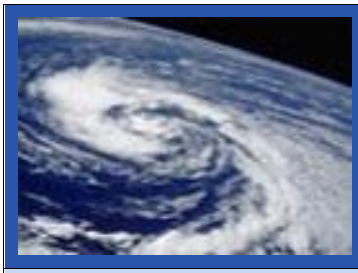


The Weather Wire

July 2013 **Volume 20 Number 7**

Contents:

North American Monsoon

In Colorado the word monsoon is used by many to describe heavy, flooding rainfall from slow moving thunderstorms. The heavy rain and thunderstorms are actually a byproduct of a larger scale weather patter change called a monsoon. The word monsoon describes a seasonal wind shift created by uneven heating of the land versus larger bodies of water like an ocean. The "monsoon season" here in Colorado typically begins in the first or second week of July and comes to an end by the first or second week of September. The thunderstorms during the month of July and August are fueled by subtropical moisture drawn northward from the south. Moisture from both the Gulf of California and the Gulf of Mexico can be imported into the state providing the necessary fuel(moisture) for daytime heat driven thunderstorms. The NWS in Tucson, AZ has devoted many links for monsoon information:

http://www.wrh.noaa.gov/twc/monsoon/monsoon_tracker.php

Below is some of the interesting information that can be found there.

What is a Monsoon?

The word monsoon is derived from the Arabic word *mausim,* which means season. Traders plying the waters off the Arabian and Indian coasts noted for centuries that dry northeast winds in the winter suddenly turn to the southwest during the summer, and bring beneficial yet torrential rains to the Asian subcontinent. We now know that these large scale wind shifts, from dry desert areas to moist tropical areas, occur in other parts of the Earth, including the Oceanic subcontinent, Southeast Asia, Australia, North America, Africa and South America.

These wind shifts, and the dramatic change in weather they bring, are all more or less driven by a similar mechanism. For much of the year, low level winds in dry subtropical regions tend to blow from the land toward the sea. However by late spring, strong solar heating causes temperatures to soar over these land areas. The intense heat causes surface air pressure to fall, forming an area of low pressure known as a

thermal low. Adjacent large bodies of water are also warmed, but not as quickly. Thus air pressures remain high relative to the land. Eventually, the pressure difference increases to the point that the cooler and much more humid air over the ocean is drawn toward the hot, dry air over land. This moist air moving onto the hot land eventually becomes unstable and develops into thunderstorms. Once this occurs and rain begins to fall, humidity levels increase over land, which only triggers more thunderstorms. This cycle will continue until land areas begin to cool in the early fall and water temperatures reach their peak in early fall. This reduces the pressure difference, which in turn causes the moist onshore flow to diminish, and the monsoon gradually ends. Full version with graphics from NWS can be found here:

http://www.wrh.noaa.gov/twc/monsoon/monsoon_whatis.php

The North American or SW Monsoon

Until the late 1970s, there was serious debate about whether a monsoon truly existed in North America. However, considerable research, which culminated in the Southwest Arizona Monsoon Project (SWAMP) in 1990 and 1993, established the fact that a bonafide monsoon, characterized by large-scale wind and rainfall shifts in the summer, develops over much of Mexico and the intermountain region of the U.S. Published papers at the time called this pattern by different names, including the "Summer Thunderstorm Season," The Mexican Monsoon," "The Southwest Monsoon," and the "Arizona Monsoon."

In 2004, a major multinational research project was conducted in northwest Mexico and the southwest U.S. The North American Monsoon Experiment (NAME) sought to better describe the monsoon in North America, and increase our ability to predict it on a daily, weekly and seasonal basis. NAME showed that despite its many names, the weather pattern we see during the summer is not only a true monsoon, but it also affects the weather over a large portion of North America. Thus the generally accepted name is now "North American Monsoon."

The North American Monsoon is not as strong or persistent as its Indian counterpart, mainly because the Mexican Plateau is not as high or as large as the Tibetan Plateau in Asia. However, the North American Monsoon shares most of the basic characteristics of its Indian counterpart. There is a shift in wind patterns in summer which occurs as Mexico and the southwest U.S. warm under intense solar heating. As this happens, the flow reverses from dry land areas to moist ocean areas. In the North American Monsoon, the low level moisture is transported primarily from the Gulf of California and eastern Pacific. The Gulf of California, a narrow body of water surrounded by mountains, is particularly important for low-level moisture transport into Arizona and Sonora. Upper level moisture is also transported into the region, mainly from the Gulf of Mexico by easterly winds aloft. Once the forests of the Sierra Madre Occidental green up from the initial monsoon rains, evaporation and plant transpiration can add additional moisture to the atmosphere which will then flow into Arizona. Finally, if the southern Plains of the U.S. are unusually wet and green during the early summer months, that area can also serve as a moisture source. This combination causes a distinct rainy season over large portions of western North America, which develops rather quickly and sometimes dramatically.

Rainfall during the monsoon is not continuous. It varies considerably, depending on a variety of factors. There are usually distinct “burst” periods of heavy rain during the monsoon, and “break” periods with little or no rain. Monsoon precipitation, however, accounts for a substantial portion of annual precipitation in northwest Mexico and the Southwest U.S. Most of these areas receive over half their annual precipitation from the monsoon. The North American Monsoon circulation pattern typically develops in late May or early June over southwest Mexico. By mid to late summer, thunderstorms increase over the “core” region of the southwest U.S. and northwest Mexico, including the U.S. and Mexican states of Arizona, New Mexico, Sonora, Chihuahua, Sinaloa and Durango. The monsoon typically arrives in mid to late June over northwest Mexico, and early July over the southwest U.S. Once the monsoon is underway, mountain ranges, including the Sierra Madre Occidental and the Mogollon Rim provide a focusing mechanism for the daily development of thunderstorms. Thus much of the monsoon rainfall occurs in mountainous terrain. For example, monsoon rainfall in the Sierra Madre Occidental typically ranges from 10 to 15 inches. Since the southwest U.S. is at the northern fringe of the monsoon, precipitation is less and tends to be more variable. Areas further west of the core monsoon region, namely California and Baja California, typically receive only spotty monsoon-related rainfall. In those areas, the intense solar heating isn’t strong enough to overcome a continual supply of cold water from the North Pacific Ocean moving down the west coast of North America. Winds do turn toward the land in these areas, but the cool moist air actually stabilizes the atmosphere.
In addition to the lower level monsoon circulation, an upper level monsoon (or subtropical) ridge develops over the southern High Plains and northern Mexico. In June, this ridge is too far south over Mexico and actually blocks deep moisture from moving north into Arizona. However by late June or early July, this ridge shifts north into the southern Plains or southern Rockies. As this shift takes place, mid and upper level moisture streams into Arizona, and low level moisture surges from Mexico meet less resistance.

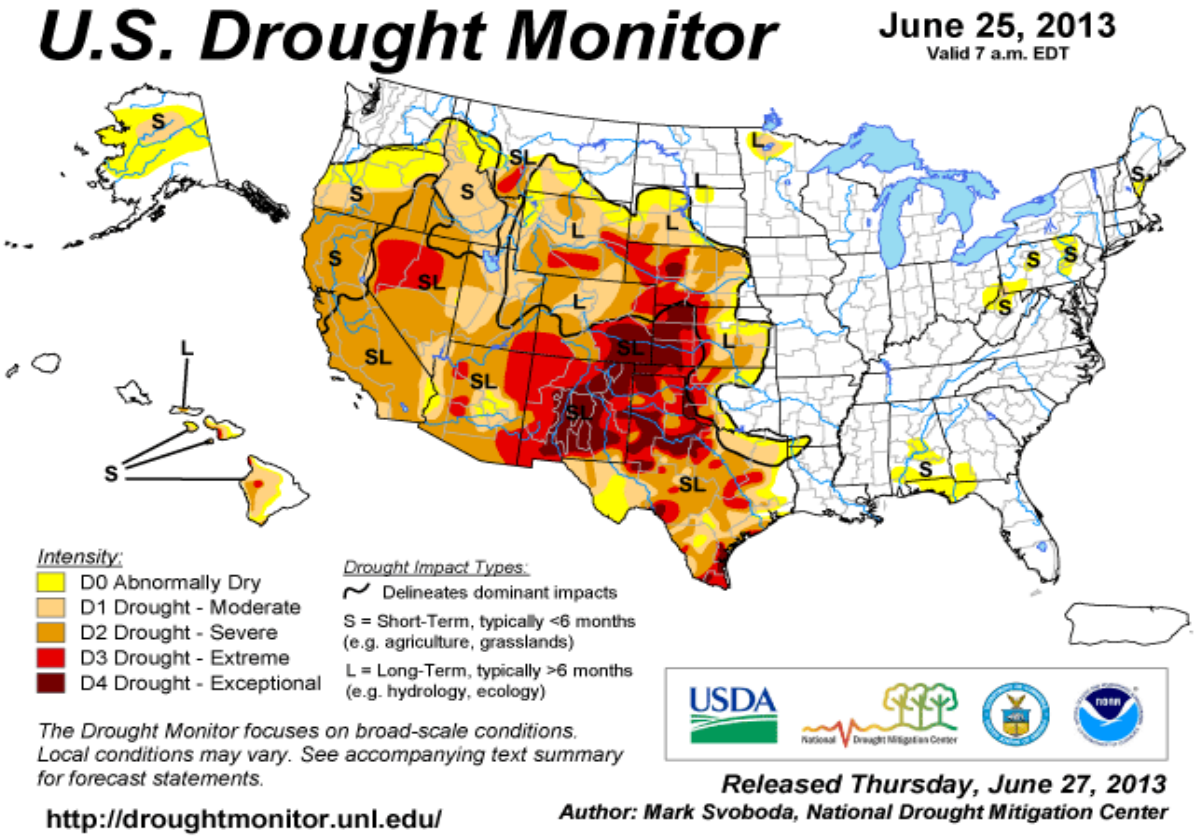
This monsoon ridge is almost as strong as the one which develops over Asia during the summer. However, since the lower level moisture flow is not as persistent as in the Indian monsoon, the upper level steering pattern and disturbances around the ridge are critical for influencing where thunderstorms develop on any given day. The exact strength and position of the subtropical ridge also governs how far north the tropical easterly winds aloft can spread. If the ridge is too close to a particular area, the sinking air at its center suppresses thunderstorms and can result in a significant monsoon “break.” If the ridge is too far away or too weak, the east winds around the high are inadequate to bring tropical moisture into the mountains of Mexico and southwest U.S. However, if the ridge sets up in a few key locations, widespread and potentially severe thunderstorms can develop.

It is important to note that the monsoon is not an individual thunderstorm. While the word “monsoon” accurately conjures up images of torrential rains and flooding, calling a single thunderstorm a “monsoon” is incorrect. A monsoon is a large scale weather pattern which *causes* our summer thunderstorms. Full version with graphics from NWS can be found here:

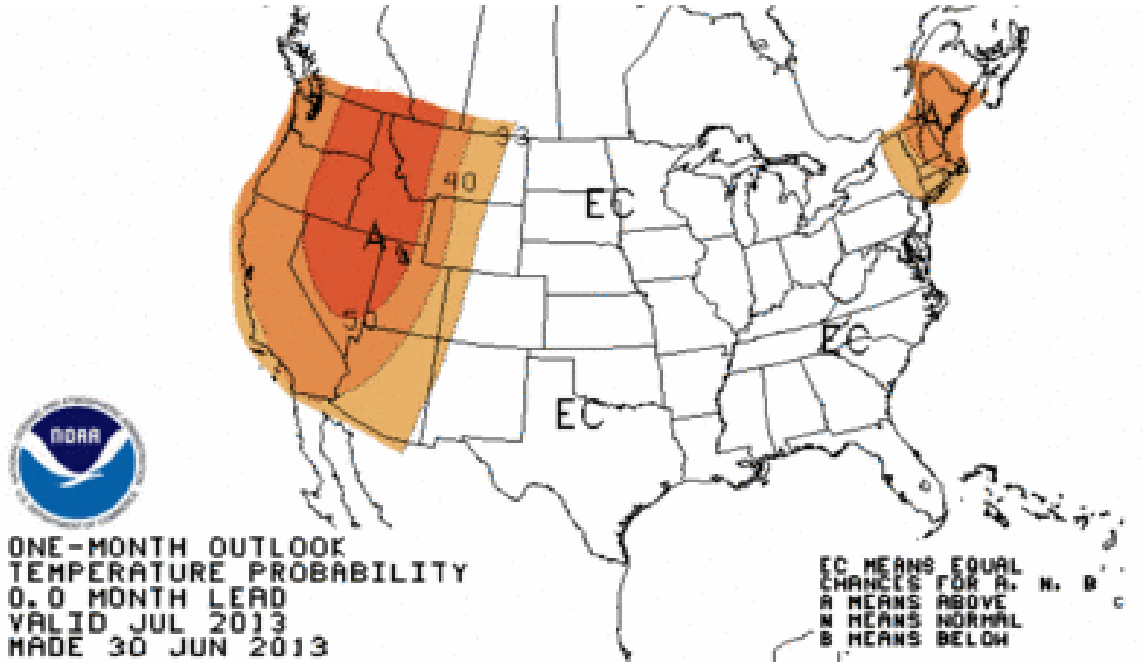
http://www.wrh.noaa.gov/twc/monsoon/monsoon_NA.php

Drought Update

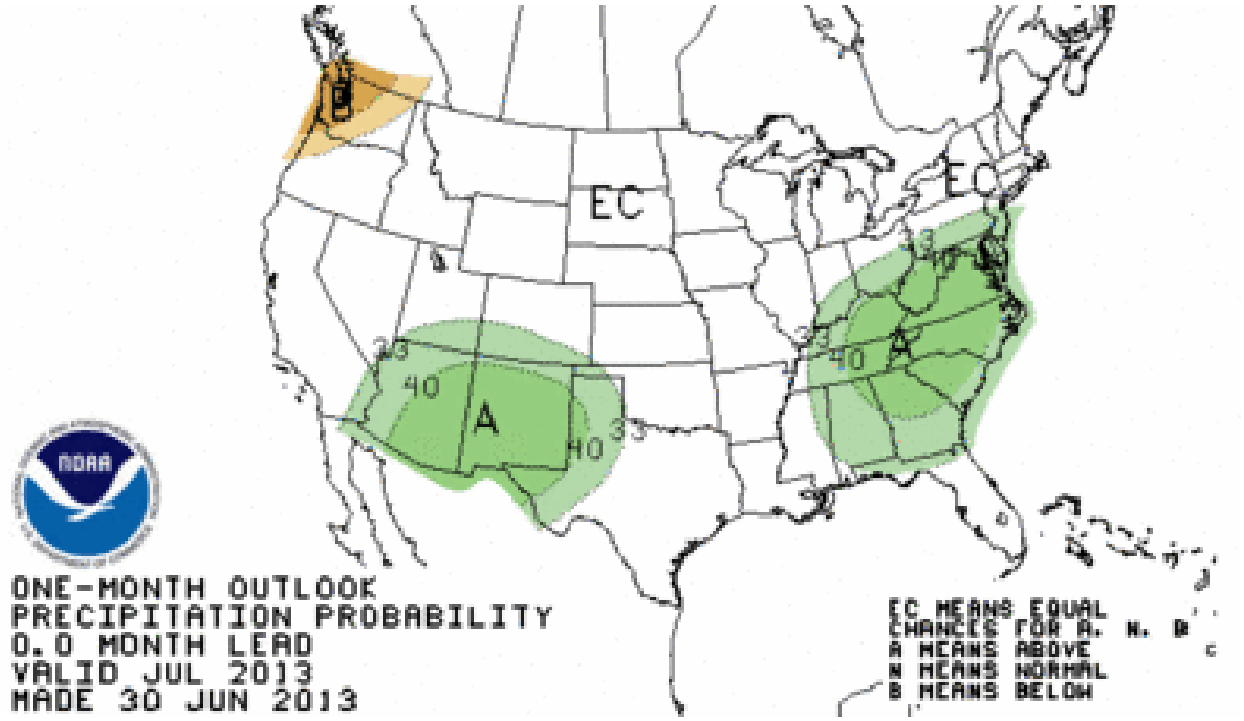
Extreme to exceptional drought continues over SE Colorado and into New Mexico, Kansas, western Oklahoma and NW Texas. There has been significant improvement over the Dakotas and parts of Montana in the past 3 months. The eastern half of the Country remains free of drought.



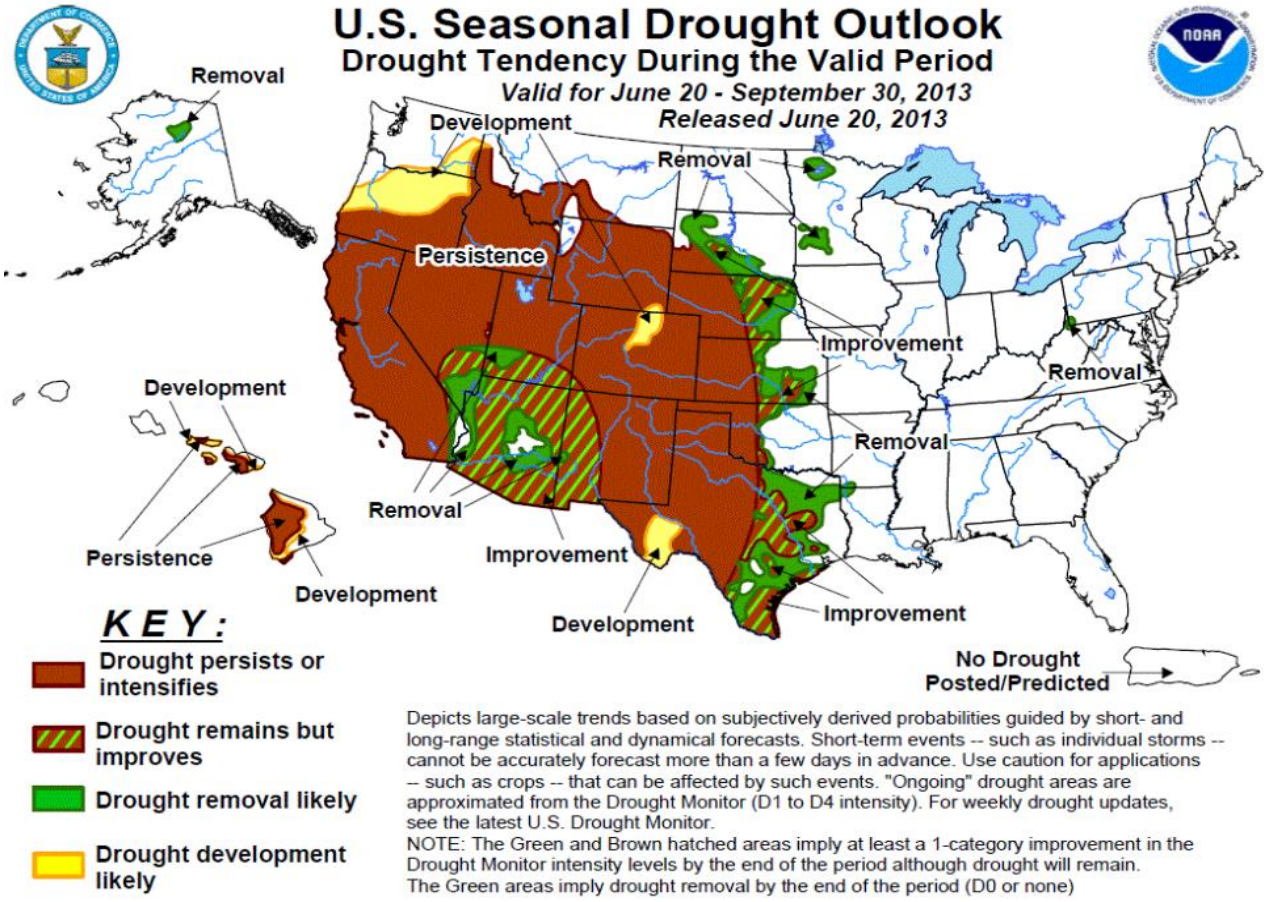
The map below shows forecasted temperature deviances for July 2013. Normal temperatures are expected over eastern Colorado.



The map below shows forecasted precipitation deviances for July 2013. Normal precipitation is expected over central and northern Colorado with a bias towards above normal precipitation over southern areas of the state.



Drought conditions are forecast to persist over Colorado with possibly some improvement over far SW portions of the state.



June Summary

June of 2013 was very warm ranking 10th on the all time list. Conditions were also very dry with well below normal precipitation for many areas. The hot and dry weather during the middle and latter part of the month created dangerous fire weather conditions and numerous large fire incidents were common state wide. The fire closest to home was the Black Forest fire which burned 14,280 acres and claimed over 500 homes making this fire the most destructive in state history. Average highs for the month were 87.8 degrees over 5 degrees above the normal of 82.4. The warmest day of the month was a record setting 100 degrees on the 11th. The other record high during the month was 99 on the 10th. There were 14 days during the month with a high of 90 or more. Average lows were 54.3 with the coldest temperature of 39 degrees on the 2nd. The mean monthly temperature was 71.1 degrees tying 1936 and 2002 for 10th warmest all time. Precipitation was well below the normal of 1.98" with only 0.75" reported at DIA resulting in a monthly deficit of 1.23". The yearly precipitation deficit is now greater than 1.5". There were 10 thunderstorm days during the month but most storms only produced light rainfall and gusty winds, normal thunderstorm days for June is 8. Severe weather was not very common for June standards even though there was a slightly higher amount of thunderstorm days versus normal.

June Stats

TEMPERATURE (IN DEGREES F)

AVERAGE MAX	87.8	NORMAL	82.4	DEPARTURE	5.4
AVERAGE MIN	54.3	NORMAL	52.3	DEPARTURE	2.0
MONTHLY MEAN	71.1	NORMAL	67.4	DEPARTURE	3.7
HIGHEST	100 on the 11th				
LOWEST	39 on the 2nd				

DAYS WITH MAX 90 OR ABOVE	14	NORMAL	8
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

New record high of 99 on the 10th

New record high of 100 on the 11th

HEATING DEGREE DAYS

MONTHLY TOTAL	29	NORMAL	62	DEPARTURE	-33
SEASONAL TOTAL	6084	NORMAL	6058	DEPARTURE	26

COOLING DEGREE DAYS

MONTHLY TOTAL	221	NORMAL	133	DEPARTURE	88
YEARLY TOTAL	263	NORMAL	155	DEPARTURE	108

PRECIPITATION (IN INCHES)

MONTHLY TOTAL	0.75	NORMAl	1.98	DEPARTURE	-1.23
YEARLY TOTAL	5.99	NORMAl	7.51	DEPARTURE	-1.52
GREATEST IN 24 HOURS		0.51" on the 23rd			
DAYS WITH MEASURABLE PRECIP			4		

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	10.7mph
PEAK WIND GUST	NA

MISCELLANEOUS WEATHER

NUMBER OF DAYS WITH THUNDERSTORM	10	NORMAL	8
NUMBER OF DAYS WITH HEAVY FOG	0	NORMAL	1
NUMBER OF DAYS WITH HAIL	0		
NUMBER OF SUNNY DAYS	4		
NUMBER OF PARTLY CLOUDY DAYS	25		
NUMBER OF CLOUDY DAYS	1		
AVERAGE RELATIVE HUMIDITY	NA		

July Preview

July is usually the warmest month of the year for Denver and surrounding areas with average high temperatures in the upper 80s to around 90. Average high temperatures to start the month are 87 degrees and 90 at month's end. The record high for July is 105 degrees set back in 2005 and is the warmest temperature in Denver history. The record low for July is 42 degrees set back in 1873 and again in 1903. The big story for July is the onset of the North American monsoon which usually begins in the first or second week of the month. The threat for severe weather lowers from June but many storms can still contain gusty winds, large hail and isolated tornadoes. Storms begin to produce heavy rains versus severe weather as moisture from the Gulf of Mexico and the Gulf of California work its way into the state. Storms to start the month are relatively fast movers but by month's end the jet stream usually lifts northwards with slower storm speeds which in turn increases the threat for flash flooding, especially over fresh burn scars. Average monthly precipitation is higher than June at 2.16". There are usually 8 days with measureable precipitation and 11 days with thunderstorms. For July of 2013 near normal temperatures are expected with near normal precipitation.

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

TEMPERATURE

AVERAGE HIGH	89.4
AVERAGE LOW	58.9
MONTHLY MEAN	74.2
DAYS WITH HIGH 90 OR ABOVE	16
DAYS WITH HIGH 32 OR BELOW	0
DAYS WITH LOW 32 OR BELOW	0
DAYS WITH LOWS ZERO OR BELOW	0

PRECIPITATION

MONTHLY MEAN	2.16"
DAYS WITH MEASURABLE PRECIPITATION	8
AVERAGE SNOWFALL IN INCHES	0.0"
DAYS WITH 1.0 INCH OF SNOW OR MORE	0

MISCELLANEOUS AVERAGES

HEATING DEGREE DAYS	6
COOLING DEGREE DAYS	289
WIND SPEED (MPH)	8.3mph
WIND DIRECTION	South
DAYS WITH THUNDERSTORMS	11
DAYS WITH DENSE FOG	Less than 1
PERCENT OF SUNSHINE POSSIBLE	71%

EXTREMES

RECORD HIGH	105 on 7/20/2005
RECORD LOW	42 on 7/4/1903

WARMEST	78.9 in 2012
COLDEST	67.4 in 1895
WETTEST	6.41” in 1965
DRIEST	0.01” in 1901
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					3.78
Brighton	1.10	0.43					1.53
Broomfield	1.46	0.79					2.25
Castle Rock	1.66	0.59					2.25
Colo Sprgs Airport	1.14	0.60					1.74
Denver DIA	0.82	0.75					1.57
Denver Downtown	1.38	0.87					2.25
Golden	1.90	0.52					2.42
Fort Collins	2.07	1.05					3.12
Highlands Ranch	2.61	0.55					3.16
Lakewood	1.50	1.06					2.56
Littleton	1.54	1.02					2.56
Parker	1.85	1.85					3.70
Sedalia - Hwy 67	1.68	1.06					2.74
Thornton	1.26	0.31					1.57
Westminster	1.42	0.98					2.40
Wheat Ridge	1.57	0.98					2.55

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