Climate Change and extreme heat wave events in Korea, 2018

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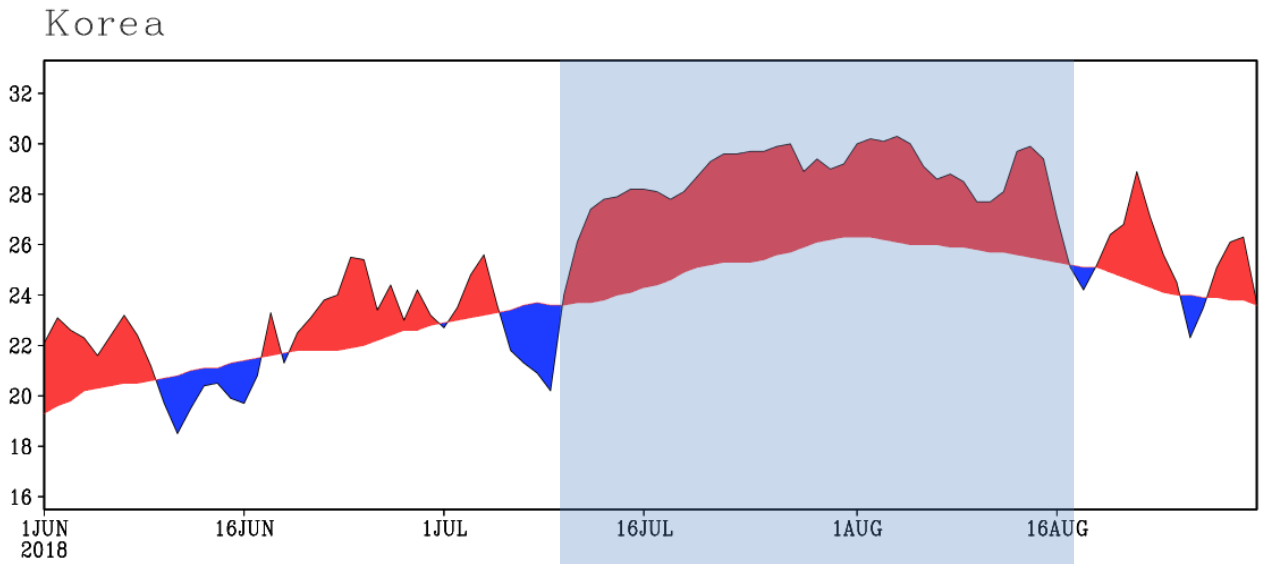
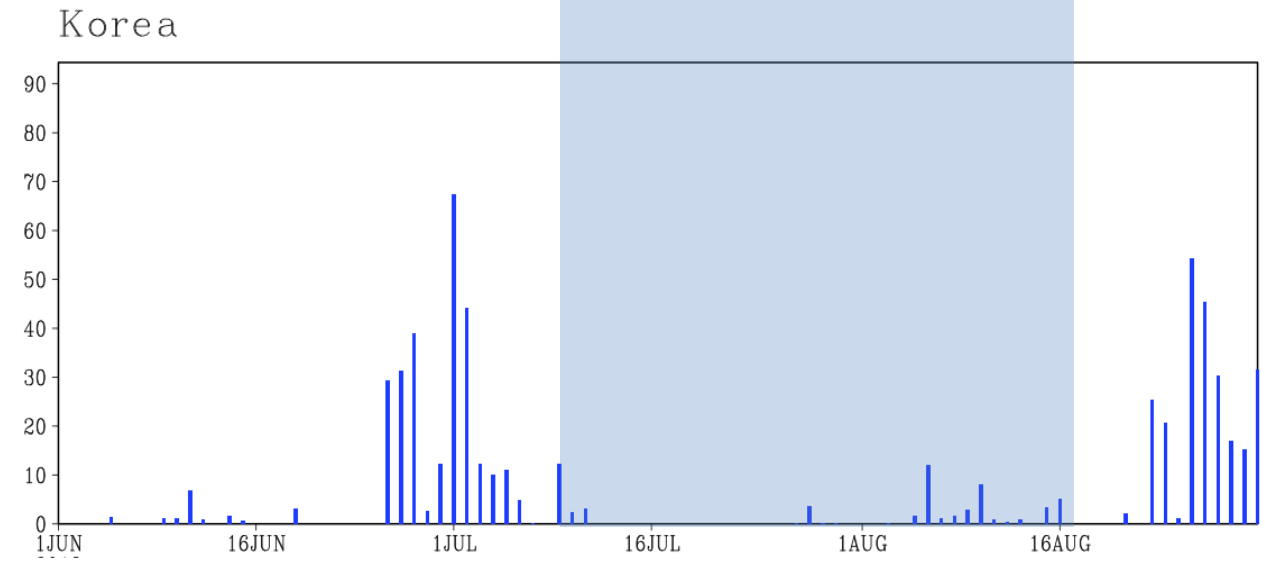
Hanyang University

• 2018 Summer (6.1-8.31) Temperature & Precipitation



Temperature



Precipitation

http://co-anal.kma.go.kr/

• Mean Temperature during June-July-August (JJA)

number of year: 46 (1973–2018)

year 2018: 25.4 (rank=1) normal(81–10) : 23.6

rank(01)	2018	25.4	rank(24)	2014	23.6
rank(02)	2013	25.4	rank(25)	2006	23.6
rank(03)	1994	25.3	rank(26)	1988	23.6
rank(04)	2010	24.9	rank(27)	1981	23.6
rank(05)	2016	24.8	rank(28)	1996	23.5
rank(06)	2012	24.7	rank(29)	1979	23.5
rank(07)	1978	24.7	rank(30)	1977	23.5
rank(08)	2017	24.5	rank(31)	1991	23.4
rank(09)	1973	24.5	rank(32)	1983	23.4
rank(10)	1990	24.3	rank(33)	1982	23.4
rank(11)	1984	24.3	rank(34)	2009	23.3
rank(12)	2001	24.2	rank(35)	1999	23.3
rank(13)	2000	24.2	rank(36)	1992	23.2
rank(14)	2005	24.1	rank(37)	1987	23.2
rank(15)	1985	24.1	rank(38)	2002	23.1
rank(16)	2011	24.0	rank(39)	1998	23.1
rank(17)	2004	24.0	rank(40)	1989	22.9
rank(18)	1997	24.0	rank(41)	1986	22.9
rank(19)	1975	23.9	rank(42)	1976	22.6
rank(20)	2007	23.8	rank(43)	1974	22.4
rank(21)	2015	23.7	rank(44)	2003	22.3
rank(22)	2008	23.7	rank(45)	1980	22.1
rank(23)	1995	23.7	rank(46)	1993	21.7

• 2018 Extreme heat wave during JJA

2018

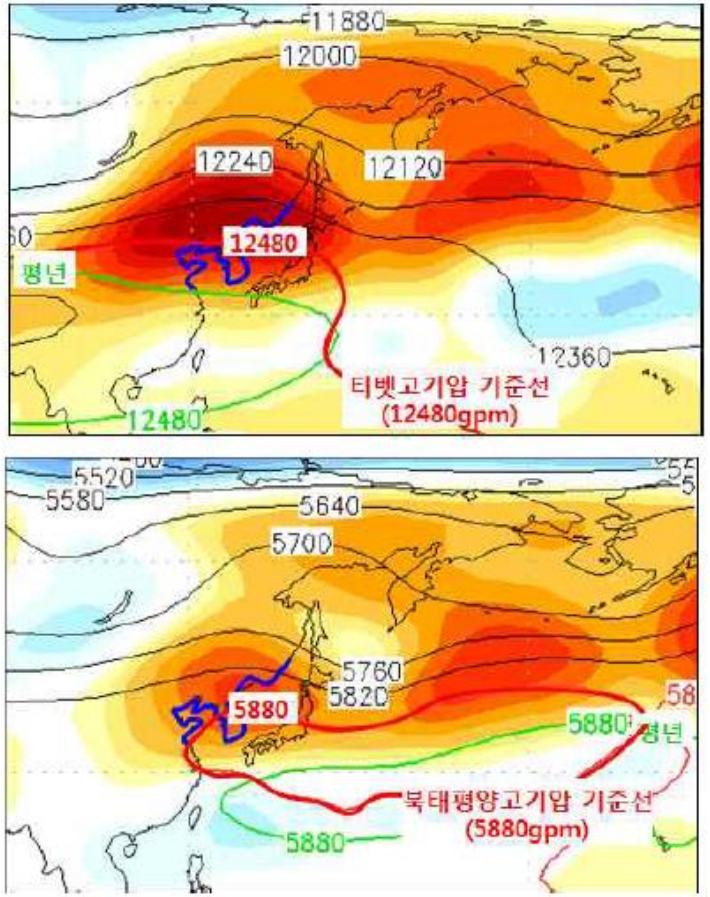


그림 1. 7월 (위) 200hPa와 (아래) 500hPa 고도 편차(빨강/파랑 채색: 평년보다 높/낮은 고도)

2018

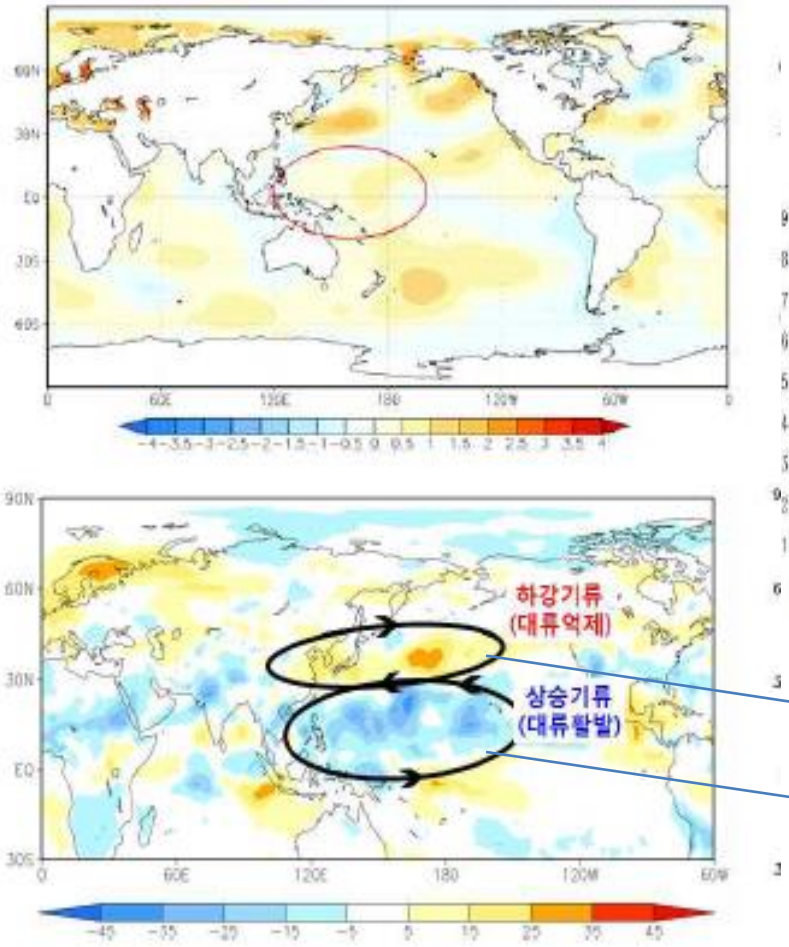


그림 2. 7월 (위) 해수면온도편차(빨강/파랑 채색: 평년보다 높/낮은 해수면온도)와
(아래) 지구장파복사[1] 편차(빨강/파랑 채색: 평년보다 대류(상승기류) 억제/활발 영역)

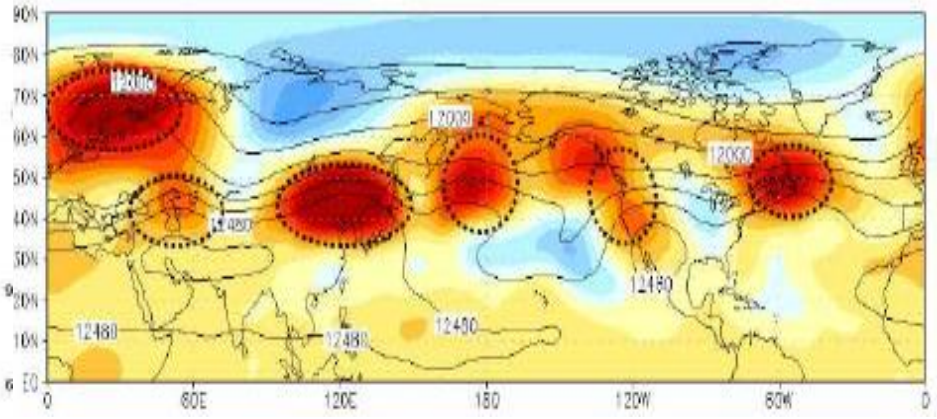


그림 3. 7월 200hPa 고도 편차(빨강/파랑 채색: 평년보다 높/낮은 고도)

Enhanced descending motion

Strong convection

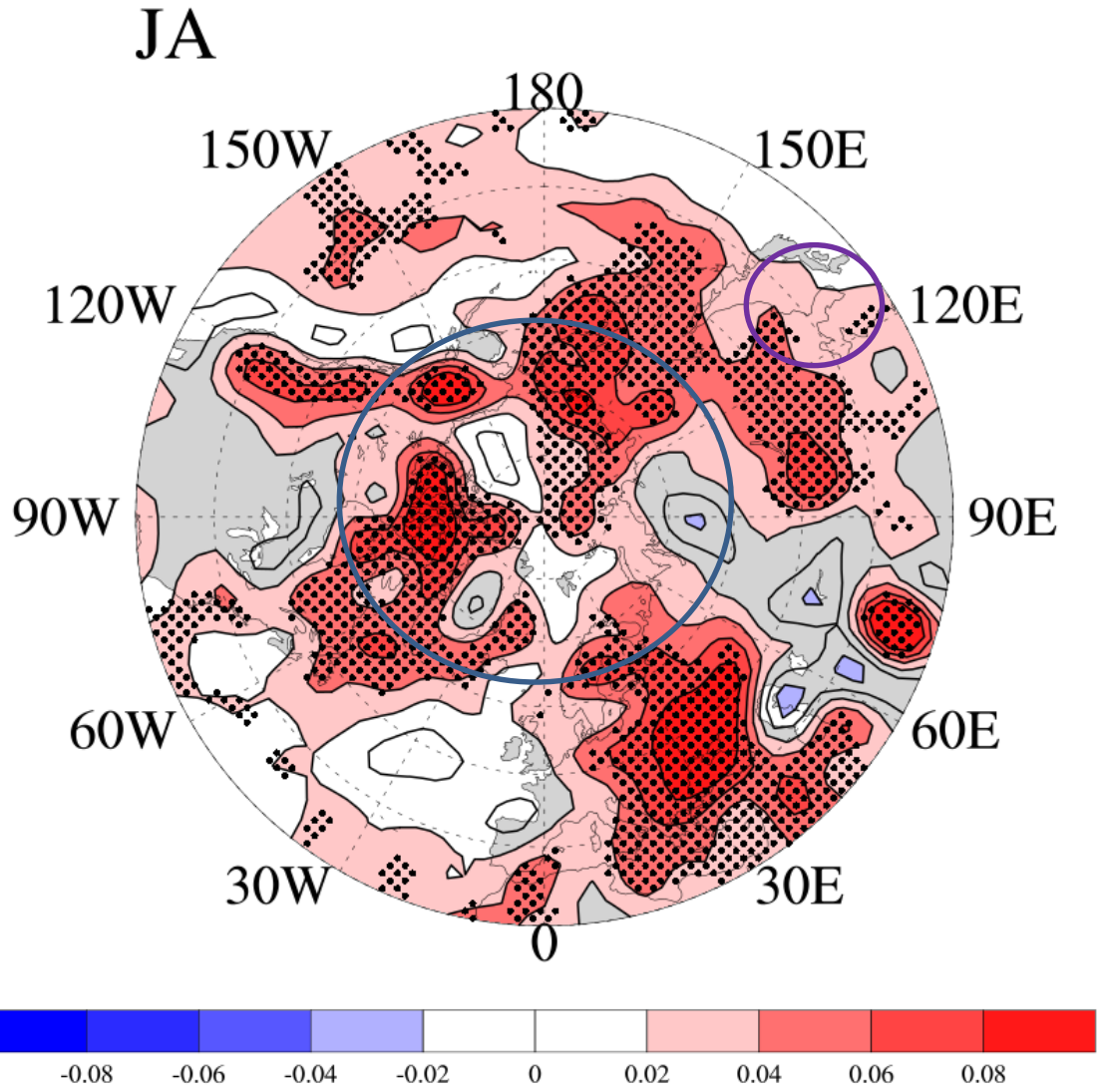
KMA 2018.08.17

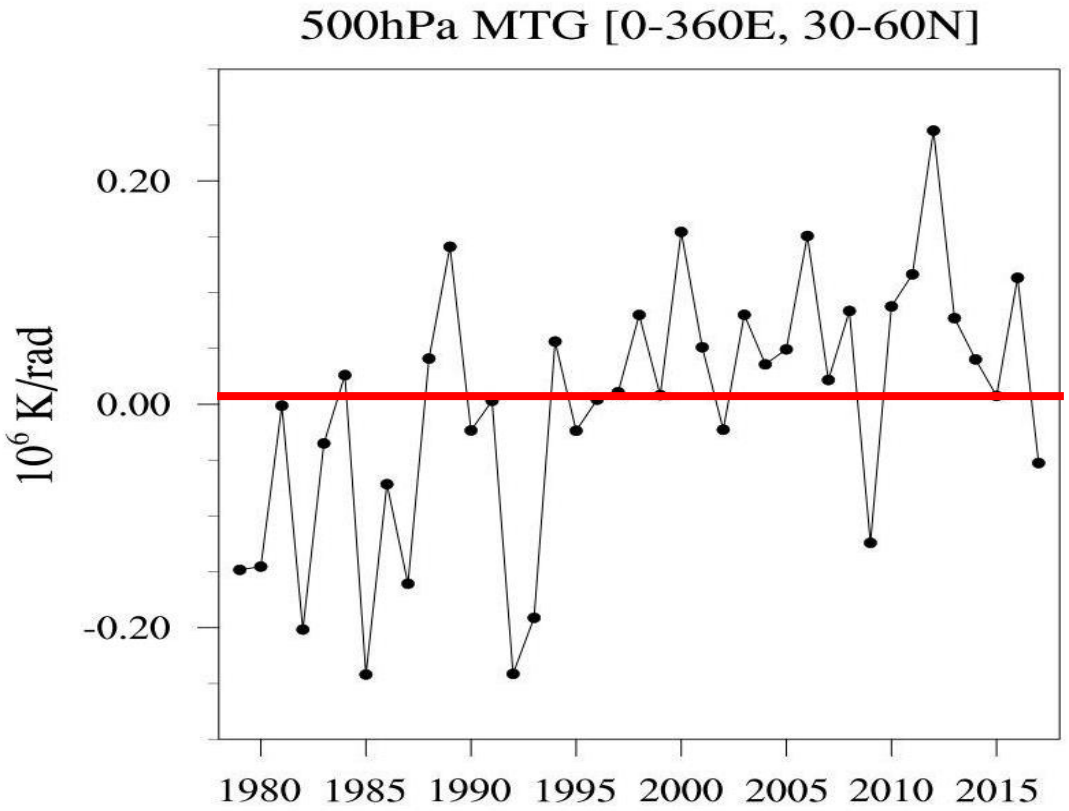
Large scale atmospheric circulation & Extreme Heat wave in South Korea

• Weakening of meridional Temperature gradient

June-July-August

Surface Air Temperature linear trend (1979-2017)

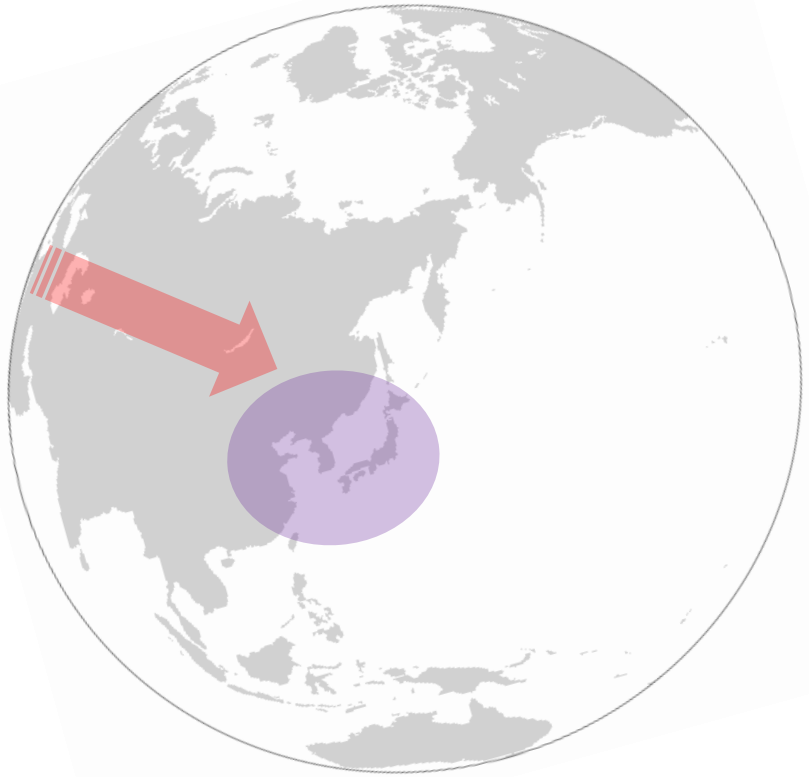




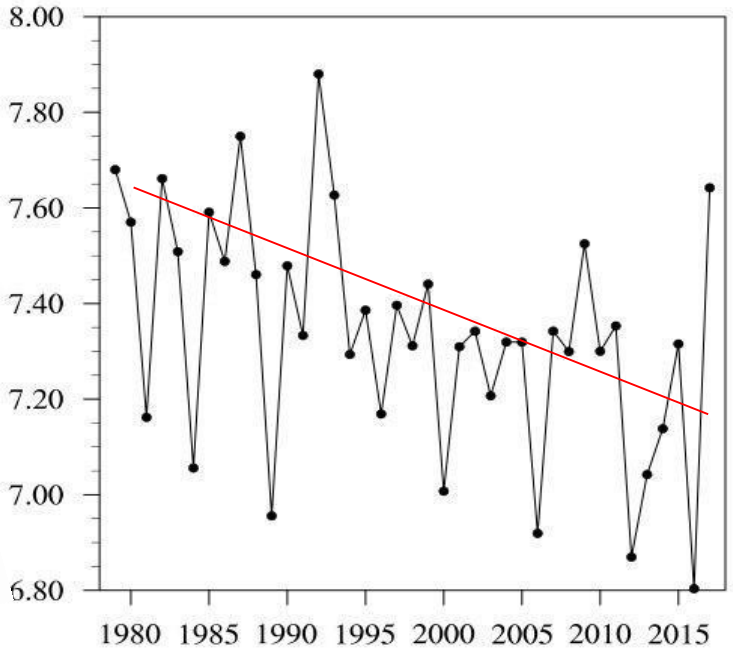
• Characteristics of atmospheric circulation in mid-latitude (30N-60N)

1979-2017 JJA	Correlation Coefficient
Meridional Temp. gradient & Zonal wind at 500hPa	-0.86**
Meridional Temp. gradient & Eddy Kinetic energy (2.5~6day)	-0.53**
Eddy Kinetic energy (2.5~6day) & Zonal wind at 500hpa	0.50**

• Eddy (2.5~6day) Kinetic energy in mid-latitudes [30N-60N] & zonal wind

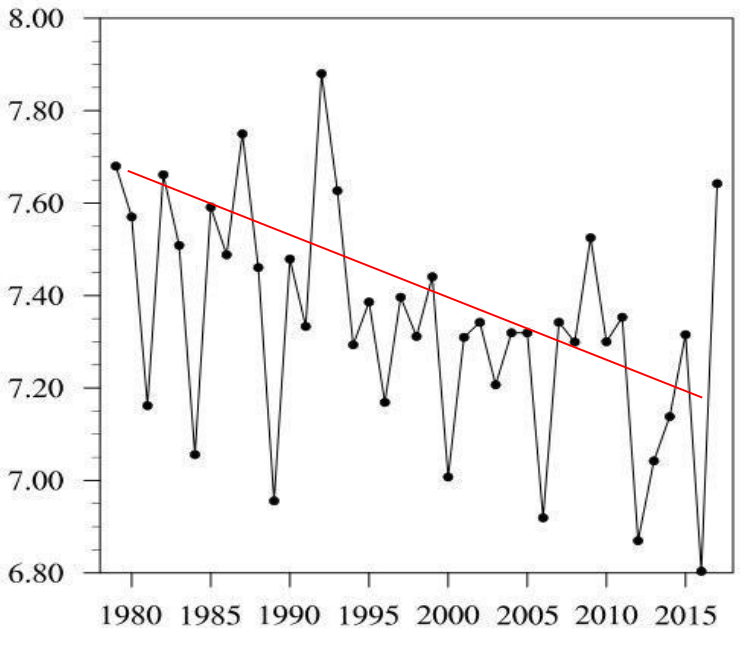


June-July-August
500hPa Eddy (2.5day-6day) Kinetic energy (30-60N, 0-360E) (1979-2017)



[m^2/s^2]

June-July-August
500hPa Zonal wind (30-60N, 0-360E) (1979-2017)



ECMWF Daily U wind (1979-2017)

• Characteristics of atmospheric circulation in mid-latitude (30N-60N)

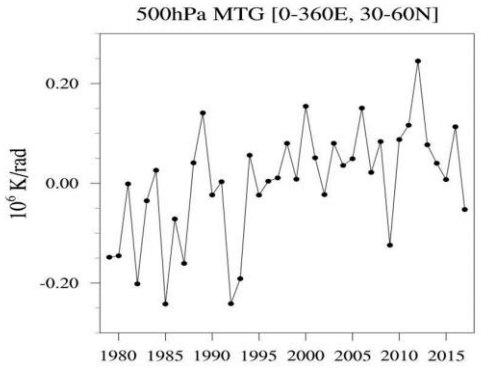
Arctic Amplification, temperatures increase

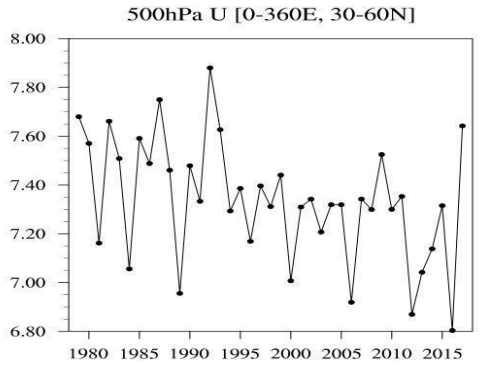
Higher geopotential heights, weaker westerly winds

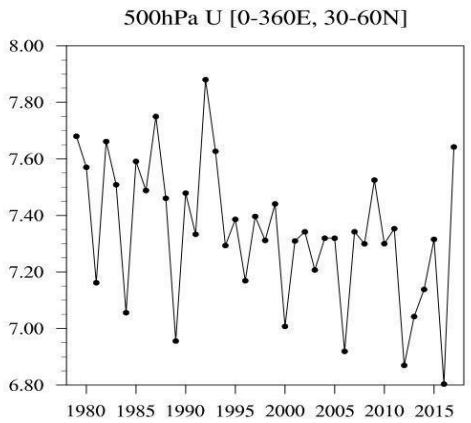
Wavier jet stream, blocking

Weather patterns move eastward more slowly

Extreme weather more likely

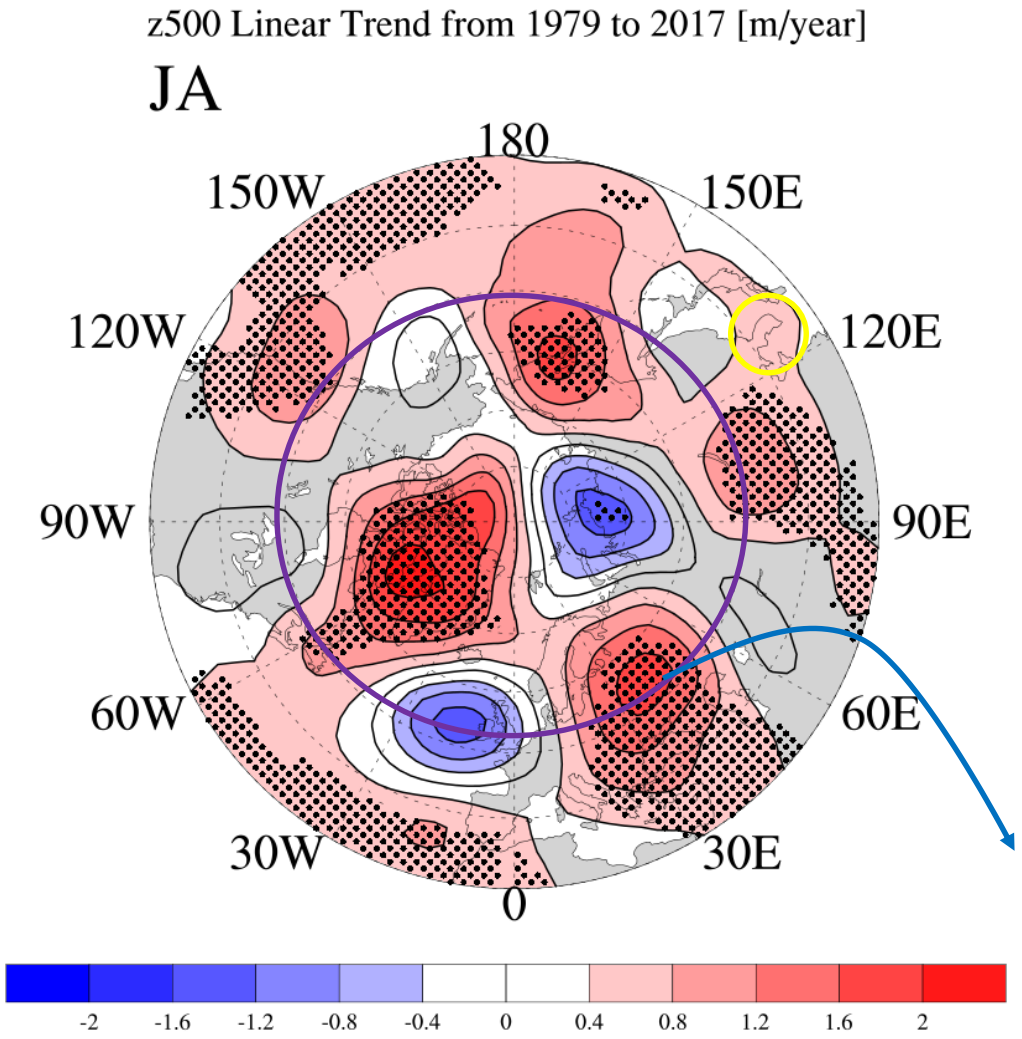






Overland et al. (2015)

• Linear trend of GPH in July-August



$$c = U - \frac{\beta}{k^2 + l^2}$$

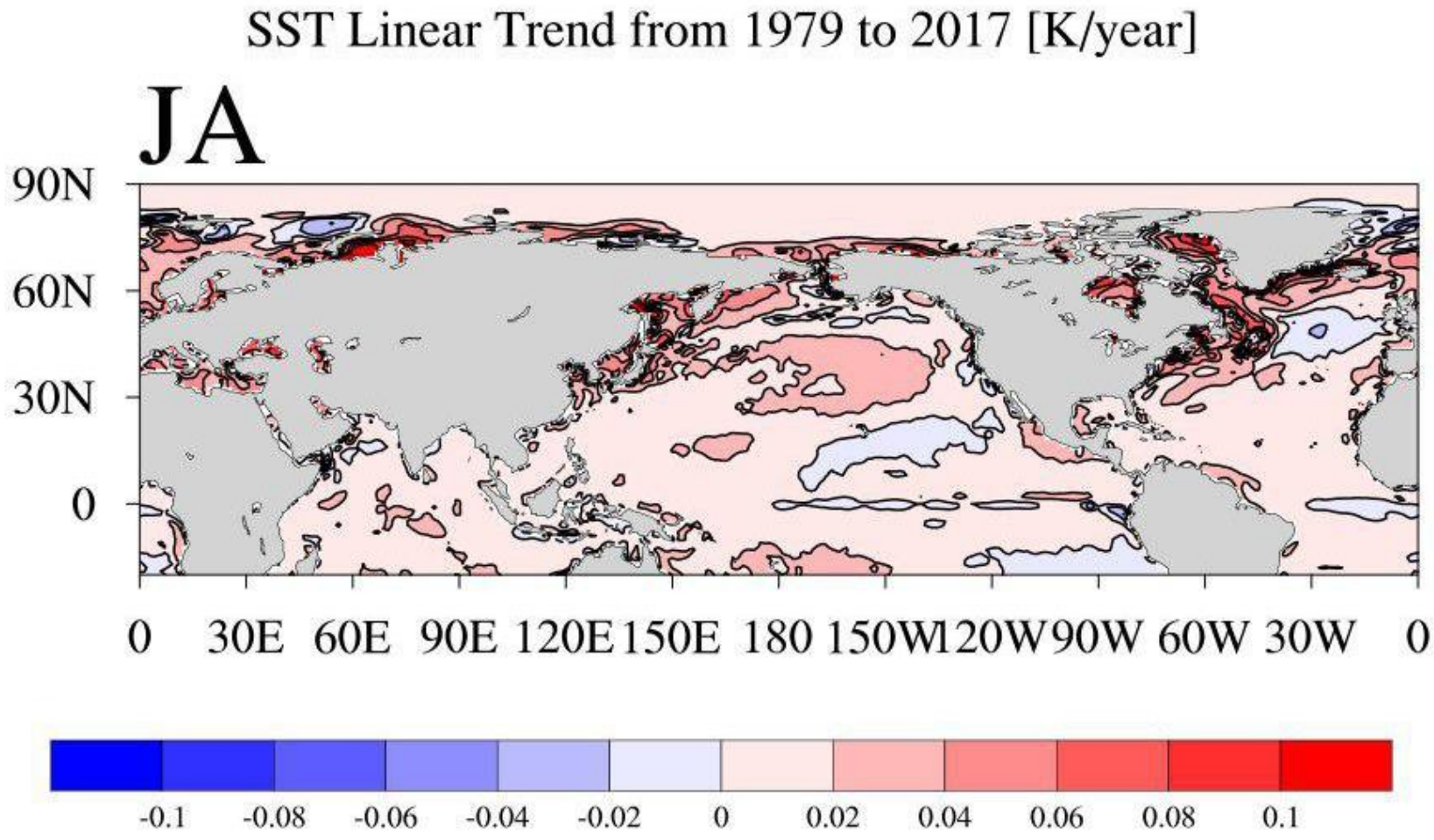
[C: Phase speed, U: Zonal wind,
K: zonal wave #, l: Meridional wave #]

Zonal wave # in which phase speed is zero : ≈ 6 (l=0)

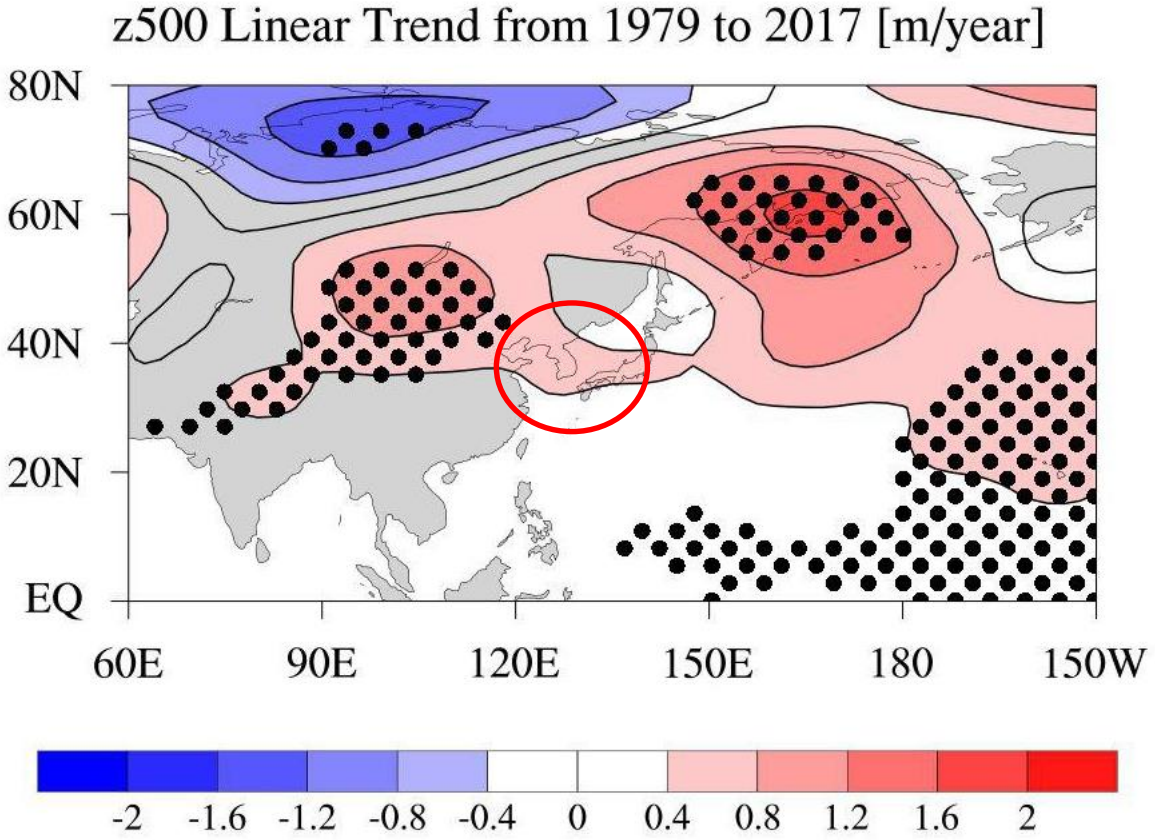
Zonal wave # ≈ 5.5

: Large scale environmental condition may act weather pattern
to move slowly eastward during summer

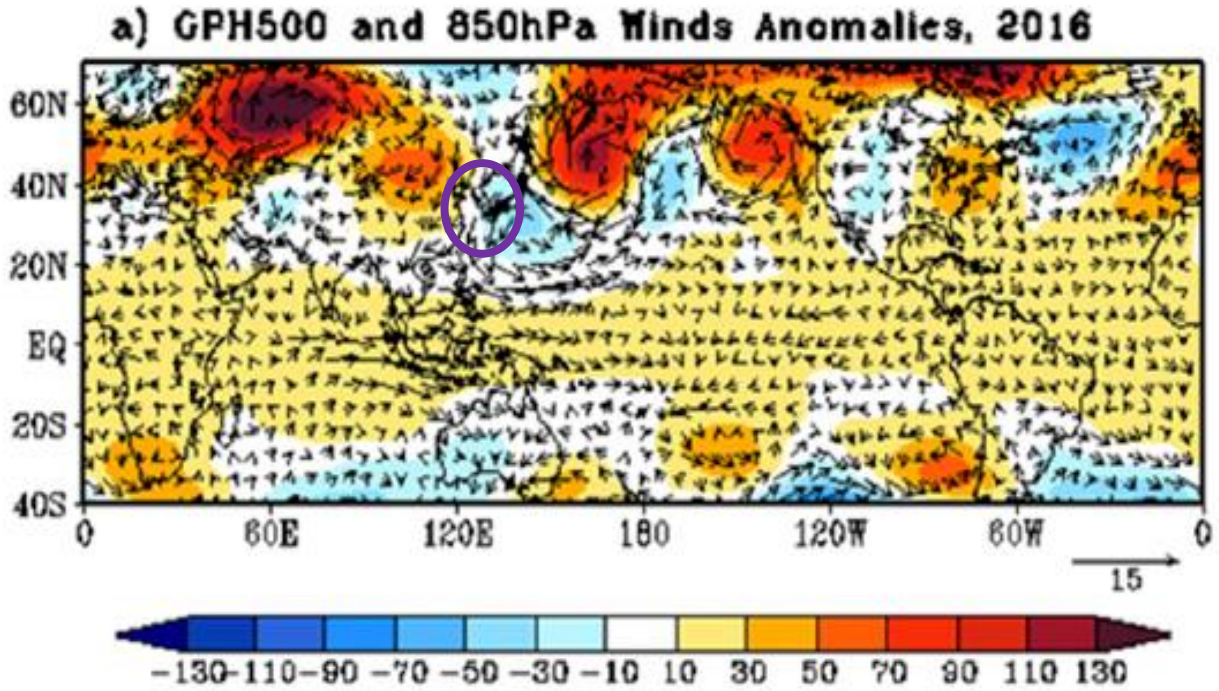
• Linear trend of SST in July-August



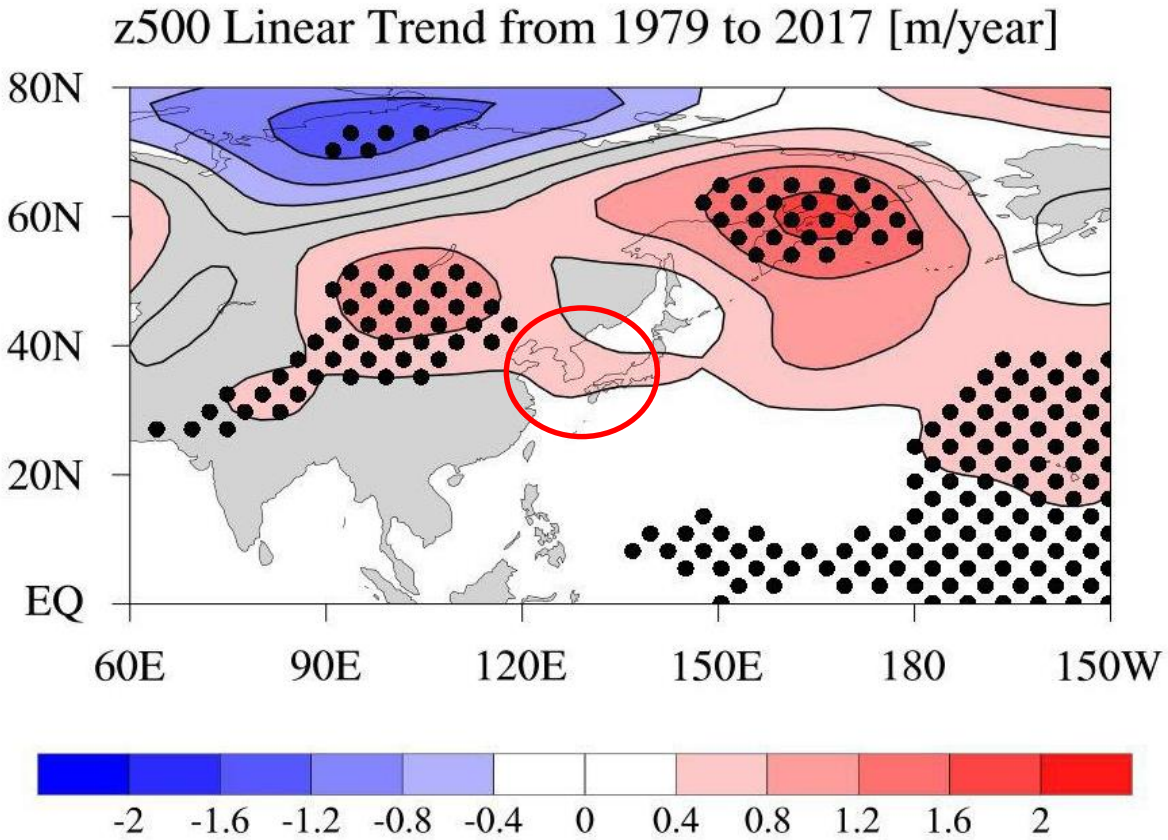
• Linear trend of GPH in July-August

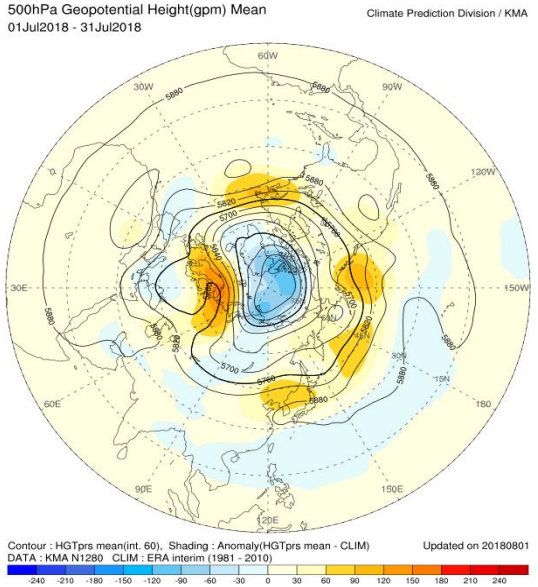


500hPa GPH August 2016

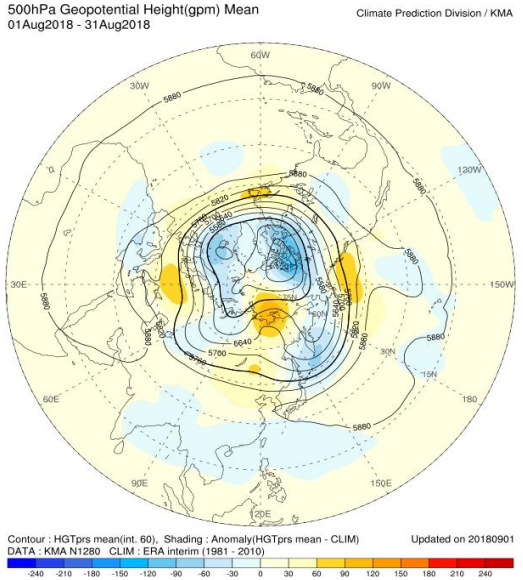


• Linear trend of GPH in July-August



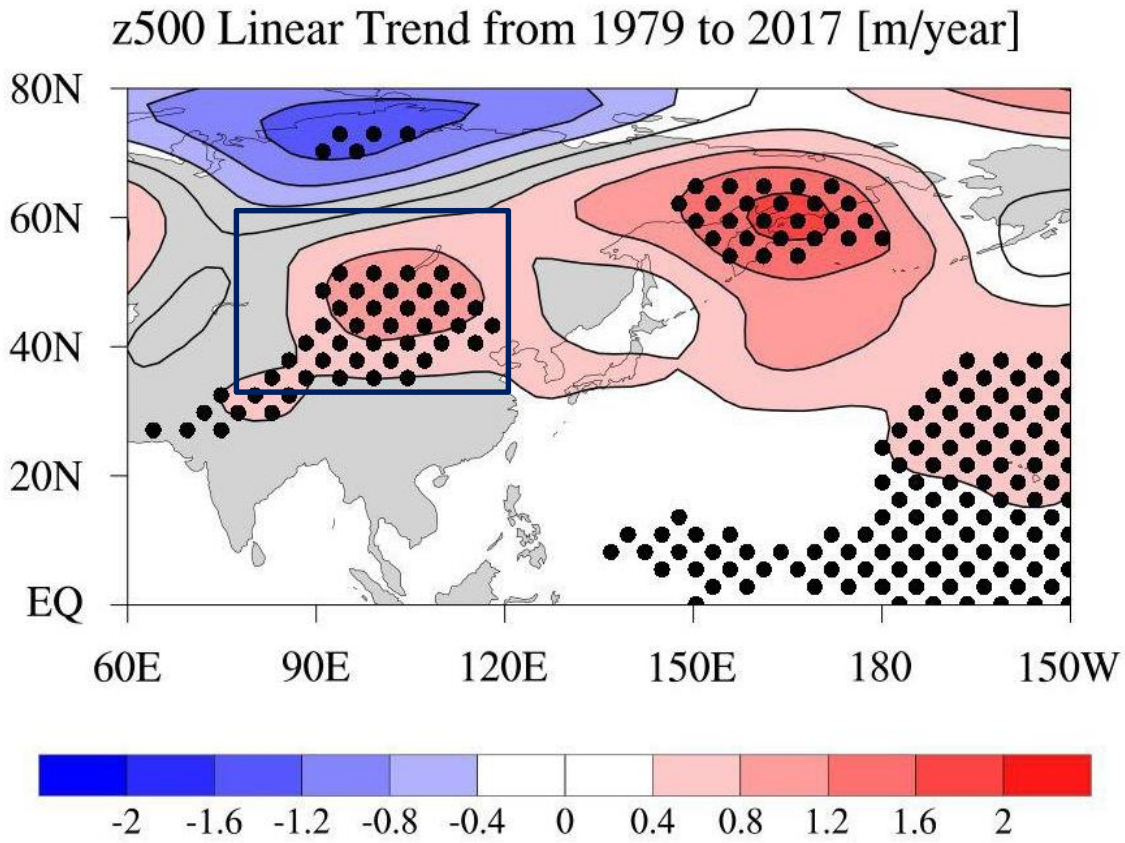


500hPa GPH
July, 2018

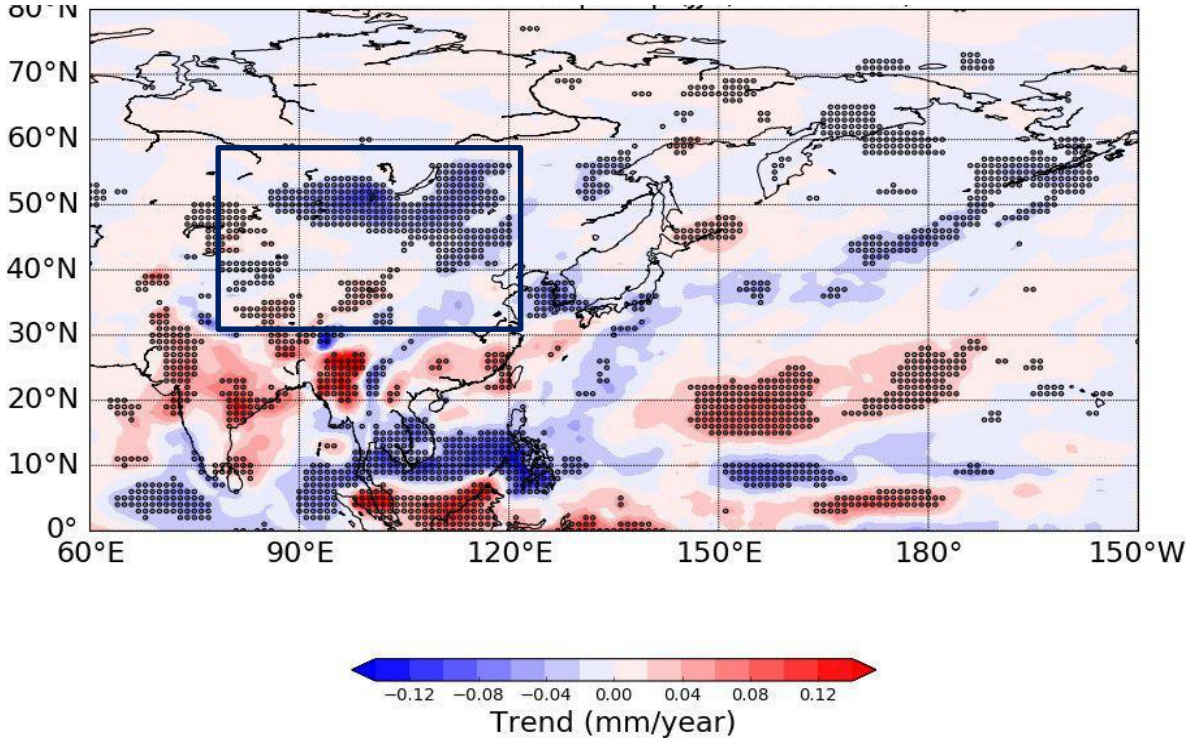


500hPa GPH
August 2018

• Linear trend of GPH in July-August & precipitation in JJA

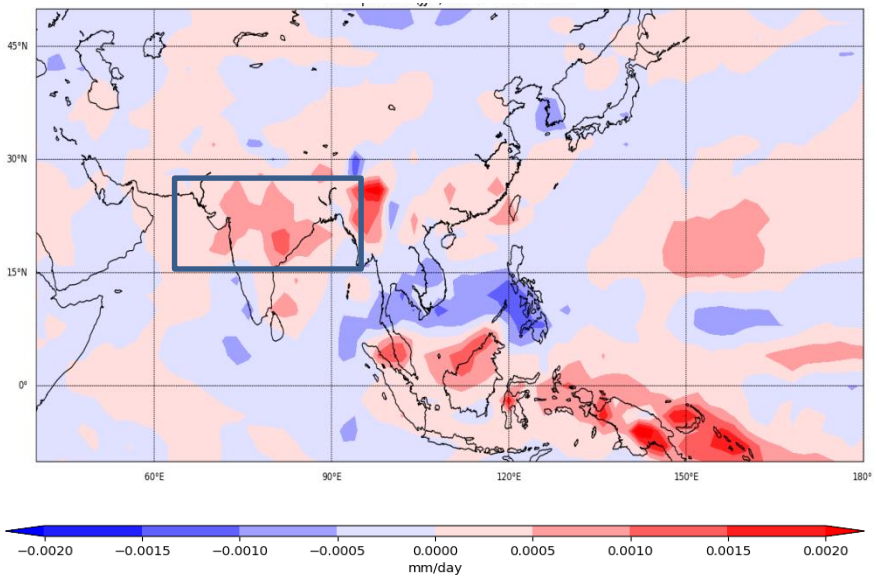


1979-2017 linear trend in precipitation during JJA

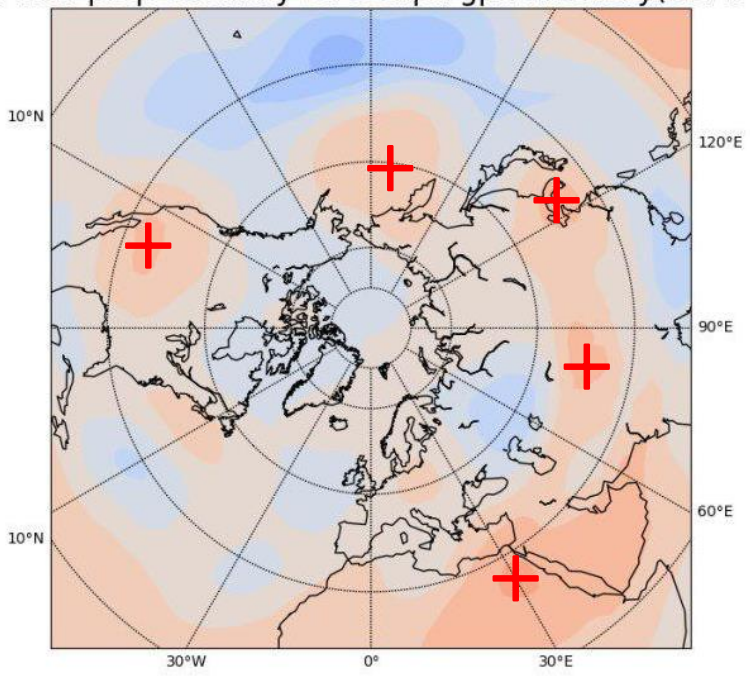


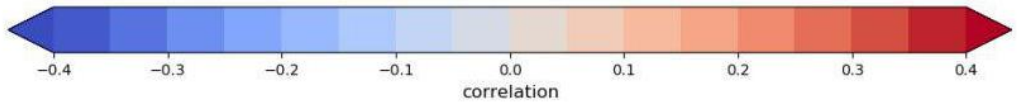
• Strengthening of Indian monsoon during JJA

1979-2017 linear trend in precipitation during JJA



Correlation with prcp anomaly & 200hpa gph anomaly(1979~2017 JJA)

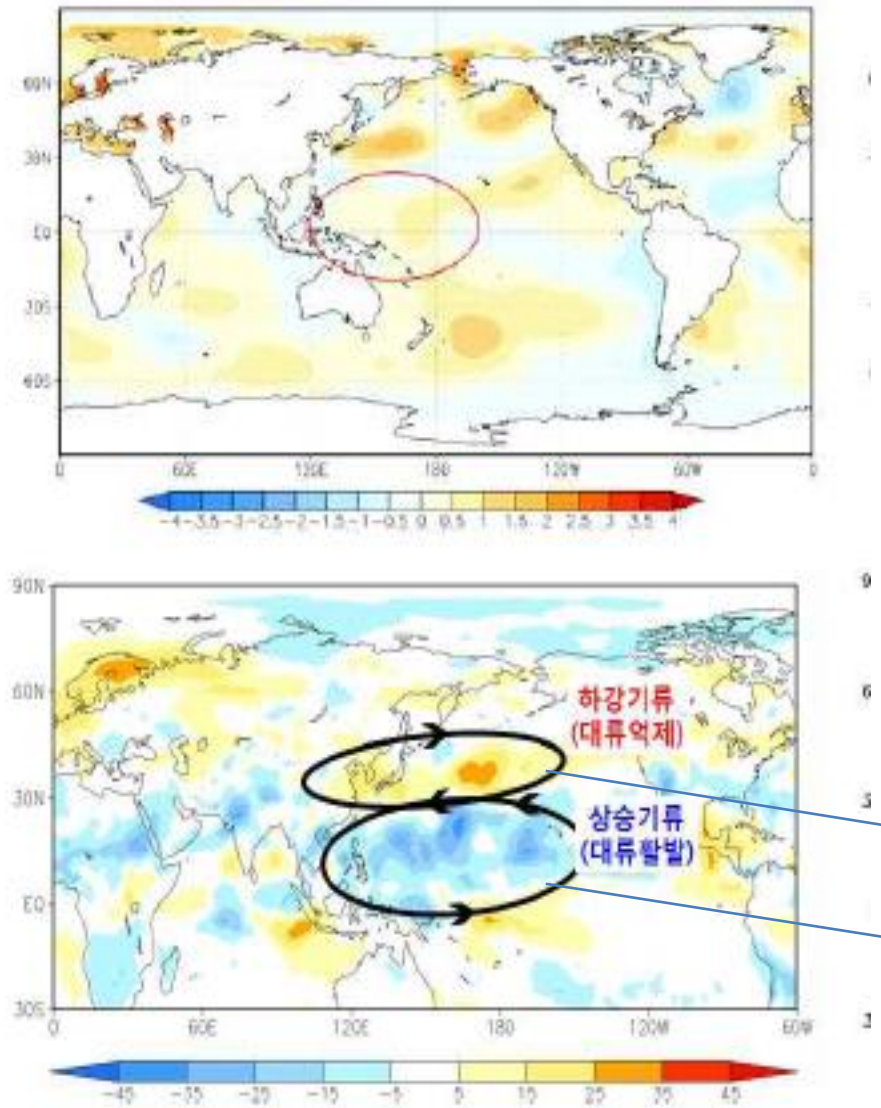




ECMWF Reanalysis dataset

• Changes in atmosphere-ocean interactions in the subtropical Pacific

2018

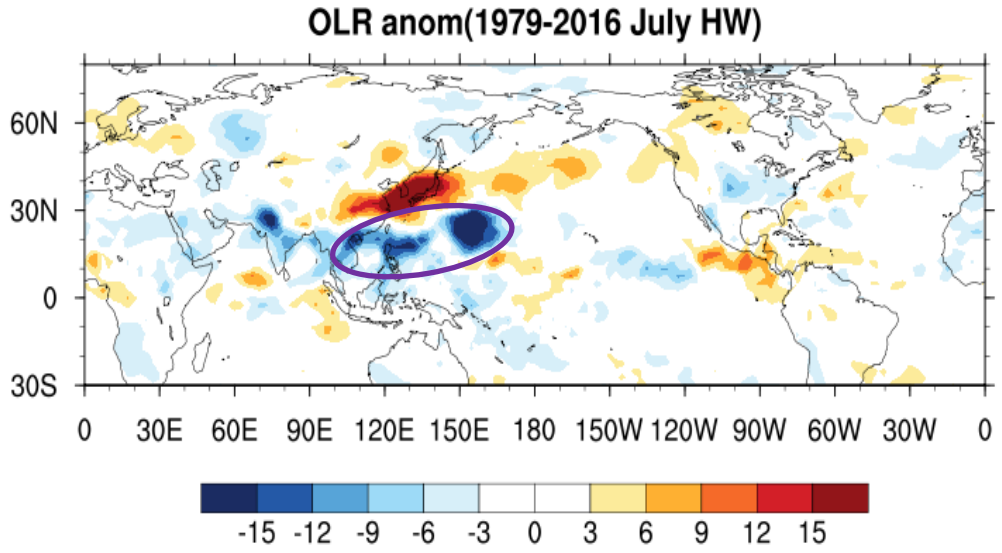


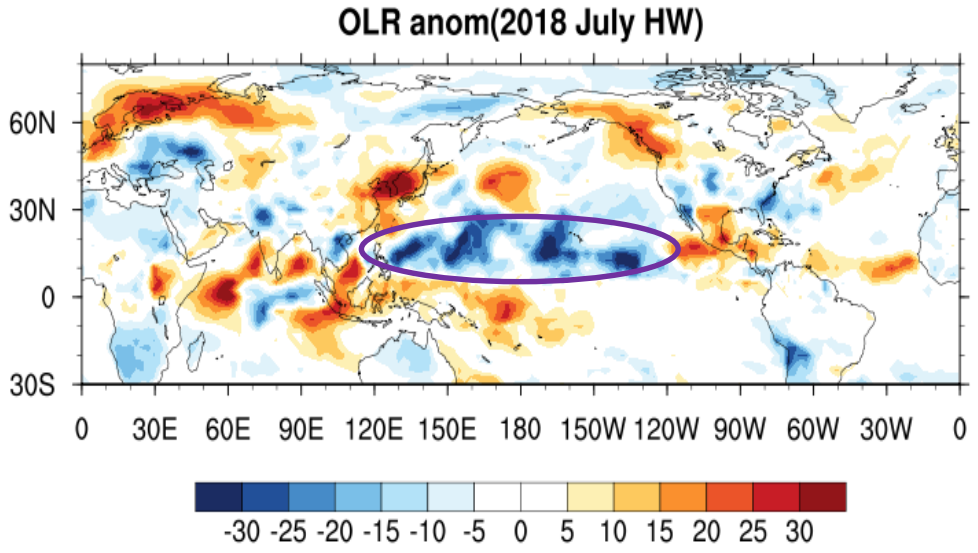
Enhanced descending motion

Strong convection

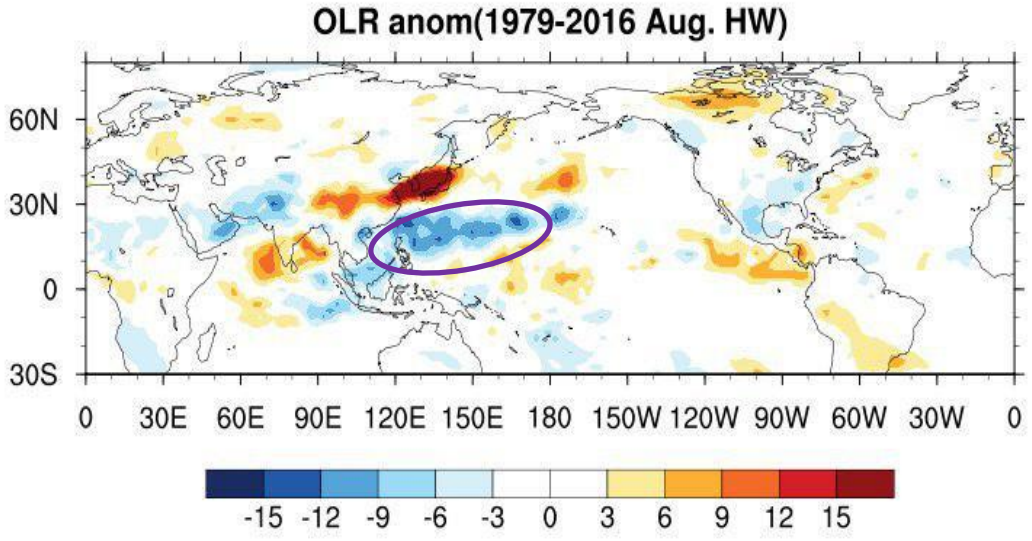
KMA 2018.08.17

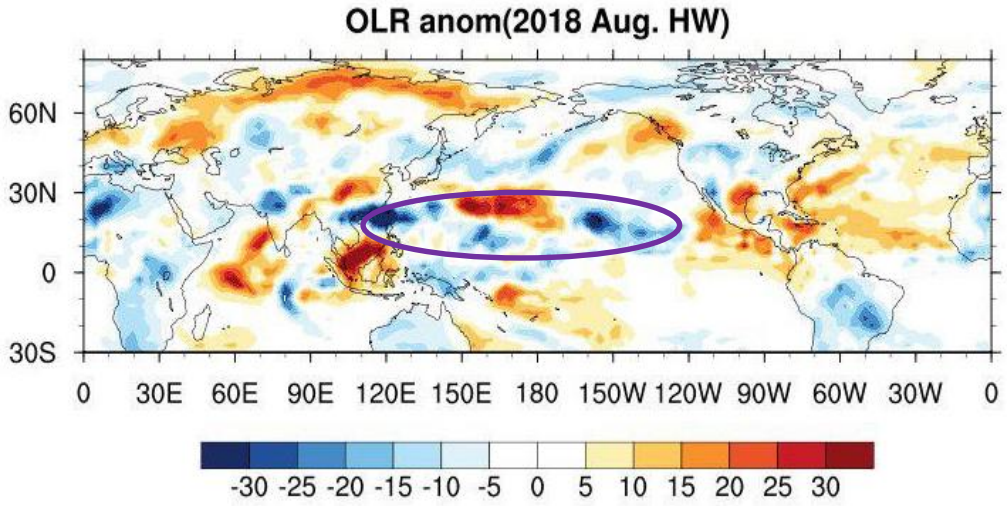
• Typical structure in convective forcing (OLR) during July-August heat wave & July and August, 2018





July



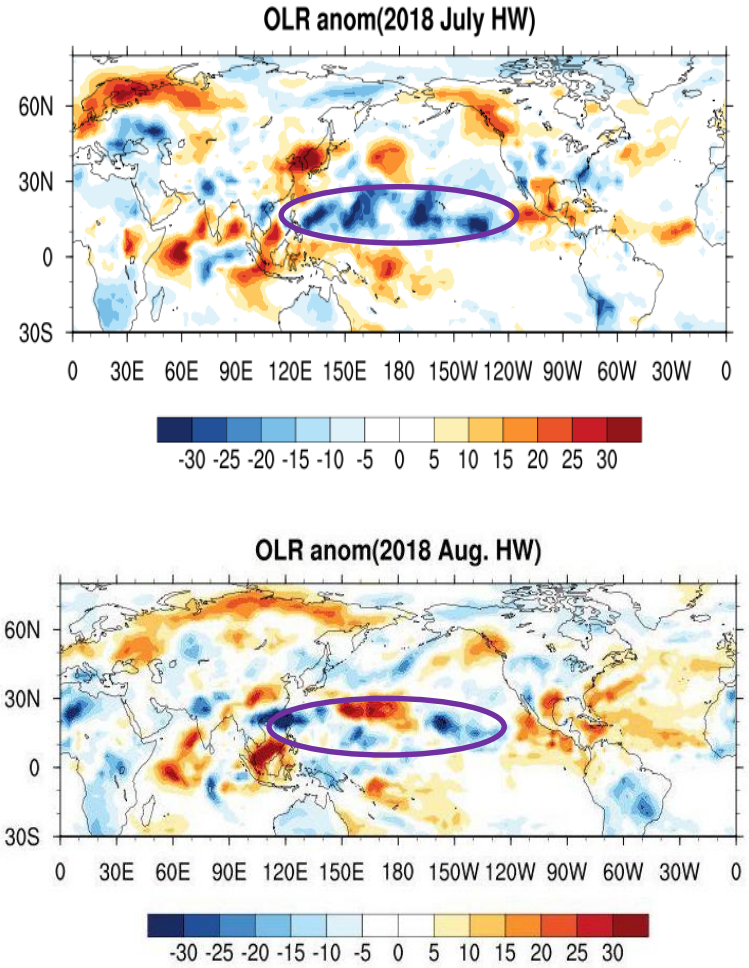


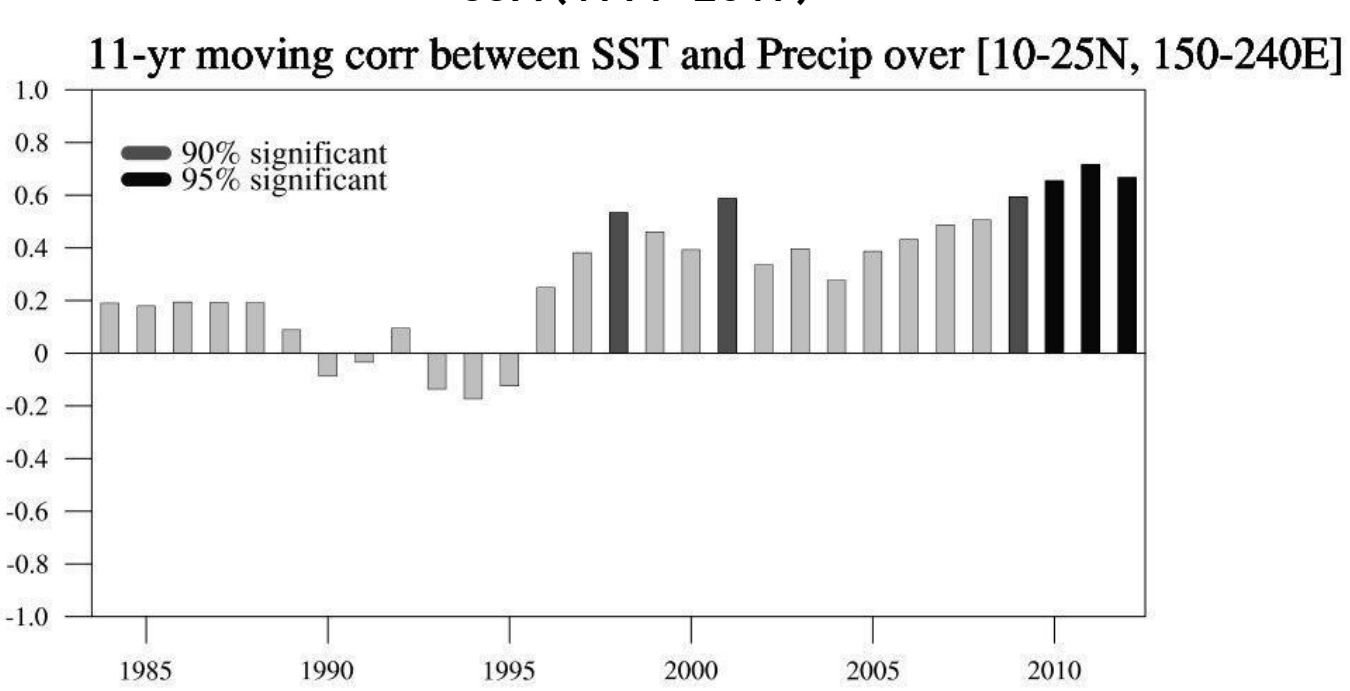
August

OLR anomalies for typical heat wave events

OLR anomalies, 2018

• Changes in atmosphere-ocean interactions in the subtropical Pacific





• Conclusion

Weakening of zonal wind in mid-latitudes

Weakening of meridional Temp. gra.

Weakening of Eddy (2.5~6day) kinetic energy

+

Strengthening of stationary wave structure in geopotential height trend

Strengthening of land-Atmosphere interaction in Mongolia

+

Circumglobal teleconnection wave associated with a strengthening of Indian summer monsoon (Anomalous high in Korean Peninsular)

+

Changes in the atmosphere-ocean interactions in the subtropical Pacific ocean

A favorable condition leading to Heat wave event in Korea

Thank you