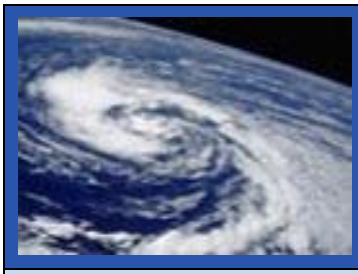


The Weather Wire

July 2017 Volume 24 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 the North American 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.

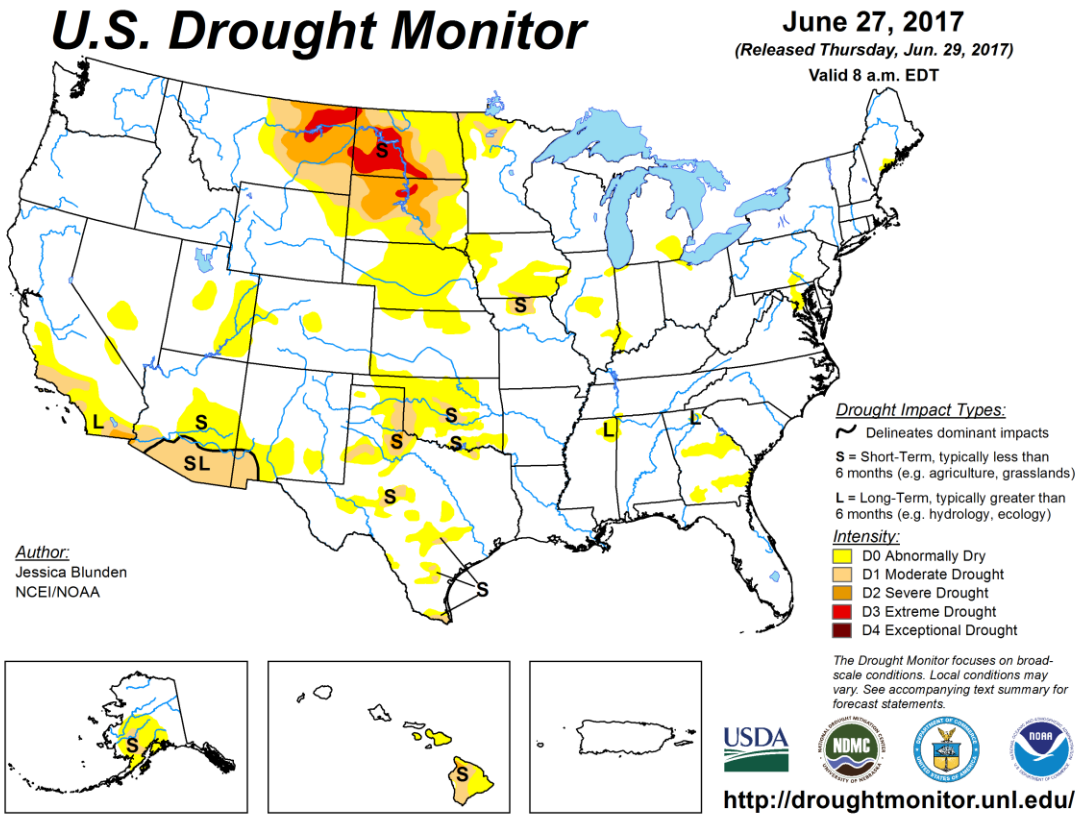
This monsoon ridge is almost as strong as the one which develops over Asia during the summer. However, since the lower level moisture flow is not as persistent as in the Indian monsoon, the upper level steering pattern and disturbances around the ridge are critical for influencing where thunderstorms 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:

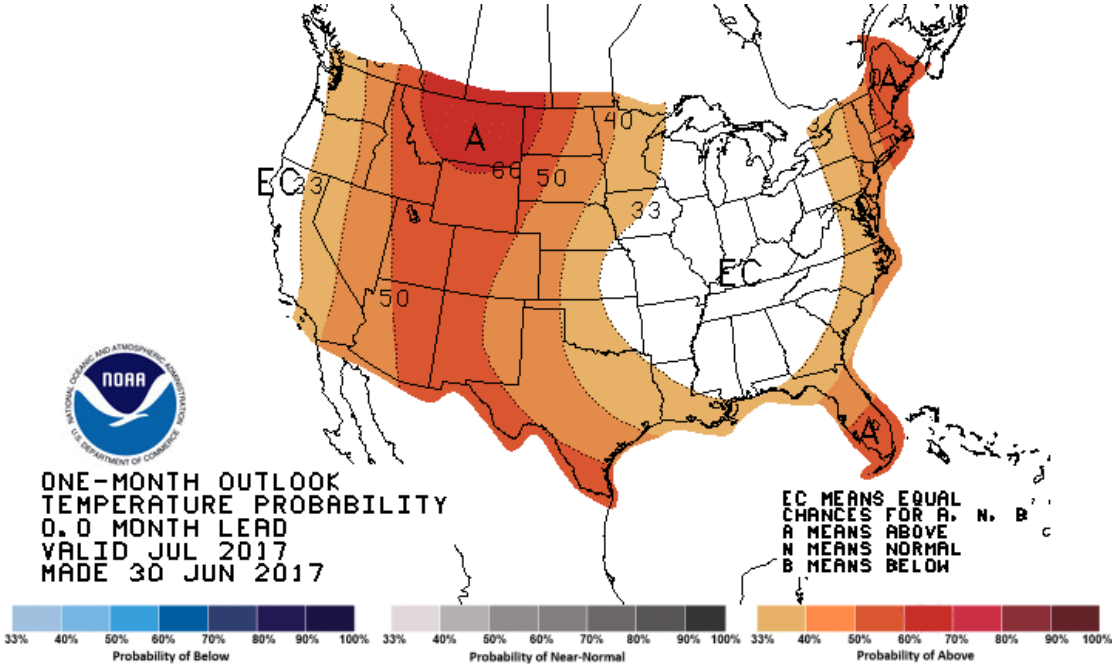
http://www.wrh.noaa.gov/twc/monsoon/monsoon_NA.php

Drought Update

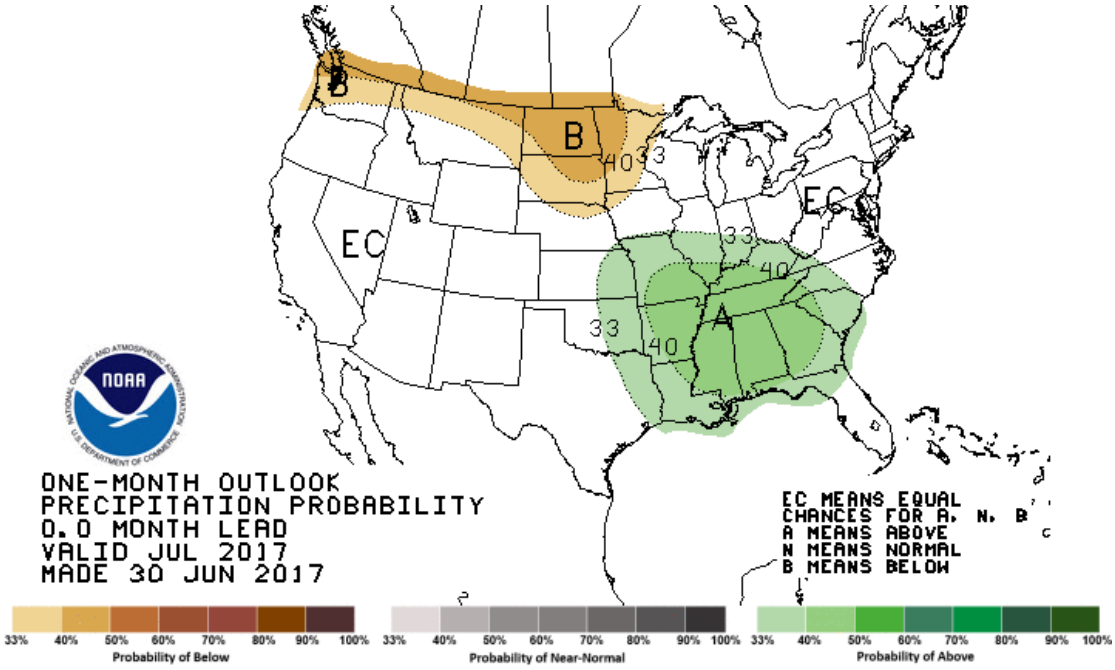
Colorado remains drought-free thanks to a wet spring season, but some pockets of abnormally dry conditions remain in Park and Teller Counties and along the Western Slope. Much of the Western U.S. is drought-free as well, but areas of severe to extreme drought have recently developed across the Dakotas and eastern Montana.



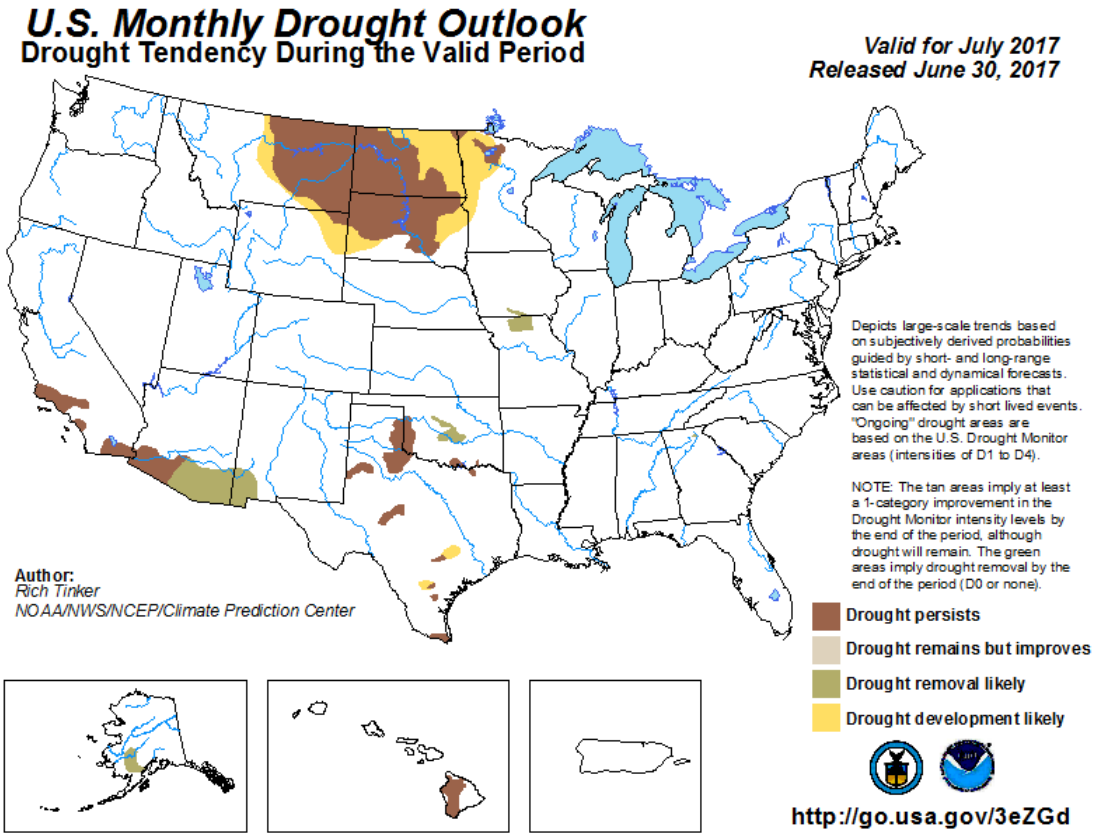
The map below shows forecasted temperature deviances for July 2017. There is a strong bias toward above normal temperatures across the western two-thirds of Colorado and a moderate bias toward above normal temperatures for the eastern plains of Colorado.



The map below shows forecasted precipitation deviances for July 2017. There are equal chances for above or below normal precipitation across all of Colorado.



Colorado is expected to remain drought-free this month, while areas of drought are expected to persist and in some cases expand across the Dakotas, eastern Montana, and northwest Minnesota. Drought removal is likely across far southern Arizona.



June Summary

June 2017 was warmer than average and much drier than average across the Denver area and eastern Colorado. Following an active May, a pattern shift occurred during the first week of June that favored high pressure over Colorado for the remainder of the month. Periodic cold fronts did arrive throughout the month as low pressure systems tracked across the Northern Rockies, but moisture remained minimal with most of these frontal passages. For the month, precipitation at DIA totaled just 0.33", which officially makes it the 20th driest June on record and well below the long-term average of 1.98". Across the I-25 corridor from Ft. Collins to Colorado Springs, precipitation amounts in June generally ranged from 0.20-1.10". There were only 5 days in which measurable precipitation occurred at DIA, but there 10 days in which thunder was observed, owing to the typical high-based "dry" thunderstorms that occurred across the region during June. Temperatures in June were 2.1 degrees above normal at DIA with an average high of 85.5 and an average low 53.6. The highest temperature of the month was 99, which occurred on the 20th and also set a record for the date. The low for the month was 42, which occurred on the 13th. Overall, there were 9 days in which the high temperature exceeded 90 degrees, which is slightly above normal. Although there were a number of hot spells during June, there were several cold fronts that provided spells of relief from the heat, most notably on the 23rd when a high of only 63 was observed at DIA, which was 30 degrees colder than the previous day's high temperature.

June Stats

TEMPERATURE (IN DEGREES F)

AVERAGE MAX	85.5	NORMAL	82.4	DEPARTURE	3.1
AVERAGE MIN	53.6	NORMAL	52.3	DEPARTURE	1.3
MONTHLY MEAN	69.5	NORMAL	67.4	DEPARTURE	2.1
HIGHEST	99 on 6/20				
LOWEST	42 on 6/13				

DAYS WITH MAX 90 OR ABOVE	9	NORMAL	7.9
DAYS WITH MAX 32 OR BELOW	0	NORMAL	0.0
DAYS WITH MIN 32 OR BELOW	0	NORMAL	0.0
DAYS WITH MIN ZERO OR BELOW	0	NORMAL	0.0

TEMPERATURE RECORDS
6/15 – Record high of 95 tied

6/20 – Record high of 99 set

HEATING DEGREE DAYS

MONTHLY TOTAL	25	NORMAL	62	DEPARTURE	-37
SEASONAL TOTAL	5109	NORMAL	6058	DEPARTURE	-949

COOLING DEGREE DAYS

MONTHLY TOTAL	167	NORMAL	133	DEPARTURE	34
YEARLY TOTAL	173	NORMAL	155	DEPARTURE	18

PRECIPITATION (IN INCHES)

MONTHLY TOTAL	0.33	NORMAL	1.98	DEPARTURE	-1.65
YEARLY TOTAL	6.64	NORMAL	7.51	DEPARTURE	-0.87
GREATEST IN 24 HOURS	0.13 on 6/29				
DAYS WITH MEASURABLE PRECIP.	5				

SNOWFALL (IN INCHES)

MONTHLY TOTAL	0.0	NORMAL	0.0	DEPARTURE	0.0
SEASONAL TOTAL	21.8	NORMAL	53.8	DEPARTURE	-32.0

GREATEST IN 24 HOURS	NA
GREATEST DEPTH	NA

WIND (IN MILES PER HOUR)

AVERAGE SPEED	10.1 mph
PEAK WIND GUST	66 mph from the W on 6/27

MISCELLANEOUS WEATHER

NUMBER OF DAYS WITH THUNDERSTORM	10	NORMAL	10
NUMBER OF DAYS WITH HEAVY FOG	0	NORMAL	<1
NUMBER OF DAYS WITH HAIL	0		
NUMBER OF SUNNY DAYS	6		
NUMBER OF PARTLY CLOUDY DAYS	22		
NUMBER OF CLOUDY DAYS	2		
AVERAGE RELATIVE HUMIDITY	47%		

July Preview

July is the hottest month on average in Denver, but also the second wettest on average due to the high frequency of thunderstorms that occur. The average high temperature for the month of July is 89.4 degrees, and the high exceeds 90 degrees an average of 16 days during the month. The record high for the month is 105, which occurred in 2005, and this is also tied for the hottest temperature on record in Denver. The average low for the month is 58.9 degrees and the coolest temperature on record is 42, which occurred way back in 1873 and again in 1903. Average rainfall during the month of July is 2.10", with an average of 11 thunderstorm days occurring during the month. The southwest monsoon typically ramps up and peaks during the second half of July, which supplies the moisture necessary for frequent thunderstorms to occur in the Denver metro area, and sometimes heavy rainfall can occur from these thunderstorms. Severe weather is common during July as well, even though the peak is typically in June. However, the biggest threats from thunderstorms gradually shift from severe weather to heavy rain and flash flooding as the month progresses. This is typically due to the fact that upper level winds gradually weaken as the summer wears on, resulting in slower-moving thunderstorms, which can produce heavier rainfall during active monsoonal periods. Some of the Front Range's more notable flash flooding events have occurred in July, such as the Big Thompson Flood in 1976 and the Ft. Collins flood in 1997. For July of 2017, we are expecting above normal temperatures and below normal rainfall, due in part to a later than normal start to the monsoon season in Colorado. The monsoonal flow looks to increase across western Colorado over the second week or so of July, but the pattern may take some time to progress toward the I-25 corridor. The monsoon will likely pick up over the Denver metro area over the second half of the month, so we should see more rainfall compared to June. However, if the stretch of dry

weather and minimal rainfall persists much longer for the I-25 corridor, eastern plains, and Front Range foothills, then fire danger will increasingly become a concern in the near-term.

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	2.10”
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	0
PERCENT OF SUNSHINE POSSIBLE	71%

EXTREMES

RECORD HIGH	105 on 7/20/2005
RECORD LOW	42 on 7/4/1903, 7/31/1873
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”

Rainfall

May 2017 to October 2017

City	May	Jun	Jul	Aug	Sep	Oct	Total
Aurora (Central)	3.39	0.31					3.70
Boulder	5.94	0.28					6.22
Brighton	4.92	1.10					6.02
Broomfield	4.72	0.51					5.23
Castle Rock	2.20	0.20					2.40
Colo Sprgs Airport	3.15	0.50					3.65
Denver DIA	3.66	0.33					3.99
Denver Downtown	4.13	0.91					5.04
Golden	5.79	0.31					6.10
Fort Collins	4.38	0.26					4.64
Highlands Ranch	4.25	1.14					5.39
Lakewood	4.69	0.83					5.52
Littleton	3.70	0.67					4.37
Parker	3.70	0.59					4.29
Sedalia - Hwy 67	3.60	0.20					3.80
Thornton	4.09	0.35					4.44
Westminster	4.80	0.67					5.47
Wheat Ridge	3.70	0.39					4.09

Skyview Weather
2350 N Rocky View Rd
Castle Rock, CO 80108

Phone: (303) 688-9175
Fax: (303) 380-3338

E-mail: Tim@SkyviewWeather.com
On the web at www.SkyviewWeather.com