Precipitation Variability in New Mexico - Some Causes and Consequences

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Due to astronomical considerations (e.g. precession of the equinoxes), climate is expected to change on our planet over long periods of time. Meanwhile, tree-ring records have established the fact that climate exhibits great variability in New Mexico on much shorter scales of time. Grissino-Mayer showed (see fig. 1) the extreme variability exhibited in tree-ring production in the vicinity of El Malpais over the past couple of thousand years. These tree rings show periods of excessively wet and dry weather, that includes droughts such as the one of the late 1500s that pales our modern benchmark drought of the 1950s.

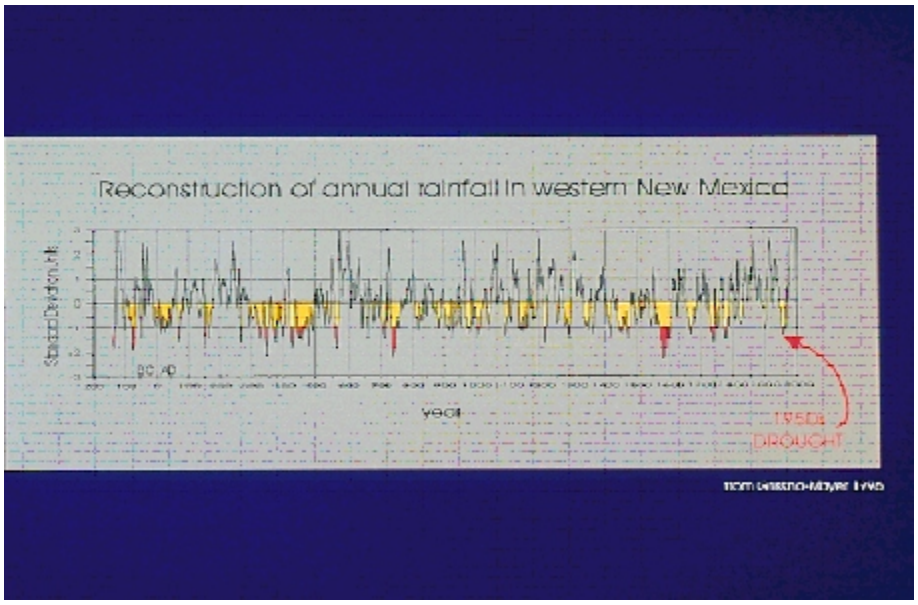


Figure 1 - Grissino-Mayer Tree Ring-derived Precipitation

Climate variability has been known to exist for a long time. However, scientists are just beginning to discover and explore the causes for these variations. The El Niño-Southern Oscillation (ENSO) was almost unheard of until people began questioning what was going on with the relentless storms pounding the western United States during the winter of 1982-1983. Pursuit of the answer managed to unearth a long-forgotten research paper written by Robert Walker in the 1920s, and modern-day scientists realized Mr. Walker had discovered something important. Now, just over 20 years after the El Niño of 1982-1983, we have a much better understanding of the relationships between ENSO and our weather, thanks to the many scientists who have explored this phenomenon.

In the late 1990s, Mantua, Hare, Zhang, Wallace and Francis published a paper entitled *A Pacific Interdecadal Climate Oscillation with Impacts on Salmon Production.* Nate Mantua and his coauthors had found another cycle that seems to have a profound influence on weather

and climate variability. We commonly refer to this cycle now as the Pacific Decadal Oscillation (PDO).

There are certainly other cycles that have an influence on New Mexico weather and climate, but it appears that the ENSO and PDO influences are profound in our region of the country. Scientists are quite certain that these two cycles are either related, or are even part of the same phenomenon. They seem to have a significant influence on each other as they interact.

A brief discussion of ENSO and the PDO while studying figure 2 may help the reader get a better grasp of just what these two cycles look like in the Pacific Ocean.

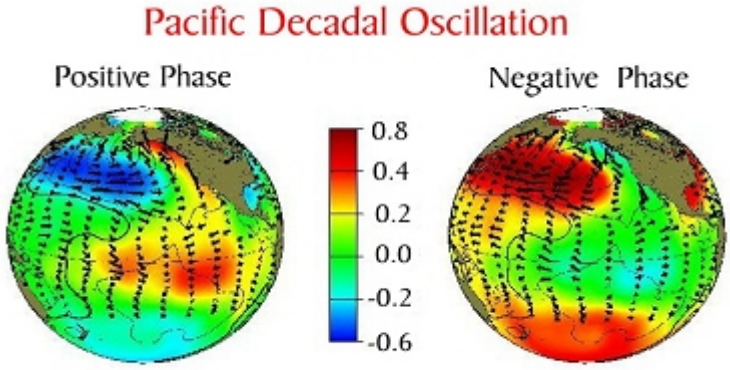


Figure 2 - PDO Phases

Figure 2 shows typical patterns of sea surface temperatures over the Pacific Ocean during the positive and negative phases. The blues represent below-normal temperatures, while the red shades depict above-normal temperatures. When we are referring to the PDO, we are really talking about the temperature and pressure patterns over the northern and central Pacific, north of 20 degrees north latitude. Consequently, in figure 2, the positive phase shows colder than normal water over the northern Pacific, with a narrow strip of warmer than normal water along the Alaskan coast. The negative phase is just the opposite, with above normal temperatures in the northern Pacific, except for a narrow band of colder than normal water along the coast of Alaska.

Meanwhile, the ENSO refers to the cycle that ranges from El Niño on one extreme to La Niña on the other. When we are referring to ENSO, we are really talking about the temperature and pressure patterns along the Equatorial Pacific. In figure 2, you will notice warmer than normal temperatures along the equator during the positive phase, and colder than normal temperatures during the negative phase.

Figure 2 essentially shows cases for which the ENSO and PDO are in phase. That is, the positive phase of the PDO is shown with an El Niño, and the negative phase is shown in conjunction with a La Niña. It is during these times the PDO and ENSO phases are considered to be in harmony.

However, this is not always the case. Although it doesn't happen very often, it's possible to have a positive PDO phase along with a La Niña, or a negative PDO phase with an El Niño. That is, it's possible to have colder than normal temperatures in the northern Pacific (positive PDO) along with colder than normal temperatures along the equator (La Niña), or vice versa. During these times, the ENSO and PDO are not in phase, and one might say they are in conflict. At other times, either of the cycles may be in between the these stages, and might be considered to be neutral.

During periods of time when the PDO and ENSO phases are in harmony, they combine their influences to maximize the likelihood of abundant or diminished precipitation in New Mexico. When the phases are in conflict, it can be difficult to determine which influence will prevail. And when the cycles are neutral, there is very little skill in producing accurate seasonal or longer-term forecasts.

It's important to know that the time scales for the ENSO and PDO are very different. The ENSO cycle averages about 4 years, but ranges from as little as 2 to as long as 7 years. The PDO cycle is much longer, averaging about 50 years. Consequently, ENSO may be the predominant driving factor for variability on a scale of only a few years, while the PDO may be the main factor influencing times scales in excess of 20 years.

Table I shows the recent PDO cycles that have been identified.

YEARS	**PDO Phase**
1871-1890	Positive
1890-1923	Negative
1923-1944	Positive
1944-1977	Negative
1977-1998	Positive

Table I - PDO Phases

From table I, you can see that the average cycle has been just over 50 years. For the three identified positive phases, the average length of that portion of the cycle was roughly 20 years. The two negative phases lasted an average of slightly more than 30 years.

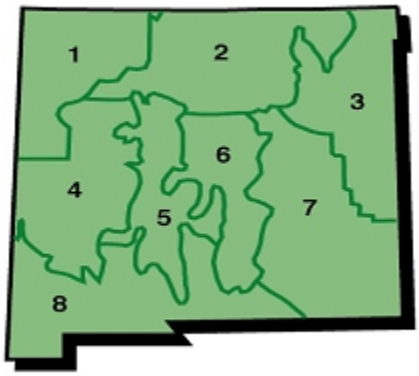
Table II shows the recent ENSO cycles.

YEARS	**PHASE**
1892-93	La Niña
1896-1897	El Niño
1901-1902	La Niña
1904	La Niña
1905-1906	El Niño
1906-1907	La Niña
1909-1911	La Niña
1911-1912	El Niño
1914-1915	El Niño
1916-1918	La Niña
1918-1919	El Niño
1921-1922	La Niña
1923	La Niña
1924-1925	La Niña
1925-1926	El Niño
1928-1929	La Niña
1938-1939	La Niña
1940-1941	El Niño
1941-1942	El Niño
1949-1951	La Niña
1952	El Niño
1955-1957	La Niña
1957-1958	El Niño
1959	El Niño
1968-1969	El Niño

1970-1972	La Niña
1972-1973	El Niño
1973-1974	La Niña
1975-1976	La Niña
1982-1983	El Niño
1986-1987	El Niño
1988-1989	La Niña
1989-1990	El Niño
1992-1993	El Niño
1997-1998	El Niño
1998-1999	La Niña

Table II - ENSO Phases

For this study, the average precipitation was calculated for each climate division of New Mexico (see fig 3) for a number of scenarios. First of all, long-term (period of record) averages were calculated for each division using data since 1895. Next, the average precipitation for each division was calculated for each phase of the PDO, and each phase of the ENSO. Calculations were made for events in which the PDO and ENSO were in phase (in harmony), and for events



in which the ENSO and PDO were out of phase (in conflict).

Figure 3 - New Mexico Climate Divisions

Relationships between the ENSO, the PDO, and Annual Precipitation in New Mexico

Table III (below) shows the relationship between PDO phases and average annual precipitation for each climate division in New Mexico. These values are compared to the long-term normals using data since 1895. Percentages of normal are calculated for the different phases.

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
+ PDO	13.78	18.07	18.31	16.17	11.45	19.50	17.19	13.18	15.96
%Normal	123	111	116	125	123	116	128	122	120
- PDO	9.90	14.92	14.77	11.88	8.34	15.18	11.80	8.95	11.97
%Normal	88	91	93	92	89	91	88	83	89
Norm.	11.23	16.32	15.86	12.97	9.33	16.76	13.45	10.78	13.34
Ratio	72 %	83 %	81 %	73 %	73 %	78 %	69 %	68 %	75 %

Table III - Relationship between PDO phases and Annual Precipitation

From table III, it's obvious that the positive PDO phase enhances precipitation in New Mexico, with average precipitation ranging from 111 percent of normal in the north mountains (division 2) to as much as 128 percent of normal in the southeast (division 7). Precipitation is below normal everywhere during the negative PDO phase, ranging from only 83 percent of normal in the southern desert (division 8) to 93 percent of normal in the northeast plains (division 3). One dramatic aspect of this result is what happens when the PDO phase changes from positive to negative. The ratios in the lower part of the table show the percentage of precipitation that falls during the negative PDO phase compared to the positive phase. Divisions 7 (the southeast) and 8 (southern desert) received only 68 to 69 percent as much precipitation during the negative phase. Consider the results for division 7. During the positive PDO phase, precipitation averages 17.19 inches. During the negative phase the average is 11.80 inches. Thus, one would see a reduction of an average of 5.39 inches per year during the negative phase. Over a 30 year period, the accumulated change would be over 160 inches.

Table IV (below) shows the relationship between the ENSO cycles and precipitation in New Mexico. Precipitation was averaged for each climate division for each ENSO phase, and compared to the long-term average.

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
El Niño	13.21	19.15	19.37	15.30	10.28	20.09	17.06	12.73	15.90
% norm.	118	117	122	118	110	120	127	118	119
La Niña	8.84	13.69	13.02	10.26	7.35	13.83	10.60	8.41	10.75
% norm.	79	84	82	79	79	83	79	78	81
Norm.	11.23	16.32	15.86	12.97	9.33	16.76	13.45	10.78	13.34
Ratio	67	71	67	67	71	69	62	66	68

Table IV - Relationship between ENSO phases and Annual Precipitation

Similar to the positive phase of the PDO, there is a relationship between El Niño and enhanced precipitation in New Mexico, while La Niña yields diminished precipitation. On average, the state receives only 68 percent as much precipitation during El Niño as it does during La Niña. This ratio ranges from 62 percent in division 7 (southeast) to 71 percent in divisions 2 (northern mountains) and 5 (central valley).

Next, calculations were made for those events in which the ENSO and PDO signals were out of phase. That is, episodes were singled out in which El Niño events coincided with negative PDO phases, and La Niña events coincided with positive PDO phases.

Table V shows the result.

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
El Niño and -PDO	11.46	17.28	17.48	13.81	10.09	18.64	14.43	11.64	14.35
% norm.	102	106	110	106	108	111	107	108	108
La Niña and +PDO	8.89	15.54	15.56	11.13	8.10	15.04	11.64	9.50	11.93
% norm.	79	95	98	86	87	90	87	88	89
Norm.	11.23	16.32	15.86	12.97	9.33	16.76	13.45	10.78	13.34

Table V - Relationship between out of phase ENSO/PDO stages and Annual Precipitation

By studying tables 3 through 5 it's apparent that the ENSO phases tend to mitigate the effects of the PDO phase and vice versa. For example, while the state average precipitation is 119 percent of normal during El Niño events (all events), the average drops to only 108 percent of normal for those events that occur during the negative PDO phase. When La Niña occurs during the positive PDO phase, precipitation is 89 percent of normal, compared to only 81 percent of

normal when there is a La Niña episode during the negative PDO phase.

The next step was to look at cases in which the ENSO and PDO phases are in agreement. Table VI shows the results for these calculations.

Precip.	Div 1	Div 2	Div 3	Div 4	Div 5	Div 6	Div 7	Div 8	ALL
El Niño and+ PDO	14.68	18.95	20.82	16.87	12.73	21.06	19.51	13.69	17.29
% norm.	131	116	131	130	136	126	146	127	130
La Niña and -PDO	7.50	11.95	12.78	9.57	7.12	13.26	11.40	8.00	10.20
% norm.	67	73	81	74	76	79	85	74	76
Norm.	11.23	16.32	15.86	12.97	9.33	16.76	13.45	10.78	13.34
Ratio LaNiña/ ElNiño	51 %	63 %	61 %	57 %	56 %	63 %	58 %	58 %	59 %

Table VI - Relationships between in phase ENSO/PDO episodes and Annual Precipitation

From table VI, it can be seen that coincidental El Niño and the positive PDO phase occurrences enhance precipitation in New Mexico more than just one of those events occurring without the other. Also, La Niña and the negative PDO phase occurrences substantially diminish precipitation. Interestingly, climate division 7 (the southeast) receives the greatest benefit from El Niño combined with the positive PDO phase, but also is affected the least by La Niña events combined with the negative PDO phase. The bottom row of table VI shows the ratio between the "bad" and "good" years. When La Niña combines with the negative PDO, the state receives only 59 percent the amount of precipitation it does when El Niño and the positive PDO phase occur together.

In a separate study in which the author combined the measurements of the ENSO and PDO phases, it was obvious that very significant events occur during these cases in which ENSO and the PDO are in phase.

Largest absolute values of the ENSO and PDO combinations have resulted in very significant periods such as the very early 1940s, when a strong El Niño occurred during a very positive PDO phase. It was in 1941 that the community of White Tail, near Cloudcroft, measured 62.45 inches of precipitation. The statewide average precipitation that year was 26.49 inches, roughly twice the normal amount. Three climate divisions (divisions 3, 6, and 7) all averaged over 30 inches of precipitation that year.

Similarly, there have been times in which La Niña episodes occurred simultaneously with strongly negative PDO phases, leading to extensive, devastating drought. In a separate study, the largest absolute negative values created by combining strong La Niña events with strongly

negative PDO phases occurred during the 1950s. It was during this time the drought of the 1950s peaked with the state averaging only 6.56 inches of precipitation in 1956, roughly half the normal.

Relationships between the ENSO, the PDO, and Seasonal Precipitation in New Mexico

The following tables (VII through X) show percentage of normal seasonal precipitation that falls in New Mexico for each climate division, for each scenario of ENSO/PDO combinations.

Spring

Condition	Div1	Div2	Div3	Div4	Div5	Div6	Div7	Div8	State
LaNina (all)	62	68	64	57	55	58	56	52	54
ElNino (all)	141	137	153	172	165	163	174	191	162
+PDO	143	116	131	160	141	143	163	175	147
-PDO	79	86	89	71	72	75	69	73	77
LaNina and -PDO	33	40	42	31	30	29	37	22	33
ElNino and +PDO	167	135	165	206	186	182	226	241	189
LaNina and +PDO	88	97	91	84	72	78	63	80	82
El Nino and -PDO	98	110	114	113	117	120	115	132	115
Ratio LaNina and -PDO to ElNino and +PDO	20 %	30 &	25 %	15 %	16 %	16 %	16 %	9 %	17 %

Table VII - Relationships between ENSO, the PDO, and Spring Precipitation in New Mexico

The ENSO and PDO signals are generally strongest in the spring. The state averages three times as much precipitation during El Niño events as during La Niña events. Positive PDO events produce generally twice the precipitation as negative PDO events. The 2nd and 3rd rows from the bottom show the mitigating influences of conflicting signals. The El Niño precipitation for the state drops from 162 percent of normal down to 115 percent when the El Niño occurs during the negative PDO phase. Meanwhile, the La Niña precipitation is boosted from 54 to 82 percent of normal when occurrence is during the positive PDO phase.

When the ENSO and PDO are in phase, the results are dramatic. The El Niño/positive PDO combination produces spring precipitation averaging 189 percent of normal, with climate divisions in the south (7 and 8) averaging a whopping 226 and 241 of normal. But when the La Niña combines with the negative PDO, things get really bad. The precipitation averages only 33

percent for the state, with climate division 8 (southern desert) only 22 percent.

The bottom row shows the ratio of La Niña/negative PDO event precipitation to El Niño/positive PDO event precipitation. The state averages only 17 percent as much spring precipitation, and this ratio is as low as 9 percent in climate division 8 (southern desert).

Summer

Condition	Div1	Div2	Div3	Div4	Div5	Div6	Div7	Div8	State
LaNina (all)	83	88	91	88	90	94	88	92	89
ElNino (all)	105	106	111	108	107	106	113	108	108
+PDO	106	99	101	105	104	96	108	102	103
-PDO	94	97	99	92	96	96	98	94	96
LaNina and -PDO	70	83	95	80	88	90	98	87	86
ElNino and +PDO	104	97	106	105	114	99	111	97	104
LaNina and +PDO	74	87	100	88	92	93	96	97	91
El Nino and -PDO	108	112	121	116	116	118	117	121	116

Table VIII - Relationships between ENSO, the PDO, and Summer Precipitation in New Mexico

Results for summer are quite interesting. For one thing, it appears that El Niño favors a little more precipitation (average of 108 percent of normal), while La Niña favors slightly diminished precipitation (averaging 89 percent of normal). The positive PDO phase also favors slightly more precipitation (103 percent of normal) compared to the negative phase (96 percent of normal).

It's interesting that the in-phase ENSO PDO events produce a result very similar to the ENSO events considered discretely. That is, the state averages 17 percent more precipitation during El Niño events than during La Niña events, and 21 percent more during El Niño/positive PDO events compared to La Niña/negative PDO events. That's not a lot of difference.

La Niña tendencies to diminish precipitation are changed very little when they occur during positive PDO phases (89 percent increases to 91 percent). Meanwhile, El Niño seems to be enhanced a bit by out an of phase negative PDO phase (108 to 116 percent). This may be because the Pacific Ocean thermal contrast diminishes, perhaps leading to weaker than normal westerlies and allowing the Southwest Monsoon to surge northward from Mexico more frequently, and or more robustly. Meanwhile, notice the effect of a La Niña combined with a negative PDO (in phase relationship) has the greatest affect in division 1 (the northwest), with

summer precipitation only averaging 70 percent of normal. This combination would produce a greater thermal contrast in the Pacific Ocean, leading to perhaps stronger westerlies (and possibly farther south) than normal in the summer. The effect on the Southwest Monsoon, which comes late to division 1 anyway, might be to diminish the northward bursts of moisture into the northwest part of New Mexico. Occasional intrusions of dry, westerly winds usually affect the northwest portion of New Mexico, and they may be more frequent and/or stronger with a La Niña/negative PDO combination.

Ratios between in-phase ENSO/PDO relationships were not calculated for summer because these were not necessarily the best and worst-case scenarios.

Autumn

Condition	Div1	Div2	Div3	Div4	Div5	Div6	Div7	Div8	State
LaNina (all)	78	87	87	75	75	78	85	72	80
ElNino (all)	128	126	125	117	124	127	124	120	124
+PDO	123	116	125	128	130	128	123	125	125
-PDO	90	83	85	98	88	86	81	93	88
LaNina and -PDO	77	81	93	91	93	95	83	91	88
ElNino and +PDO	139	129	142	129	135	132	134	122	133
LaNina and +PDO	74	107	99	76	74	80	72	71	82
El Nino and -PDO	109	95	89	100	95	104	95	102	99
Ratio LaNina and -PDO to ElNino and +PDO	55 %	63 %	65 %	71 %	69 %	72 %	62 %	75 %	66 %

Table IX - Relationships between ENSO, the PDO, and Autumn Precipitation in New Mexico

Both the positive PDO phase and El Niño enhance autumn precipitation over New Mexico, with precipitation, respectively, averaging 125 and 124 percent of normal. When the two signals are in phase, the effect is enhanced slightly, with autumn precipitation averaging 133 percent of normal.
The effects of an El Niño are diminished considerably when it occurrence coincides with with a negative PDO phase. The result is that the state receives precipitation very close to normal (99 percent).

Interestingly, while precipitation averages 80 percent of normal during La Niña events, the occurrence of a negative PDO during these events does not add to the misery. In fact, the

negative PDO somehow mitigates the effects of the La Niña to some degree in most climate division, producing a statewide average that is 88 percent of normal. The reason may lie in the convention of defining autumn to be September through November. It's possible, for the same reasons provided for the summer "boost" of conflicting signals, that much of the mitigating precipitation actually falls in September and is the result of an extended Southwest Monsoon. This possibility seems to be supported by the fact it is divisions 1 and 2 (northwest and northern mountains) where the negative PDO does not mitigate the effects of La Niña. That is the region of the state where the Southwest Monsoon usually comes to an abrupt halt in early September. Note, also, that the La Niña is only mitigated slightly in autumn by a positive PDO, with the state averaging 82 percent of normal compared to 80 percent. However, a look at the individual climate divisions shows that this mitigation really doesn't occur at all in the south, but has some significance over the northern mountains (division 2) and northeast plains (division 3).

Winter

Condition	Div1	Div2	Div3	Div4	Div5	Div6	Div7	Div8	State
LaNina (all)	89	90	68	71	67	76	59	65	73
ElNino (all)	104	101	95	98	103	99	99	103	100
+PDO	132	121	119	138	134	117	127	137	128
-PDO	83	92	92	89	85	93	90	90	89
LaNina and -PDO	81	80	67	55	50	70	50	45	62
ElNino and +PDO	132	120	160	139	151	131	170	150	144
LaNina and +PDO	86	94	106	91	105	100	124	97	100
El Nino and -PDO	88	96	92	76	93	87	74	72	85
Ratio LaNina and -PDO to ElNino and +PDO	61 %	67 %	42 %	40 %	33 %	53 %	29 %	30 %	43 %

Table X - Relationships between ENSO, the PDO, and Winter Precipitation in New Mexico

The first row of the table shows the relationship between La Niña and diminished winter precipitation everywhere in New Mexico. As other studies have revealed, the southern portion of New Mexico suffers more than the north, with climate division 7 (southeast) only receiving 59 percent of the normal precipitation during La Niña winters. Also, as other studies by the author have shown, El Niño by itself does not necessary make for a good winter. The statewide average for all El Niño events was 100 percent of normal. However, when one considers the El Niño impact on autumn and spring precipitation (162 and 124 percent of normal, respectively), the overall result of an El Niño autumn-winter-spring combination is one of enhanced precipitation,

a better snow pack, and more abundant spring runoff.

Table X also shows the impact of the positive and negative PDO phases on New Mexico precipitation (128 percent versus 89 percent of normal). And when the ENSO and PDO cycles are in harmony, one can see that the impact is enhanced. While the El Niño by itself only produces near-normal precipitation in New Mexico, add the benefit of the positive PDO phase and the average is 144 percent of normal. The affect on the eastern plains is especially noteworthy, ranging from 160 percent of normal precipitation in division 3 (northeast) to 170 percent of normal in division 7 (southeast).

While both the La Niña and negative PDO phase are related to diminished winter precipitation in the state (73 percent and 89 percent of normal, respectively), the combination of the two produce an average winter precipitation that is only 62 percent of normal. The effect is especially drastic in the south and also the central valley (division 5), with averages only 45 to 50 percent of normal.

Notice the mitigating influence of the positive PDO phase creates an average of 100 percent of normal for the state during La Niña events, the same for all El Niño events. However, the distribution is quite different. The variability during the El Niño events is quite small from climate division to climate division (ranging from 95 to 104 percent of normal), while La Niña episodes during positive PDO phases produce a range from 86 percent of normal in the northwest to 124 percent of normal in the southeast.

The results shown in rows 4 and 8 suggest that the El Niño doesn't have a lot of impact on New Mexico in winters in which the PDO is negative. This doesn't happen very often but in these cases the mitigating influence of El Niño on the negative PDO seems to be minimal.

Table X makes it obvious that in-phase ENSO and PDO signals create either a very dry or very wet winter. The statewide average precipitation for La Niña/negative PDO combinations is only 43 percent of the precipitation during El Niño/positive PDO events. This ratio is as low as 29 percent in division 7 (southeast), 30 percent in division 8 (southern desert), and 33 percent in division 5 (central valley).

Summary

The ENSO and PDO cycles both have a profound influence on precipitation in New Mexico. El Niño and the positive PDO both favor enhanced precipitation, while La Niña and the negative PDO both favor diminished precipitation. When El Niño and the positive PDO occur simultaneously, precipitation is especially enhanced. Strong El Niño events combined with a significantly positive PDO lead to very wet periods in New Mexico, such as those experienced in the early 1940s and throughout times in the 1980s and early 1990s.

The combination of La Niña and the negative PDO work in harmony to further diminish precipitation. Strong La Niña events combined with a significantly negative PDO lead to super drought periods, such as those experienced in the 1950s.

Although there must be many other factors at work, the ENSO and PDO states should be considered very important factors in producing seasonal and longer-term forecasts. Since the ENSO cycle is relatively short compared to the PDO (averaging 4 years compared to 50 or more), the ENSO and PDO are both very significant factors to consider when preparing season and perhaps annual precipitation forecasts. Since ENSO cycles will come and go throughout one predominant phase of the PDO cycle, the PDO cycle may be the main factor to consider when assessing the precipitation likelihood over a multi-year period. One very limiting factor is that relationships between both Pacific cycles and New Mexico precipitation is weakest in the summer, when a significant percentage of the annual precipitation falls. However, the signals are strongest during the cooler portion of the year, when precipitation production for snow pack is crucial.

These studies of the PDO cycle suggest that the positive phase that benefitted New Mexico greatly in the 1980s and most of the 1990s came to an end in 1998. The PDO was negative from mid-1998 until late 2002 when an El Niño event developed. Even during predominant negative (positive) PDO phases, El Niño (La Niña) events temporarily "pull" the PDO back to a positive value. This also suggests that ENSO and the PDO have a strong relationship. They may both be part of the same cycle, or it may be that the PDO is influenced by ENSO (or vice versa) or even that the PDO is mainly a reflection or memory of long-term ENSO events.

In any case, it will likely be sometime between 2005 and 2010 before we know whether or not we are in a predominant negative PDO phase that began in 1998. If, indeed, a negative PDO phase began in 1998, and if historical relationships between the PDO phase and New Mexico precipitation do not change, the overall result will likely be a reduction of precipitation in New Mexico through the late 2020s. The historical relationships would suggest a reduction of 20 to 30 percent in the total precipitation from 1998-2028 compared to the amounts measured from the late 1970s through 1997. The consequences of reduced precipitation will likely be to accelerate and exacerbate water issues that would surface anyway as demand of a limited resource continue to increase.

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