

# Variations of Annual Precipitation and Air Temperature in Oklahoma, 1895 – 2005

## Contents

[Nondiscrimination Statement](#)  
[Product Disclaimer Statement](#)  
[Publication Statement](#)  
[Objective](#)  
[Background](#)  
[Data Sources](#)  
[Data Processing](#)  
[Figure Explanation](#)  
[Example Interpretation](#)  
[Annual precipitation and air temperature variations for Oklahoma](#)

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## **iii. PUBLICATION STATEMENT**

Copies of this publication are available on the web page of the Grazinglands Research Laboratory, El Reno, Oklahoma, <http://ars.usda.gov/Main/docs.htm?docid=11617>

[Return to Contents](#)

## **Objective**

This publication presents graphical displays of persistent variations in annual precipitation and mean air temperature during 1895-2005 over large climate regions in Oklahoma. Recognition and consideration of such persistent variations can assist with agricultural planning and development of management strategies for sustainable water resources utilization.

[\*\*Return to Contents\*\*](#)

## **Background**

Persistent, multi-year variations in annual precipitation and mean air temperature can have significant implications for agriculture and water resources management. 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 and forced the migration of thousands of farm families. Recent sustained dry conditions in Oklahoma, may lead many agricultural producers to reconsider the continued viability of crops that were once profitable during wetter climate conditions in the 1980s and 1990s. And, from the water resources point of view, droughts in the 1930s, 1950s and 1960s and population growth prompted Oklahoma officials to plan and build a number of water supply reservoirs, such as the Atoka reservoir and pipeline in southeastern Oklahoma that augment the water supply for Oklahoma City. Sustained wet conditions, though usually welcome in the semi-arid Great Plains, can also have significant, detrimental consequences. Recurring floods in the 1940s and 1950s prompted the Soil Conservation Service to construct over 2000 flood retarding structures in Oklahoma alone. Similar impacts of climate fluctuations are noted throughout recorded history, and continue today in many parts of the country.

Traditionally, assessment of climate effects on water resources management and agricultural production have been based on long-term averages, short-term seasonal-to-interannual variations, and on extreme events. Less attention has been given to persistent variations in precipitation and air temperature that last 5 years and longer. This is unfortunate, since these variations can have significant economic and environmental impacts, as noted above. Research is being conducted at the ARS Grazinglands Research Laboratory to identify long-term precipitation and air temperature 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 and share information on the existence, duration and geographical extent of past precipitation and air temperature variations, which can be used as a guide to what might happen in the future.

[Return to Contents](#)

## **Data Sources**

Annual precipitation and air temperature variations were calculated from monthly precipitation and mean air temperature data that were averaged over large regions called climate divisions. Climate divisions were defined by the U.S. Weather Bureau in the 1940s. Often these climate divisions coincide with crop reporting districts. Maps outlining the climate divisions in Oklahoma are provided in this publication. The weather statistics from a number of cooperative weather service stations within each climate division are averaged to produce the monthly precipitation and mean air temperature for the climate division. These monthly precipitation and mean air temperature data for climate divisions are calculated and published by NOAA's National Climatic Data Center in Asheville, North Carolina (available at [www.ncdc.noaa.gov](http://www.ncdc.noaa.gov)).

[Return to Contents](#)

## **Data Processing**

Monthly precipitation and mean air temperature were summed for each climate division and over each year from 1895 through 2005. These annual values were then plotted as time series for each climate division.

To highlight multi-year variations in annual climate variables, a weighted moving average filter was applied to each time series. The length of the filter was 5 years, and the weights were 0.133, 0.233, 0.268, 0.233, and 0.133. Two years of climate values were added at the beginning and end of the original 1895-2005 time series, thereby ensuring a value for the filtered time series on the first and last year (1895 and 2005, respectively). The two years prior to 1895 were assigned the mean of the climate values for 1985, 1986 and 1987, and the two years after 2005 were assigned the mean of the climate values for 2003, 2004 and 2005. This methodology was found to work well to highlight multi-year variations and long-term trends. Large departures in the 5-year moving average are believed to be relevant for agricultural and water resources applications, while small departures are likely to have less significance.

[Return to Contents](#)

## **Figure Explanation**

Annual precipitation is plotted in inches [in] along the left side of precipitation variation graphs, mean annual air temperature is plotted in degrees Fahrenheit [F] along the left side of air temperature graphs, and year is plotted at the bottom of the graph. Each graph consists of four elements, as illustrated on next page for the central Oklahoma climate division. First, annual precipitation and air temperature values are connected by thin, black lines. Second, the filtered annual precipitation and air temperature time series is represented by a heavy, black line. Third, the long-term average (1895-2005) is plotted as a horizontal heavy, black line. And, fourth, persistent climate variations are identified by colored areas between the long-term average and the filtered time series.

[Return to Contents](#)

## Example Interpretation

The plot of annual precipitation for Central Oklahoma (Climate Division 3405) on the next page is used to illustrate the interpretation of persistent precipitation variations lasting 5 years and longer. Referring to the filtered time series (heavy, black line) and the green and brown shaded areas, it is easy to find the drought of the early 1910s and the 1930s Dust Bowl years. But there were similar dry periods during 1950s, the 1960s, and even the late 1970s. Attention is also called to the period of sustained above-average precipitation during the 1980s and 1990s. It appears that producers and managers in central Oklahoma had above normal precipitation for those 20 years, at least relative to annual rainfall.

There are subtle differences in intensity and duration of dry and wet periods as one shifts from one climate division to an adjacent climate division. However, persistent wet and dry periods cover large areas and can be recognized across several climate divisions. For example, the Dust Bowl drought of the 1930s can be identified in all of Oklahoma's climate divisions, and was most pronounced in the Oklahoma Panhandle and the least in southeastern Oklahoma.

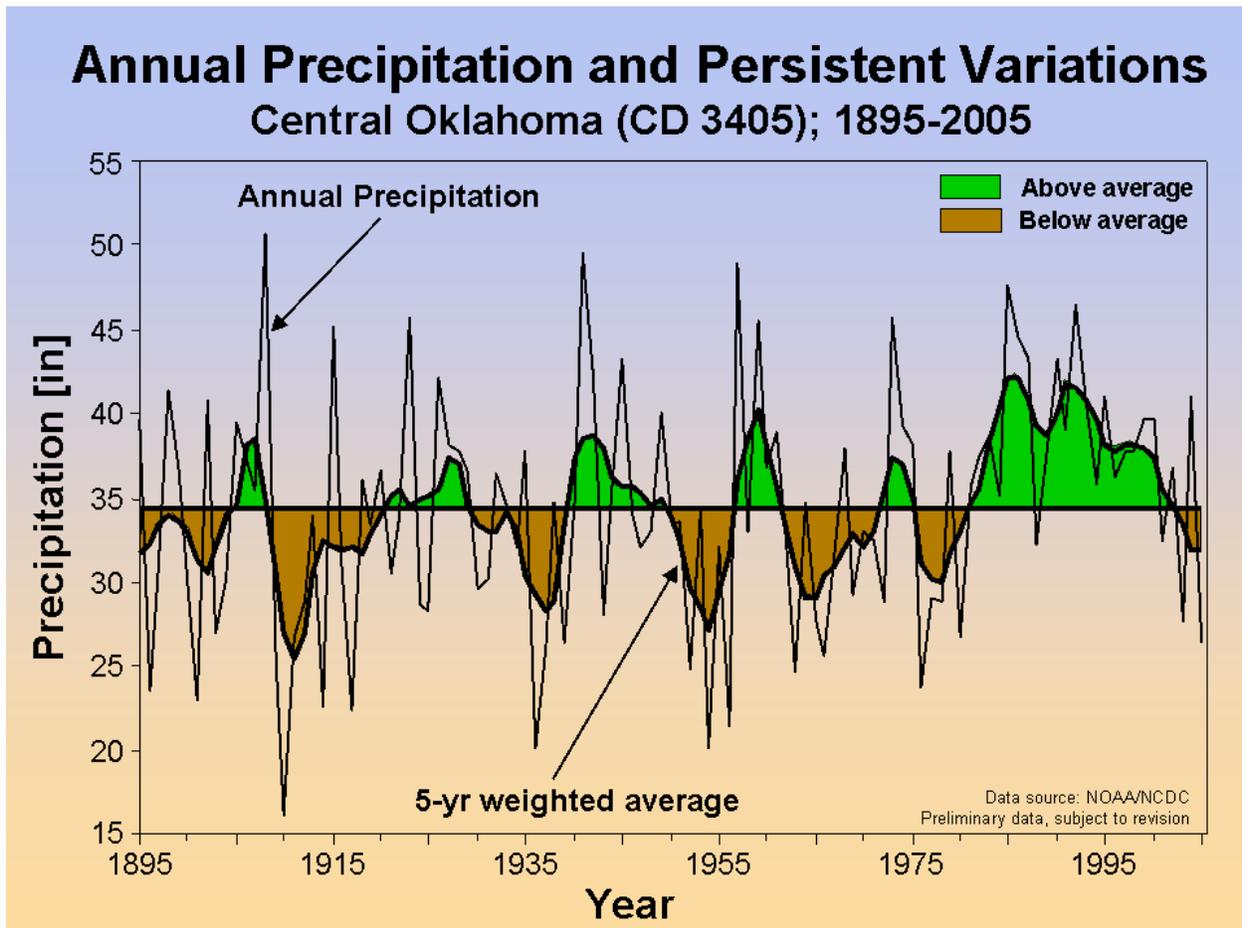
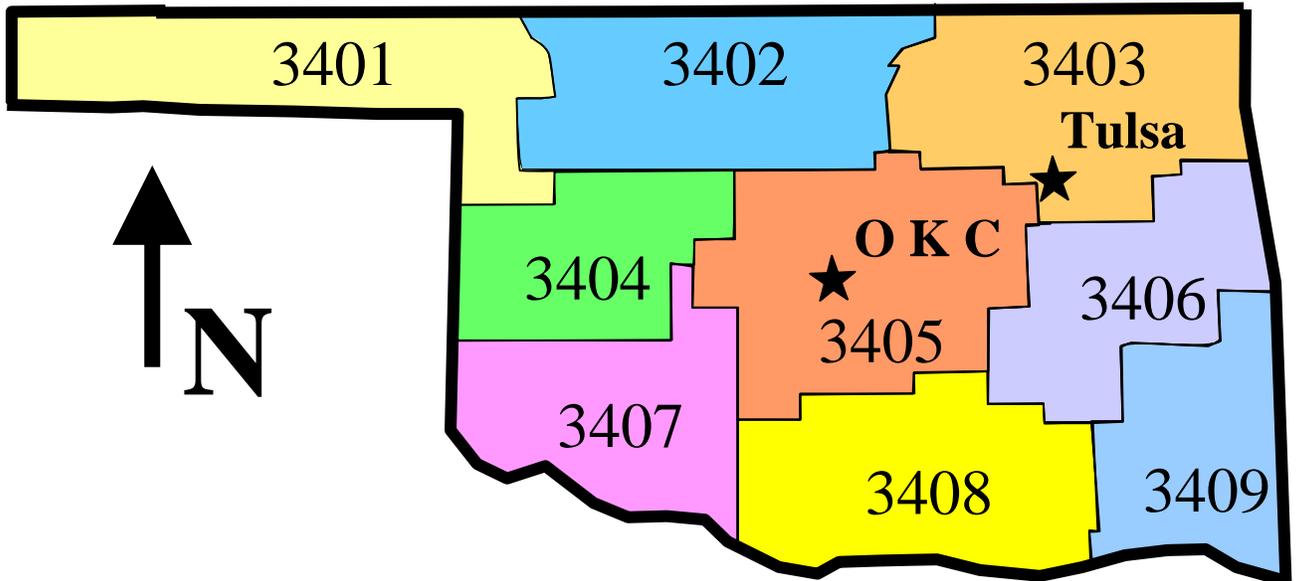


Figure 1. Annual precipitation and persistent variability for Central Oklahoma.

[Return to Contents](#)

# Climate Divisions of Oklahoma

Click on a Climate Division for plots



3401: Panhandle

3402: North Central

3403: Northeast

3404: West Central

3405: Central

3406: East Central

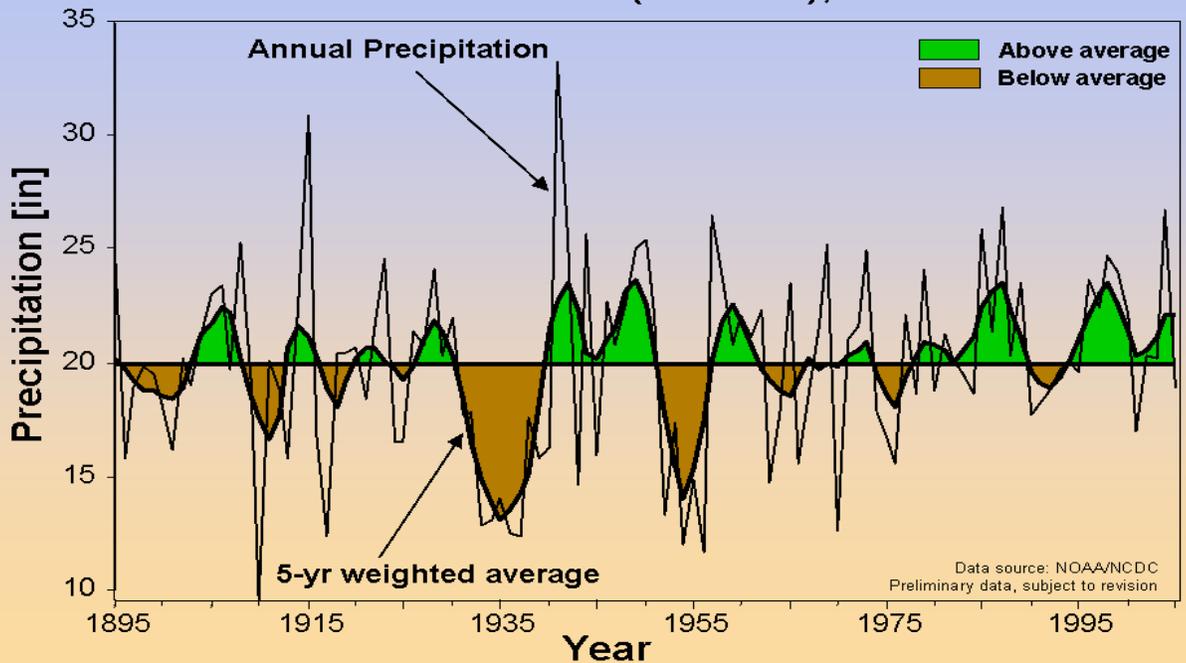
3407: Southwest

3408: South Central

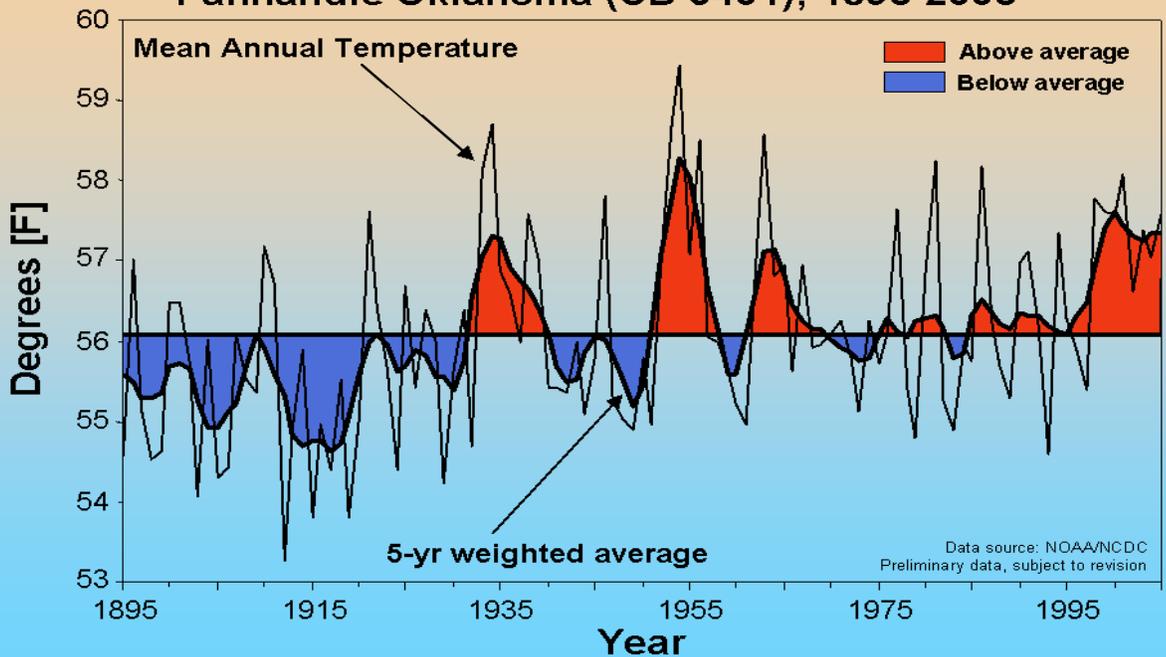
3409: Southeast

[Return to Contents](#)

## Annual Precipitation and Persistent Variations Panhandle Oklahoma (CD 3401); 1895-2005



## Mean Annual Temperature and Persistent Variations Panhandle Oklahoma (CD 3401); 1895-2005

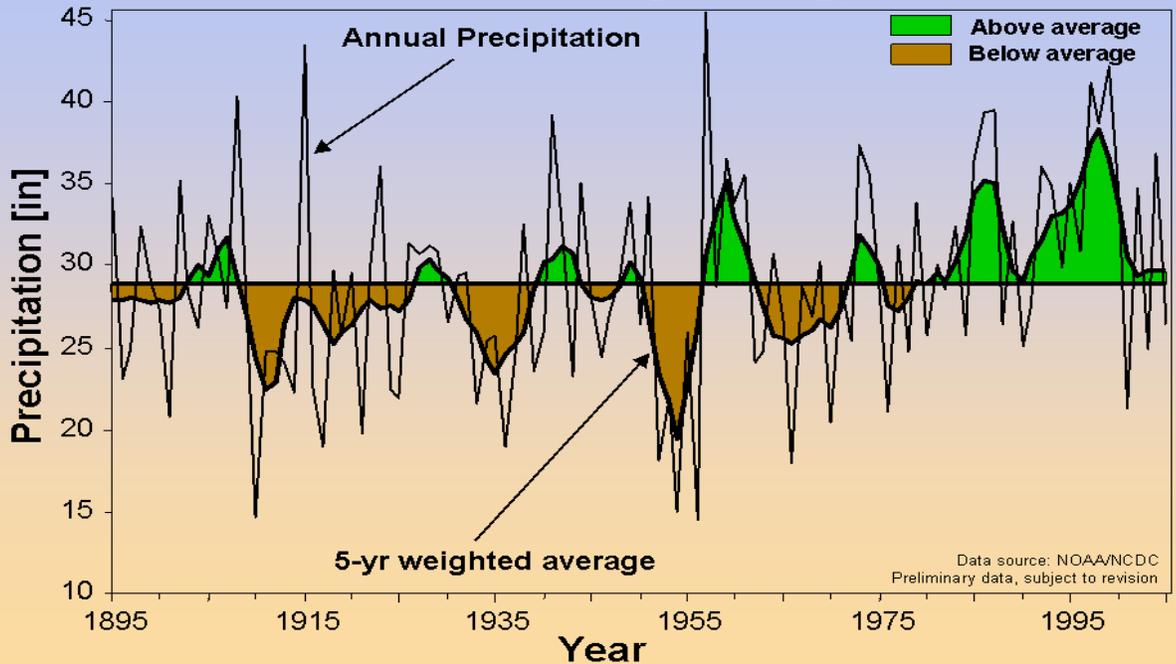


Annual precipitation (top) and mean air temperature (bottom)  
Panhandle Oklahoma climate division (3401)

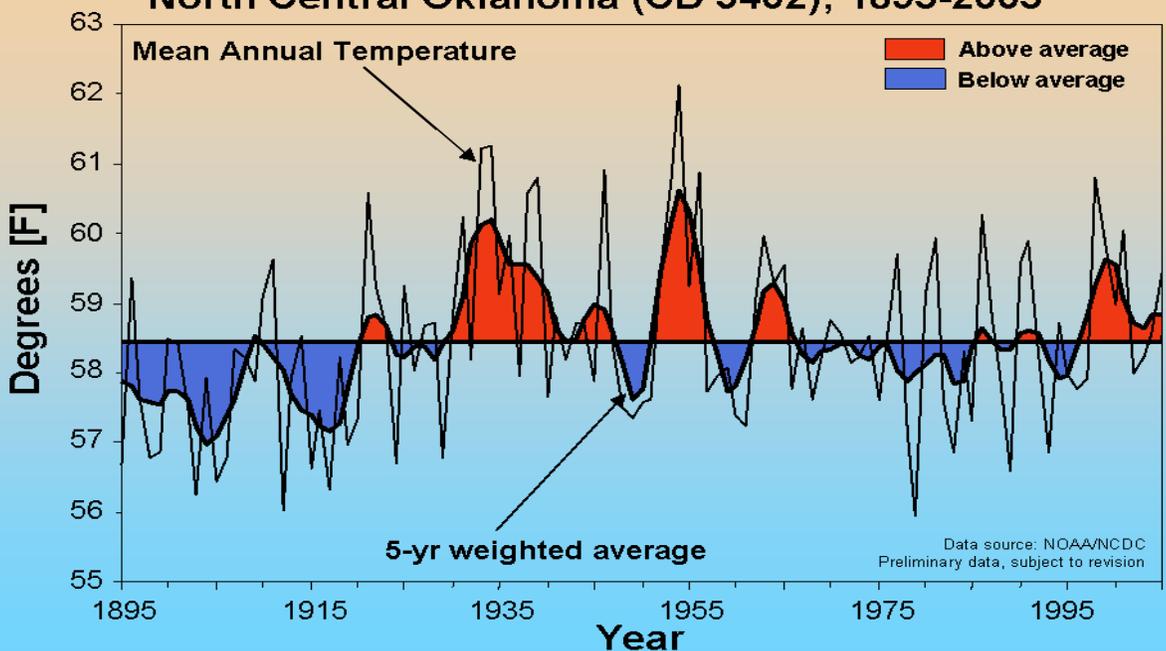
[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)

## Annual Precipitation and Persistent Variations North Central Oklahoma (CD 3402); 1895-2005



## Mean Annual Temperature and Persistent Variations North Central Oklahoma (CD 3402); 1895-2005



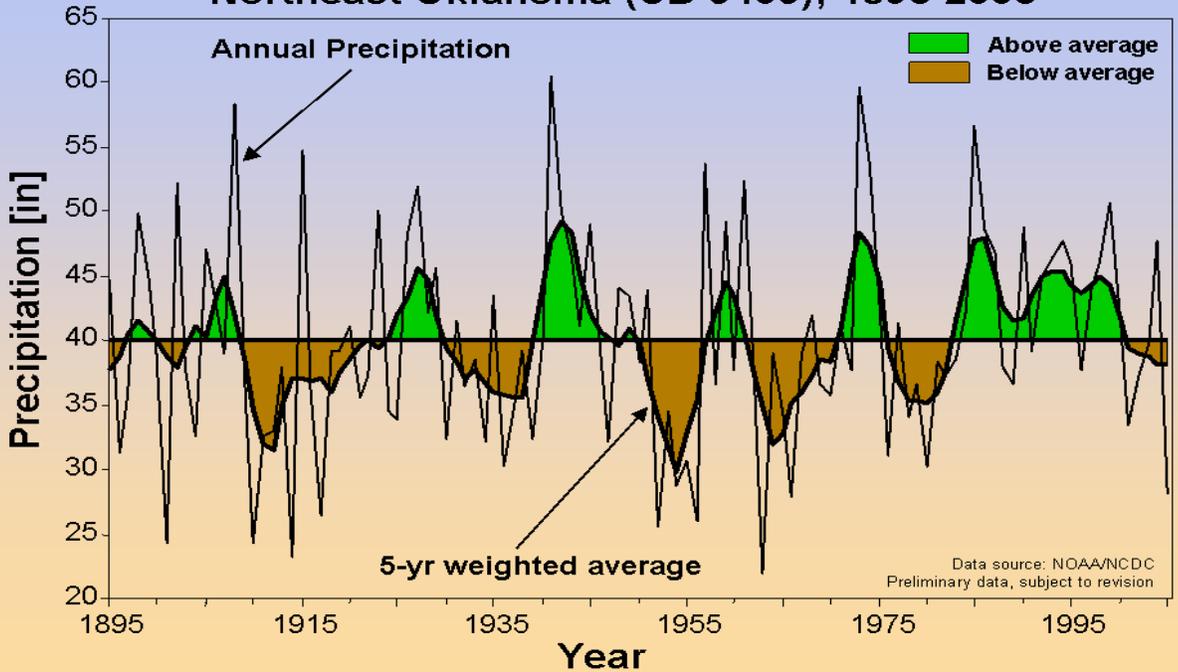
Annual precipitation (top) and mean air temperature (bottom)  
North Central Oklahoma climate division (3402)

[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)

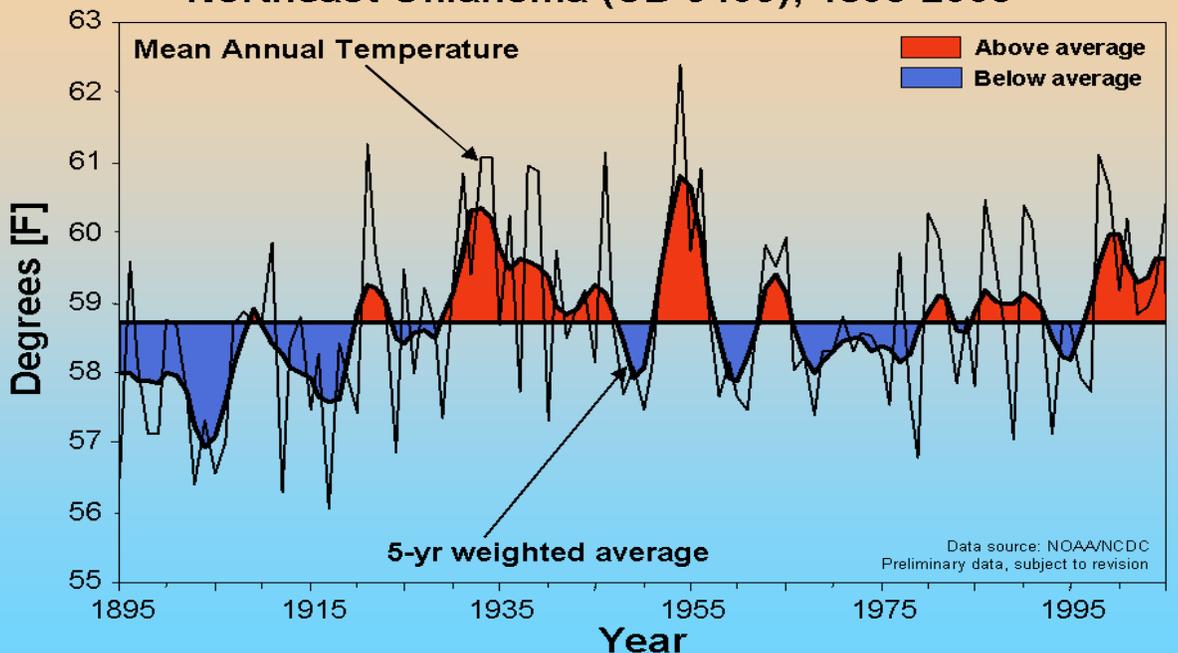
# Annual Precipitation and Persistent Variations

Northeast Oklahoma (CD 3403); 1895-2005



# Mean Annual Temperature and Persistent Variations

Northeast Oklahoma (CD 3403); 1895-2005



Annual precipitation (top) and mean air temperature (bottom)

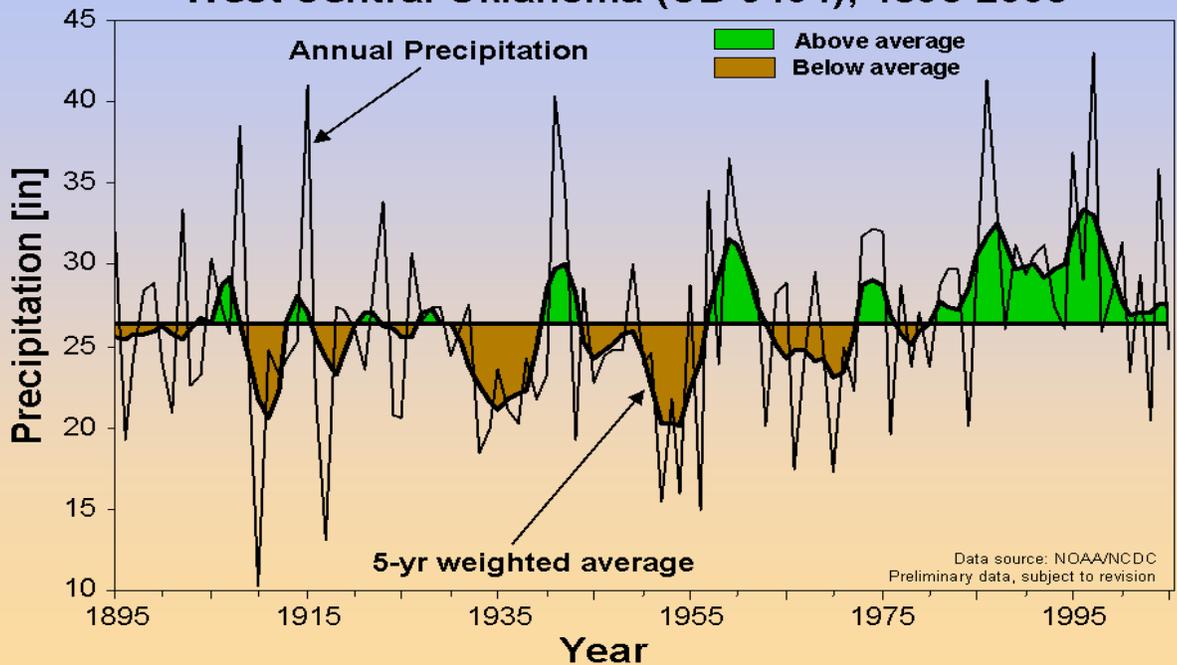
Northeast Oklahoma climate division (3403)

[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)

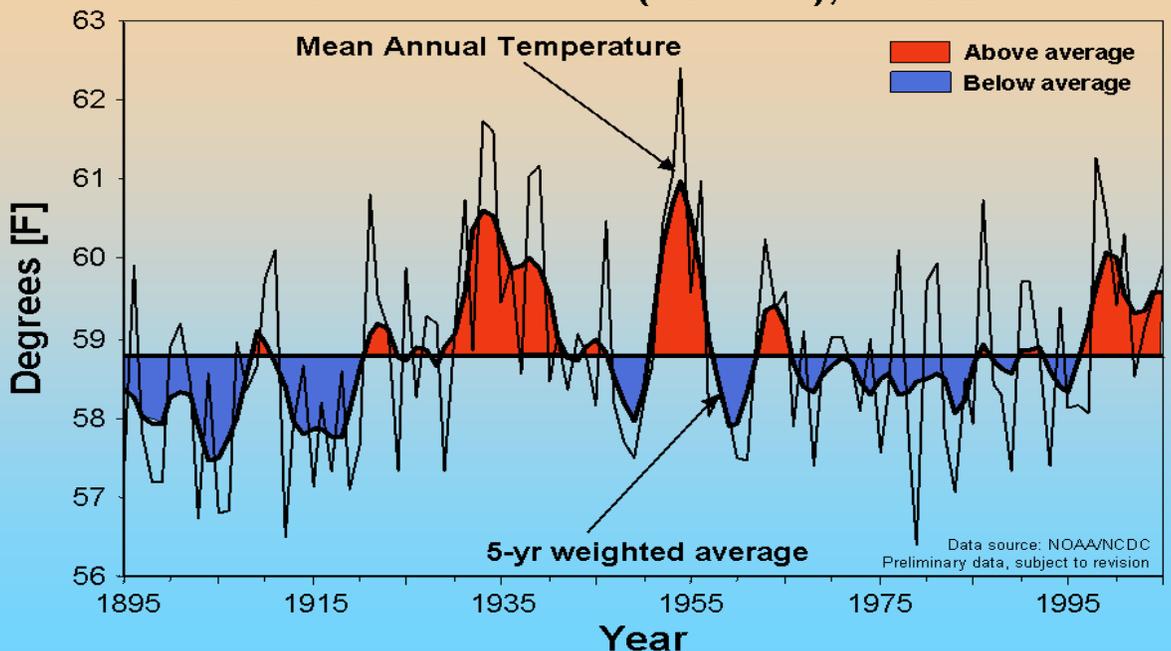
# Annual Precipitation and Persistent Variations

West Central Oklahoma (CD 3404); 1895-2005



# Mean Annual Temperature and Persistent Variations

West Central Oklahoma (CD 3404); 1895-2005

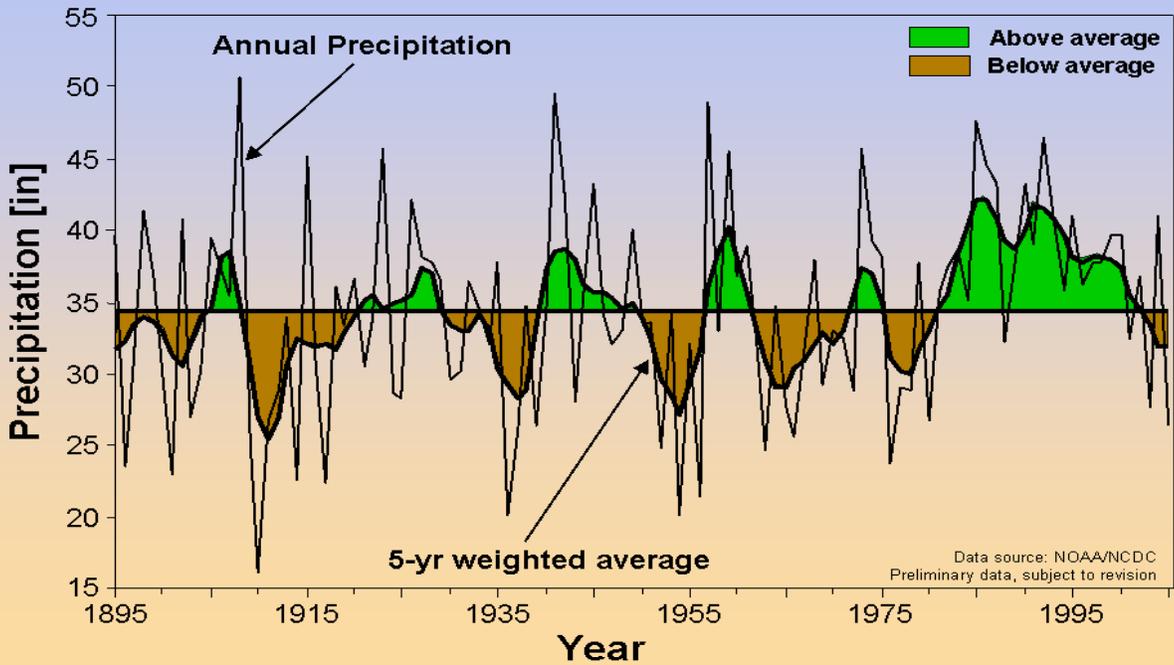


Annual precipitation (top) and mean air temperature (bottom)  
West Central Oklahoma climate division (3404)

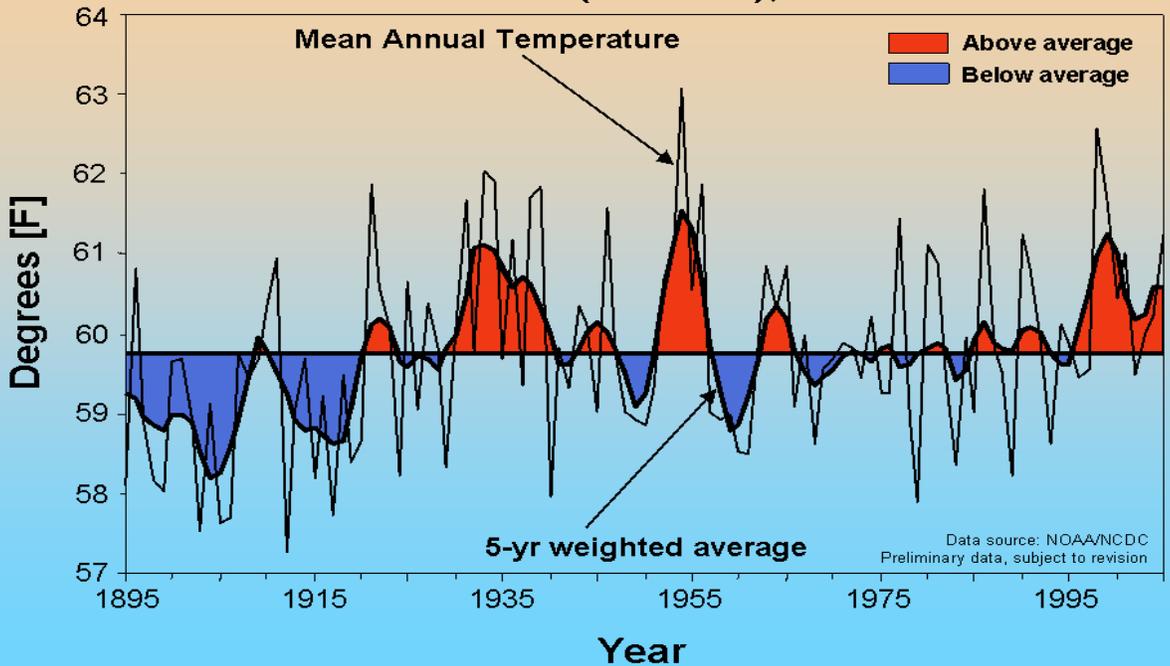
[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)

## Annual Precipitation and Persistent Variations Central Oklahoma (CD 3405); 1895-2005



## Mean Annual Temperature and Persistent Variations Central Oklahoma (CD 3405); 1895-2005

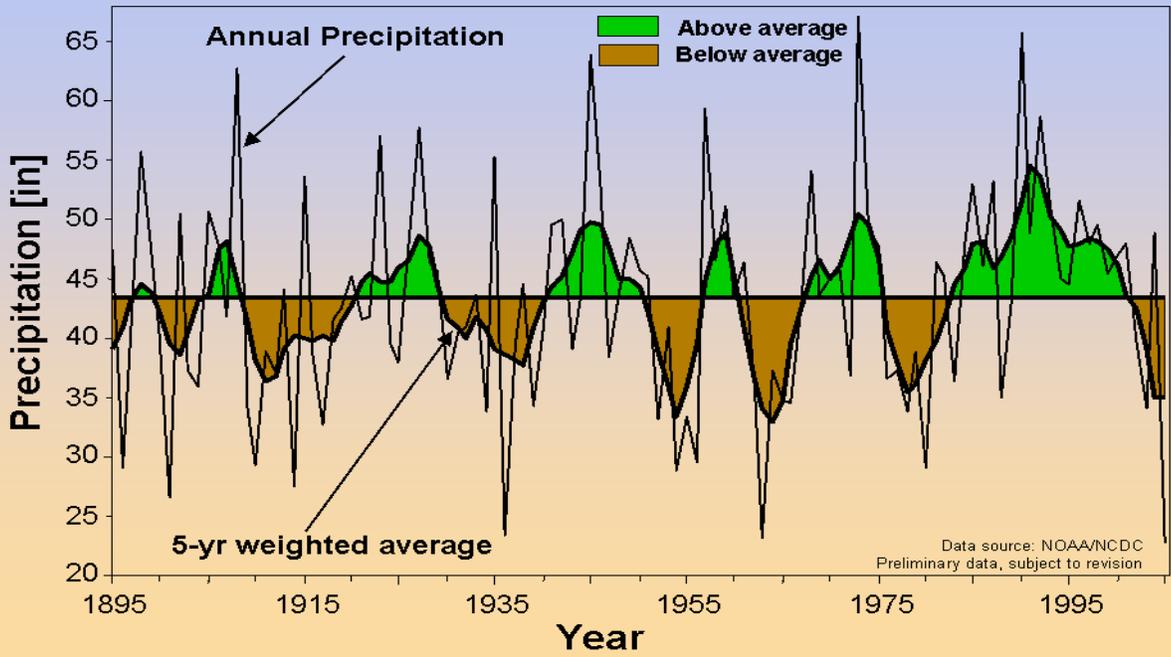


Annual precipitation (top) and mean air temperature (bottom)  
Central Oklahoma climate division (3405)

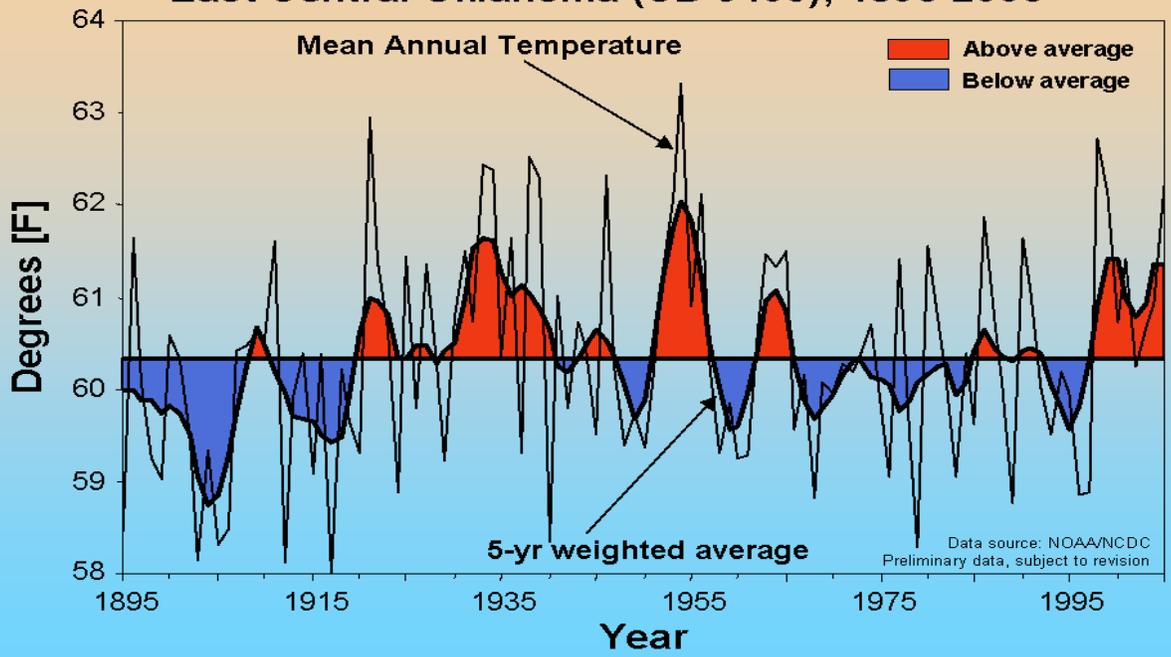
[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)

# Annual Precipitation and Persistent Variations East Central Oklahoma (CD 3406); 1895-2005

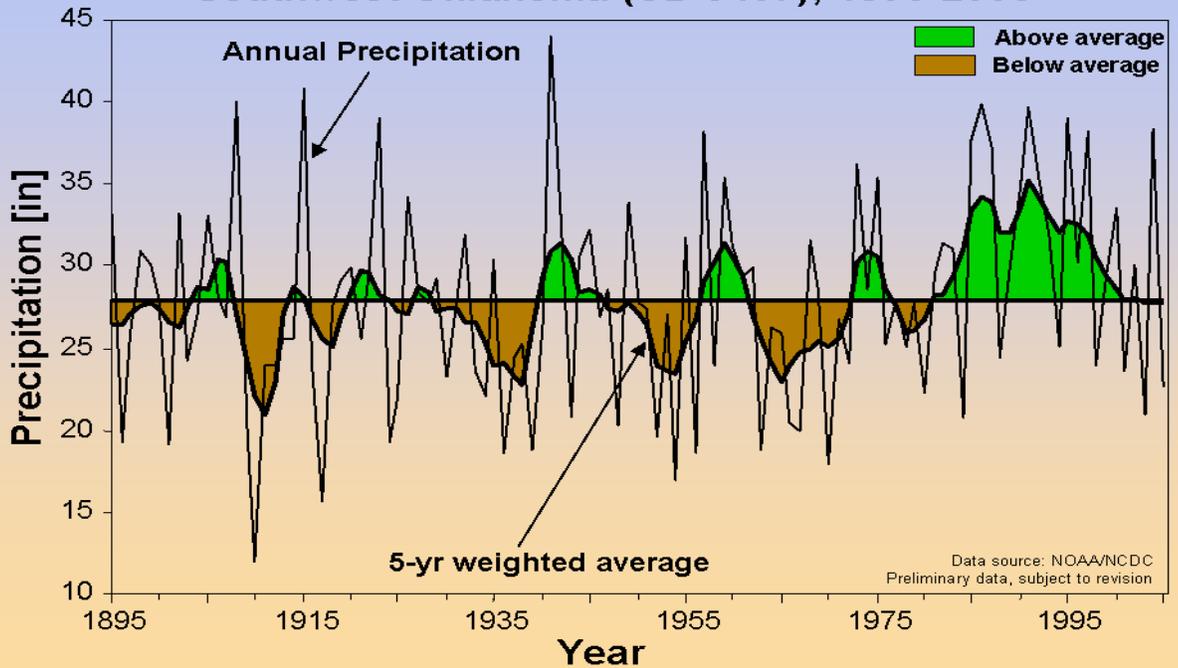


# Mean Annual Temperature and Persistent Variations East Central Oklahoma (CD 3406); 1895-2005

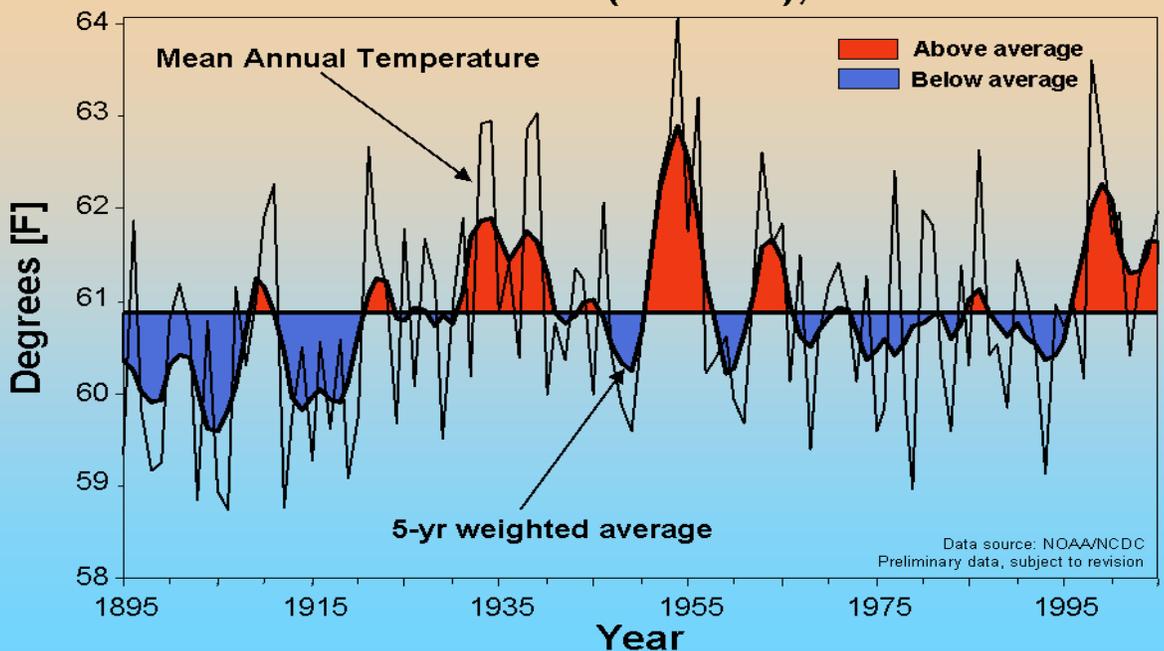


Annual precipitation (top) and mean air temperature (bottom)  
East Central Oklahoma climate division (3406)

## Annual Precipitation and Persistent Variations Southwest Oklahoma (CD 3407); 1895-2005



## Mean Annual Temperature and Persistent Variations Southwest Oklahoma (CD 3407); 1895-2005

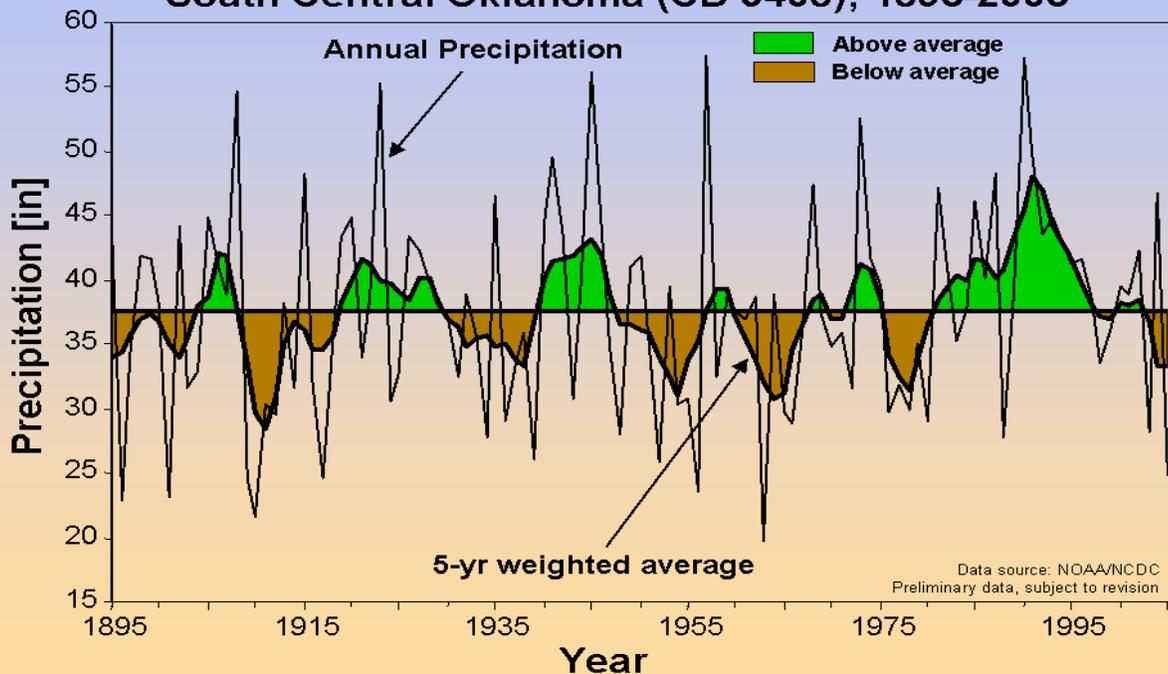


Annual precipitation (top) and mean air temperature (bottom)  
Southwest Oklahoma climate division (3407)

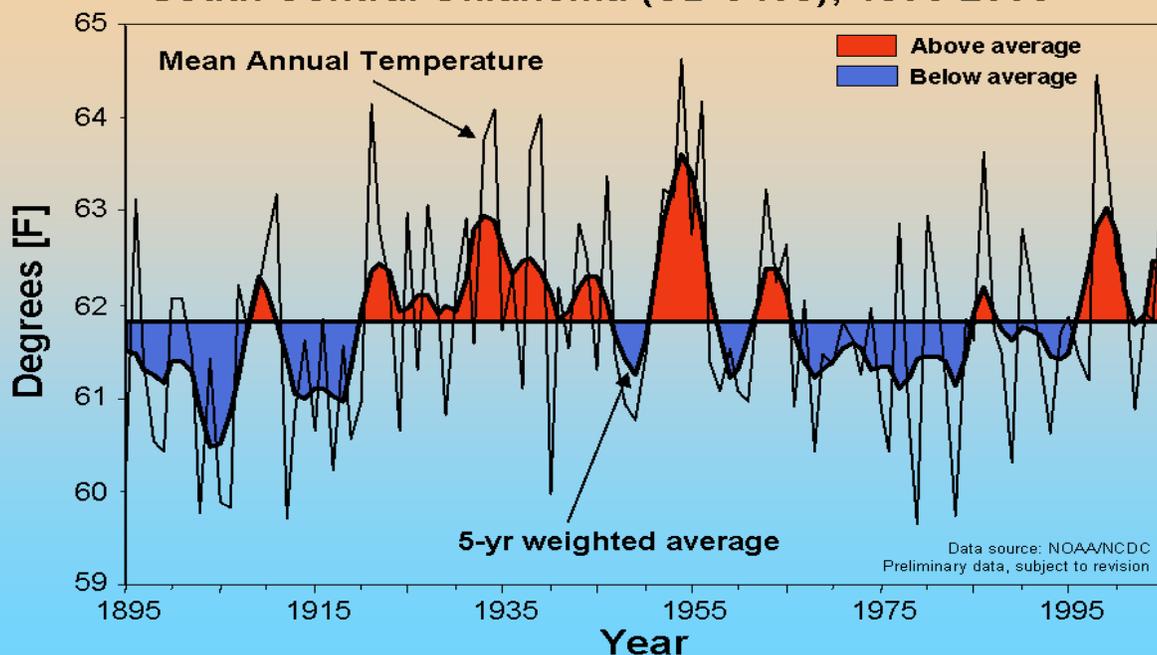
[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)

## Annual Precipitation and Persistent Variations South Central Oklahoma (CD 3408); 1895-2005



## Mean Annual Temperature and Persistent Variations South Central Oklahoma (CD 3408); 1895-2005

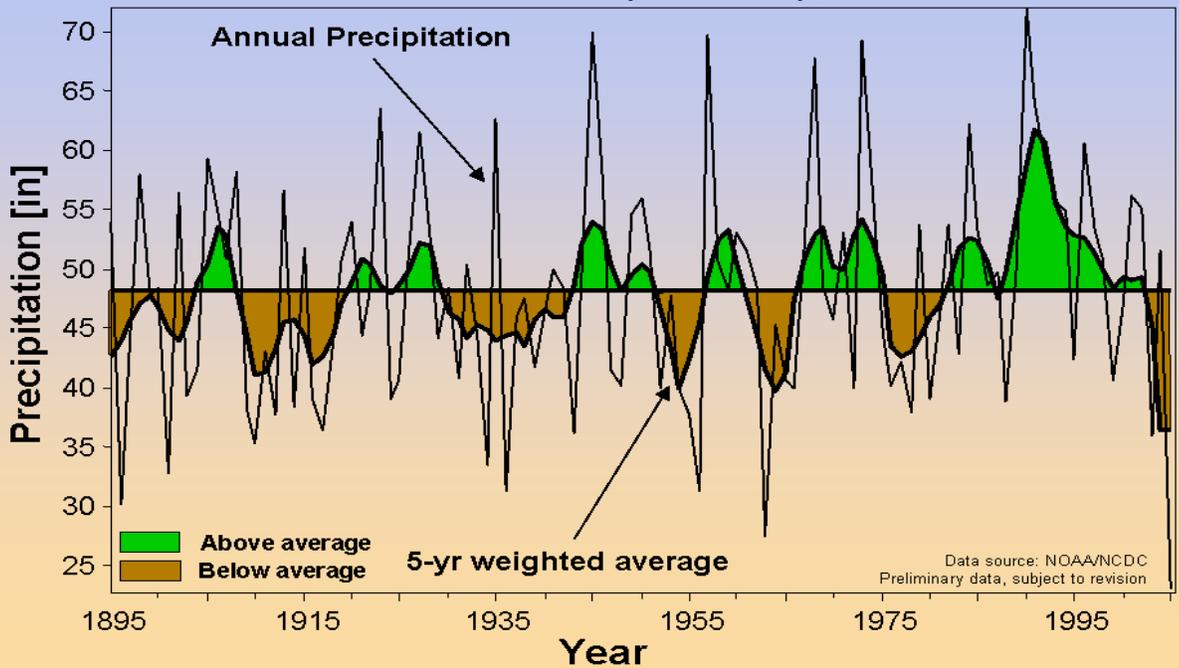


Annual precipitation (top) and mean air temperature (bottom)  
South Central Oklahoma climate division (3408)

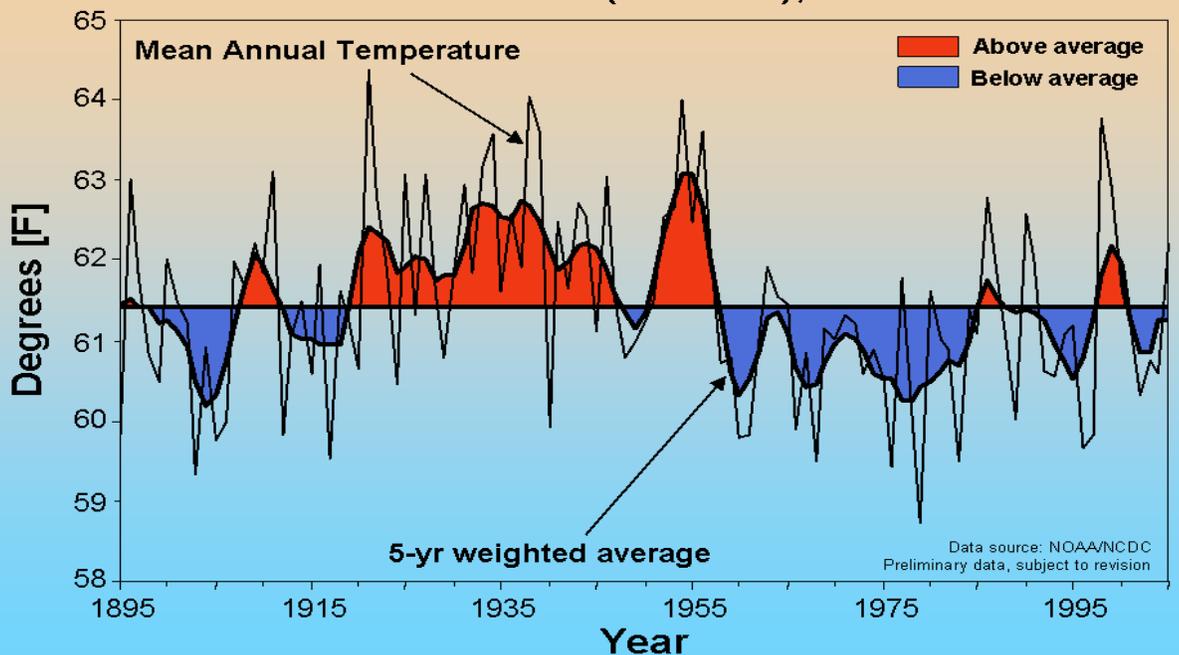
[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)

## Annual Precipitation and Persistent Variations Southeast Oklahoma (CD 3409); 1895-2005



## Mean Annual Temperature and Persistent Variations Southeast Oklahoma (CD 3409); 1895-2005



Annual precipitation (top) and mean air temperature (bottom)  
Southeast Oklahoma climate division (3409)

[Return to Map of Oklahoma Climate Divisions](#)

[Return to Contents](#)