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END InSight

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Monsoon brings relief, but not likely to end drought conditions

By Melanie Lenart & Rebecca Carter

Everyone knows that the monsoon can spell relief for parched plants and Southwesterners weary of the sun's incessant glare. But just how likely is it that this year's monsoon will break the current drought that grips much of Arizona and New Mexico?

Not very likely, any way you look at it. Using Tucson as an example, rainfall records from 1895-2001 show that drought occurred in 17 of those years; but in only four was the monsoon sufficient to break the drought, according to Andrew Comrie, a University of Arizona climatologist and geography professor involved in CLIMAS' END Insight Initiative.

Comrie stated that the Tucson area would need 9 to 12 inches of precipitation over the three-month monsoon period to break the current drought, compared to an average of 6 to 7 inches during the season. NOAA has given the likelihood of sufficient rain falling to end the drought only a 2 or 3% chance.

It is far more likely that enough rain will fall to at least ease the current drought situation, if not totally eradicate it. Comrie believes that there is a 15 to 20% chance that enough rain will fall to bring parts of the region out of severe drought (measured at –4 on the Palmer Drought Severity Index) up to –2, or moderate drought conditions. Significant improvements have already been noted in southeastern Arizona and western New Mexico.

Predicting the strength of a monsoon season, however, challenges climatologists because of the many complexities involved. Various researchers have found evidence that summer rainfall correlates to a number of factors, including snowpack and changes over the Pacific Ocean. But climatologists are still working out the details of this intriguing system.

Researchers are also challenged to better forecast which locations will benefit from the monsoon's spotty storms, which can leave some places lush and green from abundant rainfall, while neighboring areas remain dry and brown when the rain misses them. Although some localized areas do seem to recurrently receive higher rainfall amounts, these areas can shift over time. Precisely why this happens is not fully understood; nor can it be forecast with a high degree of certainty.

The term "monsoon" describes the change in wind direction that occurs near the beginning of summer, bringing with it the clouds that played hooky during spring.

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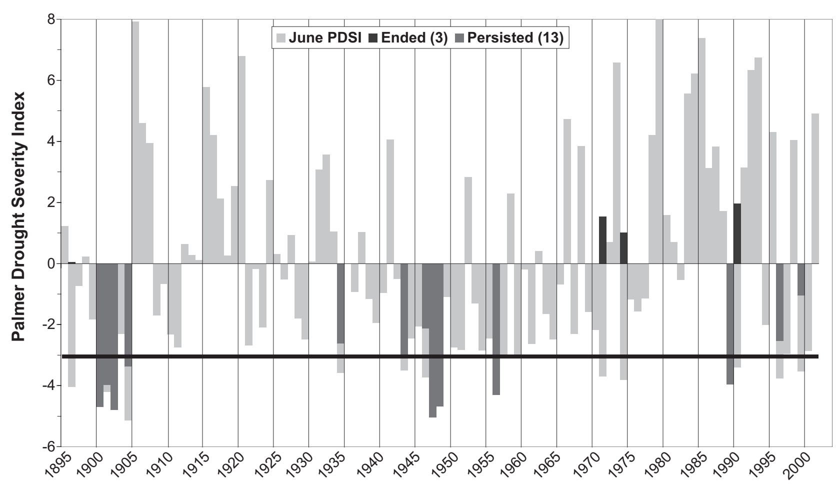

Does the monsoon end drought? Southeastern Arizona experienced 17 years of severe drought from 1895-2001 (indicated by PDSI below -3 for month of June). Monsoon rains ended drought conditions (indicated by PDSI > -0.5 for September) in only four of those years. Source: National Climatic Data Center.

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Monsoon, continued

The winds of change tend to bring rain around July 3 to the southern New Mexico and around July 6 to southern Arizona, give or take about two weeks. Monsoon conditions then migrate north over the ensuing week or so.

It's no coincidence that the arrival of the North American monsoon comes on the tail end of the hot, dry spring. As with the much stronger Asian monsoon that graces and sometimes floods India, the change in wind direction is driven by the heating of the land.

Hot air rises off the heated land, causing nearby air to rush in to fill the void. In much the same way a stiflingly hot morning sets the stage for a midday updraft, the seasonally heated land surface draws in the raw material of sea breezes. This coastal air is filled with moisture evaporated from the nearest seas. The Gulfs of Mexico and California fuel the North American monsoon, with some backup from the Pacific Ocean.

According to David Gutzler, a climate researcher at the University of New Mexico in Alburquerque, the strength of the North American monsoon can be related to snowpack on nearby mountaintops. However, the relationship holds better for New Mexico than for Arizona. In an analysis published in the *Journal of Climate* (Volume 13, page 4018), he found that April 1 snowpack at four key Southwestern stations explained about 61% of New Mexico's summer rainfall variation and about 30% of Arizona's summer rainfall variation for the period 1961-1990.

"Our speculation was that if there is a snowpack effect, it seemed plausible that land surface forcing (i.e., heating) might affect New Mexico more than Arizona simply because we're farther from monsoon moisture sources," said Gutzler.

"Snowpack was really low this year in the parts of the Rockies that we've looked at that show this correlation," he pointed out. Similarly, Arizona snowpack was only about 25% of the usual amount.

Although this type of empirical study cannot confirm a cause-effect relationship, he notes that the correlation fits the expectation that snowmelt would temper the heating of the land, thus leading to a weaker monsoon. The reverse also holds, which appears so far to be good news for the Southwest this summer.

However, for reasons that remain mostly unexplained at this point, the dry winter / wet summer relationship falls apart somewhat when other periods are considered, such as 1951-60 and 1991-95. In some cases, snowfall events after April 1 appear to have tipped the scale. Tropical storms can also influence summer rainfall totals in ways that don't necessarily relate to the monsoon itself.

Gutzler and others continue to examine the influence of Pacific Ocean sea surface temperatures on Southwest precipitation. Two factors that come into play are the tropical Pacific Ocean changes that fluctuate year-to-year with the phase of El Niño, and slower changes in the North Pacific Ocean that influence climate on 15-30 year time scales. The 15-30 year variability in the North Pacific seems to have an effect on short-term wintertime atmospheric connections between the Pacific and the North American continent (the so-called "Pacific / North American (PNA) teleconnection," a circulation pattern that plays out in the atmosphere somewhere between 2-4 miles above the earth). Atmospheric variations associated with these long-term changes in the North Pacific Ocean also seem to be connected to multi-year precipitation variations across the Southwest in the 20th century, such as the severe long-term drought in the 1950s.

Gutzler suspects the rather weak correlation he found for El Niño and summer rainfall occurs because El Niño tends to increase winter precipitation in the Southwest. The heavier snowfall then goes on to weaken the monsoon. Similarly, he believes that the positive phase of the PNA teleconnection pattern that heralds wet summers in Arizona again relates to snowfall, because his work with others has correlated a positive PNA index with low snowpack.

If monsoon strength were only dependent on snowfall, the Southwest could be in good shape for the ongoing season. However, a long-term drought would have a tendency to weaken the North American monsoon, albeit spottily. For instance, during the 1950s drought, monsoonal rains were in short supply in Las Cruces, New Mexico, but not in Tucson (*Journal of Climate,* Volume 11, page 3130).

All in all, it seems Southwesterners can hope for some temporary relief from the ongoing drought. At the very least, the monsoon promises to provide cloud cover that will slow the evaporative drain of water from the landscape. At best, it can replenish soil moisture in some local areas, giving vegetation a fighting chance in the potentially dry months to come.