

Lake Havasu City 2018 Weather Summary

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Acknowledgements: I would like to thank Mr. Dave Eaton for his willingness to contribute weather data from his station (SLHC) over the many years this report has been written. I would also like to thank the Mohave County Flood Control District staff for access to rain gauge and other weather data from their stations in the Lake Havasu area.

Introduction

According to the National Oceanographic and Atmospheric Administration (NOAA), 2018 was globally (land and oceanic) the 4th warmest year on record (since records were officially kept starting in 1880), behind 2016, 2015, and 2017 (in order from highest). It's departure from the 20th century average was 1.42°F (0.79°C). The average rate of warming over the past 139 years has been 0.13°F (0.07°C) per decade; yet, the average rate of increase is more than twice that rate (0.31°F / 0.17°C) since 1981. The year 2018 also marked the third wettest year on record in the contiguous United States. In contrast, Lake Havasu City experienced a relatively quiet year from the perspective of its overall mean temperature and setting daily high and daily low temperature records. In addition, precipitation around the city was scarce, about 75% of the average of 4.2 inches.

Temperatures

Lake Havasu City's 2018 mean temperature was 76.71°F over 3 stations, 0.07°F lower than last year's average mean (76.78°F) and 1.81°F higher than the city's 41-year average of 74.90°F. The 2018 high temperature average was 88.27°F compared to the 41-year average of 86.82°F, while the 2018 low temperature average was 65.14°F compared to 62.98°F for the 41-year average.

Only 9 official record temperatures (those reported to the National Weather Service from the Public Works Maintenance Facility on London Bridge Road) were either broken (4) or tied (5) in 2018 (Table 1). All broken records were daily highs, two ties for high temperatures, and three ties for record lows. Unofficially, one other record high temperature was reported from the Fire Station #5 station (FS#5 with the highest temperature of the year at 120.6°F).

Two monthly temperature averages in 2018 also broke records, including April (64.97°F) with a record highest average low temperature and September (104.52°F) with a record high average temperature. September only had one day under 100°F for a high, the most ever in September. January was the 2nd warmest with respect to overnight low temperatures with a 4 station average

Table 1: Official, unofficial record and tied-record temperatures reported in 2018.

Date	Temperature	Previous Record	Weather Station	Comments
1/5/2018	75°F	74°F in 1986	PWMF	Daily high temp.
1/28/2018	80°F	78°F in 2003	PWMF	Daily high temp.
2/3/2018	83°F	Tied officially	PWMF	Daily high temp.
2/4/2018	84°F	79°F in 2009	PWMF	Daily high temp.
2/5/2018	83°F	80°F in 2007	PWMF	Daily high temp.
2/21/2018	38°F	Tied officially; 35°F @FS#5	PWMF	Daily low temp
2/22/2018	38°F	Tied officially; 35.6°F @FS#5	PWMF	Daily low temp
2/26/2018	39°F	Tied officially; 36°F @FS#5	PWMF	Daily low temp
7/21/2018	120.6°F	Unofficially @FS#5 over 120°F in 2000	FS#5	Unofficial Record daily high
12/23/2018	72°F	Tied officially	PWMF	Daily high temp.

of 47.93°F (compared to January 2003 which had a 3 station average of 49.12°F). August registered the 3rd warmest overnight low average over 4 stations at 87.84°F.

The first 100°F day this year was on April 24th and the first temperature at or above 110°F was on June 3rd (110°F at PWMF; 111.9°F at FS#5). There were 133 days at or above 100°F; 33 of those days were at or above 110°F at PWMF and 43 of those days were at or over 110°F at FS#5. Only one day unofficially reached 120°F (120.6°F at FS#5). There were officially only 5 days with low temperatures below 40°F (at PWMF) and 13 days at SLHC, with the lowest temperature of the year at 34.8°F on February 20th.

There were 23 days with overnight official lows above 90°F and two at or above 95°F. Unofficially, overnight lows at FS#5 included 29 days at or above 90°F and 5 days above 95°F, the City Hall weather station recorded the highest low temperature of the year at 99.0°F on July 25th, which was also the day of the warmest overnight low averaged over all stations (95.4°F). Just a note: Lake Havasu City has never officially recorded an overnight low temperature at or above 100°F. Curiously, the PWMF recorded a low temperature of 89°F on July 25th. Throwing that out of the average, the averaged low temperature from the other four stations was 97.0°F.

The temperatures recorded in 2018 reflect changes in overall maximum and minimum temperature trends experienced since records have been kept for Lake Havasu City in late 1977. The latest 10-year trend of average monthly high and low temperatures are compared with the 41/42-year averages in Table 2, which also shows the day-night temperature differences for each month and the mean annual temperatures over both periods. Please note that the trends were

Table 2: Lake Havasu City average monthly high and low daily temperatures and the average daily temperature range within the past 10 years and for the entire 41-year record keeping period. Included are the mean temperatures over both time frames.

10-year monthly averages				41-year monthly averages		
Month	High Temp	Low Temp	Temp Difference	High Temp	Low Temp	Temp Difference
January	66.48	45.51	20.97	65.25	44.39	20.86
February	71.52	48.67	22.85	70.30	47.72	22.58
March	79.48	55.08	24.40	77.87	53.54	24.33
April	85.99	61.51	24.48	86.01	60.30	25.71
May	94.03	70.15	23.88	95.31	69.54	25.77
June	105.68	80.55	25.13	105.55	78.32	27.24
July	108.27	87.22	21.04	109.35	85.25	24.10
August	106.26	85.22	21.04	107.36	84.14	23.22
September	101.49	77.84	23.64	98.95	74.54	24.41
October	88.25	64.71	23.53	88.71	63.65	25.06
November	75.33	52.62	22.72	74.41	51.57	22.83
December	64.14	45.12	19.03	62.80	42.83	19.97
ANNUAL	87.24	64.52	22.73	86.82	62.98	23.84

10-year Mean Temperature

75.88

40-year Mean Temperature

74.90

created using data from all available weather stations within each year, so they best represent the conditions in the city's area. Breaking down the long-term averages into successive 10-year averages can show the pattern of shifting temperatures (Table 3). Overnight low temperatures have been increasing steadily about a degree per decade leading to an increase of 2.6°F over the 41-year period (Note: since there is an extra year involved, the latest "decade" is actually 11 years long). The differences in temperature between 1978-1987 and 2008-2018 throughout an annual cycle are pervasive with few periods in which the 2008-2018 temperatures are not higher than the 1978-1987 temperatures (Figure 1). The departure between the two series averages +2.6°F for the annual cycle, but with a range from over +9°F to less than -4°F (Figure 2).

Decadal high temperature trends revealed a more modest increase in temperature from 1978-1987 to 2008-2018 (Table 1; Figure 3). High temperatures increased between the first two decadal series, decreased between the 1988-1997 and 1998-2007 series before rising again to the present decade. With an overall change of 0.5°F over the 41-year period, the main differences

Table 3: Average high and low temperature ($^{\circ}\text{F}$) changes for successive decades starting in 1978 and the overall 41-year difference.

Average Whole Year Temp. Differences ($^{\circ}\text{F}$)	1978-1987 & 1988-1997	1988-1997 & 1998-2007	1998-2007 & 2008-2018	1978-1987 & 2008-2018
High Temps.	1.2	-1.5	0.8	0.5
Low Temps.	1.0	1.0	0.6	2.6

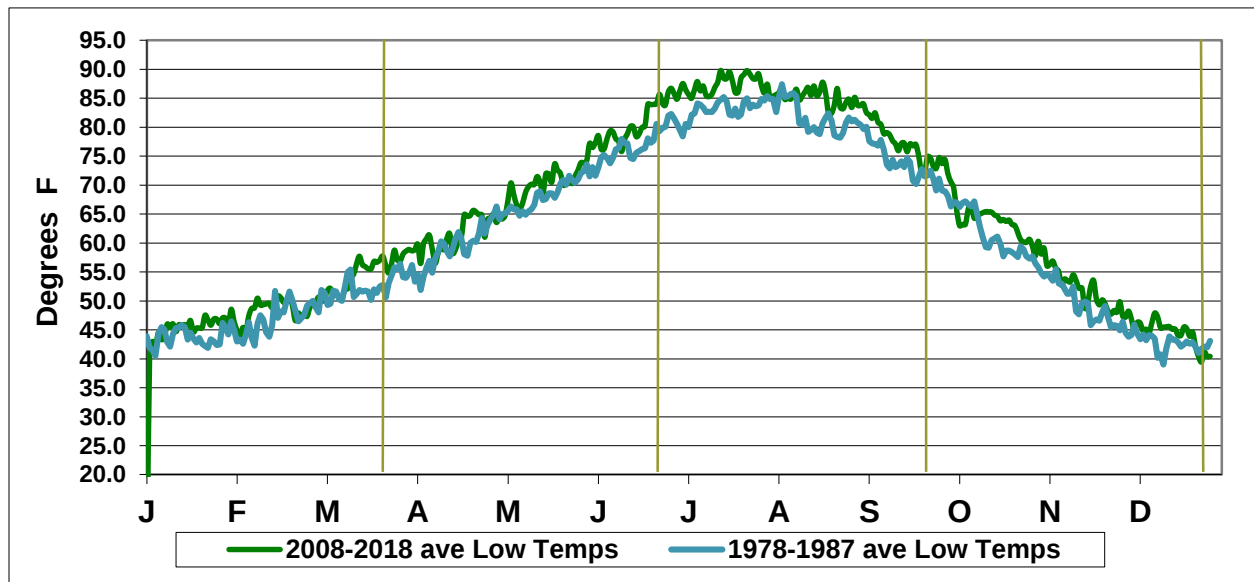


Figure 1: Separation between Ten-year overnight low temperature averages for 1978-1987 and 2008-2018.

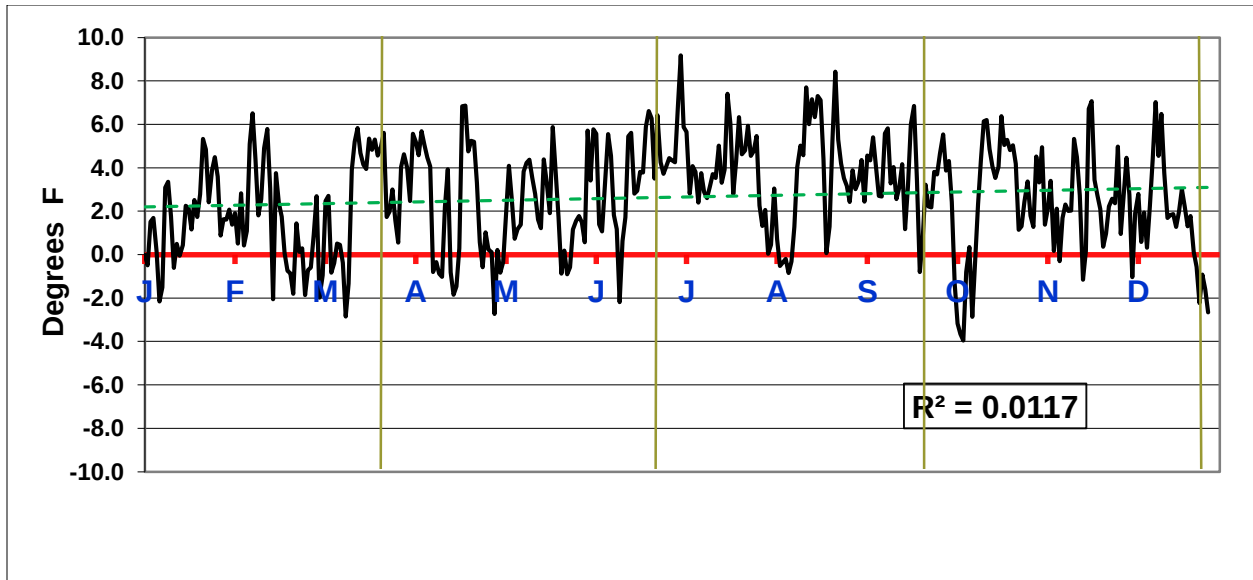


Figure 2: Temperature differences between the 1978-1987 and 2008-2018 low temperature trends indicate most of the year is warmer in the more recent trend, averaging 2.6°F warmer. The green dashed line is a trend line with an $R^2 = 0.0117$.

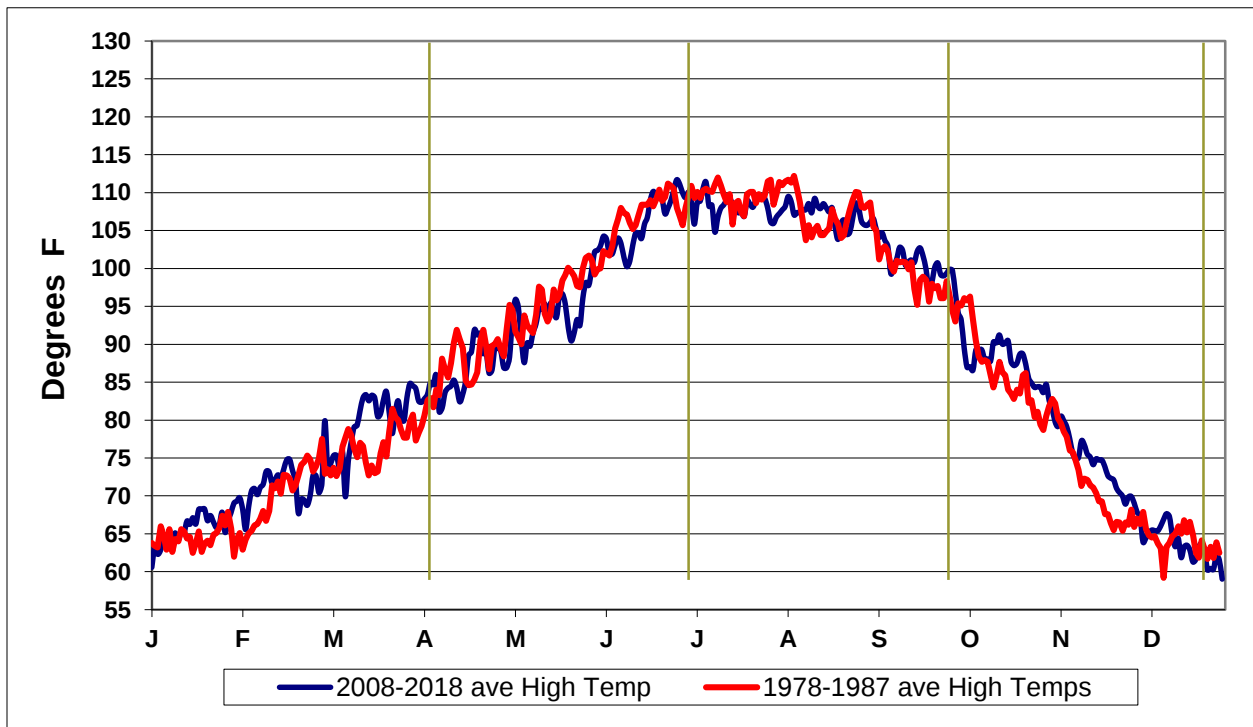


Figure 3: Separation between Ten-year overnight high temperature averages for 1978-1987 and 2008-2018. Note higher temperatures in the 2008-2018 trend in the February-March and October-November time frames.

noted appear to be in shoulder seasons, particularly in February-March and October-November, both warmer during the most recent series (Figure 3). Interestingly, the summer months have similar temperature trends. This observation along with the low temperature trend changes provide evidence that a warming climate has mostly impacted the Lake Havasu area by retained heat in the overnight atmosphere almost year-round, possibly warming earlier in the year, and extending the summer heat further into autumn than in the past (the later may be related to extended monsoonal flow).

Large swings in temperature usually occur in the spring and 2018 was no different. May exemplified this phenomenon when a cold front passed through the area breaking down a high pressure ridge. This resulted in a 15°F difference in high and low temperatures over a 3 day period (Figure 4).

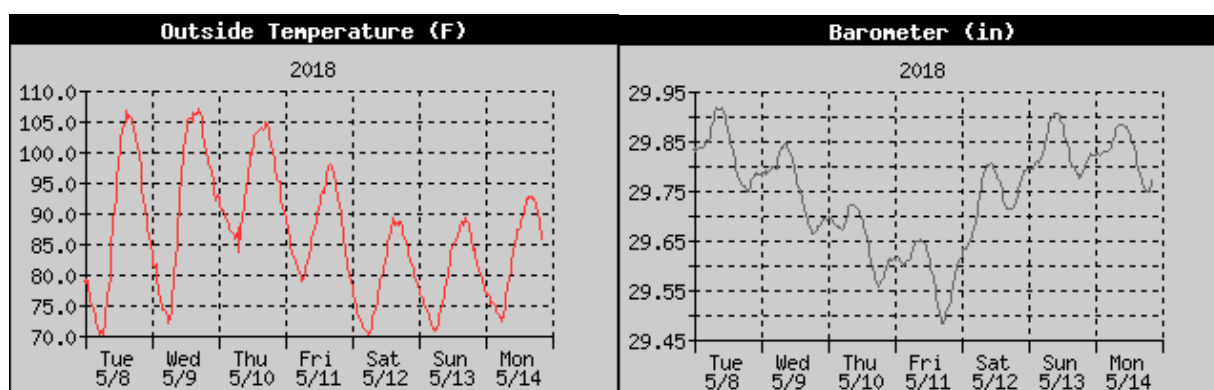


Figure 4: Temperature and Barometer trends over a 7-day period in May illustrating the passage of the cold front and associated changes in temperature and pressure.

Precipitation

The contiguous United States (the lower 48 states) marked its third wettest year on record (behind 1973 and 1983) according to the NOAA 2018 report. However, Lake Havasu City bucked that statistic and had an extremely dry year (drier than in either 2016 or 2017). Though 2018 was dry, at least 10 other years within the 47-year record that started in 1967 were drier. However, this was the driest year since 2009. Only two out of 14 monitored rain gauges in the Lake Havasu area recoded precipitation amounts above the City's 47-year average of 4.18", the Crossman Peak and Pittsburg Mine gauges (Table 4). These two gauges are higher in elevation than the area of the city itself. The other stations ranged from as little as 1.76" at the North Havasu gauge to 3.35", in the Mohave Mountains. Only one station within the City limits recorded over 3" of rainfall, the LHC South Side weather station, and that is with two months of missing data. The official rainfall amount at the PWMF station was 2.82" and the average over

Table 4: 2018 Precipitation monthly totals (in inches) for 14 rain gauges in the Lake Havasu City area. Note that the rainfall amount for May at FS#5 is unavailable and the rain amount at Pittsburg Mine in August may not be correct.

Elevations	472'	503'	1057'	730'	716'	4688'	2410'	1260'	682'	675'	605'	2395'	1045'	1556'
	PWMF (OMF)	LHCFS	SLHC	City Hall	Airport	Crossman Peak	Pittsburg Mine	Horizon Six	Desert Hills	Crystal Beach	North Havas	Ram Peak	Castle Rock Wash	Mohave Mtns.
January	0.39	0.33	n/a	0.39	n/a	0.87	1.02	0.71	0.35	0.35	0.4	0.47	0.51	0.79
February	0.08	0.00	0.04	0.00	0.18	0.04	0.04	0	0.16	0.32	0.04	0.04	0.36	0.08
March	0.23	0.22	0.34	0.20	0.22	0.47	0.4	0.27	0.16	0.2	0.2	0.24	0.19	0.27
April	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0
May	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0
June	0.00	0.00	0.00	0.00	0.00	0	0.04	0	0	0	0	0	0	0
July	0.52	0.79	n/a	0.20	n/a	1.1	1.57	0.44	0.04	0.59	0.4	0.63	0.16	0.24
August	0.04	0.10	0.92	0.08	n/a	0.24	0.32	0.08	0	0	0	0.35	0	0.75
September	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0
October	1.03	1.11	1.31	1.26	n/a	1.42	1.26	1.3	0.67	0.95	0.36	0.67	0.63	0.63
November	0.03	0.00	0.03	0.00	n/a	0.16	0	0	0.04	0	0	0.04	0.04	0.08
December	0.50	0.37	0.42	0.35	n/a	0.52	0.4	0.4	0.35	0.48	0.36	0.44	0.43	0.51
Total	2.82	2.92	n/a	3.62	n/a	4.82	5.05	3.20	1.77	2.89	1.76	2.88	2.32	3.35

the 14 gauges was 2.84". Only four measurable precipitation events were recorded from January to the first part of July, the initiation of the monsoon season. The wettest month of the year was October, followed by July and January. April, May, June, and September did not record any rainfall. February and November were almost as dry as the four months above. Two main rain events in October that brought the most rain to this area were caused by closed low pressure systems, one on the 3rd and 4th (Figure 5), and one associated with the remnants of Tropical Storm Sergio (on the 12th and 13th). Closed low pressure systems have been discussed in previous annual summaries as they should be considered a third main rainmaker in this area outside of the monsoon season or the winter cold front period. They mostly occur in the autumn (particularly in October) and less so in the early spring.

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0-hour analysis valid 0000 UTC Thu 04 Oct 2018

RAP (00z 04 Oct)

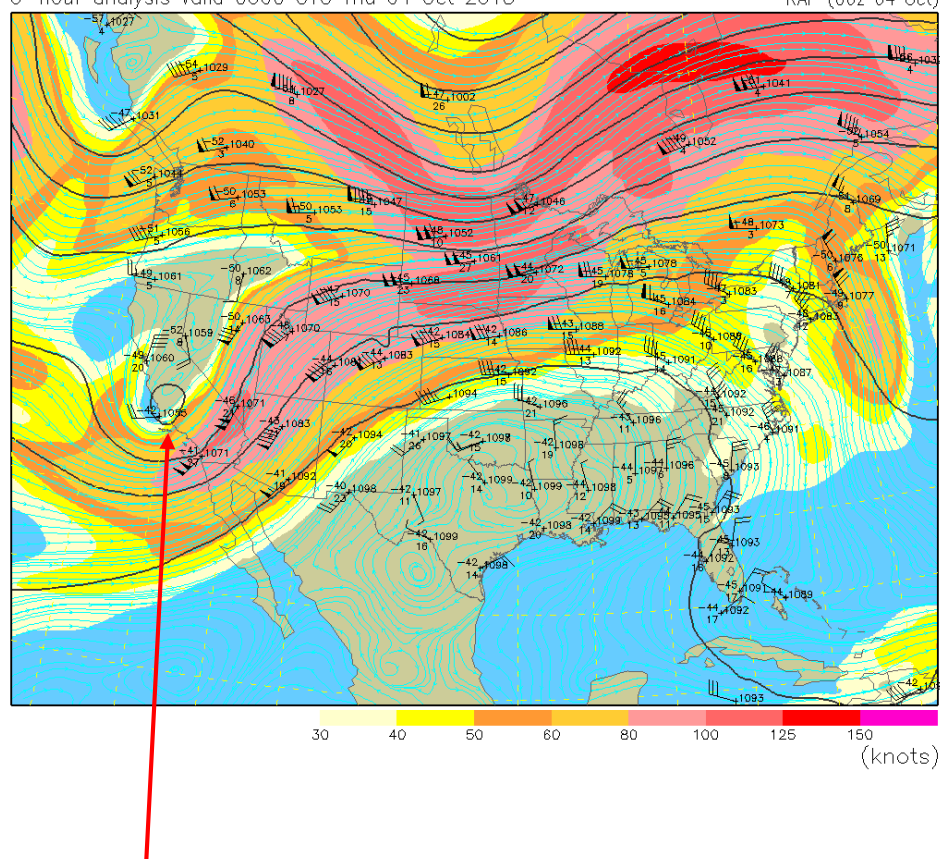


Figure 5: A closed low pressure system with the center in south-central California (arrow) brought rain to Lake Havasu City on October 3-4, 2018. The lead side of the low center is usually associated with clouds and rain. This map is the 250mb air pressure shown to occur at different elevations (given in decameters above sea level).

This is the last annual weather summary report I will be producing and as such I thought I would include a summary of the precipitation distribution in the Lake Havasu area (on the Arizona side). For 2018, which was a very dry year, the distribution of annual rainfall indicates that elevation largely dictates the rainfall amounts (Figure 6). Higher rainfall amounts occur over the Mohave Mountains (up to 5000 ft in elevation), which is fairly consistent with other years (Figure 7). Historically, January and August are typically the rainiest months, January by cold fronts that tend to evenly spread out rainfall amounts in this area, and August by spotty, convective thunderstorms during monsoon season that result in a more uneven rainfall distribution. Though August 2018 was not among the rainiest months, this pattern can still be observed (Figures 8 and 9).

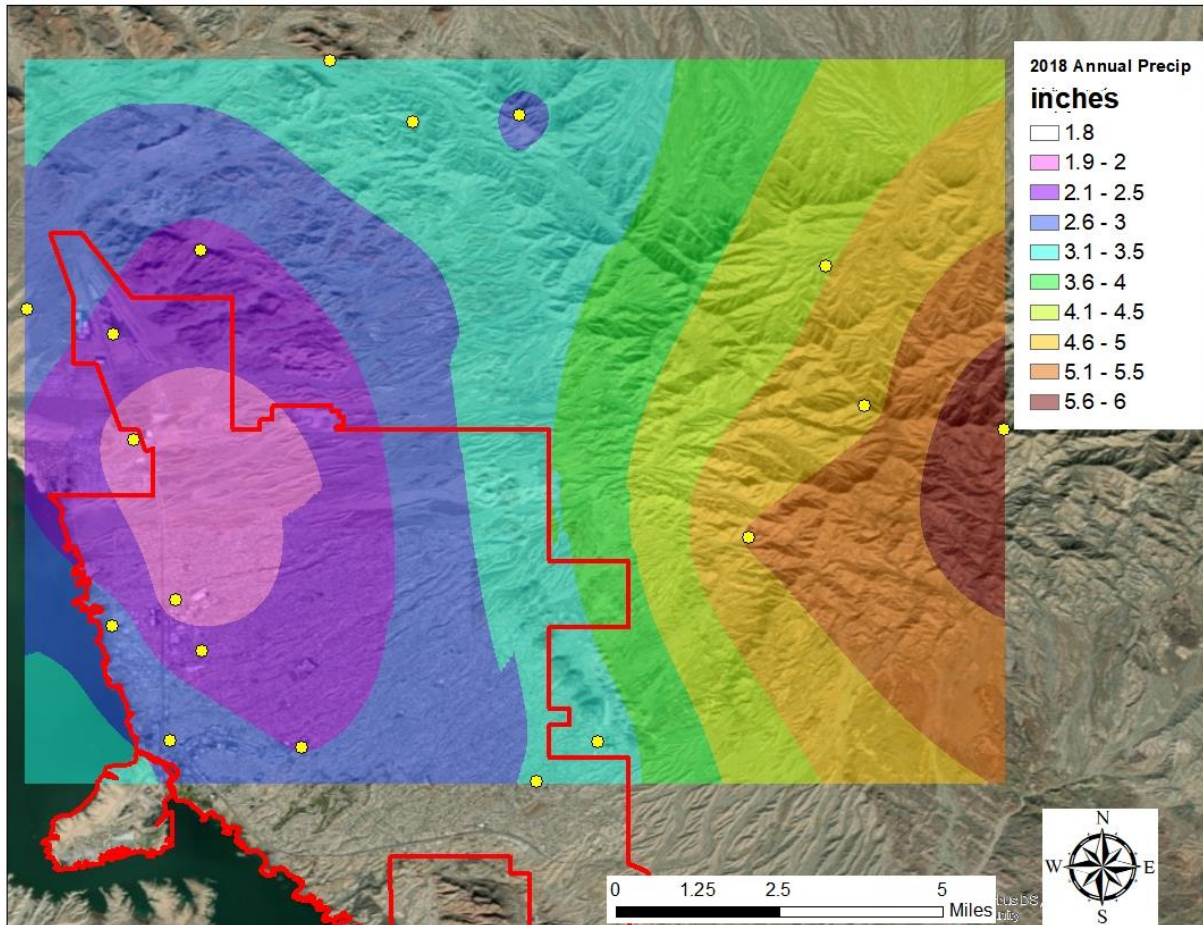


Figure 6: 2018 annual precipitation over the Lake Havasu City area with higher amounts over the higher elevations of the Mohave Mountains.

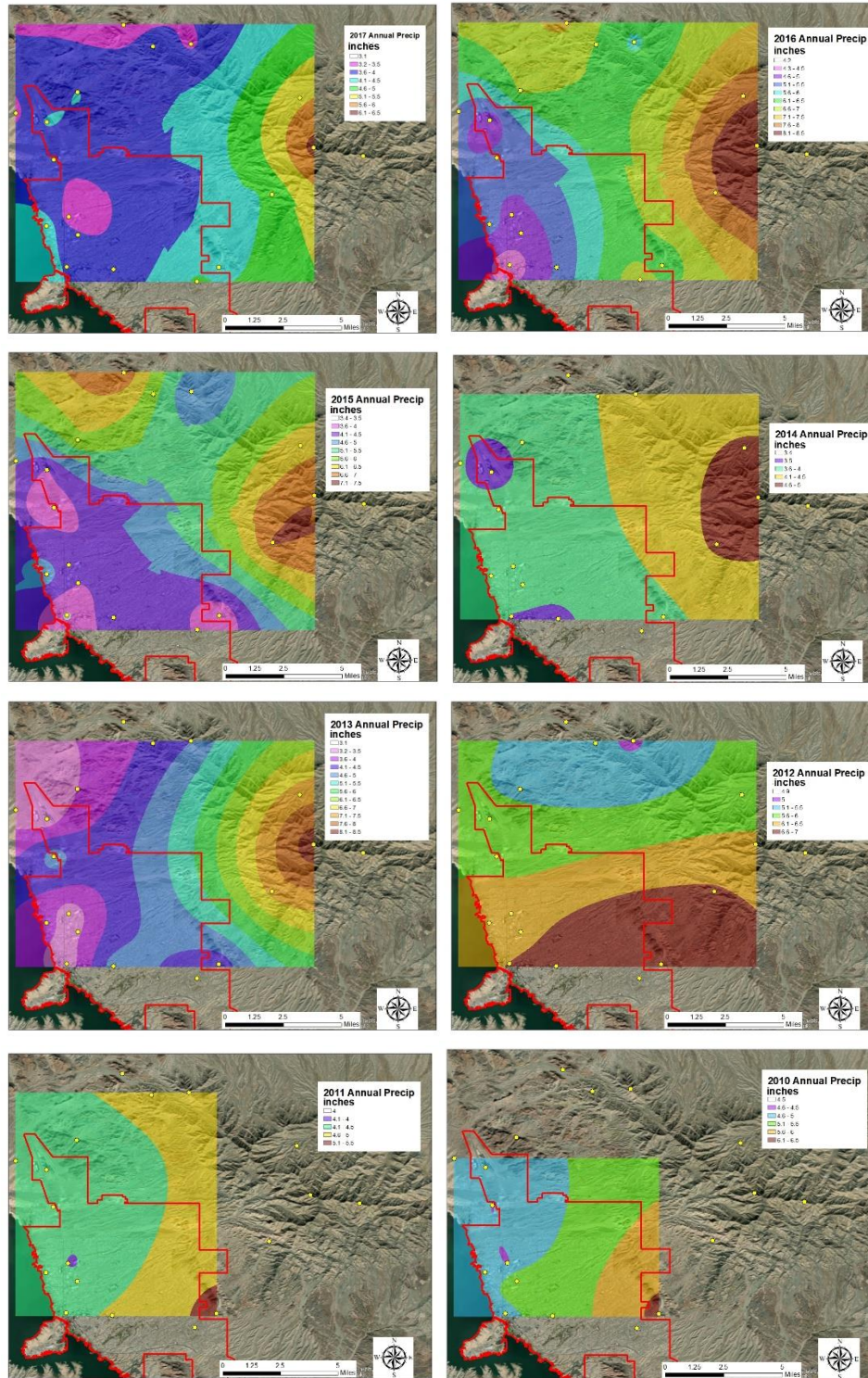


Figure 7: 2017-2010 annual precipitation distributions. Note that rain gauges were added by the Mohave County Flood Control District over the years, so the earlier years have fewer stations.

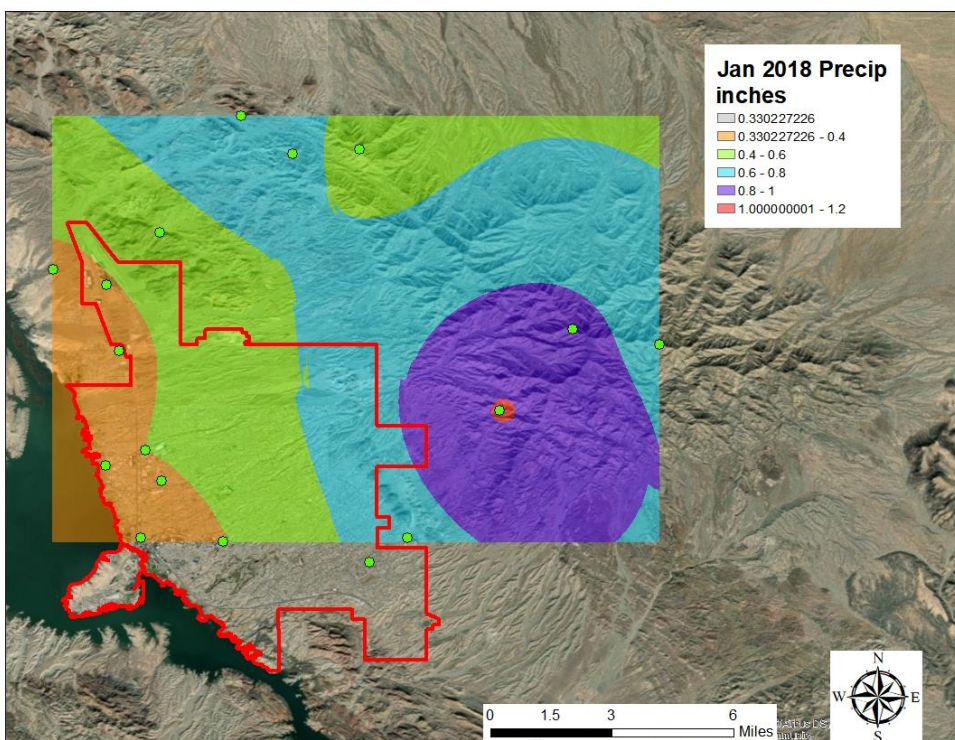


Figure 8: January 2018 precipitation distribution.

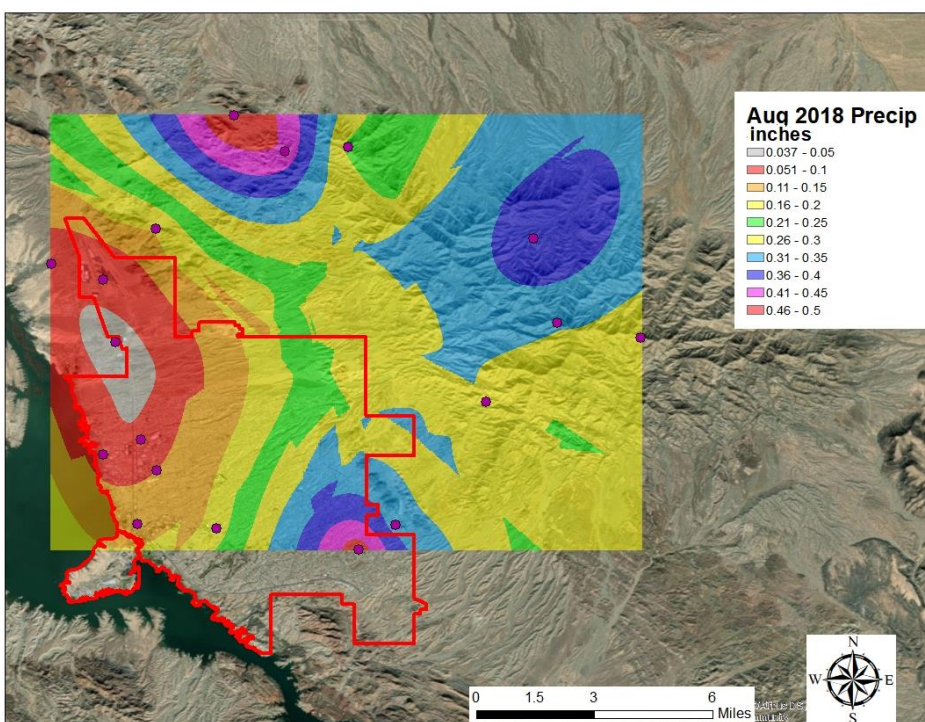
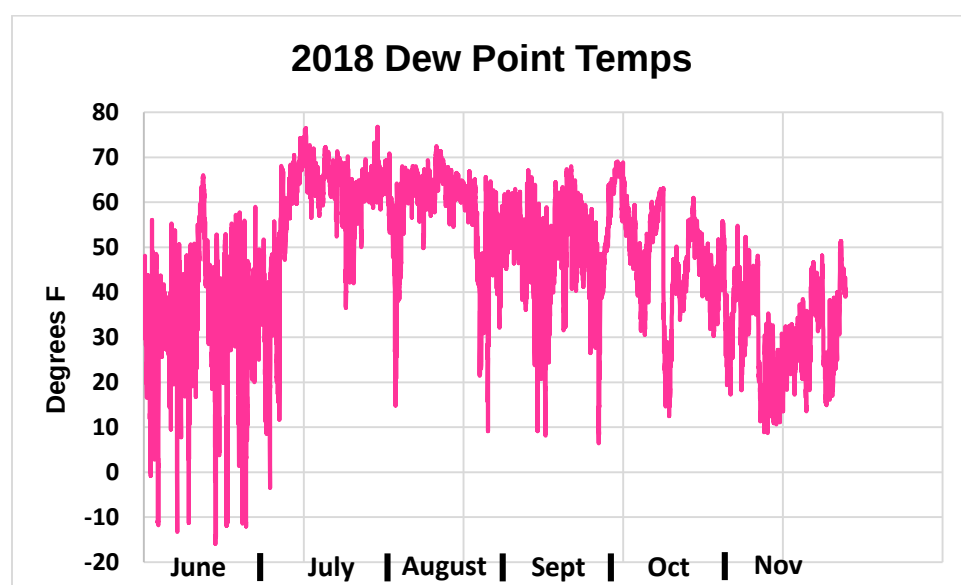


Figure 9: August 2018 precipitation distribution.

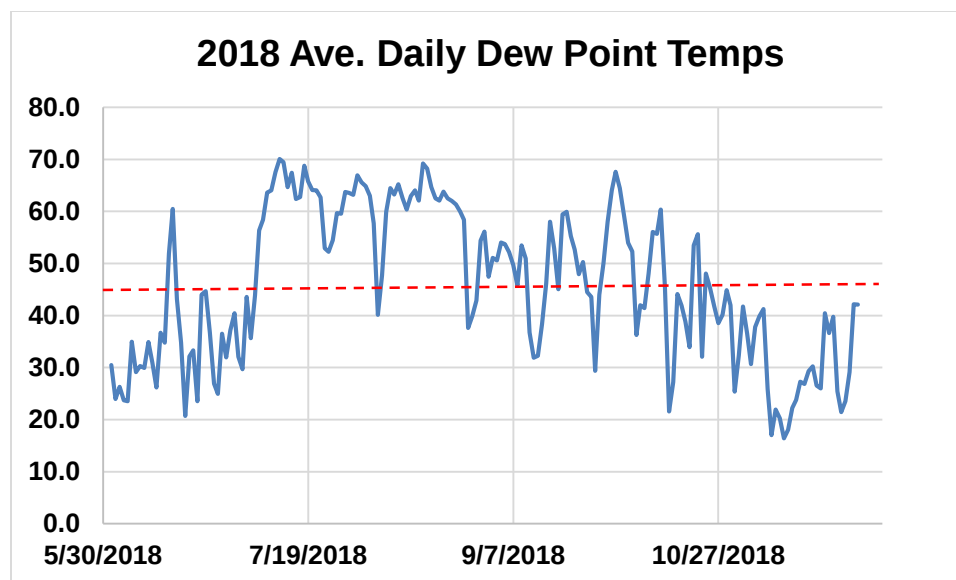
Humidity-Dew Point Temperatures and Monsoon

Dew point temperatures dipped near or below 0°F a few times in April, May and June again in 2018 with the lowest recorded dew point temperatures between -21.4°F and -21.8°F from 2:30-5:30pm on April 8th at the FS#5 station. These dew points happened during this station's daily high temperature of 93.4°F and the relative humidity during this time was 1%.

Summer humidity prevued on June 16th, but was not sustained. July 7th marked the abrupt beginning of the monsoon season (Figure 10A-B). The monsoon season was fairly consistent during July and August with only two minor drying periods showing as abrupt dips in the trend (Figure 10B). September experienced only 2 more short, dry periods, neither of which were related to typical weak cold fronts that usually enter this area during this month. October indicates the typical ragged end of the monsoon season with the closed low pressure systems entering the area.



(A)



(B)

Figure 10: Dew point temperatures from June through November, 2018 from Fire Station #5 weather station (A). The daily average dew point temperature from the same data set, which more clearly illustrates the overall humidity level. (B) The dashed red line in (B) indicates the general dew point threshold (45°F), if sustained above, would mark monsoonal conditions.

Peak Winds

Peak wind averages over four stations (FS#5, SLHC, City Hall, and Airport) are given in Table 5). Unfortunately, the Airport station broke down during the summer and was down throughout the rest of the year. August was the windiest month this year, followed closely by June, July, May, and April, respectively. The airport station continues to show that that area is the windiest every month. The highest peak wind gust recorded at the station was 50 mph in July during a monsoonal thunderstorm.

Table 5: 2018 monthly average of peak wind speeds for four weather stations recording wind speed. The airport monthly and annual averages are consistently higher than the other three stations.

Month	LHCFS	LHC South	City Hall	Airport	ave.
January	6.90	n/a	6.79	n/a	6.84
February	8.80	7.56	8.72	n/a	8.36
March	10.02	8.34	8.76	n/a	9.04
April	10.70	n/a	9.97	11.09	10.59
May	10.97	9.81	10.25	11.56	10.65
June	11.11	n/a	10.60	11.23	10.98
July	10.78	n/a	9.88	11.67	10.78
August	12.25	10.48	10.90	n/a	11.21
September	8.58	7.93	8.32	n/a	8.27
October	9.81	7.64		n/a	8.72
November	8.15	6.33		n/a	7.24
December	7.23	5.42		n/a	6.33
Yearly Average	9.95	7.94	n/a	n/a	9.42

Selected 2018 Weather in Photos

The following are a few photos of clouds and showers over the Lake Havasu City area in 2018.



Figure 11: Rare cumulonimbus cloud and shower in January.



Figure 12: Sunset on February 23rd, 2018 glowing off of broken stratus clouds.



Figure 13: Sunrays through stratus clouds on April 7, 2018.

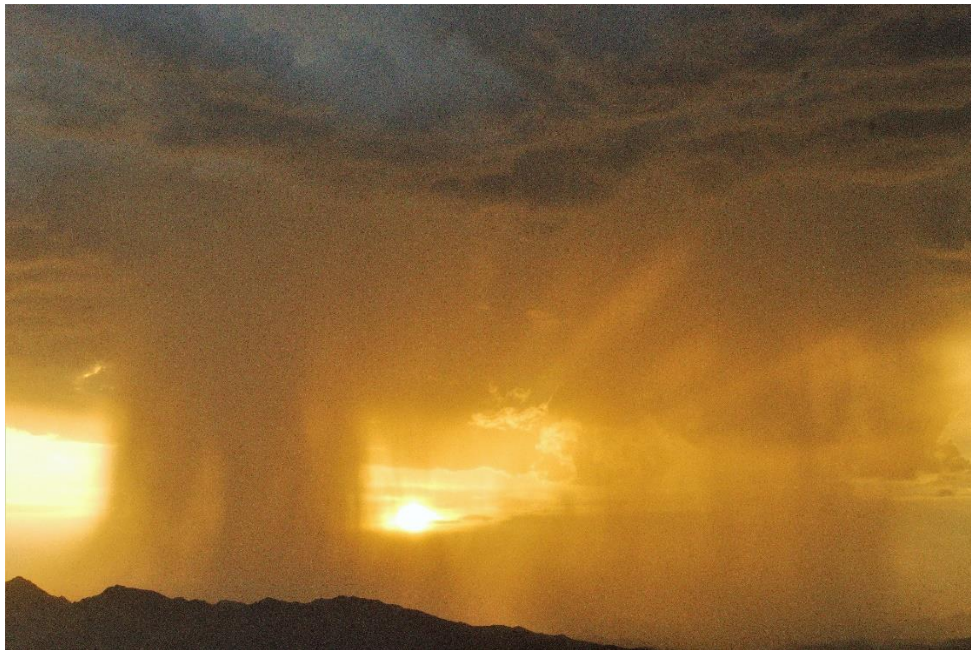


Figure 14: July 18th, 2018 thunderstorm near sunset over the Chemehuevi Mountains.



Figure 15: Smoke from California wildfires made possible to image the Sun's disk at sunset, August 10, 2018.



Figure 16: Cumulonimbus clouds on October 22nd, 2018 indicating continuing monsoon activity in the area.



Figure 17: December 29th 2018 high cirrus clouds and jet contrails at sunset.