Drought History

for New Mexico's 8 Regions

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What is drought?

Defining drought can be difficult because the impacts associated with drought are often far-reaching and devastating. A *meteorological drought* is a prolonged period when precipitation is below "normal" for the location (Heim 2002). An *agricultural drought* occurs when soils are too dry to grow healthy vegetation, particularly crops or forests. As water becomes scarce in rivers, lakes, and other water bodies, a *hydrological drought* develops. If, at any time, the water demands of society (e.g., water for drinking, maintaining lawns and gardens, washing clothes) exceed the availability of good-quality water, then a *socioeconomic drought* has occurred. A socioeconomic drought may arise even during times of normal precipitation because of increased water demand from a growing population, increased temperatures and wind speeds, new businesses, or other societal changes.

Why be prepared for drought?

Since 1998, the National Oceanic and Atmospheric Administration has identified 25 droughts nationwide as weather disasters based on both damages and costs in the amount of $235.3 billion dollars. The 2012 drought, which at its height affected over 80% of the contiguous U.S., resulted in estimated damages and costs of over $50 billion from both direct and indirect impacts.

Drought can result in crop, pasture, and forest damage; increased livestock and wildlife mortality; increased fire hazard; threats to aquatic and wildlife habitats; increased water demand; and reduced water supplies.

Proper management of water resources is necessary to protect supplies for drinking water, sanitation, and fire protection as well as to maintain economic activity and environmental sustainability. ***Because disasters affect families, neighbors, and businesses locally, community-level planning is necessary to reduce the vulnerability to drought in New Mexico.***

"Droughts-of-Record" in New Mexico

For purpose of planning, we consider the "drought-of-record" to be the drought with the worst environmental conditions rather than the drought with the worst recorded impacts. Hence, a shorter and less severe drought with high monetary losses in our recent past (e.g., during 2011) will not outweigh a long and severe drought in our early history, when fewer people lived in the region. We choose to prepare for the worst.

We compared Palmer Drought Severity Indices for each region's "Drought-of-Record" and other drought periods including the most recent (hence, memorable) drought of 2011 to present (data through December 2012) in Tables 1-8.

How to be prepared for drought?

Local officials and other key stakeholders in New Mexico will be better prepared for drought when they complete the following: (1) have assessed their vulnerability to drought, (2) understand past droughts and the local climate, (3) monitor drought, (4) prepare a thorough set of actions to be taken before, during, and after a drought, and (5) educate citizens on this plan.

Having a plan in place will enable these individuals to understand key factors to monitor so they may respond proactively to drought conditions early. Following this plan helps reduce the risk such that, when drought conditions occur, water resources do not run out. This report will help government officials and resource managers by overviewing the climate and drought history record-keeping began in the late 19th century.

How is drought measured?

To quantify drought severity, the scientific community has developed several methods to assess drought, including departure from normal precipitation, the Palmer Drought Severity Index, and the Standardized Precipitation Index. All three use weather observations to diagnose drought conditions. The simplest of these is the annual departure from normal precipitation, which is the actual precipitation total for the year subtracted from the annual normal. Large negative values indicate a precipitation deficit for that year.

The Palmer Drought Severity Index uses observations or estimates of precipitation, temperature, and soil water content. Values typically range from +4 representing extremely wet conditions to –4 representing extremely dry conditions. Values less than –1 indicate some level of drought, and the values become more negative with less rainfall and hotter temperatures.

The Palmer Drought Severity Index helps to diagnose agricultural drought because it is sensitive to soil moisture conditions and works well at relatively long time scales. The index does not account for reservoir levels and streamflow, so it has drawbacks for diagnosing hydrological drought.

The Standardized Precipitation Index is based solely on precipitation but has the advantage of multiple time scales (e.g., 3 months, 6 months, 1 year) to better highlight short-term versus long-term droughts. Values typically range from +2 as extremely wet to –2 as extremely dry, with values less than –1 representing drought.

A more recent method to measure drought intensity is the U.S. Drought Monitor (Figure 1). This product depicts weekly drought conditions for the United States on a drought intensity scale of D0 to D4, with D0 representing areas that are abnormally dry and D4 representing areas of exceptional drought. Although the levels are subjectively determined, they are established through expert review of weather and water data, including local observations,

as well as reports of drought impacts from local, tribal, state, and federal officials as well as the public and media. Figure 1 displays the weekly percentage of area each of New Mexico's regions affected by D0 through D4 drought since 2000[1].

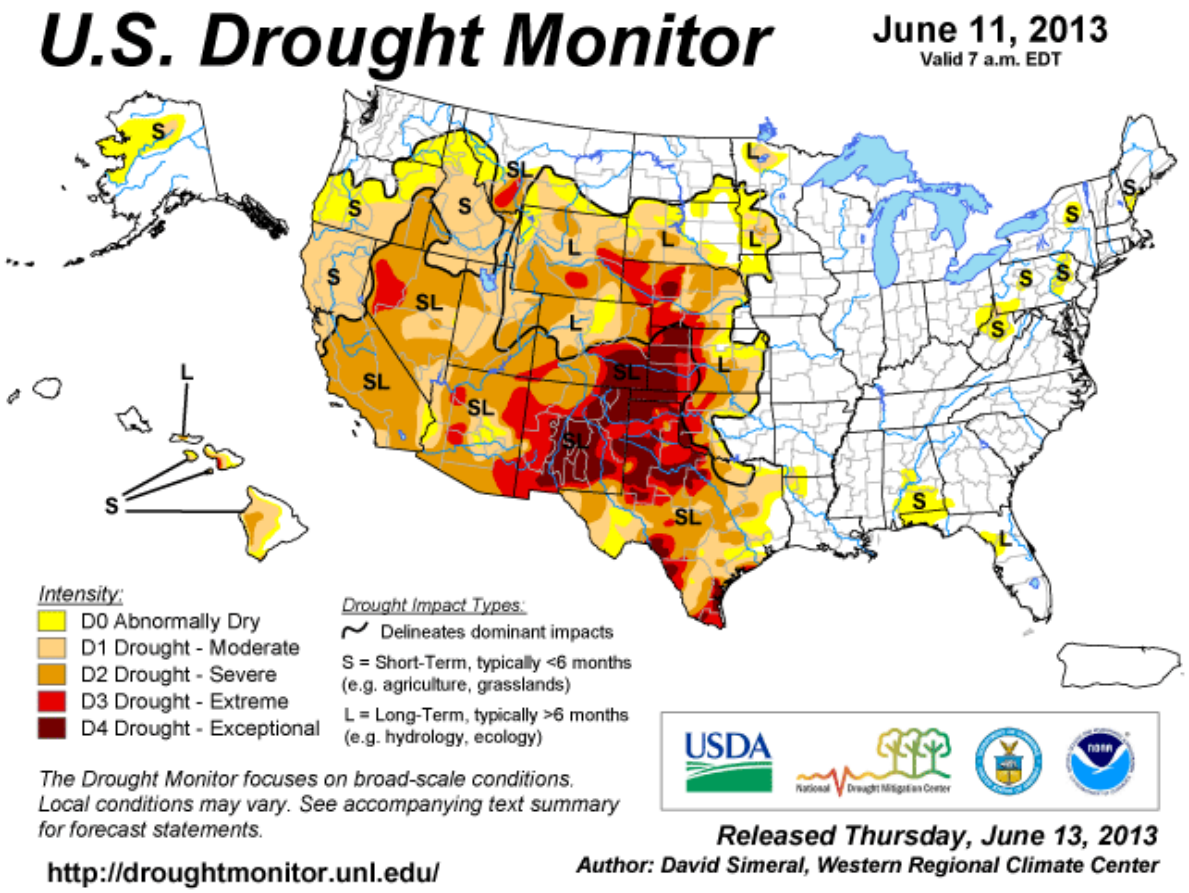

Figure 1*. Example map of the U.S. Drought Monitor from the drought assessment issued for the week preceding June 11, 2013. The color scale (yellow to dark red) displays the level of drought from D0 (abnormally dry) to D4 (exceptional drought). Significant regional impacts on agriculture* are designated with an "**S**" and regional impacts on water supply are designated with an "**L**". The maps are released each Thursday at 8:30 a.m. Eastern Time. Courtesy of the National Drought Mitigation Center.

[1] Data provided by the National Drought Mitigation Center.

Has New Mexico experienced drought?

Drought is a recurring condition in New Mexico, and is part of our climate. Our climate history can provide us insight into what we may see in the future. Being "drought ready "means, in part, that we recognize how our climate has changed over time. This report examines New Mexico's drought History.

The Climate of of New Mexico

Temperature, precipitation, and topography are the three main elements of our climate. Because the New Mexico is located in the middle latitudes, within the Rocky Mountains, and north of the Mexican desert, its citizens experience a wide range of weather conditions. Hence, our climate is highly variable, from year to year, season to season, and month to month.

Figure 2. *Map of the climate divisions of New Mexico.*

Region 1: Northwest Plateau

The Northwest Plateau region of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 3 shows the annual temperature (top) and annual precipitation (bottom) in the Northwest Plateau of New Mexico since 1895.[2] The annual temperature for the Northwest Plateau of New Mexico averages 49.0 degrees Fahrenheit, while precipitation averages 11.25 inches. Warmer-than-average periods have spanned the late 1890s through the 1900s, the 1950s through the early 1960s, and the 1980s through the early 2010s. Significant periods of drier-than-average conditions include the late 1890s through the mid-1900s and the mid-1940s through the 1970s.

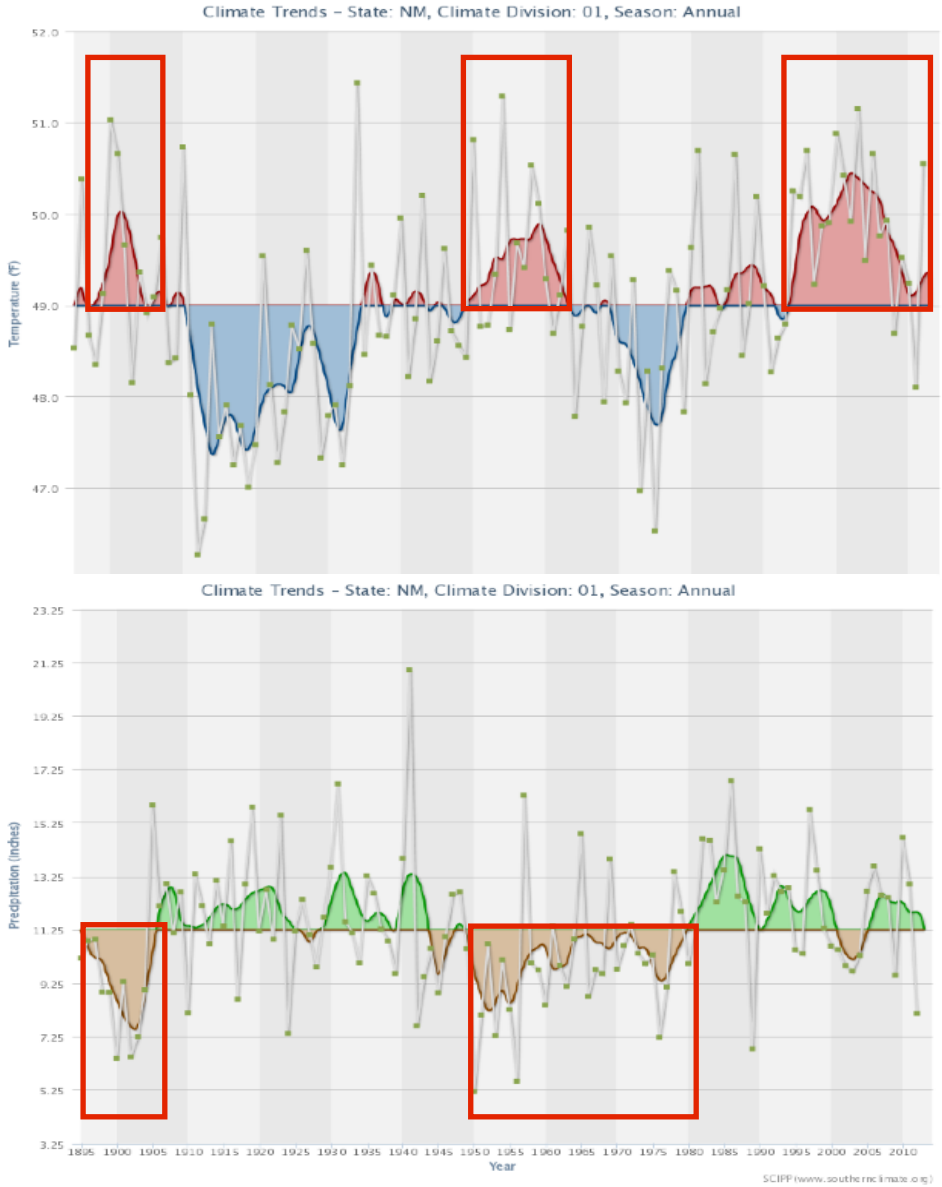

Figure 3. *The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Northwest Plateau of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record in this region include the droughts in the late 1890s through the mid-1900s and 1940s through the 1960s. The period with the longest duration of PDSI less than -4 is undoubtably the late 1890s through the mid-1900s. Table 1 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the late 1890s through the mid-1900s well exceeds intensity of all other droughts; hence, ***the period from December 1897 to December 1904 is the drought-of-record for the Northwest Plateau of New Mexico.***

Because of its intense heat combined with non-stop dry conditions, ***November 1942 to October 1968 comes in second for the drought-of-record for the Northwest Plateau of New Mexico.***

Table 1: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Northwest Plateau of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
December 1897 - December 1904	84 (of 85 months)	16 consecutive, 11 consecutive, plus 15 other	–6.29
November 1942- October 1968	201 (of 312 months)	17 consecutive plus 9 other	–6.52
November 1999 - August 2004*	45 (of 58 months)	3 consecutive	–5.05

Note: Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Northwest Plateau of New Mexico, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 4. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during July and August (top of Figure 3).

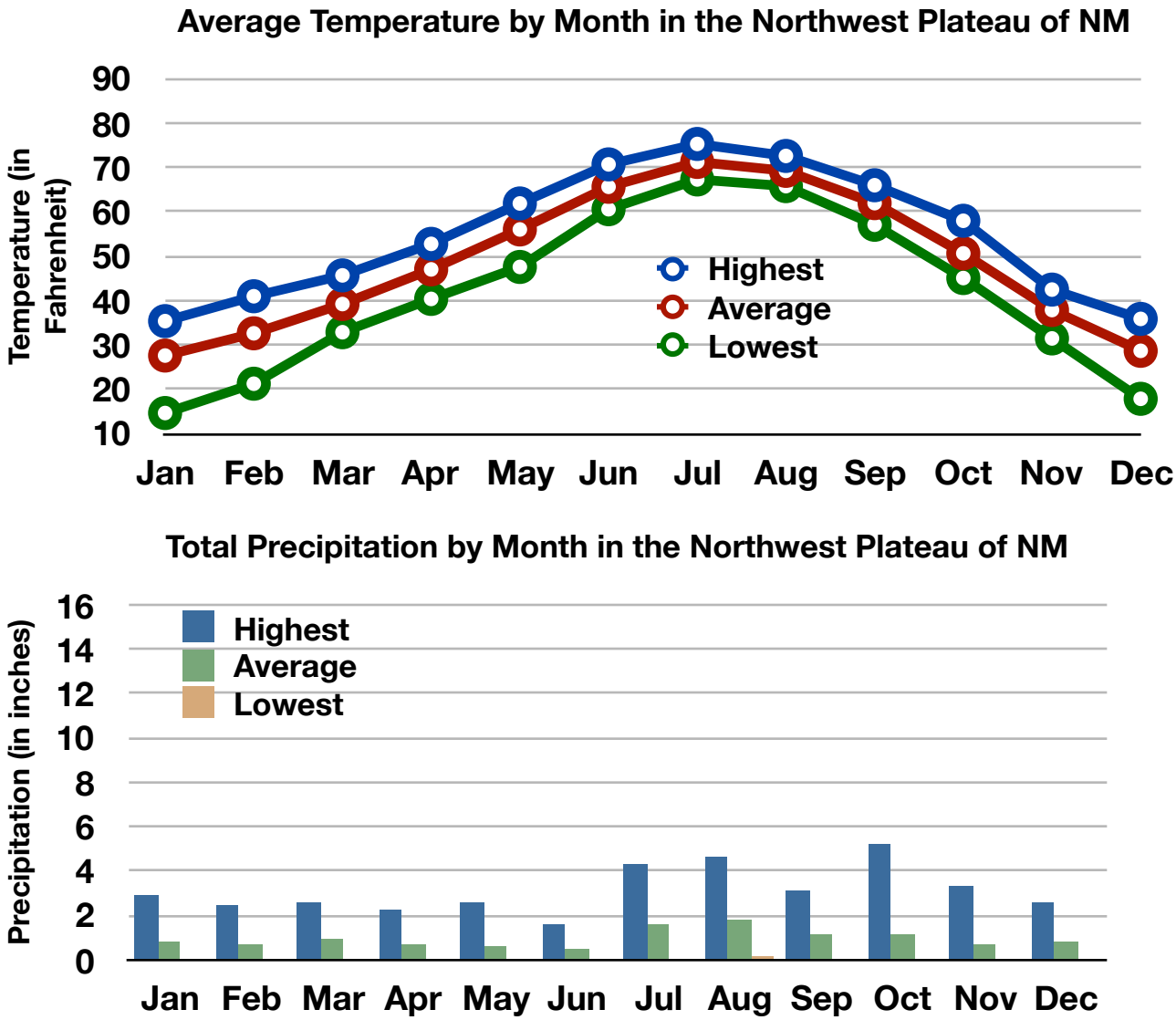

Figure 4. *Top graph: The monthly average temperature (in degrees Fahrenheit) across the Northwest Plateau of New Mexico using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Northwest Plateau of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred at least once during April, May, June, October, and November] The three peaks of precipitation, first in July, then in August, and finally in October are clearly visible.*

The region has experienced long and extreme droughts in its past. Figure 5 displays the departure from normal precipitation, and Palmer Drought Severity for the region from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 3.

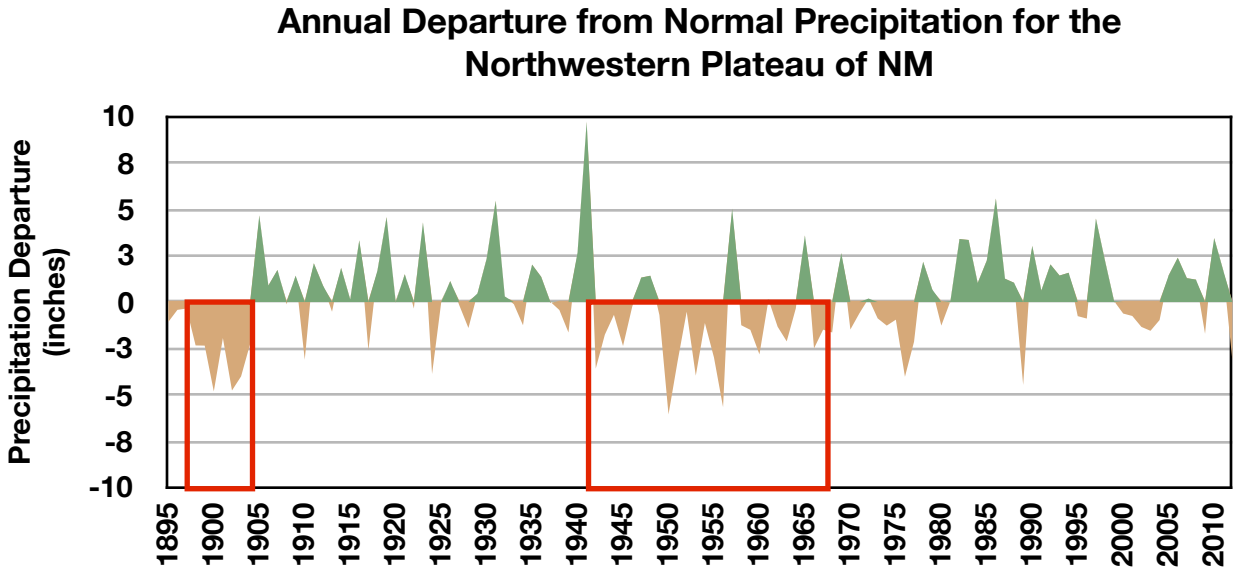

***Figure 5a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Northwest Plateau of New Mexico from 1895 to 2012.*

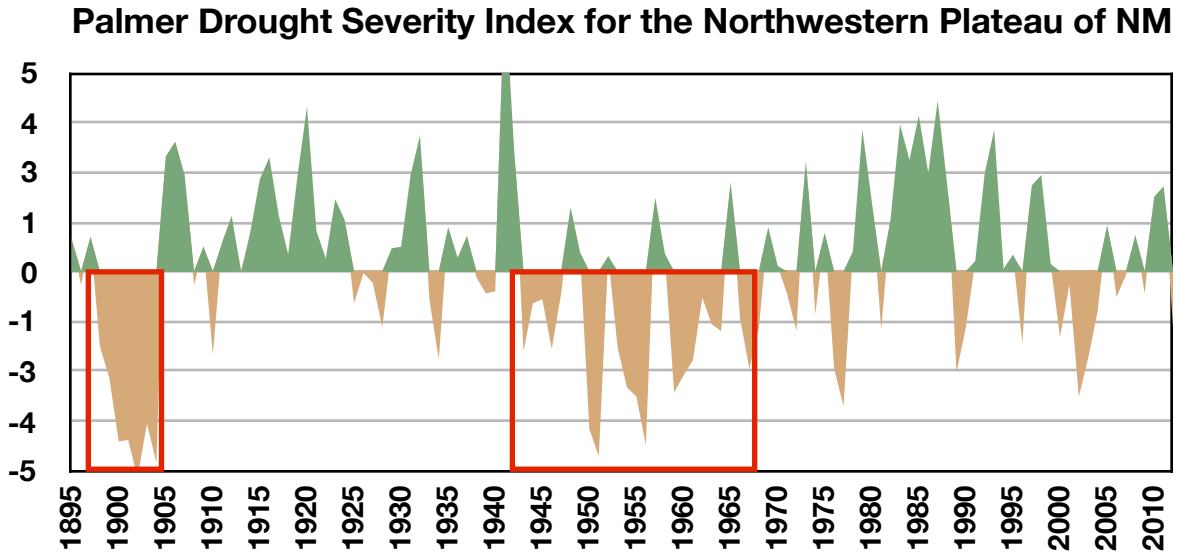

***Figure 5b**. Palmer Drought Severity Index for the Northwest Plateau of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 6 we look at drought designation in the Northwest Plateau region from the year 2000 to 2013. We can see that many instances of abnormally dry to severe conditions covered up to 100% of the region from 2002 to 2008. Extreme to exceptionally dry conditions covered 70-100% during this time period as well. In 2011 to 2013 we see that the region experienced another period of abnormally dry to extreme conditions covering 25-100% of region.

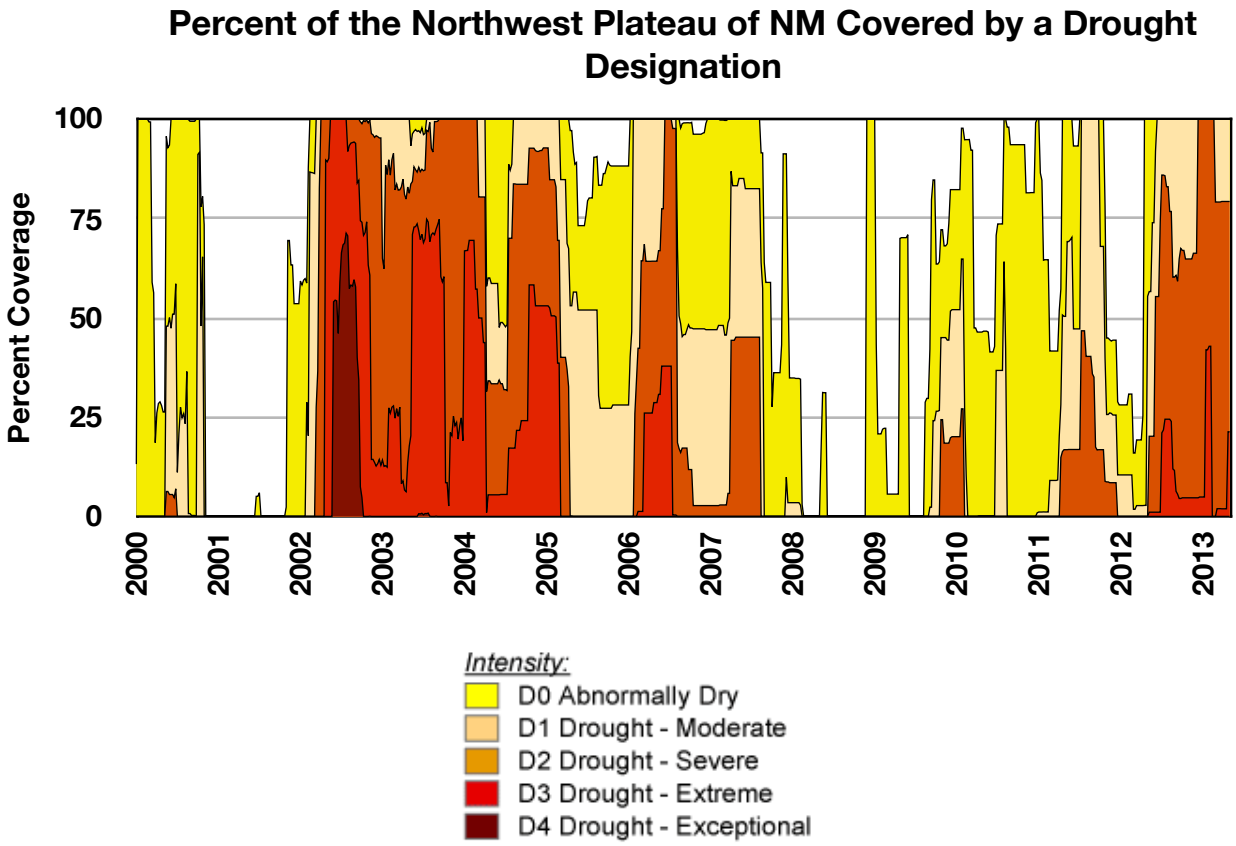

Figure 6. *Drought history for the Northwest Plateau of New Mexico as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 1. Note that the Northwest Plateau of New Mexico was experiencing extreme (bright red) to exceptional drought (dark red) across most of the area during much of 2002 through 2004 and 2011 to present (May 2013).*

For more information on the sources of drought information, see Table 9 on page 47.

Region 2: Northern Mountains of New Mexico

The Northern Mountains region of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 7 shows the annual temperature (top) and annual precipitation (bottom) in the Northern Mountains of New Mexico since 1895.[3] The annual temperature for the Northern Mountains of New Mexico averages 46.2 degrees Fahrenheit, while precipitation averages 16.27 inches. Warmer-than-average periods have spanned the 1960s and the late 1970s through the early 2010s. Significant periods of drier-than-average conditions include the early 1900s, the mid-1940s through the mid-1950s, the 1960s through the early 1980s, the early 2000s, and the early 2010s.

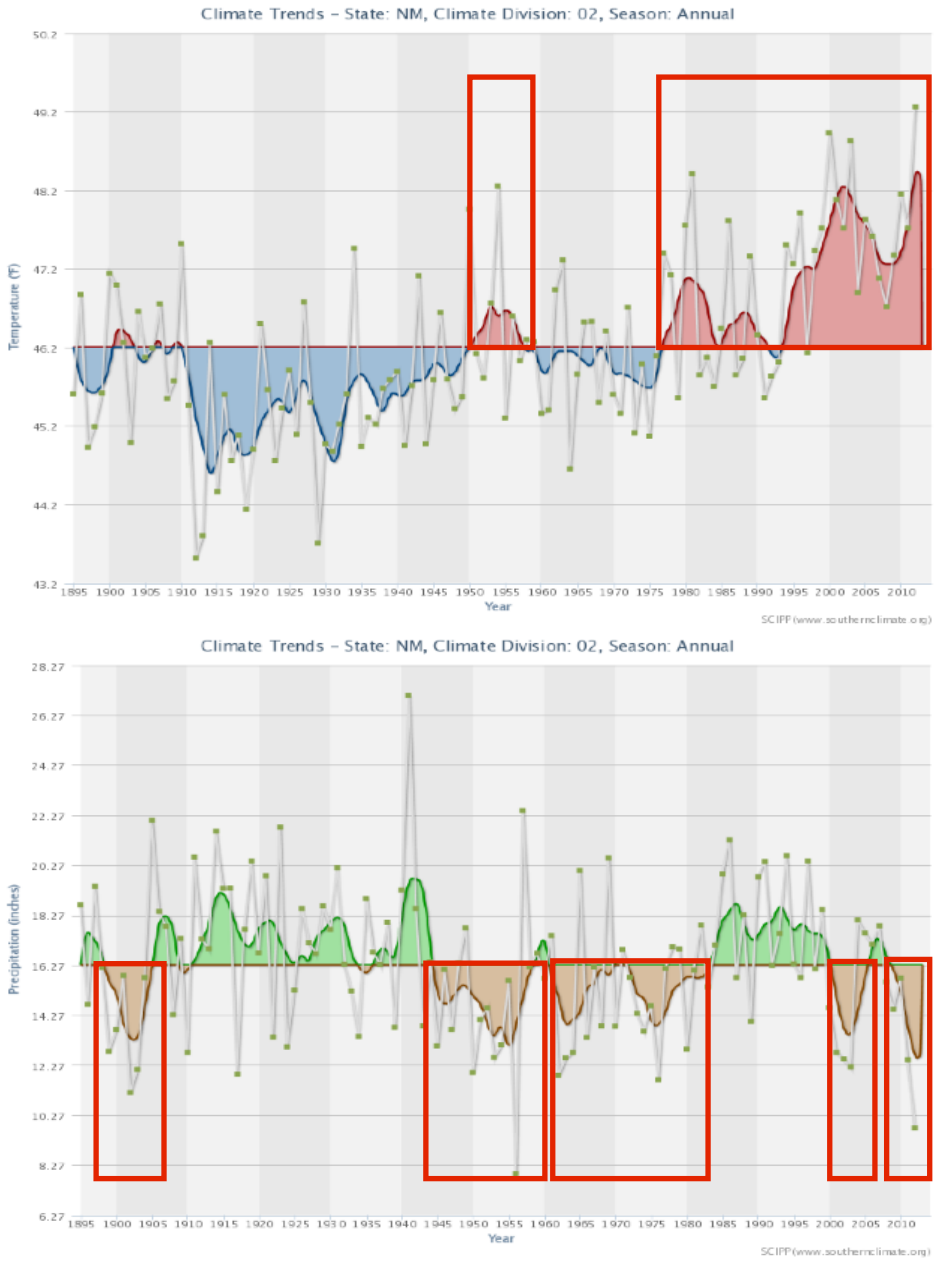

***Figure** 7. The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Northern Mountains of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record in this region include the droughts in the early 1900s, the early 1950s, the 1960s through the 1970s, and the 2000s. The longest period of dry conditions undoubtably was during the 1960s and 1970's. Table 2 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the 1950s exceeds in intensity and duration of most other droughts; hence, ***the period from November 1949 to February 1957 is the drought-of-record for the Northern Mountains of New Mexico.***

Table 2: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Northern Mountains of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
October 1898 – August 1904	61 (of 71 months)	9 consecutive plus 7 others	–5.82
November 1949 – February 1957	82 (of 88 months)	9 consecutive plus 6 others	–5.99
May 1962 – October 1978	113 (of 200 months)	5 consecutive plus 4 other	–4.69
November 1999 – March 2004	44 (of 53 months)	8 consecutive, 7 consecutive plus 3 others	-7.16
December 2005 – December 2012*	46 (of 73 months)	10 consecutive plus 8 others	-7.32

Note: Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Northern Mountains region, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 8. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during July and August (top of Figure 8).

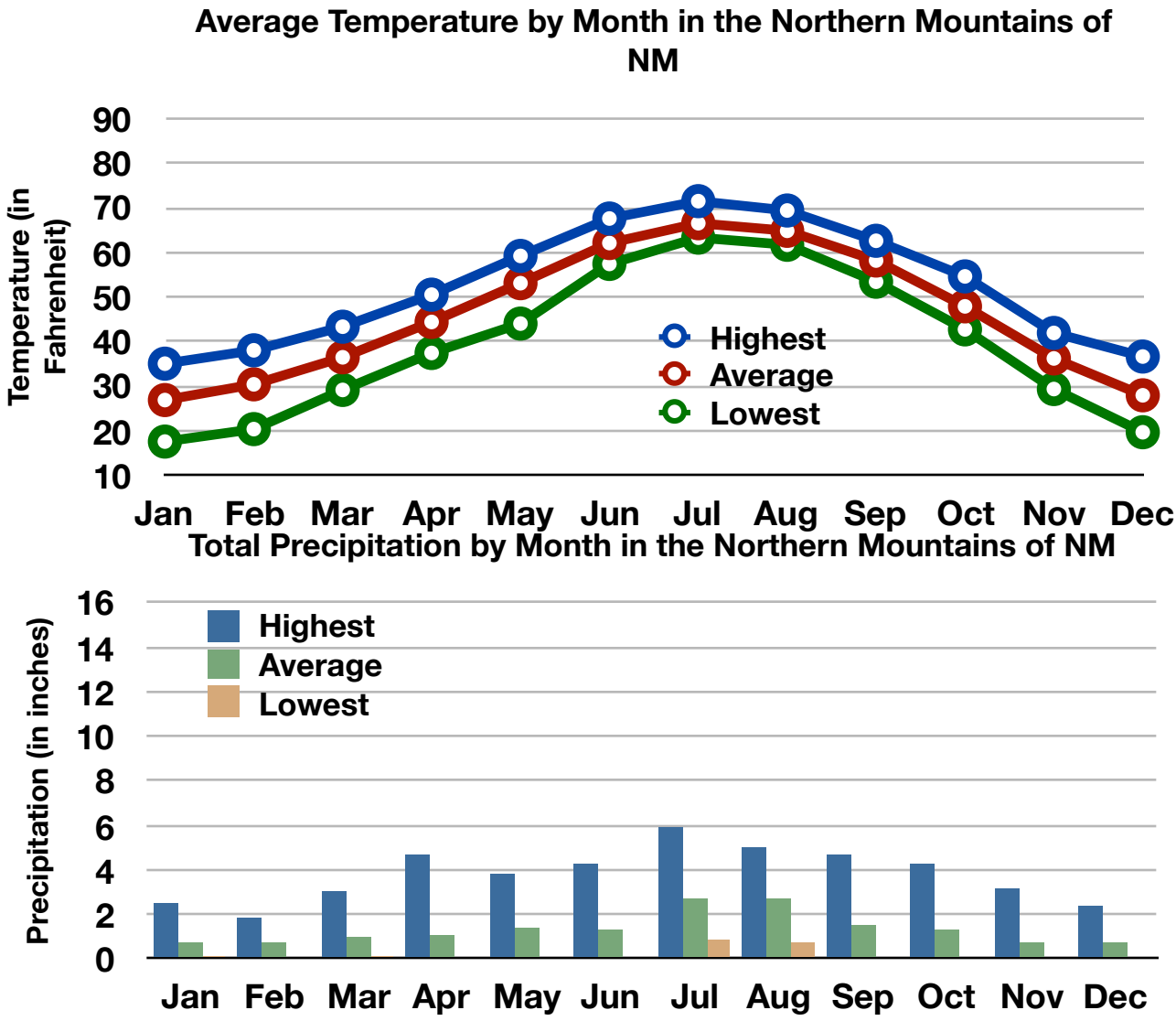

***Figure 8**. Top graph: The monthly average temperature (in degrees Fahrenheit) across the Northern Mountains of New Mexico using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Northern Mountains of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred at least once during April, October, and November.] The two peaks of precipitation, first in July, then in August, are clearly visible.*

The region has experienced long and extreme droughts in its past. Figure 9 displays the departure from normal precipitation and Palmer Drought Severity Index for the region from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 7.

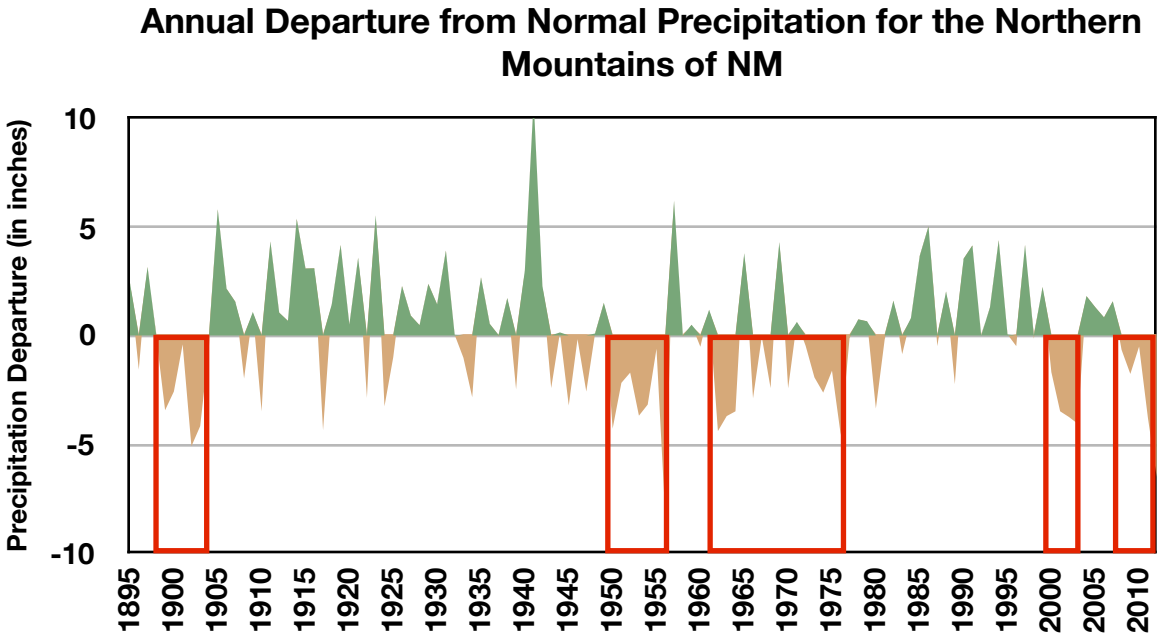

***Figure 9a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Northern Mountains of New Mexico from 1895 to 2012.*

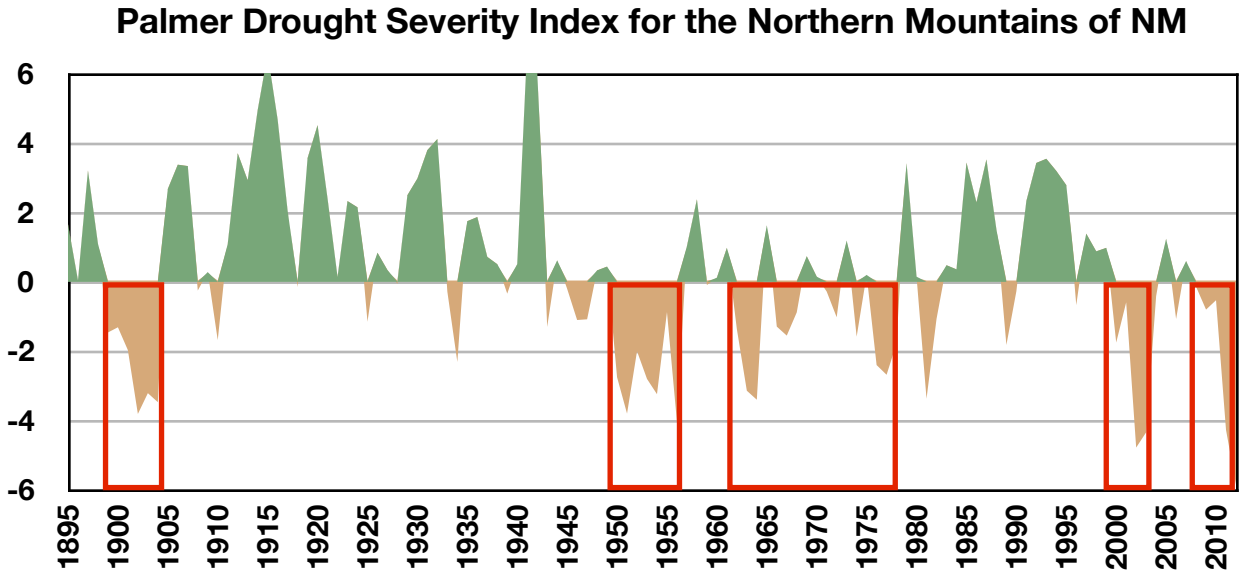

***Figure 9b**. Palmer Drought Severity Index for the Northern Mountains of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 10 we look at drought designation in the Northern Mountains region from the year 2000 to 2013. We can see that abnormally dry to exceptional conditions covered up to 25-100% of the region multiple times. The region also experienced extreme to exceptionally dry conditions covering 25% or more of the region from 2011 to 2013.

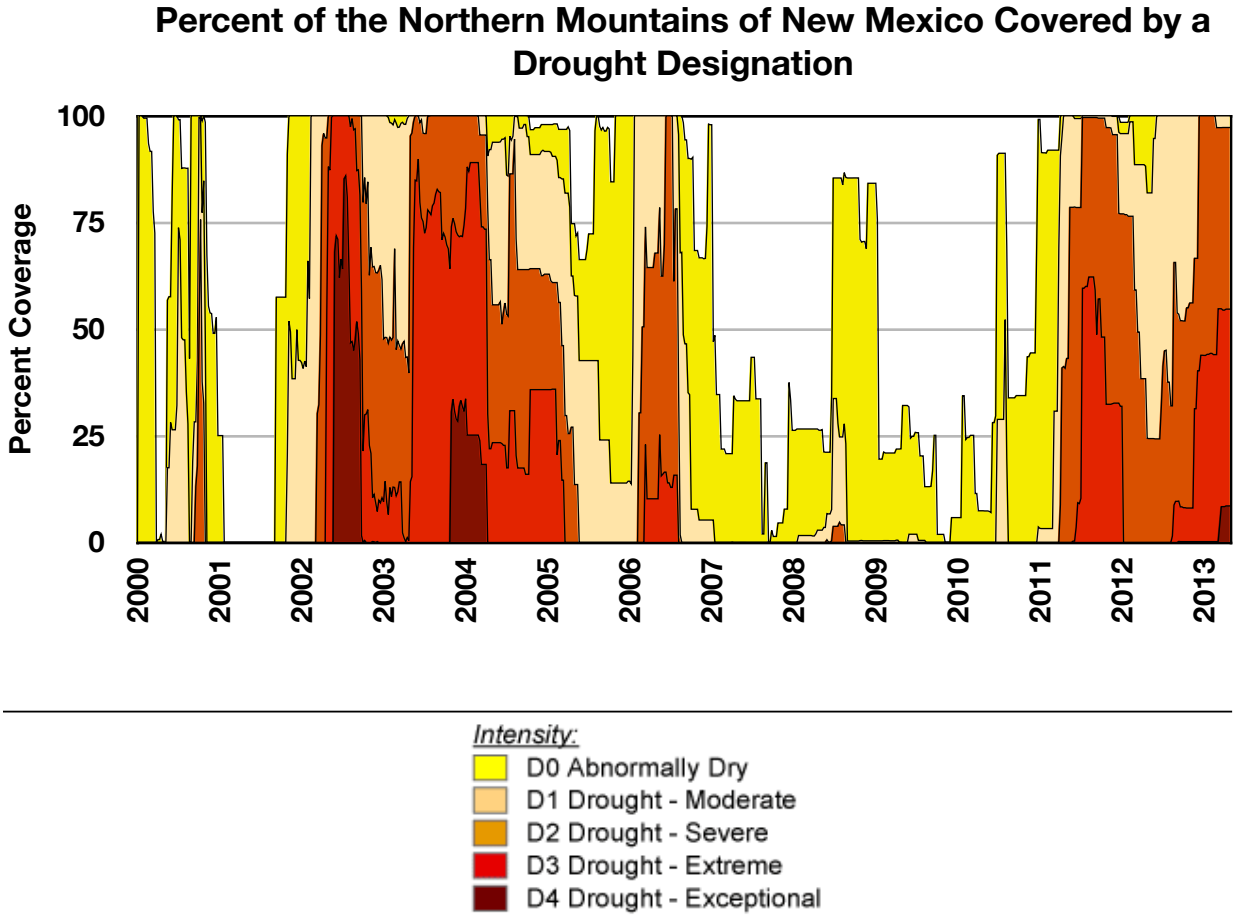

Figure 10. *Drought history for the Northern Mountains of New Mexico as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 1. Note that the Northern Mountains of New Mexico were experiencing extreme (bright red) to exceptional drought (dark red) across most of the climate division during much of 2002 through 2004 and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.*

For more information on the sources of drought information, see Table 9 on page 47.

Region 3: Northeastern Plains of New Mexico

The Northeastern Plains region of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 11 shows the annual temperature (top) and annual precipitation (bottom) in the Northeastern Plains of New Mexico since 1895.[4] The annual temperature for the Northeastern Plains of New Mexico averages 54.8 degrees Fahrenheit, while precipitation averages 15.75 inches. Warmer-than-average periods have spanned the 1930s to the late 1960s and the mid 1990s to the early 2010s. Significant periods of drier-than-average conditions include the 1900s, the mid-1930s, the 1950s, the mid 1960s, and the early 2010s.

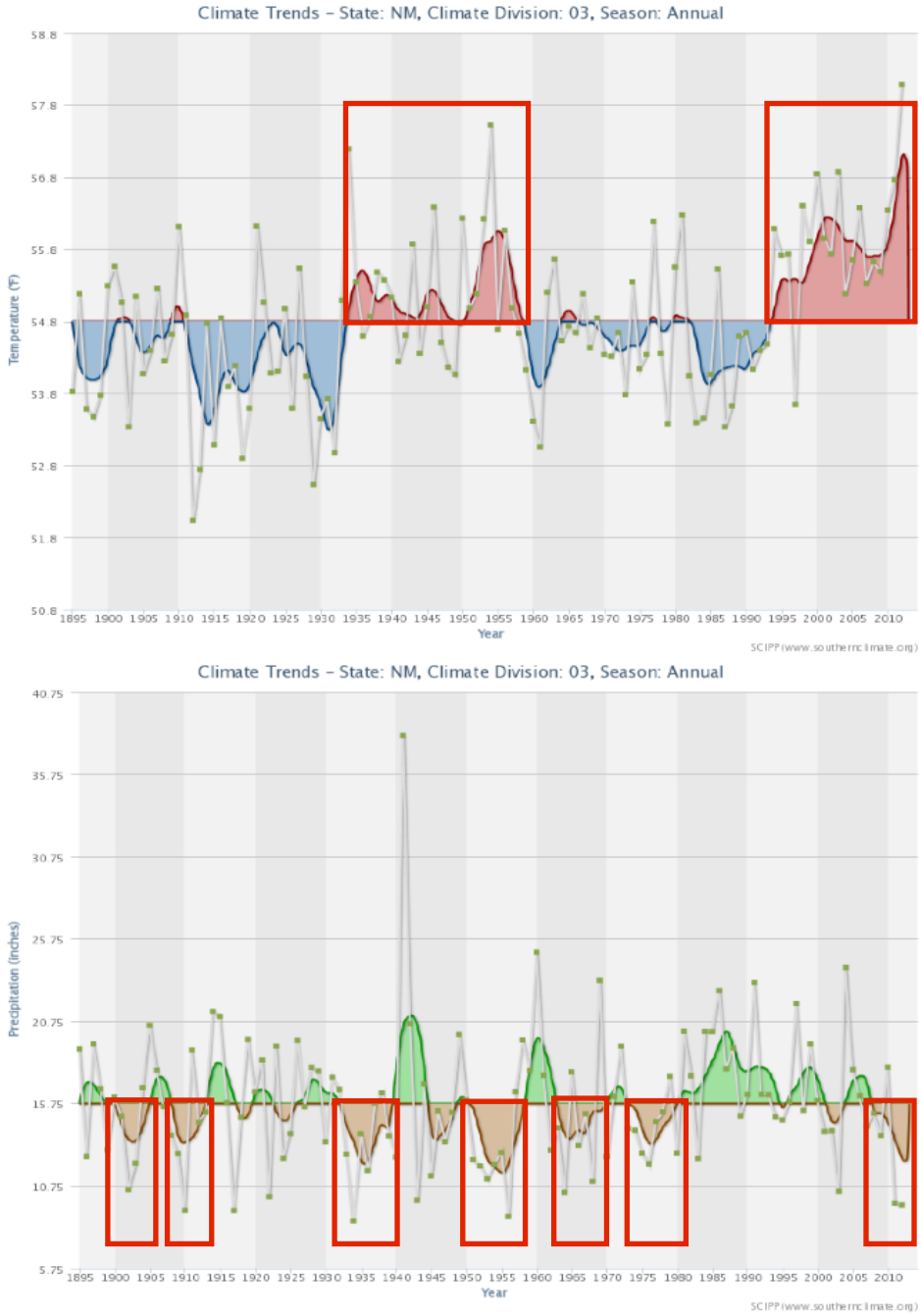

***Figure** 11. The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Northeastern Plains of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record in this region include the droughts in the 1930s, the 1950s, and the mid 2000s to the present. The longest periods of dry conditions were during the 1930s and 1950s. Table 3 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the 1930s exceeds the intensity and duration of most other droughts; hence, ***the period from April 1933 to October 1940 is the drought-of-record for the Northeastern Plains of New Mexico***.

Because of its intense heat combined with non-stop dry conditions, ***November 1949 through September 1957 comes in second for the drought-of-record for the Northeastern Plains of New Mexico***.

Table 3: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Northeastern Plains of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
October 1898 – May 1904	39 (of 68 months)	0	–3.91
March 1908 – June 1911	33 (of 40 months)	4	–4.26
April 1933 – October 1940	68 (of 91 months)	10 consecutive	–5.08
November 1949 – September 1957	79 (of 95 months)	7 consecutive plus 5 others	-4.9
August 1962 – January 1969	46 (of 78 months)	1	-4.19
October 1973 - October 1978	44 (of 61 months)	1	-4.03
December 2005 - December 2012*	52 (of 85 months)	6 consecutive twice	-5.36

Note: Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Northeastern Plains of New Mexico, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 12. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during July and August (top of Figure 3).

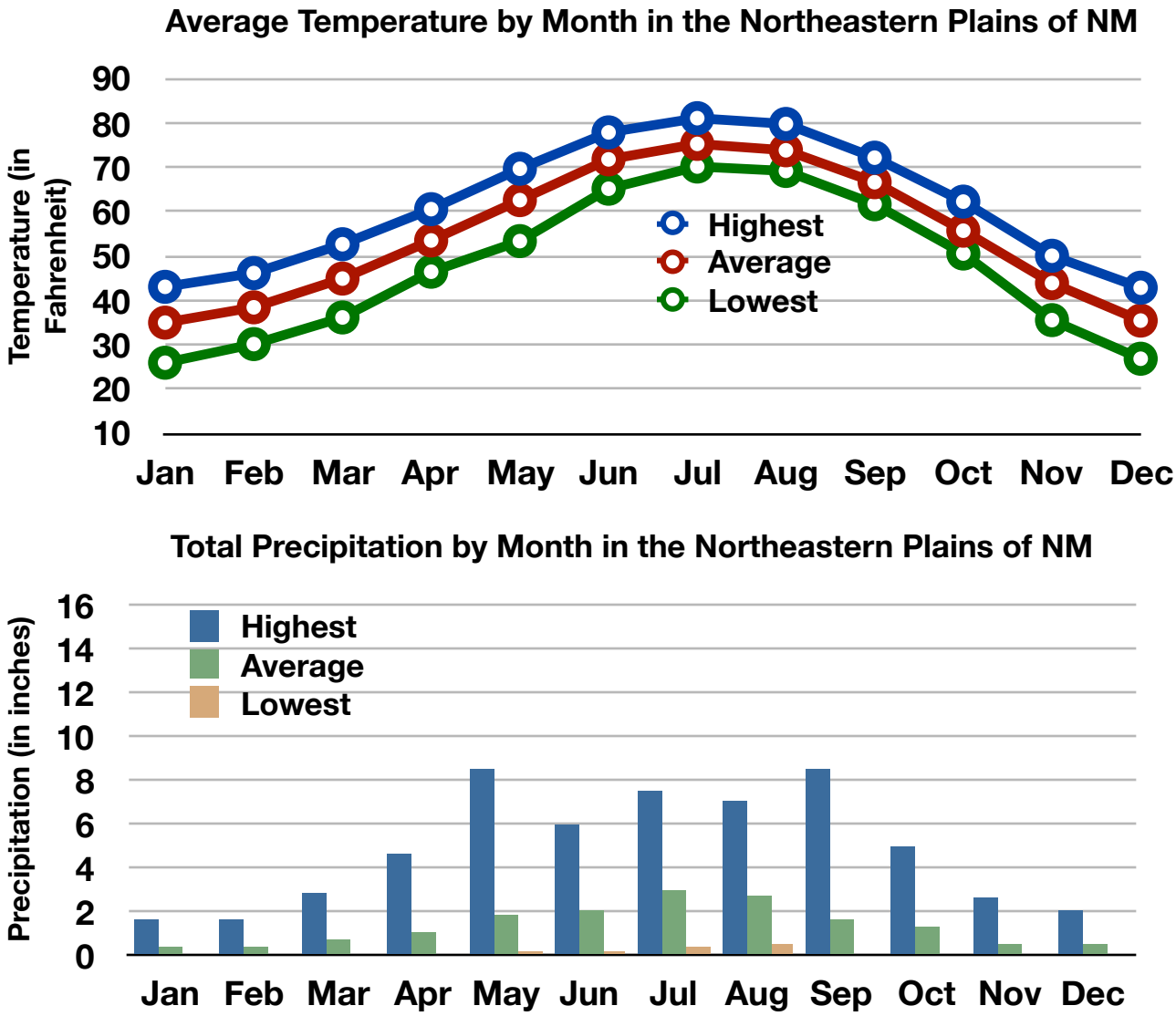

Figure 12. *Top graph: The monthly average temperature (in degrees Fahrenheit) across the Northeastern Plains of New Mexico using data from 1895 to 2012. The blue (middle) line is the average of all climate-division average temperatures for that time period. The red (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Northeastern Plains of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred at least once during January, February, March, October, November, and December.] The two peaks of precipitation, first in May, then in September, are clearly visible.*

The Northeastern Plains of New Mexico has experienced long and extreme droughts in its past. Figure 13 displays the departure from normal precipitation, and Palmer Drought Severity Index for the the region from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 11.

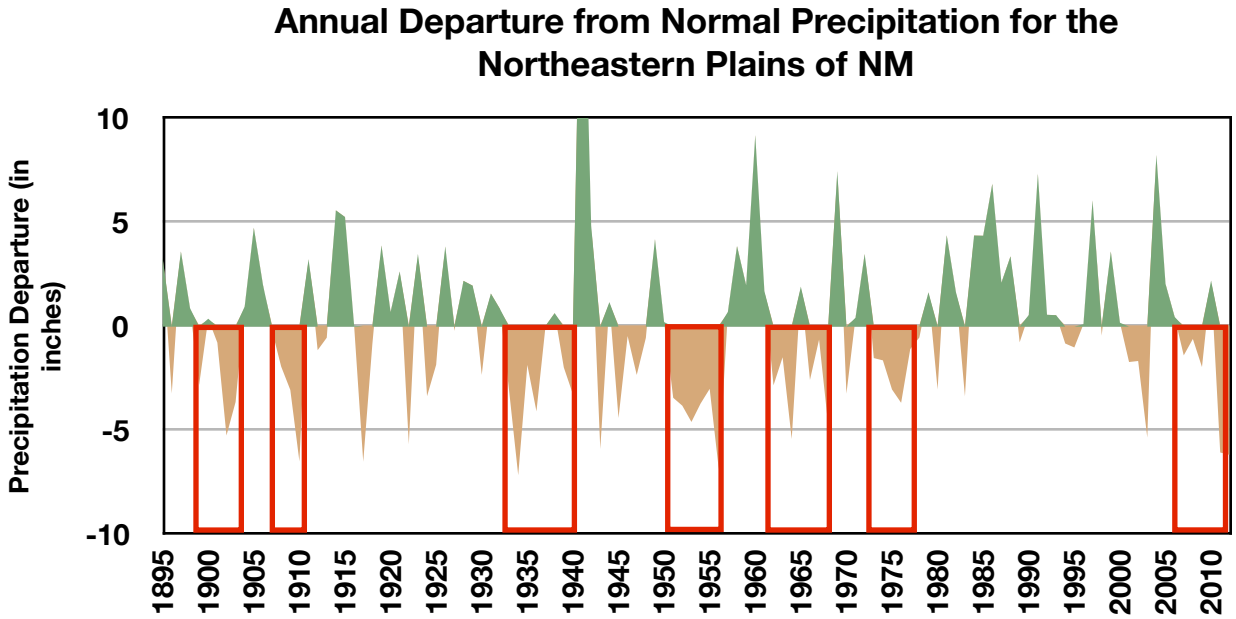

***Figure 13a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Northeastern Plains of New Mexico from 1895 to 2012.*

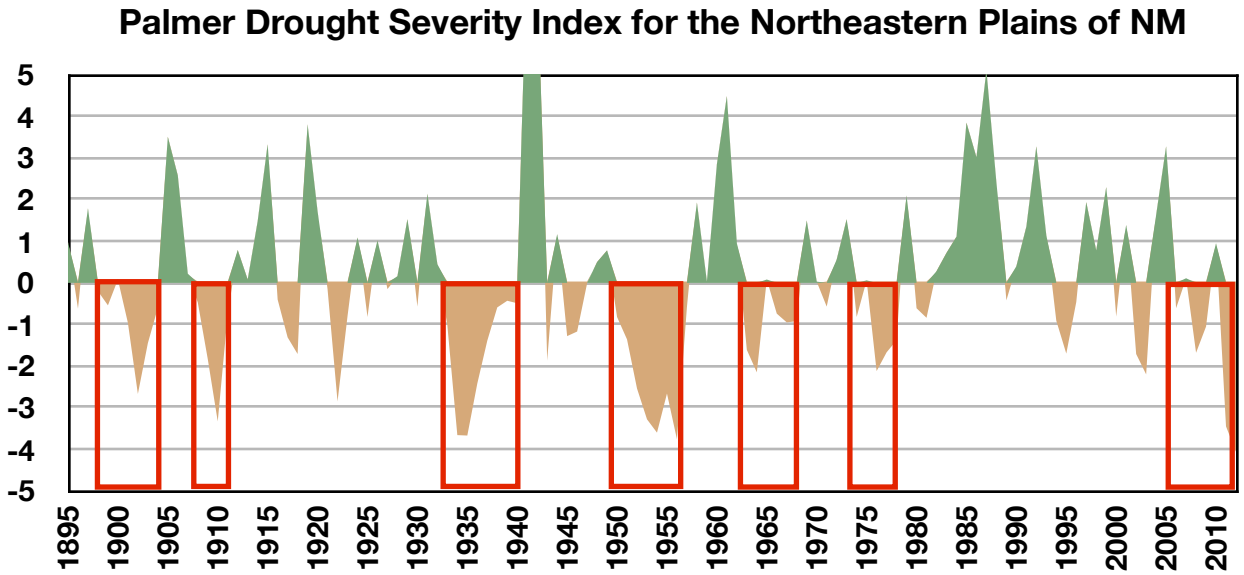

***Figure 13b**. Palmer Drought Severity Index for the Northeastern Plains of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 14 we look at drought designation in the Northeastern Plains region from the year 2000 to 2013. We can see that moderate to extreme conditions covered up to 100% of the region in 2002-2004. The region experienced also experienced a period of extreme to exceptional drought covering 25 to nearly 100% of region from 2011 to 2013.

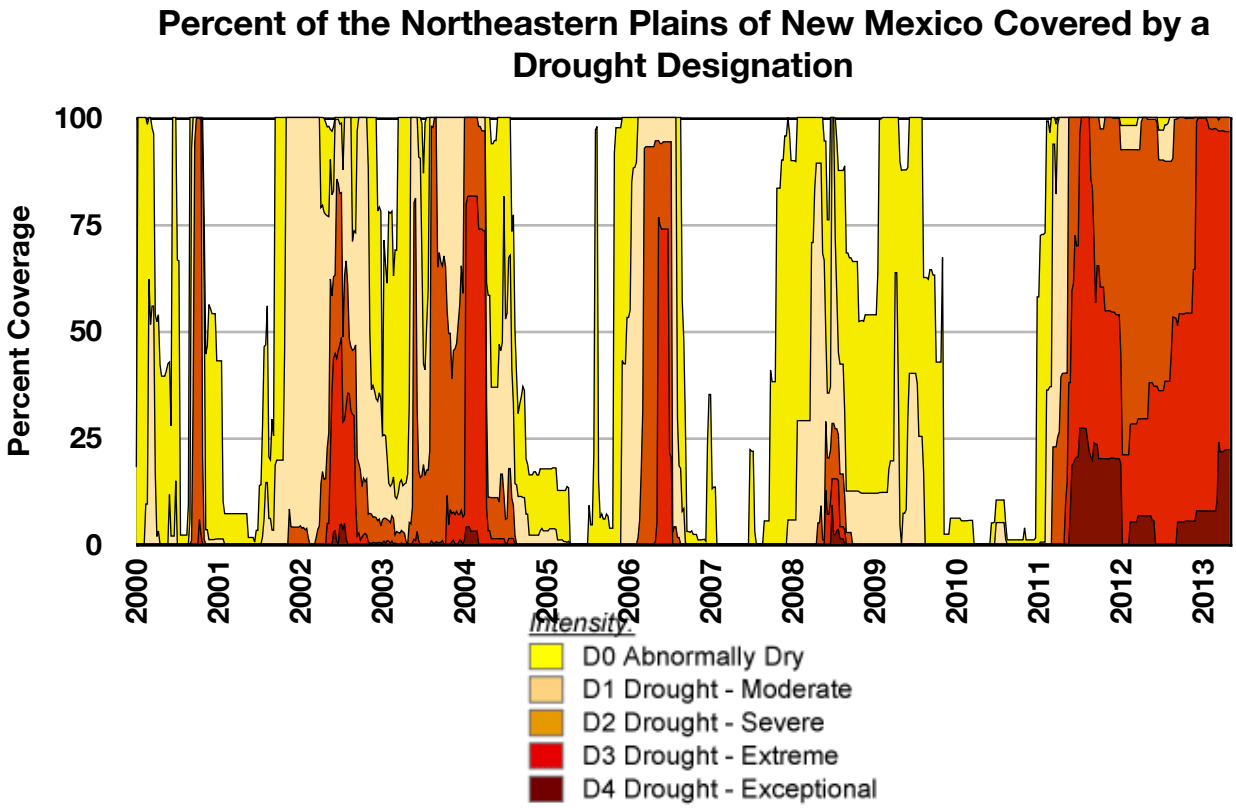

***Figure 14**. Drought history for the Northeastern Plains of New Mexico, as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 5. Note that the Northeastern Plains of New Mexico was experiencing extreme (bright red) to exceptional drought (dark red) across most of the climate division during much of 2003, 2006, and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.*

For more information on the sources of drought information, see Table 9 on page 47.

Region 4: Southwestern Mountains of New Mexico

The Southwestern Mountains region of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 15 shows the annual temperature (top) and annual precipitation (bottom) in the Southwestern Mountains of New Mexico since 1895.[5] The annual temperature for the Southwestern Mountains of New Mexico averages 49.6 degrees Fahrenheit, while precipitation averages 13.06 inches. Warmer-than-average periods have spanned the late 1890s through the 1900s, the 1980s, and the mid-1990s through the early 2010s. Significant periods of drier-than-average conditions include the late 1890s through the early 1910s, the mid-1940s through the late 1950s, and early 2010s.

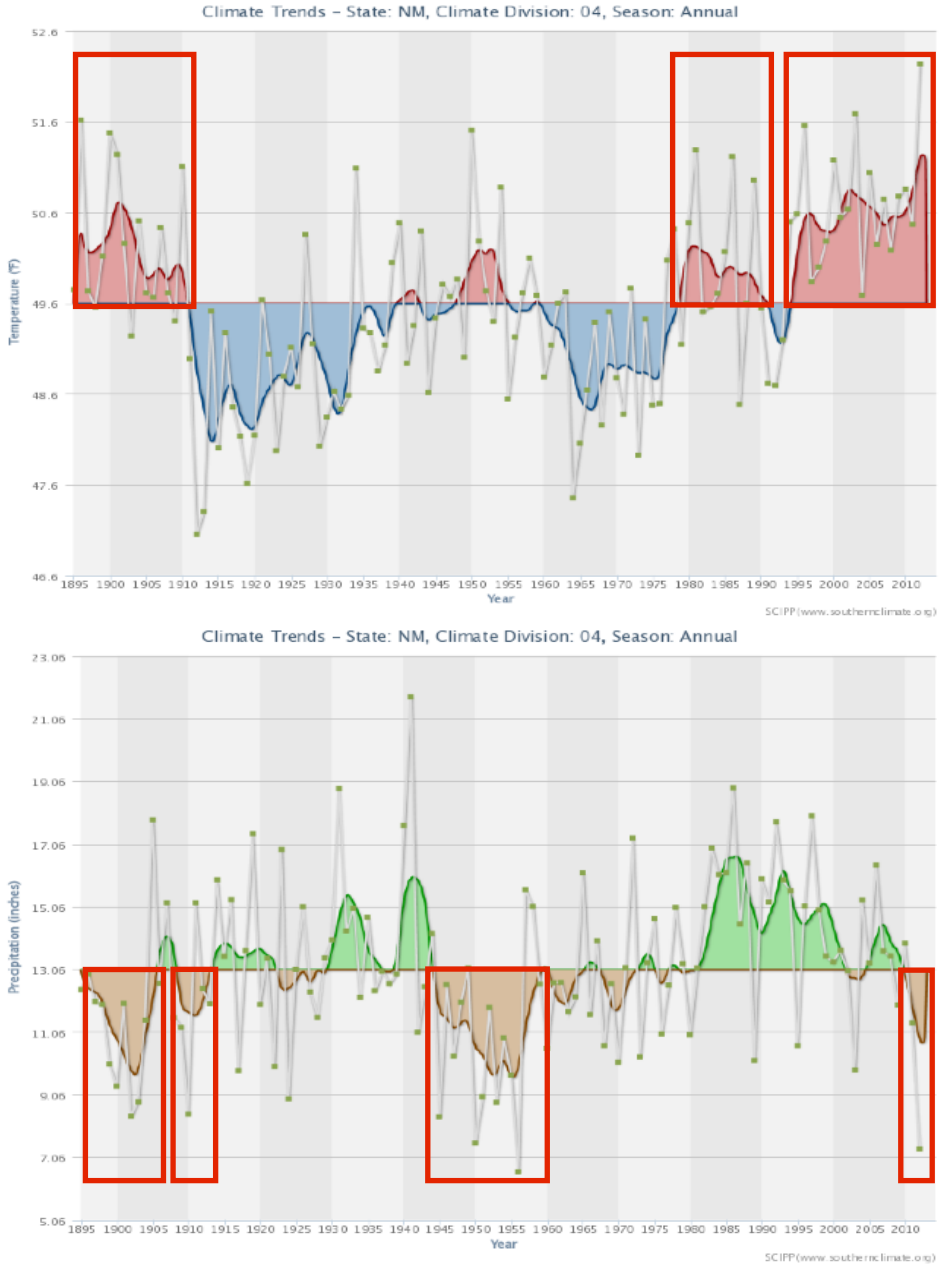

Figure 15. *The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Southwestern Mountains of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record in this region include the droughts in the late 1890s through the mid-1900s and the mid-1940s through the mid-1950s. The period with the longest duration is undoubtably the mid-1940s through the mid-1950s. Table 4 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the the mid-1940s through the mid-1950s well exceeds intensity of all other droughts; hence, ***the period from June 1945 to June 1957 is the drought-of-record for the Southwestern Mountains of New Mexico***.

Because of its intense heat combined with non-stop dry conditions, ***November 1897 to August 1904 comes in second for the drought-of-record for the Southwestern Mountains of New Mexico.***

Table 4: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Southwestern Mountains of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
November 1897 - August 1904	80 (of 82 months)	11 consecutive, 10 consecutive, plus 12 other	–5.91
October 1909 - May 1911	32 (of 32 months)	5 consecutive plus 2 other	–4.77
June 1945 - June 1957	119 (of 145 months)	14 consecutive, 12 consecutive, plus 4 other	–6.41
January 2009 - December 2012*	38 (of 48 months)	5 consecutive plus 7 other	–5.21

Note: Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Southwestern Mountains of New Mexico, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 16. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during July and August (top of Figure 16).

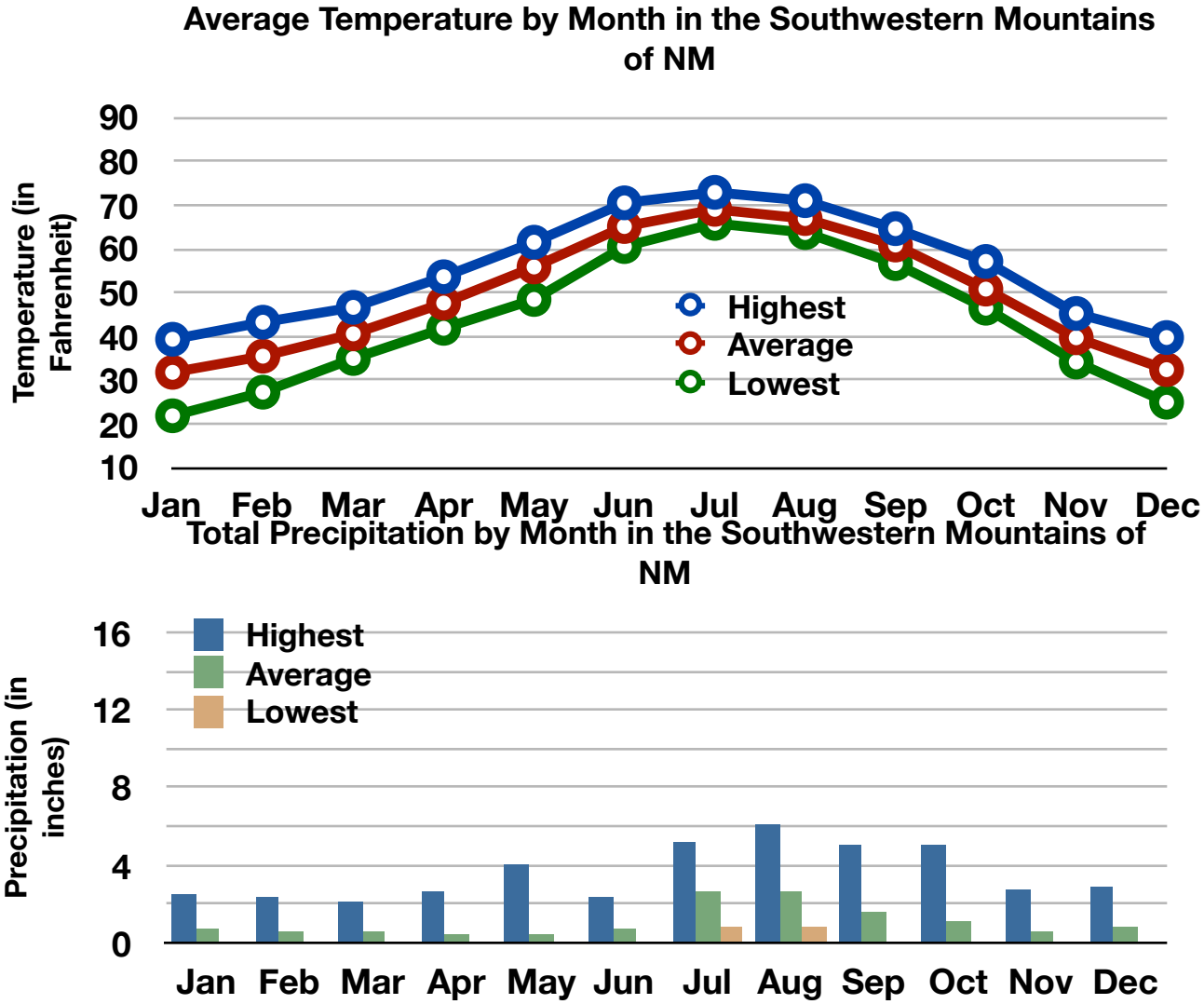

Figure 16. *<u>Top graph</u>: The monthly average temperature (in degrees Fahrenheit) across the Southwestern Mountains of New Mexico using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. <u>Bottom graph</u>: The average total precipitation (in inches) by month across the Southwestern Mountains of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred at least once during January, April, May, June, October, November, and December] The two peaks of precipitation, first in July, then in August, are clearly visible.*

The Southwestern Mountains of New Mexico has experienced long and extreme droughts in its past. Figure 17 displays the departure from normal precipitation and the Palmer Drought Severity Index for the region from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 2.

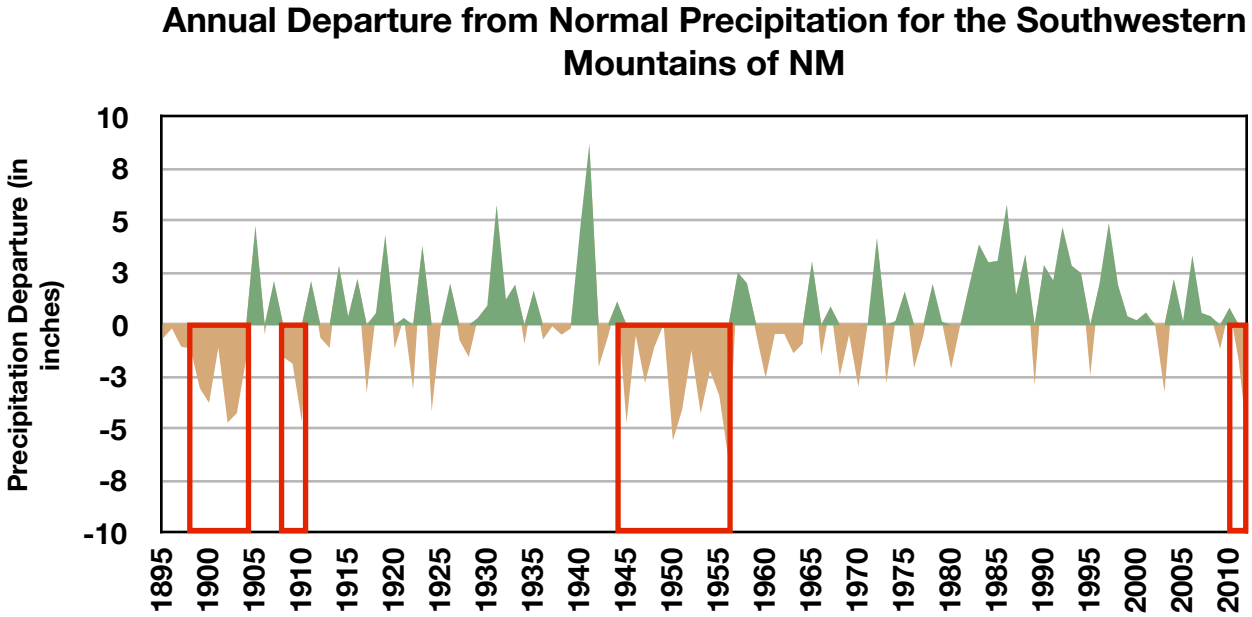

***Figure 17a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Southwestern Mountains of New Mexico from 1895 to 2012.*

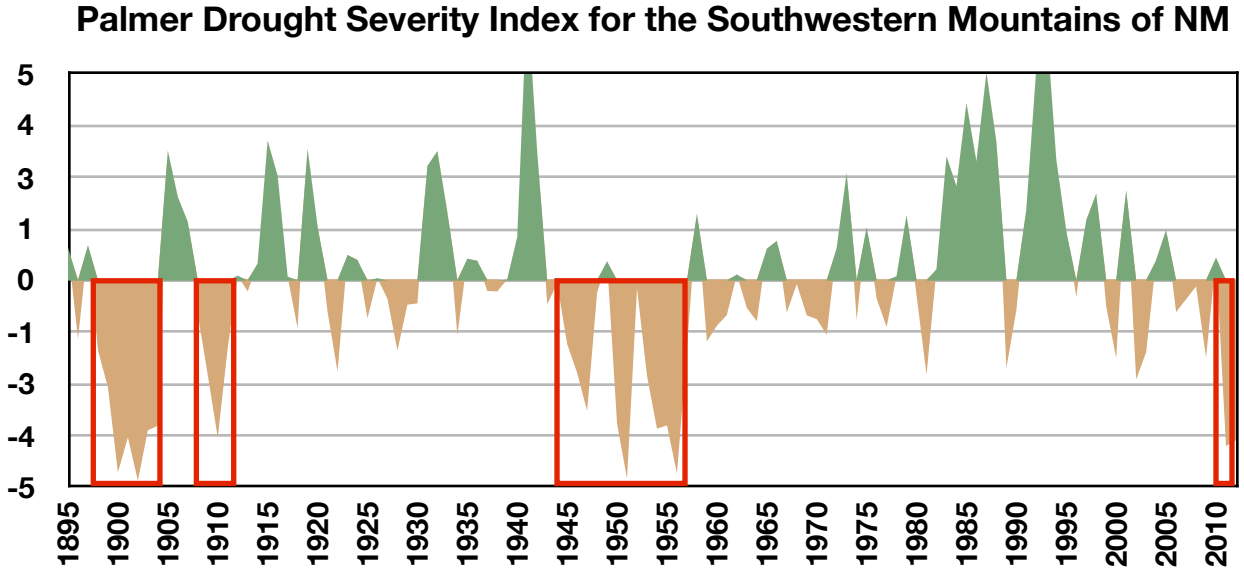

***Figure 17b**. Palmer Drought Severity Index for the Southwestern Mountains of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 18 we look at drought designation in the Southwest Mountains region from the year 2000 to 2013. We see that abnormally dry to extreme conditions covered up to 100% of the region in 2002-2004. The region experienced a period of extreme to exceptional drought covering 25 to nearly 100% of region from 2011 to 2013.

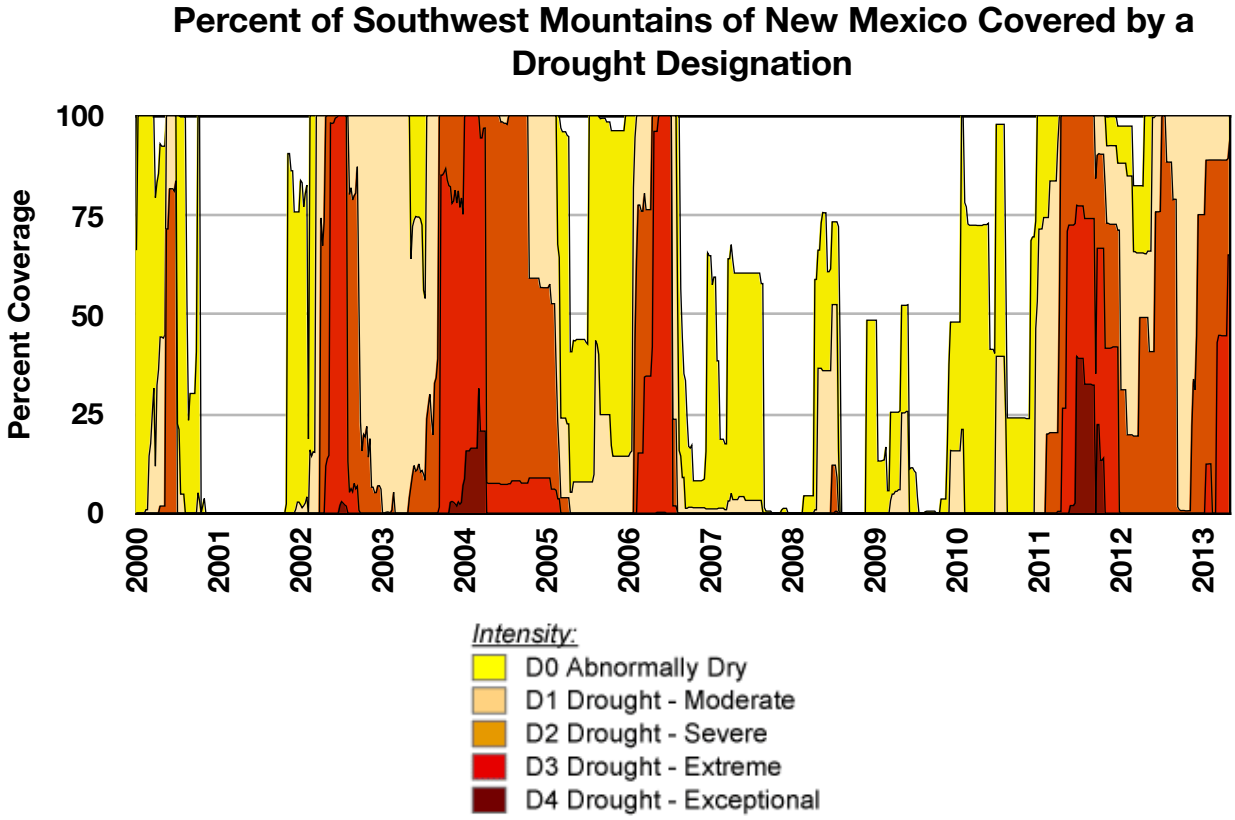

***Figure 18**. Drought history for the Southwestern Mountains of New Mexico as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 1. Note that the Southwestern Mountains of New Mexico was experiencing extreme (bright red) to exceptional drought (dark red) across most of the area during much of 2004, 2006, and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.*

For more information on the sources of drought information, see Table 9 on page 47.

Region 5: Central Valley

The Southwestern Mountains region of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 19 shows the annual temperature (top) and annual precipitation (bottom) in the Central Valley of New Mexico since 1895.[6] The annual temperature for the Central Valley of New Mexico averages 56.3 degrees Fahrenheit, while precipitation averages 9.45 inches. Warmer-than-average periods have spanned the late 1890s through the 1900s, the 1930s, the 1960s, the early 1980s, and the mid 1990s through the early 2010s. Significant periods of drier-than-average conditions include the late 1890s through the early 1910s, the mid-1940s through the late 1950s, and the early 2010s.

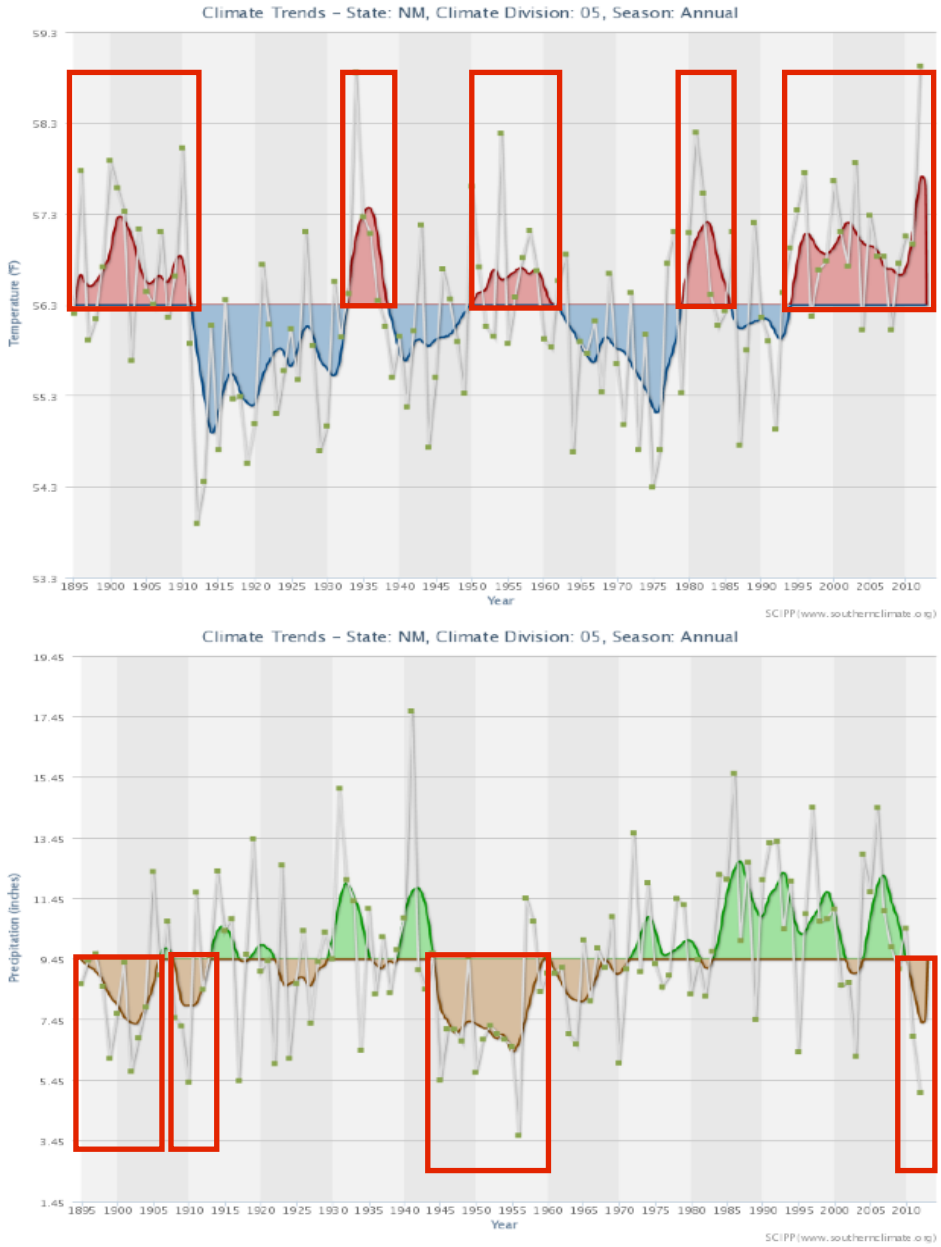

Figure 19. *The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Central Valley of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record include the droughts in the late 1890s through the mid-1900s and the mid-1940s through the mid-1950s. The period with the longest duration is undoubtably the mid-1940s through the mid-1950s. Table 5 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the mid-1940s through the mid-1950s well exceeds intensity and duration of all other droughts; hence, ***the period from June 1945 to June 1957 is the drought-of-record for the Central Valley of New Mexico.***

Because of its intense heat combined with non-stop dry conditions, ***February 1898 to August 1904 comes in second for the drought-of-record for the Central Valley of New Mexico.***

Table 5: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Central Valley of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
February 1898 - August 1904	70 (of 79 months)	6 consecutive plus 1 other	–4.76
October 1908 - January 1911	28 (of 28 months)	5 consecutive	–4.38
June 1945 - June 1957	127 (of 145 months)	10 consecutive plus 1 other	–5.61
November 2010 - December 2012*	25 (of 25 months)	3 consecutive	–4.18

Note: *Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Central Valley of New Mexico, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 20. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during July and August (top of Figure 20).

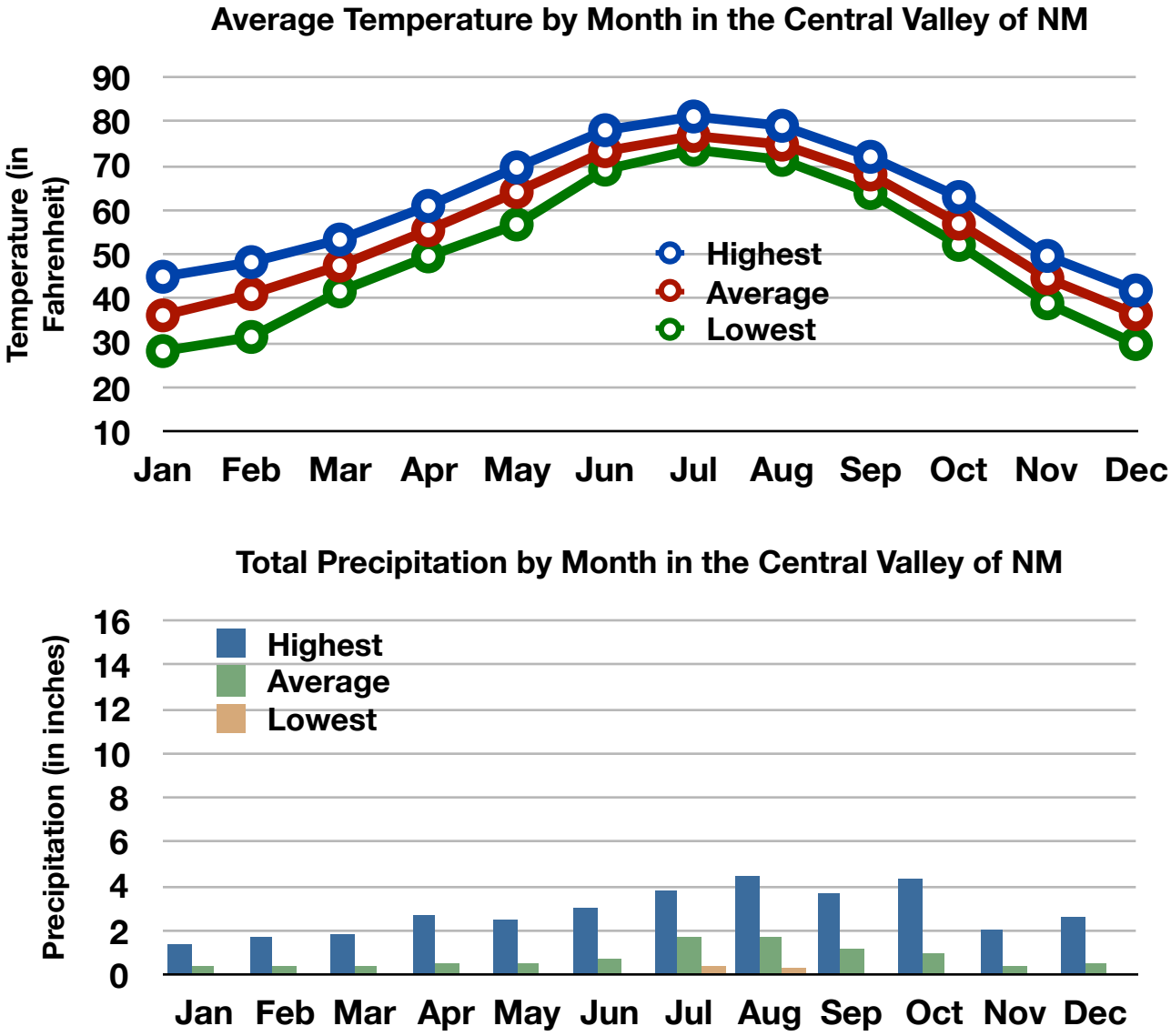

Figure 20. *Top graph: The monthly average temperature (in degrees Fahrenheit) across the Central Valley of New Mexico using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Central Valley of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred every month except July, August, and September] The two peaks of precipitation, first in August, then in October, are clearly visible.*

The Central Valley of New Mexico has experienced long and extreme droughts in its past. Figure 21 displays the departure from normal precipitation and Palmer Drought Severity Index for the Central Valley of New Mexico from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 19.

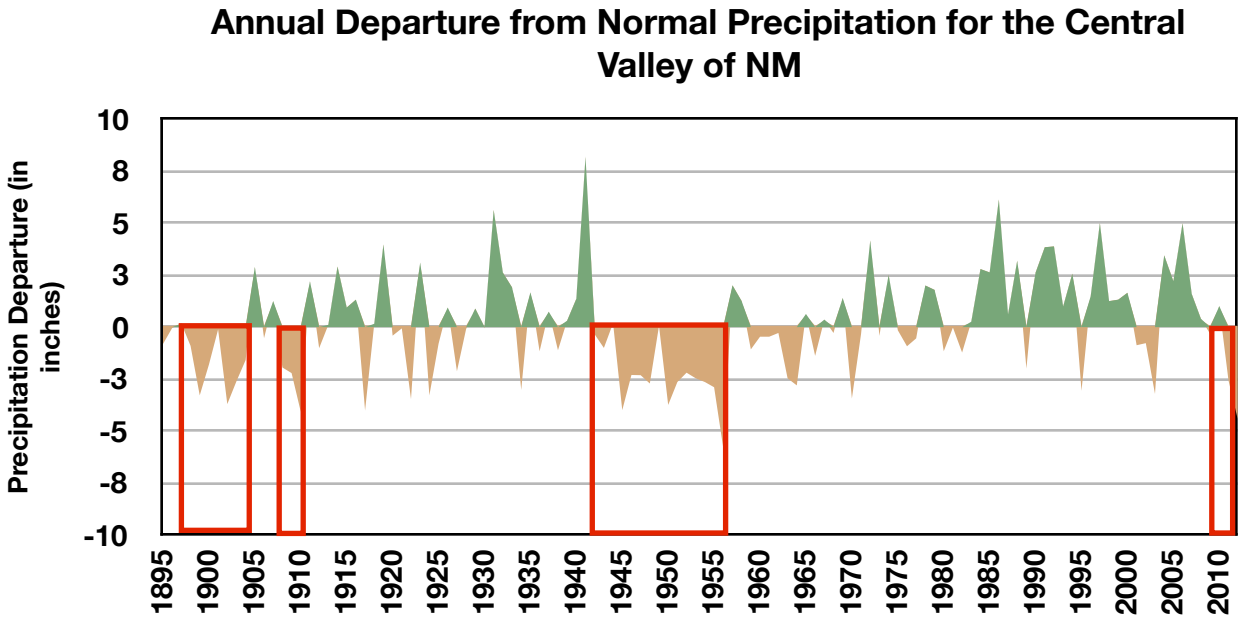

***Figure 21a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Central Valley of New Mexico from 1895 to 2012.*

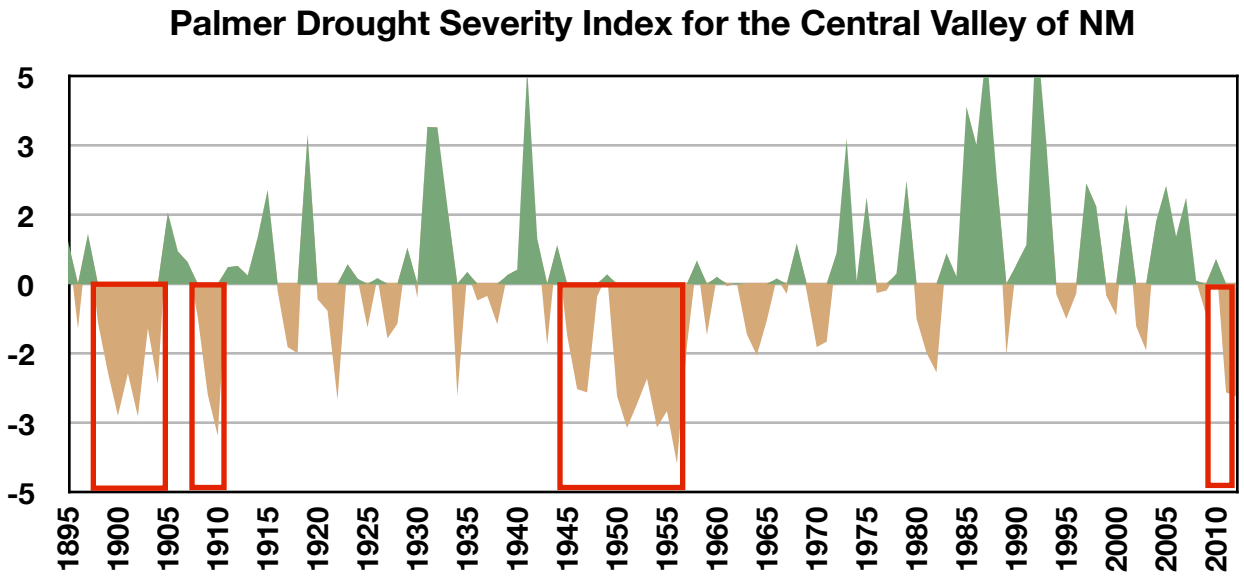

***Figure 21b**. Palmer Drought Severity Index for the Central Valley of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 22 we look at drought designation in the Central Valley region from the year 2000 to 2013. Abnormally dry to extreme conditions covered up to 100% of the region in years 2000-2004. From 2011 to 2013 the region also experienced extreme to exceptional drought covering nearly 25-100% of region.

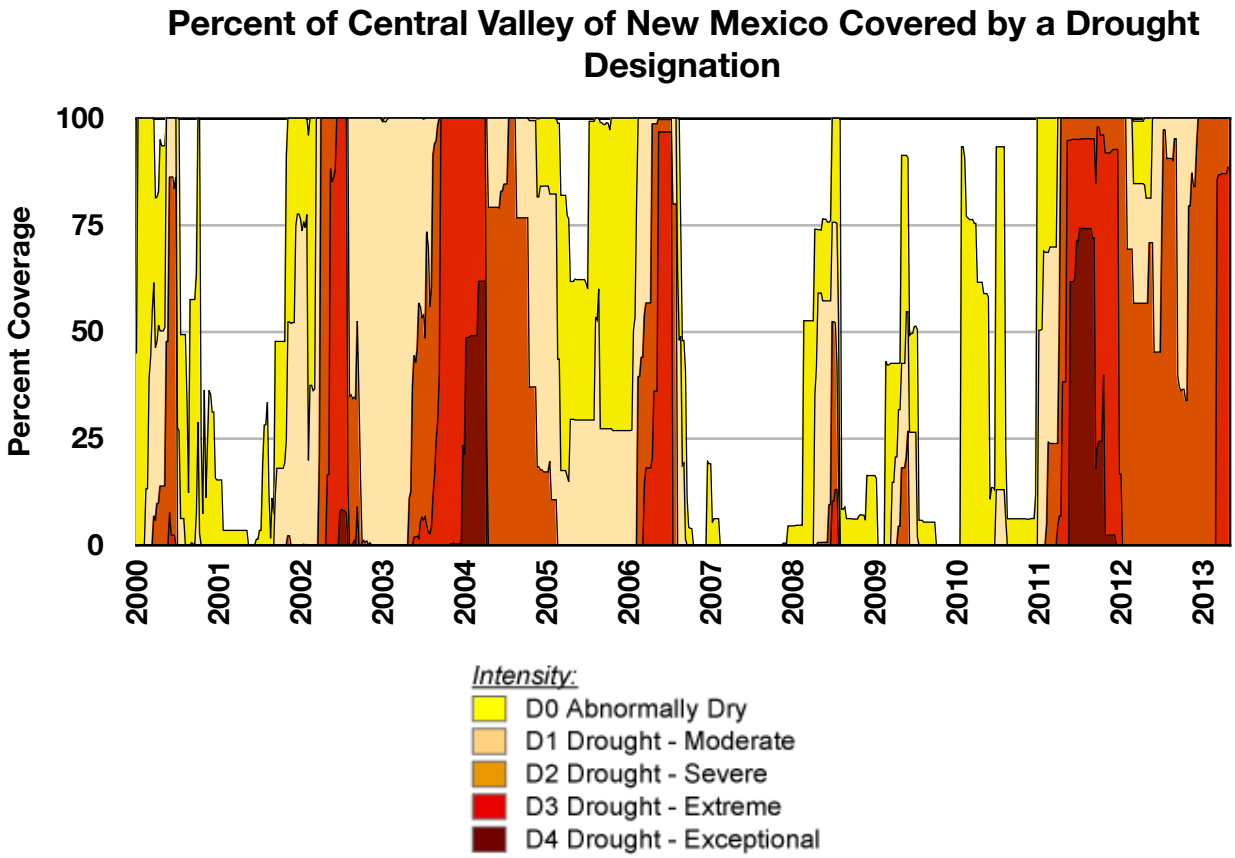

***Figure 22**. Drought history for the Central Valley of New Mexico as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 1. Note that the Central Valley of New Mexico was experiencing extreme (bright red) to exceptional drought (dark red) across most of the area during much of 2003, 2004, 2006, and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.*

For more information on the sources of drought information, see Table 9 on page 47.

Region 6: Central Highlands

The Central Highlands region of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 23 shows the annual temperature (top) and annual precipitation (bottom) in the Central Highlands of New Mexico since 1895.[7] The annual temperature for the Central Highlands of New Mexico averages 49.5 degrees Fahrenheit, while precipitation averages 16.8 inches. Warmer-than-average periods have spanned the late 1890s to the early 1910s, the early 1940s to the mid 1950s, and the 1980s through the early 2010s. Significant periods of drier-than-average conditions include the late 1890s to the early 1910s, the mid 1930s, the mid 1940s through the mid 1950s, the early 2000s, and the early 2010s.

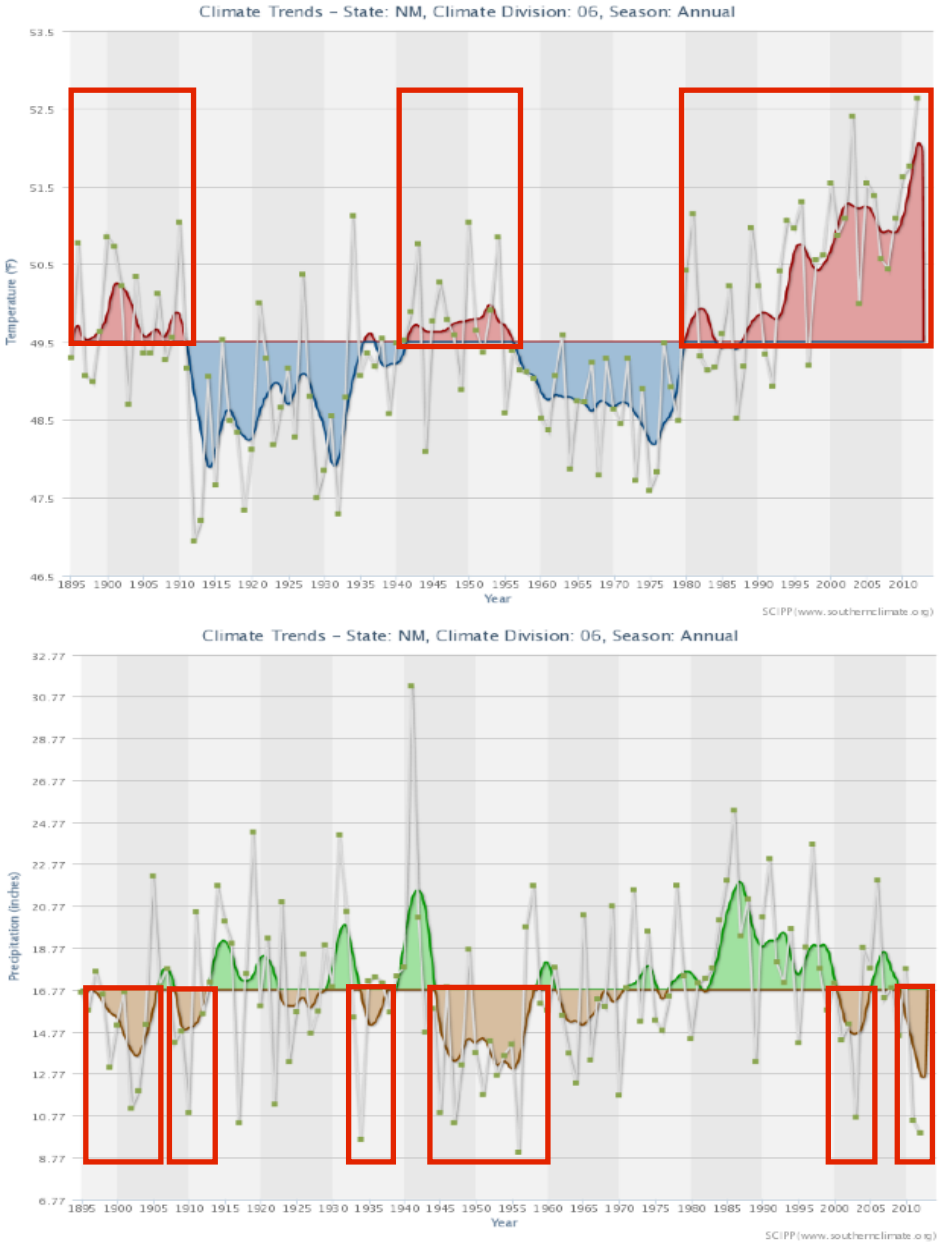

Figure 23. *The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Central Highlands of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record include the droughts in the early 1900s, the 1940s through the 1950s, and the late 2000s. The longest period of dry conditions undoubtably was during the mid-1940s through the 1950s. Table 6 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the mid-1940s through the 1950s well exceeds the duration and intensity of all other droughts; hence, ***the period from April 1943 to June 1957 is the drought-of-record for the Central Highlands of New Mexico.***

Because of its intense heat combined with non-stop dry conditions, ***October 1898 through August 1904 comes in second for the drought-of-record for the Central Highlands of New Mexico***.

Table 6: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Central Highlands of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
October 1898 – August 1904	75 (of 79 months)	9 consecutive twice	–6.49
June 1908 – June 1911	34 (of 37 months)	13 consecutive	–5.41
December 1933 - August 1938	32 (of 57 months)	8 consecutive	-5.65
April 1943 – June 1957	140 (of 171 months)	11 consecutive plus 18 others	–5.70
November 1999 – September 2004	48 (of 59 months)	5 consecutive plus 6 others	-5.79
September 2007 - December 2012*	45 (of 64 months)	21 consecutive plus 1 other	-7.23

Note: Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Central Highlands of New Mexico, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 24. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during June, July, and August (top of Figure 24).

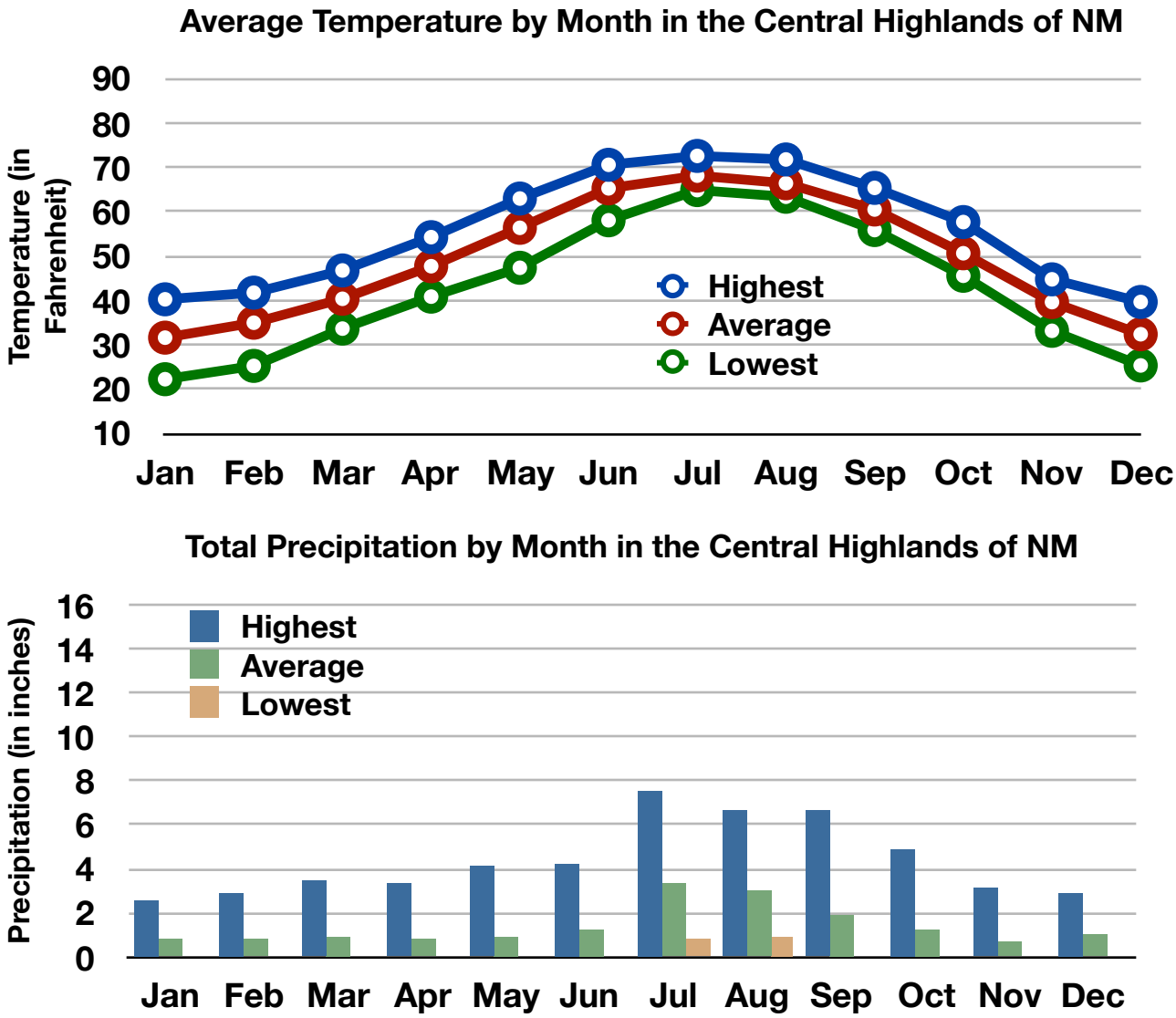

Figure 24. *Top graph: The monthly average temperature (in degrees Fahrenheit) across the Central Highlands of New Mexico using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Central Highlands of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred at least once during January, April, May, June, October, November, and December.] The three peaks of precipitation in July, August, and September are clearly visible.*

The Central Highlands of New Mexico has experienced long and extreme droughts in its past. Figure 25 displays the departure from normal precipitation and Palmer Drought Severity Index for the region from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 23.

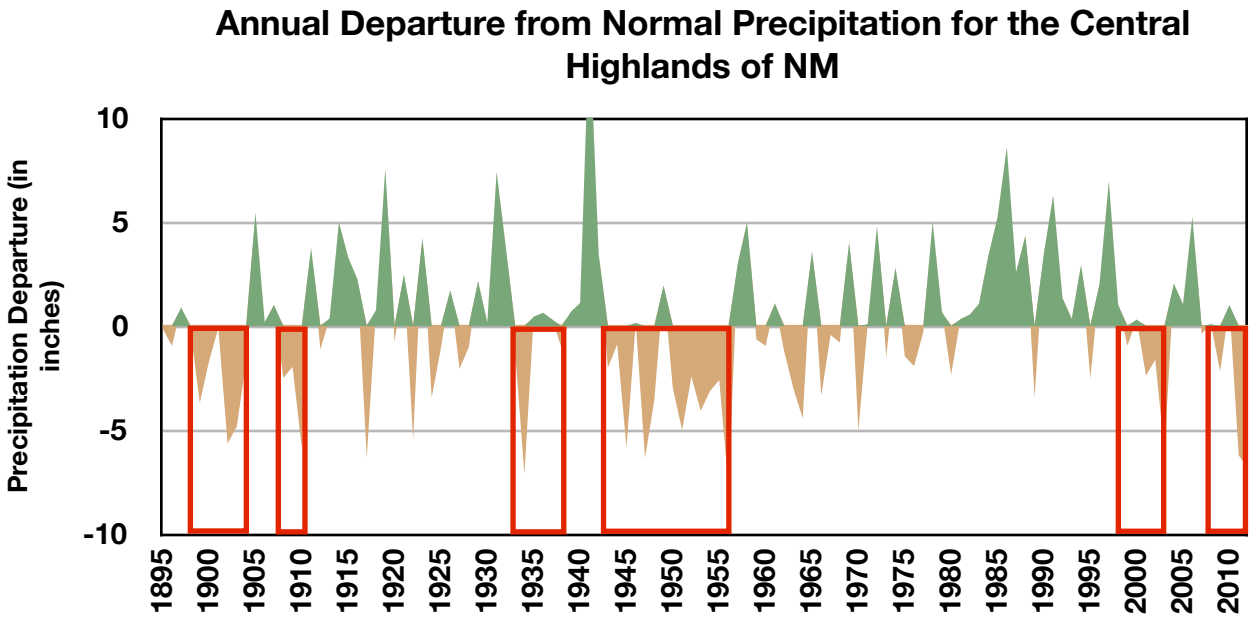

***Figure 25a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Central Highlands of New Mexico from 1895 to 2012.*

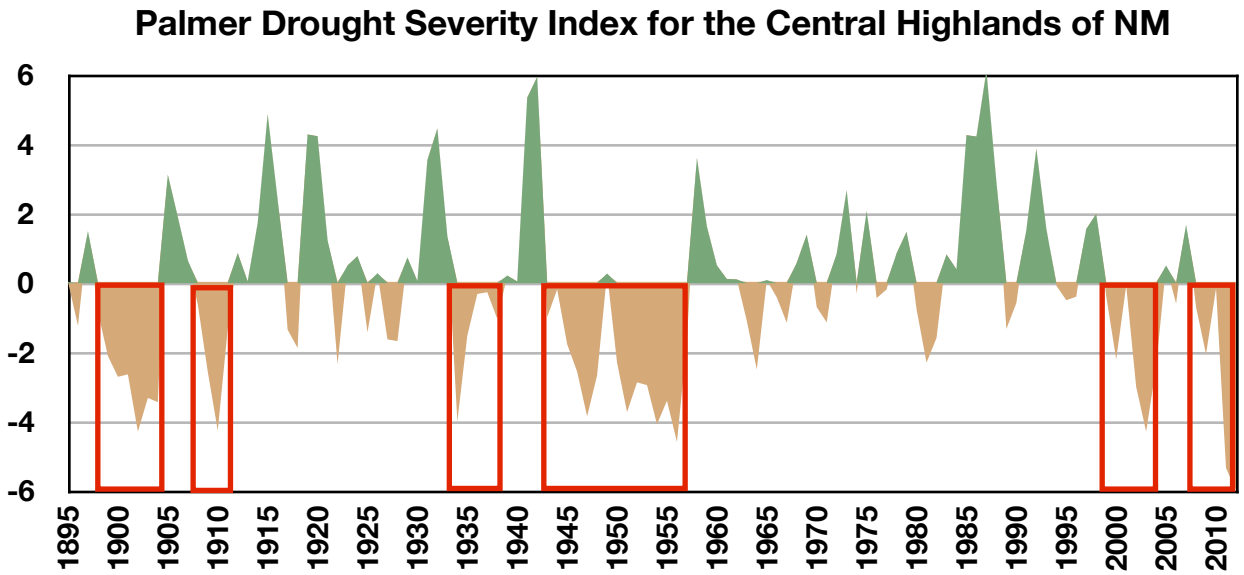

***Figure 25b**. Palmer Drought Severity Index for the Central Highlands of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 26 we look at drought designation in the Central Plains region from the year 2000 to 2013. We see that many instances of abnormally dry to severe conditions covered up to 100% of the region from 2002 to 2007. Extreme to exceptionally dry conditions covered 30-100% during this time period as well. In 2011 to 2013 we see that the region experienced another period of abnormally dry to extreme conditions covering 25-100% of region.

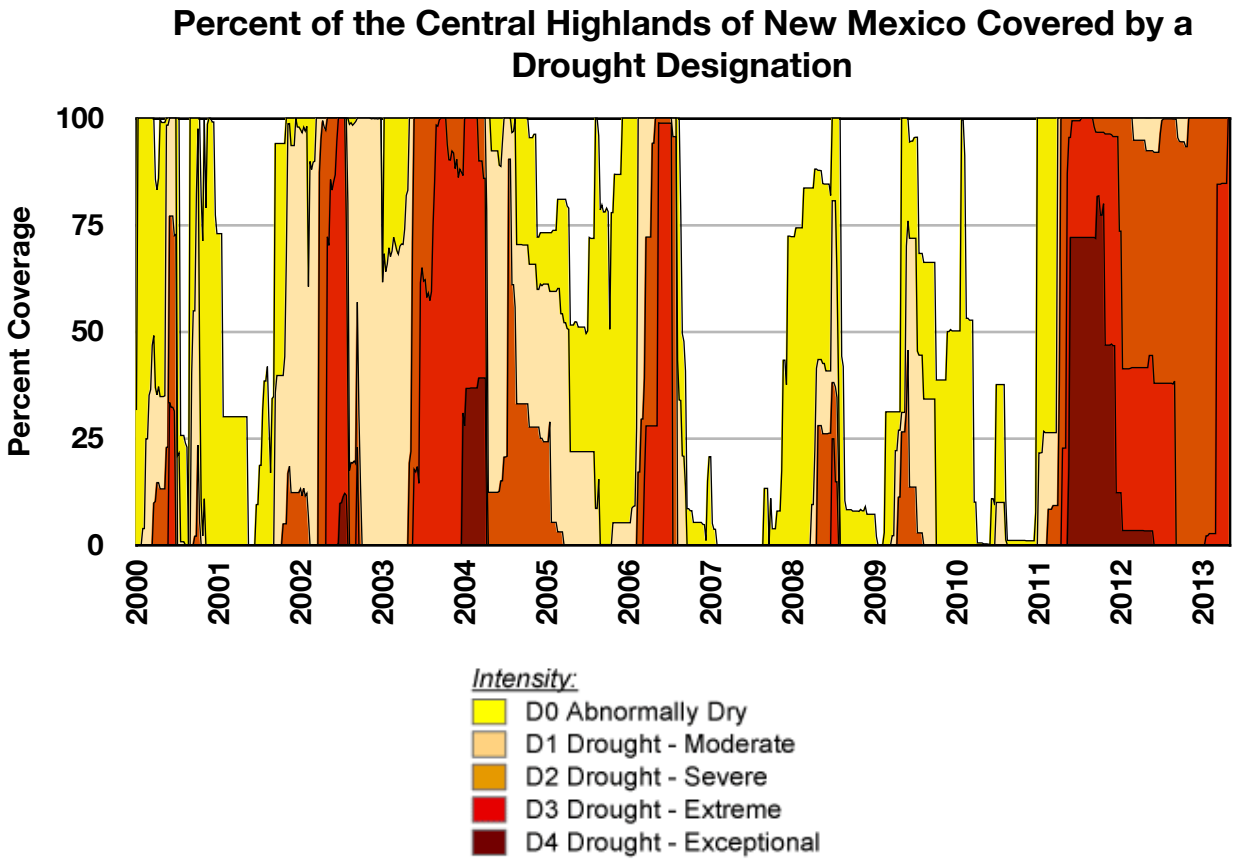

Figure 26 *Drought history for the Central Highlands of New Mexico as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 1. Note that the Central Highlands were experiencing extreme (bright red) to exceptional drought (dark red) across most of the climate division during much of 2003 and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.*

For more information on the sources of drought information, see Table 9 on page 47.

Region 7: Southern Plains of New Mexico

The Southern Plains region of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 27shows the annual temperature (top) and annual precipitation (bottom) in the Southeastern Plains of New Mexico since 1895.[8] The annual temperature for the Southeastern Plains of New Mexico averages 58.8 degrees Fahrenheit, while precipitation averages 13.51 inches. Warmer-than-average periods have spanned the late 1900s, the 1950s, and the late 1980s through the early 2010s. Significant periods of drier-than-average conditions include the 1900s, the early 1910s, the mid-1940s through the late 1950s, the 1960s, and the early 2010s.

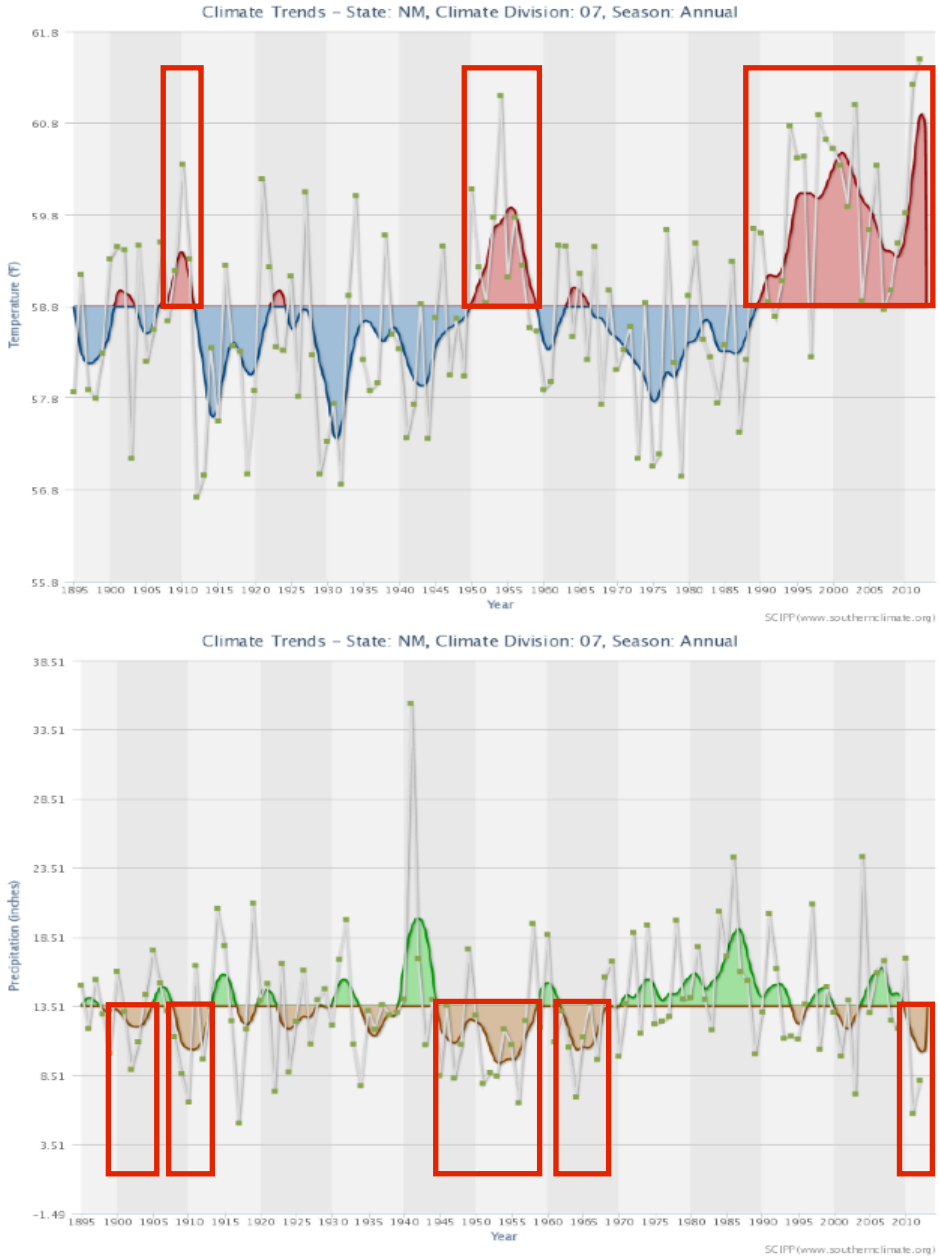

Figure 27. *The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Southeastern Plains of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record include the droughts in the early 1910s, the 1940s through the mid-1950s, and the 1960s. The longest period of dry conditions undoubtably was during the mid-1940s through the 1950s. Table 7 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the mid-1940s through the 1950s well exceeds the duration and intensity of all other droughts; hence, ***the period from May 1945 to September 1957 is the drought-of-record for the Southeastern Plains of New Mexico.***

Table 7: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Southeastern Plains of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
August 1898 – August 1904	50 (of 77 months)	1	–4.23
March 1907 - November 1912	40 (of 67 months)	10 consecutive	–5.19
May 1945 - September 1957	119 (of 149 months)	7 consecutive plus 13 others	-4.84
May 1962 – November 1967	55 (of 67 months)	6 consecutive	-4.43
November 2010 - December 2012*	26 (of 26 months)	8 consecutive, 7 consecutive plus 1 other	-6.57

Note: Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Southeastern Plains of New Mexico, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 28. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during August (top of Figure 28).

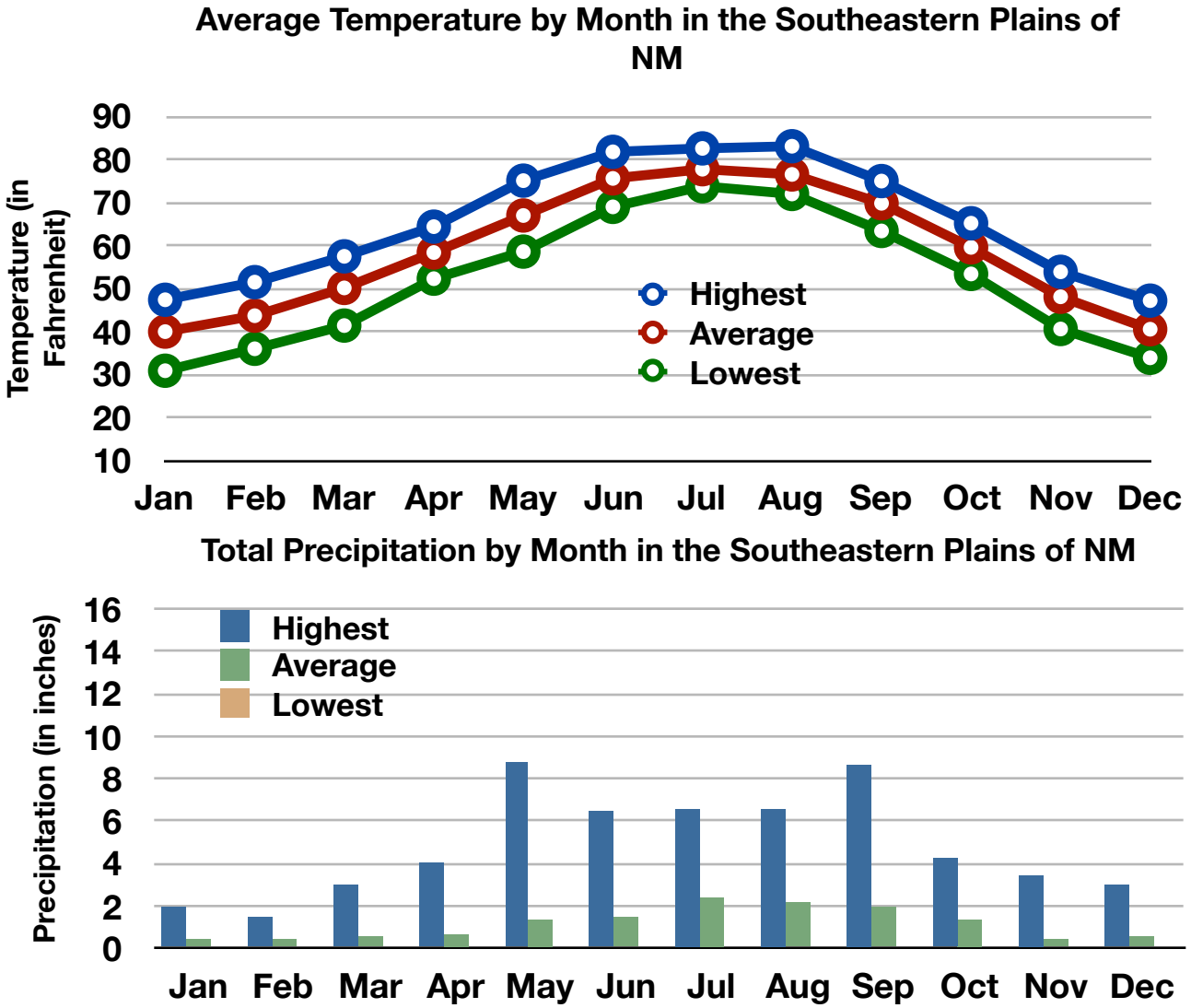

Figure 28. *Top graph: The monthly average temperature (in degrees Fahrenheit) across the Southeastern Plains of New Mexico using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Southeastern Plains of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred every month except June, July, and September.] The two peaks of precipitation, first in May, then in September, are clearly visible.*

The Southeastern Plains of New Mexico has experienced long and extreme droughts in its past. Figure 29 displays the departure from normal precipitation and Palmer Drought Severity Index for the region from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 27.

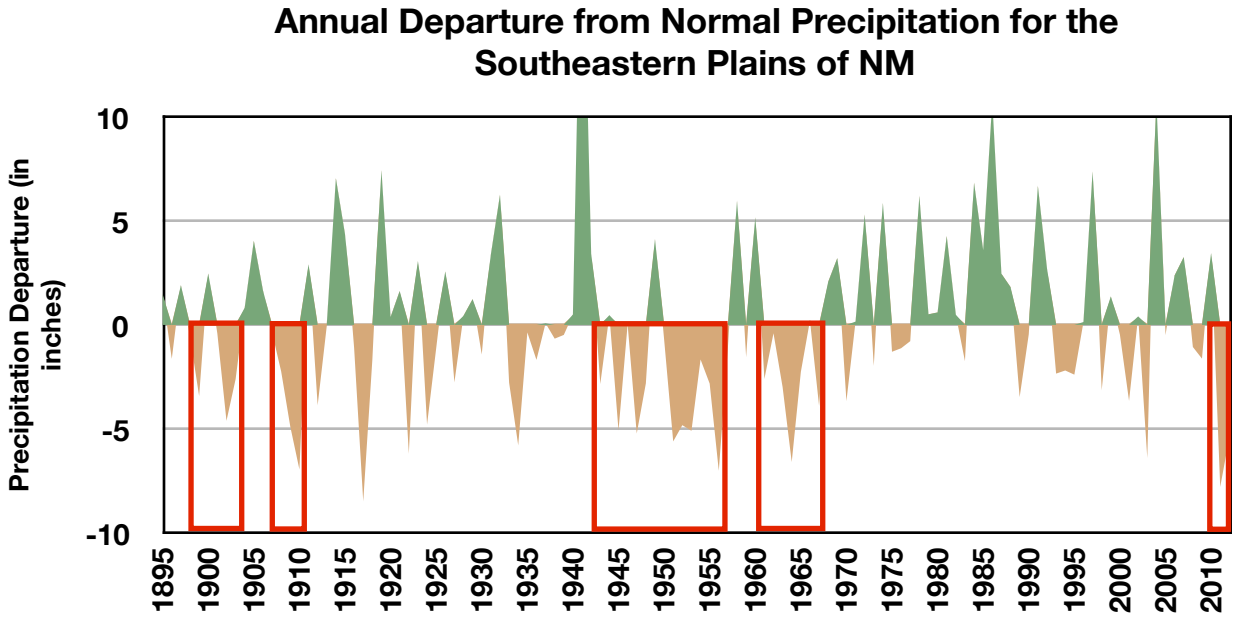

***Figure 29a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Southeastern Plains of New Mexico from 1895 to 2012.*

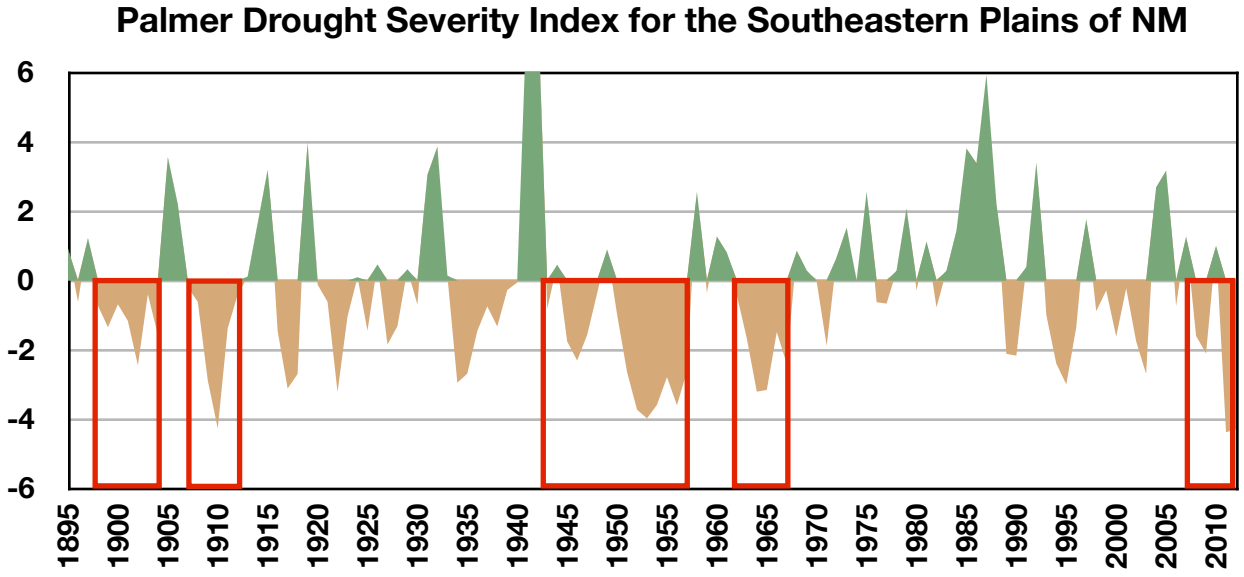

***Figure 29b**. Palmer Drought Severity Index for the Southeastern Plains of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 30 we look at drought designation in the Southeastern Plains of New Mexico in years 2000 to 2013. We can see that many instances of abnormally dry to extreme conditions covered up to 100% of the region from 2000 to 2004. Exceptionally dry conditions covered a little over 50% during this time as well. From 2011 to 2013 we see that the region experienced another period of abnormally dry to exceptional conditions covering 30-100% of region.

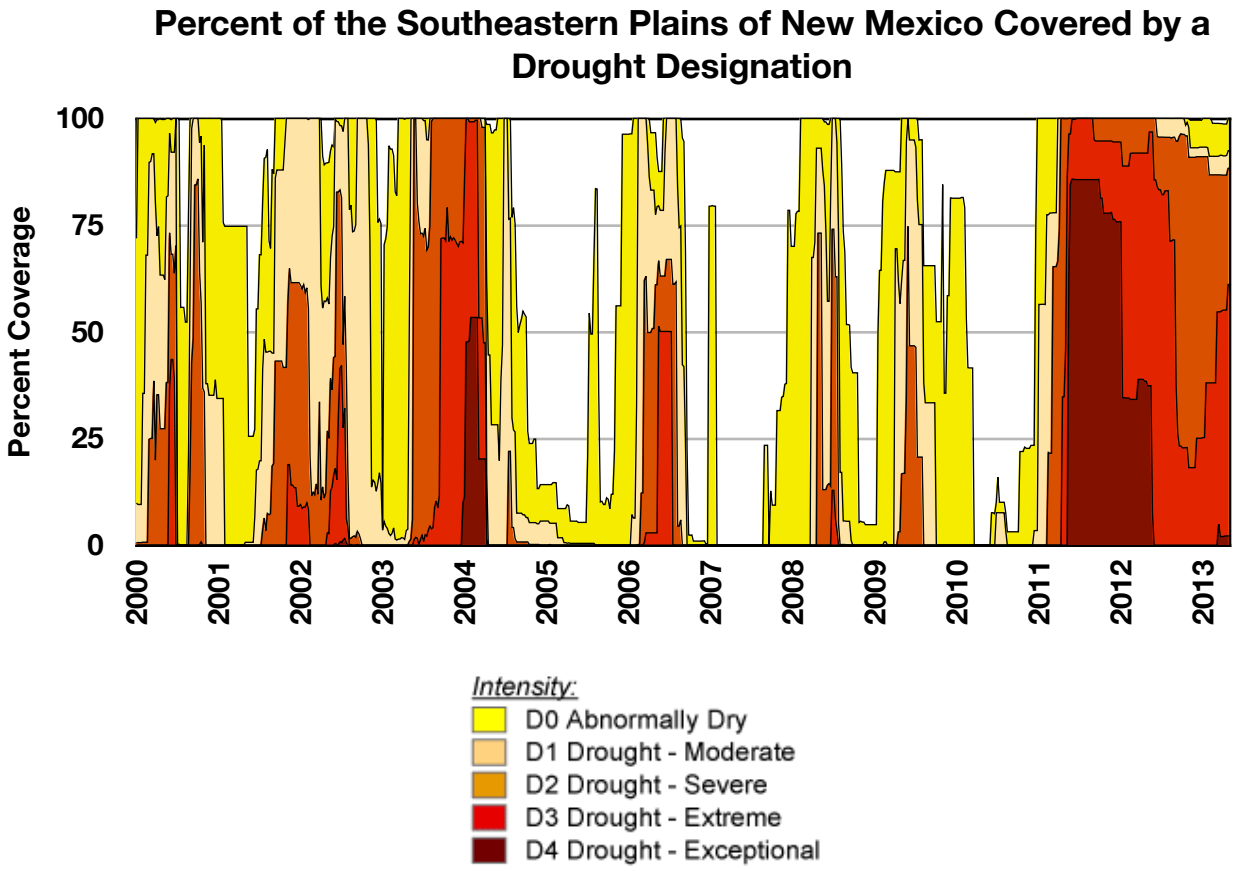

Figure 30. *Drought history for the Southeastern Plains of New Mexico as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 1. Note that the Southeastern Plains were experiencing extreme (bright red) to exceptional drought (dark red) across most of the climate division during much of 2003 and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.*

For more information on the sources of drought information, see Table 9 on page 47.

Region 8: Southern Desert of New Mexico

The Southern Desert of New Mexico has experienced a wide range of temperatures and precipitation over the past several decades. Abnormally hot and dry conditions have occurred multiple times since the early 1900s. Figure 31 shows the annual temperature (top) and annual precipitation (bottom) in the Southern Desert of New Mexico since 1895.[9] The annual temperature for the Southern Desert of New Mexico averages 59.4 degrees Fahrenheit, while precipitation averages 10.75 inches. Warmer-than-average periods have spanned the late 1890s through the 1900s, the 1930s through the 1950s, and the mid-1990s through the early 2010s. Significant periods of drier-than-average conditions include the late 1890s through the 1900s, the mid-1940s through the late 1950s, and the early 2010s.

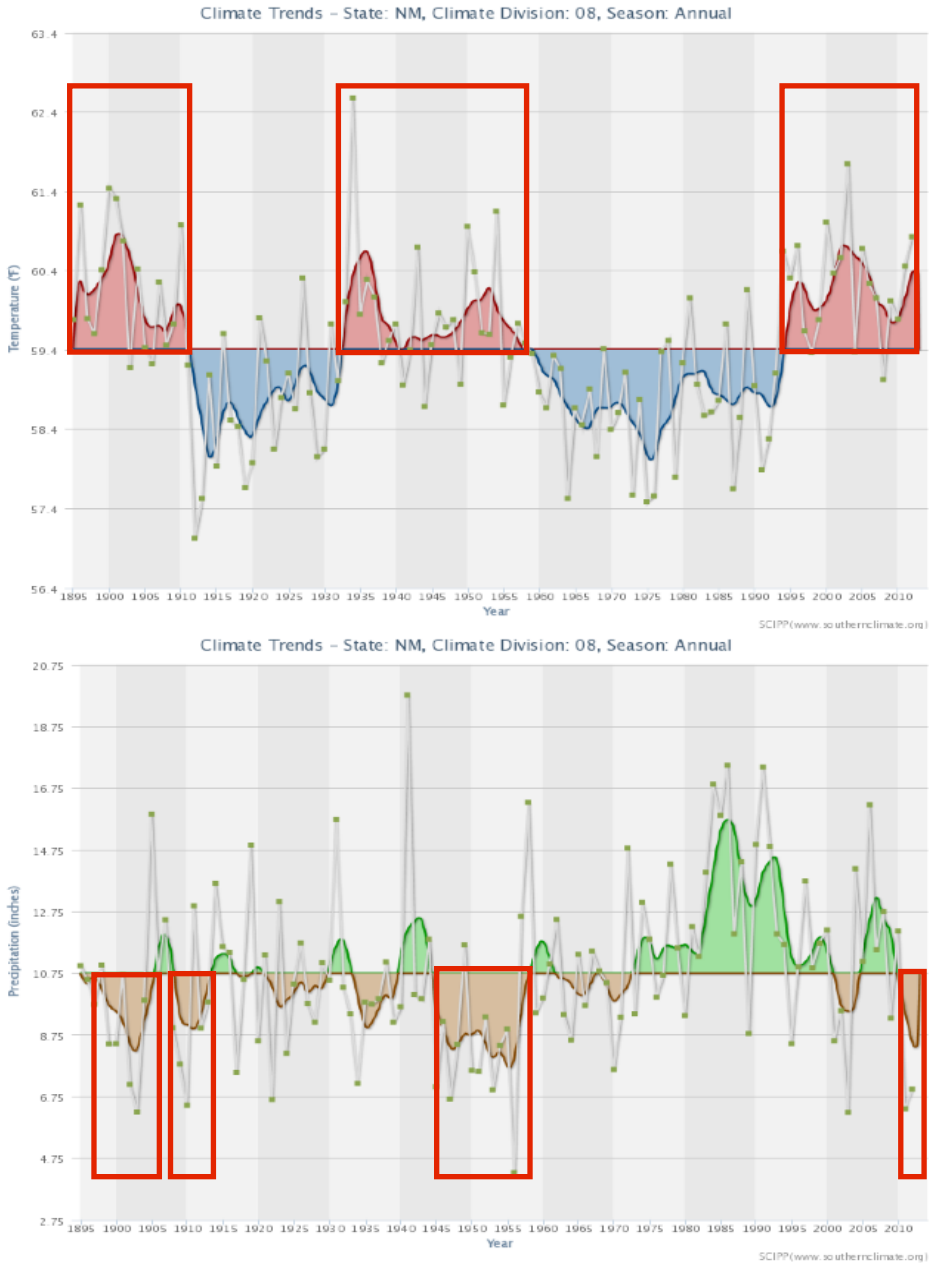

Figure 31. *The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Southern Desert of New Mexico from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.*

Options for the drought-of-record include the droughts in the late 1890s through the mid-1900s and the mid-1940s through the mid-1950s. The period with the longest duration is undoubtably the the mid-1940s through the mid-1950s. Table 8 compares Palmer Drought Severity Indices for these droughts and others. Using these indices, the drought of the the mid-1940s through the mid-1950s well exceeds intensity of all other droughts; hence, ***the period from February 1943 to June 1957 is the drought-of-record for the Southern Desert of New Mexico***.

Because of its intense heat combined with non-stop dry conditions, ***November 1897 to August 1904 comes in second for the drought-of-record for the Southern Desert of New Mexico.***

Table 8: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Southern Desert of New Mexico

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
November 1897 - August 1904	77 (of 82 months)	9 consecutive plus 5 other	–5.45
March 1908 - April 1914	52 (of 74 months)	5 consecutive plus 1 other	–4.58
September 1933 - November 1938	50 (of 63 months)	7 consecutive plus 1 other	–4.71
February 1943 - June 1957	147 (of 173 months)	10 consecutive, 6 consecutive, plus 8 other	–5.29
November 2010 - December 2012*	26 (of 26 months)	6 consecutive plus 3 other	–5.34

Note: *Data only available through December 2012; drought conditions may have continued past this date.*

To understand when there is the greatest stress on water availability for the Southern Desert of New Mexico, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 32. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during June, July and August (top of Figure 32).

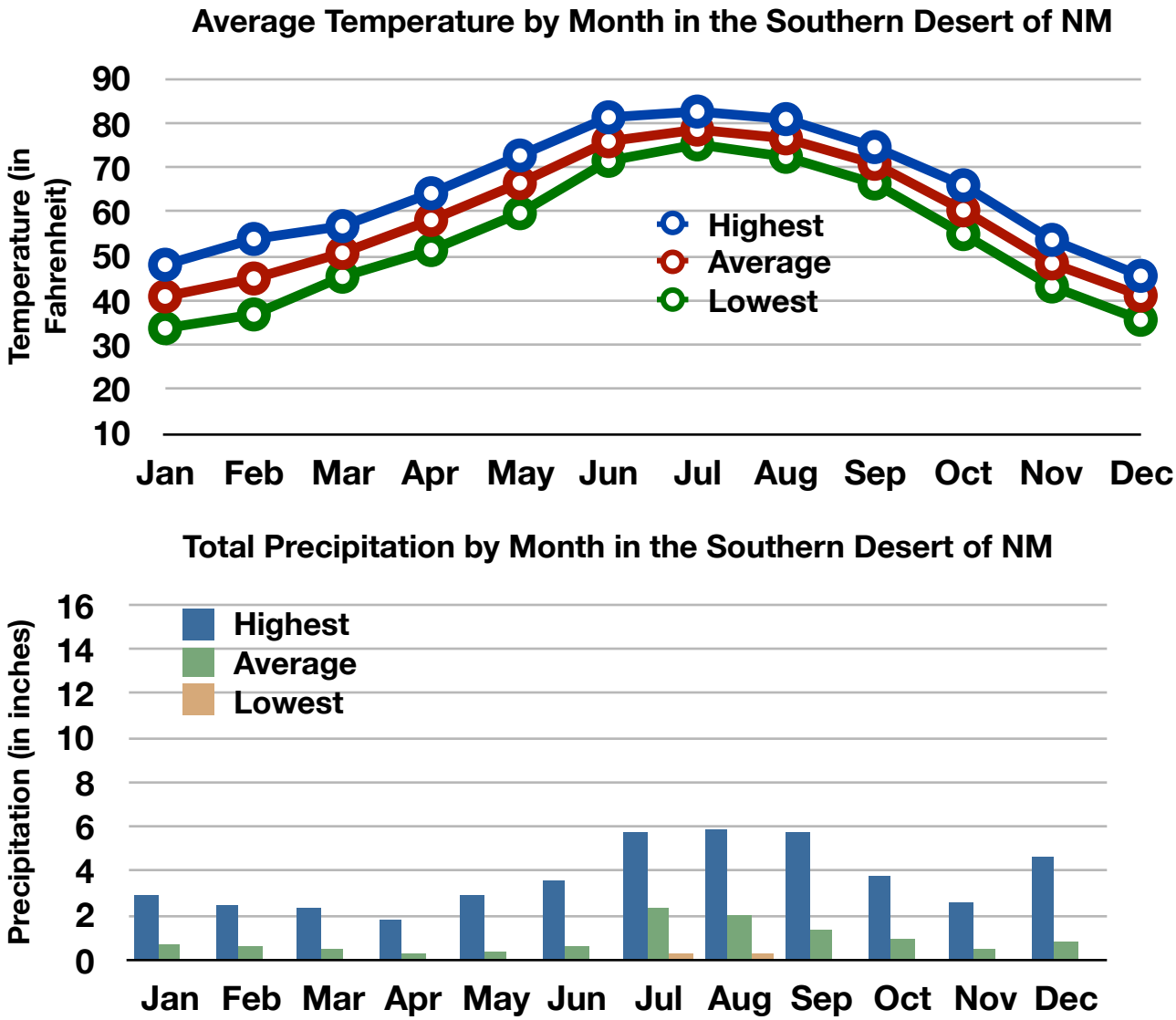

Figure 32. *Top graph: The monthly average temperature (in degrees Fahrenheit) across the Southern Desert of New Mexico using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Southern Desert of New Mexico using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred every month except July, August, and September] The three peaks of precipitation, first in july, then in August, and finally September, are clearly visible.*

The Southern Desert of New Mexico has experienced long and extreme droughts in its past. Figure 33 displays the departure from normal precipitation, Palmer Drought Severity Index, and two-year Standardized Precipitation Index for the region from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 31.

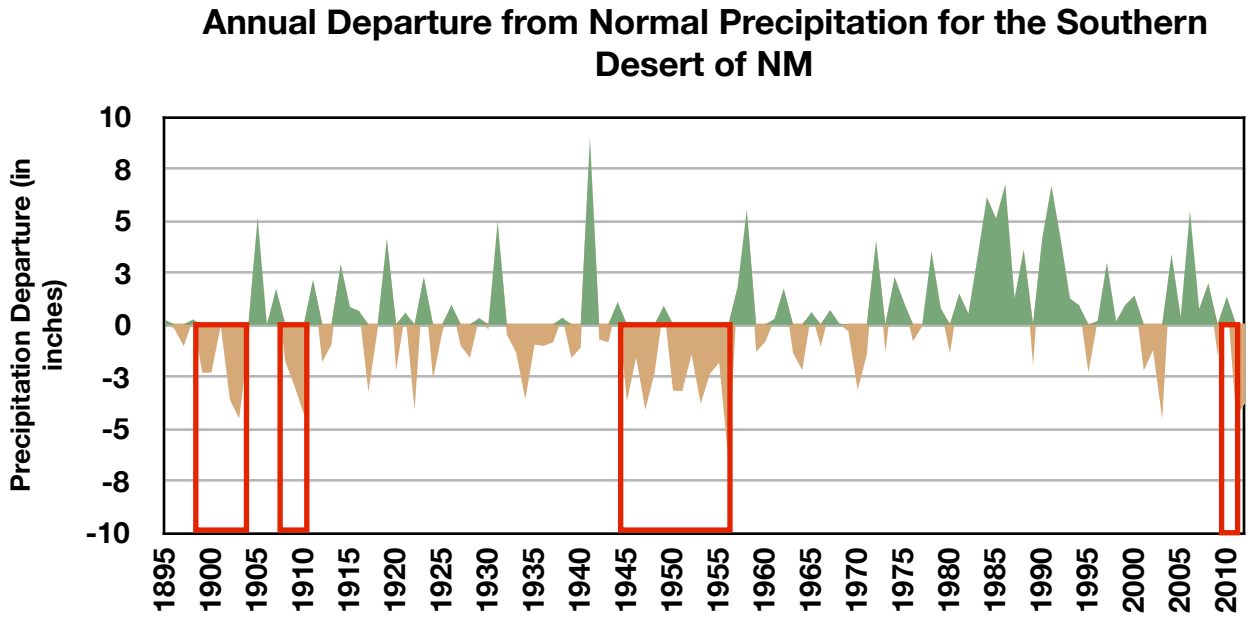

***Figure 33a**. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Southern Desert of New Mexico from 1895 to 2012.*

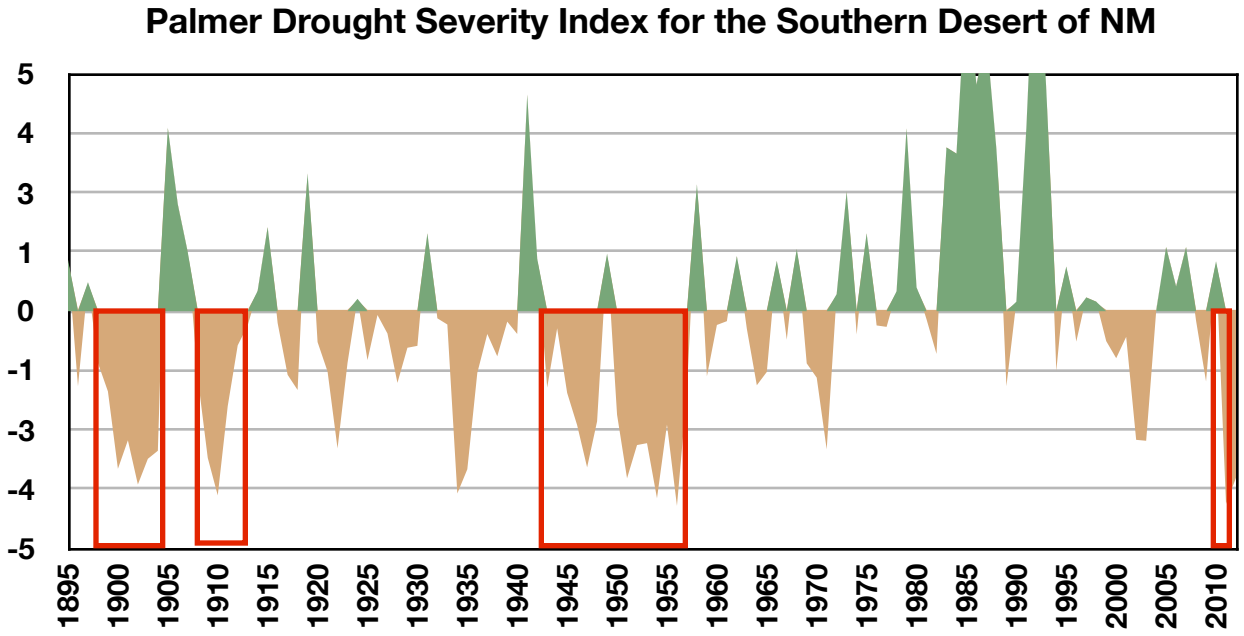

***Figure 33b**. Palmer Drought Severity Index for the Southern Desert of New Mexico from 1895 to 2012.*

The region has experienced dry conditions through many periods of its history. In Figure 34 we look at drought designation in the Southern Desert of New Mexico from the year 2000 to 2013. We see that many instances of abnormally dry to extreme conditions covered up to 100% of the region from 2000 to 2007. Exceptionally dry conditions covered more than 75% during this time period as well. In 2011 to 2013 we see that the region experienced another period of severe to exceptional conditions covering up to 100% of region.

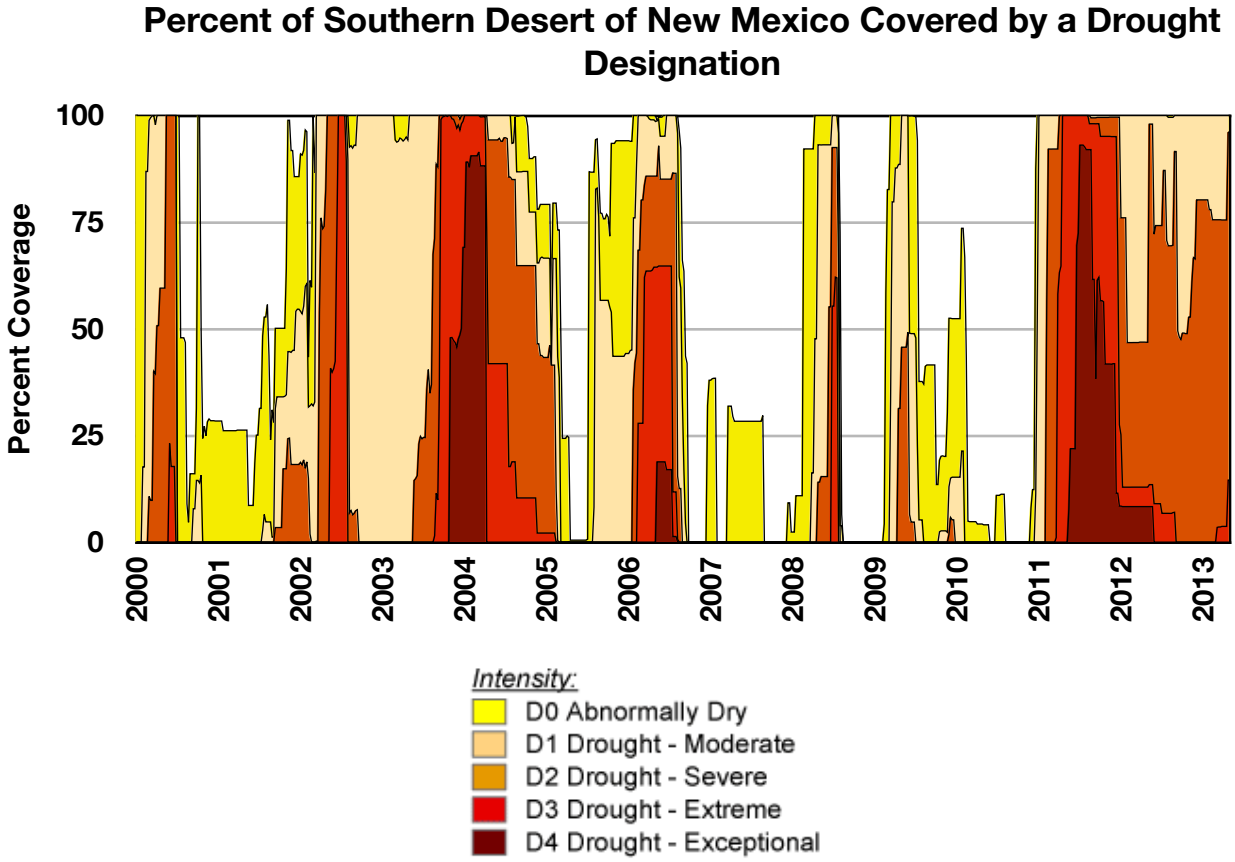

***Figure 34**. Drought history for the Southern Desert of New Mexico as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 5. Note that the Southern Desert of New Mexico was experiencing extreme (bright red) to exceptional drought (dark red) across most of the area during much of 2003, 2004, 2006, and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.*

For more information on the sources of drought information, see Table 9 on page 47.

Drought Resources

There are several excellent sources of information for drought monitoring and reporting, ranging from national to local (Table 9). These resources are designed to help you pan and prepare for drought conditions in you region. Table 9: Sources of Drought Information & Tools

Table 9: Sources of Drought Information & Tools

Source	Web Address	Uses
Major Sources of Information		
National Integrated Drought Information System	www.drought.gov	Consolidated source of drought information, monitoring & reporting tools, including many of the other sources listed below
National Drought Mitigation Center	drought.unl.edu	Consolidated source of drought information, including drought planning, monitoring reporting, risks, and impacts
New Mexico Climate Center	weather.nmsu.edu/products/nm-climate-maps/	Consolidated source of New Mexico climate information
Specific Drought-Related Tools		
U.S. Drought Monitor: *National Drought Mitigation Center*	droughtmonitor.unl.edu	Current and past diagnoses of drought conditions, both nearby and across the United States
New Mexico Drought Product: *New Mexico Climate Center*	weather.nmsu.edu/products/drought/	Current precipitation information & comparisons of conditions across a range of time periods
U.S. Seasonal Drought & Precipitation Outlooks: *Climate Prediction Center*	www.cpc.noaa.gov	Large-scale trends in drought across the U.S. for the next few months; Expert assessments (not forecasts) of possible changes in precipitation conditions over a range of times (6-10 days, 8-14 days, 1 month, & 3 months)

DThe New Mexico Climate Center provides a drought monitoring web site at weather.nmsu.edu/products/drought/. The Center also provides graphics that summarize the current precipitation totals across a variety of time scales (e.g., last, 30 day, last 90 days), as shown in Figure 35.

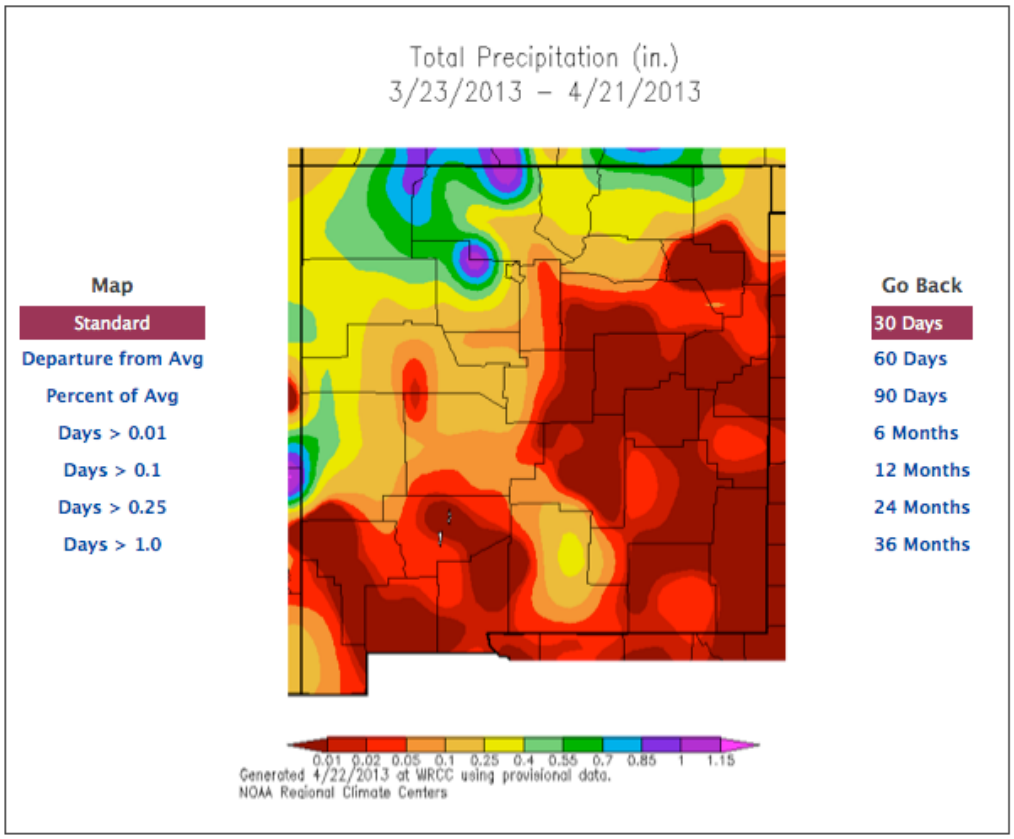

Figure 35*. Example of a drought monitoring product from the New Mexico Climate Center (weather.nmsu.edu/products/nm-climate-maps/). This example provides an assessment of the past 30 days ending on April 21, 2013 and includes total rainfall for the period.*

Acknowledgments

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