Mechanisms of Pacific Decadal Variability

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There are several different ‘flavors’ of mechanisms governing decadal variability in the Pacific.

- Interactions between the ocean and atmosphere can produce noise that drives low-frequency changes in the ocean.
- Interactions between annual scale changes can influence the ocean-atmosphere system on decadal and centennial timescales.
- The memory of the coupled system (ocean mostly) can provide negative feedbacks forcing oscillatory behavior.
- But how can we test these mechanisms given the relatively short instrumental record?
Models!!!
• Stochastic forcing plays an important role in the Pacific. When a hybrid coupled model is forced stochastically it can simulate interdecadal variability through forcing by noise alone.
Latif, 1998
How it works

- When the subtropical gyre is strong warm water is transported poleward.
- The atmospheric response generates a wind stress anomaly, which weakens the subtropical gyre.
- The ocean then adjusts, with lag time, resulting in an oscillation through feedback.
- In this mechanism the Tropics play a minor role.
- Does this explain it all?
PDO SST Pattern

Mestas-Nunez and Miller, 2006
Predictability

The problem with predictability of decadal variability is inextricably linked with the problem of predicting interannual phenomena like ENSO.

According to models SST anomalies in the central North Pacific can be used to predict changes ~5 years later.

What is the major problem with this?
Why might we need a longer record?

MacDonald and Case, 2005
MacDonald and Case, 2006: Reconstructed PDO
PDO Index (Mantua, 1997)
Simple red-noise model:

\[ X_t = \alpha \cdot X_{t-1} + \xi \]

- Autocorrelation
- White noise
Red-noise + ENSO model:

\[ P_t = \alpha \cdot P_{t-1} + \beta P_t + \zeta \]
Power spectra

- ENSO
- PDO
- MC-95%
- Mean
- Min. 20%
Prediction
Where else might this apply?
NINO3.4

SST Correlation

PDSI Correlation
Autocorrelation
PDO
PDSI Correlation
SST Correlation
ACF+NN3.4 ≥ 0.2