# The Four Peaks Post

Fall 2014

National Weather Service — Phoenix, AZ

**Inside this issue:**



**Office Leadership**

**Meteorologist in Charge**

Vacant

**Warning Coordination Meteorologist**

Ken Waters

**Science and Operations Officer**

Vacant

**Questions**:

w-psr.webmaster@noaa.gov

## Fall Edition of

## The Four Peaks Post Newsletter!

By Charlotte Dewey, Meteorologist Intern

Another Monsoon has come to a close. As many years can usually be remembered by a select few events, there were a number of significant events that transpired this summer that are noteworthy. Everyone may remember something different, so we will give a Meteorological and Climate perspective view. As we rapidly approach the Winter Solstice, we can look forward to cooler temperatures and seasonal change in the Desert Southwest.

We look forward to many more newsletters coming out with great information that will hopefully be helpful and informative.

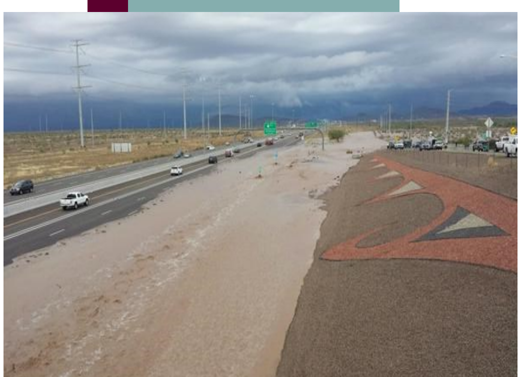
Image credit Dave Dilli Photography 2010

# Revisiting Precipitation Recurrence Intervals

By Mike McLane, Senior Service Hydrologist

***Minor updates to article to correct terminology***

A previous edition of this newsletter discussed use of precipitation frequency or recurrence interval data by the National Weather Service to help assess the rarity of precipitation events. We explained that a recurrence interval is an estimate of the interval of time between events and that it is sometimes referred to as return period. This article will provide additional information on proper interpretation and use of interval data.



**I-17 flooding from August 19, 2014 New River, AZ Flooding.**

**Photo courtesy: Flood Control District of Maricopa County**

The tail end of this year's monsoon season brought much needed rainfall to south-central Arizona. However, this rain also resulted in extensive flooding and property damage. The numerous heavy rain events in August and September generated considerable interest from the public and media on the rarity of these heavy rainfall events. Our office was asked to provide an assessment of the recurrence intervals for these events. Everyone knew these were rare events, but were they 100 year, 500 year, or maybe even 1000 year events?

The National Weather Service seldom shies away from providing direct answers to questions we are asked, but in this case we did the ole "soft shoe tap dance." After reading the remainder of this article, hopefully you will understand the reasoning for this.

Recurrence intervals are developed using historical rainfall data. These records are only available for a small number of gages and for a relatively short period of record (generally less than 150 years). Statistical equations have been developed that interpolate between data points and extrapolate recurrence intervals well beyond the period of data record. This can result in considerable uncertainty in the recurrence estimates, especially for extreme events.

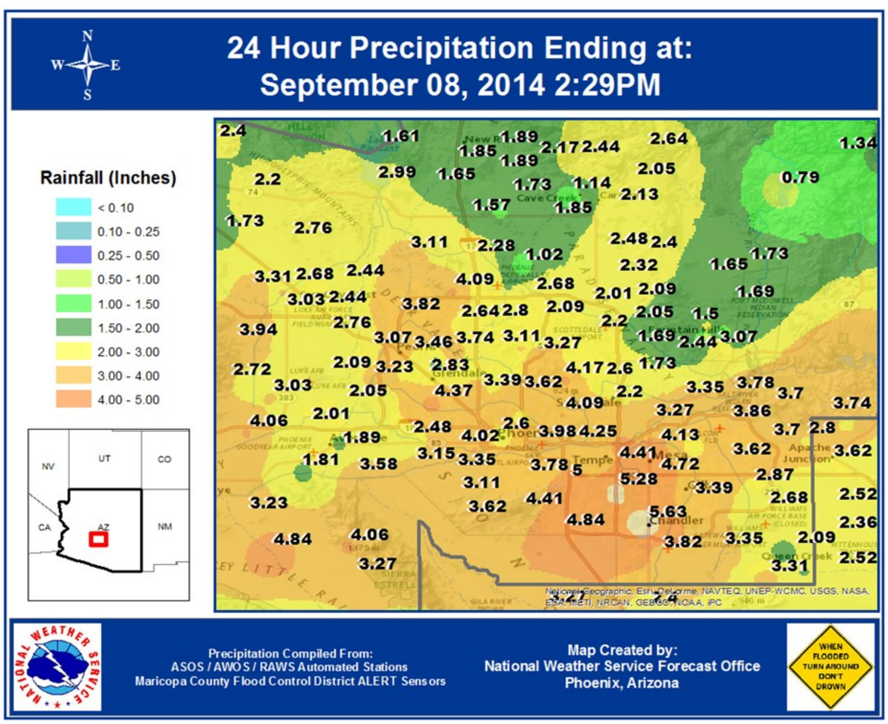
There also is considerable confusion as to what exactly a recurrence interval means. Take for instance the occurrence of a 100 year event. Does this mean another 100 years will past before a similar event repeats? The correct answer is no. In fact, another 100 year event could occur tomorrow. We are really talking about the probability of reoccurrence. For a 100 year event, there is a 1 percent chance of the event occurring in a given year. A good analogy is a coin toss. It is possible for the coin to come up heads two, three, or even more times in a row even though the probability of a head on a single toss is only 50 percent. Similarly, consecutive storm systems can produce back to back 100 year events even though the probability of getting one 100 year event in a year is only one percent.

(Continued next page)

# Continued: Revisiting Precipitation Recurrence Intervals

We also must consider the spatial coverage or extent of storms. Precipitation frequency estimates are derived for points. Although the probability of a single point receiving a 100 year event in a year is only one percent, during that same year there may be several points receiving one hundred year events within the spatial area that encompasses these adjacent points. The probability of either of these points, or multiple points in an area (say the Phoenix metropolitan area) receiving what would be a 100 year event for a single point is much greater than 1 percent for the year.

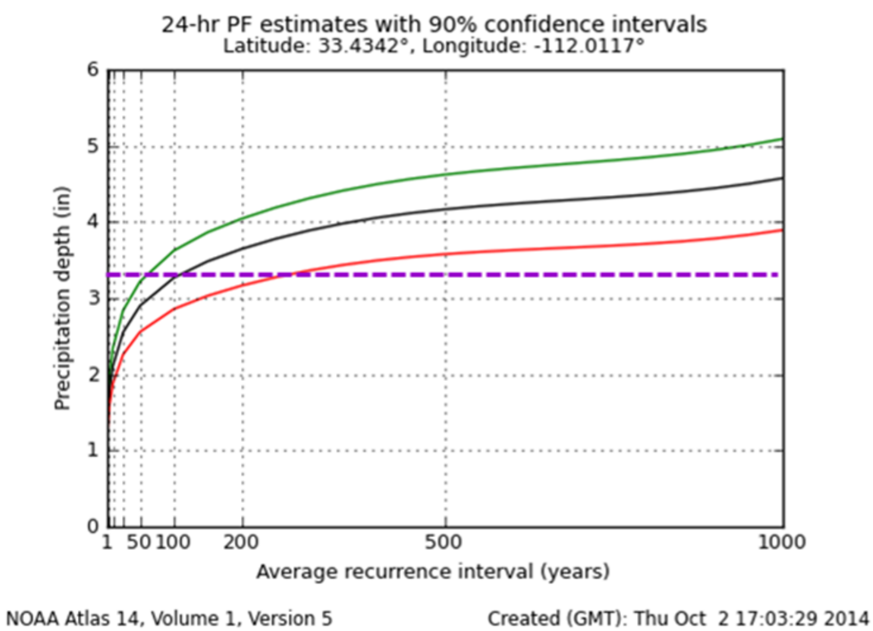
The rain that fell across the Phoenix metropolitan area was pretty historic. As seen in the graphic below, widespread totals in excess of three inches occurred across the region and some reports of around six inches were received from the southeast valley. Phoenix Sky Harbor International Airport received 3.30 inches, establishing record rainfall amount for this date (September 8) as well as a daily rainfall record for the most rainfall on a calendar day in the history for Phoenix. This is the most rainfall received at the official Phoenix observing site since observations began in 1895. So let's put this rainfall into perspective.

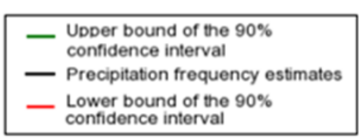



(Continued next page)

# Continued: Revisiting Precipitation Recurrence Intervals

The graph below shows the 24-hour precipitation recurrence intervals for a point located exactly at Sky Harbor. The horizontal purple line shows the 3.30 inch precipitation amount that was measured on September 8th. If we follow this line to the right to where it intersects the black curved line, and then drop vertically to the horizontal axis, we can find an estimate of this event's precipitation frequency. In this case, we find the recurrence interval to be about 100 years. This seems reasonable considering the rainfall that occurred eclipsed a record dating back to 1895. There is, however, some uncertainty in this estimate. A measure of this uncertainty can be determined by checking where the purple dashed line intersects the green and red curved lines. These two lines provide the upper and lower bounds of the 90 percent confidence interval. Following these intersection points vertically to the horizontal axis, you can see the upper and lower bounds of our estimate are about 50 years and slightly more than 200 years. So, we can say with 90 percent confidence from this graph that the rain that fell at Phoenix Sky Harbor Airport on September 8th had a recurrence interval somewhere more between 50 and slightly more than 200 years (or somewhere between a 2% and 0.5% chance of occurring in any given year).




As you can see, there is quite a bit of uncertainty and subsequent confusion that can result from using recurrence intervals. This uncertainty also increases considerably for rare events, when one is using recurrence intervals that are much greater than the period of record for available rainfall observations. Hopefully this helps to better understand why the NWS tends to refrain from using recurrence interval terminology when assessing the historical significance of rainfall events. As Paul Harvey was so fond of saying, "Now you know the rest of the story."

For additional information on precipitation frequency data, visit the Office of Hydrologic Development's Precipitation Frequency Data Server at:

**http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_gis.html**

# The Four Peaks Post

## Automated Surface Observing System (ASOS)

By Walt Jameson, Electronics Technician

The Automated Surface Observing System (ASOS) is a joint effort of the National Weather Service (NWS), the Federal Aviation Administration (FAA) and the Department of Defense (DOD). ASOS systems serve as the primary weather observing network for the nation. The primary function of the ASOS is to support weather forecast activities and aviation operations. ASOS data also supports meteorological, hydrological and climatological research.

The ASOS program began in the early 1990s, with the first ASOS going on line in June 1992 and the first ASOS were commissioned in September of 1992. There are now more than 1,000 ASOS, primarily located at local airports, providing current weather information on a continuous basis. The ASOS normally provides an hourly observation and is capable of transmitting an additional eleven special observations (one every six minutes).

The ASOS is capable of reporting:


The numbers in parenthesis represent the sensor in the picture

(1) Precipitation: Accumulation and precipitation beginning and ending times.

(2 & 3)Temperatures: Air and Dew Point. Sea-level pressure and Altimeter settings

(4) The Present Weather: The type and intensity of rain, snow and ice pellets (hail). Obstructions to visibility: Fog, haze, and/or dust. (Determined by data from multiple sensors)

(6) Surface Visibility: Up to 10 statute miles, referenced to the pilots point of view.

(7) Wind direction, speed, and character (gusts, squalls, and varying direction).

(8) Sky Condition: Cloud height and amount, up to 12,000 feet.

The one limitation to the ASOS is that it can only determine these conditions in the immediate area of the equipment and the area directly above the sensor site (to 12,000 ft.).

The Data Collection Platform, DCP, (5) gathers the data from the sensors and transmits it to the Acquisition Control Unit, ACU, (normally located in the Air Traffic Control Tower).

The ACU processes the data and makes it available to the Air Traffic personnel on local displays and to the rest of the world in the form if a METAR (Meteorological Aerodrome Report).

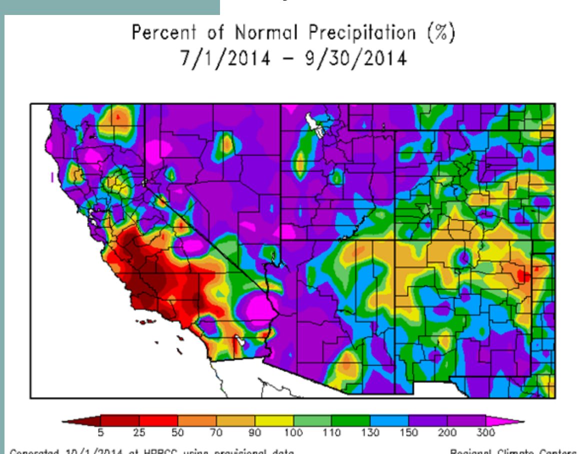
# Southwest Climate Corner

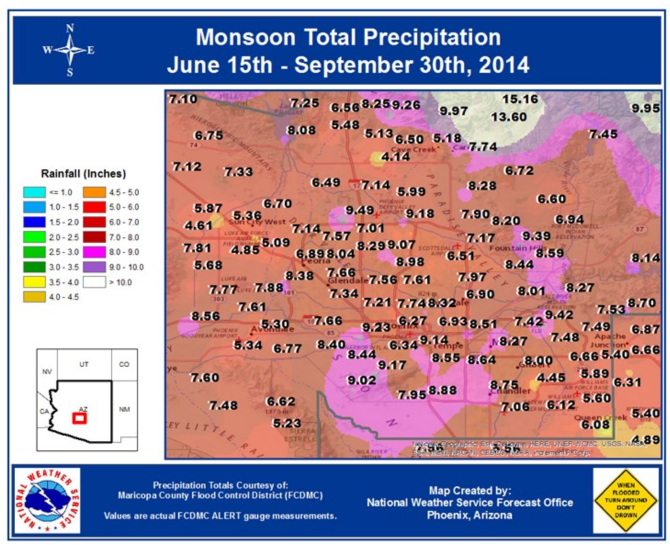
By Mark O'Malley, Forecaster/Climate Science Program Manager

| Station | June | July | August | Sept | Total (Dept) |
|---|---|---|---|---|---|
| Deer Valley | 0.00 | 0.71 | 2.57 | 3.73 | 7.01 (+3.55) |
| Scottsdale | 0.00 | 0.32 | 2.47 | 3.90 | 6.69 (+3.57) |
| Lost Dutchman SP | 0.00 | 2.01 | 1.24 | 5.89 | 9.14 (+5.21) |
| Carefree | 0.00 | 0.67 | 4.06 | 4.25 | 8.98 (+5.57) |
| East Mesa | 0.00 | 0.69 | 1.10 | 6.83 | 8.62 (+4.90) |
| Tempe | 0.00 | 0.27 | 1.13 | 6.11 | 7.51 (+4.39) |
| Litchfield Park | 0.00 | 0.53 | 2.38 | 5.40 | 8.31 (+5.27) |
| Youngtown | 0.00 | 0.87 | 1.10 | 4.23 | 6.20 (+3.23) |

Monsoon season 2014 (June 15-Sept 30) was one of the most active in recent memory for the region. In fact, many observation stations recorded at least double the normal amount of monsoon season rainfall this year. For Arizona and southeast California, this was the third consecutive season of above normal activity and beneficial rainfall. This active season once again temporarily helped improve short term drought conditions, though longer term drought continues.

Within the Phoenix metropolitan area, rainfall totals were much above average across the entire city. Unlike the past 2 years, where rainfall was more spotty and only some of the metro received heavy amounts, this year provided generous rain for just about everybody. In some cases, the 2014 monsoon rainfall totals approached and exceeded what normally would be expected for the entire calendar year.




| City | June 15-30 2014 Rainfall | July 2014 Rainfall | Aug 2014 Rainfall | Sept 2014 Rainfall | Monsoon Rainfall |
|---|---|---|---|---|---|
| Phoenix | 0.00 (-0.02) | 0.06 (-0.99) | 1.17 (+0.17) | 5.11 (+4.47) | 6.34 (+3.63) |
| Yuma | 0.00 (-0.01) | 0.28 (-0.01) | 0.49 (+0.02) | 1.44 (+0.91) | 2.21 (+0.91) |
| Tucson | 0.00 (-0.15) | 1.43 (-0.82) | 1.89 (-0.50) | 2.76 (+1.47) | 6.08 (+0.00) |
| Flagstaff | 0.00 (-0.21) | 4.32 (+1.71) | 5.31 (+2.20) | 3.10 (+0.72) | 12.73 (+4.42) |

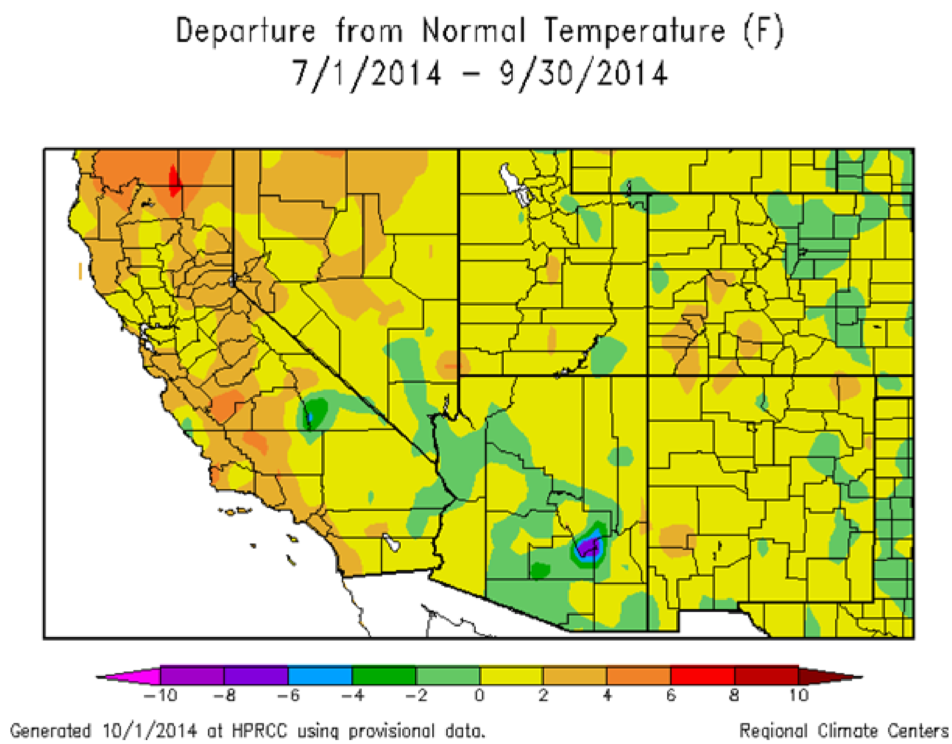
(Continued next page)

# Continued: Climate Corner

**Temperatures:**

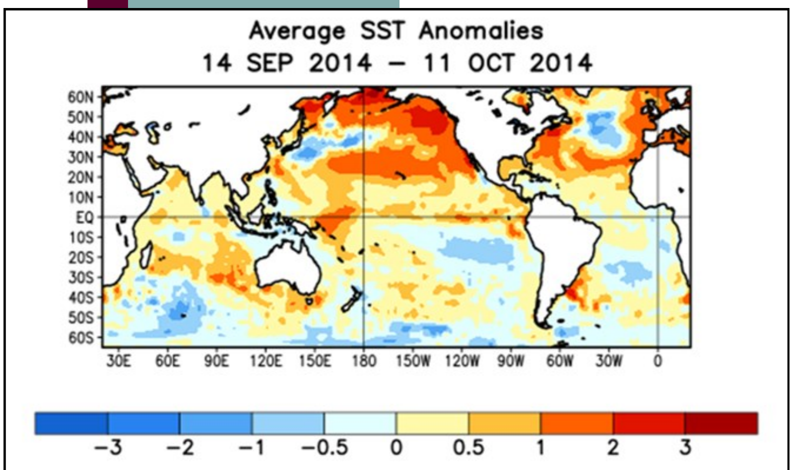
When averaged over the entire monsoon season, temperatures across the region were near to slightly above normal (normals are calculated for the 1981-2010 period). The most persistent and excessive heat occurred during the middle and end of July, however the summer as a whole saw fewer 110 degree days than is typical.

| City | June 2014 Avg Temp | July 2014 Avg Temp | Aug 2014 Avg Temp | Sept 2014 Avg Temp | Monsoon Average |
|---|---|---|---|---|---|
| Phoenix | 93.2 (+2.4) | 96.5 (+1.7) | 91.6 (-2.0) | 89.0 (+0.6) | 92.6 (+0.7) |
| Yuma | 91.7 (+2.7) | 96.3 (+1.8) | 93.4 (-0.9) | 92.0 (+3.0) | 93.4 (+1.7) |
| Tucson | 88.9 (+4.1) | 88.3 (+1.3) | 85.1 (-0.2) | 82.8 (+1.2) | 86.3 (+1.6) |
| Flagstaff | 62.4 (+2.5) | 67.5 (+1.4) | 62.0 (-2.2) | 59.5 (+2.1) | 62.9 (+1.0) |




(Continued next page)

# Continued: Climate Corner

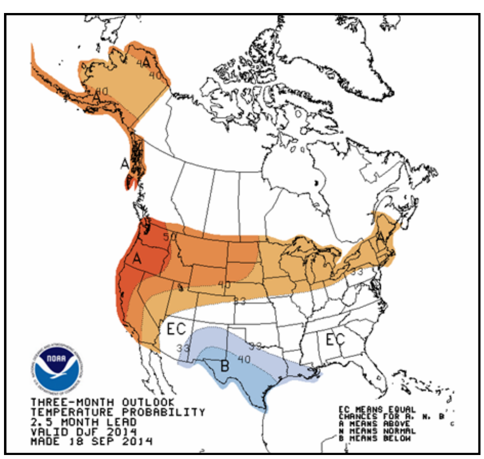


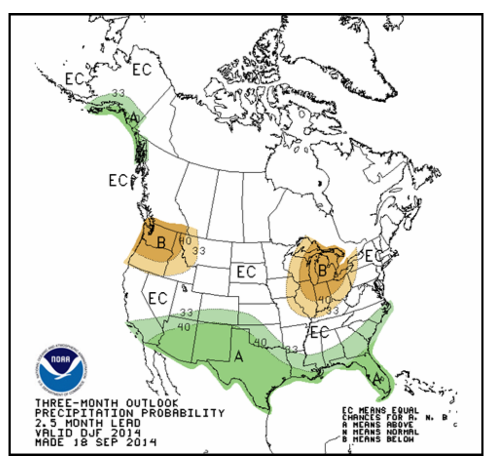

**What's on the climate forecast horizon?**

Water temperatures over the equatorial Pacific have been slowly warming during the late spring and summer months of 2014. This is a pre-cursor towards a developing El Nino phase that will materialize during the winter. However, all indications suggest this El Nino will only be a weak event which has little predictable influence over winter weather in the Southwest United States.

Despite only a weak El Nino across the equatorial Pacific, many other signals across the North Pacific Ocean have led several climate models to suggest the possibility of a wetter than usual winter. The official Climate Prediction Center probabilistic outlook for the winter season (Dec-Jan-Feb) calls for nearly equal chances for above, below, or near normal temperatures, and a slightly better chance for above average precipitation.

| City | Average Nov-Feb Precipitation | 2013-14 | 2012-13 | 2011-12 | 2010-11 | 2009-10 |
|---|---|---|---|---|---|---|
| Phoenix | 3.36 | 2.82 | 2.62 | 1.91 | 1.78 | 4.27 |
| Yuma | 1.49 | 1.11 | 1.63 | 1.60 | 0.73 | 2.88 |
| Tucson | 3.30 | 3.06 | 2.81 | 3.22 | 0.71 | 4.42 |
| Flagstaff | 7.84 | 4.17 | 6.60 | 5.33 | 8.50 | 11.14 |



# Record Rainfall and Widespread Flooding Across Phoenix Metro, Sept 8, 2014

By Charlotte Dewey, Meteorologist

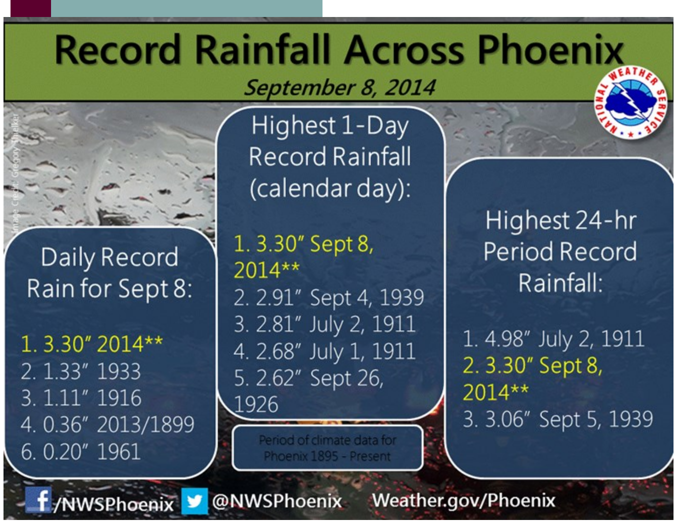
A plume of tropical moisture associated with Hurricane Norbert moved into the desert southwest during the early morning hours on Sunday September 7th. The increased humidity across the region led to numerous showers and thunderstorms across far northwest Arizona during the afternoon hours on Sunday, but conditions across the Phoenix metro were largely tranquil through late evening Sunday. That changed, however, around 11 pm Sunday night as a complex of showers and thunderstorms developed in Pinal and Pima Counties (South-central Arizona), merged with an existing complex from La Paz County (Southwest Arizona), and raced northward toward Phoenix.

Heavy rainfall began in the East Valley around 2 am and quickly spread into central Phoenix and the West Valley around 3 am. By 3 am, numerous underpasses along U.S. 60 were inundated and impassable and by daybreak Interstate 10 was impassable at 43rd Avenue. Showers continued periodically through approximately 8 am before tapering off around 10 am.

Phoenix Sky Harbor airport recorded an astonishing 3.30 inches of rain over a 7 hour period (roughly 0.50"/hour rainfall rates). This is the most rain ever recorded on a calendar day since records began in Phoenix in 1895! As if that wasn't impressive enough, some locations in Chandler recorded nearly 6" of rain during the same time period, and one trained spotter reported 6.09" in northwest Chandler. For comparison sake, the average Monsoon rainfall total for Phoenix is 2.71 inches.

Below left: WFO Phoenix rainfall records.

Below right: Courtesy Arizona DOT, flooded Interstate 10 at 43rd ave during morning rush hour.




# 2015 Annual AMS Meeting in Phoenix

## January 4—8, 2015

The annual American Meteorological Society (AMS) meeting will be held in Phoenix, AZ in January.  WeatherFest is an interactive science and weather fair for weather enthusiasts of all ages. Children and parents are invited to come to WeatherFest. Make plans to bring your children to this fun, educational, and engaging event. Hosted by the American Meteorological Society.

# The Mystery of Chaff

By James Sawtelle, Meteorologist

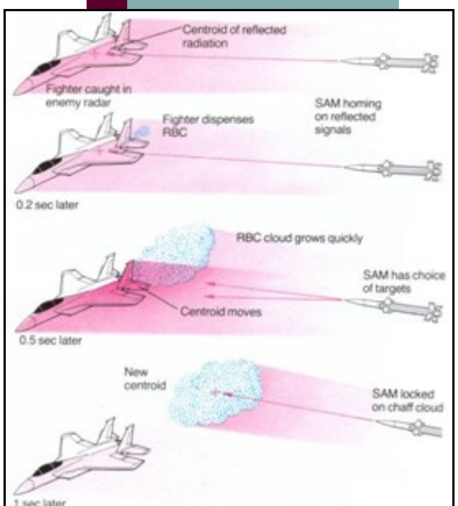



**Figure 1.** A missile decoy "cloud" forms when Rapid Bloom Chaff (RBC) is released by a combat aircraft.

Imagine a sunny day here in the Phoenix Valley. You have the day off and you're getting ready to go meet some friends at the lake. But wait!... The weather has been pretty weird lately so you decide to play it safe and check out the current weather conditions on your favorite weather app--just in case there are some pesky showers or thunderstorms popping up somewhere. You decide to check out the weather radar first. As your screen loads you can't believe what you see! An area of rain showers is showing up on the weather radar! HUH?? Rain showers on a beautiful day like this?!

Chaff often appears to be rain showers and can lead to confusion by those not trained to recognize it. What makes chaff so annoying is that it can often appear to be rain showers.

**What is chaff?** Chaff is one of the known missile countermeasures equipped on some military aircraft. It is released into the air during flight in an effort to fool radar-guided anti-aircraft weapons that are or could be launched toward other aircraft in high-threat situations. In addition, combat aircraft often release chaff during flight training and military exercises. The chaff may consist of a variety of small, highly reflective, (i.e. easy for a radar to detect) lightweight material including tiny pieces of flat aluminum or metallized pieces of paper and material that can be carried in the wind. After the chaff is released by the aircraft, it creates a reflective radar "cloud" that is intended for the radar-guided missile to detect and hone in on. Thus the chaff acts as a decoy to misdirect the missile into the chaff's reflective cloud instead of the aircraft's location.

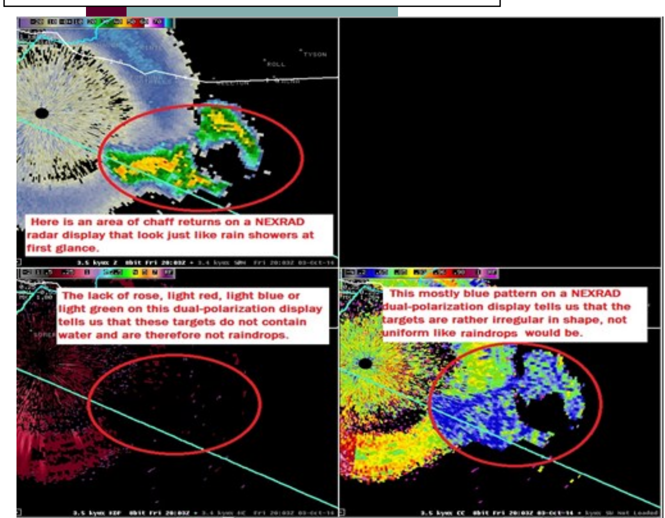



**Figure 2.** Dual-polarization radar image over Yuma County, Arizona showing an example of Chaff.

**Modern chaff as seen by weather radar today.** The same principle that makes chaff highly visible to radar-guided anti-aircraft missiles makes it highly reflective to weather radar. The chaff often detected by weather radars today is believed to be more highly reflective, cover a larger area and last longer than ever before. For instance, one type of modern chaff known as "RBC" (rapid bloom chaff) creates a very highly reflective chaff cloud that expands very quickly. And the larger the chaff cloud, the more likely it is to fill the weather radar beam's cross section completely, producing a stronger return signal from the higher amount of reflected energy. (See figure 1.)

When detected by weather radar, the chaff cloud can actually look like an area of rain showers at first glance on a weather radar display. Fortunately, meteorologists in well-equipped weather offices virtually never rely on just one type of data and can rule out the chaff radar signatures from being rain showers fairly quickly. For instance, NWS meteorologists can look at complementing dual-polarization weather radar displays to quickly rule out rain showers. See figure 1 for a very recent, real-world example of a chaff cloud signature in southwest Yuma county, Arizona that occurred on 3 October 2014.

(Continued next page)

# Continued: The Mystery of Chaff

If you ever have any doubt about the returns that you observe on a weather radar display, you will want to cross check the data. One of the best weather data options available to you for diagnosing chaff returns is weather satellite imagery. For example, examination of a visible satellite image taken during our 3 October chaff episode reveals clear skies over the chaff area. (See figure 4.) Hurray! Now you can breathe a sigh of relief because this confirms that those weather radar returns are not rain showers! Because this chaff occurred on a clear day, it was simple for us to confirm that there were not any rain showers. Cross checking weather radar with satellite imagery, specifically visible satellite, can help clarify chaff versus rain showers. Figure 2 shows the spread of chaff by the wind, expanding the area of high reflectivity on the radar.

**Chaff-prone areas in Central Arizona.** Another tip for identifying chaff is to watch out for it in chaff-prone areas. Some of the areas more prone to chaff near Phoenix include Yuma county, southwest Maricopa county, and Pinal county. Although keep in mind that winds and chaff longevity make it possible to see chaff far from traditional, chaff-prone areas. Because weather radars are becoming more popular among the general public, this chaff clarification is important to note when analyzing the radar.

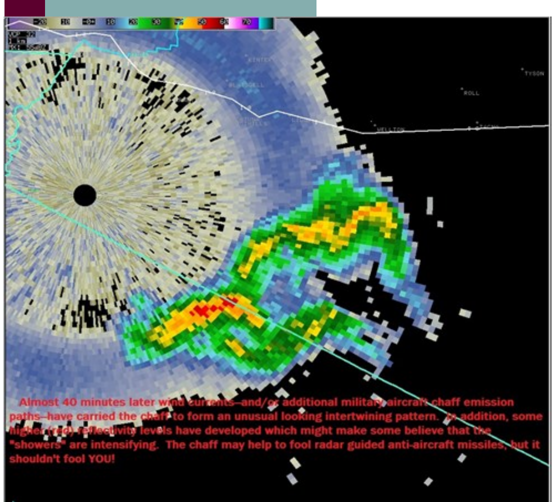



**Figure 3.** Almost 40 minutes later, wind currents—and/or additional military aircraft chaff release paths—have carried the chaff to form an unusual looking, intertwining pattern. In addition, some higher (red) reflectivity levels have developed which might make you believe that the "showers" are intensifying.

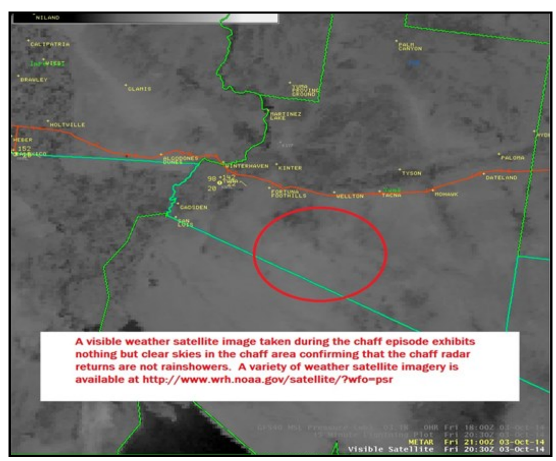



**Figure 4.** A visible satellite image taken during the chaff episode in Figure 1 exhibits nothing but clear skies in the chaff area confirming that the chaff radar returns are not rain showers.

SAWS VI

PROVIDE · PREPARE · PREVENT

APRIL 17-18, 2015
LAS VEGAS, NEVADA

## Southwest Aviation Weather Safety (SAWS) Workshop VI: Spring 2015

### "Collaborating for a Safe & Productive National Airspace System"

By Jessica Nolte, Meteorologist/Aviation Program Manager

The Southwest Aviation Weather Safety (SAWS) Workshop will return in 2015 and will be hosted at the Riviera Hotel & Casino in Las Vegas, Nevada! This will be the sixth SAWS installment since the workshop was first held in 2007. The workshop hosts/planners include the Weather Forecast Offices in Las Vegas, NV, Albuquerque, NM, Phoenix, AZ and the Center Weather Service Unit at the Air Route Traffic Control Center in Palmdale, CA. Over the past five workshops, attendees (particularly pilots!) have indicated they would like the workshop offered on or over a weekend. We are excited to host our first workshop (at least for the Aviator Day) on a Saturday, and we look forward to one of our strongest pilot/aviator showings ever!

The first workshop day, Aviation Weather Forecasting, will feature presentations and discussions regarding decision support services for general aviation, airline and air traffic control, aviation weather forecasting, leveraging current and future technologies; and more. The second day (on a Saturday for the first time as alluded to above!), the Aviator & Controller Weather Workshop, will feature presentations covering topics from aviation weather hazard anticipation and avoidance, understanding NWS forecasts and tools, etc., and attendance at this workshop day is intended to satisfy FAA WINGs safety accreditation.

The benefit of having an in-person workshop is the opportunity to meet friends, partners, and co-workers old and new! As with past in-person workshops, there will be a social dinner/networking event in between the workshop days. Additional information about this dinner event, along with lodging/amenities at the Riviera and local resource information will be made available on the SAWS VI website at: http://www.wrh.noaa.gov/psr/aviation/SAWS6/. We are currently looking for presentations, poster or booth proposals and the Call for Presentations is available on the SAWS VI website.

Questions about the workshop can be directed to the NWS Phoenix Aviation Program Manager, Jessica Nolte (Jessica.Nolte@noaa.gov). The SAWS VI planning committee is very excited for this latest installment is the successful SAWS series. We look forward to meeting up with our aviation and forecasting colleagues, both old and new in Las Vegas in April 2015!

And for all things SAWS, check out the new main SAWS page featuring links to all previous workshops, including the workshop agendas and presentations!

http://www.wrh.noaa.gov/psr/SAWS/

# Departures from WFO Phoenix

By Charlotte Dewey, Meteorologist

This summer we had two faces at WFO Phoenix depart and move on.

The first was at the start of the summer, our Observation Program Leader (OPL) Michael Bruce. Michael was a longtime Arizona resident who attended McClintock High School in Tempe and Arizona State University. He went on to serve in the U.S. Army for 3 years. Michael worked at a number of places before ending in Phoenix including Barton Air Traffic Control as a weather observer in Buffalo, NY and the Atmospheric Science laboratories at White Sands Missile Range in New Mexico, by providing weather support for testing and development. His National Weather Service career began in Des Moines, IA where he was Meteorological Technician and network radar operator for a quick 2 years before moving on to be the Official in Charge at NWS La Crosse, WI. It was in 1995 that Michael began at the Data Acquisition Program Manager (DAPM) and Observation Program Leader (OPL) at WFO Phoenix. Michael and his wife, Sandy, of more than 23 years of marriage have a son named Wyatt. At the beginning of the summer Michael retired and has moved back to La Crosse, WI to be near family and enjoy the variety of weather in the upper Midwest.

Also departing WFO Phoenix at the end of the summer was our Meteorologist in Charge, (MIC) Gary Woodall. Gary came to Phoenix from Dallas and has been the MIC for just longer than 5 years. With backgrounds in severe weather and much of his time in the National Weather Service coming from the Southern Region, Gary is looking forward to the next chapter in his NWS career in the Memphis, TN weather forecast office (WFO). It's been a pleasure to work with Gary and we all wish him good luck in this new adventure.