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Southeast China extreme drought event in August 2019: Context of coupling of mid-latitude and tropical systems

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1.Introduction

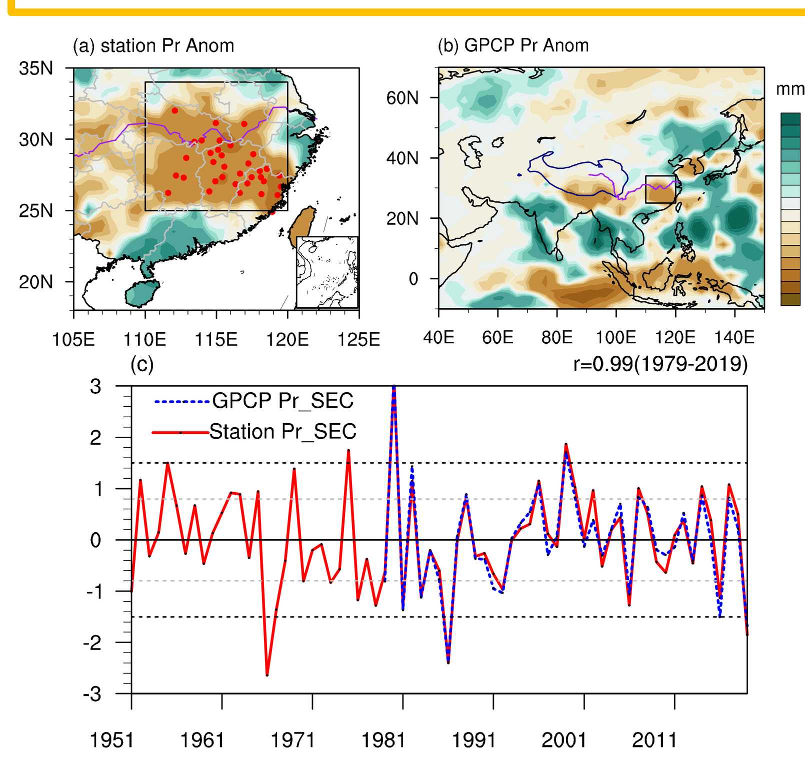


Fig 1. (a) Station precipitation anomalies in August 2019; (b) GPCP; (c) Normalized time series of area-averaged precipitation anomalies over the SEC in August .

- From late summer to mid-autumn in 2019, Southeast China (SEC) suffered an extreme drought, which devastated more than 3.3 million hectares of crops and caused serious economic losses;
- Previous studies highlighted the role of super positive IOD and El Niño Modoki from the August–October-averaged perspective, as well as the Madden–Julian oscillation;
- This study aimed to investigate the synergistic influences of the mid- to high-latitude and tropical atmospheric circulation anomalies and analyze the role of the Tibetan Plateau (TP) on the SEC extreme drought in August 2019.

2. Datasets, methods, and models

- **Datasets:**

GPCP V2.3 (2.5° × 2.5°) and **839 China stations** (interpolated to a 0.5° × 0.5° ; 1951–2019) precipitation; **ERSST V5** SST (2° × 2°); **ERA-Interim** atmospheric circulation variables (0.75° ×0.75°); 1979–2019

- **Methods:**

A horizontal wave activity flux diagnosis; Multivariate empirical orthogonal function; Regression; Correlation; Partial correlation; A two-tailed Student's *t*-test

- **Models:**

Hybrid Single-Particle Lagrangian Integrated Trajectory (**HYSPLIT**) 5.0 model; A linear baroclinic model (**LBM**); The version 2 of the finite-volume atmospheric model of LASG, IAP, CAS (**CAS FGOALS-f2**)

3. Drought atmospheric circulation and transport of water vapor

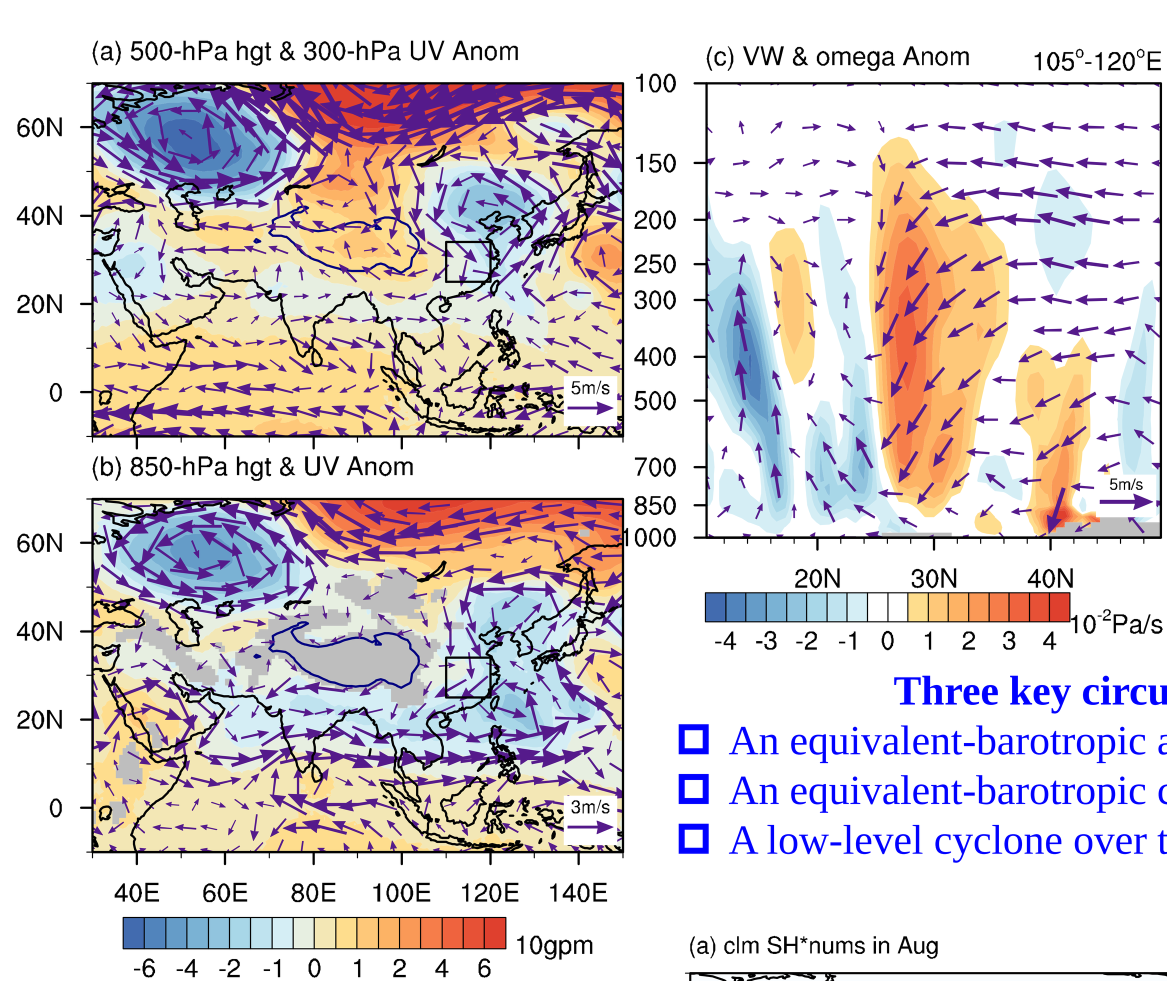


Fig.2 (a) 500-hPa geopotential height and 300-hPa wind anomalies in August 2019; (b) 850-hPa geopotential height and wind anomalies; (c) Meridional-vertical circulation anomalies averaged between 105° –120° E.

Three key circulation systems

- An equivalent-barotropic anticyclone over the TP
- An equivalent-barotropic cyclone over the Northeast China
- A low-level cyclone over the western North Pacific (WNP)

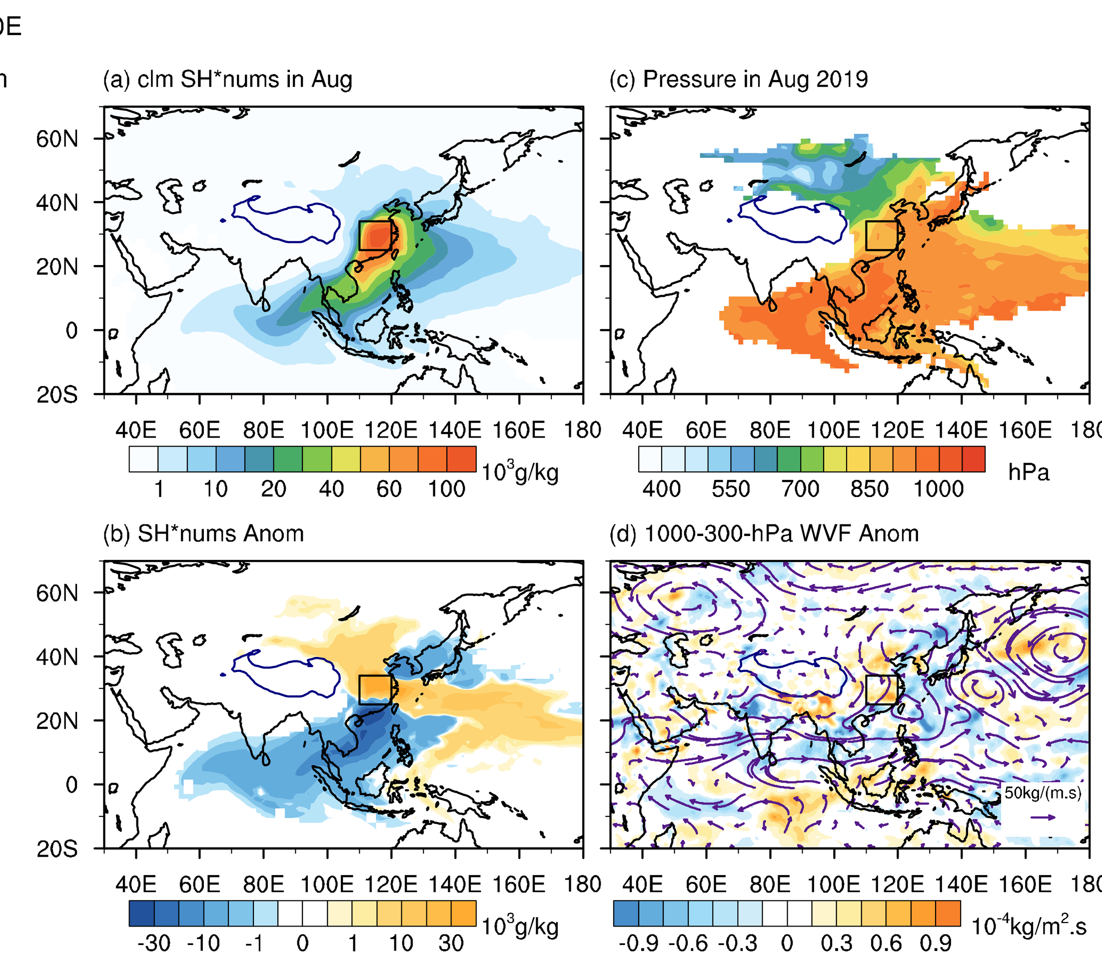
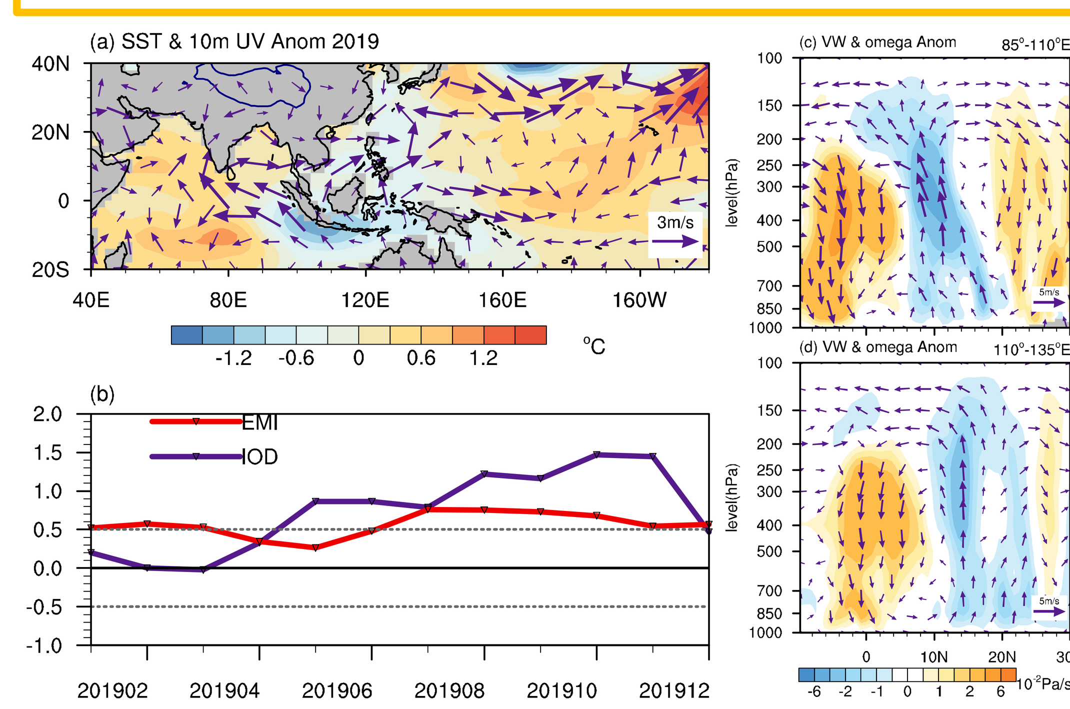


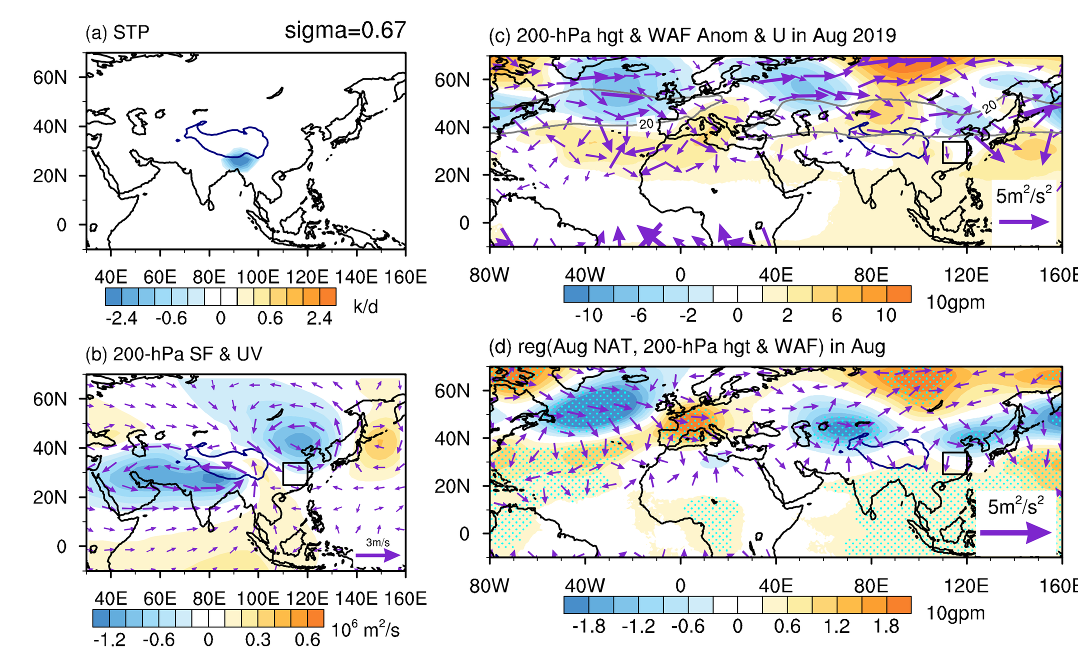
Fig .3 (a) Climatological number of particles weighted by specific humidity arriving at the SEC for backward 10 d in August; (b) Anomalies of number of particles in August 2019; (c) Pressure of particles in August 2019; (d) 1000–300-hPa column-integrated water vapor flux anomalies and their divergence in August 2019.

4. Mechanism of atmospheric circulation anomalies



- **Tropical SSTAs**

Fig.4 (a) SSTA and 10 m wind anomalies in August 2019; (b) Time series of IOD and El Niño Modoki index in 2019; (c) Meridional-vertical circulation anomalies averaged between 85° –110° E; (d) for 110° –135° E.



- **Mid-latitude dynamics**

Fig.5 (a) Location of heating source in the LBM; (b) Response of 200-hPa stream function and wind in LBM; (c) 200-hPa geopotential height and wave activity flux anomalies in August 2019; (d) Regression pattern against the North Atlantic tripole SSTA index in August.

5. Relationship between the tropical convection and SEC drought

- **Observation**

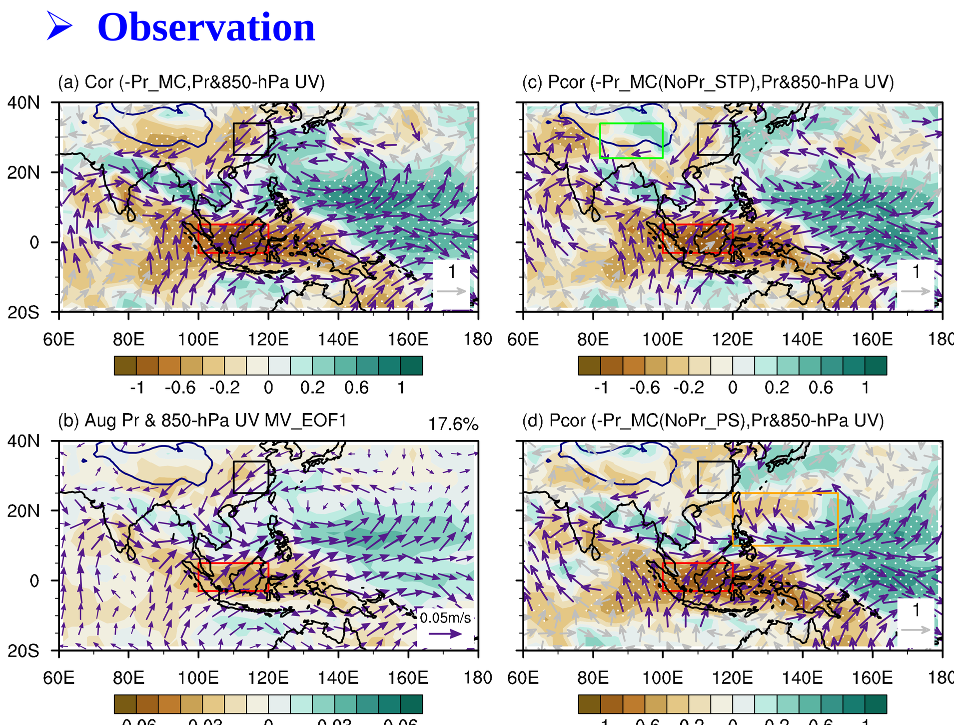


Fig.6 (a) Correlation between 850hPa winds /precipitation and negative Maritime Continent precipitation index; (b) First mode of MV-EOF analysis of precipitation and 850hPa winds; (c) partial correlation with the impacts of precipitation over southern TP excluded; (d) with the impacts of precipitation over the Philippine Sea excluded.

- **Numerical experiments**

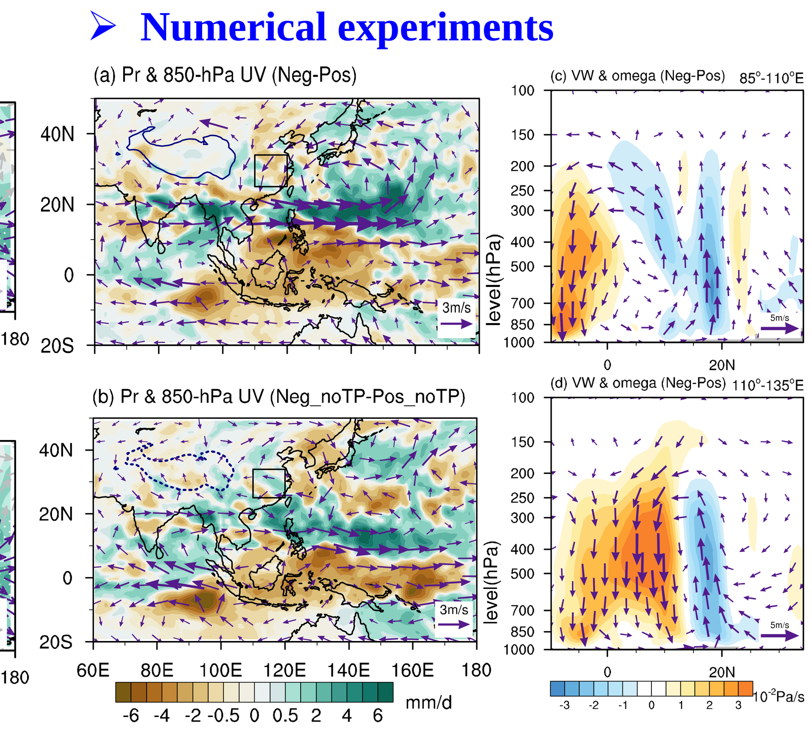
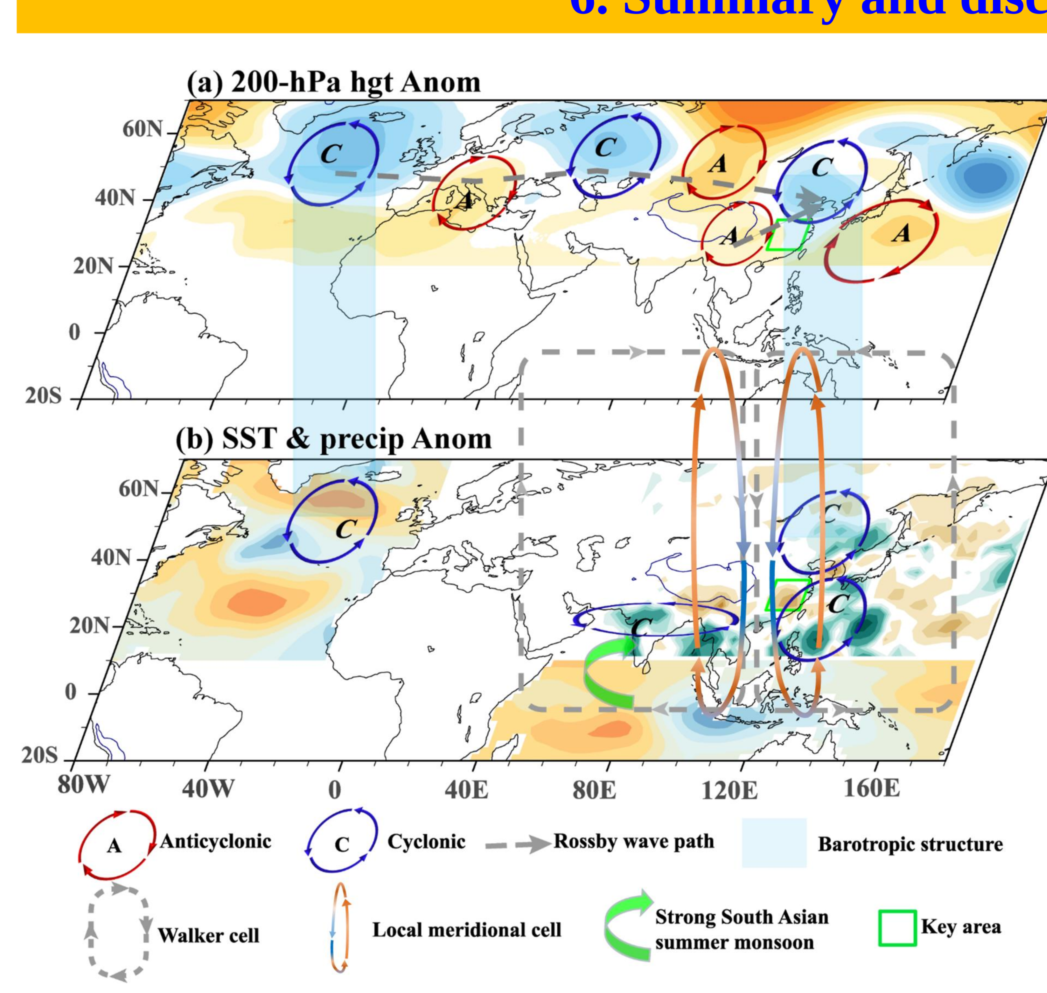


Fig.7 (a) Precipitation and 850-hPa winds differences between the MC_Neg and MC_Pos; (b) Differences between the MC_Neg_noTP and MC_Pos_noTP; (c) and (d) Differences in the meridional-vertical circulation between the MC_Neg and MC_Pos over 85° –110° E and 110° –135° E, respectively.

6. Summary and discussion



- ✓ **Tropical SSTAs**

positive IOD + El Niño Modoki
↓
Walker cell and local meridional circulation
↓
TP anticyclone + WNP cyclone

- ✓ **Mid-latitude dynamics**

North Atlantic tripole SSTA
↓
mid-latitude Rossby wave
↓
Northeast China cyclone

- ✓ **Synergistic effects**

Southeast China extreme drought

Jiang JL, Su TH, Liu YM*, Wu GX et al. Southeast China Extreme Drought Event in August 2019: Context of Coupling of Midlatitude and Tropical Systems, ***Journal of Climate***, 2022 35(22), 3699-3713