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DECADAL VARIATIONS IN THE STRENGTH OF ENSO TELECONNECTIONS WITH PRECIPITATION IN THE WESTERN UNITED STATES

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ABSTRACT

Changing patterns of correlations between the historical average June–November Southern Oscillation Index (SOI) and October–March precipitation totals for 84 climate divisions in the western US indicate a large amount of variability in SOI/precipitation relations on decadal time scales. Correlations of western US precipitation with SOI and other indices of tropical El Niño–Southern Oscillation (ENSO) processes were much weaker from 1920 to 1950 than during recent decades. This variability in teleconnections is associated with the character of tropical air–sea interactions as indexed by the number of out-of-phase SOI/tropical sea surface temperature (SST) episodes, and with decadal variability in the North Pacific Ocean as indexed by the Pacific Decadal Oscillation (PDO). ENSO teleconnections with precipitation in the western US are strong when SOI and NINO3 are out-of-phase and PDO is negative. ENSO teleconnections are weak when SOI and NINO3 are weakly correlated and PDO is positive. Decadal modes of tropical and North Pacific Ocean climate variability are important indicators of periods when ENSO indices, like SOI, can be used as reliable predictors of winter precipitation in the US. Copyright © 1999 Royal Meteorological Society.

KEY WORDS: El Niño; Southern Oscillation; Pacific Decadal Oscillation; precipitation

1. INTRODUCTION

Over the past several decades, teleconnections between El Niño–Southern Oscillation (ENSO) in the tropical Pacific Ocean and surface climate in several parts of the world have been identified (Trenberth, 1976, 1984, 1997; Horel and Wallace, 1981; Namias and Cayan, 1984; Yarnal and Diaz, 1986; Redmond and Koch, 1991; Ropelewski and Halpert, 1996). Redmond and Koch (1991) identified significant correlations between the average June–November Southern Oscillation Index (SOI) and winter precipitation in the western US for the period 1934–1985. Their analysis indicates positive correlations between SOI and winter precipitation in the northwestern US and negative correlations between SOI and winter precipitation in the southwestern US. Where these correlations are statistically significant and reliable they have been used to make probabilistic forecasts of winter precipitation in the western US from SOI (Redmond and Koch, 1991; Kahya and Dracup, 1994; Piechota and Dracup, 1996).

Some of this research has focused on El Niños to the exclusion of La Niña, and *vice versa*. In contrast, the work by Redmond and Koch described linear relations between SOI and precipitation, relations which exploit near-mirror image climate responses of precipitation to El Niños and La Niñas in many regions in the western US. Recently, some studies have identified asymmetries in ENSO teleconnections with North American climate (Hoerling *et al*., 1997; Livezey *et al*., 1997). These asymmetries, however, are not

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well understood and are only beginning to be used in ENSO forecasts. In this study, the linear relations described by Redmond and Koch are examined in greater detail, with a particular focus on long-term variations in their reliability.

Suspicions that SOI teleconnections may not be consistent through time have been reported by Trenberth and Shea (1987), Elliott and Angell (1988), Redmond and Cayan (1994), Trenberth and Hoar (1996), and Trenberth (1997). There has been speculation that the variability in SOI/precipitation relations may be due to data problems in the SOI (Ropelewski and Jones, 1987; Elliott and Angell, 1988; Trenberth, 1997), or that the SOI may not be the best index of ENSO (Elliott and Angell, 1988). Other research has indicated that the SOI is a reliable descriptor of ENSO processes in the tropical Pacific Ocean, but that changes in the ocean/atmosphere system in the North Pacific Ocean may drive the variability in SOI/precipitation relations in the extratropics (Ropelewski and Jones, 1987; Elliott and Angell, 1988). The objective of this study is to (i) identify variability in the reliability of relations between SOI and winter precipitation in the western US, (ii) determine whether variability in these relations is limited to the SOI or whether other indices of ENSO yield teleconnections with similar variability, and (iii) examine long-term tropical and extratropical conditions that may be related to long-term major variations in SOI/precipitation relations.

2. DATA AND METHODS

Average June–November SOI and October–March precipitation data are studied here to be consistent with the study by Redmond and Koch (1991), which describes long-term average relations between ENSO and western US precipitation. Variations from these average relations are the focus of the current study.

2.1. Indices of ENSO and variability of the North Pacific Ocean

The SOI is an index of the atmospheric pressure difference across the tropical Pacific Ocean that is commonly used to monitor ENSO conditions (Trenberth and Shea, 1987; Elliott and Angell, 1988; Redmond and Koch, 1991; Trenberth and Hoar, 1996). The SOI is computed as the standardized difference between standardized sea level pressures (SLPs) measured at Tahiti and Darwin, Australia (Figure 1). The Tahiti minus Darwin SLP index is negative for El Niño conditions and positive for La Niña conditions. Monthly SOI values for the years 1895–1993 were obtained from the Climate Research

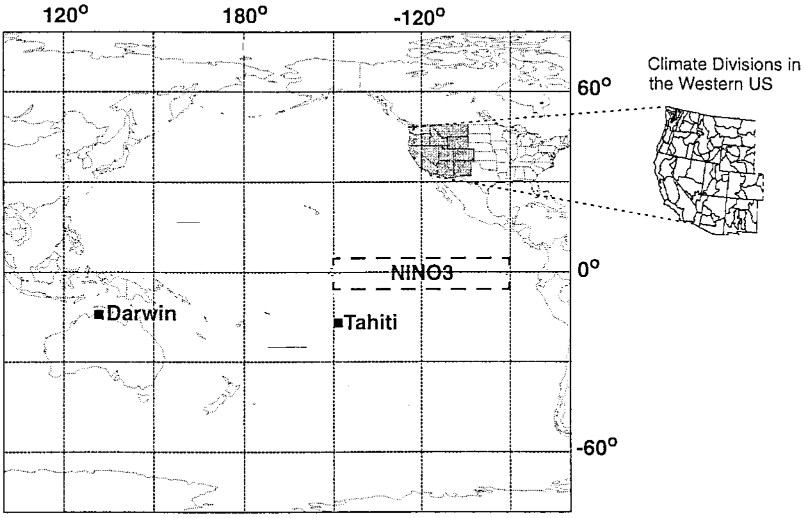


Figure 1. Areas where winter climate division precipitation (shaded) are analysed in this study. SLPs measured at Darwin and Tahiti are used to compute the SOI and SSTs in the dashed box are used to compute NINO3

Unit, University of East Anglia, and used to compute June–November averages of SOI for comparison with winter precipitation in the western US.

Another common index of ENSO is the average of sea surface temperature (SST) anomalies over the region from 90 to 150°W longitude and from 5°N to 5°S latitude, called NINO3 SSTs (Figure 1). NINO3 data were obtained from the Kaplan avGOSTA data set, which is available at the Kaplan internet site (http://ingrid.ldgo.columbia.edu/SOURCES/.KAPLAN/.Indices/.NINO3/.avGOSTA). NINO3 directly measures the oceanic aspects of ENSO in a part of the Pacific Ocean that is most critical for the development of extratropical climatic effects (Hoerling and Kumar, 1977). NINO3 SSTs are used in this study as an alternative index of ENSO conditions to determine whether variations in SOI/precipitation relations are results of SOI errors or whether the variations indicate real differences in tropical/extratropical connections.

In addition to indices of ENSO, the Pacific Decadal Oscillation (PDO), an index of long-term variability of the North Pacific Ocean was examined. The PDO is an index that reflects the dominant mode of decadal variability of SSTs in the North Pacific Ocean (Mantua *et al.*, 1997), and is calculated as the leading principal component of monthly SSTs in the Pacific basin poleward of 20°N latitude.

2.2. Precipitation data

Monthly precipitation totals for the years 1895–1995 for 84 climate divisions in the western US were obtained from the National Climatic Data Center (Asheville, NC). The climate divisions represent regions within states that are relatively climatically homogeneous and that contain observation sites with enough historical records to reliably compute long-term precipitation estimates (Karl and Riebsame, 1984). October–March precipitation totals were computed for each of the 84 climate divisions and for each year of record.

2.3. Methods of analysis

Redmond and Koch (1991) identified SOI/precipitation relations for the western US by computing linear correlations between the average June–November SOI (hereafter referred to as SOI) and October–March (hereafter referred to as winter) precipitation for climate divisions in the western US for the 62 year interval from 1934 to 1995. In this study, to examine variability in SOI/precipitation relations for the western US, correlations between SOI and winter precipitation for each of the 84 climate divisions in the western US were computed for overlapping 30-year periods (e.g. 1901–1930, 1911–1940, 1921–1950, 1931–1960, 1941–1970, 1951–1980 and 1961–1990). Correlations between SOI and winter precipitation that were significantly different from zero at a 95% confidence level were mapped for each 30-year period. The maps then were examined and compared to identify variability in SOI/precipitation relations. Similar 30 year period correlations were also calculated between western US winter precipitation and other tropical indices of ENSO (e.g. NINO3 and SLP at Darwin, Australia). These additional analyses were performed to verify the variations in SOI/precipitation relations and to provide a basis for understanding the conditions associated with variations in SOI/precipitation relations.

The 95% confidence levels used were based on the assumption that each SOI is independent from the others (i.e. serial correlation is equal to zero). Serial correlation in time series reduces the effective number of independent observations and thus reduces the degrees of freedom used to determine the confidence in estimates of correlation coefficients. Over the long term, the lag-1 serial correlation of the year-to-year SOI time series is near zero ($r = -0.02$), and is only significantly different from zero at a 95% confidence level for one 30 year period in the SOI time series used in this study. Similarly, over the long term, lag-1 serial correlations for only nine of the 84 climate divisions are significant at a 95% confidence level. In order to mitigate some of the possible complications introduced by serial correlation, and to verify that the correlation counts computed between SOI and precipitation were significant and not obtained by chance, Monte Carlo simulations were performed and simple counts of correlation coefficients above a threshold of 0.362 were computed for each 30 year period. The correlation threshold of 0.362 was chosen because this is the two-tailed significance level for 30 independent observations (28 degrees of freedom).

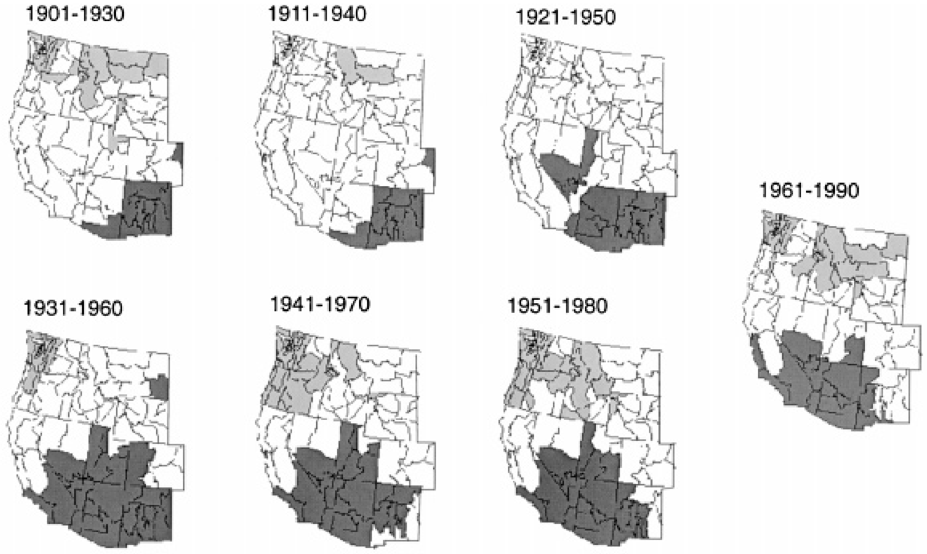


Figure 2. Significant positive (light grey) and negative (dark grey) correlations between the average June–November SOI and October–March climate division precipitation in the western US for a series of 30 year periods

This threshold provides a convenient and consistent threshold to use as an index of meaningful correlations between SOI and precipitation.

3. RESULTS AND DISCUSSION

Correlations between SOI and winter precipitation for the 84 climate divisions in the western US have varied through time (Figure 2). In general, winter precipitation in the northwestern US is positively correlated with SOI and winter precipitation in the southwestern US is negatively correlated with SOI. For 1901–1930, winter precipitation for relatively equal numbers of climate divisions in the northwestern and southwestern US were significantly correlated with SOI. The number of significant correlations between SOI and winter precipitation in the western US decreased dramatically for the periods 1911–1940 and 1921–1950, especially in the northwestern US. During 1921–1950, the only significant correlations between SOI and winter precipitation were in the southwestern US. During 1931–1960, significant correlations were indicated for divisions of the northwestern US and several for the southwestern US. During 1941–1970, 1951–1980 and 1961–1990, a relatively large number of significant correlations between SOI and winter precipitation occurred. The maps of the significant correlations for these three recent periods are similar to the overall correlation map generated by Redmond and Koch (1991).

The series of maps (Figure 2) indicate large deviations in the number and location of significant correlations between SOI and winter precipitation in the western US, especially during 1911–1940 and 1921–1950. Counts of significant correlations between SOI and winter climate division precipitation in 30 year moving windows (Figure 3A) indicate consistently fewer significant correlations starting around 1920 and lasting until about 1950, and more counts after the early 1950s (Figure 3A). A similar analysis was performed in which the areas, rather than the numbers, of climate divisions with significant SOI/precipitation correlations were totalled for 30 year periods, with similar results.

To assess the significance of the variations in the numbers of significant SOI/precipitation correlations for 30 year periods, a pattern significance test was performed (Livezey and Chen, 1983). The SOI time series was randomly shuffled 1000 times. For each trial, the number of significant correlations between SOI and climate division precipitation for 30 year periods were computed. For each 30 year period, 95% and 99% exceedence levels of numbers of significant correlations in the 1000 trials were compared with the

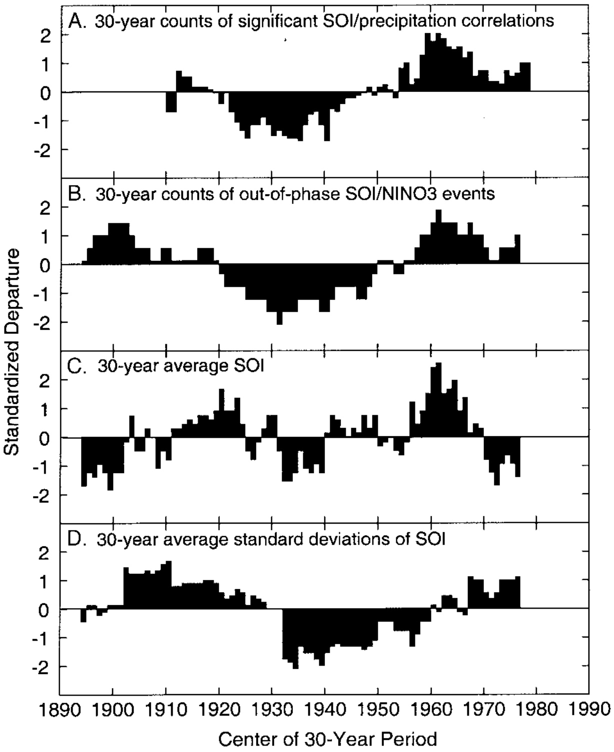


Figure 3. (A) Standardized 30 year moving counts of significant correlations between the average June–November SOI and October–March climate division precipitation in the western US, (B) standardized 30 year moving counts of years when the extremes of the average June–November SOI are out of phase with the extremes of the average June–November NINO3 SSTs, (C) standardized 30 year moving average June–November SOI, and (D) 30 year moving standard deviations of June–November SOI

number of significant correlations for the original (unshuffled) SOI time series. Numbers of significant correlations above about 25 in Figure 4 exceeded 99% of the random trials, whereas numbers of significant correlations above about 15 exceeded 95% of the trials. Numbers of significant correlations before the 1920s and after the 1950s generally were far more than 99% significant. In addition, the number of significant positive (northwestern US) and negative (southwestern US) correlations were tested independently. The number of significant positive correlations was much (significantly) reduced during the 1920–1950 period relative to other time periods (Figure 5A), whereas the number of significant negative correlations were relatively constant, especially after 1930 (Figure 5B). These results suggest that the

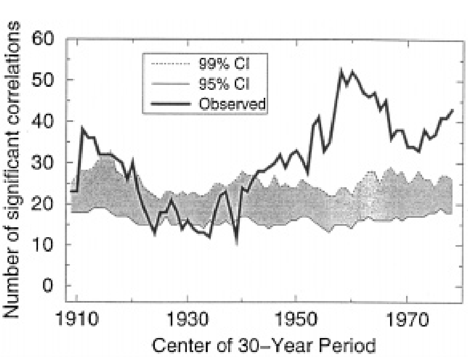


Figure 4. Number of significant correlations between the average June–November SOI and October–March climate division precipitation in the western US. The solid line indicates the observed values and the shaded area indicates the area between the 95% and 99% confidence intervals (CI)

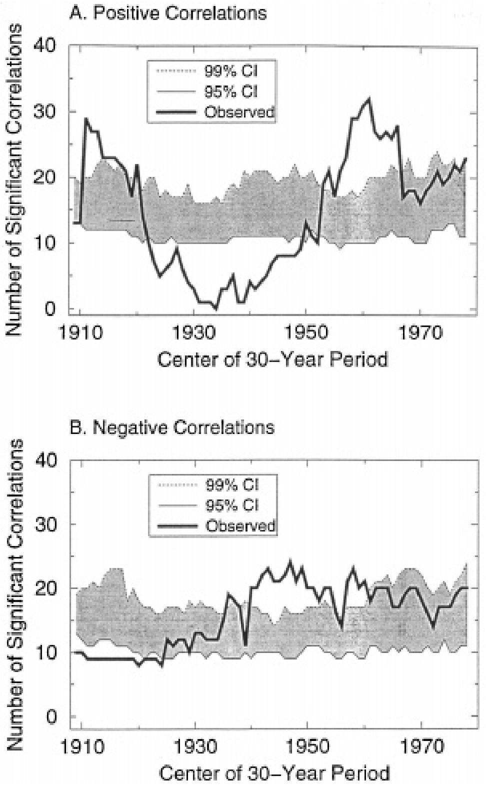


Figure 5. Number of significant (A) positive and (B) negative correlations between the average June–November SOI and October–March climate division precipitation in the western US. The solid line indicates the observed values and the shaded area indicates the area between the 95% and 99% confidence intervals (CI)

majority of the variability in significant correlations between SOI and precipitation in the western US are the result of changing correlations between SOI and precipitation in the northwestern US.

There is a general anti-correlation between winter precipitation in the northwestern and southwestern US (Redmond and Koch, 1991; Dettinger *et al.*, 1998). This anti-correlation is due, in part, to the effects of ENSO. The variability in the strength of ENSO teleconnections with precipitation in the western US can be seen in the correlations between winter precipitation in the northwestern US and southwestern US for different time periods. For example, 30 year moving correlations between winter precipitation averaged for climate divisions in the northwestern US and winter precipitation averaged for climate divisions in the southwestern US indicate weaker relations from about 1920 to 1950 and stronger relations from 1950 to 1980. The correlation between the time series of northwest–southwest precipitation correlations and the time series of 30 year counts of significant correlations between SOI and winter precipitation in the western US is -0.43 (significant at a 99% confidence level). The similarity between these two time series indicates that the spatial patterns of ENSO teleconnections to precipitation in the western US, and not just the strength of the teleconnections, varied from the earlier epoch to the more recent one.

These changes in the reliability of SOI/precipitation relations may be related to long-term differences in the strength of the ENSO variations that force them. Notably, however, the decadal variations in SOI/precipitation correlations shown in Figure 3A are not generally contemporaneous with either long-term changes in SOI means or standard deviations (Figure 3C and D), or at least not as contemporaneous as some of the relations that follow.

Because of concerns regarding the reliability of SOI data measured before 1935, especially data measured at Tahiti (Ropelewski and Jones, 1987), other indices of ENSO also were correlated with winter precipitation in the western US for 30 year moving periods. Two other indices are: (i) average June–November NINO3 SSTs (hereafter referred to as NINO3), and (ii) average June–November SLPs measured at Darwin, Australia (hereafter referred to as Darwin SLP; Darwin SLP data were obtained from the Climate Research Unit, University of East Anglia). Correlations between these two indices are consistently high throughout the decades of the 20th century. However, correlations between these indices and winter precipitation in the western US show significant variations that are closely related to the changing counts of significant SOI/precipitation correlations, with correlations of 0.78 and 0.69, respectively (Figure 6). Thus, the changing precipitation teleconnections in the western US are not simply a consequence of employing SOI to index ENSO variations.

Decadal-scale variations in the counts of significant correlations between ENSO indices and winter precipitation in the western US has important implications for using ENSO indices as precipitation predictors. To explore, in part, why changes occur, analyses of the decadal-scale relations between ENSO indices and Pacific Ocean SSTs were performed. Trenberth and Hoar (1996) have noted that the extremes of SOI and El Niño/La Niña do not always occur together. In a prototypical El Niño or La Niña episode (Rasmusson and Carpenter, 1982), when departures of SOI are negative (tropical easterlies are weak), NINO3 departures are positive (SSTs are warm), and when SOI departures are positive (strong tropical easterlies), NINO3 departures are negative (cold SSTs). Thus, SOI and NINO3 are generally out-of-phase. Recent depictions of ENSO as a coupled tropical air–sea interaction anticipate or predict this out-of-phase relation as a characteristic part of the ENSO process (Philander, 1990). However, during some years, the SOI and NINO3 are not out-of-phase, for example, in 1882 and in 1946, both the SOI and NINO3 departures were negative, and in 1935, both were positive. The reliability of the SOI/NINO3 anticorrelations also varies from decade to decade. Thirty year counts of the number of times the extremes of SOI occurred out-of-phase with the extremes of NINO3 were computed (extremes for both indices were

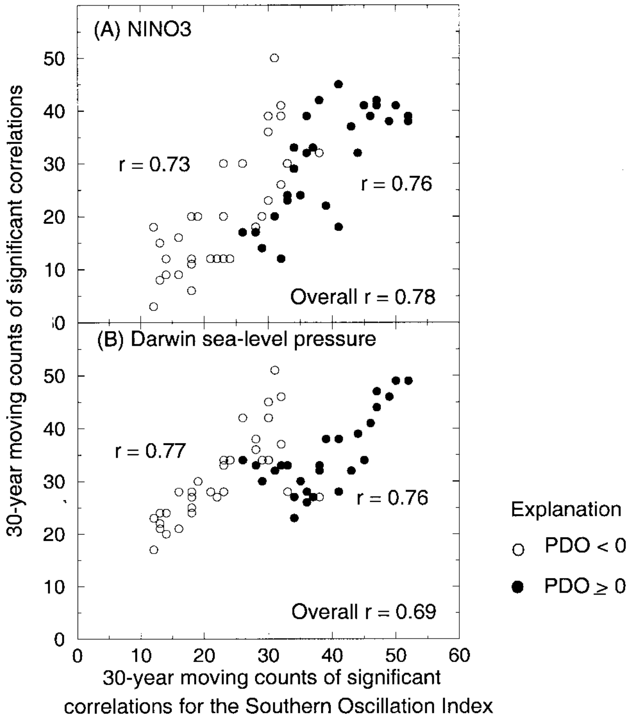


Figure 6. Comparison of 30 year moving counts of significant correlations between the average June–November SOI and October–March climate division precipitation and 30 year moving counts of significant correlations between (A) average June–November NINO3 SSTs and October–March climate division precipitation, and (B) average June–November Darwin SLPs and October–March climate division precipitation. Counts during 30 year periods with positive and negative values of the PDO are indicated by filled and open circles, respectively

defined as departures greater than or equal to 0.5 standard deviations (S.D.) or less than or equal to -0.5 S.D.s). The 30 year counts (Figure 3B) are remarkably similar to the 30 year counts of significant correlations between SOI and winter precipitation in the western US (Figure 3A). The correlation between these two time series of counts is 0.86. Counts of the number of times the Darwin SLP and NINO3 extremes are out of phase also are very similar ($r = 0.86$) to the counts shown in Figure 3B. The precisely shared timing of variations in the strength of SOI/precipitation relations for the western US with how strongly SOI and NINO3 are out-of-phase indicates that the interdecadal periods in which ENSO teleconnections to western US precipitation are erratic reflect interdecadal episodes during which the tropical air–sea connections that drive ENSO are themselves weakened or erratic. Long-term deviations of the SOI/NINO3 anticorrelations (Figure 3B) do not correspond directly, in time, to the mid-century weakening of SOI (decreasing standard deviations of SOI) shown in Figure 3D, but are likely a contributor to that weakening. Some other influence besides ENSO air–sea interactions must be modulating either the SLPs associated with the SOI or Darwin SLP during these periods, or modulating

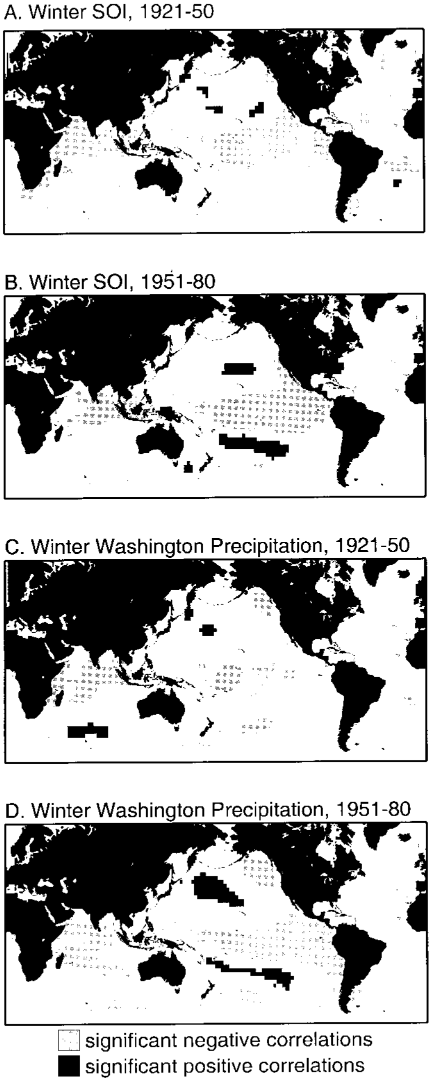
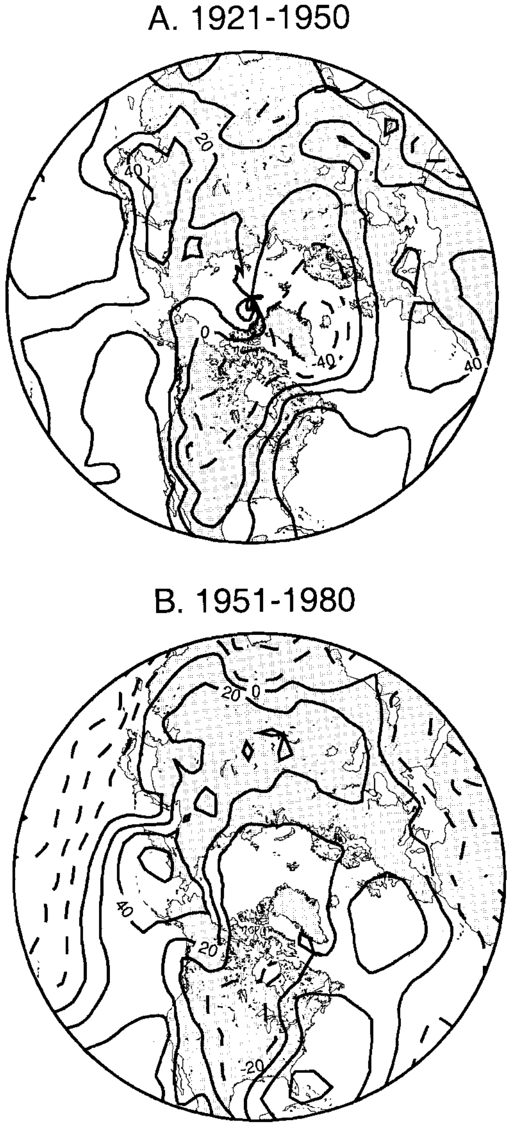


Figure 7. Correlations (significant at a 95% confidence level) between winter (October–March) SSTs (Parker *et al.*, 1995) and the October–March SOI for (A) 1921–1950 and (B) 1951–1980, and between winter SSTs and October–March precipitation for Washington for (C) 1921–1950 and (D) 1951–1980

the SSTs measured by NINO3, or both. Consistent with these results, but on much shorter time scales, Ghil and Jiang (1998), in a study of forecast skill for ENSO, found that the forecast skill of ENSO was high when SOI and NINO3 were out-of-phase, and was low when SOI and ENSO were not anticorrelated.

A broader depiction of the apparent disconnection between SOI and SST variations from about 1920 to 1950 is indicated by epochal correlations between SOI and SSTs in Figure 7A and B. Correlations of SOI with SST (Figure 7A) from 1921 to 1950 were weak everywhere and did not resemble the strong tropical patterns associated with ENSO observed in more recent decades (Figure 7B). Similarly, correlations between Washington winter precipitation totals (computed as the average October–March precipitation for all climate divisions in the state of Washington) and global SSTs from 1921 to 1950 also were weak (Figure 7C) and also did not indicate the ENSO-like tropical correlation patterns observed


A. 1921-1950

B. 1951-1980

Figure 8. Correlations (× 100) between the June–November SOI and October–March SLPs for the Northern Hemisphere for (A) 1921–1950 and (B) 1951–1980. The solid lines indicate positive correlations and the dashed lines indicate negative correlations. The first solid line is the zero correlation isoline and the contour interval is 20

more recently (Figure 7D). Thus, neither SOI nor Washington precipitation was as closely associated with tropical SSTs between about 1920 and 1950. The lack of teleconnections of tropical SSTs with precipitation in the western US (shown in Figure 7A and C) suggests a failure of more than just the reliability of the specific ENSO indices (SOI and NINO3) used in this study, and instead indicates that tropical processes and their teleconnections with western US precipitation were globally weakened and disconnected for a period of several decades.

The weak relations between ENSO and extratropical climate from about 1920 to 1950 also are illustrated by correlations between SOI and winter SLPs for the Northern Hemisphere (Figure 8A and B). The small correlations from 1921 to 1950 indicate proportionately weaker forcing of North American winter weather by the tropical ENSO processes represented by SOI, especially along the subtropical Pacific Ocean. Overall, the Pacific–North American wave train of highs and lows that have characterized ENSO winters in recent decades (Figure 8B) are almost missing in the earlier period (Figure 8A). These wave trains reflect, and affect, shifts in the jet stream and storm tracks over the North Pacific Ocean and North America that, in turn, propagate the ENSO teleconnections into western North America. In the earlier period, when the wave trains were not reliably present (Figure 8A), teleconnections also fail.

The decline in the strength of relations between SOI and winter precipitation earlier this century appears to be related to decadal-scale variations in the North Pacific Ocean climate. The PDO is an index of the dominant form of decadal variability of SSTs in the North Pacific Ocean (Mantua *et al.*, 1997). The precise mechanisms for this form of climate variation remain uncertain (Latif and Barnett, 1996; Gu and Philander, 1997; Zhang *et al.*, 1997) but on interdecadal time scales, do not directly follow ENSO variations. When PDO is negative, the SSTs in the central North Pacific Ocean are warmer than average, and when PDO is positive, the SSTs in the central North Pacific Ocean are cooler than average. Associated with these extremes are interdecadal excursions of Pacific and North American (PNA) atmospheric circulation that resemble the classic PNA pattern. A 30 year moving average of the June–November PDO index exhibits variations that closely mirror the strength of SOI/precipitation relations, as depicted by 30 year counts of significant correlations (Figure 9). On the 30 year time scale, the PDO was higher than average from about 1920 to 1950, and lower than average from about 1950 to 1980, and is thus highly anticorrelated ($r = -0.88$) with the SOI/precipitation correlation counts.

As noted in Figure 6, the correlations between each of the three tropical ENSO indices considered here and precipitation in the western US all vary with PDO. The variations of NINO3 and Darwin SLP

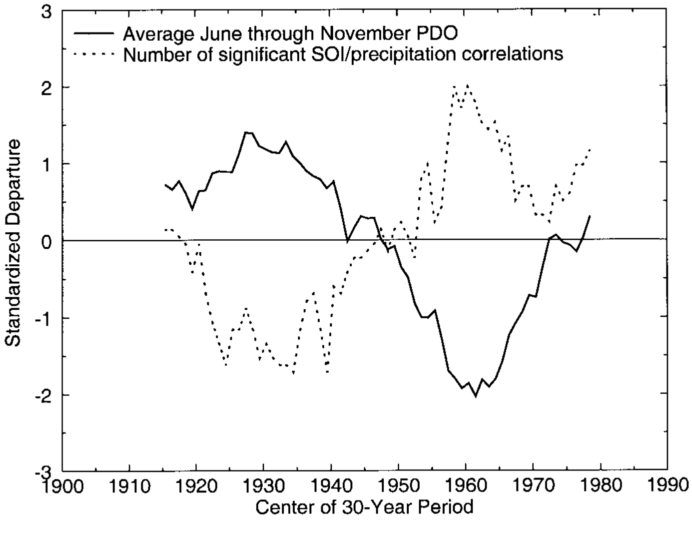


Figure 9. Thirty year moving average of June–November PDO and 30 year counts of significant correlations between average June–November SOI and October–March precipitation in the western US. The data are plotted for the year of the SOI/precipitation correlations

teleconnections, however, do not appear to be as sensitive to PDO as are SOI teleconnections. The open circles (PDO < 0) in Figure 6(a) and (b) indicate considerably smaller counts with respect to SOI (horizontal axis) than do the filled circles (PDO > 0). Although the means of the negative PDO and positive PDO subsets of teleconnections for all three indices used in Figure 6 are significantly different at a 95% confidence level, the teleconnections with respect to NINO3 and especially Darwin SLP (vertical axis) appear to be less dictated by PDO than are SOI teleconnections (Wolter, 1987). Very likely, the shape and extent of the Southern Oscillation SLP pattern, especially near Tahiti, changes when PDO changes sign, and this change is reflected in variations of the tropical teleconnections to western US precipitation. Viewed differently, it might be expected that during the positive phase of PDO (on 30 year time scales), ENSO influences on western US precipitation are blocked or superseded; however, recall that the periods of positive PDO and low SOI/precipitation correlations also corresponds to periods when SOI and NINO3 are less frequently out-of-phase. Thus, whatever the (possible) influence of PDO on western US precipitation, there also is an interference in the tropics between positive PDOs and ENSO air–sea interactions (see also Dettinger *et al.*, 1999).

To understand the weakening of ENSO extratropical teleconnections during positive PDO periods requires additional research. Some possible explanations are (i) positive PDO blocks or interferes with the propagation of the ENSO signal through the extratropics, (ii) decreased anticorrelation between SOI and tropical SSTs results in a break in ENSO teleconnections with the extratropics (Dettinger and Ghil, 1998), and/or (iii) a decrease in ENSO variability results in partial disconnection of typical ENSO air–sea interactions during positive PDO periods (Ghil and Jiang, 1998).

4. CONCLUSIONS

Correlations between SOI and winter precipitation in the western US for overlapping 30 year periods varied in strength and pattern during the 20th century. These variations appear to be related to how closely the oceanic and atmospheric components of ENSO interact from decade to decade to form the out-of-phase SOI and NINO3 relations that have been observed in recent decades. The variations also appear to be associated with large-scale variability of the North Pacific Ocean climate system as indexed by the PDO. ENSO teleconnections with precipitation in the western US are strong when SOI and NINO3 are out-of-phase and PDO is negative. ENSO teleconnections with precipitation in the western US are weak when SOI and NINO3 are weakly correlated and PDO is positive. These ENSO teleconnections are less closely tied to the decadal mean or variance of ENSO fluctuations. Thus, the reliability of teleconnections between the tropical Pacific Ocean and the climate of the US is a remarkably direct function of the state of the tropical and North Pacific Ocean climate system. The results of this study indicate that teleconnections change on decadal time scales. Fortunately, the decadal variations may be anticipated from observations of the slower evolution of the Pacific Ocean climate system. Unfortunately, this also implies that analysis of longer climate series will not always improve the depiction or statistical significance of a particular hydroclimatic teleconnection. Furthermore, analysis of short time series, from the most recent past, may lead to overconfident estimates of teleconnection strength.

If these changes in teleconnections are indeed a function of PDO state, then these teleconnections will certainly revert to the much weaker state of the pre-1950 period at some time (potentially soon, e.g. Hodge 1997; Ghil and Jiang, 1998). Then, the skill of long-range forecasting of climatic conditions in the western US would decline and many existing ENSO-based management strategies could be threatened (e.g. Collier *et al.*, 1997). Consequently, knowledge of the states of the decadal modes of tropical and North Pacific Ocean climate variability is an important scientific issue, since these decadal variations will dictate the nature (and successful prediction) of interannual, as well as decadal climate fluctuations in North America (as well as elsewhere, see Dettinger *et al.*, 1999). The decadal state of the climate system then will be the best indicator of whether ENSO teleconnections can be used as reliable predictors of seasonal precipitation or whether ENSO teleconnections will be unreliable.

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