Climate & Water in Arizona

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Pima County Local Drought Impacts Group
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• (a) Southern shift of ITCZ in January.
  Figure 7.9 in *The Atmosphere, 8th edition*, Lutgens and Tarbuck, 8th edition, 2001.
(b) Northern shift of ITCZ in July. Figure 7.9 in *The Atmosphere, 8th edition*, Lutgens and Tarbuck, 8th edition, 2001.
Ocean Circulation

[Map of ocean currents with labels and arrows indicating warm-water and cold-water currents.]
Moisture Sources
Moist Air Mass Ascends Ridge

Heavy Rain

Rain Shadow Region

Drier Air Descends and Warms
Winter Storm Pattern

Surface Weather Map at 7:00 A.M. E.S.T.
Monsoon Monthly Precipitation

D.S. Gutzler, et. al. 2004, BAMS, Fig. 2.
Average Annual Precipitation

Precipitation (in)
- 3.00 - 11.00
- 11.01 - 17.00
- 17.01 - 23.00
- 23.01 - 29.00
- 29.01 - 45.00
Arizona has two distinct wet seasons

Flagstaff Avg 20.65”

Winter precipitation has greatest impact in northern half of Arizona and high elevations.

Summer precipitation is the dominant precipitation season in the southern half of Arizona.

Tucson Avg 11.44”
Average August Precipitation

Precipitation (in)
- 0.25 - 1.25
- 1.26 - 2.25
- 2.26 - 3.25
- 3.26 - 4.75
- 4.76 - 7.25
El Niño-Southern Oscillation (ENSO)

- Redistribute energy, moisture
- Persistent changes: Duration 1-3 years
- Recur every 2-7 years

Slide courtesy of Greg McCabe, USGS
Arizona statewide October thru March Precipitation
(versus Southern Oscillation Index for prior June - November)

Years used
1933/34 - 1996/97

Correlation
-0.54

20.23 cm / 7.97"
16.28 cm / 6.41" (all)
11.22 cm / 4.42"

Western Regional Climate Center
Pacific Decadal Oscillation

• Discovered in 1990s
• Occurs every 20-30 years

Courtesy of N. Mantua – University of Washington
Mantua et al., 1997 Bulletin of the American Meteorological Society
AZ PDO (Oct.-Sept.) Precipitation % Average

Negative PDO

Positive PDO

Based on Maxwell and Holbrook, NWS Tucson
Pacific Decadal Oscillation - PDO

monthly values for the PDO index: 1900 - August 2012

Dry Southwest

http://jisao.washington.edu/pdo
Atlantic Multidecadal Oscillation (AMO)


North Atlantic Sea Surface Temperatures
Warm (positive) – Cool (negative)
20-40 year long phases (~ 60-80 yr cycle)

AMO – Warm (positive) phase – more frequent (or severe) droughts in SW.
Global Climate Models Predictions for Precipitation Change 2080-2099

- Annual
- Summer (JJA)
- Winter (DJF)
Climate Change Precipitation projections for the period 2091-2200

Figure 3. Projected annual precipitation changes from 2091 to 2100.*

*Changes are relative to 1971–2000 averages. Credit: Three maps drawn by JL Weiss, UA; Data from Hoerling and Eischeid NOAA ESRL
Climate Change Temperature projections for the period 2091-2200

**Figure 1.** Projected June–August temperature changes from 2091 to 2100.*

**Figure 2.** Projected December–February temperature changes from 2091 to 2100.*

*Changes are relative to 1971–2000 averages. Credit: Three maps drawn by JL Weiss, UA; Data from Hoerling and Eischeid NOAA ESRL*
Jan-Mar Average Temperatures (Climate Divisions)

Year

Temperature (F)

Mohave - Colorado Plateau - Yavapai

Gila County - Southeast and Southern Counties - Maricopa & Pinal Counties
St. Johns on the Northeast Plateau (elev 5790 ft.)

Increase in annual temperatures – very rural location

Decreasing trend in days below freezing
Lake Mead Water Level

Federal Shortage Level is 1075 ft.
Arizona Precipitation depends on:

- Positions of persistent pressure patterns that control regional circulation and wind direction, and the position of the jet stream.
- Atlantic and Eastern Pacific sea surface temperatures which control teleconnections like El Niño.

The big question is:

- How will these change in the future, and will they change in a similar way as they have in the past?