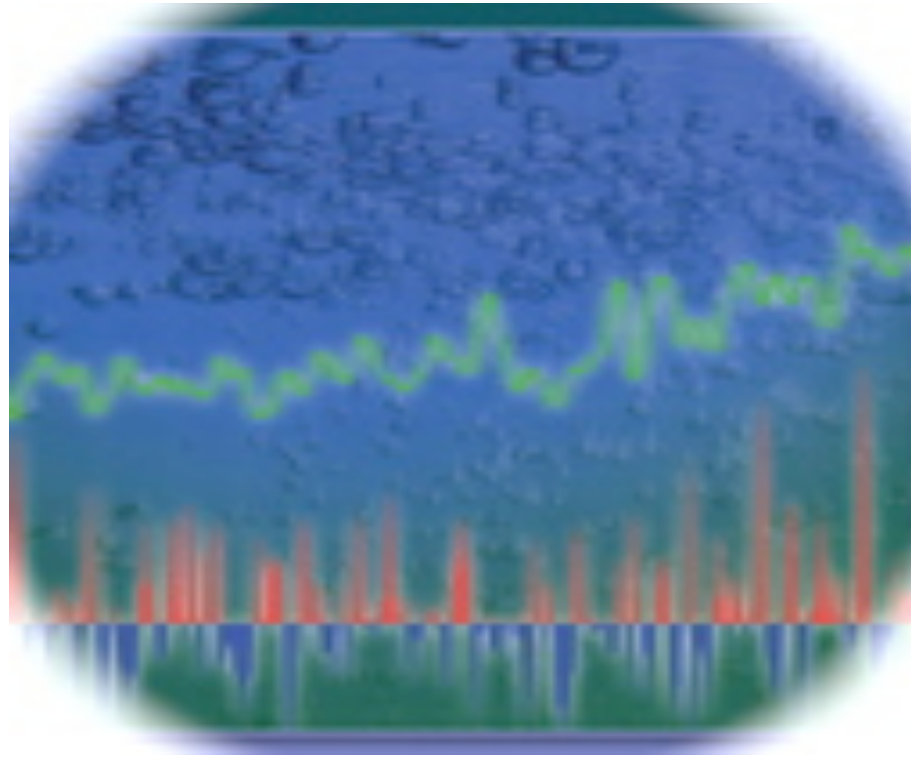


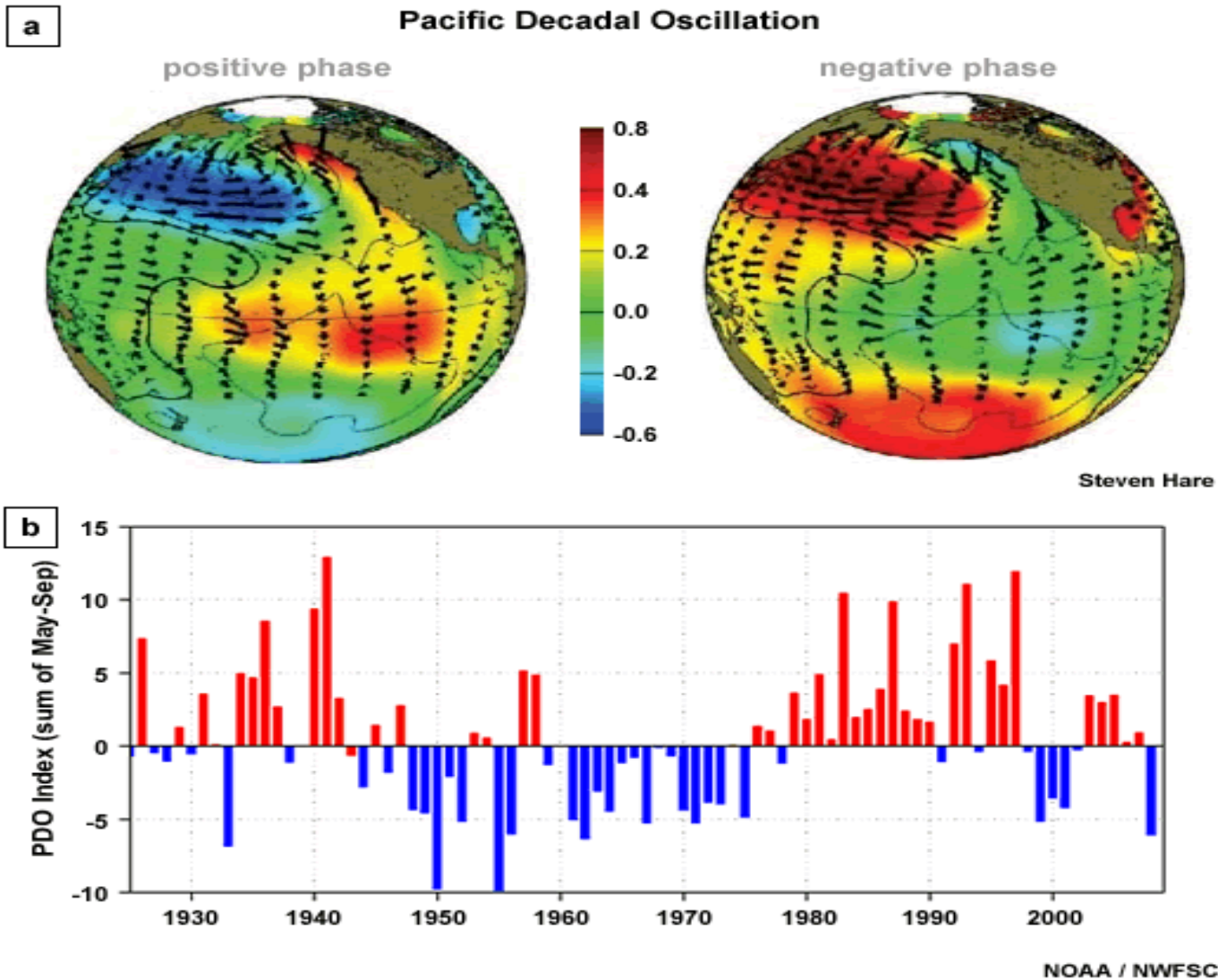
Climate Dynamics: Why Does Climate Vary?



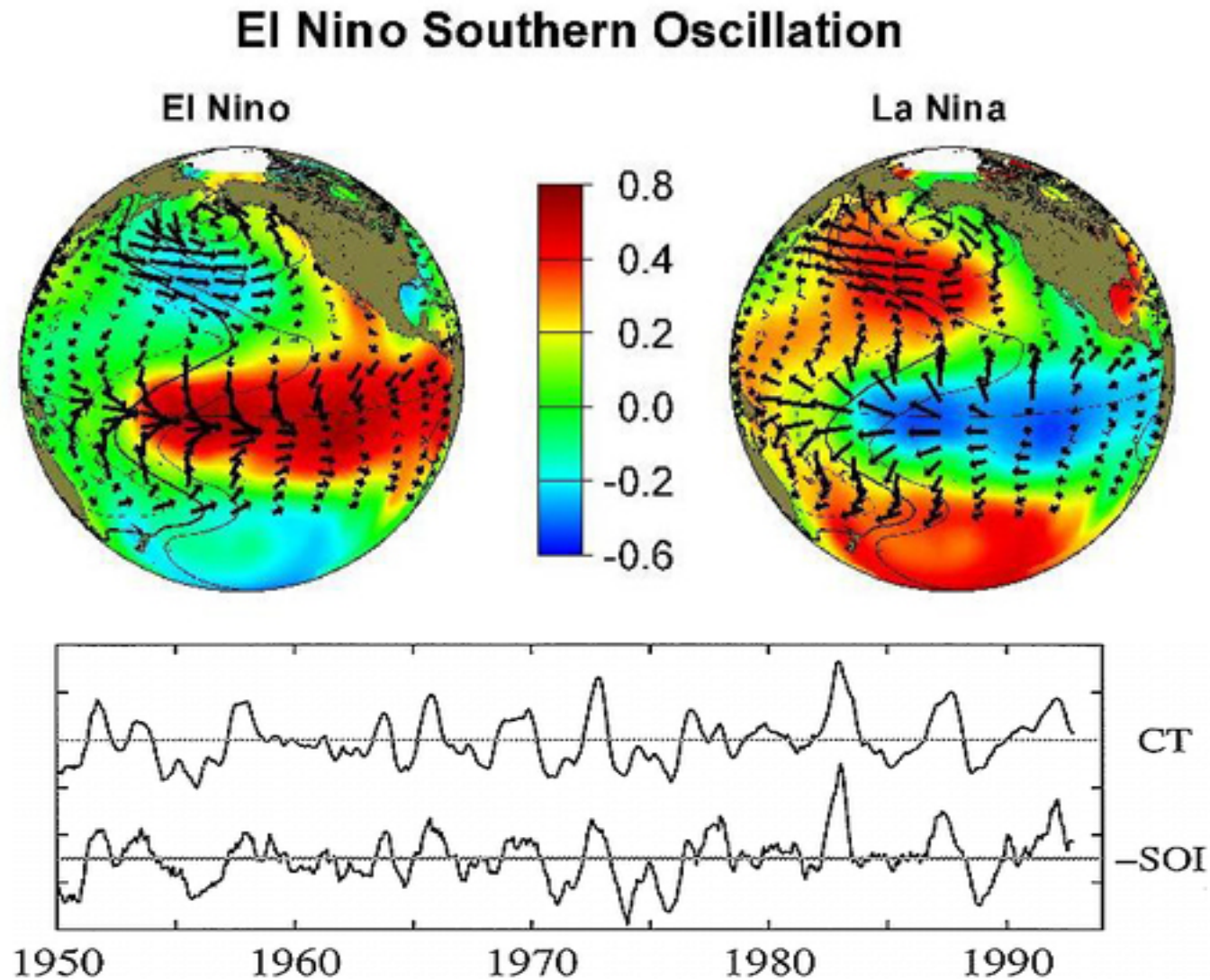
Pacific Decadal Oscillation: Noise Integration, Nonlinear Rectification, and Scale Interaction

<http://www.esrl.noaa.gov/psd/people/dezheng.sun/lectures/ATOC7500.html>

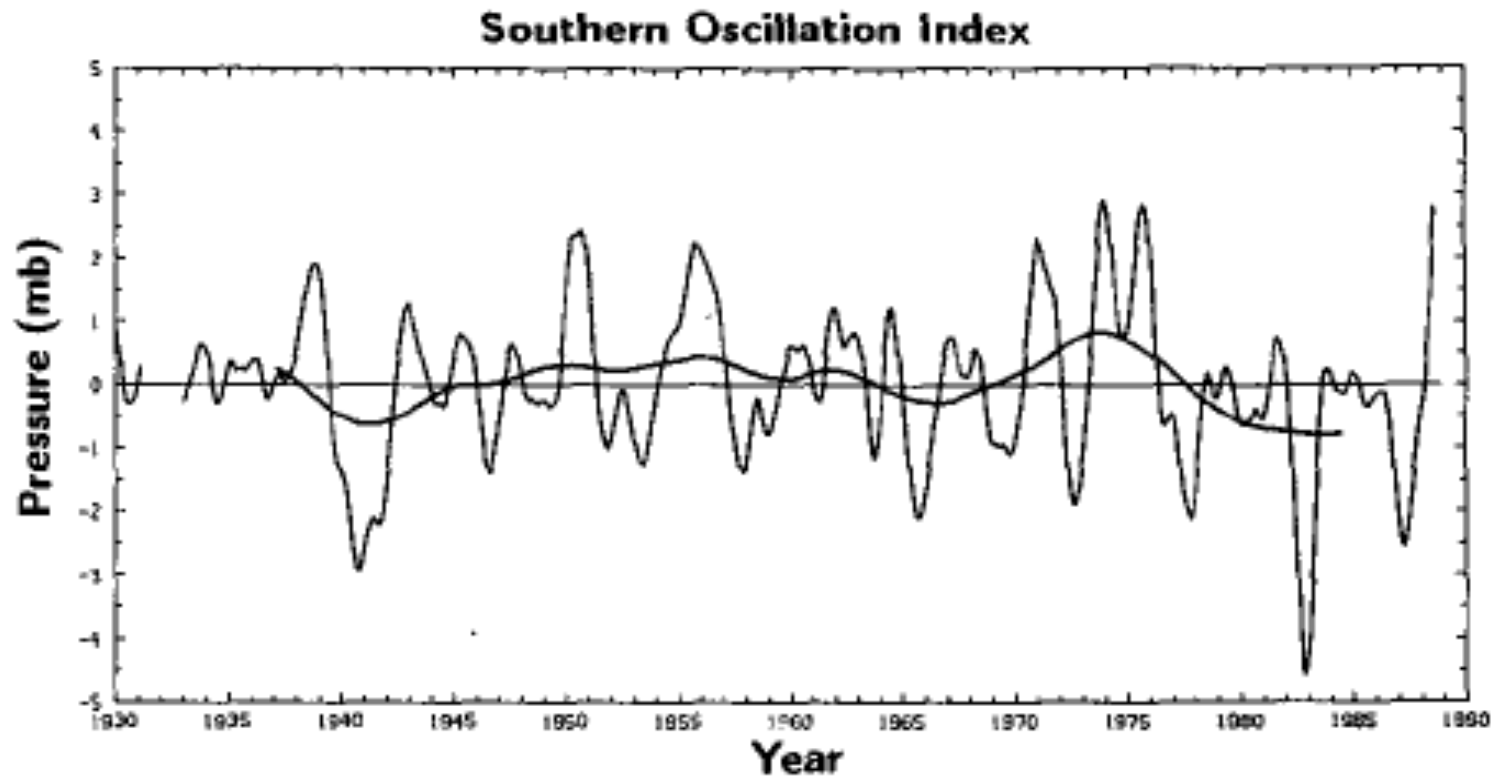
The Pacific Decadal Oscillation



The El Nino-Southern Oscillation



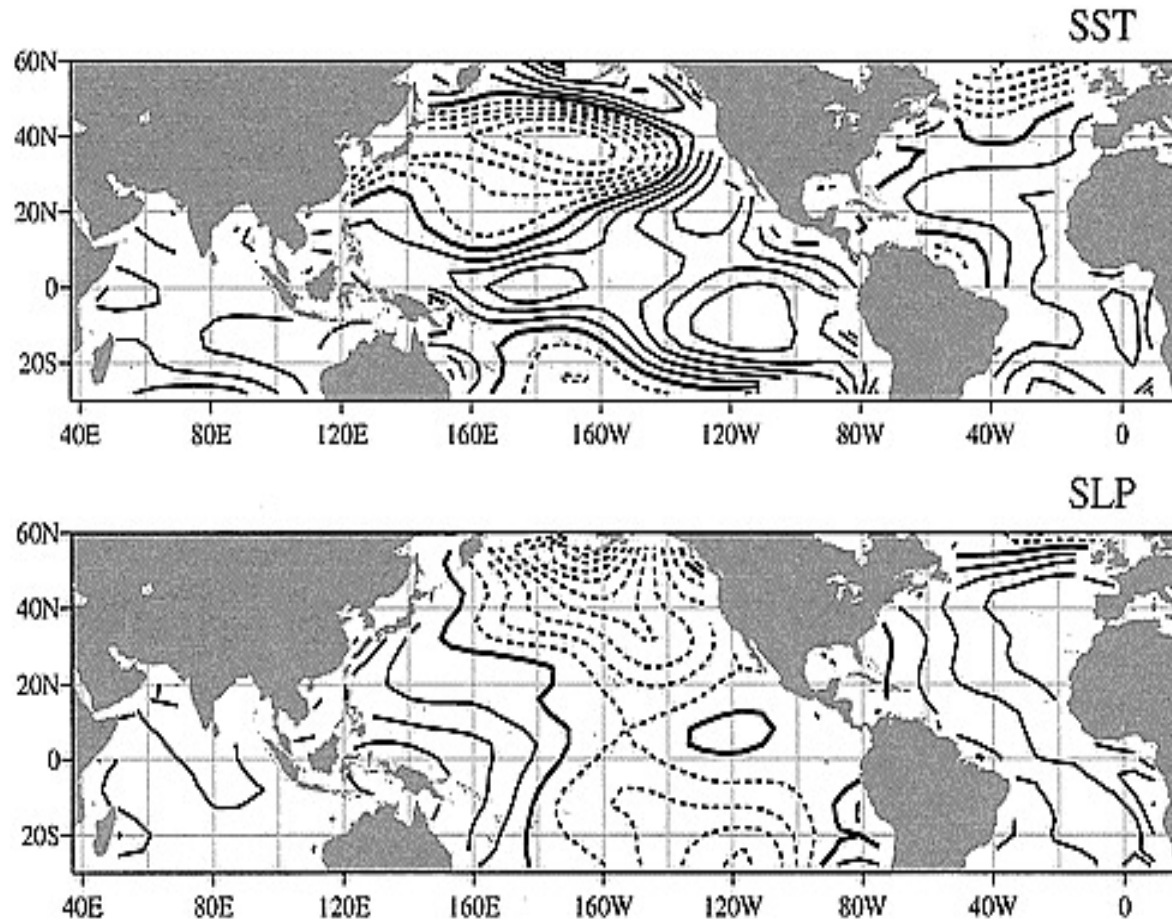
The 1976 Regime Shift



Trenberth (1990)

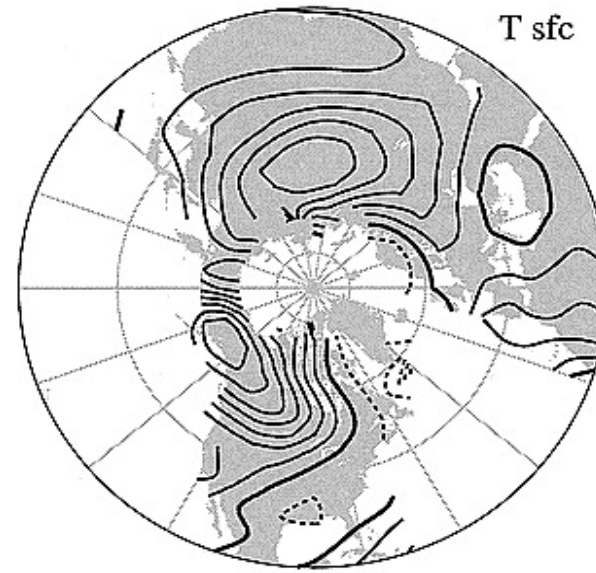
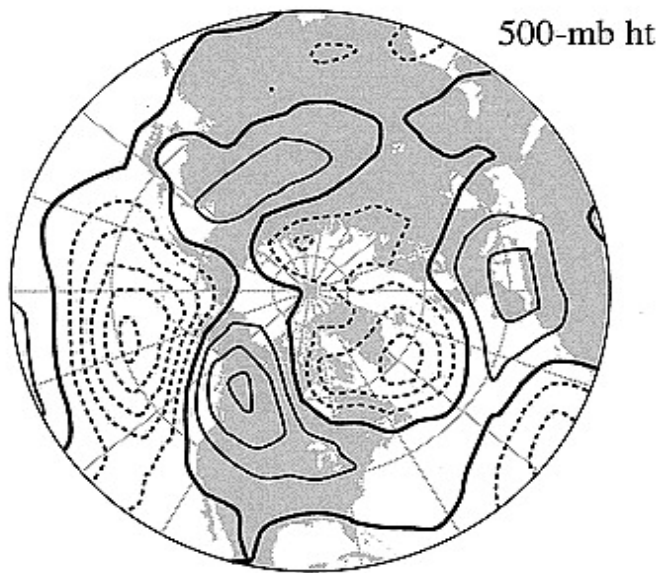
The 1976 Regime Shift

Epoch 1977–93 minus epoch 1950–76

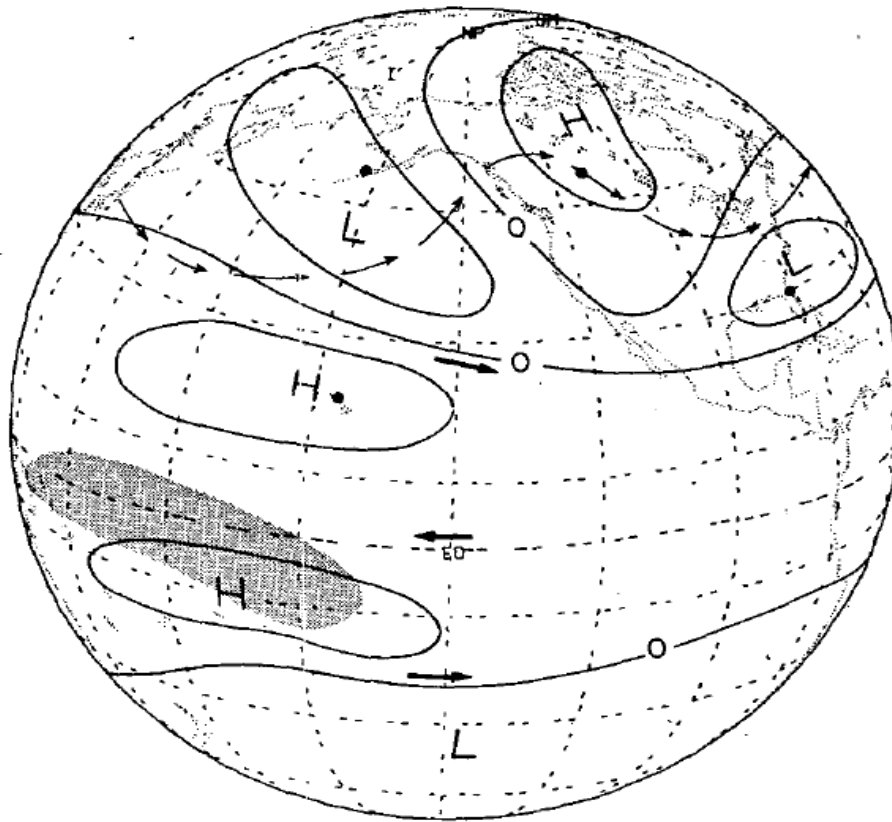


The 1976 Regime Shift

Epoch 1977–93 minus epoch 1950–76



The Pacific/North American teleconnection pattern (PNA)



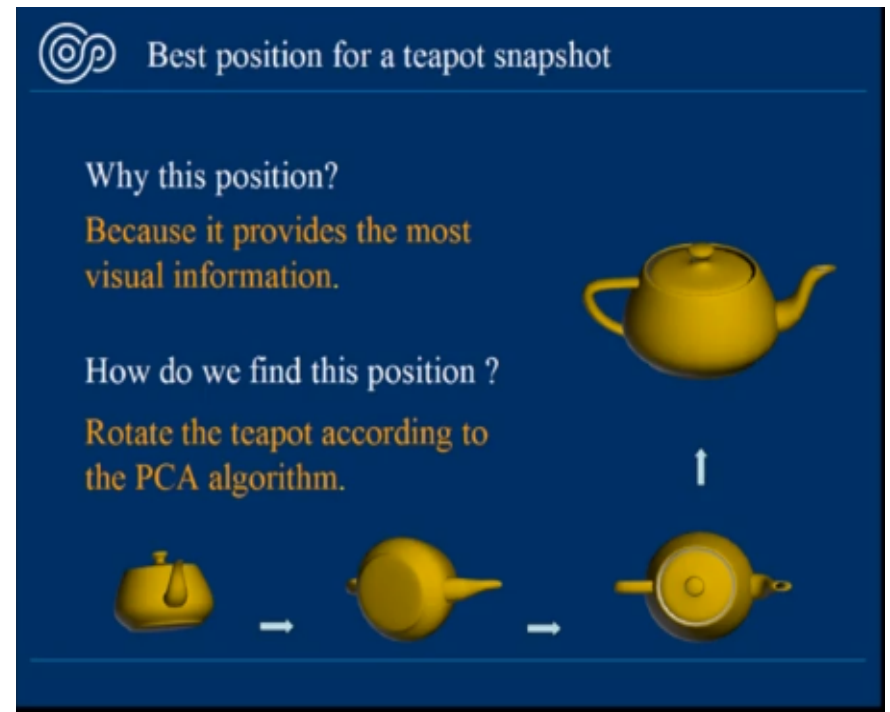
Horel and Wallace 1981

Principal Component Analysis

PCA is an orthogonal linear transformation that transforms the data to a new coordinate system such that the greatest variance by any projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance on the second coordinate, and so on.

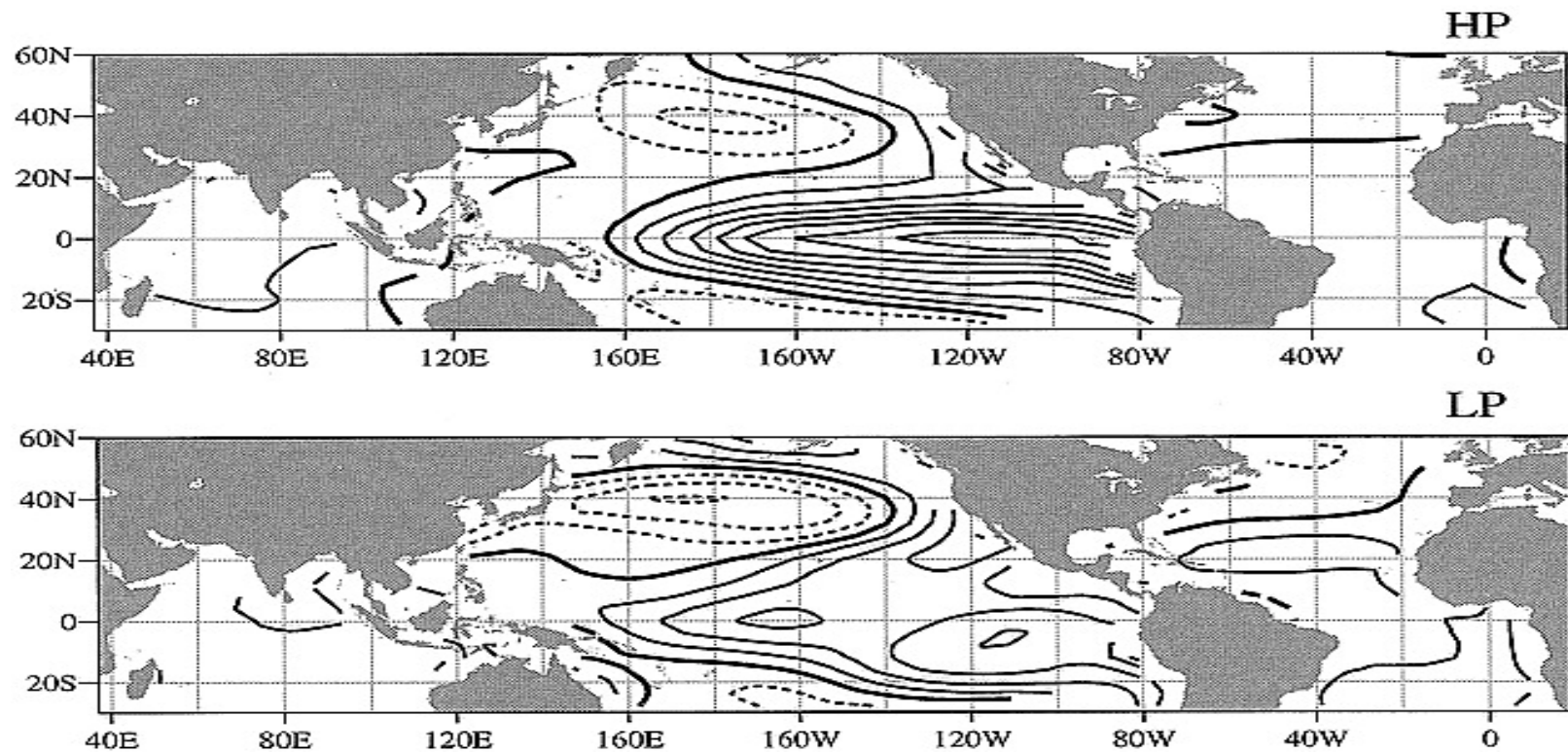
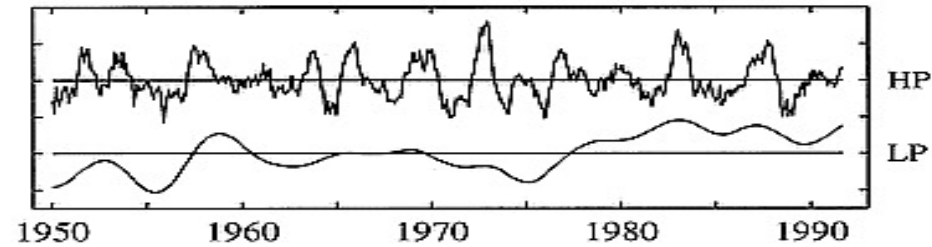
Jolliffe, I.T. (2002). *Principal Component Analysis*, second edition (Springer).

Horel, J. D., 1984: Complex Principal Component Analysis: Theory and Examples. *J. Climate Appl. Meteor.*, **23**, 1660–1673.

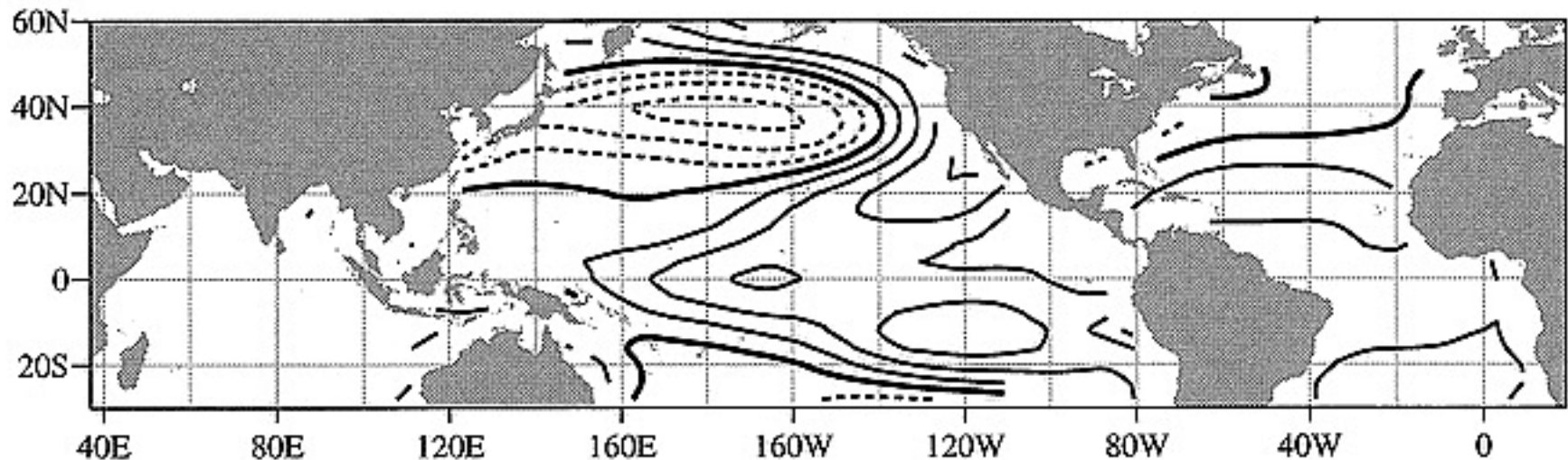
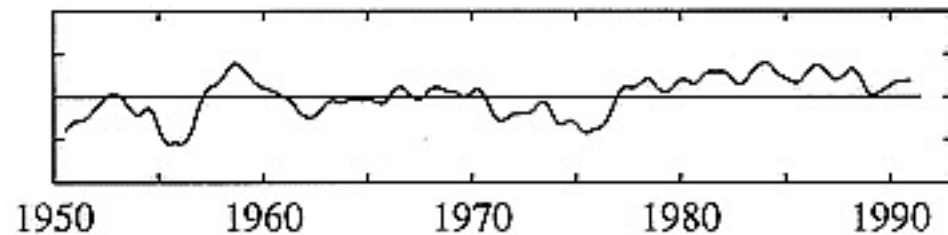


<http://www.youtube.com>

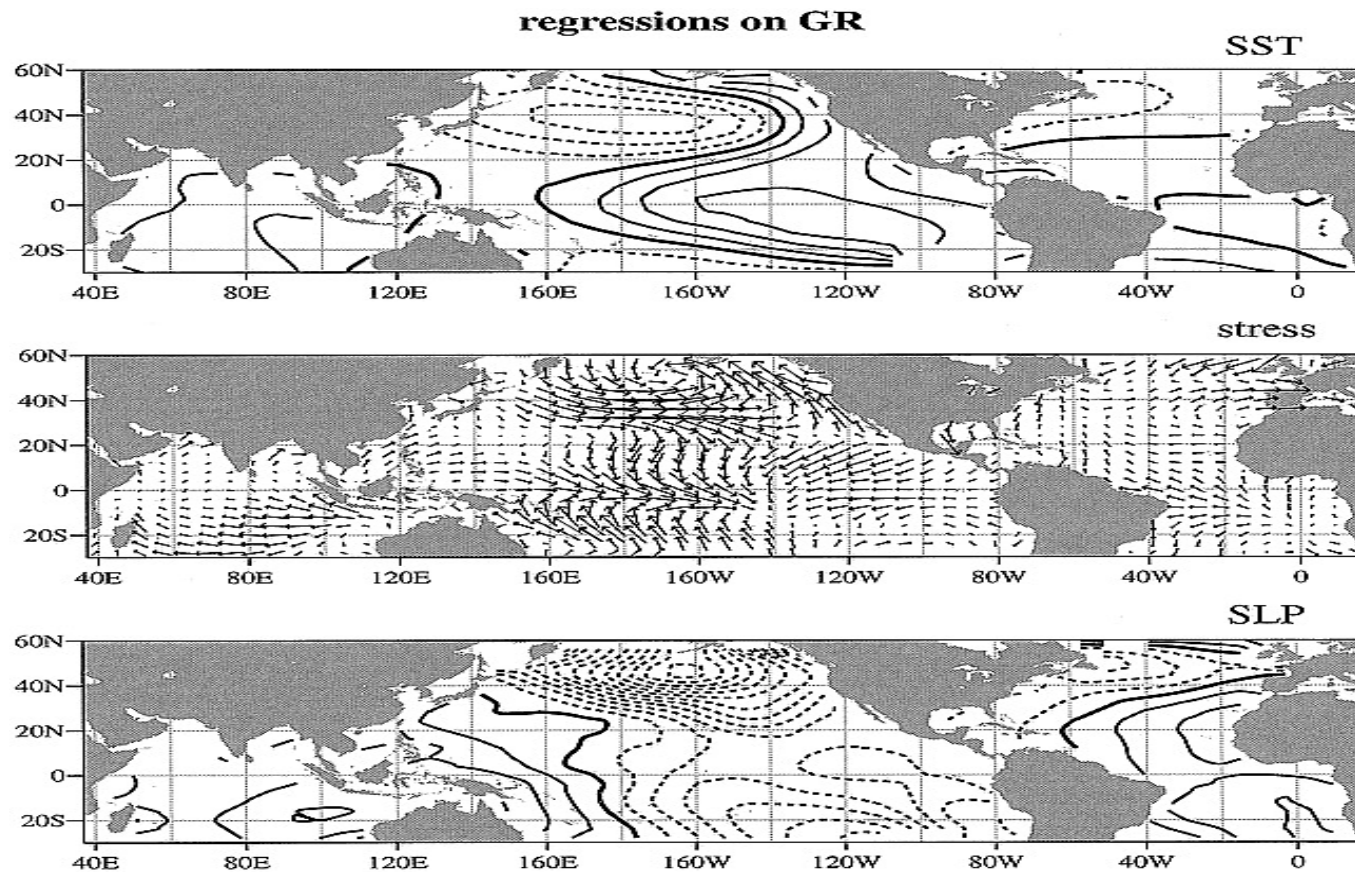
PCs of Global SST Variability



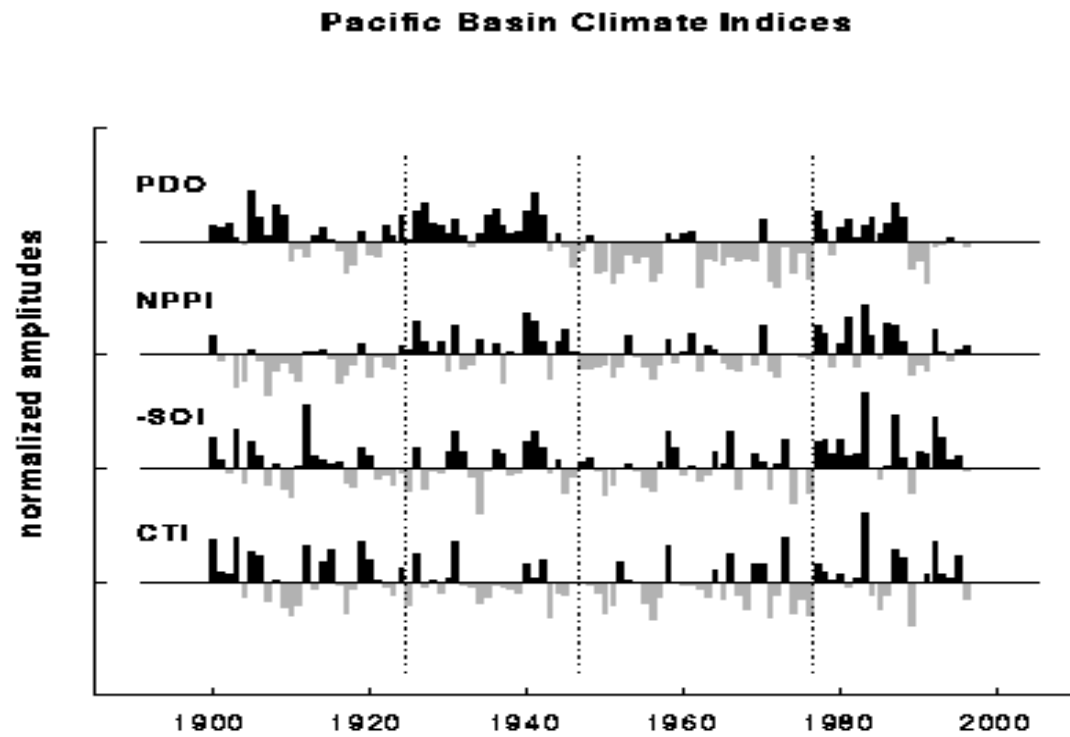
PDO shown as the leading PC of the Residual Variability of Global SST



PDO: Spatial Patterns

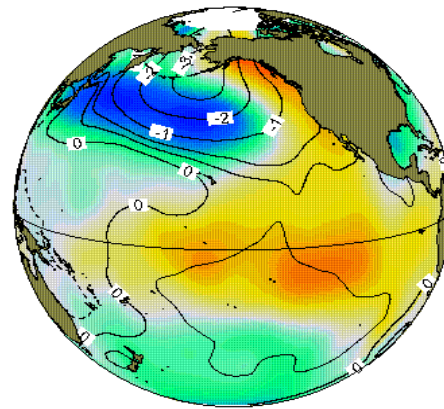


PDO and Other Pacific Basin Climate Indices



Spatial Patterns of PDO and ENSO: Similarity and Differences

(a) SST and SLP regressed on the PDO index



(b) SST and SLP regressed on the CTI

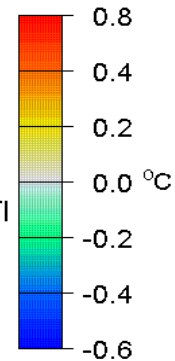
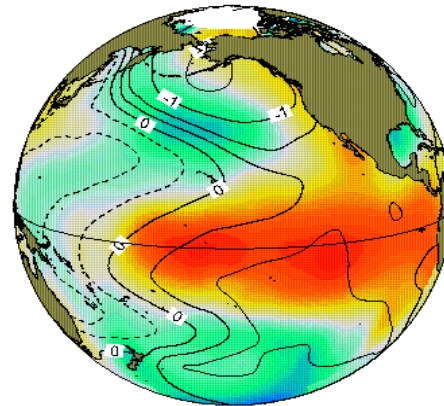
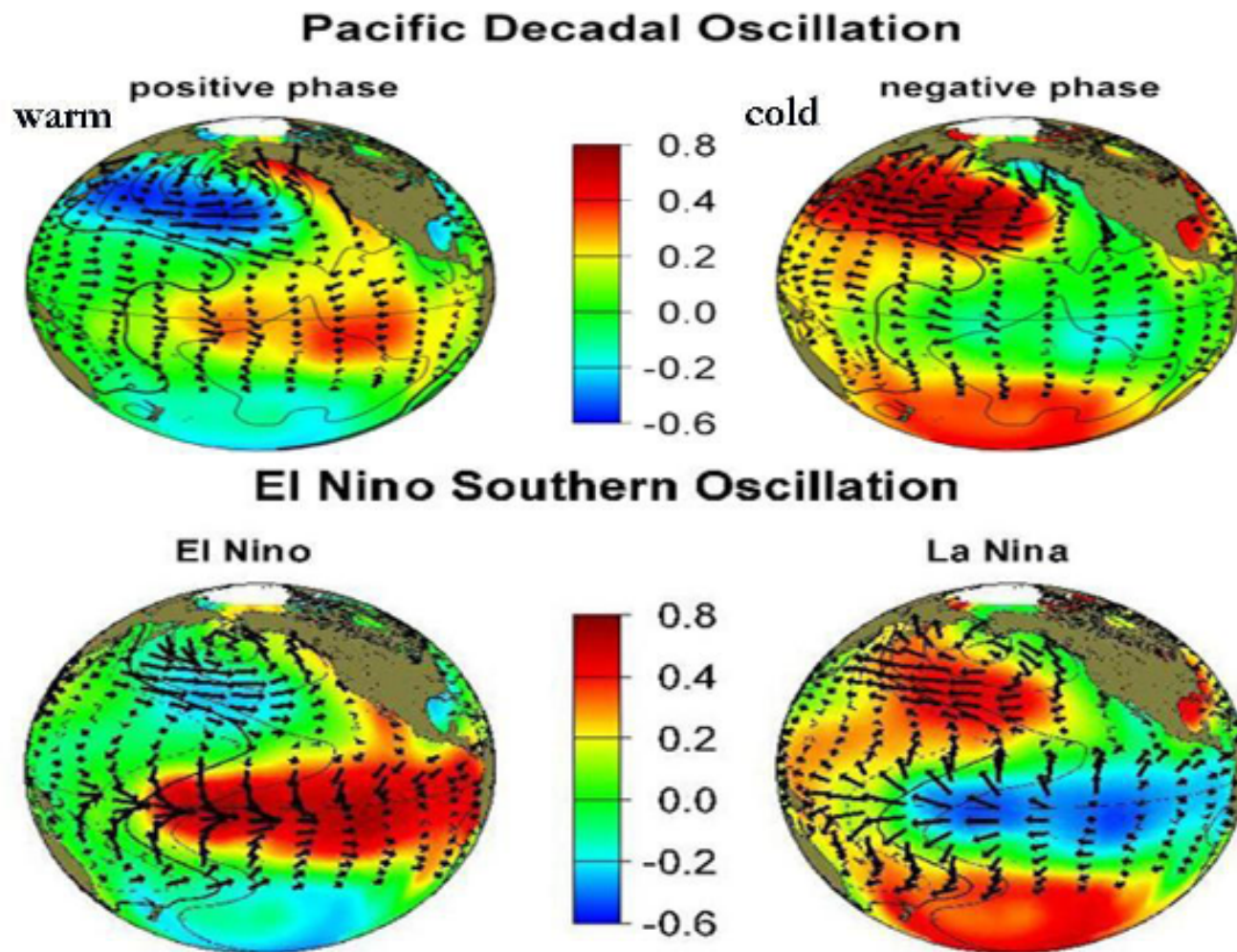


Figure 2

Spatial Patterns of PDO and ENSO: Similarity and Differences



The PDO and Alaskan salmon production

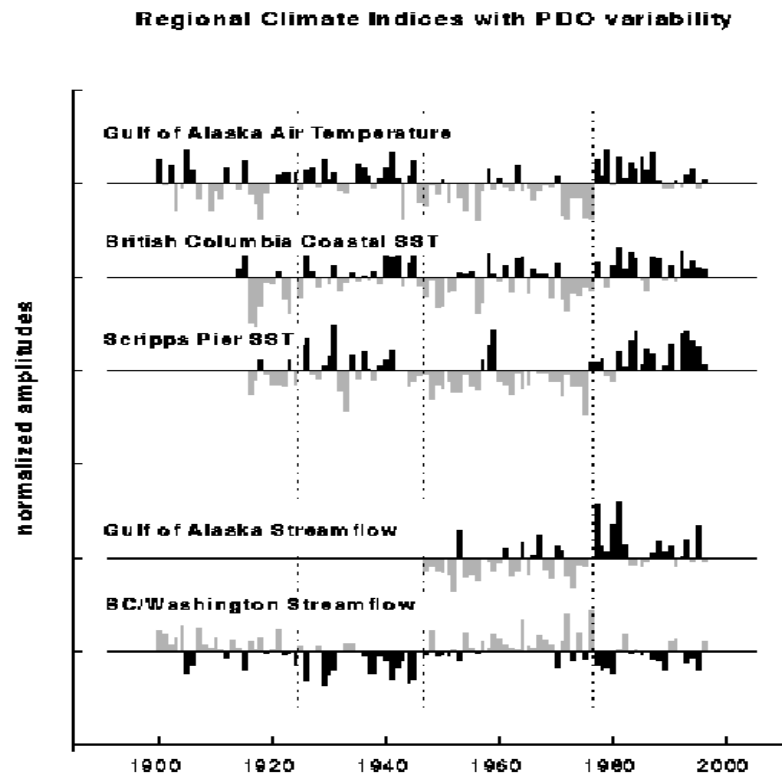


Figure 5

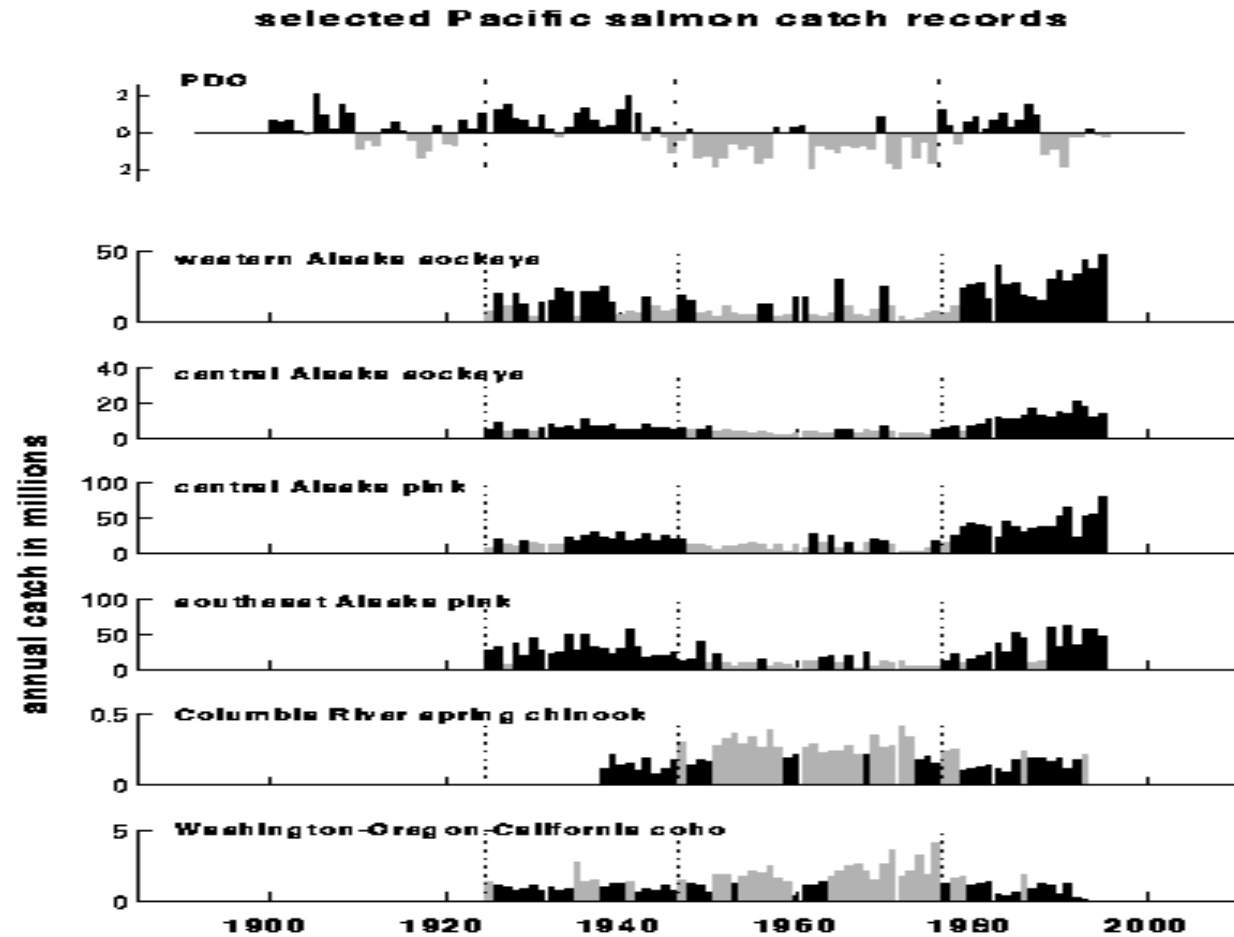
Selected regional climate time series with PDO signatures. Dotted vertical lines are drawn to mark the PDO polarity reversal times in 1925, 1947, and 1977. Bars are shaded as in Figure 1.

TABLE 3: Percent change in mean catches of four Alaskan salmon stocks following major PDO sign changes in 1947 and 1977.

salmon stock	1947 step	1977 step
western Alaska sockeye	-37.2%	+242.2%
central Alaska sockeye	-33.3%	+220.4%
central Alaska pink	-38.3%	+251.9%
southeast Alaska pink	-64.4%	+208.7%

Mantua et al. 1997

PDO and Pacific salmon production



Recommended Readings

Zhang, Yuan, John M. Wallace, David S. Battisti, 1997: ENSO-like Interdecadal Variability: 1900–93. *J. Climate*, 10, 1004–1020.

Frankignoul, Claude; Hasselmann, Klaus (1977). "Stochastic climate models, Part II Application to sea-surface temperature anomalies and thermocline variability". *Tellus* 24 (4): 289–305.

Alexander, Michael A; Ileana Bladé, Matthew Newman, John R. Lanzante, Ngar-Cheung Lau, James D. Scott (2002). "The Atmospheric Bridge: The Influence of ENSO Teleconnections on Air–Sea Interaction over the Global Oceans". *Journal of Climate* **15** (16): 2205–2231

Alexander, Michael A.; Deser Clara (1995). "A Mechanism for the Recurrence of Wintertime Midlatitude SST Anomalies". *Journal of Physical Oceanography* 125 (1): 122–137

Newman, M.; Compo, G.P.; Alexander, Michael A. (2003). "ENSO-Forced Variability of the Pacific Decadal Oscillation". *Journal of Climate* 16 (23): 3853–3857