Lake Havasu City Weather Summary for 2008 and 2009

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Introduction

This summary report combines the Lake Havasu City weather results of the 2008 and 2009 calendar years and includes a look at the official 39 year reporting period. Lake Havasu City began reporting daily weather temperatures and precipitation to the National Weather Service in 1967; however, the temperature data from 1967 to August 1977 is largely unavailable and precipitation data covering all months of the year begins in 1970. The number of weather stations has grown and shrank over the years. From 1967 to 1993 only one reporting station existed. Although only one station continued to report to the National Weather Service, beginning sporadically in 1993 and full time in 1994, a weather station at the City's airport began to record added wind related weather conditions (wind speed and direction) along with temperature and precipitation data. Successive weather stations that permanently recorded a wide variety of weather information (including barometric pressure, humidity, dew point, heat index, wind chill, evapotranspiration, UV index, solar radiation intensity, etc.) were added beginning in 2003 and since then the number of stations for weather tracking has fluctuated between four and six (see on-line Weather Comparison Report 2006).

2008 and 2009 Summary

All averages given in this section are from four weather stations: Fire Station #5 on Lake Havasu Avenue (formerly station #1), Public Works Maintenance Facility on London Bridge Road, at Mohave Community College and at City Hall (a Mohave County sponsored weather station). The City's airport AWOS weather station was out of service both years.

Temperature

High Temperatures

The highest recorded temperature in 2008 was 116.7^{o}F on August 1st and in 2009 was 118.6^{o}F on July 17th. The annual (12 month) mean high temperature for 2008 was 86.4^{o}F and 86.6^{o}F for 2009, pretty average relative to the 32 year average annual high temperature of 86.7^{o}F. In 2008 and 2009, Lake Havasu City experienced 119 and 128 days, respectively, above 100^{o}F and 48 days each year at or above 110^{o}F. Both sets of numbers were not unusual compared to the 32 year historic data set. On the other hand there were some unusual conditions during these two years. May 2009 with an average daily high temperature of 100.9^{o}F was the hottest May since 1997 and July 2009 at 110.6^{o}F was the hottest July since 1998. None of the days in either month set an individual high record temperature. However, four daily high temperature records (96^{o}F for two days and 95^{o}F for 2 days) were set and one record tied (95^{o}F) during a hot spell between October 26th and November 1st, 2008.

High temperature extremes in another way also happened during these two years. January 2008 with a daily high temperature average of 60.7°F and June 2009 at 98.9°F had the lowest high temperature averages for those months of the 32 year record. The flip-flop from the normal rise in temperature from May to June in 2009 was primarily due to the unusual build-up of an upper atmospheric high pressure dome occupying the southwest in May. High pressure, although containing cooler air high in the atmosphere, is also heavier than surrounding air and it tends to sink towards the ground. As it does so, the air below is compressed, heating it up. A common analogy to this is a manual bicycle air pump when used, heats up due to the action of compressing the air into a tire. As the high pressure system slowly moved eastward, the jet stream moved south bringing in cooler air for June.

Low Temperatures

The lowest temperature in 2008 was 33.7°F on January 20th and in 2009 was 34.9°F on December 27th. The annual average low temperatures in 2008 and 2009 were 64.1°F and 63.8°F compared to the 32-year average of 62.9°F. Three record low temperature days were recorded at 57°F each on May 24th, 2008 and October 2nd and 6th, 2009. May 26th, 2008 tied a record low temperature also at 57°F. Studying low temperatures particularly for the summer months is instructive in that they can gauge how efficiently the ground surface and near surface atmosphere dissipate radiant heat (i.e. how quickly the air will cool down overnight). There were 16 days in 2008 and 15 days in 2009 in which the recorded low temperatures were at or above 90°F. All these days correspond with monsoonal high humidity and dew point temperatures. The “thicker” atmosphere inhibits cooling because water vapor in the air is close to saturation and it tends to trap the heat. The daily low temperature on August 2nd, 2008 was 96.1°F. Three days in 2009 also experienced overnight low temperatures above 95°F with the highest at 98.2°F on July 17th, one of the highest low temperatures recorded in the 32 year period.

In 2009, the same trend present for monthly high temperatures is true for the monthly low temperatures for those months. Two months averaged the highest low temperature for those months in quite sometime and two months averaged the coolest low temperature for those months. May recorded the warmest low temperature average at 76.5°F for a May in the past 32 years and July was the warmest low temperature average at 88.7°F for a July since 1996 and 2nd warmest over the 32 year period. June experienced the coolest low temperature average at 77.7°F for a June since 1998 and October averaging 61.5°F was the coolest for an October since 1994.

Temperature Changes

Typical temperature increases during the spring or fall after a cold front has passed and the cooler air mass is replaced with high pressure are about 20°F over a three to five day period (Figure 1). A more extreme example occurred from April 15th to April 20th 2009 when the daily high temperature series climbed 37°F from 65°F to just over 103°F (Figure 2). The barometric pressure trend at the surface over this same period increased dramatically the first day after the front’s passage (Figure 3), yet with compressive heating as the upper level ridge developed over the region, the surface air pressure decreased causing a local surface low pressure feature in the Lover Colorado River topographic trough. Note that most 24 hour temperature rises (high to high) are less than 10^{o}F.

Temperature drops can also be impressive when cold fronts replace warm air. The largest temperature drops in a 24 hour period in 2008 occurred twice when the temperature dropped about 22^{o}F, between February 13th & 14th from 76.2^{o}F to 54.2^{o}F and between May 20th & 21st from 108.8^{o}F to 87.2^{o}F.

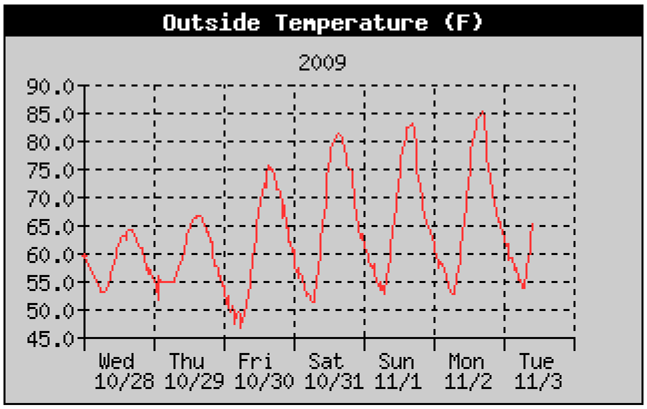

Figure 1: Typical high temperature profile after a cold front and as a succeeding high air pressure ridge or dome becomes established. In this case the five day temperature increase was 20^{o}F.

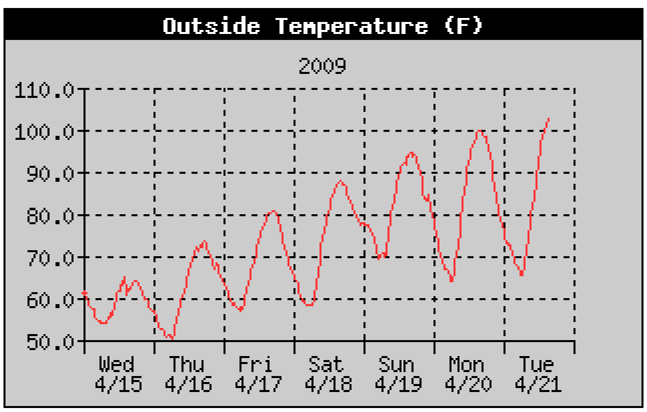

Figure 2: This temperature trend documents an unusual increase after a cold front and as a succeeding high air pressure system becomes established. Total high temperatures increased from 65^{o}F to 103^{o}F during this period.

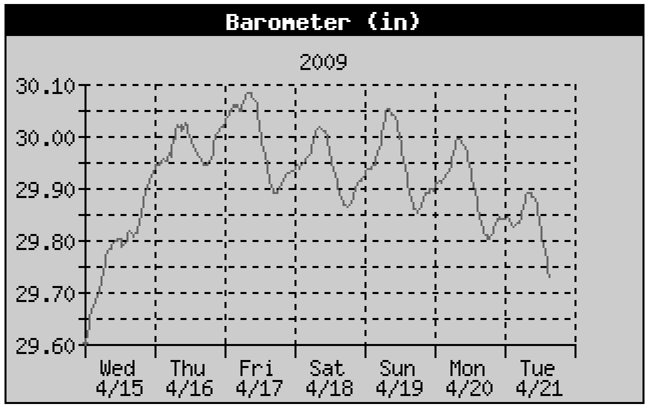

Figure 3: Barometric pressure pattern over the same period as in Figure 2, depicting initial rapidly increased air pressure and a slowly declining pressure trend due to compression surface heating.

Heat Index

High air temperatures in Lake Havasu City may not commonly exceed 120^{o}F (see the 32 year and 10 year trends section below), yet the combination of air temperature, relative humidity, wind speed and solar radiation commonly produces heat indices between 118^{o}F and 125^{o}F during the summer. There are three types of heat index calculated from weather stations. Heat index is a calculation based on air temperature and relative humidity. The Temperature/Humidity/Wind (THW) Index adds the cooling effect of wind and is the value that represents what it "feels" like in the shade and the Temperature/Humidity/Sun/Wind (THSW) Index includes solar radiation to determine what it would "feel like" in direct sunlight. THSW produces the highest index temperature, but not usually when the solar radiation is most intense.

July and the first part of August tend to produce the highest values as the humid monsoon season is present, but June can also produce 120^{o}F plus THSW (Table 1). The highest THSW indices in 2008 and 2009 were approximately 124^{o}F, but note that the Heat Index and the THW are the same in each case. The wind speed is not high enough in these situations to create a noticeable cooling effect. Neither do any of these readings occur when the sun is highest in the sky (all mid to late afternoon). Solar radiation maximums during these three months are typically in the upper 900 to 1000 W/m^2 and the Ultraviolet Index (UV Index) midday maximums are 13.5 to 14.0, which are well into the National Weather Service's extreme health risk category.

Precipitation

Drought conditions over the past 12 years in the southwest continued in Lake Havasu City in 2008 and 2009. Although the 2008 total average rain fall amount, based on four weather stations in the City, was 4.18 inches, on par with the City's 39 year average,

Table 1: Maximum Heat Indices for June through August in 2008 and 2009

Date	Time	Out Temp	Out Hum	Dew Pt.	Wind Speed	Heat Index	Shade THW Index	Sun THSW Index	Solar Rad.	UV Index
6/30/2008	4:00 PM	115.4	9	41.8	2	108.7	108.7	118.7	668	6.1
7/10/2008	3:30 PM	107.9	21	59.6	6	109.8	109.8	120.8	736	7.9
8/1/2008	5:30 PM	116.3	10	45.9	3	111.4	111.4	124.1	515	2
6/30/2009	4:00 PM	111.9	14	51.6	5	109.9	109.9	120.3	674	6.6
7/18/2009	2:30 PM	117	11	49	4	113.3	113.3	123.9	851	10.3
8/5/2009	4:00 PM	115.4	12	49.7	9	111.7	111.7	121	647	5.8

over 50% of that total (2.56 inches) accumulated in January and December. There were two extensively dry stretches in 2008 of 90 and 86 days without measureable rainfall. The precipitation average total for 2009 was 2.73 inches, most of which fell in February and August and there were 93 days from September 5th to December 7th in which there was no measureable precipitation. The typical hit and miss August monsoon rains resulted in expected variable accumulation rates at each station (0.47” to 1.04”), yet each year’s August accumulations resulted from only two storm events. Despite the general lack of rainfall, at least one good evening lightening storm lit up the sky each year with the California side of Lake Havasu getting most of the action (Figures 4 and 5). Comparing the last two years with a seven year running average (Table 2) does not seemingly support the notion of a long term drought in the southwest; however, the 7-year average annual amount is heavily influence by the 2004 – 2005 winter in which almost 14 inches of rain fell in Lake Havasu City. Rainfall amounts from 2006 onward have averaged only 3.02 inches, below the historical precipitation average.

Evapotranspiration (ET)

Evapotranspiration (ET) is the other part of the equation that determines what plant types can grow in an area, thus defining the ecosystem. When climatic ET rates from the soil far exceeds precipitation rates, desert conditions exist. ET recordings have only been kept in Lake Havasu City since 2003. Both 2008 and 2009 ET totals are approximately 85.7 inches (over seven feet!). Compared with rainfall totals of four inches or less each of the past two years, the potential net water loss to the atmosphere is staggering. The distribution of the ET amounts is the same for each year, but the ET maximum for 2008 is in June while it is in July for 2009 (Figure 6). This shift is probably reflected in the relatively cool June 2009 temperatures.

Table 2: The Lake Havasu City 7-year average monthly precipitation amounts starting with 2003.

MONTH	Precipitation (inches)
January	0.71
February	1.10
March	0.48
April	0.19
May	0.06
June	0.01
July	0.21
August	0.94
September	0.37
October	1.08
November	0.71
December	0.45
7- YEAR ANNUAL AVERAGE	6.12

Figure 4: Thunderstorm with well defined rain shaft on the California side of Lake Havasu, August 2009.

(a)

(b)

Figure 5: Lightening strikes during monsoon thunderstorms over the Chemehuevi Mountains on the California side of Lake Havasu (a) and over the northern portion of Lake Havasu City (b).

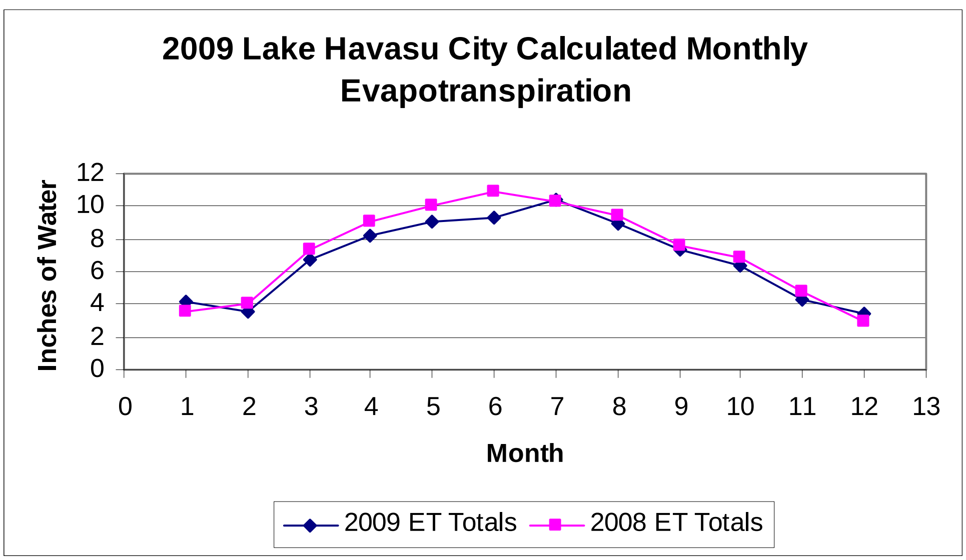

Figure 6: Distribution of evapotranspiration rates over 2008 and 2009.

<u>Dew Point Temperatures and the Arizona Monsoon Season</u>

Dew point temperature and relative humidity have reliably been available only since 2003 when a weather station was installed at Mohave Community College. The other weather station utilized by the City that consistently records these two parameters was installed at Fire Station #5 in 2006. The Mohave County weather station at City Hall also records relative humidity, but not dew point temperature.

Extreme low dew point temperatures

Very low dew point temperatures usually indicate a very dry atmosphere. Desert air is typically dry, but usually contains a certain level of water vapor. Particular events involving dry air masses can be associated with cold polar fronts or with excessive compression heating by an upper atmosphere high pressure dome or ridge. As the examples below indicate, low dew point temperatures can happen almost any time of the year.

2008 – Dew point temperatures stayed below 10^{o}F for 43 hours from December 31st, 2007 through the January 2nd, 2008. Between January 16th and 18th, except for two readings just above 10^{o}F, the lowest dew point was 1.6^{o}F at a relative humidity of 18% and air temperature of 42^{o}F. Dew point temperatures on April 21st were below zero from 10:30am to 3:30pm with the lowest at -7.5^{o}F (lowest for 2008) for an hour (1:30-2:30pm) at a relative humidity of 3% and air temperature of 81.2^{o}F. June 9th recorded dew point temperatures at or below zero (-0.1^{o}F) for only three half-hour periods when the relative humidity at these times was 2% and the air temperature at 106^{o}F. This was the first time since July 4th, 2007 that the relative humidity was down to 2%. At that time the relative humidity also reached an amazing 1% (almost no water vapor in the air).

2009 – On March 26th at 6:00pm, the dew point temperature reached -6.8^{o}F (lowest for 2009) coinciding with a relative humidity of 4% and an air temperature of 74.7^{o}F. The dry air continued to create negative and single digit dew point temperatures between 5:00pm and 2:30 am on March 27th. On April 4th from 2:00pm to 5:00pm, the dew points were below 4ºF with the lowest at -3.5^{o}F at 4:00pm at a relative humidity of 5% and an air temperature of 75^{o}F. The dew point temperature on June 21st dipped to 3.7^{o}F at 1:00pm when the relative humidity was 3% (lowest for 2009) and the air temperature was 97^{o}F. Lastly, December 4th from 1:30 pm to 5:30 pm experienced negative dew points with the lowest at -5.9^{o}F at 5:00pm. The relative humidity at that time was 7% and the air temperature was 58.6^{o}F.

The 2008 monsoon season began a little early, approximately on July 3rd, as average dew point temperatures rose from 40^{o}F to above 50^{o}F over a four day period and extended to September 22nd, but with a ragged end extending to approximately October 10th (Table 3). The jet stream usually begins to move southward in mid-September bringing in cold fronts and drier air that can temporarily break up the humidity. Large amounts of moist humid air still moving north from the Gulf of California this time of year quickly replaces the cooler air and re-elevating dew point temperatures.

Monsoon seasons usually start rather well defined, but the 2009 monsoon season started with two slugs of humid air in mid and late June, each temporarily replaced by drier air. By July 15th humid conditions with dew point temperatures over 50°F prevailed and were maintained until September 14th when drier air passed over the city. A stronger cold front with drier air moved in on September 21st ending the monsoon season.

Available dew point temperature information only goes back to 2003, but in the period of the last seven years, the average high dew point temperature period before any break of drier air is 60 days (Table 3). The average duration when high dew point temperatures permanently decrease for the year is about 80 days from monsoonal onset, which could happen as late as mid-October.

Precipitation during the monsoon season for both years was subpar with an average of less than 1 inch. At the end of the 2009 monsoon season, a north moving tropical storm (Olaf) in the Pacific Ocean at the end of the Baja California peninsula was threatening to cross over the peninsula and continue north in the Gulf of California and up the Colorado River Valley. If left alone, remnants of the system could have moved over Lake Havasu, potentially bringing significant rainfall. However, a cold front moved through the area before the storm and guided it eastward past the Baja peninsula and over the Mexico mainland where it dissipated as a collection of thunderstorms (Figure 7).

Table3: Approximate end point dates of monsoonal activity over the period from 2003 to 2009 as determined using dew point temperatures.

Year	Approximate Begin Date	Date of First Drop in Dew Point	Date of Last High Dew Point	Duration To First Dew Point Drop (days)	Duration to Last High Dew Point (days)
2003	7/11/2003	9/9/2003	10/12/2003	61	94
2004	7/10/2004	8/20/2004	9/19/2004	42	72
2005	7/14/2005	9/9/2005	9/28/2005	58	77
2006	6/26/2006	8/26/2006	9/14/2006	62	81
2007	7/7/2007	9/17/2007	9/25/2007	42	50
2008	7/3/2008	9/14/2008	10/10/2008	74	97
2009	6/26/2009	9/14/2009	9/21/2009	81	88
			Average	**60**	**80**

Note: Dates are based on when the dew point temperature rises to or falls from 50°F.

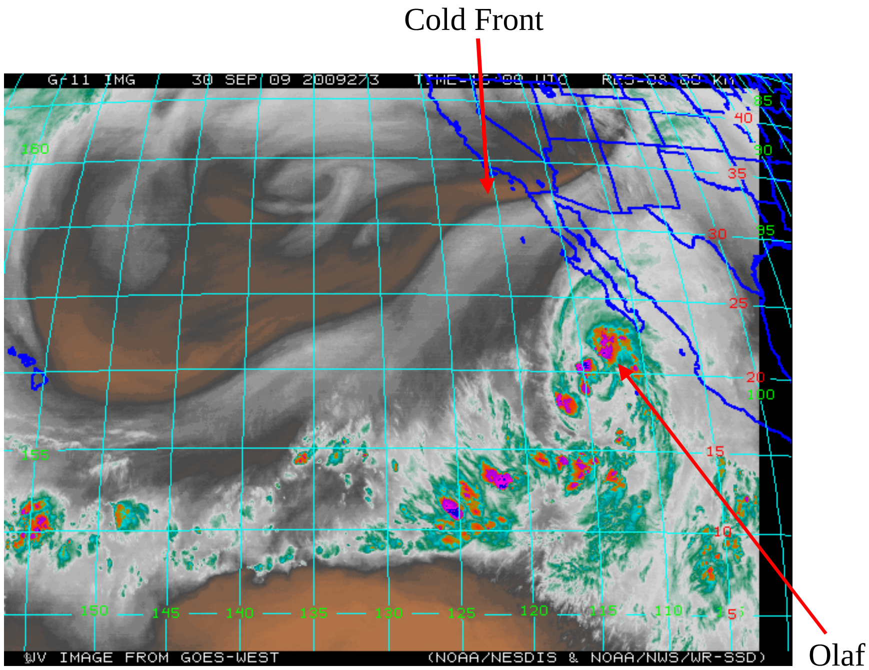

Figure 7: A well defined cold front passing through the desert southwest acted to steer Tropical Storm Olaf eastward from the Pacific Ocean to the Gulf of California.

Winds

Individual peak wind speeds at each of the three weather stations that record this parameter are taken over thirty minute intervals with the highest reported. May was the windiest month in 2008 with an average peak wind speed of 12.6 mph. April and June 2009 tied with an average peak wind speed of just over 11 mph. The month of March had the top recorded wind gusts in both 2008 and 2009 with speeds of 49 and 43 mph, respectively. The average peak wind speeds spread over 2008 was 9.88 mph while 2009 averaged 9.08 mph. 2009 was a bit different from previous years in that there were nine months in which the average peak wind speed was below 10 mph versus most other years that have only seven months below that level. November was the quietest month at 6.8 mph, yet August average peak wind speed was only 7.9 mph, three mph slower than for August 2008.

Regardless of the 2008 and 2009 results, the longer term average windiest month is still June, followed closely by April, July and May (Table 4). November winds seem to be at a minimum for the year.

Table 4: The Lake Havasu City 7-year average for average high wind speeds starting with 2003.

MONTH	7-Year Average High Wind Speed (mph)
January	8.84
February	8.62
March	9.22
April	10.92
May	10.62
June	10.96
July	10.80
August	9.57
September	9.06
October	8.39
November	7.04
December	7.97
7- YEAR ANNUAL AVERAGE	9.33

30 plus year and 10 year Trends

Lake Havasu City daily temperature and precipitation data has been reported to the National Weather Service (NWS) in Las Vegas, Nevada since September 1967, yet the actual high and low temperature readings are only continuously available starting in August of 1977. Temperature records in this interval are either entirely missing or contain one or two month's readings in a given year, usually during the winter months. Curiously, daily precipitation data is continuously available beginning November 1969. Weather readings sent to the NWS are not used for forecasting weather, but used for general record keeping and regional climate studies. Readings from 1967 to 1993 are available from only one source, the temperature and rain gauge supplied by the NWS. These gauges were first located at the old airport on the Island until late 1982 when they were relocated to a city Fire Station (former station #1, today station #5) on Lake Havasu Avenue where readings were taken until 2002, when the weather station was relocated again to its current location at the Public Works Maintenance Facility on London Bridge Road. A weather station installed at the new airport location north of the city began full time operation in 1994 recording daily temperature, wind and precipitation information. More weather stations were installed in the 2000's that provided a full spectrum of weather related data.

Temperatures

A look at ten year and 32 year averaged high and low temperatures for each month quantifies what most everyone who lives in this region already knows, the two hottest months are July and August and the coolest month is December (Table 5). The trends of temperature changes throughout the year have stayed mostly consistent with a slower warming trend toward the summer than cooling trend after the summer (Figures 8 and 9). Comparing 10 year trends with the 32 year trends, high temperature averages are similar as are most low temperature averages with the exception of a slight deviation of elevated low temperatures in the 10 year trend from May through July and again from late August through September. This can be better visualized on Figure 10, showing the number of days whose lows are 90^{o}F or higher.

<u>Some quick statistics about the 32 year temperature period</u>:

Although June 29, 1994 was the hottest day ever officially recorded in Lake Havasu City at 128^{o}F, July 14th over the past 32 years, averages the hottest day of the year at 111.4^{o}F. The average for June 29th is 109.8^{o}F, tying for 12th hottest day with three other days.

For an area known for its extreme heat, official high temperatures do not reach 120^{o}F or above very often. Out of the last 32 years, only 12 years recorded at this level. Two years, 1994 and 1995, recorded 11 days each at or above 120^{o}F, whereas the last year to record 6 or more days above 120^{o}F was 1998. Since that year, only nine days have been above that mark.

The 32-year average number of days at or above 100^{o}F is 105 and the average number of days at or above 110^{o}F is 29. Over the past 10 years, the average number of days at or above 100^{o}F is slightly higher at 115, but the average number of days at or above 110^{o}F is lower at 16. The year with the most days over 110^{o}F is 1994 at 86 days. 1996 had the most days over 100^{o}F at 146 days.

Fifteen out of the last 32 years experienced below freezing temperatures, with the coldest temperature at 25^{o}F occurring on December 24, 1990. This was one of six straight sub thirty-degree days, the deepest cold snap during the 32 year period. Only 4 out of the last ten years had temperatures at or below freezing. December 25th tends to be the coldest day of the year with an average of 38.9^{o}F.

The 32 year mean high temperature is 86.8^{o}F and the mean low temperature is 62.7^{o}F. Combining the 32 year high and low mean temperatures yields a mean annual temperature of 74.8^{o}F, which is among the overall warmest regions in the United States, but not the warmest. South Florida has that title with Key West averaging almost 78^{o}F. Weather in that region is much more consistent year-round.

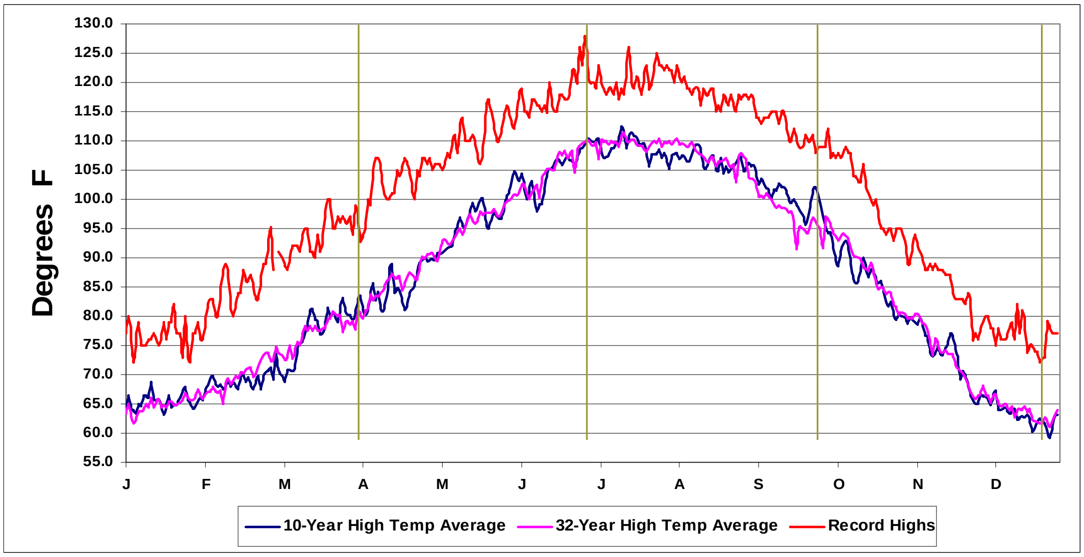

Figure 8: Ten year and 32 year high average temperature annual trends ending in 2009. The curve relationships do not indicate that high temperatures have significantly changed one way or the other within the last ten years. The record high temperature curve indicates that record high temperatures usually deviate around 10°F from the average highs in the summer and winter, but increase that difference to 15-20°F in the spring and somewhat in the early fall. Light brown vertical lines indicate the division between the seasons.

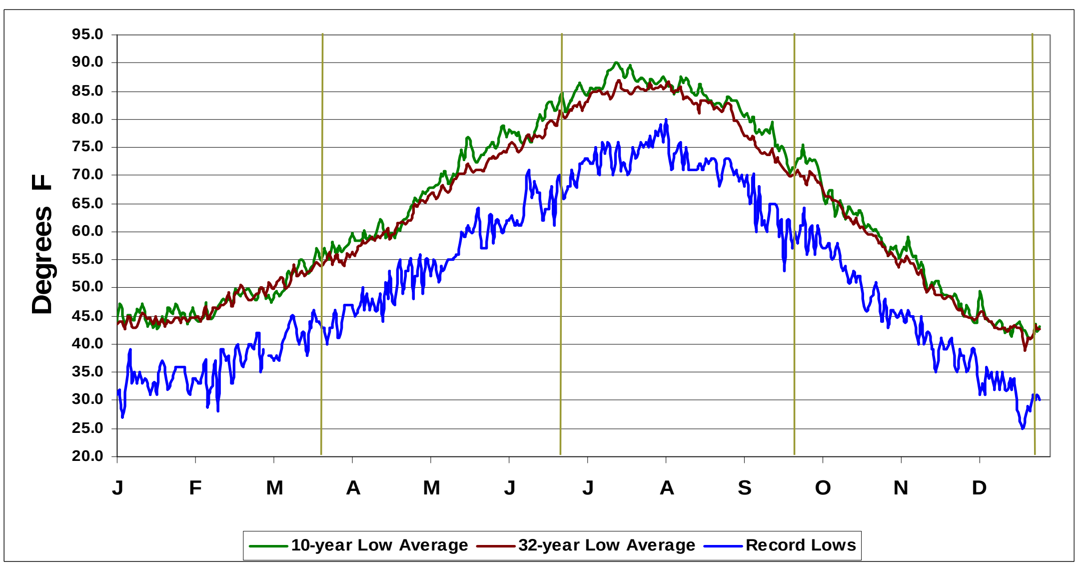

Figure 9: Ten year and 32 year low average temperature annual trends ending in 2009. The ten year curve hints that the low temperatures during the summer months (May to September) have slightly risen in the last ten years. The gap difference between the 32 year curve and the record low temperature curve is more subtle than for the high temperature curve relationship in Figure 8. Light brown vertical lines indicate the division between the seasons.

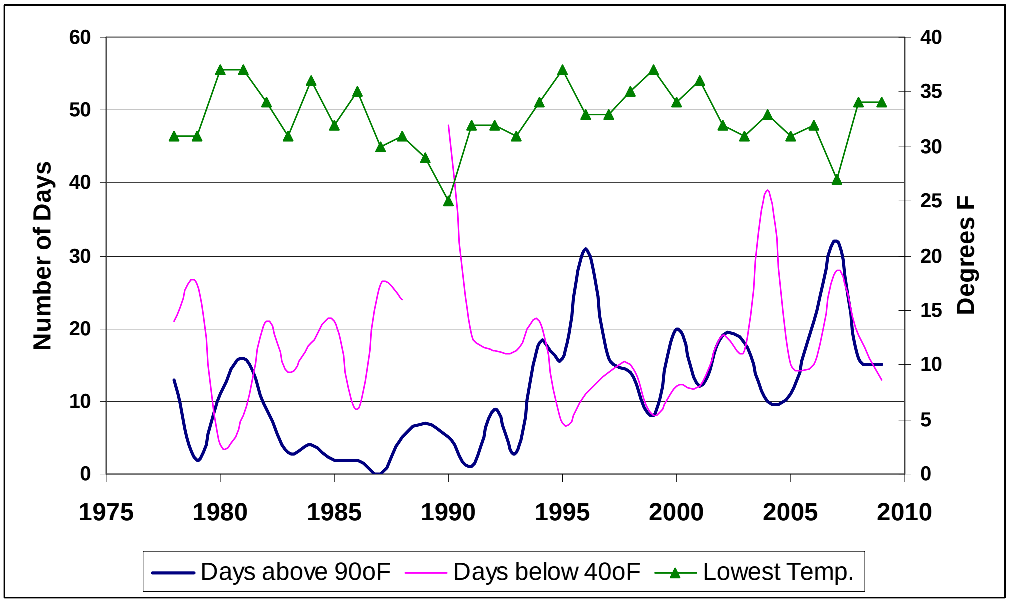

Figure 10: Trends of the number of days each year when the low temperature is above 90°F in the summer and when the low temperature is below 40°F in the winter and the lowest temperature of each year (green). An increasing trend for the number of days above 90°F is evident beginning in 1994.

The average daily temperature difference between daily highs and lows for each month indicate that June and December have the most and least spread, respectively (Table 5; Figure 11). Although June is not ranked as the hottest month, temperatures typically get over 110°F in the later half of the month. June is also one of the driest months of the year and air humidity tends to be very low, in the single digits. Dry air is more transparent to long-wave radiation (infrared) that leaves the earth's surface after being heated by the sun. Fewer large molecules are present in the air to absorb heat, so the radiation is more readily capable of escaping into the upper atmosphere and outer space. With the onset of the monsoon season, increase air humidity begins to trap more of the heat radiation, keeping it closer to the earth's surface and keeping the air from cooling down as much.

Precipitation

Full year rainfall records are available a few years earlier than the temperature data, beginning in 1970. The 39 year precipitation annual average is 4.15 inches with individual years highly varied from almost 18 inches in 1998 to a low of 1.24 inches in 1996. January (0.64") and August (0.57") average the wettest months and May (0.07") and June (0.04") are clearly the driest months (Table 6). In fact, only 1.54 inches have ever been recorded in June over the 39 year period and almost an inch of that fell in 1972 (1992 precipitation information is suspect and has not been included in any of the presented statistics). The winter months produce cold fronts that develop in the Pacific Ocean and provide regional wide rains. If a front stalls for several days, such as the

Table 5: Lake Havasu City 10 year and 32 year monthly average high and low temperatures, average daily temperature differences and the corresponding annual averages.

Month	10 year High Temp Ave.	10 year Low Temp Ave.	10 Year Daily Temp. Difference	32 year High Temp Ave.	32 year Low Temp Ave.	32 Year Daily Temp. Difference
January	65.6	44.9	20.7	64.9	44.2	20.8
February	68.8	47.2	21.6	69.9	47.4	22.5
March	76.9	53.2	23.7	77.3	53.1	24.3
April	85.0	60.8	24.2	85.9	59.9	26.0
May	96.6	72.2	24.3	95.8	69.6	26.2
June	104.7	79.7	**25.0**	105.3	77.6	**27.7**
July	**109.2**	86.9	22.3	**109.7**	84.7	25.0
August	106.6	84.9	21.7	107.8	83.8	24.0
September	101.1	76.7	24.5	98.2	73.6	24.6
October	87.3	64.2	23.2	88.7	63.2	25.5
November	74.1	52.5	21.6	74.2	51.3	22.9
December	**63.3**	43.7	**19.7**	**62.1**	42.0	**20.1**
ANNUAL	**86.6**	**63.9**	**22.7**	**86.7**	**62.5**	**24.2**

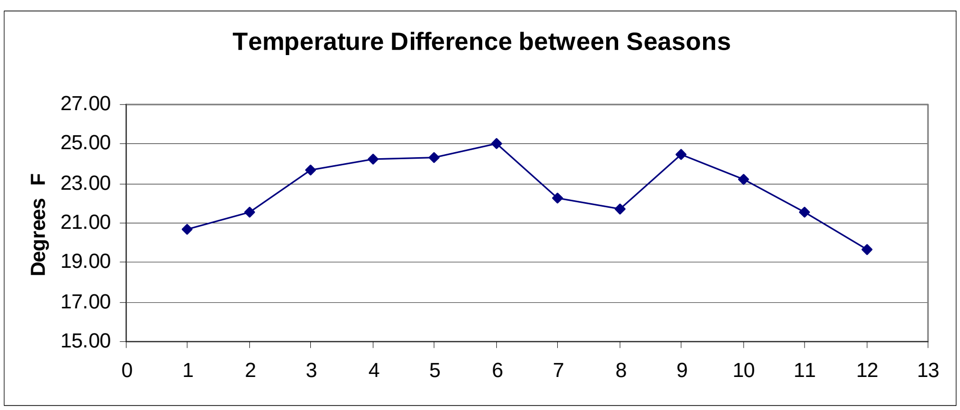

Figure 11: Thirty year average of temperature differences between high and low daily temperatures throughout a year (January = 1; December = 12).

so-called pineapple express, when moisture is fed from the sub-tropics, a large amount of rainfall can be experienced (e.g. February 1998 – 7” and winter of 2004-2005 – 5.8”). Summer monsoonal storms are hit and miss, but if hit, can produce a large volume of water in an extremely short period. (e.g. August 2005 – up to 4.46”). The current regional drought experienced in the desert southwest began in the late 1990’s. Lake Havasu City has experienced years during and prior to this drought when there were excessively long periods between measureable rainfall events. The longest recorded time is 157 days in 1996, which might have started the current drought. There have been a few other years with continuous no rain periods over 120 days long; the winter/spring of both 1971-1972 and 1970-1971 at 154 days each, in 1993 at 148 days, in 1994 at 138 days, and in 1989 with 129 days. The stretch for 1989 was broken by a 0.02 inch rainfall, followed by another 89 dry days, making this period the longest at 213 days with the smallest rainfall amount between in the 39 year record.

Lake Havasu City Monthly High Temperatures and El Nino Events

Although this section is straying from the rest of the report by including a portion of 2010’s weather information, a comparison of Lake Havasu City’s monthly high temperatures with El Nino events is in order since the 2009-2010 season experienced the fourth strongest El Nino on record and that 32 years of temperature data is now available. El Nino events are warmer than normal sea surface temperatures in the equatorial central and eastern Pacific Ocean caused by decreased westward, wind-driven (Trade Winds) surface currents. The trade winds controlling the currents are, in turn, controlled by air pressure differences between one end of the Pacific and the other and wind always travels from relatively high pressure to relatively low pressure (from east to west in the case of trade winds). With lower than normal air pressure in the eastern Pacific, the equatorial currents slow and warm water stays closer to North and South America, temporarily changing deeper ocean currents and the weather patterns around the world. El Nino conditions usually develop late summer to fall and extend through the winter into the spring, depending on the intensity of the El Nino event. The southern tier of the United States tends to get more rain than normal (again depending on the intensity of the event) and as indicated by the chart below, cooler-than-normal air temperatures are experienced primarily in the spring in Lake Havasu City. Three major El Nino events and five more minor events have occurred within the period of record available for Lake Havasu City temperatures. The three major events occurred in 1982-1983, 1997-1998, and 2009-2010, with the 1997-1998 event the strongest recorded.

Comparing Lake Havasu City high monthly temperature averages between El Nino and normal years indicates that only major events exhibit noticeable cooling, particularly from February to June (Figure 12). Mild El Nino and La Nina event years (cooler than normal equatorial waters of the central and eastern Pacific) show little change from normal in Lake Havasu City high temperatures.

Precipitation amounts during major El Nino events have produced higher than average precipitation volumes, typically in the range from 4.5 to 8 inches, but have not

Table 6: Recorded precipitation totals and monthly averages for the period from 1970 to 2009. Lake Havasu City has officially recorded almost 14 feet of rain during this period. 1992 data is suspect and not used in these calculations.

Month	Summation 1970-1991	Summation 1993-2009	Total Precipitation	Monthly Average
January	**13.37**	**11.05**	**24.88**	**0.64**
February	10.88	9.50	20.38	**0.52**
March	14.5	5.78	20.28	**0.52**
April	3.77	1.36	5.13	**0.13**
May	2.07	0.47	2.54	**0.07**
June	**1.44**	**0.13**	**1.57**	**0.04**
July	9.38	2.73	12.11	**0.31**
August	13.61	8.47	22.08	**0.57**
September	9.19	5.78	14.97	**0.38**
October	8.19	4.36	12.55	**0.32**
November	6.50	6.24	12.74	**0.33**
December	8.96	5.00	13.96	**0.36**
TOTAL	101.86	59.87	161.73	**4.15**

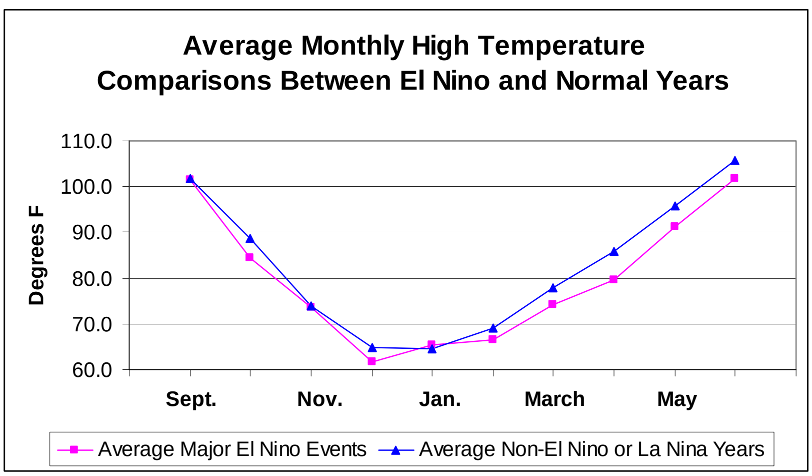

Figure 12: Monthly high temperature averages in Lake Havasu City from September to June for major El Nino and non-El Nino years. The El Nino effect is most pronounced in the winter and spring.

exclusively produced unusually large rainfall amounts. Although almost 18 inches of rain fell at the Lake Havasu Regional airport during the 1998 El Nino event, several non-El Nino years such as 1978 and the winter of 2004-2005 produced unusually large rainfall volumes of 13 plus inches and 10 plus inches, respectively.

Summary

Weather for 2008 and 2009 was mostly typical for Lake Havasu City with the major exception of the May – June temperature reversals in 2009 and the drier than normal conditions continuing the region's drought. Neither year's summer was excessively hot with both staying below 120^{o}F nor were the winters excessively cold staying above freezing. Yet each year experienced solar heat indexes up to 124^{o}F. A summer time low temperature of 98^{o}F in July 2009 was one of the highest ever recorded in the city and in April of the same year a daily high temperature increase of 37^{o}F occurred over a seven day period. Evapotranspiration rates for each year were over seven feet and each year experienced dew point temperatures below 0^{o}F at different times of the year, signifying extremely dry air conditions. Each year's monsoon season was longer than other recent years, but neither produced much rainfall. Each year had windiest months in the spring, typical of most years.

Long term temperature (32 year) and precipitation (39 year) records show a slight increase in summer time low temperatures and drier than normal conditions over the last 10 years. Summer time days over 120^{o}F are not very common and yet the 32 year average for days over 100^{o}F is 105 with July 14th the hottest day of the year on average. The 32 year mean high temperature for Lake Havasu City is 86.8^{o}F and the mean low temperature is 62.7^{o}F. The month with the highest daily temperature variation is June and the least is December, also the coldest month of the year. The 39 year precipitation average is 4.15 inches, with June the driest month and January and August the wettest months. El Nino events may bring cooler winter and spring temperatures, but they do not necessarily bring a significantly larger volume of rainfall than some non-El Nino years.