# USING PAST CLIMATIC DATA TO ESTIMATE EFFECTS OF PREDICTED CLIMATE CHANGE ON TEMPERATURE AND PRECIPITATION IN SOUTH CENTRAL OREGON

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Levels of atmospheric carbon dioxide ($CO_2$) have increased from preindustrial levels of 275-285 ppm in the early 1800's to the current level of 350 ppm. The largest input of carbon dioxide into the atmosphere is through the burning of carbon stored in fossil fuels and in tropical rain forest vegetation. Seasonal variations in atmospheric carbon dioxide reflect increased uptake of carbon dioxide by vegetation during the summer and reduced plant activity during the winter.

Carbon dioxide and other greenhouse gasses (methane, nitrous oxide, chlorofluorocarbons, and lower atmosphere ozone) trap incoming, short-wave solar radiation from the sun and do not allow the reflected, long-wave radiation from the earth to pass out through the atmosphere. By acting like a greenhouse to trap heat from the sun, increasing concentrations of these gasses cause the earth to become warmer. Carbon dioxide accounts for about 50 percent of the warming, methane 20 percent, and the other gasses account for the remaining 30 percent of the temperature increase.

The effect of increased greenhouse gasses on temperature is generally agreed upon. With a doubling of present levels of atmospheric carbon dioxide, which is predicted to occur within 50 to 100 years, mean annual global temperatures are predicted to increase 3 - 4°C (5.4 - 7.2°F) at the equator and 8 - 10°C (12.8 - 18°F) in the Arctic. The mean annual global temperature has already 0.6°C (~1°F) in the past 30 years. Six of the 10 warmest years in the 130-year record of mean annual global temperature have occurred since 1978.

Precipitation patterns and amounts are predicted to change with global warming, but changes in precipitation for a given region are difficult to predict using global climate models because of the scale of model resolution. For example, all of Oregon, parts of Washington, Idaho, Nevada, California, and some of the Pacific Ocean are lumped together as one data point in the National Atmosphere and Space Administration (NASA) global climate model.

Another approach to understanding the effects of increased temperature on precipitation is to look at past climatic records for an area. The National Ocean and Atmospheric Administration (NOAA) has compiled a data set of mean monthly temperature and monthly precipitation for a 94-year period from 1896 to 1990 for Division 7 in south central Oregon. The data set is currently based on 34 reporting stations in Crook, Lake, Deschutes, Wheeler, Grant, Harney, Jefferson, and Klamath counties (Figure 1).

From 1896 to 1991 the composite mean annual temperature for all the reporting weather stations in south central Oregon was calculated as 7.86°C (46°F). Only seven water years, October 1 to September 31, have had mean annual temperatures more than 1°C (1.8°F) above the 94-year, long-term, composite mean (1917-1918, 1925-1926, 1933-1934, 1939-1940, 1986-1987, 1987-1988, and 1990-1991). And only one year, 1933-1934, was 2°C (3.6°F) warmer than the long-term mean temperature. It is interesting to note that three of the last four water years are among the seven warmest years recorded since 1895 in south central Oregon (Figure 2). Previous warm years were separated by intervals of 7, 7, 5, and 45 years. The recent warm period with current levels of atmospheric carbon dioxide may be coincidental or may be a foreshadowing of future trends.

The long-term mean annual precipitation for south central Oregon is 30.6 cm (12.1 inches). Five years (1923-1924, 1930-1931, 1938-1939, 1954-1955, 1976-1977) have had precipitation <66.6 percent of the long-term mean (Figure 3).

To understand how precipitation might be affected by increases in temperature, individual months with a mean temperature 2°C (3.6°F) above the long-term mean monthly temperature were selected from the long-term record. The number of months used in the analysis varied from four in July to 17 in February. Analysis indicated that months with a mean monthly temperature 2°C above the long-term mean monthly temperature had precipitation 5 percent, 13 percent, and 11 percent above the mean during November, December, and February. However, precipitation for October, January, March, April, May, June, July, August, and September was, respectively 88, 77, 99, 87, 65, 55, 70, 71, and 62 percent of long-term monthly precipitation (Figure 4).

The composite mean annual precipitation for months with temperatures >2° above the mean monthly temperature was 27 cm (10.6 inches) compared to the measured long-term mean annual precipitation of 30.6 cm (12.1 inches). This reduction in mean annual precipitation was for a composite year with a mean annual temperature of 10.6°C (51.1°F), which is 2.74°C (4.9°F) above the measured long-term mean annual temperature of 7.86°C (46.1°F) (Figure 5).

The 94-year weather record for south central Oregon cannot be used to statistically predict precipitation with an increase in annual temperatures 3 - 4°C (5.4 - 7.2°F) above the mean annual temperature. Such warm temperatures are outside the existing data set. Although it is tempting to predict precipitation with temperatures warmer than those measured in the past, it is dangerous to do so because the relationship between precipitation and temperature may change at air temperatures warmer than those measured in the past.

Only one year, the water year of 1933-1934, had a mean annual temperature 2°C (3.6°F) above the long-term mean. However, the current pattern of decreased precipitation with increased temperatures indicates a strong possibility that eastern Oregon will become significantly drier if mean annual temperature increases by 4°C (7.2°F) in response to higher concentrations of greenhouse gasses in the atmosphere.

If (with predicted climate change) warmer, drier conditions become the new norm for south central Oregon, patterns of above and below-ground resource acquisition of carbon dioxide, light, water, and nutrients may be altered, and the ability of range plants to photosynthesize, absorb water and nutrients, and grow may change. If resource capture by a species is disadvantaged compared to resource capture by other species in the community, populations of the disadvantaged species will decline. If perennial grasses and forbs are less able to adapt to the new climate than are sagebrush and western juniper, the amount of available forage for livestock and wildlife may decline. On the other hand, long-lived shrubs and trees may be at a disadvantage during a period of rapid climate change. If all species are equally disadvantaged by climate change, community composition should not change.

Research is needed to measure the relative abilities of western juniper, sagebrush, rabbitbrush, and perennial grasses to capture above and below-ground resources with conditions that mimic expected increases in temperature and reductions in precipitation. Such research would allow prediction of changes in community composition. If sagebrush and western juniper are more successful in acquiring resources than are perennial grasses under conditions of increased air temperature and decreased precipitation, present levels of domestic livestock grazing may not be possible if perennial grasses are to be maintained in eastern Oregon. If information on the response of rangeland plants to climate change is available before anticipated global climate change is realized, necessary adjustments in grazing on public and private lands can be made to define alternative grazing strategies and reduce dislocation of permittees while retaining perennial grasses in the ecosystem.

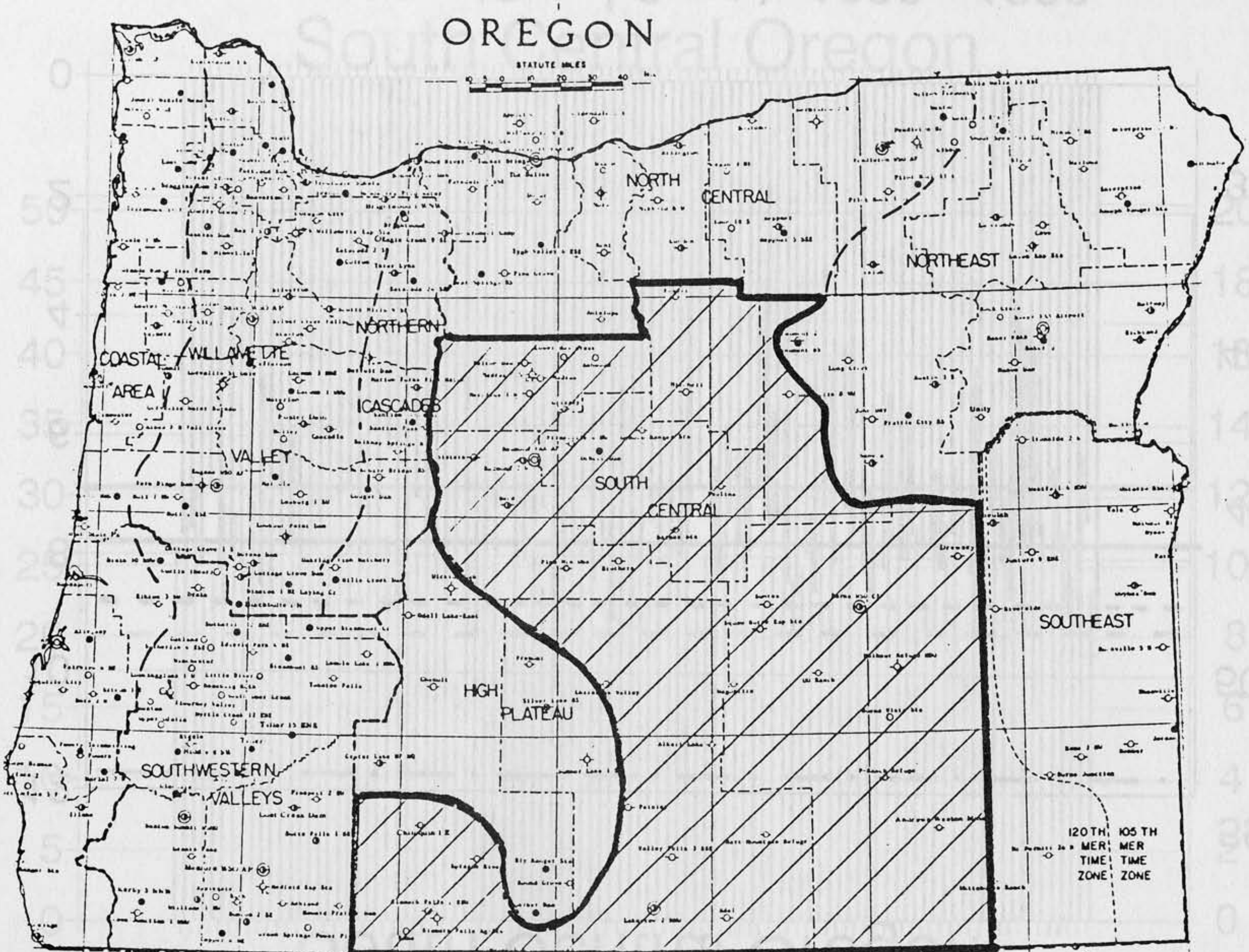
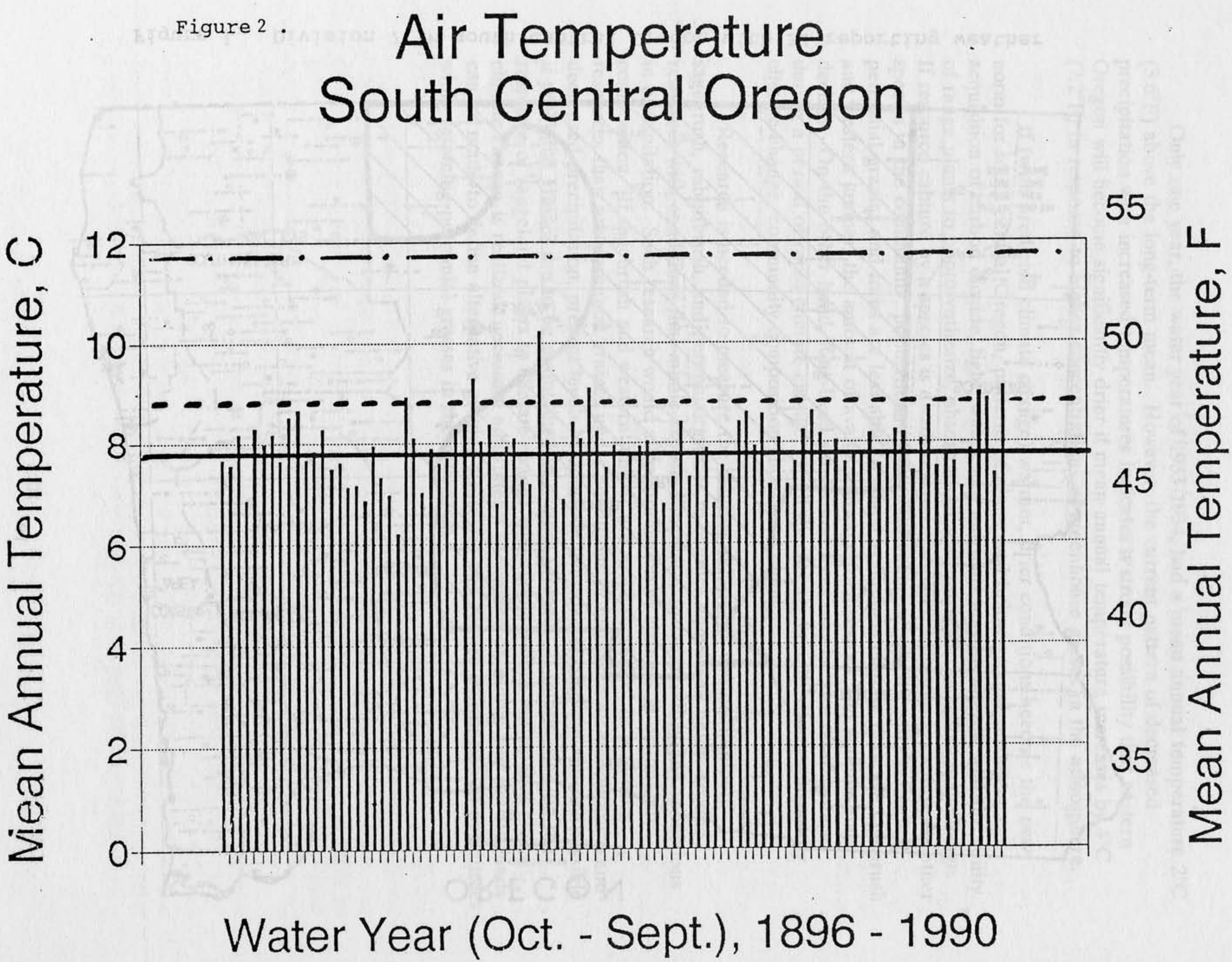



Figure 1. Division 7 in south central Oregon with 34 reporting weather

Figure 2.



Air Temperature
South Central Oregon
Mean Annual Temperature, C
12
10
8
6
4
2
0
Mean Annual Temperature, F
55
50
45
40
35
Water Year (Oct. - Sept.), 1896 - 1990

Figure 3.

# Precipitation
# South Central Oregon

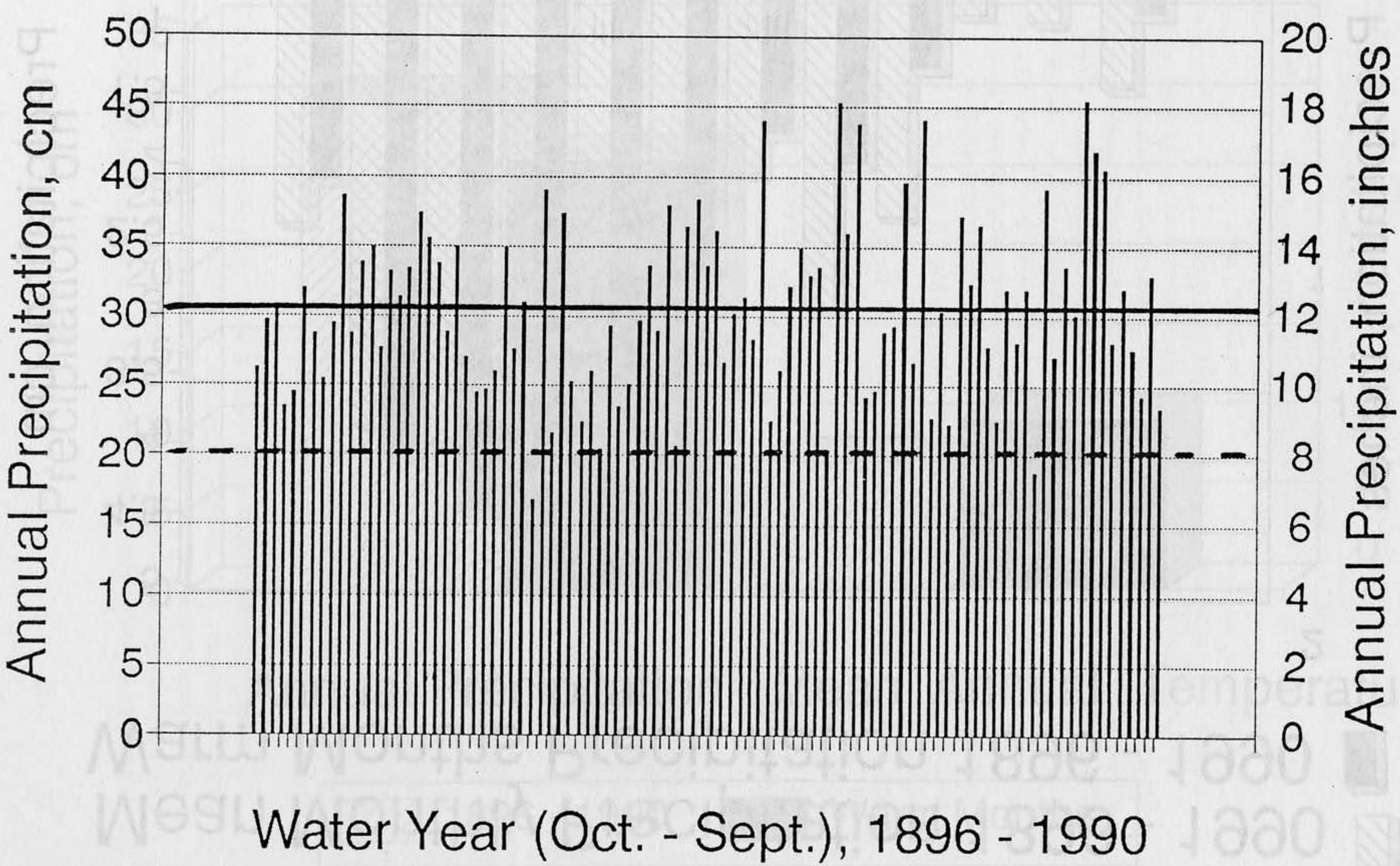
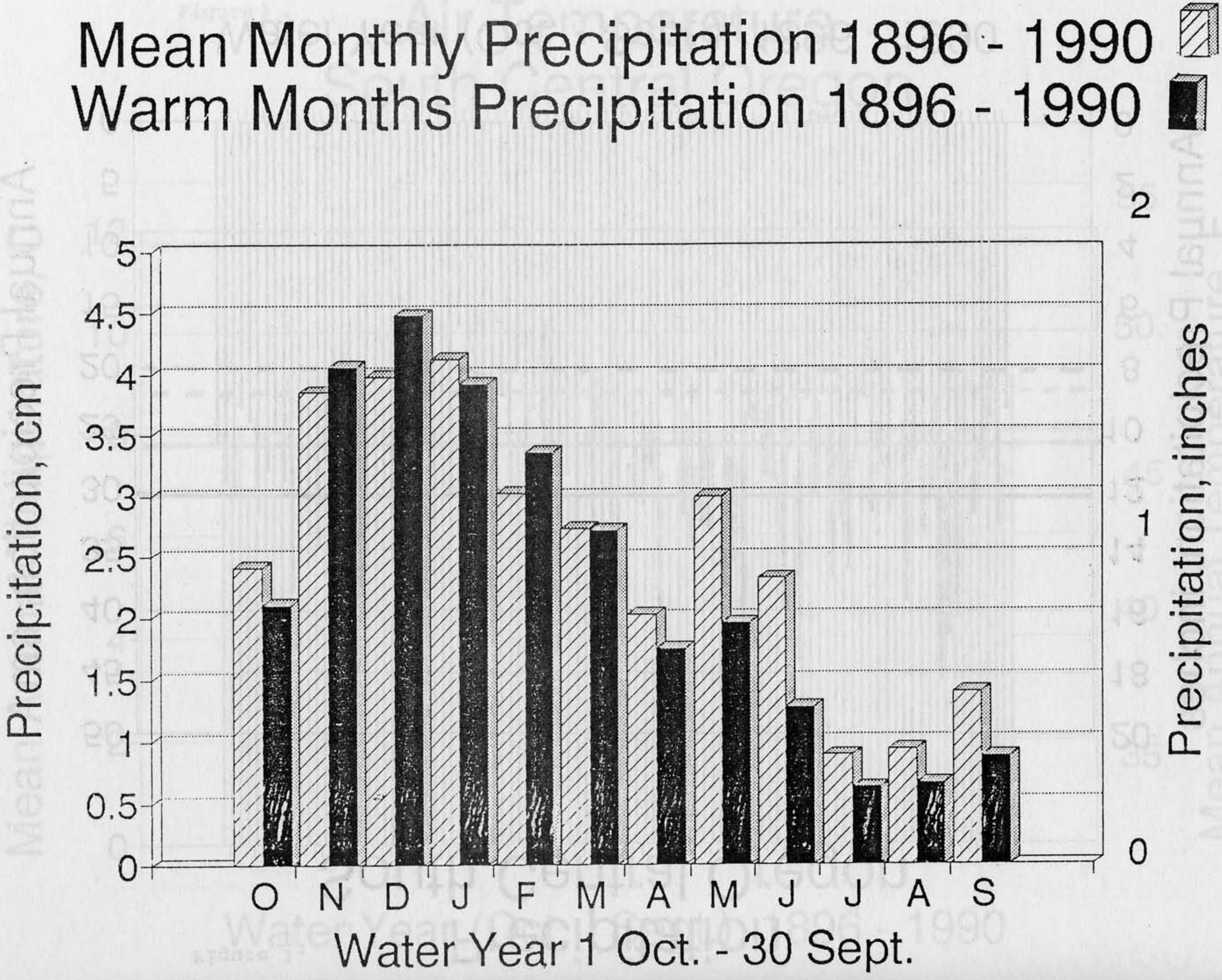
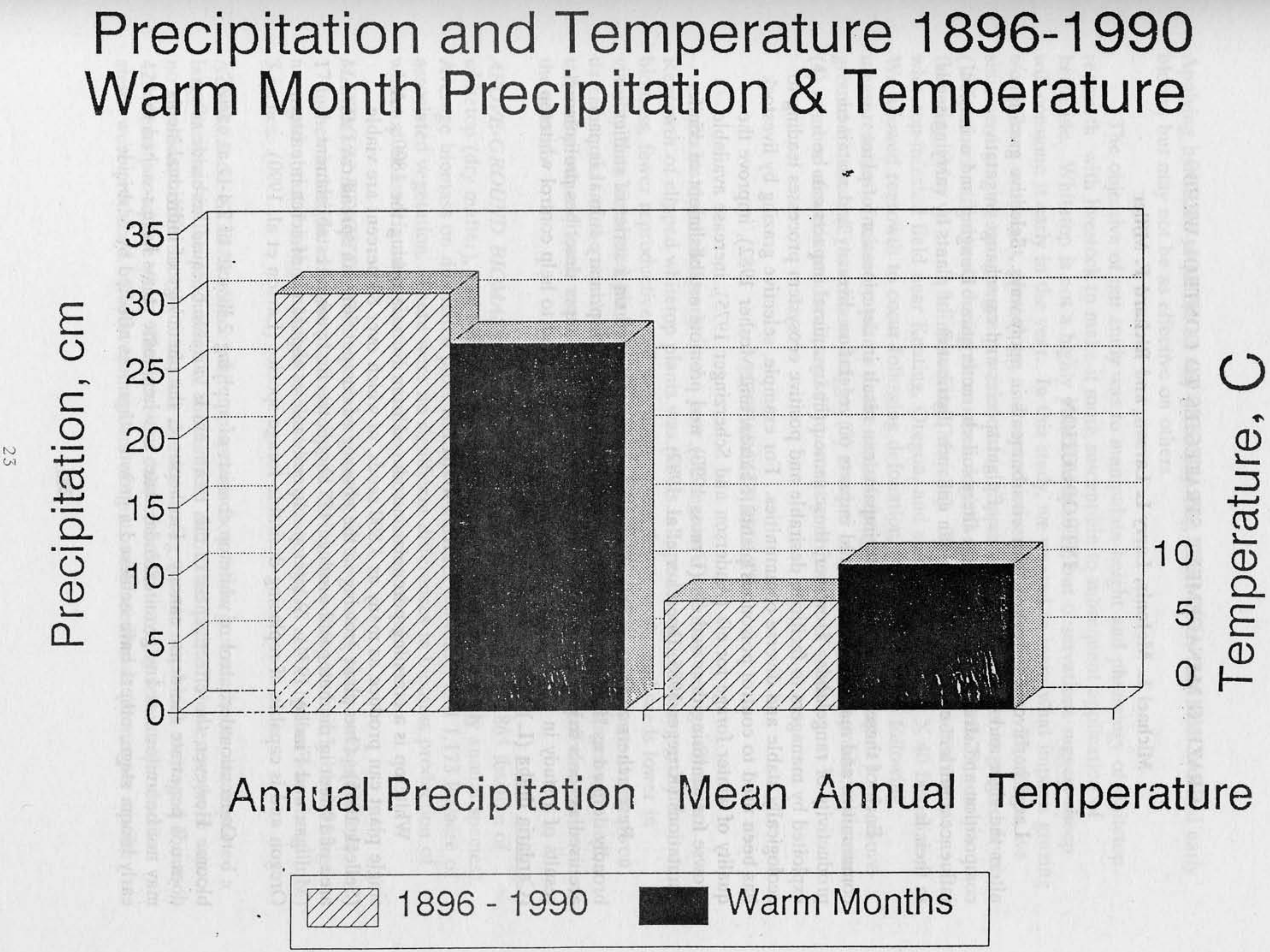


Figure 4.



Mean Monthly Precipitation 1896 - 1990
Warm Months Precipitation 1896 - 1990
Precipitation, cm
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Precipitation, inches
2
1
0
O N D J F M A M J J A S
Water Year 1 Oct. - 30 Sept.

Figure 5.


Precipitation and Temperature 1896-1990
Warm Month Precipitation & Temperature
Precipitation, cm
35
30
25
20
15
10
5
0
Temperature, C
10
5
0
Annual Precipitation
Mean Annual Temperature
1896 - 1990
Warm Months