Interdecadal Variations of the East Asian Winter Monsoon in CMIP5 Preindustrial Simulations

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Background

- Many previous studies indicate that, on the interdecadal timescale, the East Asian winter monsoon (EAWM) weakens significantly in the mid-1980s. Roles of external forcings in this event have been well addressed in our previous work (Miao et al. 2018).
- Actually in this process, influences from internal variability of the climate system cannot be neglected. Whether the internal variability could also cause interdecadal variation of EAWM resembling observation is investigated in this study.

Data and method

- **19 CMIP5 models**
  - ➢ 500-yr preindustrial control (piControl) simulations

    Impose non-evolving, pre-industrial conditions
- **Method**
  - ➢ The moving *t* test method to identify cases showing significant interdecadal variation of the EAWM.
  - ➢ The multicase ensemble mean (MCE) to examine the large-scale common characteristics of these identified cases.
  - ➢ The multicase consistency to evaluate the robustness of the MCE.
- **Definition of EAWM index**

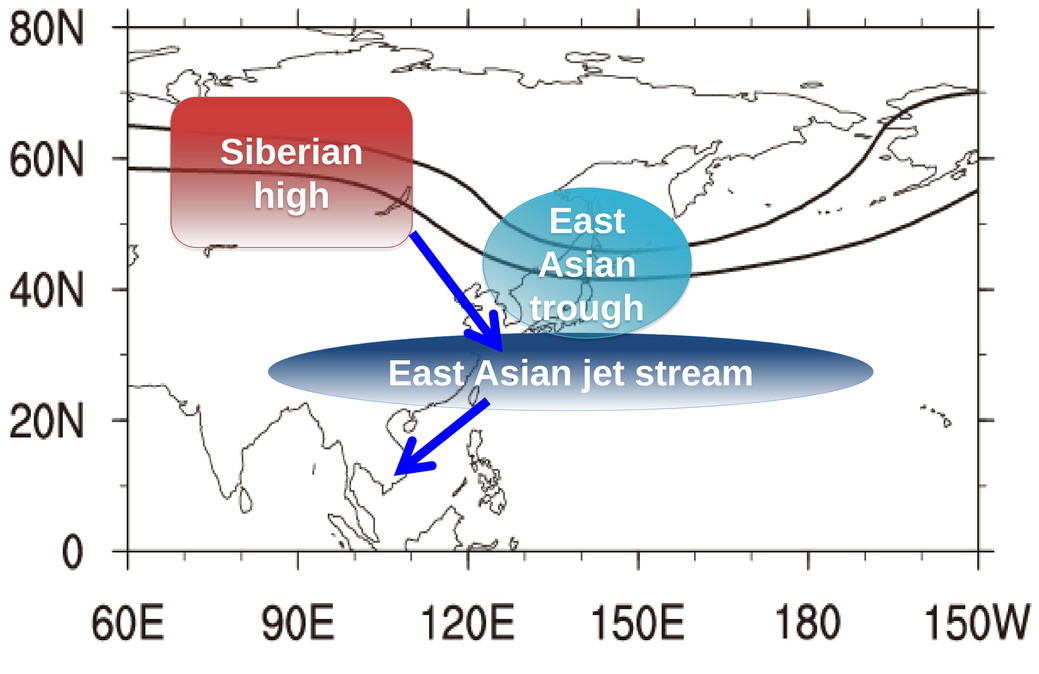
$$\text{EAWM index} = \frac{1}{3}\times \text{Stand}[\overline{\text{SLP}}(40°\text{–}60°\text{N}, 80°\text{–}125°\text{E})] \rightarrow \text{Siberian high}$$

$$-\frac{1}{3}\times \text{Stand}[\overline{\text{Z500}}(25°\text{–}45°\text{N}, 110°\text{–}145°\text{E})] \rightarrow \text{East Asian trough}$$

$$+\frac{1}{3}\times \text{Stand}[\overline{\text{U300}}(25°\text{–}40°\text{N}, 80°\text{E–}180°) - \overline{\text{U300}}(45°\text{–}60°\text{N}, 60°\text{–}160°\text{E})] \rightarrow \text{East Asian jet stream}$$

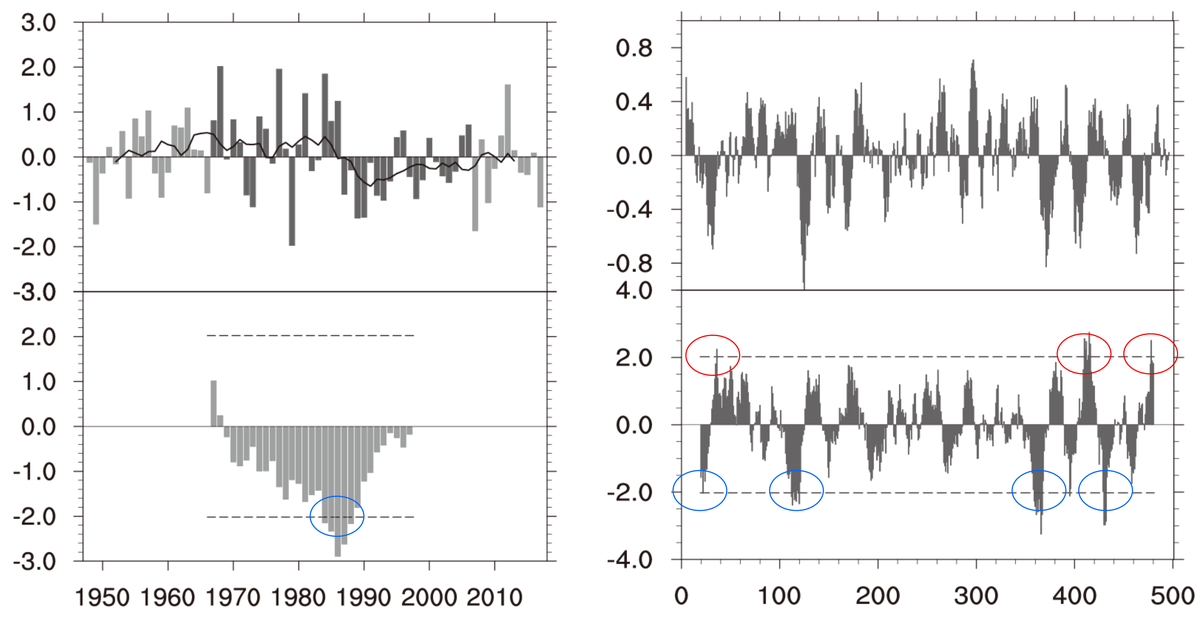
SLP (sea level pressure) Z500 (500-hPa geopotential height)

U300 (300-hPa zonal wind)



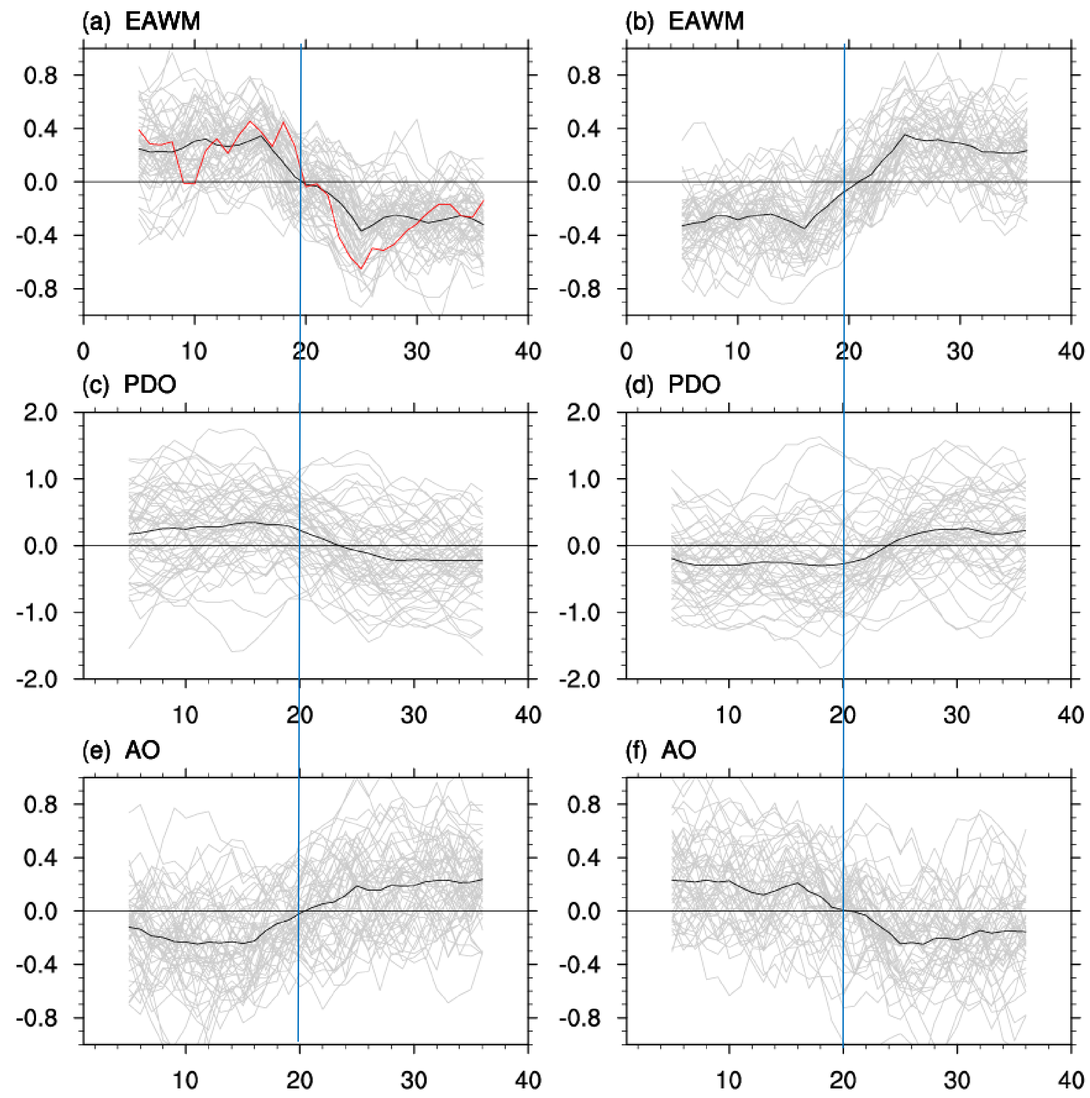
Results

- **EAWM index (top) and moving *t* value (bottom)**



Observation GFDL-ESM2M piControl

- ➢ In total, we identify 53 (49) cases of significant interdecadal weakening (strengthening) of the EAWM from 19 CMIP5 piControl simulations.
- **Climate indices in the identified cases**



EAWM weakened EAWM strenthened

Conclusion

- Internal variability can also cause interdecadal variations of the EAWM, and the phase shifting of the AO is likely the main reason for the EAWM's interdecadal variations in the unforced long-term simulations.
- Internal variability of the climate system could contribute to the observed interdecadal weakening of the EAWM around mid-1980s.

Miao et al., 2018: Interdecadal Weakening of the East Asian Winter Monsoon in the Mid-1980s: The Roles of External Forcings. Journal of Climate, 31, 8985–9000.

Miao et al., 2020: Interdecadal Variations of the East Asian Winter Monsoon in CMIP5 Preindustrial Simulations. Journal of Climate, 33, 559–575.