

Winter Circulation Anomalies in the Western United States Associated with Antecedent Season and Inter-decadal ENSO Variability, 1948-1998

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Research Question

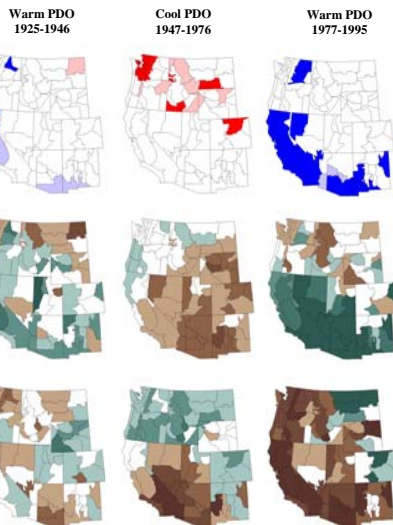
- Do winter circulation anomalies over the western United States, preceded by fall season El Niño or La Niña events, conform to "canonical" ENSO patterns during both cool and warm phases of the PDO?

Background and Rationale

- Strong lagged relationship exists between fall ENSO and winter precipitation in the West¹
- This relationship is operationally useful to stakeholders²
- Cool ENSO events (La Niña) during fall typically precede:
 - Below- (above-) normal precipitation in SW (NW)
 - Ridging anomalies along much of Pacific coast³
- Warm ENSO events (El Niño) during fall typically precede:
 - Above- (below-) normal precipitation in SW (NW)
 - Trouthing anomalies over the southwestern states⁴
- However, these "canonical" impacts can vary on decadal time scales commensurate with phasing of the PDO⁵

Previous Research

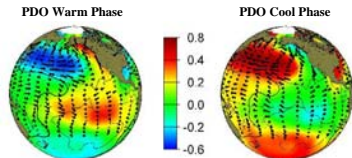
- Consistency of winter (DJF) precipitation anomalies following fall (SON) ENSO events varies with PDO⁶



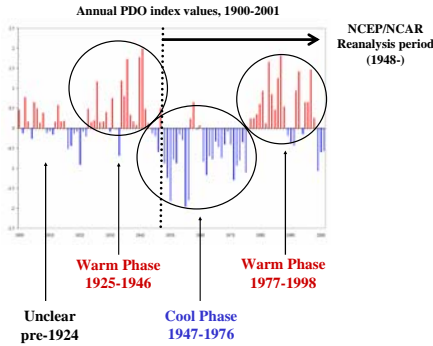
Correlations between SON ENSO and DJF precipitation (A)
Percent of normal DJF precipitation following fall El Niño (B)
and fall La Niña (C) conditions

Methodology: To PDO or Not to PDO? Using the PDO index as a diagnostic tool for ENSO analysis

- N. Pacific SSTs capture both interannual & decadal ENSO signals⁷
- PDO index does not improve ENSO-based seasonal climate prediction for the Western U.S.
- But, PDO index has diagnostic value for examining multidecadal ENSO impacts during discrete Pacific climate regimes
- Three distinct 20th century PDO phases:
 - 1925-1946 (warm), 1947-1976 (cool), 1977-1998 (warm)
 - PDO phasing may have had different periodicity pre-1925
 - PDO behavior after 1998 still somewhat uncertain
- For this study, focused on most recent cool and warm phases



SST anomaly map from JISAO webpage: <http://tao.atmos.washington.edu/pdo>



Data: fall season ENSO events

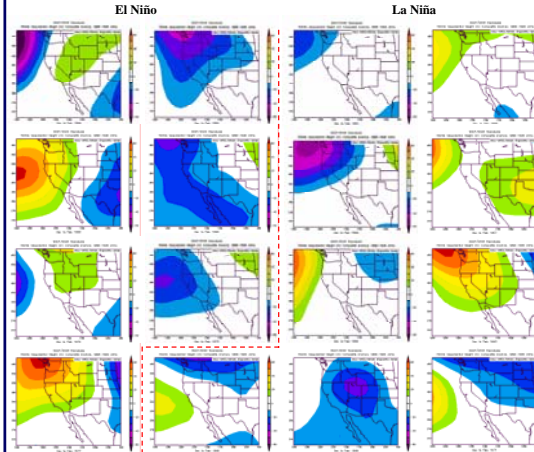
- NOAA definition: 3-month average SST anomaly of $\pm 0.5^\circ\text{C}$ in Niño 3.4

	Fall El Niño events				Fall La Niña events			
Cool PDO Phase 1947-1976	1951	1957	1963	1965	1950	1954	1955	1956
	1969	1972	1976		1961	1962	1964	1967
					1970	1971	1973	1974
					1975			
Warm PDO Phase 1977-1998	1977	1982	1986	1987	1983	1984	1988	1995
	1991	1994	1997		1998			

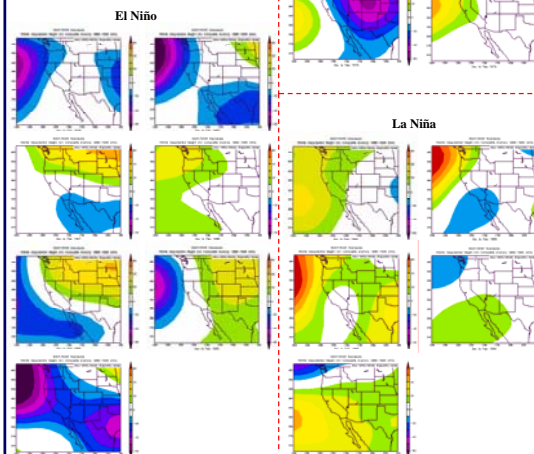
Data: winter season circulation anomalies

- 700mb geopotential height anomalies using NCEP/NCAR Reanalysis

DJF circulation anomalies following SON ENSO: PDO cool phase, 1948-1976



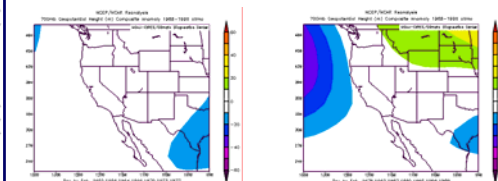
DJF circulation anomalies following SON ENSO: PDO warm phase, 1977-1998



Results

- For PDO cool phase, 1947-1976:
 - ~3 out of 7 fall El Niño events correspond to winter troughing anomalies over, or just west of, the southwestern states
 - ~10 out of 13 fall La Niña events correspond to winter ridging anomalies along or off the Pacific coast
- For PDO warm phase, 1977-1998:
 - ~6 out of 7 fall El Niño events correspond to winter troughing anomalies over, or just west of, the southwestern states
 - ~4 out of 5 fall La Niña events correspond to winter ridging anomalies along or off the Pacific coast

DJF Circulation Composites following SON El Niño Events



Cool PDO, 1947-1976

Warm PDO, 1977-1998

Key Implications

- La Niña may be dominant ENSO phase for next 15-20 years⁸
- PDO may have also shifted to cool phase around 1998
- If true, next two decades could see periods of:
 - Weak predictive information for the Southwest (i.e., fall El Niño events may not be well-linked to above-normal winter precipitation anomalies)
 - Strong predictive information for the Northwest (i.e., fall La Niña events may be well-linked to above-normal winter precipitation anomalies)
- Stakeholders in Southwest could be most negatively affected
 - Frequently anomalously dry winters \rightarrow drought
 - Uncertain seasonal precipitation forecasts during El Niño

References

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Acknowledgements

The author would like to thank Beano Cook for his continuing commentary regarding college football.