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1895-2006 Annual Precipitation, Long-Term Trends, Persistent Variations, and Annual Precipitation Expectations for Oklahoma Climate Divisions

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i. Nondiscrimination Statement

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The data and methodology underlying the annual precipitation, long-term trends in average annual precipitation, and persistent variations in annual precipitation, are subject to assumptions and limitations described in a dedicated section of this report. Precipitation data, derived precipitation information, and underlying assumptions and limitations are accepted by the recipient. Also, wet or dry state of current precipitation variations can serve as a likely indicator, but not guaranteed, of future precipitation persistence. As such the recipient understands that there is no warranty, expressed or implied, concerning the accuracy, completeness, reliability or suitability of the herein presented precipitation information for any one purpose, and that the developers shall be under no liability to any person by reason of any use made thereof.

The recipient is encouraged to use the herein presented precipitation data in conjunction with other independent predictions of upcoming annual precipitation, such as NOAA’s seasonal precipitation forecasts, local precipitation forecasts by agricultural consultants, or the El Nino Southern Oscillation (ENSO) state. If the guidance on predicted precipitation from various sources agrees, then one can have higher confidence in the persistence of a current annual precipitation variation.

v. Acknowledgments

Sincere appreciation is extended to Dr. Jean Steiner for providing valuable comments and suggestions on the content and layout of this publication. Special thanks are also extended to James Campbell for processing the precipitation data and developing the graphical data displays.

1. Objectives

For each of the nine climatic regions of Oklahoma: (1) display the 1895-2006 annual precipitation; (2) show long-term trends in average annual precipitation; (3) identify persistent, multi-year annual precipitation variations about the long-term trend; (4) define major wet and dry periods; and (5) provide probability plots from which annual precipitation expectations can be estimated.

Note: Evaluation of monthly precipitation, long-term trends in average monthly precipitation, and corresponding persistent variations and expectations are developed in a separate report ("Annual and Monthly Precipitation Expectations for Oklahoma Climate Divisions Based on the 1895-2005 Precipitation Record", available on the web page of the Grazinglands Research Laboratory, El Reno, Oklahoma, http://ars.usda.gov/Main/docs.htm?docid=11617).

2. Rationale

Long-term trends in average annual precipitation define the current precipitation average relative to past historical values and may indicate the need to update annual precipitation statistics used for planning and decision making. Size and duration of persistent, multi-year annual precipitation variations draw attention to potential vulnerabilities of the agricultural and water resources system to cumulative impacts. The most recent precipitation variation is an indicator of the currently prevailing wet or dry state of the climate. Annual precipitation expectations help quantify risk associated with variations in annual precipitation.

3. Purpose

To provide agricultural producers, water resources managers, and conservationists with annual precipitation information for risk-based planning, management, and decision making.

4. Goal

To reduce agriculture's vulnerability to multi-year precipitation variations, increase agricultural profitability, and enhance conservation and sustainable utilization of water resources.

5. Background

Climate and consequently watershed hydrology and water availability vary from season-to-season, year-to-year, decade-to-decade, century-to-century, and even longer time scales. Seasonal and inter-annual climate variations are common occurrences, and society has built systems that are resilient to these variations. For example, water supply reservoirs are designed to overcome and be operated under seasonal and inter-annual climatic variations. In rain-fed agriculture, agronomic practices are designed around seasonal precipitation variations, and crop insurance programs provide a safety net when seasonal or annual droughts occur.

Persistent, multi-year variations in annual precipitation can have more profound and significant implications than seasonal and inter-annual variations, mainly due to their cumulative effects on agricultural productivity and water availability. For example, the multi-year dry spell of the Dust Bowl in the 1930s, in combination with land mismanagement, destroyed the agricultural economy of the Great Plains during that time. More recently, sustained dry conditions at the beginning of the 21st century in central Oklahoma may lead many agricultural producers to reconsider agricultural productivity expectations that were achievable during wetter climate conditions in the late 1980s and early 1990s. From the water resources point of view, past multi-year variations produced both recurring floods and water shortages, which prompted Oklahoma and federal officials to build a system of flood control and water supply reservoirs in Oklahoma to ensure both safety and adequate water storage capacity to meet the projected future water demand.

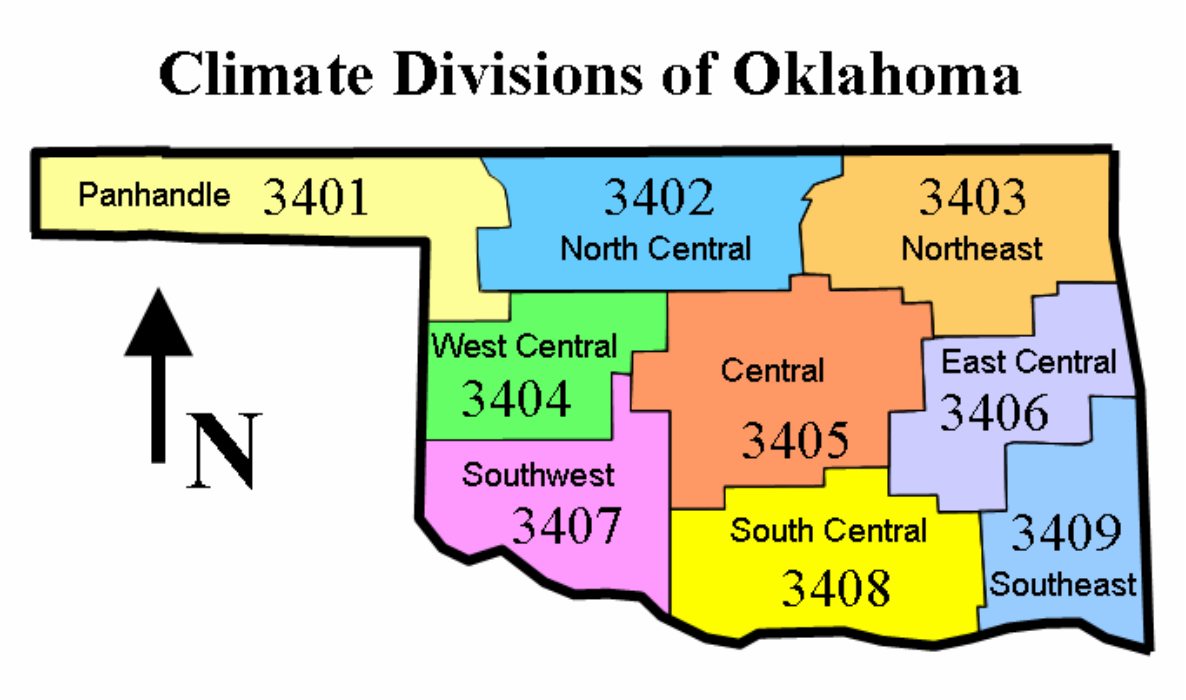
Long-term trends in climate are defined here as gradual changes over 30 or more years. Advances in the understanding of global climate change have drawn attention to long-term trends in the current climate. While agriculture can adapt to gradual long-term trends, it is important to recognize the direction and magnitude of these trends, and to strategically plan for economic opportunities and adaptation needs to maintain a competitive and sustainable agricultural. For water resources, long-tem trends may warrant consideration in water supply projections, as well as in the planning and design of flood protection, navigation, and water storage infrastructure that generally have a life time well beyond 50 years.

Traditionally, assessments of climate effects on water resources management and agricultural production have been based on long-term averages, seasonal-to-interannual variations, and on extreme events. Less attention has been given to persistent precipitation variations that last 5 to 20 years or to longer-term trends. This is unfortunate, since cumulative effects of these variations can have significant economic and environmental impacts, as noted above. Research is being conducted at the USDA-ARS Grazinglands Research Laboratory to identify long-term precipitation trends, multi-year precipitation variations, assess their impact on agricultural productivity and water resources availability, and produce climate-related decision information in support of agricultural and water resource planning and management. The first task in this effort is to identify the existence and duration of past annual precipitation variations, define long-term trends in average annual precipitation, and determine annual precipitation expectations. These can serve as a reference of currently prevailing precipitation characteristics, and can also be used as a guide to what might potentially happen in the upcoming year under the assumption that a wet or dry variation will persist, or that average conditions apply.

6. Data Sources and Climate Divisions of Oklahoma

The 1895-2006 monthly precipitation data for climate divisions are calculated and published by NOAA's National Climatic Data Center (NCDC) in Asheville, North Carolina (available at www.ncdc.noaa.gov). Climate divisions are large regions defined by the U.S. Weather Bureau in the late 1940s (Guttman and Quayle, 1996). There are nine climate divisions in Oklahoma. Often these climate divisions coincide with crop reporting districts. A map outlining the climate divisions in Oklahoma is provided below. The weather statistics from a number of cooperative weather service stations within each climate division are averaged by NCDC to produce the monthly precipitation for each climate division. The annual precipitation and derived information that are presented herein are based on the 1895-2006 climate division monthly precipitation data published by NCDC.

Guttman, N. B., and R. G. Quayle. A Historical Perspective of U.S. Climate Divisions. Bulletin of the American Meteorological Society, Vo. 77, No. 2, p. 293-303.



7. Assumptions and Limitations

There are three assumptions pertaining to the underlying climate division monthly precipitation data and three additional assumptions pertaining to the methodology used to derive annual precipitation and long-term trends in average annual precipitation.

Data assumptions:
1. The climate division monthly precipitation data published by NOAA/NCDC represent monthly precipitation averaged over representative stations within a climate division. The number and location of stations within a division varies by division and over time as stations open and close. By using many stations within a division to calculate averages, the potential source of bias due to number and location of stations is minimized (Guttman and Quayle, 1996, p. 297), but may be of concern in complex mountainous terrain where climatological homogeneity is an issue. Here in Oklahoma the terrain is relatively flat and a change in number and location of stations over time within a division is assumed not to be a major issue for the development of annual precipitation and long-term trends in average annual precipitation.

2. Another issue that may be of concern is the climatological homogeneity within a climate division (Guttman and Quayle, 1996, p. 299-300), especially in mountainous terrain. While there are no significant mountain chains in Oklahoma, there is a steep east-west gradient in annual and monthly precipitation. Thus, one should assume that derived annual precipitation for a climate division applies, strictly speaking, to the center of the climate division. If the location of interest is at the edge of a climate division, it is assumed that annual precipitation at that location can be estimated by way of inverse-distance interpolation with the annual precipitation of the adjacent climate division(s).

3. Climate division monthly precipitation data (published by NOAA/NCDC) prior to 1931 was estimated with regression equations from state averages published by the USDA (Guttman and Quayle, 1996, p. 297). This led to a generally reduced variance when compared to monthly precipitation after 1930. Documentation of quantitative comparisons and details of the variance patterns are no longer available (Guttman and Quayle, 1996, p. 300). For the application herein, it is assumed that the reduced variance in monthly precipitation prior to 1931 is not a factor, because annual precipitation is the sum of monthly values and associated monthly variation information is largely averaged out.

Methodology assumptions:

1. For various reasons, long time-series of precipitation often display a change in average precipitation over time. It is assumed that the change in average precipitation is due to a slow, gradual change in precipitation spanning several decades, as opposed to an abrupt shift over a short time. Slow changes in average precipitation are called long-term precipitation trends. For the precipitation record analyzed in this report, it is assumed that any long-term trend is only in the average precipitation, and average precipitation variability about the long-term trend is stationary.

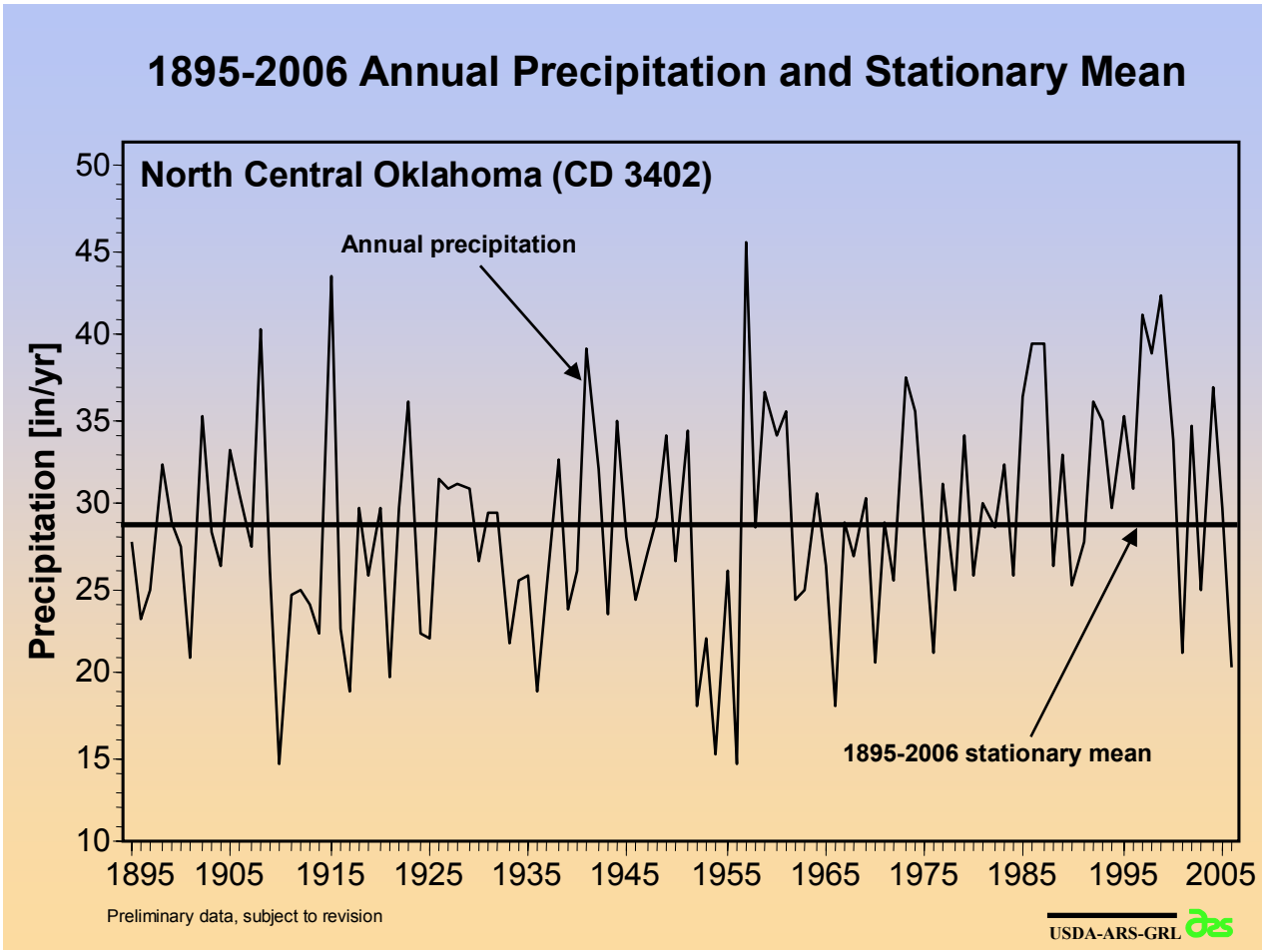
2. Past and future long-term annual precipitation trends beyond the ends of the precipitation record are not known and no attempt was made to extrapolate or project any trend from within the precipitation record into the past or future. For the calculation of long-term trends in average annual precipitation, the last/first 30-year average precipitation conditions were assumed to represent conditions outside the range of the precipitation record. This assumption has the effect of introducing some degree of flattening in the long-term annual precipitation trend in the first/last years of the precipitation record.

3. Five-year weighted moving average of annual precipitation exposes the existence of persistent, multi-year above and below average precipitation variations. Large multi-year precipitation variations are called wet or dry periods. It is assumed that once a wet or dry period has been initiated the wet or dry state may persist for a few years, and therefore a current wet or dry period can serve as a likely, but not guaranteed, indicator of wet or dry precipitation state for the upcoming year.

8. Data Preparation and Interpretation

8.1 Annual Precipitation and 1895-2006 Stationary Mean

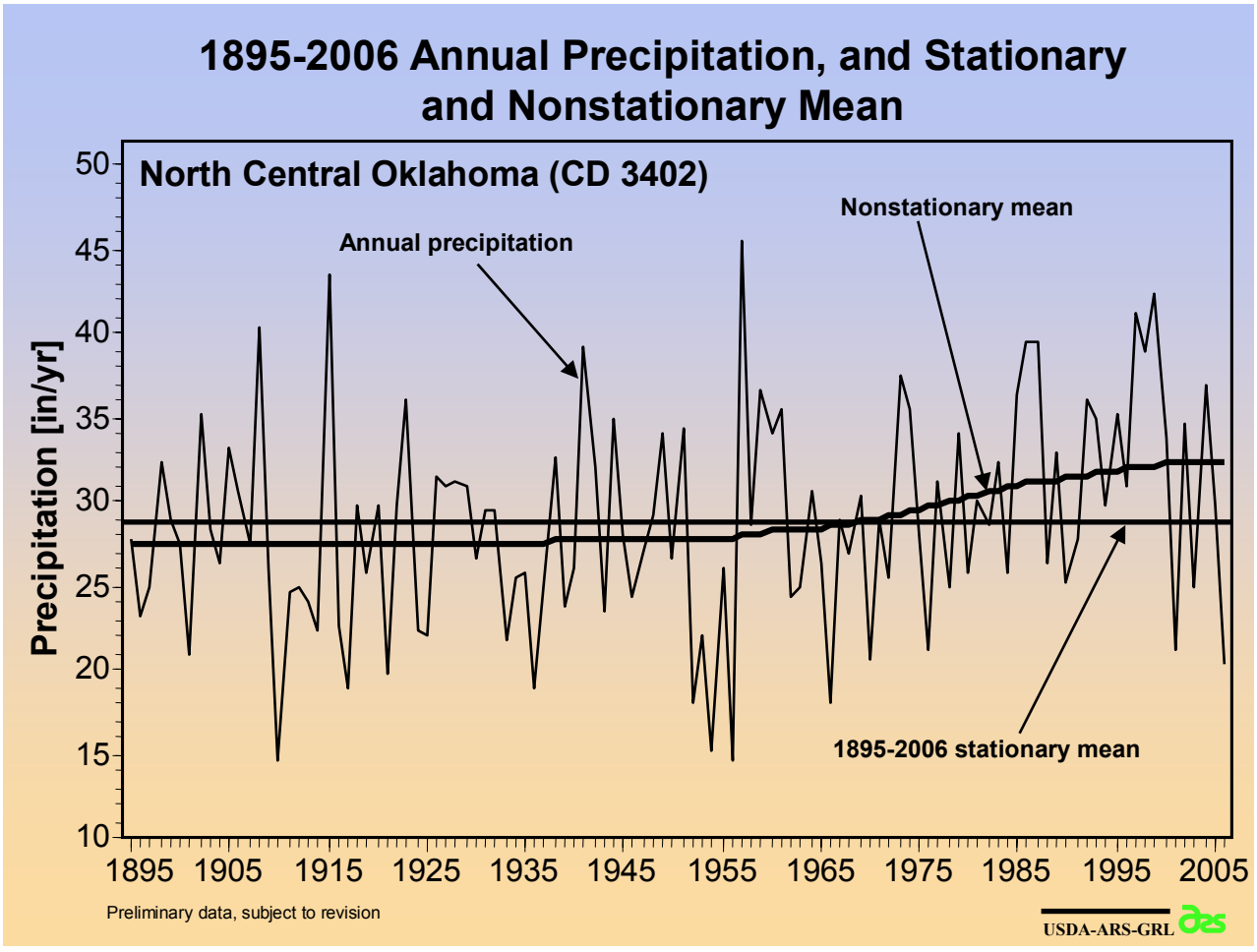
Climate division monthly precipitation from 1895 through 2006 was summed into annual values which were plotted as a time series. The figure below clearly shows the pronounced year-to-year variation of annual precipitation. The horizontal line in the figure is the 1895-2006 average annual precipitation, also called the stationary mean annual precipitation.



8.2 Annual Precipitation and Long-Term Trends in Average Annual Precipitation

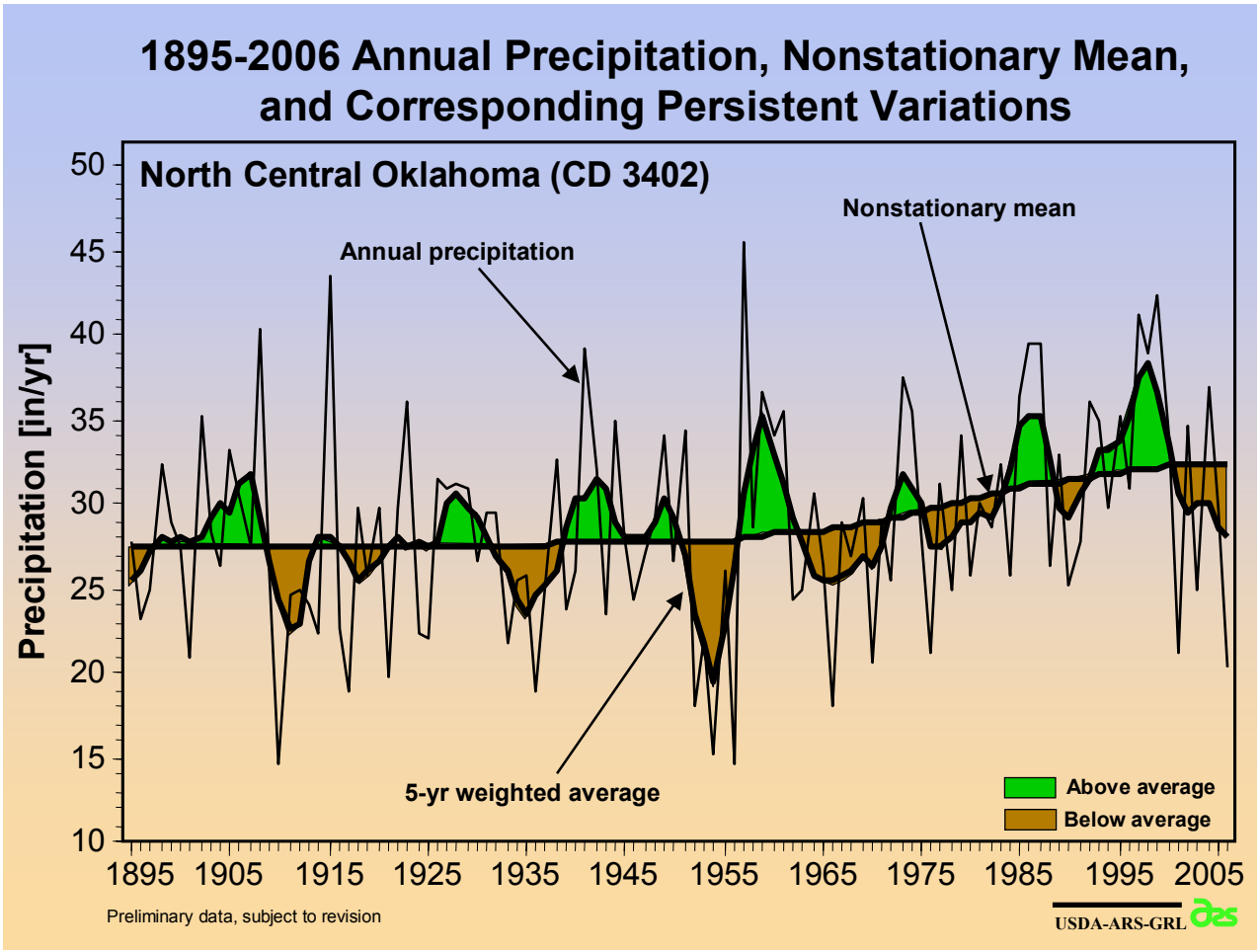
For various reasons, a long-term trend in average annual precipitation can be found in many precipitation records. Long-term trend is defined as a slow, systematic change in average annual precipitation over many decades and reflects the nonstationary nature of the climate. A long-term trend in average annual precipitation was calculated by simple average of 1-year overlapping windows of 30-year averages of annual precipitation. Since past or future trends beyond the ends of the precipitation record are not known, 30-year average precipitation conditions were assumed to prevail outside the range of the precipitation record. This introduced a degree of flattening in the long-term trend at both ends of the precipitation record. In the figure below, the slightly curved line near the 1895-2006 average annual precipitation represents long-term trends in average annual precipitation, also called nonstationary mean annual precipitation.

In many practical applications, it is more realistic to use the long-term trend in average annual precipitation as a measure of the mean as opposed to the 1895-2006 straight-line average precipitation. Indeed, the nonstationary mean is a better reflection of current precipitation expectations for many agricultural and water resources management applications at smaller time-scales, say about 1 to 5 years. For example, why use annual precipitation values from the early 20th century to estimate today's average precipitation? Precipitation values of the recent 30 or 40 years may better represent the current average precipitation.



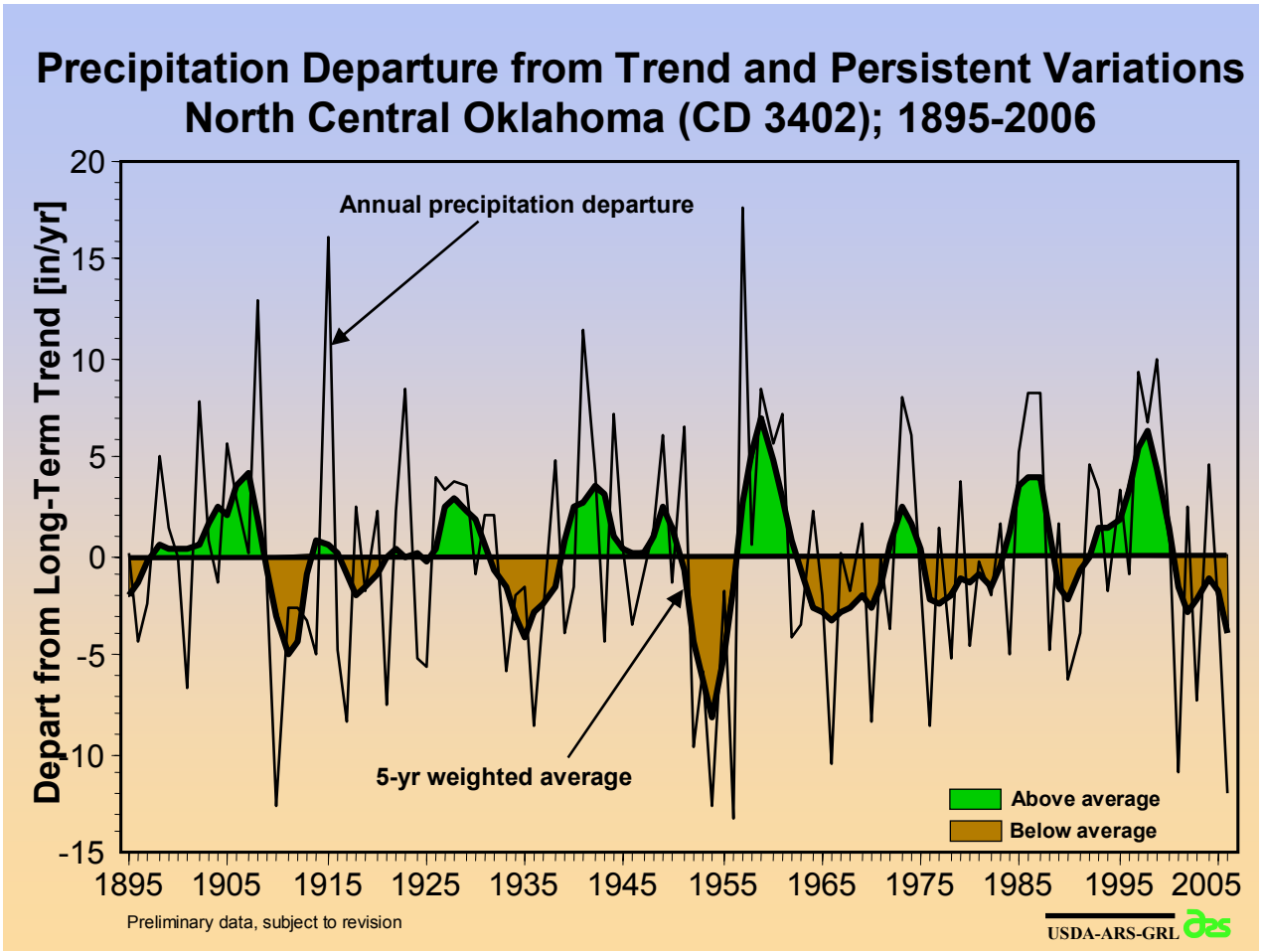
8.3 Persistent Variations in Annual Precipitation

Persistent, multi-year above and below average precipitation occurrences, called precipitation variations, are often found in annual precipitation time-series. To highlight multi-year variations in annual precipitation, a weighted moving average filter was applied to the annual precipitation time series. The length of the filter was 5 years and the weights conformed to a sine function. This method was found to work well to highlight multi-year variations. In the figure below, the green areas are above average variations and the brown areas are below average variations. The line separating the green and brown areas is the nonstationary mean annual precipitation. Large and lasting variations in the 5-year moving average are believed to be relevant for agriculture and water resource applications spanning about 1 to 5 years, while small variations are likely to have less significance. For agricultural and water resource applications that address issues at time scales of several decades and beyond, the long-term trend in average annual precipitation must also be taken into consideration.



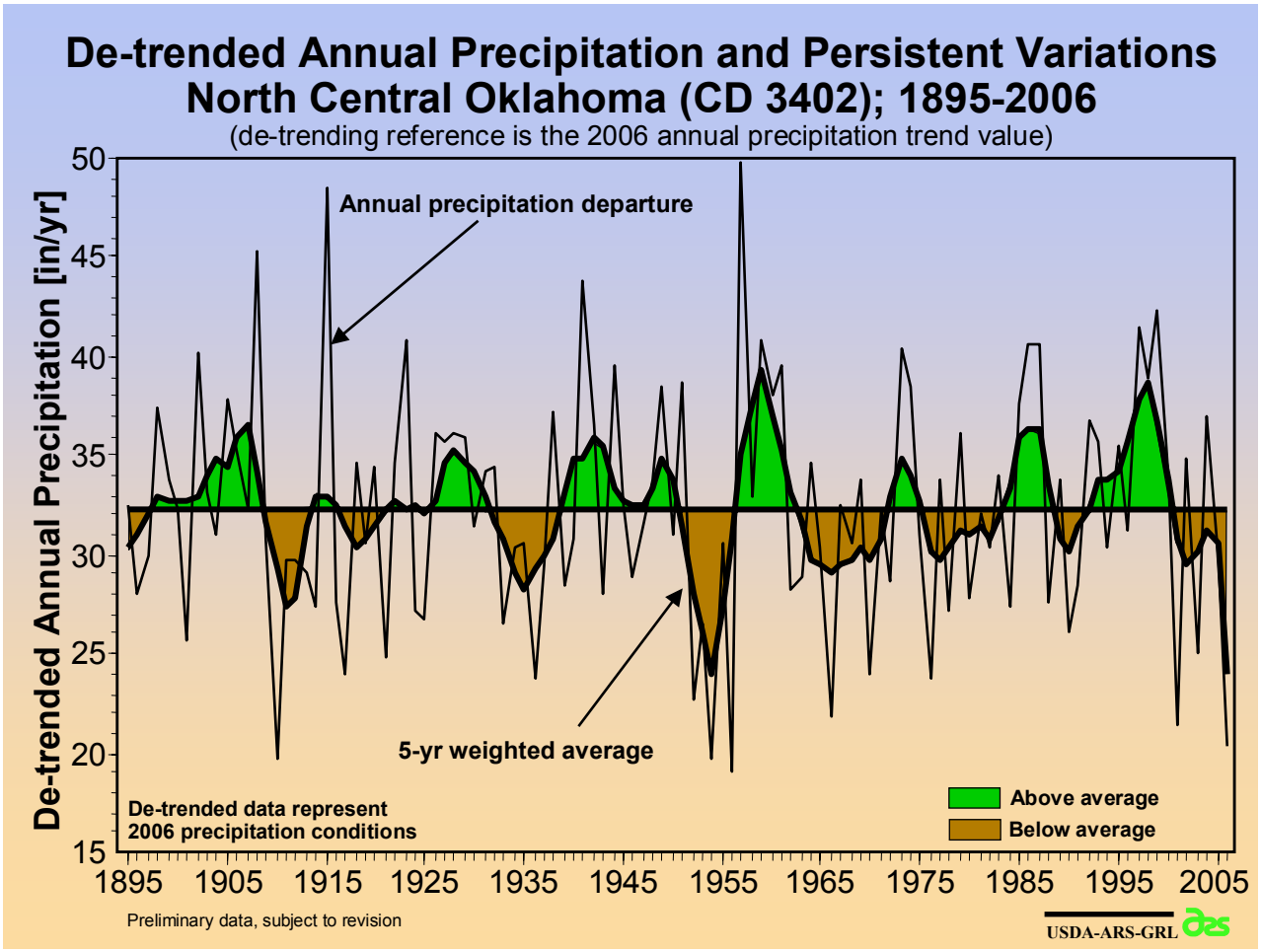
8.4 De-Trending of Annual Precipitation

The presence of a long-term trend and the desire to extract statistical information from past wet or dry variations to support today's decision making requires that the long-term trend in the annual precipitation record first be removed by a process called de-trending. De-trending involves adjusting annual precipitation values in a way that removes the long-term trend, thereby referencing all annual precipitation values to a reference average annual precipitation. In a first step, the long-term average annual precipitation trend is subtracted from the annual precipitation values to produce precipitation departures from the long term trend as shown in the following figure. The data in this figure represent the same information as in the previous one, except that the curved long-term trend line has been straightened-out and precipitation departures from this trend are depict.



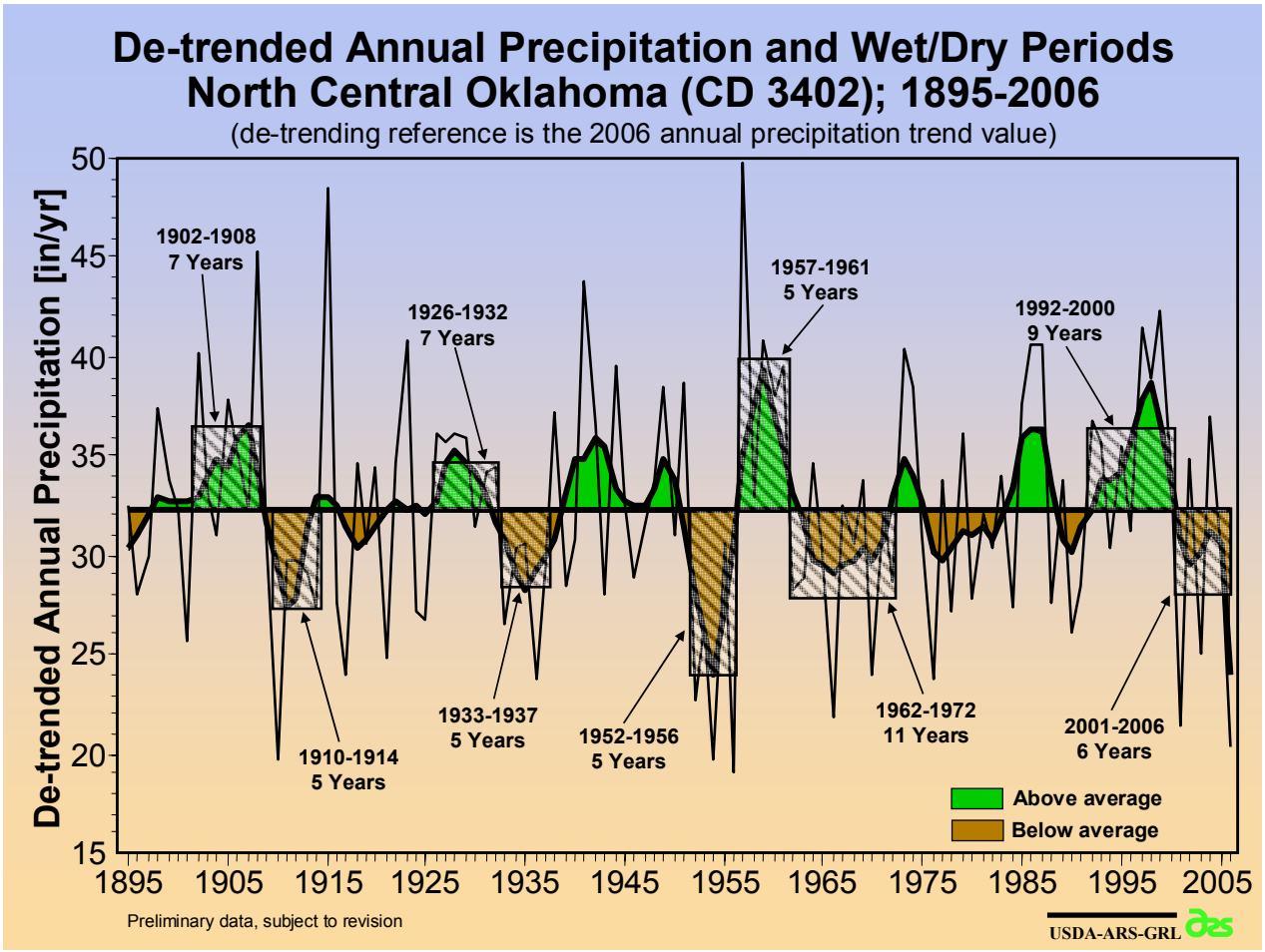
De-Trending of Annual Precipitation (cont.)

In a second step, a reference average annual precipitation value is added. The obvious selection for reference average annual precipitation is the current average annual precipitation as this leads to decision information that is relevant for present climatic conditions. In doing this, the de-trended annual precipitation can be used to derive statistics that are representative of current climatic conditions. The figure below shows the de-trended annual precipitation. The annual precipitation data do not represent actual precipitation values, but precipitation values that would have existed if today's reference average annual precipitation were applicable for the entire record.



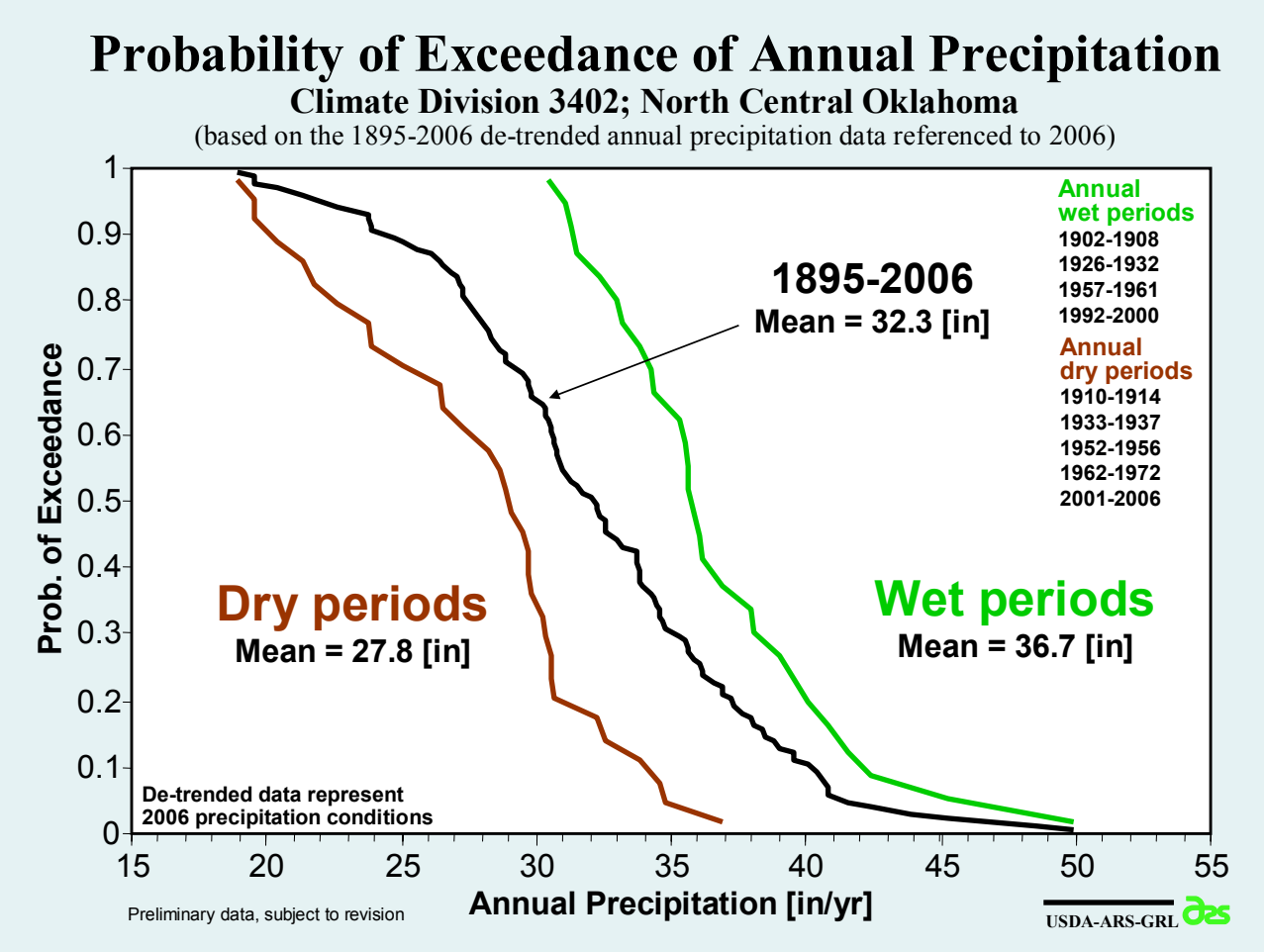
8.5 Identification of Wet and Dry Periods

A persistent, multi-year wet or dry period is defined as a sequence of five or more consecutive years with annual precipitation values that are predominantly above or below the long-term trend in average annual precipitation. A set of heuristic criteria has been developed to define the beginning, ending and characteristics of a wet or dry period. These heuristic rules were applied to the de-trended annual precipitation time series to define wet and dry periods that can be used to develop precipitation expectations that are applicable for today's climate. The figure below shows the identified wet and dry periods.



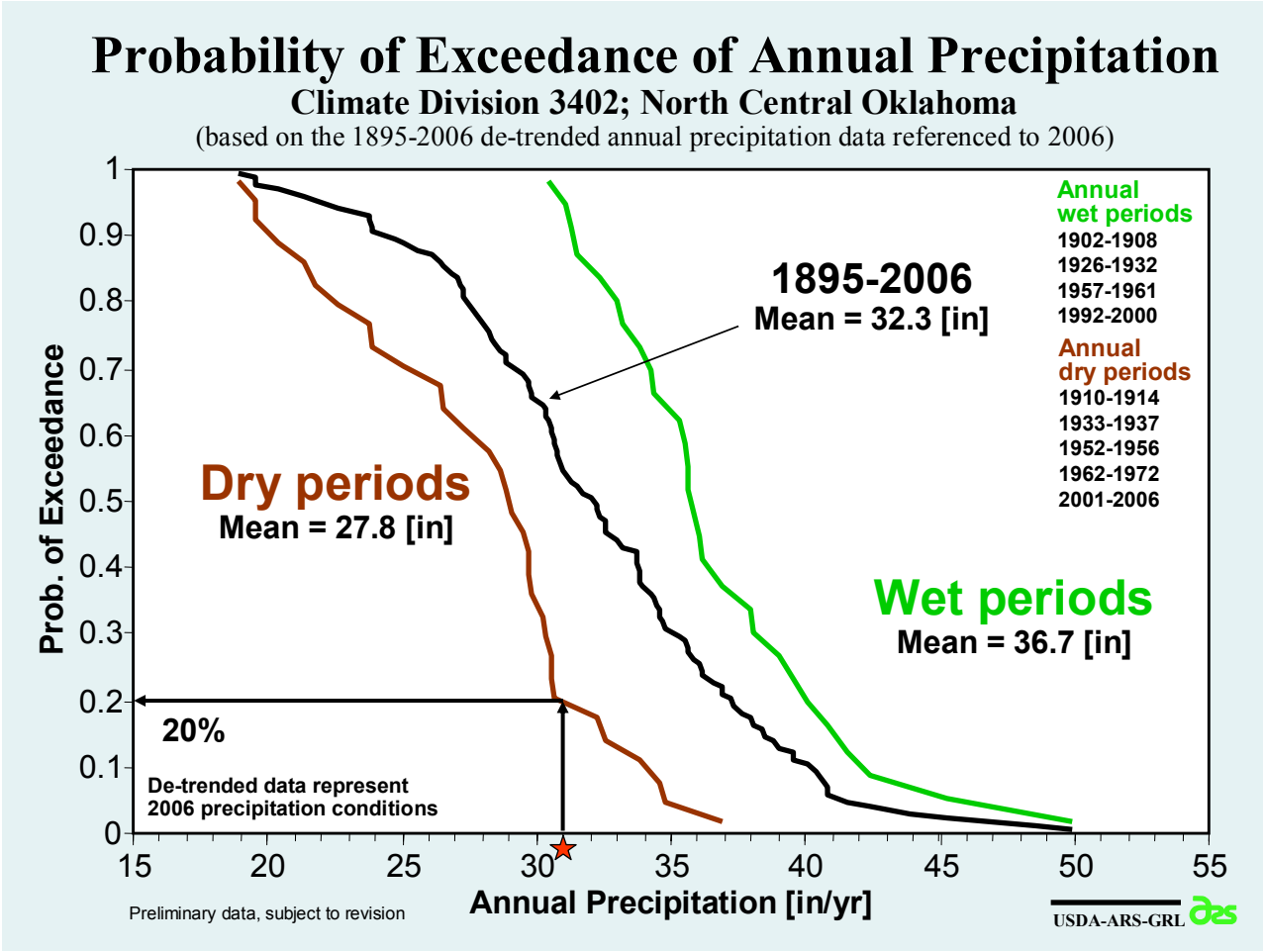
8.6 Interpretation of Precipitation Expectation Plots

A widely accepted method to describe expectations is the Probability-of-Exceedance (PoE). A PoE is defined as the probability that a specified amount of precipitation will either be attained or exceeded. Specifically, PoE curves were calculated for annual precipitation for 1895-2006, and for wet and dry periods. The example PoE plot for annual precipitation is shown in the figure below. In this example, the black line is the probability of exceedance based on the entire 1895-2006 period of record (112 years) without consideration of wet and dry periods, and it represents precipitation expectations based on long-term average conditions. The green line is the probability of exceedance based on years that were identified as belonging to persistent wet periods, and it represents precipitation expectations during wet periods. The brown line is the probability of exceedance based on years that were identified as belonging to persistent dry periods, and it represents precipitation expectations during dry periods. The PoE plots were developed using the de-trended annual precipitation with respect to present climatic conditions, and therefore the precipitation expectations estimated from this PoE plot are valid for currently prevailing precipitation conditions. Using these plots, the user can estimate expectations of annual precipitation amounts based on all years, or on wet or dry periods under the assumption that a current wet or dry period will persist.



Interpretation of Precipitation Expectation Plots (cont.)

For example, to estimate the probability that a specified annual precipitation is equaled or exceeded during a dry period, the user would locate the specified annual precipitation on the lower precipitation axis of the plot (indicated with a star), draw a vertical line upward from that point until it intersects with the brown line, and then draw a horizontal line from that intersecting point to the left (vertical) axis of the plot. The value on this axis is the estimated probability that that the specified annual precipitation will be equaled or exceeded during a dry period. The same estimation can be done for wet periods, or by assuming that long-term average precipitation conditions apply.



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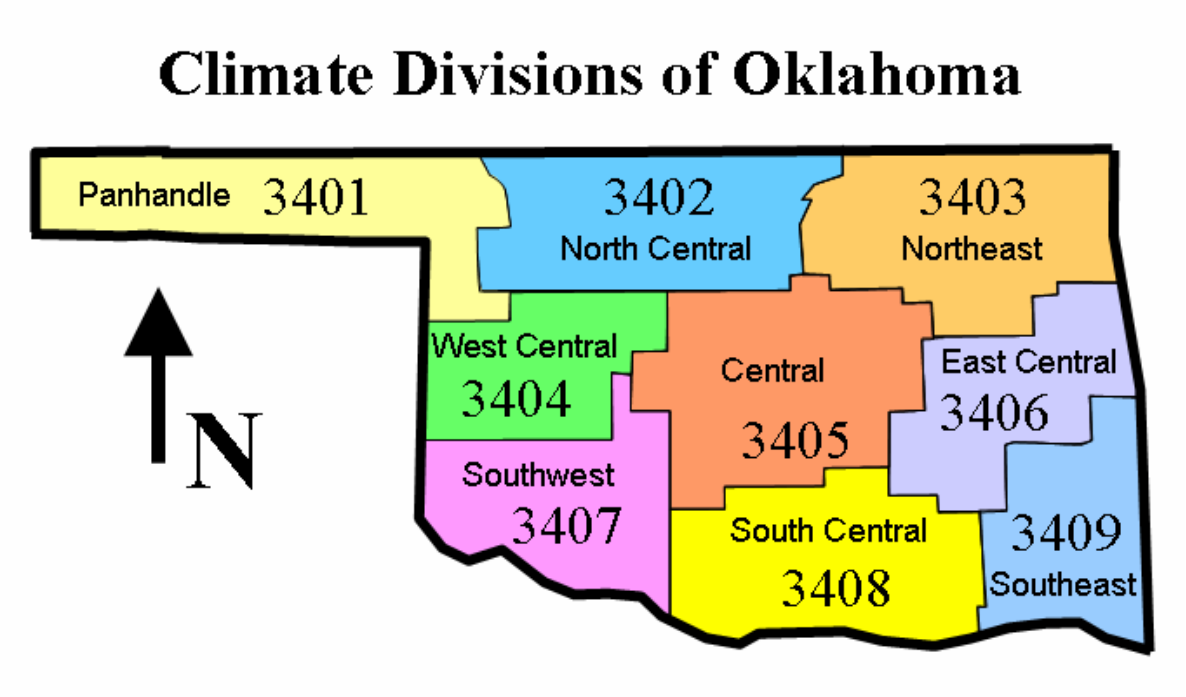
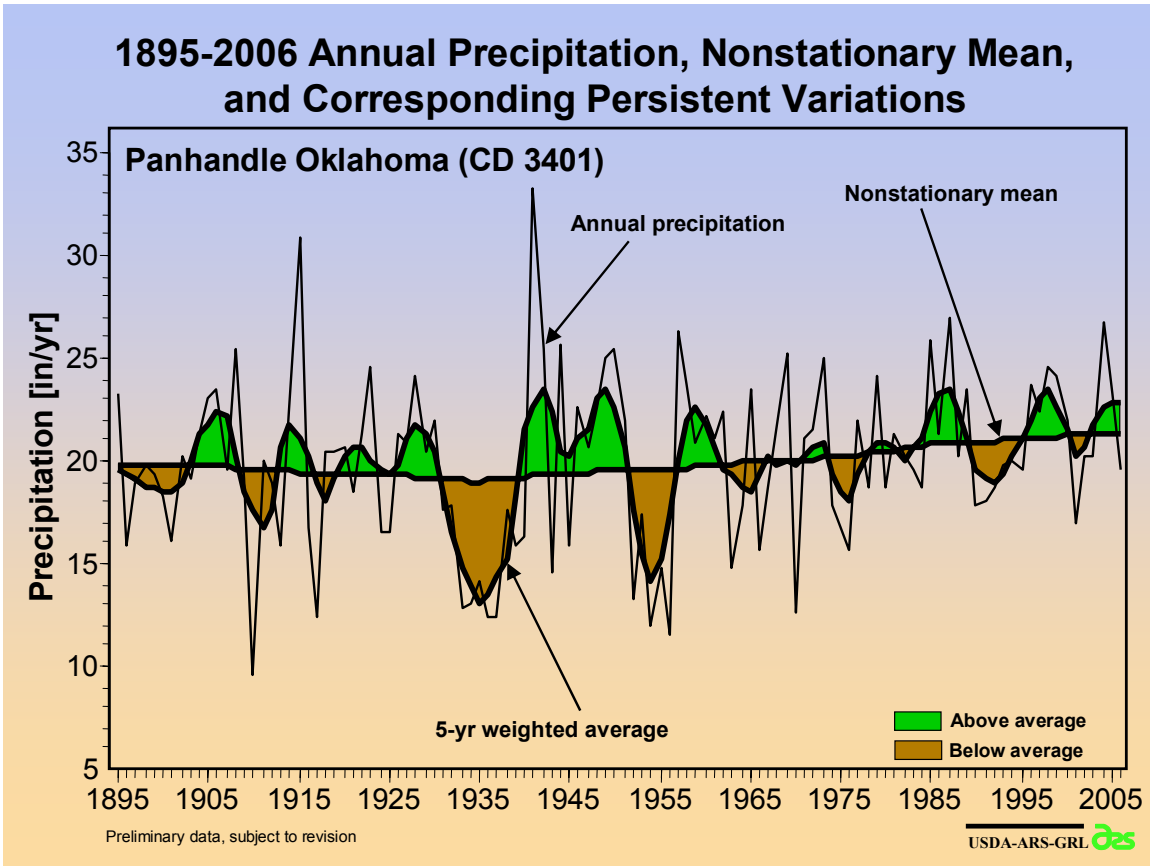
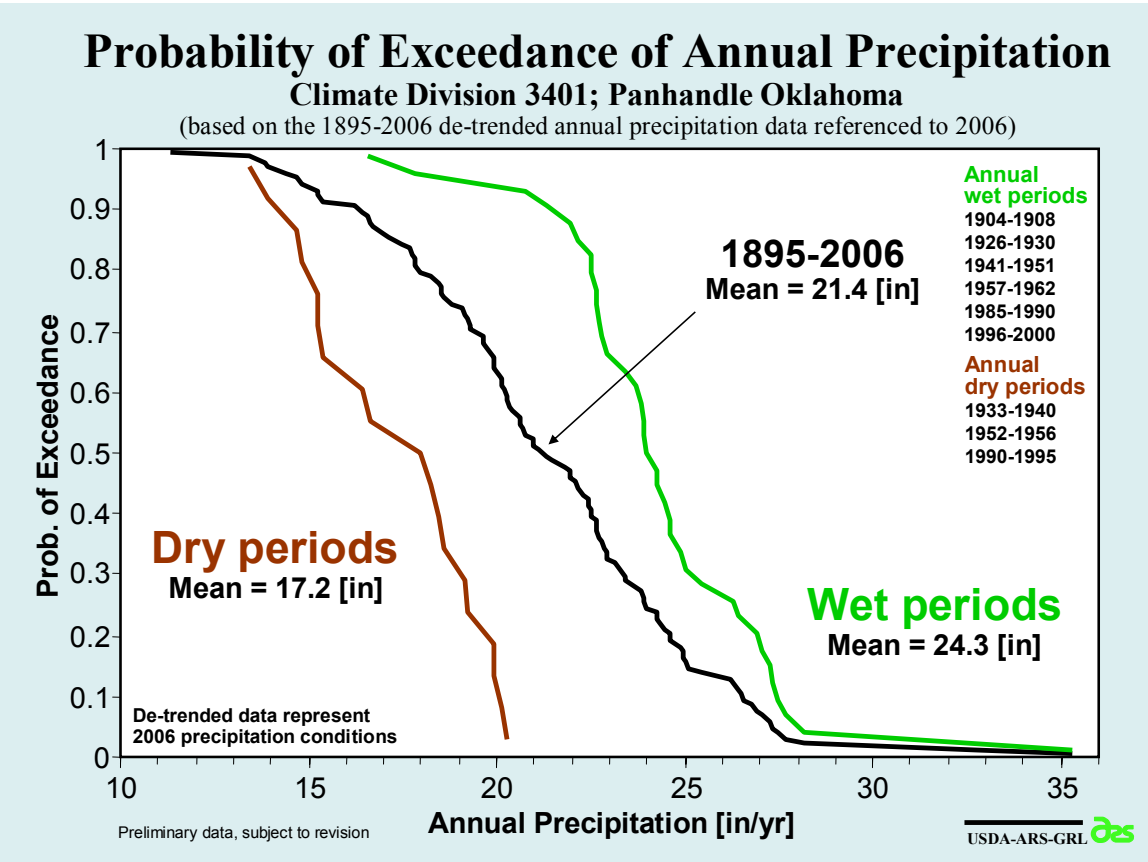
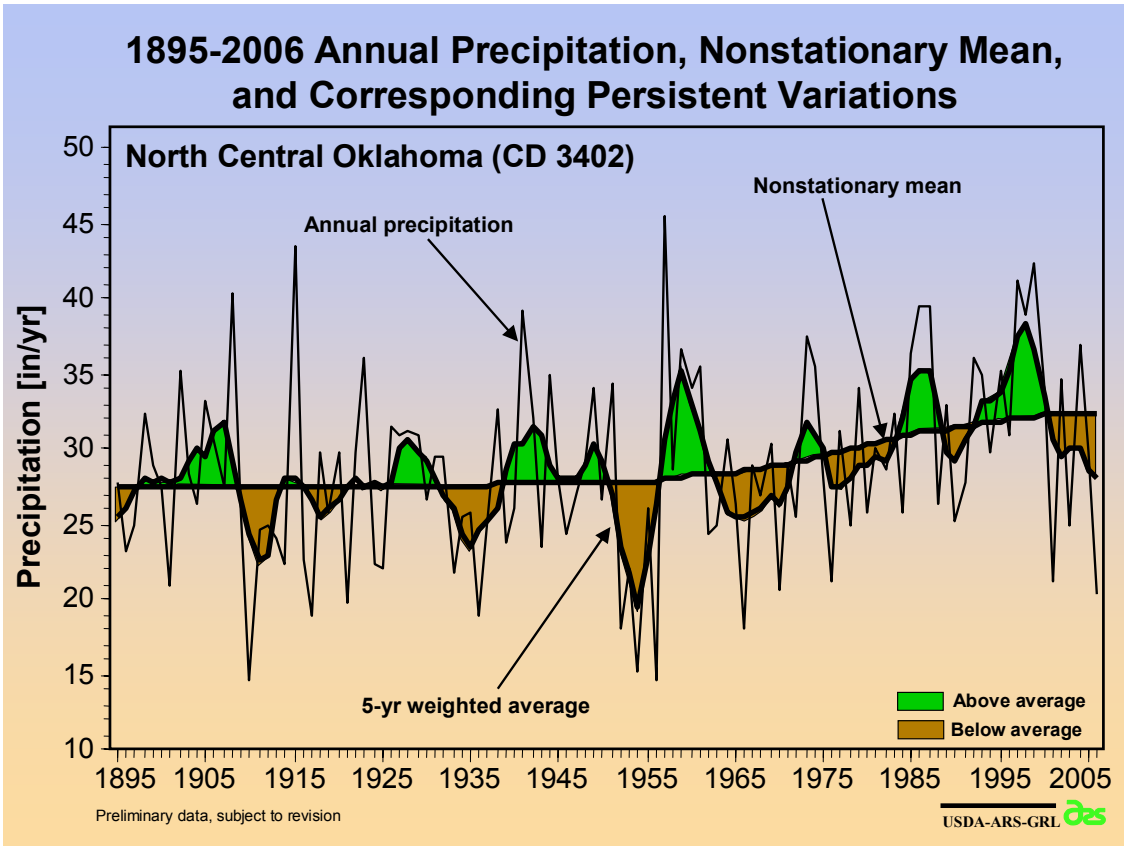
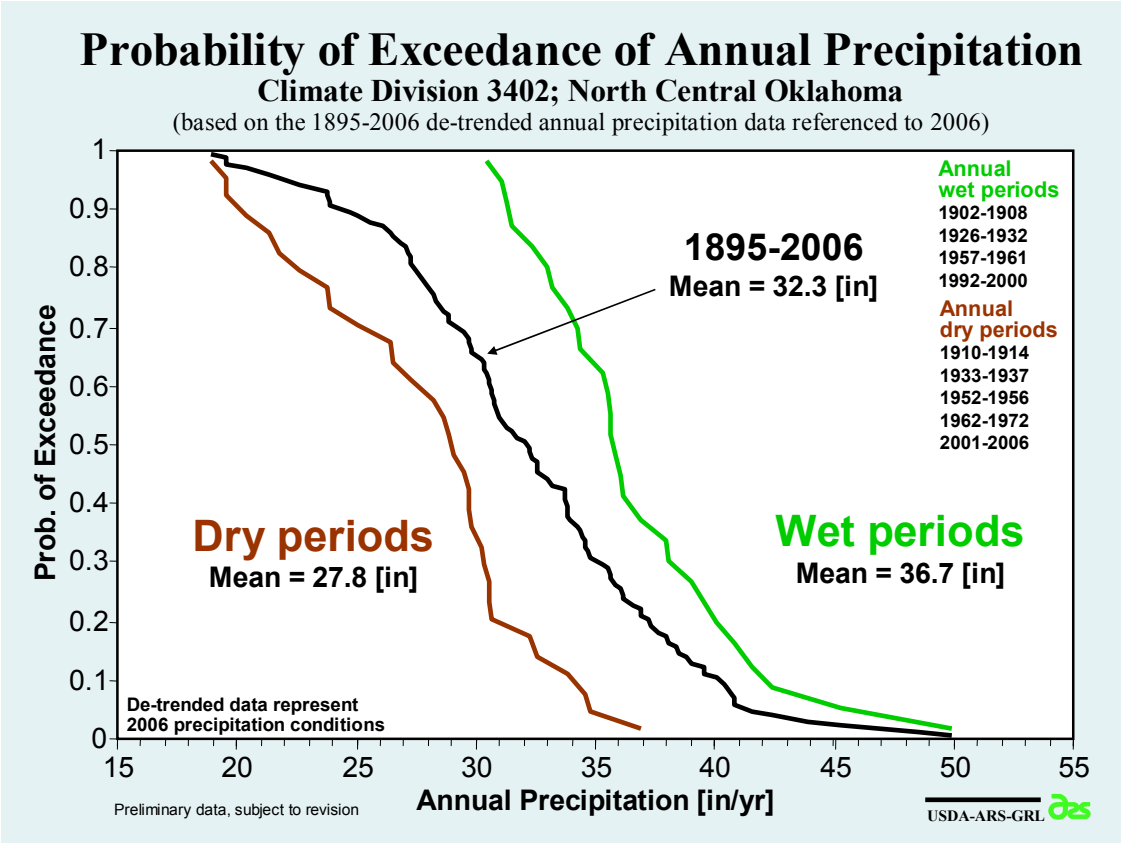
9. Plots of 1895-2006 Annual Precipitation, Long-Term Trends in Average Annual Precipitation, and Persistent Variations for Oklahoma Climate Divisions

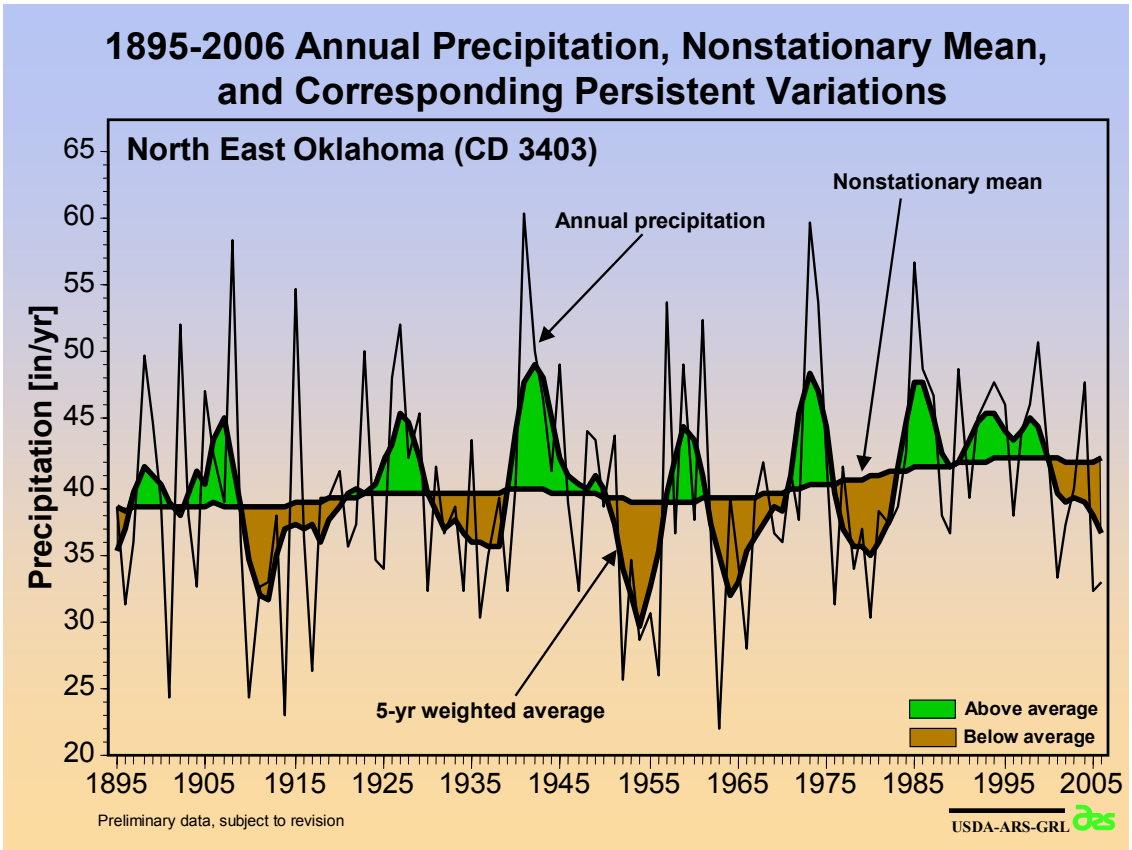


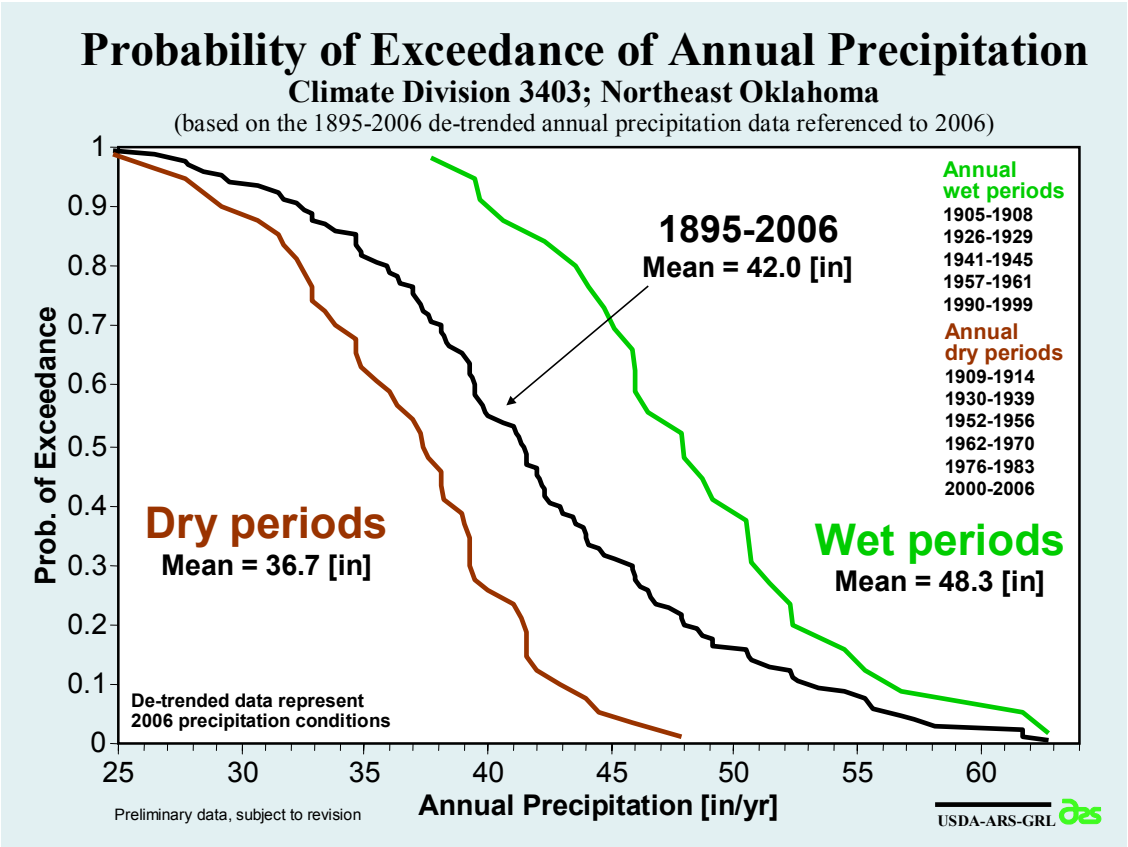

1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
Panhandle Oklahoma (CD 3401)
Annual precipitation
Nonstationary mean
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
35
30
25
20
15
10
5
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL

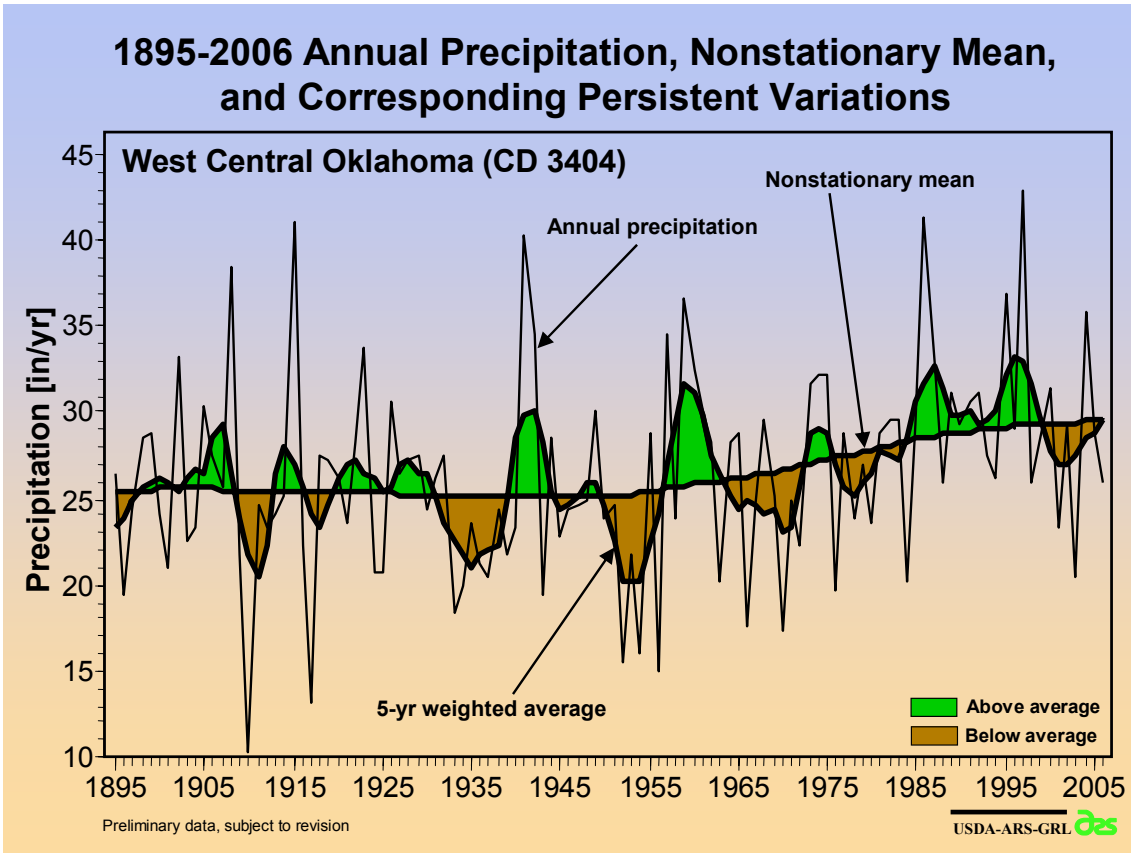

Probability of Exceedance of Annual Precipitation
Climate Division 3401; Panhandle Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
Annual wet periods
1904-1908
1926-1930
1941-1951
1957-1962
1985-1990
1996-2000
Annual dry periods
1933-1940
1952-1956
1990-1995
1895-2006
Mean = 21.4 [in]
Dry periods
Mean = 17.2 [in]
Wet periods
Mean = 24.3 [in]
De-trended data represent 2006 precipitation conditions
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
15
20
25
30
35
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL

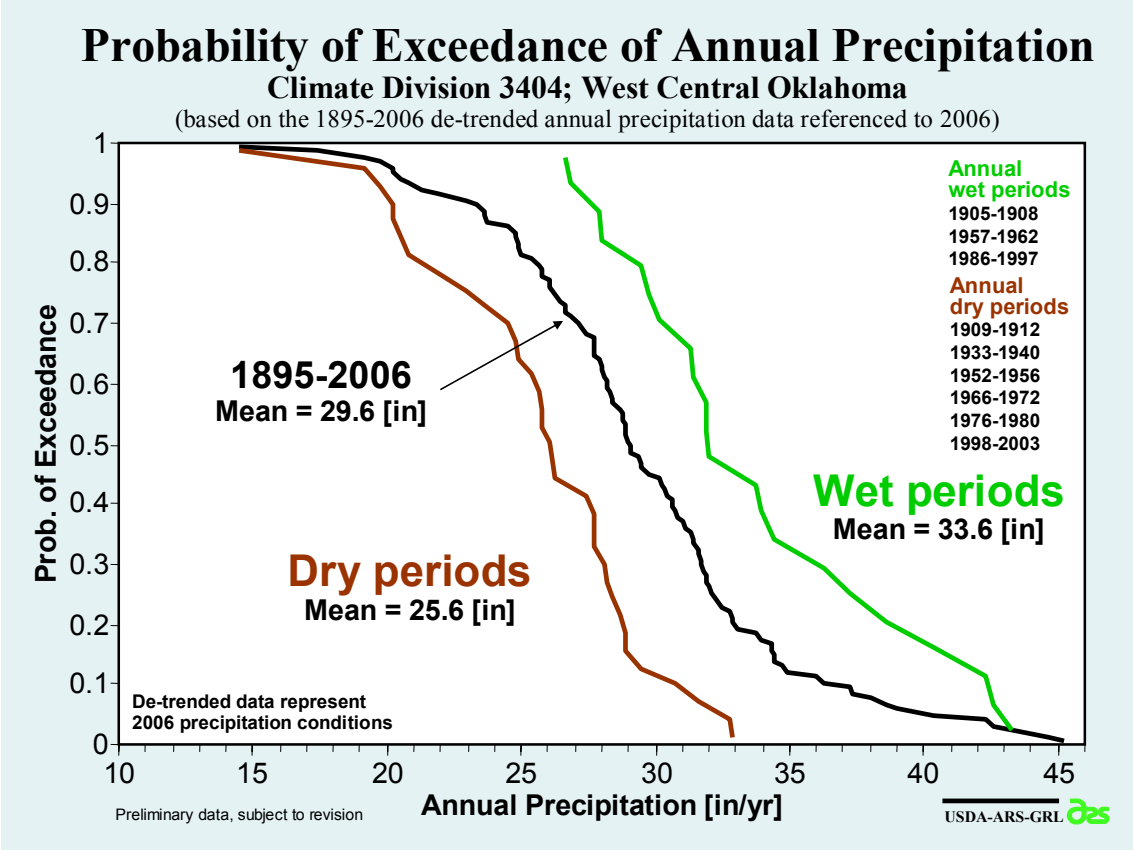

1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
North Central Oklahoma (CD 3402)
Annual precipitation
Nonstationary mean
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
50
45
40
35
30
25
20
15
10
1895 1905 1915 1925 1935 1945 1955 1965 1975 1985 1995 2005
Preliminary data, subject to revision
USDA-ARS-GRL

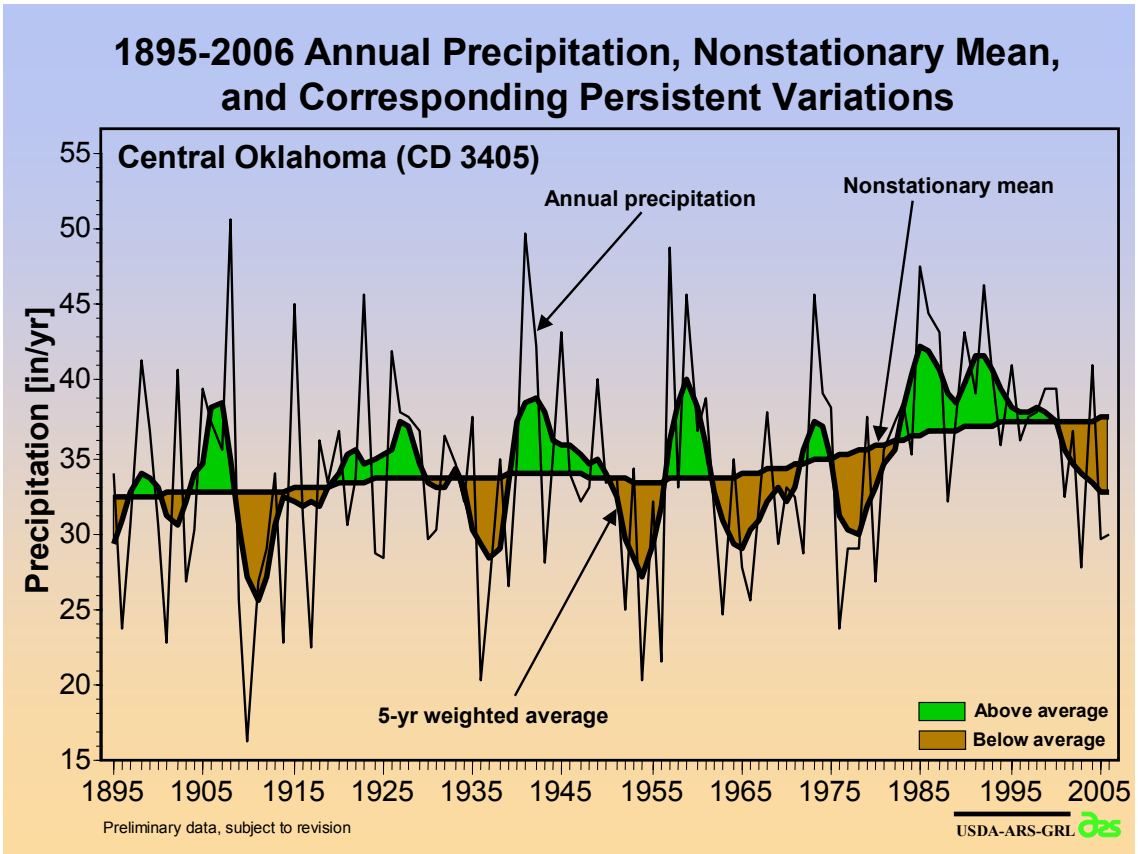

Probability of Exceedance of Annual Precipitation
Climate Division 3402; North Central Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
1895-2006
Mean = 32.3 [in]
Annual wet periods
1902-1908
1926-1932
1957-1961
1992-2000
Annual dry periods
1910-1914
1933-1937
1952-1956
1962-1972
2001-2006
Dry periods
Mean = 27.8 [in]
Wet periods
Mean = 36.7 [in]
De-trended data represent 2006 precipitation conditions
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
15 20 25 30 35 40 45 50 55
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL

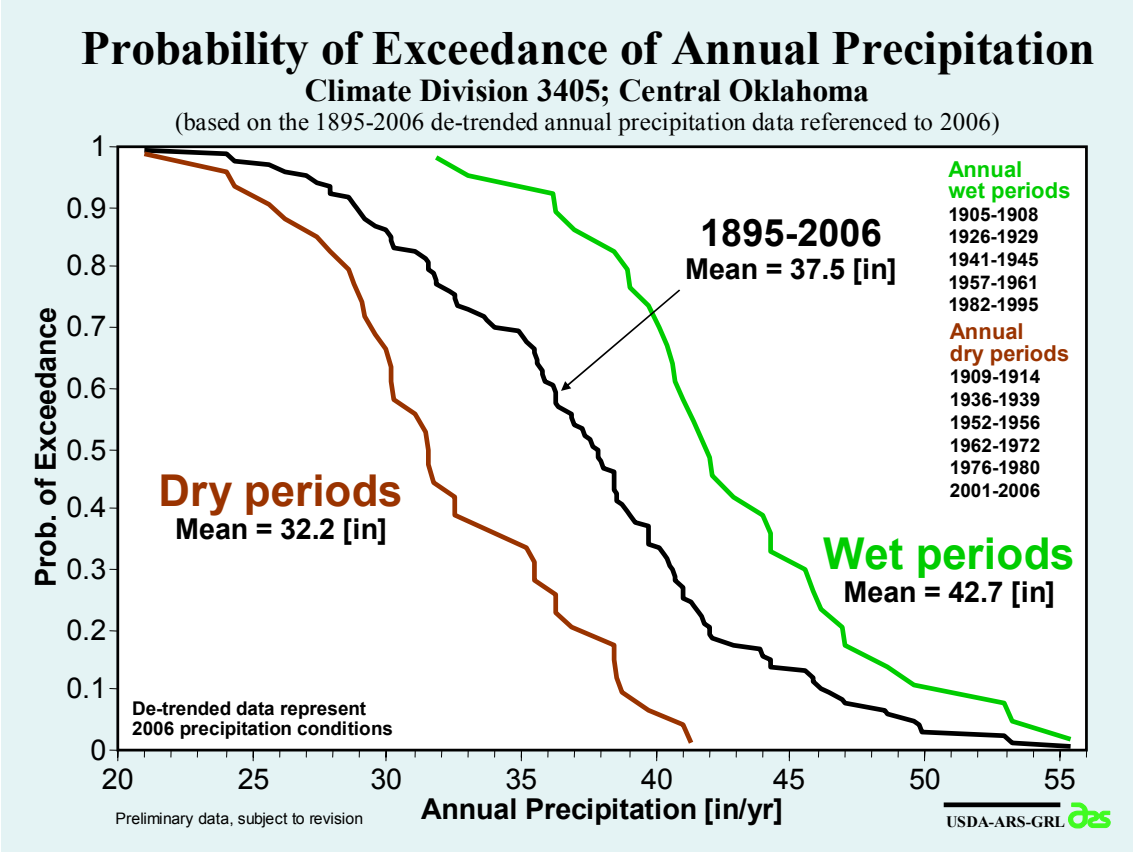

1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
North East Oklahoma (CD 3403)
Nonstationary mean
Annual precipitation
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
65
60
55
50
45
40
35
30
25
20
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL


Probability of Exceedance of Annual Precipitation
Climate Division 3403; Northeast Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
1895-2006
Mean = 42.0 [in]
Annual wet periods
1905-1908
1926-1929
1941-1945
1957-1961
1990-1999
Annual dry periods
1909-1914
1930-1939
1952-1956
1962-1970
1976-1983
2000-2006
Dry periods
Mean = 36.7 [in]
Wet periods
Mean = 48.3 [in]
De-trended data represent 2006 precipitation conditions
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
25
30
35
40
45
50
55
60
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL

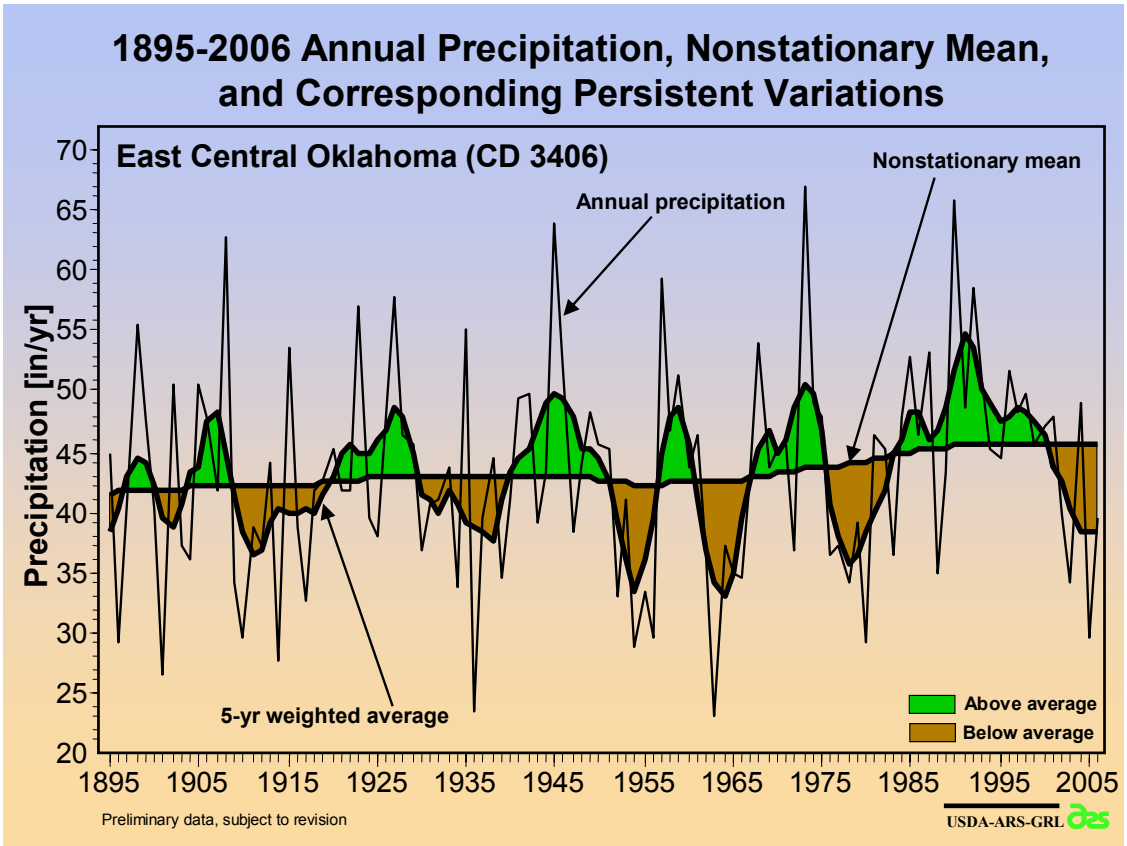

1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
West Central Oklahoma (CD 3404)
Nonstationary mean
Annual precipitation
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
45
40
35
30
25
20
15
10
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL

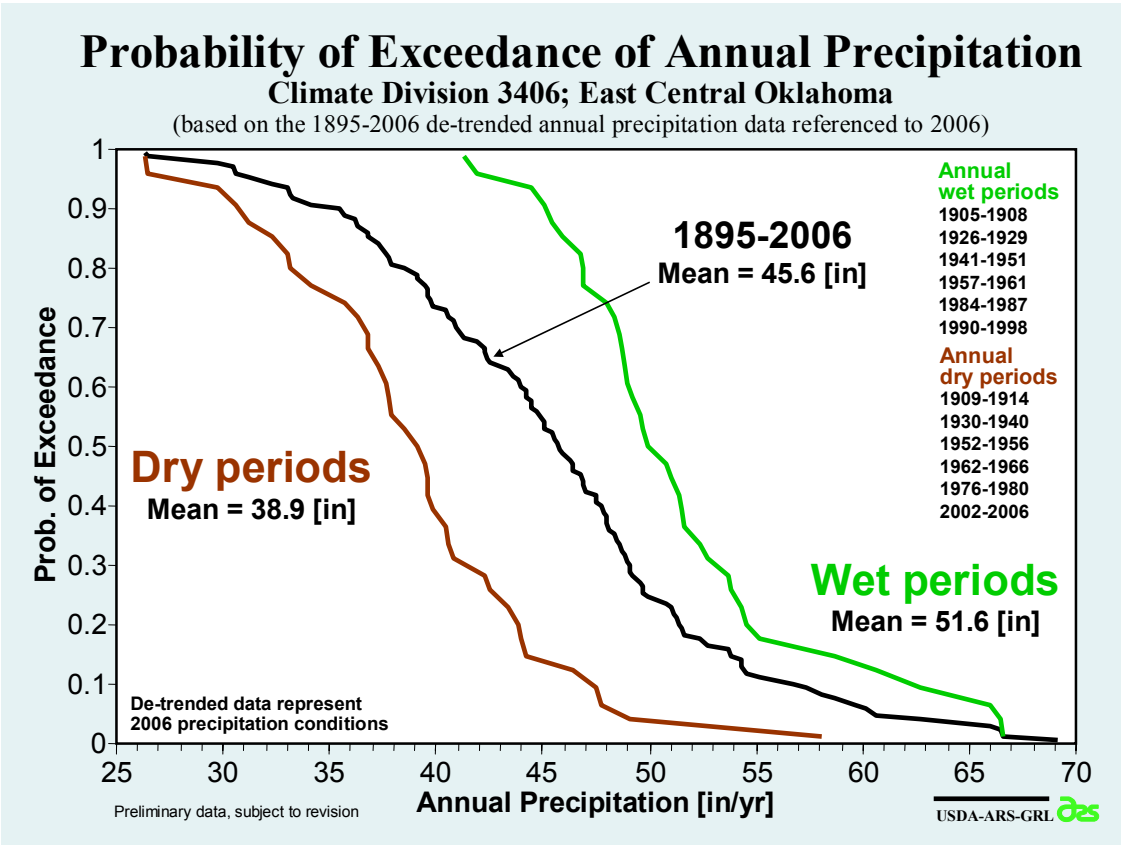

Probability of Exceedance of Annual Precipitation
Climate Division 3404; West Central Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
Annual wet periods
1905-1908
1957-1962
1986-1997
Annual dry periods
1909-1912
1933-1940
1952-1956
1966-1972
1976-1980
1998-2003
1895-2006
Mean = 29.6 [in]
Wet periods
Mean = 33.6 [in]
Dry periods
Mean = 25.6 [in]
De-trended data represent
2006 precipitation conditions
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
15
20
25
30
35
40
45
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL

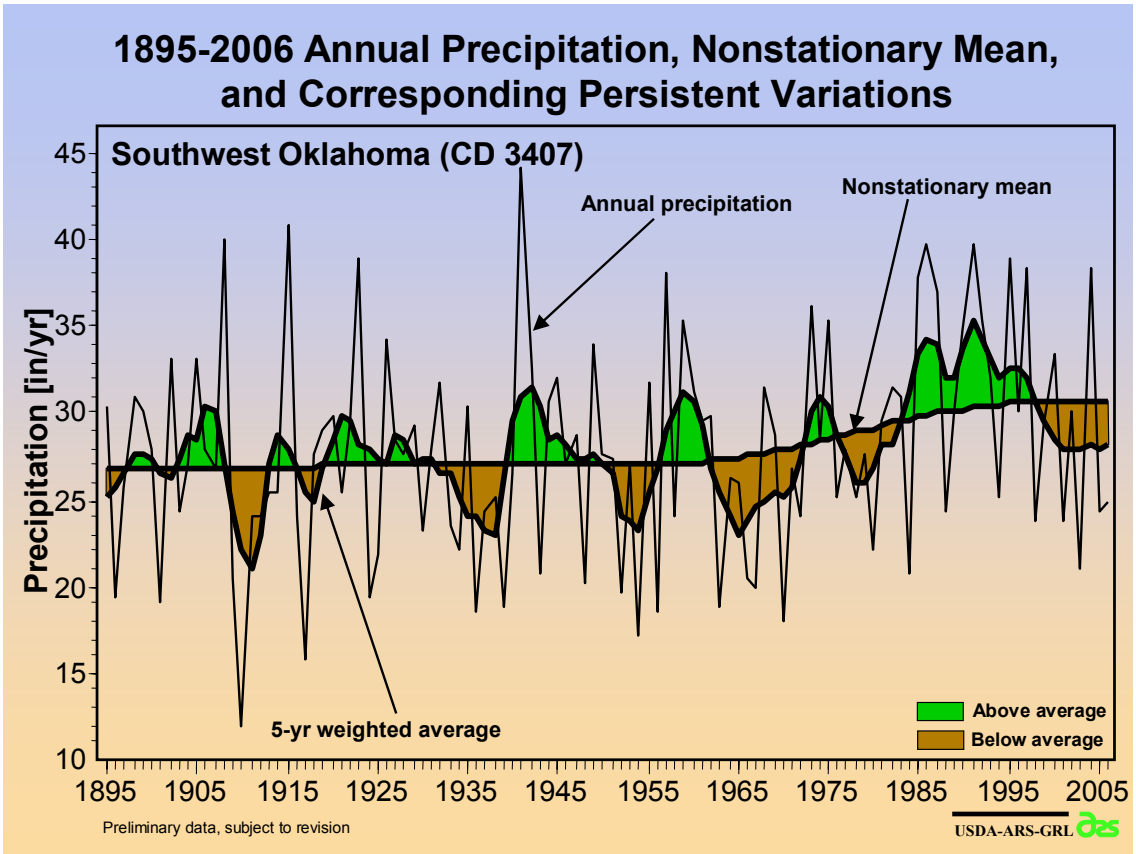

1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
Central Oklahoma (CD 3405)
Annual precipitation
Nonstationary mean
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
55
50
45
40
35
30
25
20
15
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL

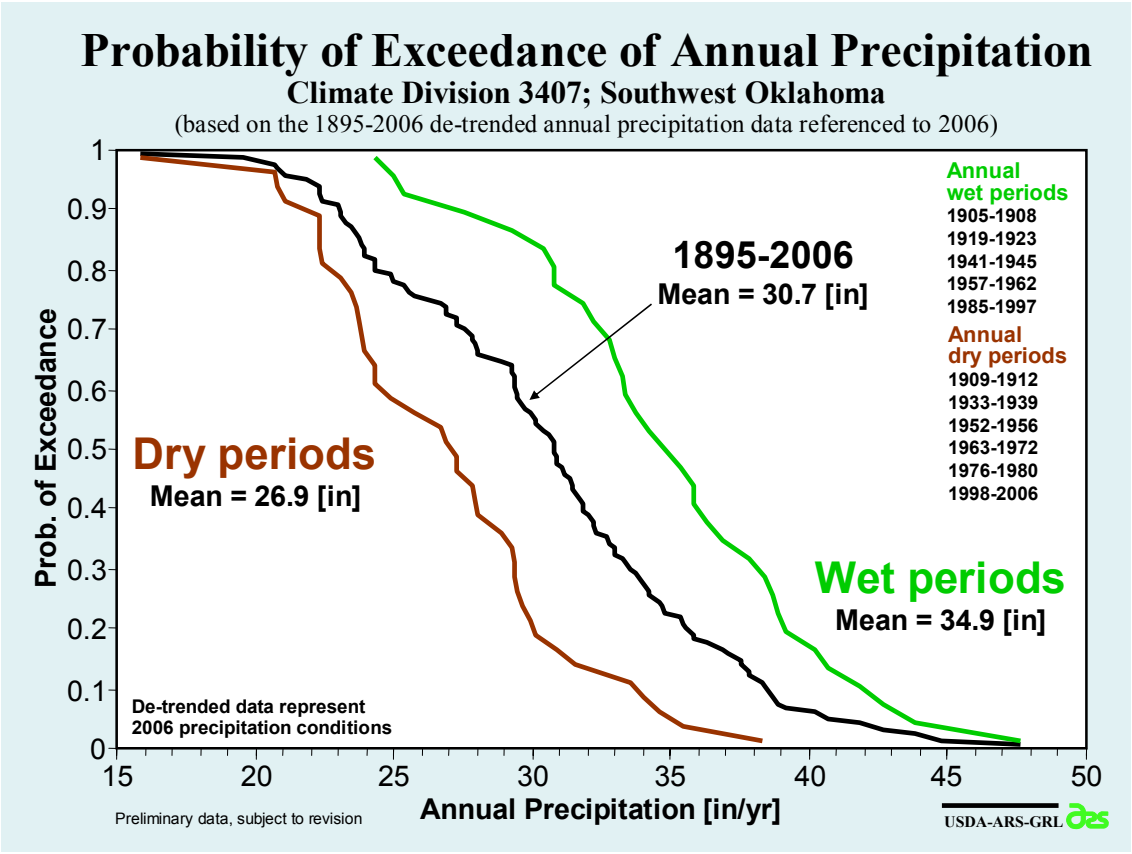

Probability of Exceedance of Annual Precipitation
Climate Division 3405; Central Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
1895-2006
Mean = 37.5 [in]
Annual wet periods
1905-1908
1926-1929
1941-1945
1957-1961
1982-1995
Annual dry periods
1909-1914
1936-1939
1952-1956
1962-1972
1976-1980
2001-2006
Dry periods
Mean = 32.2 [in]
Wet periods
Mean = 42.7 [in]
De-trended data represent 2006 precipitation conditions
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
20
25
30
35
40
45
50
55
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL

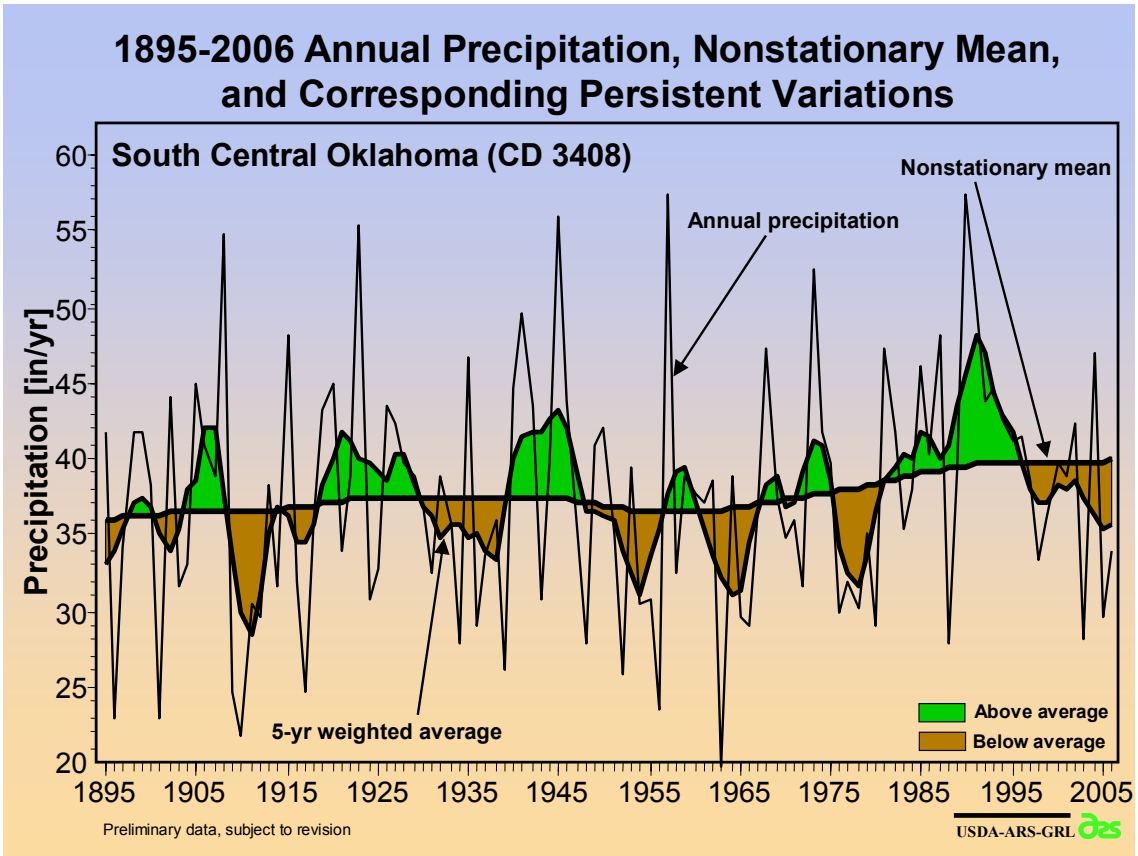
t

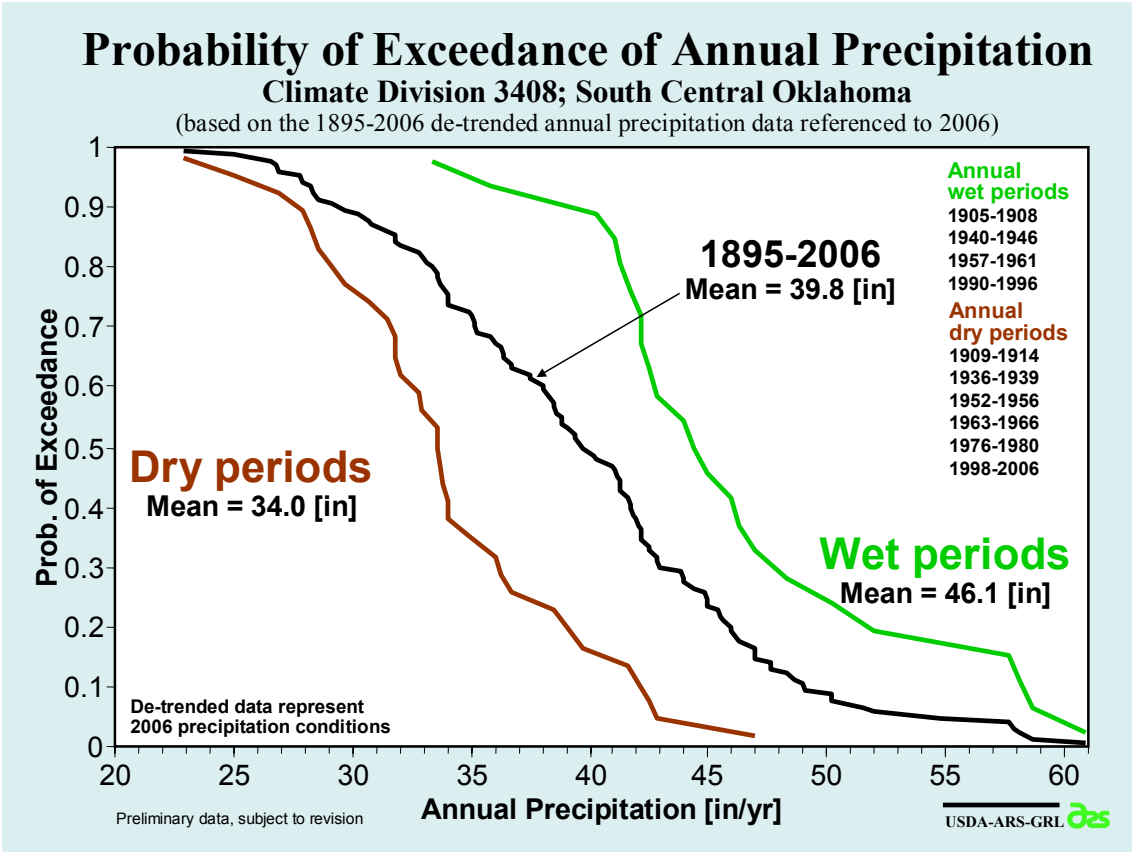

1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
East Central Oklahoma (CD 3406)
Nonstationary mean
Annual precipitation
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
70
65
60
55
50
45
40
35
30
25
20
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL

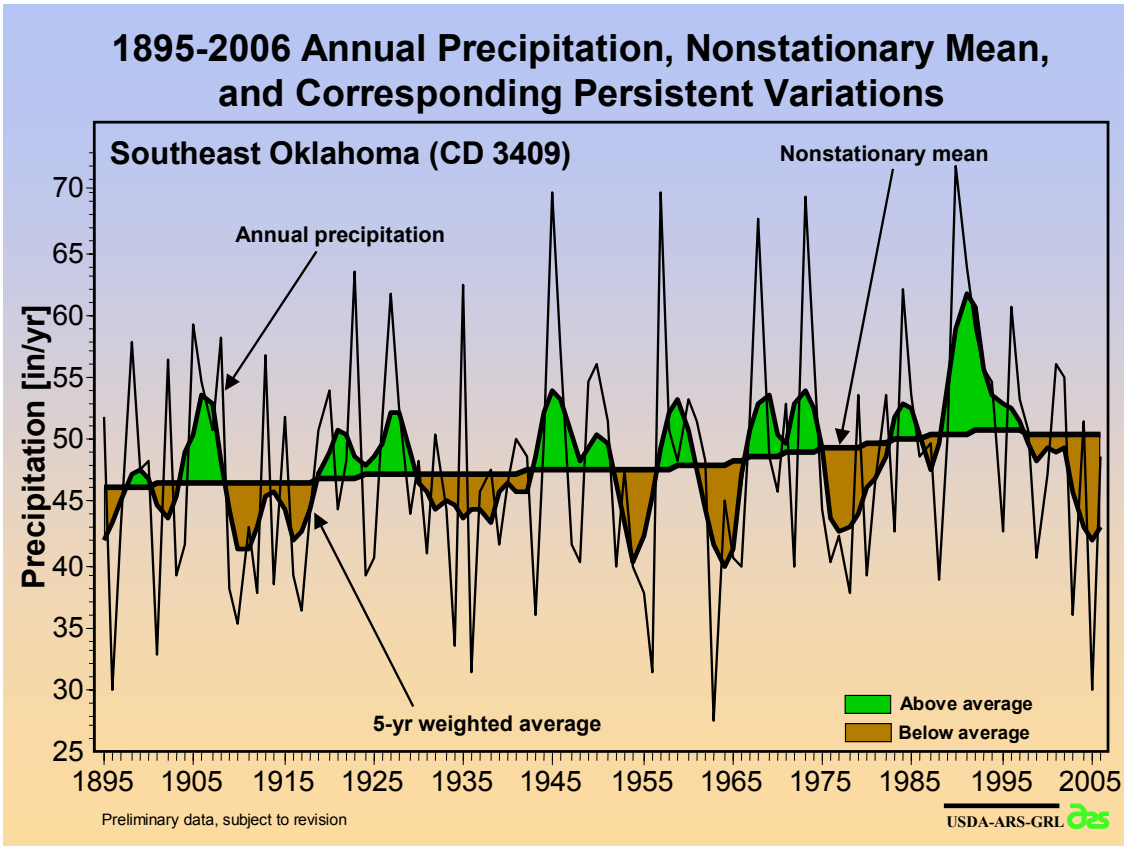

Probability of Exceedance of Annual Precipitation
Climate Division 3406; East Central Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
1895-2006
Mean = 45.6 [in]
Annual wet periods
1905-1908
1926-1929
1941-1951
1957-1961
1984-1987
1990-1998
Annual dry periods
1909-1914
1930-1940
1952-1956
1962-1966
1976-1980
2002-2006
Dry periods
Mean = 38.9 [in]
Wet periods
Mean = 51.6 [in]
De-trended data represent 2006 precipitation conditions
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
25
30
35
40
45
50
55
60
65
70
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL

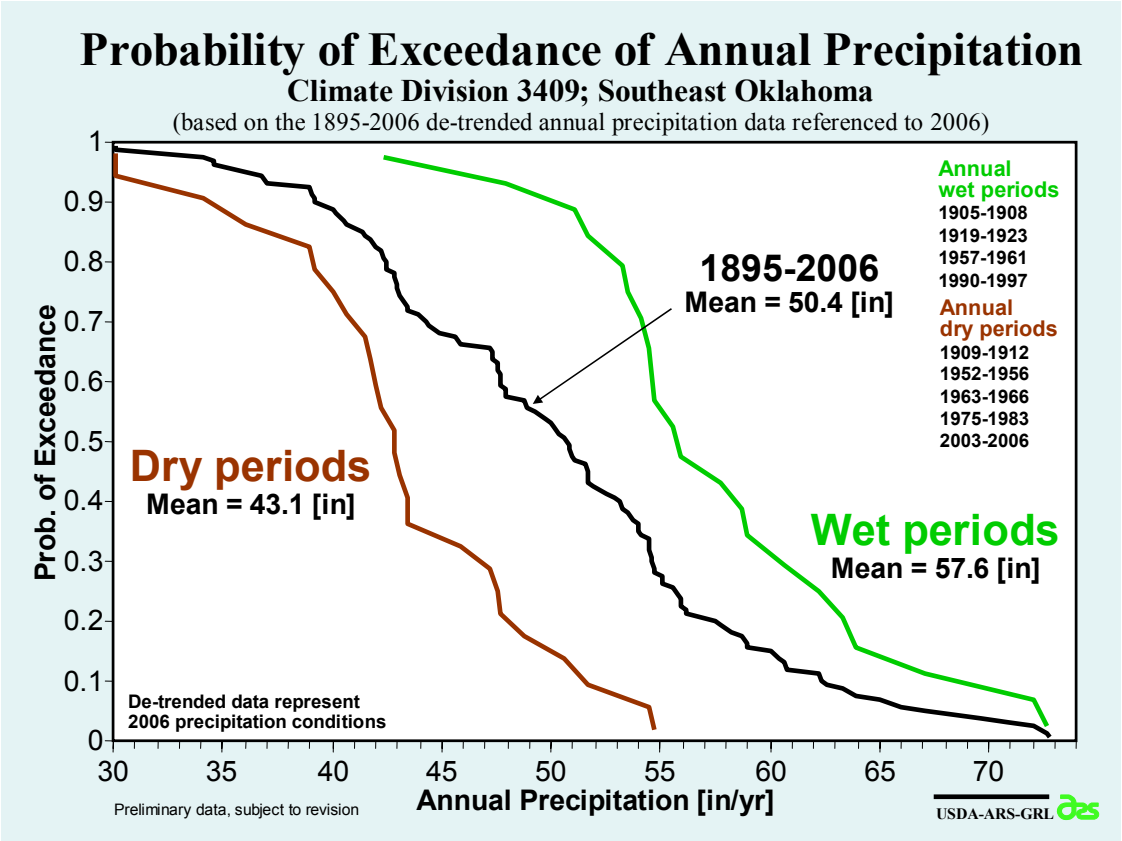

1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
Southwest Oklahoma (CD 3407)
Annual precipitation
Nonstationary mean
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
45
40
35
30
25
20
15
10
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL


Probability of Exceedance of Annual Precipitation
Climate Division 3407; Southwest Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1895-2006
Mean = 30.7 [in]
Annual wet periods
1905-1908
1919-1923
1941-1945
1957-1962
1985-1997
Annual dry periods
1909-1912
1933-1939
1952-1956
1963-1972
1976-1980
1998-2006
Dry periods
Mean = 26.9 [in]
Wet periods
Mean = 34.9 [in]
De-trended data represent 2006 precipitation conditions
15
20
25
30
35
40
45
50
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL


1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
South Central Oklahoma (CD 3408)
Nonstationary mean
Annual precipitation
Precipitation [in/yr]
60
55
50
45
40
35
30
25
20
5-yr weighted average
Above average
Below average
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL


Probability of Exceedance of Annual Precipitation
Climate Division 3408; South Central Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1895-2006
Mean = 39.8 [in]
Annual wet periods
1905-1908
1940-1946
1957-1961
1990-1996
Annual dry periods
1909-1914
1936-1939
1952-1956
1963-1966
1976-1980
1998-2006
Dry periods
Mean = 34.0 [in]
Wet periods
Mean = 46.1 [in]
De-trended data represent 2006 precipitation conditions
20
25
30
35
40
45
50
55
60
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL


1895-2006 Annual Precipitation, Nonstationary Mean, and Corresponding Persistent Variations
Southeast Oklahoma (CD 3409)
Nonstationary mean
Annual precipitation
5-yr weighted average
Above average
Below average
Precipitation [in/yr]
70
65
60
55
50
45
40
35
30
25
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Preliminary data, subject to revision
USDA-ARS-GRL


Probability of Exceedance of Annual Precipitation
Climate Division 3409; Southeast Oklahoma
(based on the 1895-2006 de-trended annual precipitation data referenced to 2006)
Annual wet periods
1905-1908
1919-1923
1957-1961
1990-1997
Annual dry periods
1909-1912
1952-1956
1963-1966
1975-1983
2003-2006
1895-2006
Mean = 50.4 [in]
Dry periods
Mean = 43.1 [in]
Wet periods
Mean = 57.6 [in]
De-trended data represent
2006 precipitation conditions
Prob. of Exceedance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
30
35
40
45
50
55
60
65
70
Annual Precipitation [in/yr]
Preliminary data, subject to revision
USDA-ARS-GRL

10. Tables of 1895-2006 Annual Precipitation, Long-Term Trend Values, and Identification of Wet and Dry Periods

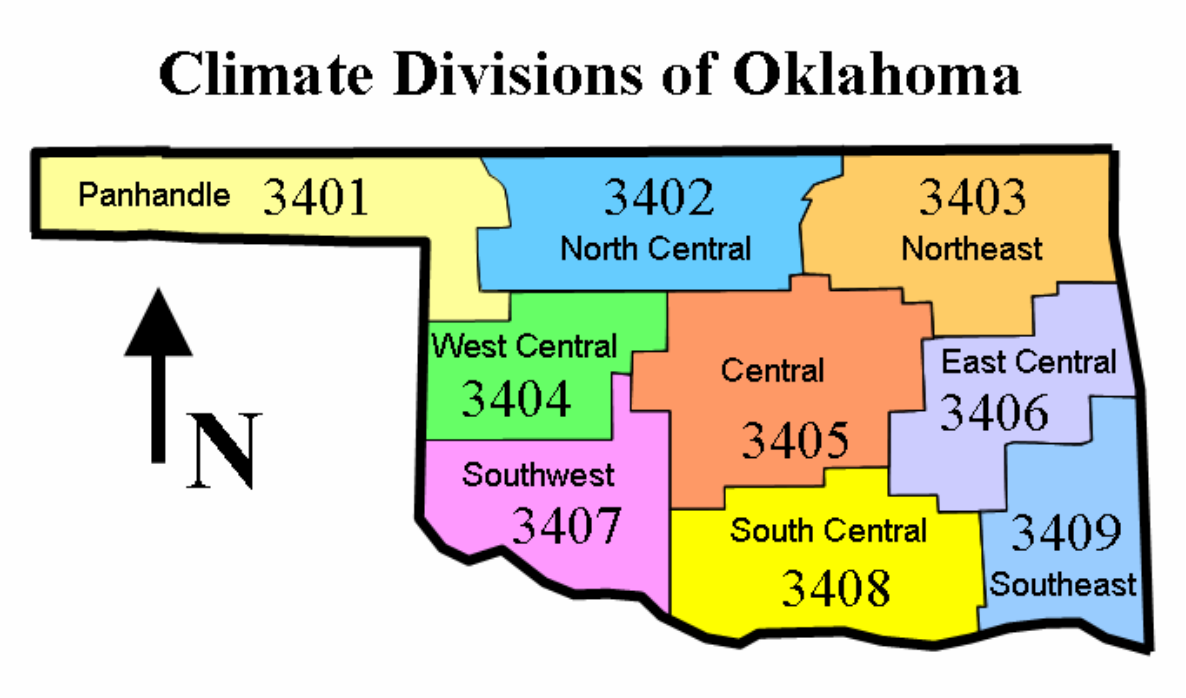


Table 1. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for the Oklahoma Panhandle (CD3401).
1895-2006 stationary mean of annual precipitation: 19.9 [in]
2006 annual precipitation trend value: 21.4 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	23.31	19.69		1931	17.68	19.11	
1896	15.80	19.68		1932	17.82	19.07	
1897	18.91	19.68		1933	12.89	19.04	D1
1898	19.78	19.68		1934	13.05	19.02	D1
1899	19.44	19.70		1935	14.05	19.01	D1
1900	18.17	19.71		1936	12.49	19.03	D1
1901	16.14	19.73		1937	12.37	19.06	D1
1902	20.19	19.75		1938	17.64	19.10	D1
1903	19.03	19.76		1939	15.77	19.16	D1
1904	21.20	19.77	W1	1940	16.32	19.23	D1
1905	22.99	19.76	W1	1941	33.25	19.29	W3
1906	23.43	19.73	W1	1942	25.40	19.32	W3
1907	19.67	19.70	W1	1943	14.58	19.34	W3
1908	25.34	19.65	W1	1944	25.68	19.37	W3
1909	19.19	19.60		1945	15.89	19.39	W3
1910	9.50	19.55		1946	22.66	19.43	W3
1911	20.09	19.51		1947	20.75	19.46	W3
1912	18.82	19.49		1948	22.61	19.47	W3
1913	15.82	19.48		1949	25.03	19.48	W3
1914	22.45	19.47		1950	25.41	19.48	W3
1915	30.87	19.46		1951	22.03	19.47	W3
1916	16.84	19.42		1952	13.33	19.46	D2
1917	12.41	19.39		1953	17.29	19.46	D2
1918	20.42	19.37		1954	12.04	19.47	D2
1919	20.44	19.36		1955	14.81	19.50	D2
1920	20.67	19.35		1956	11.61	19.54	D2
1921	18.38	19.35		1957	26.41	19.60	W4
1922	21.39	19.35		1958	23.75	19.65	W4
1923	24.55	19.35		1959	20.84	19.71	W4
1924	16.52	19.32		1960	22.08	19.76	W4
1925	16.49	19.30		1961	21.16	19.81	W4
1926	21.34	19.28	W2	1962	22.34	19.85	W4
1927	20.79	19.25	W2	1963	14.73	19.88	
1928	24.11	19.22	W2	1964	17.83	19.92	
1929	20.36	19.18	W2	1965	23.52	19.95	
1930	22.01	19.15	W2				

Table 1. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	15.57	19.97		2000	22.03	21.20	W6
1967	18.68	20.00		2001	16.96	21.21	
1968	21.60	20.02		2002	20.25	21.24	
1969	25.18	20.04		2003	20.20	21.27	
1970	12.55	20.05		2004	26.73	21.32	
1971	21.03	20.07		2005	23.25	21.35	
1972	21.59	20.10		2006	19.65	21.36	
1973	24.96	20.14					
1974	17.86	20.16					
1975	16.65	20.19					
1976	15.61	20.24					
1977	22.06	20.29					
1978	18.68	20.34					
1979	24.13	20.40					
1980	18.71	20.46					
1981	21.29	20.53					
1982	20.21	20.60					
1983	19.52	20.66					
1984	18.69	20.73					
1985	25.82	20.79	W5				
1986	21.41	20.83	W5				
1987	26.85	20.86	W5				
1988	20.30	20.87	W5				
1989	23.50	20.89	W5				
1990	17.75	20.90	D3				
1991	18.15	20.92	D3				
1992	18.72	20.95	D3				
1993	19.76	20.99	D3				
1994	19.91	21.02	D3				
1995	19.64	21.05	D3				
1996	23.60	21.09	W6				
1997	22.39	21.12	W6				
1998	24.66	21.15	W6				
1999	24.04	21.17	W6				

Table 2. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for North Central Oklahoma (CD3402).
1895-2006 stationary mean of annual precipitation: 28.7 [in]
2006 annual precipitation trend value: 32.0 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	27.59	27.38		1931	29.44	27.45	W2
1896	23.13	27.36		1932	29.52	27.45	W2
1897	24.90	27.37		1933	21.68	27.45	D2
1898	32.39	27.39		1934	25.47	27.46	D2
1899	28.85	27.40		1935	25.82	27.47	D2
1900	27.35	27.42		1936	18.97	27.50	D2
1901	20.72	27.43		1937	24.74	27.54	D2
1902	35.25	27.46	W1	1938	32.48	27.58	
1903	28.33	27.47	W1	1939	23.68	27.63	
1904	26.22	27.48	W1	1940	26.13	27.69	
1905	33.08	27.48	W1	1941	39.26	27.72	
1906	30.43	27.47	W1	1942	32.01	27.74	
1907	27.49	27.44	W1	1943	23.35	27.73	
1908	40.37	27.41	W1	1944	34.98	27.74	
1909	25.88	27.38		1945	28.02	27.74	
1910	14.63	27.34	D1	1946	24.35	27.76	
1911	24.69	27.32	D1	1947	27.14	27.77	
1912	24.73	27.32	D1	1948	29.24	27.77	
1913	24.11	27.33	D1	1949	33.93	27.77	
1914	22.30	27.34	D1	1950	26.45	27.76	
1915	43.55	27.36		1951	34.21	27.76	
1916	22.61	27.35		1952	18.08	27.73	D3
1917	18.95	27.35		1953	21.90	27.73	D3
1918	29.76	27.36		1954	15.04	27.76	D3
1919	25.69	27.38		1955	26.00	27.80	D3
1920	29.61	27.40		1956	14.50	27.86	D3
1921	19.85	27.42		1957	45.52	27.96	W3
1922	29.68	27.46		1958	28.71	28.03	W3
1923	36.01	27.48		1959	36.61	28.11	W3
1924	22.39	27.48		1960	33.93	28.18	W3
1925	21.97	27.48		1961	35.50	28.22	W3
1926	31.38	27.49	W2	1962	24.18	28.26	D4
1927	30.81	27.47	W2	1963	24.82	28.31	D4
1928	31.18	27.46	W2	1964	30.68	28.37	D4
1929	30.97	27.45	W2	1965	26.39	28.42	D4
1930	26.60	27.45	W2				

Table 2. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	17.98	28.48	D4	2000	33.71	31.91	W4
1967	28.77	28.56	D4	2001	21.22	31.91	D5
1968	26.88	28.64	D4	2002	34.69	31.93	D5
1969	30.29	28.75	D4	2003	24.94	31.92	D5
1970	20.49	28.86	D4	2004	36.83	31.95	D5
1971	28.90	28.99	D4	2005	29.77	31.97	D5
1972	25.50	29.13	D4	2006	20.37	32.00	D5
1973	37.38	29.28					
1974	35.50	29.41					
1975	28.14	29.53					
1976	21.16	29.66					
1977	31.22	29.79					
1978	24.73	29.91					
1979	33.91	30.05					
1980	25.68	30.18					
1981	30.13	30.33					
1982	28.57	30.47					
1983	32.36	30.61					
1984	25.83	30.74					
1985	36.31	30.86					
1986	39.29	30.97					
1987	39.49	31.04					
1988	26.38	31.09					
1989	32.79	31.14					
1990	25.08	31.21					
1991	27.58	31.29					
1992	36.06	31.38	W4				
1993	34.92	31.47	W4				
1994	29.83	31.55	W4				
1995	35.07	31.64	W4				
1996	30.90	31.72	W4				
1997	41.21	31.79	W4				
1998	38.73	31.85	W4				
1999	42.15	31.89	W4				

Table 3. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for North East Oklahoma (CD3403).
1895-2006 stationary mean of annual precipitation: 39.8 [in]
2006 annual precipitation trend value: 42.0 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	38.39	38.37		1931	41.56	39.55	D2
1896	31.22	38.36		1932	36.46	39.56	D2
1897	35.81	38.40		1933	38.57	39.58	D2
1898	49.83	38.47		1934	32.17	39.58	D2
1899	44.95	38.52		1935	43.41	39.59	D2
1900	38.88	38.56		1936	30.19	39.60	D2
1901	24.36	38.59		1937	34.88	39.61	D2
1902	52.12	38.64		1938	39.17	39.64	D2
1903	37.90	38.66		1939	32.30	39.69	D2
1904	32.54	38.68		1940	40.28	39.75	
1905	47.14	38.69	W1	1941	60.49	39.78	W3
1906	42.51	38.70	W1	1942	50.13	39.76	W3
1907	38.96	38.69	W1	1943	46.40	39.71	W3
1908	58.34	38.68	W1	1944	41.22	39.67	W3
1909	35.90	38.64	D1	1945	49.03	39.62	W3
1910	24.34	38.60	D1	1946	38.99	39.57	
1911	32.62	38.58	D1	1947	32.09	39.50	
1912	32.92	38.60	D1	1948	44.03	39.44	
1913	37.98	38.64	D1	1949	43.51	39.36	
1914	23.10	38.68	D1	1950	38.42	39.28	
1915	54.85	38.76		1951	43.96	39.18	
1916	36.18	38.81		1952	25.48	39.07	D3
1917	26.36	38.87		1953	34.59	38.98	D3
1918	39.11	38.95		1954	28.66	38.92	D3
1919	39.15	39.04		1955	30.68	38.88	D3
1920	41.05	39.13		1956	26.05	38.87	D3
1921	35.64	39.21		1957	53.67	38.91	W4
1922	37.19	39.30		1958	36.56	38.94	W4
1923	49.98	39.39		1959	49.19	38.98	W4
1924	34.55	39.44		1960	37.66	39.00	W4
1925	33.96	39.49		1961	52.33	39.03	W4
1926	48.12	39.55	W2	1962	36.28	39.03	D4
1927	52.00	39.55	W2	1963	21.84	39.04	D4
1928	42.26	39.55	W2	1964	39.08	39.10	D4
1929	45.50	39.54	W2	1965	34.10	39.16	D4
1930	32.37	39.54	D2				

Table 3. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	27.85	39.24	D4	2000	41.59	42.06	D6
1967	38.90	39.33	D4	2001	33.38	42.01	D6
1968	41.93	39.43	D4	2002	37.31	41.97	D6
1969	36.56	39.53	D4	2003	39.87	41.93	D6
1970	35.82	39.64	D4	2004	47.77	41.93	D6
1971	41.20	39.76		2005	32.23	41.95	D6
1972	37.62	39.89		2006	32.91	42.01	D6
1973	59.68	40.04					
1974	53.73	40.15					
1975	42.14	40.24					
1976	31.14	40.33	D5				
1977	41.36	40.43	D5				
1978	33.98	40.51	D5				
1979	36.71	40.62	D5				
1980	30.22	40.74	D5				
1981	38.35	40.88	D5				
1982	37.17	41.03	D5				
1983	38.45	41.18	D5				
1984	42.34	41.32					
1985	56.71	41.44					
1986	48.67	41.52					
1987	46.94	41.57					
1988	37.94	41.62					
1989	36.62	41.67					
1990	48.80	41.74	W5				
1991	39.30	41.80	W5				
1992	45.00	41.88	W5				
1993	46.40	41.96	W5				
1994	47.83	42.01	W5				
1995	45.98	42.05	W5				
1996	37.73	42.08	W5				
1997	44.13	42.09	W5				
1998	46.06	42.09	W5				
1999	50.81	42.09	W5				

Table 4. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for West Central Oklahoma (CD3404).
1895-2006 stationary mean of annual precipitation: 26.4 [in]
2006 annual precipitation trend value: 29.6 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	26.53	25.48		1931	26.19	25.11	
1896	19.28	25.47		1932	27.61	25.08	
1897	24.29	25.49		1933	18.41	25.06	D2
1898	28.47	25.51		1934	19.98	25.05	D2
1899	28.88	25.53		1935	23.61	25.05	D2
1900	24.03	25.54		1936	21.18	25.06	D2
1901	20.91	25.55		1937	20.32	25.08	D2
1902	33.32	25.57		1938	24.27	25.10	D2
1903	22.64	25.58		1939	21.80	25.15	D2
1904	23.23	25.58		1940	23.34	25.20	D2
1905	30.44	25.58	W1	1941	40.28	25.23	
1906	27.45	25.56	W1	1942	34.63	25.23	
1907	25.72	25.54	W1	1943	19.36	25.20	
1908	38.57	25.51	W1	1944	28.66	25.19	
1909	21.64	25.47	D1	1945	22.70	25.18	
1910	10.30	25.42	D1	1946	24.40	25.20	
1911	24.72	25.40	D1	1947	24.71	25.21	
1912	23.27	25.40	D1	1948	24.76	25.22	
1913	24.19	25.41		1949	30.13	25.22	
1914	25.18	25.42		1950	23.87	25.22	
1915	41.08	25.43		1951	24.66	25.22	
1916	22.25	25.40		1952	15.42	25.23	D3
1917	13.18	25.39		1953	21.78	25.26	D3
1918	27.43	25.39		1954	15.95	25.32	D3
1919	27.24	25.40		1955	28.72	25.39	D3
1920	26.07	25.40		1956	14.99	25.44	D3
1921	23.55	25.40		1957	34.62	25.55	W2
1922	28.16	25.41		1958	23.96	25.64	W2
1923	33.82	25.39		1959	36.59	25.75	W2
1924	20.76	25.36		1960	32.52	25.83	W2
1925	20.60	25.32		1961	30.04	25.90	W2
1926	30.69	25.30		1962	28.33	25.97	W2
1927	26.54	25.25		1963	20.15	26.04	
1928	27.35	25.21		1964	28.29	26.12	
1929	27.45	25.17		1965	28.83	26.18	
1930	24.42	25.13					

Table 4. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	17.46	26.25	D4	2000	31.46	29.40	D6
1967	24.50	26.34	D4	2001	23.43	29.41	D6
1968	29.62	26.44	D4	2002	29.36	29.43	D6
1969	25.15	26.53	D4	2003	20.41	29.44	D6
1970	17.29	26.62	D4	2004	35.87	29.48	
1971	24.88	26.74	D4	2005	28.72	29.51	
1972	22.20	26.87	D4	2006	26.01	29.56	
1973	31.74	27.02					
1974	32.29	27.14					
1975	32.08	27.27					
1976	19.69	27.38	D5				
1977	28.70	27.50	D5				
1978	23.79	27.62	D5				
1979	27.02	27.74	D5				
1980	23.69	27.88	D5				
1981	28.75	28.01					
1982	29.70	28.15					
1983	29.69	28.26					
1984	20.11	28.37					
1985	29.35	28.49					
1986	41.31	28.60	W3				
1987	33.05	28.67	W3				
1988	26.02	28.71	W3				
1989	31.23	28.76	W3				
1990	29.38	28.82	W3				
1991	30.60	28.88	W3				
1992	31.26	28.95	W3				
1993	27.49	29.02	W3				
1994	26.17	29.09	W3				
1995	36.83	29.16	W3				
1996	29.09	29.23	W3				
1997	43.04	29.29	W3				
1998	25.88	29.32	D6				
1999	50.81	29.36	D6				

Table 5. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for Central Oklahoma (CD3405).
1895-2006 stationary mean of annual precipitation: 34.2 [in]
2006 annual precipitation trend value: 37.6 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	33.97	32.27		1931	30.10	33.60	
1896	23.59	32.28		1932	36.40	33.63	
1897	30.41	32.33		1933	34.53	33.65	
1898	41.29	32.40		1934	32.03	33.66	
1899	36.67	32.44		1935	37.67	33.66	
1900	30.57	32.49		1936	20.14	33.66	D2
1901	22.88	32.52		1937	26.25	33.69	D2
1902	40.87	32.57		1938	34.74	33.73	D2
1903	26.87	32.60		1939	26.44	33.79	D2
1904	30.19	32.64		1940	34.88	33.85	
1905	39.38	32.68	W1	1941	49.59	33.89	W3
1906	37.21	32.72	W1	1942	42.21	33.88	W3
1907	35.55	32.72	W1	1943	28.11	33.85	W3
1908	50.56	32.72	W1	1944	35.27	33.84	W3
1909	25.40	32.69	D1	1945	43.29	33.82	W3
1910	16.10	32.66	D1	1946	33.88	33.80	
1911	26.70	32.67	D1	1947	31.98	33.76	
1912	28.86	32.69	D1	1948	33.00	33.71	
1913	33.88	32.74	D1	1949	40.00	33.66	
1914	22.63	32.77	D1	1950	33.43	33.60	
1915	45.06	32.84		1951	33.50	33.53	
1916	31.16	32.90		1952	24.95	33.47	D2
1917	22.39	32.96		1953	34.28	33.42	D2
1918	35.97	33.04		1954	20.16	33.40	D2
1919	33.38	33.12		1955	32.15	33.40	D2
1920	36.61	33.20		1956	21.44	33.41	D2
1921	30.59	33.27		1957	48.87	33.47	W4
1922	33.68	33.35		1958	32.98	33.52	W4
1923	45.71	33.42		1959	45.56	33.57	W4
1924	28.56	33.46		1960	36.78	33.60	W4
1925	28.25	33.50		1961	38.96	33.62	W4
1926	42.09	33.54	W2	1962	31.56	33.64	D3
1927	38.10	33.55	W2	1963	24.68	33.68	D3
1928	37.75	33.55	W2	1964	34.69	33.75	D3
1929	36.65	33.56	W2	1965	27.78	33.82	D3
1930	29.63	33.57					

Table 5. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	25.53	33.92	D3	2000	39.62	37.41	
1967	31.65	34.02	D3	2001	32.37	37.42	D5
1968	37.90	34.12	D3	2002	36.77	37.43	D5
1969	29.17	34.21	D3	2003	27.78	37.42	D5
1970	33.08	34.32	D3	2004	40.93	37.45	D5
1971	32.40	34.43	D3	2005	29.49	37.48	D5
1972	28.75	34.57	D3	2006	29.99	37.55	D5
1973	45.65	34.72					
1974	39.26	34.84					
1975	38.12	34.96					
1976	23.70	35.07	D4				
1977	29.07	35.20	D4				
1978	28.85	35.34	D4				
1979	37.67	35.50	D4				
1980	26.84	35.65	D4				
1981	35.58	35.83					
1982	37.45	36.00	W5				
1983	38.69	36.16	W5				
1984	35.01	36.32	W5				
1985	47.52	36.46	W5				
1986	44.53	36.57	W5				
1987	43.32	36.65	W5				
1988	32.18	36.71	W5				
1989	37.69	36.78	W5				
1990	43.25	36.87	W5				
1991	39.14	36.95	W5				
1992	46.44	37.04	W5				
1993	40.57	37.12	W5				
1994	35.83	37.18	W5				
1995	41.06	37.24	W5				
1996	36.15	37.29					
1997	37.69	37.33					
1998	37.84	37.36					
1999	39.57	37.40					

Table 6. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for East Central Oklahoma (CD3406).
1895-2006 stationary mean of annual precipitation: 43.2 [in]
2006 annual precipitation trend value: 45.7 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	44.97	41.56		1931	40.45	42.82	D2
1896	29.10	41.57		1932	41.01	42.83	D2
1897	40.35	41.62		1933	43.56	42.84	D2
1898	55.67	41.71		1934	33.88	42.82	D2
1899	47.41	41.77		1935	55.22	42.80	D2
1900	40.37	41.82		1936	23.37	42.76	D2
1901	26.60	41.85		1937	39.40	42.76	D2
1902	50.56	41.91		1938	44.55	42.76	D2
1903	37.27	41.94		1939	34.44	42.80	D2
1904	35.97	41.98		1940	41.08	42.85	D2
1905	50.68	42.01	W1	1941	49.52	42.88	W3
1906	47.83	42.05	W1	1942	49.92	42.90	W3
1907	41.76	42.05	W1	1943	39.14	42.90	W3
1908	62.77	42.04	W1	1944	43.19	42.92	W3
1909	34.14	42.01	D1	1945	63.89	42.94	W3
1910	29.39	41.99	D1	1946	52.40	42.93	W3
1911	38.79	41.98	D1	1947	38.45	42.88	W3
1912	37.07	41.98	D1	1948	43.91	42.83	W3
1913	44.09	42.00	D1	1949	48.43	42.77	W3
1914	27.56	42.01	D1	1950	45.72	42.68	W3
1915	53.71	42.06		1951	45.30	42.58	W3
1916	38.69	42.11		1952	33.14	42.48	D3
1917	32.65	42.17		1953	40.98	42.39	D3
1918	41.61	42.26		1954	28.95	42.33	D3
1919	42.45	42.34		1955	33.35	42.29	D3
1920	45.27	42.43		1956	29.60	42.28	D3
1921	41.59	42.52		1957	59.31	42.31	W4
1922	41.87	42.62		1958	46.63	42.33	W4
1923	57.13	42.70		1959	51.23	42.34	W4
1924	39.51	42.75		1960	43.55	42.33	W4
1925	38.08	42.79		1961	46.34	42.34	W4
1926	47.97	42.83	W2	1962	36.32	42.35	D4
1927	57.79	42.83	W2	1963	23.15	42.39	D4
1928	46.37	42.81	W2	1964	37.29	42.48	D4
1929	45.72	42.81	W2	1965	34.79	42.57	D4
1930	36.68	42.81	D2				

Table 6. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	34.61	42.70	D4	2000	47.00	45.66	
1967	42.84	42.83		2001	47.90	45.63	
1968	54.08	42.97		2002	39.77	45.59	D6
1969	43.69	43.09		2003	34.01	45.54	D6
1970	45.01	43.20		2004	49.00	45.57	D6
1971	45.72	43.32		2005	29.64	45.60	D6
1972	36.84	43.43		2006	39.48	45.68	D6
1973	67.06	43.57					
1974	49.04	43.64					
1975	47.68	43.70					
1976	36.59	43.76	D5				
1977	37.22	43.84	D5				
1978	33.96	43.93	D5				
1979	38.96	44.04	D5				
1980	29.06	44.17	D5				
1981	46.48	44.33					
1982	45.20	44.49					
1983	36.33	44.64					
1984	48.01	44.81	W5				
1985	52.96	44.94	W5				
1986	46.27	45.05	W5				
1987	53.26	45.14	W5				
1988	35.00	45.21					
1989	43.28	45.30					
1990	65.72	45.41	W6				
1991	48.79	45.50	W6				
1992	58.60	45.59	W6				
1993	51.03	45.66	W6				
1994	45.04	45.70	W6				
1995	44.53	45.73	W6				
1996	51.70	45.74	W6				
1997	48.06	45.73	W6				
1998	49.60	45.70	W6				
1999	45.57	45.69					

Table 7. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for Southwest Oklahoma (CD3407).
1895-2006 stationary mean of annual precipitation: 27.9 [in]
2006 annual precipitation trend value: 30.7 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	30.28	26.79		1931	28.05	27.04	
1896	19.33	26.78		1932	31.84	27.04	
1897	25.78	26.81		1933	23.59	27.04	D2
1898	30.84	26.84		1934	22.10	27.04	D2
1899	30.08	26.86		1935	30.37	27.05	D2
1900	28.00	26.87		1936	18.64	27.05	D2
1901	19.09	26.88		1937	24.40	27.07	D2
1902	33.26	26.90		1938	25.24	27.08	D2
1903	24.25	26.91		1939	18.80	27.12	D2
1904	27.02	26.93		1940	26.61	27.17	
1905	33.09	26.93	W1	1941	44.05	27.20	W3
1906	28.05	26.93	W1	1942	32.71	27.18	W3
1907	26.93	26.92	W1	1943	20.72	27.15	W3
1908	39.95	26.90	W1	1944	30.64	27.14	W3
1909	20.48	26.87	D1	1945	32.18	27.11	W3
1910	11.96	26.83	D1	1946	27.00	27.11	
1911	23.92	26.82	D1	1947	28.65	27.09	
1912	24.00	26.83	D1	1948	20.30	27.07	
1913	25.56	26.85		1949	33.90	27.05	
1914	25.53	26.86		1950	27.72	27.03	
1915	40.92	26.89		1951	27.40	26.99	
1916	24.03	26.90		1952	19.66	26.97	D3
1917	15.70	26.91		1953	27.11	26.96	D3
1918	27.66	26.95		1954	17.03	26.97	D3
1919	29.02	26.97	W2	1955	31.73	26.99	D3
1920	29.97	27.01	W2	1956	18.58	27.00	D3
1921	25.56	27.03	W2	1957	38.13	27.06	W4
1922	29.59	27.06	W2	1958	23.96	27.10	W4
1923	38.99	27.08	W2	1959	35.32	27.15	W4
1924	19.37	27.06		1960	31.28	27.19	W4
1925	21.87	27.06		1961	29.48	27.22	W4
1926	34.14	27.07		1962	29.84	27.26	W4
1927	28.36	27.05		1963	18.85	27.30	D4
1928	27.71	27.04		1964	26.31	27.37	D4
1929	29.25	27.03		1965	25.98	27.44	D4
1930	23.22	27.03					

Table 7. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	20.42	27.52	D4	2000	33.49	30.68	D6
1967	19.98	27.61	D4	2001	23.68	30.68	D6
1968	31.56	27.72	D4	2002	30.08	30.68	D6
1969	28.65	27.82	D4	2003	21.01	30.67	D6
1970	17.88	27.91	D4	2004	38.31	30.69	D6
1971	26.77	28.03	D4	2005	24.30	30.70	D6
1972	24.13	28.17	D4	2006	24.90	30.73	D6
1973	36.20	28.31					
1974	28.56	28.43					
1975	35.33	28.56					
1976	25.21	28.67	D5				
1977	27.97	28.78	D5				
1978	25.02	28.90	D5				
1979	27.68	29.02	D5				
1980	22.23	29.15	D5				
1981	29.65	29.29					
1982	31.42	29.43					
1983	31.06	29.56					
1984	20.78	29.68					
1985	37.74	29.81	W5				
1986	39.89	29.92	W5				
1987	37.13	30.00	W5				
1988	24.35	30.06	W5				
1989	30.15	30.13	W5				
1990	34.86	30.20	W5				
1991	39.76	30.28	W5				
1992	35.44	30.35	W5				
1993	31.92	30.42	W5				
1994	25.11	30.48	W5				
1995	38.98	30.54	W5				
1996	30.23	30.59	W5				
1997	38.27	30.62	W5				
1998	23.86	30.63	D6				
1999	29.33	30.66	D6				

Table 8. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for South Central Oklahoma (CD3408).
1895-2006 stationary mean of annual precipitation: 37.5 [in]
2006 annual precipitation trend value: 39.9 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	41.70	36.03		1931	32.53	37.44	
1896	22.96	36.05		1932	38.79	37.44	
1897	34.24	36.11		1933	35.55	37.44	
1898	41.85	36.19		1934	27.81	37.42	
1899	41.70	36.25		1935	46.62	37.42	
1900	38.26	36.30		1936	29.01	37.40	D2
1901	23.03	36.33		1937	33.58	37.39	D2
1902	44.16	36.39		1938	35.95	37.39	D2
1903	31.71	36.42		1939	26.15	37.43	D2
1904	32.91	36.46		1940	44.54	37.47	W3
1905	44.90	36.49	W1	1941	49.54	37.48	W3
1906	41.00	36.52	W1	1942	43.53	37.45	W3
1907	38.81	36.53	W1	1943	30.83	37.40	W3
1908	54.72	36.53	W1	1944	40.02	37.37	W3
1909	24.55	36.50	D1	1945	56.07	37.34	W3
1910	21.62	36.48	D1	1946	43.68	37.28	W3
1911	30.31	36.49	D1	1947	34.78	37.19	
1912	29.57	36.52	D1	1948	27.97	37.09	
1913	38.23	36.57	D1	1949	40.94	37.00	
1914	31.64	36.60	D1	1950	41.97	36.91	
1915	48.24	36.67		1951	35.16	36.80	
1916	31.99	36.74		1952	25.90	36.71	D3
1917	24.67	36.82		1953	39.53	36.65	D3
1918	35.82	36.93		1954	30.33	36.60	D3
1919	43.29	37.03	W2	1955	30.74	36.56	D3
1920	44.87	37.12	W2	1956	23.55	36.54	D3
1921	34.05	37.19	W2	1957	57.51	36.56	
1922	38.70	37.27	W2	1958	32.44	36.55	
1923	55.35	37.34	W2	1959	38.77	36.55	
1924	30.59	37.37		1960	37.71	36.54	
1925	32.74	37.40		1961	36.97	36.56	
1926	43.46	37.44		1962	38.60	36.59	
1927	42.33	37.43		1963	19.63	36.62	D4
1928	39.65	37.44		1964	38.87	36.70	D4
1929	38.71	37.43		1965	29.62	36.77	D4
1930	36.90	37.43					

Table 8. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	28.95	36.87	D4	2000	39.62	39.78	D6
1967	36.42	36.98		2001	38.96	39.79	D6
1968	47.35	37.10		2002	42.38	39.80	D6
1969	37.47	37.18		2003	28.15	39.77	D6
1970	34.88	37.26		2004	46.83	39.81	D6
1971	35.88	37.34		2005	29.64	39.84	D6
1972	31.58	37.45		2006	34.05	39.91	D6
1973	52.47	37.58					
1974	41.67	37.66					
1975	39.62	37.75					
1976	29.78	37.84	D5				
1977	31.88	37.95	D5				
1978	30.01	38.08	D5				
1979	35.06	38.21	D5				
1980	29.11	38.35	D5				
1981	47.24	38.52					
1982	41.72	38.67					
1983	35.25	38.79					
1984	37.88	38.93					
1985	46.06	39.06					
1986	40.16	39.16					
1987	48.26	39.25					
1988	27.75	39.32					
1989	39.14	39.41					
1990	57.28	39.50	W4				
1991	49.84	39.58	W4				
1992	43.65	39.64	W4				
1993	44.76	39.70	W4				
1994	42.72	39.73	W4				
1995	41.19	39.76	W4				
1996	41.56	39.77	W4				
1997	38.48	39.77					
1998	33.46	39.75	D6				
1999	36.15	39.77	D6				

Table 9. 1895-2006 Annual precipitation, long-term trends in average annual precipitation, and identification of wet and dry periods for Southeast Oklahoma (CD3409).
1895-2006 stationary mean of annual precipitation: 48.0 [in]
2006 annual precipitation trend value: 50.6 [in]

Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods	Year	Annual Precip. [inches]	Long-Term Trend of Precip. [inches]	Wet and Dry Periods
1895	51.67	46.10		1931	40.87	47.14	
1896	30.10	46.09		1932	50.40	47.15	
1897	42.90	46.14		1933	44.37	47.17	
1898	58.00	46.23		1934	33.44	47.16	
1899	47.63	46.29		1935	62.57	47.17	
1900	48.35	46.34		1936	31.19	47.15	
1901	32.90	46.38		1937	45.92	47.17	
1902	56.34	46.44		1938	47.48	47.20	
1903	39.17	46.47		1939	41.66	47.27	
1904	41.55	46.52		1940	46.50	47.34	
1905	59.35	46.54	W1	1941	50.03	47.40	
1906	54.73	46.57	W1	1942	48.49	47.45	
1907	50.73	46.56	W1	1943	36.11	47.48	
1908	58.19	46.54	W1	1944	49.94	47.57	
1909	38.15	46.52	D1	1945	69.95	47.66	
1910	35.17	46.50	D1	1946	57.26	47.69	
1911	43.14	46.49	D1	1947	41.56	47.69	
1912	37.73	46.49	D1	1948	40.13	47.68	
1913	56.73	46.51		1949	54.69	47.68	
1914	38.41	46.50		1950	56.06	47.67	
1915	51.83	46.51		1951	51.55	47.63	
1916	39.01	46.54		1952	39.89	47.59	D2
1917	36.25	46.60		1953	47.66	47.57	D2
1918	44.02	46.68		1954	39.90	47.56	D2
1919	50.70	46.75	W2	1955	37.68	47.57	D2
1920	53.98	46.82	W2	1956	31.20	47.61	D2
1921	44.32	46.89	W2	1957	69.85	47.68	W3
1922	48.15	46.97	W2	1958	50.65	47.73	W3
1923	63.59	47.04	W2	1959	48.27	47.77	W3
1924	39.01	47.06		1960	53.16	47.80	W3
1925	40.55	47.10		1961	51.46	47.85	W3
1926	51.69	47.15		1962	48.37	47.90	
1927	61.63	47.15		1963	27.48	47.96	D3
1928	52.59	47.14		1964	45.23	48.08	D3
1929	44.22	47.14		1965	40.69	48.19	D3
1930	48.33	47.14					

Table 9. Continued

Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods	Year	Annual Precipitation [inches]	Long-Term Trend of Precipitation [inches]	Wet and Dry Periods
1966	39.82	48.33	D3	2000	47.31	50.53	
1967	51.96	48.48		2001	56.10	50.52	
1968	67.67	48.62		2002	55.02	50.49	
1969	48.60	48.73		2003	35.91	50.43	D5
1970	45.80	48.82		2004	51.57	50.44	D5
1971	52.99	48.91		2005	29.99	50.47	D5
1972	39.82	49.00		2006	48.82	50.55	D5
1973	69.36	49.12					
1974	56.90	49.16					
1975	44.56	49.19	D4				
1976	40.21	49.24	D4				
1977	42.22	49.31	D4				
1978	37.82	49.39	D4				
1979	53.70	49.48	D4				
1980	39.03	49.57	D4				
1981	46.67	49.69	D4				
1982	53.75	49.82	D4				
1983	42.80	49.94	D4				
1984	62.12	50.06					
1985	53.60	50.15					
1986	48.56	50.21					
1987	49.78	50.26					
1988	38.86	50.32					
1989	49.91	50.40					
1990	71.98	50.49	W4				
1991	63.96	50.56	W4				
1992	59.04	50.61	W4				
1993	55.68	50.66	W4				
1994	54.77	50.67	W4				
1995	42.48	50.67	W4				
1996	60.74	50.66	W4				
1997	53.28	50.62	W4				
1998	50.87	50.57					
1999	40.50	50.54					