

Impacts of Recent **El Niño Modoki** on Extreme Climate Conditions In East Asia and the United States during Boreal Summer

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and

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Data and Methods

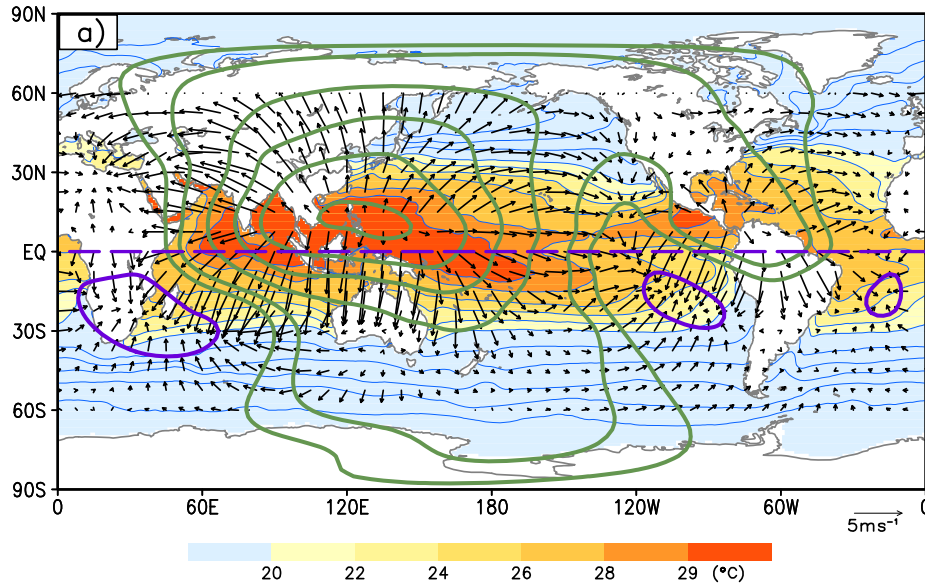
Data (monthly, Jan 1979 – Dec 2005):

- HadISST from UK Meto
- Atmospheric data from NCEP/NCAR Reanalysis, USA
- GPCP precipitation rate from NASA, USA
- China's 160-station rainfall data from Beijing University, China
- US 102-division rainfall/temperature data from NCEP, USA
- Japan 72-station rainfall data from JMA, Japan

Methods:

Linear partial correlation/regression, composite, & wavelet analyses

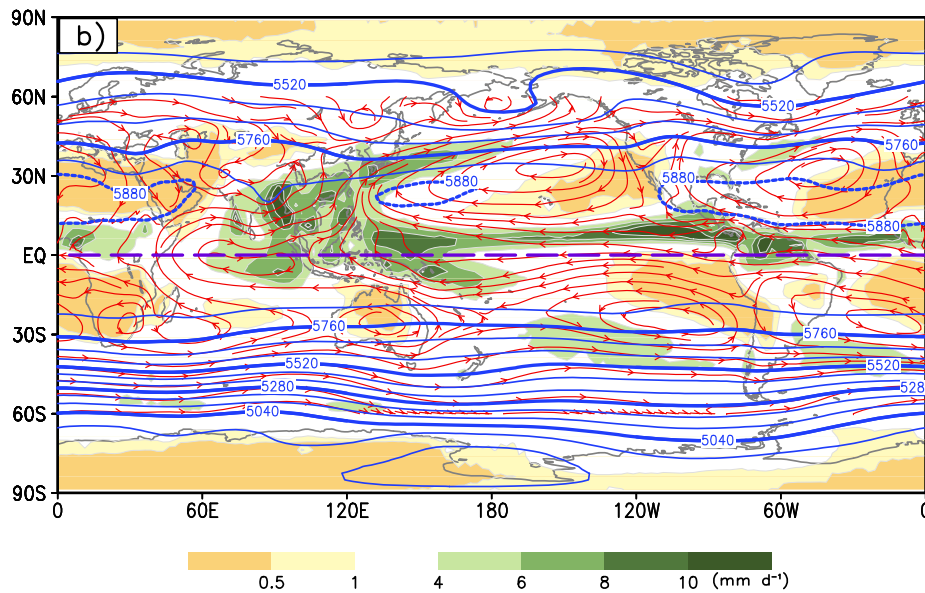
Climatological means for 1979-2005 summers



SST (shading)

200hPa velocity potential (contours)

200hPa divergent winds (arrows)

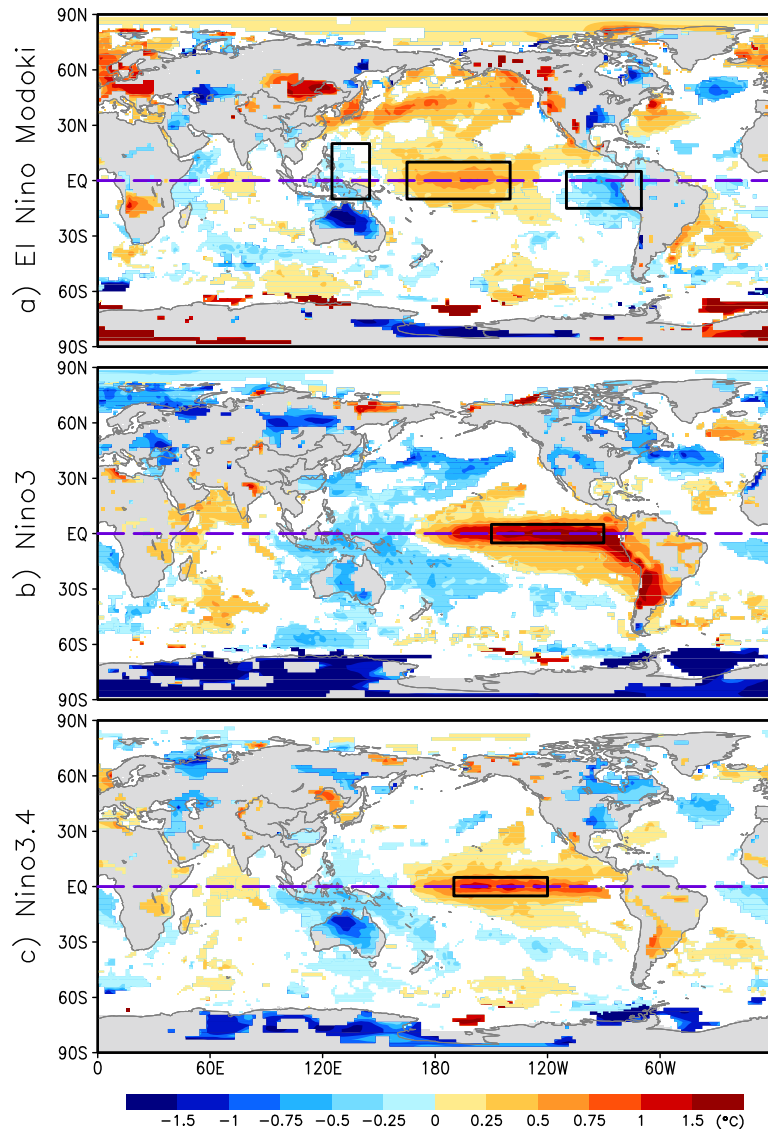


GPCP rain rate (shading)

500hPa geopotential height (contours)

850hPa horizontal wind (streamlines)

Composite SST and Skin Temperature Anomaly Patterns



El Niño Modoki

(1994, 2002, 2004)

Tripole in tropical Pacific

$$EMI = [SSTA]_C - 0.5 [SSTA]_E - 0.5 [STA]_W$$

Canonical El Niño (Niño 3)

(1982, 1987, 1997)

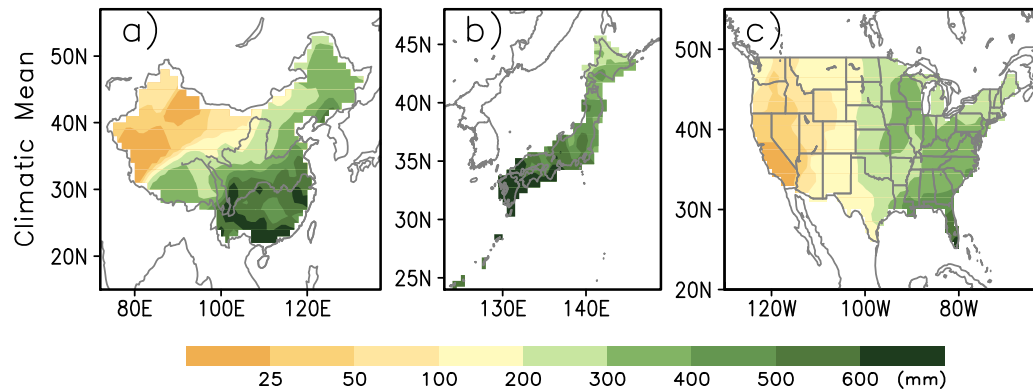
Dipole in tropical Pacific

El Niño (Niño 3.4)

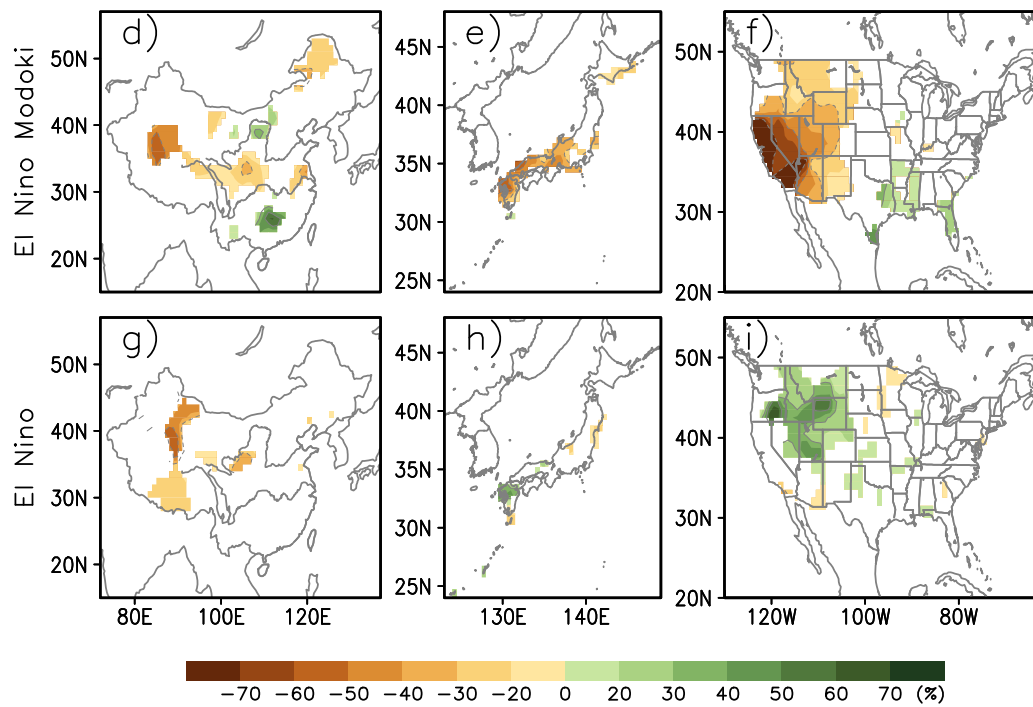
(1994, 2002, 2004;
1982, 1987, 1997)

As the **mean** of the above two

Normal Rainfall & Composite “Anomaly Percent to Normal”



Normal rainfall
(mean of 27 summers)

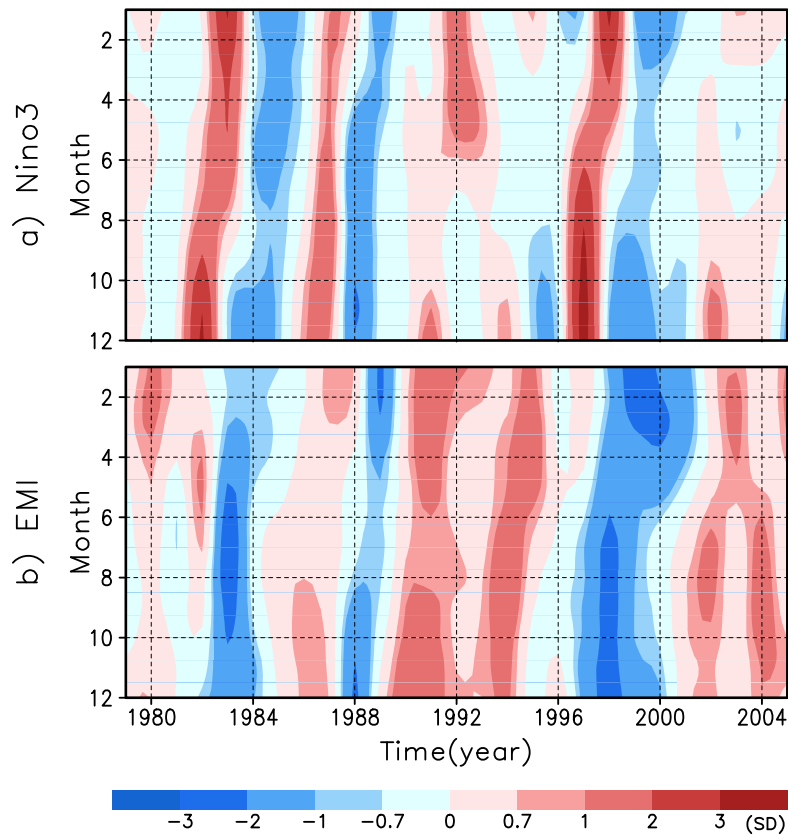


Anomaly Percent to Normal

El Niño Modoki
(1994, 2002, 2004)

Canonical El Niño
(1982, 1987, 1997)

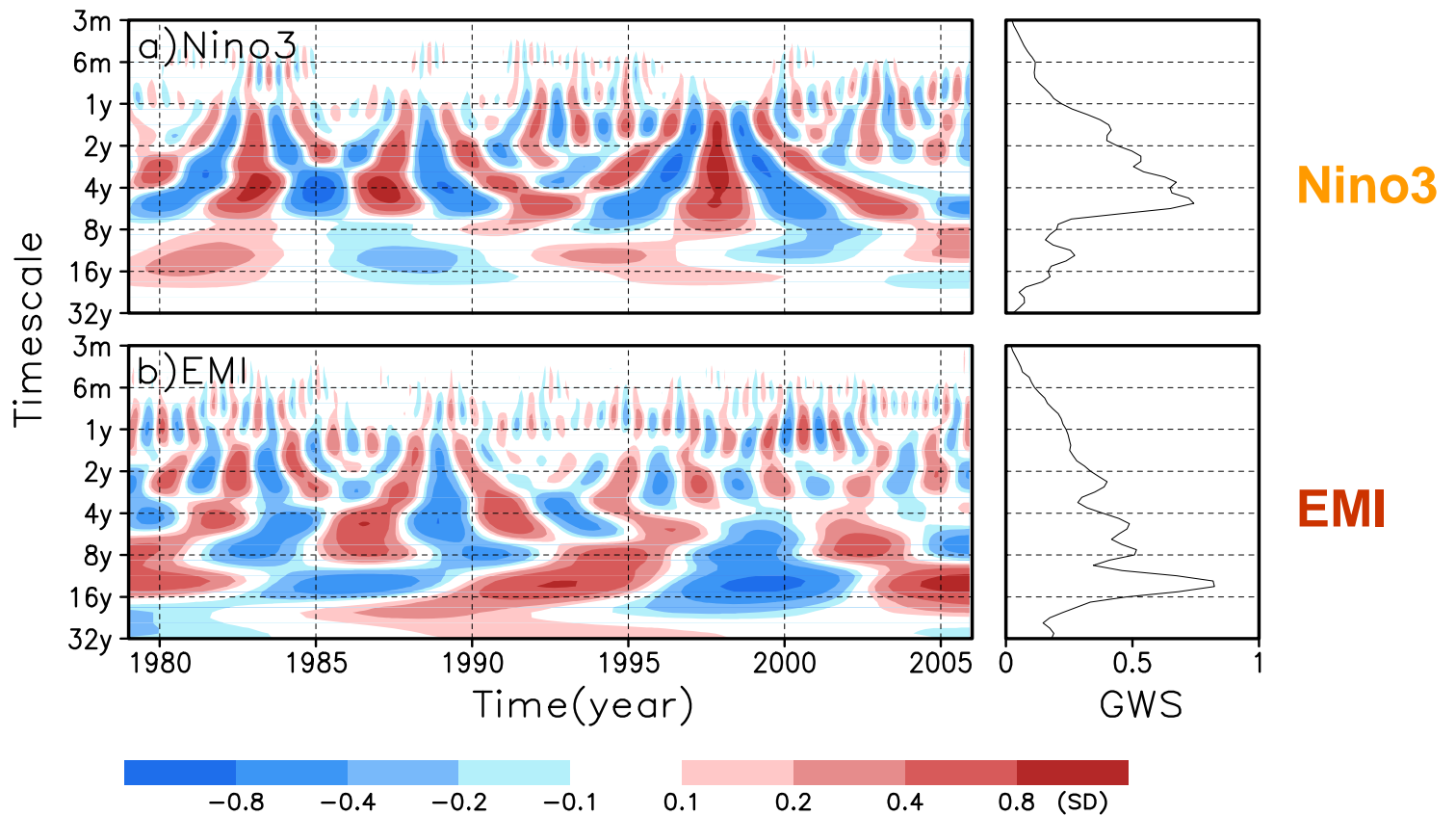
Normalized time series of Nino3 and EMI



Niño3: Largely phase-locked to the seasonal cycle.

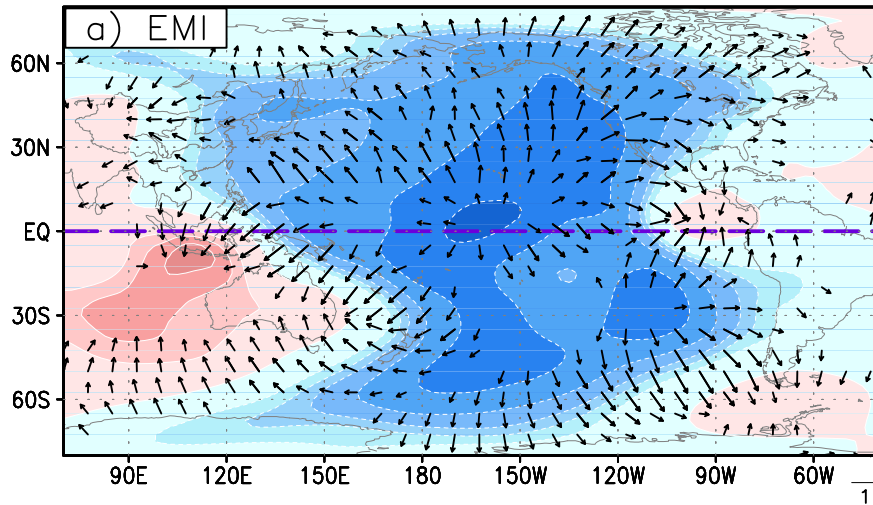
El Niño Modoki: Less clear phase-locking with seasonal cycle.

Dominant Timescales

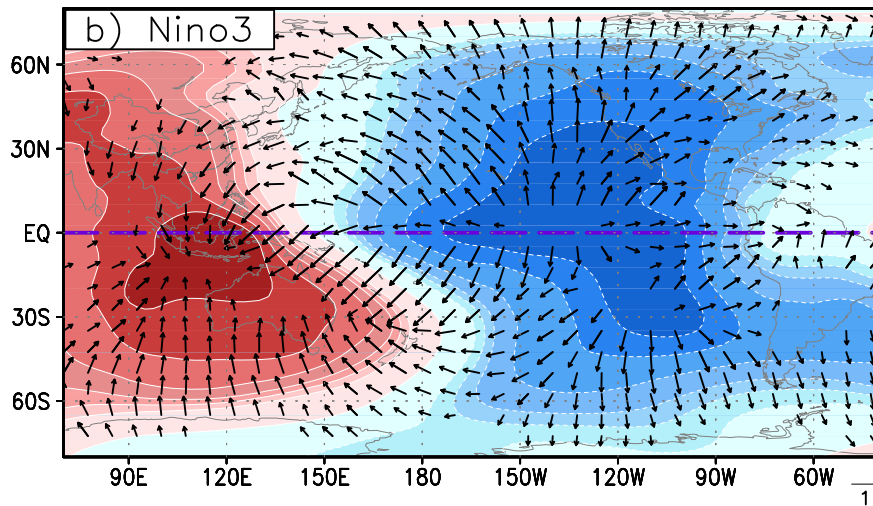


Real part of Morlet wavelet coefficients and spectra

Upper-level atmospheric circulations

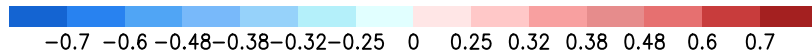


El Niño Modoki
Tripole pattern in tropical Pacific region.

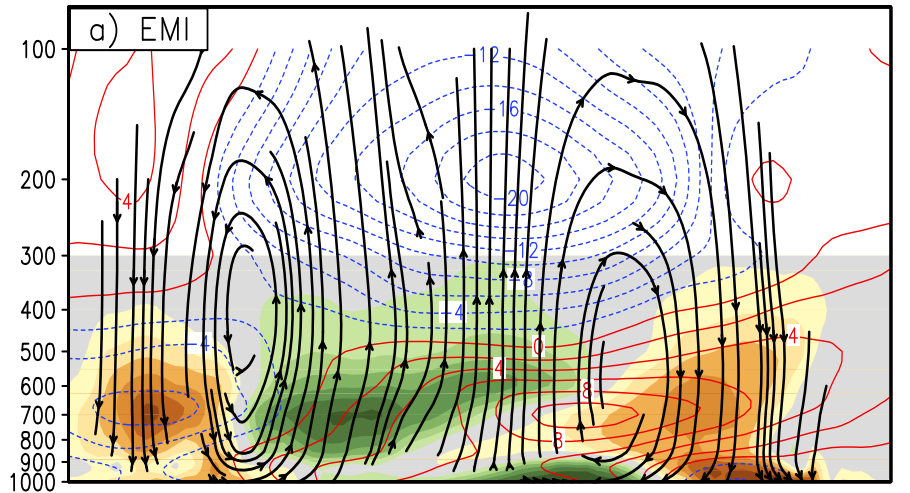


El Niño
Dipole pattern in same region.

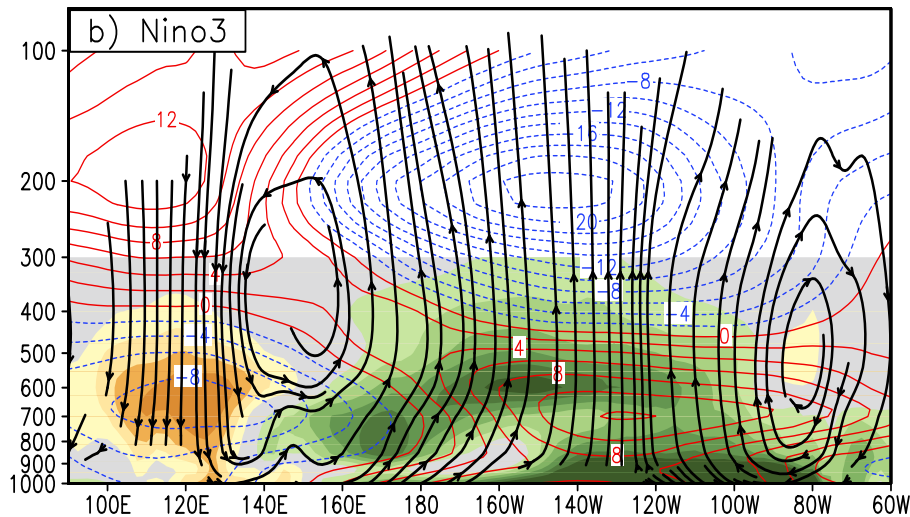
Partial correlation patterns of 200hPa divergent winds (arrows) and velocity potential anomalies (shaded; $105\text{m}^2\text{ s}^{-1}$) against a) EMI and b) Niño3 index.



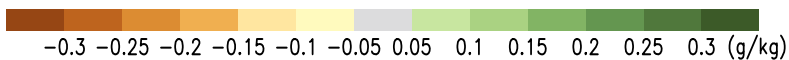
Walker Circulations



EMI: Double cells over the tropical Pacific. Joint ascent branches spans 135E-130W. West descent (110-135E) suppress convection in normal ITCZ/SPCZ in this longitude. East descent (east 120W) enhance the dryness in PDZ.

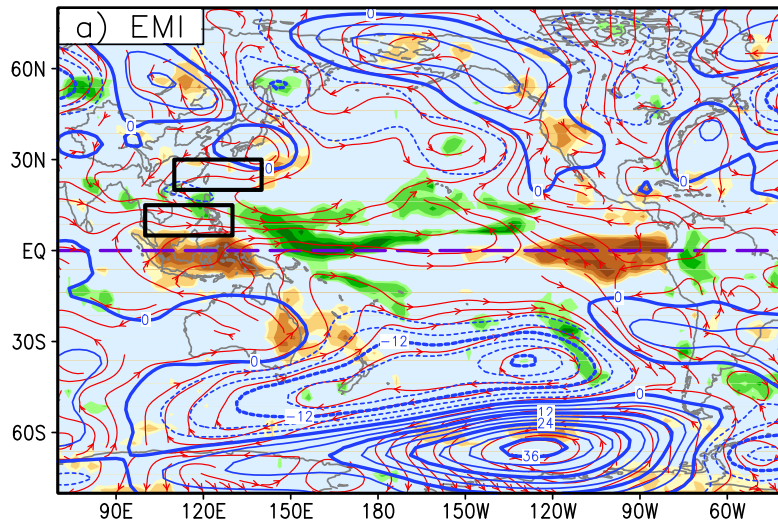


Nino3: One and a half cells over The tropical Pacific. Eastern Part is the wettest. No PDZ.



Specific humidity anomaly is shaded. Vertical speed at the pressure level is enlarged by a factor of -50.

Mid- and low-level circulations and rain patterns

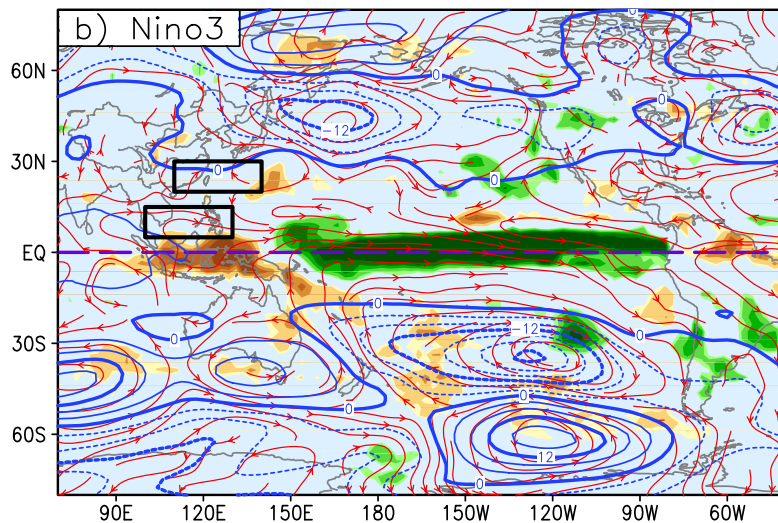


El Niño Modoki:

Tripole rainfall pattern in tropical Pacific; westerlies transport moisture from C. tropical Pacific to extratropical Pacific.

**NW Pacific: positive phase of PJ pattern
W. North Pacific monsoon enhanced,
East Asian monsoon weakened.**

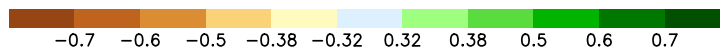
NE Pacific: positive phase of PNA pattern.



El Niño:

Wet region concentrates on the Equator from central to eastern Pacific.

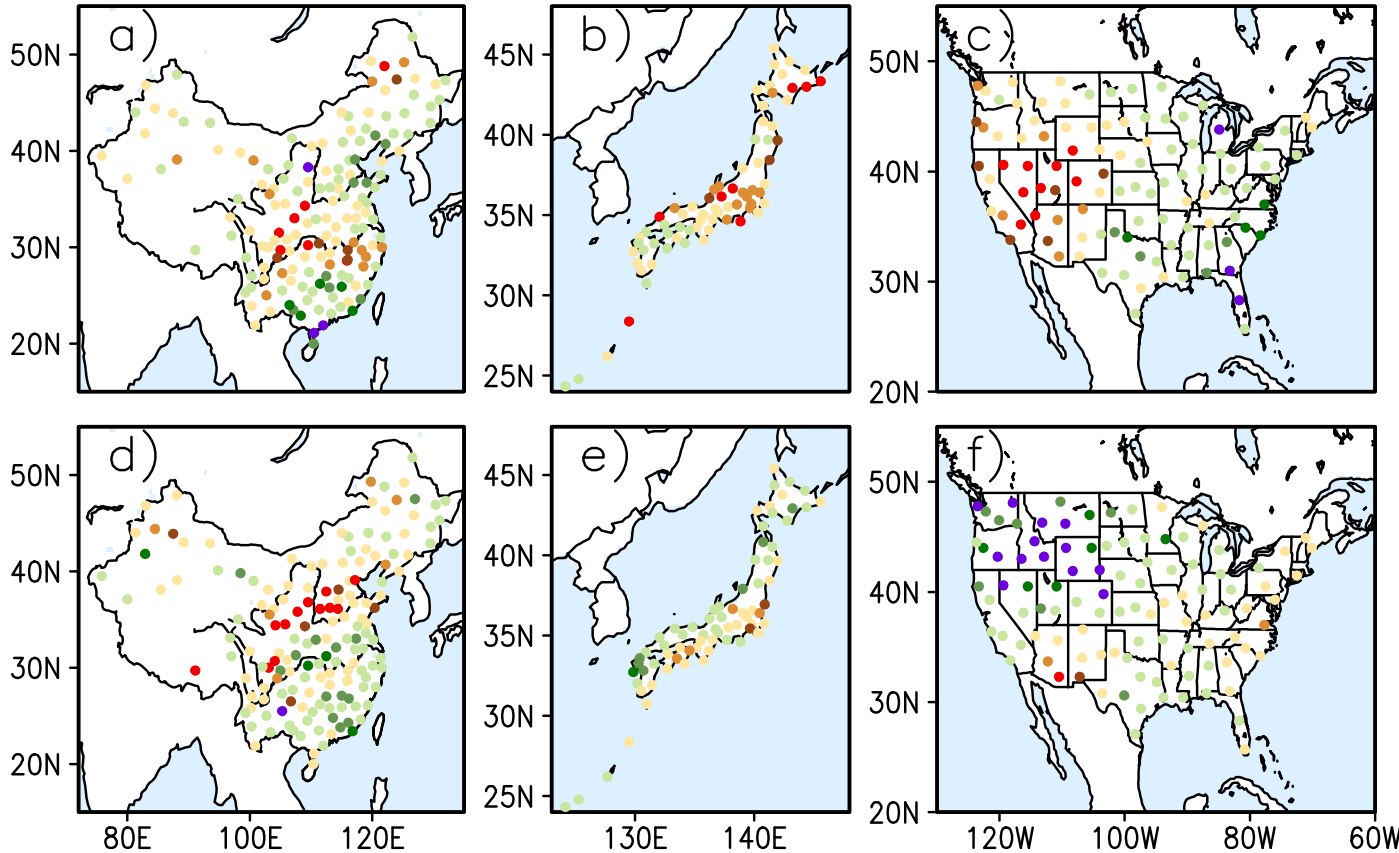
Zonally oriented low systems across extratropical Pacific. No PNA.



Rainfall anomalies in China, Japan and the USA



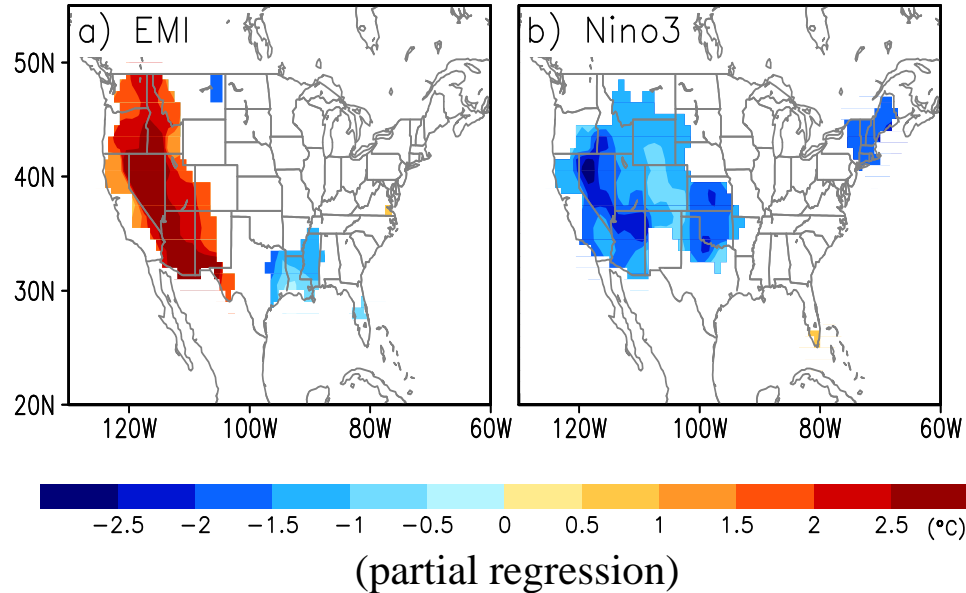
EMI



Nino3

(partial correlation)

Temperature anomalies in the USA



El Niño Modoki: West is warmer, which exacerbates the drought due to lack of rainfall in recent summers in a positive phase of the decadal component of the EMI.

El Niño: West is cooler.

Summary

1. **El Niño Modoki** has **opposite SST gradients** along the Pacific equator.
2. Teleconnection paths starts from the two-cell Walker Circulation in the tropical Pacific and regional meridional circulations to influence the climate in East Asia and the USA.
3. The large decadal variability of El Niño Modoki provides background for persistent droughts in the western USA in the early 21st century.
4. The spatial/temporal features of El Niño Modoki and its teleconnection patterns that influence the summer climate in East Asia and the USA are very different from those of canonical El Niño. Mixing the two phenomena increases the difficulty to understand and predict them.

This presentation is based on our recently published paper in “Climate Dynamics” :
Weng, HY, Ashok K, Behera SK, Rao SA, Yamagata T (2007) Impacts of recent
El Niño Modoki on dry/wet conditions in the Pacific rim during boreal summer.
Clim Dyn, DOI 10.1007/s00382-007-0234-0.