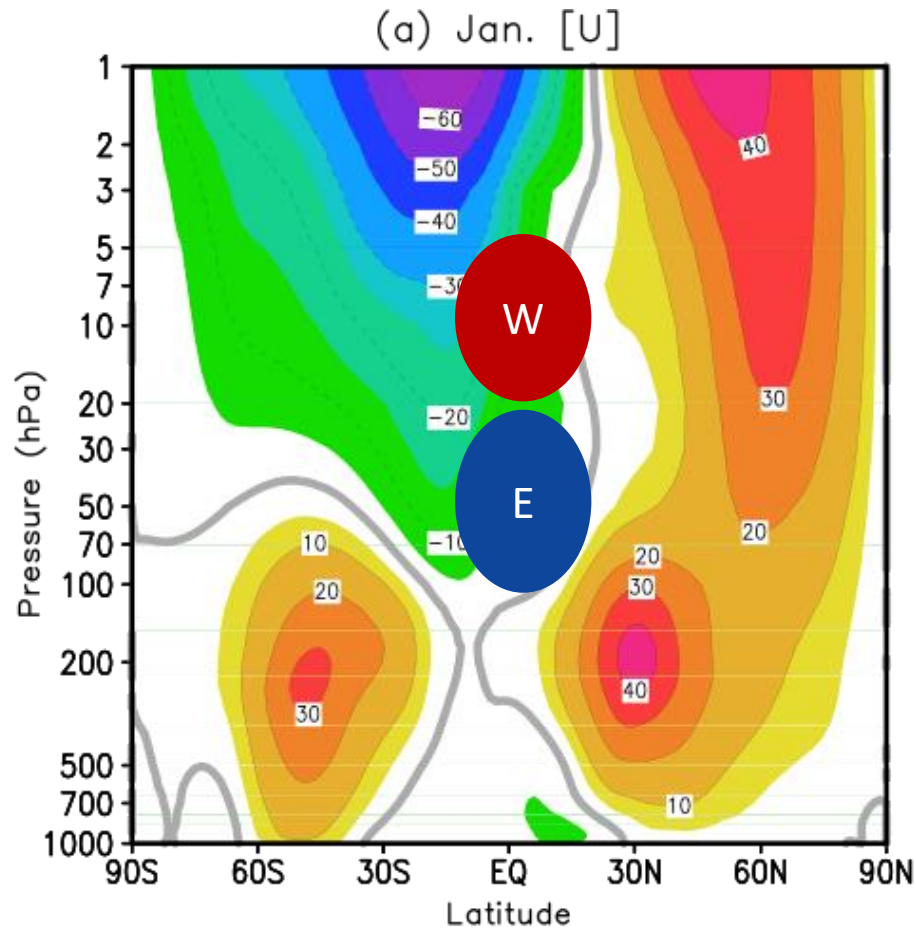


Impact of Stratospheric Quasi-Biennial Oscillation on Subseasonal Variability over East Asia

Yuna Lim, Seok-Woo Son
Seoul National University

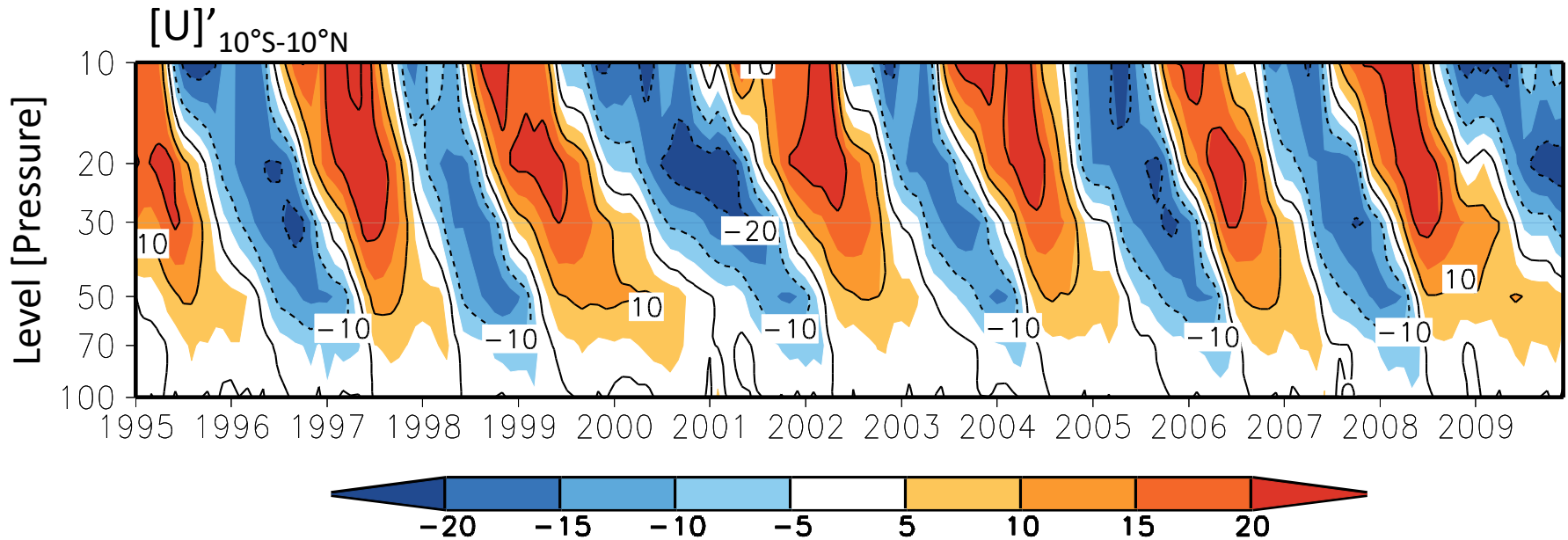
Quasi-Biennial Oscillation (QBO)

- The QBO is the variability of zonal winds over the equatorial lower stratosphere.

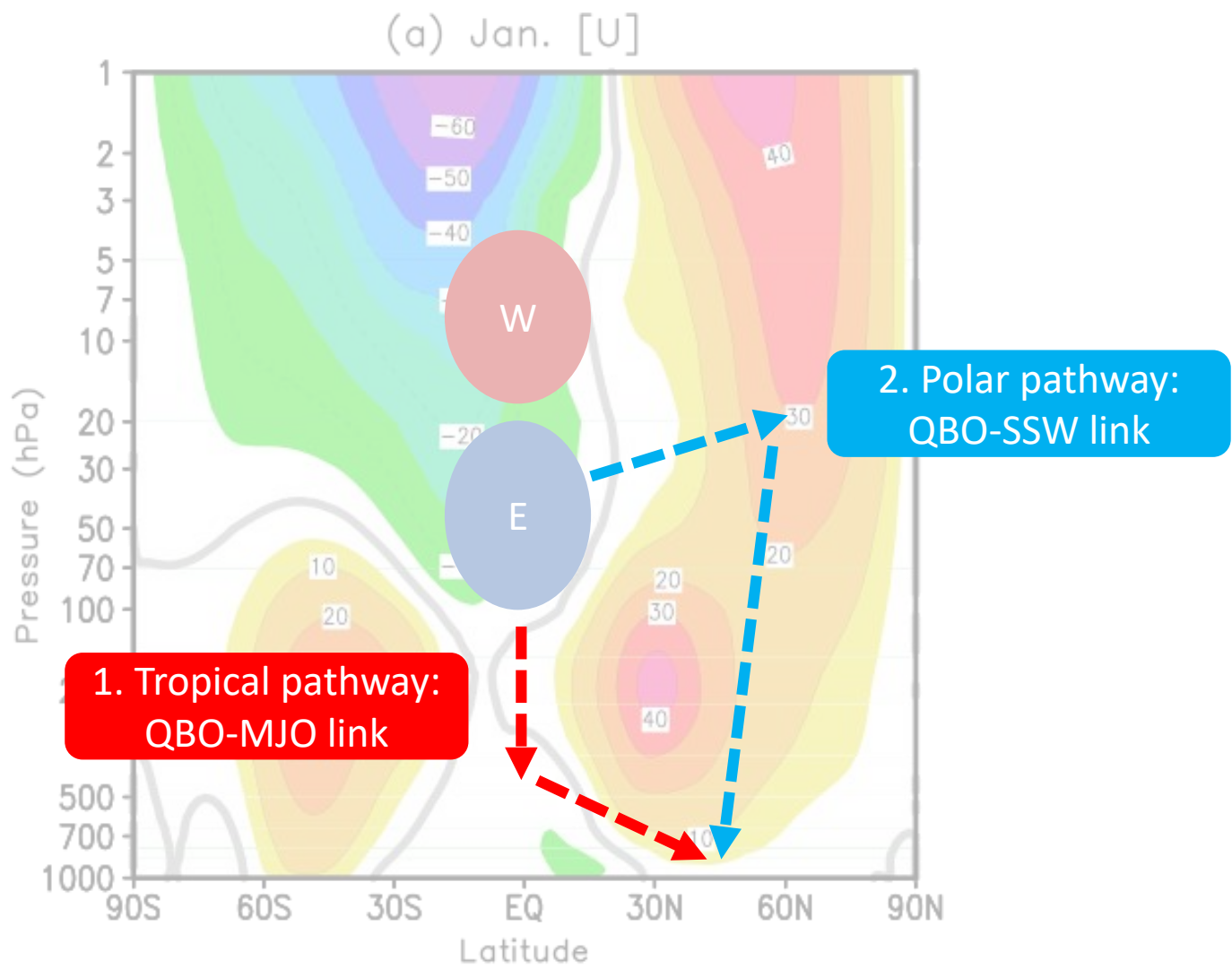


Quasi-Biennial Oscillation (QBO)

- The QBO is the variability of zonal winds over the equatorial lower stratosphere.
- The zonal winds propagate downward, alternating its direction between easterly and westerly with a period of about 28 months (*Baldwin et al., 2001*).



Possible pathways for QBO influence



Contents

QBO-MJO link and its influence on east Asia surface climate

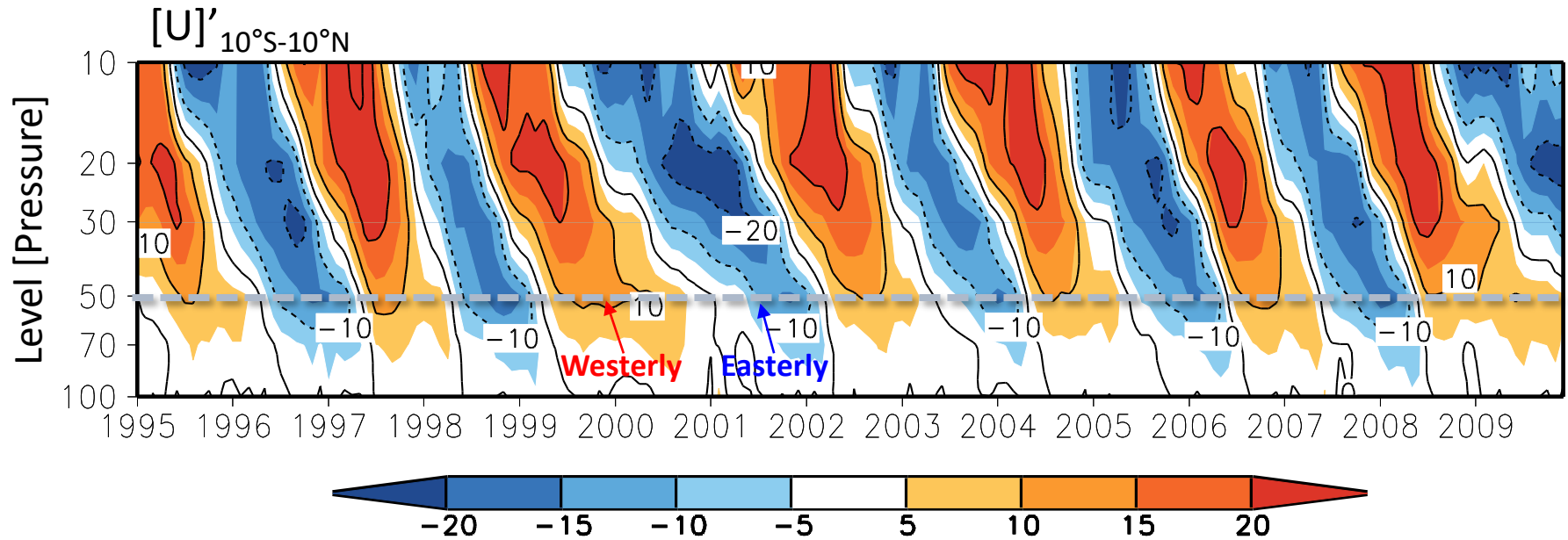
QBO-SSW link and its influence on east Asia surface climate

Preview of 2018/19 winter

QBO

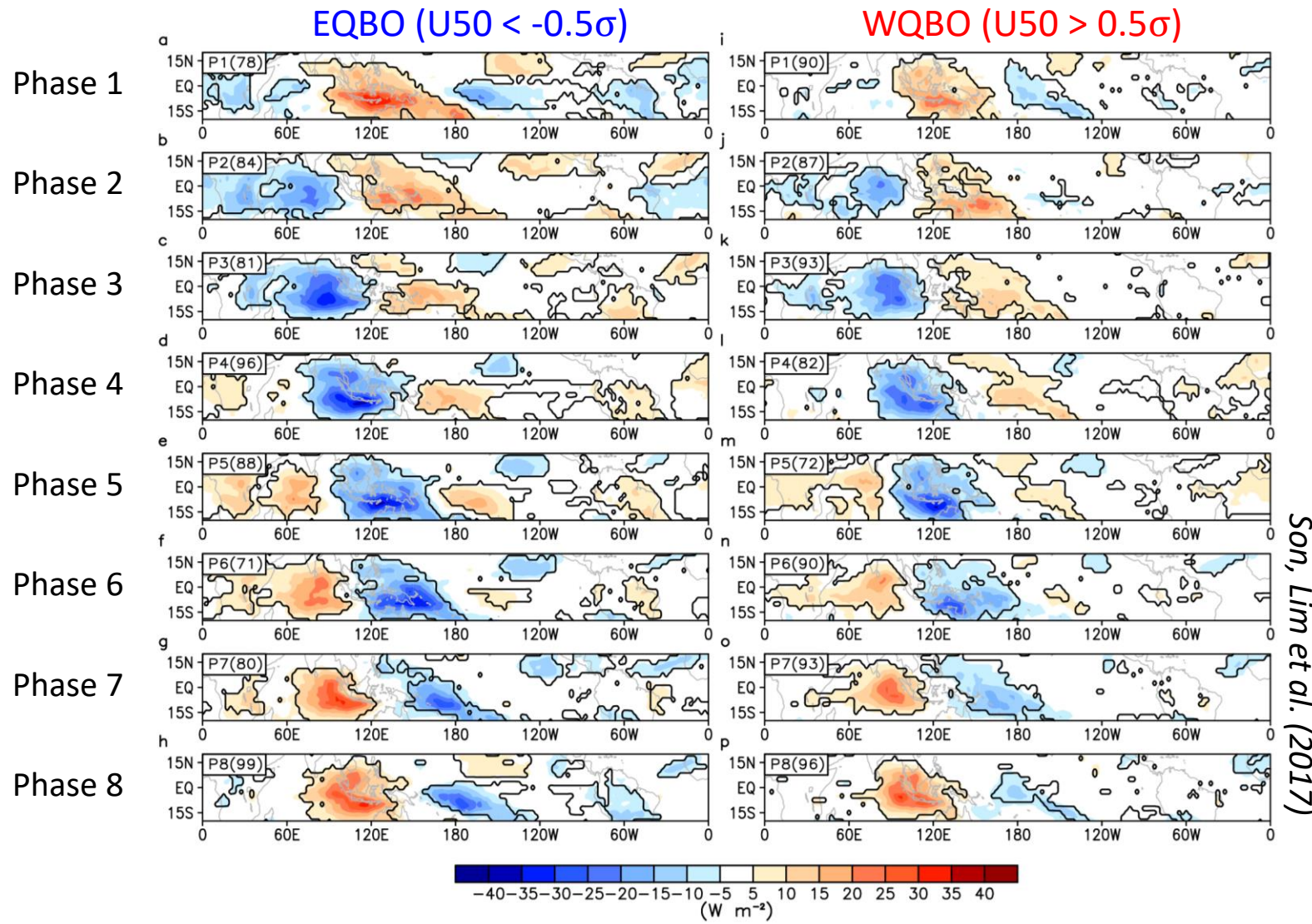
Definition: 50-hPa zonal-mean zonal wind anomalies averaged over the tropics (10°S - 10°N)

1979/80-2015/16 winters (37 winters) are mainly analyzed. The period is subtly different between studies, but the result is not changed.



QBO-MJO convection

*MJO filtered OLR'

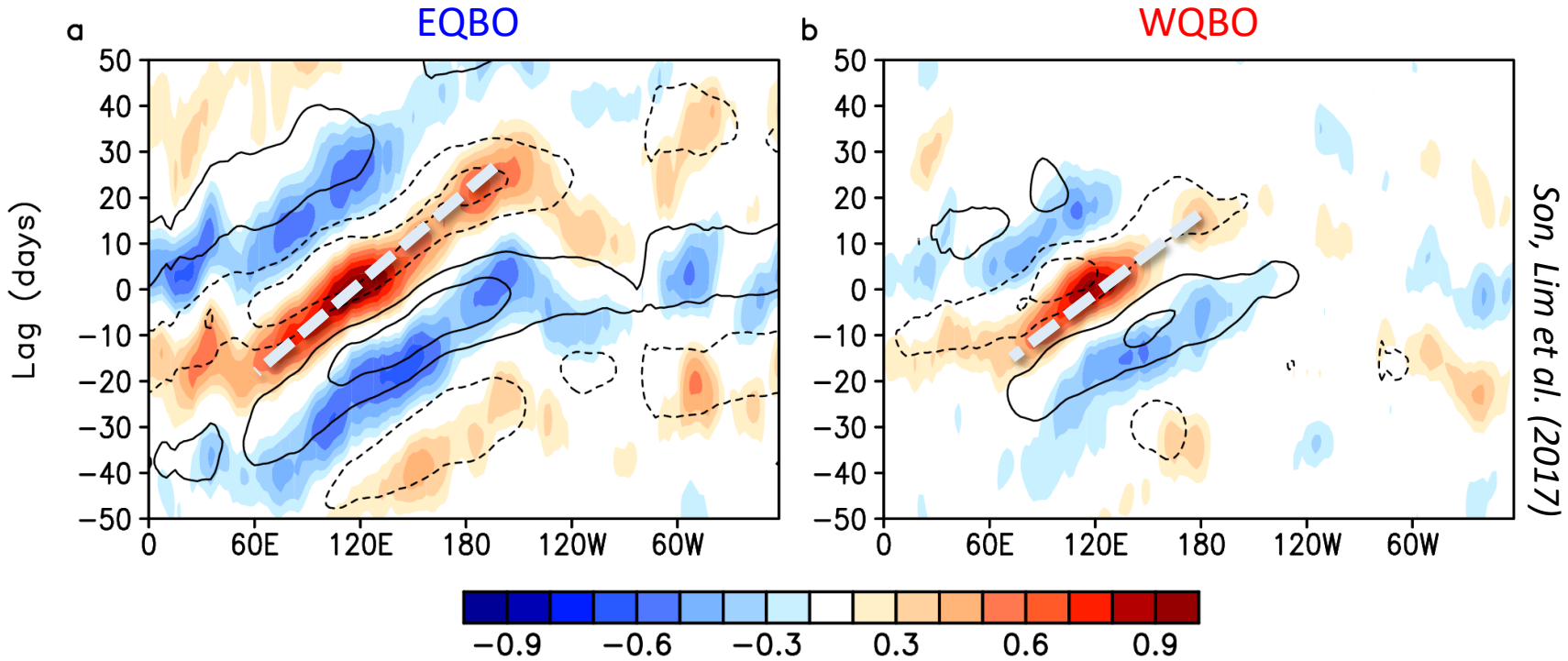


Son, Lim et al. (2017)

MJO convections are enhanced during EQBO winters.

QBO-MJO activity

MJO convections persist longer and propagate farther eastward during EQBO winters.

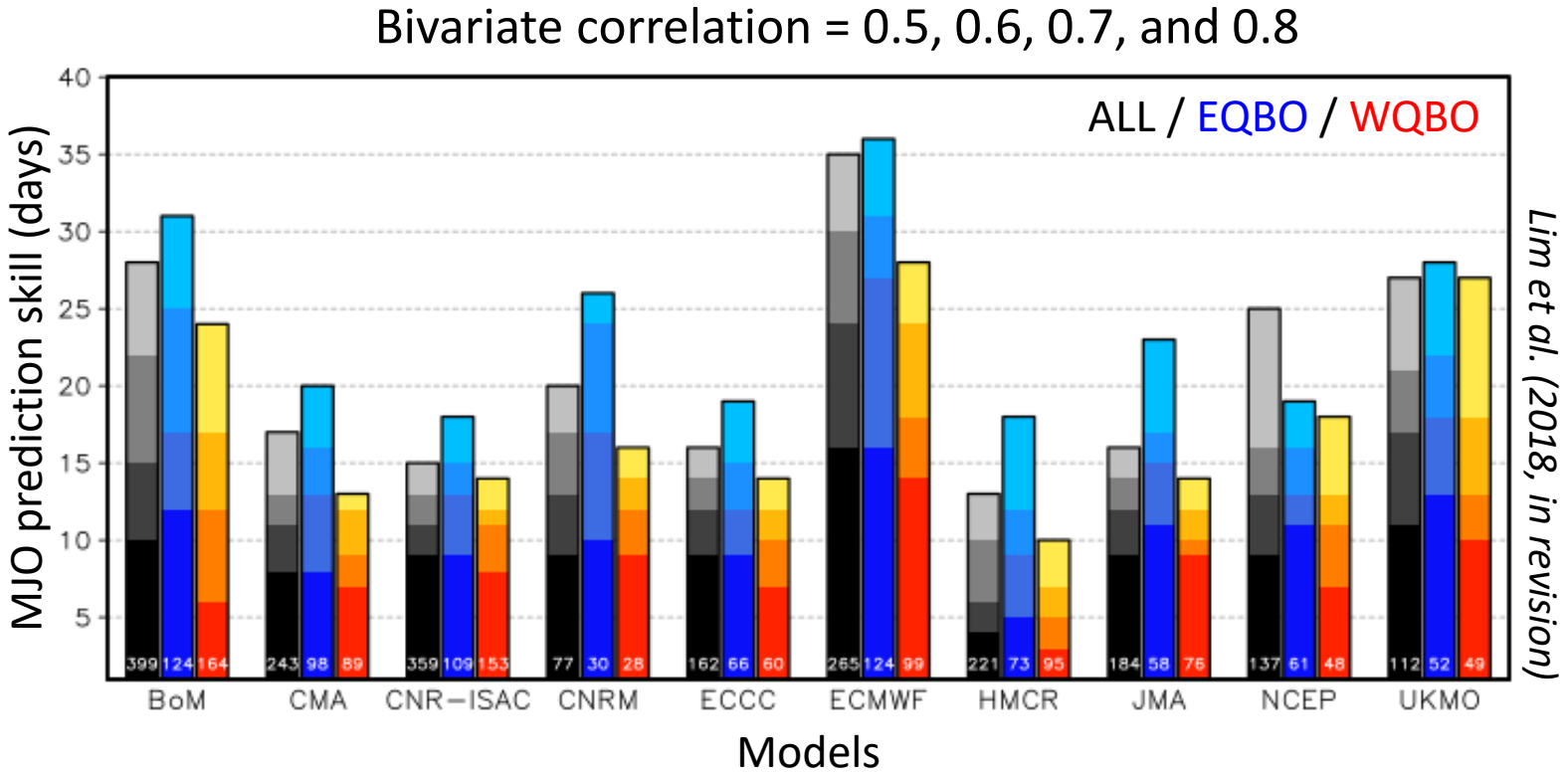


Correlation coefficient
Shading: OLR' $_{15^{\circ}\text{S}-5^{\circ}\text{N}, 100-130^{\circ}\text{E}}$, OLR' $_{15^{\circ}\text{S}-5^{\circ}\text{N}}$
Contour: OLR' $_{15^{\circ}\text{S}-5^{\circ}\text{N}, 100-130^{\circ}\text{E}}$, 850-hPa U' $_{15^{\circ}\text{S}-5^{\circ}\text{N}}$

Son, Lim et al. (2017)

QBO-MJO prediction skill

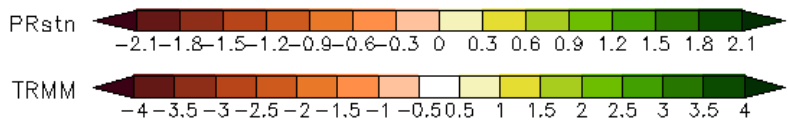
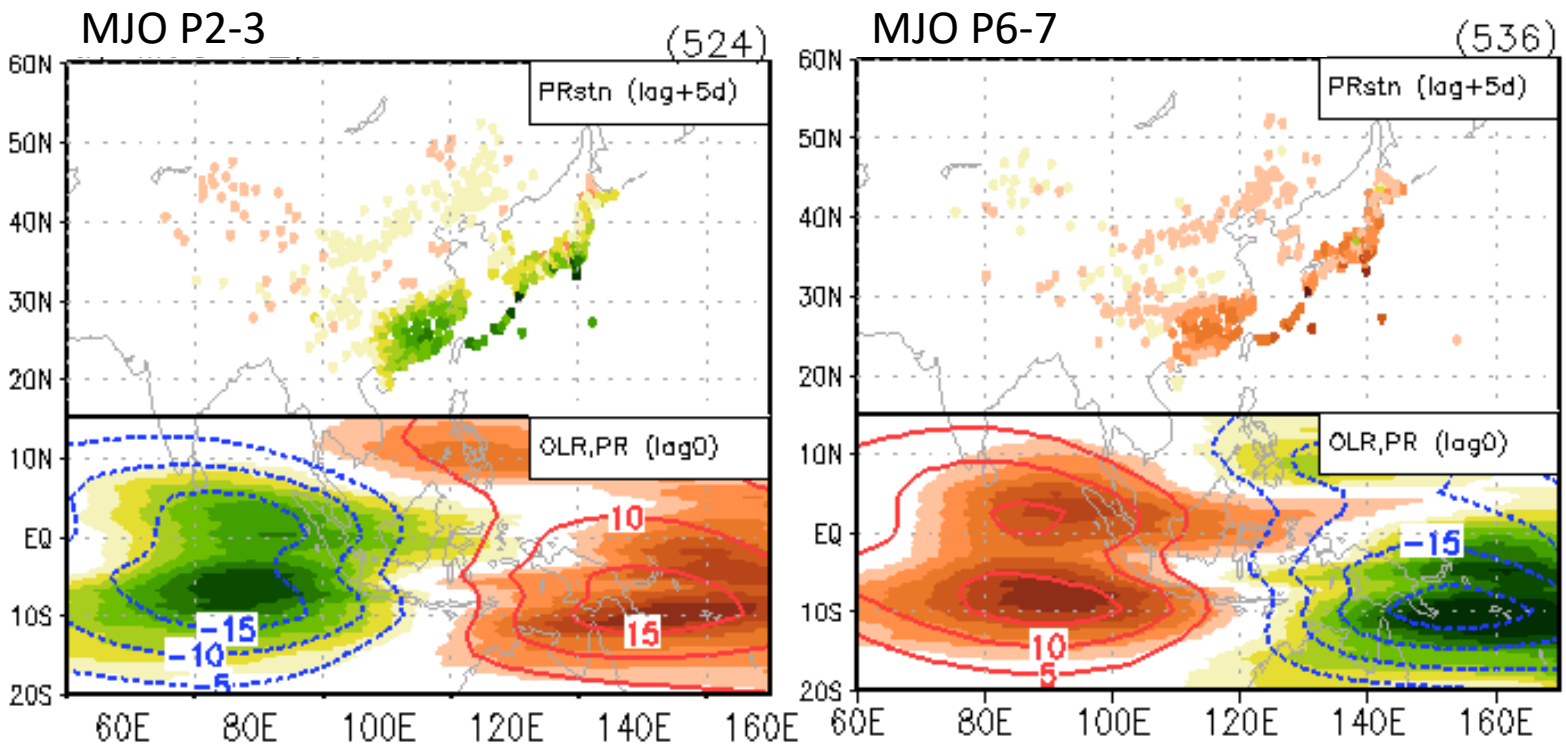
Even in the operational models, the QBO-MJO link is partly shown.
 The MJO is better predicted during EQBO winters in the S2S models.



MJO impact on east Asia

The boreal winter precipitation anomalies over east Asia are dependent on the MJO phase (Jeong et al. 2005).

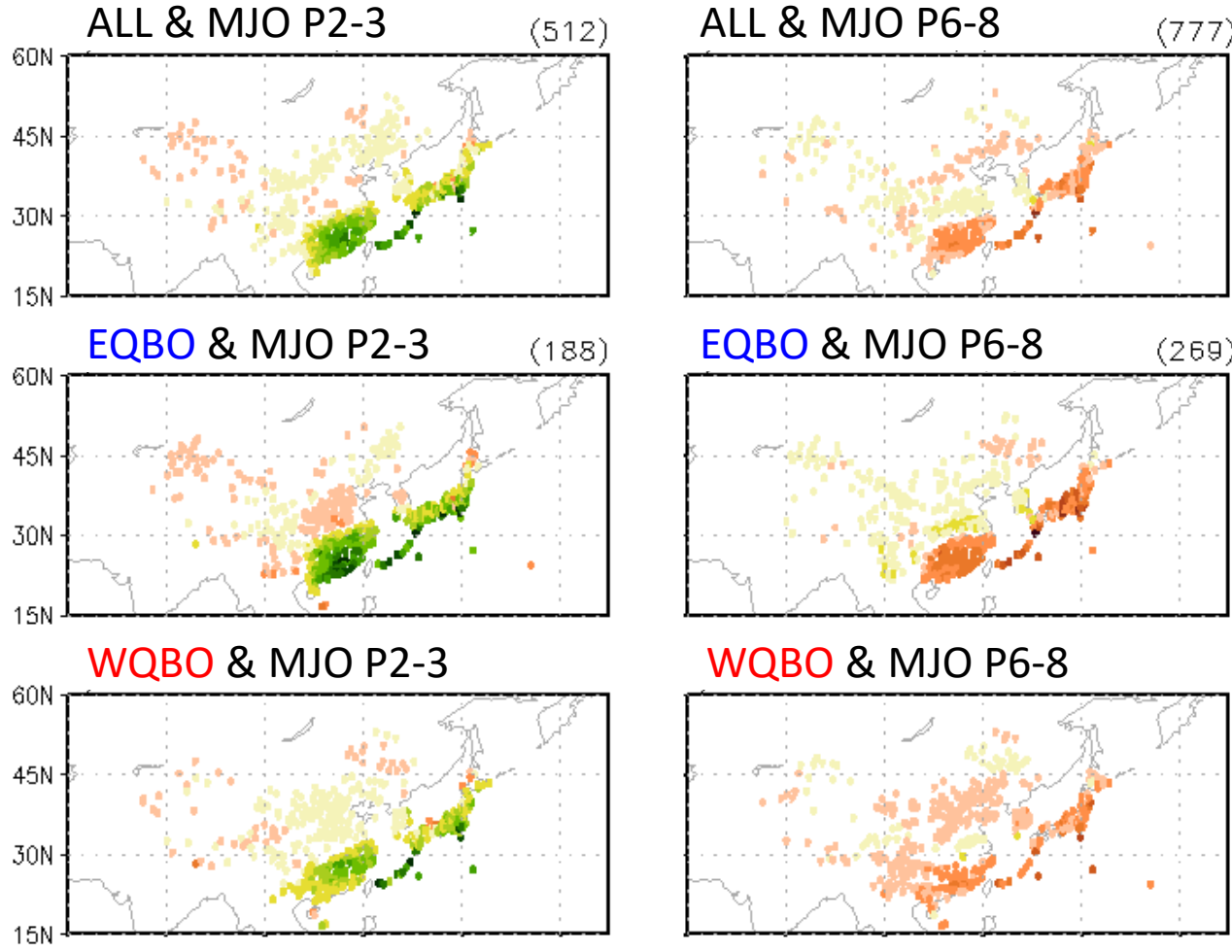
*MJO filtered observational PRCP' & OLR'



Kim et al. (2018, in preparation)

MJO impact with QBO

*MJO filtered observational PRCP'

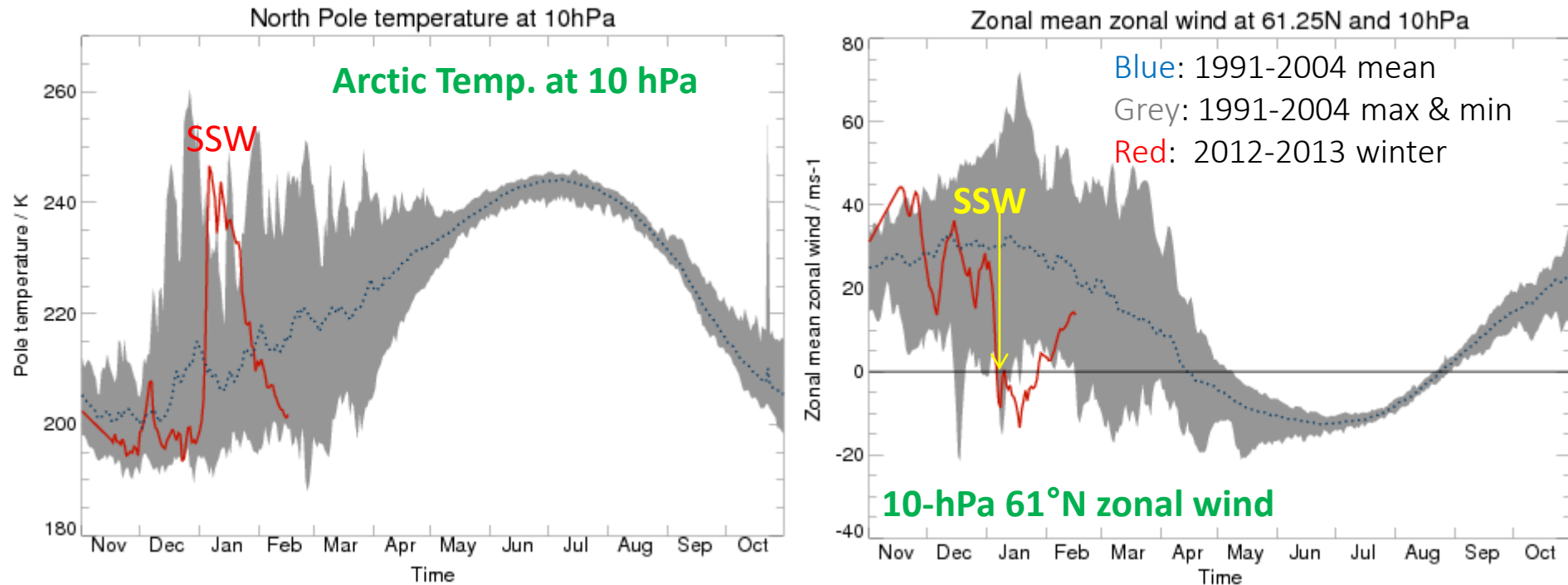


Kim et al. (2018, in preparation)

Not only the MJO activity but also its impact is modulated by the QBO.

Stratospheric Sudden Warming (SSW)

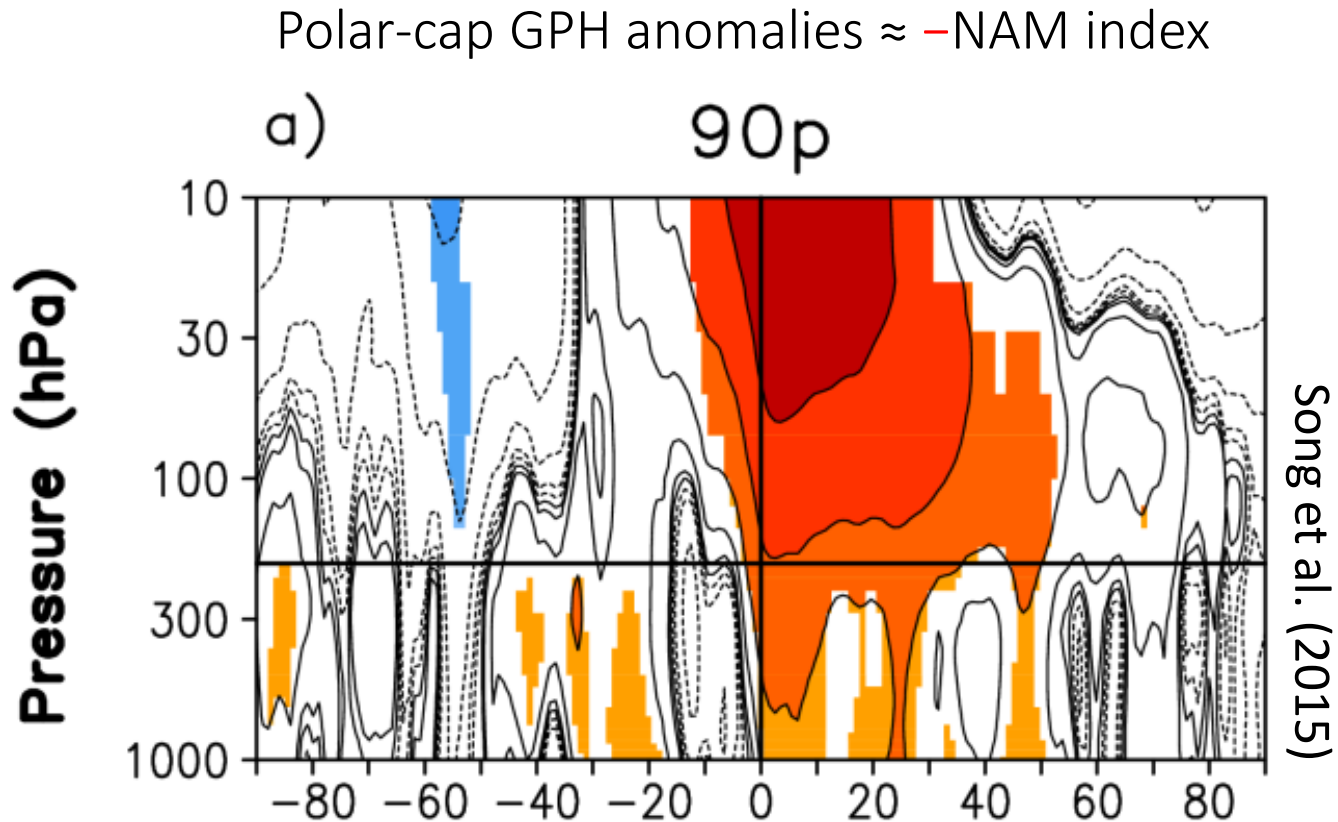
Arctic stratospheric temperature rapidly increases by extratropical wave driving, often resulting in a zonal-wind reversal from westerly to easterly.



<http://www.met.reading.ac.uk/research/stratclim/current/diagnostics.html>

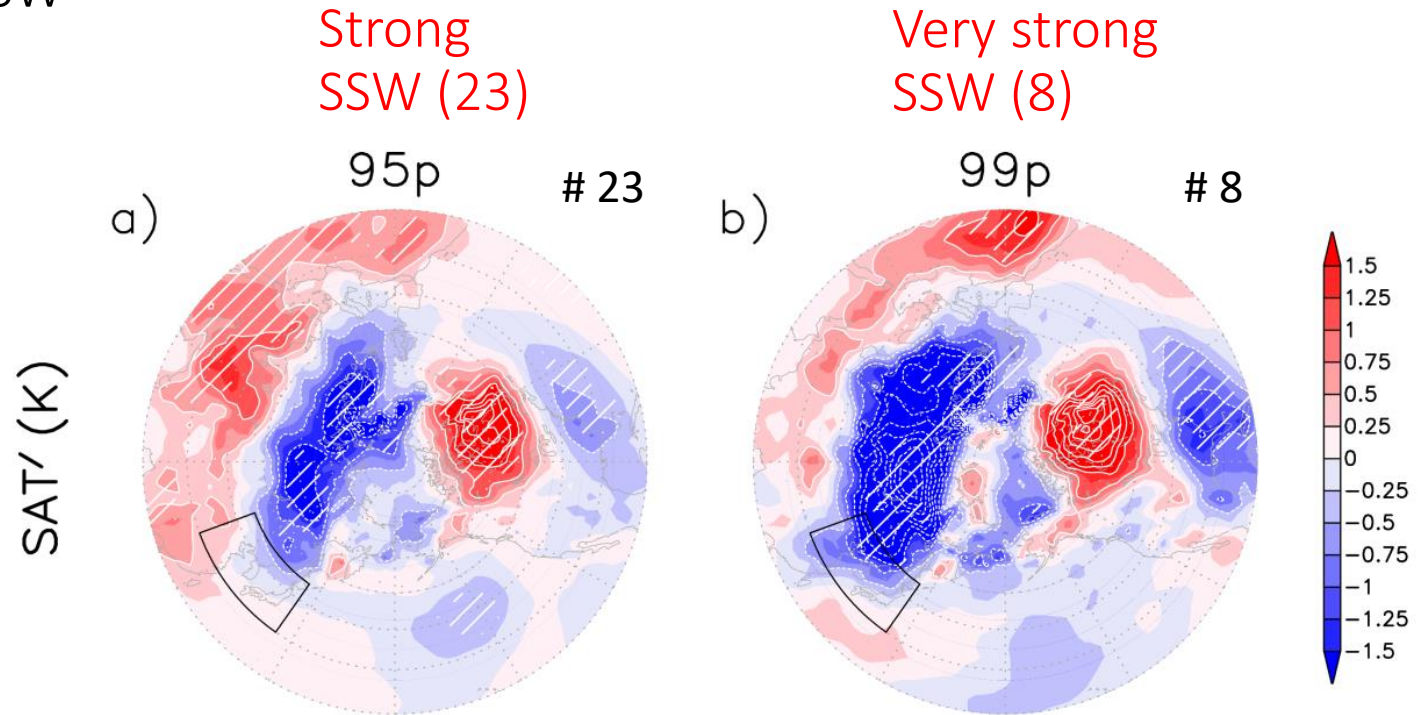
SSW downward coupling

Stratospheric vortex weakening propagates downward to the surface within a week from the onset, resulting in a significant decrease in NAM index at the surface.



SSW impact on east Asia

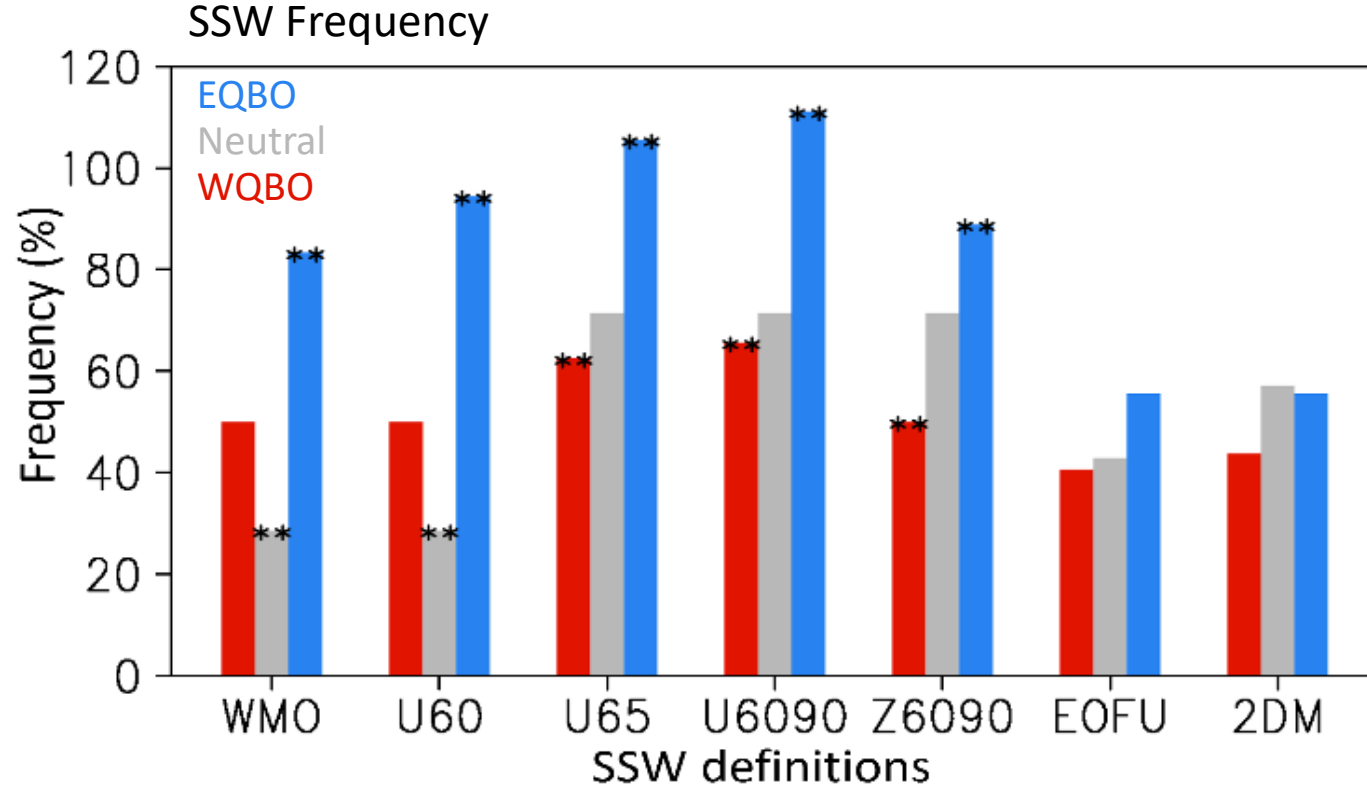
30-day average
after SSW



Song et al. (2015)

Cold northeast Asia after SSW events; the surface response is stronger for stronger SSW events.

QBO-SSW frequency

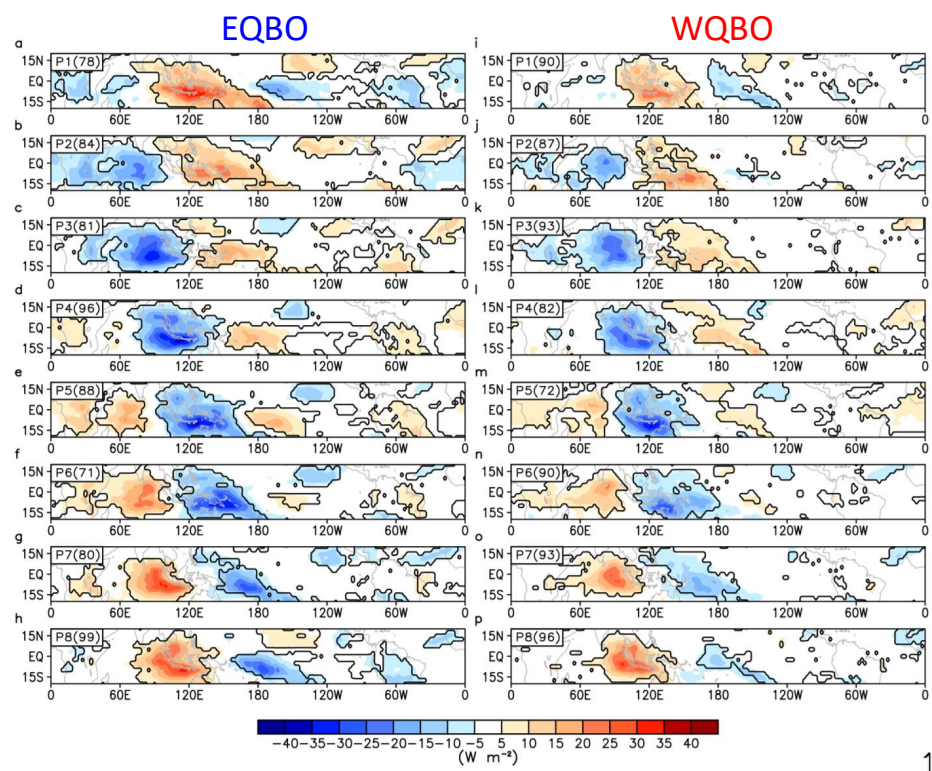


QBO : Singapore station data
SSW : NNR1, 1958-2015

During EQBO winters, SSW events are more frequently occurred by controlling the direction of wave propagation (e.g., Holton and Tan 1980).

It may result in colder northeast Asia due to more SSW events.

Summary

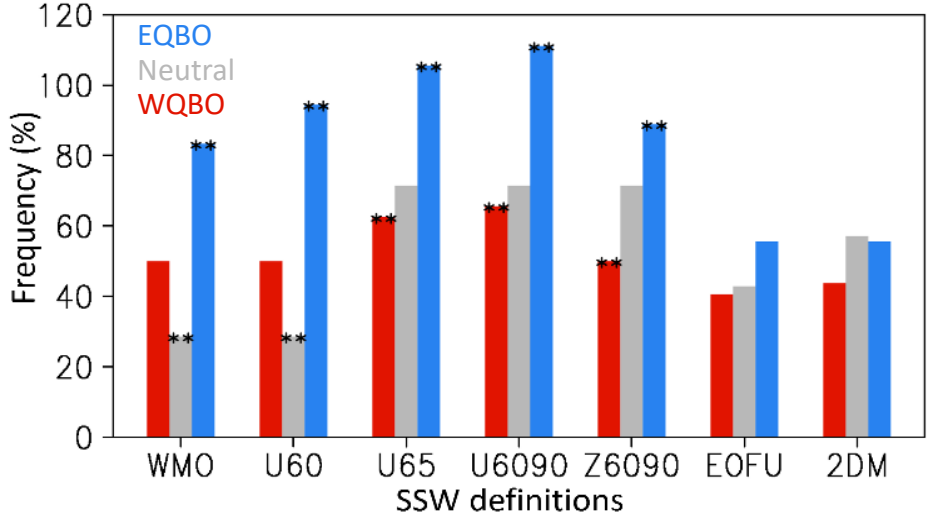


MJO activity is enhanced during EQBO winters than during WQBO winters.

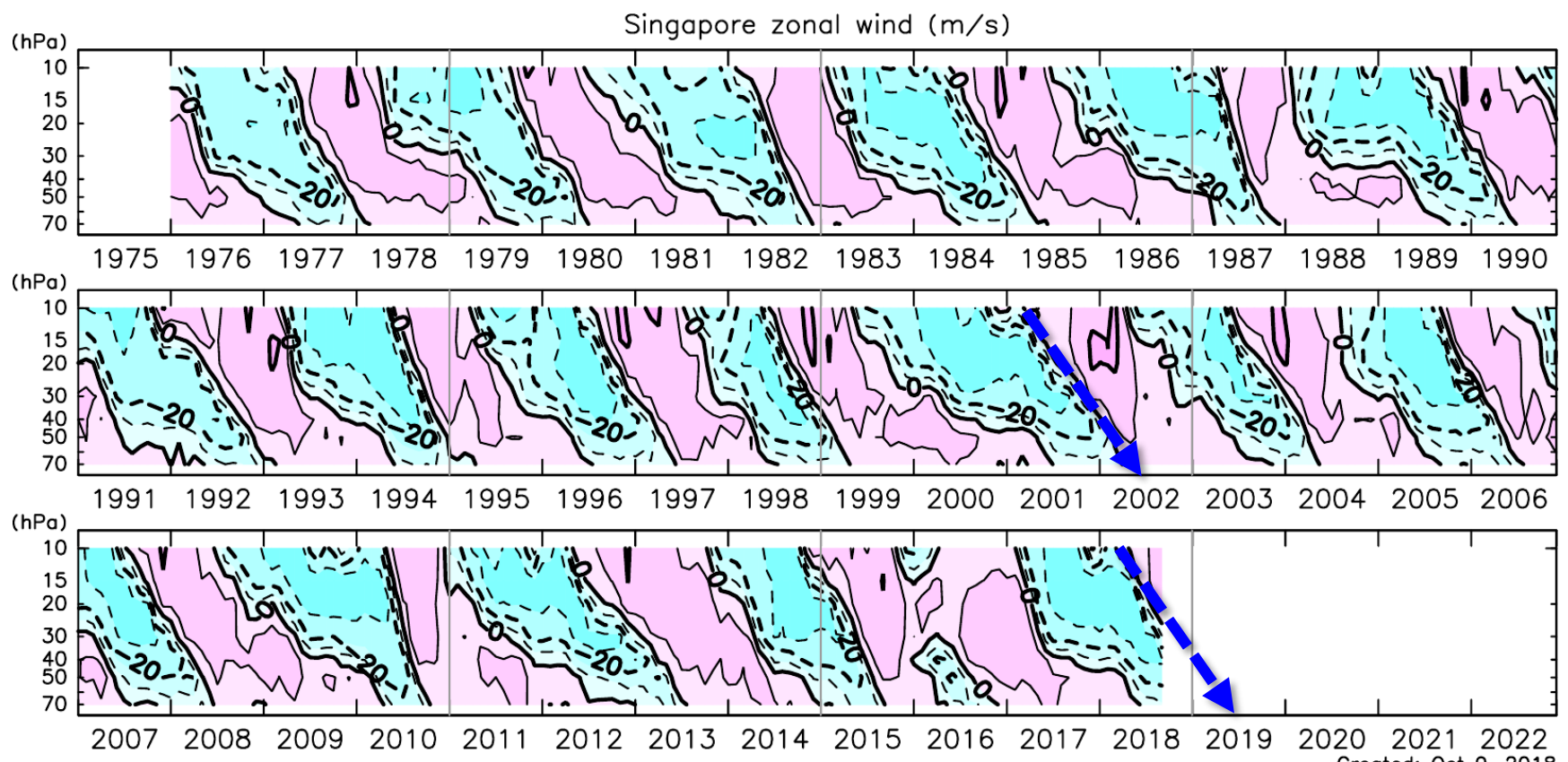
SSW is more frequently occurred during EQBO than during WQBO.



SSW Frequency



Preview of QBO in 2018/19 winter



Created: Oct 9, 2018

https://www.gfd-dennou.org/arch/eriko/QBO/png/tz_uwnd_Singapore.png

Easterly phase of QBO will be presented in this upcoming winter.

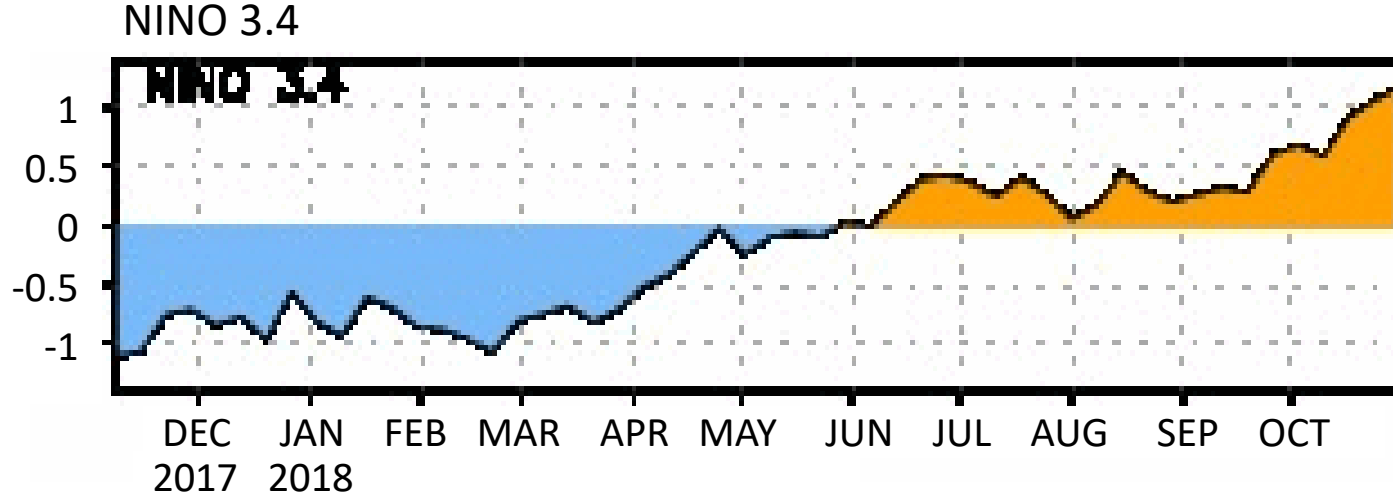
Preview of QBO in 2018/19 winter

Easterly QBO in 2018/19 winter

→ Enhanced MJO events & more frequent SSW events

→ Large subseasonal variabilities in east Asian surface climate

Possible impact of El Niño



“El Niño in 2018/19 winter”

Stratospheric pathway

→ More frequent SSW events
(Song and Son 2018)

→ Colder northeast Asia

Tropospheric pathway

→ Warmer east Asia through
teleconnection

Large uncertainty over east Asia is expected.

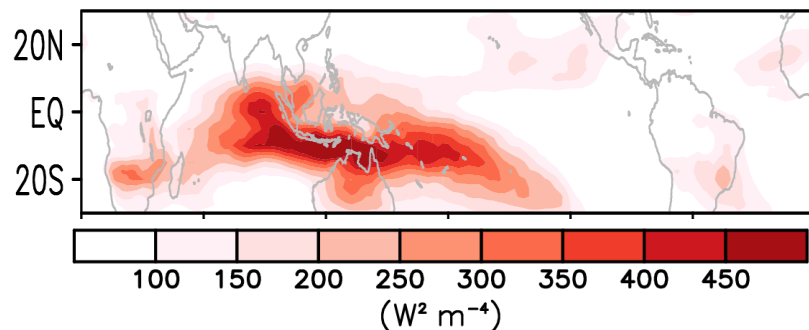
Thank you

Supplements

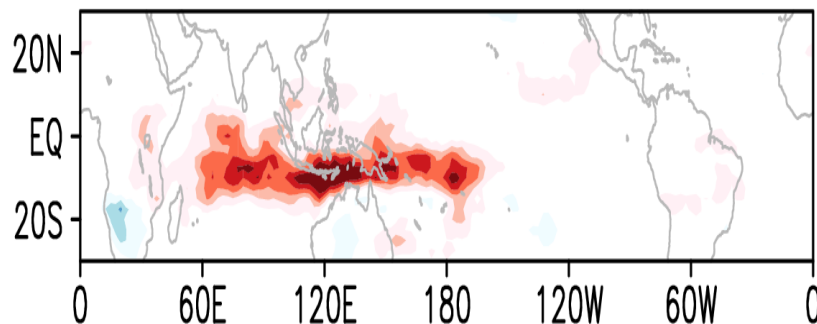
QBO vs. ENSO

- QBO modulates the MJO activities during the boreal winter (*Yoo and Son 2016*).
- ENSO controls the extent of MJO (*Woolnough et al. 2000; DeMott et al. 2018*).

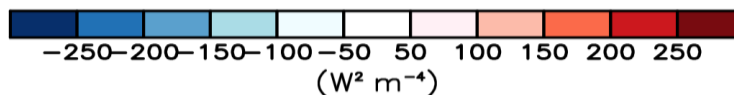
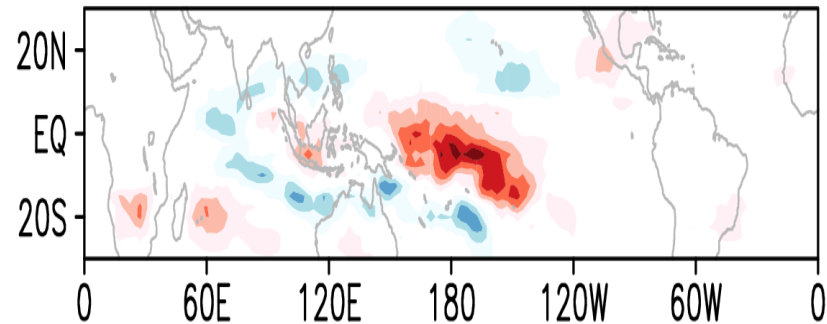
DJF MJO filtered OLR Var.



EQBO-WQBO, DJF OLR Var.

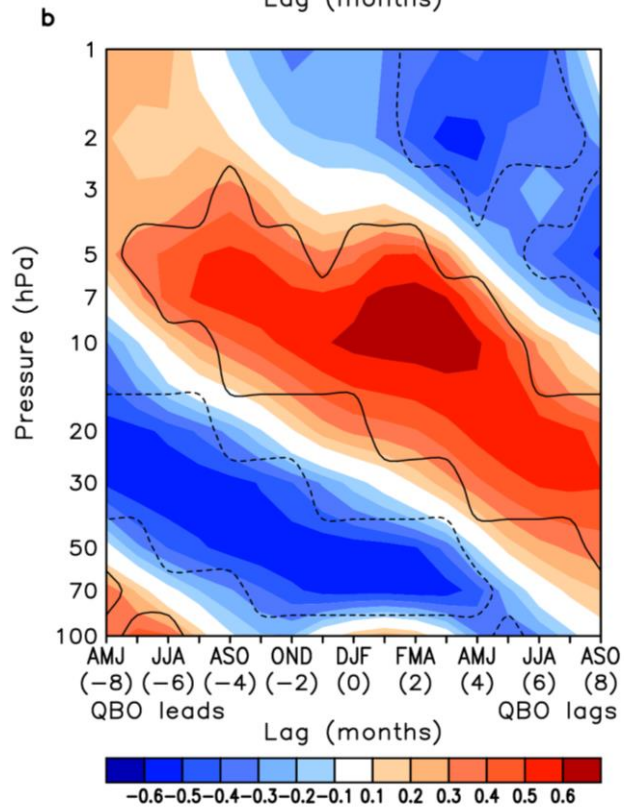
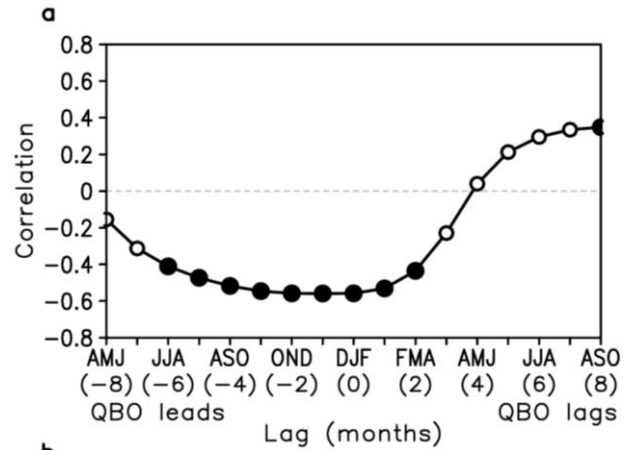


El Niño-La Niña, DJF OLR Var.



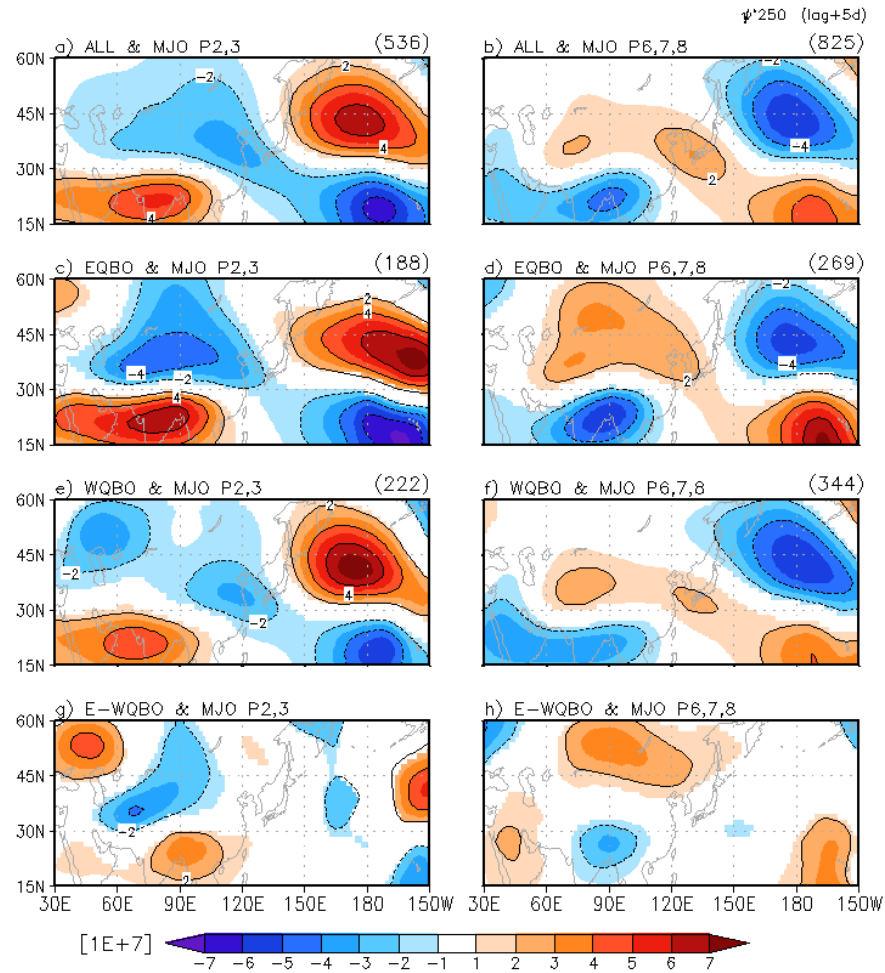
Son, Lim et al. (2017)

QBO-MJO: Seasonality



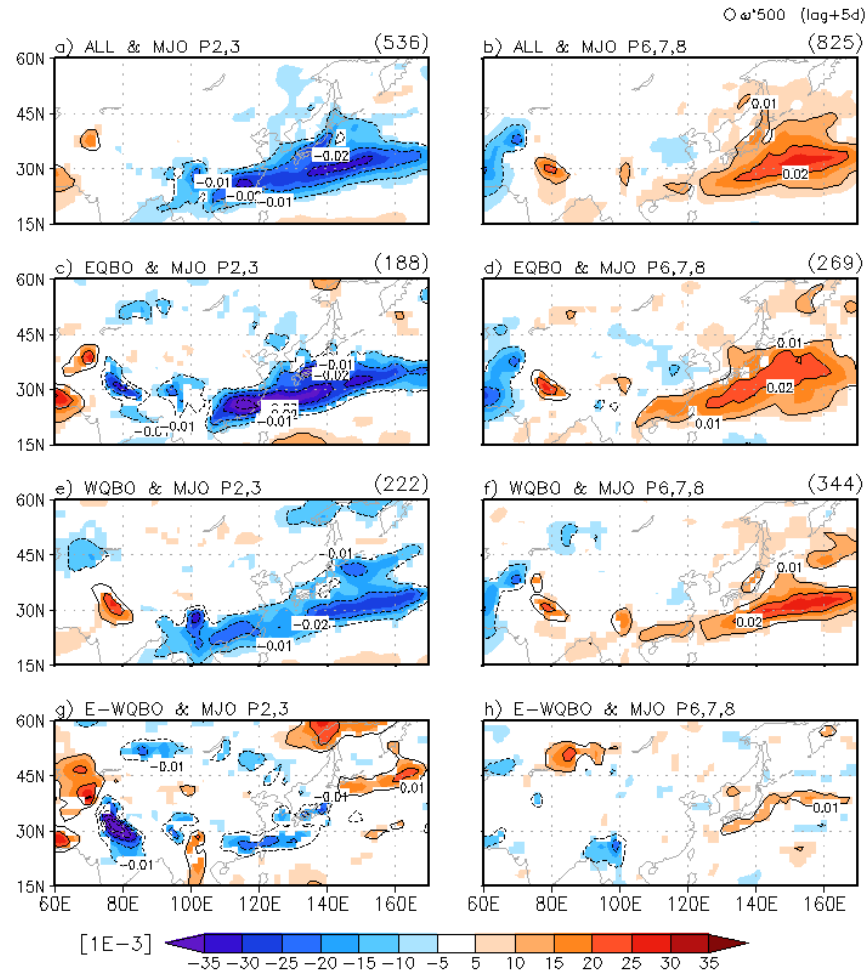
QBO-MJO circulations

ψ'_{250}



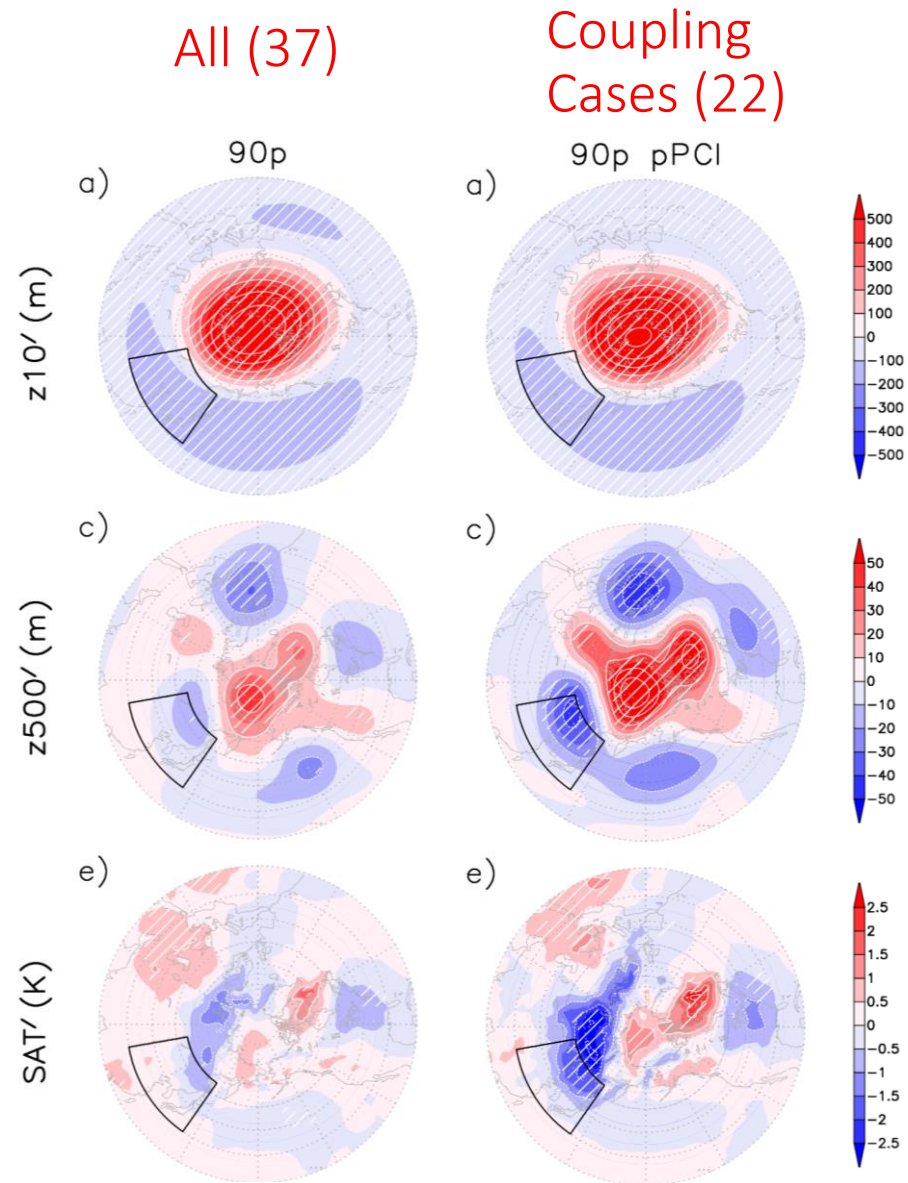
QBO-MJO circulations

$\omega'500$

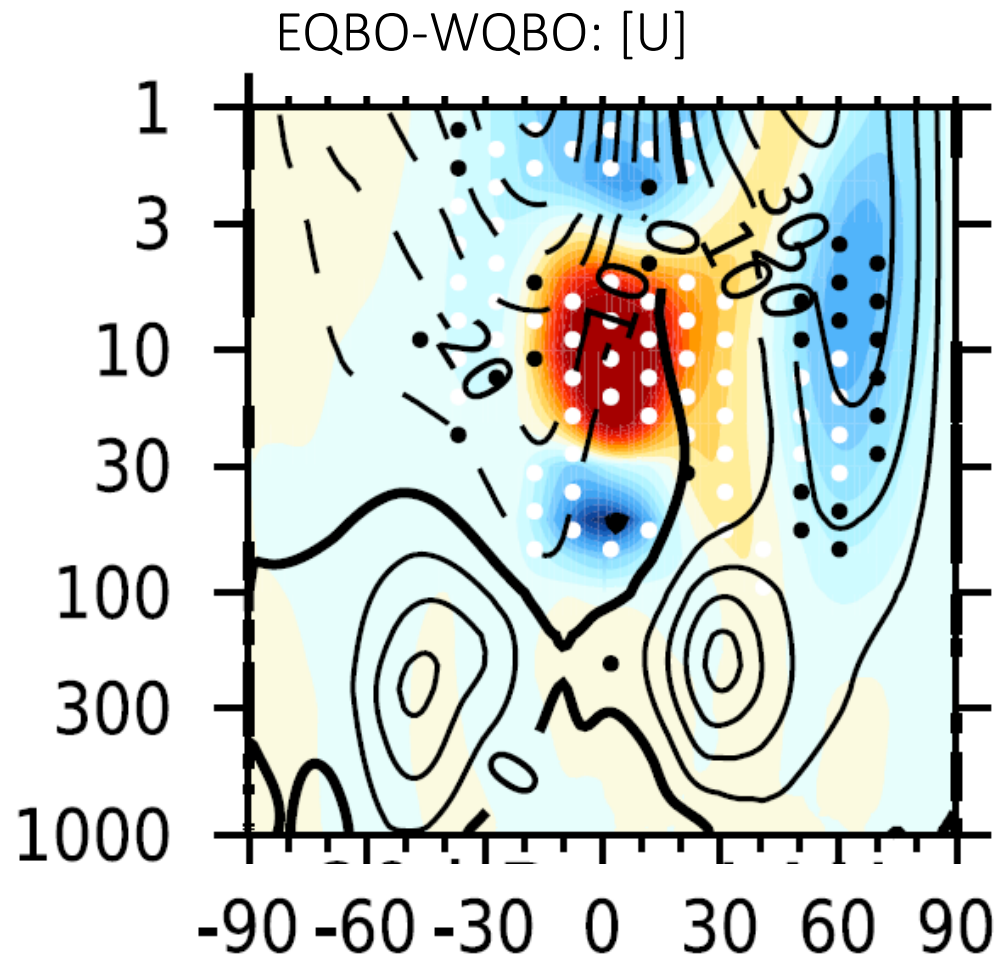


SSW impacts

30-day average
after SSW

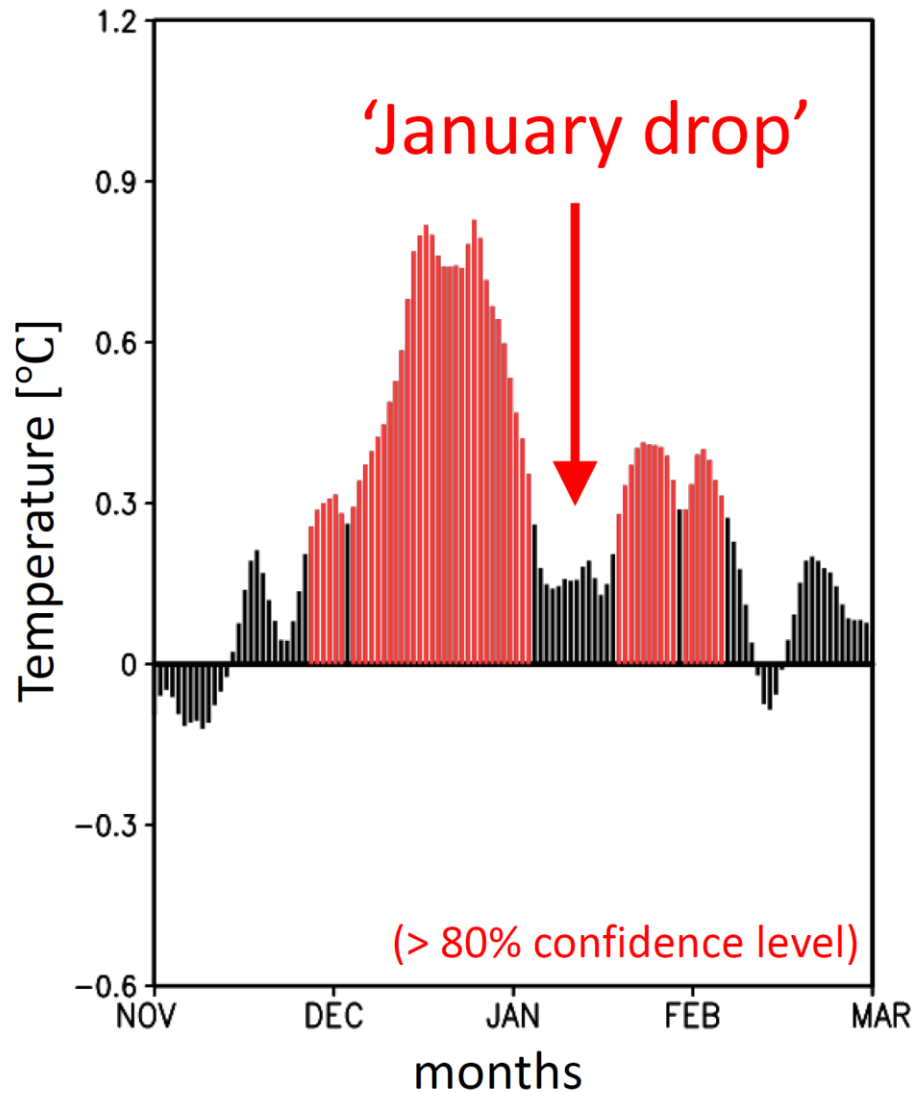


QBO-SSW



Gray et al. (2018)

Impact of El Niño



A weak relationship between El Niño and the surface air temperature over east Asia is observed in January (Son et al. 2014; Kim et al. 2017).