Lake Havasu City 2011 Weather Summary

Doyle Wilson, Water Resources Coordinator

The four weather stations tracked by the city year-round are located at the Public Works (now Operations) Maintenance Facility (PWMF) on London Bridge Road (elev. 472 feet), at City Hall (elev. 730 feet), at Mohave Community College (MCC) (elev. 640 feet) and at fire Station #5 on Lake Havasu Avenue north of Mesquite Avenue (elev. 503 feet). The PWMF site data is sent to the National Weather Service everyday and is considered the official weather station for the City, though only high and low temperature data with daily precipitation is reported. The MCC station is monitored by AccuWeather and high and low temperatures from this station are reported in the local newspaper. More detail of these stations is given in the 2006 summary report. A combined average is compiled for high and low temperature and for precipitation amounts from the four stations. Three of the stations record peak wind speeds and a monthly combined average is also calculated. In late November, a new weather station was established at the Lake Havasu City Municipal Airport and will be included in future data collection. This station is the same brand as the stations at MCC and Fire Station #5, but without solar and ultraviolet sensors.

2011 began with a second year of La Nina conditions, though weaker than in 2010. The 2010-2011 winter produced record snow falls in the Rocky Mountains of the Colorado River Watershed. Since the major weather systems were further north than usual, significant snow accumulation in Arizona was lacking. Although the skiing industry in our region did not have a great year, Colorado River water users still benefited overall as Rocky Mountain snow melt and runoff in the spring of 2011 were at record levels. This amount of water raised the Lake Mead water level by more than 30 feet from its historic low elevation of 1082 feet above sea level. The lake level was only 7 feet above the elevation (1075') that would trigger a federal declaration of water shortage on the lower Colorado River. This would mean less available water to Lake Havasu City.

Temperatures

The general high and low temperature profile for Lake Havasu City in 2011 is not drastically different from other years, yet many high and low temperatures were broken in one of the most varied weather years in quite some times (Figure 1).

With a couple of exceptions, high temperatures throughout the year were within normal limits compared to past years. Record high temperatures were recorded in January, April, August and September. January started with record tying low temperatures, but quickly warmed to a record 81^{o}F on the 17th (Table 1; Figure 2). Interestingly, the barometric pressure dropped significantly over a four day period leading to the high temperature

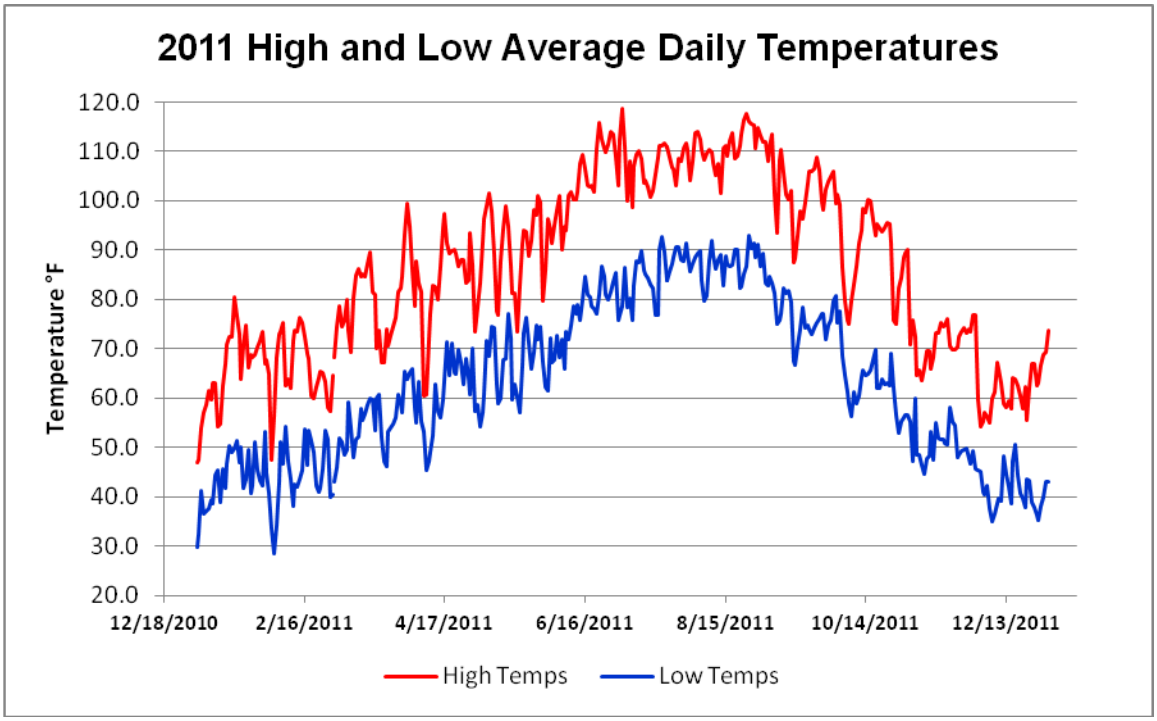


Figure 1: 2011 high and low temperature profiles for Lake Havasu City.

(Figure 3). This signature is usually seen when cold fronts enter the area. April Fool's Day was the first 100°F day of the year and a record for that date. August essentially equaled August 1995, the hottest on record, with an average high of just over 111°F. The weather station at Fire Station #5, which was the historic official site, recorded an average August high temperature of 113.1°F. A four day record setting period from August 23rd to the 26th plus one other record setting day (August 18th), where temperatures varied between 116° and 119°F, helped to make this August one of the hottest. 119°F, the hottest official temperature, was recorded three times in 2011 at the PWMF station. The Fire Station #5 site recorded a yearly high temperature of 120.8°F on July 2nd. Ten days throughout the year had record high temperatures and two days, April 8 and 9, recorded the lowest high temperatures for those dates (Table 1) because a cold front with lots of moisture entered the region (Figures 4 and 5). The average high temperature for the year was 86.3°F, which is on par for the 10 year and 30 year averages. There were 126 days above 100°F and 66 days above 110°F. The number of days over 100°F was not unusual (Figure 6), yet the number of days over 110°F was the third highest since records began in 1977.

At Fire Station #5's weather station, the highest TSHW (heat index taking into account the wind, humidity and solar radiation) was recorded at 126.1°F on August 27th. This index depicts what people experience when in the sun. Twenty-five days during the summer had a TSHW heat index of 120°F or more this summer.

Table 1: Record or tied temperatures set in 2011. Official temperatures are from the weather station at the Public Works Maintenance Facility on London Bridge Road. The data from this station is sent daily to the National Weather Service. Unofficial temperatures are from three other weather stations in the city.

Date	Official High Temp.	Unofficial High Temp.	Official Low High Temp.	Official Low Temp.	Unofficial Low Temp.
January 1				31°F tied	28.8°F
January 2					31.9ºF
January 17	80ºF	81°F			
January 22	75°F				
February 2				30.0ºF	
February 3				28.0ºF	
February 11				38°F	37.6°F
April 1	100ºF				
April 2	97°F				
April 8			63°F		
April 9			62°F	45°F	
May 2				PWMF offline	53.7ºF
May 16				PWMF offline	58.6ºF
May 19				PWMF offline	56.8ºF
May 30				60ºF	
May 31					61.3ºF
July 5				72°F	
July 17				75°F	
August 5				76°F	
August 18	116°F				
August 23	119°F				
August 24	119°F	119.3°F			
August 25	118°F				
August 26	117°F	117.9°F			
September 4	115°F	115.4°F			
September 23	110°F tied				

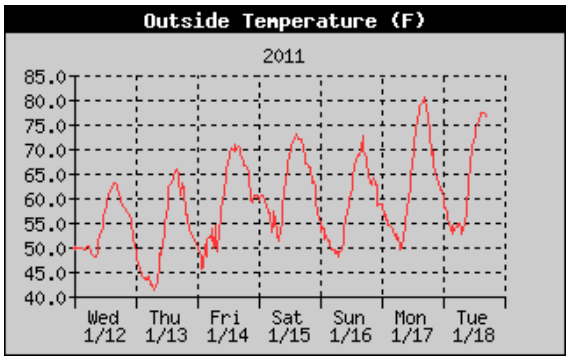


Figure 2: Temperature trend for the week of January 12 to 18, 2011.

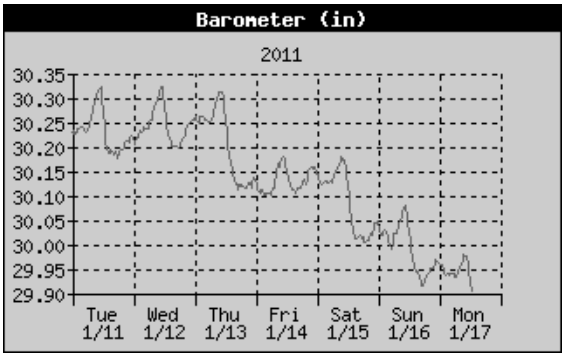


Figure 3: Barometric pressure trend leading to the record high temperature.

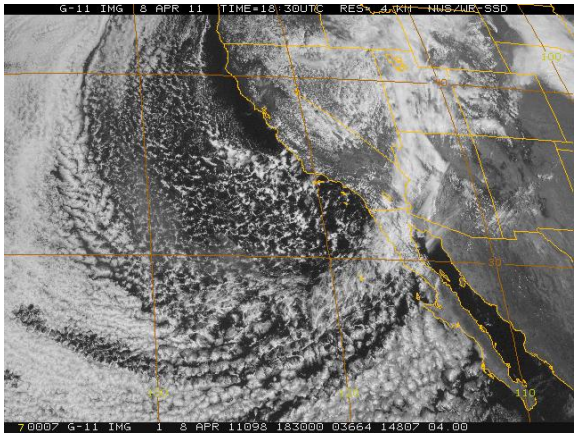


Figure 4: Visible satellite photo of a cold front over the southwest united States on April 8, 2011.

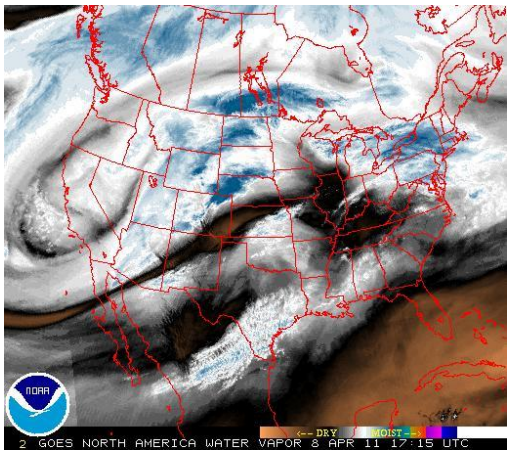


Figure 5: Same front in a water vapor view showing moisture with the front.

On the flip side, 2011 did not wait to cool down the Lake Havasu City area. The official low for New Year's morning was 31°F, tying the old record and the MCC station recorded an unofficial record of 28.8°F. The corresponding wind chill made the air feel like 27.2°F. February set an all-time official record low temperature average, at 42.8°F and 44.4°F over the four stations. The official coldest temperature for the year was recorded the morning of February 3rd at 28.0°F. This was an all time record low for that date. LHC experienced one of the coolest Memorial Day weekends ever. One record low temperature was set on May 30th at 60°F topping the old record by two degrees. However, there have been days in early June in the past in which the overnight low went down to 60°F and the latest ever in the year where there was a low temperature in the 50°F's was on May 29, 1990.

December was the coolest since 2001, averaging 41.7°F from five stations (the airport station is added here). The PWMF station averaged 39.9°F, only fourth time that the month averaged below 40°F at that station. Record low temperatures were either tied or broken on nine occasions at the PWMF station (Table 1). Other stations recorded unofficial record lows seven times (City Hall station and Fire Station #5). The highest low temperature of the year was set at 97.1°F on August 25th. The Fire Station #5 weather station recorded 20 days with overnight low temperatures over 90°F, but the average from four weather stations was only 13 days, the fewest since 2005 (Figure 2).

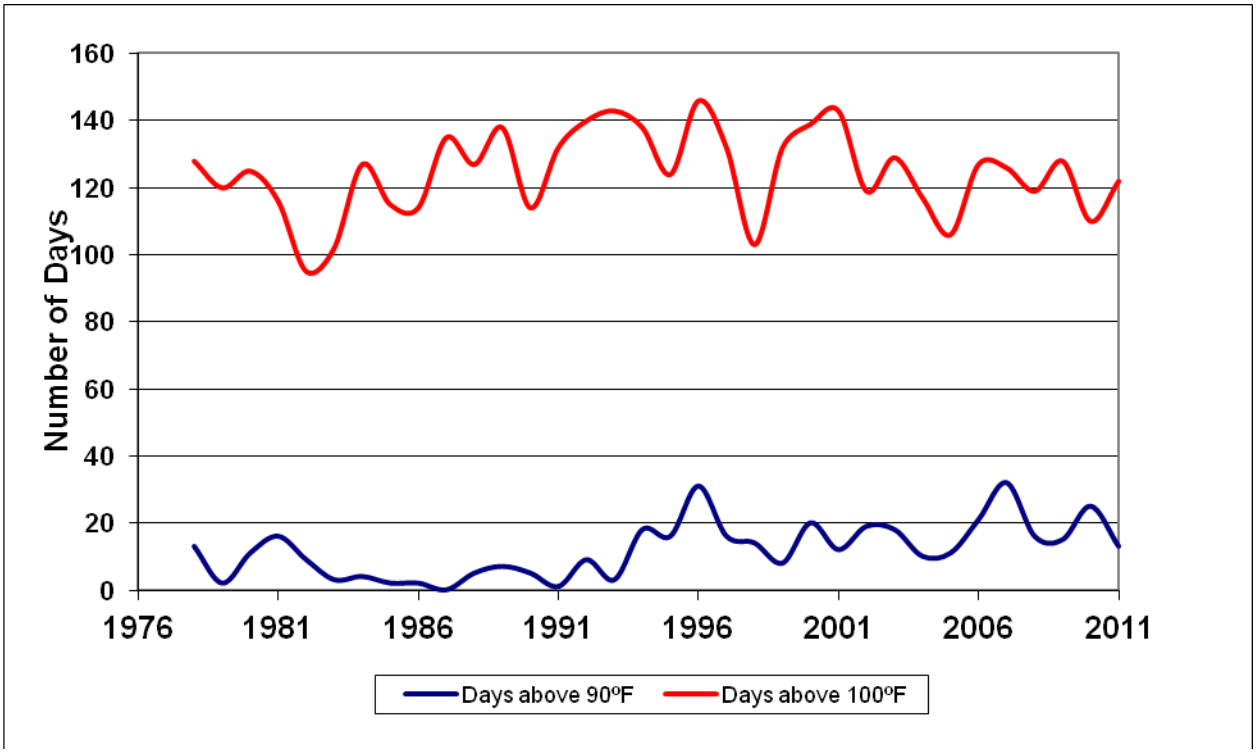


Figure 6: Comparison of the number of days since 1978 in the warmer months in which high daily temperatures are above 100°F and the number of days above 90°F. The most notable trend observed is the overall increase in the number of days staying above 90°F since 1994.

There were at least five episodes in 2011 when either significant warm air or a cold front or some cooler air mass entered the lower Colorado River region during the late afternoon or evening that caused the daily high or low temperature to occur only 6-9 hours before the next day's high or low temperature instead of the usual ~ 24 hours. April 8th's high temperature occurred just after midnight and the low temperature for the day occurred just before the next midnight. The daily low temperature on September 5th was just before midnight and the low for the next day was 6 hours later when renewed

monsoonal flow entered the region. September 12th's high temperature was 101°F and the high temperature on the 13th was just after midnight (66°F), eight hours later. A cold front passed through on October 3rd just before midnight, which brought daily high temperatures for that day and the next to within 9 hours of each other. Lastly, a cut-off pressure system that brought rain to the area on December. 1st provided the daily high temperature at midnight with a corresponding low temperature at 2:00 pm earlier in the day. The high temperature on December 2nd was at 6:00pm (not too unusual), but the daily low temperature occurred before midnight, not the morning before and the low was only 8 hours before the low of the next day..

Precipitation

2011 was the second year in a row that Lake Havasu City experienced higher than average precipitation, at 4.66" from the PWMF official weather station and 4.6" average over all four stations. The most active months were February (ave. 1,16"), July (ave. 1.07") and September (ave. 0.85"), though November and December were moderately active at (ave. 0.53" and 0.64"), respectively (Figure 7). A cold front in the second half of February brought rain to the city and snow to the Mohave Mountains. Some of September's rain came from the remnants of Hurricane Hillary that travelled north up the lower Colorado River valley from the Gulf of California. Only two months, June (no surprise) and August, did not record any rain and January barely had any (0.02"). Although January was dry, there was a pretty amazing virga event at sunset on the 7th (Figure 8). Virga is rain, ice crystals or snow from clouds that evaporates before getting to the ground and the photo shows that there were pretty strong winds aloft to curve the rain path. No rain was recorded in Lake Havasu City in August, but there were a few near misses during the month with stray thunderstorms to the west in California (Figure 9).

A cut-off low pressure system brought in 0.5" of rain over a two day period the first of December. The low was centered over LHC area for a while (Figure 10) with a low barometric pressure of 29.570 inches Hg, one of the lowest measurements in this area since May 28th when the barometer was at 29.472. The storm also brought a dusting of snow to Crossman Peak (1-2 inches - one of the earliest in recent years – since the 1980's; Figures 11-12) and moderately dense fog the morning of the 3rd. Fog is not a very common weather phenomenon in Lake Havasu City, yet it occurred again on December 14th due to another the lingering cut off low that also brought in about 0.12 inches of rain. As explained in the 2010 weather summary a cut-off low is a low atmospheric pressure center that should be connected to the jet stream as a cold front, but is detached and is not controlled or steered by the jet stream movement (see Figure 10).

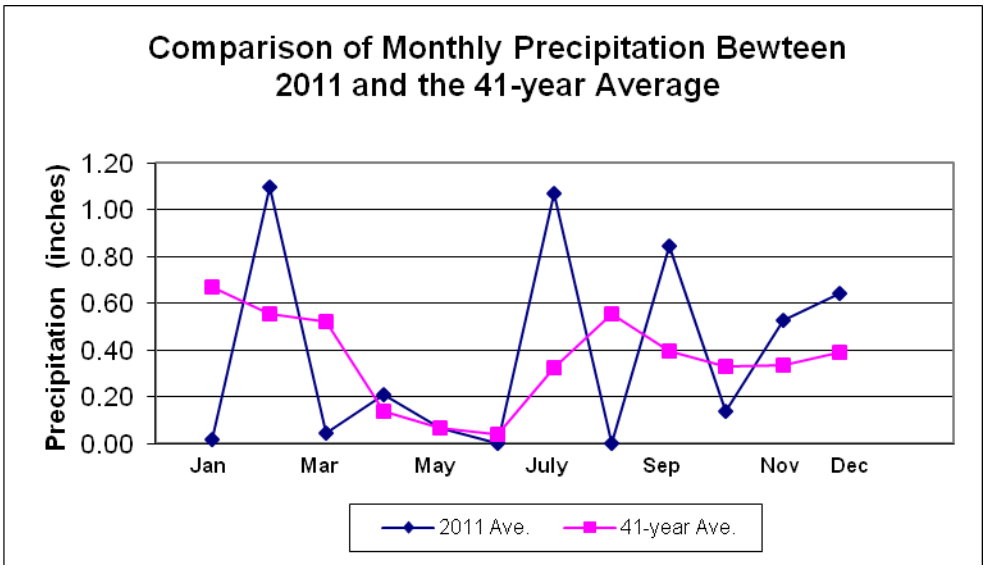


Figure 7: Average monthly rainfall (over four stations) for 2011 compared with the City's 41-year monthly averages.

Figure 8: Strong upper level winds affect the virga path from an isolated altocumulus cloud at sunset on January 7, 2011.

Figure 9: Thunderstorm northwest of LHC at sunset on August 27, 2011.

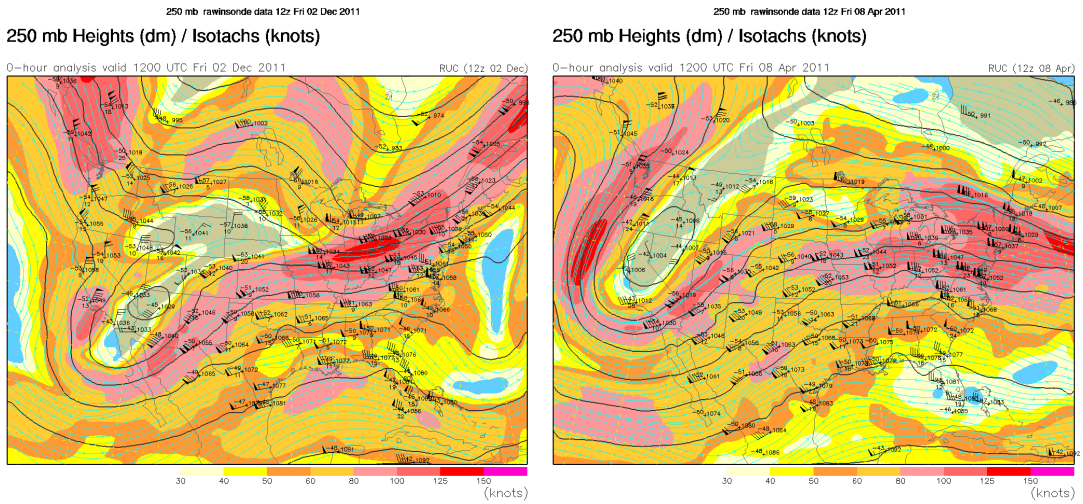


Figure 10: Upper atmosphere map of North America showing the elevation changes in the 250mb air pressure level on December 2, 2011 (left). Specifically, this map shows the jet stream (pink and red areas) and the cut-off low pressure centered over northwestern Arizona. Flags represent wind speeds. The map on the right shows the contrasting pattern of air pressure flow of a normal cold front on April 8, 2011.

Figure 11: Snow on a Joshua tree and Crossman Peak on December 3, 2011.

Figure 12: View looking west towards LHC showing the contrast of snow on Crossman Peak and the barren lower elevations.

Dew Point Temperatures

Dew point temperatures are usually most notable during the summer monsoon season when they elevate to create humid conditions along with temperatures between 100^{o} and 120^{o}F. Although the National Weather Service has developed a timed season when monsoon begins and ends (June 15 to September 30), it is the local dew point temperatures that actually let us know when these conditions are present. The monsoon usually has a sharp beginning and a ragged ending, meaning that in September, weak

cooler masses may move into the area to temporarily depress the dew point temperatures. These conditions usually only last a couple of days before more humid air moves back in. This process may continue until near the end of October before permanently abating for the year.

The monsoon season abruptly began on July 3rd when dew point temperatures shot upward from 24°F to 63°C in just four hours and only a day after the hottest high temperature of the year (Figure 13). The period from July 3rd to July 11th experienced the highest dew points of the summer. The monsoon season continued until dew point temperatures dropped permanently October 5th after a cold front passed through the area, a total of 94 days. This length tied 2003 for the second longest monsoon since records have been kept starting in 2003. This monsoon season produced only two main thunderstorms storms (7/6 (1.09") and 9/13 (0.65")) and four minor precipitation events (7/4 (0.03"), 7/10 (0.05"), 9/6 (0.12"), 9/10 (0.03")) for a total of 1.97", a vast improvement from the 0.06" accumulated during the 2010 monsoon season (the driest since records have been kept).

Extremely low dew point temperatures were also recorded in 2011. The most impressive resulted from an arctic cold front that passed through the area on February 1st & 2nd , accompanied with winds to almost 40 mph and wind chills in the upper 20°'s. Just after midnight (1:00am) on the 2nd, the dew point temperature fell to -21.1°F, the lowest by far since records began in 2003. This means that the air temperature would have to dip to this level for ice crystals (not water condensation – too cold) to form in the air near ground level. Translated, this is extremely dry air. The dew point temperatures were in the negative range from 6:30 pm on February 1st to 8:30am on February 3rd, at total of 37 hours – very unusual!! At the minimum dew point, the relative humidity was 6%, the air temperature was 41.6°F, winds were directly from the North at 16 mph (high gust at 32 mph – Fire Station #5). Wind chill was 33.4°F and the barometer was at 30.243" and rising. The THWS was 27.2°F. The THSW at 6:00am on 2/3/2011 was 20.2°F with an air temperature of 29.3°F. Figure 14 shows other weather parameters associated with the passage of the front.

Peak Wind Speeds

The average peak wind value for 2011, at 9.48 mph, was almost the same as for 2010, but the distribution of the highest wind months was a bit different. The highest monthly average peak wind, at 11.68 mph, was in April, with May coming second place (Table 2). November has the lowest average peak wind at 7.55 mph, followed by September (7.72 mph). The highest gust recorded in 2011 was 44 mph on July 7th, which was associated with a monsoon thunderstorm that produced the most rain of the summer. Forty mile per hour plus gusts were also recorded in April, August, October and December. The April, October and December winds were associated with cold fronts. Lastly, parts of Lake Havasu City experienced a brief (~10-20 minutes) intense downward wind gust about 8:30 pm on May 9th that may have been part of a microburst. These winds recorded from

the weather stations did not exceed 38 mph, but locally, the wind was intense enough to enter vents through attics into homes. No rain was recorded with this wind.

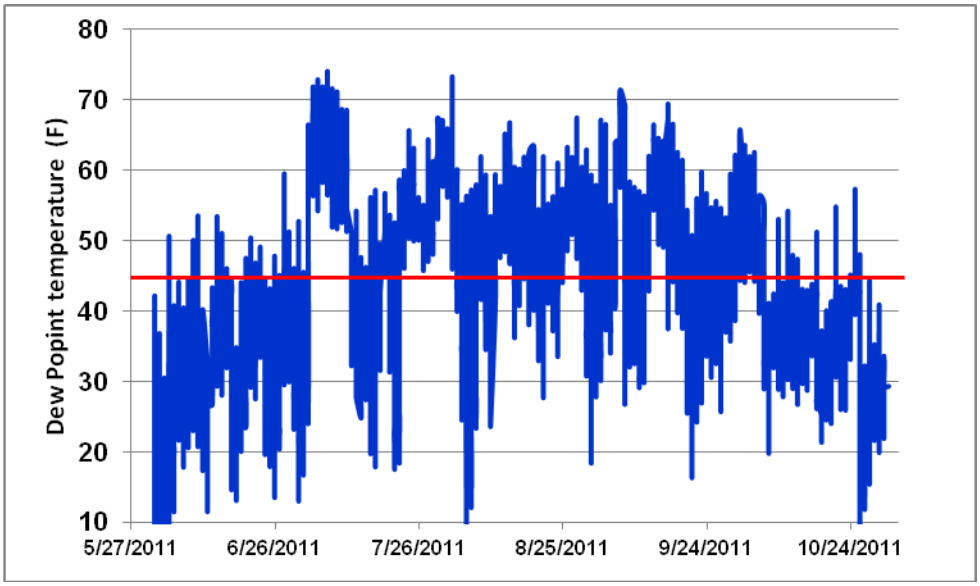


Figure 13: Dew point temperatures from June through October 2011. Dew points at or above the red line drastically reduce evaporative cooler efficiencies and begin to affect heat indicies.

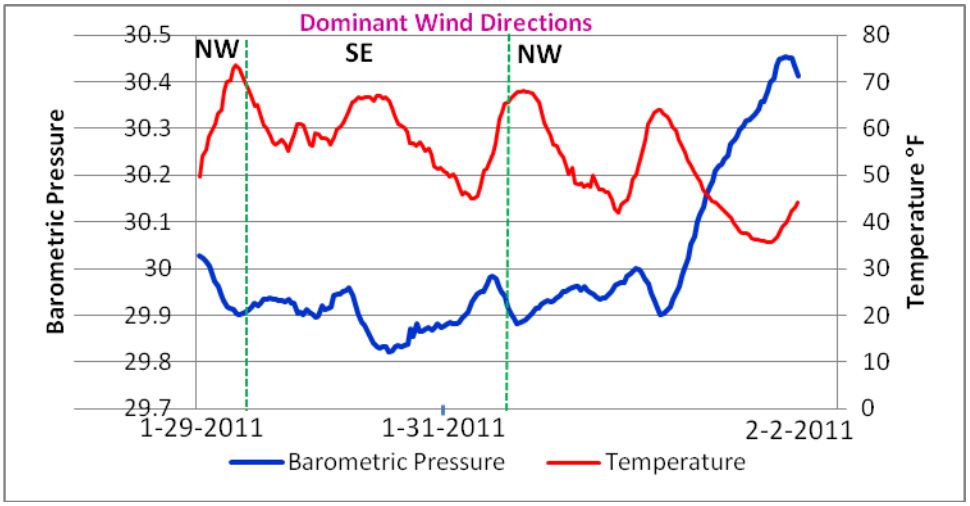


Figure 14: Weather parameters leading to the passage of the arctic cold front on February 1st and 2nd in the Lake Havasu City area. The temperature cycles are normal diurnal variations, but the sudden rise of the barometer pressure and notable temperature decrease (more than 20°F) indicated that the front passed through and cold, dense air (i.e. higher pressure) moved over the area. The wind direction change is typical of cold fronts that pass through our region.

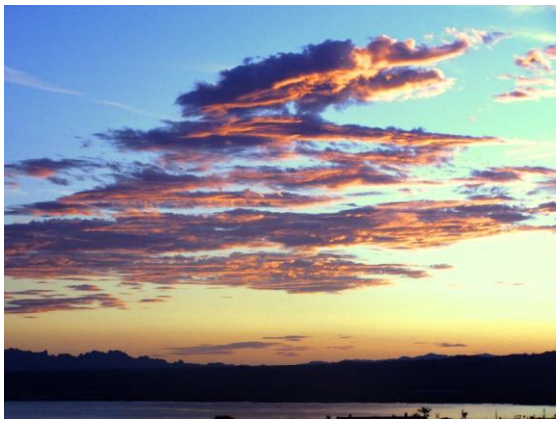
Table 2: Peak wind speed averages in Lake Havasu City for each month in 2011 and over an 9-year average. The overall averages are comparable, but there are slight departures from the norm in February and September.

Month	2010	9-year Average
January	9.37	**8.82**
February	9.97	**8.72**
March	9.47	**9.27**
April	11.68	**10.97**
May	11.15	**10.70**
June	10.83	**10.96**
July	10.19	**10.80**
August	9.46	**9.69**
September	7.72	**8.67**
October	8.00	**8.50**
November	7.55	**7.49**
December	8.03	**8.02**
Average	9.57	**9.38**

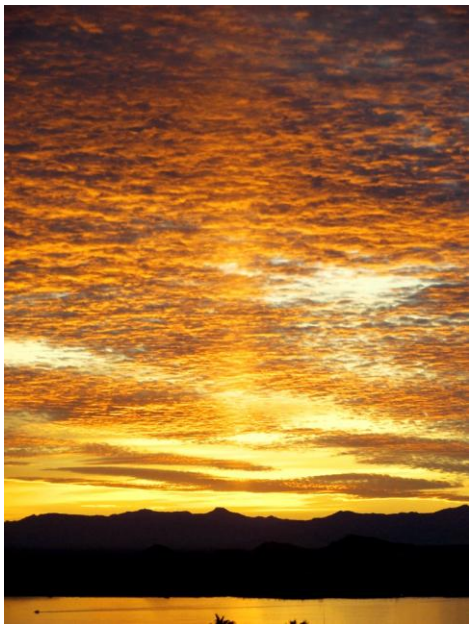
Some selected sunsets and a sunrise over Lake Havasu City in 2011

1-7-2011 – Sunrise - Broken Stratus Clouds

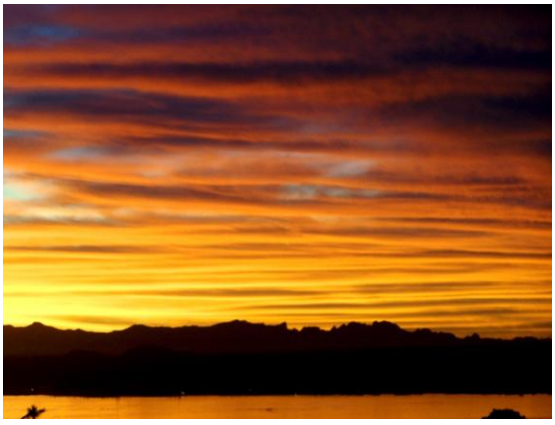
1-7-2011 – Poorly formed Mammatus clouds at sunset



7-28-2011 – Broken altocumulus clouds



11-11-2011 – Altocumulus clouds with a sun ray.



12-29-2011- Altostratus clouds

12-31-2011 – Patch of Altostratus clouds