Lake Havasu City 2010 Weather Summary

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The four weather stations tracked by the city year-round are located at the Public Works 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 what is sent to the National Weather Service everyday and the MCC station is monitored by AccuWeather. 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.

2010 began with the culmination of a moderately strong El Nino event with higher than normal winter precipitation and definitely cooler temperatures than normal well into the late spring. This transitioned into La Nina conditions in the late summer, which strengthened through to the end of the year. As described in last year’s summary report, La Nina conditions do not necessarily have a major affect on the region’s weather.

Temperatures

A moderately strong El Nino (warmer than normal equatorial seawater surface temperatures (SST) off the west coast South America) ushered in the New Year keeping temperatures down through June, but waned and was replaced by a growing La Nina (cooler than normal SST) condition through the end of the year. El Nino implications to the Lake Havasu area are explained more fully in last year’s summary report, but briefly, this phenomenon tends to produce cooler than average temperatures from winter through late spring. Past Lake Havasu City temperature and rainfall data indicate that La Nina conditions do not force a significant difference from normal conditions.

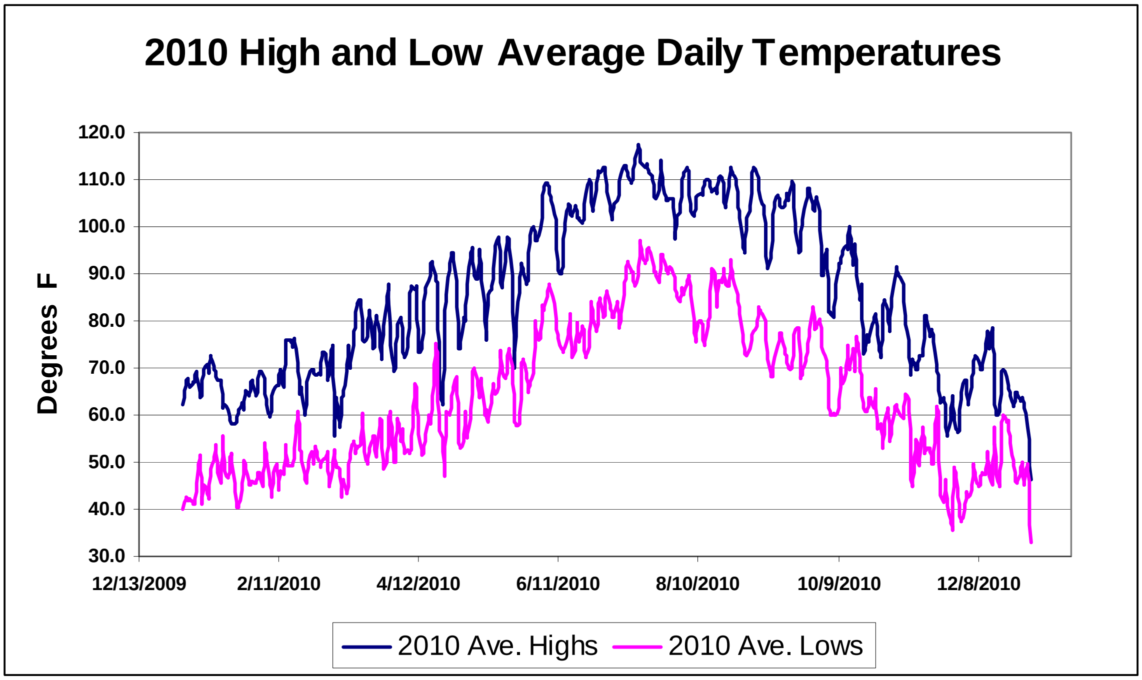


Figure 1: 2010 high and low temperature profiles for Lake Havasu City.

The month of May was the coolest May since 1980 and the second coolest on record with a four station high temperature average of 89.3°F. The 1980 average came from only one station, which was located at the former Island Airport. The average low temperature for May was also cooler than normal at 65°F, which was the first time it was this low since 1991. May 23rd reached a record low 56.4°F at the City Hall weather station. The previous low record for this date was 64°F set in 1996. April also had the coolest low temperature average for an April since 1999. Cold fronts were passing through the area on a regular basis in April and May bringing in cooler than normal air temperatures.

September, on the other hand, was the second warmest on record (since 2001) with a four station average of 104°F. September 27th tied a record high of 108°F for that date. December was also the warmest since 2000 at 66.1°F even though the last week of the month cooled down considerably. Also the average low temperature for December was the highest on record at 47.8°F, but the month also included a tie for the lowest temperature of the year, which occurred on December 31st at 33.1°F (It was the second time this year that the thermometer reached this value (12-27-2010). The month of February also had one of warmest low temperature averages for that month since 2000.

December was rather manic in that three of several cold fronts, besides bringing in rain, timed their passage so that successive daily lows and daily highs occurred within a few hours of each other:

<u>12-15 to 12-17:</u> The weather system that passed through on the 15th was evidently a combination of first a warm front and later a cold front. The low for that day was at 2:30am and the first front passed through at 3:30am, when the barometric pressure was at its lowest, but the temperatures began to rise. Later that day at 5:00pm the winds shifted

direction from predominantly southeast to northeast and the barometer dipped moderately, indicating that a weak cold front passed through. The high for 16th was at midnight while the cooler air was passing through after the front on the 15th. The low was at 11:30pm. The low for the 17th was at 4:30am, just 5 hours after the low temp for the 16th. The high for the 17th was at 5:00pm, 41 hours after the high for the 16th.

<u>12-20 to 12-21:</u> The high for the 20th was at 8:30pm and the high for the 21st was at midnight, just 3 ½ hours after the high for the 20th. The low for the 21st was at 7:00pm, 34 ½ hours after the low for the 20th. The barometer indicated that the front passed through at 4:30pm on the 20th, but there was no wind direction change. Between 9:30am on the 20th and 2:00pm on the 21st, 28 ½ hours later, the temperature changed only four degrees.

<u>12-29 to 12-30:</u> A third cold front passed through. The high on the 29th was at 3:30am, 10 ½ hours after the high on the 28th, and less than five degrees cooler. The low for the 29th was only 10 ½ hours later at 1:30pm and only four degrees cooler than the high. This was followed by another low at 3:30am on the 30th and a high at 4:00pm. Thirty-six and a half hours lapsed between highs and 14 hours between lows. The wind direction changed at 11:30pm on the 29th, coincident with the barometric pressure low. Between 7:00pm on the 28th and 11:30pm on the 29th, again 28 ½ hours, the temperature did not change more than four degrees.

January 21st had similar situation in which the low temperature for the day (49.9$_o$F) was at 2:00pm and the high temperature (60.7$_o$F) was at 6:00pm, just 4 hours later, but there was an almost 11 degree difference and conditions quickly returned to normal the next day.

This year's high temperature was 118.3^{o}F on July 15th, average for the 33 year period beginning in 1978. This temperature had a corresponding solar heat index (THSW – see 2008-2009 report) of 124.3^{o}F. However, because of the El Nino effect on the early summer, the number of days over 100^{o}F and over 110^{o}F, at 110 days and 41 days, respectively were below the 33 year averages of 125 days and 49 days. On the other hand the lowest temperature of the year at 31^{o}F is only two degrees below the 33 year average for lowest temperatures. Furthermore, the number of days in 2010 whose low temperature was below 40^{o}F and above 90^{o}F, were 7 days and 25 days, respectively. The 33 year averages for these statistics are 18 days below 40^{o}F and 12 days above 90^{o}F. The 25 days above 90^{o}F is the third most within this 33 year period and continues a general upswing in summer low temperatures over the past 17 years (Figure 2). The warmest low morning temperature was 97.8^{o}F on July 16th just after the high temperature for the year.

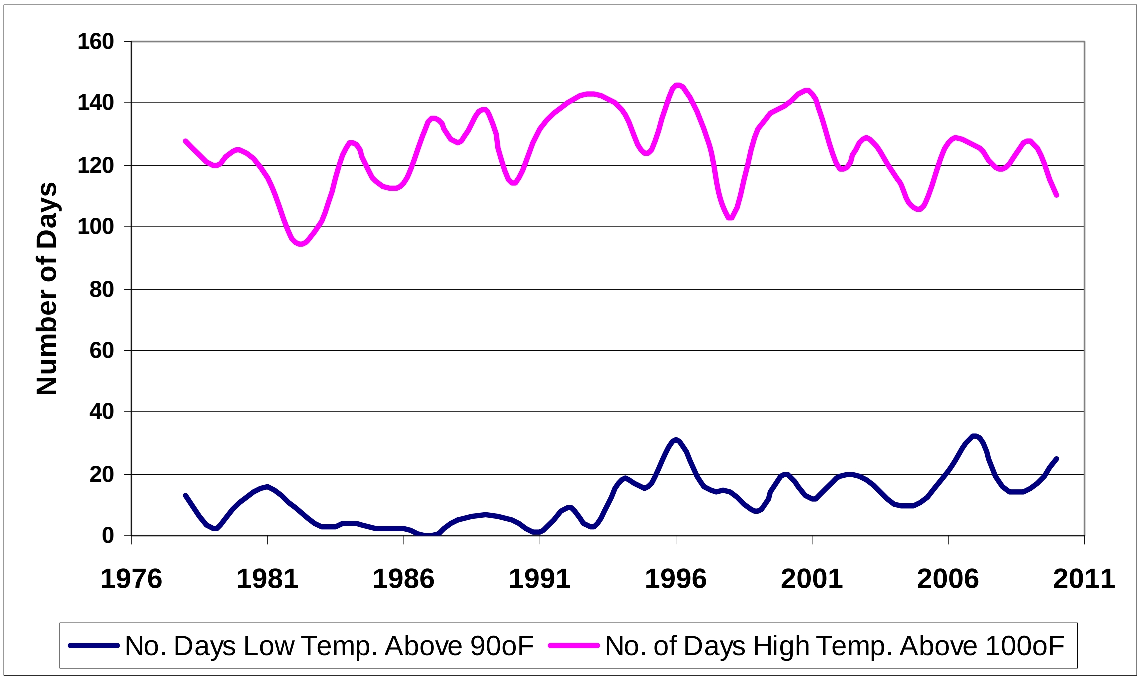


Figure 2: Comparison of the number of days since 1978 in the warmer months in which high daily temperatures are above 100^{o}F and those low daily temperatures in the cooler months below 40^{o}F. The most notable trend observed is the overall increase in the number of days staying above 90^{o}F since 1994.

Precipitation

This was a bookend type of year with most precipitation at the beginning and ending of the year (Figure 3). January was the wettest month with a four station average of 2.08" followed by December at 0.95". The four station average rainfall for 2010 was 5.05", close to 1" more than the 40 year average of 4.17". The city did experience very dry conditions during the summer with one dry spell lasting 138 days between measurable precipitation events. When it finally rained in early September, it averaged only 0.06" over the four stations monitored. It did not rain again until October when several small and one large storm cell passed over the city. The latter caused flooding on the city's south side (Figure 4). This rain event was short-lived (less than an hour), but intense with more than an inch falling east of the city. Smaller rain events took place the day after. This system was not from monsoonal action nor was it a typical cold front storm. The weather system was a cut-off low pressure air mass (Figure 5). A cut-off low is an air mass that should be with a large frontal system, but has been isolated from other activity and from the jet stream that controls where the boundary (or front) of the air mass moves. With no guiding mechanism to steer it, the low pressure mass wanders aimlessly for days without moving very far. This one was off the California coast for several days before moving into Arizona.

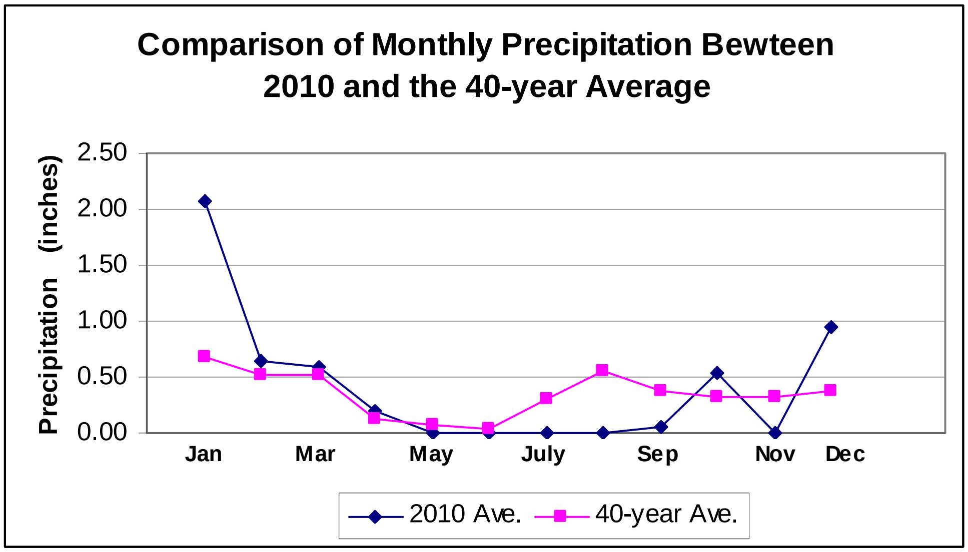


Figure 3: Average monthly rainfall (over four stations) for 2010 compared with the City's 40-year monthly averages.

Figure 4: Storm flooding from the October 20th rain event. Most of the water probably came from the Mohave Mountains as the storm cell was centered over that area.

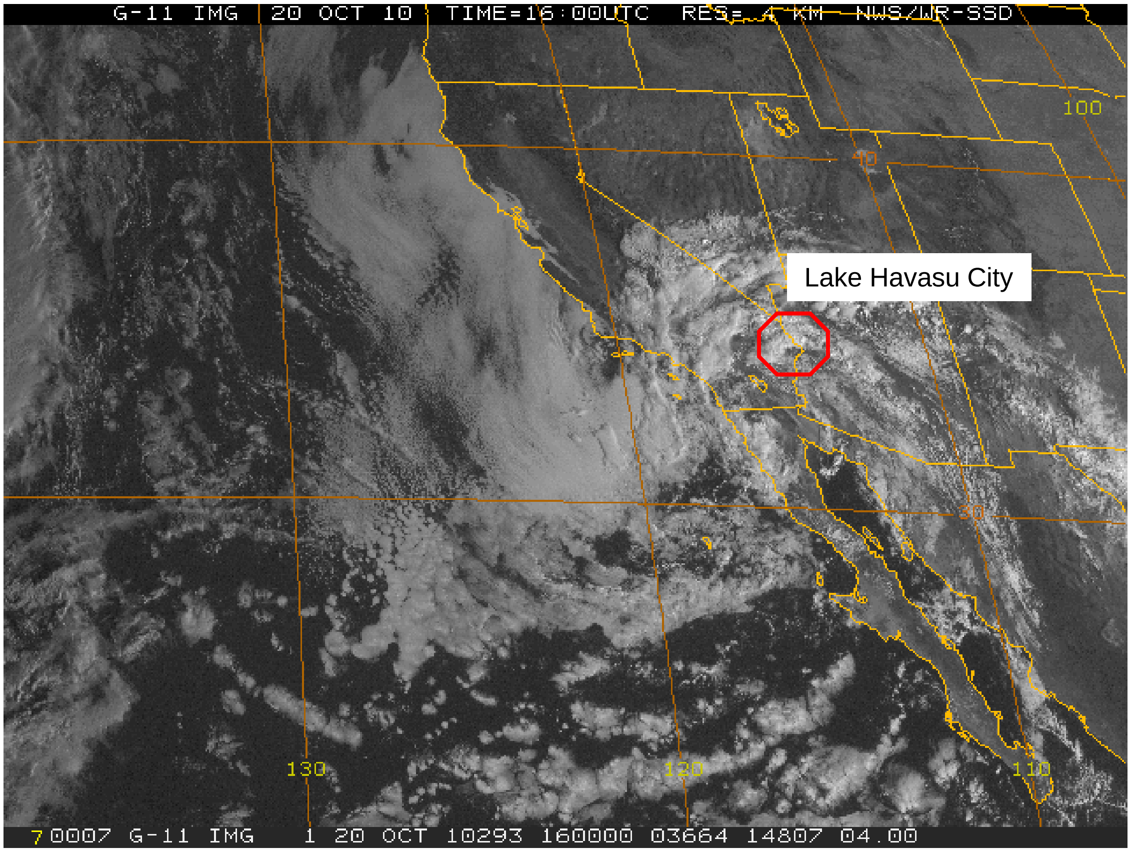


Figure 5: A Cut-off low pressure air mass from which a tiny storm cell grazed passed the east side of the city on October 20th, but produced flooding within the city.

2010 Monsoon Season

Monsoon season was remarkable only in its inability to bring in rain, but it was typically humid and sticky. Moreover, it did not last long and was broken up by periods of drier air especially in early September before returning in late September and October. Almost no rain fell until the first part of September, but only averaged 0.06” from four weather stations for the one storm event that did occur.

Dew Point Temperatures

Very low dew point temperatures, those in the single digits or below zero, indicate very dry air masses (they are actually called frost points when below 32°F). Relative humidities are also low when dew points are very low, but not necessarily single digits. Lake Havasu City usually experiences these conditions in June and the first of July prior to monsoon season, but in 2010 the only single digit dew point temperatures in the first half of the year was for four one-half hour intervals on July 2nd during the late afternoon and early evening. The lowest value was 3.4°F (relative humidity at 2%) when the outside temperature was 109.6°F. The next single digit dew point temperatures did not occur until the late evening of November 24th. The dry air mass stayed over Lake Havasu City for another day and a half with the lowest dew point at -3.4°F (relatively humidity at

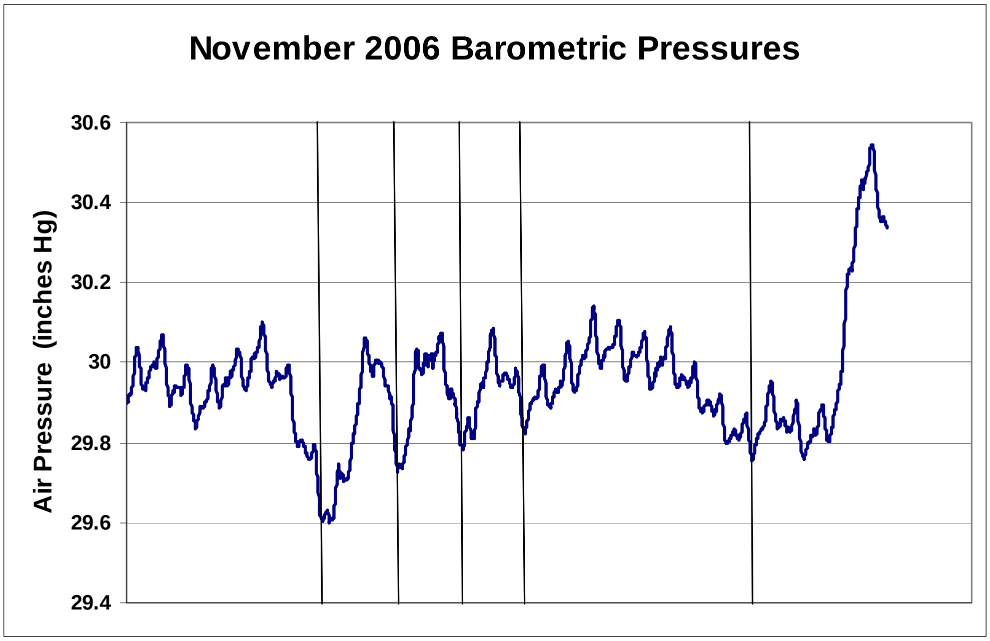
11%) with an outside temperature of 49^{o}F. The only dew point temperature lower than this for 2010 occurred on New Year's eve, at -5.3^{o}F (relative humidity at 11%) with an outside temperature of 46.5^{o}F.

Peak Wind Speeds

Peak wind speeds recorded every 30 minutes are averaged over each month to compare general wind conditions over the course of a year. There are three weather stations in the city that generate peak wind data and these are averaged together each month. Wind conditions for the first half of 2010 normal when compared to the average over the last eight years, the span of available documentation. July was the windiest month followed closely by June, April and May (Table 1). The second part of 2010 was a little different with August peak winds averaging one per hour faster than the eight year average, September experienced a one mile per hour decrease and November an amazing 2.5 miles per hour increase. This November was quite different from other documented Novembers in that the barometric (air) pressure record indicates that more fronts with a significant pressure change between the high and low pressure centers passed through the area even though no rain was associated with any of them. The greater magnitude of pressure difference between the high and low centers and the closer they are to each other will yield increasing wind speeds. November 2010 had at least five and maybe even seven low pressure fronts with four having significant pressure changes (Figure 6).

Month	2010	8-year Average
January	8.13	**8.74**
February	8.18	**8.57**
March	9.48	**9.25**
April	10.58	**10.88**
May	10.80	**10.64**
June	11.08	**10.97**
July	11.40	**10.88**
August	**10.73**	**9.72**
September	**6.89**	**8.79**
October	8.84	**8.56**
November	**9.95**	**7.48**
December	7.91	**8.02**
Average	9.57	**9.37**

Table 1: Peak wind speed averages in Lake Havasu City for each month in 2010 and over an 8-year average. The overall averages are comparable, but the second half of 2010 contains departures from the norm.



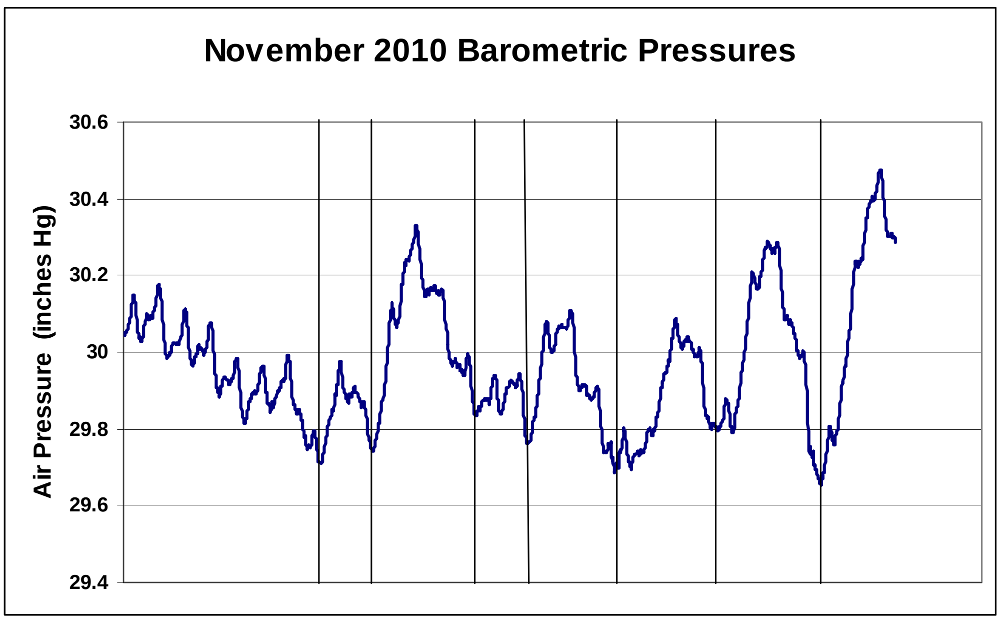


Figure 6: Note the difference between the typical 2006 November air pressure signature and the 2010 air pressure trend. Each vertical line indicates when a low pressure front probably passed through the city, but the 2010 high to low pressure changes are greater than those in the 2006 pattern, resulting in increased wind speeds. The smaller ups and downs on each curve are diurnal changes with the lower pressures in the late afternoon. Each curve runs from November 1st through the end of November 30th.