

# 1996 Weather Conditions

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## **Abstract**

*Weather again presented significant challenges to Arizona cotton producers in 1996. Warm early season weather allowed most growers to plant earlier than normal and the 1996 crop moved through the first half of the season in excellent shape. The arrival of high monsoon humidity in early July combined with high July temperatures to create heat stress conditions which led to fruit shed at most central and western production areas. The stressful combination of humidity and temperature remained entrenched through much of July and August, creating generally poor fruiting conditions in both months. Monsoon activity continued through mid-September in many areas, then was followed by a month of generally good weather conditions for finishing the crop. Cool weather effectively ended the growing season after mid-October. The overall warm year produced seasonal heat unit accumulation well in excess of normal. Precipitation was generally well below normal, especially along the Colorado River.*

## **Introduction**

The 1996 growing season proved to be another challenging one for many Arizona cotton producers. Warm winter and near normal spring weather provided an early and promising start to the 1996 season. However, high July temperatures combined with early monsoon humidity to create heat stress conditions which reduced fruit retention and lowered final yields across much of the central and western production areas. In this report we review the 1996 weather conditions in key cotton production areas using information obtained from the Arizona Meteorological Network (AZMET).

## **Methods**

Weather data collected from six AZMET stations -- Litchfield Park, Marana, Maricopa, Parker, Safford and Yuma Valley -- were selected for review in this report. The selected locations range in elevation from 120' (Yuma Valley) to 2955' above sea level (Safford) and provide a broad geographic representation of the cotton production regions of Arizona.

Meteorological parameters of importance to cotton production -- temperature, dew point temperature (Td), precipitation (PPT) and heat unit (HU) accumulation (86°F/55°F thresholds: sine curve method) were summarized for calendar year 1996, then plotted in such a manner to facilitate comparisons against normals. Temperature, Td and HU normals were computed using past AZMET data collected over the period 1987 through 1995. A seven-day moving average (equal weights) was used to smooth temperature and Td normals to improve graphical presentation. Precipitation normals were obtained from the nearest NOAA Cooperative Observer station; AZMET PPT normals proved too variable due to the relatively short record length (1987-95) of AZMET records.

Graphs which depict how a particular weather variable behaved relative to normal are presented for each location. Maximum and minimum temperature (Tx & Tn) and Td are presented showing 1996 values and normals. Patterns

of above or below normal conditions are clearly evident from these graphs. Cumulative precipitation plots are used to show how PPT accumulated relative to normal during 1996. Finally, HU accumulation is presented as the cumulative departure from normal throughout calendar year 1996. Readers should note that any time HU departure from normal moves in a positive direction (positive slope) HU accumulation is above normal. Likewise, anytime the line depicting HU departure from normal moves in a negative direction (negative slope), HU accumulation is below normal.

## Results

In reviewing the 1996 weather conditions we have chosen to break the year into six, two-month production periods as indicated below:

PRODUCTION PERIOD	MONTHS
Pre-Plant	January-February
Planting	March-April
Early Season	May-June
Mid-Season	July-August
Late Season	September-October
Harvest & Tillage	November-December

A description of the major weather events impacting each production period follows.

### Pre-Plant Period: January & February

1996 began on a warm and dry note. January temperatures averaged well above normal (Figures 1-12), due largely to above normal maximum temperatures (Tx; Figures 1-6). Minimum temperatures (Tn) remained at or below normal at all locations for much of January due to clear skies and low dew point temperatures (Td; Figures 13-18) which enhanced radiational cooling at night. The first rains of 1996 arrived late in the month and provided significant precipitation (PPT) on 31 January and/or 1 February at all locations except Yuma and Parker (Figures 19-24).

Above normal temperatures continued through much of February (Figures 1-12) and were accompanied with higher humidity and some significant precipitation. February Tn were significantly above normal (Figures 7-12) due to relatively high Td (Figures 13-18) and increased cloudiness. Significant rains approaching 1.0" were reported in early February at central and southeastern production areas. A late February storm system provided the month's only cool weather and generated light PPT at all locations except Yuma.

Heat unit accumulation during the winter months of January and February was above normal (Figures 25-30), reflecting the above normal temperatures observed in both months. Heat unit accumulation raced ahead of normal by 100-150 HUs by the third week of February, allowing soils to warm and providing some good mid-February planting conditions in the Yuma area. The week-long cool spell near the end of February reduced HU accumulation considerably; however, annual HU accumulations still exceeded normal by 75-100 HUs at the end of the month.

### Planting Season: March & April

March produced the usual periods of oscillating temperatures, but when the month ended, temperature (Figures 1-12) and HU accumulation (Figures 25-30) were slightly above normal. There were several periods of very warm weather in March which provided growers in central production areas some good planting opportunities. The only significant PPT event of the entire planting season occurred between 13 and 14 March (Figures 19-24). Rainfall was generally light; however, very heavy rainfall (2.5") occurred in the Litchfield Park area. March rainfall was

below normal at all locations except Litchfield Park. Dew point temperatures averaged above normal at low elevation locations and below normal at Marana and Safford (Figures 13-18).

April temperatures were at or slightly below normal during the first three weeks of the month, but dry weather generally made for good planting conditions. At low elevations Tx averaged slightly below normal, but were offset by higher Tn which resulted from above normal Td. Higher elevation locations reported normal temperatures and below normal Td. HU accumulation for the first three weeks of the month was slightly below normal at all central and southeastern locations; normal HU accumulation was observed along the Colorado River.

The period of mild temperatures came to an abrupt end in the last week of April with the arrival of hot, dry weather. Maximum temperatures during the last week of April exceeded 100°F in western and central Arizona and reached the mid-90s in southeast Arizona. This late hot spell increased the monthly HU accumulations to normal levels at most locations. PPT was not observed at any monitored site during April.

### **Early Season: May & June**

The late April hot spell represented the beginning of an extended period of very warm temperatures (Figures 1-12). Temperatures in May surged to above normal levels at all locations with Tx approaching or exceeding 110°F near mid-month. Humidity levels, as expressed by Td, were above normal at central and western locations (Figures 13-18). In contrast, Td at the higher elevation locations of Safford and Marana remained below normal. The only break in the hot May weather was a brief cool spell which entered the state the fourth week of the month. Temperatures during the cool spell dropped below normal for about four days, but rebounded quickly to above normal levels by the end of the month.

Precipitation was not a factor in cotton production during the month of May as all locations went without rainfall for the second consecutive month (Figures 19-24). Heat unit accumulation was well above normal at all locations during May (Figures 25-30), with all locations exceeding normal HU accumulation by 75 HUs or more.

The high temperatures of May continued through much of June (Figures 1-12). Both Tx and Tn temperatures exceeded normal at most locations in June. Maximum temperatures approached or exceeded 110°F at all monitored locations for significant portions of the month. Minimum temperatures, while warm, remained below 75°F through much of June. Yuma Tn bucked the statewide trend and generally ran below normal for the month. The warm June temperatures did not impose any serious heat stress on the crop because the combination of air and Td was insufficient to push crop temperatures into the stressful range. It is important to note, however, that Td were in fact well above normal for much of the month (Figures 13-18) and did contribute to above normal Tn (Figures 7-12).

The June heat wave was interrupted by a brief cooling spell near the end of the month. Both Tx and Tn temperature dipped to nearly 10°F below normal for a few days, then rebounded to normal by month's end. This brief cool spell also reduced HU accumulation and thereby reduced monthly HU accumulations relative to normal (Figures 19-24). Most locations reported monthly HU accumulations of 50-75 HUs above normal. Exceptions to this trend were along the Colorado River where June HU accumulation was slightly below normal.

June proved to be normal with respect to PPT. Only Safford reported any significant precipitation -- a light rain on the 25 June and a heavy rain (1.1") on 29 June (Figures 25-30).

### **Mid-Season: July & August**

The 1996 cotton crop entered the mid-summer months of July and August ahead of schedule due to the warm spring and early summer weather. Annual HU accumulation at the end of June exceeded normal by 150-220 HUs in central and western Arizona and by nearly 300 HUs in Marana and Safford (Figures 25-30). By most accounts, the crop appeared to be in excellent condition going into early July.

The optimal June weather quickly turned hostile in early July. An early and intense surge of humidity combined with high temperatures to create a very stressful condition for cotton (Figures 1-18). Dew point temperatures

increased into the upper 60s and lower 70s during the first week of the month (Figures 13-18), driving Tn into the low 80s in most low desert locations (Figures 7-12). Daytime temperatures (Figures 1-6), while not extreme in an absolute sense, combined with the high humidity to create intense heat stress conditions. Rapid declines in fruit retention were noted in most low desert locations shortly after this early July heat stress. The stressful early July conditions continued through much of the month due to hot temperatures and high Td. High Tn (Figure 7-12) were observed in most locations throughout the month -- a direct response of the higher humidity. Heat unit accumulation in July continued above normal across the entire cotton production region, with July totals exceeding normal by 50-75 HUs (Figures 25-30).

The high temperatures and humidity of July proved more positive at higher elevation areas where the potential for heat stress is far lower. The high humidity at Safford raised night temperatures well above normal, but minimum temperatures still remained in the low 70°F range -- a range considered unlikely to generate heat stress conditions. Crops at higher elevations therefore benefited from the higher July HU accumulation which effectively lengthened the growing season at these locations.

July proved to be another dry month at most locations (Figure 19-24). No precipitation was reported along the Colorado River and only light rains were reported in most of the remaining production areas. Heavy isolated rains were reported in the Litchfield Park and produced near normal rainfall in that production area.

August proved a little less stressful than July in central production areas. Temperatures and Td continued to run above normal (Figure 1-18), but the Tn and Td were not as high as in July. Exceptions to this trend were observed along the Colorado River where the high humidity and high night temperatures continued for much of the month, especially near Yuma.

Late August produced another major heat stress event when air temperatures and Td again combined to create very stressful conditions (Figures 1-18) for growers attempting to grow a top crop. Daytime temperatures remained near normal during this period, but minimum temperatures again moved into the upper 70s and low 80s in central and western production areas. Only upper elevation areas escaped this late August period of extreme heat.

Heat unit accumulation continued to run above normal in August due mostly to the higher night temperatures (Figures 25-30). Exceptions to this trend were Safford and Marana which reported near-normal HU accumulation for the month. Colorado river locations reported HU accumulations of nearly 50 HUs above normal while central Arizona HU accumulation totaled about 20 HUs above normal.

August PPT was light and spotty at Maricopa, Litchfield Park and Marana (Figures 19-24). August brought both Parker and Yuma Valley their first significant precipitation in nearly four months, though monthly precipitation totals at both locations remained below normal. Only Safford reported frequent and normal precipitation for the month.

#### **Late Season: September & October**

Monsoon humidity remained entrenched across much of southern Arizona during the first two weeks of September (Figures 13-18), bringing considerable cloudiness and significant rainfall to most locations. The increased cloudiness helped keep Tx below normal (Figures 1-6); however, the clouds and humidity kept Tn at or slightly above normal (Figures 7-12). The humidity retreated from the state in the last half of September, bringing much cooler night temperatures, and lower HU accumulation. HU accumulation for the month totaled slightly below normal at most locations, due to the cool nights of late September (Figures 25-30).

Precipitation totals varied with location (Figures 19-24) with Safford and Litchfield Park reporting above normal PPT. Safford received two large rains (1.0+") in the first half of September and posted a monthly PPT total in excess of 3.5". Marana reported near normal September PPT while all other locations reported below normal PPT.

Early October brought a return to very warm weather. Maximum temperatures at central and low desert production areas again increased above 100°F while temperatures in the 90s were common in high elevation areas. The warm

spell ended abruptly about the 10th of the month with the passage of a cold, fall storm system. Temperatures dropped rapidly in response to this storm and remained below normal for the remainder of the month. Temperatures at higher elevation locations dropped below freezing late in the month, effectively ending the cotton growing season. The storm provided little in the way of PPT with only central Arizona locations reporting light PPT.

October continued dry across much of the cotton production area (Figures 19-24). Two locations -- Parker and Yuma -- reported no October PPT, while light amounts were recorded at Marana, Litchfield Park and Maricopa. Safford, which received a significant rain late in the month, reported near normal October PPT.

Heat unit accumulation was below normal at all locations in October (Figures 25-30). Reductions in HU accumulation relative to normal ranged from about 20 HUs at high elevation locations (Safford and Marana) to about 50 HUs in central and western Arizona.

#### **Harvest & Tillage Season: November & December**

The 1996 production season finished on a dry and relatively warm note which proved positive for harvest and fall tillage operations. Both November and December produced the normal variable weather associated with the winter months, but in general, temperatures continued to run above normal (Figures 1-12). Frost did not occur in most central and western locations until late November or early December (Figures 7-12). Humidity levels fluctuated with the passage of storm systems and averaged slightly above normal (Figures 13-18). Rainfall continued to be very light as the storm systems continued to remain north of Arizona (Figures 19-24). Yuma and Parker reported no rainfall in either month and other locations reported PPT totals for two-month period of less than 0.25". Heat unit accumulation exceeded normal in both months by more than 50 HUs in all locations except Safford. HU accumulation in Safford was slightly above normal.

## MAXIMUM TEMPERATURE: YUMA VALLEY 1996 vs. NORMAL

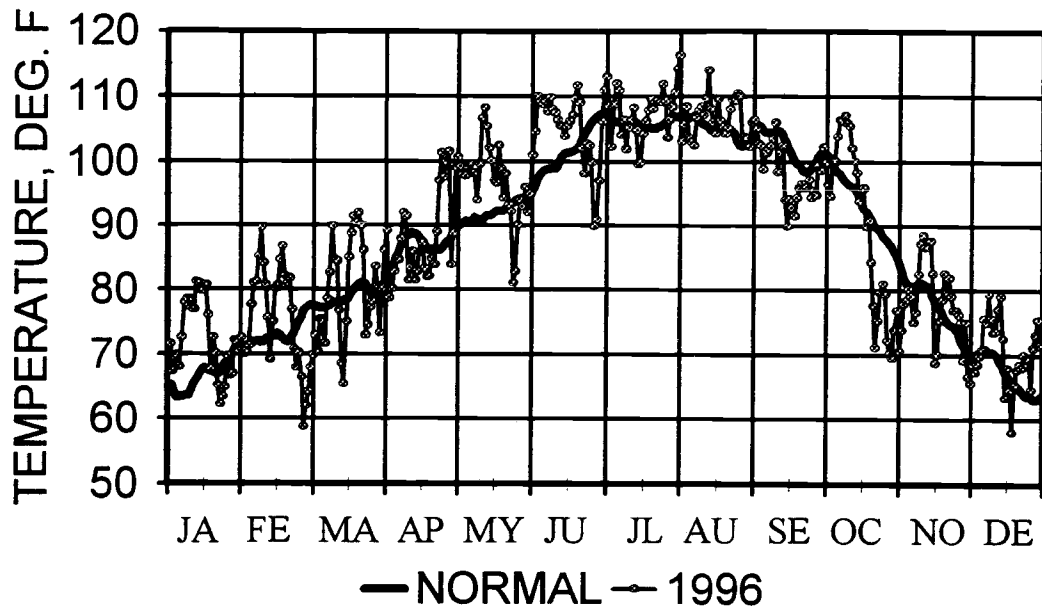


Figure 1. Maximum temperatures observed at Yuma Valley during calendar year 1996. Heavy line indicates normal conditions.

## MAXIMUM TEMPERATURES: PARKER 1996 vs. NORMAL

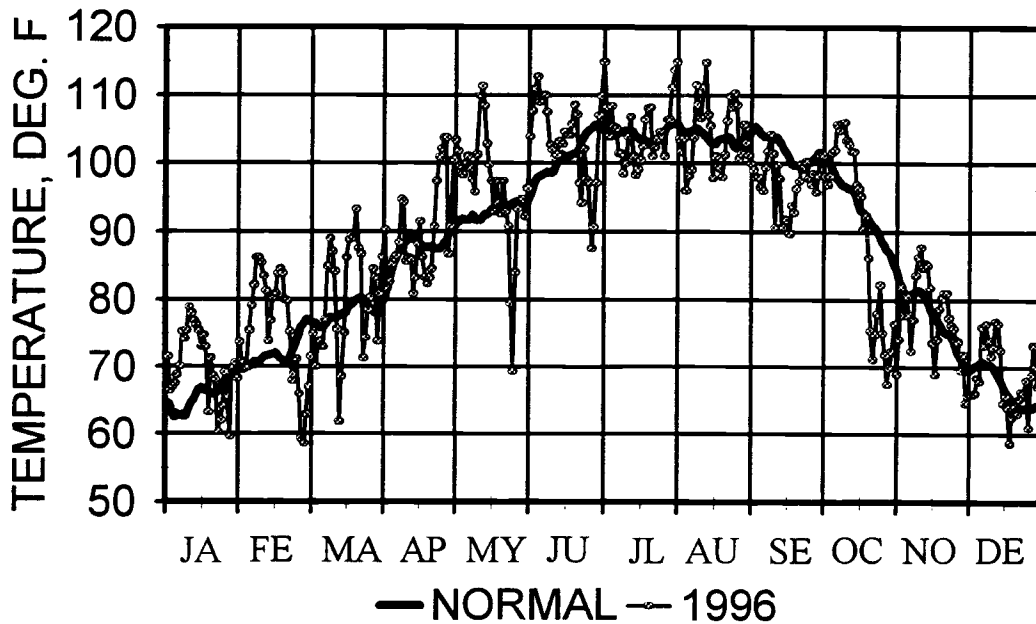


Figure 2. Maximum temperatures observed at Parker during calendar year 1996. Heavy line indicates normal conditions.

### MAXIMUM TEMPERATURE: LITCHFIELD PK. 1996 vs. NORMAL

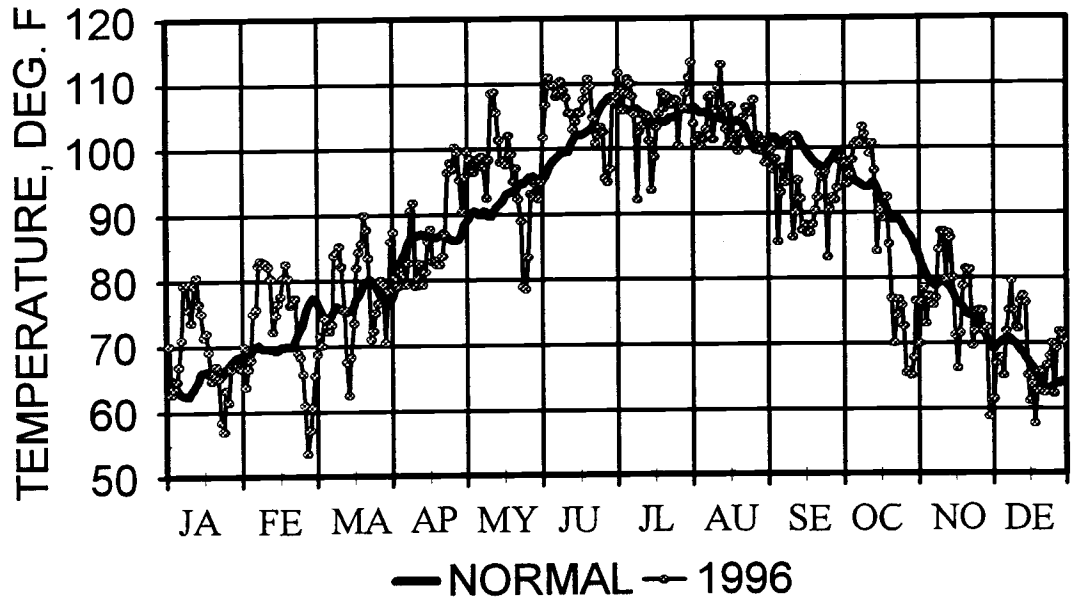


Figure 3. Maximum temperatures observed at Litchfield Park during calendar year 1996. Heavy line indicates normal conditions.

### MAXIMUM TEMPERATURE: MARICOPA 1996 & NORMAL

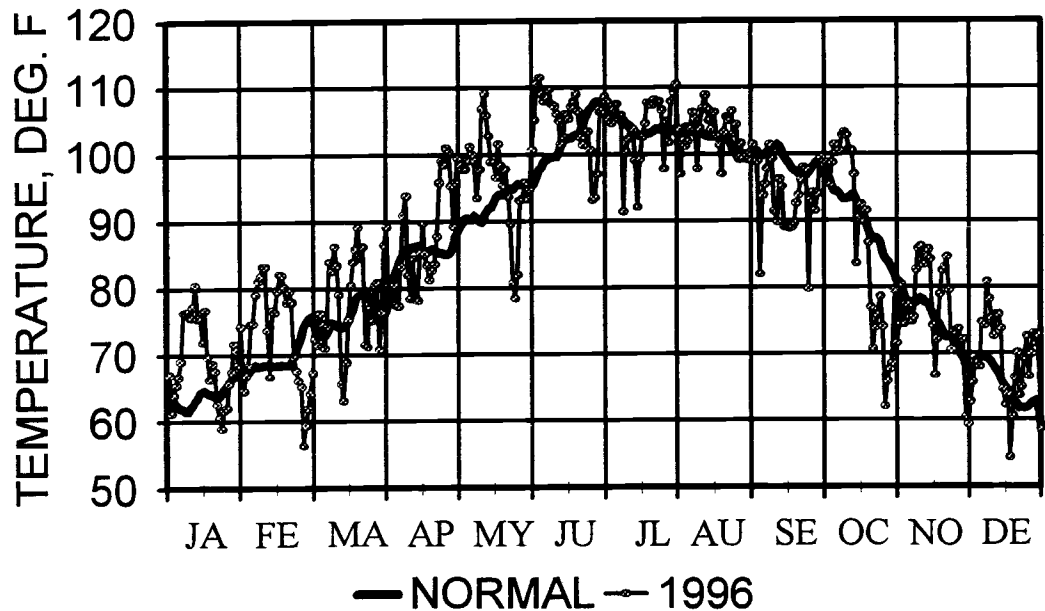


Figure 4. Maximum temperatures observed at Maricopa during calendar year 1996. Heavy line indicates normal conditions.

## MAXIMUM TEMPERATURES: MARANA

1996 vs. NORMAL

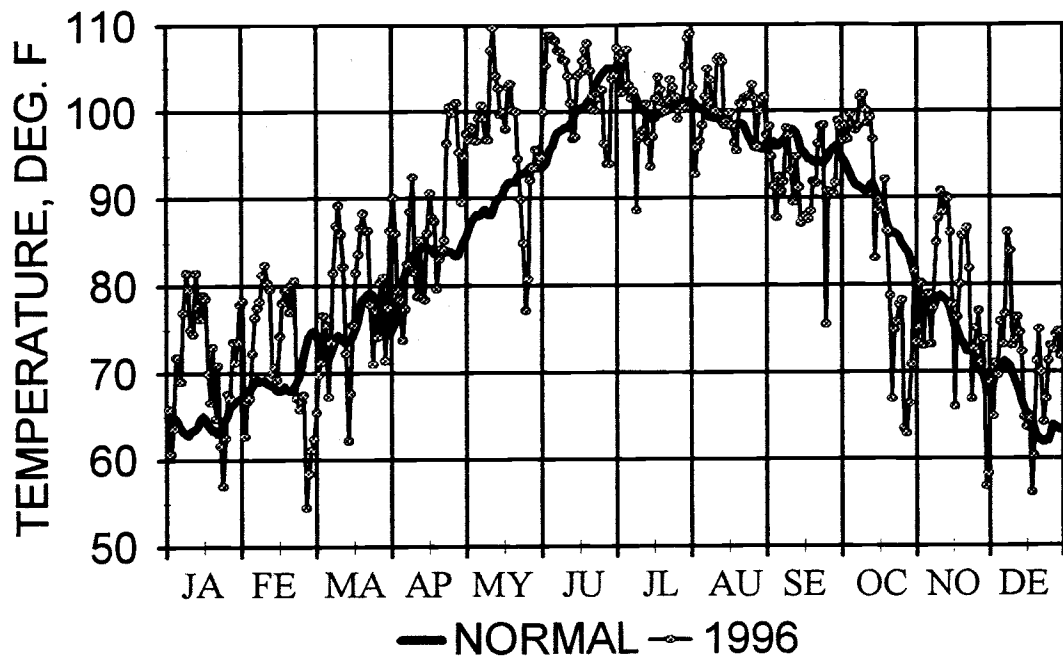


Figure 5. Maximum temperatures observed at Marana during calendar year 1996. Heavy line indicates normal conditions.

## MAXIMUM TEMPERATURE: SAFFORD

1996 vs. NORMAL

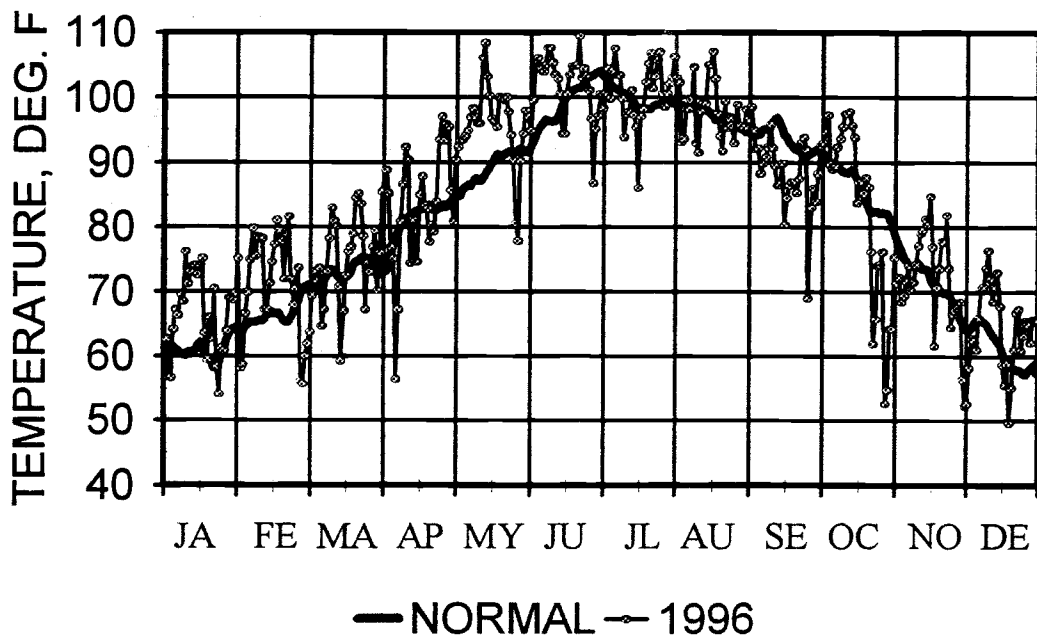


Figure 6. Maximum temperatures observed at Safford during calendar year 1996. Heavy line indicates normal conditions.



## MINIMUM TEMPERATURE: YUMA VALLEY 1996 vs. NORMAL

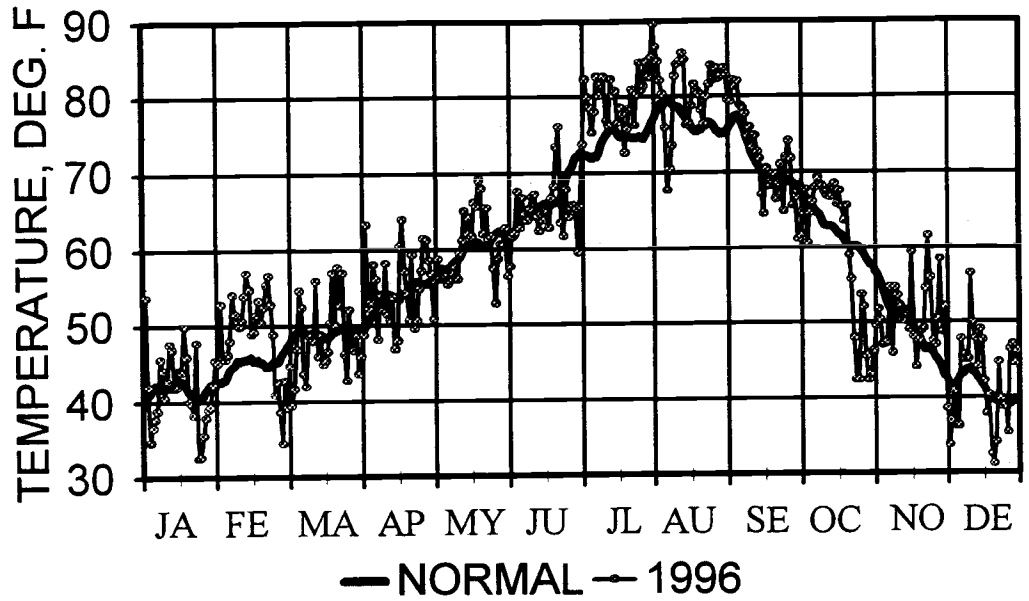


Figure 7. Minimum temperatures observed at Yuma Valley during calendar year 1996. Heavy line indicates normal conditions.

## MINIMUM TEMPERATURES: PARKER 1996 vs. NORMAL

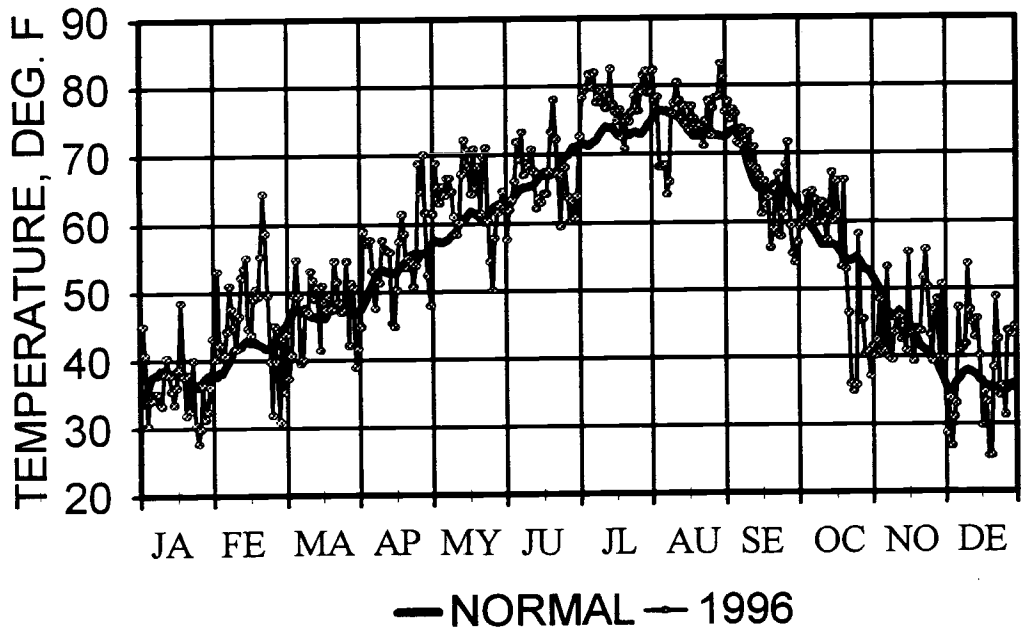


Figure 8. Minimum temperatures observed at Parker during calendar year 1996. Heavy line indicates normal conditions.

**MINIMUM TEMPERATURE: LITCHFIELD PK.  
1996 vs. NORMAL**

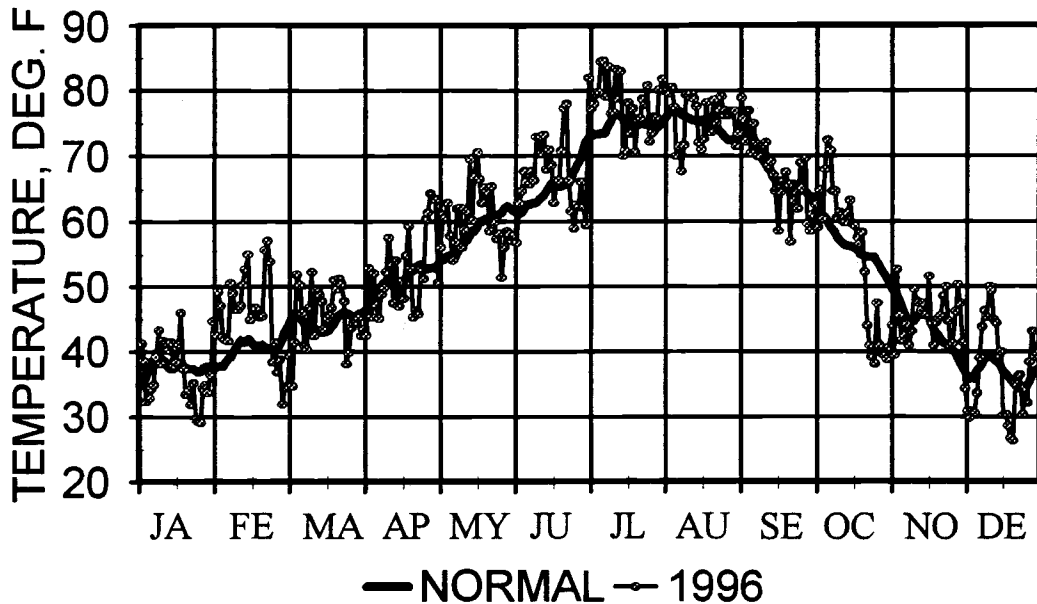


Figure 9. Minimum temperatures observed at Litchfield Park during calendar year 1996. Heavy line indicates normal conditions.

**MINIMUM TEMPERATURE: MARICOPA  
1996 & NORMAL**

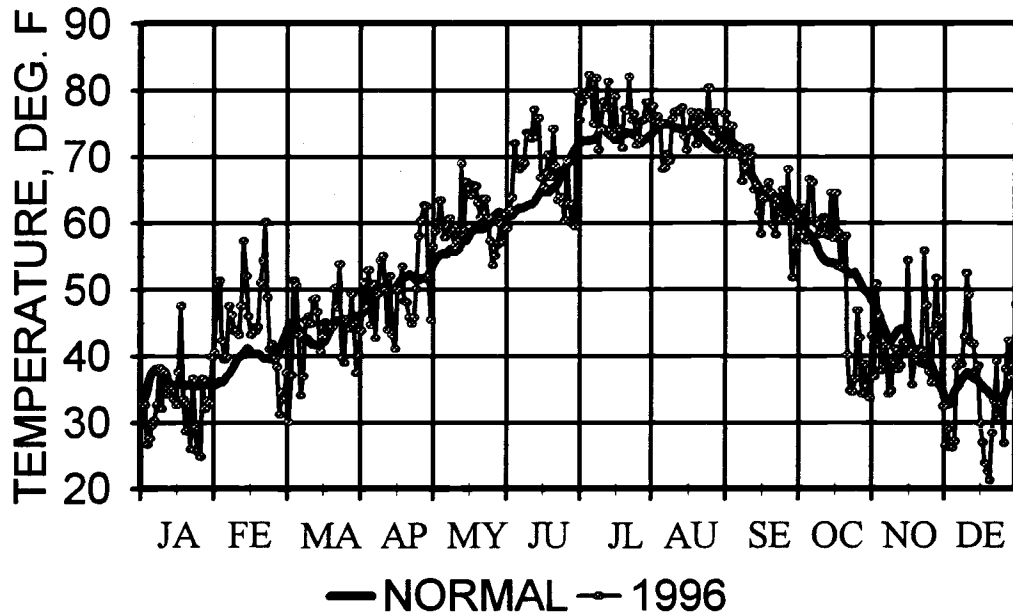


Figure 10. Minimum temperatures observed at Maricopa during calendar year 1996. Heavy line indicates normal conditions.

# MINIMUM TEMPERATURES: MARANA

1996 vs. NORMAL

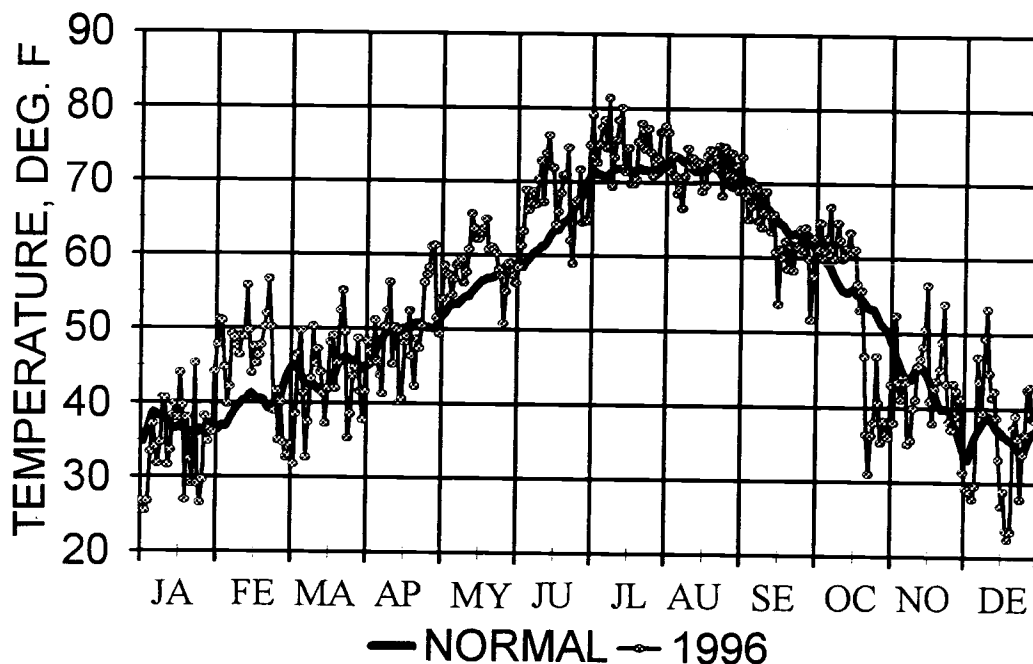


Figure 11. Minimum temperatures observed at Marana during calendar year 1996. Heavy line indicates normal conditions.

# MINIMUM TEMPERATURE: SAFFORD

1996 vs. NORMAL

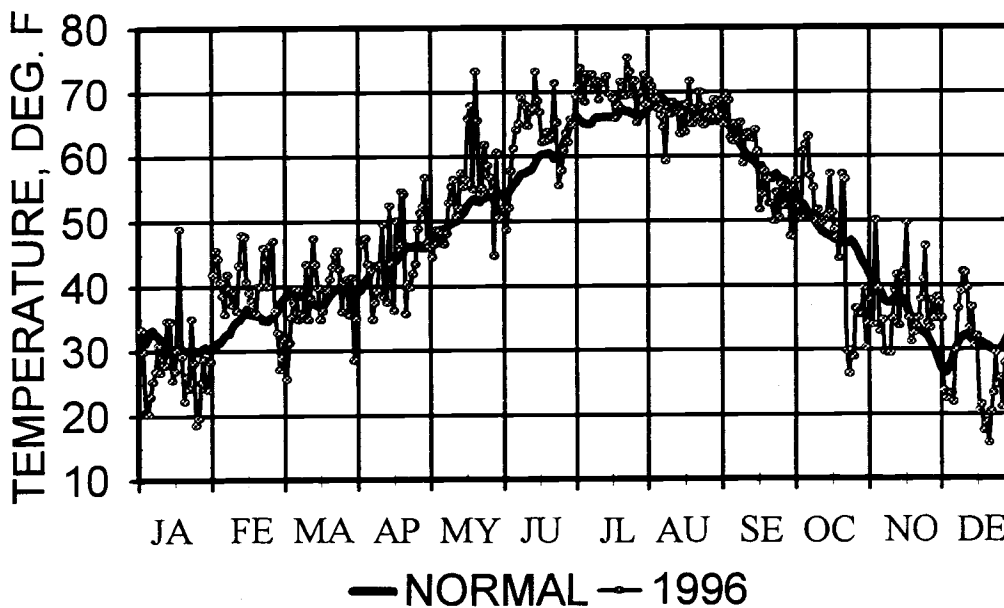


Figure 12. Minimum temperatures observed at Safford during calendar year 1996. Heavy line indicates normal conditions.

## DEW POINT TEMPERATURE: YUMA VALLEY 1996 vs. NORMAL

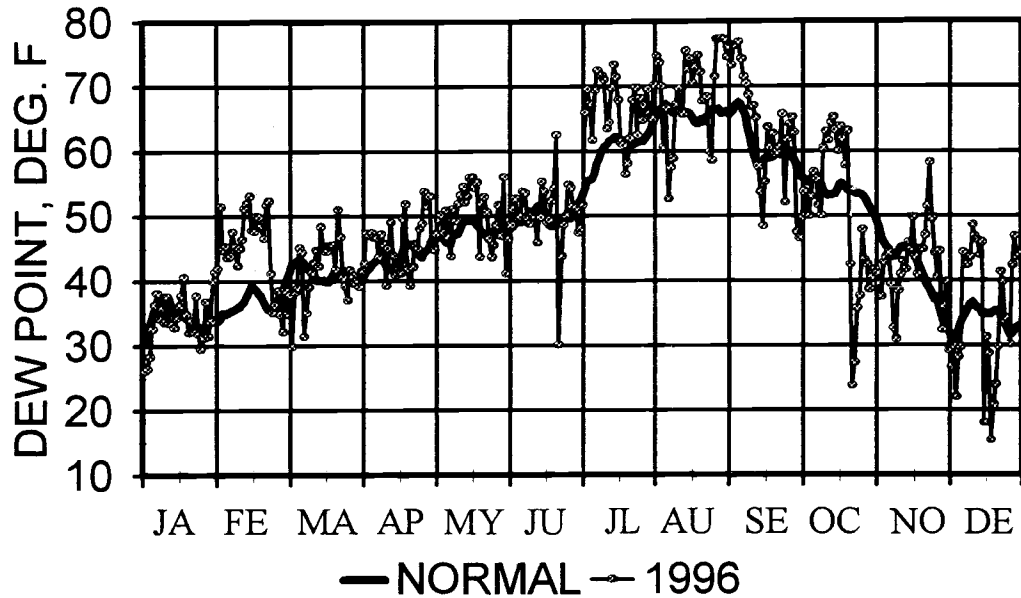


Figure 13. Dew point temperatures observed at Yuma Valley during calendar year 1996. Heavy line indicates normal conditions.

## DEW POINT TEMPERATURES: PARKER 1996 vs. NORMAL

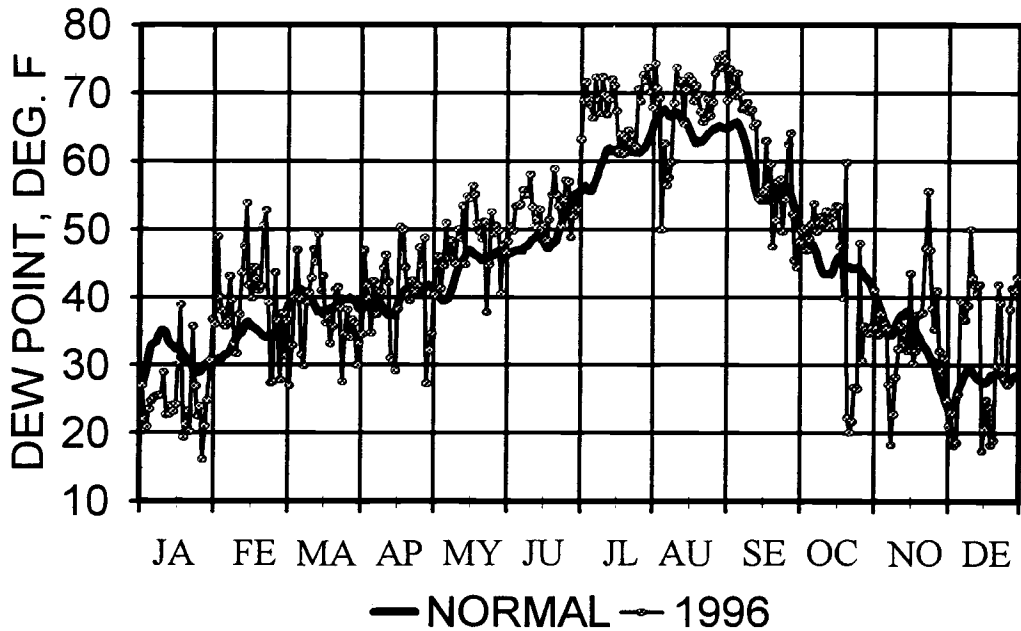


Figure 14. Dew point temperatures observed at Parker during calendar year 1996. Heavy line indicates normal conditions.

## DEW POINT TEMPERATURE: LITCHFIELD PK. 1996 vs. NORMAL

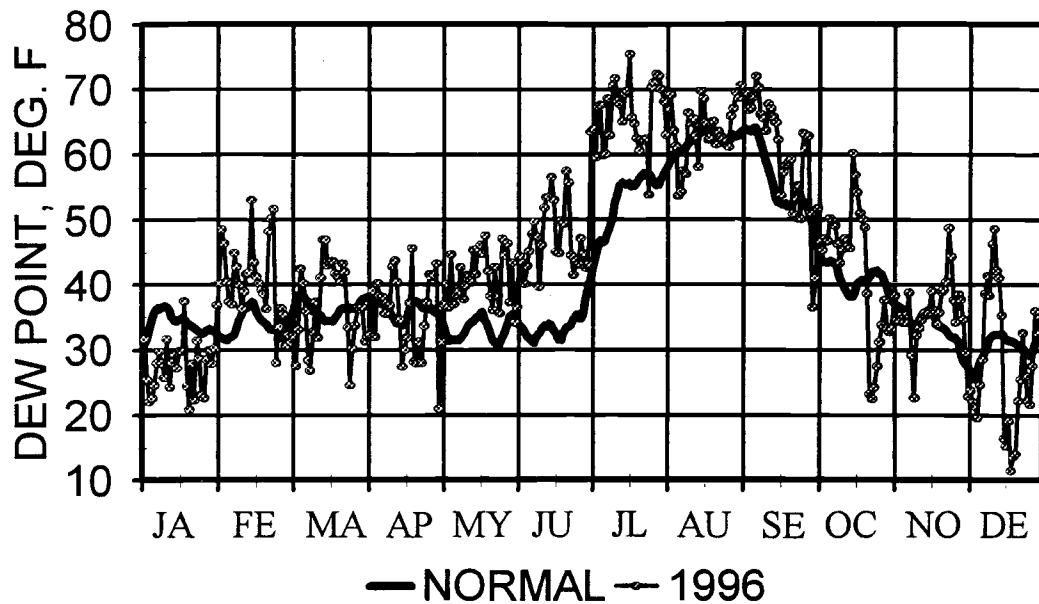


Figure 15. Dew point temperatures observed at Litchfield Park during calendar year 1996. Heavy line indicates normal conditions.

## DEW POINT TEMPERATURE: MARICOPA 1996 & NORMAL

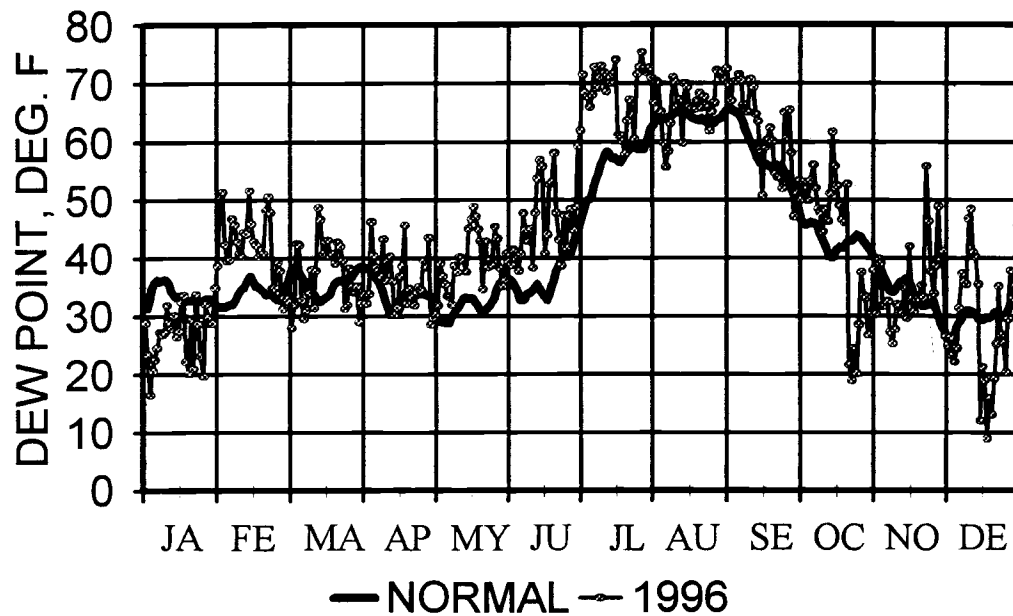


Figure 16. Dew point temperatures observed at Maricopa during calendar year 1996. Heavy line indicates normal conditions.

### DEW POINT TEMPERATURES: MARANA 1996 vs. NORMAL

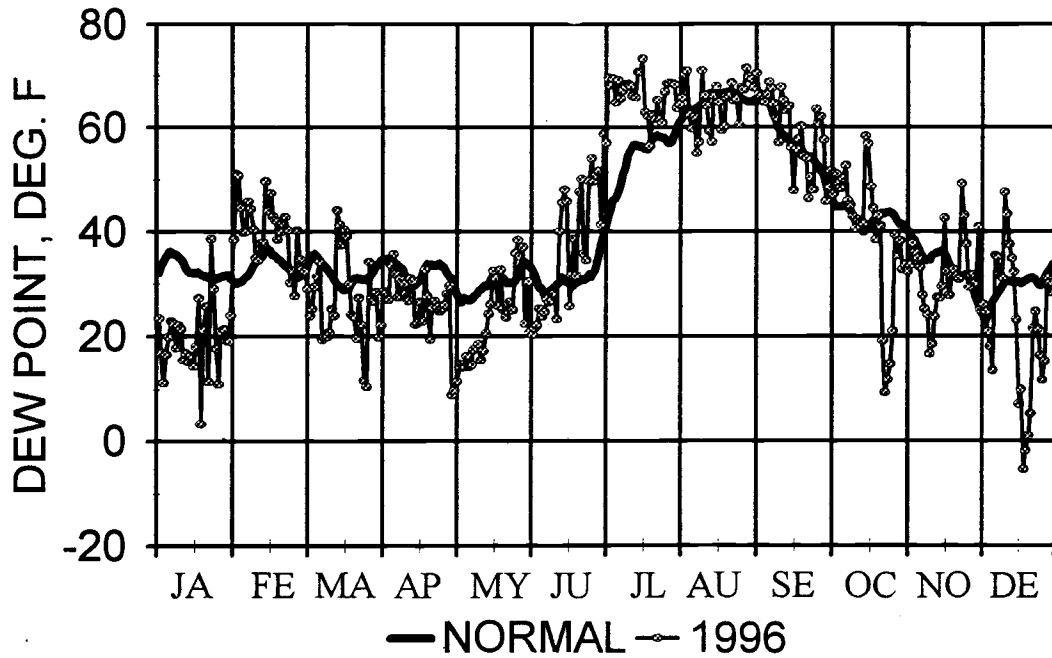


Figure 17. Dew point temperatures observed at Marana during calendar year 1996. Heavy line indicates normal conditions.

### DEW POINT TEMPERATURE: SAFFORD 1996 vs. NORMAL

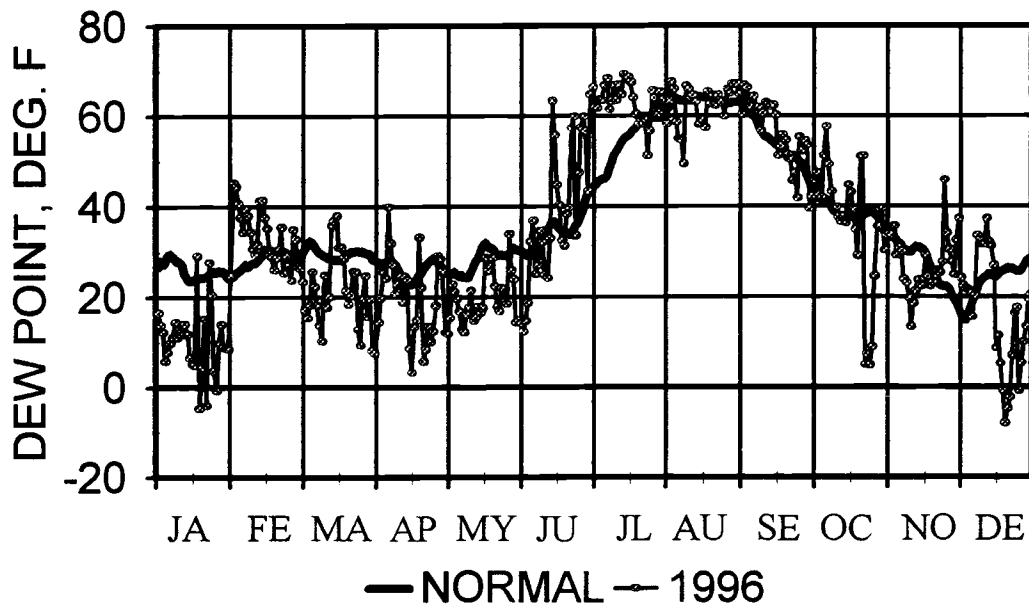


Figure 18. Dew point temperatures observed at Safford during calendar year 1996. Heavy line indicates normal conditions.

## CUMULATIVE PRECIPITATION: YUMA VALLEY 1996 vs. NORMAL

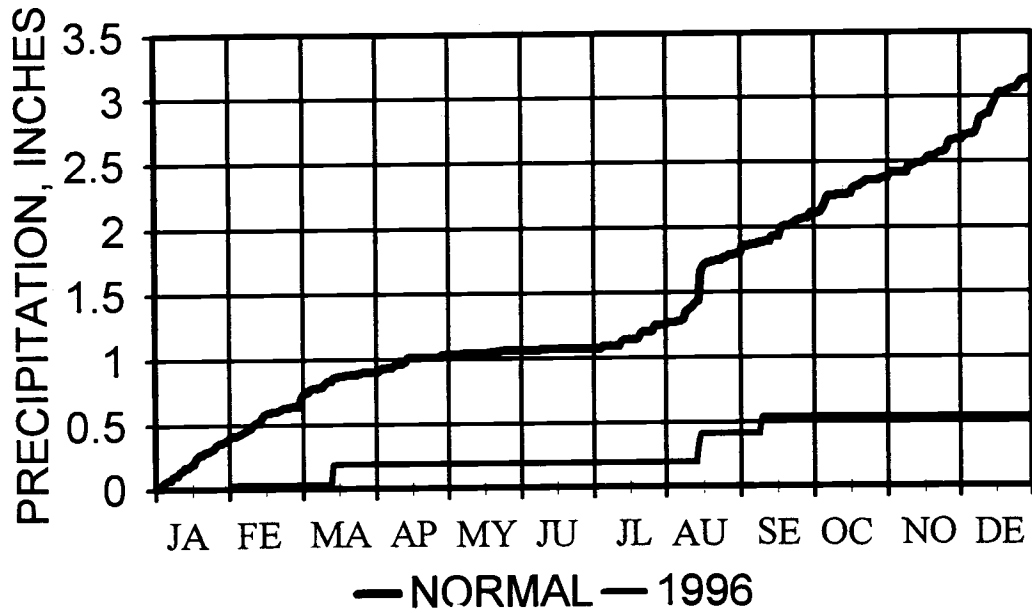


Figure 19. Cumulative precipitation observed at Yuma Valley during calendar year 1996. Heavy line indicates normal conditions.

## CUMULATIVE PRECIPITATION: PARKER 1996 vs. NORMAL

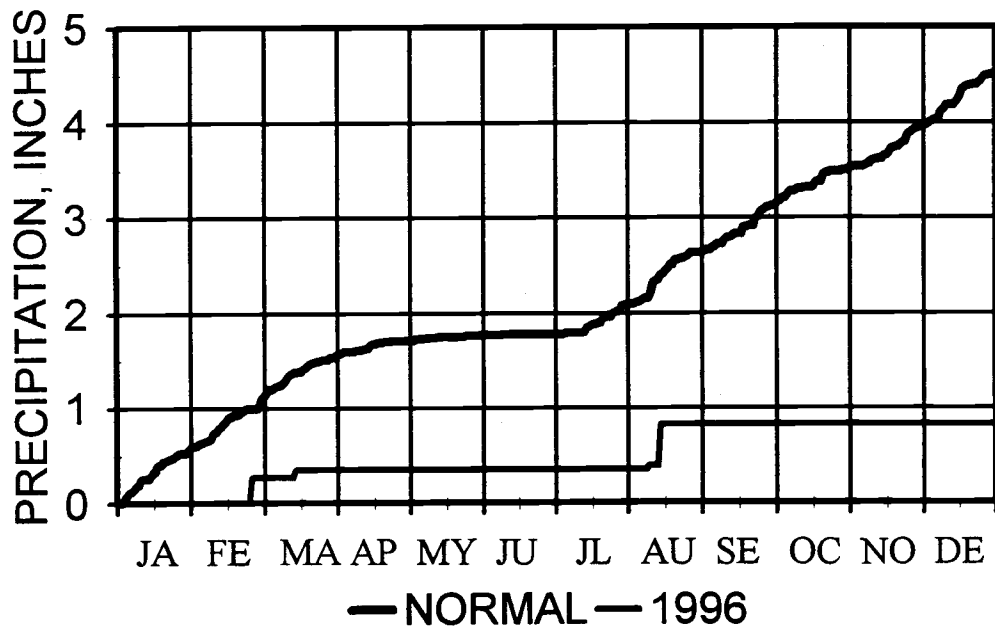


Figure 20. Cumulative precipitation observed at Parker during calendar year 1996. Heavy line indicates normal conditions.

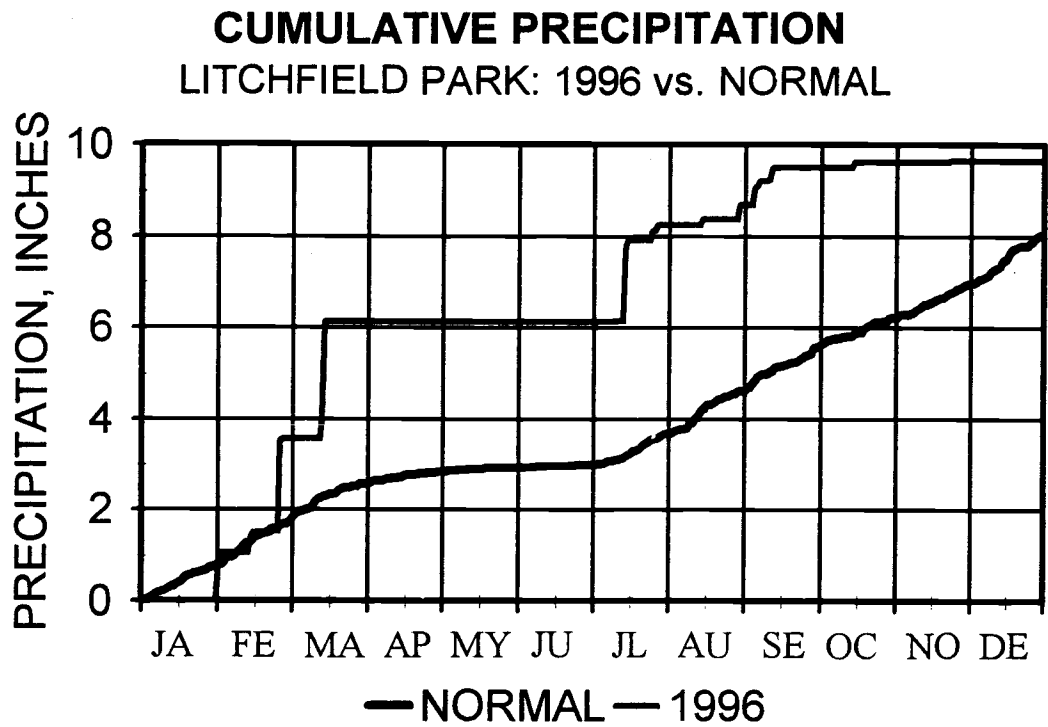


Figure 21. Cumulative precipitation observed at Litchfield Park during calendar year 1996. Heavy line indicates normal conditions.

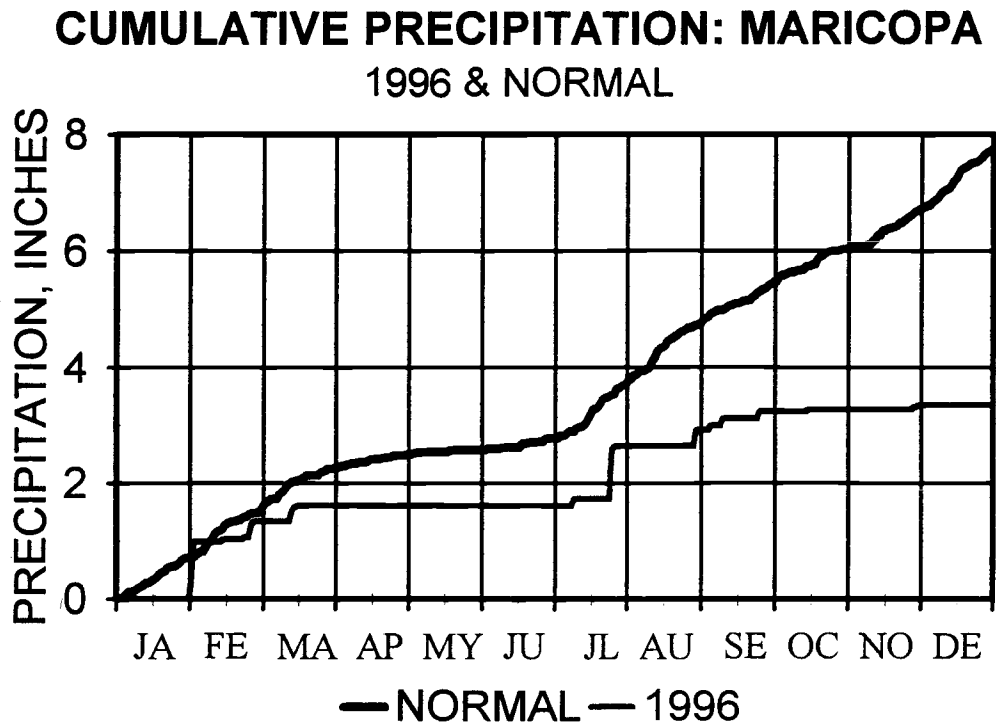


Figure 22. Cumulative precipitation observed at Maricopa during calendar year 1996. Heavy line indicates normal conditions.



## CUMULATIVE PRECIPITATION: MARANA 1996 vs. NORMAL

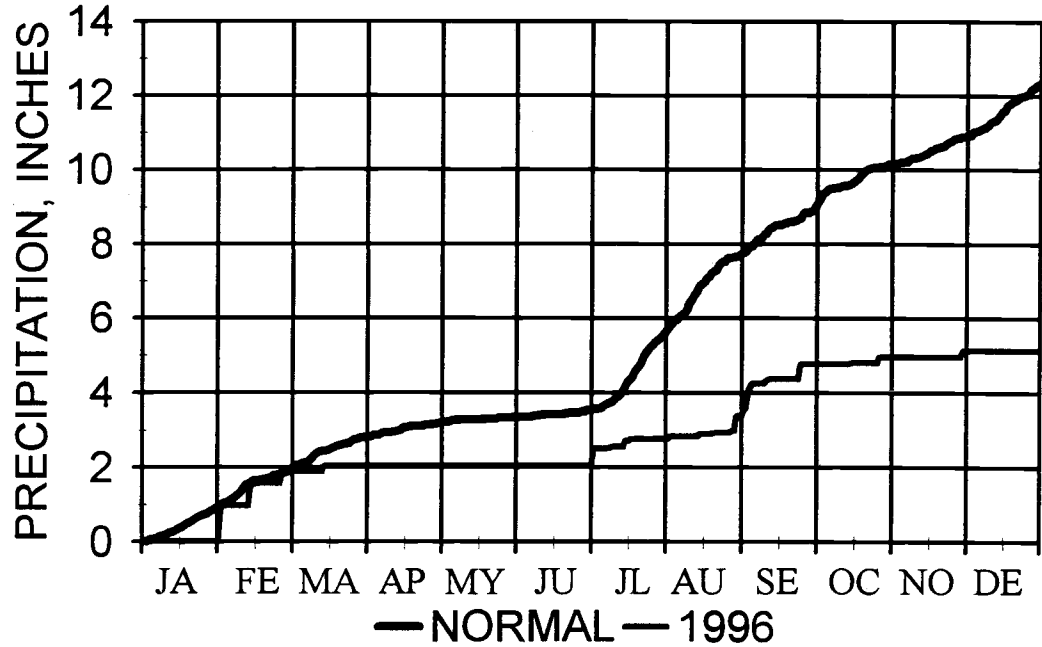


Figure 23. Cumulative precipitation observed at Marana during calendar year 1996. Heavy line indicates normal conditions.

## CUMULATIVE PRECIPITATION: SAFFORD 1996 vs. NORMAL

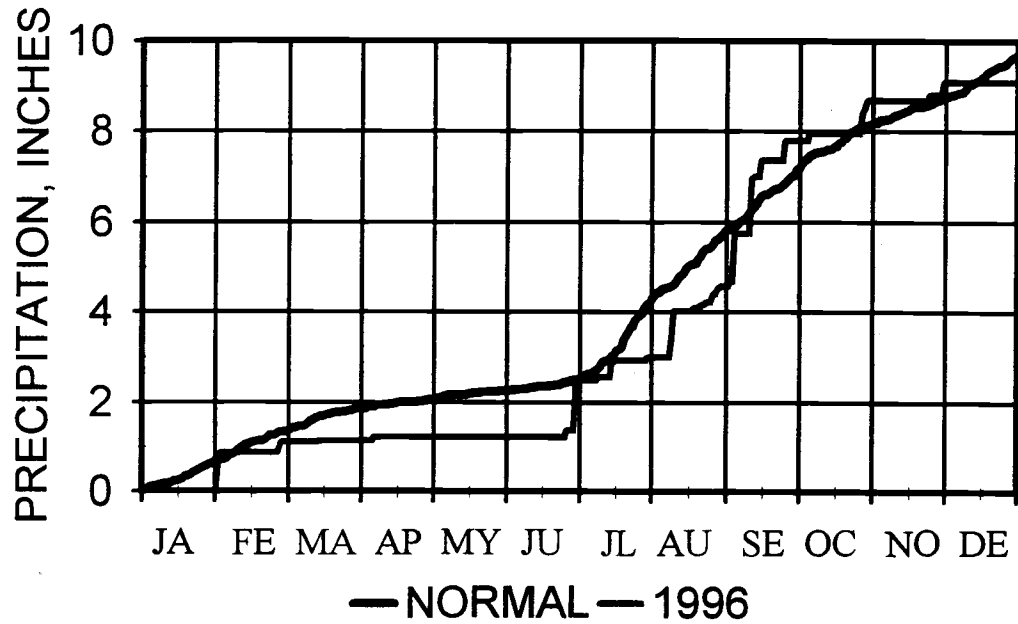


Figure 24. Cumulative precipitation observed at Safford during calendar year 1996. Heavy line indicates normal conditions.

## HEAT UNIT ACCUMULATION: YUMA VALLEY 1996 RELATIVE TO NORMAL

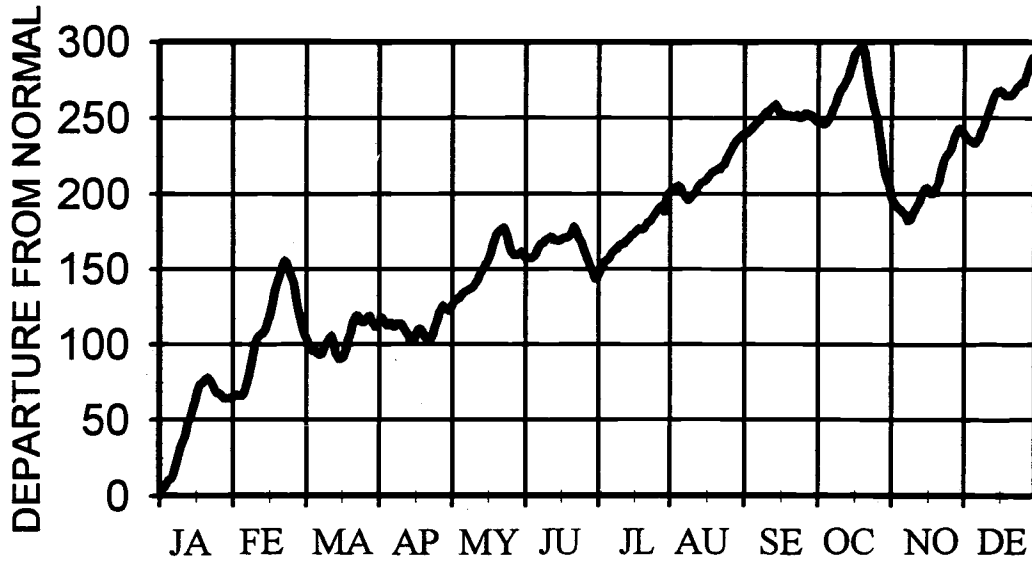


Figure 25. Departure of heat unit accumulation relative to normal for Yuma Valley during calendar year 1996.

## HEAT UNIT ACCUMULATION: PARKER 1996 RELATIVE TO NORMAL

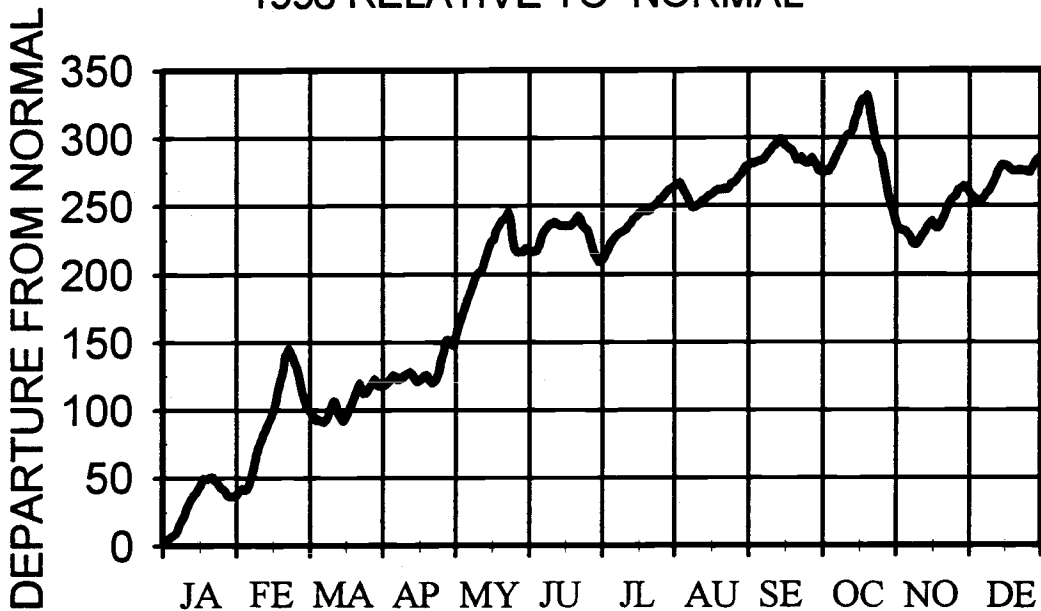


Figure 26. Departure of heat unit accumulation relative to normal for Parker during calendar year 1996.

## HEAT UNIT ACCUMULATION: LITCHFIELD PK. 1996 RELATIVE TO NORMAL

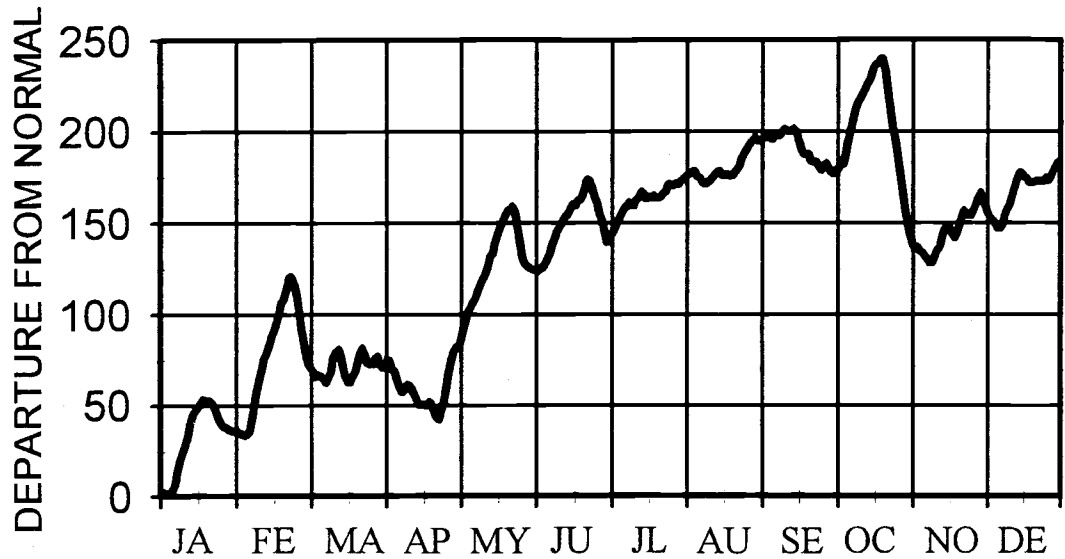


Figure 27. Departure of heat unit accumulation relative to normal for Litchfield Park during calendar year 1996.

## HEAT UNIT ACCUMULATION: MARICOPA 1996 & NORMAL

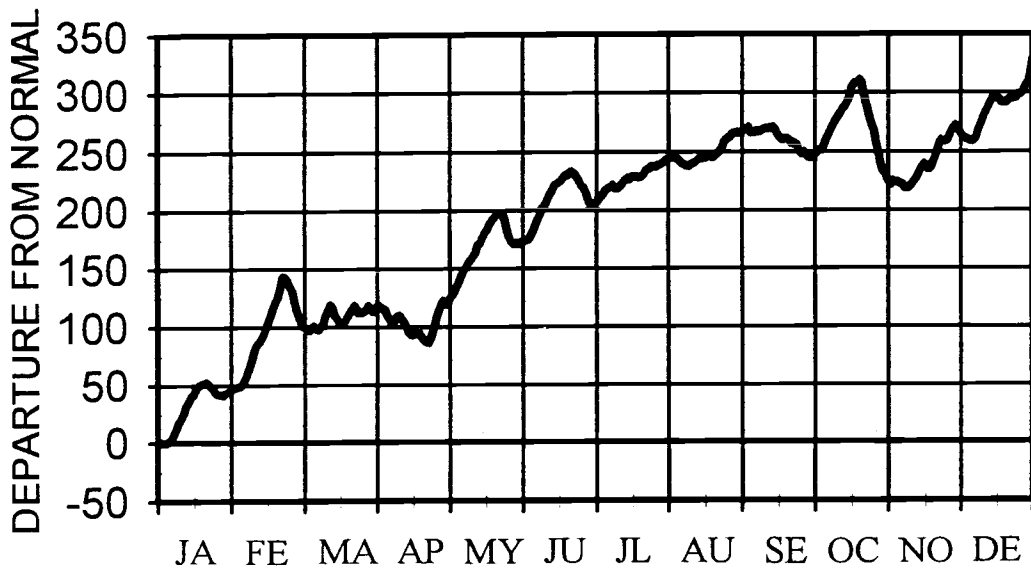


Figure 28. Departure of heat unit accumulation relative to normal for Maricopa during calendar year 1996.

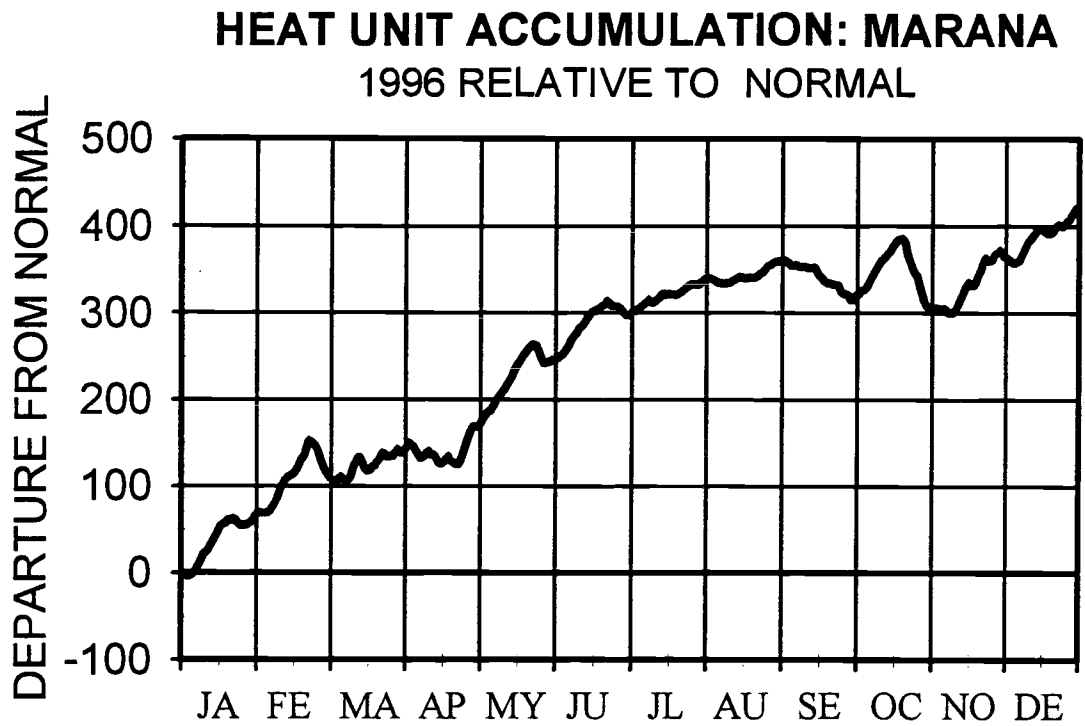


Figure 29. Departure of heat unit accumulation relative to normal for Marana during calendar year 1996.

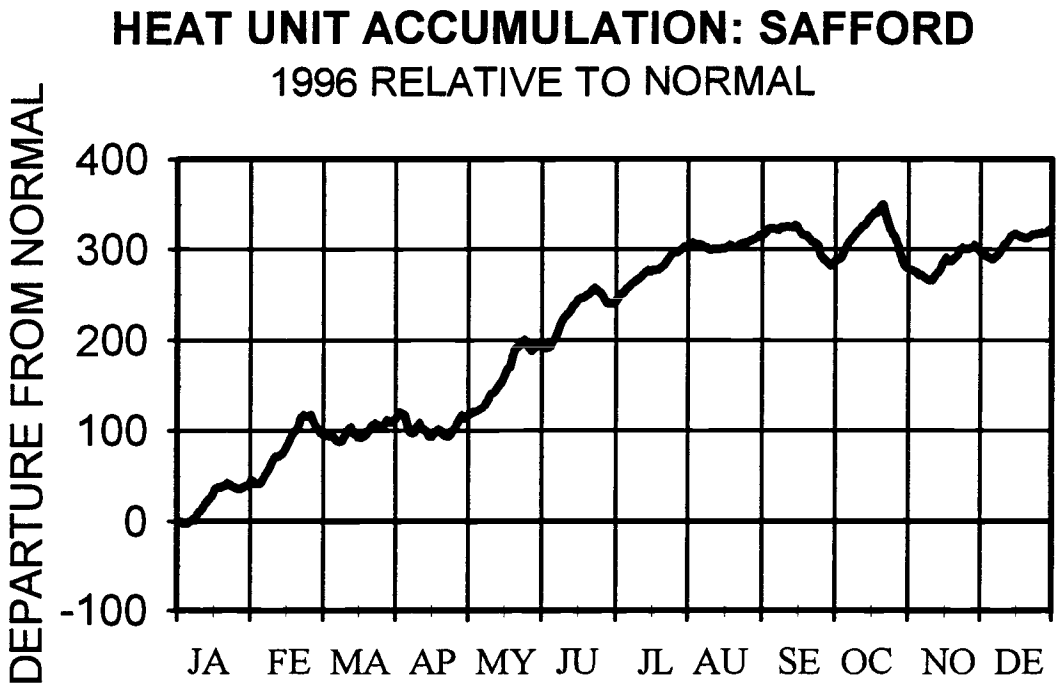


Figure 30. Departure of heat unit accumulation relative to normal for Safford during calendar year 1996.