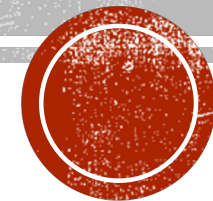# CONNECTIONS BETWEEN SUBTROPICAL HIGH PRESSURE, THE HADLEY CIRCULATION AND BAROCLINIC INSTABILITY

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CONTENTS

Motivation

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Interannual variability

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Conclusion

- The subtropical high connects the mid-latitude and low-latitude and controls tropical and subtropical weather systems and extreme events.

- We compare the global subtropical highs and find the common rules .

MOTIVATION

DATA AND METHOD

Datasets	Resolution	Period
ERA-5	0.25°×0.25°	1979~2018
NCEP-DOE	2.5°×2.5°	1979~2018
JRA-55	1.25°×1.25°	1979~2018

DATA AND METHOD
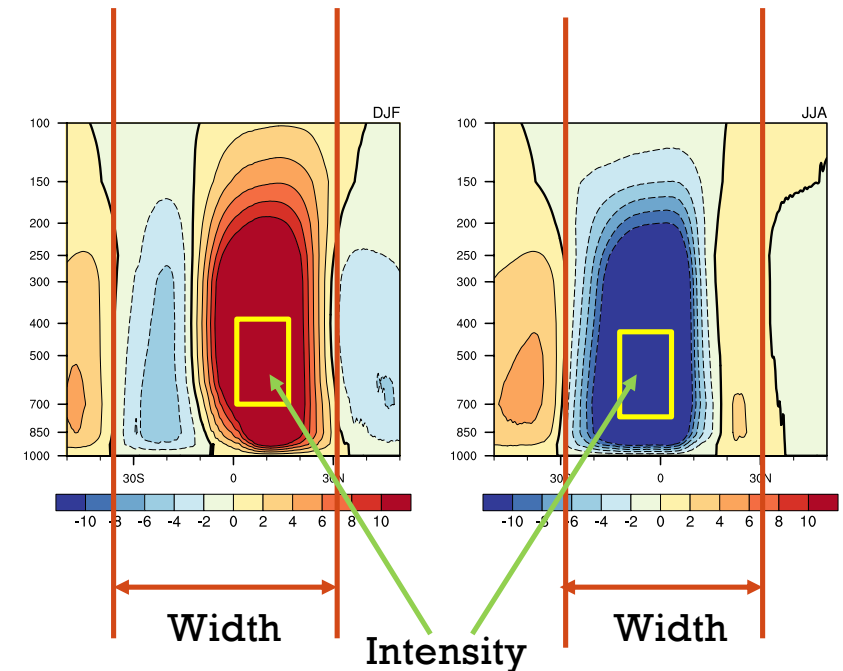
- **The definition of Hadley Cell (units: kg·s⁻¹)**

$$\psi(p,\varphi) = \frac{2\pi \cdot a \cdot \cos\varphi}{g} \cdot \int_p^{P_s} V(p,\varphi)dp$$

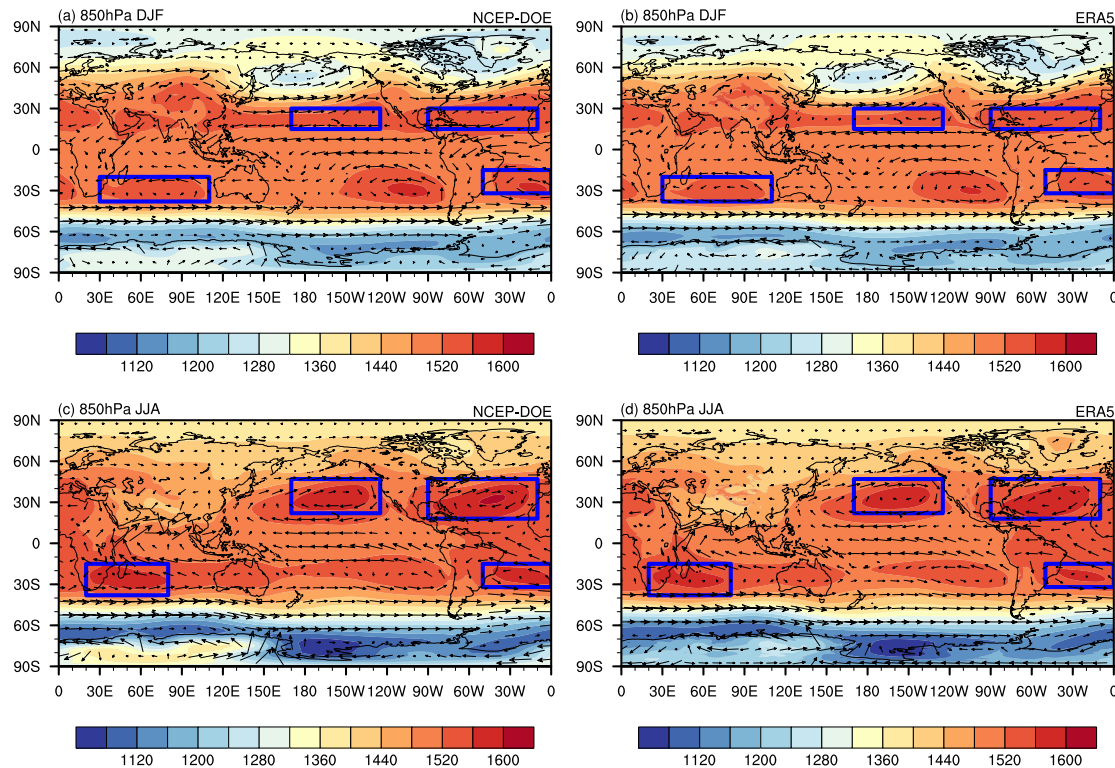Intensity: vertically averaged maximum value of ψ between 400 and 700 hPa;

Width: zero isoline for ψ on the poleward of HC between 400 and 700 hPa.

- **The definition of Eady Growth Rate (units: s⁻¹)**

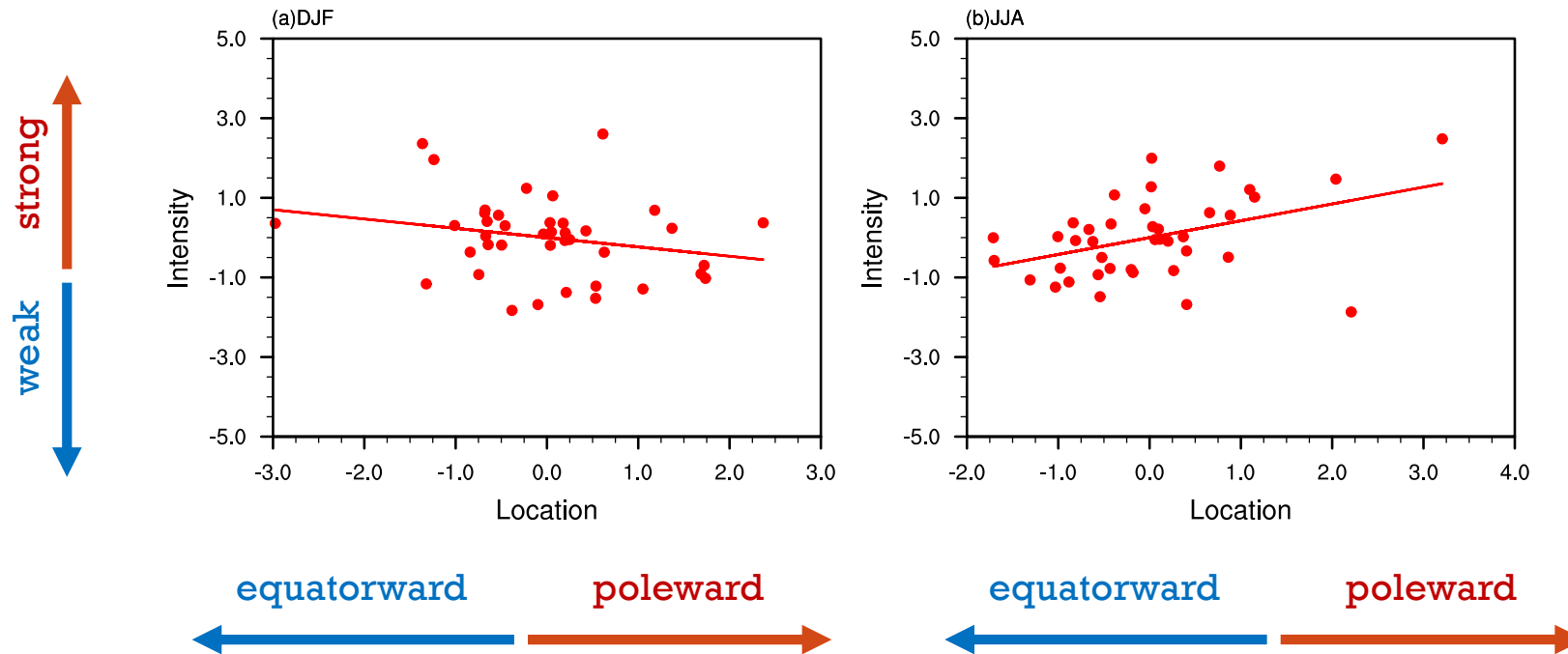$$\sigma = 0.31 \cdot \frac{|f|}{N} \cdot \frac{d\boldsymbol{V}}{dz}$$
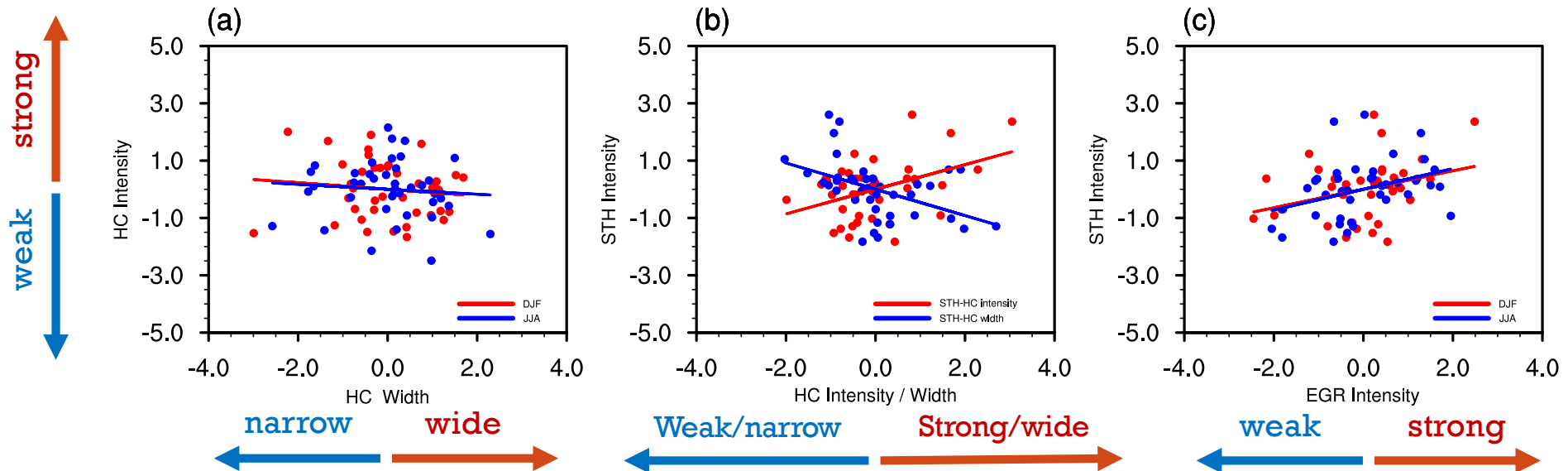
THE DEFINITION OF SUBTROPICAL HIGHS

- 850 hPa geopotential height (over 1560 gpm);

- Mean intensity: Box average intensity;

- Center: Maximum location.

SUBTROPICAL HIGH INTENSITY AND LOCATION

- DJF: STH intensity increases when it moves equatorward;
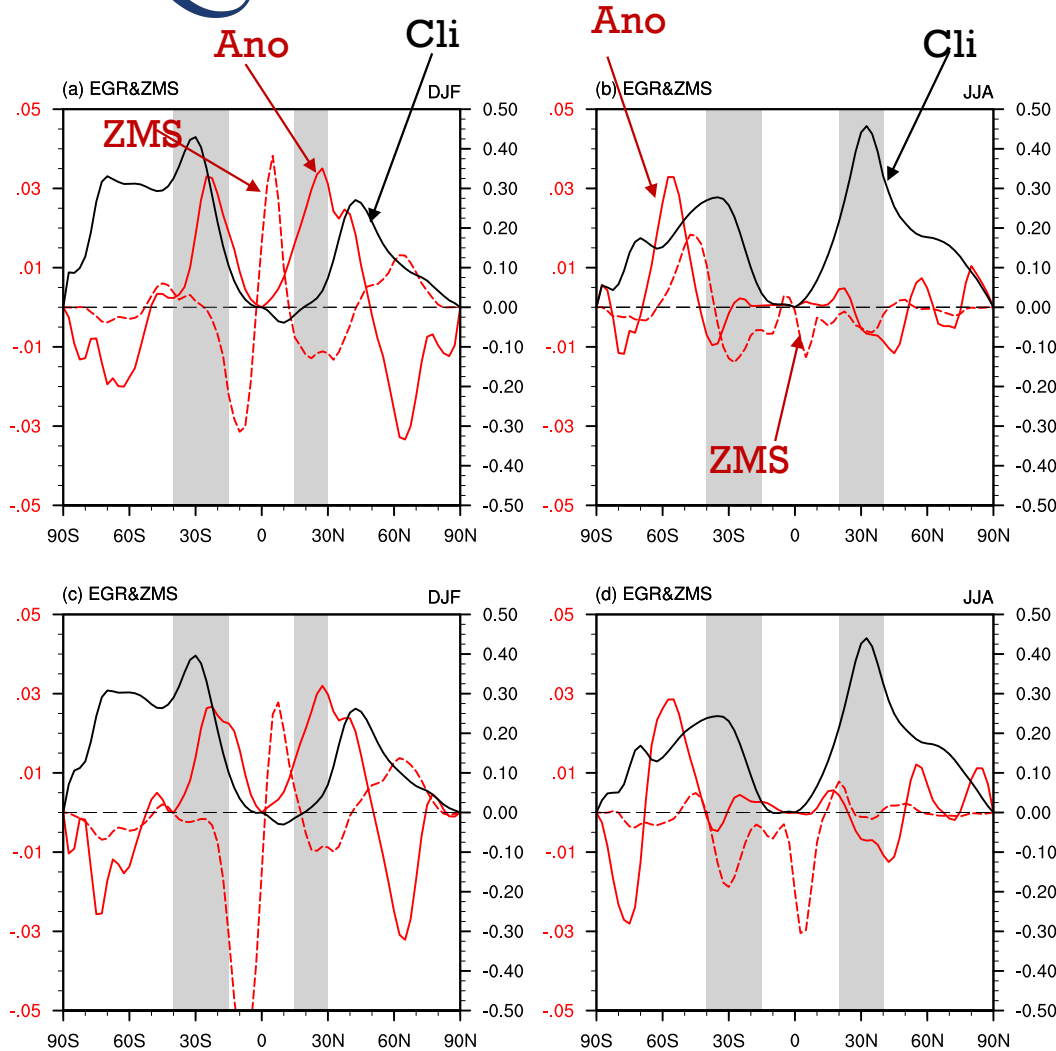
- JJA: STH intensity increases when it moves poleward.

SUBTROPICAL HIGH, HADLEY CELL AND EADY GROWTH RATE

JJA & DJF:
- When the Hadley cell is wide, the Hadley cell is weak;
- When the Hadley cell is strong, the Subtropical High is strong;
- When the Hadley cell is wide, the Subtropical High is weak;
- When the Eady Growth Rate is strong, the, the Subtropical High is strong.

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(a) EGR&ZMS — DJF — ERA5
Ano, Cli, ZMS

(b) EGR&ZMS — JJA — ERA5
Ano, Cli, ZMS

(c) EGR&ZMS — DJF — NCEP

(d) EGR&ZMS — JJA — NCEP

EADY GROWTH RATE AND ZONAL MEAN STREAMFUNCTION

❑ DJF:
- The EGR moves equatorward when the STH is strong;
- The descent is strong;

❑ JJA:
- The EGR moves poleward and STH is strong;
- The descent is strong;

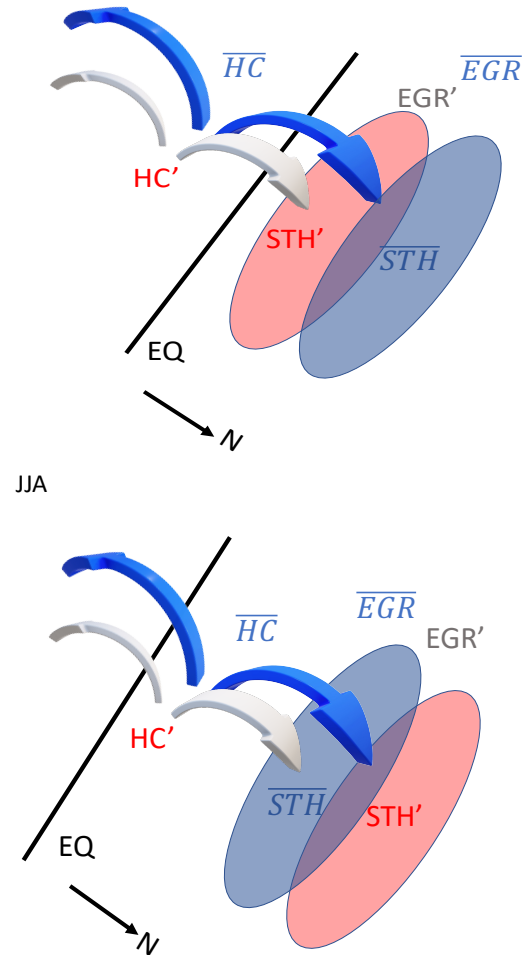**Strong STH – Weak STH**

Climatology (black)
EGR Difference (red solid)
ZMS Difference (red dashed)
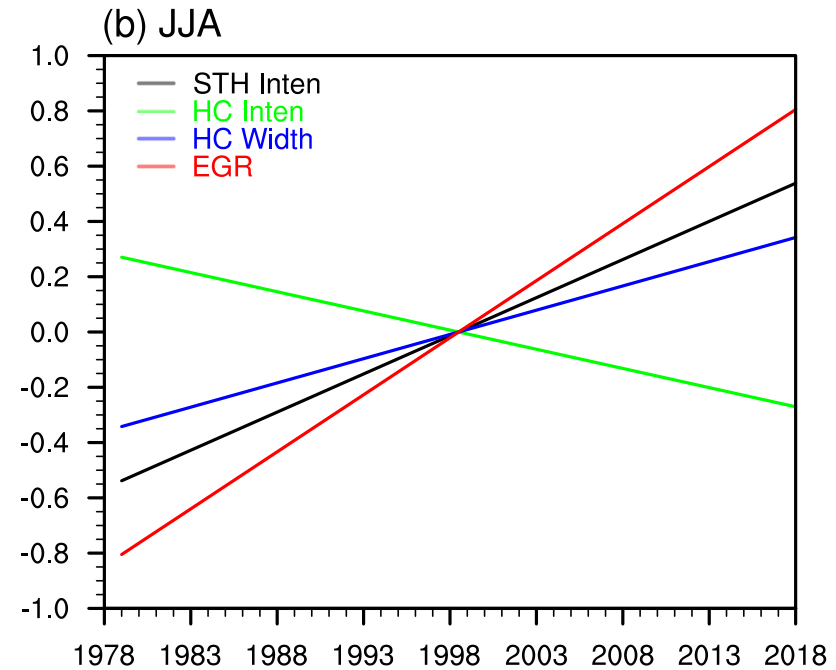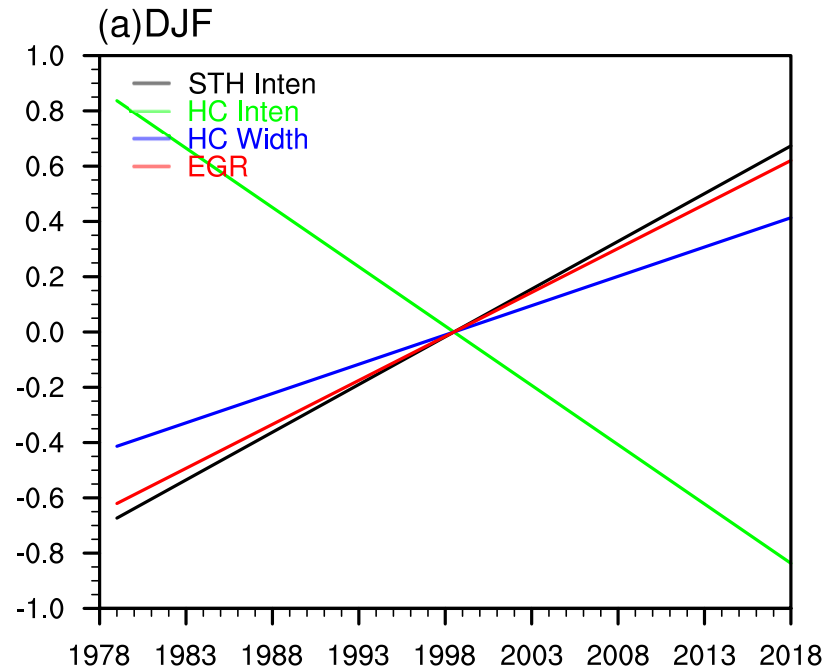*Subtropical high (grey shading)*

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Interannual Variability

SCHEMATIC

❑ DJF:
- The Eady Growth Rate moves equatorward and strong when the Subtropical High is equatorward and strong;
- Hadley cell is narrow and strong.

❑ JJA:
- The Eady Growth Rate moves poleward and strong when the Subtropical High is poleward and strong;
- Hadley cell is narrow and strong.

Trend

UNIVERSITY OF
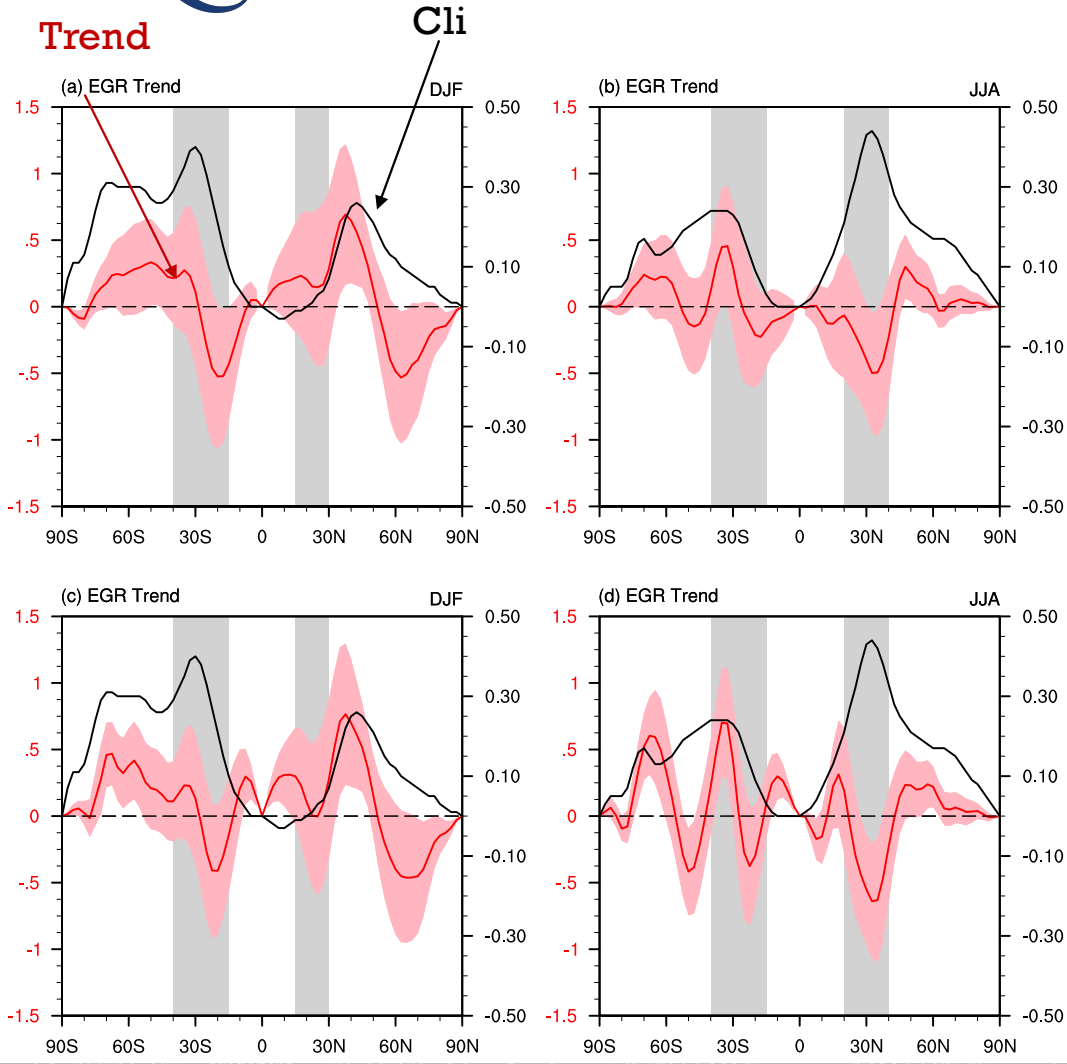EXETER

(a)DJF

(b) JJA

❑DJF and JJA:

* Subtropical High intensities are increasing;
* Eady Growth Rate is increasing.
* Hadley Cell intensity is decreasing;
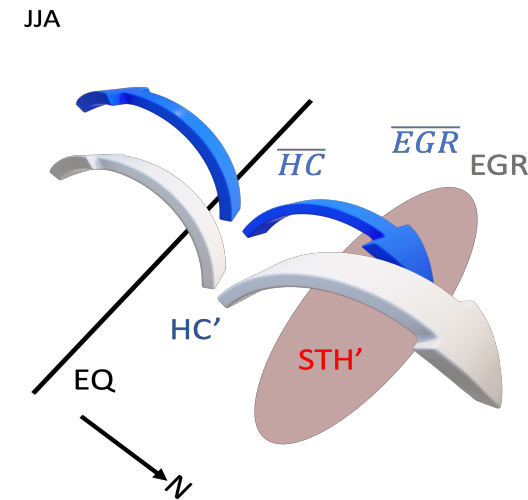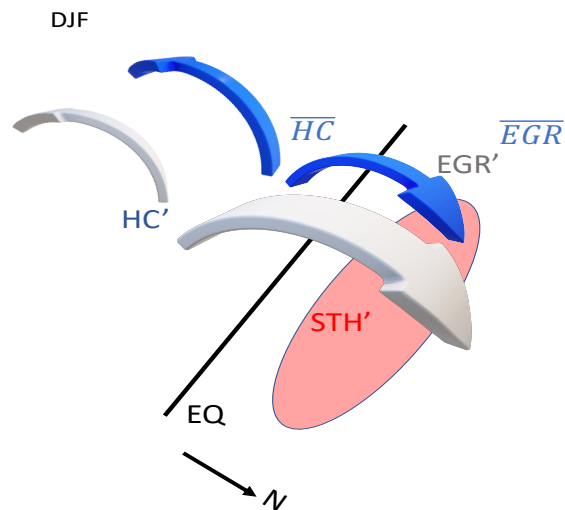* Hadley Cell width is increasing;

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ZONAL MEAN EADY GROWTH RATE

- DJF - EGR moves equatorward;

- JJA - EGR moves poleward.

Climatology: black line
Trend: red line
Red shading is the 95% confidence level
Grey shading is the location of STH

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SCHEMATIC

DJF

$\overline{HC}$ $\overline{EGR}$

HC' EGR'

STH'

EQ

$\mathcal{N}$

JJA

$\overline{HC}$ $\overline{EGR}$ EGR'

HC' STH'

EQ

$\mathcal{N}$

❑ DJF:

• The Eady Growth Rate is equatorward and strong when the Subtropical High is strong;
• Hadley cell is wide and weak.

❑ JJA:

• The Eady Growth Rate is poleward and strong when the Subtropical High is strong;
• Hadley cell is narrow and strong.

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CONCLUSION

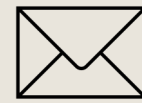|	JJA	DJF
Interannual Variability	STH is strong and poleward	STH is strong and equatorward
	Hadley Cell is strong and narrow	Hadley Cell is strong and narrow
	EGR is strong and poleward	EGR is strong and equatorward
Trend	STH is strong	STH is strong
	Hadley Cell is weak and wide	Hadley Cell is weak and wide
	EGR is strong and poleward	EGR is strong and equatorward

Subtropical High and Eady Growth Rate have the same relationship on interannual and trend time scales

⇒ Eady Growth Rate rather than Hadley Cell can best explain the variability and changes of the subtropical highs.

THANKS

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