ENSO diversity and impacts

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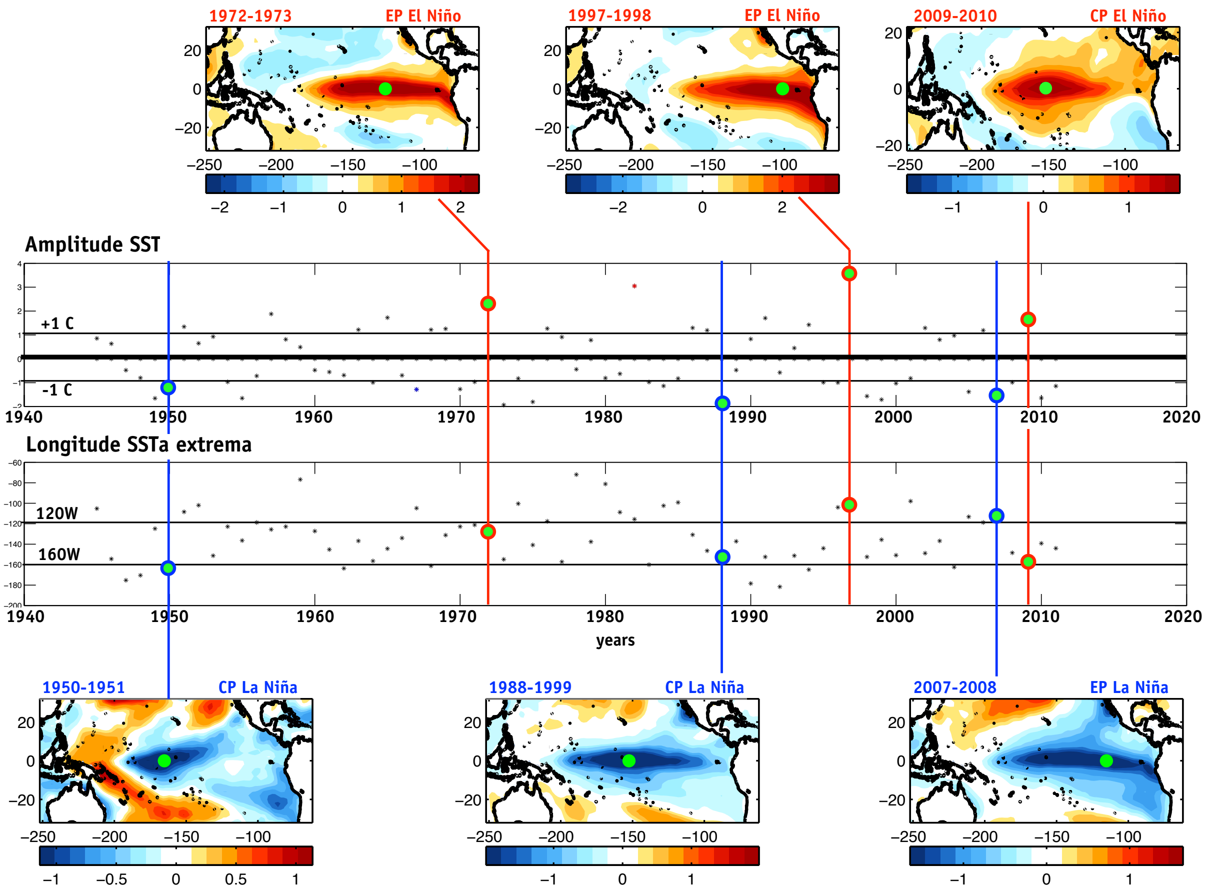
and

ENSO Diversity Working Group

A glimpse at ENSO Diversity

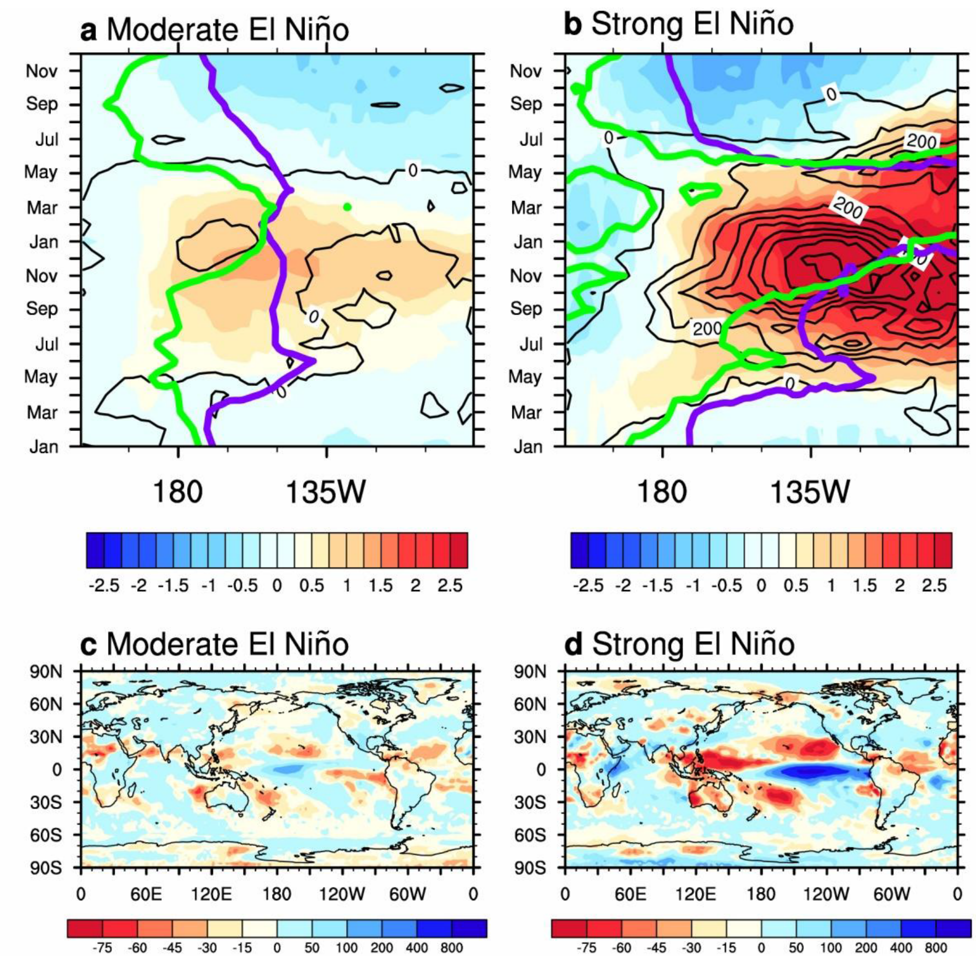


Extreme positive and negative events in NDJ of each year from 1940

Figure from Di Lorenzo

Local Impacts: Moderate and Strong El Niños

(Cai et al., Nat. Geo. 2014)



Composites of moderate and strong events: SST (shading), rainfall (contours), 28°C isotherm (purple line), 5 mm/day isopleth (green line)

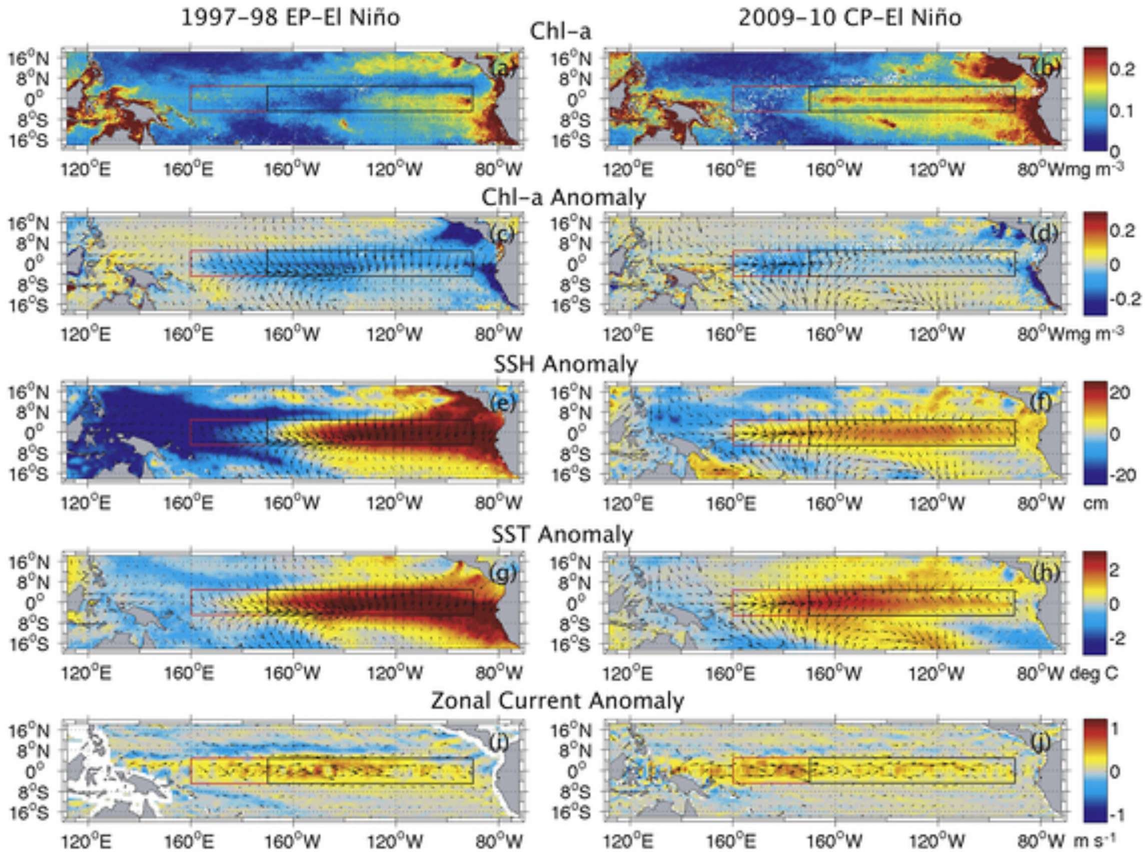
Strong events: DJF Niño3 rainfall > 5mm/day

Moderate events: El Niño events that are not strong

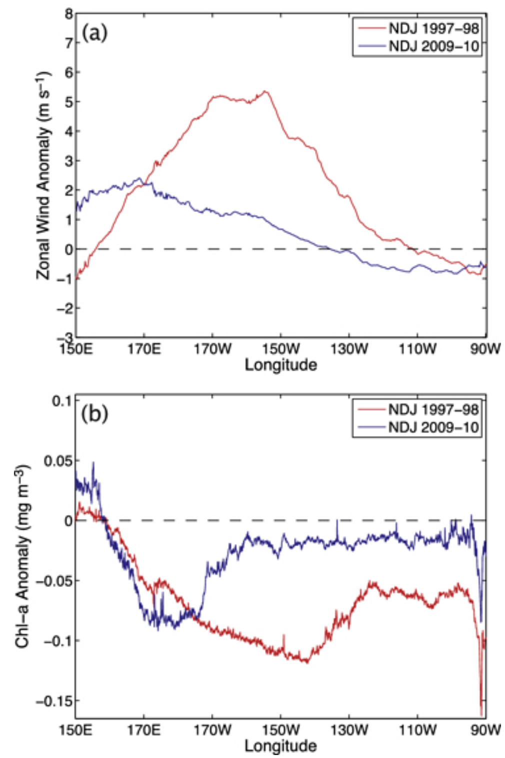
Composite spatial patterns of DJF rainfall anomalies, in percentage of climatology

Biological impacts along the equator

NDJ Fields, Monthly Climatologies over 1997-2010



Zonal wind anomaly
5°S-5°N

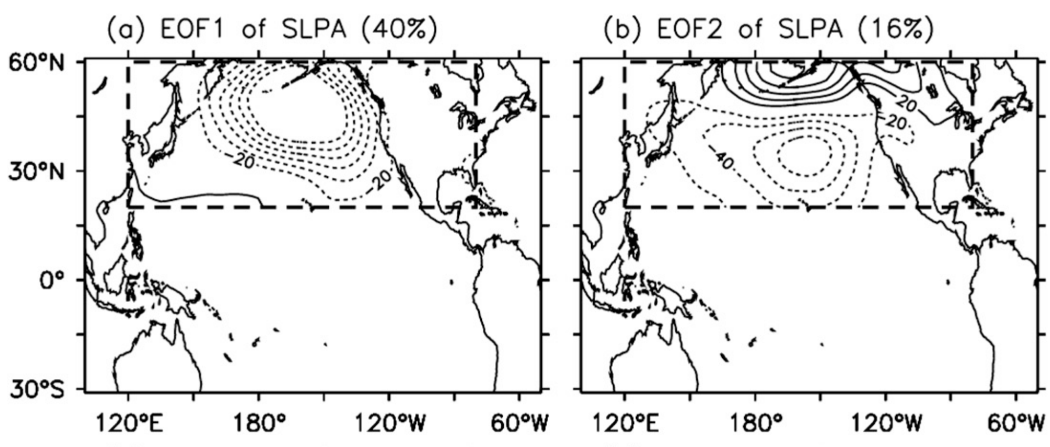


Chl-a anomaly

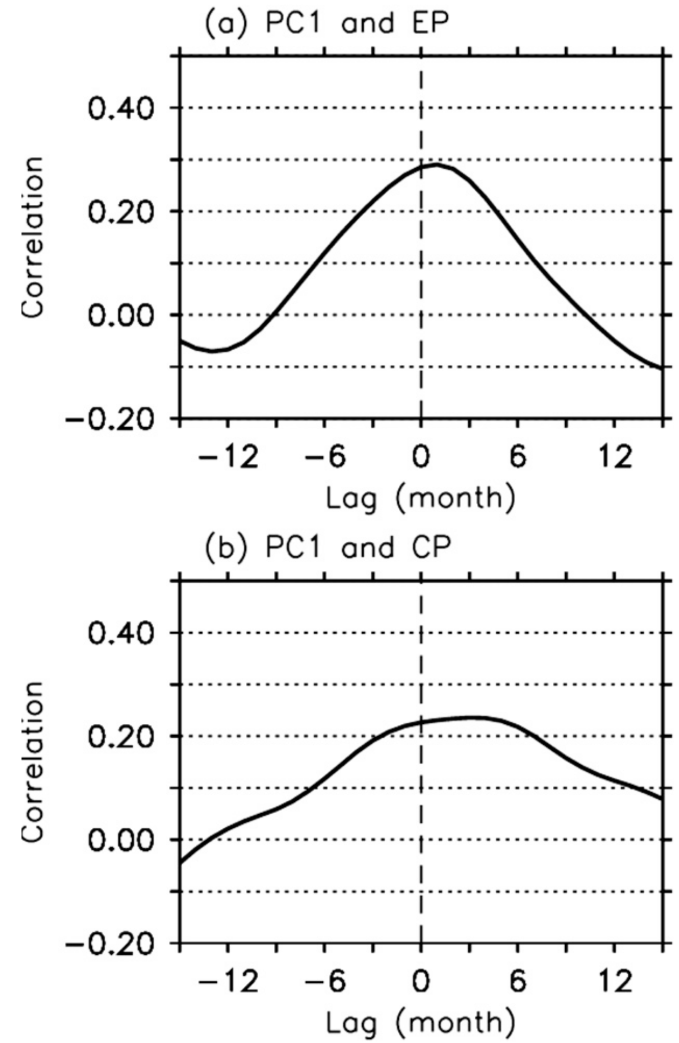
Gierach et al. 2012

ENSO influence on extra-tropical modes of variability

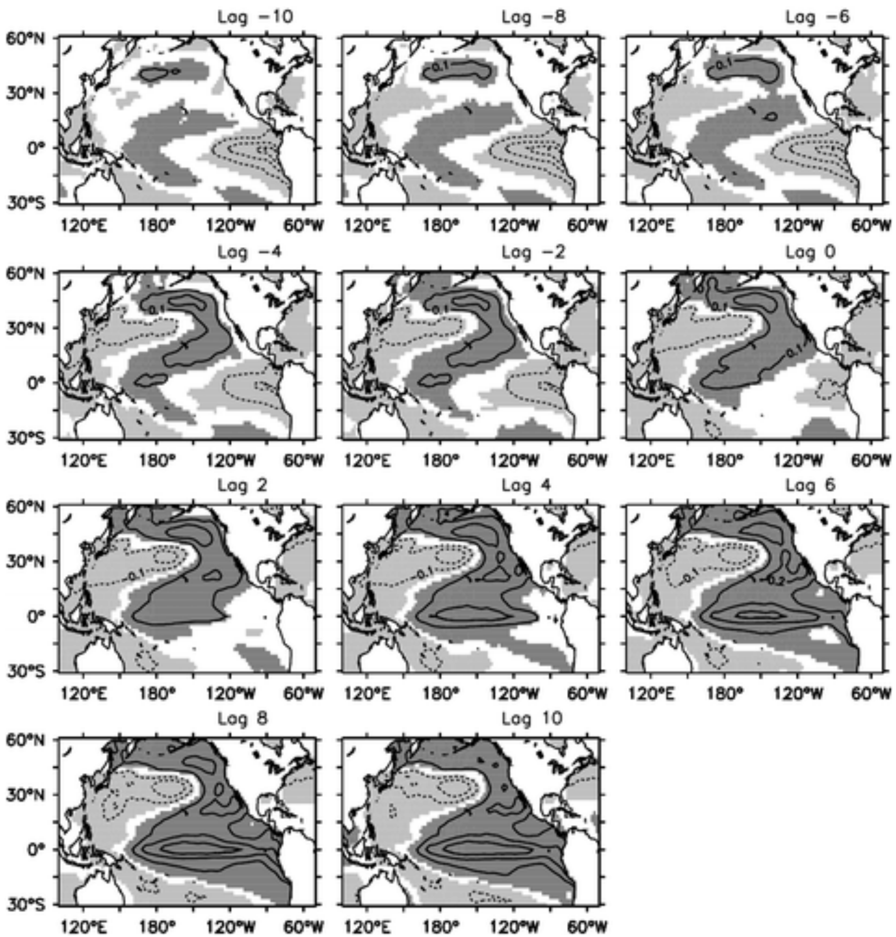
Leading EOFs of North Pacific SLPA variability



Yu and Kim 2012



NPO as "Precursor" for Central Pacific events



Lag-regression of SST upon the North Pacific Oscillation (NPO) index, second EOF of winter SLP over the North Pacific

Yu and Kim 2011

Di Lorenzo et al. (2010) argue that CP warming can result in SLP anomalies responsible for the excitation of the NPGO, the second EOF of North Pacific SSH at decadal timescales

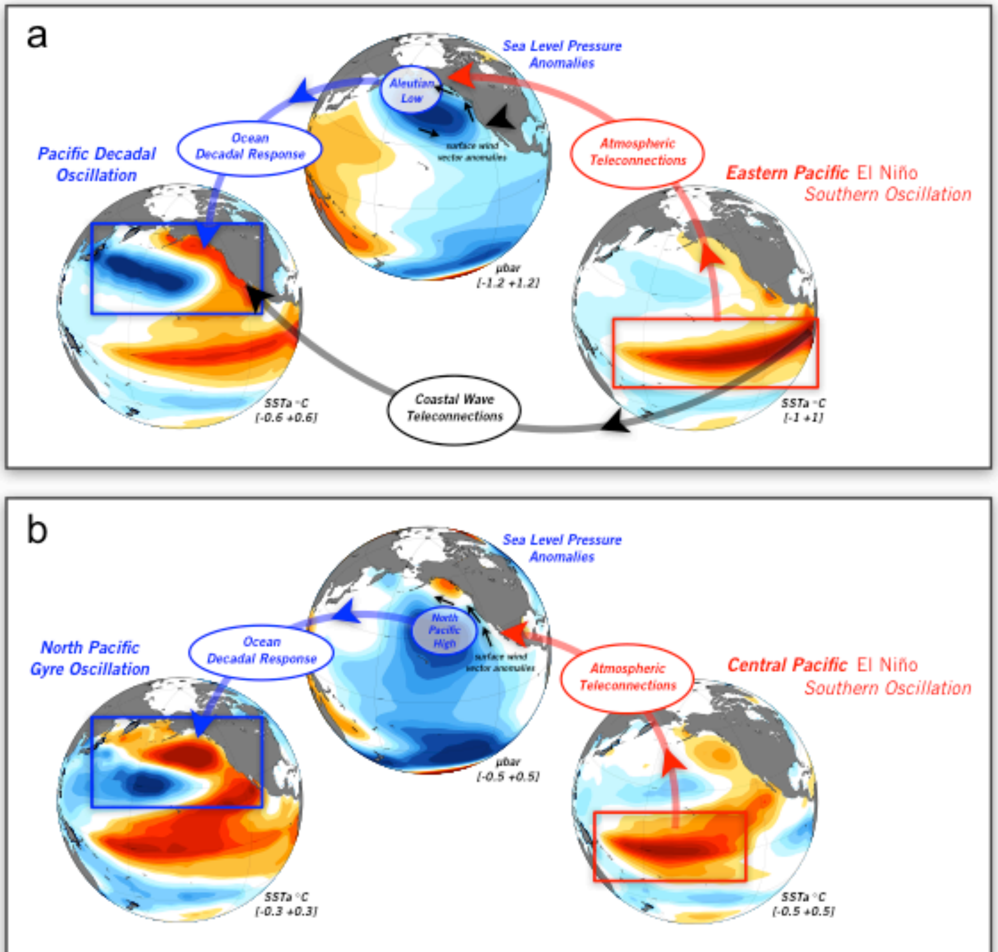
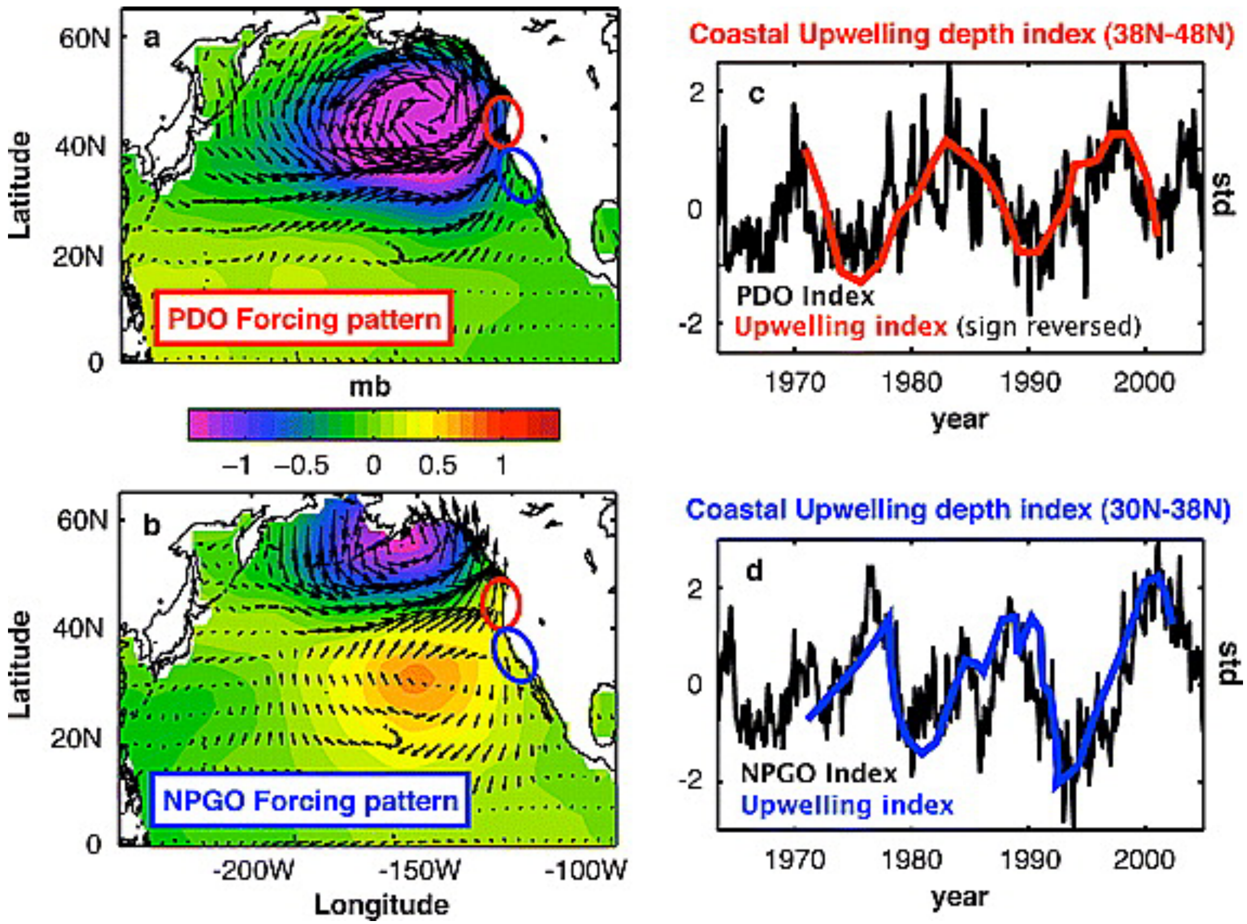


Figure by Manu Di Lorenzo

Modes of North Pacific atmospheric variability and ecosystem dynamics

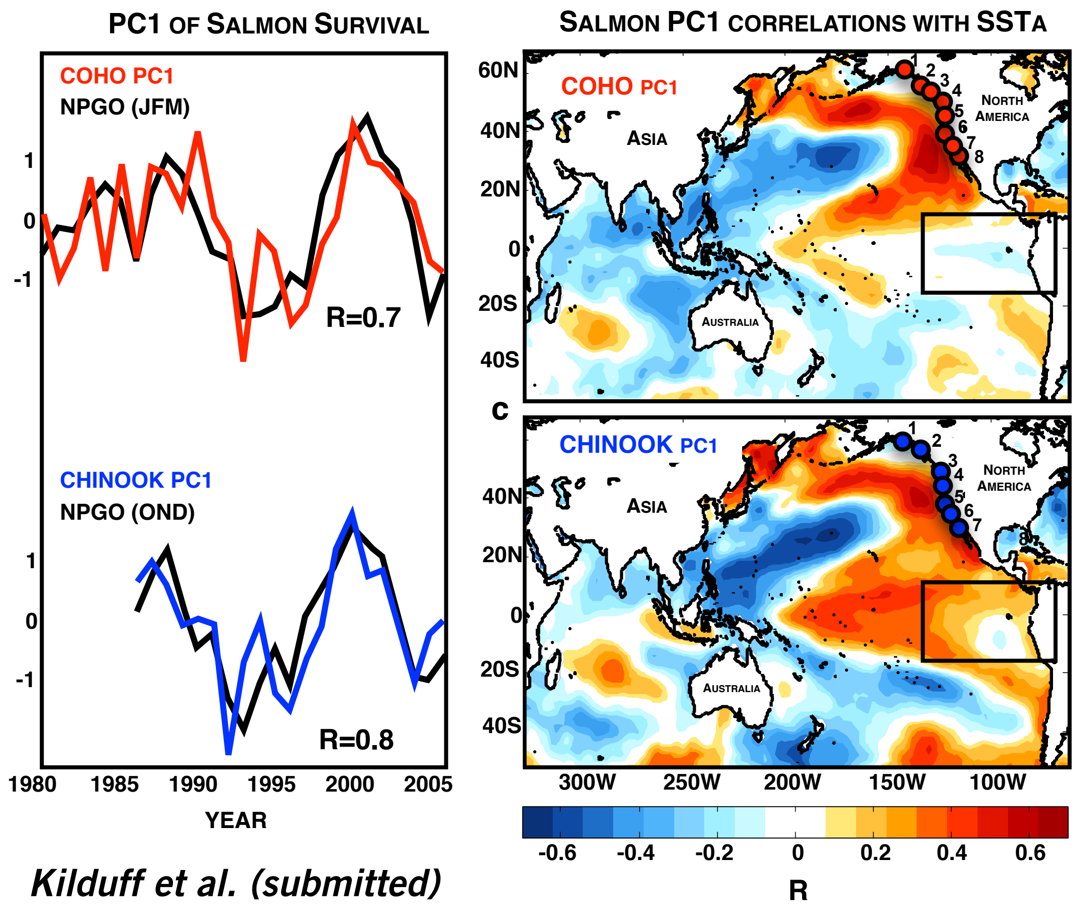
Regression of PDO and NPGO indices upon wind stress and SLPA



Di Lorenzo et al. 2008

Salmon and CP-ENSO/NPGO

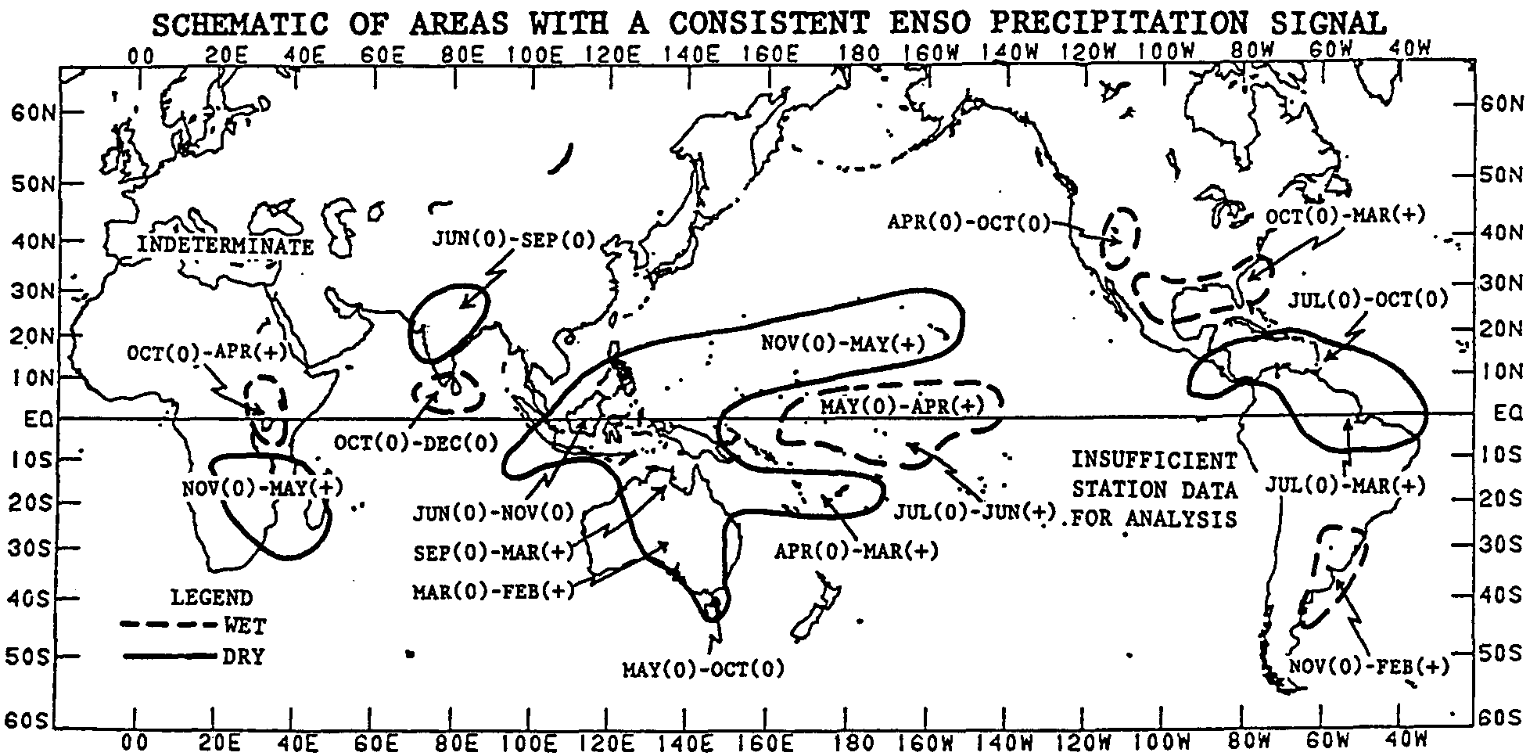
Salmon survival rates linked to emerging influence of CP-ENSO/NPGO



Kilduff et al. (submitted)

ENSO influence on precipitation

From station data dating as far back as 1875: 25 ENSO warm events: 24 months composites + harmonic analysis



Ropelewski and Halpert 1987

ENSO influence on surface temperatures

Low SO –Warm

High SO – Cold

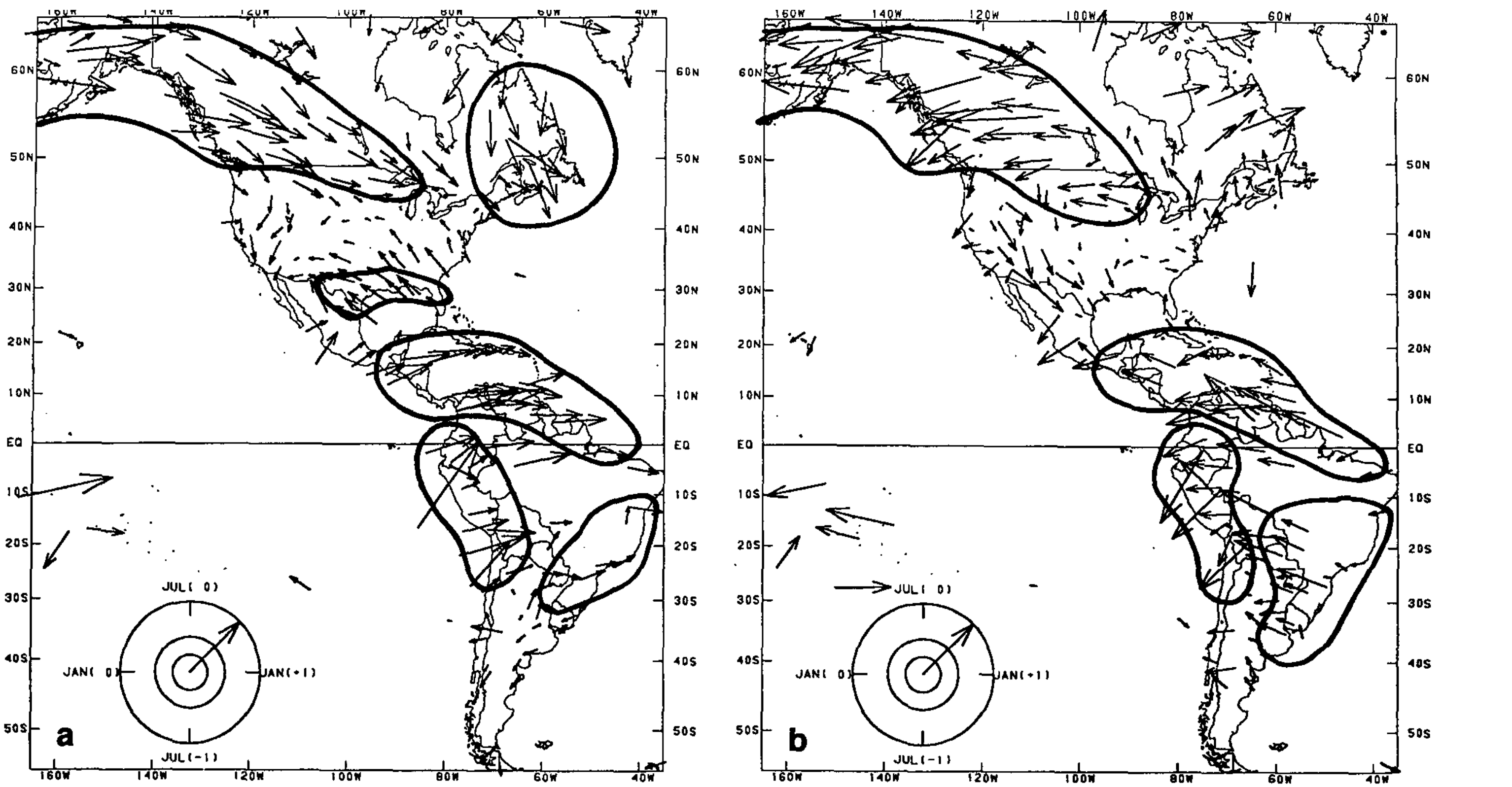


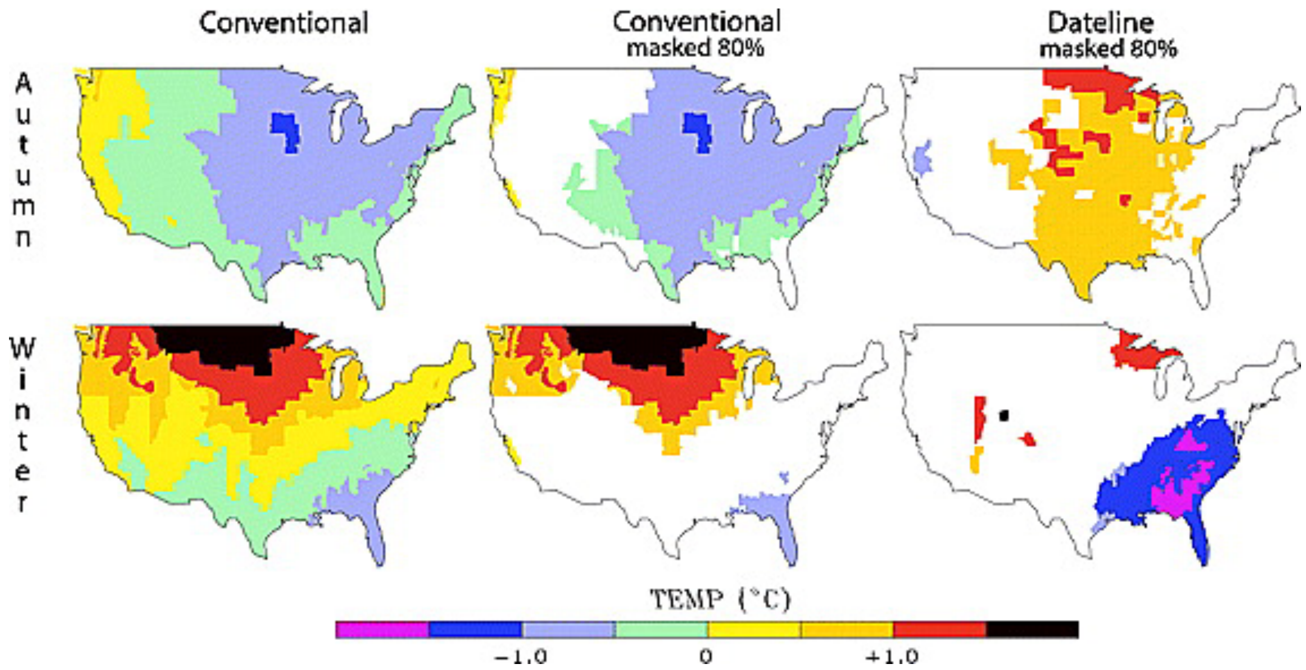
FIG. 6. Subjectively determined "core regions" of consistent (a) low or (b) high SO–temperature relationships: North and South America.

Halpert and Ropelewski 1992

Temperature response to different types of El Niños (conventional, dateline)

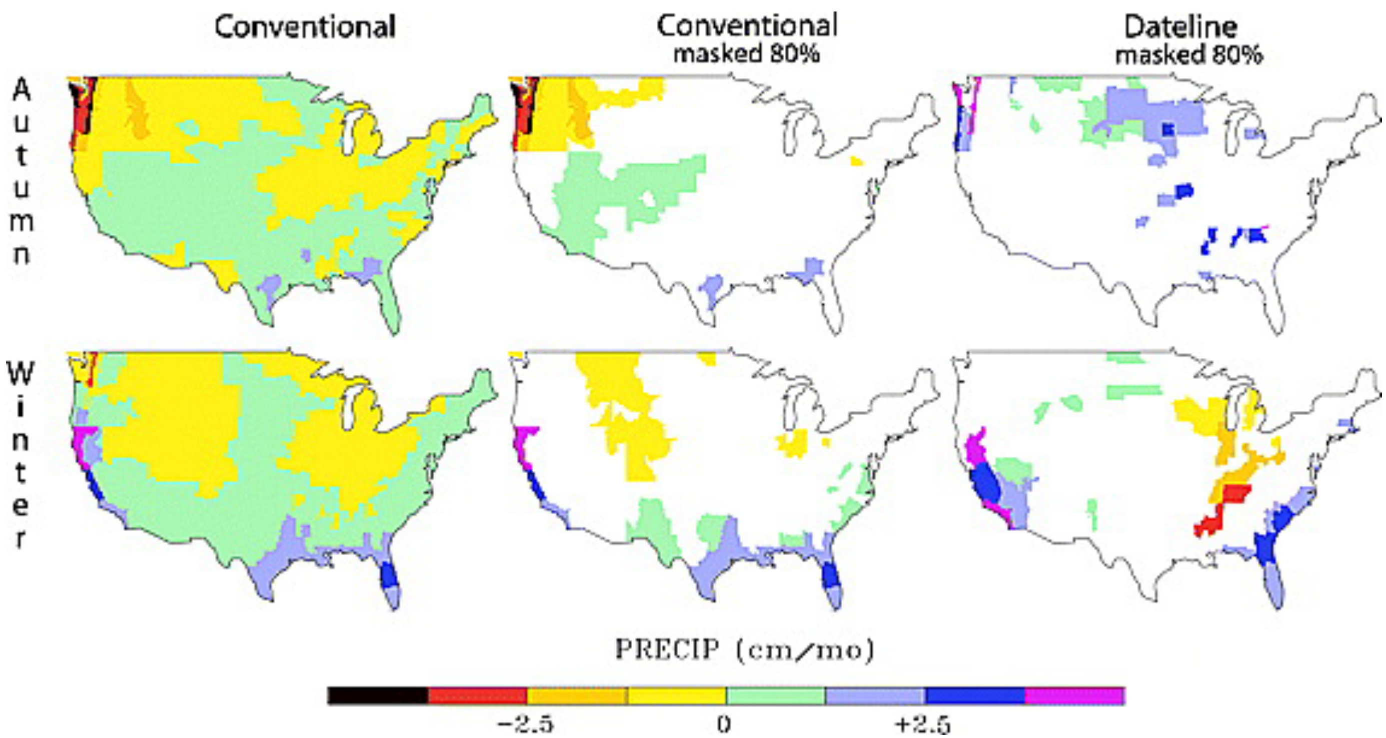
Events used:

Definition of events types:



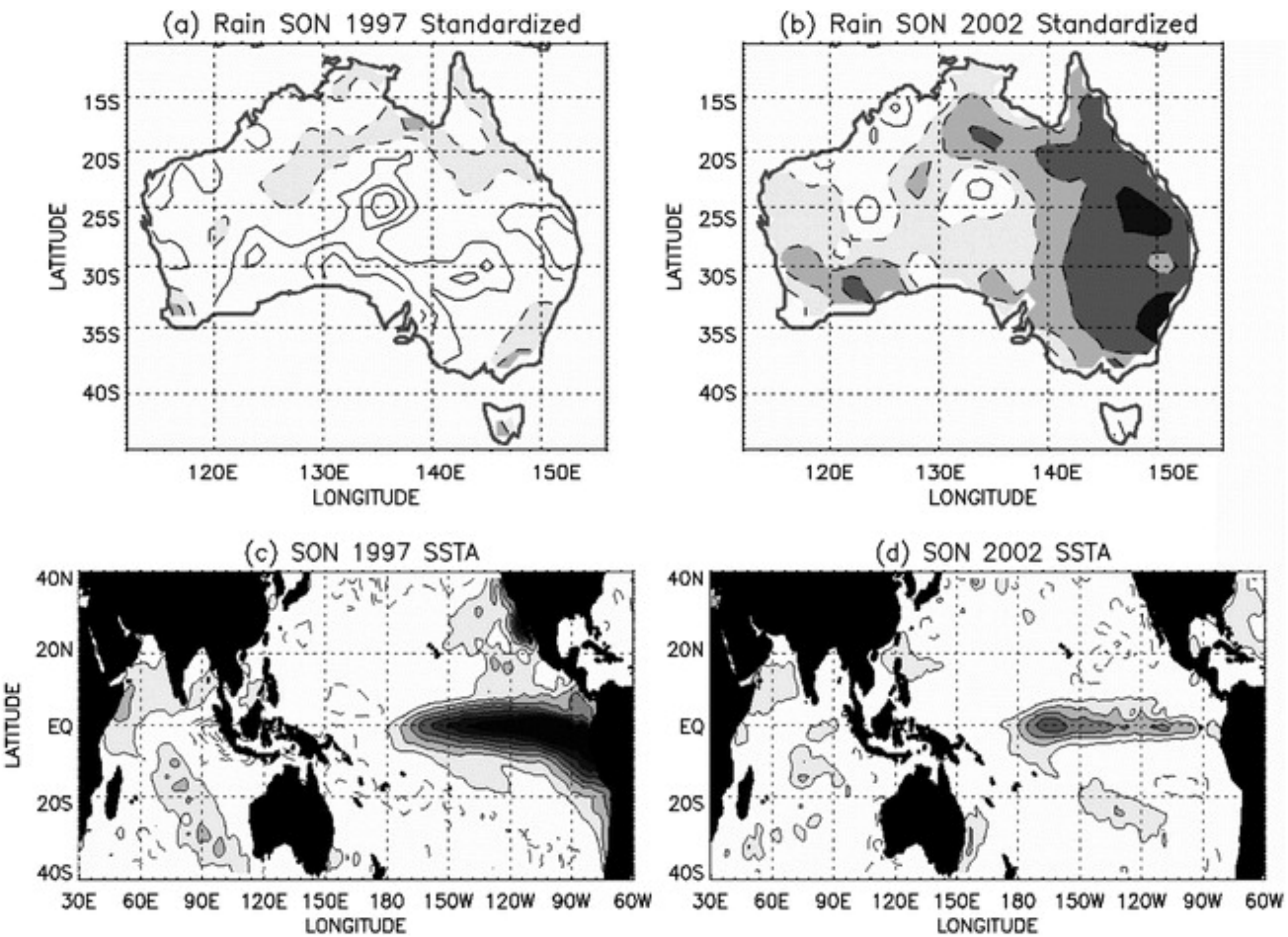
Larkin and Harrison 2005

Precipitation response to different types of El Niños (conventional, dateline)

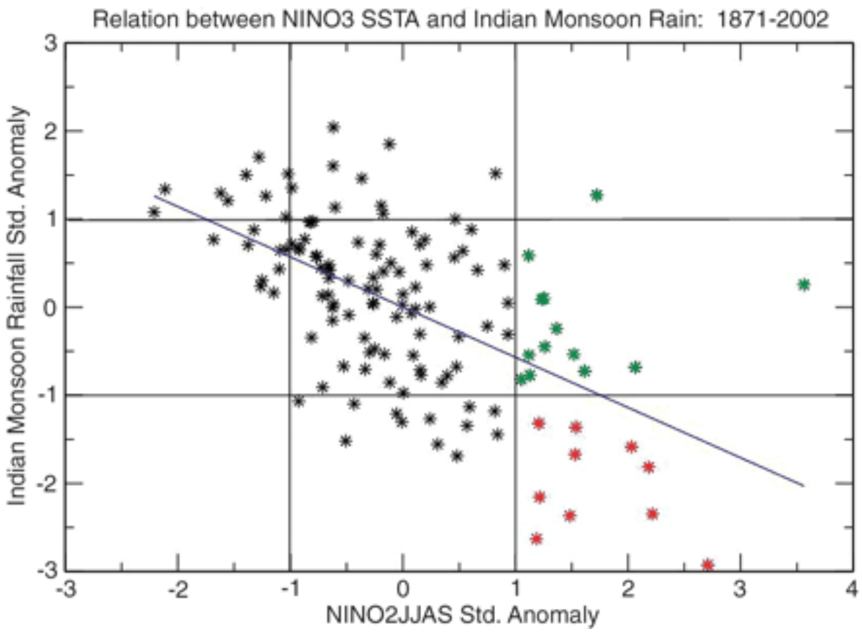


Larkin and Harrison 2005

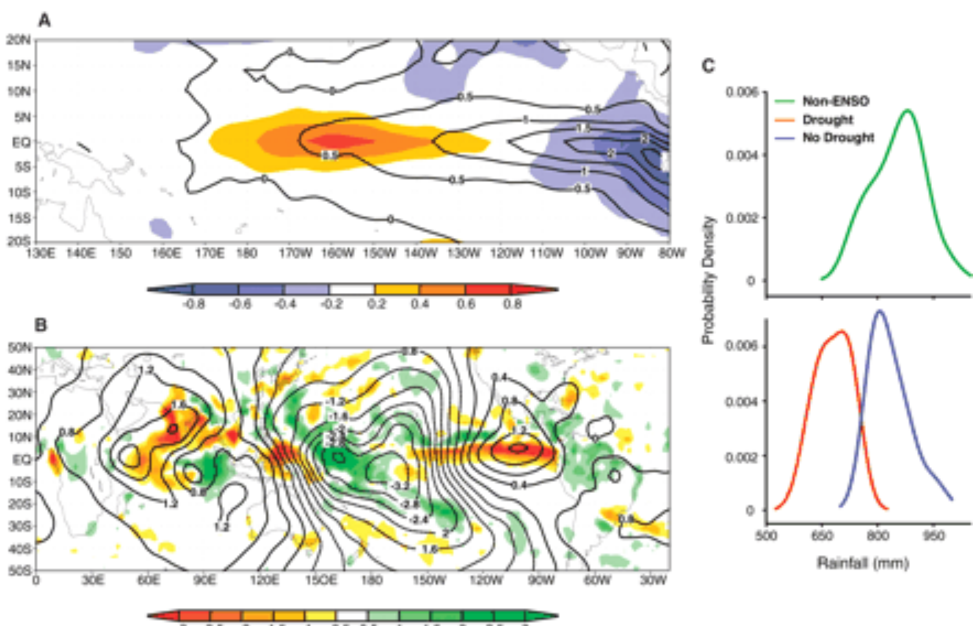
In Australia, differences in spatial patterns may have large consequences on rainfall



Wang and Hendon 2007

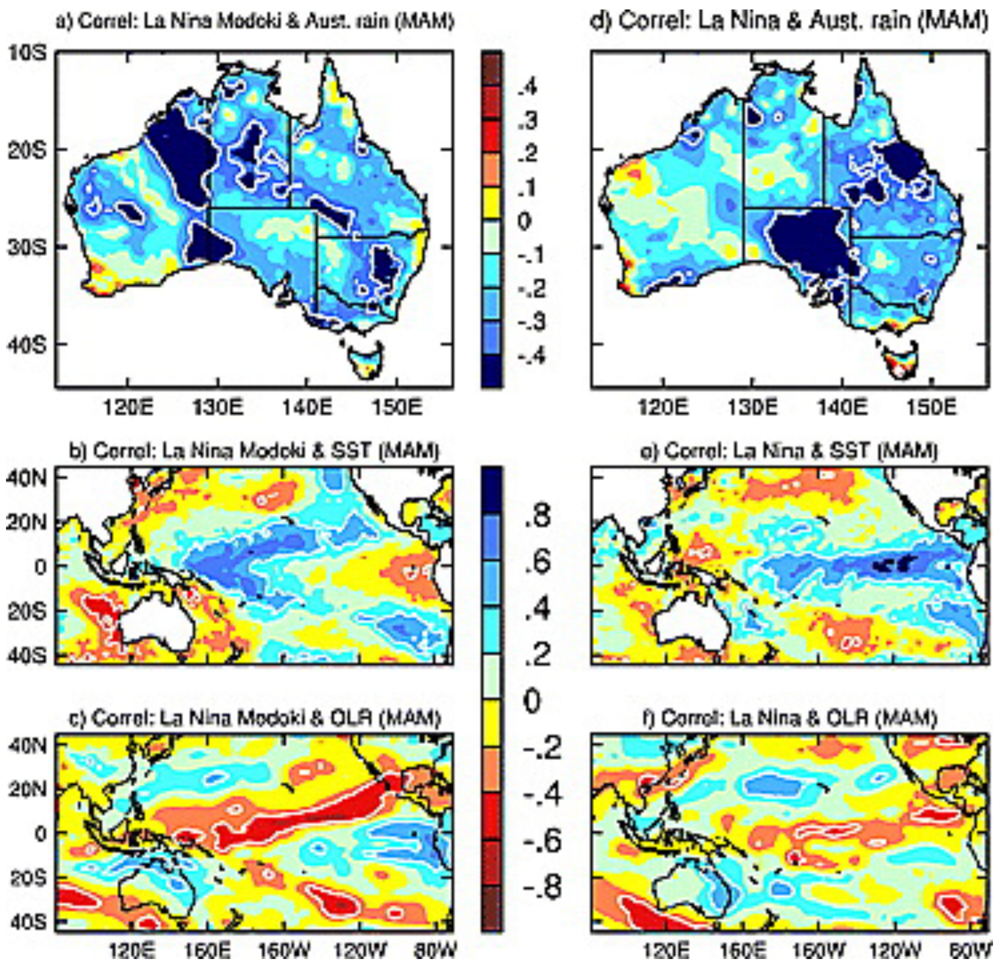


In India, severe droughts associated to the failure of the Summer Monsoons has been related to warming in the Central Pacific (Kumar et al. 2006)



Influence of different types of La Niña upon Precipitation over Australia

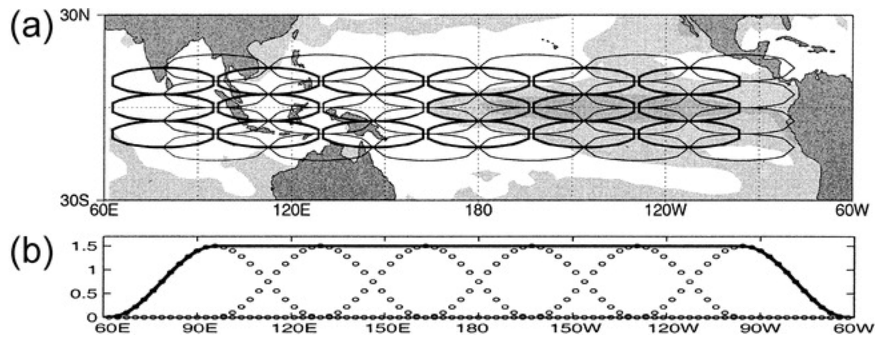
La Niña Modoki | La Niña



Cai and Cowan, 2009

Correlation based on negative phase of El Niño Modoki index

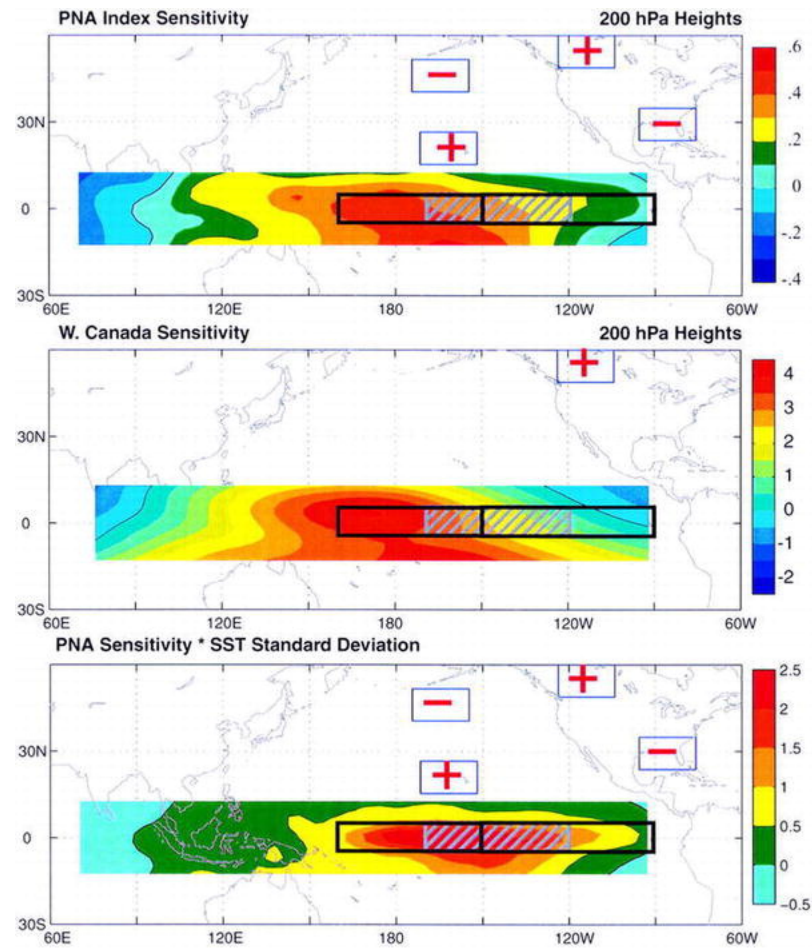
Which areas of the tropical Pacific matter for remote impacts?



1. ENSO-related variability is largest in the **central and eastern tropical Pacific**

2. Global climate has the largest sensitivity to the **central and western tropical Pacific** and Indian Ocean

3. Therefore, "ENSO diversity" and future changes in ENSO-related SST variations will have relatively minor global impacts unless those changes are large in the **central and western tropical Pacific**



Barsugli and Sardeshmukh 2002

Challenges

The main challenge is the short data record leading to a relatively small number of cases to analyze.

Limited understanding of processes involved

Opportunities

Try to extend data record, use proxy

Perform numerical experiments to test ideas

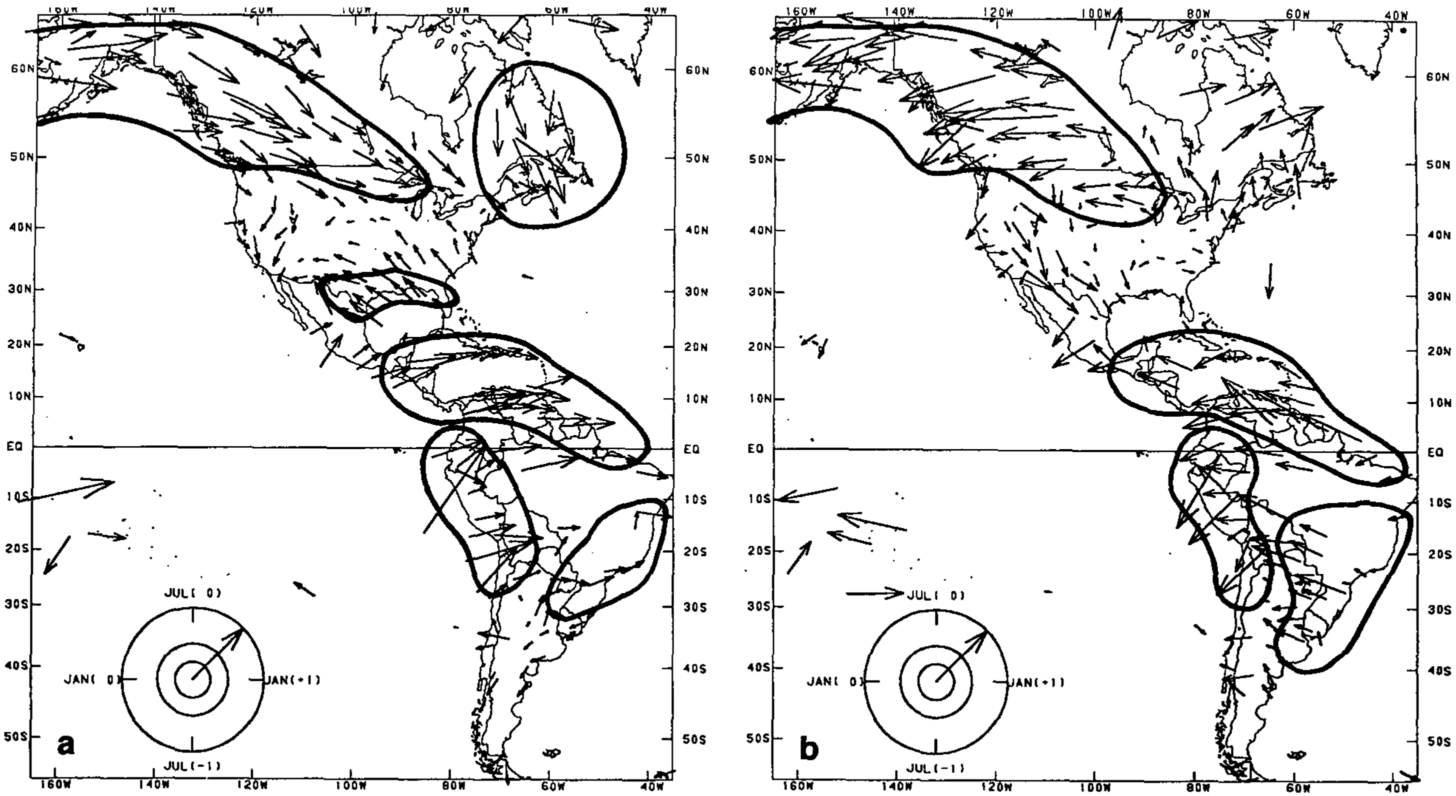
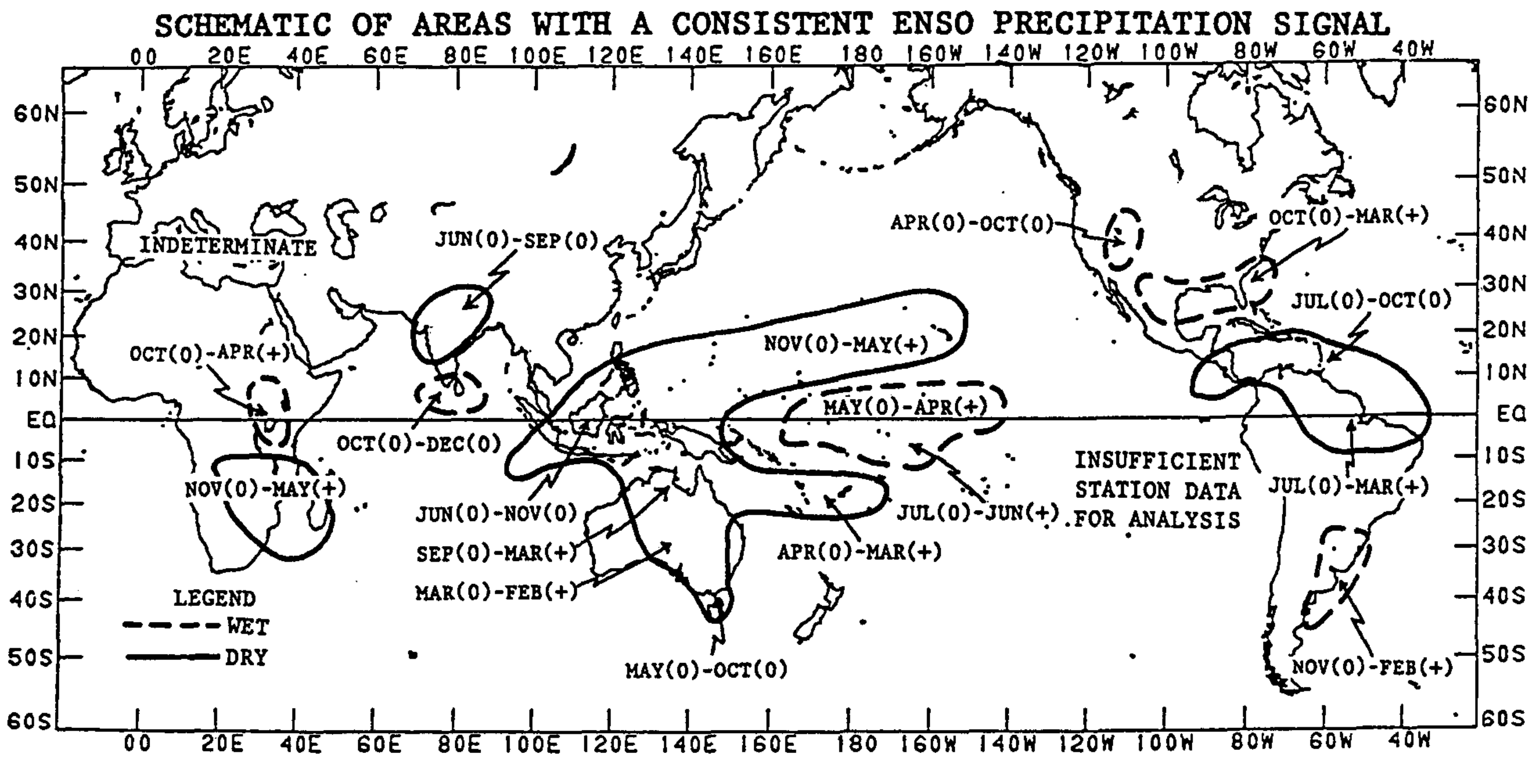
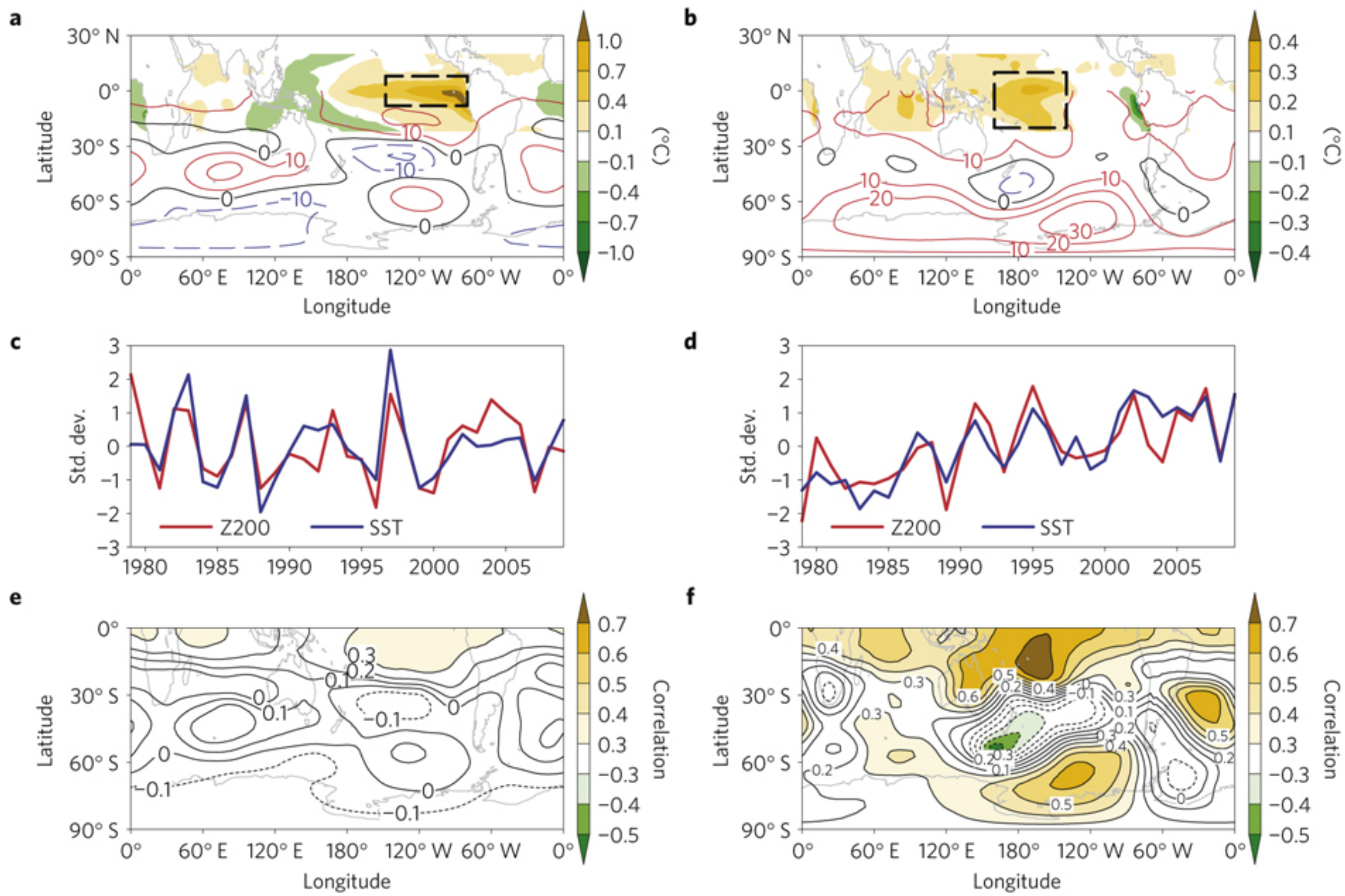


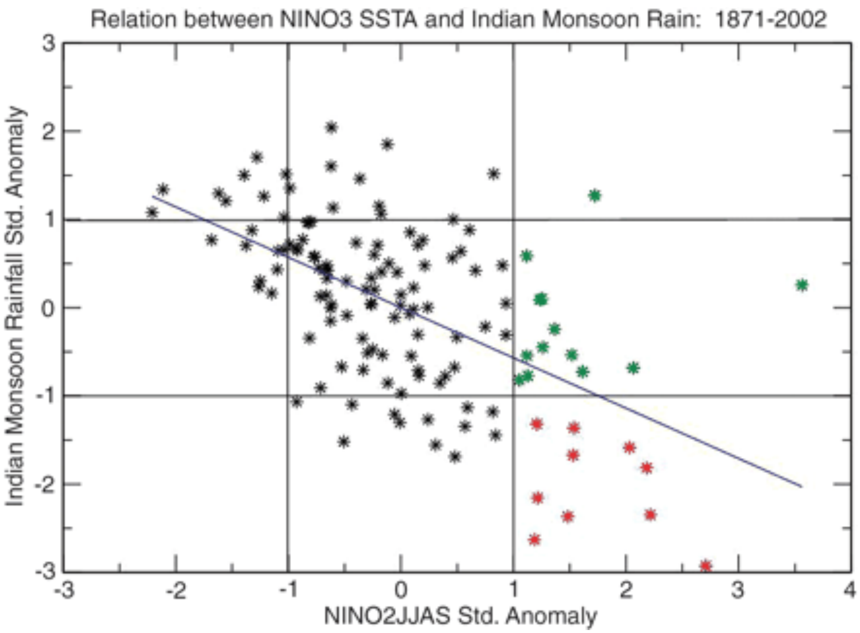
FIG. 6. Subjectively determined "core regions" of consistent (a) low or (b) high SO–temperature relationships: North and South America.

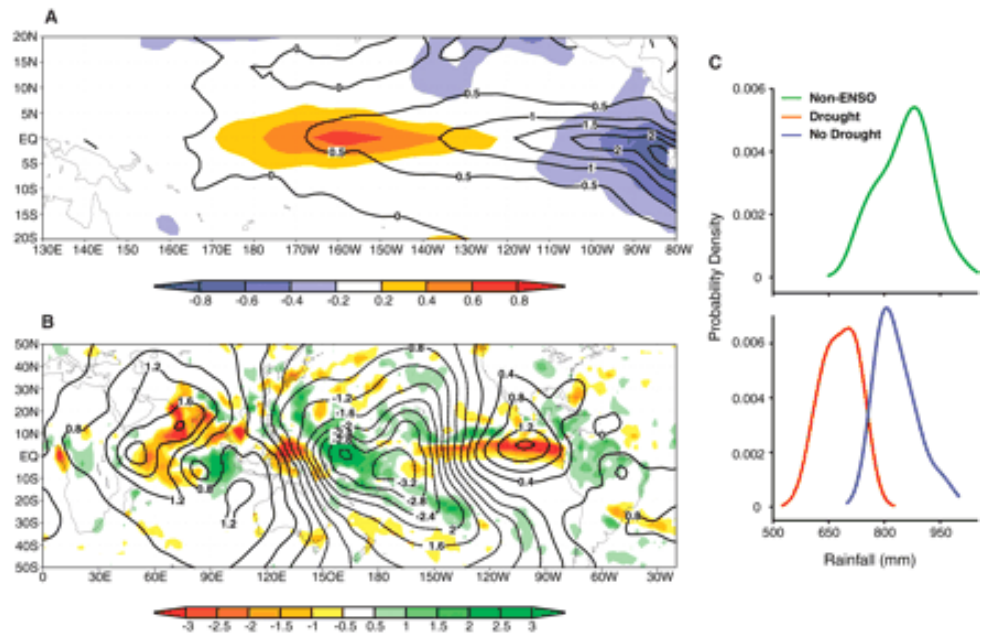


SCHEMATIC OF AREAS WITH A CONSISTENT ENSO PRECIPITATION SIGNAL
INDETERMINATE
JUN(0)-SEP(0)
APR(0)-OCT(0)
OCT(0)-MAR(+)
JUL(0)-OCT(0)
OCT(0)-APR(+)
NOV(0)-MAY(+)
MAY(0)-APR(+)
OCT(0)-DEC(0)
NOV(0)-MAY(+)
JUN(0)-NOV(0)
SEP(0)-MAR(+)
MAR(0)-FEB(+)
JUL(0)-JUN(+)
APR(0)-MAR(+)
INSUFFICIENT STATION DATA FOR ANALYSIS
JUL(0)-MAR(+)
NOV(0)-FEB(+)
MAY(0)-OCT(0)
LEGEND
WET
DRY



a
b
c
d
e
f
Latitude
Longitude
(°C)
Std. dev.
Z200
SST
Correlation


Relation between NINO3 SSTA and Indian Monsoon Rain: 1871-2002
Indian Monsoon Rainfall Std. Anomaly
NINO2JJAS Std. Anomaly


A
B
C
Non-ENSO
Drought
No Drought
Probability Density
Rainfall (mm)