Central-Pacific El Niño: Dynamics, Climate Impacts, and Its Recent Emergence

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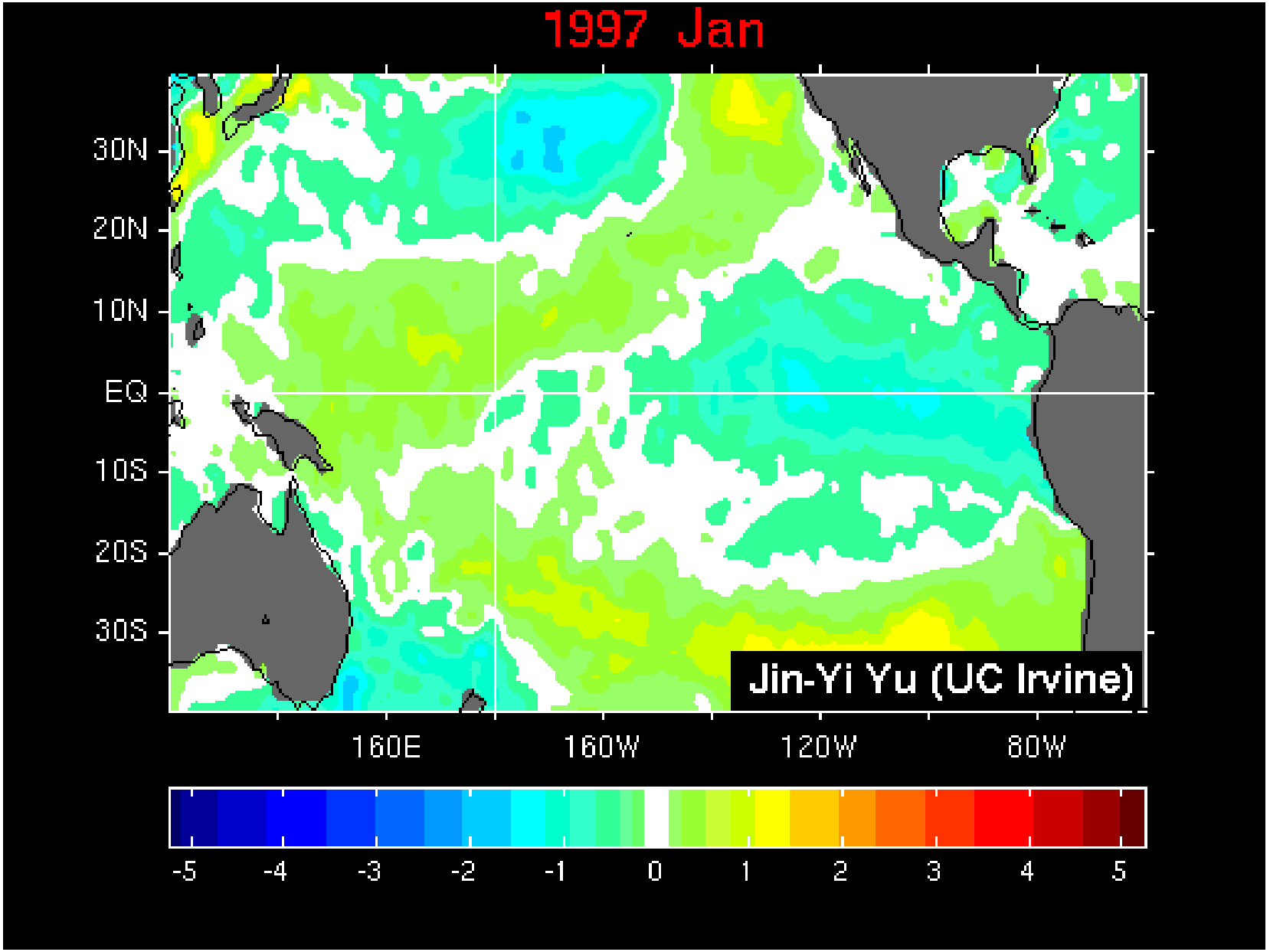
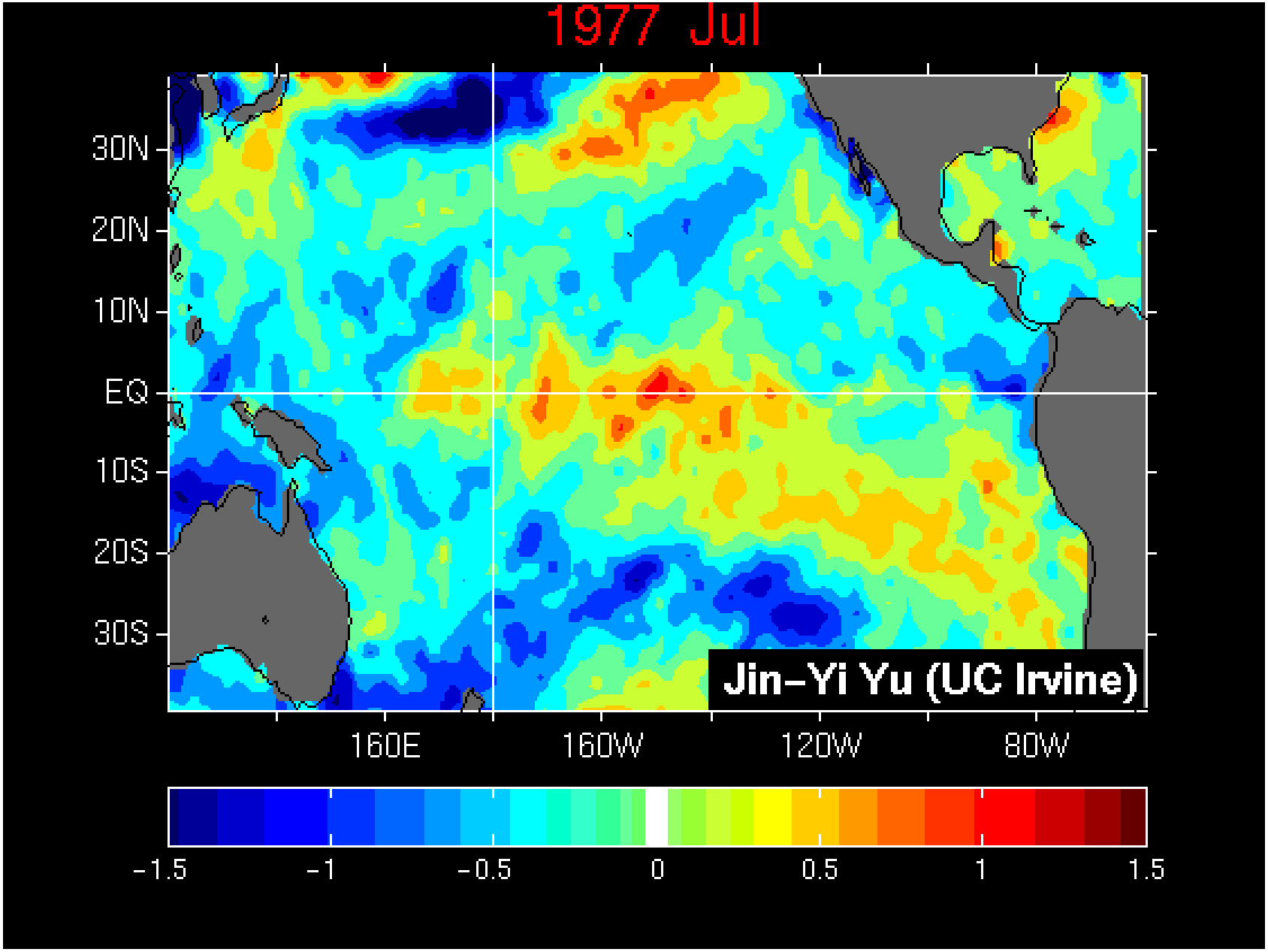
1997-98 El Niño

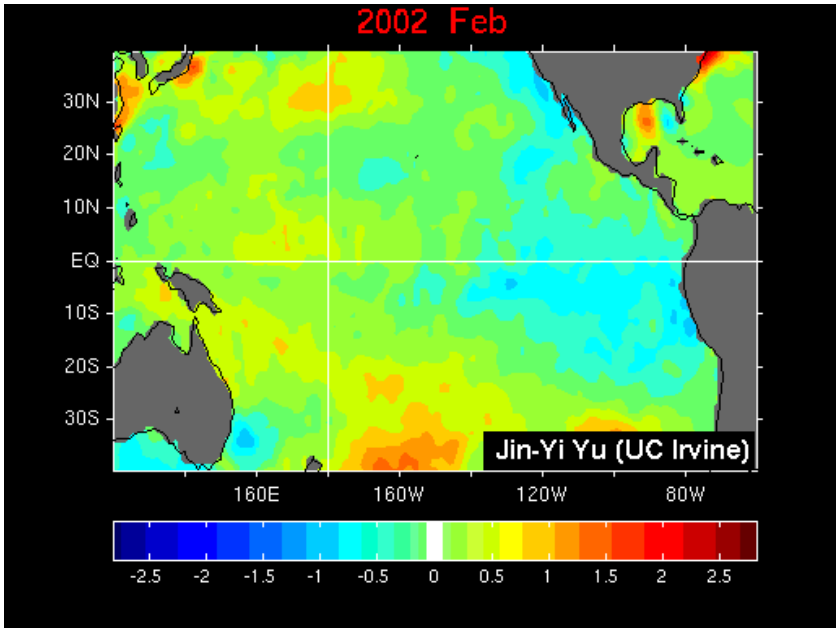


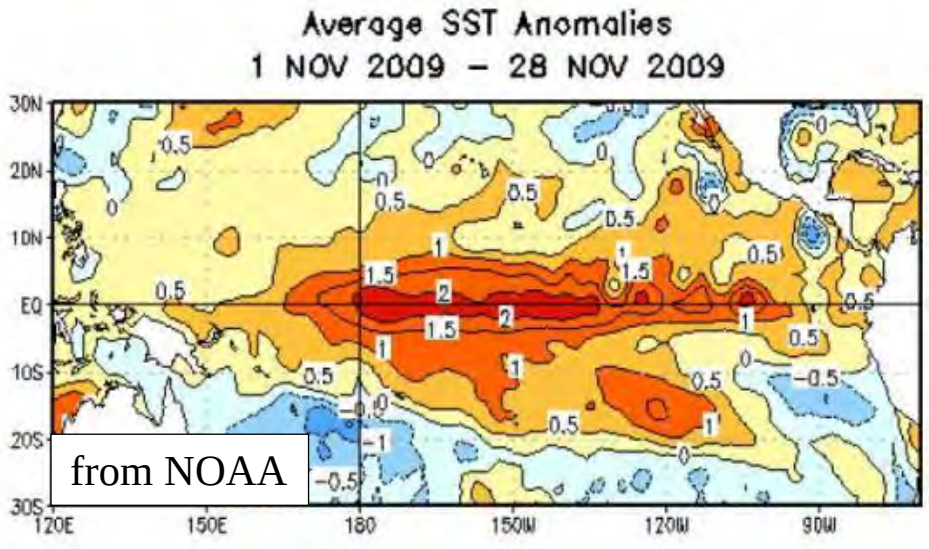
1977-78 El Niño

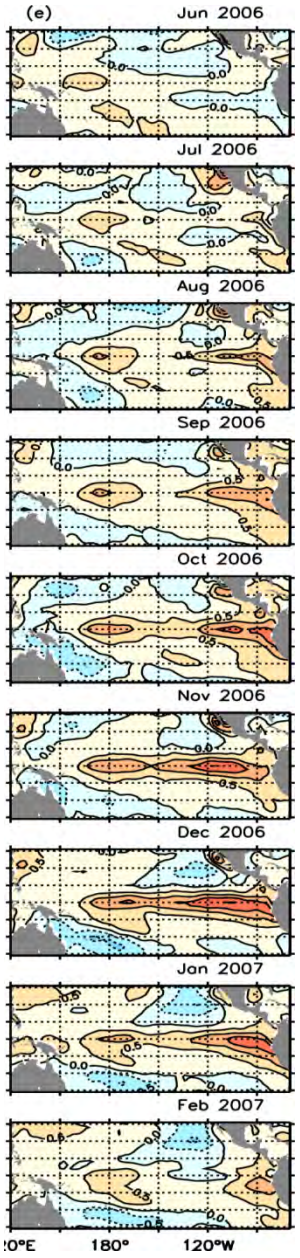


More CP El Niño Events after 1990

2002-03 and 2004-05 El Niño Events





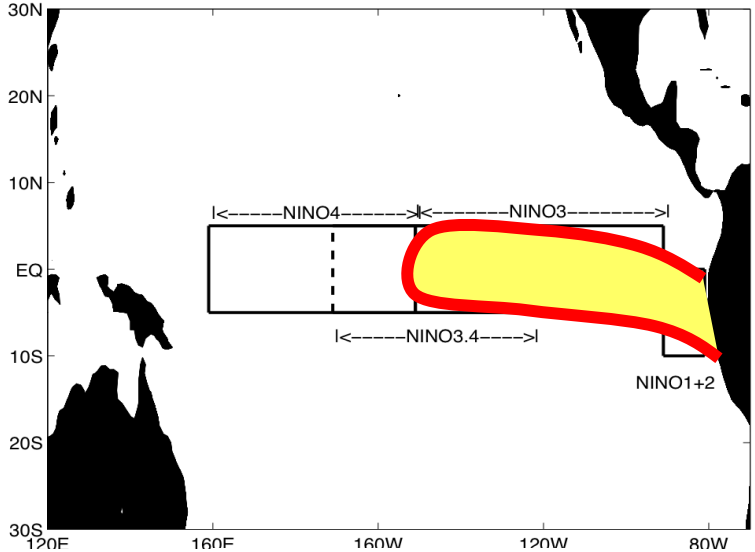


2006-07
El Niño

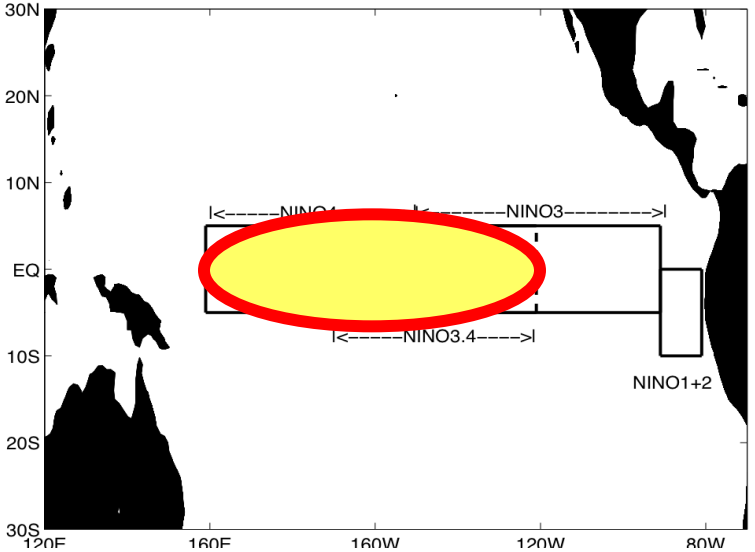
Two Types of El Niño

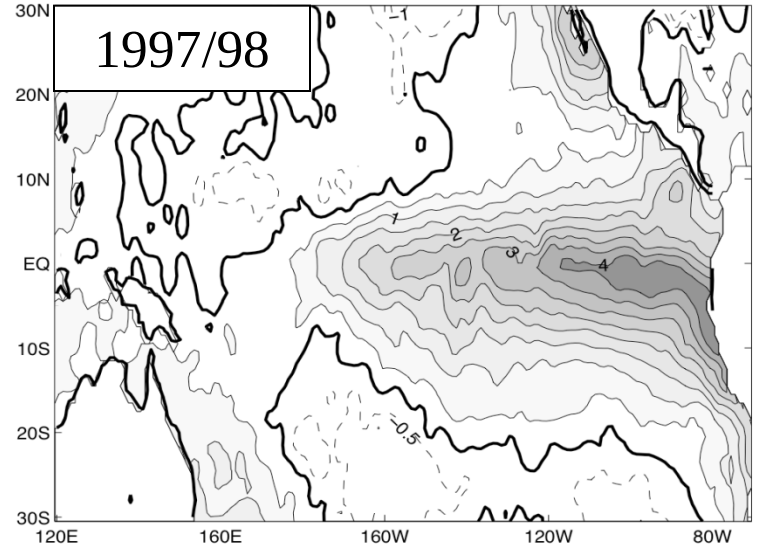
(Yu and Kao 2007; Kao and Yu 2009)

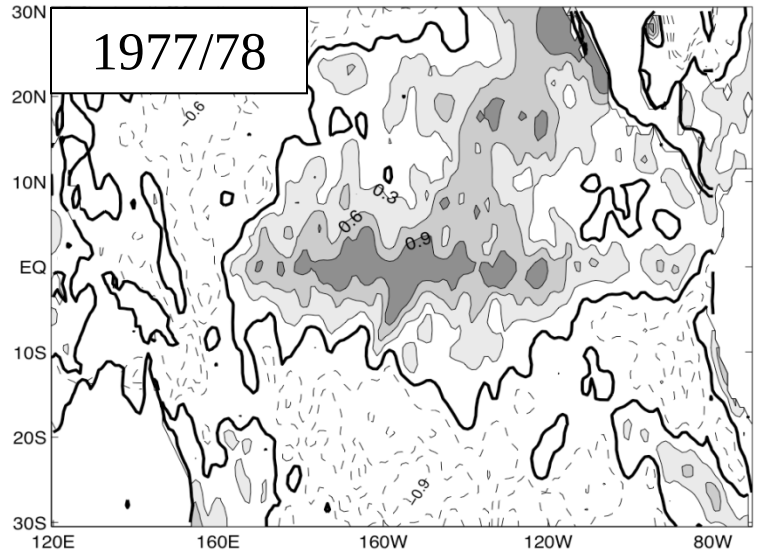
Eastern-Pacific El Niño



Central-Pacific El Niño



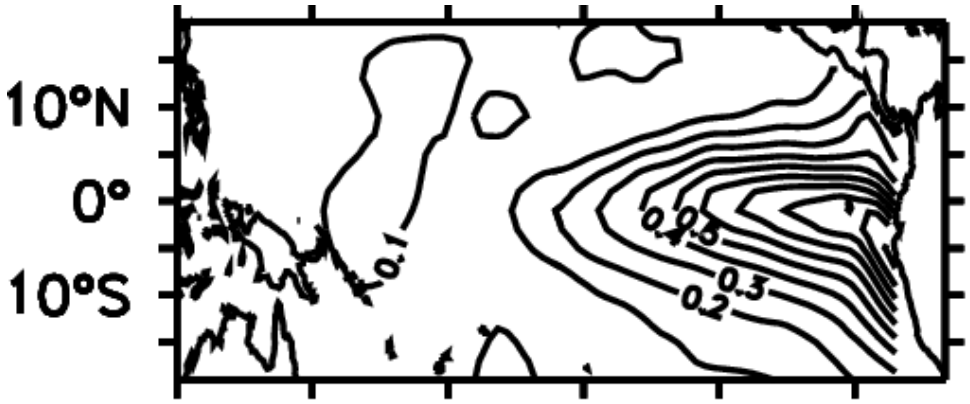


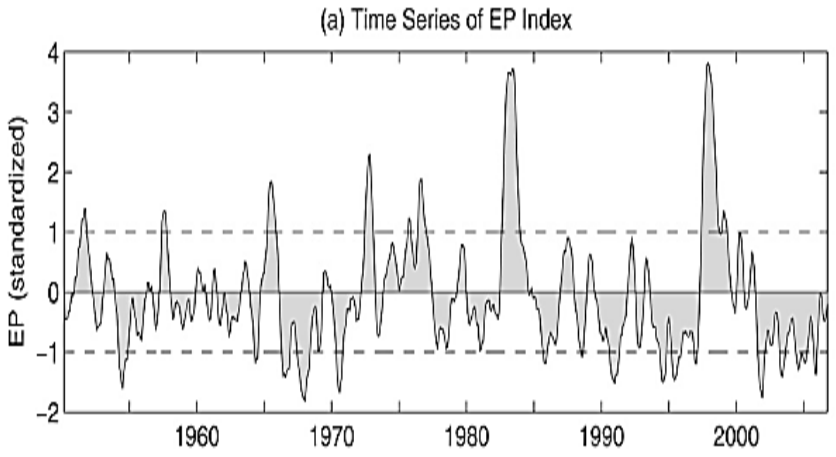


Regression-EOF Method for EP- and CP-ENSO

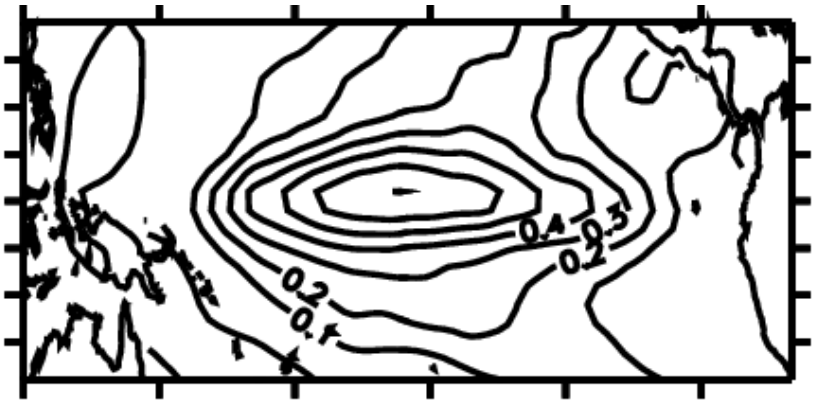
(Kao and Yu 2009)

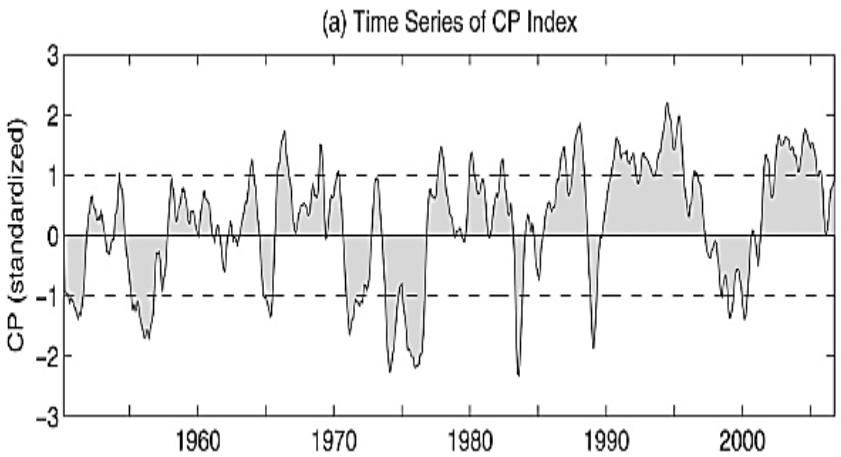
Eastern-Pacific (EP) ENSO





Central-Pacific (CP) ENSO

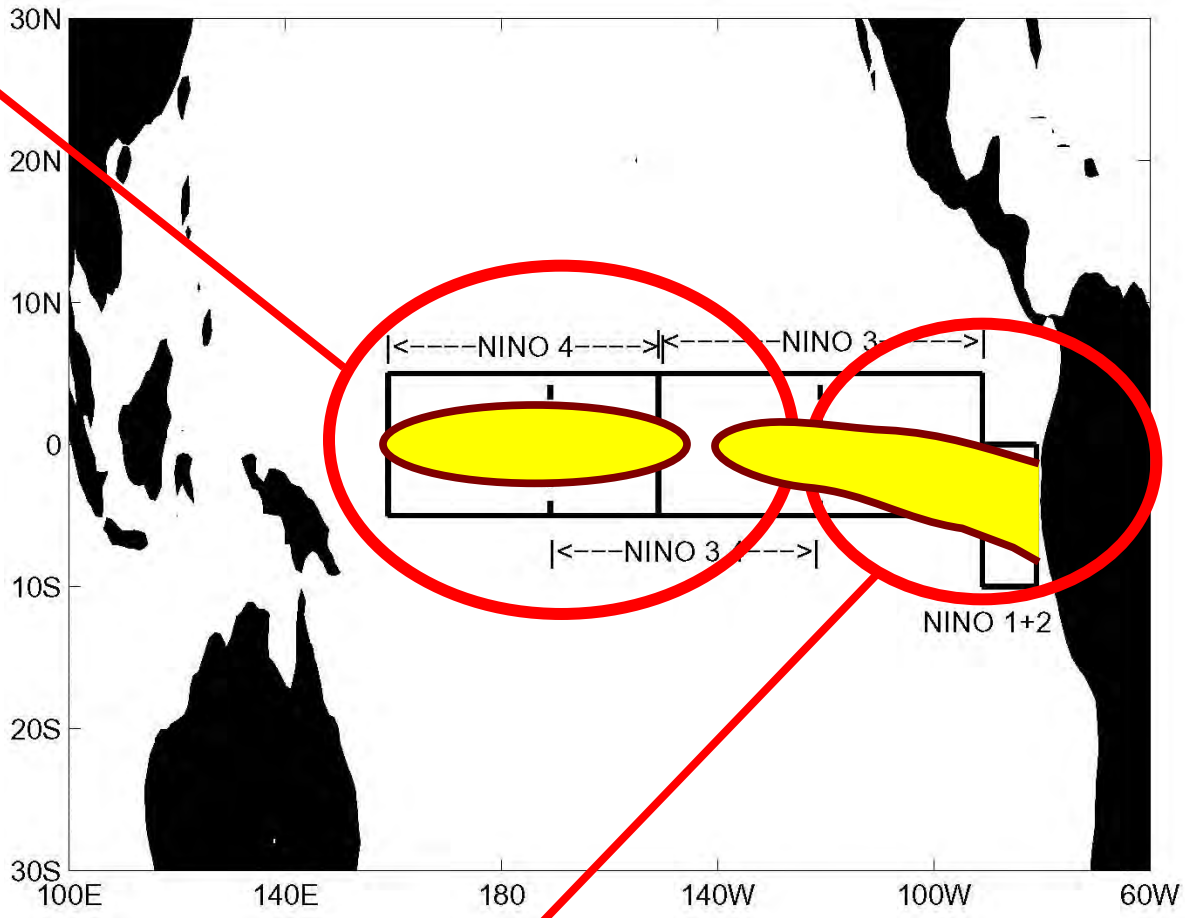




Different Generation Mechanisms

(Yu and Kao 2007; Kao and Yu 2009)

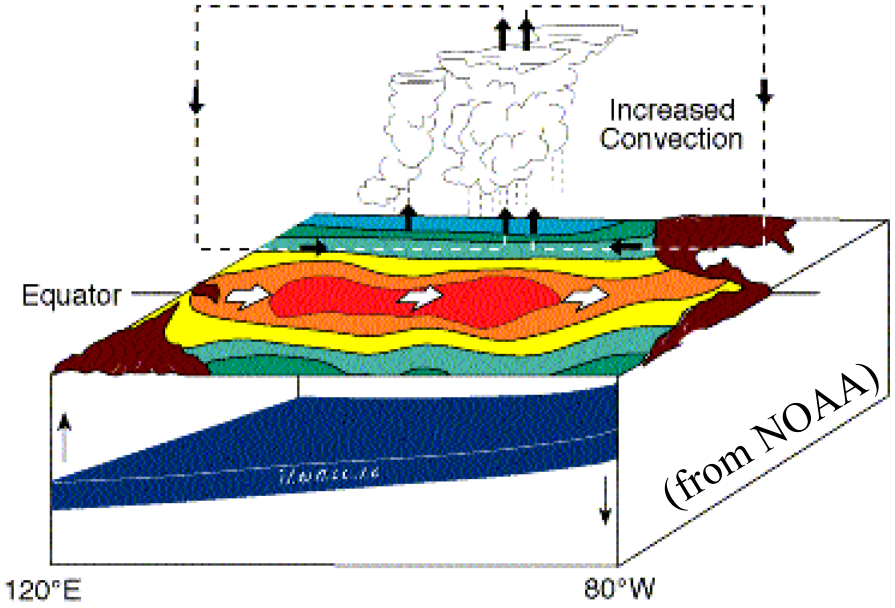
Central-Pacific El Niño (related to atmospheric forcing)



Eastern-Pacific El Niño (related to thermocline variation)

El Niño-Southern Oscillation

ENSO Condition

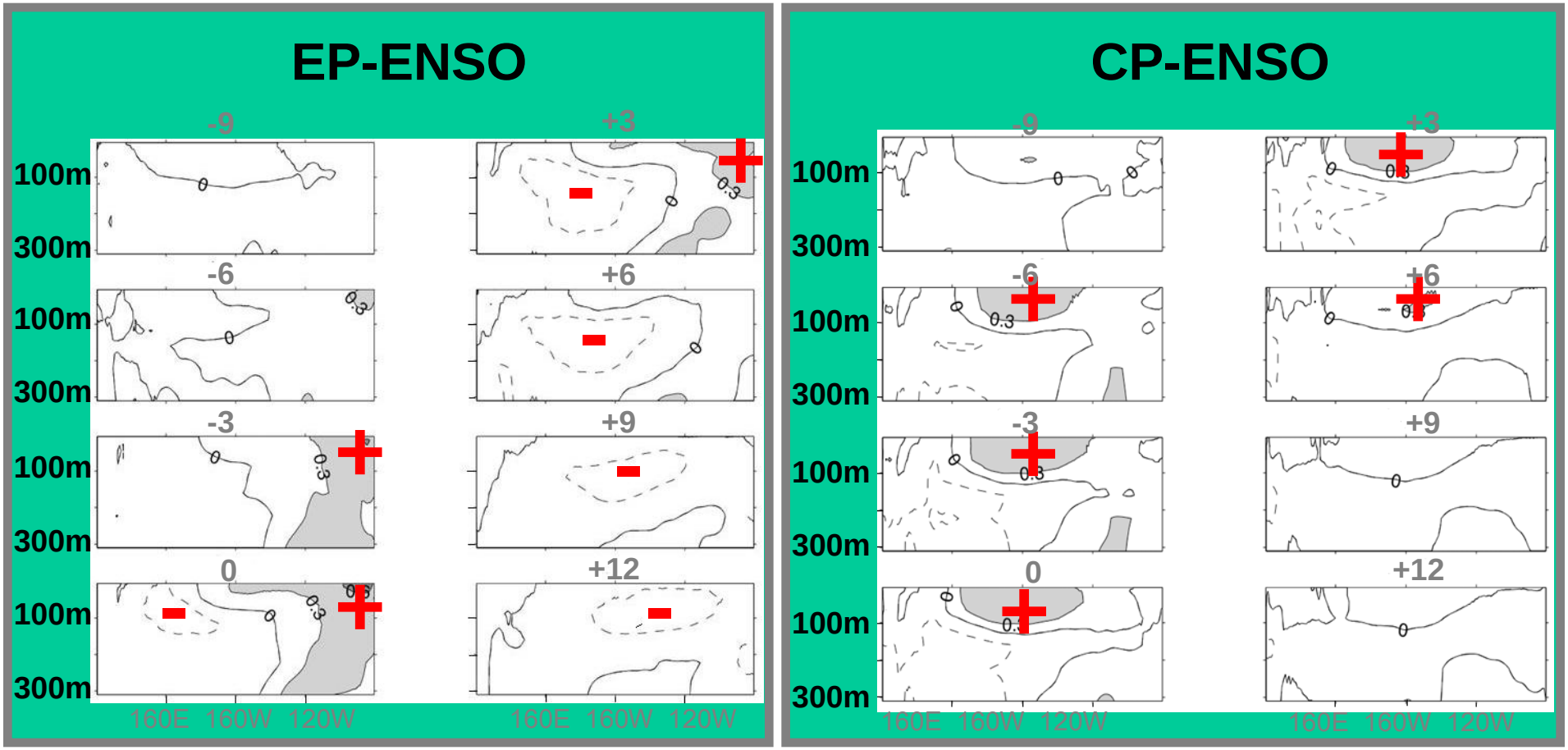


ENSO is a ***basin-wide*** coupled ocean-atmosphere phenomenon that involves equatorial ***thermocline variations***.

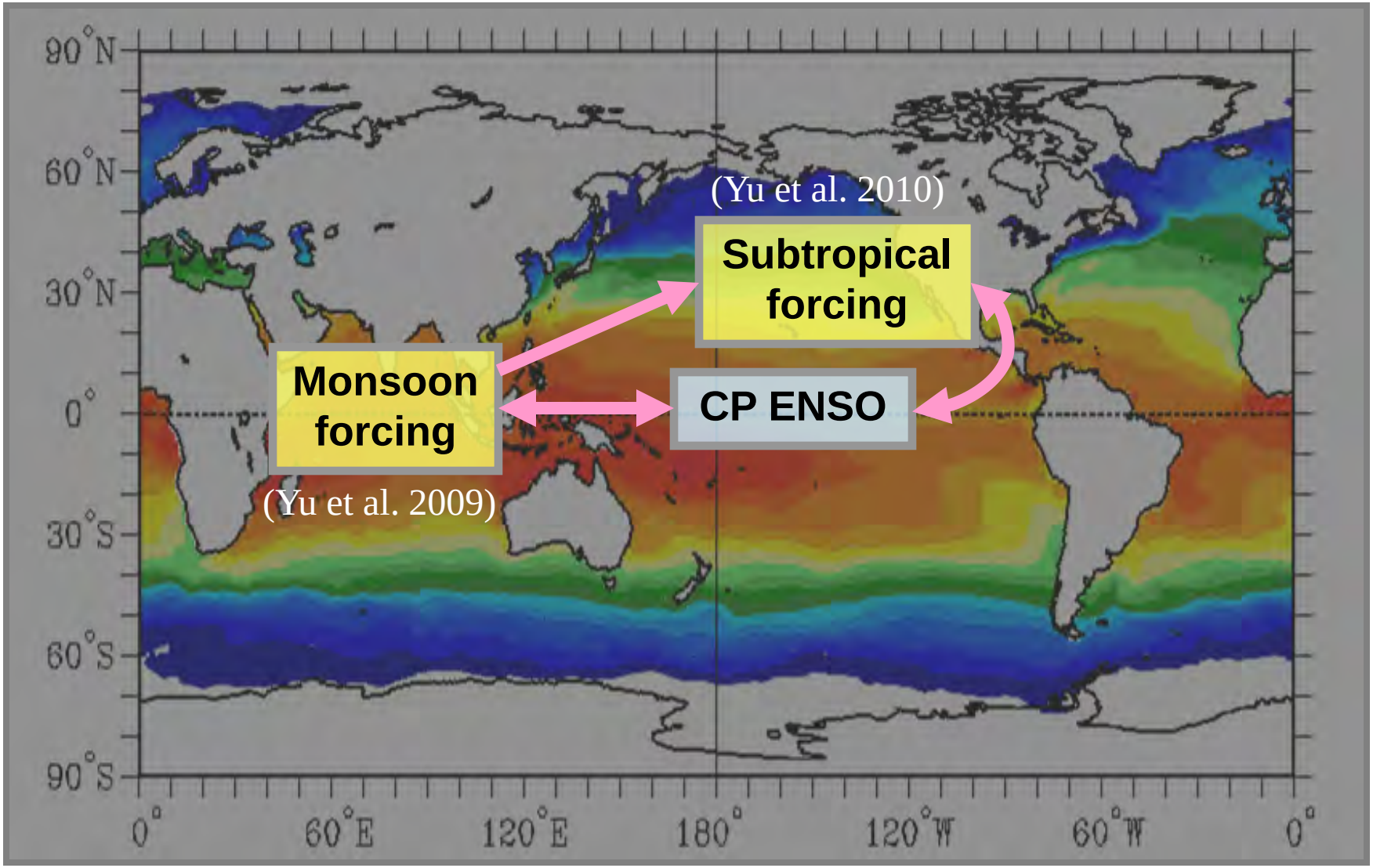
Subsurface Ocean Temperature Evolutions

(Subsurface ocean temperature lag-correlation with the principal components)

(Kao and Yu 2009)

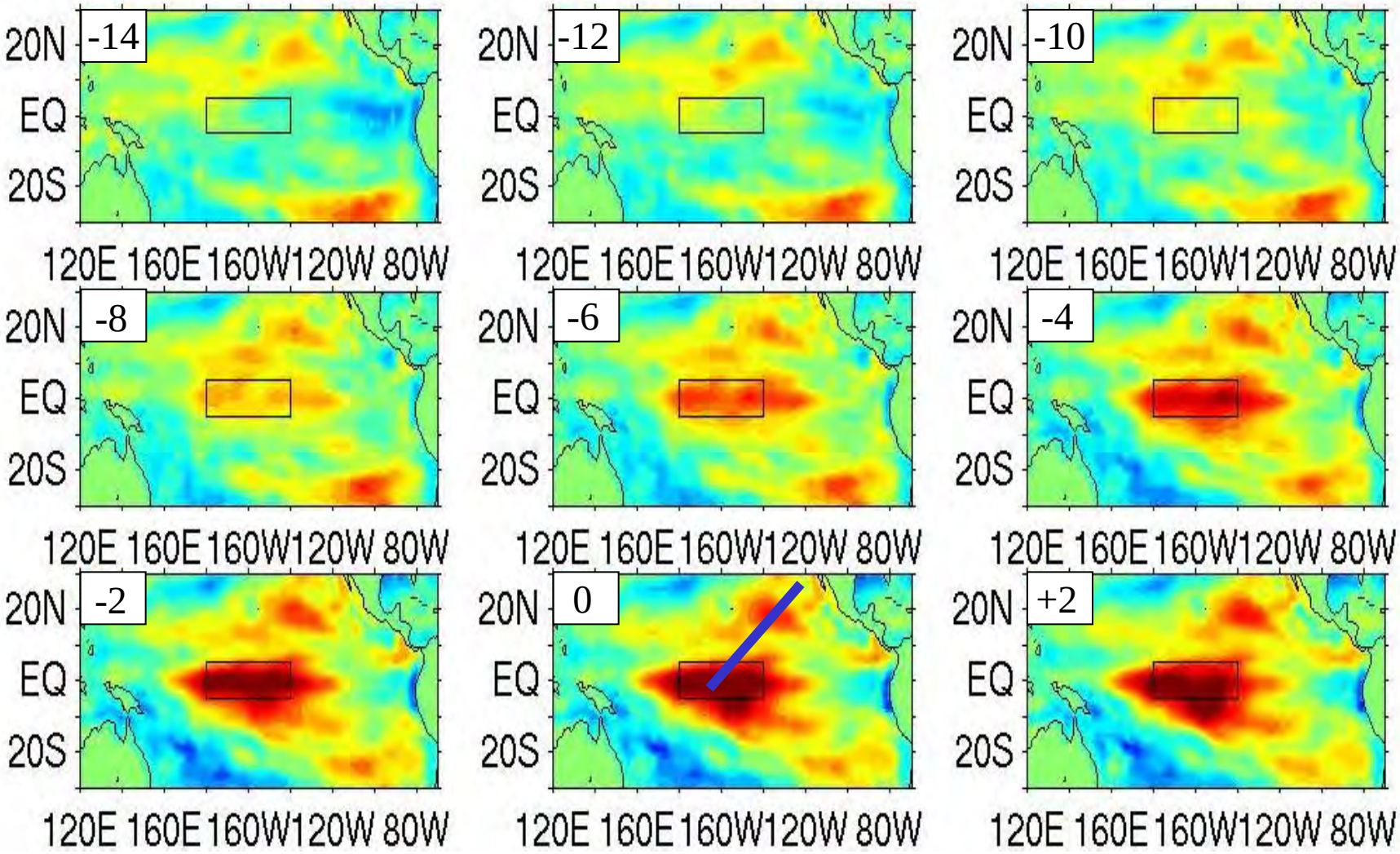


Possible Forcing Mechanisms for CP ENSO



CP-ENSO SST Variations

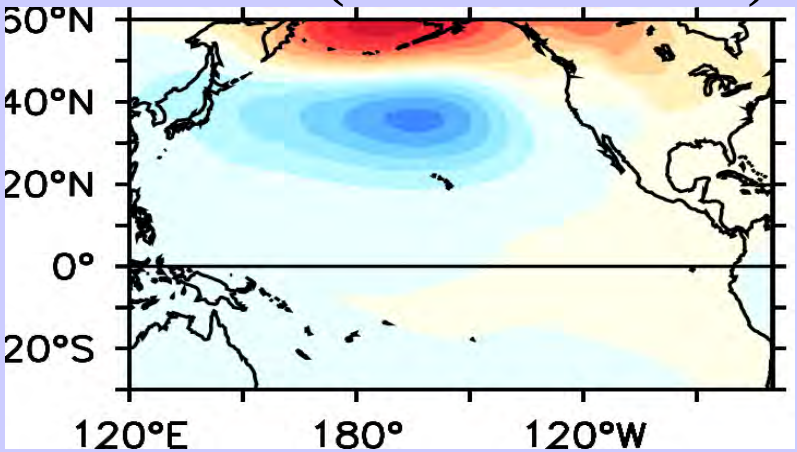
(Yu et al, 2010; Journal of Climate)



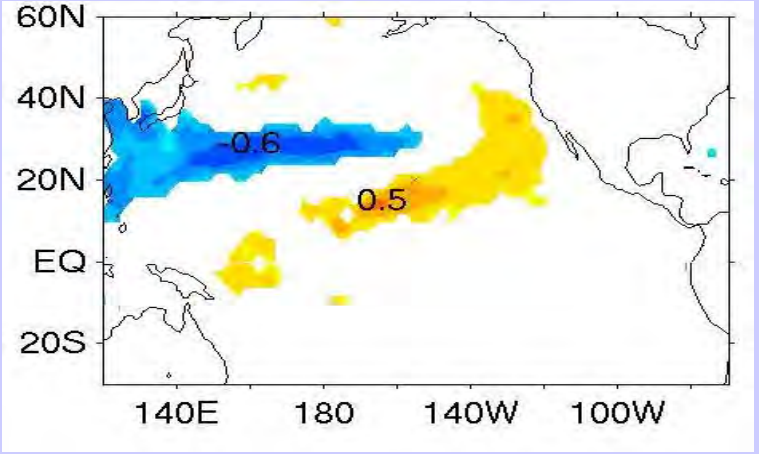
North Pacific Oscillation (NPO) and Associated SST Anomalies

(Yu and Kim 2011)

NPO (SLP EOF mode)



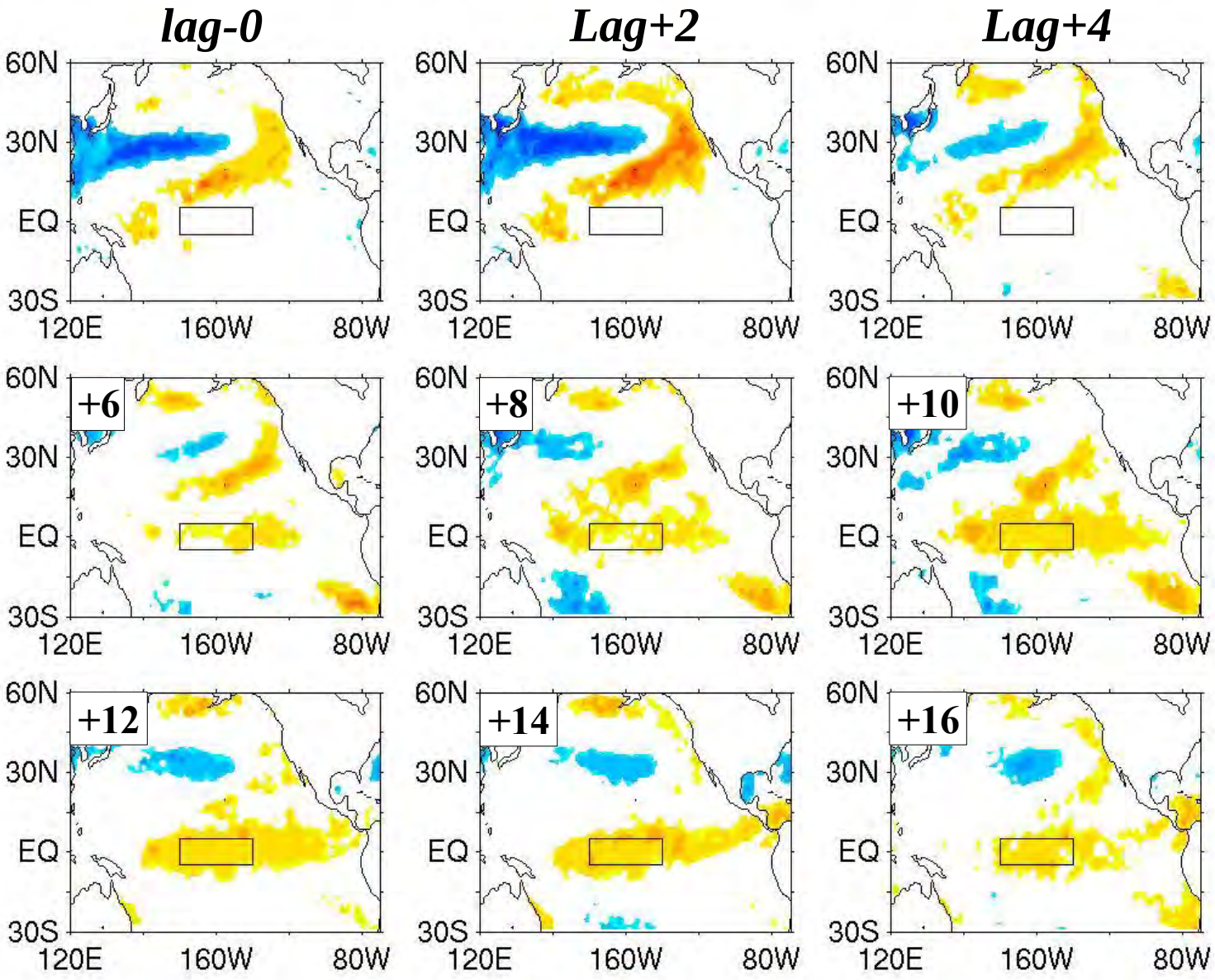
Correlated SST



EOF2

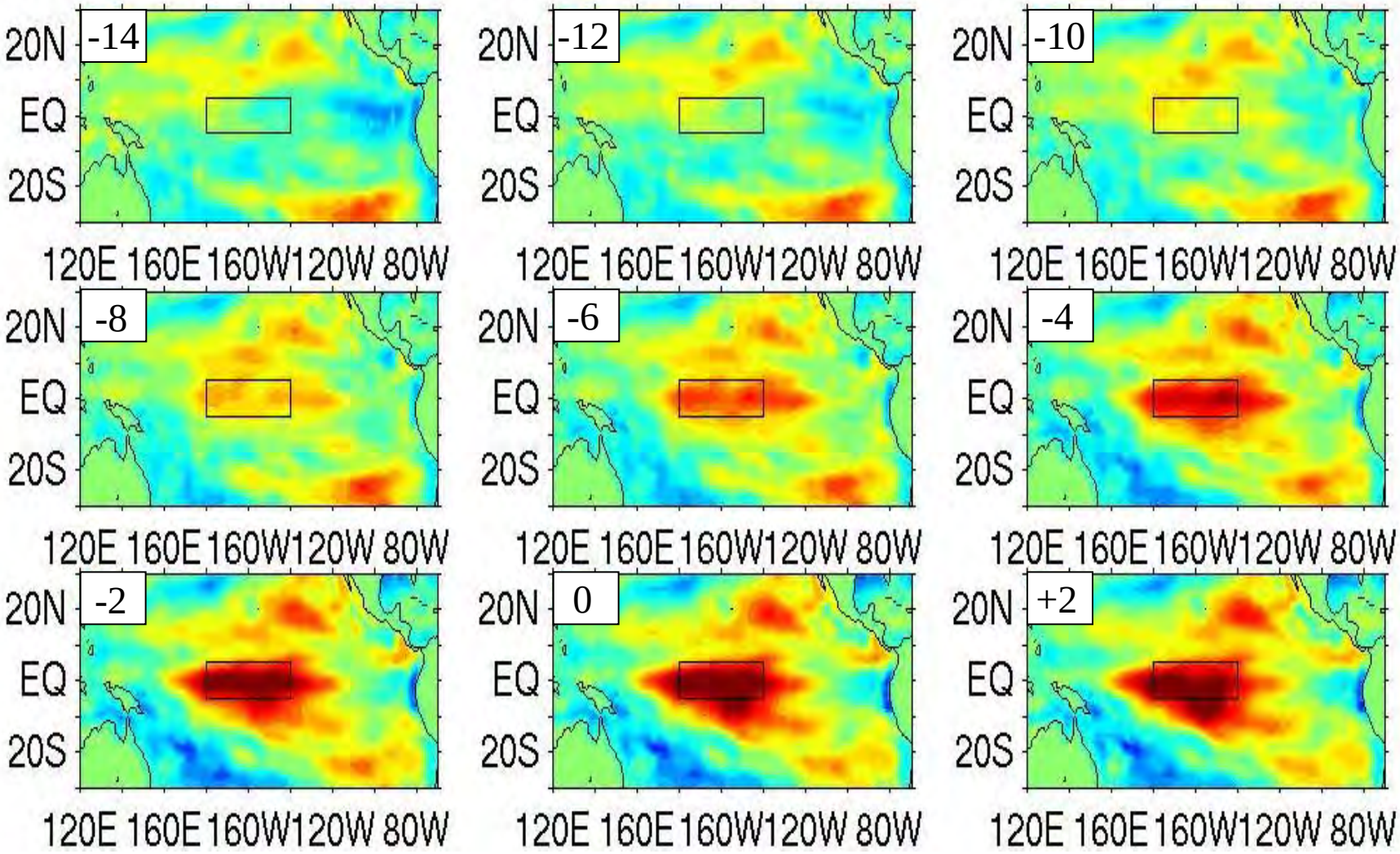
NPO-Correlated SSTA Evolution

(Yu and Kim 2011)

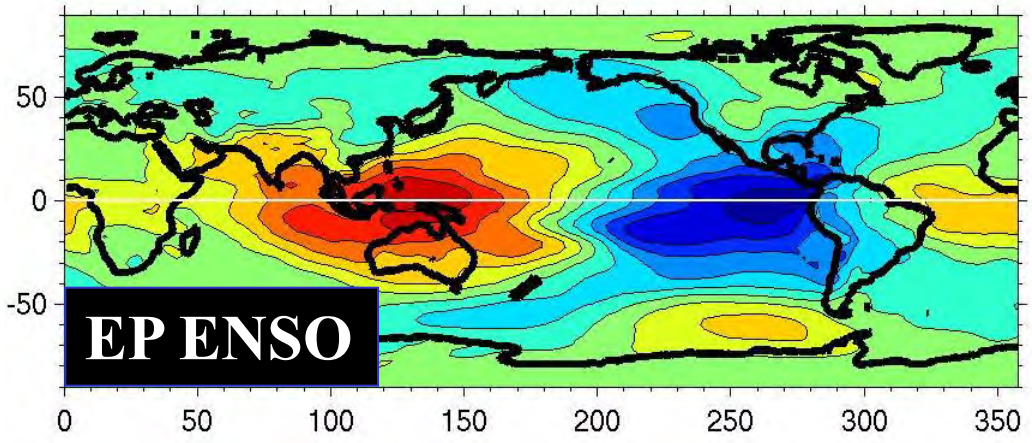


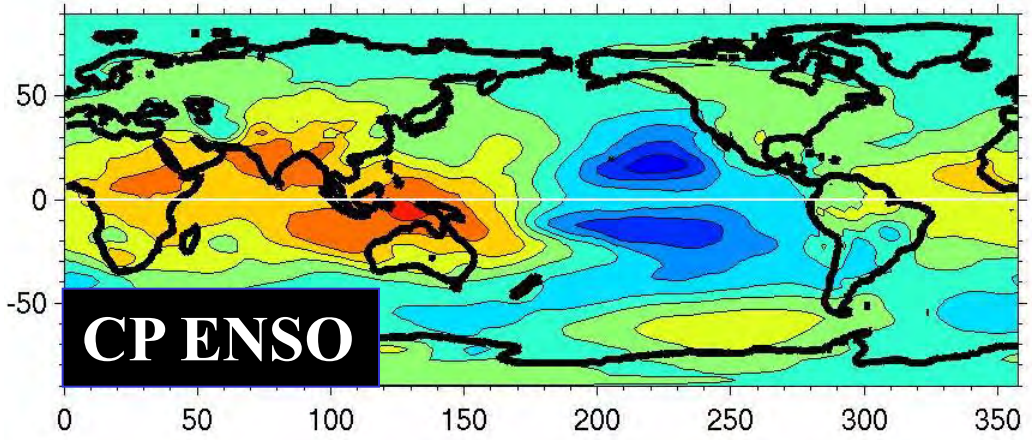
CP-ENSO SST Variations

(Yu et al, 2010; Journal of Climate)

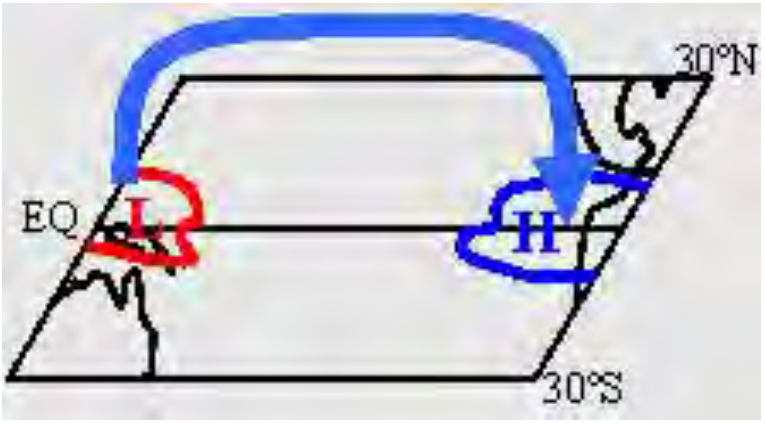


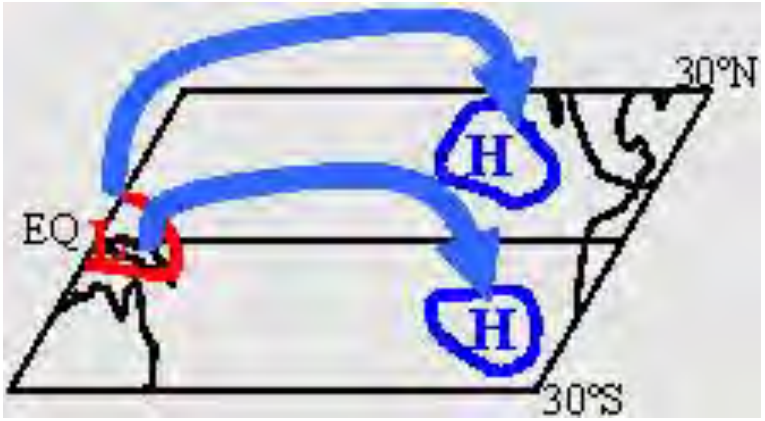
EP/CP-ENSO Correlates with SLP





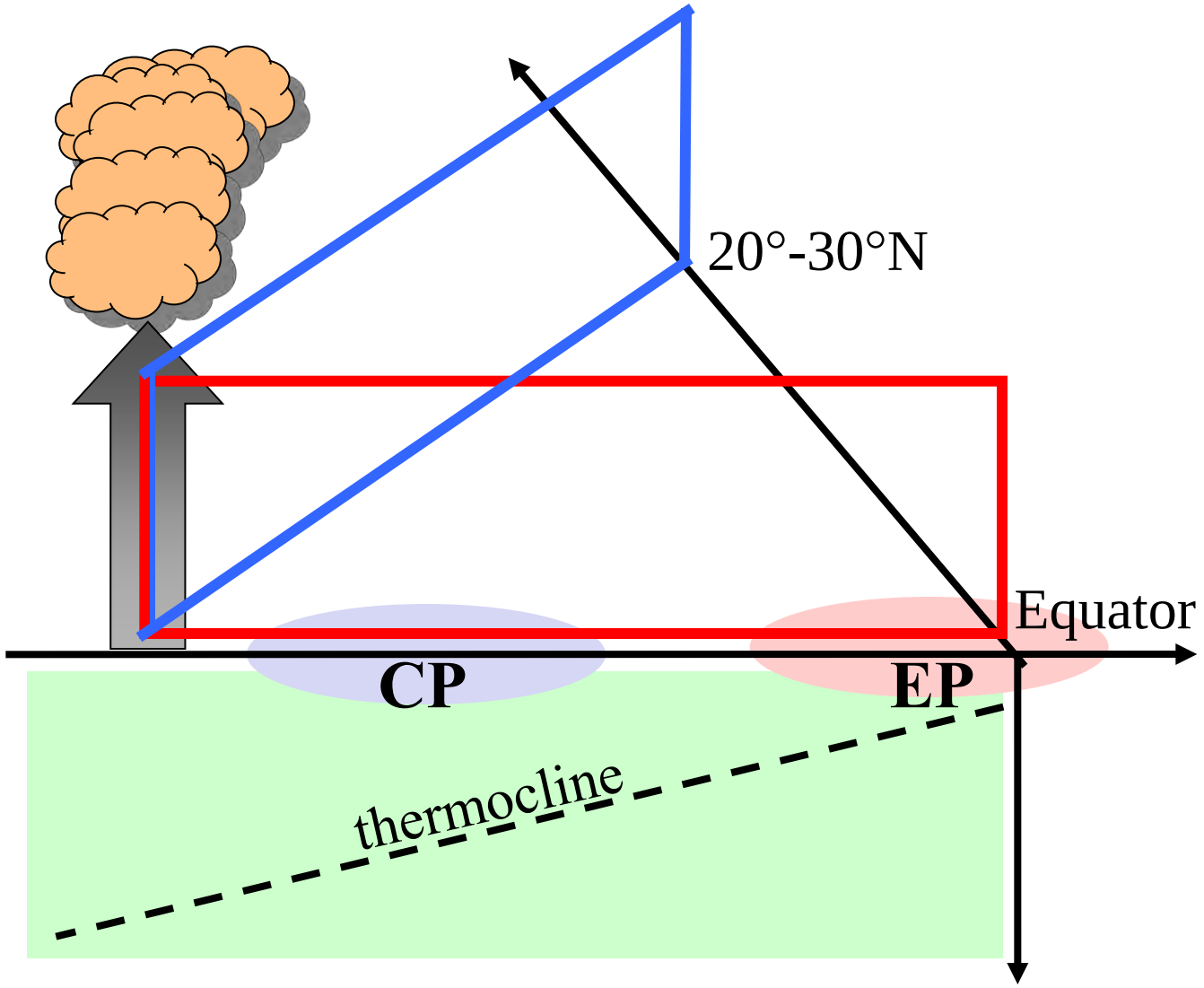
Walker Circulation



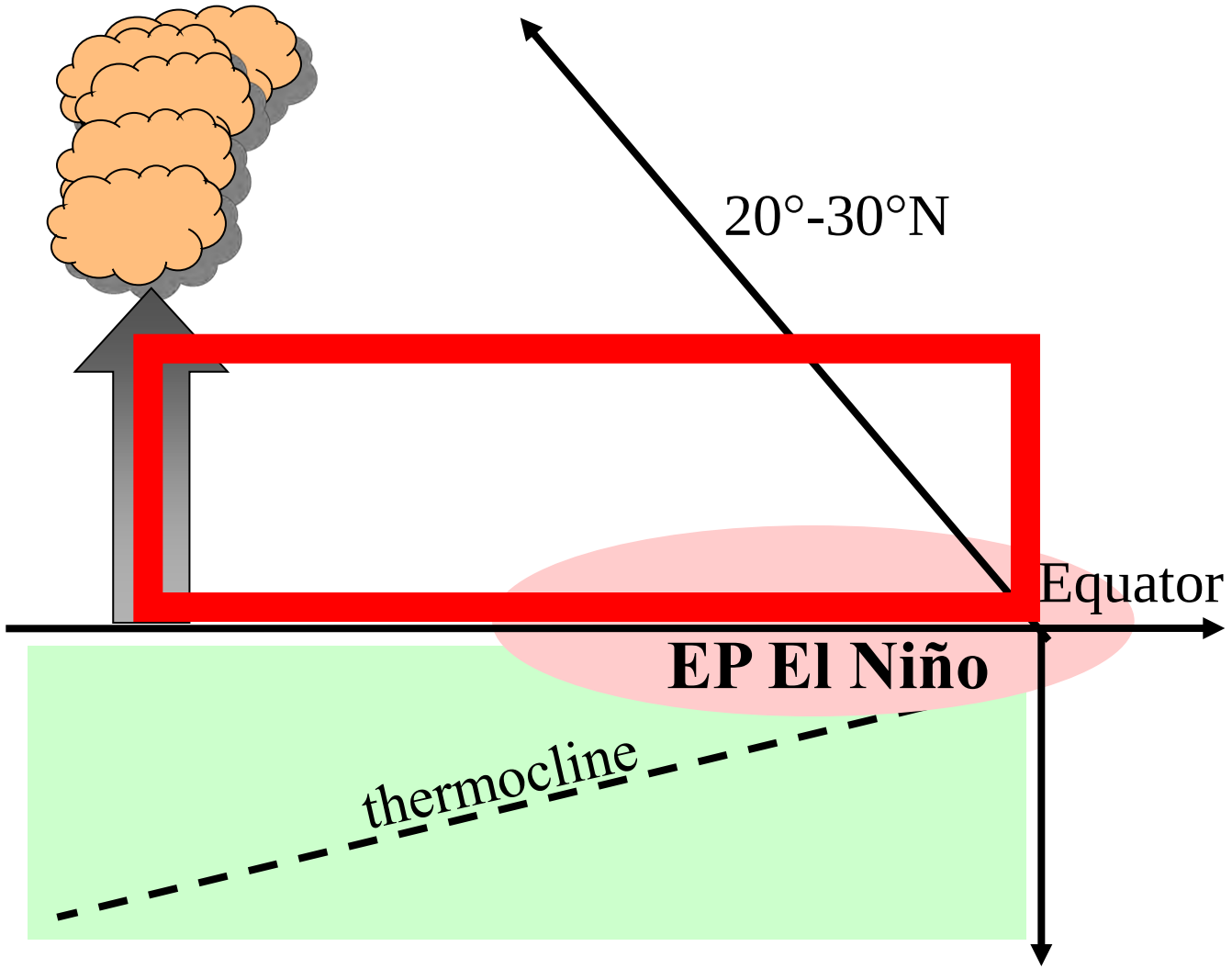


Hadley Circulation

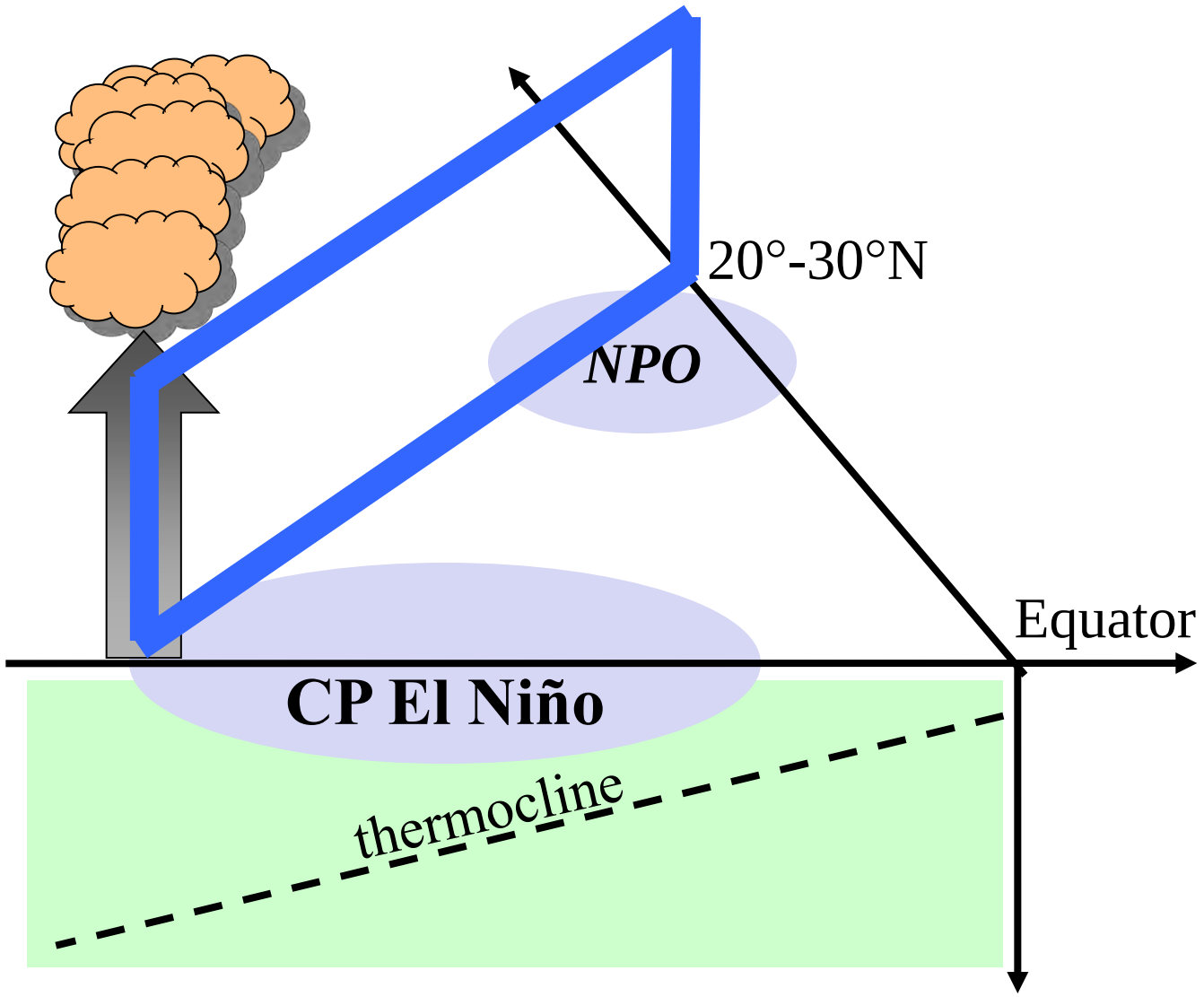
Walker and Hadley Circulations



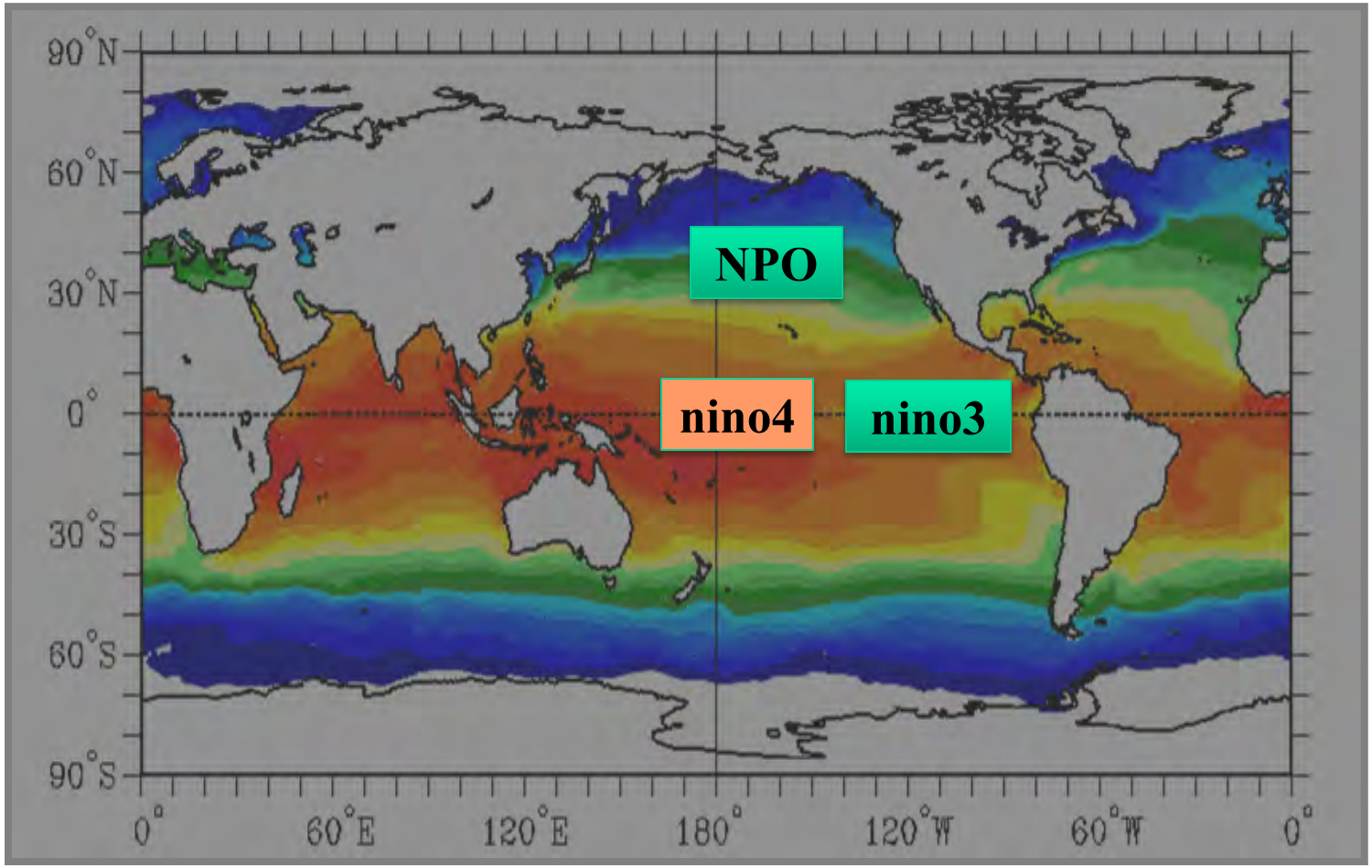
When Walker Circulation Is Stronger…



When Hadley Circulation Is Stronger…



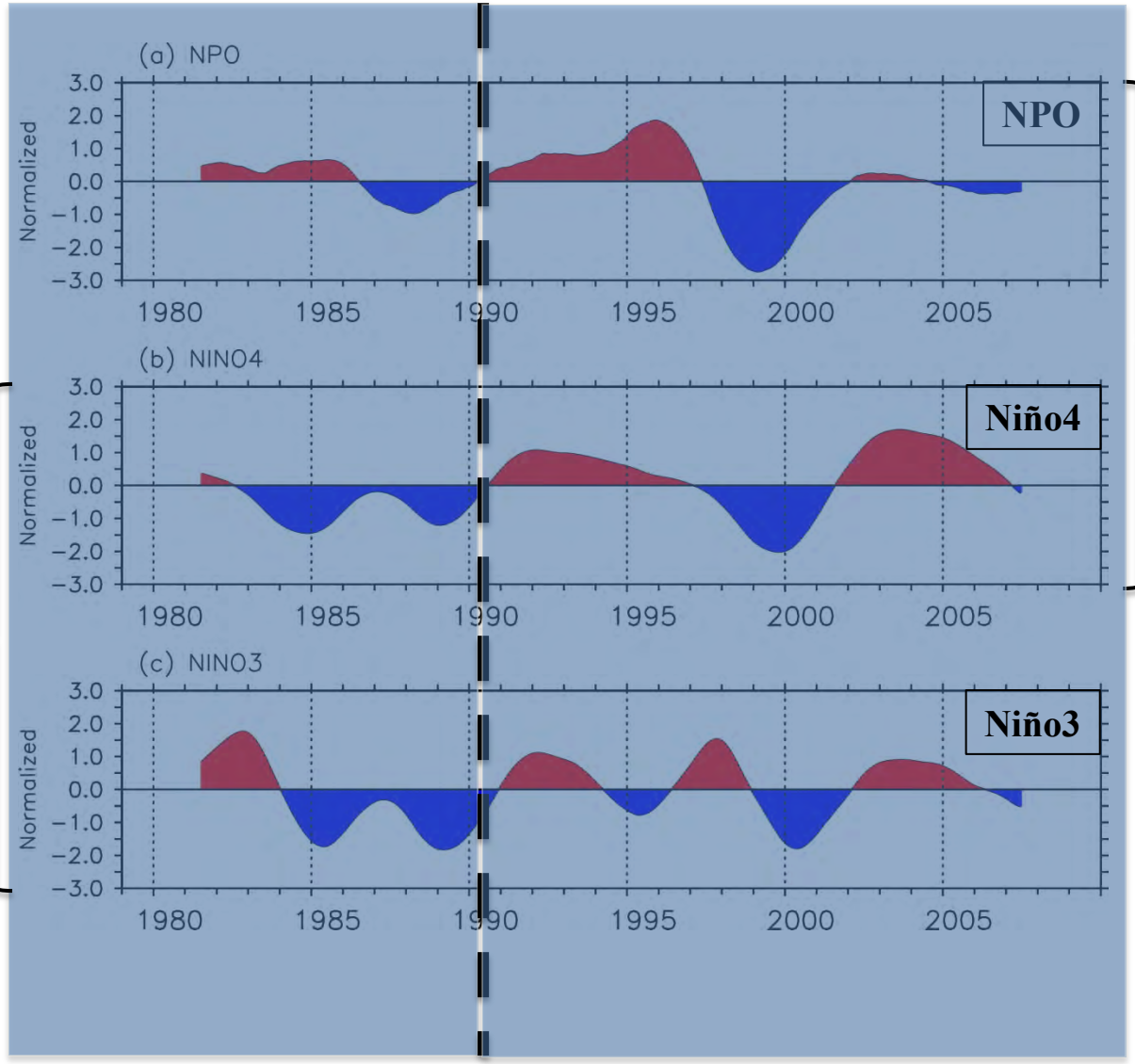
NPO and Tropical Pacific SST Variations



NPO Index and Niño Index

(5-year running means; using CFS Reanalysis)

1990



1990

Before 1990

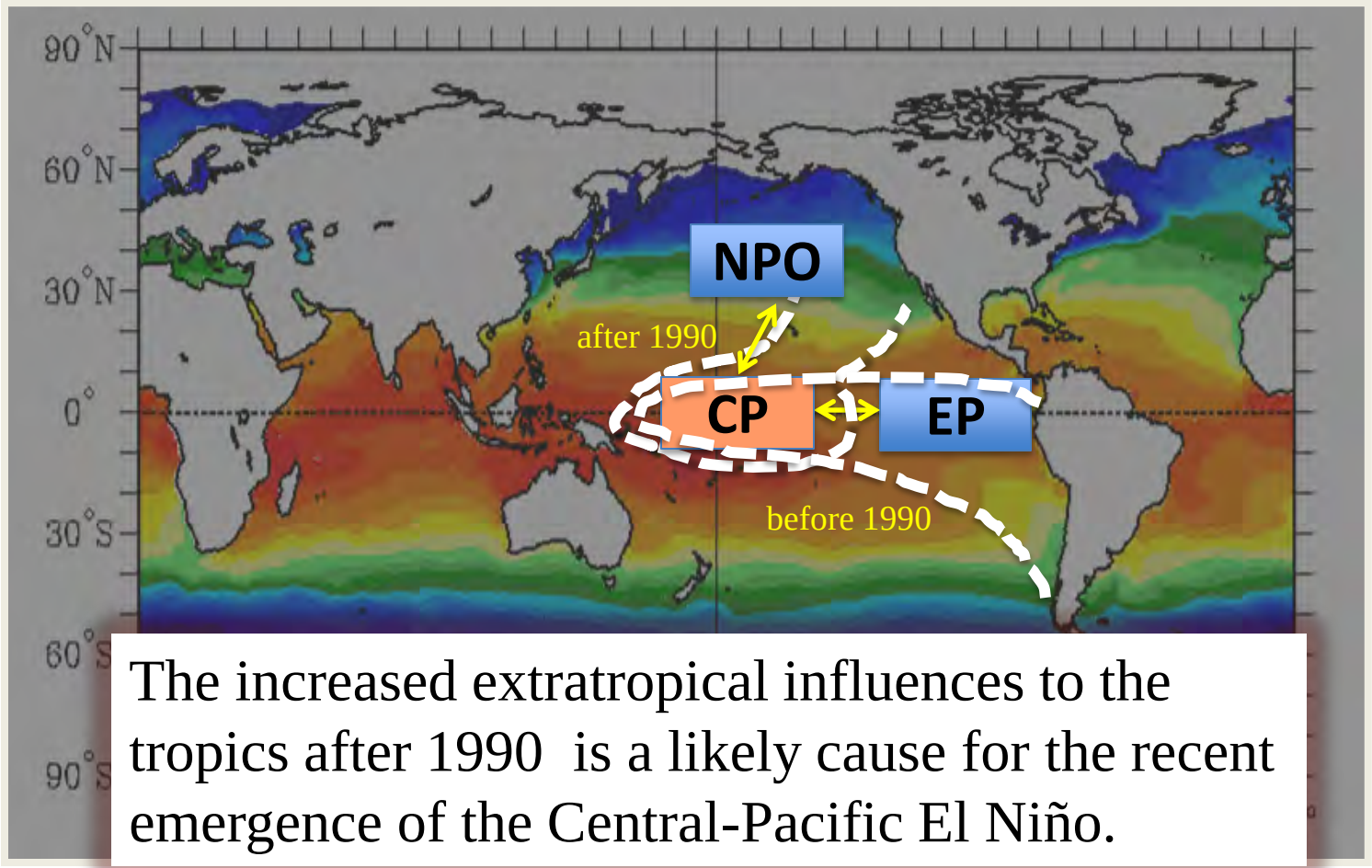
Central T. Pacific SSTA is less related to extratropical atmosphere, but more related to eastern tropical Pacific.

After 1990

Central Pacific SSTA is closely related to Extratropical atmosphere (i.e. NPO), but less related to eastern tropical Pacific.

Central-Pacific SST Variability

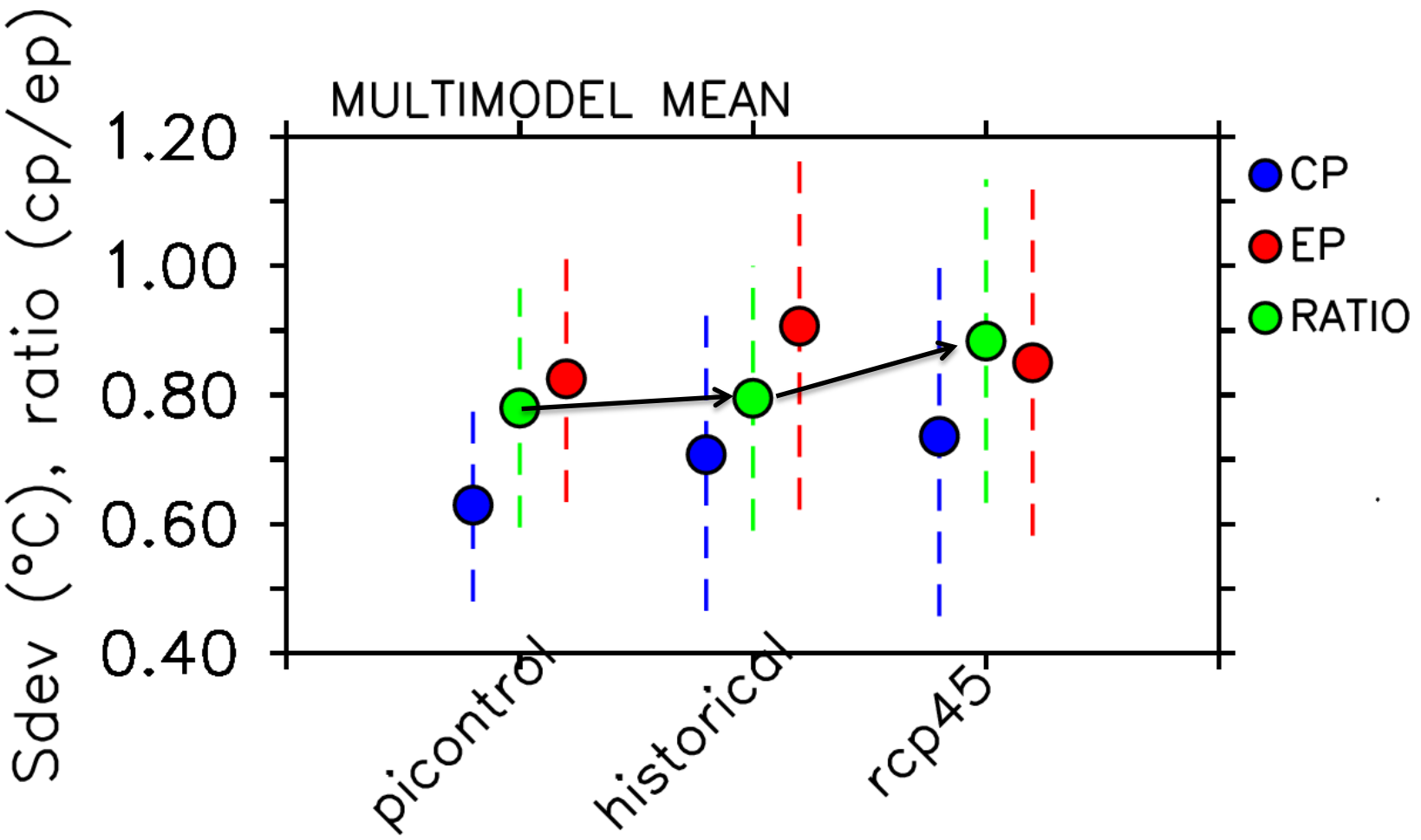
(Yu, Lu, and Kim 2012)



The increased extratropical influences to the tropics after 1990 is a likely cause for the recent emergence of the Central-Pacific El Niño.

CMIP5 Projection of the Two Types of ENSO

(Kim and Yu 2012)

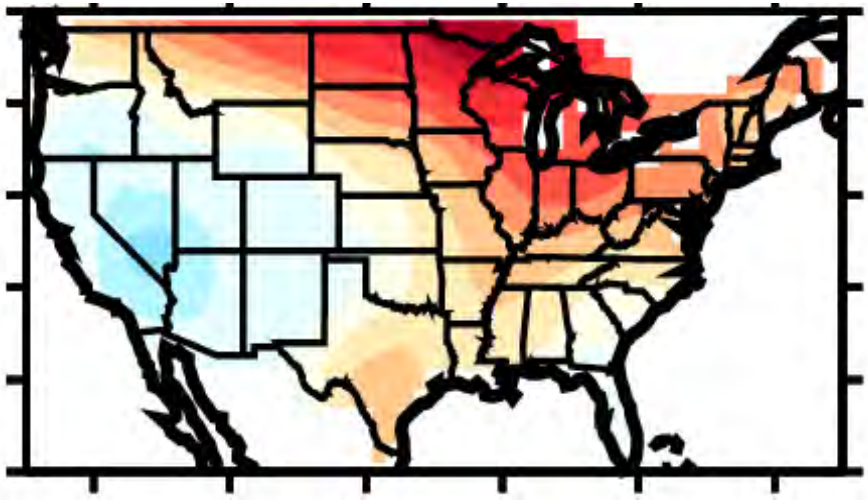


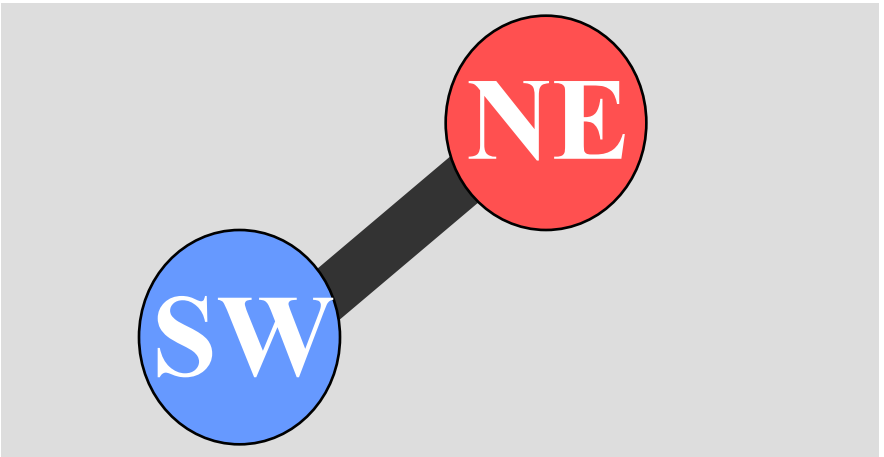
Regressed US Winter (JFM) Temperature

(1948-2010)

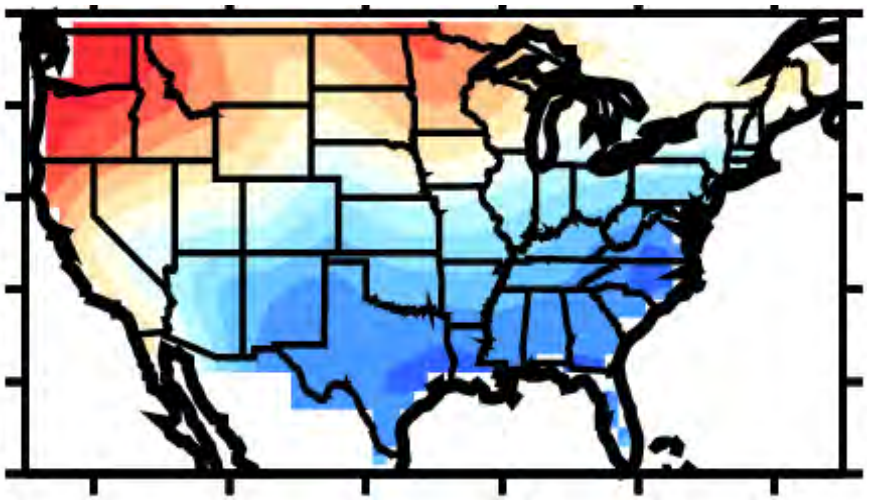
(Yu, Zou, Kim, and Lee 2012)

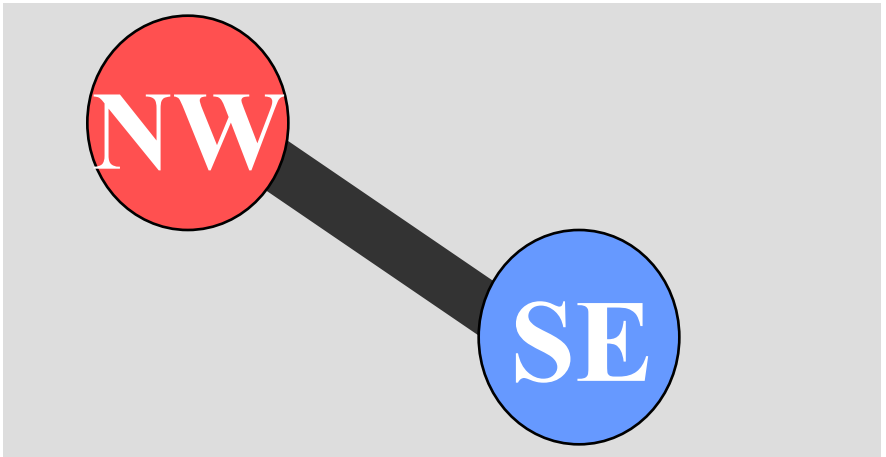
With EP El Niño Index





With CP El Niño Index

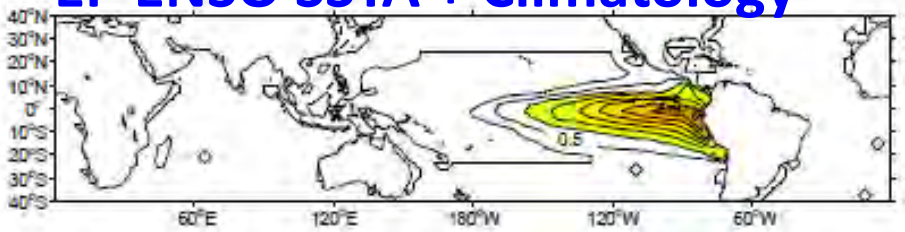


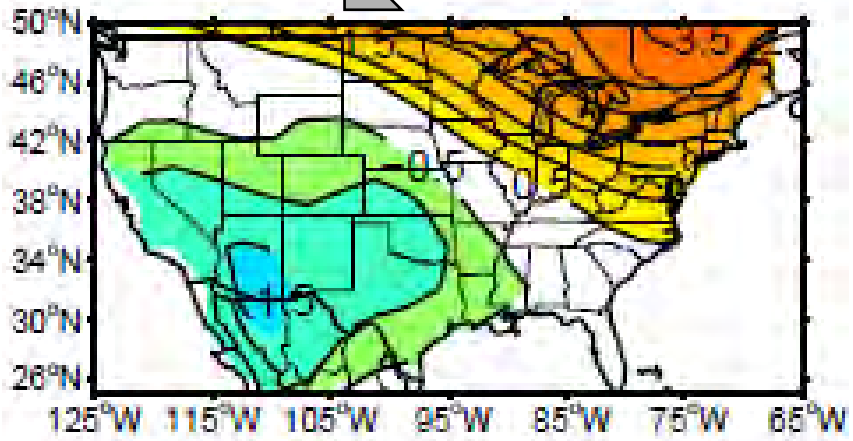


Forced CAM4 Experiments

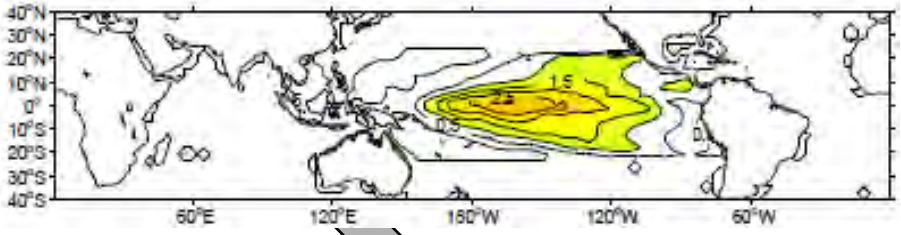
NCAR CAM4
Forced by the SST from

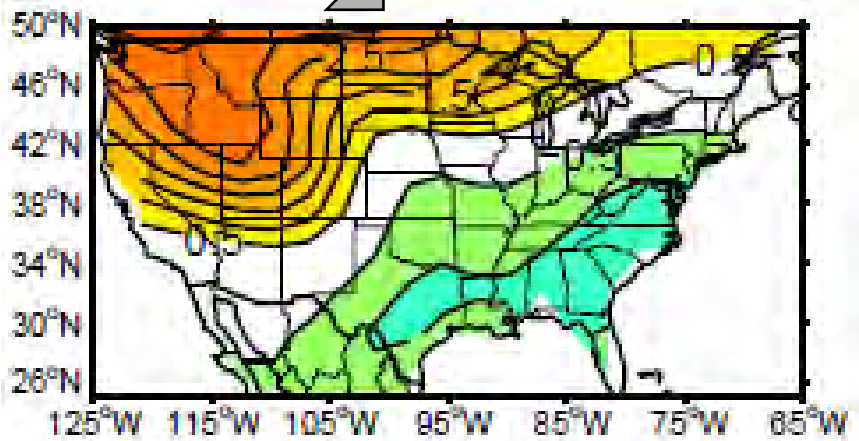
EP ENSO SSTA + Climatology



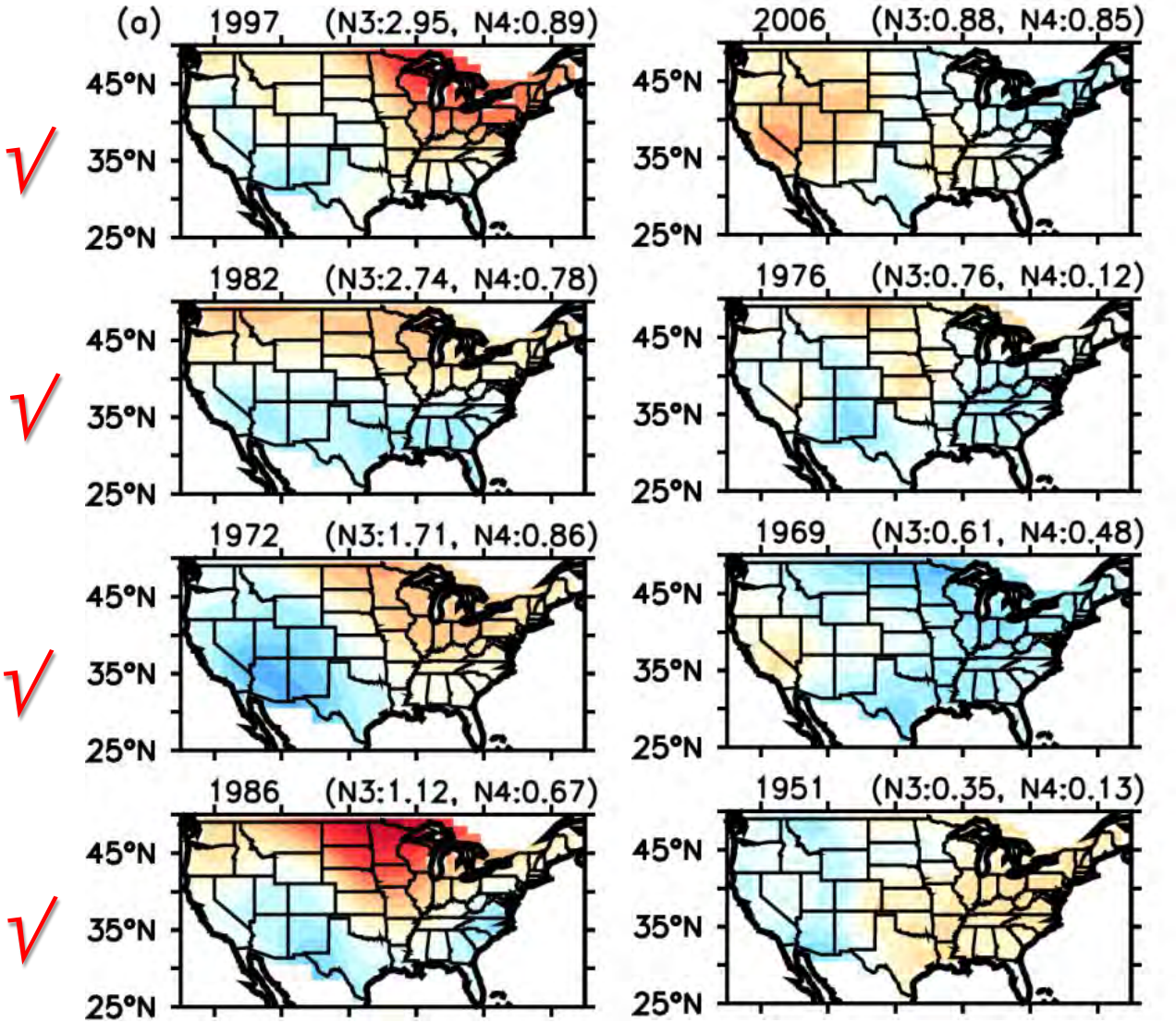


CP ENSO SSTA + Climato





Case Studies with EP El Nino Events



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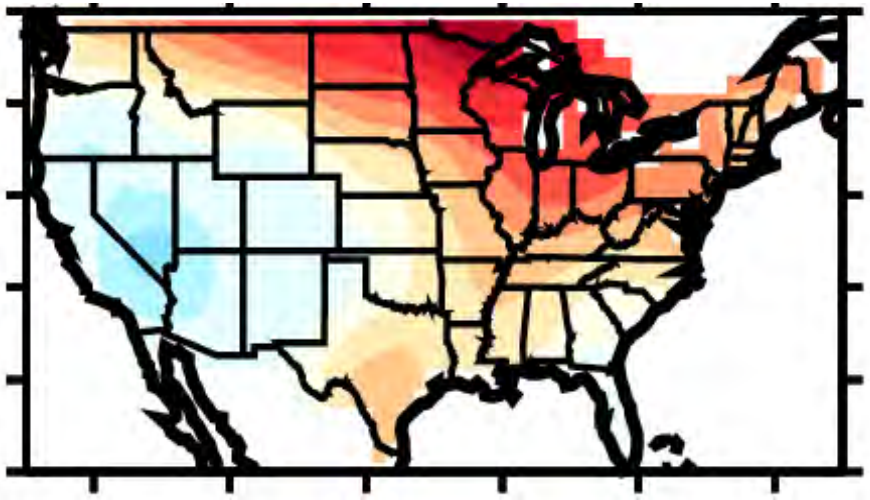
Strong EP Events

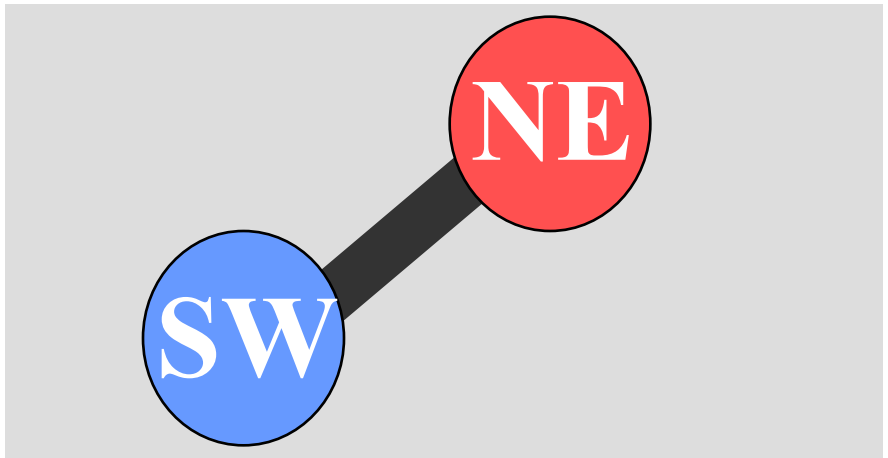
Weak EP Events

Regressed US Winter (JFM) Temperature

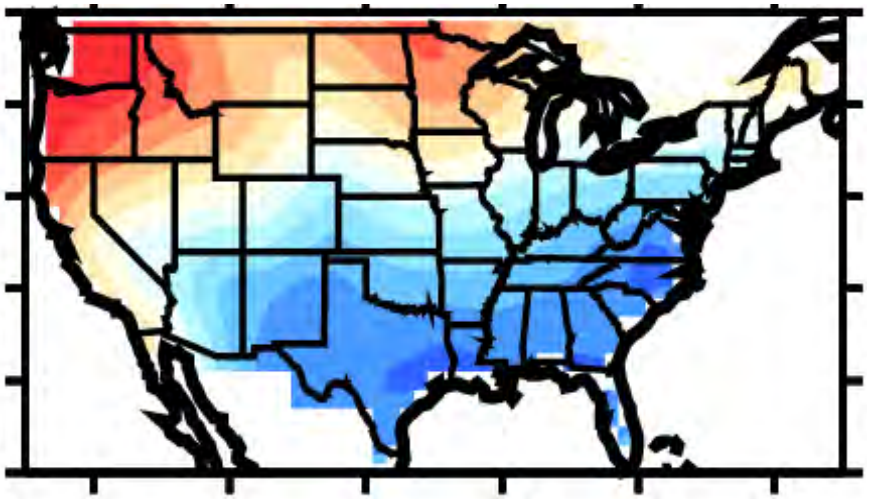
(1948-2010)

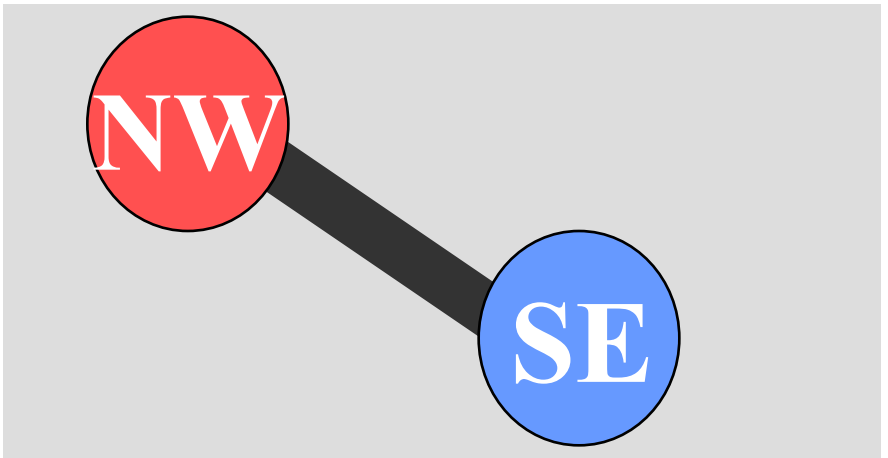
With EP El Nino Index



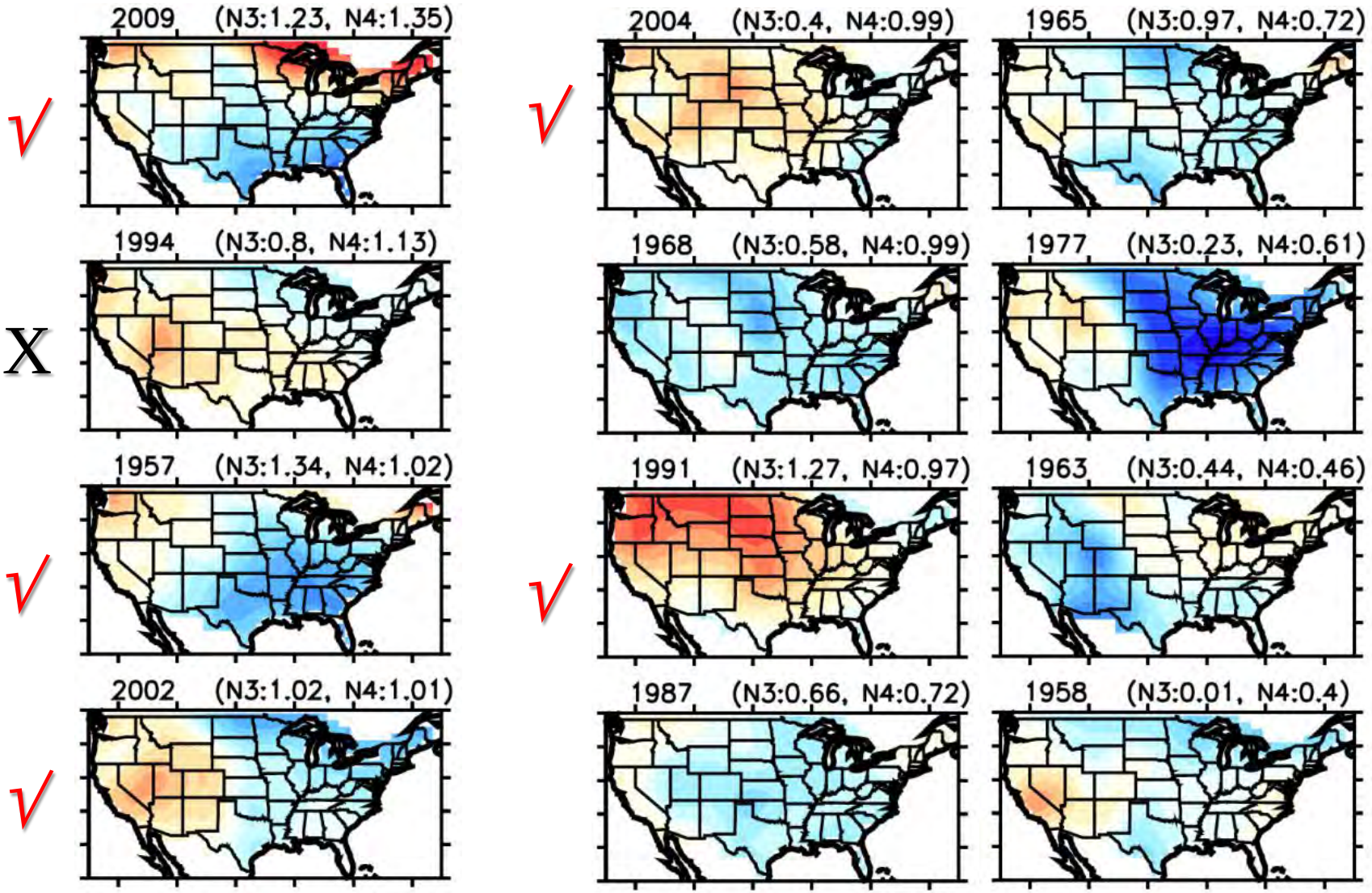


With CP El Nino Index





Case Studies with CP El Nino Events



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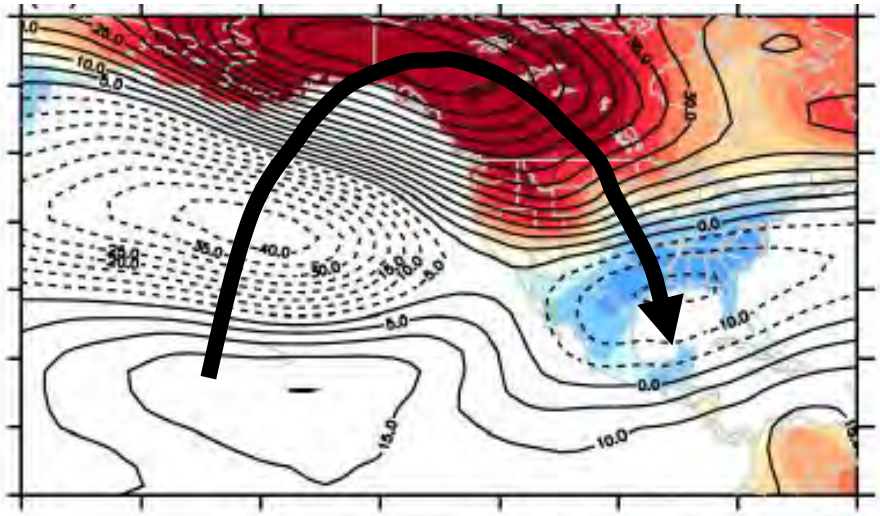
Strong Events **Weak Events**

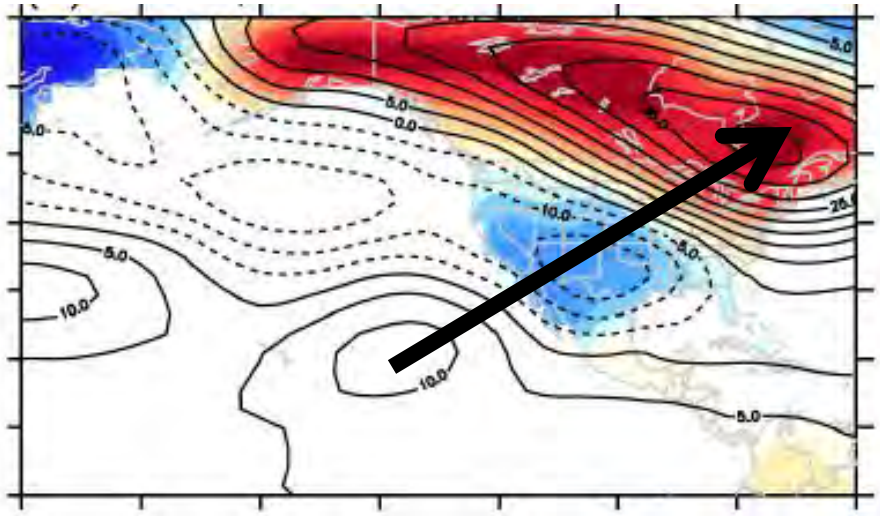
Atmospheric Response to EP/CP ENSO

Φ_{500mb} Anomalies Regressed with EP/CP Index

CP: Pacific North America Pattern

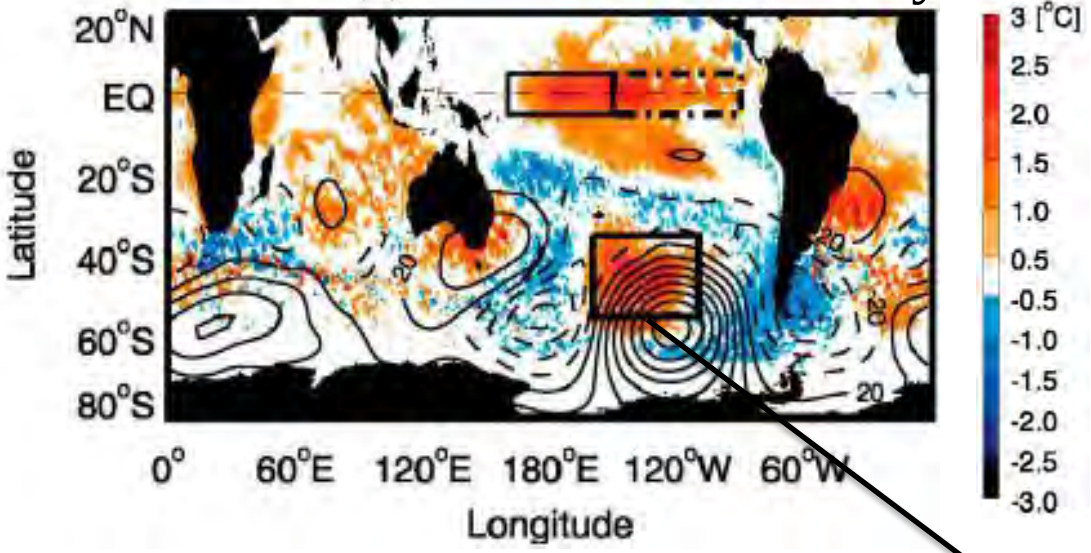


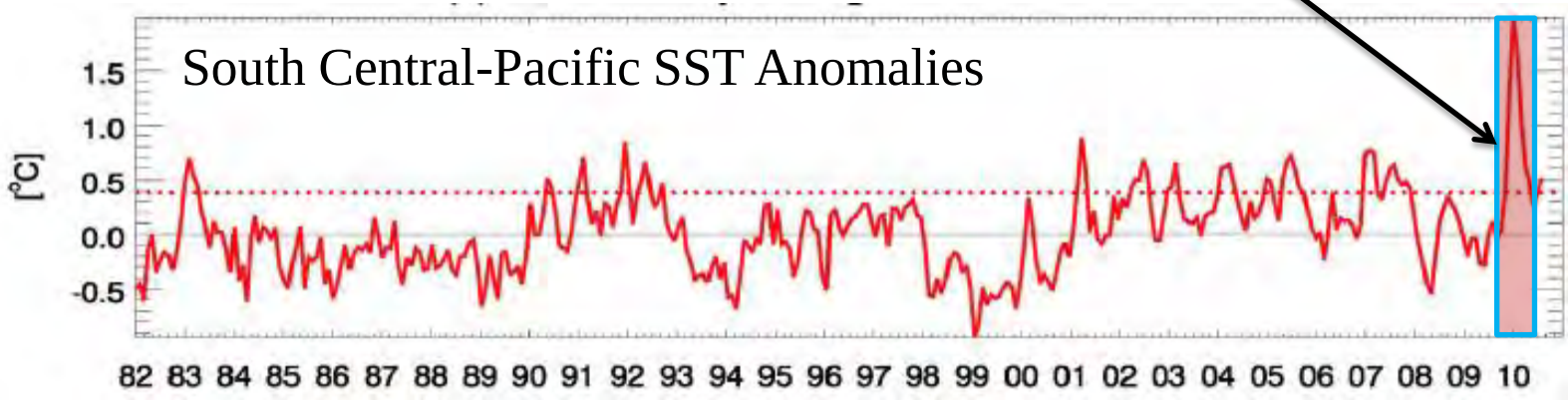
EP: Polarward Wave Train Patt



Record Warming in South Central Pacific

November 2009 SST anomaly





(Lee. et al. 2010)

Summary

- There may exist two distinct types of El Niño: an Eastern-Pacific type and a Central Pacific type.
- Tropical Pacific Ocean interacts with the Walker circulation to produce the EP El Niño but interacts with the Hadley circulation to produce the CP El Niño.
- The increased influence of NPO over tropical Pacific SST is a likely cause for the shift of El Niño from the Eastern-Pacific type to the Central-Pacific type.
- The emergence of the CP El Niño since the 1990s may be responsible for some of the changes in regional climate global wide.