Oklahoma's Climate

Weather is the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness. Climate is the statistical collection of weather conditions (e.g., averages, extremes) at a place over a period of years. In addition to the composition of gases in the atmosphere, the climate of an area is primarily affected by its latitude, elevation, proximity to a large water body (e.g., Gulf of Mexico), and the prevailing winds. Terrain, vegetation, smaller water bodies, and other more localized physical conditions can affect the climate of any specific location.

The mean annual temperature over the state ranges from 62˚F along the Red River to about 58˚F along the northern border. It then decreases westward to 56˚F in Cimarron County. Temperatures of 90˚F or greater occur, on average, about 60-65 days per year in the western panhandle and the northeast corner of the state. The average is about 115 days in southwest Oklahoma and about 85 days in the southeast. Temperatures of 100˚F or higher occur, frequently during some years, from May through September, and very rarely in April and October. Except for most of the panhandle, the western half of Oklahoma averages 15 days or more with temperatures of 100˚F or higher, ranging from about 35 days in the southwest corner to 25 in the northwest. The eastern half of the state and most of the panhandle average less than 15 days of triple-digit temperatures. Years without 100˚F temperatures are rare, ranging from about one of every seven years in the eastern half of the state to somewhat rarer in the west.

Precipitation provides an estimated 127 million acre-feet of renewable water each year to Oklahoma, founding the state's water budget. The dominant feature of the spatial distribution of rainfall across Oklahoma (Figure 1) is a sharp increase in rainfall from west (~17 inches) to east (~56 inches), helping to support more ecosystems than all but one other U.S. state. Excessive daily rainfall of 8 inches or more, while rare, has been recorded. Recently, however, several 500-year events have been observed by the Oklahoma Mesonet, including at Oklahoma City on June 14, 2010 (10.0 inches over 12 hours); Burneyville on April 29, 2009 (28.9 inches over 1 day); and Fort Cobb on August 19, 2007 (7.4 inches over 3 hours).

Extreme precipitation events pose a substantial risk to lives and property, especially in areas prone to flash flooding. In fact, since 2000, flooding was involved in 13 Presidential Disaster Declarations in Oklahoma (overseen by FEMA). Overall, Oklahoma has had more Major Disaster Declarations than any other state since 2000. Flash flooding claimed 13 lives in Oklahoma from 2000-2010. Heavy rainfall also is associated with enhanced soil erosion as well as increased leaf and root pathogens in vegetation. Although these high-flow events typically capture the headlines, the other end of the water-availability spectrum — drought — is arguably more economically devastating. Drought is associated with agricultural crop and pasture damage (both quality and quantity), increased residential water demand, increased risk of wildfire and smoke-related respiratory diseases, and differential mortality and morbidity in forest species. Low streamflow associated with drought affects water quality as well as quantity. Since 2000, drought was involved in 14 declared disasters by the U.S. Department of Agriculture where one or more Oklahoma counties were listed as "primary natural disaster areas."

Floods of major rivers and tributaries may happen during any season, but they occur with greatest frequency during those spring and autumn months associated with greatest rainfall. Such floods cost many lives and property damage during the first 50 years of statehood, but flood prevention programs have reduced the frequency and severity of such events. Flash flooding of creeks and minor streams remains a serious threat, especially in urban and suburban areas, where urban development and removal of vegetation have increased runoff.

Drought is a recurring part of Oklahoma's climate cycle, as it is in all the Plains states. Almost all of Oklahoma's usable surface water comes from precipitation that falls within the state's borders. Therefore, drought in Oklahoma is tied almost entirely to local rainfall patterns (i.e., the influence of upstream events on drought is very small). Western Oklahoma is slightly more susceptible to drought because precipitation there tends to be more variable (percentage-wise) and marginal for dryland farm applications.

Drought episodes can last from a few months to several years. Those that last a few months can elevate wildfire danger and impact municipal water use. Seasonal droughts can occur at any time of the year, and those that coincide with crop production cycles can cause billions of dollars of damage to the farm economy. Multi-season and multi-year episodes can severely impact large reservoirs, streamflow and groundwater.

Annual average relative humidity ranges from about 60 percent in the panhandle to just over 70 percent in the east and southeast. On average, cloudiness increases from west to east across Oklahoma. Average annual lake evaporation varies from 48 inches in the extreme east to 65 inches in the southwest, numbers that far exceed the average yearly rainfall in those areas. Evaporation and percolation into the soil expend about 80 percent of Oklahoma's precipitation.

Prevailing winds are from the south to southeast throughout most of the state from the spring through autumn months. These prevailing winds typically are from the south to southwest in far western Oklahoma, including the panhandle. The winter wind regime is roughly equal split between northerly and southerly winds.

On average, thunderstorms occur about 55 days per year in eastern Oklahoma, decreasing to about 45 days per year in the southwest. The annual rate increases to near 60 days annually in the extreme western panhandle. Late spring and early summer are the peak seasons for thunderstorms. December and January, on average, feature the fewest thunderstorms.

Tornadoes are a particular hazard in Oklahoma. Since 1950, an average of 54 tornadoes have been observed annually within the state's borders. Tornadoes can occur at any time of year, but are most frequent during springtime. Three-fourths of Oklahoma's tornadoes have occurred during April, May, and June. May's average of 20 tornado observations per month is the greatest. The winter months each average less than one tornado per month.

Climate-related water challenges in Oklahoma's future

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." – the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC)

That statement reflects the essence of a vast amount of observational data and climate research: the earth's climate has warmed on average during the last 100 years and will very likely continue to warm through the 21st century. Further, ample evidence from observational data and climate modeling studies indicates that this global-scale warming is not attributable to natural variability.

OCS has conducted a review of the current assessments of climate change research and concludes the following to be true:

- The earth's climate has warmed during the last 100 years;
- The earth's climate will very likely continue to warm for the foreseeable future;
- Much of the global average temperature increases over the last 50 years can be attributed to human activities, particularly increasing greenhouse gases in the atmosphere; and
- Oklahoma will be impacted.

In particular, climate change is projected to continue to alter the water cycle across the U.S., including the total amount of annual precipitation, timing of the precipitation, precipitation intensity and frequency, and location of precipitation. Nationwide, most locations *already have experienced* increases in both precipitation and streamflow and decreases in drought during the second half of the 20th Century.

The U.S. Global Climate Research Program (USGCRP) projects that more frequent heavy rainfall events and droughts will affect much of the Great Plains as climate changes. The USGCRP notes, "Projections of increasing temperatures, faster evaporation rates, and more sustained droughts brought on by climate change will only add more stress to overtaxed water sources."

A variable precipitation history (Figure 2) and an uncertain future under climate change combine to challenge even the most forward-thinking and resourceful managers of resources and infrastructure. With precipitation intensity projected to increase across much of the United States, recent statements that "stationarity is dead" verbalize concerns that the added uncertainty of climate change, as well as questions about the ability of global climate models to produce realistic precipitation extremes, will confound the already uncertain results from extreme value statistics for long return periods (e.g., 100 years and longer).

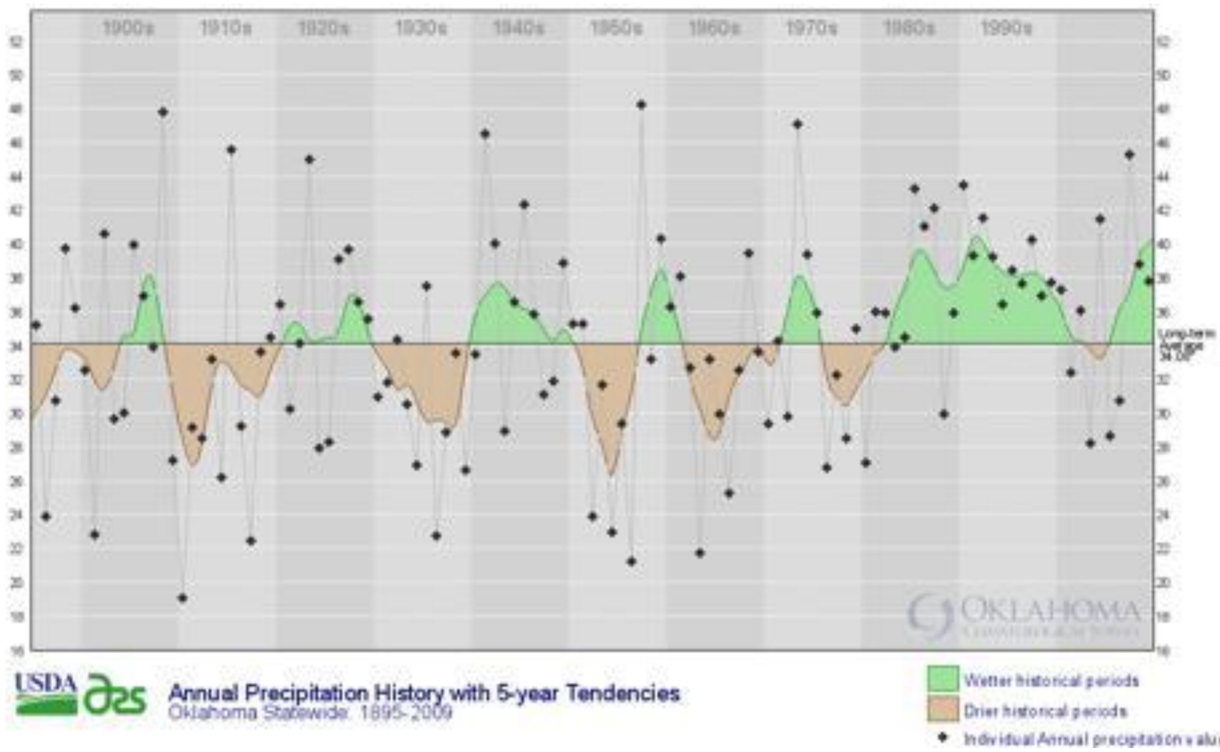

Figure 2: Annual Precipitation History for Oklahoma. Dots denote each year's statewide average precipitation (in inches). Five year running averages highlight drier (brown shading) and wetter (green shading) historical periods.

(Excerpted from <u>Oklahoma Comprehensive Water Plan Supplemental Report</u> "Climate Issues & Recommendations." December 2010)