ENSO Diversity and its Teleconnections

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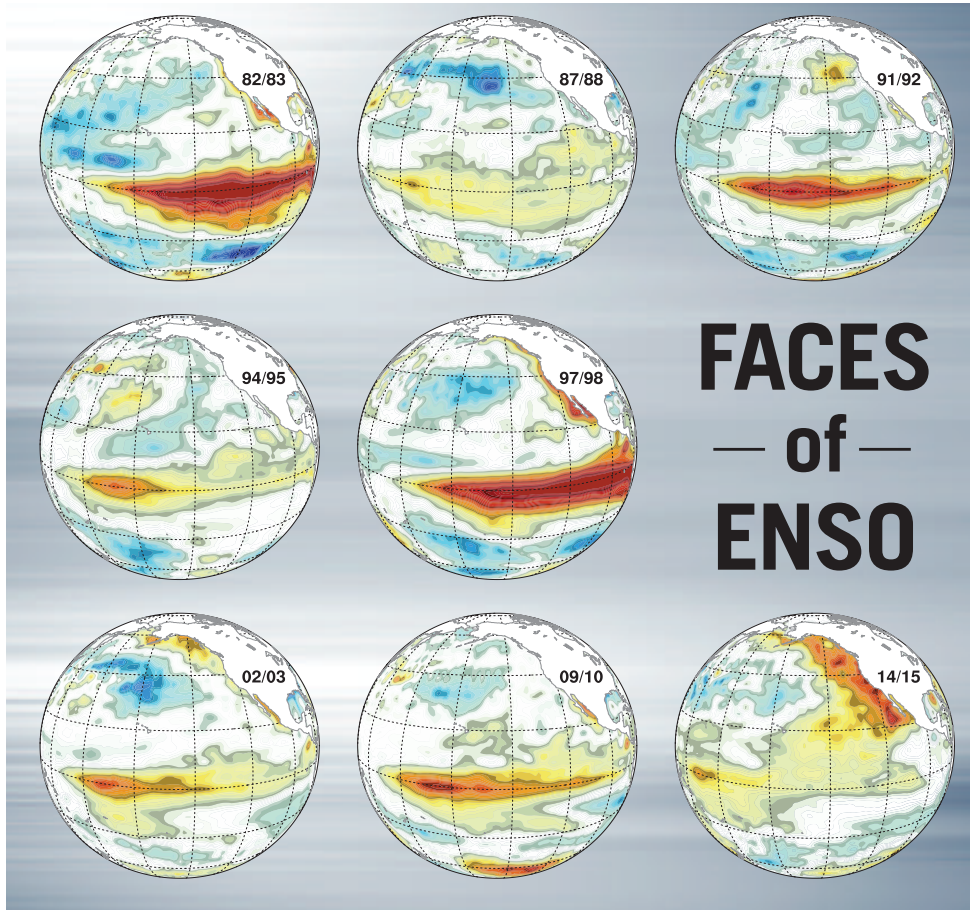
1. How can we view ENSO Diversity?
2. Major characteristics of different ENSO types
3. Teleconnections
4. Precursors of different types of ENSO events

How can we view ENSO Diversity?



DJF SST anomalies for 8 El Niño events over the past 30 years

ENSO Diversity WG, BAMS, 2015

ENSO events differ in amplitude, temporal evolution and spatial pattern

"No two El Niño events are quite alike" (K. Wyrtki 1975)

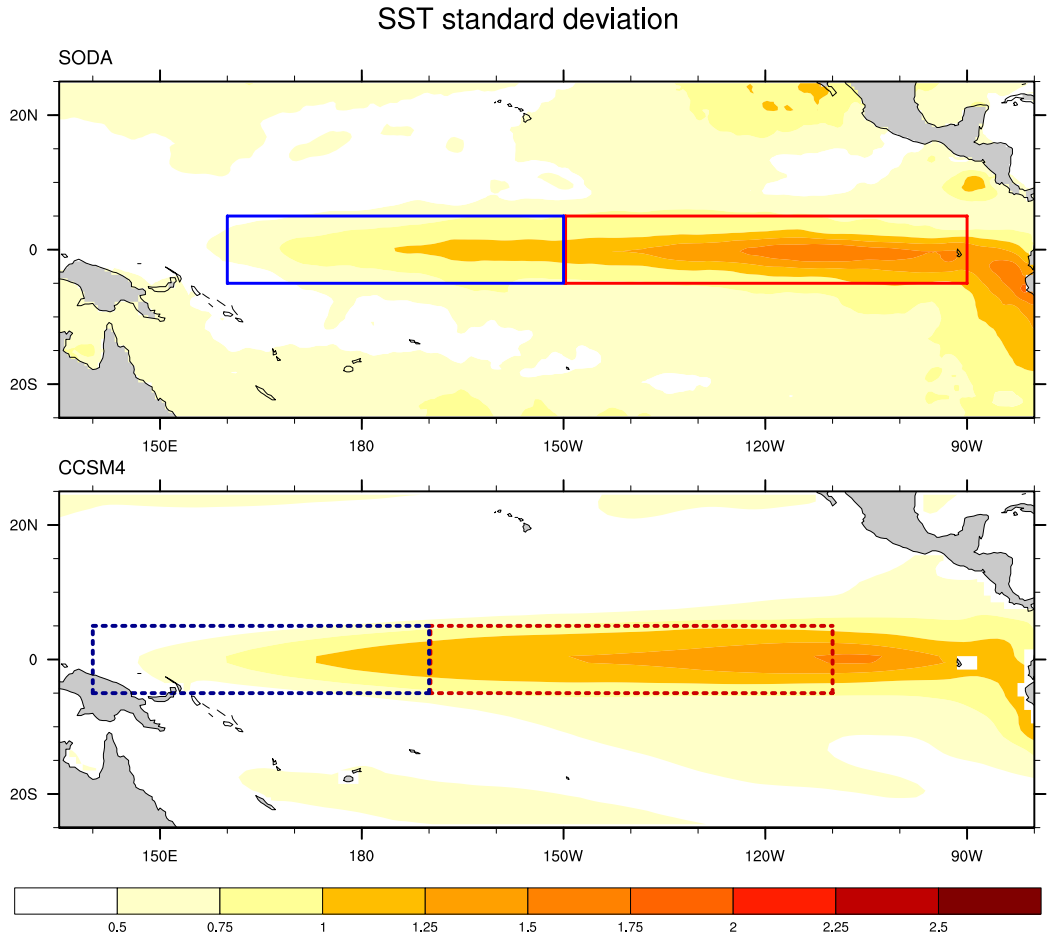
ENSO Diversity not just "two different types" more a continuum

Characteristics of different ENSO types

4 different indices are used to identify different types of events

SODA

CCSM4



Niño3

Niño4

Niño3-m

Niño4-m

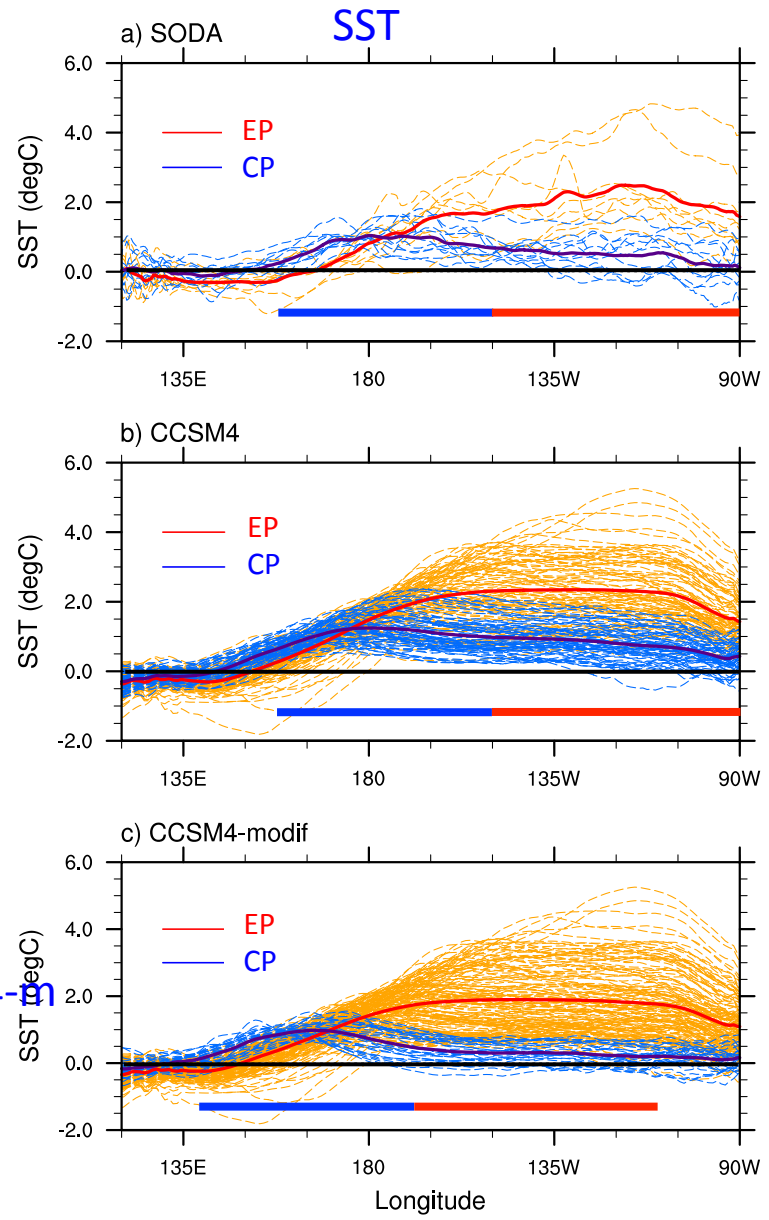
Composite equatorial profiles

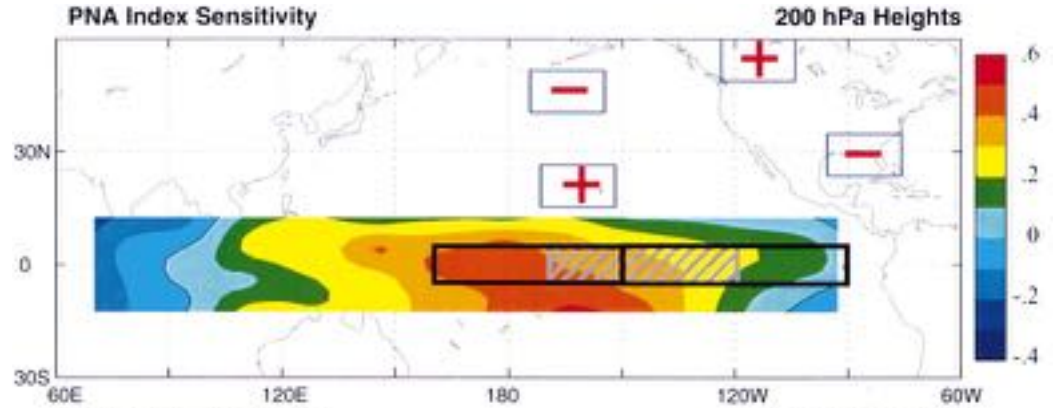
SST

SODA

CCSM4

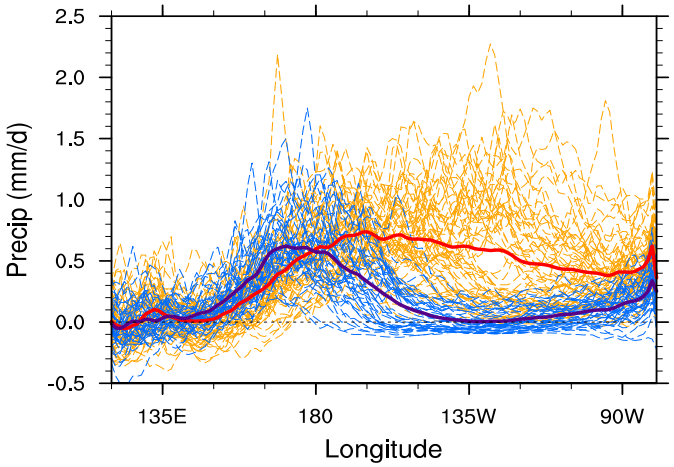
CCSM4-m





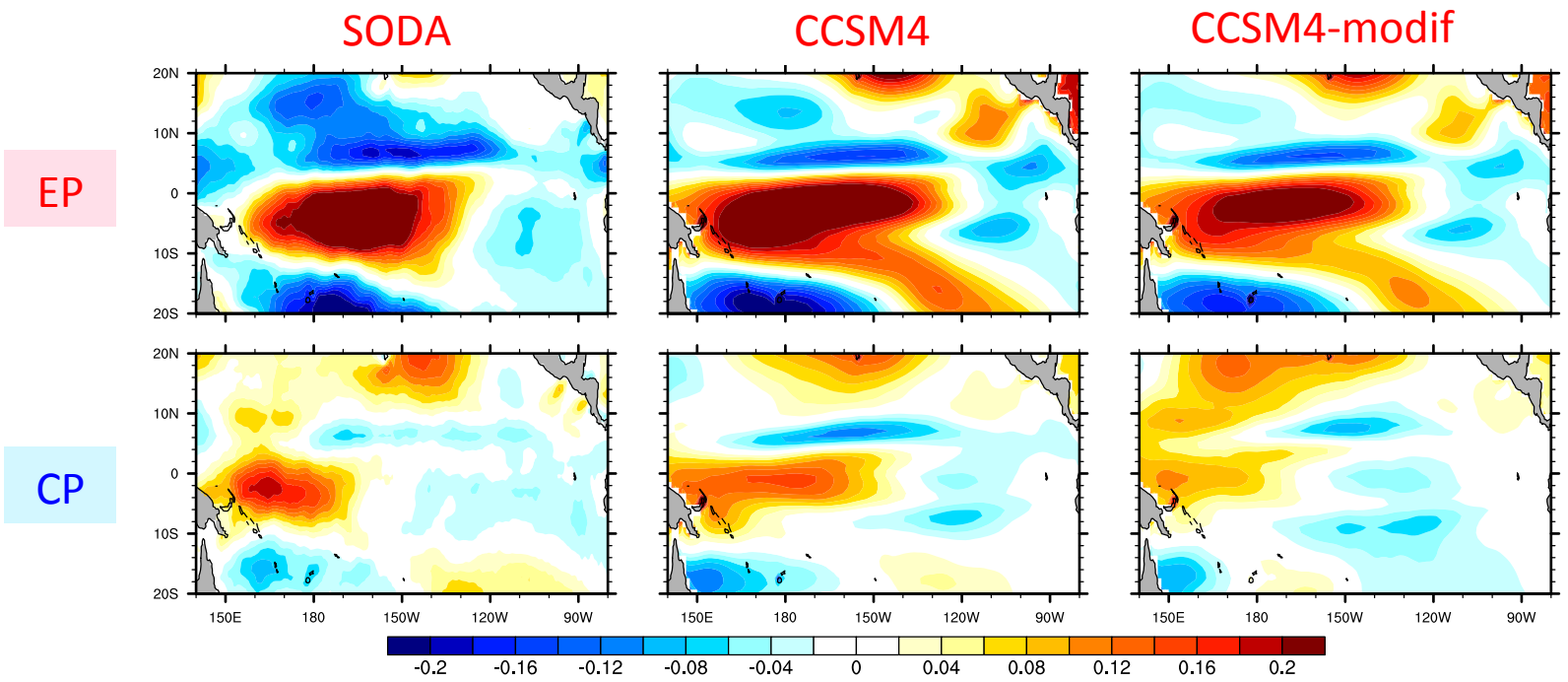
Barsugli and Sardeshmukh 2002

Precipitation



Capotondi 2013

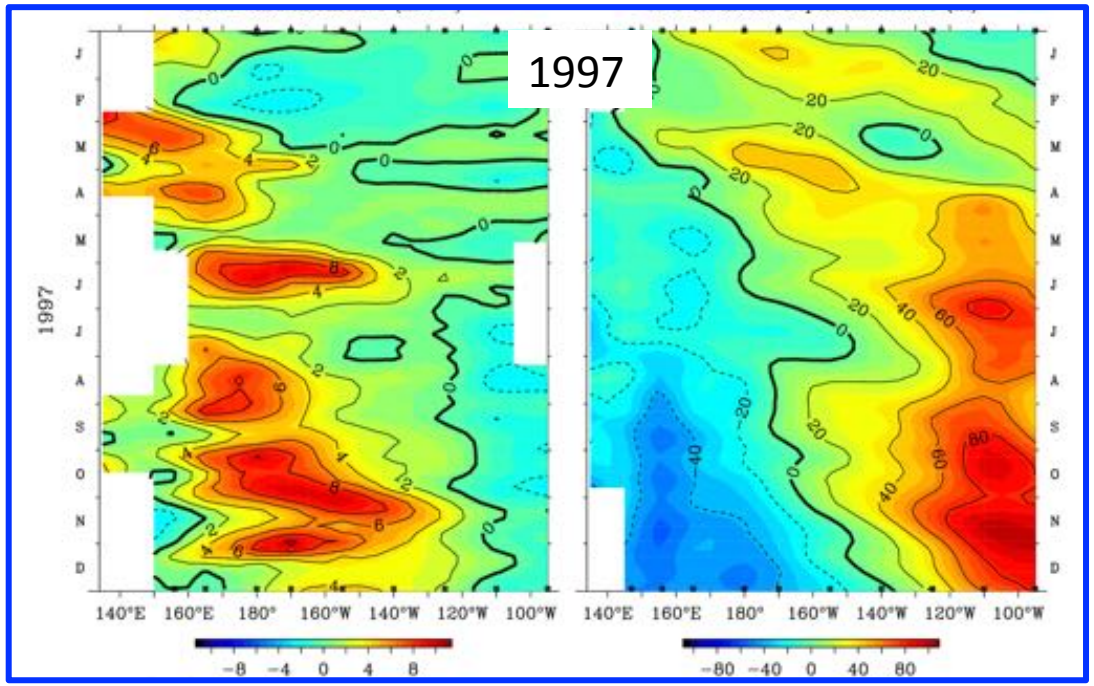
Composite **Zonal Wind Stress** patterns

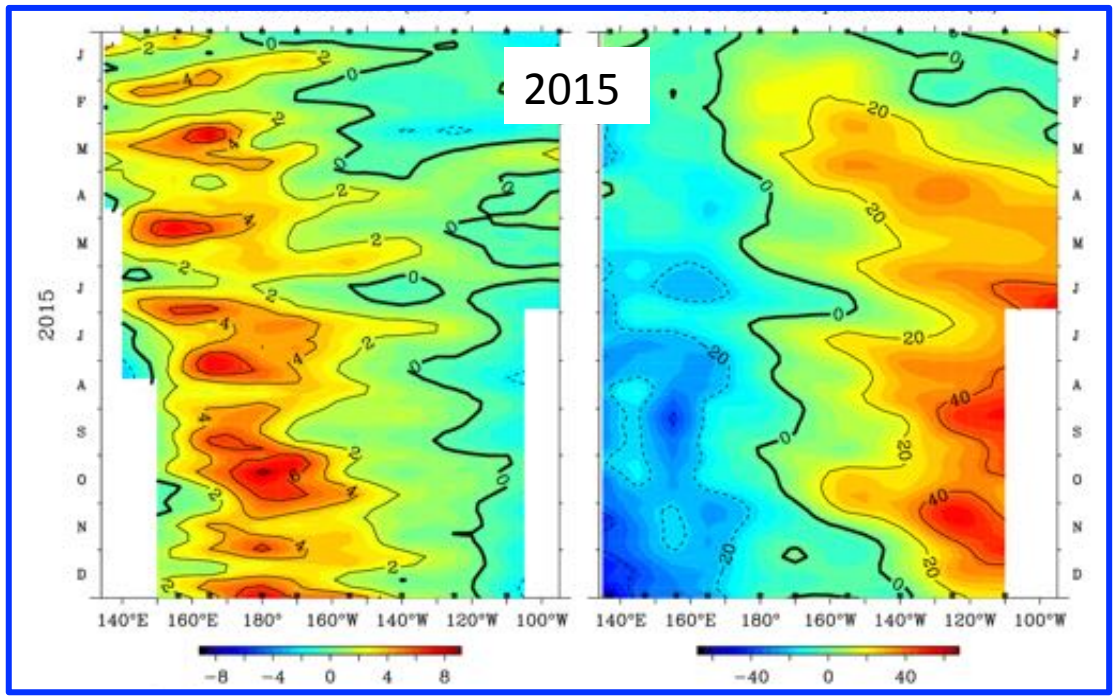


Wind stress anomalies are confined in the western part of the basin during CP events

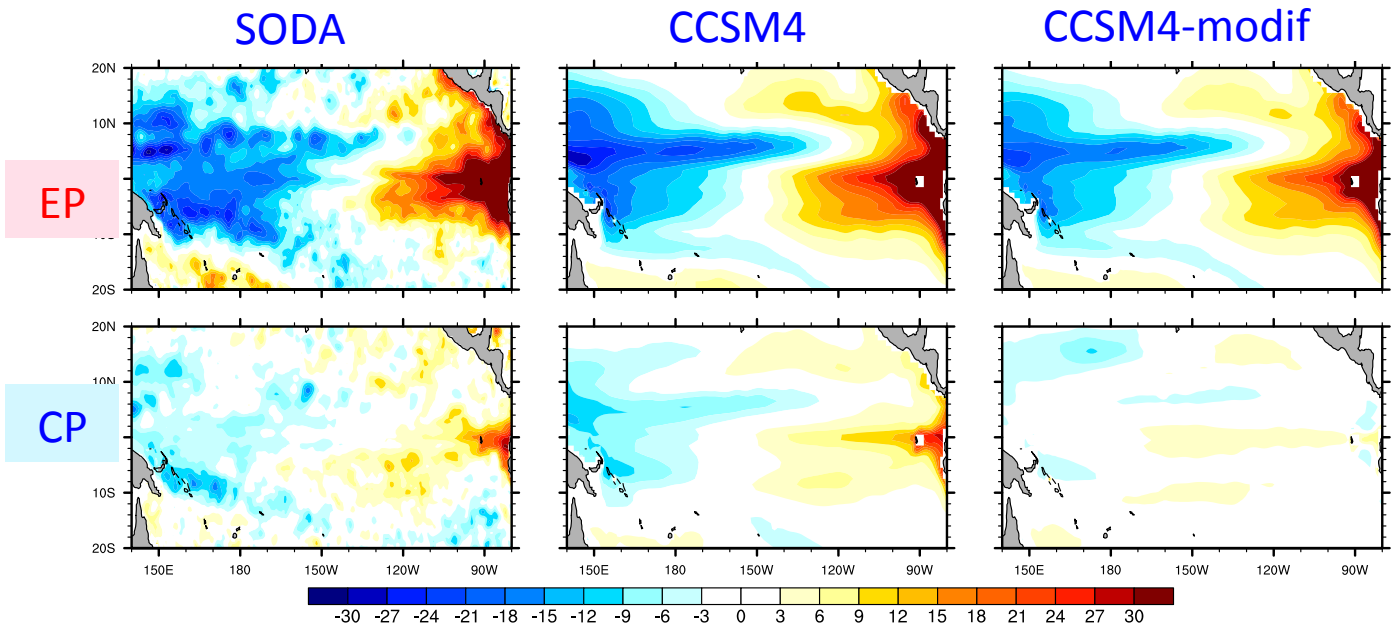
High-frequency wind activity is also confined in western Pacific during CP events, with less influence on thermocline depth in the eastern Pacific (TAO website)

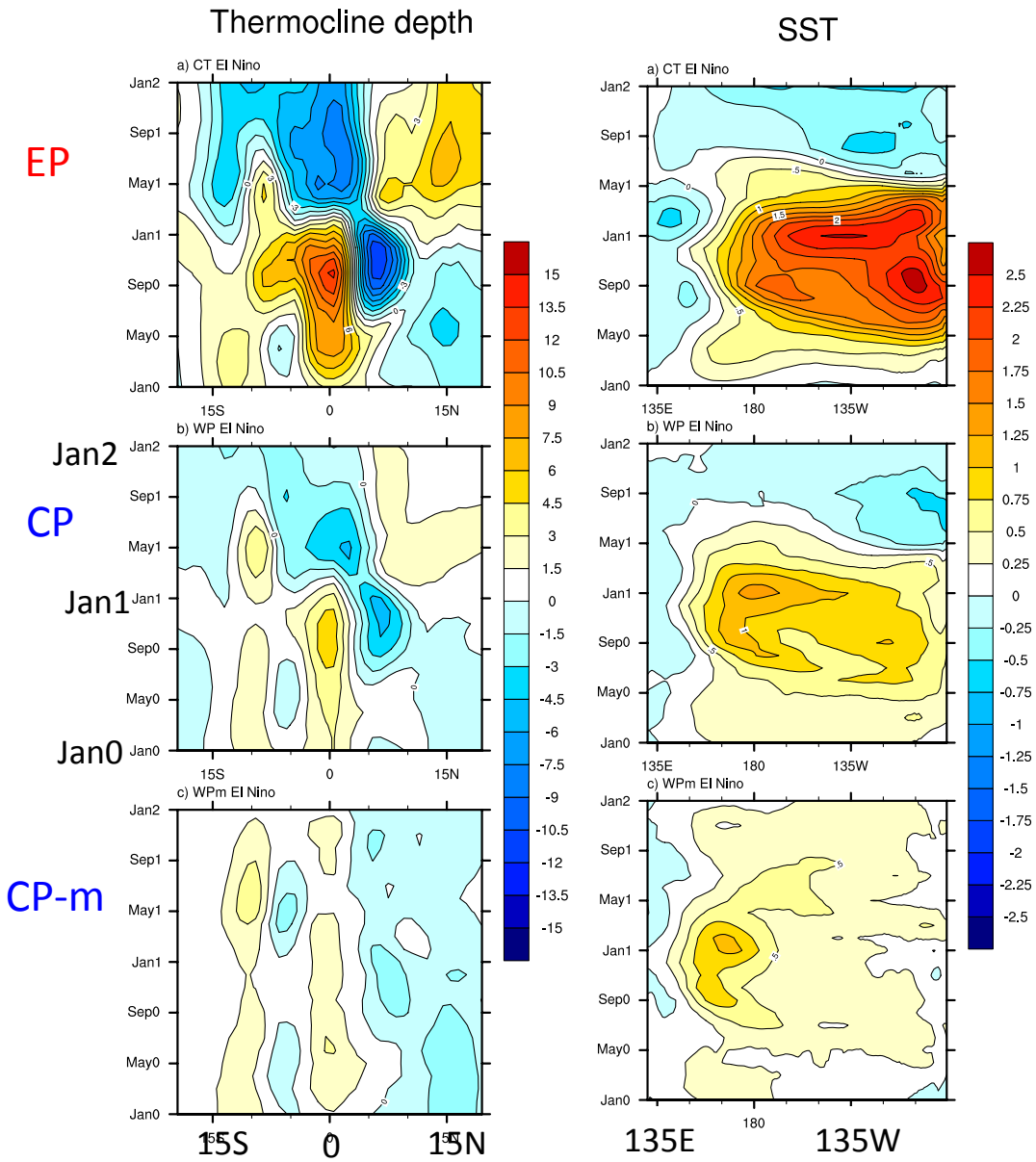
Zonal wind anomalies Z20





Evolution of thermocline depth (Z15) provides insights in system dynamics

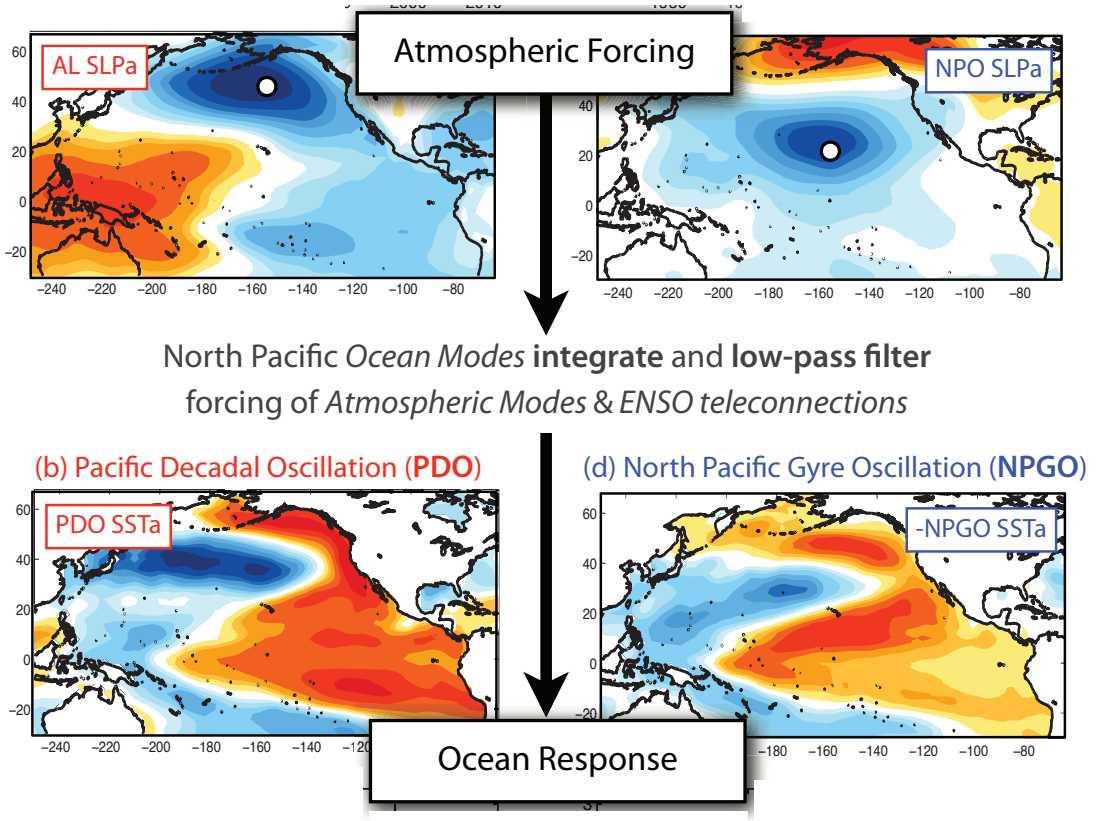




Capotondi 2013

Teleconnections

The two leading modes of atmospheric SLP variability (Aleutian Low, North Pacific Oscillation) force the two leading modes of SST and SSH variability (PDO, NPGO)



Di Lorenzo et al. 2013

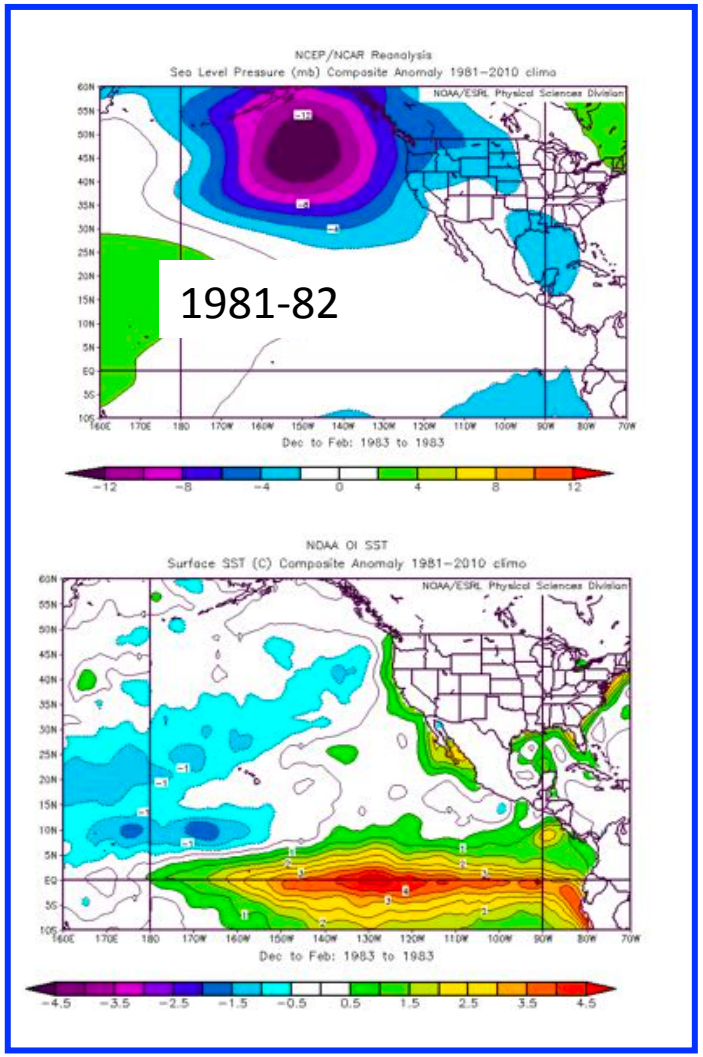
Teleconnections

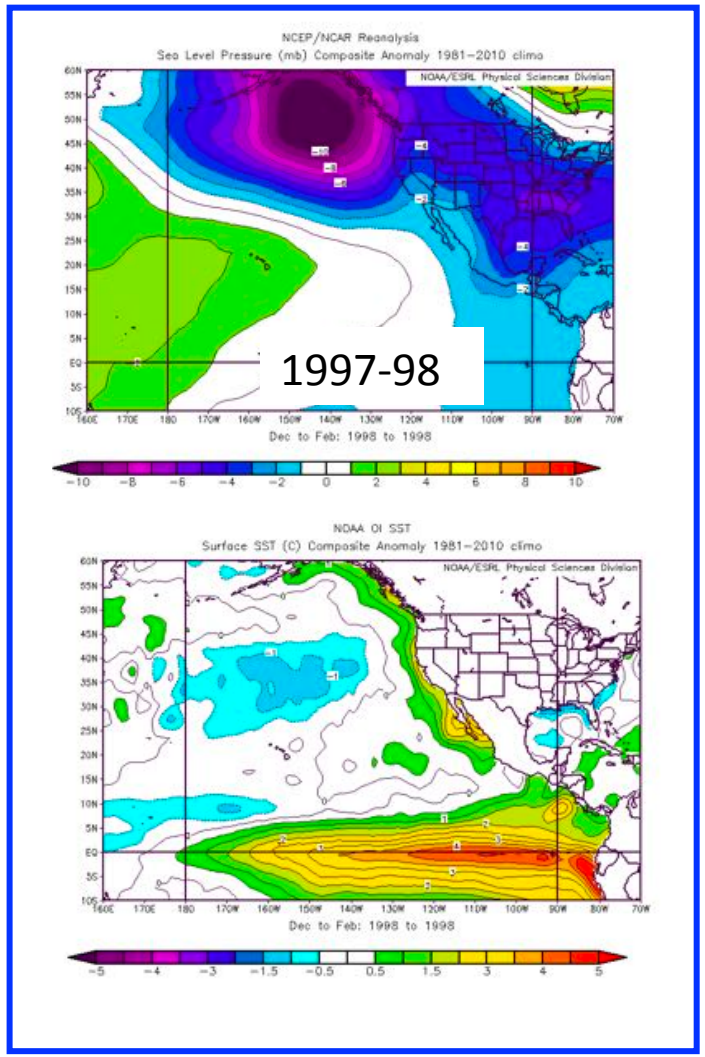
AL and NPO are energized by EP and CP ENSO events at interannual and decadal timescales

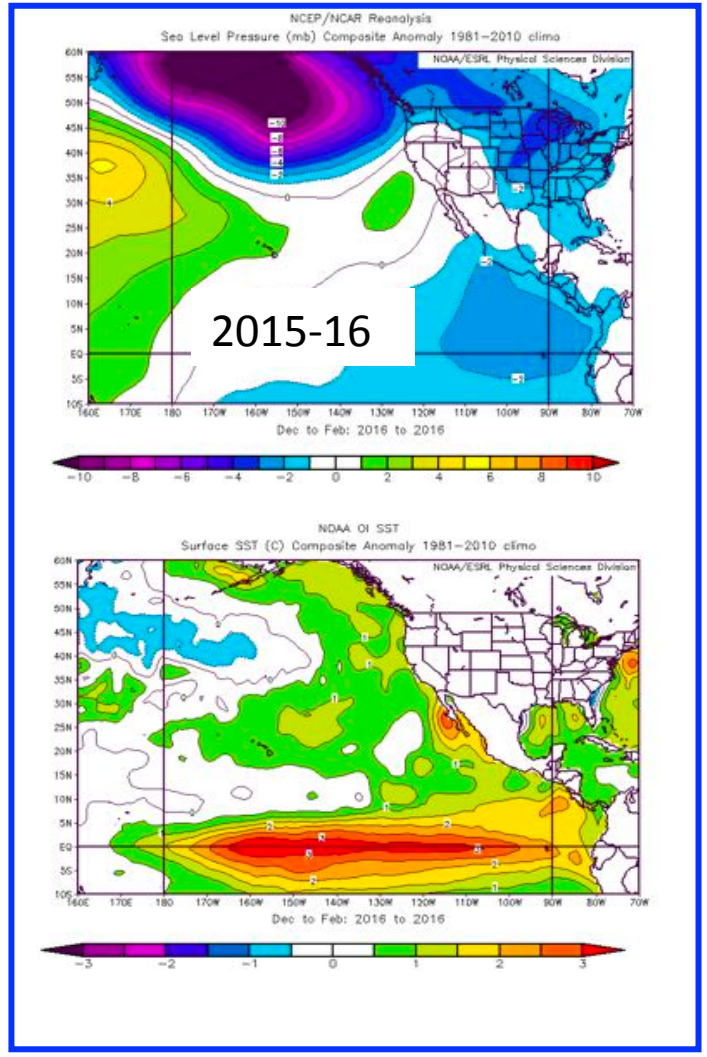
Di Lorenzo et al. 2013

However…. there is a large inter-event diversity in SLP signatures of tropical SSTa

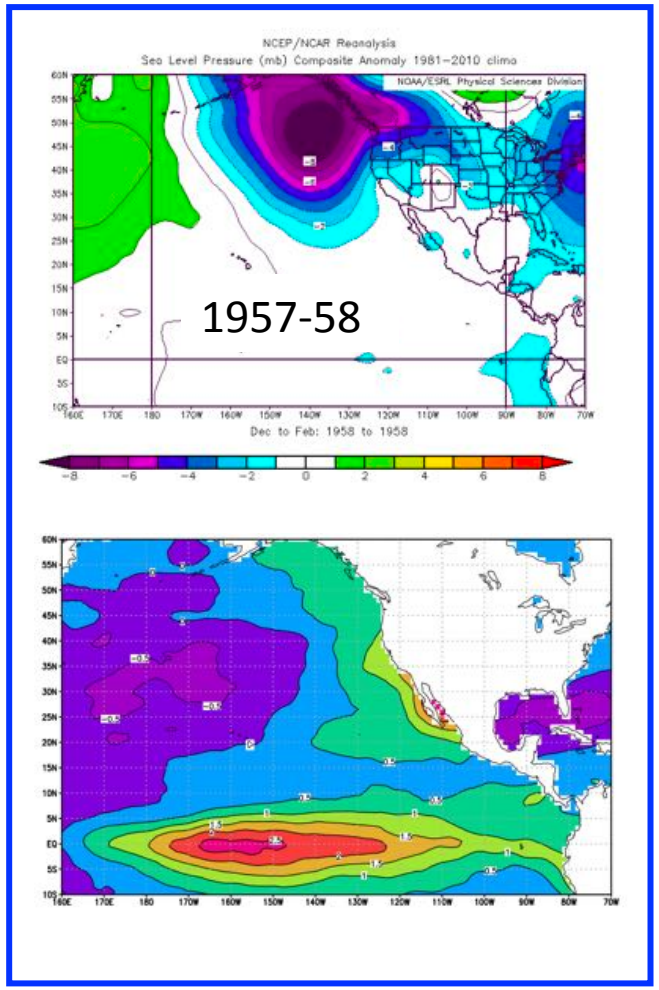
DJF averages

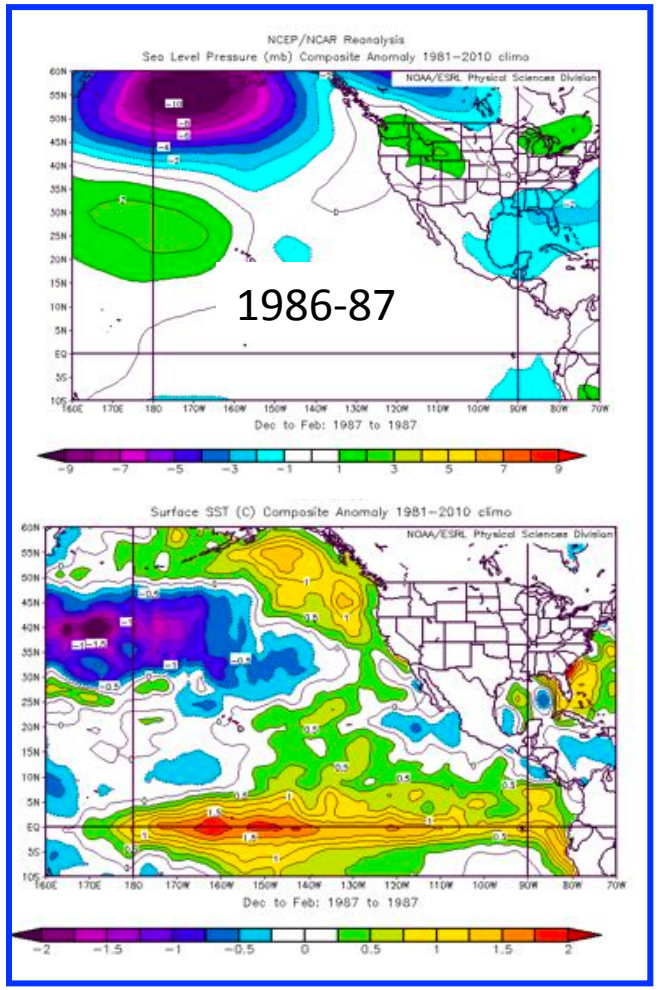


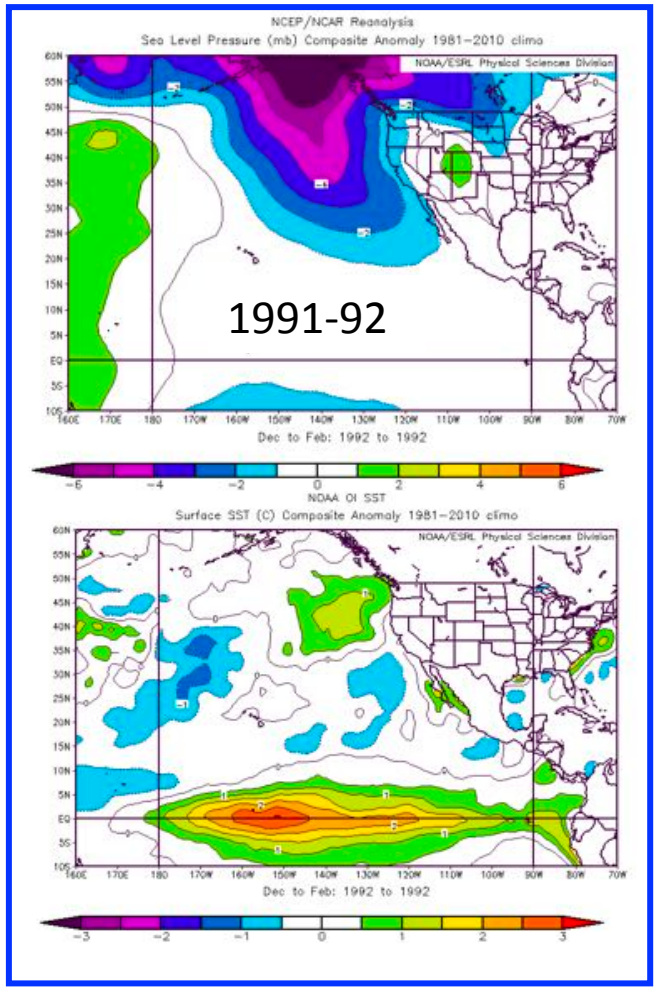




CP-like events







Impacts of individual ENSO events through atmospheric bridge(s) may differ not only because of differences in the detail of the SST anomalies, but also due to unpredictable atmospheric noise

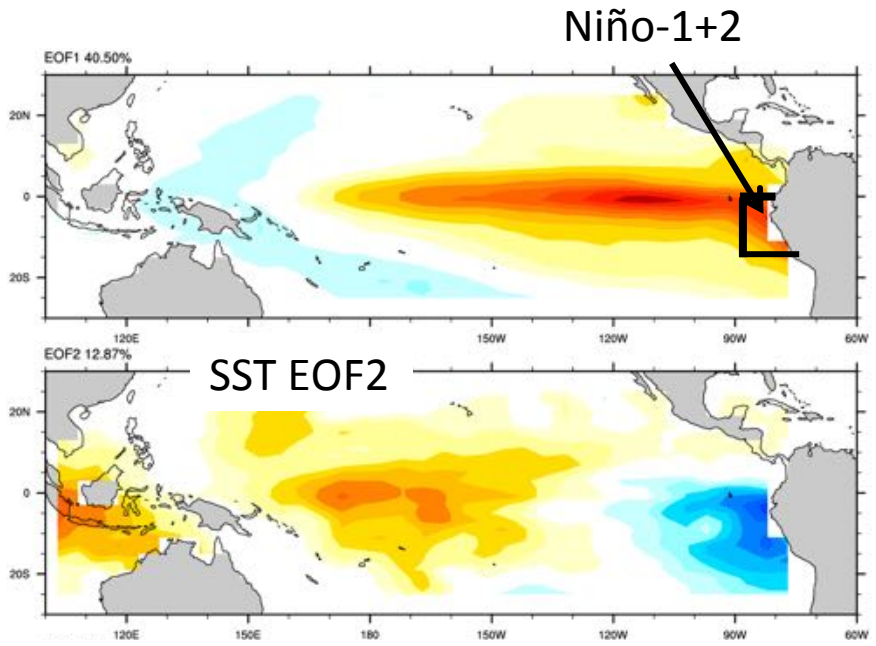
Can we anticipate EP and CP events?
How to determine "**Optimal Precursors**"?

Linear Inverse Modeling

$\boldsymbol{x}(t) = \mathbf{G}(t)\ \boldsymbol{x}(0)$

Target approach

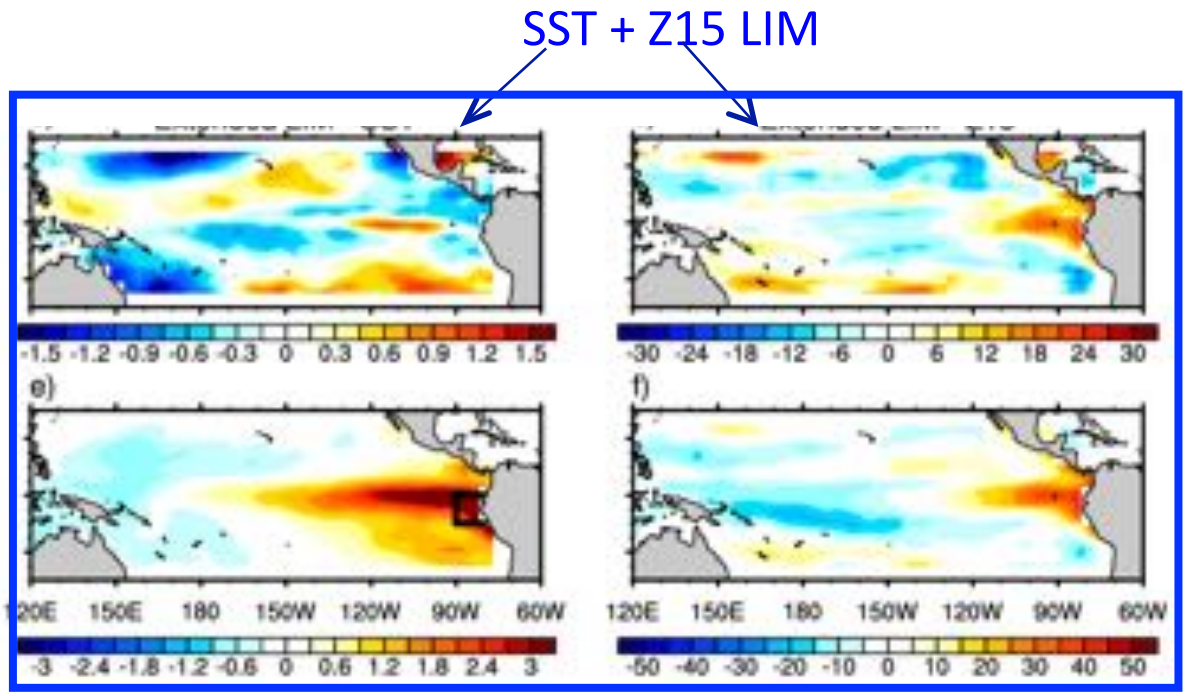
$y(t) = \mathbf{H(t)}\ \mathbf{x}(0)$



Optimal initial structure ψ_{1i} is determined as the leading eigenvector of $\mathbf{H}^T\mathbf{H}$

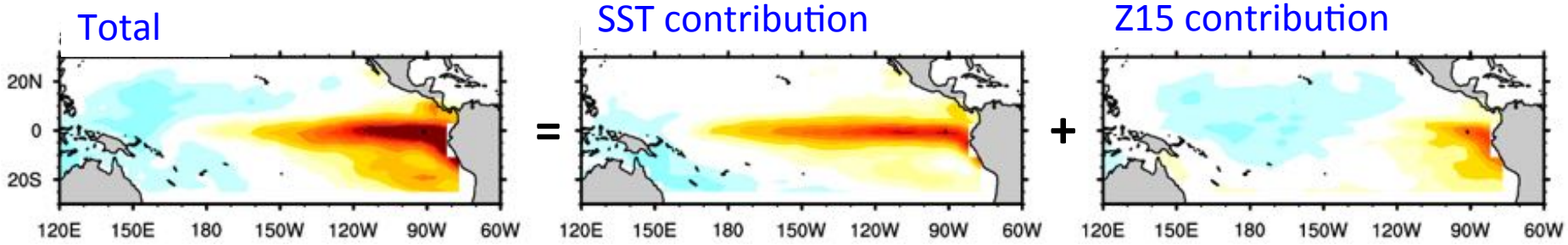
Capotondi and Sardeshmukh 2015

What are the optimal precursors patterns for maximizing SSTs in the NINO-1+2 region?



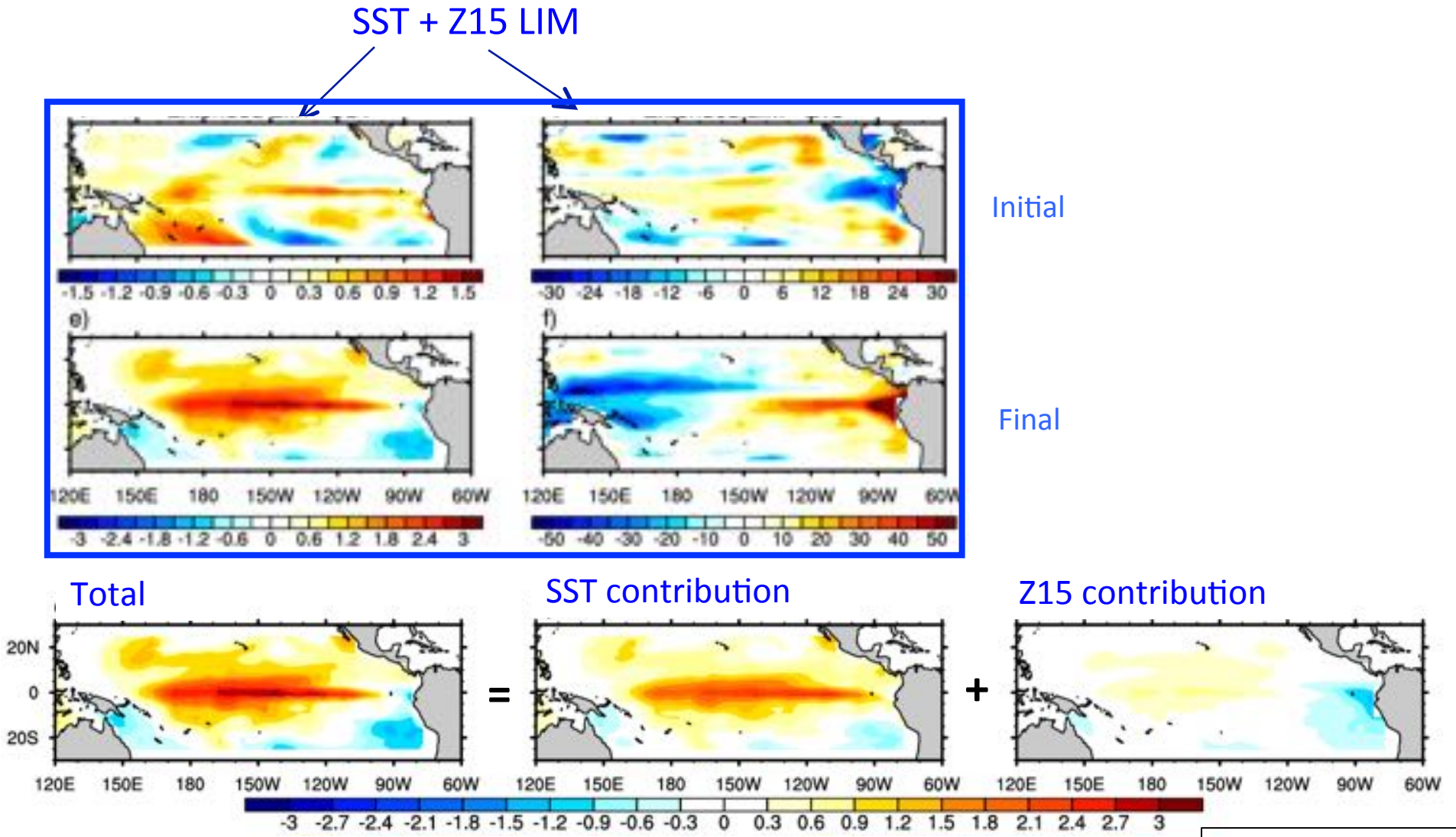
Initial

Final



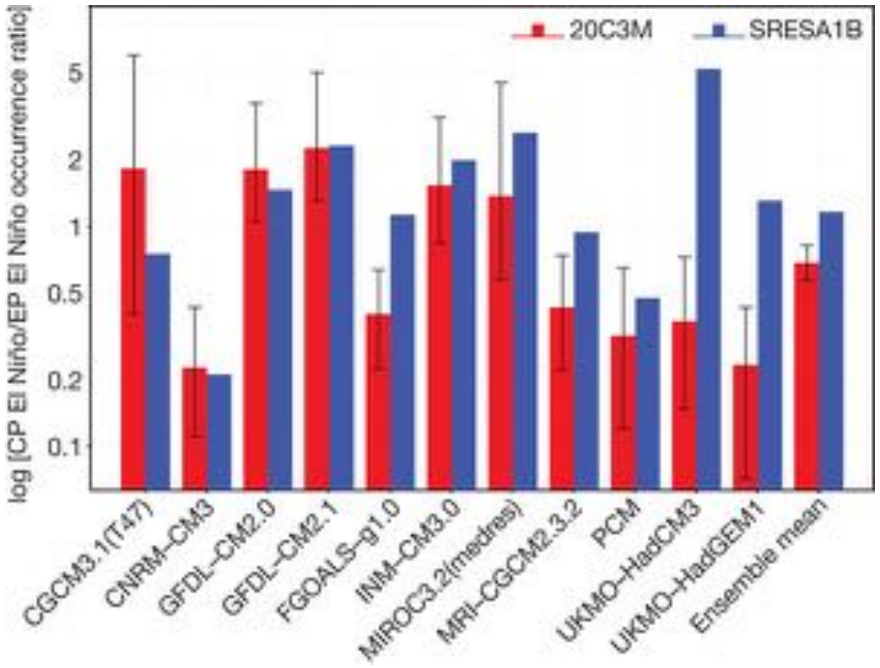
Capotondi and Sardeshmukh 2015

What are the optimal precursors patterns for maximizing the amplitude of **CP case** ?



Capotondi and Sardeshmukh 2015

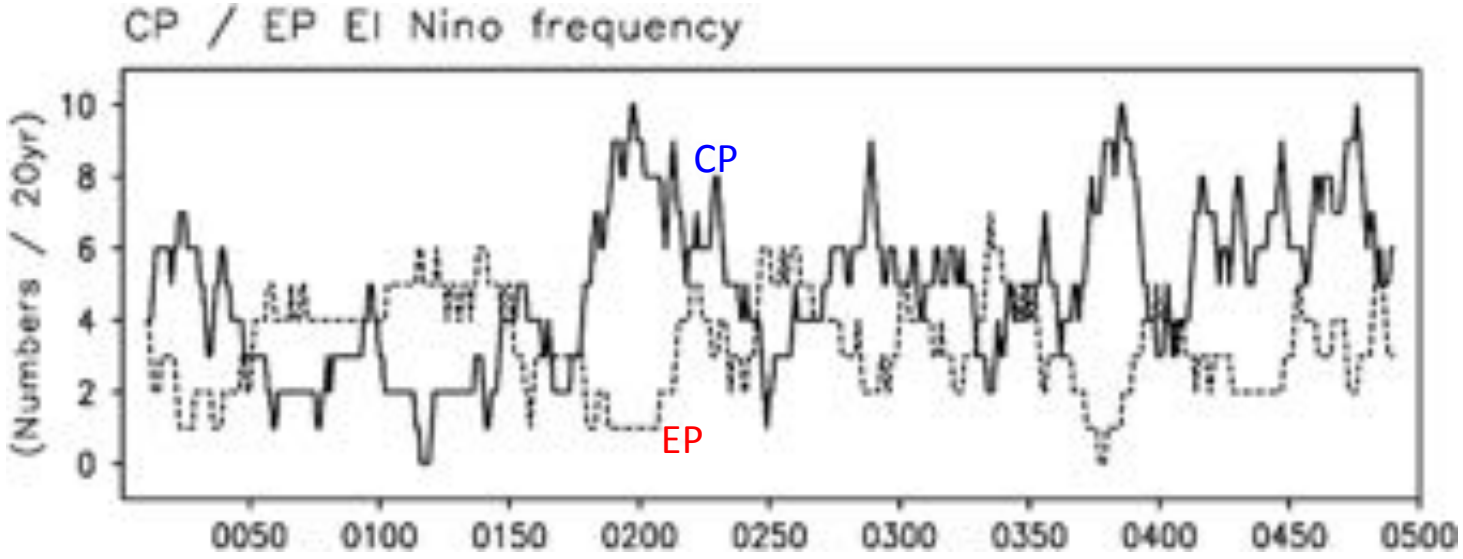
Will CP events increase with Global Warming?



Log(CP/EP ratio) for 20thC and Climate Change CMIP3 simulations

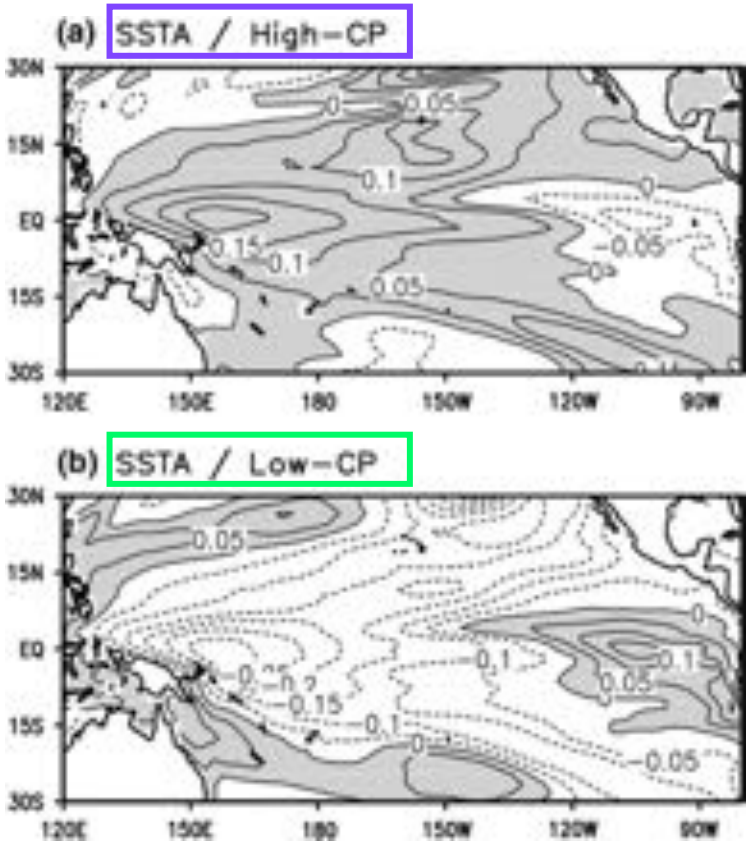
Yeh et al. 2009

Control model simulations (GFDL_CM2.1) show that the frequency of CP events vary decadally and is correlated with the zonal SST gradient



20-year sliding frequency of CP and EP events
Frequency varies decadally

Choi et al. 2011



Composite SST for high-CP and low-CP

Conclusions

- “No two El Nino events are quite alike”
- CP events are weaker than EP events, but can be as influential
- EPs energize the AL/PDO, CPs energize NPO/NPGO, but large inter-event variations
- Optimal precursors of EP and CP events include both surface (SST) and subsurface (thermocline depth) components
- CP/EP ratio may vary decadally dependent upon the background conditions