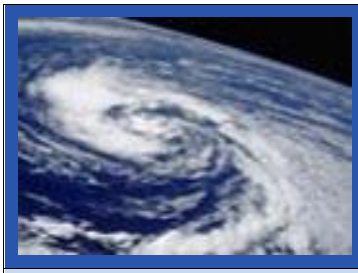


The Weather Wire

August 2013 **Volume 20 Number 8**

Contents:

Thunderstorm Forecasting

In Colorado forecasting thunderstorms can be quite tricky due to their random nature of development and many atmospheric variables. The most important ingredients are heat and moisture but here in Colorado there are many other factors at work. All storms need moisture, an unstable air mass, and lift to develop.

Heat: The heating of the lower atmosphere is crucial for thunderstorm formation as hot air rises, providing needed lift. The warm air near the surface becomes warmer than surrounding air and then rises to form clouds. If enough moisture is present a thunderstorm can develop by daytime heating alone. Without daytime heating from the sun, the cool air will remain in place and pool in low lying areas creating a stable environment. Even if there is plentiful moisture available in the atmosphere if temperatures do not warm sufficiently to provide lift then the air will not rise and condense to form clouds and eventually thunderstorms to precipitate the water out of the air. When moisture levels are high it typically does not take as much heating to produce storms and when moisture levels are low daytime heating can generate storms that contain little rainfall but gusty winds. Daytime heating is not the only lifting mechanism of air and often times the combination of geographic features, winds and upper air disturbances along with daytime heating are needed to produce thunderstorms. The strength of thunderstorms depends upon how all these variables come together including moisture…

Moisture: Without moisture even if the air rises due to heat it will not produce clouds and therefore thunderstorms. Many times in Colorado we have a lot of daytime heating but limited moisture which results in high cloud bases (distance from bottom of the cloud to the ground) and relatively weak storms that produce more wind than rain but can still contain lighting. As moisture increases typically less daytime heating is needed and with lower cloud bases there is less evaporation of moisture from cloud base to the surface increasing the chances for heavier rains. Moisture in the summer time is provided by the both the Atlantic from the Gulf of Mexico and the Pacific from the Gulf of California. The North American Monsoon develops during the first week or two in July and continues through early September. Moisture from the Pacific works its way northward into Colorado and provides the moisture in the mid and upper levels needed for

thunderstorms. Surface moisture is generally provided from the Atlantic (Gulf of Mexico) as southerly winds draw moisture northward into the Great plains and can be pushed westward back into the Front Range mountains and foothills. When moisture at the surface and aloft are high the threat for heavy rainfall increases. What is a high moisture value? Well, in Denver anything over 1.0" of precipitable water is considered high. What is precipitable water you ask? It is the amount of water in a column of air if that would fall out as rain. The slower the upper level wind speeds are the slower the thunderstorms will move and be able to deposit higher rainfall amounts over a single location. Since storms are great recyclers of air, rainfall amounts may be much greater than actual precipitable water amounts. Storms of the same strength that move faster will produce less rain as it will be over the location for less time. Along with moisture storm motion plays a key role in forecasting potential rainfall amounts.

Lift: There can be many lifting mechanisms to generate thunderstorms beyond daytime heating alone. Sometimes when temperatures are at their peak the air just needs a little extra push to get storms going. One lifting mechanism in Colorado that is quite common is terrain (mountains). The mountains can provide lift from winds blowing air up the mountain itself "upslope" but also by differential heating. The southern slopes of the mountains warm faster than the north slopes and creates an area of air that is warmer than the surrounding air and will in turn begin to rise. (Remember: Warm is relative to the air around it and does not necessarily mean it is warm to the human body!) This is the main reason that thunderstorms first develop over the mountains and foothills earlier in the day. Lift can also be provided aloft. The air at the surface may not necessarily need to warm if air at the upper levels of the atmosphere are cooling. The air at the ground is becoming relatively warmer even though the temperature is not necessarily changing. This is why all these little disturbances become so important in forecasting thunderstorms. Even a few degree change in the upper levels can be enough to tilt the scales towards convection and thunderstorm activity. Winds play a large role in thunderstorm characteristics but let's focus on surface winds for just a minute. Fronts are areas of wind shift and convergence and are a common are of lift which we typically associate with winter storms as fronts are much stronger. In the summer fronts are weaker as the temperature difference is smaller between the air masses ahead of and behind the front. There are also smaller scale fronts that can be generated by thunderstorms such as gust fronts/outflow boundaries. The rain from a thunderstorm cools the air and when there is enough rain cooled air, the cooler air undercuts warmer air as it pushed outwards from the center of the storm. These mall scale gust fronts can create very strong winds and can generate new thunderstorm development. These gust fronts typically contain higher moisture behind it as well adding fuel to thunderstorms that it creates. One term that is used by local meteorologists in Denver is the "Denver Cyclone" and is caused by surface winds and their interaction with the Palmer Divide. Many cases when winds are from the S to SE over the eastern plains the winds literally wrap around the higher terrain of the Palmer Divide back into the Denver Metro area and create a convergence line (winds converging on a single location or line). The S to SE winds over the plains wrap counter clockwise around the Palmer Divide with winds over southern Denver suburbs from the S to SE but northern areas are often from the N to NW. These winds typically converge over northern Douglas County extending northeastward through Arapahoe and Adams County. Thunderstorms can initiate where the winds converge creating additional lift. Once these initial storms develop outflow typically generates now storms in and around the Denver Metro area. Once the thunderstorms create outflow the Denver Cyclone can wash out to set up again another day.

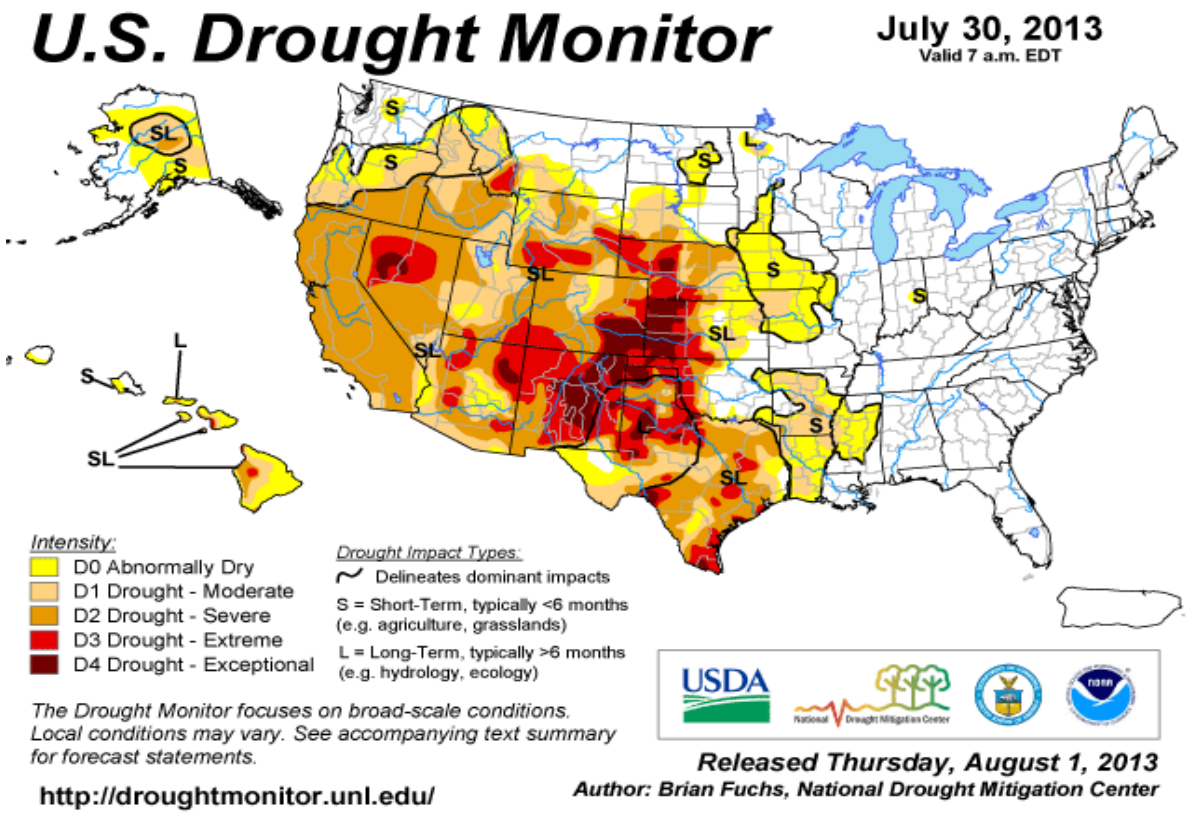
Winds: Winds at the surface can cause convergence and lift but winds in the upper atmosphere have a different effect on thunderstorms. Not only do they steer where storms will move but they separate updrafts and downdrafts allowing storms to sustain themselves over a longer period of time. The greater the difference in wind speed and direction with height is called wind shear. There are two types of winds shear, speed shear and directional shear. Storms with high wind shear values have the potential to spin and become "super cell" thunderstorms capable of producing severe weather and tornadoes. Typically winds shear is highest in the spring and early summer when severe weather season is at its peak. In the later summer months upper level winds are typically lighter and have less directional shear which results in slower moving thunderstorm cells and a lower threat for severe weather with heavy rainfall being the primary threat.

Unstable Air Mass: In simplest terms, Instability is simply the tendency for air to continue to rise once it has a lifting mechanism. This occurs is the air is warmer than the surrounding air, and relates to the temperature profile of the atmosphere. If air does not continue to rise (that is, its cooler than the surrounding air) the air is stable, and storms will not form, even if ample moisture and a lifting mechanism are present.

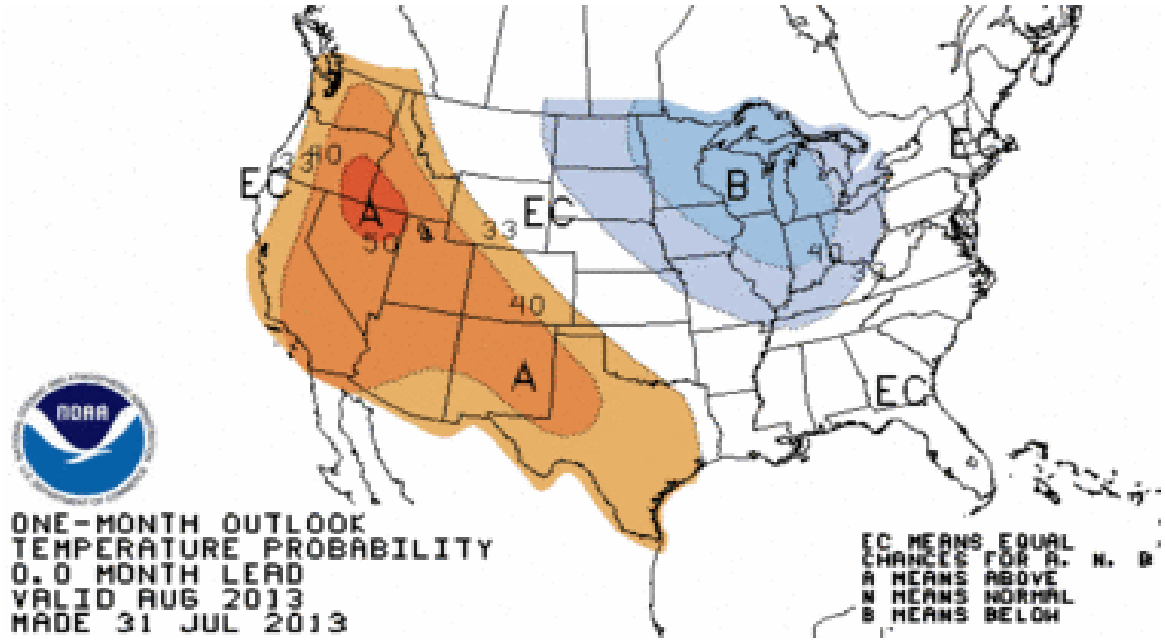
Now that we know a little more about the variables that need to be taken into account to forecast thunderstorms it is no wonder that forecasting storms in Colorado can be difficult. If all of the little variables weren't enough the weather models we base our forecasts on can also have small errors. It all boils down to the fact that we can usually nail down days with high risk but cannot say exactly where the strongest storms of the day will be due to the randomness of where the prime conditions will exist.

Drought Update

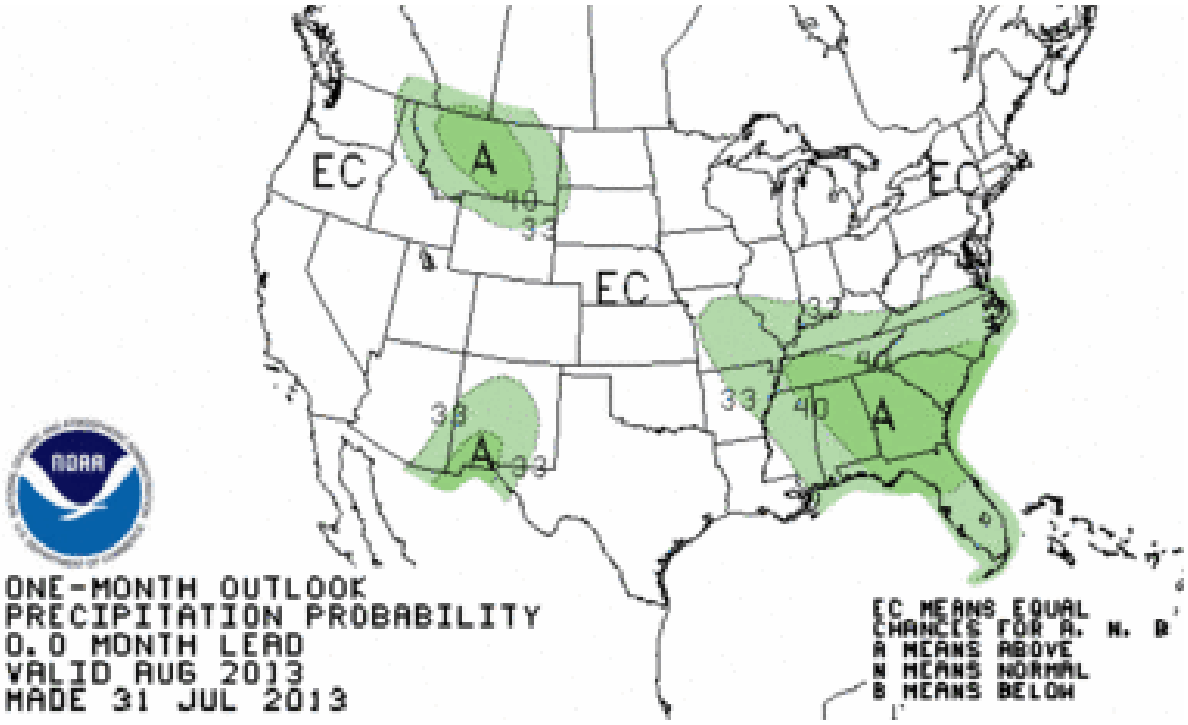
Extreme to exceptional drought continues over SE Colorado and into Kansas, New Mexico, western Oklahoma and NW Texas. There has been significant improvement over the Dakotas and parts of Montana since the spring and the eastern half of the Country remains free of drought.



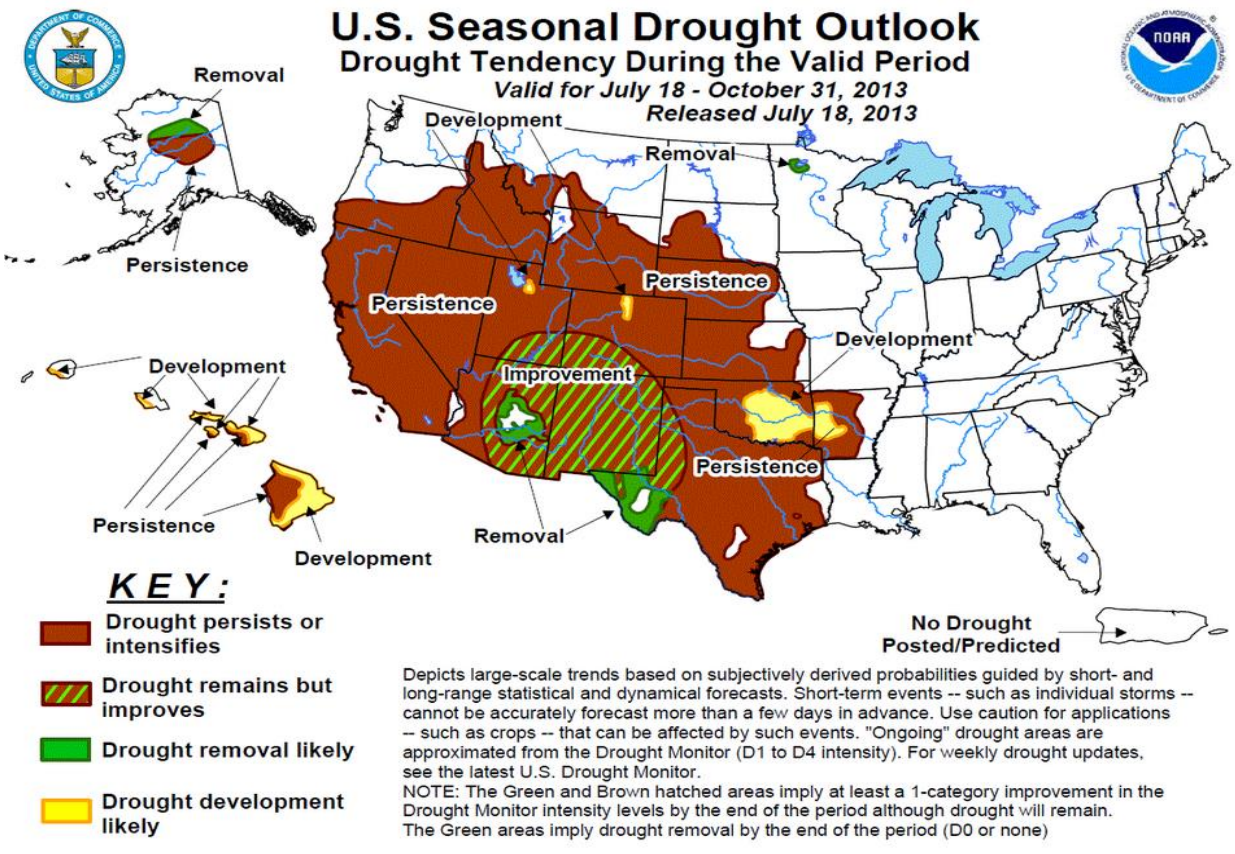
The map below shows forecasted temperature deviances for August 2013. Normal to slightly above normal temperatures are most likely over eastern Colorado.



The map below shows forecasted precipitation deviances for August 2013. Normal precipitation is expected over Colorado.



Drought conditions are forecast to persist over Colorado with possibly some improvement over SW portions of the state. There have been pockets of improvement over parts of the eastern plains but overall drought is expected to continue.



July Summary

July was near normal in every climate category except rainfall which fell just a bit short. There were 13 days with thunderstorms and 7 days during the month with measureable precipitation at DIA. The monthly total precipitation was 1.98", slightly below the normal of 2.16". Many western Denver suburbs reported higher monthly totals of 3" or more. The heaviest rain fell on the 15th with 0.87" reported during the 24 hour period. There were 17 days during the month with a temperature at or above 90 degrees which is 1 day above normal. Even though there was an extra 90 degree day thrown in there high temperatures were 1.2 degrees below normal at 88.2 degrees. Average low temperatures were slightly above normal which resulted in a monthly mean temperature of 74.3 degrees only 0.1 degrees warmer than the normal of 74.2 degrees. The highest temperature of the month was 100 on the 11th and the coldest was 55 on the 2nd. There were 5 days considered sunny during the month and 2 cloudy days and 24 days with partly to mostly cloudy skies. The North American monsoon has taken shape over the Desert southwest during the month and has sent waves of subtropical "monsoon" moisture into Colorado providing beneficial rains for many locations outside of the I-25 corridor. Some of these slow moving thunderstorms have produced flooding in the numerous burn scars scattered over the state. It DOES NOT take as much rain to produce flooding over freshly burned areas and it does over areas with vegetation. Hikers and campers need to be aware of watercourses that travel through burned terrain and take precautions if heavy rain is in the area.

July Stats

TEMPERATURE (IN DEGREES F)

AVERAGE MAX	88.2	NORMAL	89.4	DEPARTURE	-1.2
AVERAGE MIN	60.4	NORMAL	58.9	DEPARTURE	1.5
MONTHLY MEAN	74.3	NORMAL	74.2	DEPARTURE	0.1
HIGHEST	100 on the 11th				
LOWEST	55 on the 2nd				

DAYS WITH MAX 90 OR ABOVE	17	NORMAL	16
DAYS WITH MAX 32 OR BELOW	0	NORMAL	0
DAYS WITH MIN 32 OR BELOW	0	NORMAL	0
DAYS WITH MIN ZERO OR BELOW	0	NORMAL	0

TEMPERATURE RECORDS

No temperature records tied or broken.

HEATING DEGREE DAYS

MONTHLY TOTAL	0	NORMAL	6	DEPARTURE	-6
SEASONAL TOTAL	0	NORMAL	6	DEPARTURE	-6

COOLING DEGREE DAYS

MONTHLY TOTAL	295	NORMAL	289	DEPARTURE	6
YEARLY TOTAL	558	NORMAL	444	DEPARTURE	114

PRECIPITATION (IN INCHES)

MONTHLY TOTAL	1.98	NORMAL	2.16	DEPARTURE	-0.18
YEARLY TOTAL	7.97	NORMAL	9.67	DEPARTURE	-1.70
GREATEST IN 24 HOURS		0.87" on the 15th			
DAYS WITH MEASURABLE PRECIP			7		

SNOWFALL (IN INCHES)

MONTHLY TOTAL	0.0	NORMAL	0.0	DEPARTURE	0.0
SEASONAL TOTAL	0.0	NORMAL	0.0	DEPARTURE	0.0
GREATEST IN 24 HOURS		0.0"			
GREATEST DEPTH		0.0"			

WIND (IN MILES PER HOUR)

AVERAGE SPEED	10.3mph
PEAK WIND GUST	58mph on the 20th

MISCELLANEOUS WEATHER

NUMBER OF DAYS WITH THUNDERSTORM	13	NORMAL	11
NUMBER OF DAYS WITH HEAVY FOG	1	NORMAL	1
NUMBER OF DAYS WITH HAIL	0		
NUMBER OF SUNNY DAYS	5		
NUMBER OF PARTLY CLOUDY DAYS	24		
NUMBER OF CLOUDY DAYS	2		
AVERAGE RELATIVE HUMIDITY	50%		

August Preview

The “monsoon” season is in its prime during the month of August with severe weather on the decline. Storms typically become slower moving and carry the potential for heavy rains versus large hail and tornadoes. Temperatures begin their slow decline now that sunlight is making a noticeable decrease each day. The sun rises at 558 on the 1st and 6:26 on the 31st losing 28 minutes while sunset times are shaved off by 40 minutes, making for a loss of 68 minutes of sunshine during the month. Oh, how it will feel like summer is ending… Average temperatures for the month of August start out at 90 degrees and finish the month at 84 degrees. Average lows start out at 60 degrees and finish at 54 degrees. The warmest day in August is 105 degrees set on the 8th back in 1878. The coldest August temperature is 40 degrees and has been set multiple times, most recently in 1910. Precipitation on average for August is lower than April at 1.69” and much of which can occur in just a storm or two. On average there are 12 thunderstorm days, 8 of which produce measureable rainfall. We will need above normal precipitation during August to have any chance at getting back to normal for the year as the following month of September, October and November precipitation begins to drop off substantially. For August of 2013 Skyview Weather believes precipitation will be normal to above normal and temperatures will be near normal to slightly below normal.

DENVER'S AUGUST CLIMATOLOGICALLY NORMAL
(NORMAL PERIOD 1981-2010 DIA Data)

TEMPERATURE

AVERAGE HIGH	87.2
AVERAGE LOW	57.9
MONTHLY MEAN	72.5
DAYS WITH HIGH 90 OR ABOVE	12
DAYS WITH HIGH 32 OR BELOW	0
DAYS WITH LOW 32 OR BELOW	0
DAYS WITH LOWS ZERO OR BELOW	0

PRECIPITATION

MONTHLY MEAN	1.69”
DAYS WITH MEASURABLE PRECIPITATION	9
AVERAGE SNOWFALL IN INCHES	0.0”
DAYS WITH 1.0 INCH OF SNOW OR MORE	0

MISCELLANEOUS AVERAGES

HEATING DEGREE DAYS	10
COOLING DEGREE DAYS	244
WIND SPEED (MPH)	8.0
WIND DIRECTION	South
DAYS WITH THUNDERSTORMS	8
DAYS WITH DENSE FOG	Less than 1
PERCENT OF SUNSHINE POSSIBLE	71%

EXTREMES

RECORD HIGH	105 on 8/8/1878
RECORD LOW	40 on Multiple Dates
WARMEST	77.0 in 2011
COLDEST	66.5 in 1915
WETTEST	5.85” in 1979
DRIEST	0.02” in 1924
SNOWIEST	0.0”
LEAST SNOWIEST	0.0”

Sunrise/Sunset (July - December Denver area)

	JUL	AUG	SEP	OCT	NOV	DEC	
	sr - ss	sr - ss	sr - ss	sr - ss	sr - ss	sr - ss	
01	0534-0831	0558-0812	0627-0731	0655-0642	0728-0556	0701-0435	01
02	0535-0831	0559-0811	0628-0729	0656-0641	0729-0555	0702-0434	02
03	0535-0831	0600-0810	0629-0728	0657-0639	0630-0454	0703-0434	03
04	0536-0830	0600-0809	0630-0726	0658-0637	0631-0453	0704-0434	04
05	0536-0830	0601-0808	0631-0725	0659-0636	0632-0452	0705-0434	05
06	0537-0830	0602-0807	0631-0723	0700-0634	0634-0451	0706-0434	06
07	0538-0830	0603-0806	0632-0721	0701-0633	0635-0450	0707-0434	07
08	0538-0829	0604-0805	0633-0720	0702-0631	0636-0449	0708-0434	08
09	0539-0829	0605-0803	0634-0718	0703-0629	0637-0448	0708-0434	09
10	0540-0829	0606-0802	0635-0717	0704-0628	0638-0447	0709-0434	10
11	0540-0828	0607-0801	0636-0715	0705-0626	0639-0446	0710-0434	11
12	0541-0828	0608-0800	0637-0713	0706-0625	0640-0445	0711-0434	12
13	0542-0827	0609-0758	0638-0712	0707-0623	0642-0444	0712-0435	13
14	0542-0827	0610-0757	0639-0710	0708-0622	0643-0443	0712-0435	14
15	0543-0826	0611-0756	0640-0708	0709-0620	0644-0443	0713-0435	15
16	0544-0826	0612-0754	0641-0707	0710-0619	0645-0442	0714-0435	16
17	0545-0825	0613-0753	0642-0705	0711-0617	0646-0441	0714-0436	17
18	0546-0824	0614-0752	0643-0703	0712-0616	0647-0440	0715-0436	18
19	0546-0824	0615-0750	0644-0702	0714-0614	0648-0440	0715-0437	19
20	0547-0823	0616-0749	0645-0700	0715-0613	0649-0439	0716-0437	20
21	0548-0822	0616-0747	0646-0658	0716-0612	0651-0439	0717-0437	21
22	0549-0822	0617-0746	0646-0657	0717-0610	0652-0438	0717-0438	22
23	0550-0821	0618-0745	0647-0655	0718-0609	0653-0437	0717-0439	23
24	0551-0820	0619-0743	0648-0654	0719-0608	0654-0437	0718-0439	24
25	0551-0819	0620-0742	0649-0652	0720-0606	0655-0437	0718-0440	25
26	0552-0818	0621-0740	0650-0650	0721-0605	0656-0436	0719-0440	26
27	0553-0817	0622-0739	0651-0649	0722-0604	0657-0436	0719-0441	27
28	0554-0816	0623-0737	0652-0647	0723-0602	0658-0435	0719-0442	28
29	0555-0815	0624-0736	0653-0645	0724-0600	0659-0435	0719-0442	29
30	0556-0815	0625-0734	0654-0644	0726-0559	0700-0435	0720-0443	30
31	0557-0814	0626-0732		0727-0557		0720-0444	31

Rainfall

May 2013 to September 2013

City	May	June	July	Aug	Sept	Oct	Total
Aurora (Central)	2.68	1.10	3.62				7.40
Brighton	1.10	0.43	1.06				2.59
Broomfield	1.46	0.79	1.10				3.35
Castle Rock	1.66	0.59	0.98				3.23
Colo Sprgs Airport	1.14	0.60	4.61				6.35
Denver DIA	0.82	0.75	1.98				3.55
Denver Downtown	1.38	0.87	1.73				3.95
Golden	1.90	0.52	3.71				6.13
Fort Collins	2.07	1.05	2.03				5.15
Highlands Ranch	2.61	0.55	1.89				5.05
Lakewood	1.50	1.06	3.39				5.95
Littleton	1.54	1.02	1.06				3.62
Parker	1.85	1.85	1.18				4.88
Sedalia - Hwy 67	1.68	1.06	1.39				4.13
Thornton	1.26	0.31	1.22				2.79
Westminster	1.42	0.98	2.13				4.53
Wheat Ridge	1.57	0.98	3.23				5.78

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