

Arkansas: A Changing Climate, a Changing Land

Lesson Plan by Ellen E. Turner
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In this lesson students will learn about some of the climate changes that occurred over geologic time, shaping the land that we call Arkansas. They will come to distinguish between *weather* and *climate* as they study the ways in which climate impacts our lives. While focusing on Arkansas, students will learn about human influence on climate in the form of global warming. As a writing exercise, they will either send letters to their senators and representative asking for their opinions on global warming or write a newspaper article informing the people of Arkansas about the effects of global warming on our state.

Grades: 6-8

Arkansas Curriculum Frameworks:

Arkansas History 1.1.7, 1.1.9, 1.1.12, 1.1.14, 2.1.4, 4.1.9, 4.1.11, 6.1.11, and 6.1.13
Science PS.2.12, LS.2.9, LS.2.12, ES.2.5, ES.2.6, ES.3.6, and ES.3.8

Key Terms:

weather	climate	uplands	lowlands	global warming
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Key Terms Defined:

weather: The state of the atmosphere at a given time and place, with respect to variables such as temperature, moisture, wind speed, and barometric pressure.

climate: The meteorological conditions, including average temperature and precipitation, that are characteristic of a particular region, calculated by averaging these conditions over a long period of time.

uplands: An area of land that is mountainous or hilly.

lowlands: An area of land that is low, sometimes moist, and usually flat or gently rolling.

global warming: An increase in the average temperature of the earth's atmosphere due to the increase in greenhouse gases, especially a sustained increase sufficient to cause climatic change.

Materials:

- A map showing Arkansas' six natural divisions (included below)
- A map showing Arkansas' mean temperatures in July (included below)
- A map showing mean annual precipitation in Arkansas (included below)
- A map showing the length of the growing season in Arkansas (included below)
- A copy of Arkansas and Global Warming for each student (included below)

Background Information:

Many people enjoy watching the Weather Channel on television and learning about precipitation, temperature, relative humidity, wind speed, and potential storms in a particular place at a particular time. Weather is the condition of the atmosphere at a given time; climate, on the other hand, represents the average of factors such as temperature and precipitation in a particular place over a long period of time. For example, while the temperature in Hope (Hempstead County) may be only 45°F on May 1 in the year 2002, the long-term average of early May temperatures in Hope is much closer to 65°F.

Climate is a component of the natural environment. What do we know about the climate in Arkansas? Fortunately for Arkansans the climate is usually neither extremely hot nor extremely cold. Average annual temperatures for the entire state vary from 58° to 65°F. The biggest differences in climate occur between the uplands of northwest Arkansas and the lowlands of southeast Arkansas. Rainfall varies from about 45 inches annually in the uplands to about 55 inches in the lowlands. The extreme northwest part of the state has the most snowfall, about 10.4 inches annually, while the southeast has the least, about 2.8 inches. The growing season is shortest on the plateau of the northwest (about 180 days), while the southeast can expect about 240 days from the last killing frost of the spring to the first killing frost of autumn. In general, the uplands are cooler and receive less rainfall, while the lowlands get the most rain and have warmer temperatures.

Scientists now keep records of measurements like temperature and rainfall amounts—information that is important to those concerned with the local economy and even potential residents of a particular area. (To learn more facts about a particular regional climate, a good source of information is NOAA, or the National Oceanic and Atmospheric Administration, an agency of the United States Department of Commerce.) It is no accident that travelers pack shorts and bathing suits for a summer trip to Florida, while heavy coats are a must for a December visit to Minnesota. They are just the beginning of the ways in which humans use information about climate to plan their lives. Some other ways include:

- * State utility companies buy power supplies based on the amount of power normally used during the peak seasons of summer and winter.
- * Architects design homes that are suitable for a particular climate. Open decks may be great for people who live in the uplands, but lowland residents construct screened porches to keep out mosquitoes on warm summer nights.
- * Farmers decide what to grow based on the length of the growing season and expected rainfall in their area.
- * County road crews in northwest Arkansas have on hand more snowplows and salt than those in southwest Arkansas.

Modern humans are not unique in their dependence on information about climate. Early settlers couldn't purchase new coats or more insulation for their homes if the winter was harsher than they expected. They had to rely on information from earlier settlers, but they also had to prepare for the worst and hope for the best as they cut wood and preserved food for the winter. Early European explorers gave detailed accounts of the weather and climate in a particular part of the state. Some of their information came from personal experiences in the state and some from the Native American residents, whose lives were affected by the climate more than modern-day Arkansans.

In the 16th century, the Spanish explorer Hernando de Soto learned about the sparse population of Native Americans in Northwest Arkansas from those who lived in the Mississippi Alluvial Plain: "The Indians stated that thence toward the north, the country, being

very cold, was very thinly populated; that cattle [buffalo] were in such plenty, no maize-field could be protected from them, and the inhabitants lived upon the meat.” In the early 1800s, Friedrich Gerstaecker, a German hunter and explorer, gave this less-than-complimentary account of the climate in Northeast Arkansas, on the St. Francis River: “On the 22nd May we were stirring at daybreak; and who would not have been so, after sleeping in the open air in a southern climate, surrounded by mosquitoes, which by the first glimmer of light collect all their forces to attack more ferociously than ever.”

The diaries of early visitors to Arkansas began to give future settlers an idea of what to expect as they arrived. The climate then was very similar to the climate today, but conditions now are very different from those thousands and millions of year ago. How do scientists know this? There are many clues that can be read in the landscape.

About 345 million years ago, during the Paleozoic Era, amphibians were the dominant land animals in Arkansas. The climate was warm and moist, and huge scale trees grew in the lowlands. When the trees died, their remains formed peat, and later coal. Coal deposits are found in several places in Arkansas, including the Arkansas River Valley. During the Mesozoic Era, about 130 million years ago, the climate remained warm, but it became much drier. As a result all but the small amphibians became extinct and were replaced by dinosaurs, whose tracks have been found in the West Gulf Coastal Plain. Much colder temperatures returned during the Cenozoic Era, about 65 million years ago, and glaciers covered much of North America. Finally, a warm, dry period followed this Ice Age, during which time vegetation in Arkansas resembled that found in more arid parts of the world, with clumps of vegetation surrounded by dry, bare ground. Wind-blown dust filled the vegetation clumps, resulting in mounds that are visible today on Arkansas’ prairies.

The landscape reveals that the *climate* has changed drastically in Arkansas over geologic time. Will it continue to change? Drastic changes in *weather* (recall the distinction between “weather” and “climate”) can cause significant problems for people, for example the floods of 1927 and the heat wave during the summer of 1980. It is interesting to note that Arkansas’ weather can be quite inconsistent from year to year, as the chart below shows.

Average January Temperatures in Arkansas from 1900-2000 (Degrees Fahrenheit)

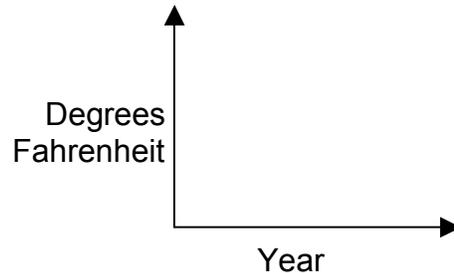
1900 -- 39°	1955 -- 45°
1905 -- 38°	1960 -- 38°
1910 -- 43°	1965 -- 33°
1915 -- 45°	1970 -- 41°
1920 -- 41°	1975 -- 38°
1925 -- 35°	1980 -- 41°
1930 -- 33°	1985 -- 34°
1935 -- 43°	1990 -- 45°
1940 -- 27°	1995 -- 37°
1945 -- 41°	2000 -- 42°
1950 -- 41°	

Note: To view a complete graph of average January temperatures from 1895 to 2002 visit NOAA’s website at <http://lwf.ncdc.noaa.gov/oa/climate/research/cag3/state.html> and click on Arkansas.*

* To access links, copy and paste into your browser.

Activities:

1. Present the “background information” above, using the four maps below if helpful.
2. With “Degrees Fahrenheit” on the Y axis and “Year” on the X axis (see below), have the students graph the “Average January Temperatures in Arkansas from 1900-2000” (above) on the board and draw lines to connect the points.



3. Ask students, “What does this graph tell you about temperature?”
Answers will vary, but the graph demonstrates that temperature, as well as other weather conditions, varies over time. Thus when we discuss climate, it is important to look at average temperatures over a long period.
Be sure students understand the important distinction between weather and climate.
4. State the following about global warming: It is obvious that climate impacts people’s lives, including the type of agriculture that they practice, the kinds of homes that they build, the kind of clothes that they buy, etc. *But can people impact climate?* Most scientists think so. Today a controversy exists regarding the worldwide trends in higher temperatures, rising sea levels, rising carbon dioxide levels, etc. Most scientists believe that humans have changed the atmosphere by burning large quantities of fossil fuels like gasoline and natural gas. When these fuels are burned for energy, they release carbon dioxide.
Why is that a problem? Carbon dioxide is a greenhouse gas, meaning it allows the sun’s rays to penetrate, but it blocks the radiation of heat back into space. Just like the glass panes on a greenhouse, carbon dioxide promotes warming by trapping heat. At normal levels of carbon dioxide, this effect is beneficial and necessary to life as we know it. However, when too much carbon dioxide accumulates in the atmosphere, global temperatures can (and have likely already started to) increase significantly. The end result could be disastrous. For example, as temperatures rise, polar ice caps will melt, raising the level of the ocean and inundating coastal areas, including some of the largest cities in the United States!
5. After a short discussion on global warming, ask the students to think of ways that Arkansas will be affected if the global climate changes significantly. List their ideas on the board.
6. Give each student a copy of Arkansas and Global Warming (included below), which summarizes Environmental Protection Agency information regarding the potential impact of global warming on our state. (For a complete copy of the EPA’s report, go to <http://www.epa.gov/globalwarming/impacts/stateimp/arkansas>.)

7. Discuss the Environmental Protection Agency information with your students then list the predictions made by the EPA next to the student predictions. Compare these two lists.
8. Give the students one of the following writing assignments:
 - a. Write a brief article about the impact of global warming on Arkansas for the school newspaper.
 - b. Write a letter to your U.S. representative and our two U.S. senators asking for their opinions on the issue of global warming and details of what, if any, actions they have taken as elected officials.

Sources:

Foti, Thomas L. *The Natural Divisions of Arkansas: A Classroom Guide*. Little Rock: Arkansas Ecology Center, 1978.

Foti, Thomas and Gerald T. Hanson. *Arkansas and the Land*. Fayetteville: University of Arkansas Press, 1992.

Gerstacker, Freidrich. 1881. *Wild Sports in the Far West: The Narrative of a German Wanderer Beyond the Mississippi, 1837-1843*. Durham, NC: Duke University Press, 1968.

Recommended Websites:

Arkansas Secretary of State: <http://www.sosweb.state.ar.us/resources.html>

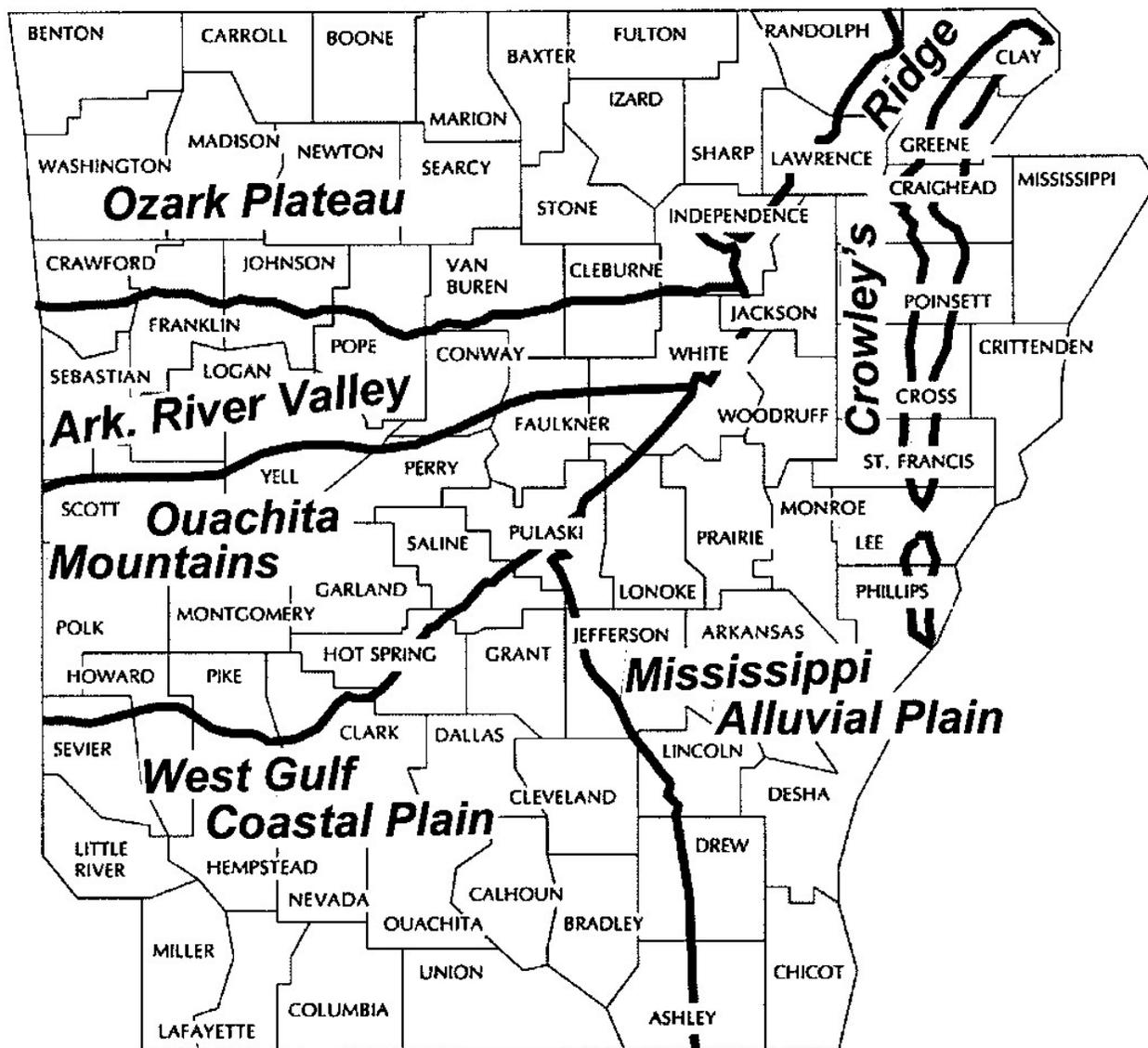
Environmental Protection Agency/Global Warming: <http://www.epa.gov/globalwarming>

NOAA (National Oceanic and Atmospheric Administration): <http://www.noaa.gov>

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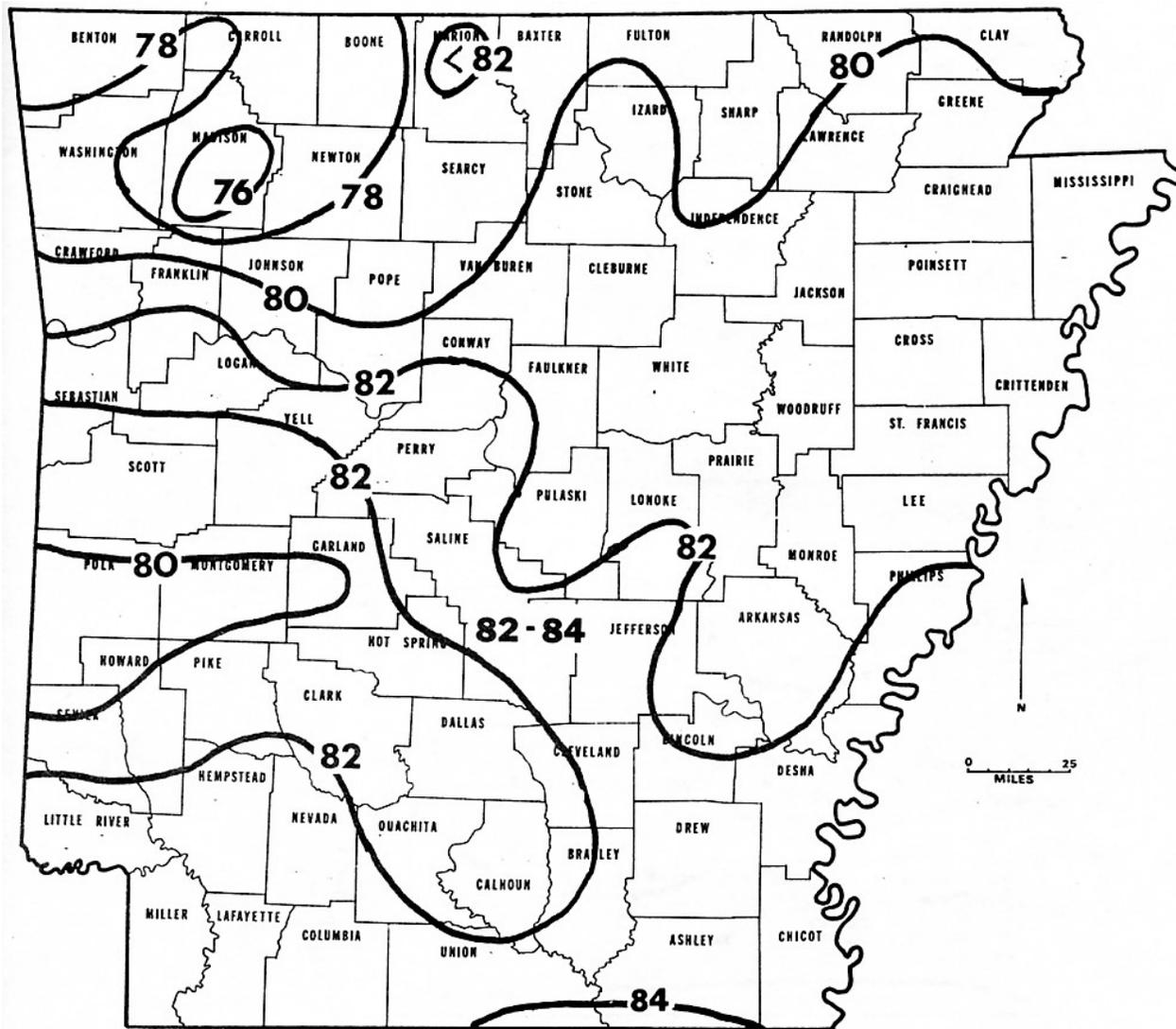
*Arkansas History lesson plans are available online at the Butler Center for Arkansas Studies website:
http://www.cals.lib.ar.us/butlercenter/lesson_plans.*

Arkansas' Six Natural Divisions



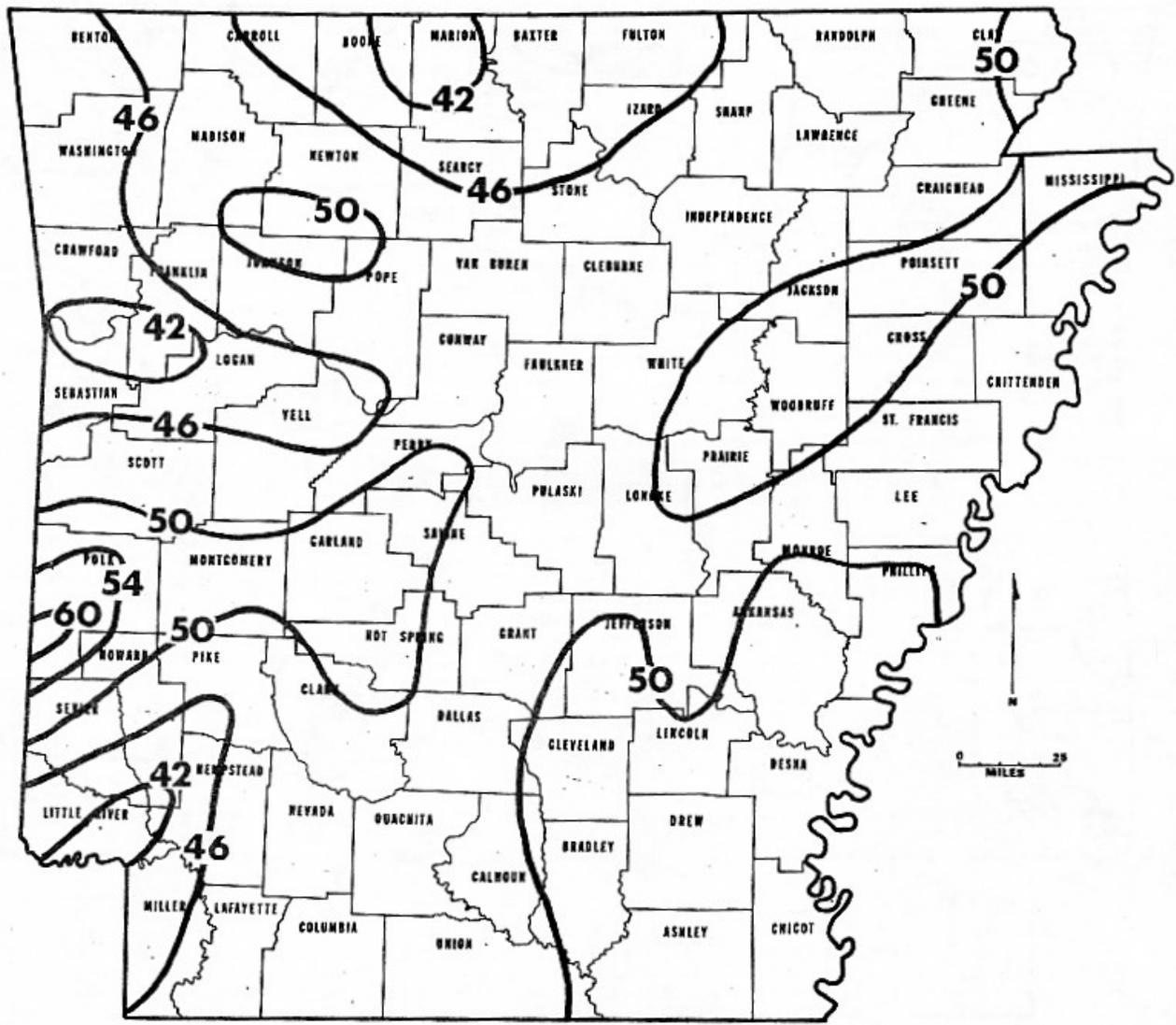
Adapted from Foti, Thomas and Gerald T. Hanson. Arkansas and the Land. Fayetteville: University of Arkansas Press, 1992, p. 36.

Note: For a very nice full-color topographic map of Arkansas without the county lines see <http://www.csd.tamu.edu/FLORA/arkansas/arknatma.htm>.



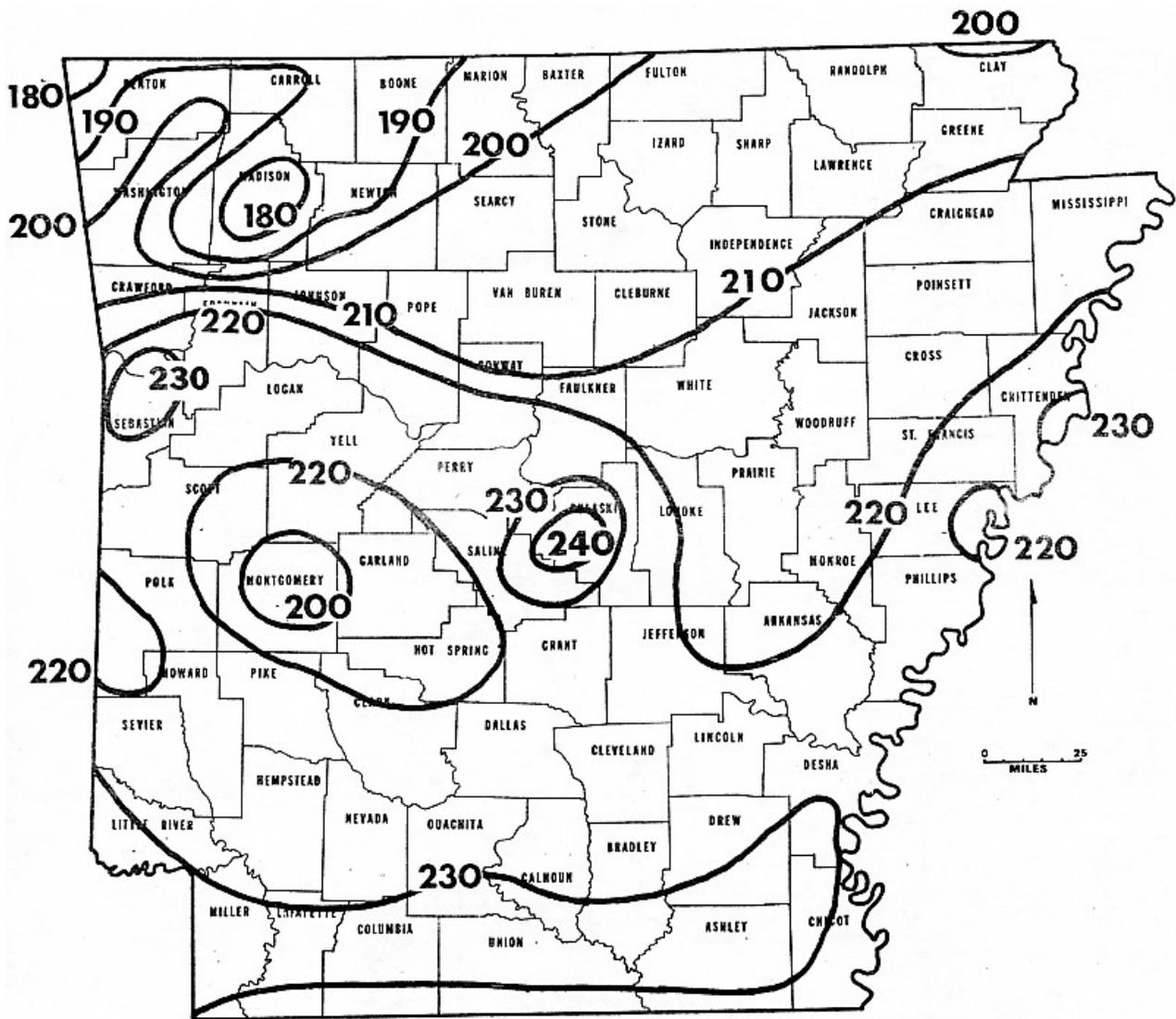
MEAN JULY TEMPERATURE IN DEGREES F.

*From Foti, Thomas L. The Natural Divisions of Arkansas: A Classroom Guide.
Little Rock: Arkansas Ecology Center, 1978, p. 31.*



MEAN ANNUAL PRECIPITATION

From Foti, Thomas L. *The Natural Divisions of Arkansas: A Classroom Guide*.
 Little Rock: Arkansas Ecology Center, 1978, p. 27.



MEAN DURATION OF GROWING SEASON IN DAYS

*From Foti, Thomas L. The Natural Divisions of Arkansas: A Classroom Guide.
Little Rock: Arkansas Ecology Center, 1978, p. 32.*

Arkansas and Global Warming

Scientists have designed sophisticated computer programs that help them make predictions about climate changes all over the world. Although not everyone agrees, most scientists believe that humans have caused global temperatures to rise by burning vast amounts of fossil fuels, causing an increase in carbon dioxide, which is a greenhouse gas. If scientists are correct, you can expect average temperatures to rise in Arkansas. There will be more very hot days in summer, and winters will be milder. Scientists aren't sure if the warmer conditions will result in more or less rain, but most models predict Arkansas will have more rain, with most of this increase happening in the summer. This may increase the number and intensity of summer thunderstorms. What else will happen in Arkansas as a result of global warming? The U.S. Environmental Protection Agency offers the following predictions:

- ✓ More heat waves may increase the number of heat-related deaths in Arkansas, particularly older people who live alone.
- ✓ Ozone at ground level, which is associated with asthma and other respiratory illnesses, may increase. Health will also be affected by increased pollution from power plants, as people use their air conditioners more and more. Warmer and wetter conditions could increase the incidence and severity of respiratory allergies.
- ✓ If conditions become warmer and moister as predicted, more mosquitoes, ticks, and other disease-carrying insects could exist in Arkansas, creating greater chances for people to get sick with diseases carried by these insects (and their hosts, such as rats). For example, mosquitoes could carry malaria into Arkansas, and Lyme disease from infected ticks could become more frequent.
- ✓ Although Arkansas has a lot of groundwater and surface water in its rivers and streams, the agricultural areas in the eastern part of the state have taken much of the groundwater there for crops. In some places saltwater in the earth seeps into the fresh groundwater if the groundwater level gets too low. If conditions become warmer, even lower groundwater levels could result. Also, less water could enter the state in the spring and summer, when farmers need it most, from its sources out of state.
- ✓ Water-based recreation could be negatively affected, and overall water quality could decrease, particularly in wetlands. Fish habitats could be significantly reduced. Also, warmer conditions could increase the demand for water, as greater evaporation dries out the soil, increasing irrigation by farmers. At the same time, cities, industries, and natural ecosystems will need more water as well.
- ✓ If conditions get significantly hotter and drier, livestock and dairy production will be hurt. Farm animals, including cows and chickens, tend to grow slower and gain less weight under such conditions. Pasture yields may also decline because of the heat. All of these would mean lost income for farmers and less food produced.
- ✓ Farmers may have a difficult time adjusting to climate variability. Increased temperatures during the growing season may not favor many of the plants that farmers have been growing for years. Unless Arkansas farmers can find new crops to grow and sell, they may have a difficult time staying in the business of agriculture. Global warming will significantly affect Arkansas' overall economy and the livelihoods of the thousands of Arkansans in agriculture and related businesses.
- ✓ All of the wild plants and animals in Arkansas are well suited to the climate the state has had for many, many thousands of years. Forests will certainly change if the conditions become warmer, and the animals that depend on the plants in those forests may not survive. The number of forest fires may increase in hotter, drier conditions. In a few short years, much of the state's forests could give way to grasslands and pasture.
- ✓ If rainfall increases, groundwater could increase, but flooding could become a greater problem, particularly in the Mississippi Alluvial Plain (the Delta) and West Gulf Coastal Plain.