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International Centre for Theoretical Physics

United Nations
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1968-19

Conference on Teleconnections in the Atmosphere and Oceans

17 - 20 November 2008

Fall-to-winter changes in the El Nino teleconnection

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Early winter to midwinter changes in the El NIÑO teleconnection

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University of Barcelona

with Matt Newman and Mike Alexander, ESRL-NOAA

Bladé et al.
JCLIM 2008

“Canonical” model for ENSO teleconnection

→Rossby wavetrain emanating from a wide region of warm SSTs and anomalous convection in the central equatorial Pacific.

BUT THIS SIMPLE PICTURE OVERLOOKS:

• there are multiple SST and heat sources in the tropics that contribute to the observed El Niño teleconnection, particularly in the *western* Pacific

→ this is well-known (e.g. Barsugli and Sardeshmukh, 2002)

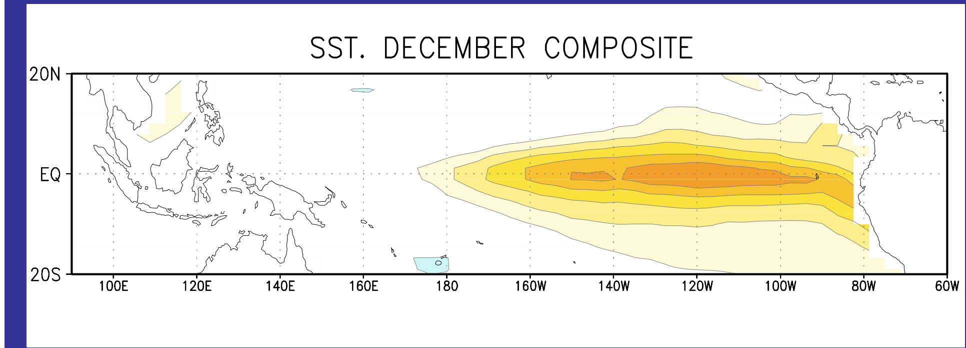
• the "TNH" El Niño teleconnection pattern does not get well established until January

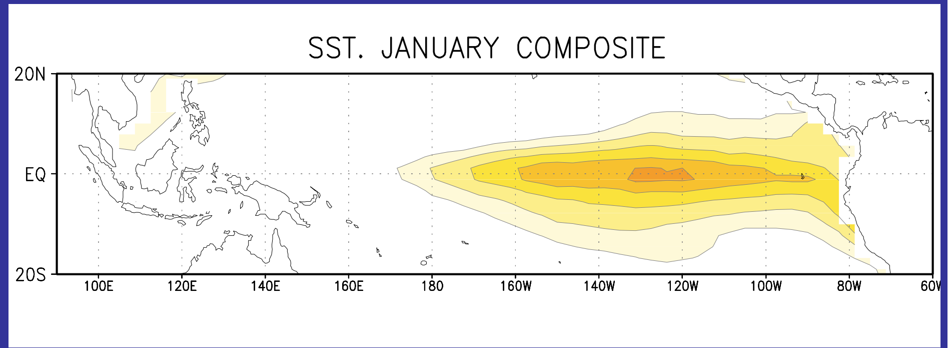
-> this is LESS well known (Wang and Fu 2000, Livezey et al. 1997)

OBSERVATIONS: EL NIÑO COMPOSITES (1950-1999)

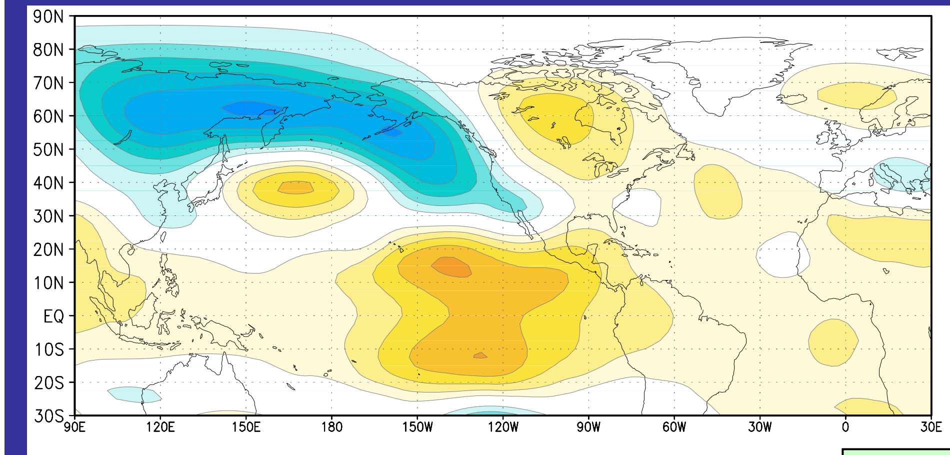
9 event composite of 200–hPa height and SST anomalies

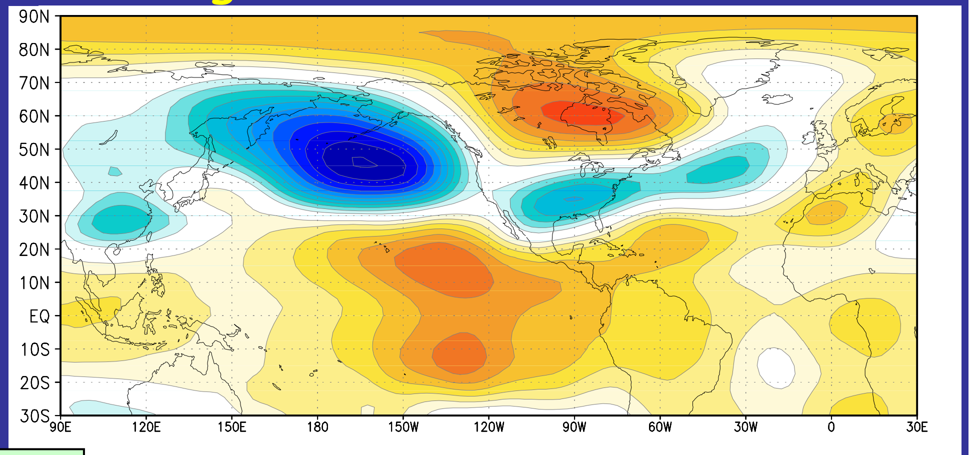
DECEMBER | **SST** | **JANUARY**





similar SST forcing





Z-200

but very different wavetrains

robust result

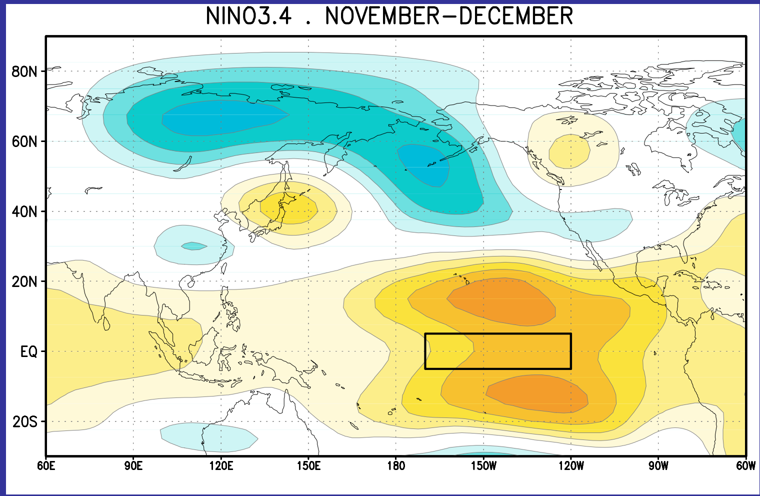
also true for

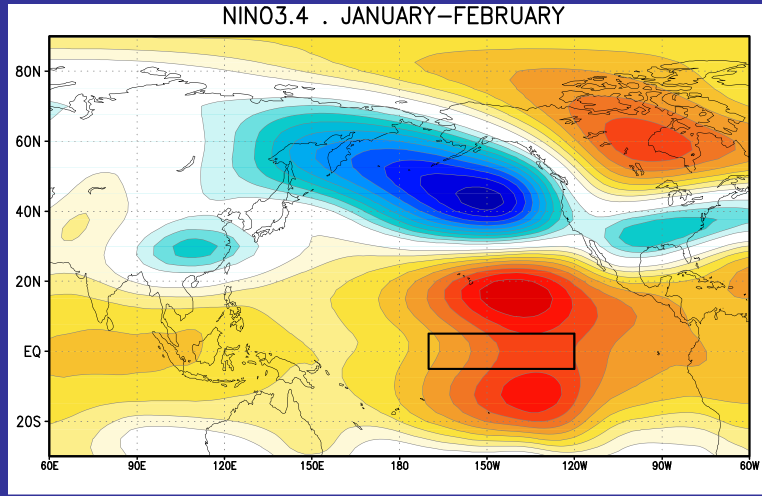
- other variables (SLP, precip)
- other criteria for EL NIÑO events
- bi-monthly means (NOV-DEC vs JAN-FEB)
- linear regressions (for any NIÑO index)
- longer periods (1950-2007)

2-month regressions vs NIÑO 3.4 index

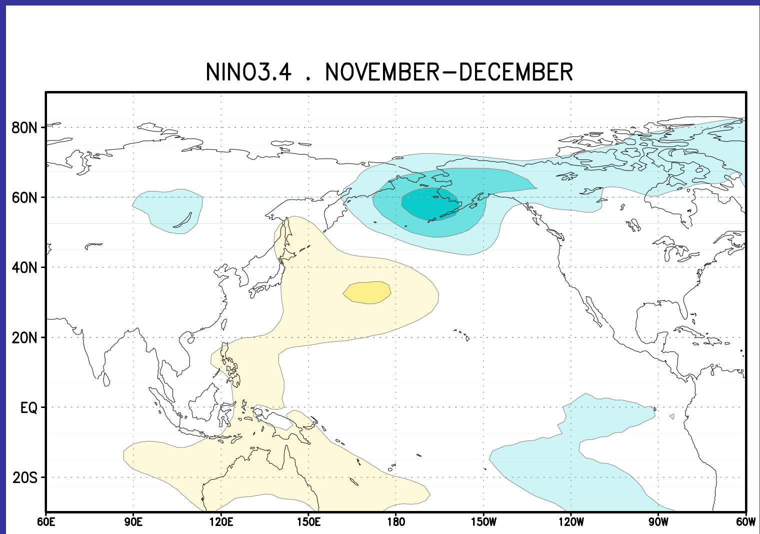
NOV-DEC JAN-FEB

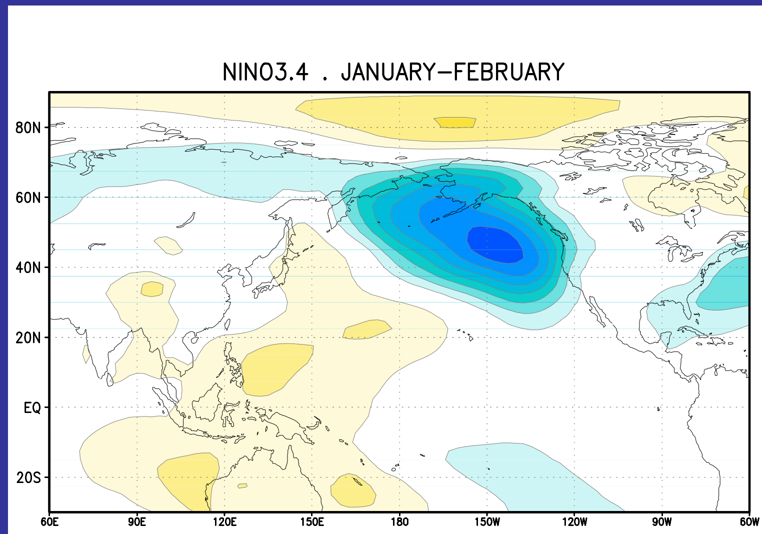
Z-200





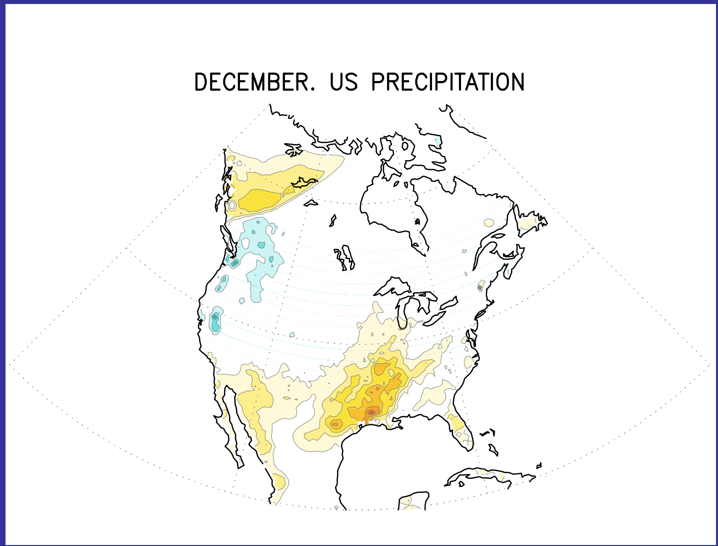
SLP



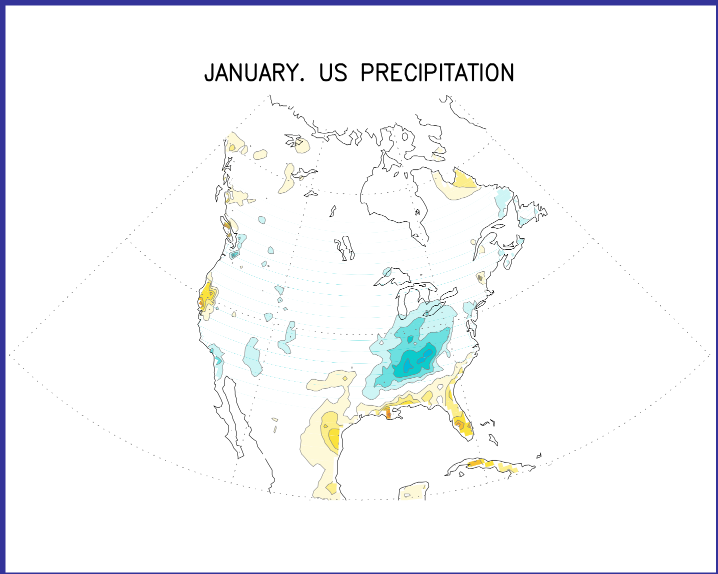


and for US precipitation EL NIÑO signal

DEC



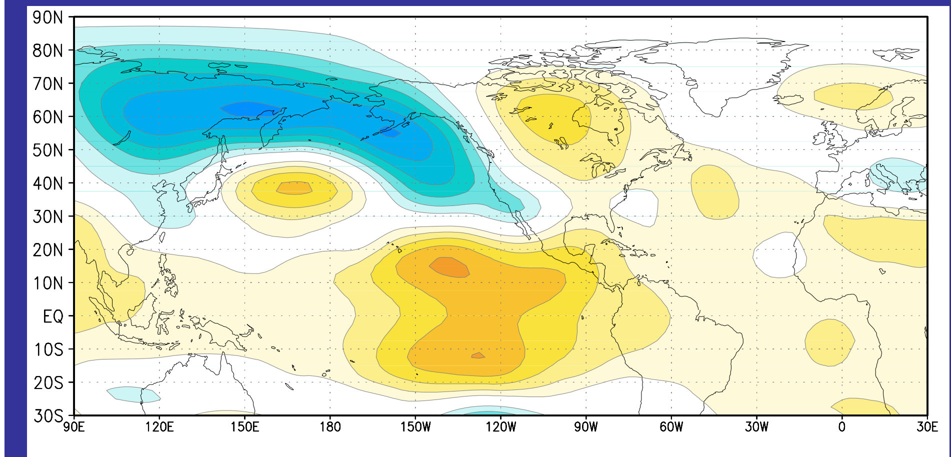
JAN

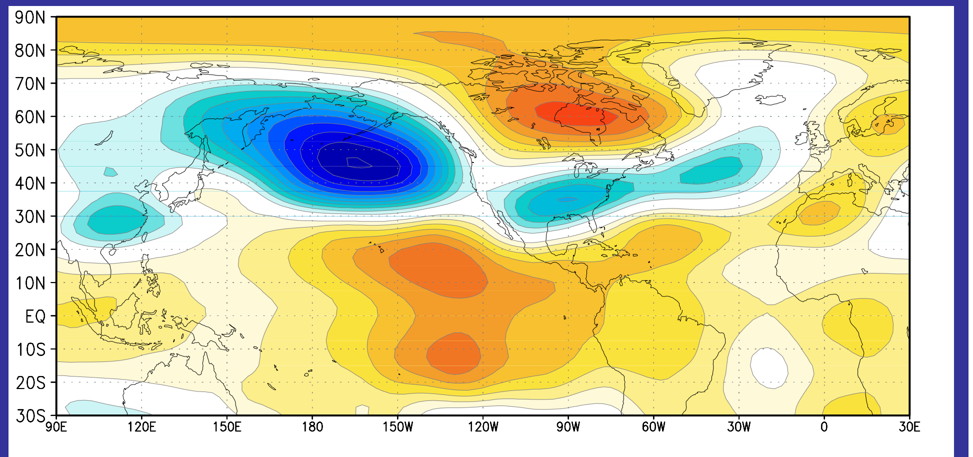


Observed us precipitation el NIÑO composites (9 strong events): 1950 - 1999

The changing orientation of the El Niño wavetrain suggest that its primary source shifts from the *western* tropical Pacific in late fall/early winter to the *central* tropical Pacific in winter

DECEMBER Z-200 **JANUARY**

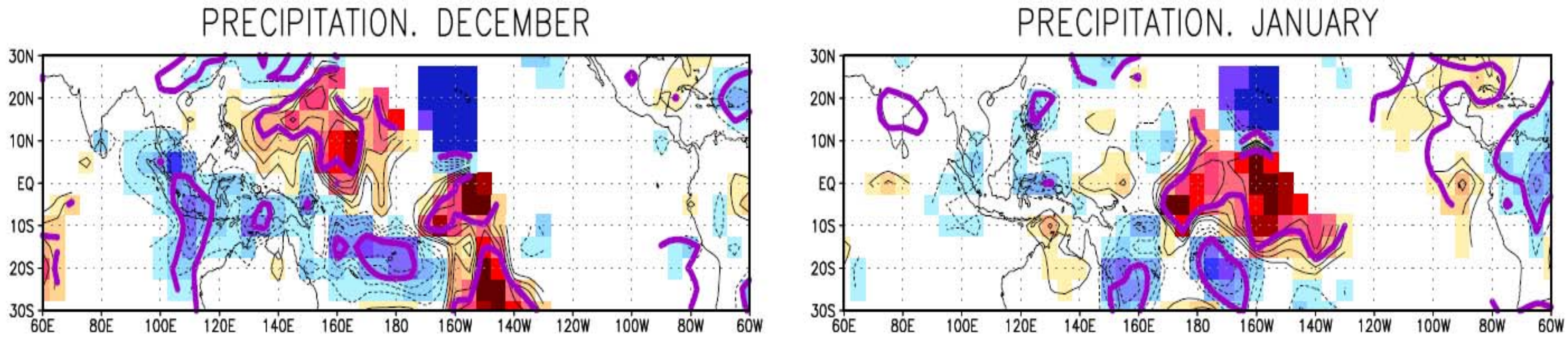


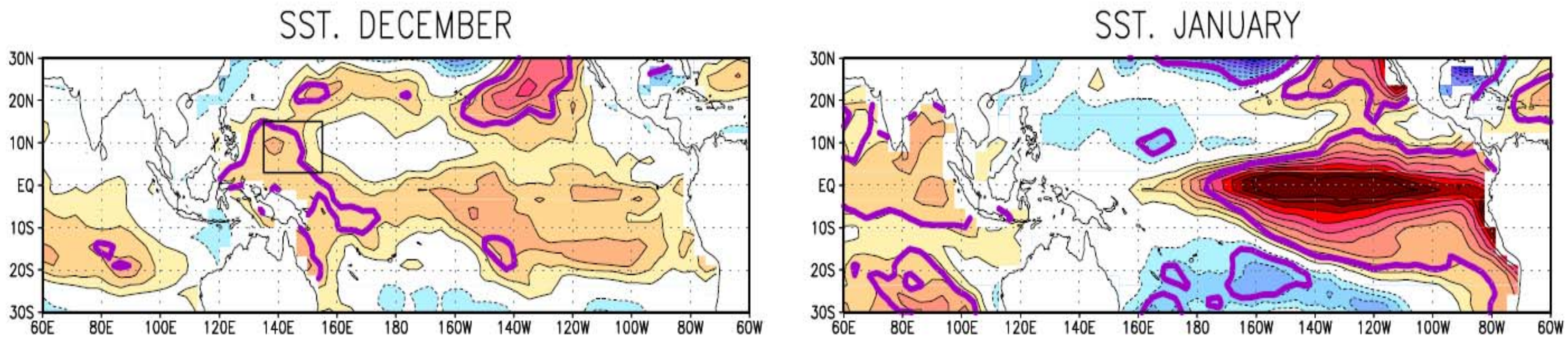


OBSERVED REGRESSIONS AGAINST NORTH PACIFIC SLP INDEX (NPI): 1950-99 (sign of NPI index reversed): GHCN PRECIPITATION AND REYNOLDS SST

DECEMBER

JANUARY





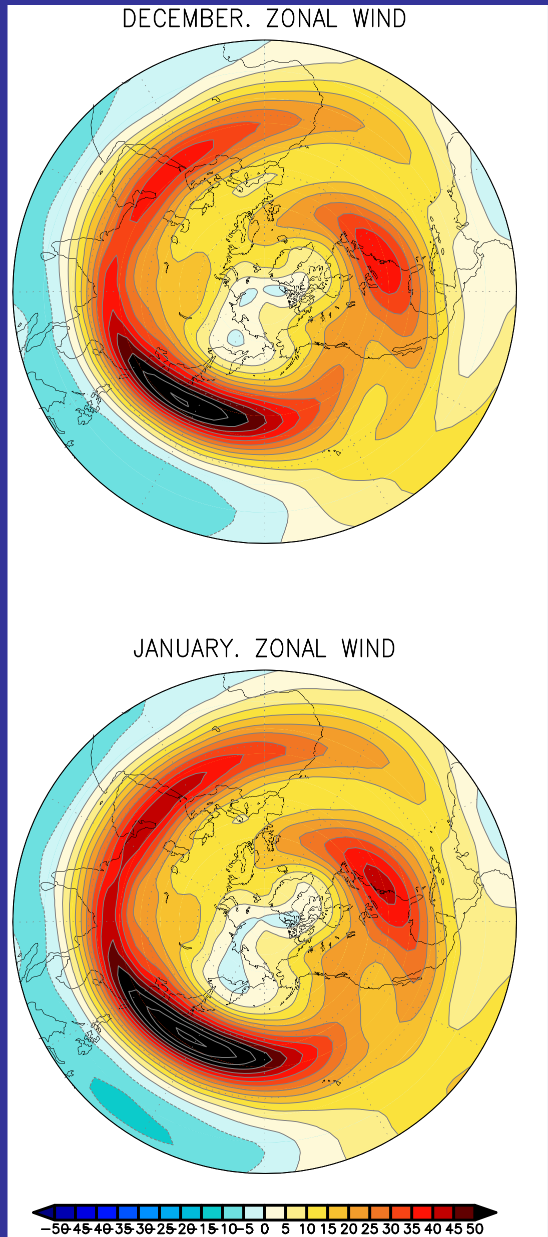
Seasonal shift in sensitivity:
more North Pacific sensitivity to precipitation and SST in western tropical Pacific in December than in January.

This sensitivity shift may be explained with simple Rossby waveguide arguments and is consistent with the results of Newman and Sardeshmukh (1998)

300 hPa $\bar{u}$

DEC

JAN



We might then expect a stronger DECEMBER El Niño teleconnection when WARM SST conditions and convection prevail in the western tropical Pacific

→**stratify 9 EL NIÑO events according to SST conditions in the tropical western Pacific:**

→ **UPPER/WARM and LOWER/COLD tercile composites (3 samples each)**

1957, **1965, 1969**, **1972**, 1976, 1982, **1987**, **1991**, **1997**

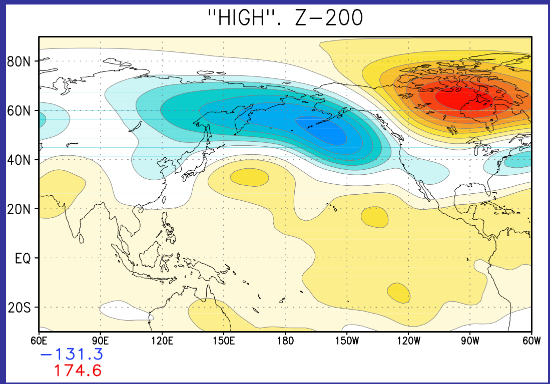
DEC

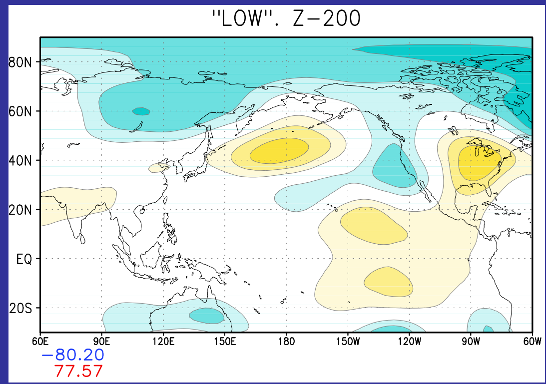
WARM TROP. WEST PACIFIC

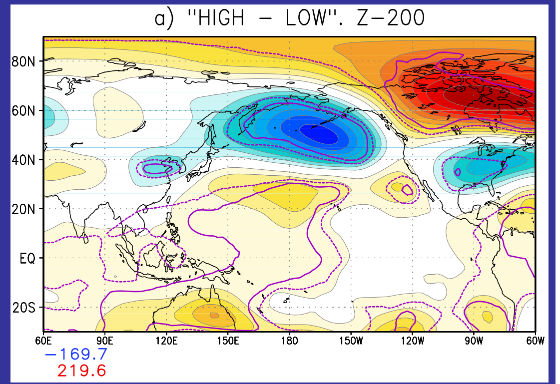
COLD TROP. WEST PACIFIC

WARM – COLD

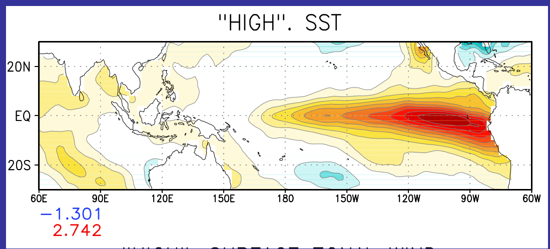
Z-200

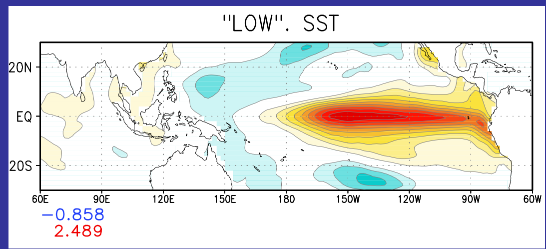


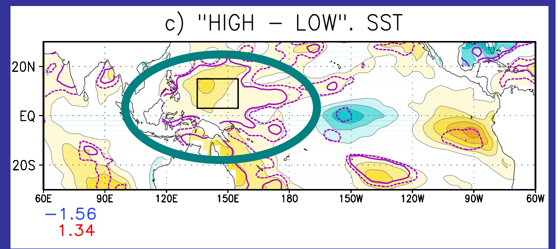




SST







EL NIÑO + WARM TROPICAL WESTERN PACIFIC (DECEMBER): 1969,1987, 1997

EL NIÑO + COLD TROPICAL WESTERN PACIFIC (DECEMBER): 1965, 1972, 1991

How well do GCMs reproduce this seasonal sensitivity shift from early winter to mid winter and associated El Niño teleconnections differences ?

Other GCMS run in AMIP mode:

- ECHAM4.5 (T42): 24-member ensemble
- ECHAM 5 (T42): 24-member ensemble
- ECHAM 5 (T85): 16-member ensemble

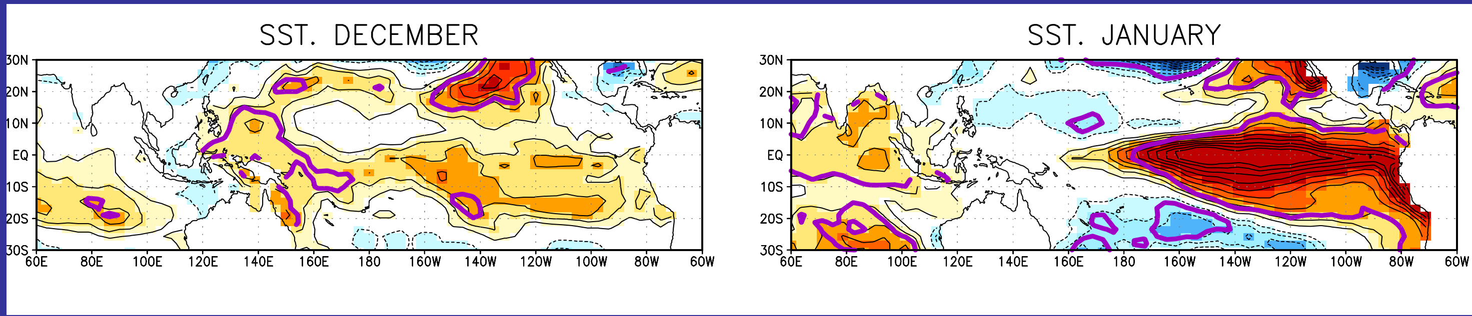
- CAM3 (T42): 5-member ensemble
- CAM3 (T85): 5-member ensemble

- GFDL-AM (T42): 10-member ensemble

SST

REGRESSIONS AGAINST NPI : 1950-1999

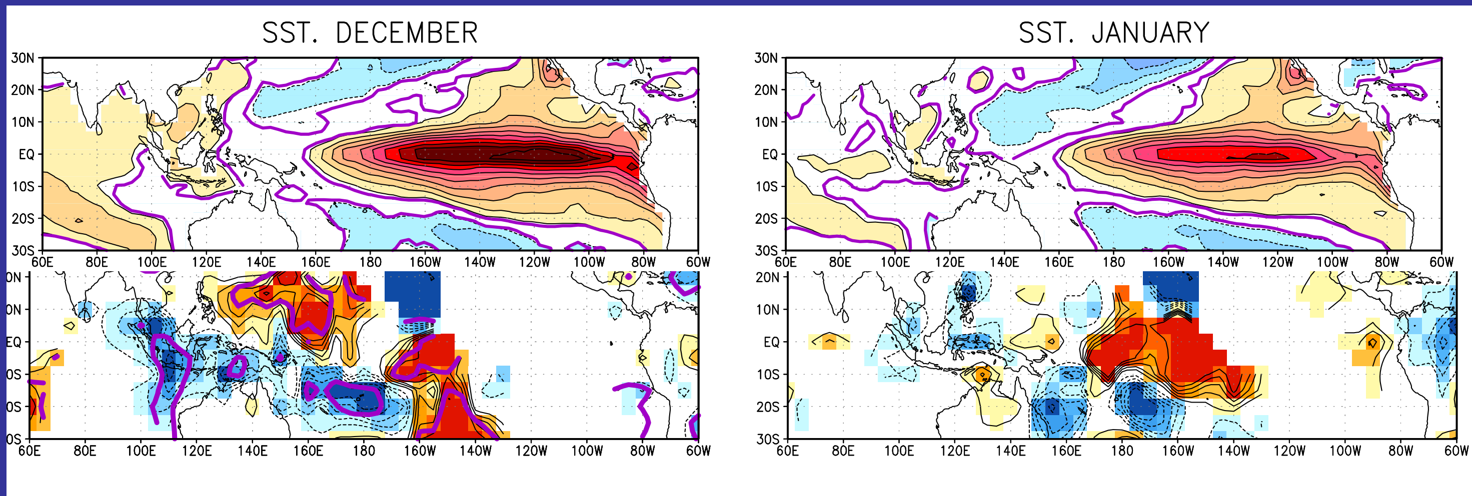
OBS



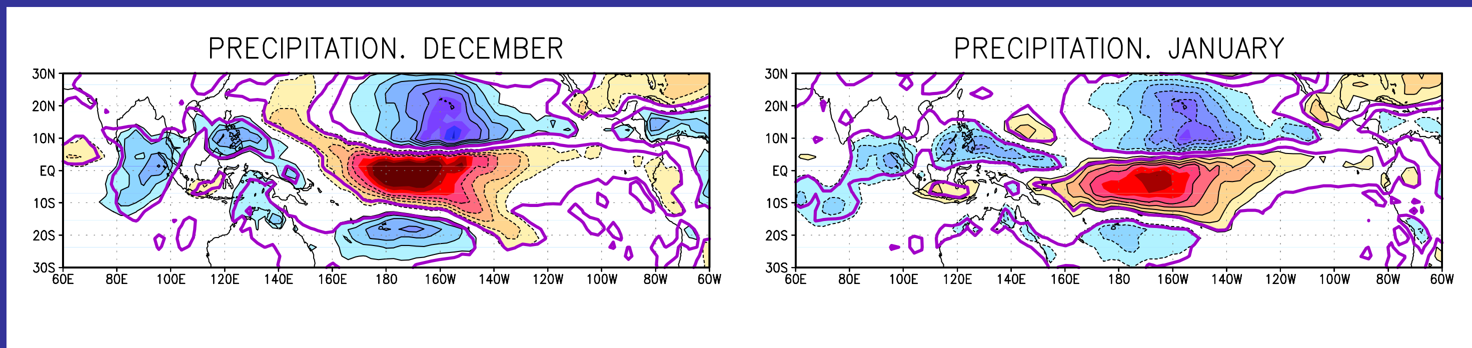
ECHAM5
(T42)

PREC

OBS



ECHAM5
(T42)

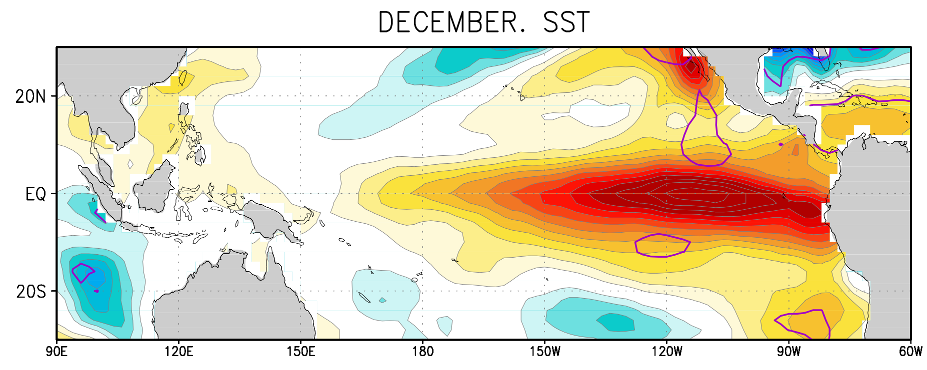


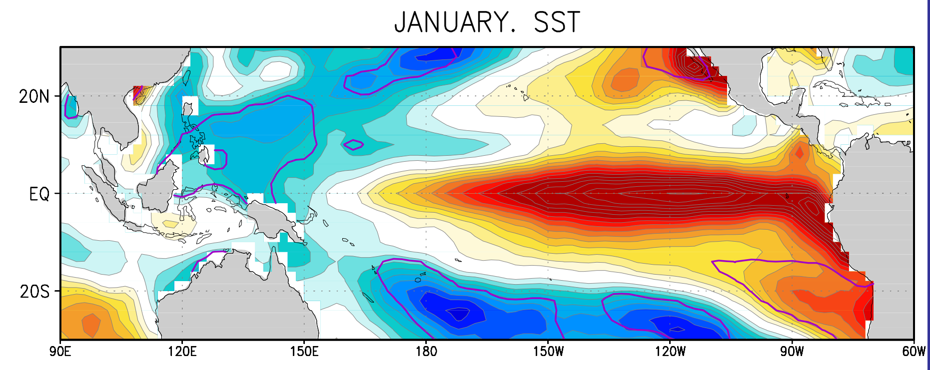
REGRESSIONS: NPI vs SST

GFDL-AM2

DECEMBER

JANUARY

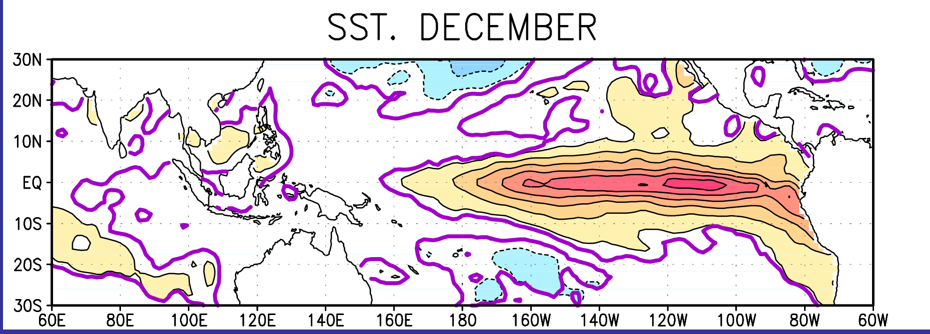


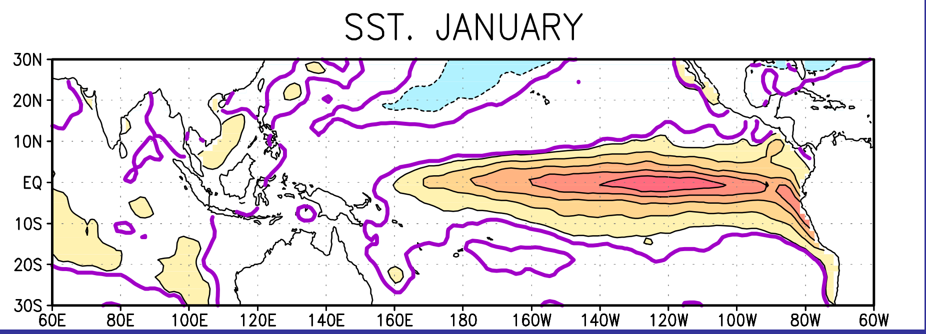


CAM3-T85

DECEMBER

JANUARY

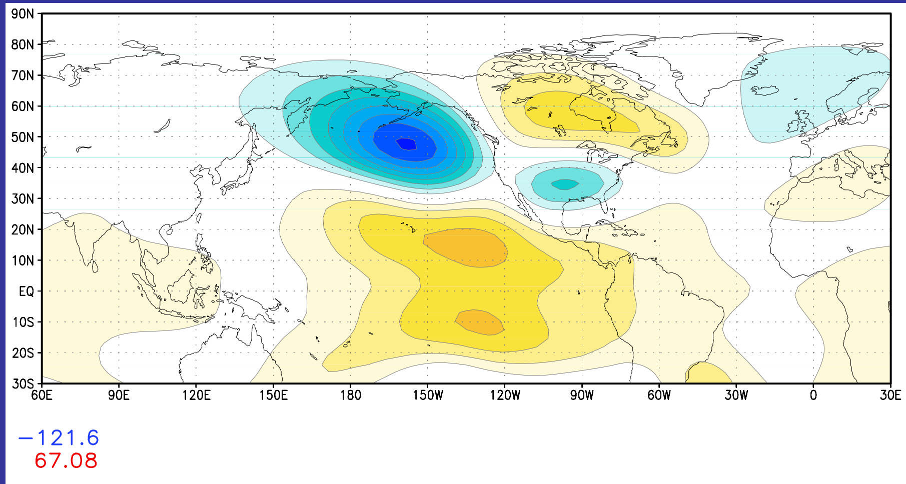




EL NIÑO Z-200 COMPOSITES

ECHAM5-T42

DECEMBER



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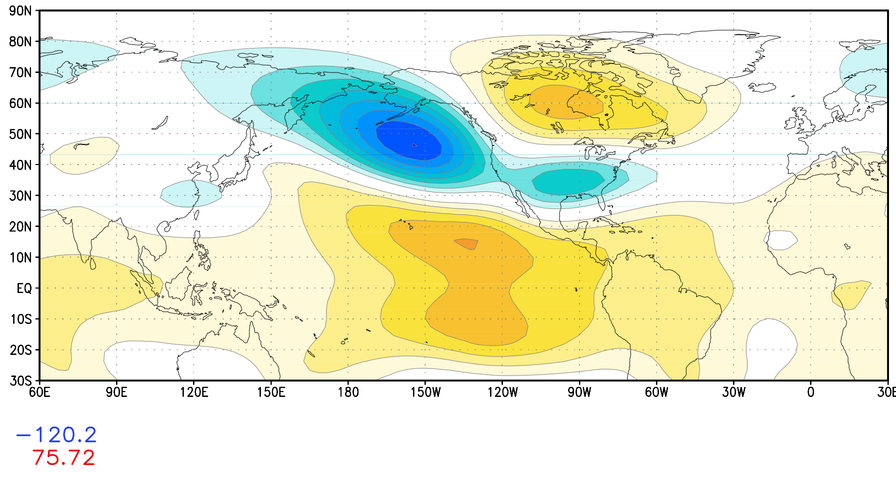
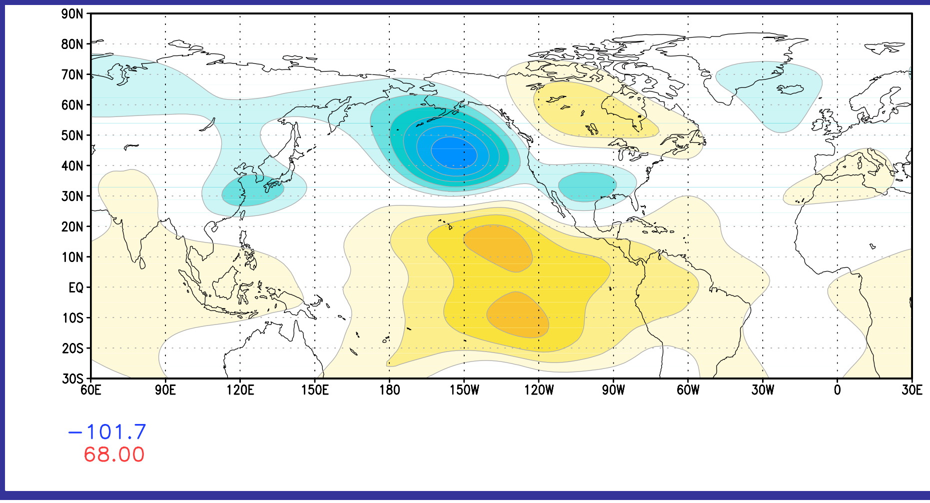


ECHAM5-T85

DECEMBER



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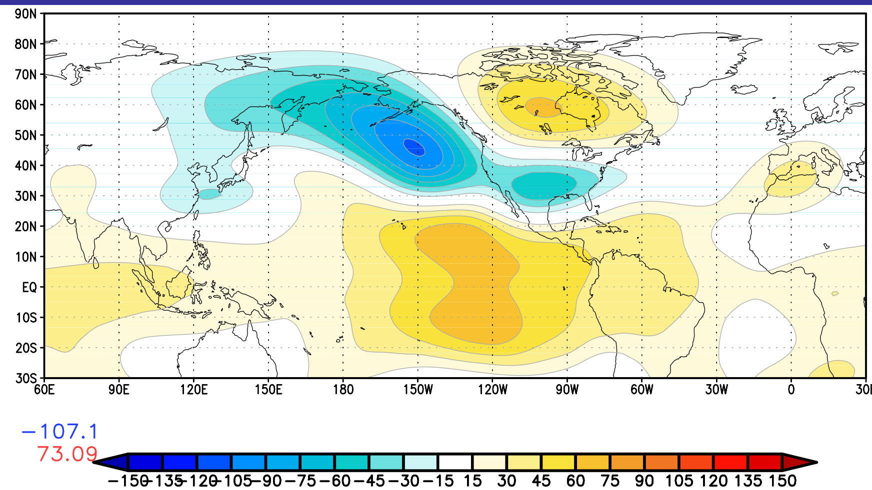
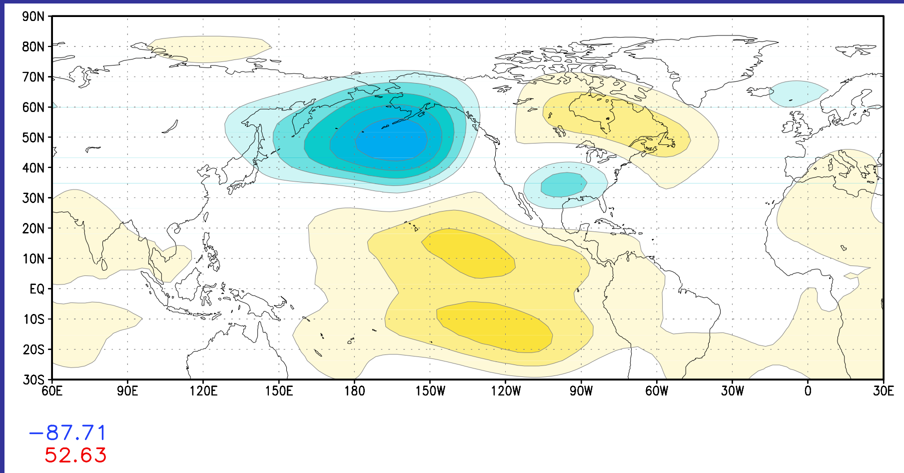
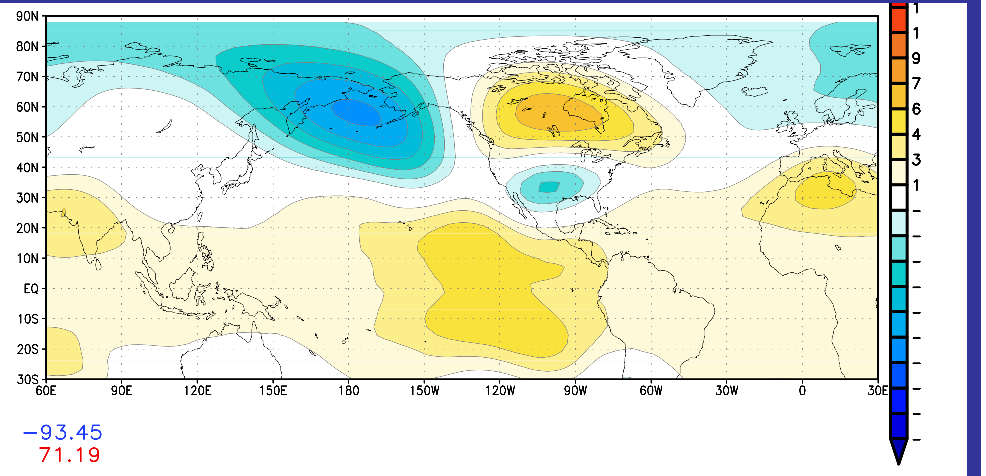


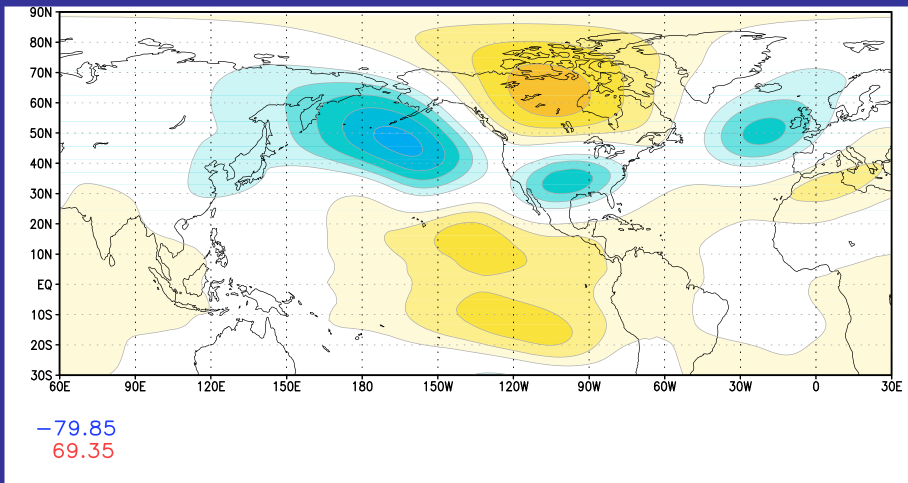
EL NIÑO Z-200 COMPOSITES

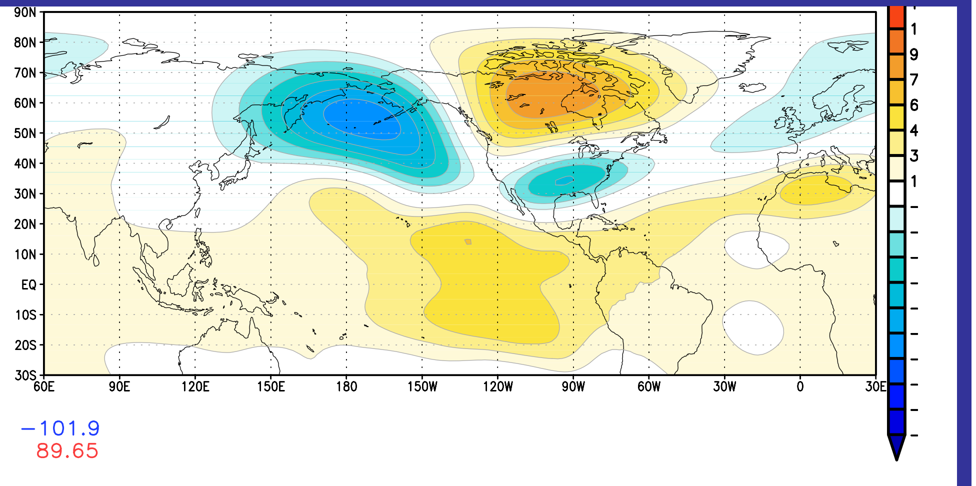
DECEMBER — CAM3-T42 — JANUARY





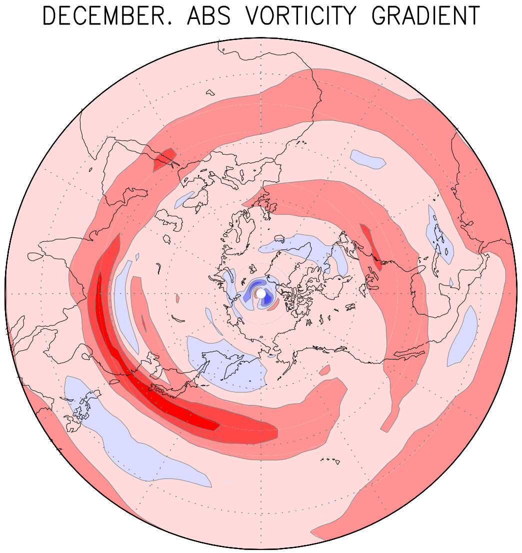
DECEMBER — CAM3-T85 — JANUARY

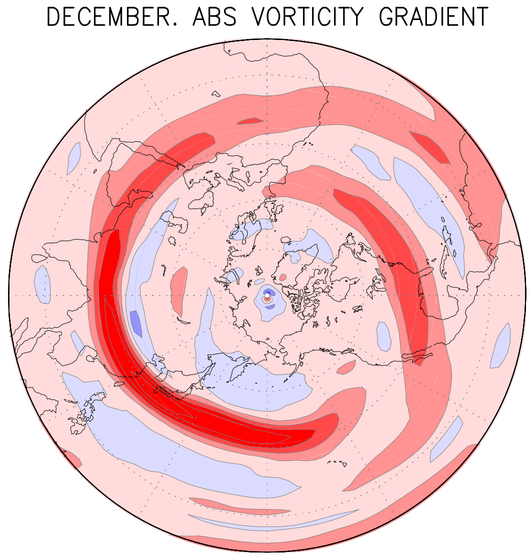




BAROTROPIC ROSSBY WAVEGUIDE

DECEMBER

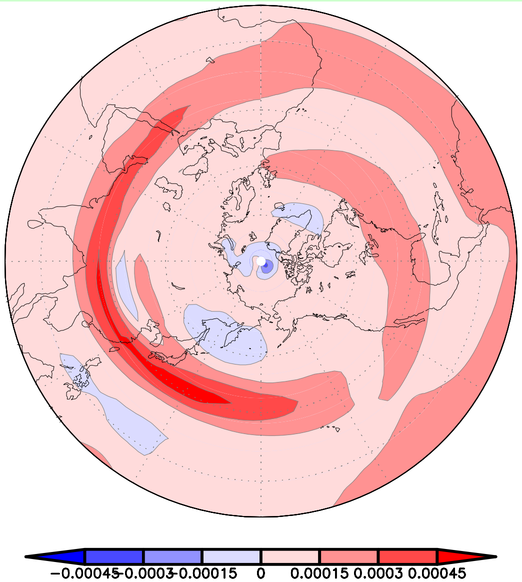


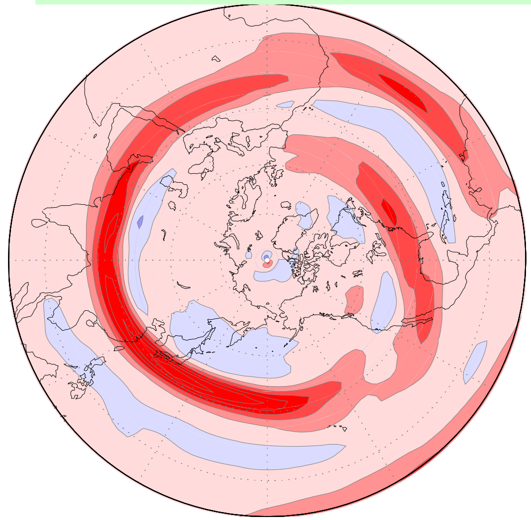


ECHAM5-T42

GFDL-AM2

JANUARY





CONCLUSIONS

- There is a dramatic shift in the sensitivity of the North Pacific circulation to tropical forcing, from the tropical western Pacific in early winter to the central/eastern Pacific in mid winter.

- This sensitivity shift is consistent with the attendant changes in the basic state jet and associated Rossby wave guide and is not well reproduced in GCMs.

- In early winter the El Niño teleconnection is strongly modulated by forcing from the western tropical Pacific, being stronger when warm conditions and convection prevail in that region.

- Diagnostic studies using DJF seasonal averages may obscure some important aspects of climate anomalies associated with El Niño.

El NIÑO 2006/07

an example of weak tropical bridge, warm SSTs and enhanced convection in TWP and a pronounced extratropical El Niño wavetrain in late fall