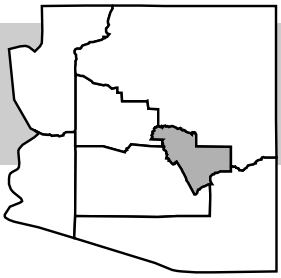
Drought Fact Sheet

Arizona Climate Division 4

(includes Globe, Miami, Payson, San Carlos)



In May 2003, U.S. Secretary of Agriculture Anne Veneman declared Arizona a drought disaster area, just as she had done a year before in May 2002. While winter 2002–2003 precipitation brought some improvements, drought and long-term water supply concerns are still key issues for Arizona decision makers. This fact sheet uses instrumental (rain gauge) and tree-ring data to compare recent dry conditions with droughts of the past.[1]

The Instrumental Record (1896–2003)

Precipitation was below average for climate division 4 (23%) in 2002, making it one of the driest years in the instrumental record. Cool-season precipitation[2] (November–April) was

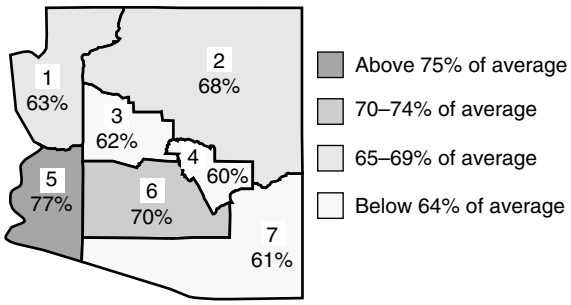
- 12.1% of average in 1904
- **23.0% of average in 2002**
- 25.6% of average in 1972
- 35.1% of average in 1921
- 36.0% of average in 1971

Based on five-year precipitation averages, 1999–2003 was one of the driest spells on record for this climate division. The driest five-year averages of cool-season precipitation were

- 55.8% of average for 1900–1904
- **59.7% of average for 1999–2003**
- 66.7% of average for 1946–1950
- 69.6% of average for 1955–1959
- 71.6% of average for 1970–1974

It is important to point out that drought conditions in Arizona can vary considerably across space. For example, cool-season precipitation throughout Arizona between 1999–2003 was below average statewide, but some areas experienced drier conditions than others.

Arizona 1999–2003 Average Precipitation by Climate Division



Tree-Ring Records (AD 1000 to 1896)

Precipitation reconstructions from AD 1000 to AD 1896 for climate division 4 show only a few years that were drier than 2002. The driest winters in the reconstruction were

- 1773, with 19.8% of average precipitation
- 1664, with 23.6% of average precipitation
- 1150, with 25.6% of average precipitation
- 1670, with 32.9% of average precipitation
- 1685, with 33.8% of average precipitation

The driest five-year periods were

- 1664–1668, with 50.6% of average precipitation
- 1778–1782, with 58.4% of average precipitation
- 1773–1777, with 60.5% of average precipitation
- 1250–1254, with 60.9% of average precipitation
- 1214–1218, with 61.6% of average precipitation

The driest ten-year periods were

- 1662–1671, with 57.6% of average precipitation
- 1773–1782, with 59.5% of average precipitation
- 1085–1094, with 67.8% of average precipitation
- 1245–1254, with 68.6% of average precipitation
- 1437–1446, with 70.7% of average precipitation

Notes:

[1]The mechanisms that lead to any specific drought period may be different from one drought to the next, making estimation of severity and duration difficult. Also, the climate system may be in a different state today than in the past, making comparisons with past droughts troublesome. The rankings presented may vary with season, data type, and period of record used in the analysis.

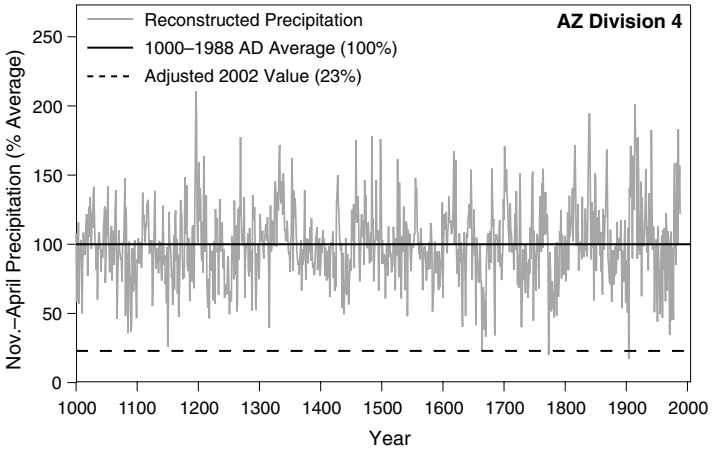
[2]While a single year or range of dates is given for simplicity, cool-season precipitation estimates are for November–April. For example, data listed for 2002 would actually be from November 2001 to April 2002.

Using Tree Rings to Reconstruct Precipitation

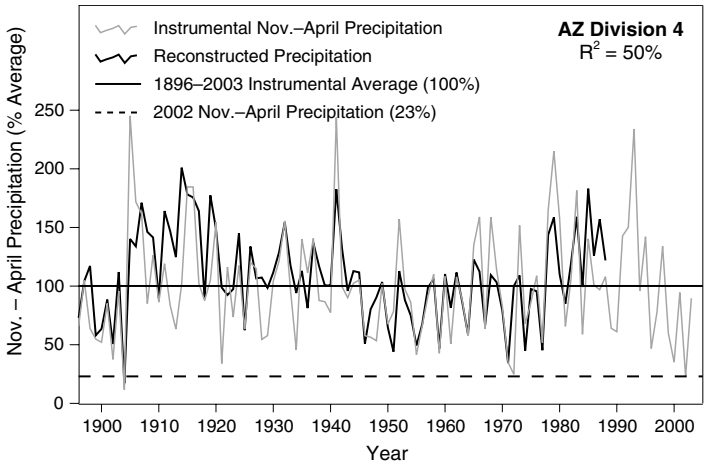
The formation of annual rings in trees can be related to climate using statistics and knowledge of the physical mechanisms responsible for ring growth. In the Southwest, the ring width of many tree species depends primarily on the amount of precipitation that falls, especially during the cool season (November–April).

Multi-year reconstructions and data, as well as details about the data adjustment method are available on our website: http://www.ispe.arizona.edu/climas/research/paleoclimate/product.html

Estimates of cool-season precipitation for climate divisions in Arizona and New Mexico for the period AD 1000–1988 were developed from hundreds of trees growing in many different areas across the West. Tree rings do best at estimating low precipitation totals, as a lack of precipitation limits tree growth. The values displayed here use linear statistics, in order to capture estimates of low precipitation, and nonlinear statistics, in order to improve estimates of high precipitation.



The graph to the right (top) shows a precipitation reconstruction for Arizona climate division 4; values are expressed as a percentage of 1000–1988 average precipitation. The adjusted 2002 average for this climate division is provided for comparison (dashed line). The reconstruction indicates that only a few years in the past thousand years were drier than 2002. Several extended dry periods stand out, particularly the late 1000s, mid-1200s, mid-1400s, late 1500s, late 1600s, late 1700s, late 1800s, and the 1950s.



The bottom right graph shows a comparison between instrumental and reconstructed November–April precipitation for Arizona climate division 4. The graph shows excellent agreement between the tree-ring and instrumental records over most of the 20th century. The R^2 value, in this case 50%, indicates the amount of variation in the instrumental precipitation record captured by the tree rings. A higher R^2 percentage reflects a more reliable reconstruction.

Data for this fact sheet was prepared by:
Kurt F. Kipfmueller, Research Associate
Laboratory of Tree-Ring Research
University of Arizona
Email: kurt@ltrr.arizona.edu
Ph: (520) 621-9731
http://www.ltrr.arizona.edu/

Based on research by:
Fenbiao Ni, UA Laboratory of Tree-Ring Research
Tereza Cavazos, CICESE, Mexico
Malcolm K. Hughes, UA Laboratory of Tree-Ring Research
Andrew Comrie, UA Geography and Regional Development
Gary Funkhouser, UA Laboratory of Tree-Ring Research

Last update: October 14, 2003

For further information:
Gregg Garfin, Assistant Staff Scientist
CLIMAS/Institute for the Study of Planet Earth
University of Arizona
Email: gmgarfin@email.arizona.edu
Ph: (520) 622-9016
http://www.ispe.arizona.edu/climas/

The Climate Assessment for the Southwest (CLIMAS) project was established by NOAA, in conjunction with the University of Arizona, to assess the impacts of climate variability and longer-term climate change on human and natural systems in the Southwest. Our mission is to improve the ability of the region to respond sufficiently and appropriately to climatic events and climate changes.