Modulation of Tropical Cyclogenesis over the Northwest Pacific by the Quasi-biweekly Oscillation under Different ENSO Phases

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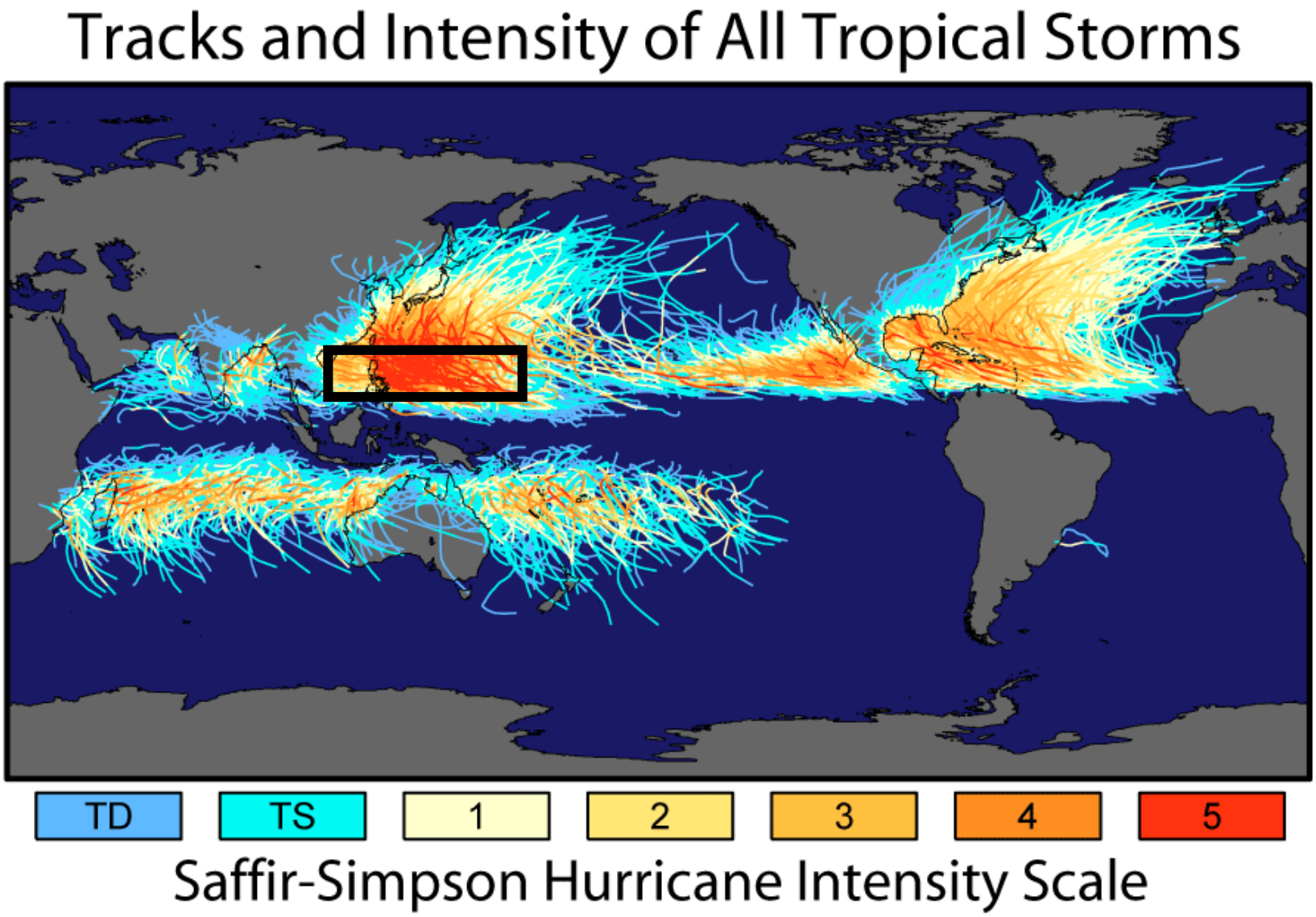
Outline

1. Introduction
2. Modulation of TC by QBWO under different ENSO phases
3. Large-scale factors affecting TCs formation
4. QBWO activity under different ENSO phases
5. Key conclusions

Introduction



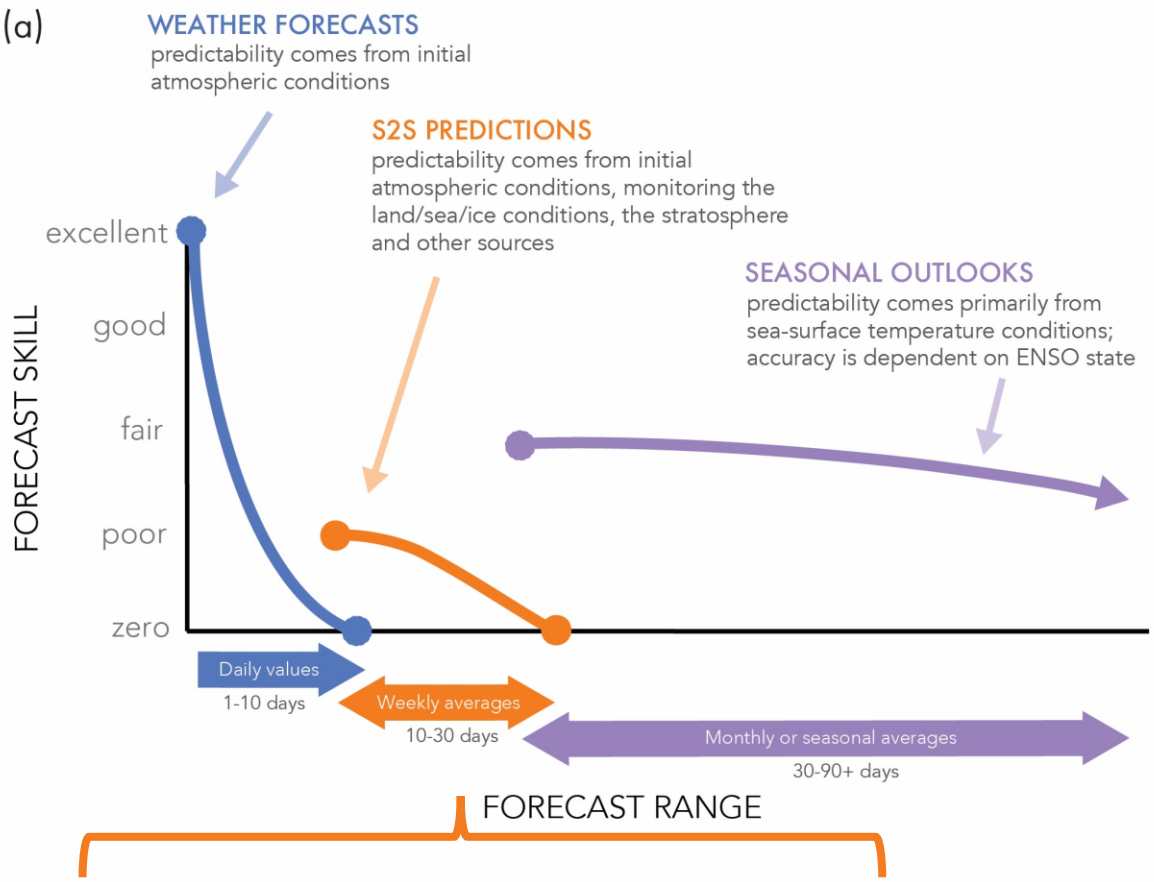
Introduction

Tropical cyclone risks

Wind

Rain

Introduction



Quasi-biweekly Oscillation (QBWO)

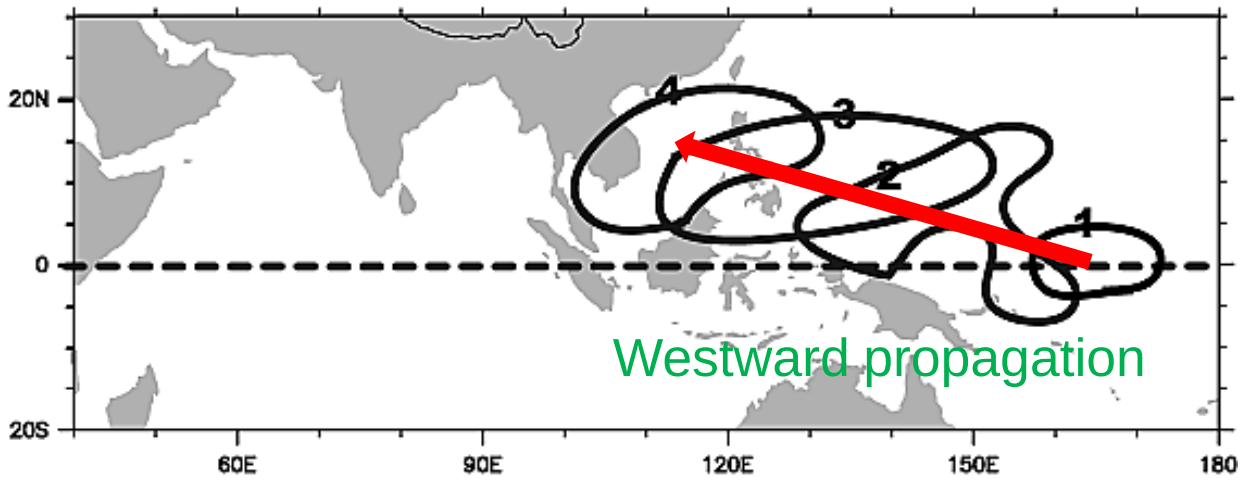
10 ~ 20 days

Madden-Julian Oscillation (MJO)

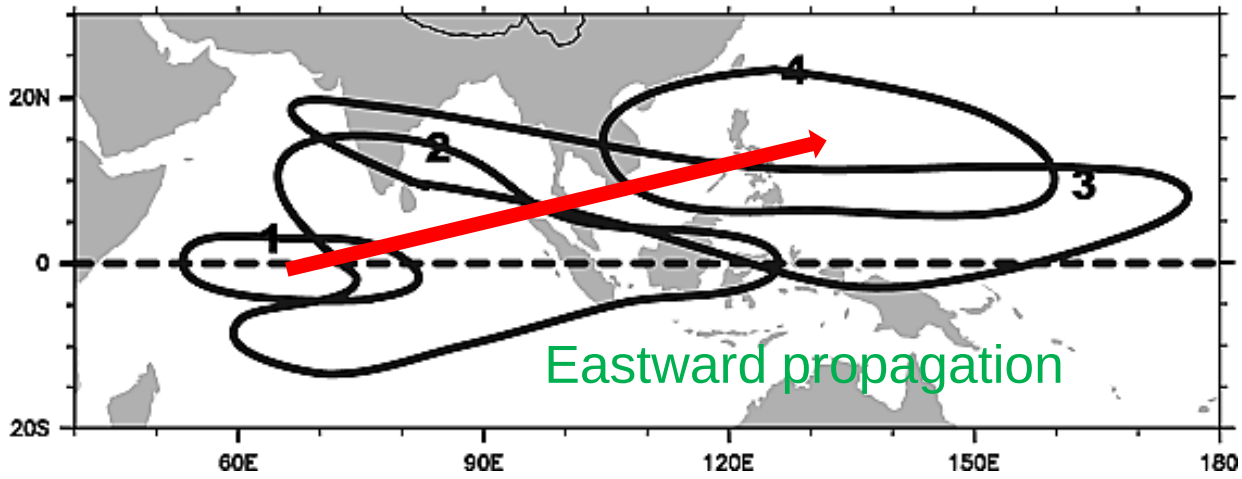
30 ~ 60 days

Introduction

QBWO



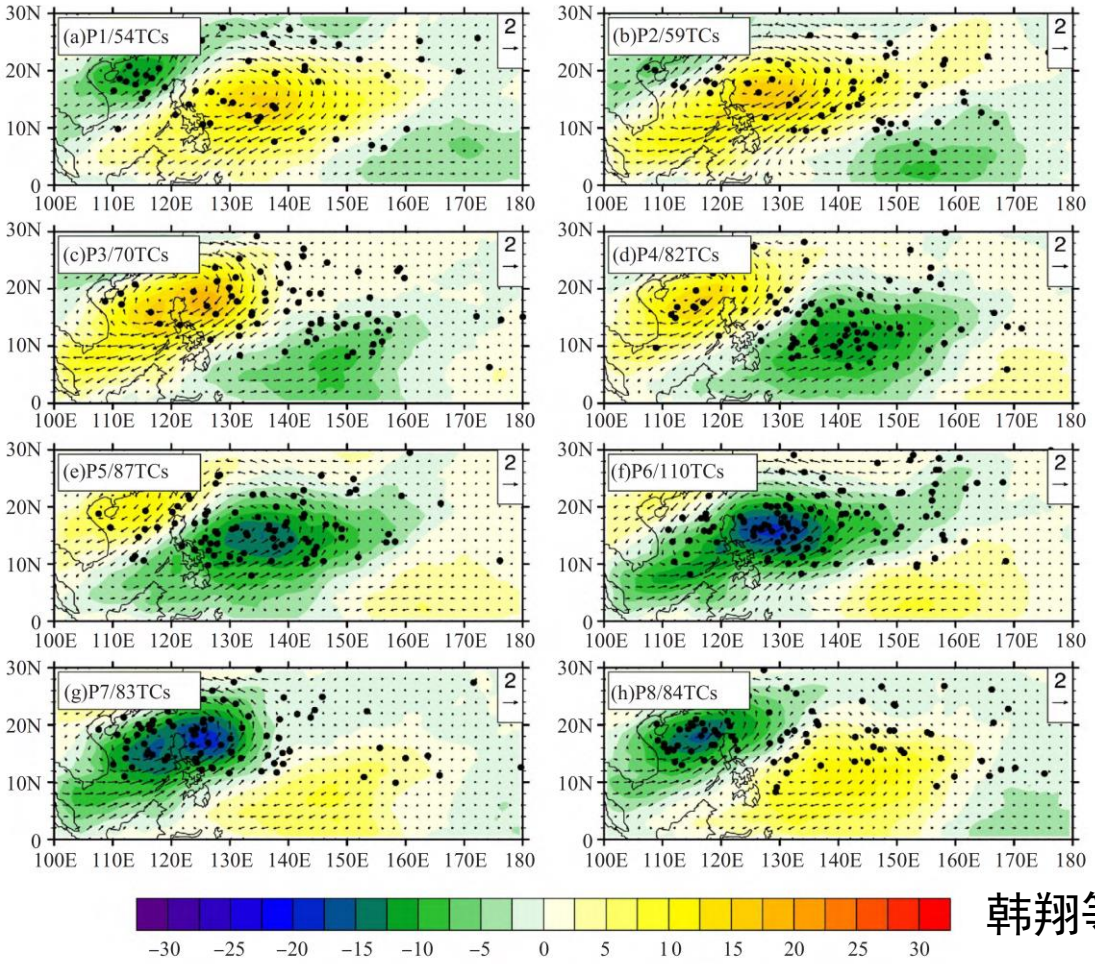
MJO



Yang et al. 2008

Introduction

QBWO and TC formation

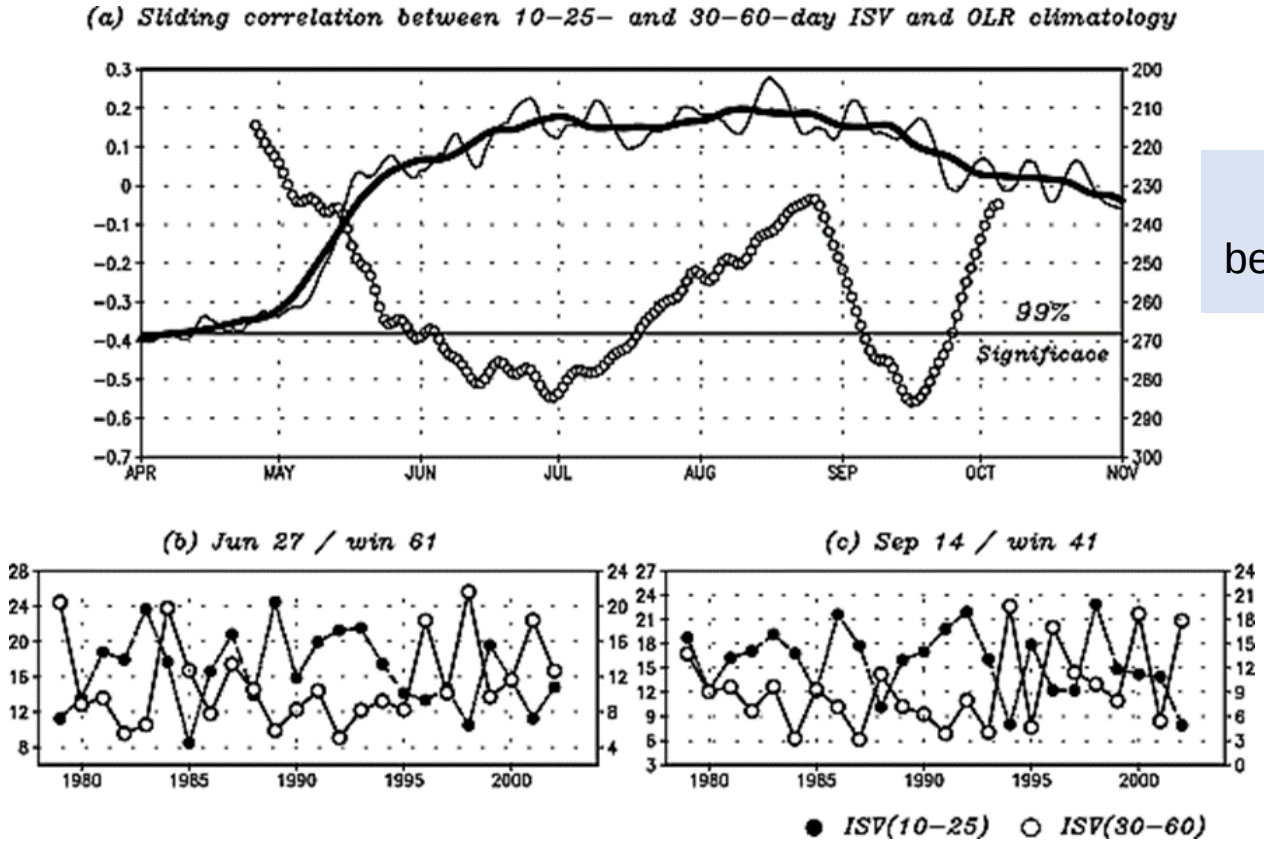


韩翔等，2018

- Features of propagation westward
- TC formation coupled with QBWO convection

Introduction

Interannual variability of MJO and QBWO

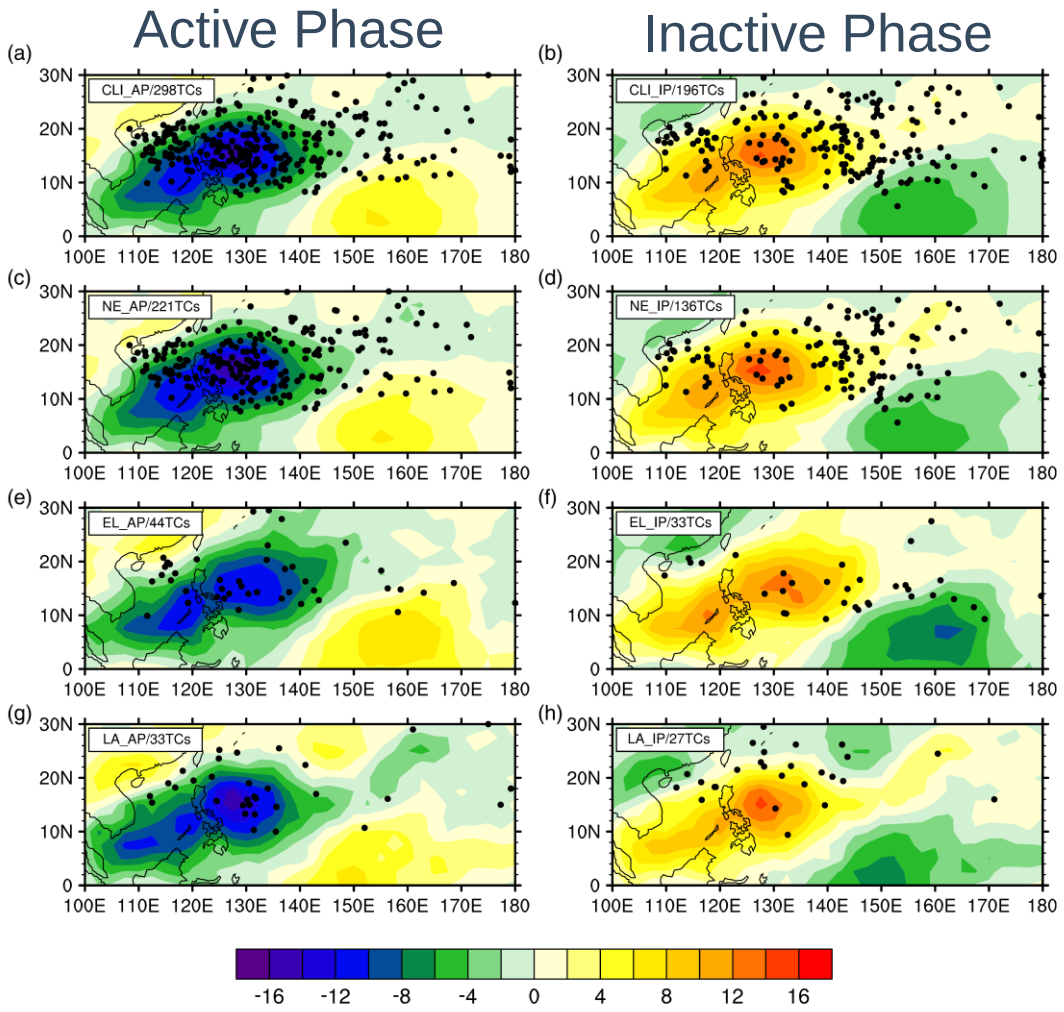


Negative correlation between MJO and QBWO

Kajikawa et al. 2005

- Strong interannual variability of QBWO and MJO mode
- How does modulation of TC formation by QBWO change under different ENSO phases?

Changes in modulation of TC by QBWO



- Enhanced QBWO convection in neutral years
- Weaker and less organized QBWO convection in El Niño and La Niña years

Changes in modulation of TC by QBWO

Statistics of TCs for different phases of QBWO under different ENSO phases (TC number/Phase days)

	All years		Neutral years		El Niño years		La Niña years	
Phase	JMA	JTWC	JMA	JTWC	JMA	JTWC	JMA	JTWC
Active Phase	**14.04%****	**13.50%****	**14.66%****	**14.53%****	12.57%	12.0%	12.5%	9.46%
Inactive Phase	**9.15%****	**9.29%****	**8.89%****	**8.89%****	10.19%	11.72%	9.41%	8.71%
Weak phase	10.5%	10.68%	10.36%	10.53%	10.70%	10.23%	11.11%	11.92%
Climatology	11.19%	11.11%	11.24%	11.27%	11.14%	11.23%	10.98%	10.21%

- "**" : 0.05 significance level
- The same conclusion can be drawn from TC data released by CMA.

- Changes in TCs formation is consistent with changes in QBWO convection.
- Enhanced modulation of TCs by QBWO and weakened modulation in El Niño years and La Niña years.

Large-scale factors affecting TCs formation

Conditions Favourable for Tropical Cyclone Formation

- Warm ocean (>26°C)
- Coriolis force (>5°N/S)
- Good source of latent heat
- Low-level disturbances
- Weak wind shear

What can QBWO Bring to Tropical Cyclone Formation?

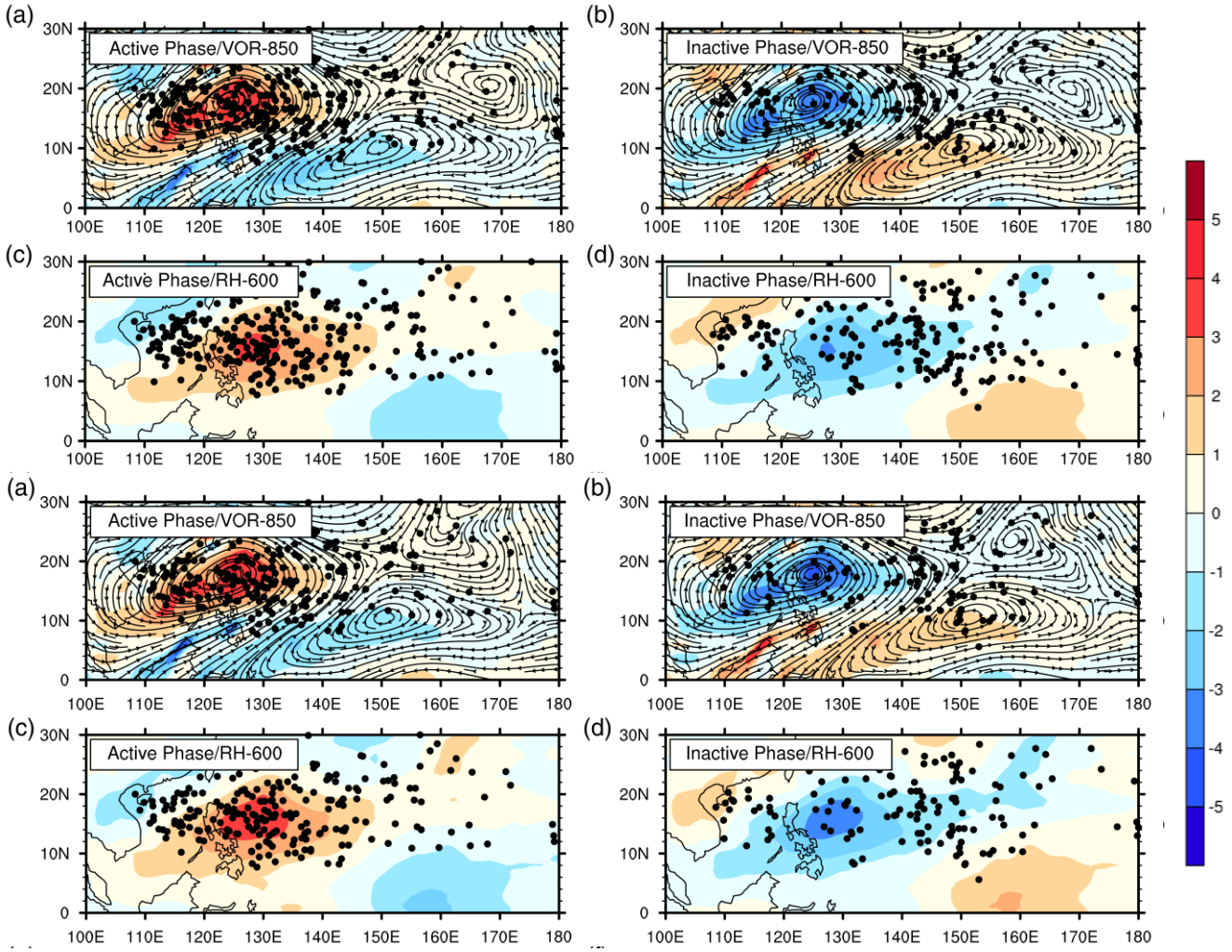
- Low-level vorticity
- Mid-level relative humidity

(Li and Zhou 2013; Zhao et al. 2015; Zhao and Wang 2016)

Large-scale factors affecting TCs formation

All years

Neutral years

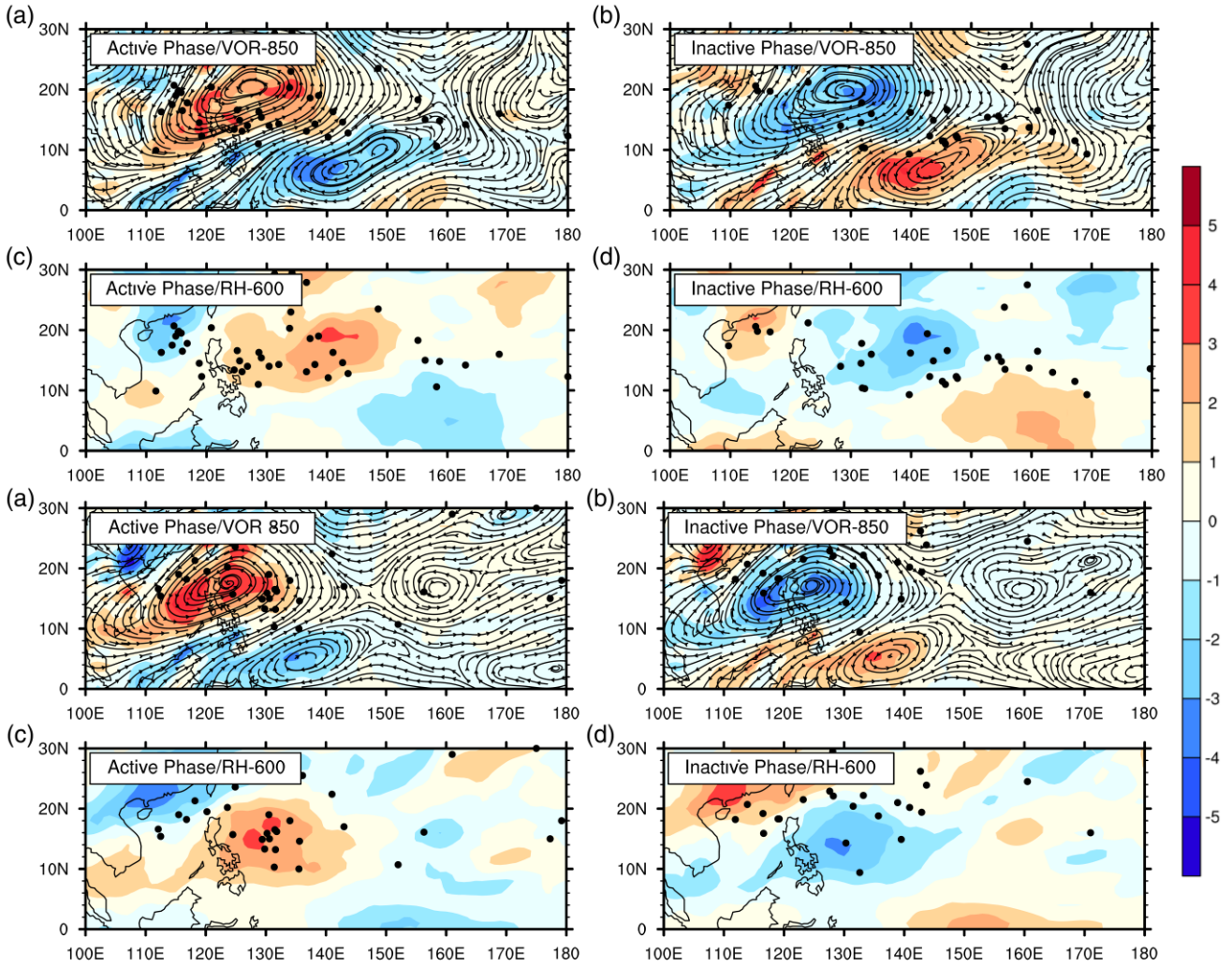


- Enhanced modulation of low-level vorticity and mid-level relative humidity by QBWO in neutral years

Large-scale factors affecting TCs formation

El Niño years

La Niña years



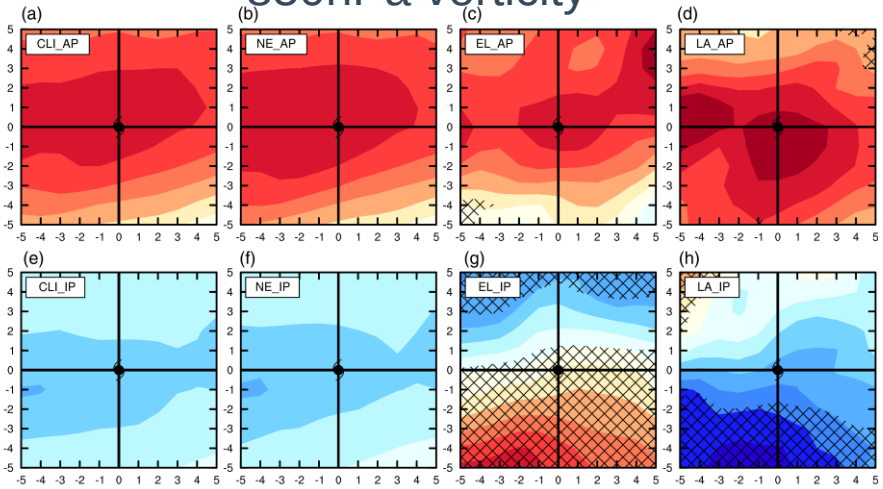
- Weakened modulation of low-level vorticity and relative humidity by QBWO in El Niño years and La Niña years

Large-scale factors affecting TCs formation

850hPa vorticity

Active Phase

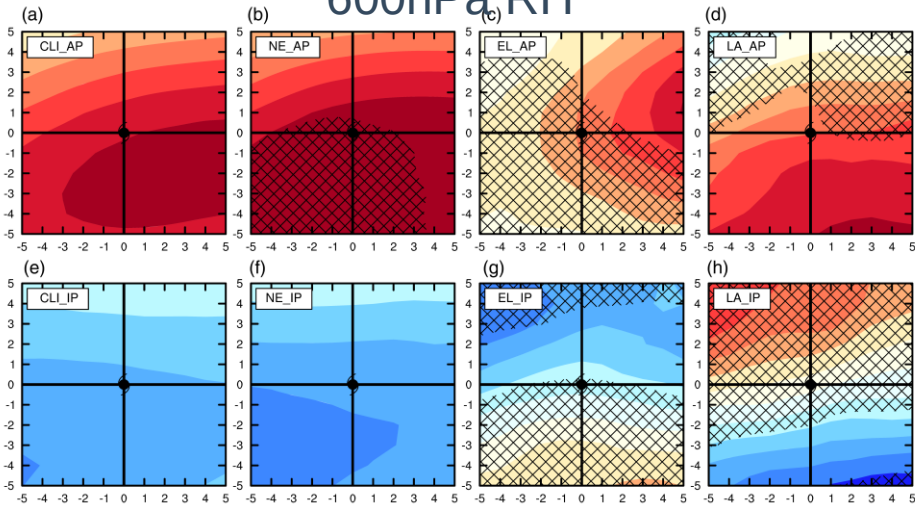
Inactive Phase



600hPa RH

Active Phase

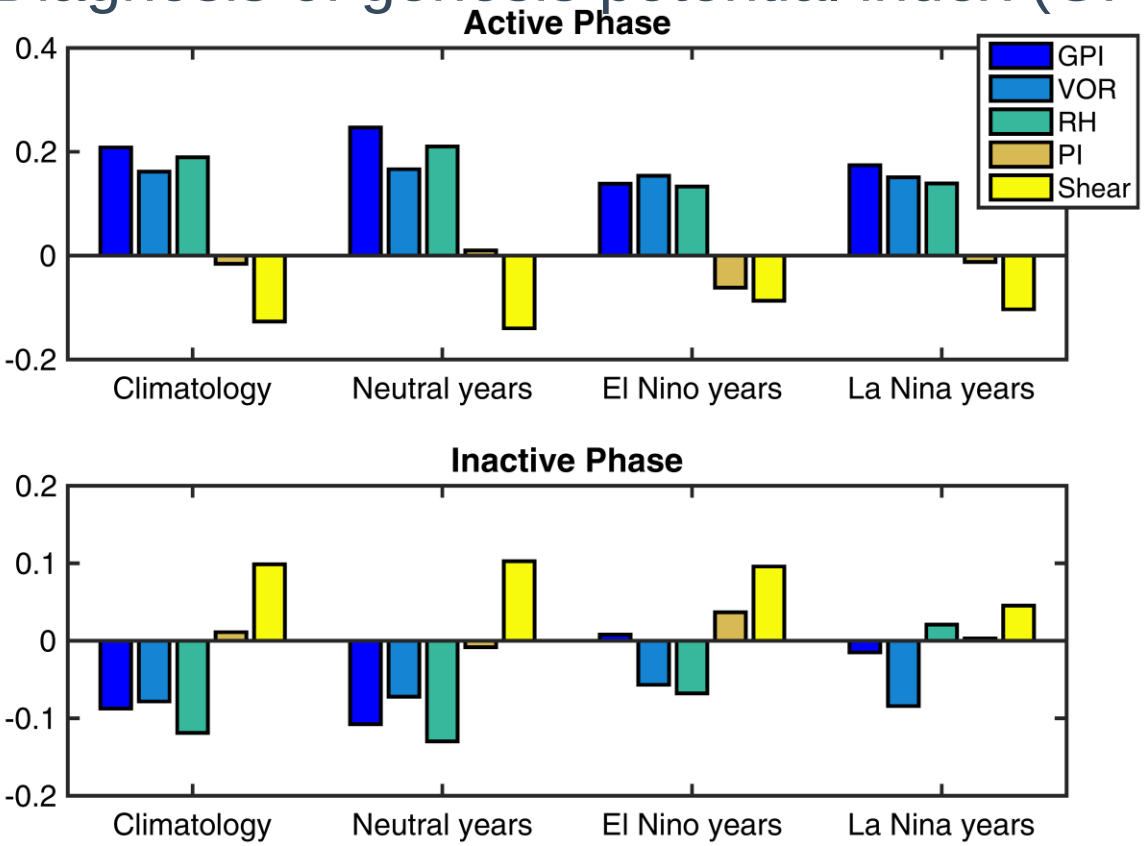
Inactive Phase



- Enhanced modulation of large-scale factors in Neutral years
- Weak modulation of large-scale factors in El Niño years and La Niña years

Large-scale factors affecting TCs formation

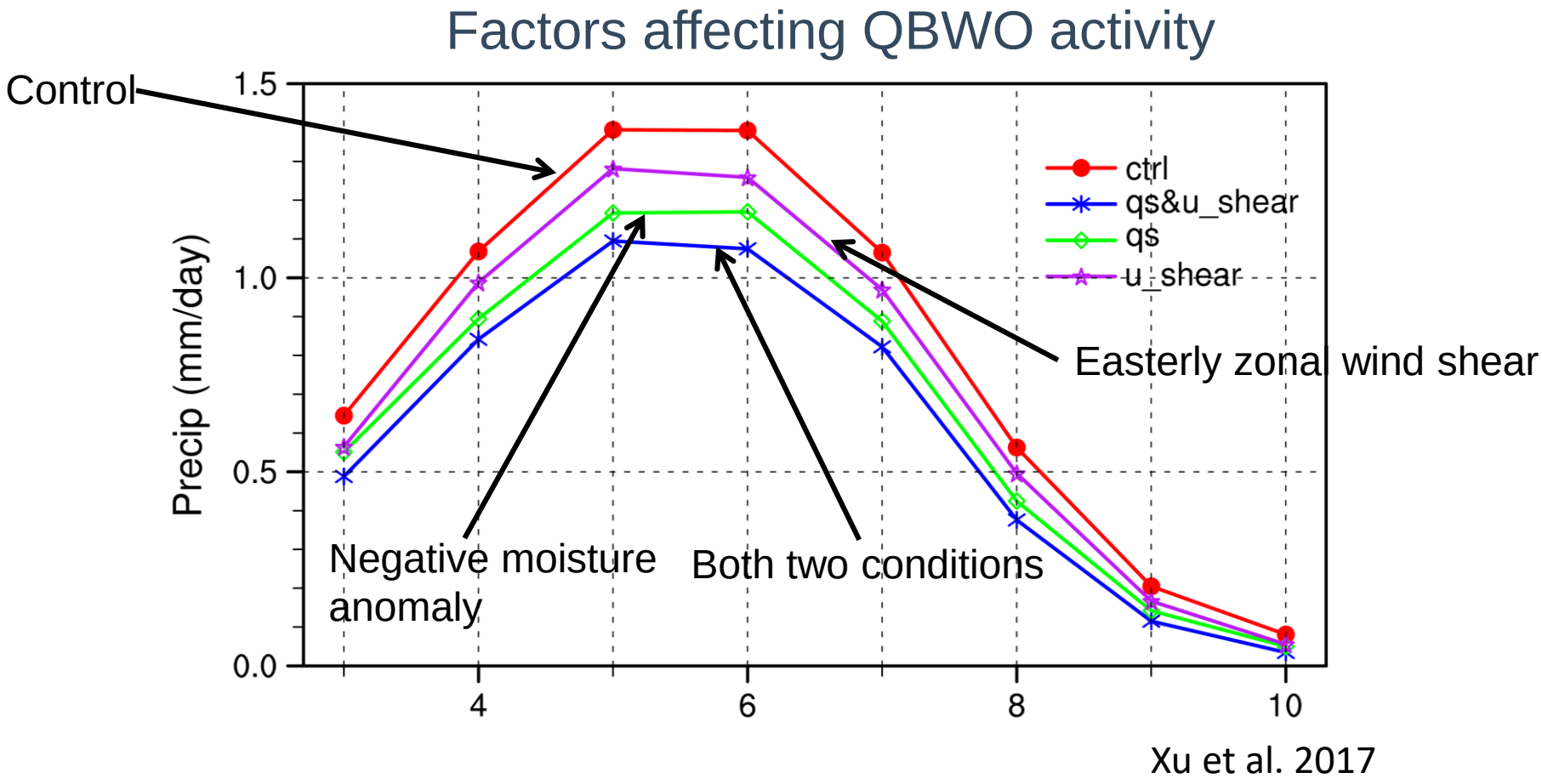
Diagnosis of genesis potential index (GPI)



- $GPI = \left|10^5\eta\right|^{\frac{3}{2}} \left(\frac{\mathcal{H}}{50}\right)^3 \left(\frac{V_{pot}}{70}\right)^3 (1 + 0.1V_{shear})^{-2}$ (Emanuel and Nolan, 2004)

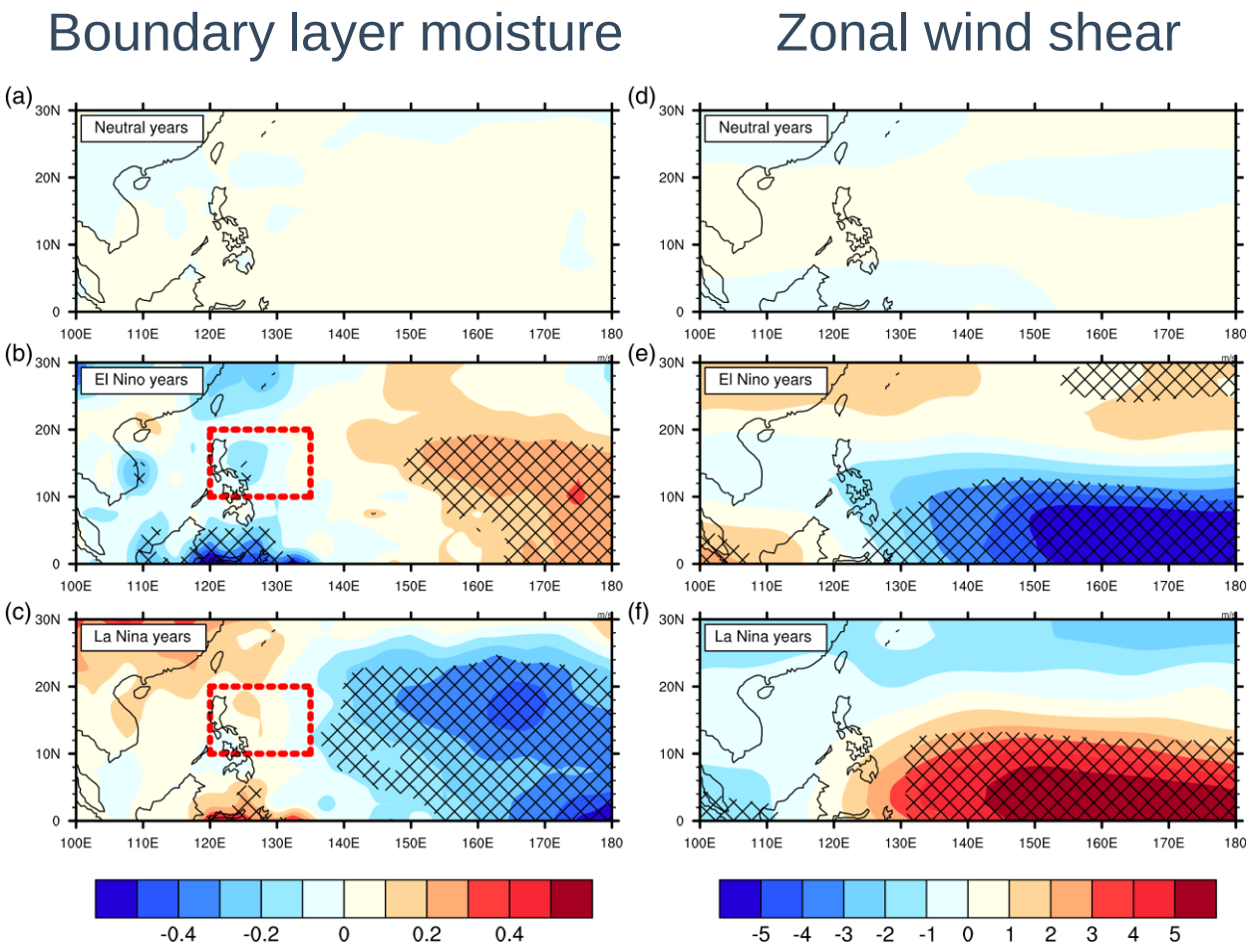
- Low-level vorticity and mid-level relative humidity are two important factors to TC formation.
- Changes in wind shear also make significant contributions
- Changes in GPI are consistent with prior analysis

Changes in QBWO activity



- Boundary layer moisture and westerly zonal wind shear are two important factors affecting QBWO activity
- Boundary layer moisture is more important than zonal wind shear

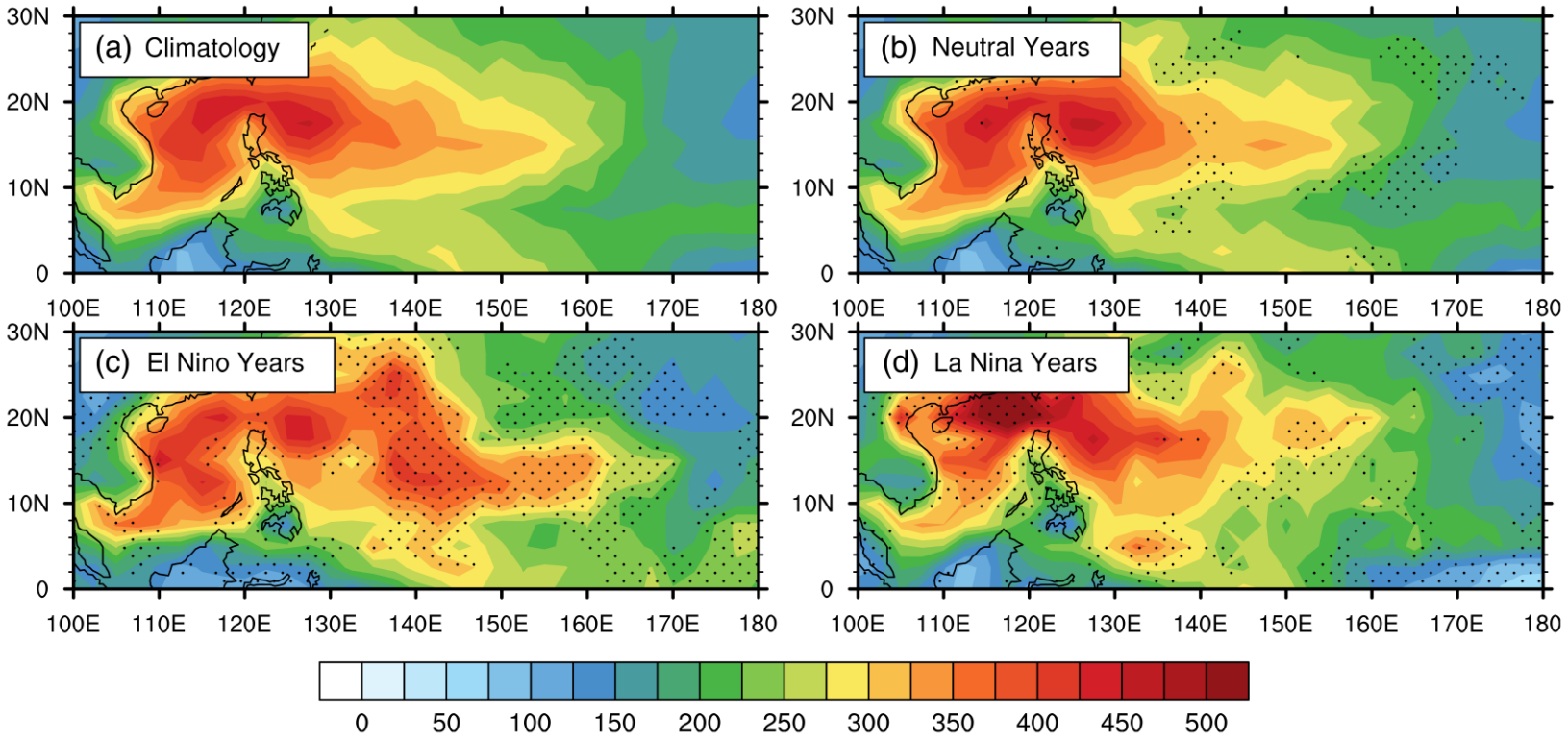
Changes in QBWO activity



- Distribution of boundary layer moisture may explain changes in QBWO activity

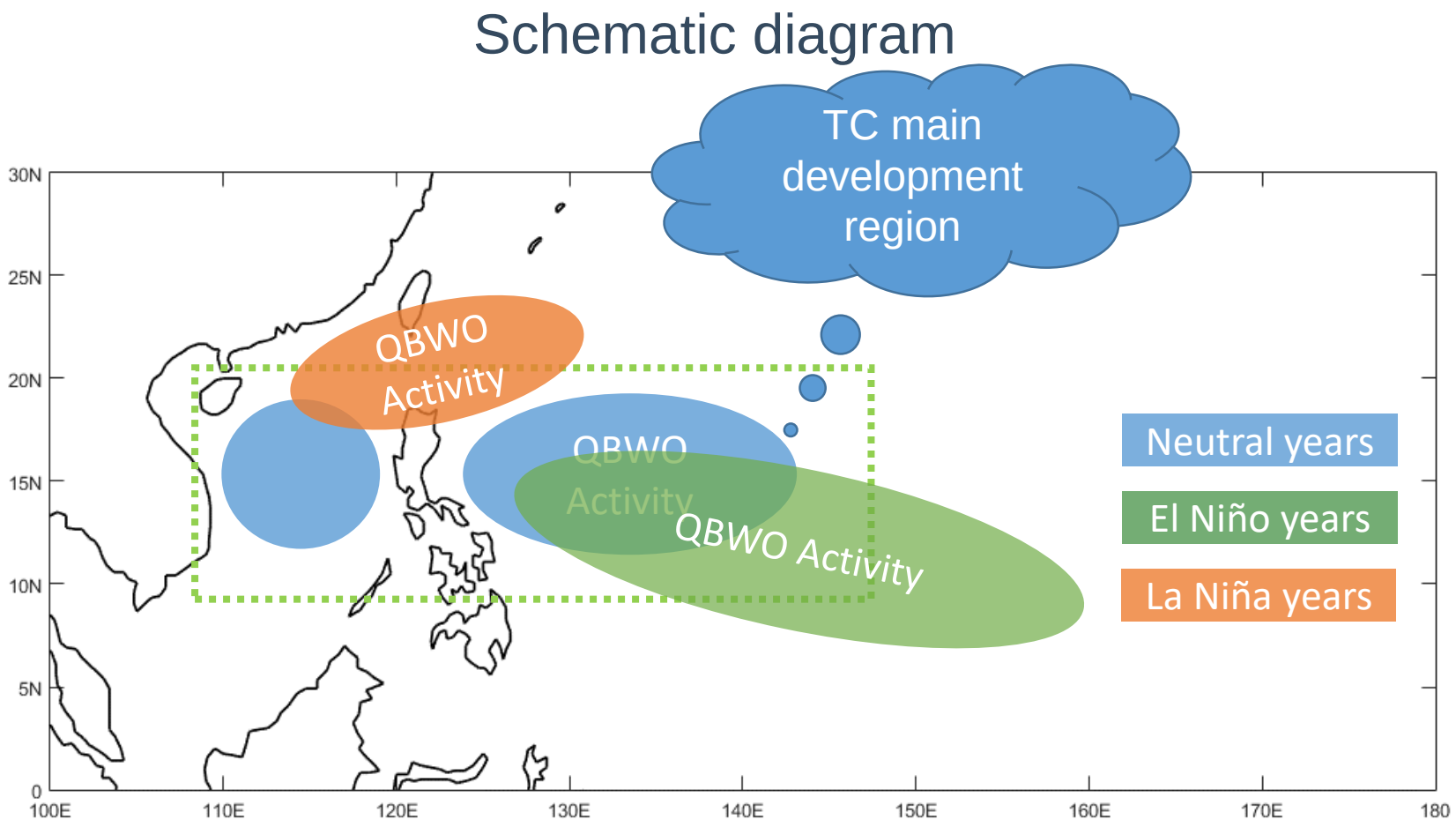
Changes in QBWO activity

Variances of 10-20 day filtered OLR



- Extended eastward QBWO activity in El Niño years
- Gathered westward QBWO activity in La Niña years

Changes in QBWO activity



Key conclusions

- Significant modulation of TCG by QBWO in the ENSO neutral years and weakened modulation of TCG by QBWO in El Niño and La Niña years;
- Large-scale environmental factors are more favorable for TCG during ENSO neutral years compared with El Niño and La Niña years;
- Changes in modulation of TC by QBWO are associated with QBWO cycle under the impact of background (e.g., boundary layer moisture and zonal wind shear) which is determined by ENSO conditions.

Thanks for your attention

Reference: Han, X., Zhao, H., Li, X., Raga, G. B., Wang, C., & Li, Q. (2020). Modulation of boreal extended summer tropical cyclogenesis over the northwest Pacific by the quasi‐biweekly oscillation under different El Niño‐southern oscillation phases. *International Journal of Climatology*, 40(2), 858-873.