2013 Lake Havasu City Weather Summary

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Introduction

As in years gone by, Lake Havasu City in 2013 experienced some record temperatures at both ends of the scale, but the year was drier and windier than normal, highlighted by an untypical bimodal monsoon season. This was the first year since 2006 that a complete weather record was reported from the airport, but the MCC weather station was offline for refurbishment from May to October. The City experienced a very hot streak in late June, but was much cooler than normal in early December. The City also went through a stretch of 125 consecutive days without rain from March to July and again was very dry at the end of the year.

Temperatures

January started the weather year with a bang. One of the coldest, windiest series of cold fronts entered the area during the first two weeks. January 5th and 6th each broke a record low temperature, at 34^{o}F and 36^{o}F, respectively, at the official weather station at the former Public Works (now Operations Maintenance Facility - OMF). The coldest days though occurred between January 12th and 15th (Table 1). January 12th tied a record low at 33^{o}F and the high temperature for the day at the MCC station was only 49.5^{o}F. Few days in Havasu rarely have highs below 50^{o}F. The next morning (13th) the MCC and City Hall weather stations recorded 28.8^{o}F and 28.7^{o}F, respectively, the lowest temperatures for the year at both stations. It was 29^{o}F officially at OMF, which tied a record, though the wind chill recorded at Fire Station #5 was 23^{o}F. That afternoon, the temperature at Fire Station #5 peaked at 49.8^{o}F and the high temperature on the 14th was 43.8^{o}F (43.2^{o}F @ MCC) and 47^{o}F at the OMF station, which broke a record for this date for the lowest daily high temperture. The next two mornings also tied record lows at 31^{o}F and, 33^{o}F, respectively. One week later, the temperatures were in the upper sixties to low seventies.

An example of what can bring very cold temperatures to our region is shown on the upper air pressure 250mb map below (Figure 1). It represents the distribution of the 250mb pressure level, which is higher in elevation towards the equator and lower in elevation toward the polar region (~40,000-45,000 feet). The specific view on January 14th during the very cold weather shows a high intensity low pressure trough digging southward from the arctic, which brought in the frigid air. The bright red and purple areas on the leading and back edges of the associated cold front, indicate fast moving winds (up to 150 knots (~150 mph)) of the jet stream.

Table 1: Record breaking or tying temperatures in 2013.

Date	Temperature	Previous Record	Weather Station	Comments
1/5/13	34°F	36°F in 1983	OMF	
1/6/13	36°F	38°F in 2005	OMF	
1/12/13	33°F	tied	OMF	
1/13/13	29°F	tied	OMF	Unofficial 28.7°F @ City Hall
1/14/13	47°F	48°F in 2007	OMF	Lowest High Temperature
1/15/13	31°F	tied	OMF	Unofficial 30.4°F @ City Hall
1/16/13	33°F	tied	OMF	
2/10/13	39°F	tied	OMF	
2/11/13	38°F	tied	OMF	
2/12/13	38.8°F	39°F in 1985	MCC	Unofficial
2/21/13	38°F	tied	OMF	
2/22/13	38°F	40°F in 1990	OMF	
2/23/13	40°F	tied	OMF	
2/26/13	39°F	42°F in 1997	OMF	
4/6/13	106°F	105°F in 1981	OMF	
5/13/13	110°F	tied	LHCFS	Unofficial
6/6/13	115.6°F	114°F in 1996	LHCFS	Unofficial
6/7/13	117°F	tied	OMF	Unofficial 118.6°F @ LHCFS
6/29/13	125°F	124°F in 1994	LHCFS	Unofficial
7/1/13	94°F	93°F in 1999	OMF	Highest low temp. 95.4°F LHCFS
7/2/13	95°F	93°F in 1999	OMF	Highest low temp. 96.3°F LHCFS
7/4/13	92°F	tied	OMF	Highest low temp. 95.6°F LHCFS
8/11/13	74°F	76°F in 1991	OMF	
8/13/13	75°F	tied	OMF	
8/24/13	71°F	73°F in 1992	OMF	
8/25/13	70°F	72°F in 1978	OMF	
12/5/13	34°F	39°F in 2001	OMF	
12/6/13	33°F	36°F in 1983	OMF	
12/10/13	34°F	36°F in 1994	OMF	

OMF – Operations Maintenance Facility; LHCFS – Lake Havasu City Fire Station #5 weather station

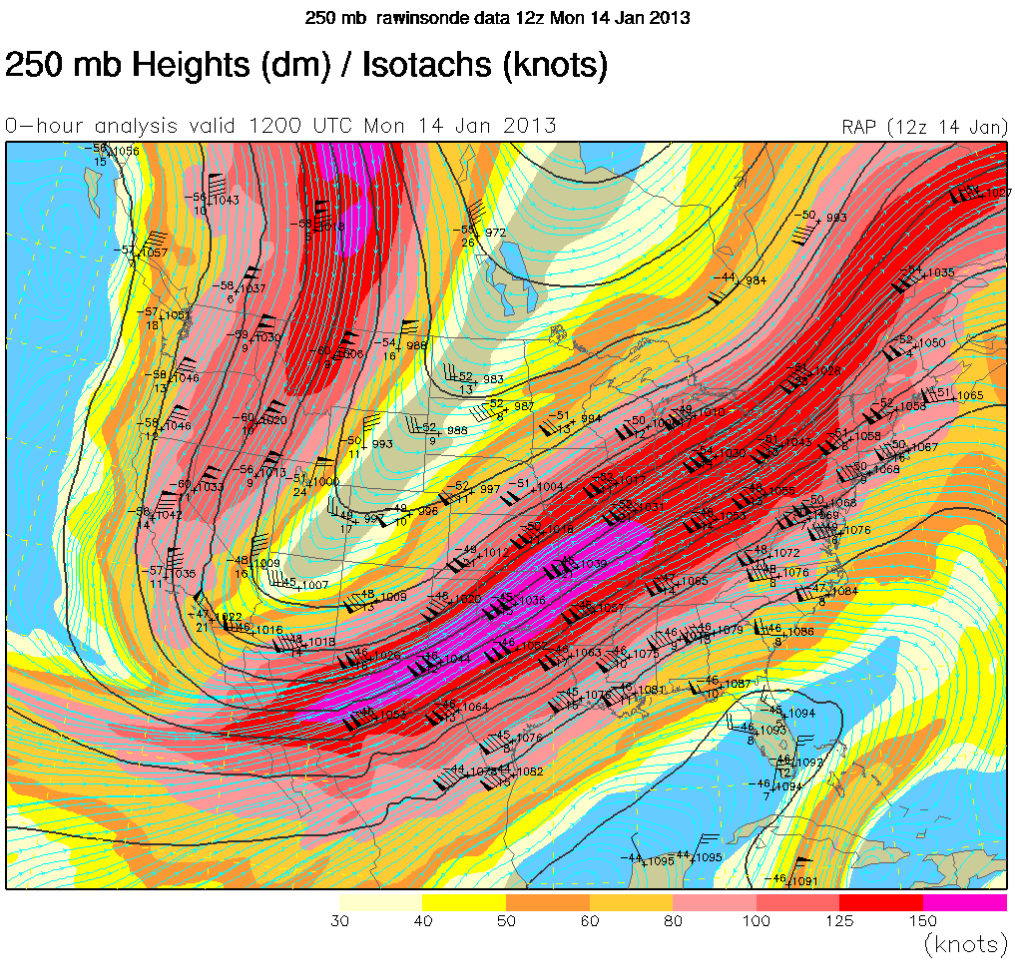

Figure 1: A large, low pressure trough with cold arctic air behind it pushing southward in January 2013.

Ten days after the arctic blast, a front from the subtropical Pacific moved through the area. A water vapor image (Figure 2) shows a well developed low pressure center off the coast of California. Temperatures increased to over 20°F warmer than 10 days earlier. Two days later when the center moved onshore, Lake Havasu city received 0.57 inches of rain.

This was the third coldest January for low temperatures on record with a low temperature of 40.95°F averaged over 5 stations and is the 2nd lowest ever average if only using the official station at OMF – 39.77°F. The 1st is 39.71°F in 1990 and 2nd is 39.94°F in 1989 – both years with only the original official station reporting located at that time at Fire Station #5.

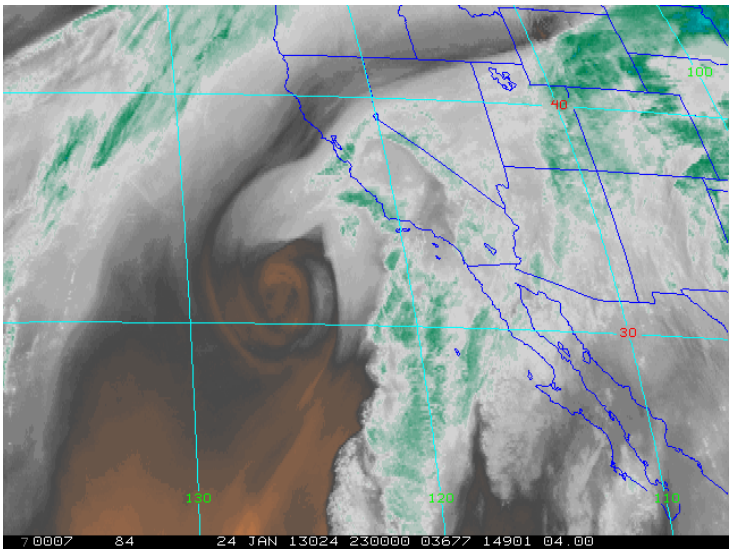

Figure 2: Low pressure center and front from the subtropical Pacific Ocean replacing the cold air that entered the Lake Havasu City area 10 days earlier.

Record breaking or tying low temperatures continued in February (Table 1), which was the 5th coolest in low temperatures at 44.57°F averaged over five stations. The top three years in this category occurred when only data from the official station was available.

Rapid warming of temperatures (25°-30°F) within a week's time between the passage of a cold front and the development of high pressure over the area was not uncommon. Two classic examples occurred in the months of March and May (Figure 3). High daily temperatures increased about 5°F/day over these periods, caused by downward compression of cold air aloft similar to a bicycle pump heating up as it compresses air into a bicycle tire. Cold fronts in late autumn showed that rapid cooling can also take place. One in early December dropped the air temperature 20°F in one day and another 10°F two days later (Figure 4).

In contrast to the above, the temperature range between high and low temperatures on some overcast days was moderately flat. On January 24th, a temperature range of only 11.5°F was experienced at the LHCFS station (54.8°F to 66.3°F). January 26th had even less variation, from 55.3°F to 60.7°F, a 5.4°F change.

The timing of cold fronts through the area can also turn the normal time of daily high and low temperatures upside down. On January 10th, the high for the day was at 2:30pm and the low for the day was at 11:30pm (47.1°F @ MCC, 47.6°F @LHCFS). Low daily temperatures were again experienced at 11:30pm on January 27th (54.5°F @MCC; 56.3°F @ LCHFS), January 29th,

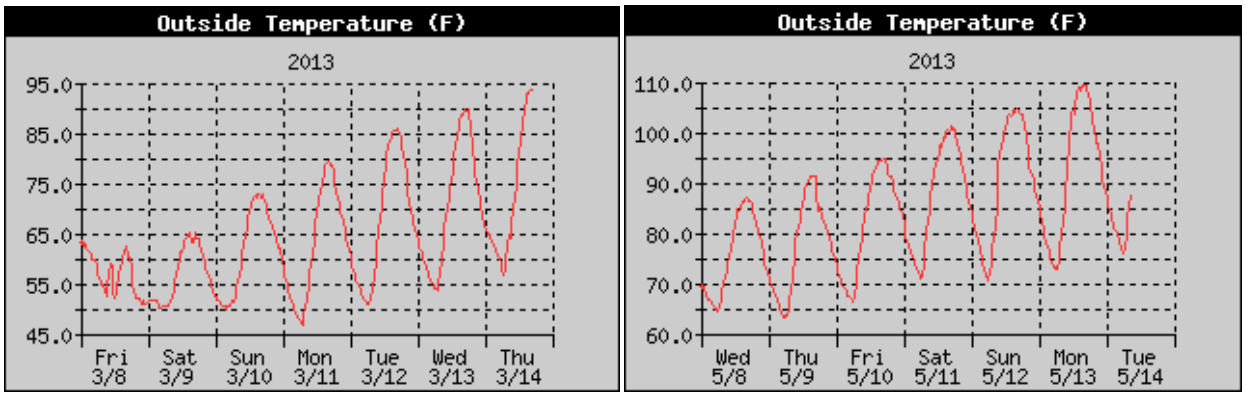

Figure 3: Rapid warming after cold fronts in mid-March and mid-May. The warming is caused by strong high pressure air establishing itself over the southwest U.S.

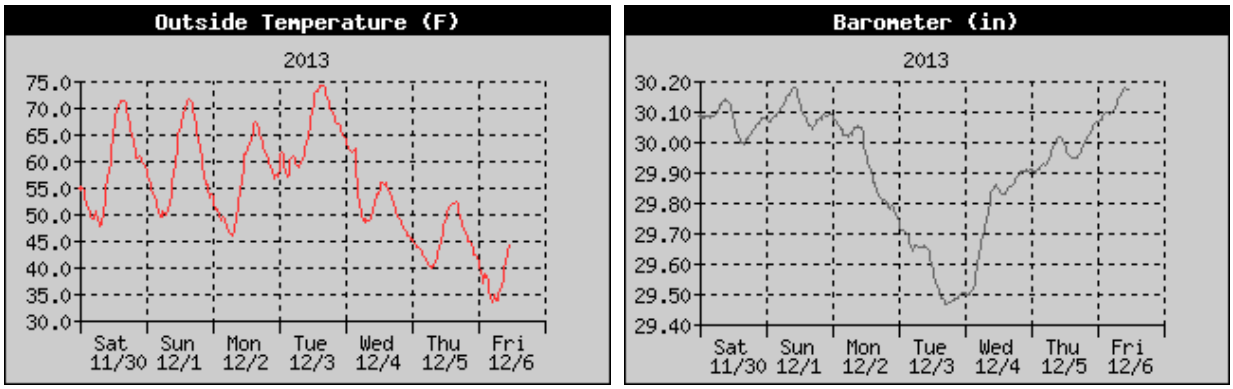

Figure 4: An example of a rapidly moving cold front through Lake Haavsu City in early December. The barometric pressure dip shows when the cold front moved through the city.

February 8th, 11th and 24th, March 8th and April 23rd. Many of the high temperatures for these days were just after midnight at the beginning of those days, but the low temperatures for the following days were only 5-8 hours after the 11:30 pm lows.

Low daily temperatures during the summer months have an entirely different connotation from the winter months. Lake Havasu City in 2013 experienced 31 days in which the low temperatures did not go below 90°F. This is only the fourth time in the City's history that 30 or more days were above this mark and they have all occurred since 2006. Furthermore, there were eight days when the temperature did not go below 95°F, the most ever. The highest low temperature of the year occurred on July 3, 96.3°F. This not a record for this date because the all time record high low temperature of 99°F occurred on this date in 2001 at the OMF

station. The year also ended with three record low temperatures in December (Table 1)

Lake Havasu City also experienced the third hottest June in on record. This was highlighted by during the last week when high temperatures were over 120 for three days, topping off near 125°F at the LHCFS weather station (Figure 5).

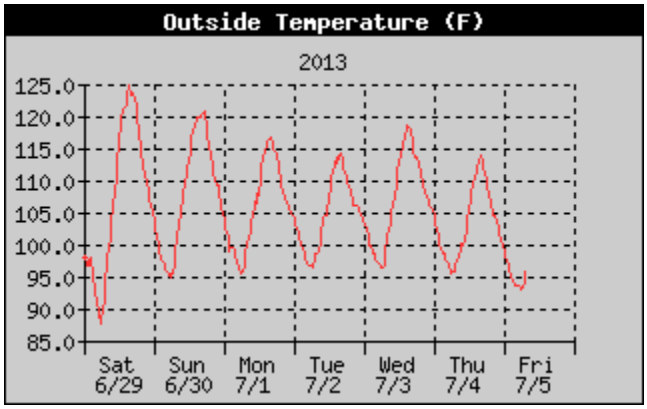

Figure 5: Heat compression development from a high pressure center in the southwest U.S. at the end of June, pushing temperatures to over 120°F over three days.

Peak Winds

The Lake Havasu area seemed windier than in other years, but the annual peak wind average was just above the 10-year average of 9.4 mph (Table 2). However, many monthly average peak wind speeds were higher than the 10 year average, but they were balanced by March and November, which had unusually low average peak winds.

Table 2: 2013 Average monthly peak winds for four weather stations. Red values at airport are record monthly high wind speed averages.

Month	LHCFS	MCC	City Hall	Airport	2013 Ave.	10-year Ave.
January	9.02	7.85	8.08	11.17	**9.03**	**8.79**
February	8.67	7.71	8.78	10.90	**9.01**	**8.81**
March	6.97	6.37	7.82	9.44	**7.65**	**9.32**
April	10.53	10.31	10.74	**14.06**	**11.41**	**10.88**
May	11.50	11.57	11.27	**14.48**	**12.20**	**11.03**
June	9.43	n/a	10.33	11.86	**10.54**	**10.84**
July	10.49	n/a	10.25	13.14	**11.29**	**10.84**
August	9.30	n/a	9.48	11.36	**10.05**	**9.70**
September	6.89	n/a	7.87	9.72	**8.16**	**8.52**
October	8.00	6.83	8.48	11.77	**8.77**	**8.42**
November	5.71	5.90	6.54	8.46	**6.65**	**7.40**
December	8.74	9.09	8.51	12.09	**9.61**	**8.22**
Yearly Average					**9.53**	**9.40**

Below is a quick summary of notable wind conditions for the year:

February : Very strong winds in the last days of February, particularly on Tuesday the 26th. With wind gusts over 30 mph.

March: Average peak wind speeds this month were the lowest recorded for the month since records were kept in 2003. The monthly average peak wind speed was ~2.5 mph less than the 10-year average of 9.44 mph. Only the airport weather station reported winds equaling the 10 year average. The Mohave Community College weather station averaged 6.37 mph.

April: April 8th: One of the most severe dust storms LHC has experienced in a long time entered the area. It was associated with a low pressure system that later was named Winter Storm Xerxes by the weather Channel (Figure 6). The air quality was extremely bad with mid level winds stirring up dust to visibilities of just a mile or two at best. Later in the afternoon, trace amounts of rain fell with the dust, making most surfaces covered in a thin layer of mud. There were three days straight of peak winds over 15 mph (up to 45 mph at the airport) with this system.

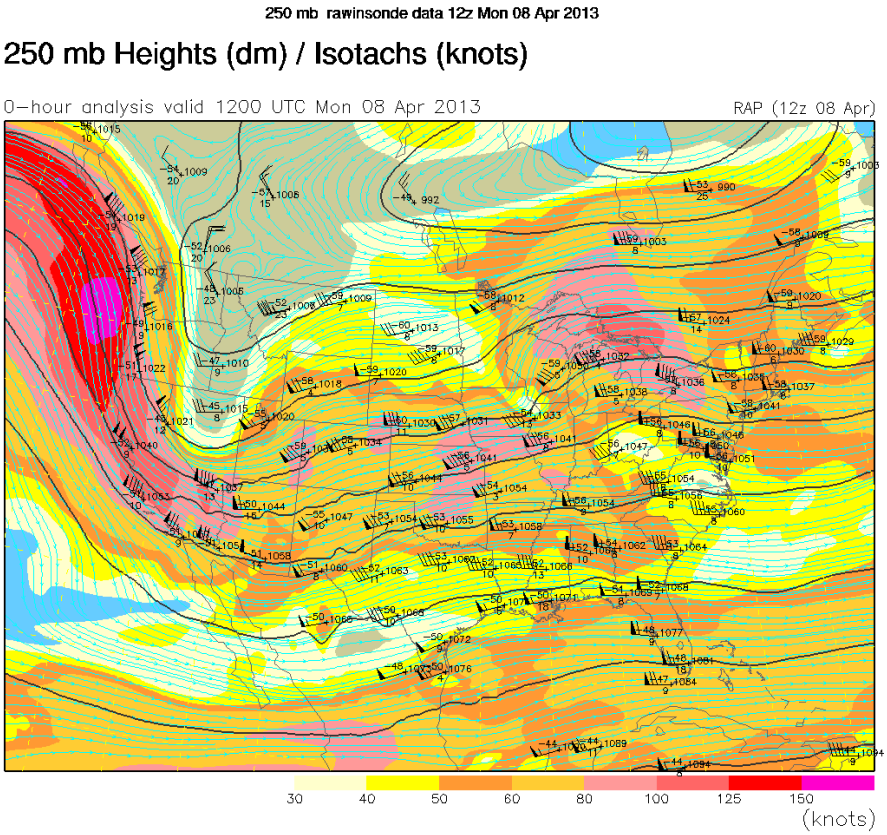

Figure 6: Upper atmosphere pressure map showing a large trough and tight turning of the jet stream to cause high winds over the southwest.

April 15th: A second massive dust storm entered the area with the system the weather channel called Yogi. This storm reduced visibility more so than the previous week's storm, but no rain. Only parts of the Mohave Mountains. could be seen and none in California. Poor air quality continued into Tuesday. High winds at the surface cleared out the dust Tuesday afternoon and continued several days (to Friday the 19th) with this system as more zonal flow took over. Both systems were associated with unusually deep upper level troughs or Rossby Waves coming out of the arctic regions of Canada, bring unseasonably cool temps to the region. Highest winds were on the 17th at 41 mph. Double digit wind speeds occurred almost continuously from April 13 to 19).

Three more dust storms entered the area at the end of the month (4/22-23; 4/29-30) and into the first of May (5/1-2). The airport weather station experienced an average April peak winds of over 14 mph**,** the highest monthly average recorded.

May: The first of May was accompanied by a very strong wind storm with typical peak wind speeds of the mid to upper 30 mph range (up to 41 mph) at the airport from 8:00am on the 1st to 4:00pm on the 2nd. Peak winds at Fire Station #5 reached 36 mph during this time, but the peak winds were generally in the upper 20mph range. May's average peak wind speed at the airport station was even higher than April's at 14.48 mph.

August: On August 29th, a monsoonal convection thunderstorm had a 46 mph peak gust recorded at Fire Station #5, the highest since this station was established in 2006. At the same time the airport station recorded a 50 mph gust.

November: This was an anomalously low peak wind velocity month with a mean peak wind speed of only 6.65 averaged over four stations.

December: This month made up for November in that it was much windier than average. The four station average was 9.61 mph versus the 10-year average of 8.22 mph. The airport area lead the way with an average peak wind speed of over 12 mph the airport station.

Dew Point Temperatures –

There were some exceptional dew point temperatures recorded at the Lake Havasu Municipal Airport during May and June in 2013.

May: The most exceptional reading during this time was the extremely low dew point temperature at the airport – from 7:00 am on the 1st to 7:00 am on the 4th, single digit to negative temperatures with two main low points (-20°F's from 3:30 – 6:00 pm on the 1st (-25.3°F the lowest) and from 1:30-7:30pm on the 3rd (-23.9°F the lowest). On May 3rd the relative humidity (RH) reached **0% four times** (including at the highest temp. of the day) between 4:30 pm to 7:00 pm for the first time from any of the weather stations monitored. No dew point temperature can

be calculated when the RH is 0%. At Fire Station #5, the dew point temperatures did not get nearly that low, but did briefly go into negative temperatures, (from 9:00-10:00 pm on the 1st and 4:00-6:00 pm on the 3rd, maxing out at -6°F when the RH reached a minimum of 2%).

June: The dew point temperatures were in the negative range at the airport station on June 17th (-14.7°F) and 19th (-16.3°F), but on the 19th the RH registered 0% again and no dew point temperature could be calculated as before (Table 3).

Table 3: High temperatures for times shown with relative humidities (RH) and dew point temperatures.

Date/Time	High	RH	Dew Point Temp.
6/19 – 4pm	102.9	1	**-15.6**
6/19 – 4:30	102.9	**0**	**---**
6/19 – 5pm	102.5	**0**	**---**
6/19 – 5:30	102.5	**0**	**---**
6/19 – 6pm	102.6	1	**-16.3**

Precipitation

2013 was a relatively dry year in Lake Havasu City and the rains were highly sporadic. The overall precipitation amount, averaged over four stations in the city, was 3.74 inches with a range from 3.17" at the airport to 4.78" at City Hall. The rainiest months were August, November and January (Table 4). Five months had no measurable precipitation and there was one 125 day stretch from March to July in which there was no measurable rainfall.

February 20th – a low pressure system entered from the west-southwest and brought in very cool temperatures (41°F was the low for the day – wind chill to 35°F) and producing snow and sleet in the early morning hours. A brief on barrage of sleet occurred down to at least 800 feet in the city was quickly converted to rain. Rain showers had occurred earlier the night before. Snow covered a large portion of the Mohave Mtns. (almost to the foothills), but also the Whipple Mtns. and a little bit on the Chemehuevi Mtns (quickly melted on the latter). Precipitation was 0.15" at Fire Station #5 weather station, 0.23" at City Hall station and was enough to cause washes in town to run a bit, but no major debris movement. The low pressure center passed right over the Lake Havasu area with an usually low value of 29.511 inches recoded (Figure 7). Upper atmosphere maps indicate a deep trough at the 250 mb level and the jet stream steered the low pressure center versus being a closed or cut-off system (Figure 8). Clouds lingered and covered the tops of the Mohave Mountains all day.

Table 4: Monthly rainfall amounts at reporting weather stations in Lake Havasu City. Note: the MCC station was down for maintenance from July to November.

Month	PWMF	LHCFS	MCC	City Hall	Airport	ave.
January	0.81	0.57	0.75	0.87	0.58	**0.72**
February	0.16	0.15	0.19	0.23	0.24	**0.19**
March	0.26	0.21	0.26	0.26	0.23	**0.24**
April	0.00	0.00	0.00	0.00	0.00	**0.00**
May	0.00	0.00	0.00	0.00	0.00	**0.00**
June	0.00	0.00	0.00	0.00	0.00	**0.00**
July	0.14	0.33	n/a	0.16	0.14	**0.19**
August	1.07	1.07	n/a	1.96	1.08	**1.30**
September	0.57	0.29	n/a	0.28	0.38	**0.38**
October	0.00	0.00	n/a	0.00	0.00	**0.00**
November	0.77	0.61	n/a	1.02	0.52	**0.73**
December	0.00	0.00	0.00	0.00	0.00	**0.00**
Total	**3.78**	**3.23**	**1.2**	**4.78**	**3.17**	**3.74**

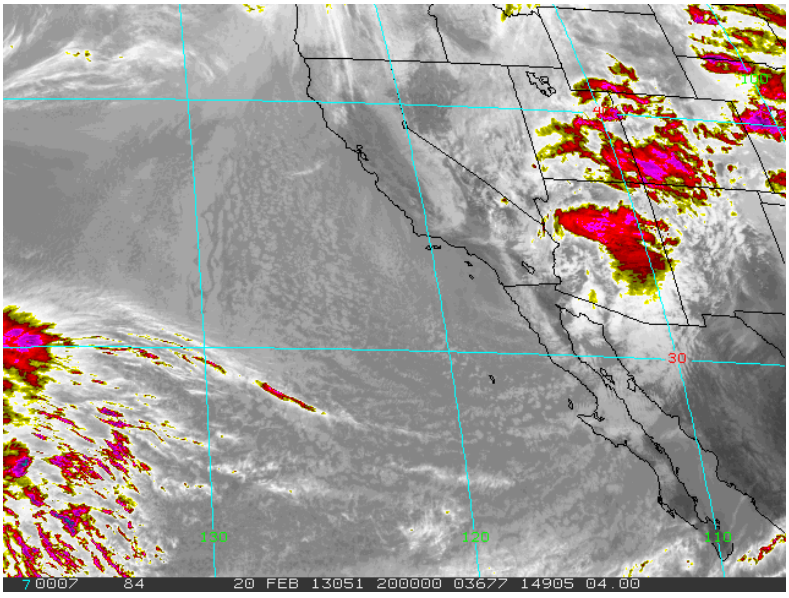

Figure 7: February cold front that brought brief sleet and snow to Lake Havasu City.

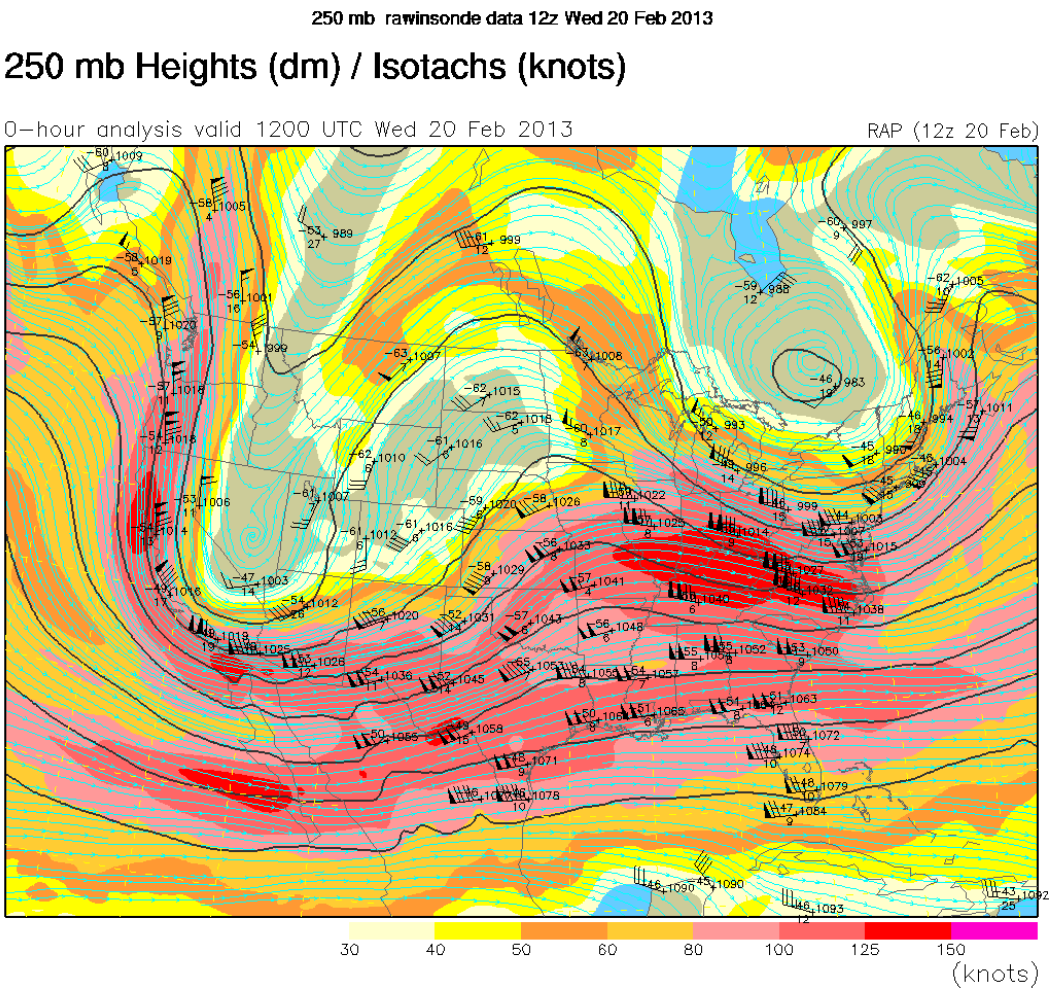

Figure 8: Upper level air pressure chart showing the strong trough of very cold air and jet stream (in red) from the arctic that reached the Lake Havasu area on February 20th.

A nicely developed cold front and low pressure system passed over the region on March 8th (Figure 9), producing approximately a quarter inch of rain. The next day begin a dry period that would last 125 days.

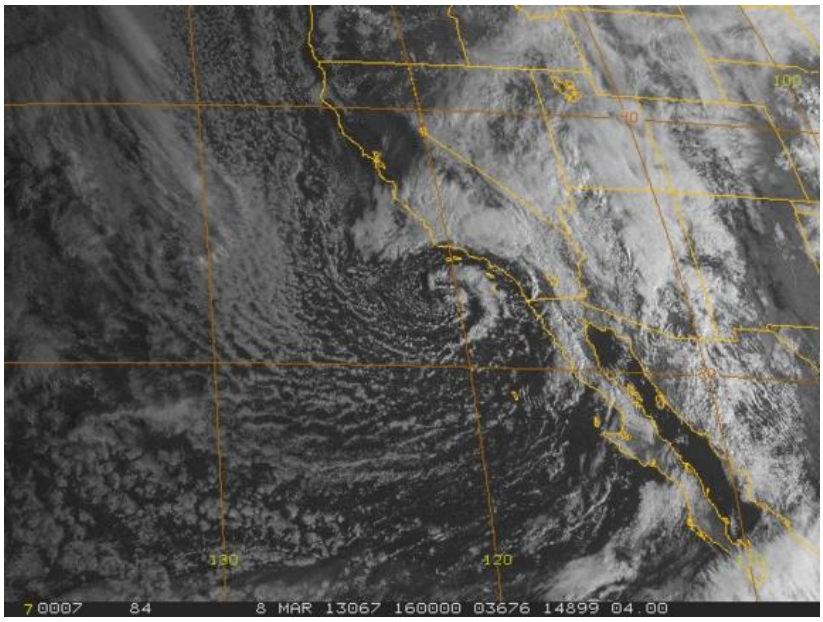

Figure 9: Visible satellite image of a classic low pressure center and associated cold front that produced a quarter inch in Lake Havasu city.

Summer Monsoon - After two years of dismal rain production from the monsoon season, 2013 produced a fair amount of rain from July through September and highlighted in August (Table 4). Monsoonal flow began at the end of June with the heat wave to elevate dew point temperatures. The first rain in 125 days happened on July11th with only 0.13", but that was enough to produce some flow in a couple of washes in the south part of town. Note in Figure 10 that cloud development is different from a cold front like in Figure 9.

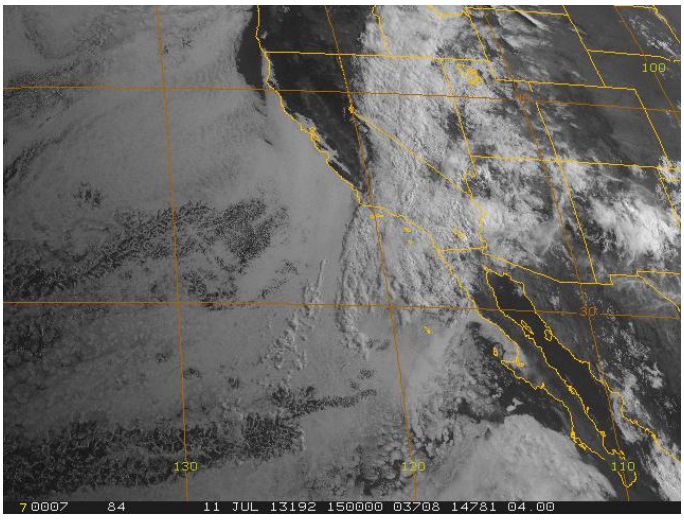

Figure 10: Visible satellite image showing almost three dimensional convective cloud development on July 11th over the southwest.

The monsoon was bimodal in that it disappeared for a week or so in early August, but came back with a vengeance (Figure 11). On August 19th, a combined upper level low pressure system cut off from the jet stream (Figure 12) and remnants from tropical storm Ivo, which came from the south and into the Mexican mainland, forced very humid air into western Arizona. On July 20th and 21st, this mixture produced widespread precipitation in Arizona from Flagstaff to Phoenix and westward through Lake Havasu City.

The following week on August 29th, more storms came through producing 0.52" with flow from the SE to NW. Lake Havasu City was sideswiped, but further north, they might have received over 2" at Havasu Heights. The city received 1.3" for August, the most in any month of the year. These convective thunderstorms build as cumulonimbus clouds that can reach 50,000 feet into the atmosphere (Figure 13).

The 2013 monsoon season abruptly ended late September, which is a bit unusual in that the late monsoon season is typically hard to completely shake off and usually goes well into October. It has a history of reforming after early fall cold fronts pass through.

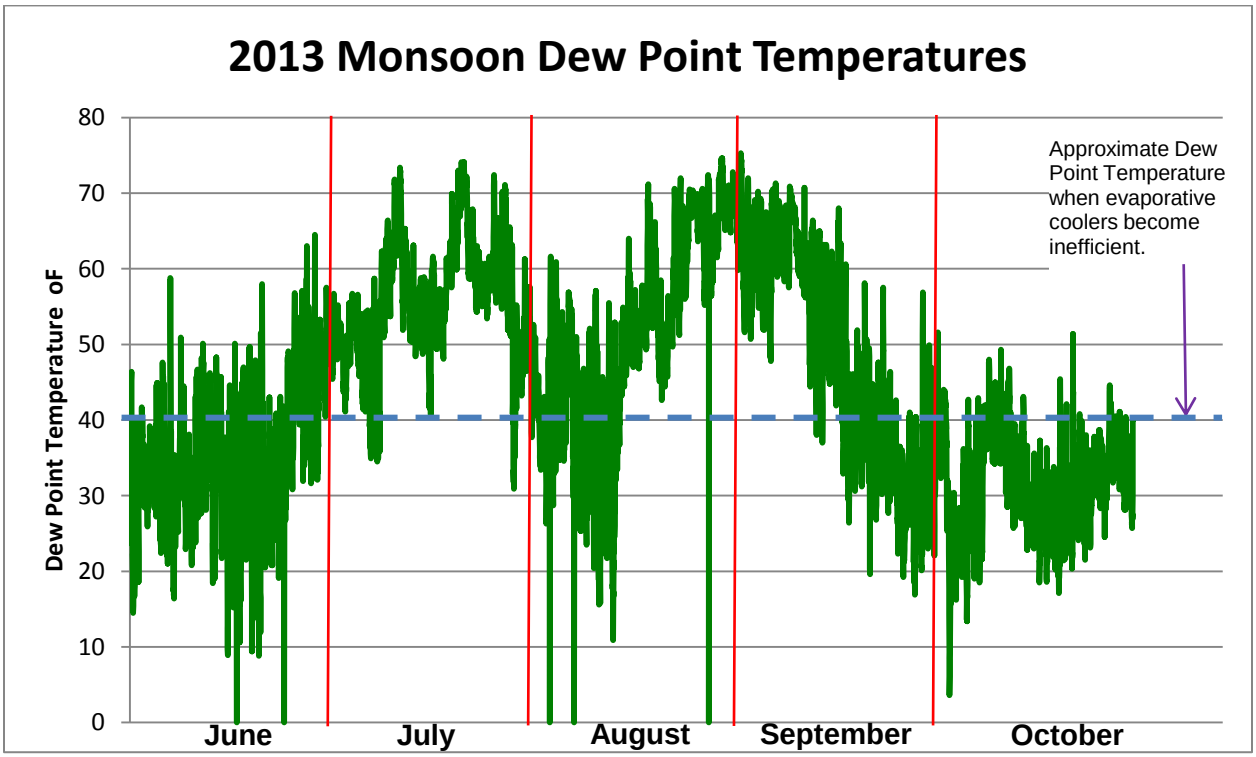

Figure 11: An unusual monsoon season dew point temperatures profile for 2013 showing two high peak periods and a fairly quick termination in late September.

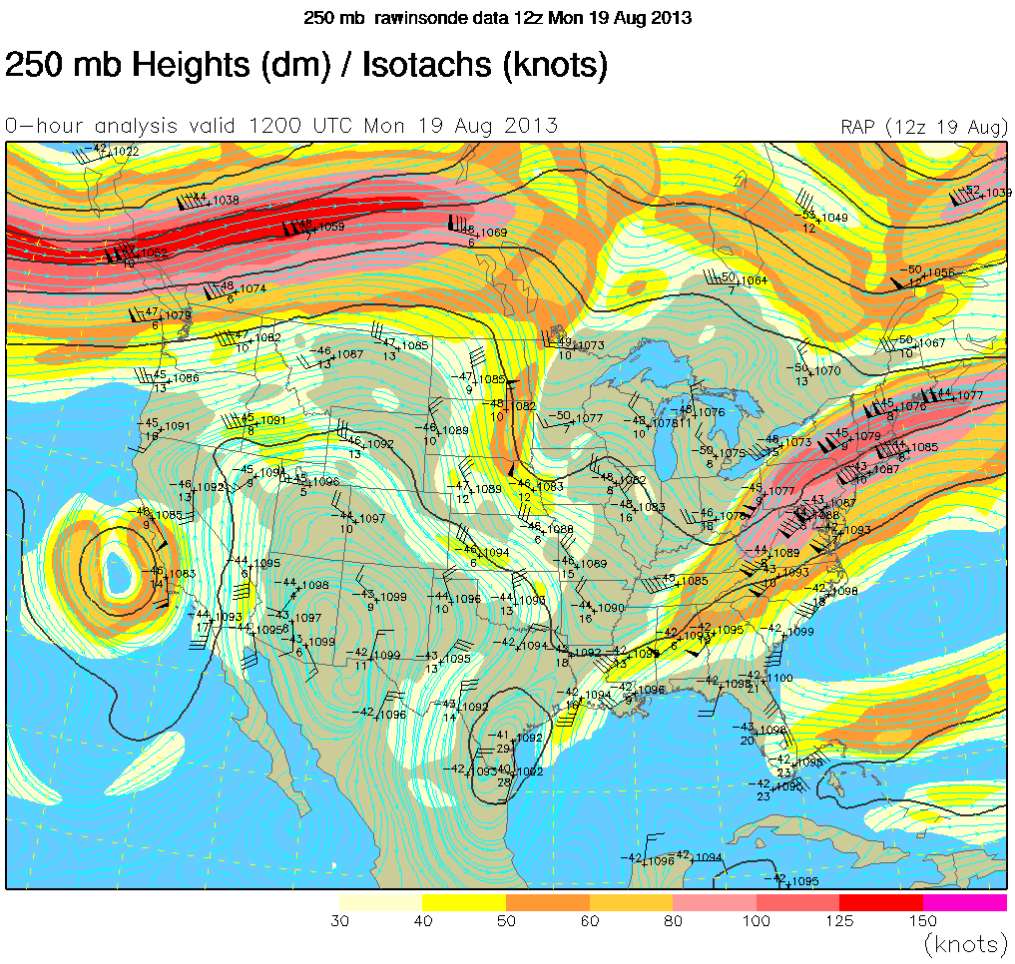

Figure 12: Upper level cut-off low pressure center that help to produce rain in the southwest on August 20th and 21st. Moisture from tropical storm Ivo (not seen here as it is lower in the atmosphere) was added to produce more rain to the region.

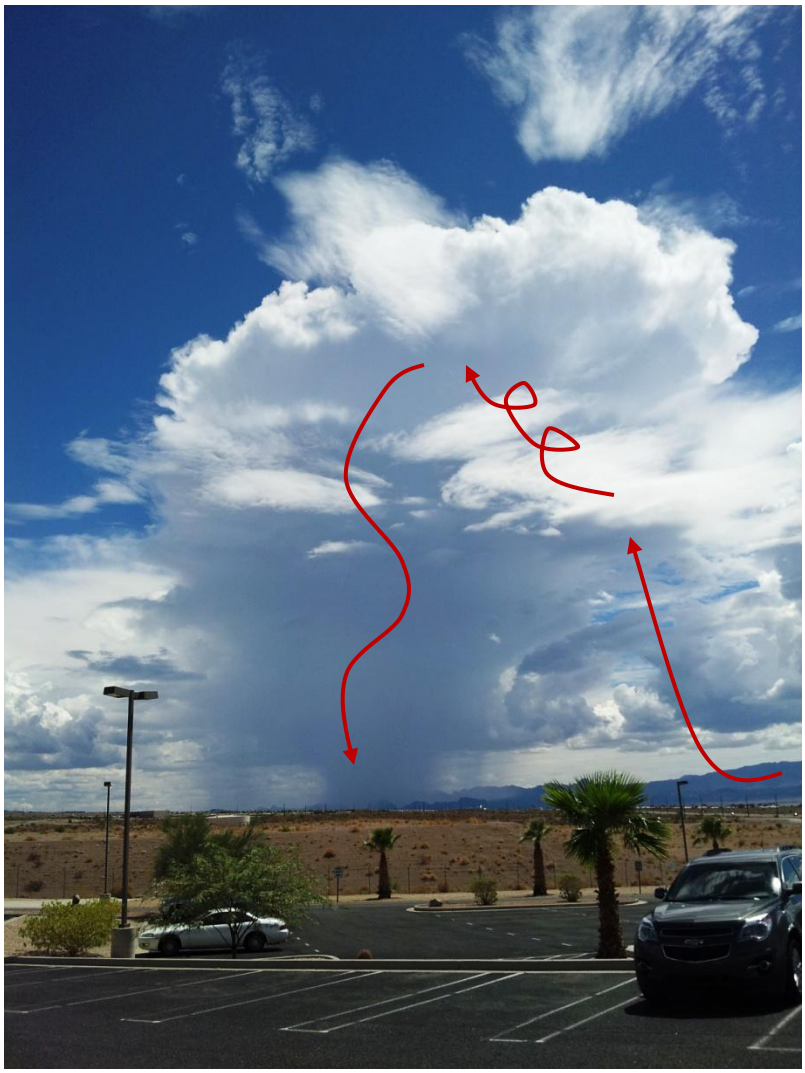

Figure 13: Moderate-sized convective thunderstorm over the Whipple Mountains on August 30th. Arrows show general up and down draft circulation within the cumulonimbus cloud.

Not all cutoff or closed low pressure systems in the southwest produce rain such the ones that occurred over our area in October and December (Figure 14). Both months had no rain fall in Lake Havasu City.

Lake Havasu City received between ½ inch and one inch of rain on November 21st that caused some washes to flow in town. It did not rain again until February 28th, 2014, 92 days later.

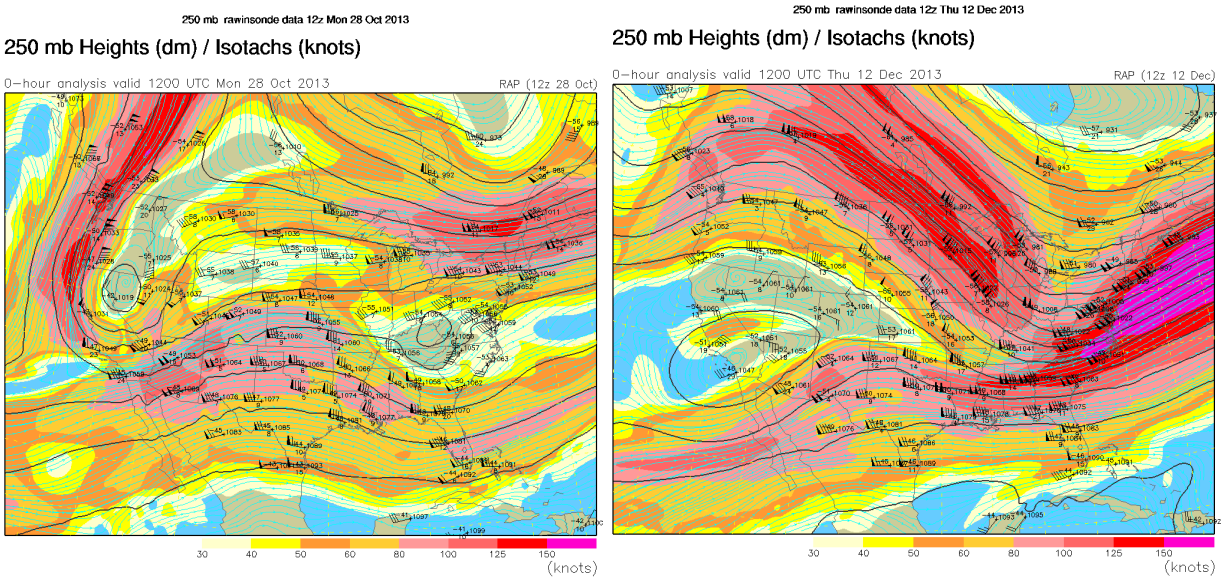

Figure 13: October 28th and December 12th upper level pressure maps (250mb) showing closed low pressure centers in the west that are weakly attached to the jet stream. Neither produced rain in our area.