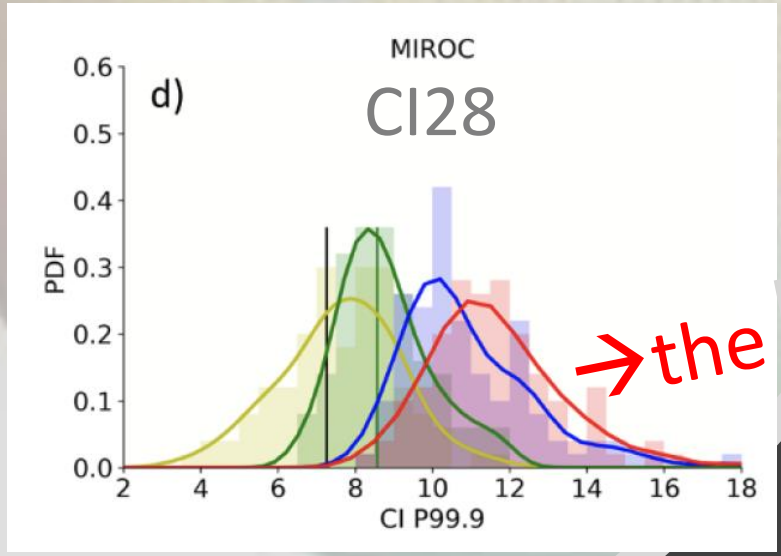
Compound Intensity (**CI**)

- a dimensionless combined index defined as multiplication between the local maximum of each normalized variable within a moving time window

(1) Quantitative attribution

CI28





- international CLIVAR C20C+ detection and attribution project
- [illegible]egree Additional warming, Prognosis and Projected Impacts (HAPPI) project

→the warmer it gets, the more compound extremes!

CI28 Pr14 Tx14

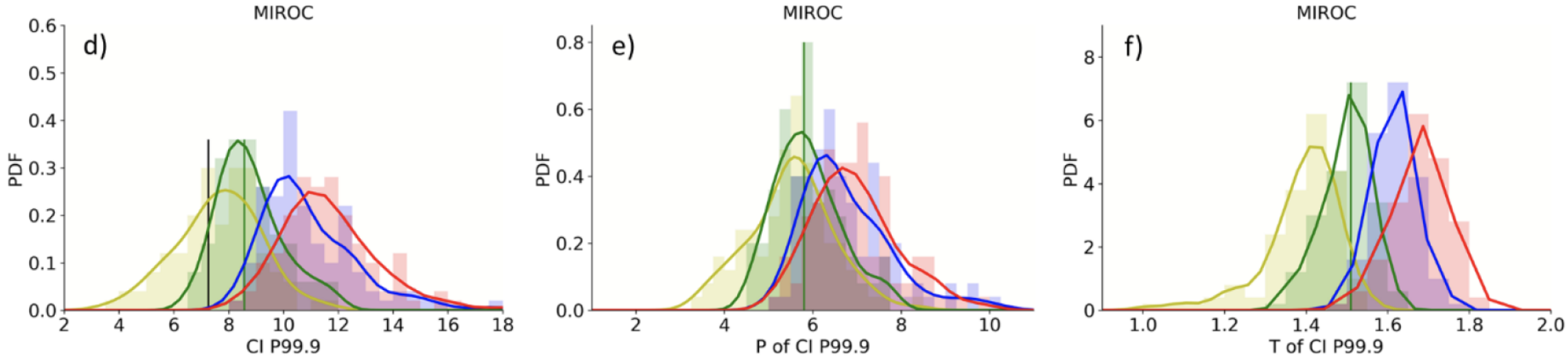
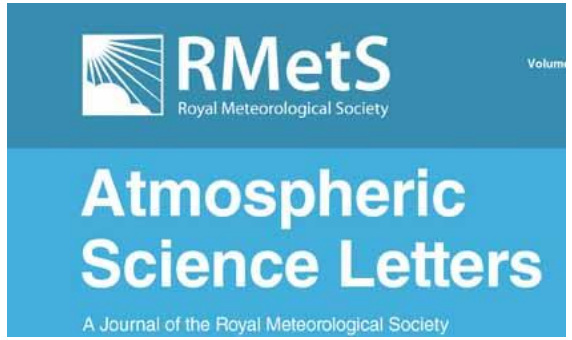


Figure 2. Probability distribution of a) CI28 and associated b) Pr14 and c) Tx14 for CAM4. Black and green vertical line indicate observation-based P99.9 and P50 of simulation ensembles, respectively. d) – e) are same but for MIROC5.

Consecutive extreme flooding and heat wave in Japan: Are they becoming a norm?

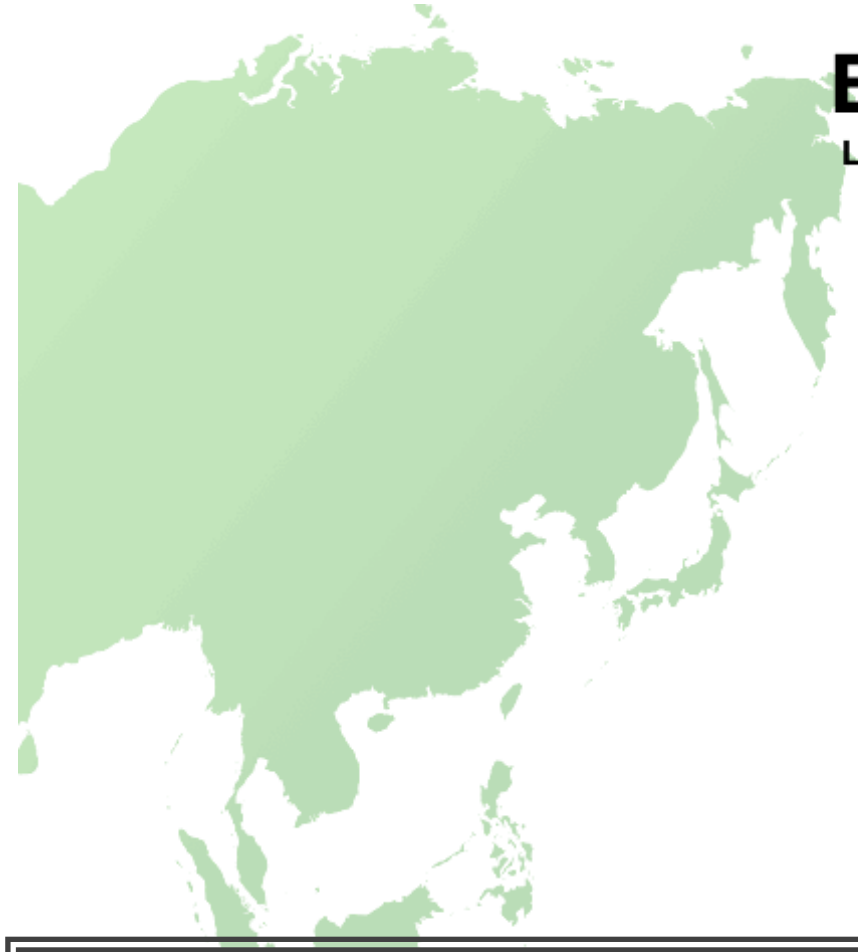
Simon S.-Y. Wang[1], Hyungjun Kim[2], Dim Coumou[3], Jin-Ho Yoon[4], Lin Zhao[5] and Robert Gillies[1]

1. Dept. Plants, Soils and Climate/Utah Climate Center, Utah State University, USA
2. Institute of Industrial Science, University of Tokyo, Japan
3. Institute for Environmental Studies, University of Amsterdam, Netherlands
4. School of Earth and Environmental Engineering, Gwangju Institute of Science and Technology, South Korea
5. Northwest Institute of Eco-Environment and Resources, Chines Academy of Sciences, China



2019 in press

(2) Synoptic attribution

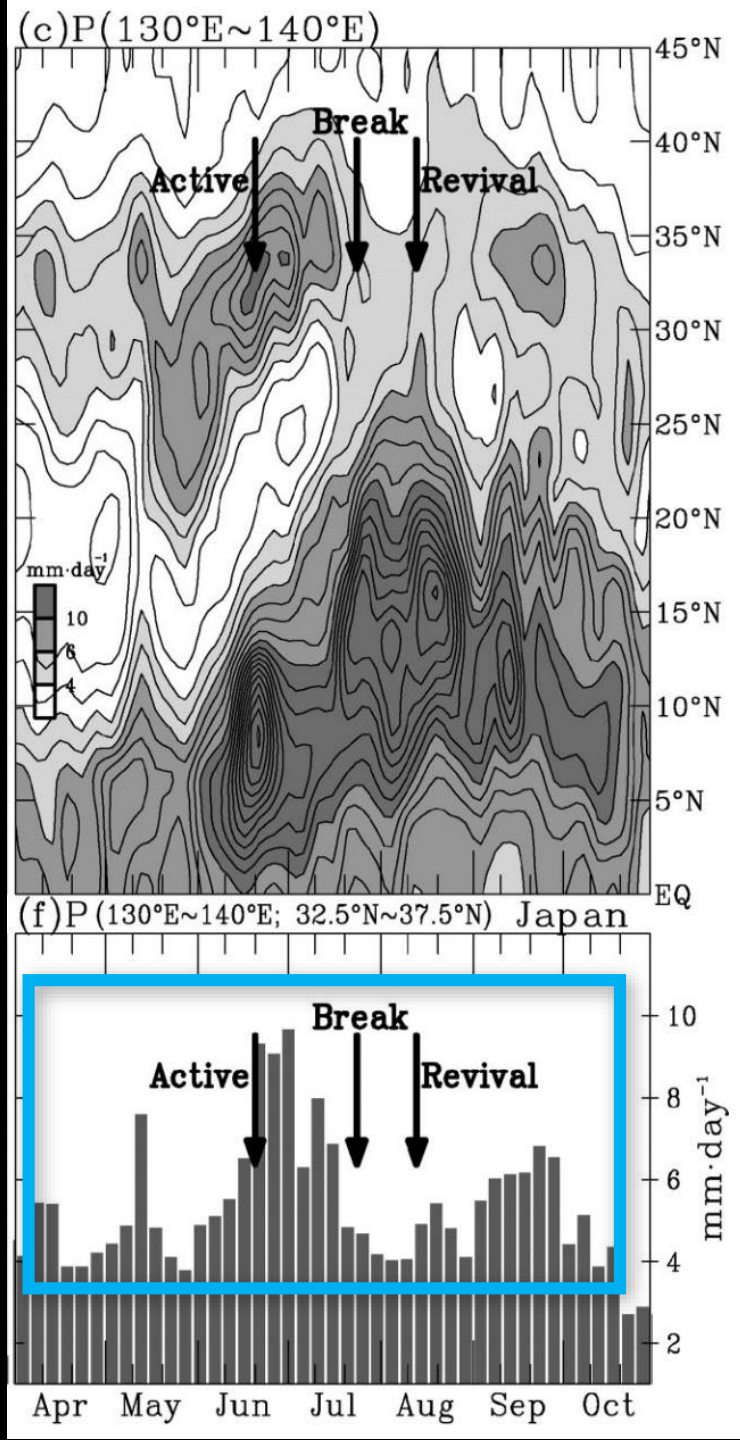


EASM Lifecycle

Leading to rain and heat in w. Japan

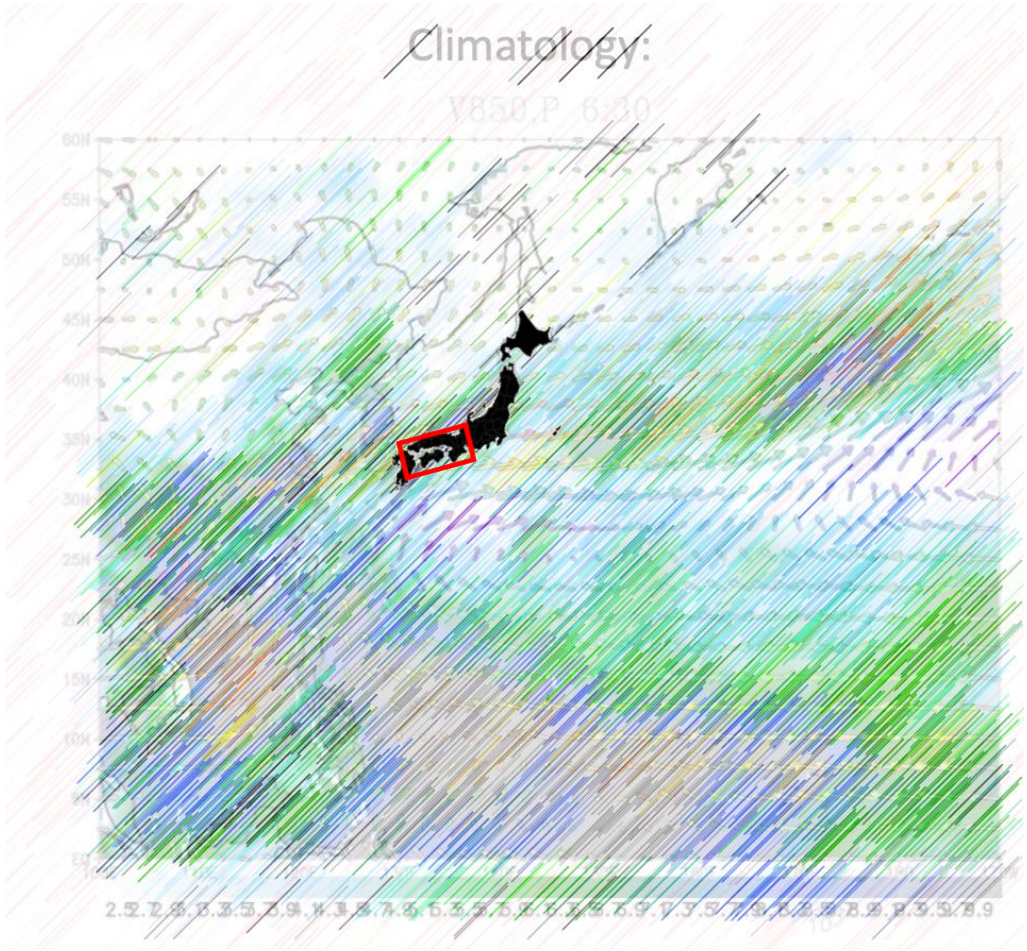
← East Asian Summer Monsoon (EASM)

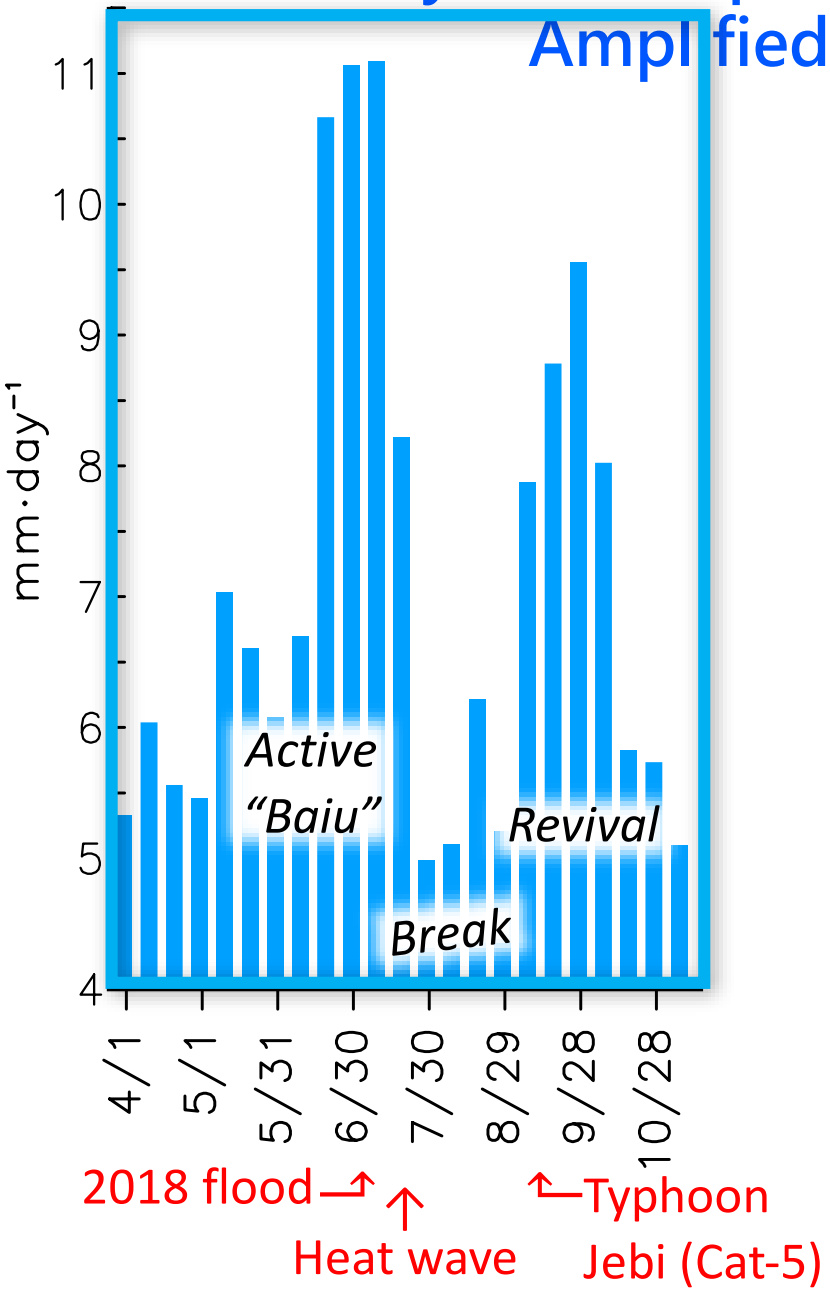
(2) Synoptic attribution



Chen et al. (2004 JCLI)

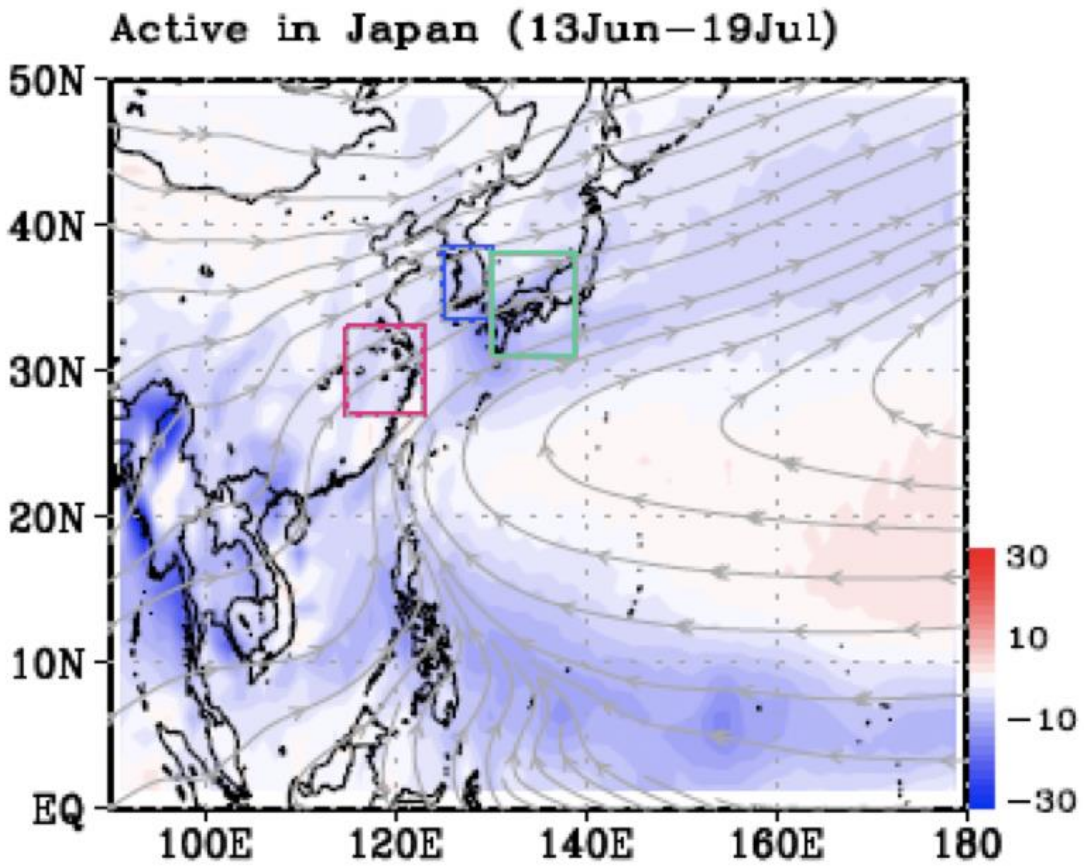
EASM Lifecycle for Japan: Amplified?

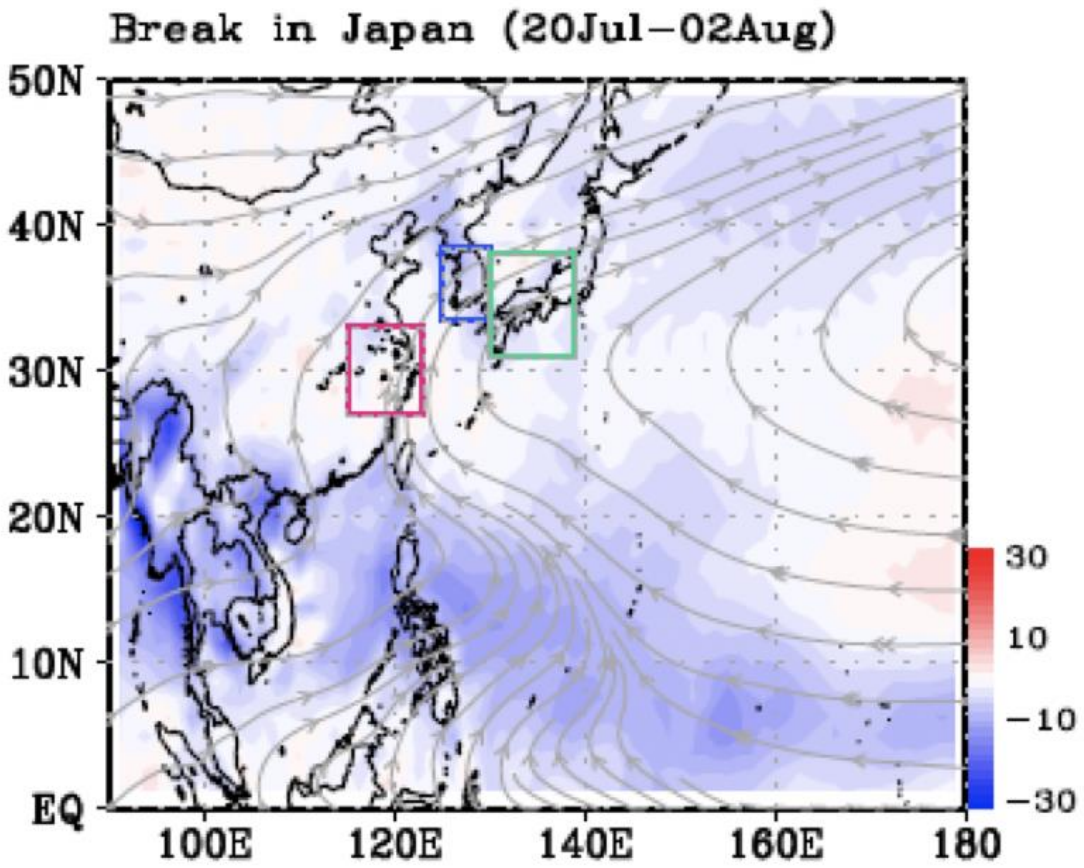




Preliminary analysis

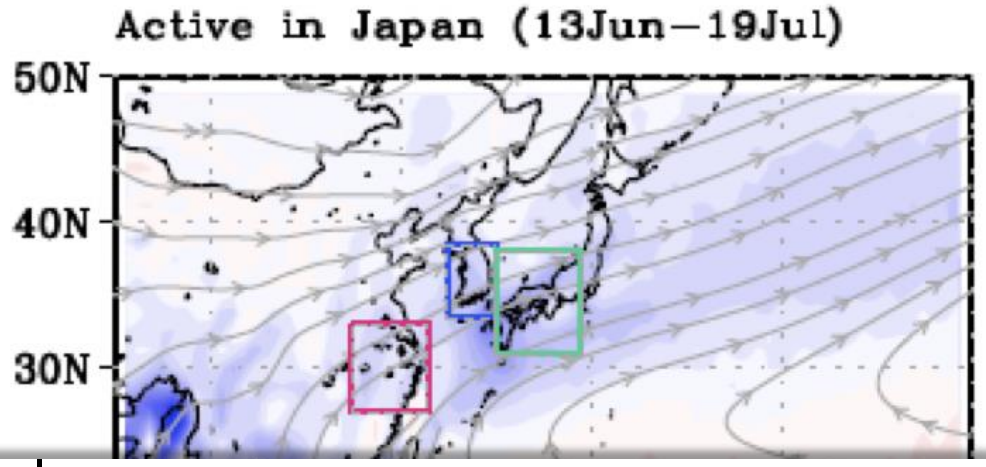
by Jina Park, GIST KR

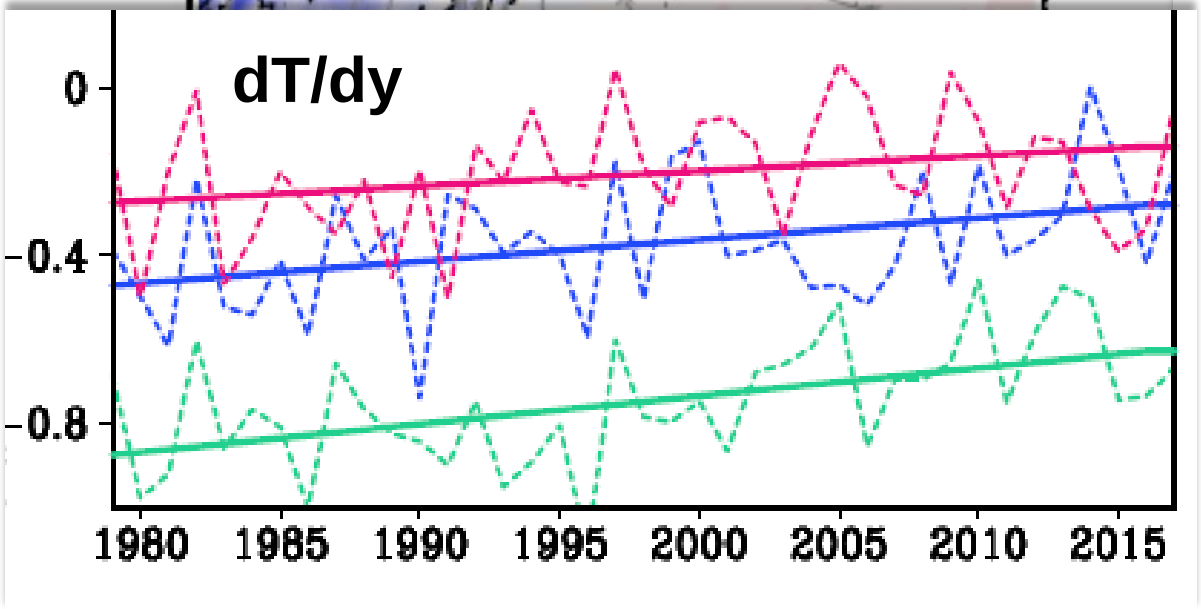


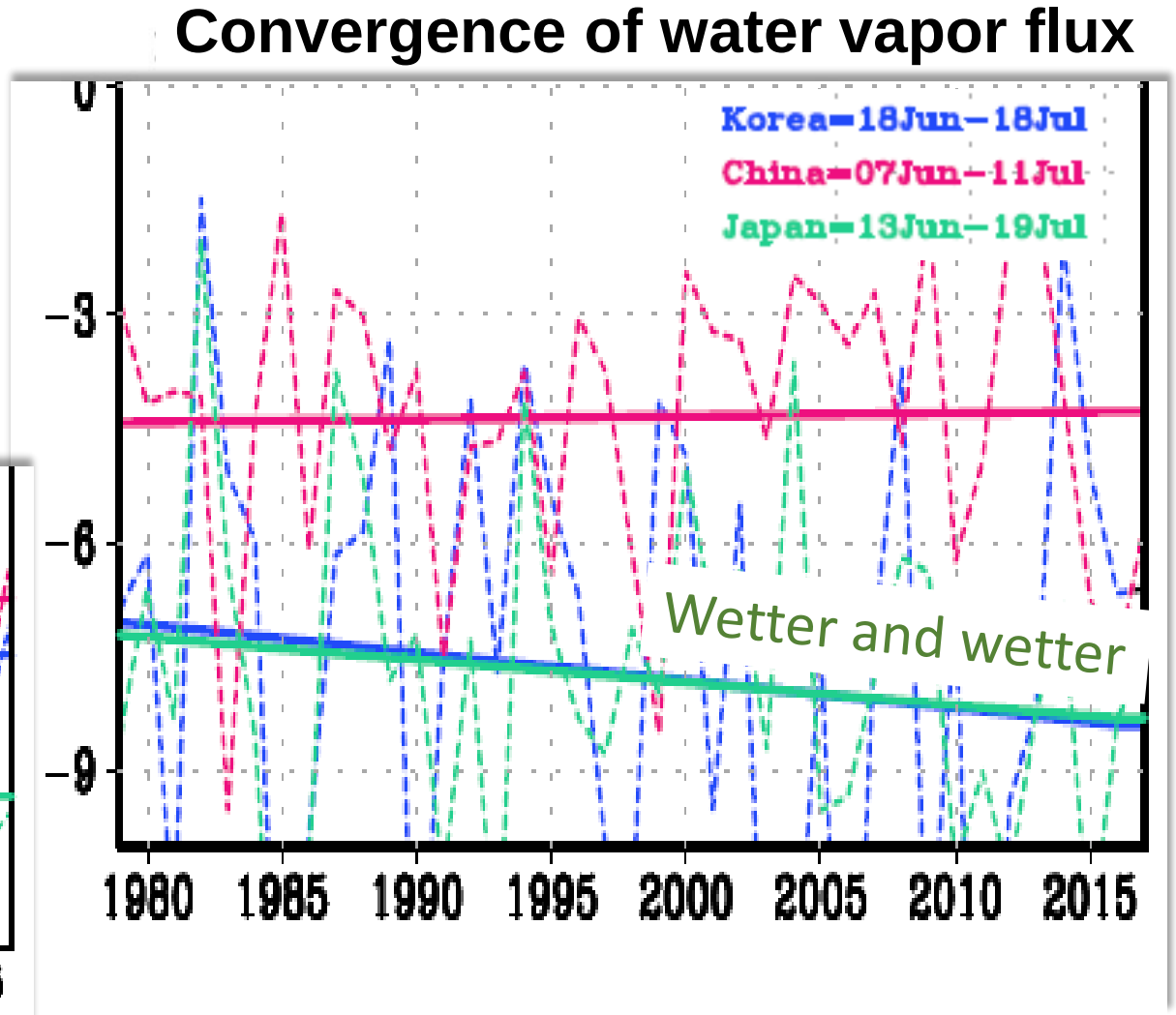


Preliminary analysis

by Jina Park, GIST KR



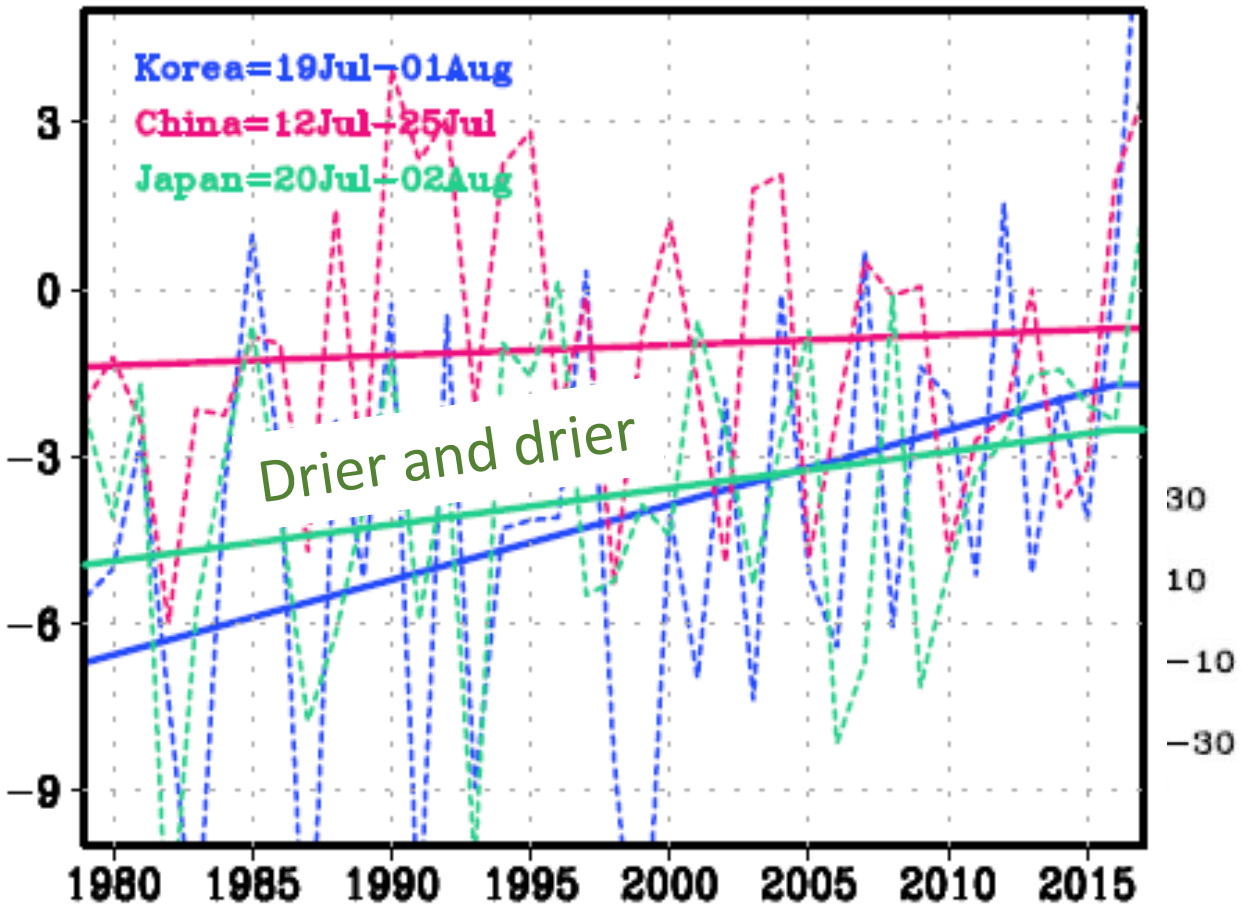


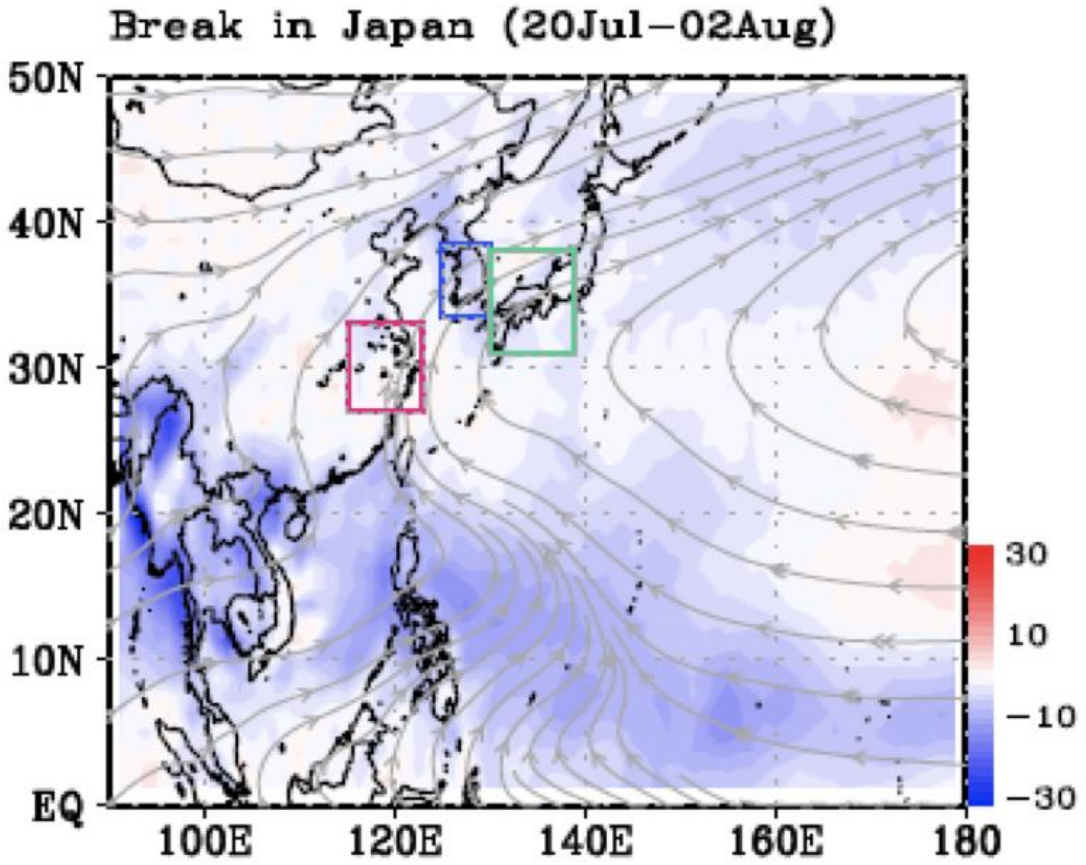


Preliminary analysis

by Jina Park, GIST KR

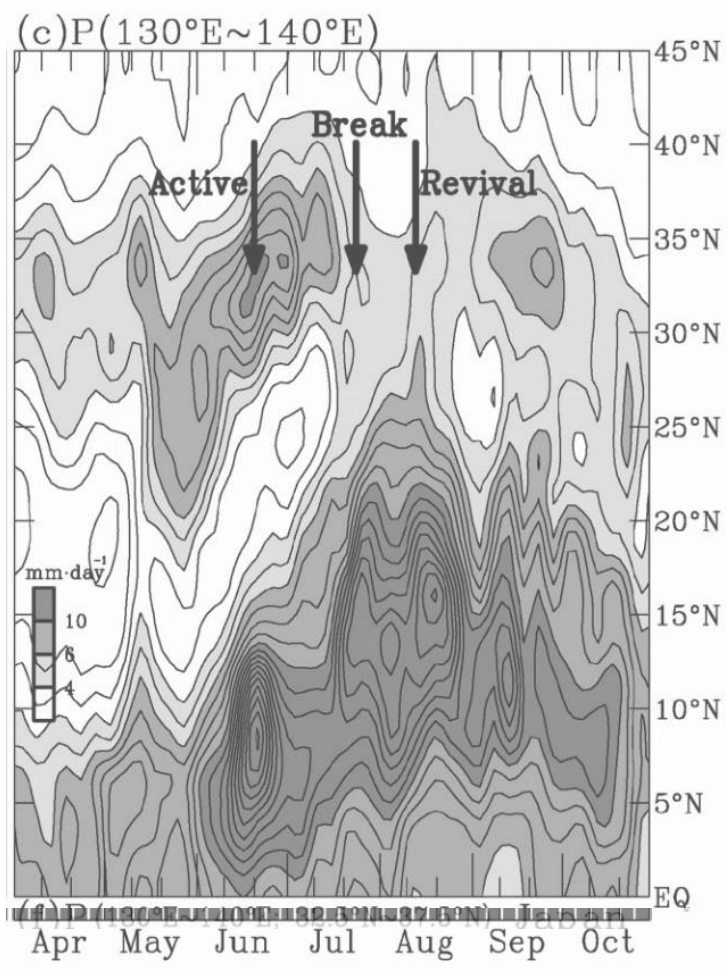
Convergence of water vapor flux

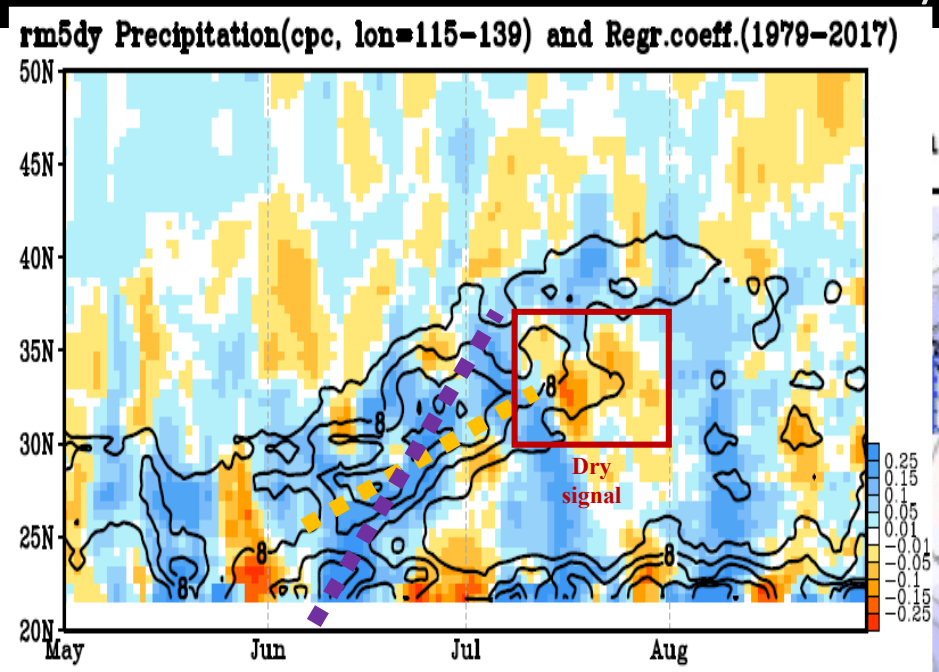


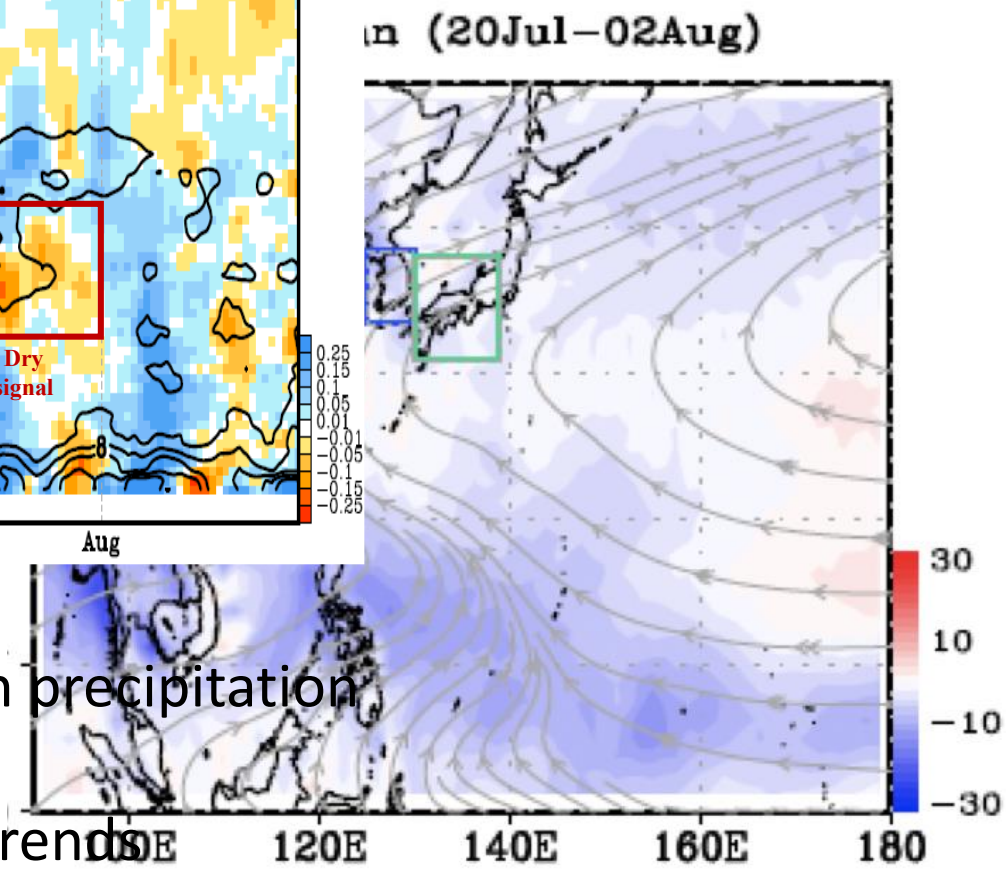


Preliminary analysis

by Jina Park, GIST KR







Couture: 5-day mean precipitation

Shading: long-term trends

Preliminary analysis

by Jina Park, GIST KR

HOW ABOUT TIMING?

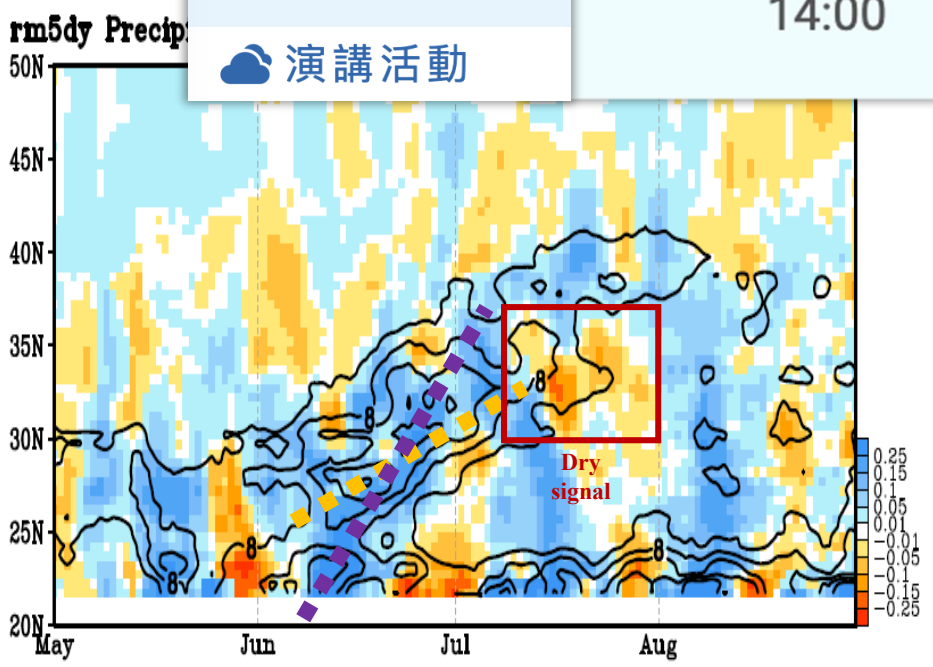
交通部中央氣象局
Central Weather Bureau

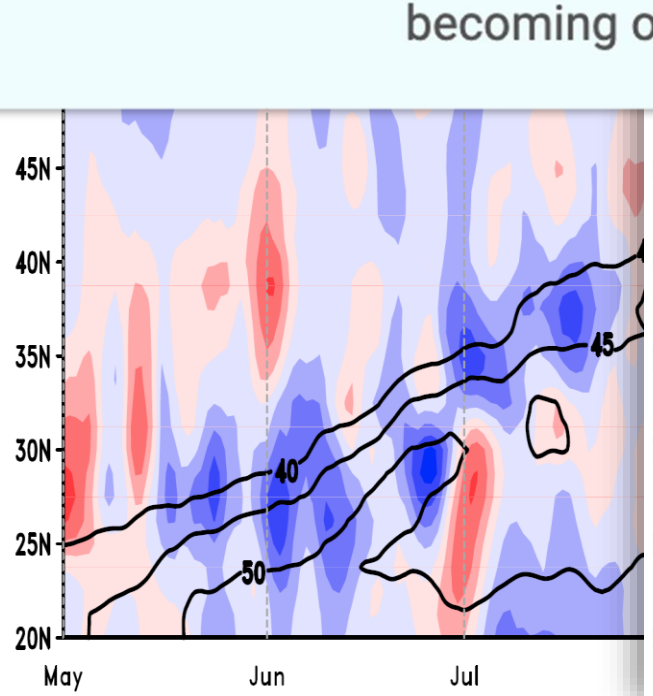
演講活動

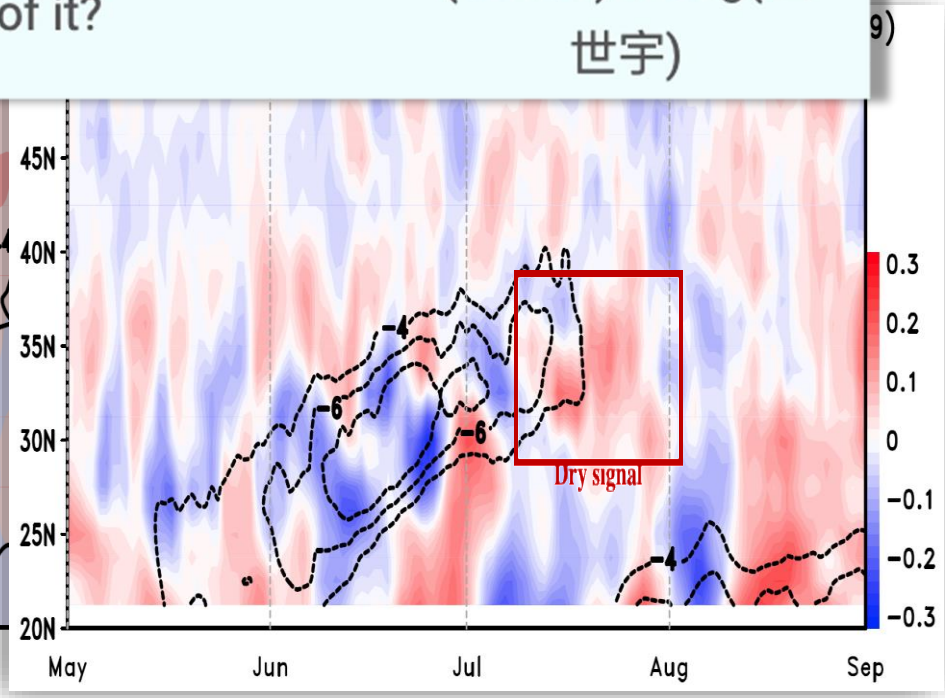
2018-07-10
14:00

Mei-Yu of Taiwan: What's the becoming of it?

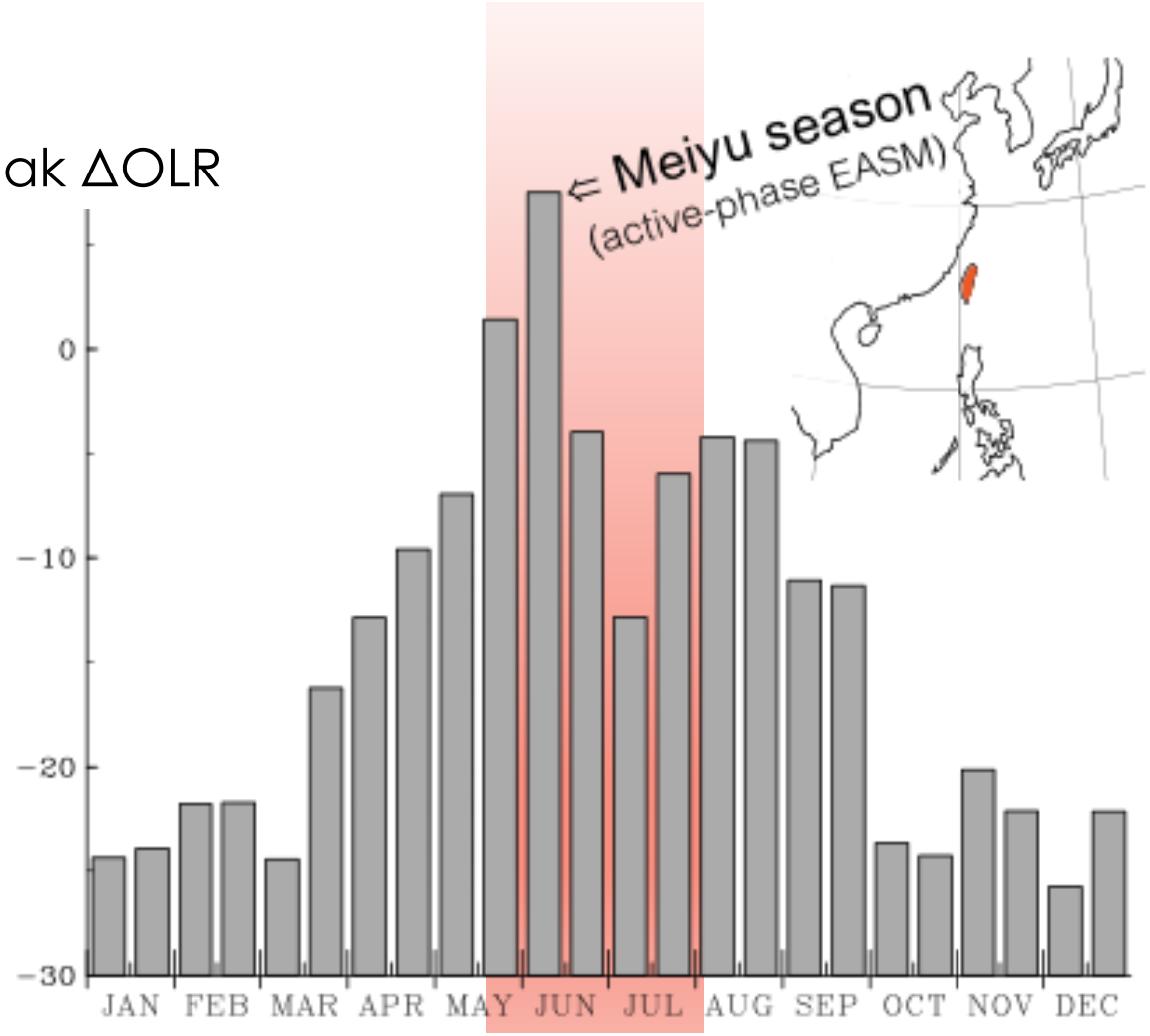
Prof. Shih-Yu (Simon) Wang(王世宇)



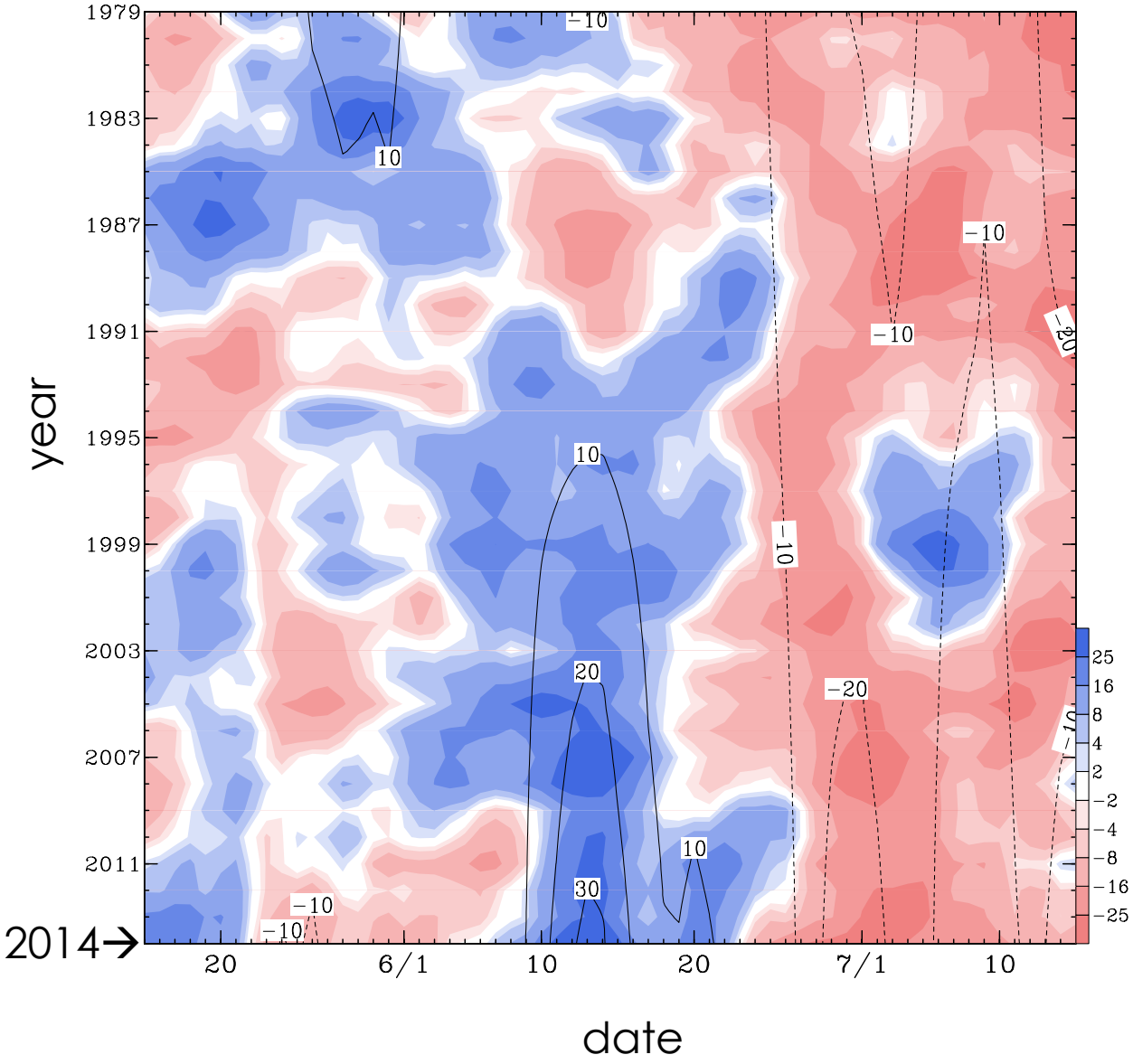




Peak ΔOLR



Each year's peak daily ΔOLR
(running means applied)

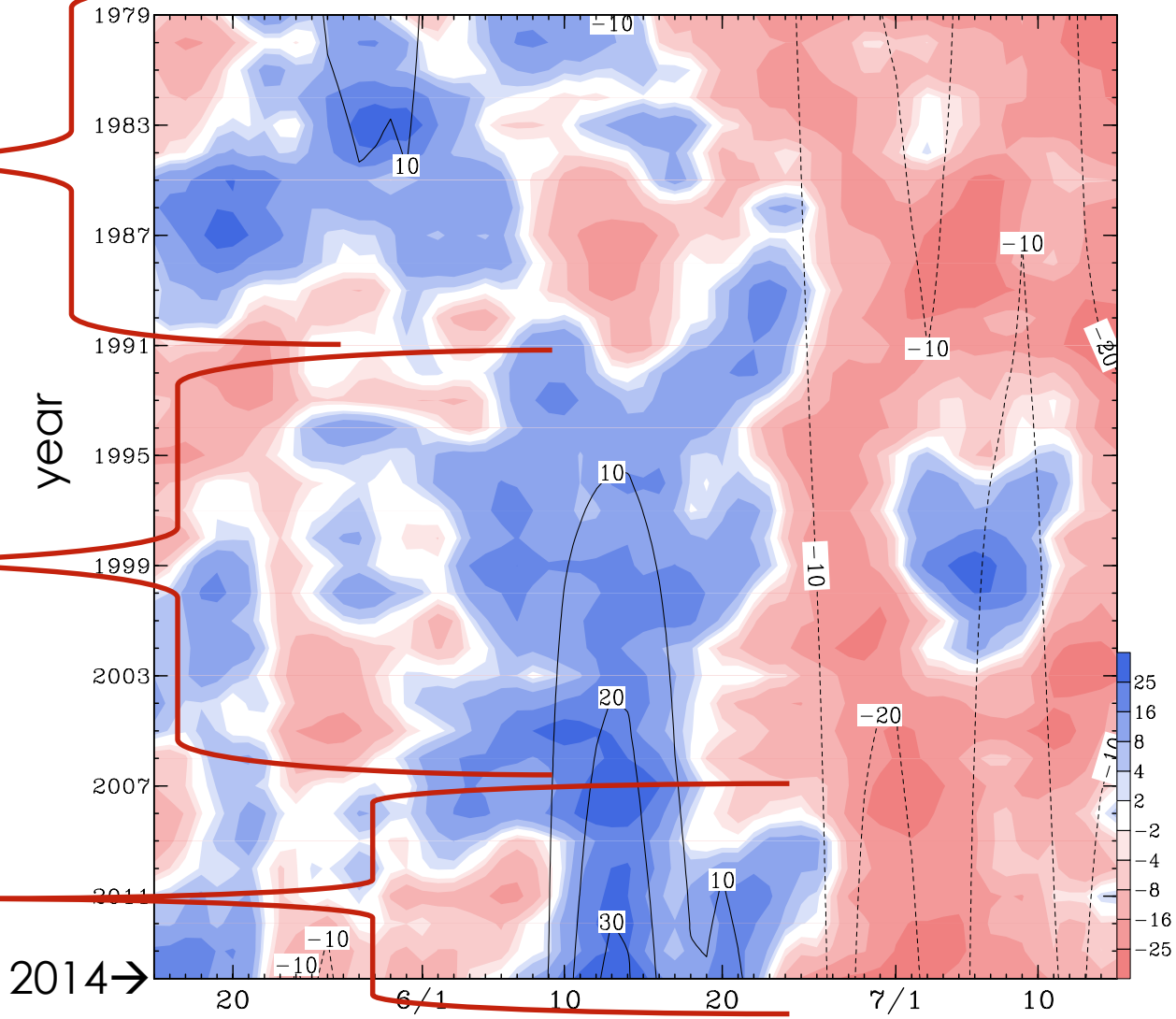


Each year's peak daily ΔOLR
(running means applied)

Textbook Meiyu Season

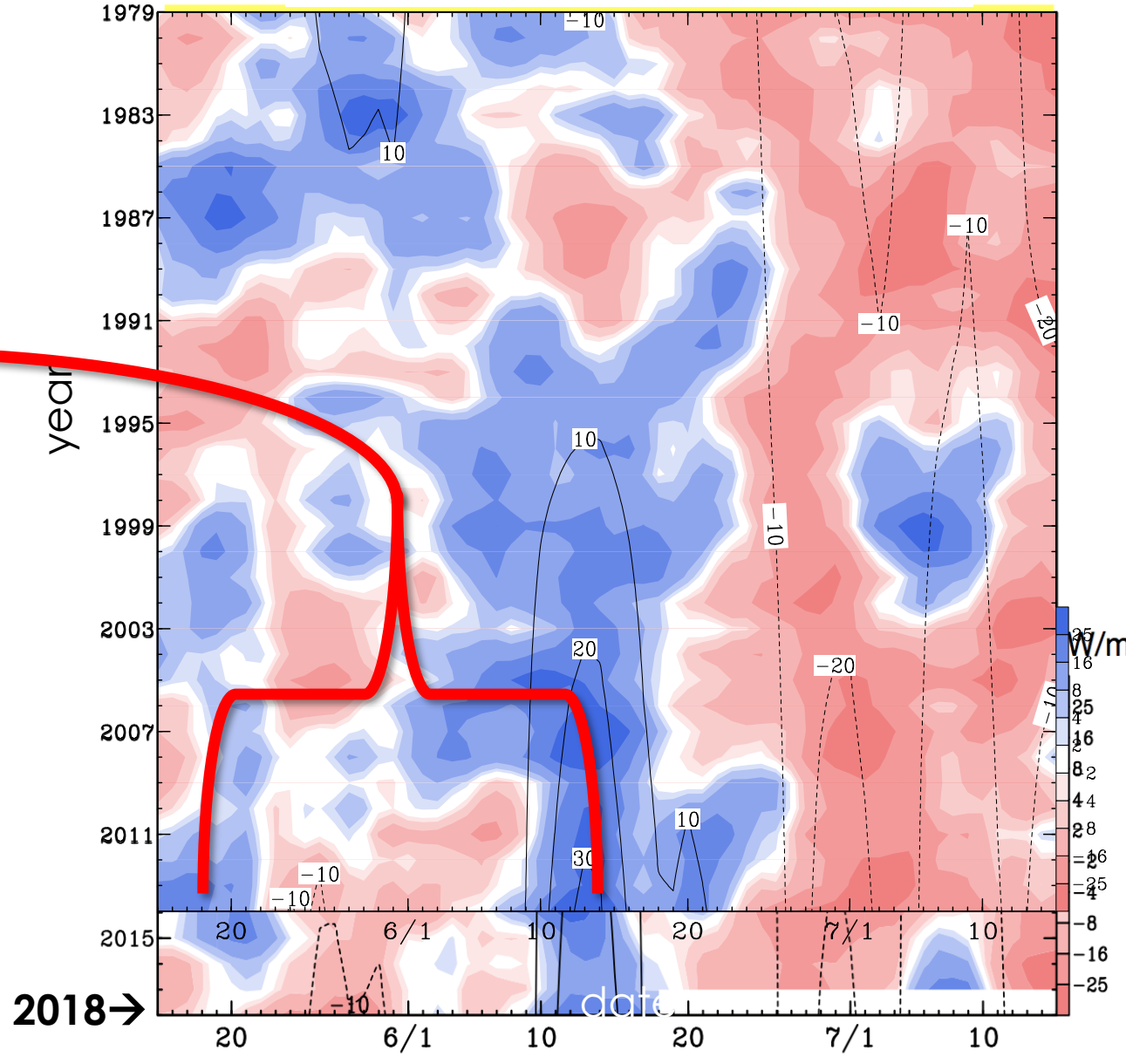
Shifted Meiyu (same length)

Shortened, enhanced Meiyu



(Wang et al. 2016)

Each year's peak daily ΔOLR
(running means applied)

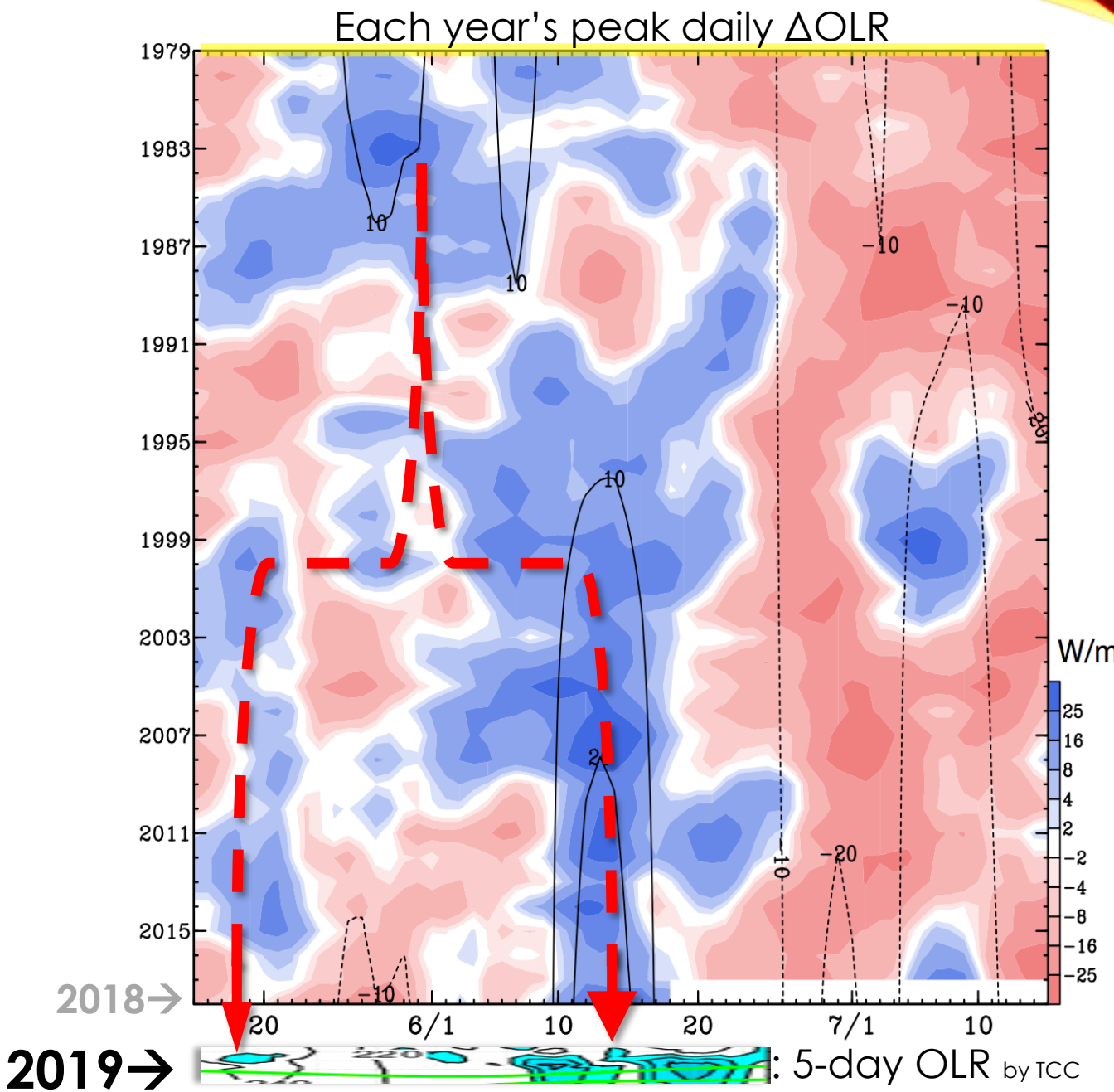


Energized at subseasonal timescale…

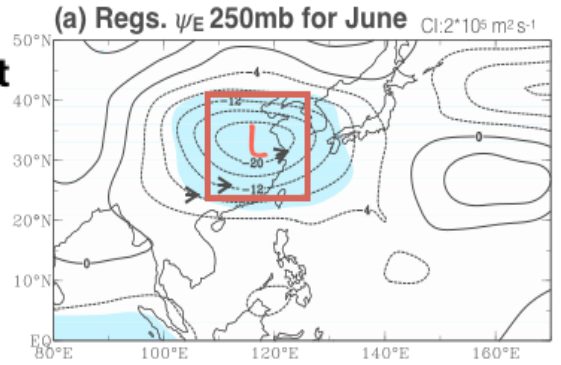
今年呢？

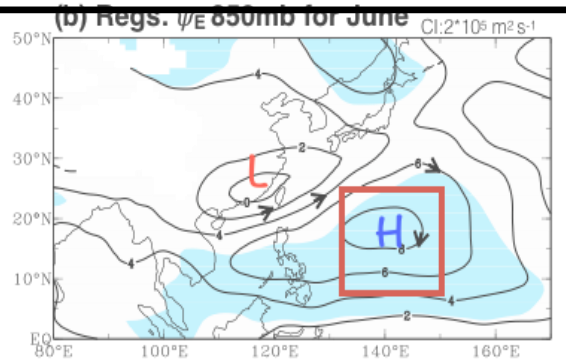
梅雨季第6道鋒面到 氣象局發布大雨特報

2019年6月22日



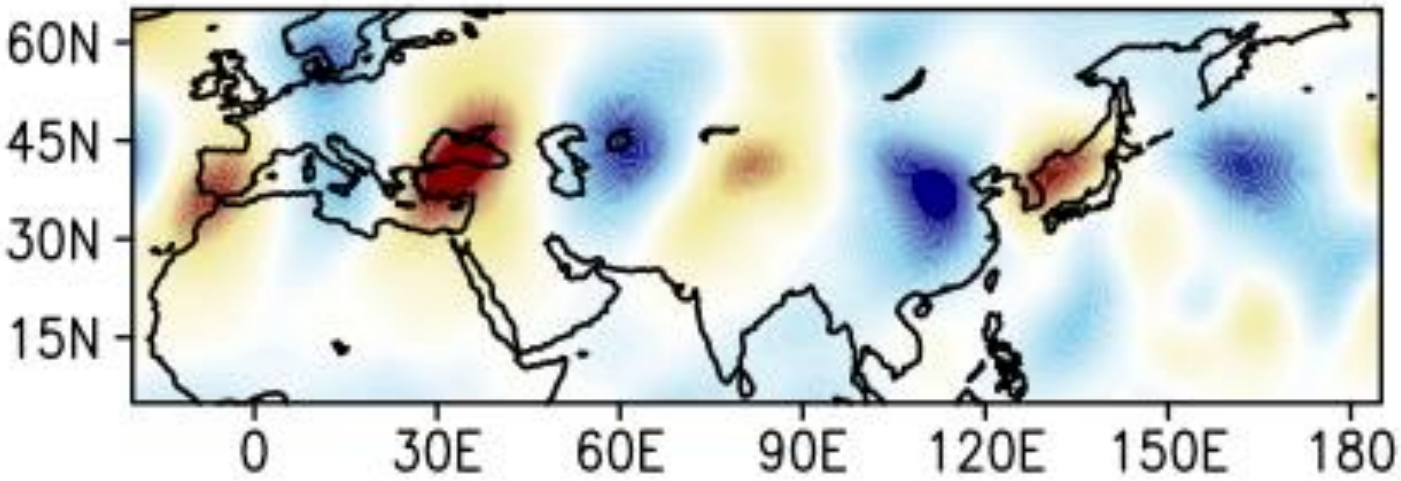
AA ⇛ Equatorward shift of polar jet
Amplification of quasi-stationary short-wave trains
vs. poleward shift of subtropical jet





(Coumou… and *Wang* 2018; NCOM)

The emerging feature:



(a) Wave train of v-wind 200 hPa (6/27-7/3)

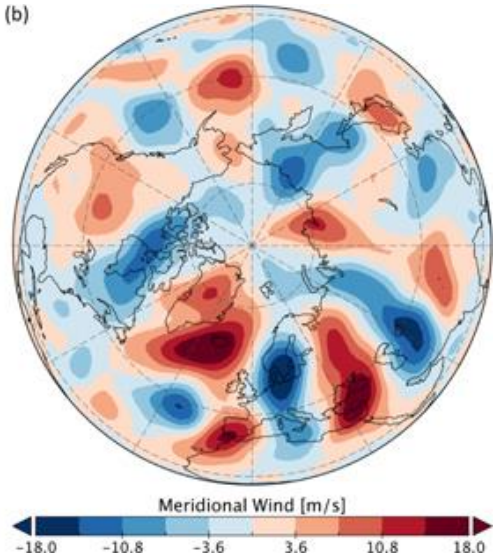
Environmental Research Letters

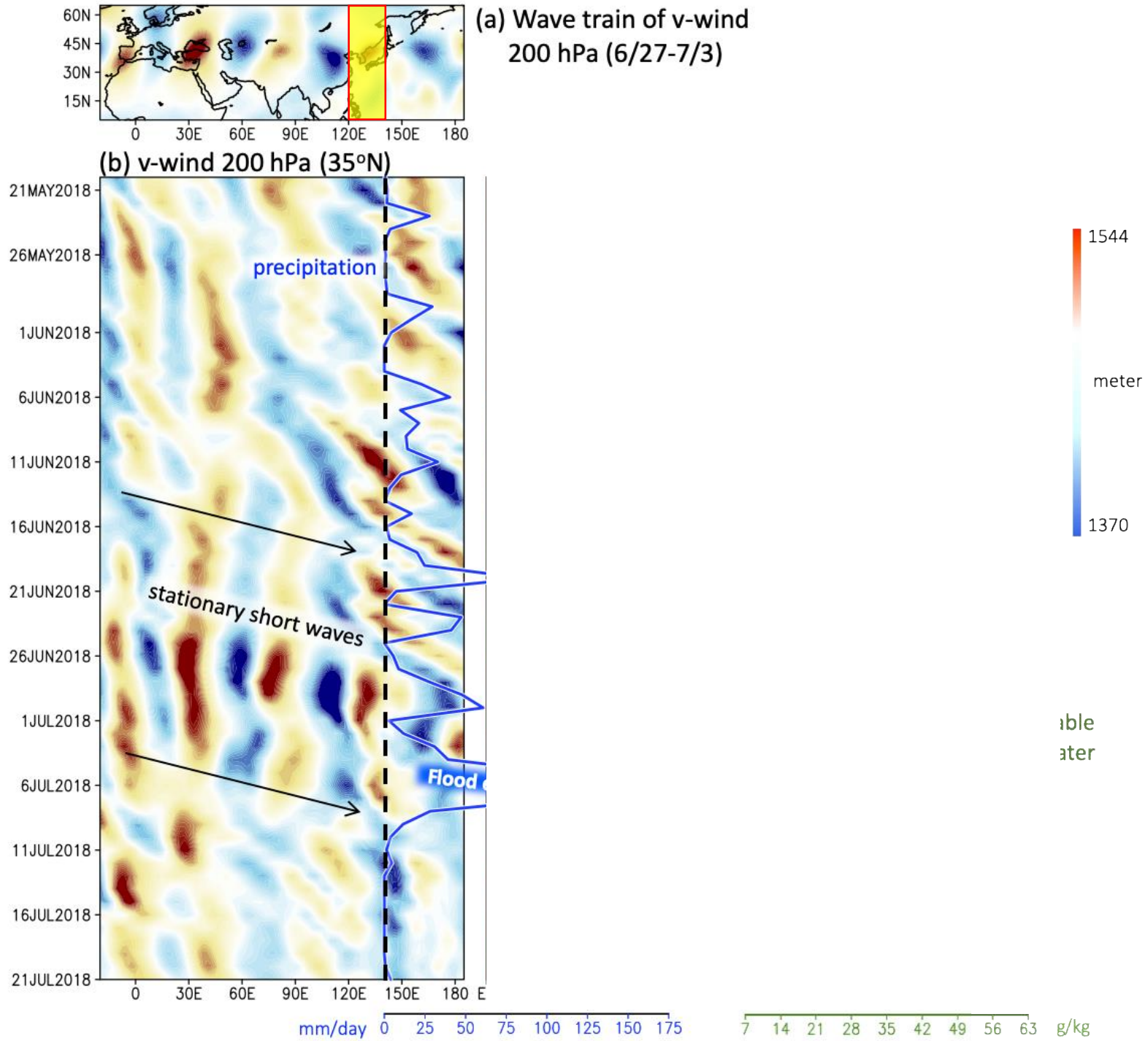
LETTER • OPEN ACCESS

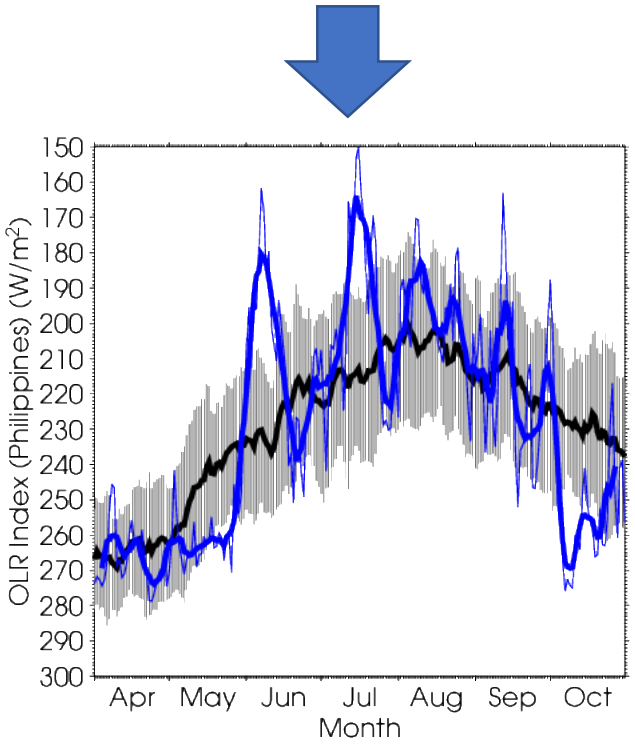
Extreme weather events in early summer 2018 connected by a recurrent hemispheric wave-7 pattern

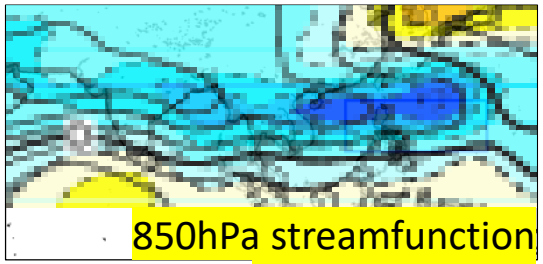
Kai Kornhuber[1,2], Scott Osprey[1,2], Dim Coumou[3,4], Stefan Petri[3], Vladimir Petoukhov[3], Stefan Rahmstorf[3] and Lesley Gray[1,2]

Published 26 April 2019 • © 2019 The Author(s). Published by IOP Publishing Ltd




(a) Wave train of v-wind
200 hPa (6/27-7/3)
60N
45N
30N
15N
0
30E
60E
90E
120E
150E
180
(b) v-wind 200 hPa (35°N)
21MAY2018
26MAY2018
1JUN2018
6JUN2018
11JUN2018
16JUN2018
21JUN2018
26JUN2018
1JUL2018
6JUL2018
11JUL2018
16JUL2018
21JUL2018
precipitation
stationary short waves
Flood
1544
meter
1370
able
ater
mm/day 0 25 50 75 100 125 150 175
7 14 21 28 35 42 49 56 63 g/kg

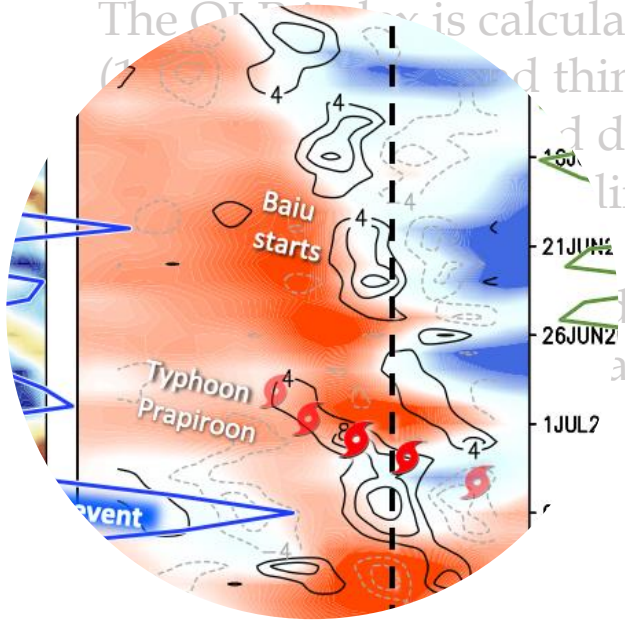




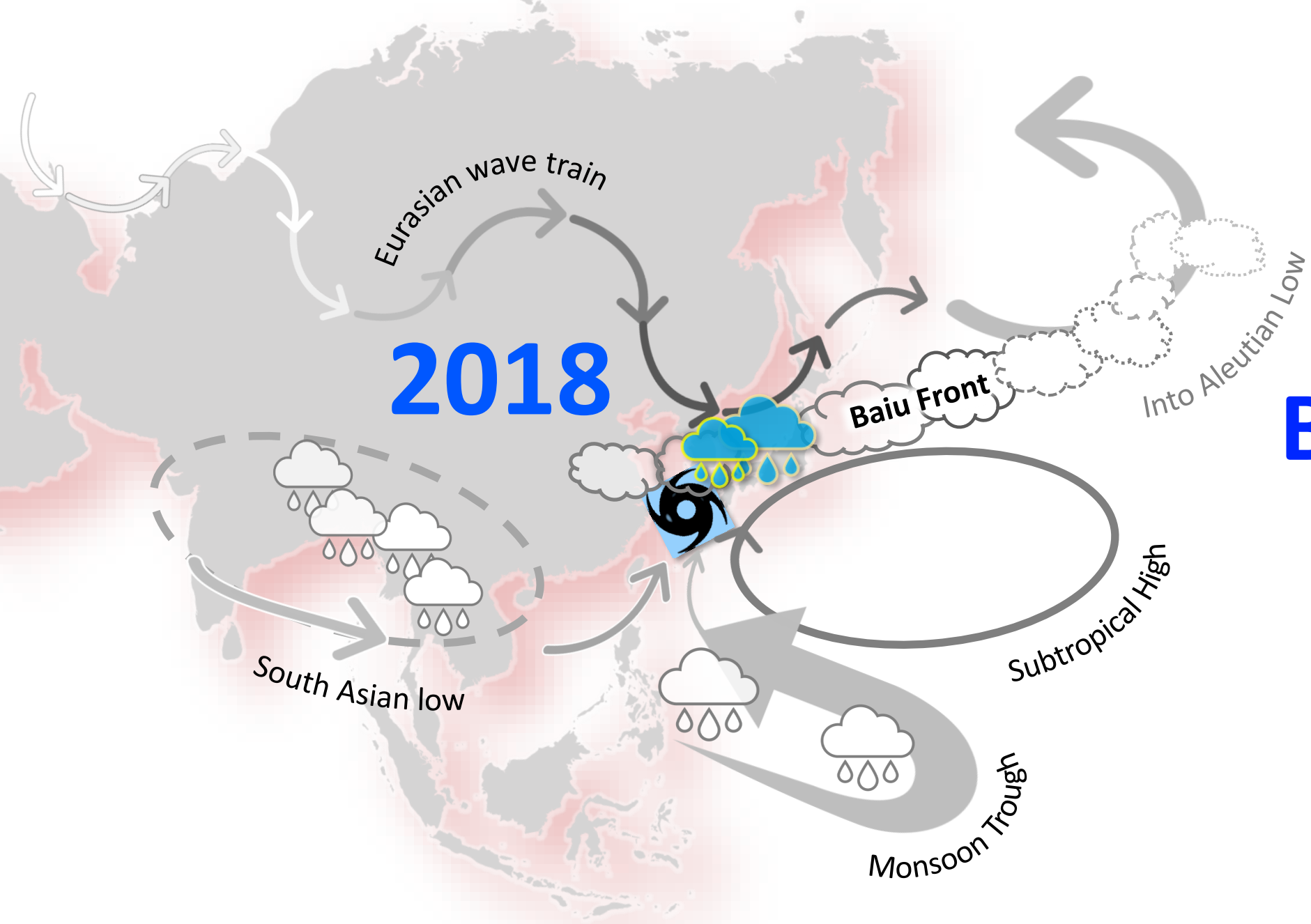
850hPa streamfunction
7/12-7/18 mean

Time-series representation of OLR (W/m²) averaged over the Philippines (shown by the rectangle on the bottom: 10°N - 20°N, 115°E - 140°E)

The OL[illegible]x is calculated after Wang and Fan (2[illegible]d thin blue lines indicate seven-[illegible]d daily mean values, [illegible] line denotes the normal (i.e., [illegible] and the gray shading shows [illegible]d deviation calculated for the [illegible]al.



気象庁
Japan Meteorological Agency


Eurasian wave train
2018
Baiu Front
Into Aleutian Low
South Asian low
Subtropical High
Monsoon Trough

Baiu phase

Eurasian wave train

Baiu Front

Into Aleutian Low

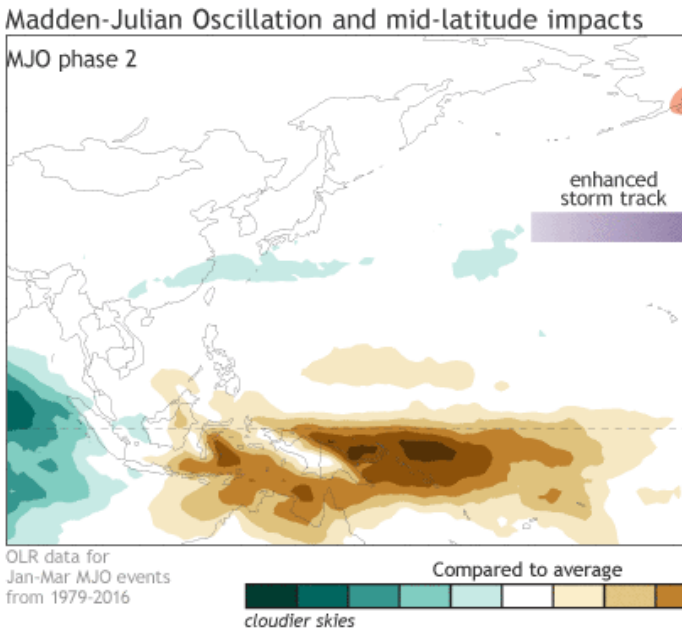
Break phase

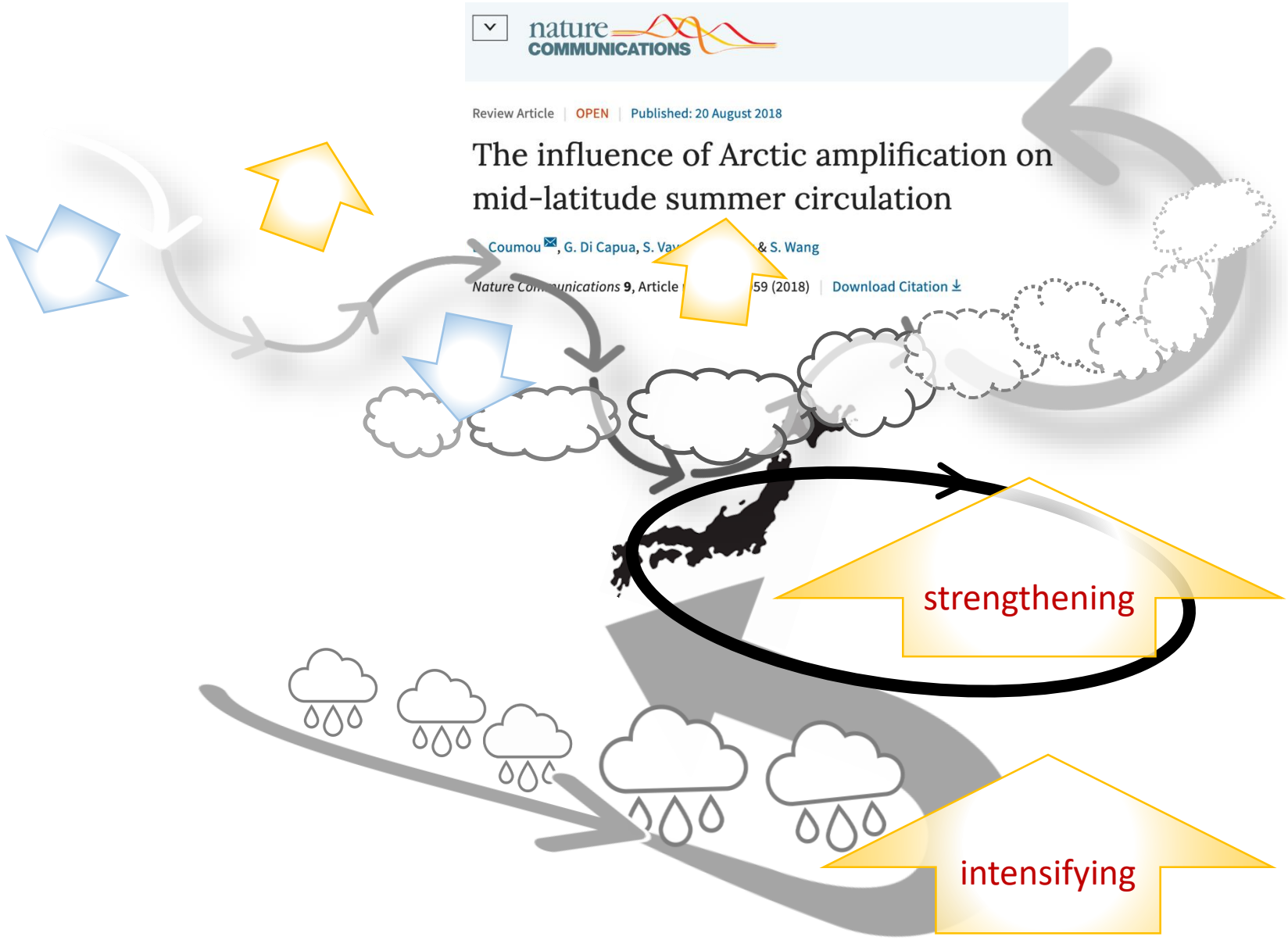
Subtropical High

South Asian low

Monsoon Trough

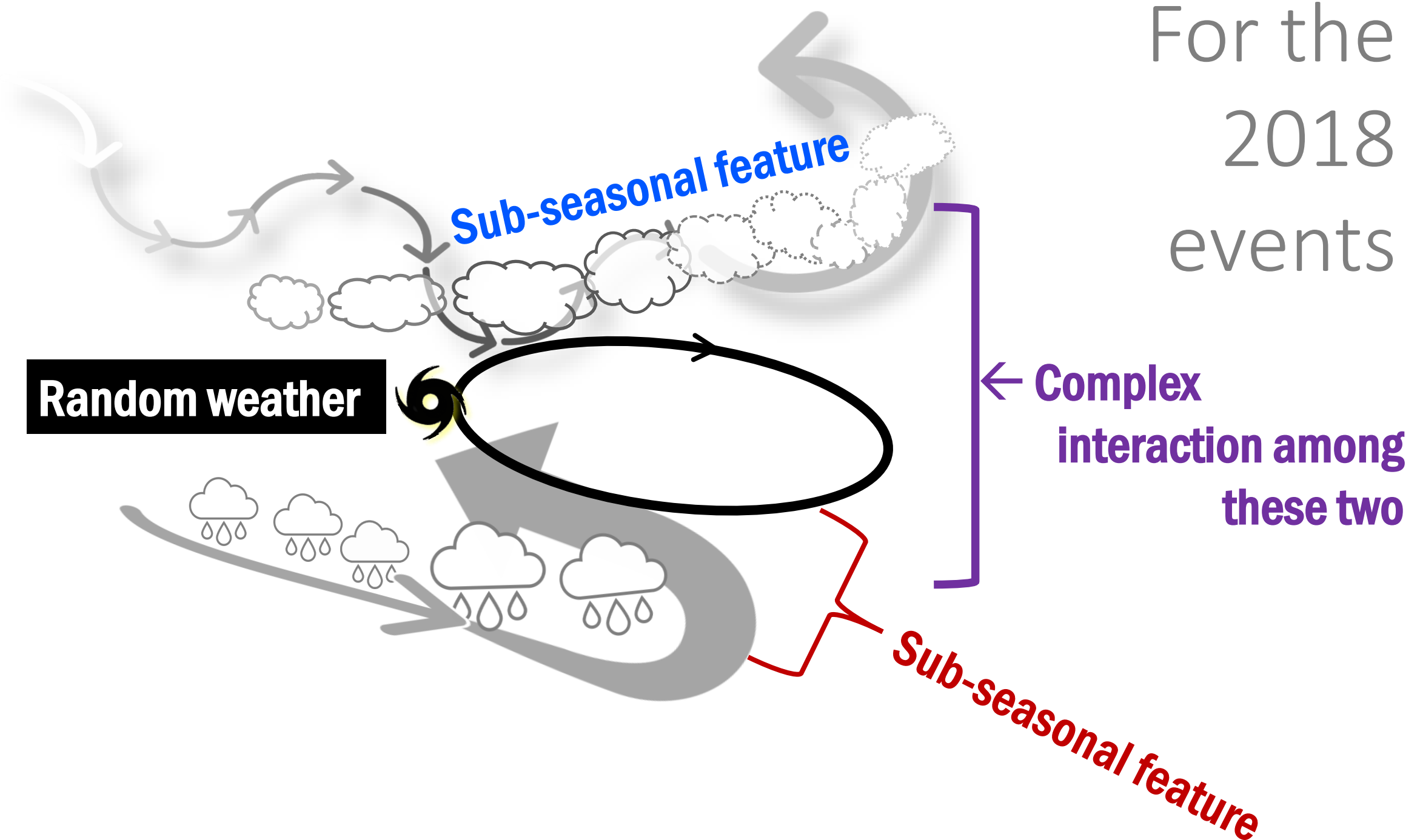
2018





Under warmer climate

For the 2018 events



SOLA, 2019, Vol. 15A, 1−7, doi:10.2151/sola.15A-001

Predictability of Record-Breaking Rainfall in Japan in July 2018: Ensemble Forecast Experiments with the Near-Real-Time Global Atmospheric Data Assimilation System NEXRA

Shunji Kotsuki[1, 2], Koji Terasaki[1], Kaya Kanemaru[3], Masaki Satoh[3, 4], Takuji Kubota[5], and Takemasa Miyoshi[1, 2, 4, 6, 7]

[1]*RIKEN Center for Computational Science, Kobe, Japan*

For the 2018

Sub-seasonal feature

← **Complex interaction among these two**

Sub-seasonal feature

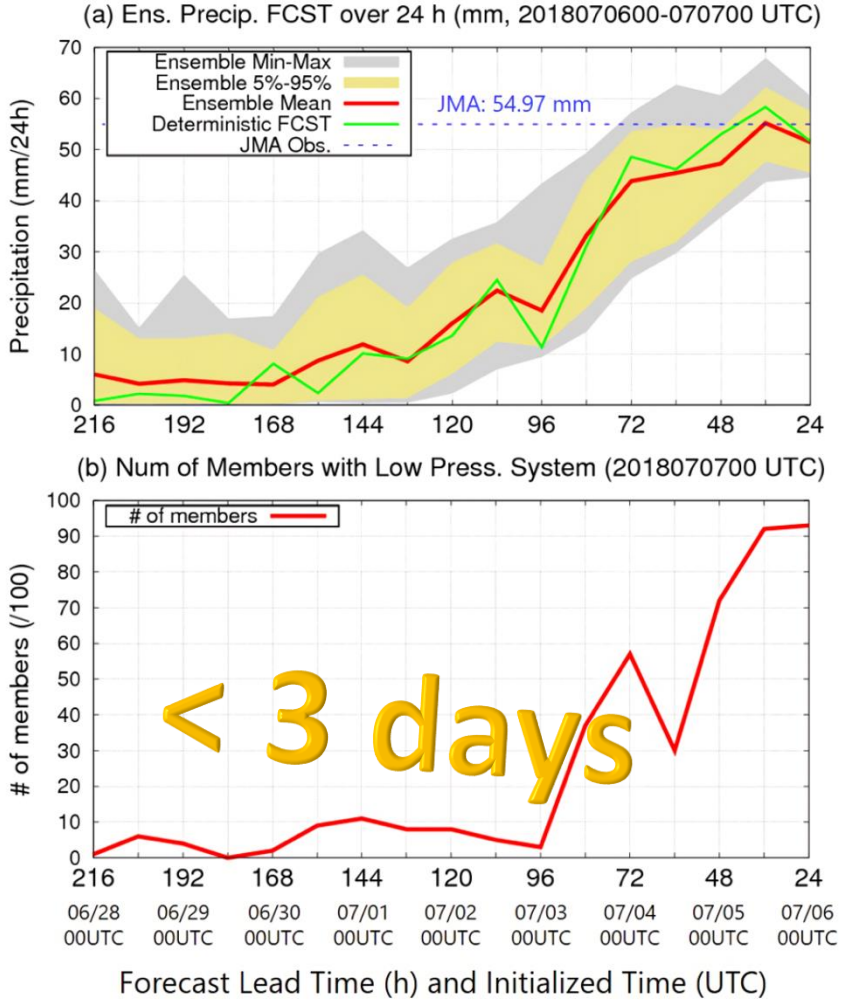
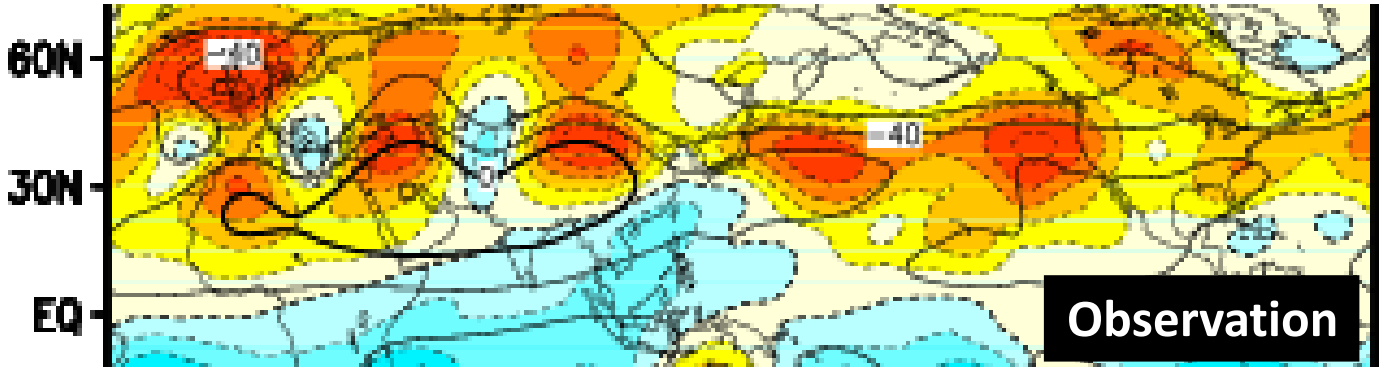


Fig. 6. (a) Domain-averaged accumulated 24-h precipitation (mm) over

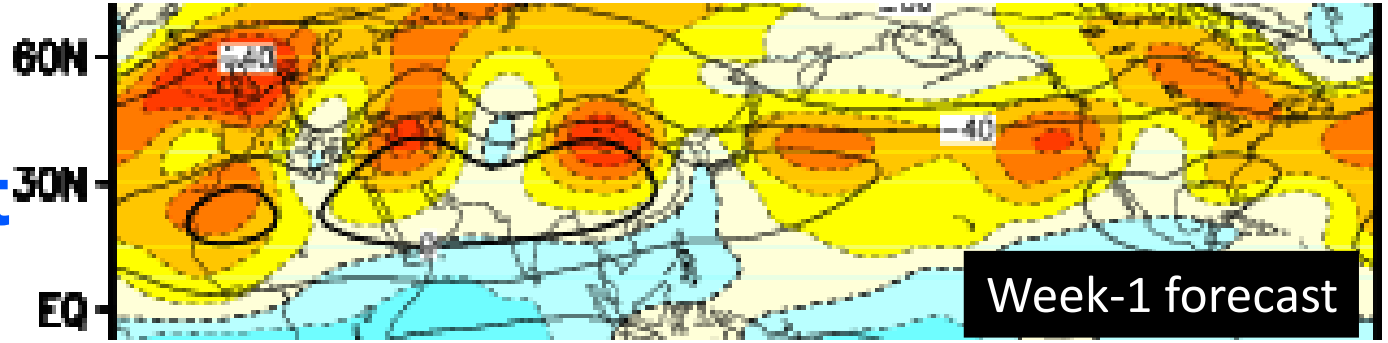
Short-wave train leading up to heavy rainfall

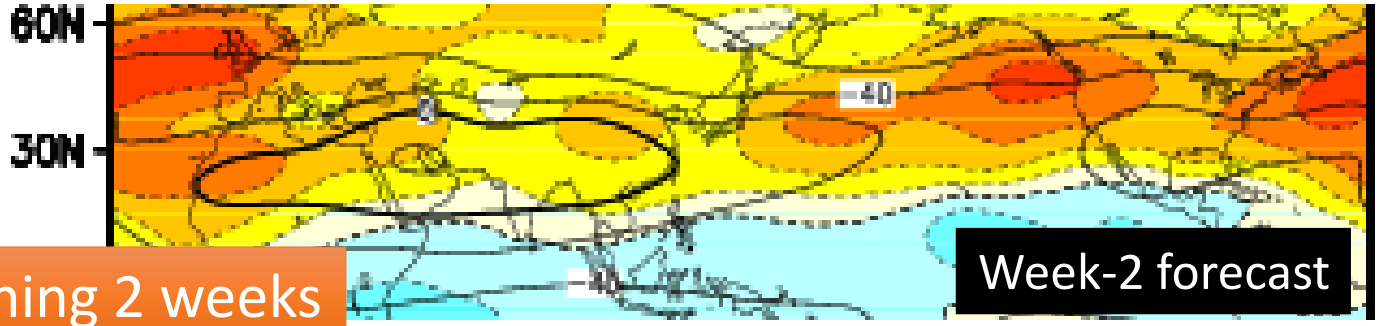
For the 2018 events

200hPa streamfunction
6/23-7/1 mean



Sub-seasonal forecast





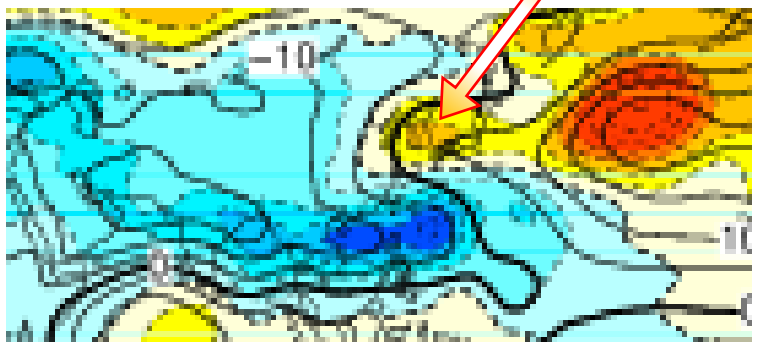
Reaching 2 weeks

JMA

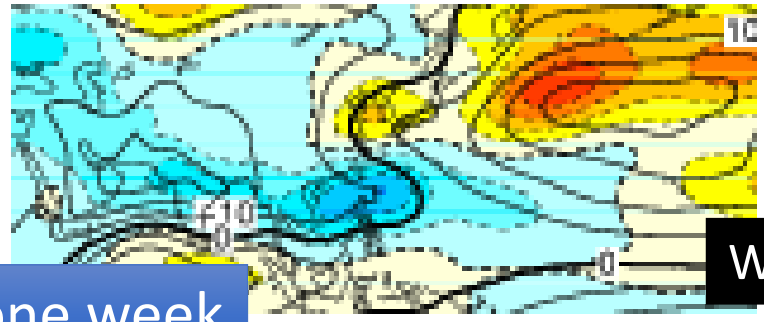
For the 2018 events

850hPa streamfunction
7/12-7/18 mean

High pressure leading to heat wave



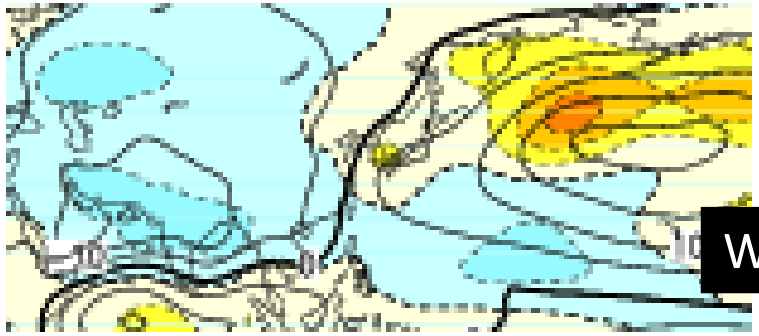
Observation



Week-1 forecast

Sub-seasonal forecast

Barely one week



Week-2 forecast

JMA

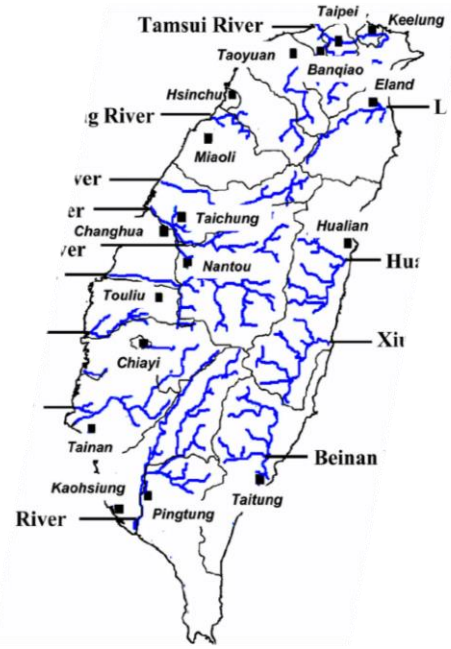
P. C., S., Nakatani, T., and Misumi, R. 2019

For the 2018 events

Paper:

Hydrological Simulation of Small River Basins in Northern Kyushu, Japan,

July 5–6, 2017. Many small mountainous river basins were subject to the core of this heavy rainfall event and were flooded, but no hydrological measurements were taken in most of these flooded basins during the event. There are few gauging stations in this mountainous region, and most that do exist are designed to monitor the larger watersheds. Consequently, it is difficult to determine the hydrological properties of the small subbasins within these larger watersheds. Therefore,



Forecast limit – *only* 3 days? Needs to improve subseasonal prediction (tropics vs. midlatitude)

Hydrologic forecast – peak flow not predicted (or not in time)

Projection – the EASM lifecycle is amplified under warming hence increasing the chance for compound extremes

Summary:

July 2018 Japan flood + heat wave

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