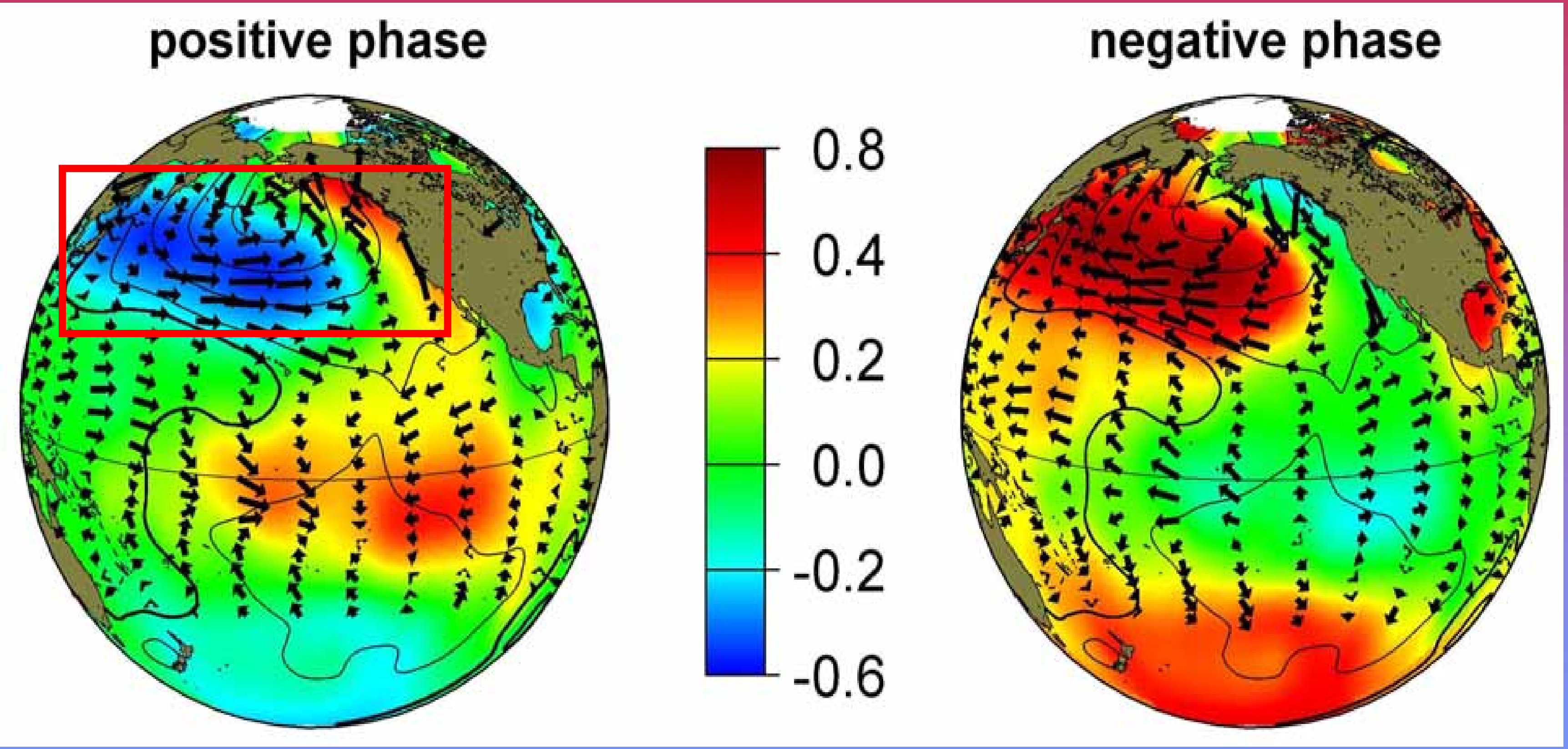
An high resolution Pacific Decadal Oscillation and some of its novel characteristics

Skip McKinnell (PICES) &

Nate Mantua (U. of Washington)

Pacific Decadal Oscillation

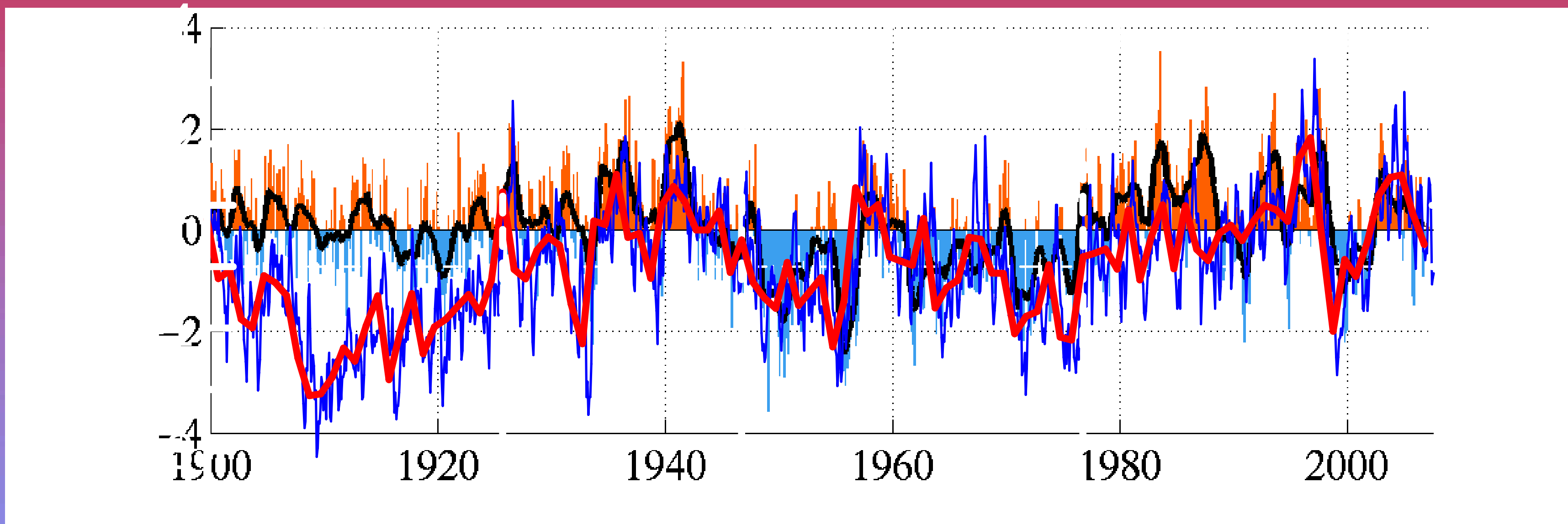


Mantua et al. 1997

PDO calculations

- Monthly Hadley Centre SSTs on a 5º x 5º lat/long grid, north of 20º N in N. Pacific
- Compute monthly anomalies from longterm monthly means, 1900-1996
- Subtract global warming SST trend from the anomalies at each grid point/month
- Compute EOFs

PDO Index - 5º grid



1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010

http://jisao.washington.edu/pdo/ c.f. Mantua et al. 1997

NOAA Extended Reconstructed SST

Current state of Knowledge

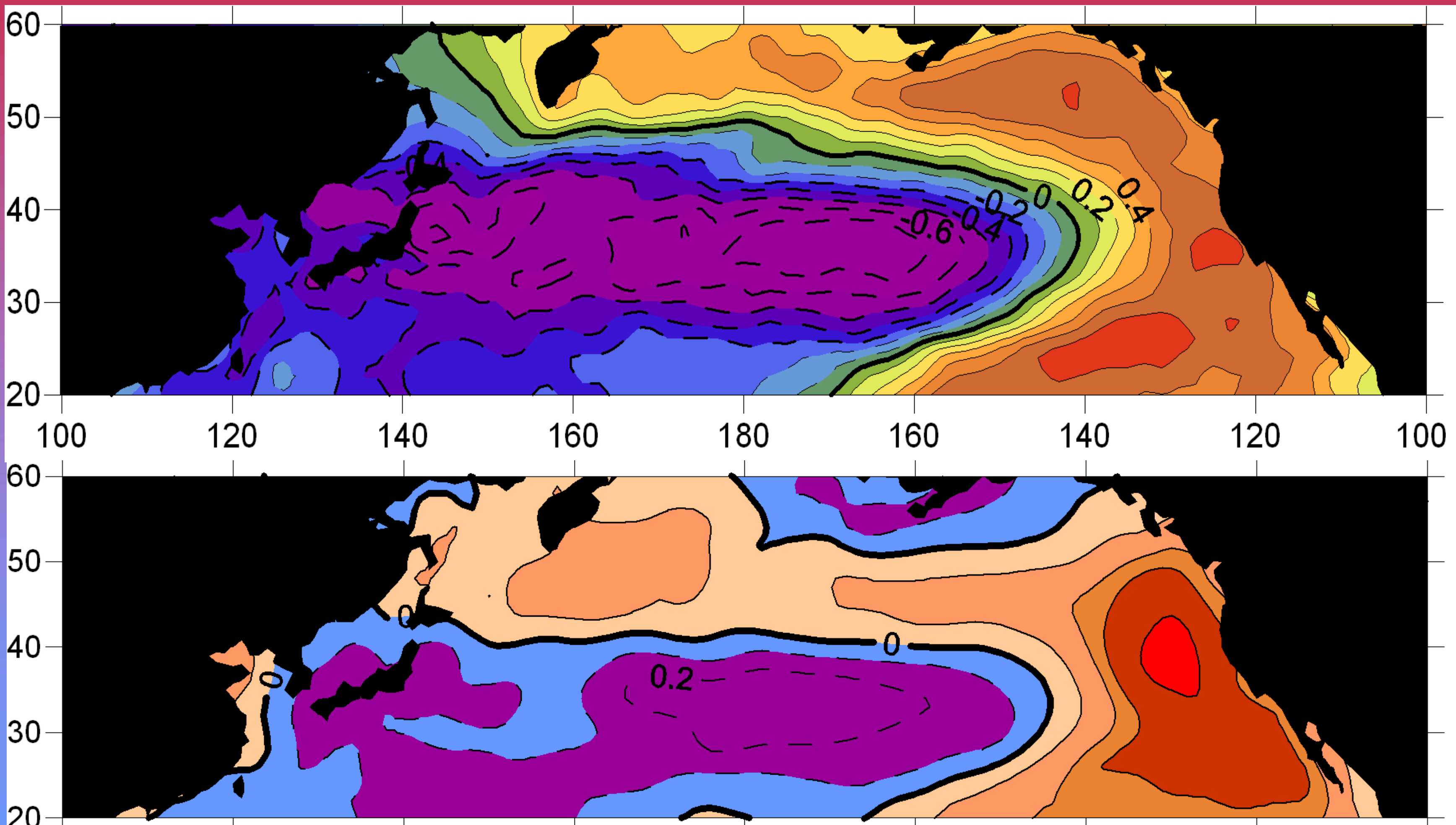
- Causes of enhanced variance of the PDO pattern at decadal/inter-decadal periods are not currently known.
- The potential predictability for this climate oscillation is not known.
- Climate models produce PDO-like oscillations, although often for different reasons.
- The PDO improves [...] climate forecasts for North America because of its strong tendency for multi-season and multi-year persistence.

http://jisao.washington.edu/pdo/

Ideas from PICES/PIO volumes

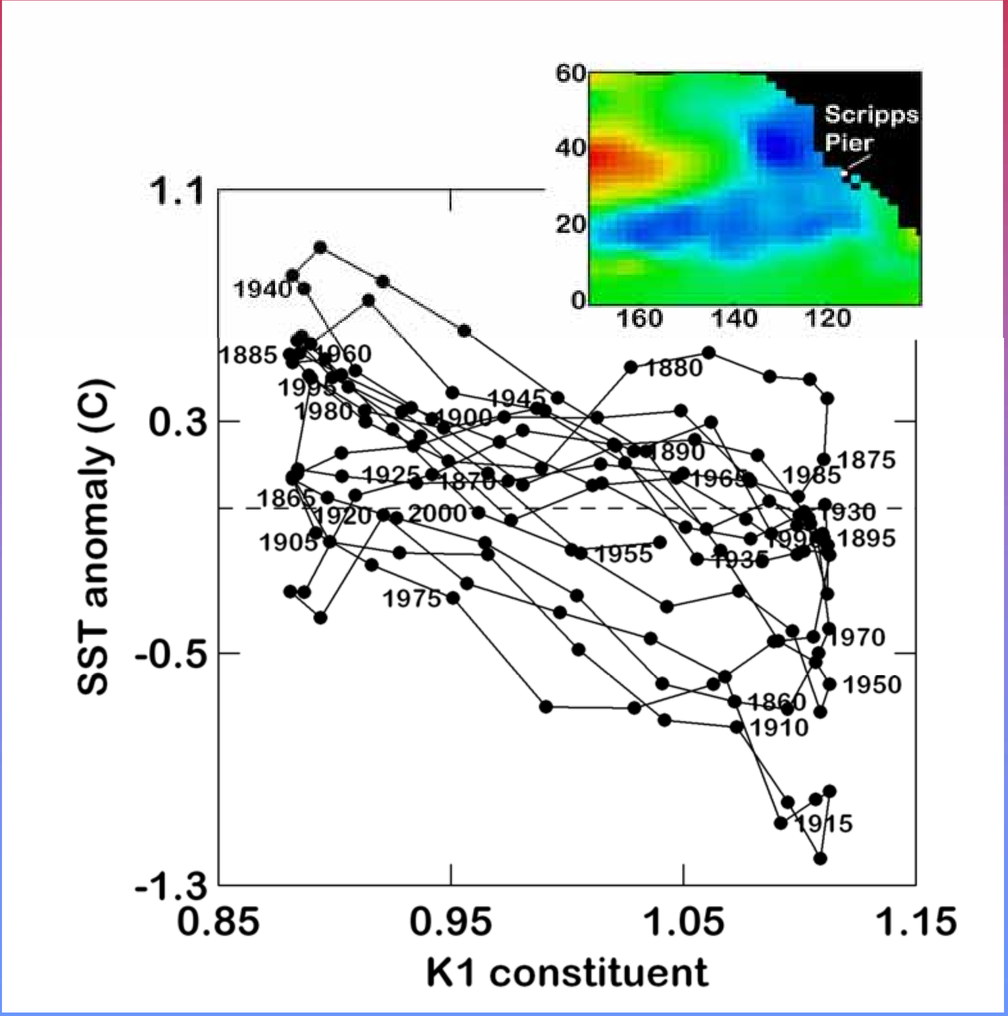
- Chaos (Overland et al. 2000)
- Superposition of bidecadal + pentadecadal cycles (Minobe 1999, 2000)
- Red noise (Pierce 2001)
- Ask the Fish (McFarlane et al. 2000)

PDO and PDO-like patterns



McKinnell & Crawford JGR 2007

January SST vs. diurnal tide - 1854-2005

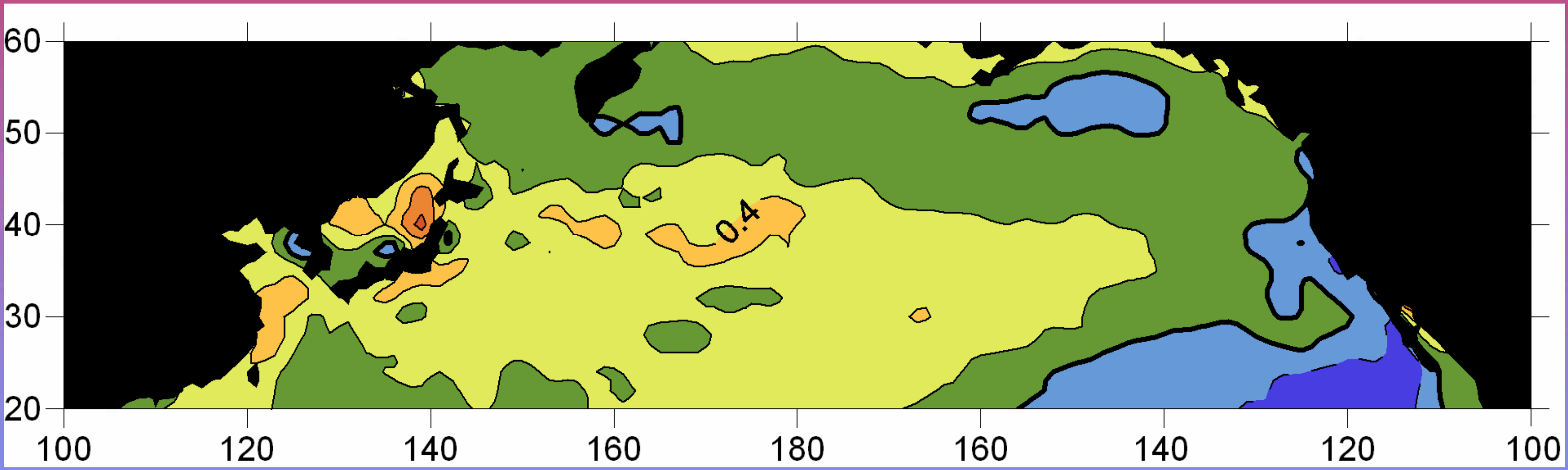


McKinnell & Crawford JGR 2007

Purpose of Study

- How is the PDO influenced by:
  - using a coarse (5x5) grid or fine (1x1) grid?
  - the satellite era??
  - removing a global mean SST?
  - removing the effect of diurnal tides?
  - seasonal variation (hysteresis)?

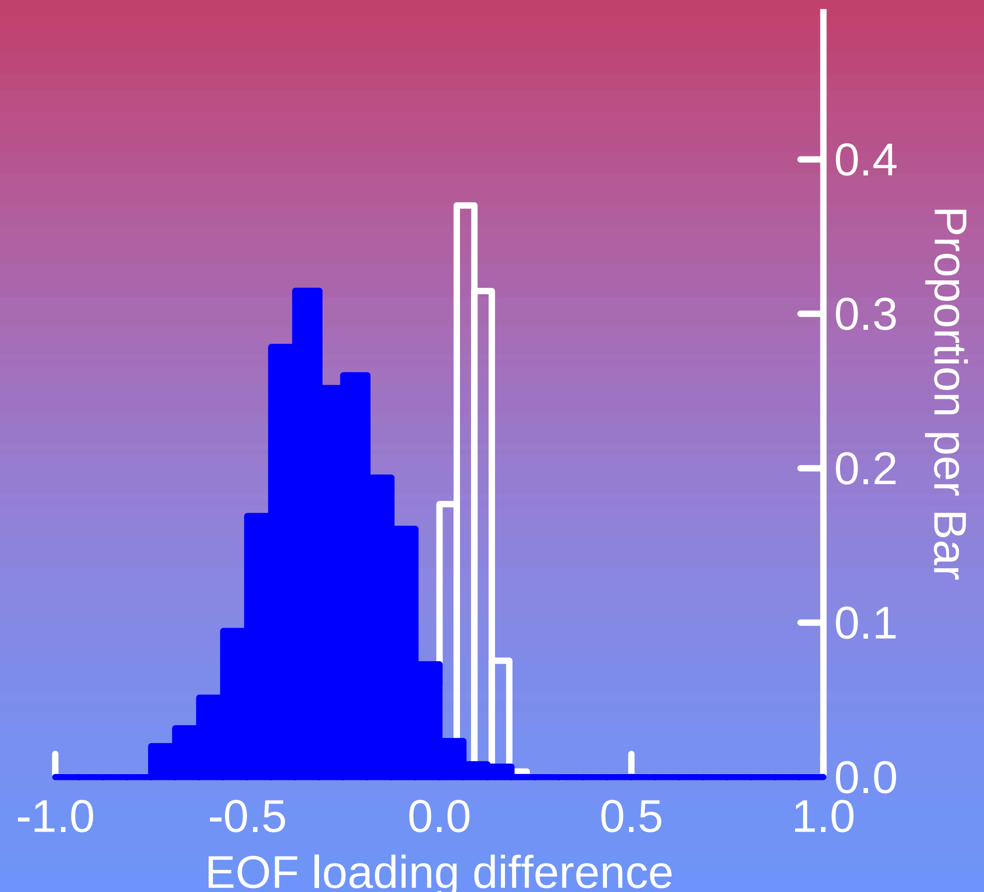
Linear SST trend 1982 – 2006 (ºC / century)



SST data – NOAA OIv2SST

Remove tide and trend (1x1)

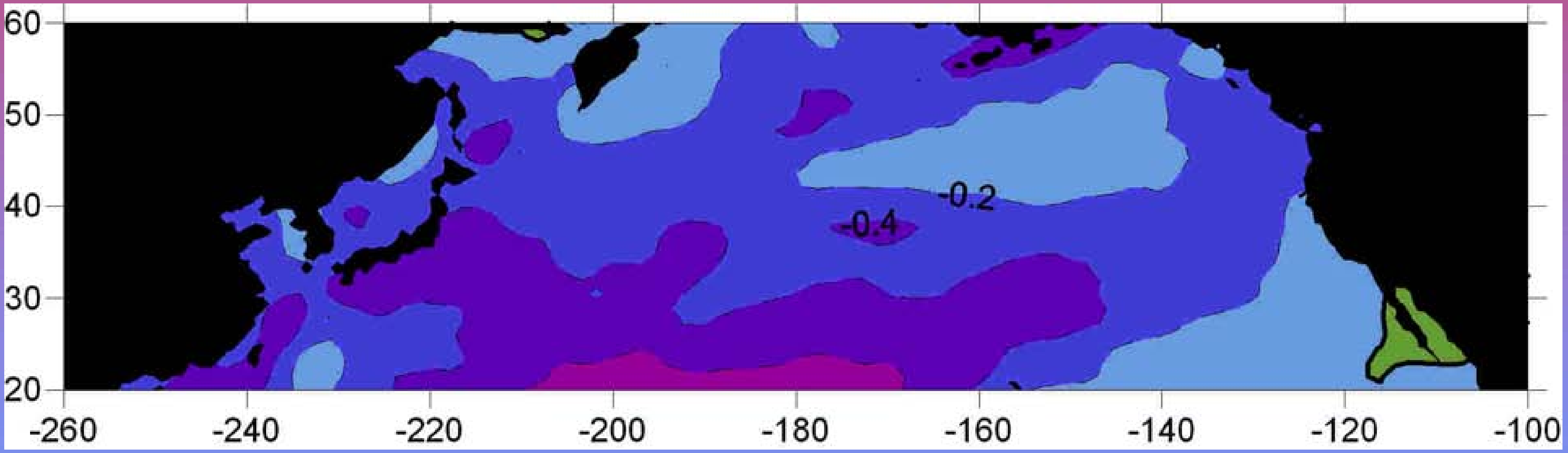
Satellite (1x1) – Pre-satellite (2x2)



Data – Hadley Centre SST, NOAA OIv2SST, NOAA Ext. Reconstructed, DFO K1 tidal constituent

EOF 1 loadings
Difference (satellite - pre-satellite)

1982-06 vs 1900-81

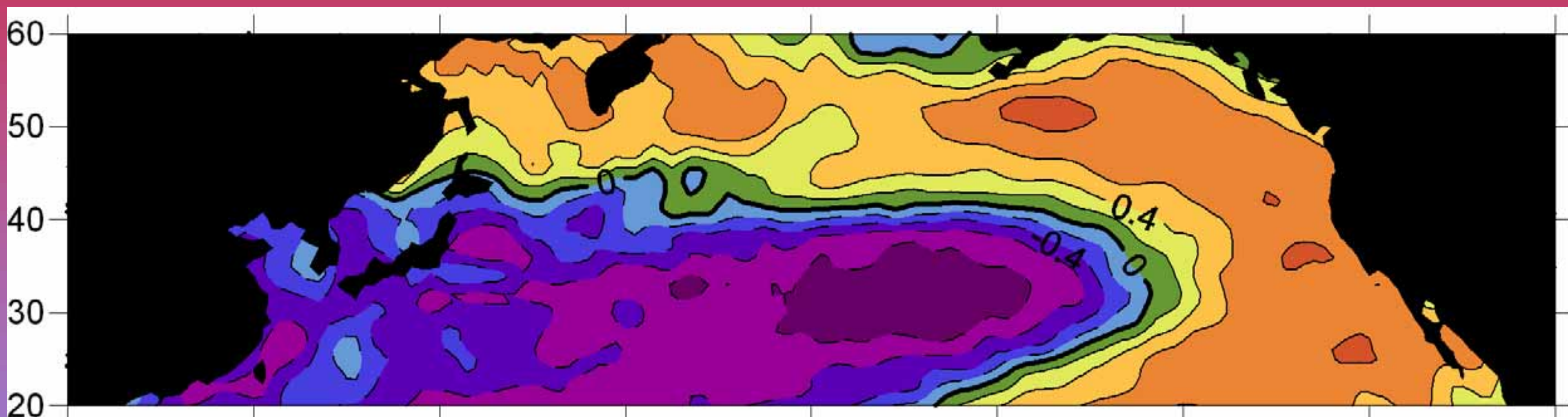


Greatest differences occur in regions with (historically) least sampling but also in some highly sampled regions (coast of Japan)

Data : NOAA Extended Reconstructed SST and OIv2SST

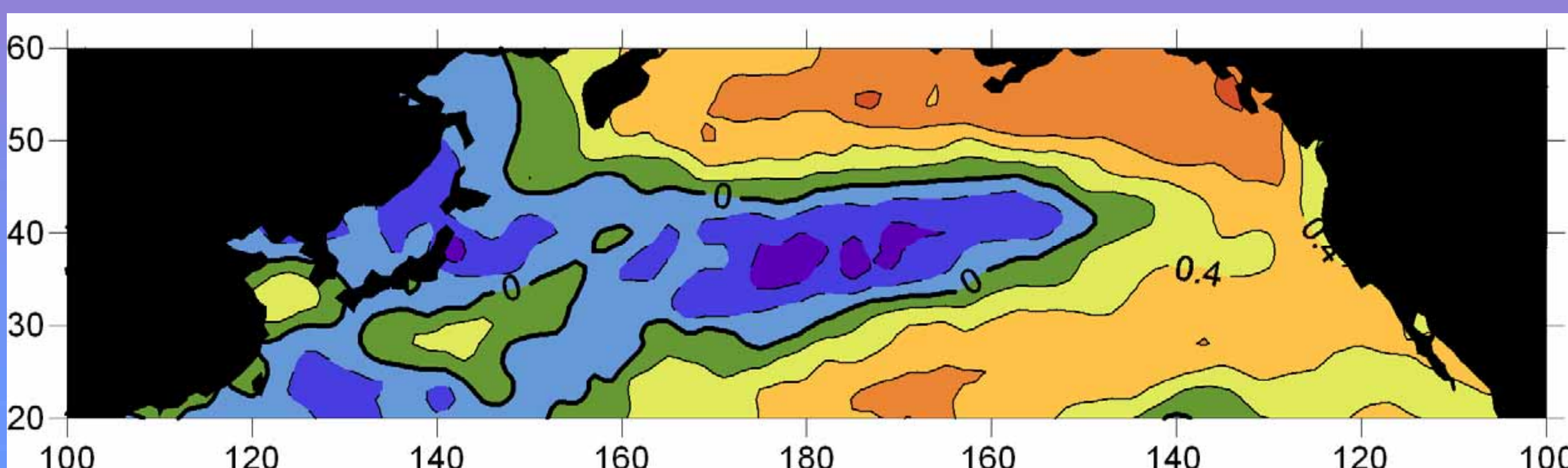
Seasonal EOF loadings 1982-2006

March – EOF 1

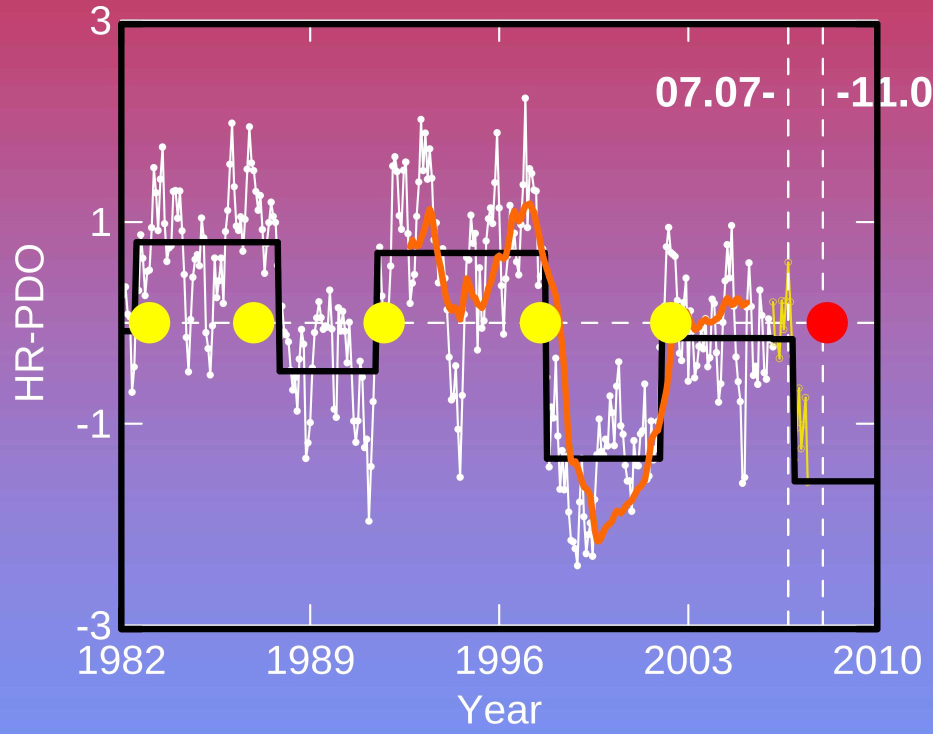


August – EOF 2

Annual heating/cooling cycle is important



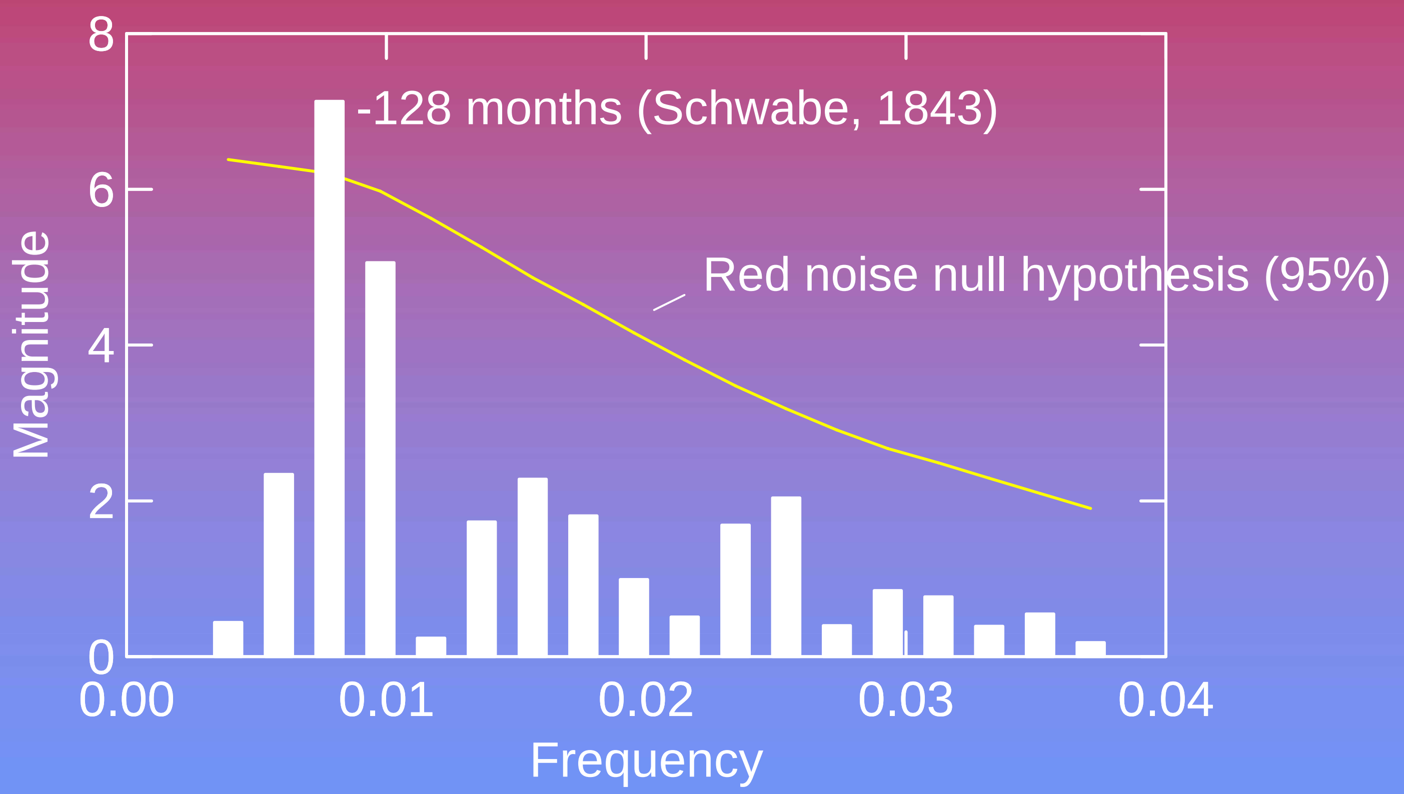
HR-PDO Index 1982-2006



July 1982
Jan. 1988
Oct. 1991
Apr. 1998
Sep. 2002
Oct. 2007

SSHI –Cummins et al. 2005

HR-PDO spectrum vs. red noise

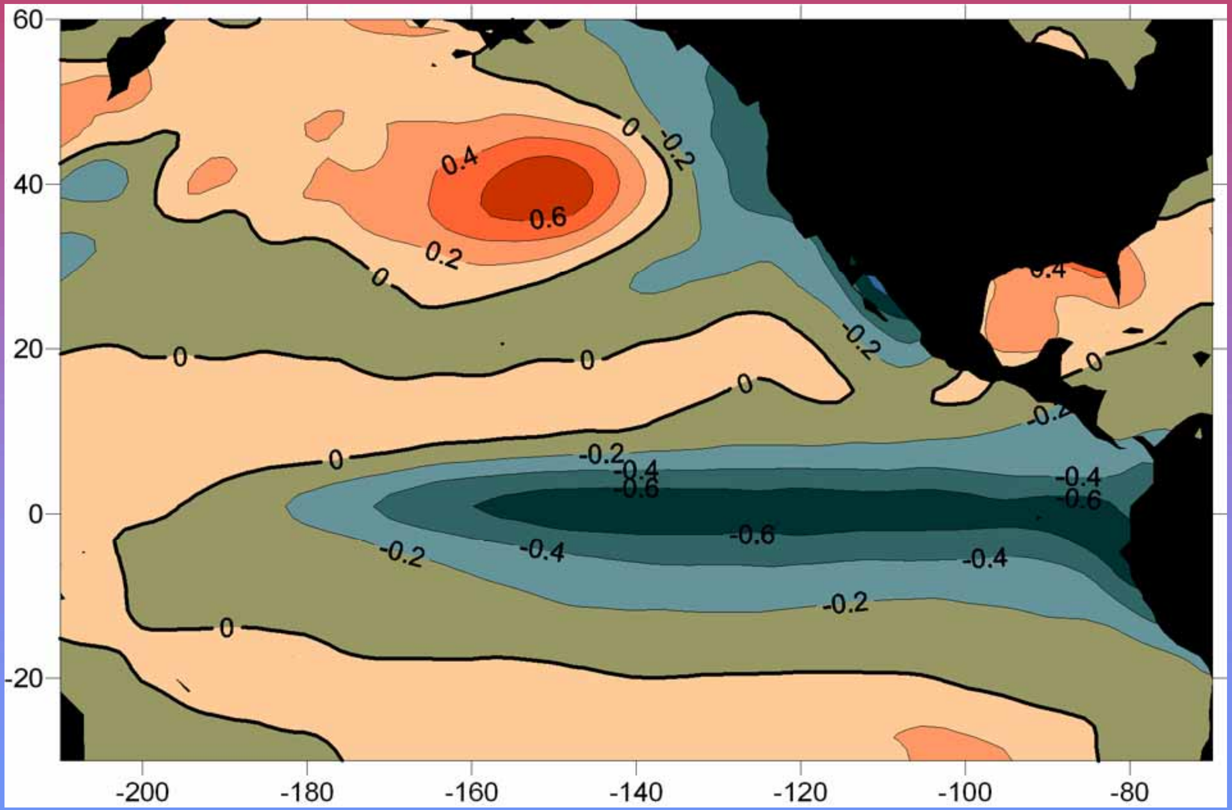


Least squares fit = 124 months

Solar variation and Climate

- Schwabe cycle = $^1/_3$ – $^1/_2$ ENSO (van Loon et al. 2007)
- FOAM generates ENSO frequency from internal dynamics but needs external ~2 wm^{-2} solar amplitude to generate the QDO (9-13 y) (White & Liu 2008)
- 9-11 y spectral peak in 1300 y of proxy air temperatures around Gulf of Alaska (Wilson et al. 2007) although 18.6 y tidal frequency was dominant.
- PCM and CCSM3 (and observations) show solar origin temperature and pressure anomalies in the North Pacific (Meehl et al., in press)

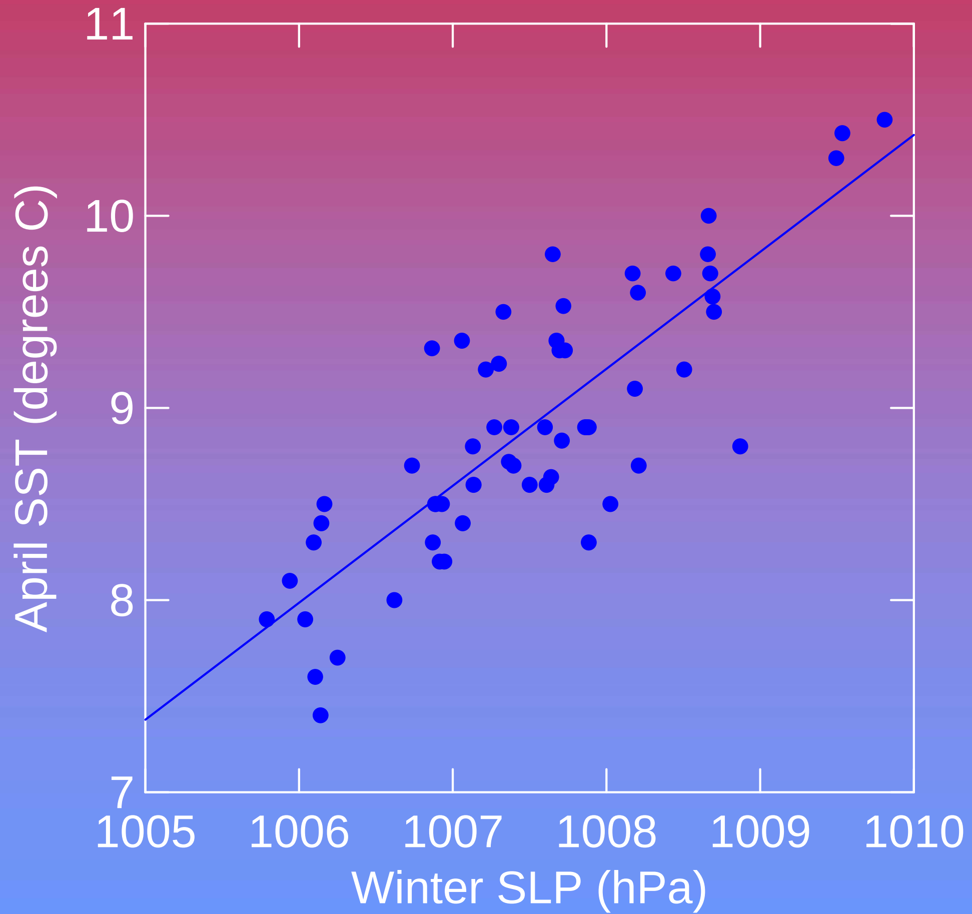
SST anomaly (djf) at solar maxima minus 1878-2007 average (djf)



Peaks
1883
1893
1905
1917
1928
1937
1947
1957
1968
1979
1989
1999

Data: SST – NOAA Extended Reconstructed SST; c.f. Meehl et al. J.Clim., in press

Western Tropical Pacific Teleconnection > SW Canada



SST – Fisheries & Oceans Canada; SLP – NOAA/NCAR NCEP Reanalysis

Summary

- Adjusting SST anomalies for global warming and 18.6 y tidal cycle has less influence on the PDO pattern than the data source or period used for its computation.
- Satellite era HR-PDO is even more “regime-like” than the PDO but the period is (so far) quasi-decadal not multi-decadal.
- Recent work (by others) indicates that the quasi-decadal signal in SST observations and models appears to be a consequence of variable solar intensity.
- Forecast - October 2007 should be the start of a 4-5 y negative phase; interrupted by an el Nino in the not too distant future.
- Average winter SST in Gulf of Alaska in 2008 was coldest since 1972 (consistent with 18.6 y cycle)