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The world's largest rail yard in North Platte, Nebraska - Photo by Natalie Umphlett
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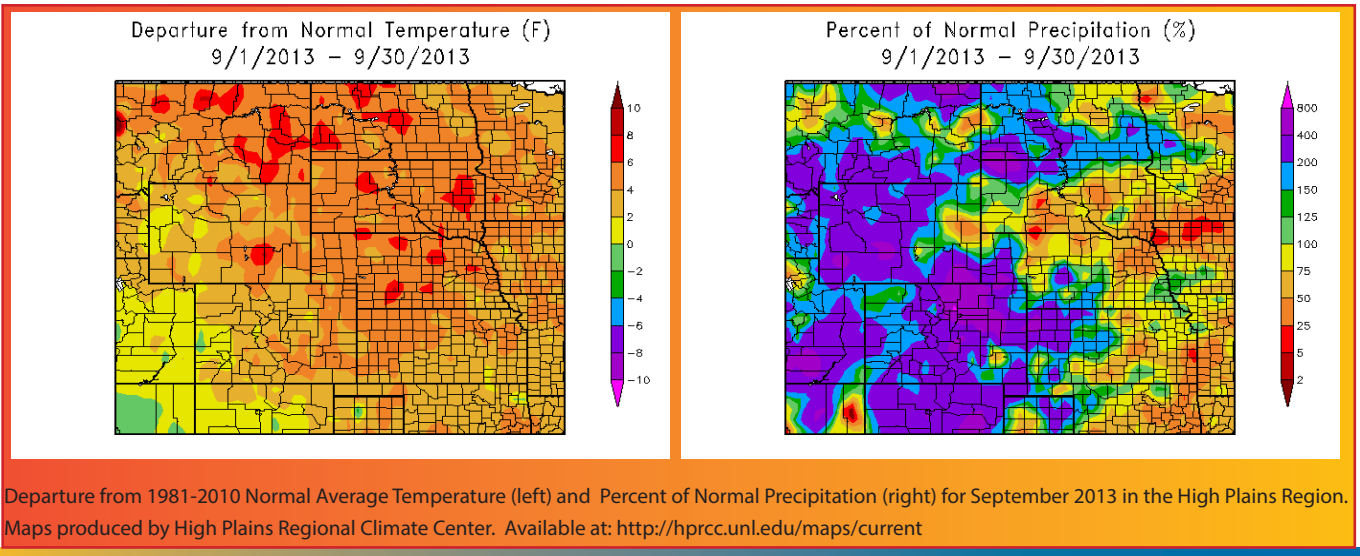
September 2013 Climate Summary

Region Breakdown

September 2013 was quite warm across the High Plains Region - even a mid-month cool down could not drop the monthly average temperatures to below normal. A large area of the Region stretching from central Kansas and eastern Colorado to the Canadian border had average temperatures of at least 4.0 degrees F (2.2 degrees C) above normal. Even some pockets of Nebraska, Wyoming, and the Dakotas had temperature departures of up to 8.0 degrees F (4.4 degrees C) above normal. As a result, many locations ranked in the top 10 warmest Septembers on record. For instance, Huron, South Dakota had its 3rd warmest September on record with an average temperature of 68.4 degrees F (20.2 degrees C), which was 6.7 degrees F (3.7 degrees C) above normal (period of record 1881-2013). Extremely warm temperatures at the beginning of the month also led to many daily records. The highest temperature in the Region occurred in Beaver City, Nebraska on the 8th with 109 degrees F (42.8 degrees C). Not only did this set a new record for the day, this also tied with September 3, 1947 for the highest September temperature on record (period of record 1893-2013). Another extreme location was Denver, Colorado which tied for its highest September temperature of 97 degrees F (36.1 degrees C) on both the 5th and the 6th (period of record 1872-2013).

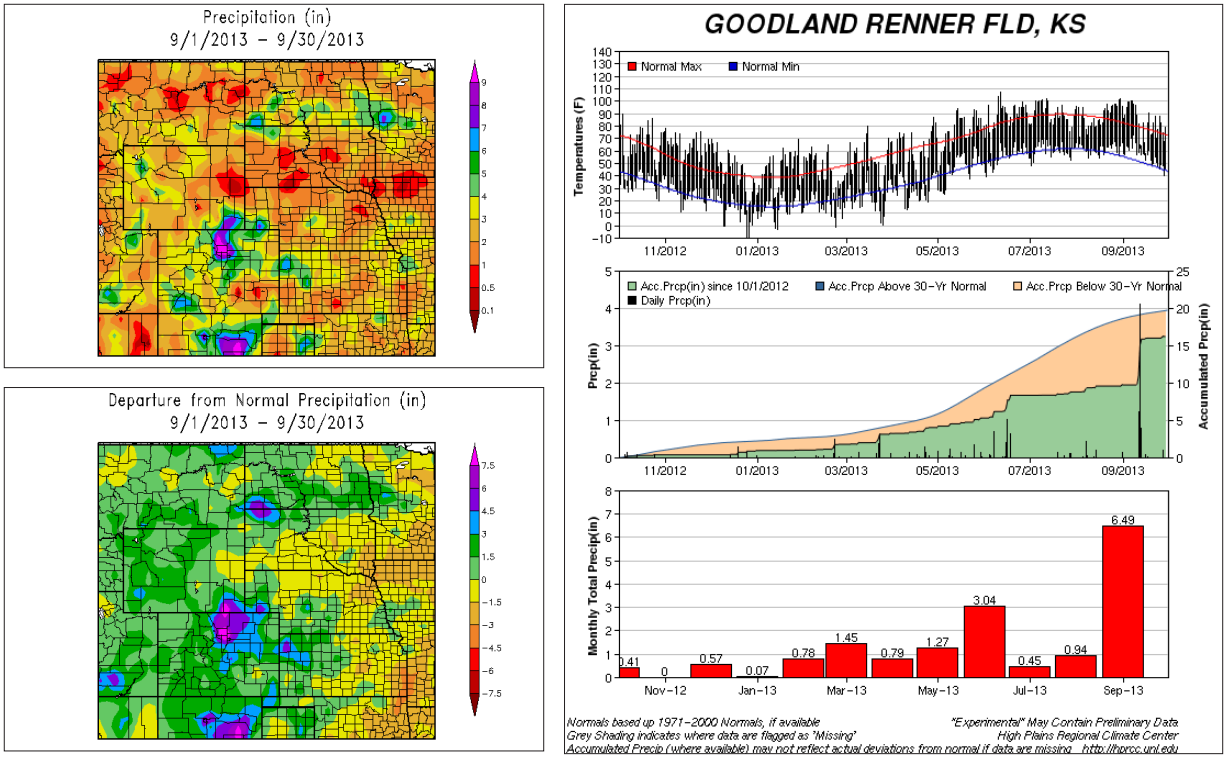


Departure from 1981-2010 Normal Average Temperature (left) and Percent of Normal Precipitation (right) for September 2013 in the High Plains Region.
Maps produced by High Plains Regional Climate Center. Available at: http://hprcc.unl.edu/maps/current

Precipitation Summary

Precipitation was the big story this month in the High Plains Region. Copious amounts of rain fell across Colorado, Wyoming, much of North Dakota, northern South Dakota, western Kansas, and the panhandle of Nebraska where precipitation totals of 200-400 percent of normal were common. Most of the precipitation fell in one week – the 9th through the 15th. Precipitation totals even topped 400 percent of normal in north-central and northeastern Colorado, southern Wyoming, northwestern Kansas, and an area along the southwestern border of the Dakotas. While the destructive flooding in Colorado grabbed the headlines, other areas in the Region received large amounts of precipitation and flash flooding as well (For more information on Colorado's historic precipitation, please see page 3). Some areas actually did miss out on the rains and received less than 50 percent of normal precipitation. Those areas included southeastern Kansas, northeastern Nebraska, and parts of central and southeastern South Dakota.

Numerous records were set this month – daily, monthly, and even some all-time records were just completely smashed. One example is from Goodland, Kansas which received 6.49 inches (165 mm) of precipitation. This new record for September was 5.27 inches (134 mm) above normal, or a whopping 532 percent of normal precipitation! The old record of 5.39 inches (137 mm) was set back in 1973 (period of record 1895-2013). 4.11 inches (104 mm) of the monthly total fell on the 12th and just obliterated the old daily record of 0.85 inches (22 mm). The rainfall on that day went down as the second highest one-day rainfall total on record and came just short of the record 4.15 inches (105 mm) that fell on June 28, 1989. Interestingly, even with the extremely heavy rainfall, Goodland was still running a precipitation deficit for the year. Wyoming had its share of records as well. Cheyenne, Wyoming set a new record for wettest September with 6.95 inches (177 mm) of precipitation which was 470 percent of normal. The old record of 4.52 inches (115 mm) also occurred in 1973 (period of record 1871-2013). Just like Colorado, the bulk of the precipitation (5.79 inches / 147 mm) fell during the week of the 9th-15th. The heaviest day for Cheyenne was the 13th with 1.37 inches (35 mm) and this snuck past the old record of 1.06 inches (27 mm) received in 1996.



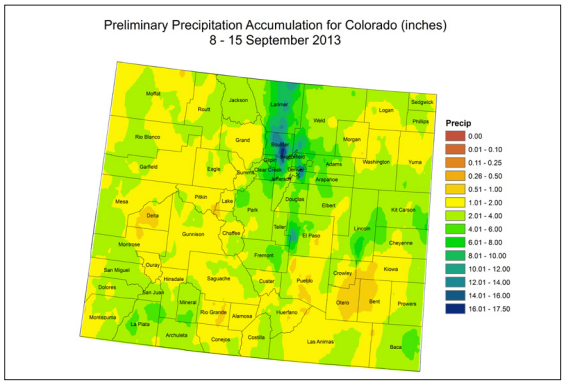
Above: Total precipitation (inches) (top left) and Departure from Normal Precipitation (inches) (bottom left) for September 2013 in the High Plains Region. Accumulated and monthly precipitation for Goodland, KS (right) over the past year. These maps are produced by HPRCC and can be found on the Current Climate Summary Maps page at: http://hprcc.unl.edu/maps/current.

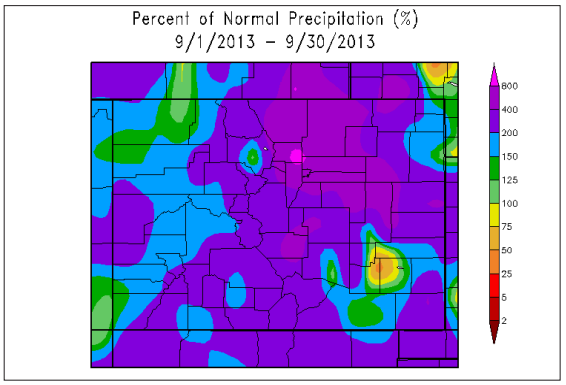
The High Plains Regional Climate Center is one of the Regional Climate Centers, and is involved in the Applied Climate Information System (ACIS) development and management effort. Data found throughout this publication were derived using products built on the ACIS framework.

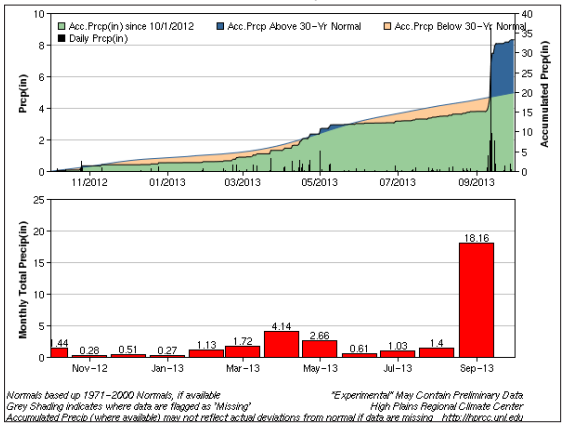
ACIS
Applied Climate Information System - Regional Climate Centers

Colorado Flooding Summary

September was an eventful month for the state of Colorado. The month started off with exceptionally warm and dry weather with record to near-record heat occurring across northeast and north-central portions of the state. Conditions changed quickly and dramatically, however. An upper level low, positioned over the desert southwest, pulled subtropical moisture northward across the state from the 9th through the 15th. Early during the event, moderate rainfall amounts were reported for many locations along the Front Range with a few areas, such as Denver and Boulder, receiving heavy rainfall of up to 2.0 inches (51 mm). On the 11th, moderate rainfall continued to fall, however showers began to intensify and become more widespread by the evening. A narrow band of very heavy rain formed just north of Denver and moved westward toward the foothills. Rainfall rates of 2 inches per hour (51 mm/hour) were reported out of the heaviest showers and as the evening progressed, flash flooding became widespread. The heavy rain continued into the morning hours of the 12th with torrential rain developing in other areas, such as Aurora. Rainfall totals the morning of the 12th were staggering with many locations receiving more rainfall than they normally would during the entire month of September. Because the ground was already saturated and streams were elevated, any rain that fell on the 12th just exacerbated the flooding that was already occurring. High flows were observed on many creeks and rivers including the Big Thompson River, the Cache la Poudre River, the St. Vrain Creek, the South Boulder Creek, and the South Platte. Rainfall eased by the 13th; however the floodwaters rushed downstream out onto the plains, flooding farmland. After somewhat of a reprieve on Friday, heavy rainfall returned on Saturday and Sunday bringing more flash flooding. The multi-day rainfall event finally ended as showers tapered off late on Sunday. Even locations far away from the initial flooding were affected as the floodwaters traveled the South Platte. Communities in western Nebraska, such as Ogallala, dealt with their own round of flooding nearly a week to a week and a half after the initial flooding started in Colorado.







Above: Total precipitation (inches) for Colorado for September 8-15, 2013 (top), Percent of Normal Precipitation for September 2013 in Colorado (middle), and accumulated and monthly precipitation for Boulder, CO over the past year (bottom). Top map courtesy the Colorado Climate Center: http://ccc.atmos.colostate.edu/. Other figures: http://hprcc.unl.edu

One of the hardest hit communities was Boulder which received 9.08 inches (231 mm) of rain in one day alone, the 12th. This daily total was notable in many different ways. Not only did this amount set a new record for that day, but also for any day in Boulder's 121 year history. The old one-day precipitation record of 4.80 inches (122 mm) was set back on July 31, 1919. By the end of the month Boulder had received 18.16 inches (461 mm) of precipitation which more than tripled the old September record of 5.50 inches (140 mm) set in 1940. Ultimately, the rainfall received in Boulder was a 1 in 1000+ year event (http://hdsc.nws.noaa.gov/hdsc/pfds/).

The impacts of the heavy precipitation and flooding were numerous and are still being realized. Lives were lost – many are still missing, roads and bridges were washed away, homes and business were destroyed, and some communities were cut off completely. Schools, businesses, and even the Rocky Mountain National Park closed as conditions were too dangerous. Photos indicate that the landscape has been reshaped and the incredible amount of damage that the flooding caused will take months to years to repair.

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ACIS
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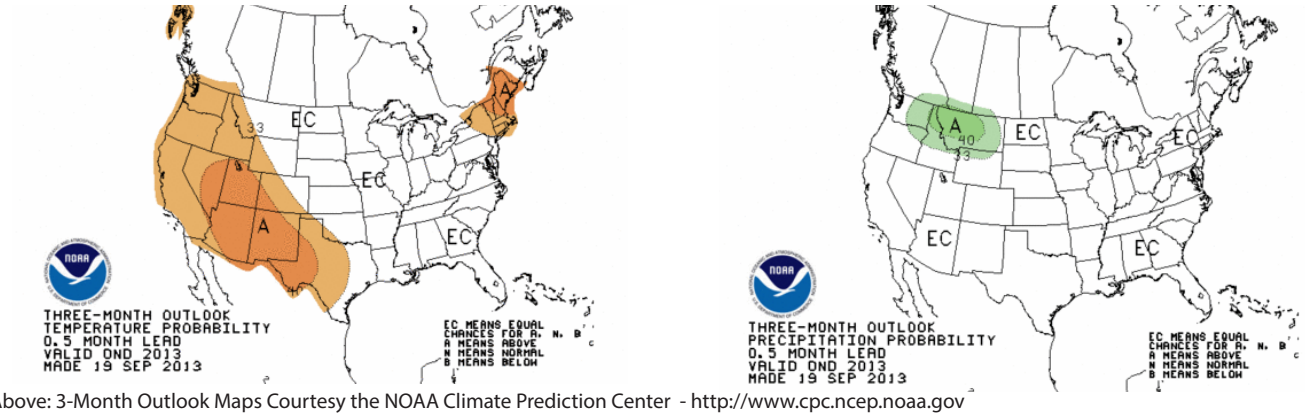
Climate Outlook

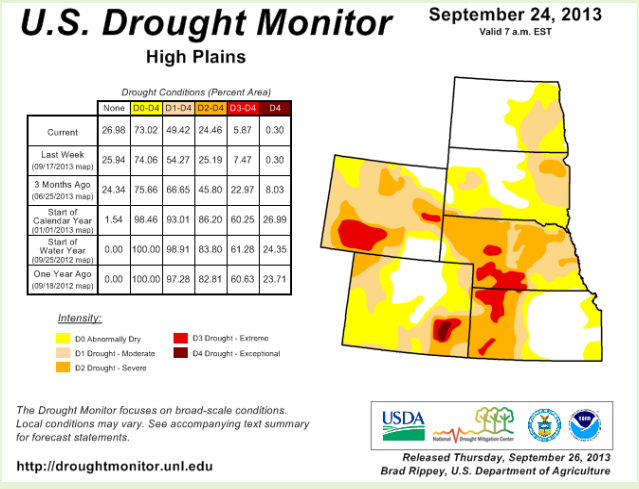
ENSO-neutral conditions were still present at the end of September and are likely to continue into the winter. For the next three months, the temperature outlook indicates a higher probability of above normal temperatures for roughly the southwestern halves of Colorado and Wyoming. Equal chances of above, near, or below normal temperatures exist for the rest of the Region. Meanwhile, the precipitation outlook indicates a higher probability of above normal precipitation in only one area of the nation including northern Wyoming, most of Montana, northern Idaho, northeastern Oregon, and eastern Washington. Equal chances of above, near, or below normal precipitation exist for the rest of the Region. The seasonal outlooks combine the effects of long-term trends, soil moisture, and when applicable, the El Niño Southern Oscillation cycle (ENSO).

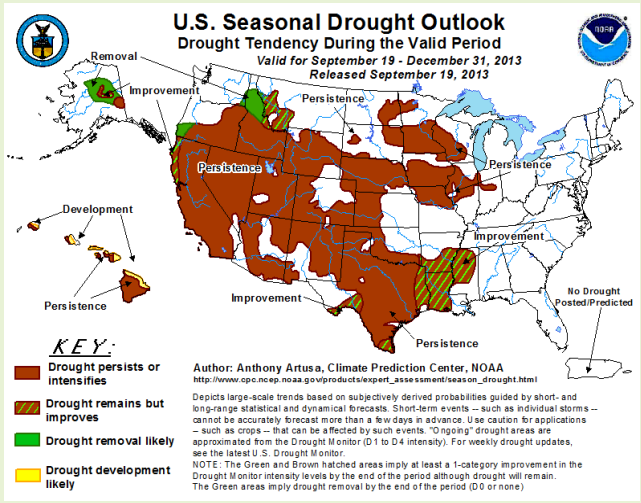


Above: 3-Month Outlook Maps Courtesy the NOAA Climate Prediction Center - http://www.cpc.ncep.noaa.gov
(left) The Three-Month Temperature Probability Outlook, (right) The Three-Month Precipitation Probability Outlook

Drought Watch

Many changes were in store for the U.S. Drought Monitor over the past month. At the end of August, approximately 64 percent of the Region was in moderate (D1) to exceptional (D4) drought, but by the end of the month this was down to just under 50 percent. Colorado had the largest improvements and experienced a decline in drought coverage from about 94 percent to just under 65 percent. Unfortunately, much of the rain that fell caused towns, roads, bridges, and farmland to become inundated in one of the worst floods in at least 35 years. All D4 conditions were eliminated in Nebraska and Kansas and only a small portion remained in eastern Colorado. Moderate to heavy rain also fell in southern Wyoming, western Nebraska, and western Kansas, improving drought conditions there as well. One of the only areas in the Region that showed declines was northeastern South Dakota where recent heat and dryness led to a one category degradation to severe drought (D2) there. According to the U.S. Seasonal Drought Outlook released September 19th, current drought conditions should persist everywhere in the High Plains Region through December 2013. No improvements were expected.





The U.S. Drought Monitor is produced as a joint effort of the U.S. Department of Agriculture (USDA), National Drought Mitigation Center, U.S. Department of Commerce and the National Oceanic and Atmospheric Administration (NOAA). Real-time data provided through ACIS from the Regional Climate Centers are often used by the agencies involved in the U.S. Drought Monitor when determining the area and intensity of drought conditions, although the product itself is not produced by HPRCC. For current Drought Monitor information, please see: http://droughtmonitor.unl.edu/

Portions of this Drought Watch are courtesy the Drought Monitor Text Discussion found on the Drought Monitor webpage.

State Summaries

Colorado	Temperatures (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	% Norm
Akron Washington County Airport	79.2	53.6	66.4	3.4	99	09/06+	37	09/28	4.29	3.13	370
Alamosa San Luis Airport	73.5	42.1	57.8	2.8	87	09/04	21	09/28	2.98	2.07	327
Colorado Springs Municipal Airport	77.8	53.1	65.4	4.5	91	09/05	33	09/28	4.80	3.61	403
Grand Junction Walker Field Airport	78.2	55.5	66.9	0.8	95	09/04	34	09/28	3.09	1.90	260
Pueblo Memorial Airport	84.2	54.9	69.5	4.8	97	09/05+	36	09/28	1.27	0.50	165

Kansas	Temperatures (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	% Norm
Concordia Municipal Airport	85.1	59.5	72.3	4.3	102	09/08+	47	09/25+	1.13	-1.78	39
Dodge City Regional Airport	85.9	58.8	72.4	3.2	101	09/07	44	09/29	1.12	-0.55	67
Goodland Renner Field	82.9	55.7	69.3	4.7	100	09/07+	40	09/28	6.49	5.27	532
Topeka Municipal Airport	85.7	59.9	72.8	4.5	104	09/08	43	09/29	3.27	-0.39	89
Wichita Mid-Continent Airport	87.8	62.3	75.1	4.1	101	09/08+	46	09/29	2.03	-1.11	65

Nebraska	Temperatures (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	% Norm
Chadron Municipal Airport	81.9	51.6	66.8	5.8	100	09/03	32	09/20	2.69	0.96	155
Grand Island Airport	82.5	58.0	70.2	5.1	99	09/09	46	09/25	2.38	0.15	107
Lincoln Municipal Airport	83.6	57.6	70.6	4.6	100	09/09	42	09/21	1.99	-1.03	66
Norfolk Karl Stefan Airfield	82.1	56.9	69.5	5.7	97	09/09	37	09/21	0.85	-1.84	32
North Platte Regional Airport	81.7	53.9	67.8	5.5	103	09/06	38	09/20	5.08	3.67	360
Omaha Eppley Airport	82.2	59.8	71.0	5.3	99	09/09	44	09/21	2.72	0.04	101
Valentine Miller Field	82.7	54.1	68.4	6.1	105	09/06	38	09/20	1.55	-0.09	95

North Dakota	Temperatures (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	% Norm
Bismark Municipal Airport	76.5	51.2	63.8	5.3	94	09/06	37	09/21	4.36	2.77	274
Fargo International Airport	75.5	53.2	64.4	5.3	92	09/06	40	09/21	4.39	1.82	171
Grand Forks International Airport	73.5	49.7	61.6	4.7	92	09/06	36	09/21+	1.97	-0.08	96
Theodore Roosevelt Airport	76.7	49.3	63.0	5.8	96	09/06	36	09/20	3.32	1.85	226
Williston International Airport	76.2	49.1	62.7	6.0	95	09/03	35	09/20	1.90	0.84	179

All Data are Preliminary and Subject to Change. + indicates multiple dates, latest date listed.
Source: National Weather Service Cooperative Observation Network Data
Data are retrieved through the Applied Climate Information System (ACIS).
These data are available for the entire period of record through the CLIMOD system. For more information please see http://hprcc.unl.edu/services.

September 2013 Climate Summary

South Dakota	Temperatures (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	% Norm
Aberdeen Regional Airport	77.4	50.4	63.9	5.0	91	09/18	33	09/21	2.44	0.25	111
Huron Regional Airport	81.5	55.2	68.4	6.7	95	09/06	34	09/21	1.36	-1.10	55
Pierre Regional Airport	82.2	54.7	68.4	5.5	101	09/06	38	09/21	1.16	-0.71	62
Rapid City Regional Airport	80.9	50.7	65.8	5.0	97	09/07	34	09/28+	1.18	-0.11	91
Sioux Falls Joe Foss Field Airport	78.6	55.3	66.9	5.6	91	09/09	35	09/21	0.77	-2.0	28

Wyoming	Temperatures (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	% Norm
Casper Natrona County International AP	76.4	47.2	61.8	3.9	95	09/04	27	09/20	1.47	0.39	136
Cheyenne Municipal Airport	73.0	50.0	61.5	3.3	92	09/03	33	09/28	6.95	5.47	470
Lander Hunt Field Airport	72.3	48.6	60.5	1.9	95	09/05	28	09/28	3.78	2.73	360
Laramie Regional Airport	69.6	44.6	57.1	3.8	87	09/02	28	09/20	3.05	1.94	275
Rawlins Municipal Airport	72.0	46.7	59.4	4.0	89	09/05+	29	09/20	2.47	1.50	255
Sheridan County Airport	77.5	47.1	62.3	4.4	97	09/05	32	09/28+	4.26	2.83	298

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Source: National Weather Service Cooperative Observation Network Data
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September 2013 Top 10 Rankings - Highlights

Monthly Rankings

Precipitation in inches / Temperature in degrees F

Wettest			
Location	**Precipitation / Rank**	**Record or Previous Record / Year**	**Period of Record**
Alamosa, CO	2.98 / WETTEST	2.62 / 1938	1906-2013
Colorado Springs, CO	4.80 / 3rd wettest	5.91 / 2011	1894-2013
Denver, CO	5.61 / WETTEST	4.67 / 1961	1872-2013
Grand Junction, CO	3.09 / 3rd wettest	3.78 / 1896	1893-2013
Goodland, KS	6.49 / WETTEST	5.39 / 1973	1895-2013
North Platte, NE	5.08 / 7th wettest	7.54 / 1942	1874-2013
Bismarck, ND	4.36 / 5th wettest	6.93 / 1977	1874-2013
Cheyenne, WY	6.95 / WETTEST	4.52 / 1973	1871-2013
Lander, WY	3.78 / 7th wettest	5.64 / 1923	1891-2013
Sheridan, WY	4.26 / 2nd wettest	8.18 / 1923	1907-2013
Warmest			
Location	**Temperature / Rank**	**Record or Previous Record / Year**	**Period of Record**
Colorado Springs, CO	65.4 / 3rd warmest	67.0 / 2010	1894-2013
Scottsbluff, NE	67.0 / 3rd warmest	68.1 / 1998	1893-2013
Valentine, NE	68.4 / 4th warmest	69.9 / 1897	1889-2013
Fargo, ND	64.4 / 5th warmest	65.6 / 1897	1881-2013
Huron, SD	68.4 / 3rd warmest	69.5 / 1897	1881-2013
Rapid City, SD	65.8 / 8th warmest	67.1 / 1952	1942-2013
Cheyenne, WY	61.5 / 10th warmest	63.9 / 1998	1872-2013

All Data are Preliminary and Subject to Change.
* indicates multiple records, latest year is listed, T stands for Trace amount of precipitation.
Source: National Weather Service Cooperative Observation Network Data

State Spotlight - Kansas

Mary Knapp - Service Climatologist
Kansas State Climate Office, Kansas State University

Strong contrasts continue

September continued with sharp differences across the month. Temperatures began much warmer than average across the state. During the first ten days of the month, many locations recorded readings over 100F. For some locations, these were the warmest readings of the year. The highest temperature recorded was 107F at three locations: Alton 2SSW (Osborne County), Norton Dam (Norton County), and Webster Dam (Mitchell County). All these were recorded on the 8th of the month. Not surprisingly, the month averaged warmer than normal. It was the 13th warmest September in the 119 years from 1895 to present. All divisions had high temperatures at 100F or warmer. The Northwest divisional average showed the greatest departure. The divisional average was 70.3F, which was 5 degrees above average. The Southeast division came closest to average. The divisional average was 72.4F which was 2.8 degrees cooler than normal. On the minimum temperature side, the coolest reading was 34F set at Brewster 4W (Thomas County) on the 11th.

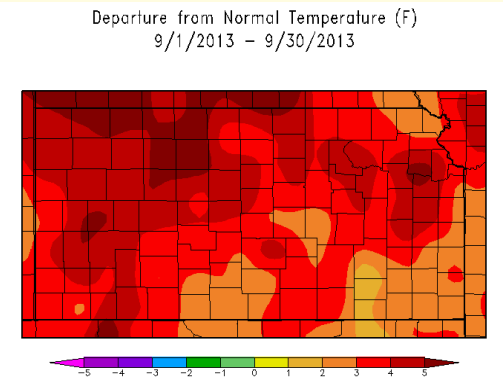

Figure 1. September 2013 departure from average temperatures across Kansas (High Plains Regional Climate Center)

Statewide, the average precipitation was 2.63 inches, which 109% of normal. The West Central division ranked the highest at 222% of normal. The average for the division was 3.56 inches. All the western divisions saw totals above average. This contributed to the elimination of exceptional drought conditions in the state. However, much of the west remains in extreme to moderate drought. In order to continue improvement in the drought conditions, continued above normal moisture will be necessary. Meanwhile, the East Central and Southeastern division had much below normal precipitation for the month. The Southeastern division averaged 2.42 inches, which was just 60% of normal. Several extremely heavy rain events occurred. For the Community Collaborative Rain Hail and Snow Network (CoCoRaHS), the greatest monthly total was 7.08 inches at Goodland 0.5 ENE. The greatest daily total for the network was 8.32 inches at Goodland 17.3 on the 19th. This isn't reflected in the monthly records, as the station reports were not complete. Of the National Weather Service (NWS) stations, the greatest total was 9.89 inches at Rossville, Shawnee County. The highest 24 hour precipitation total from a NWS site was 6.30 inches also at Rossville, on the 19th. Despite these heavy amounts, September ended as the 61st wettest or 59th driest of 119 years – right in the middle of the range.

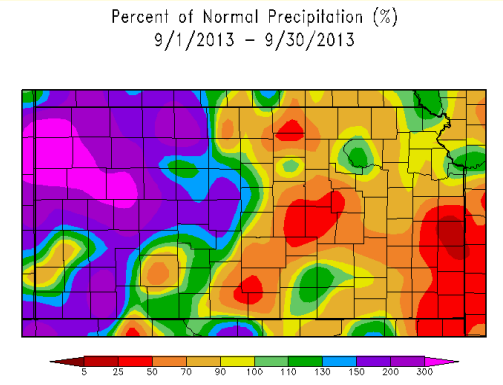

Figure 2. September 2013 percent of normal precipitation across Kansas (High Plains Regional Climate Center)

The continued moisture in to September allowed for normal conditions to remain on the Drought Monitor, with some improvements in the western divisions. These have been limited, as rainfall for the year continues to be well below average. Warmer than average temperatures have somewhat limited the benefits of the above average rainfall, and severe to exceptional drought conditions remain throughout the western region. The Seasonal Drought Outlook suggests continued improvement on the eastern edges of the drought region and continuing drought in the western third of the state. Given the fact that we are moving into the drier part of the year, even normal precipitation will have minimal impact on the long term deficits in the region. The El Niño/Southern Oscillation (ENSO) is expected to remain neutral. For October, the temperature outlook is neutral. That means conditions are equally likely to be above or below normal. The precipitation outlook calls for a greater chance of drier than normal conditions in October. The mid-term outlook of 8-14 days calls for average temperatures through the 17th of October. Precipitation outlook calls for greater chance of above normal across the State.

Severe weather was limited this month. No tornadoes were reported in September. However, there were 3 hail reports and 16 wind damage reports. With the heavier rain events there was some localized flooding.

For more information about the Kansas State Climate Office: http://www.ksre.ksu.edu/wdl/

The KSU's AWDN is a part of the High Plains Automated Weather Data Network (AWDN). Data are available through KSU or HPRCC.

State Spotlight - North Dakota

F. Adnan Akyüz - State Climatologist, Barb Mullins - Assistant to the State Climatologist
North Dakota State Climate Office, North Dakota State University

Precipitation:

The North Dakota Agricultural Weather Network recorded precipitation totals of below normal in the northeastern part of the state and above normal most elsewhere with the highest amounts to the west and southwest (Figure 1). The first six days of September were dry with much of the remainder of the month having scattered showers. Widespread rains fell from the 7th through the 9th. Rain totals of 1 to 2 inches fell in the southeast on the 14th. Roughly a half inch fell in the west on the 23rd. Rainfall with totals around a half to an inch fell in the east on the 28th which helped alleviate drought conditions in the area. However, the late September rains hampered small grain harvest.

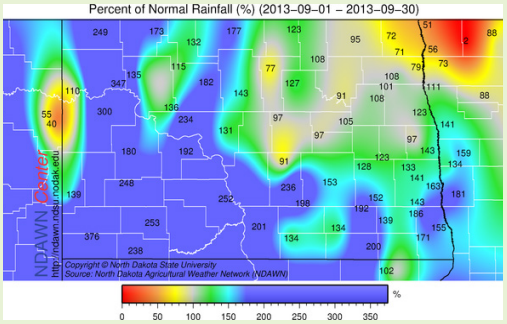

Figure 1. Percent of Normal Precipitation in September 2013 for North Dakota (North Dakota State Climate Office)

Temperature:

NDAWN September average air temperatures ranged from ~59 °F in the north to ~65 °F in the south. Departure from normal average air temperatures were 2 °F to 7 °F above normal across the state (Figure 2). For many places the September average air temperatures ranked in the top 10 warmest. Grand Forks area average temperature ranked 9th warmest, Fargo area was 5th, Bismarck area was 6th, and Williston area was 8th warmest (http://rcc-acis.unl.edu/). The unusually warm September temperatures balanced the impact of a late spring planting for most crops by adding the necessary growing degree days for maturity.

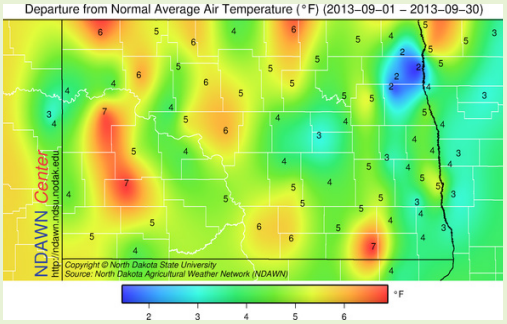

Figure 2. Temperature Departure from Normal in September 2013 for North Dakota (North Dakota State Climate Office)

For more information about the North Dakota State Climate Office: http://www.ndsu.edu/ndsco
For more information on the North Dakota Agricultural Network: http://www.ndawn.ndsu.nodak.edu
The North Dakota Agricultural Network is a part of the Automated Weather Data Network (AWDN).

About the High Plains Regional Climate Center

The High Plains Regional Climate Center (HPRCC) operates out of the University of Nebraska - Lincoln (UNL) in Lincoln, Nebraska. As one of 6 regional climate centers throughout the nation, HPRCC works closely with other organizations such as the National Climatic Data Center (NCDC), Local and Regional National Weather Service (NWS) Offices, and other climate services organizations such as the National Drought Mitigation Center (also located at UNL) to provide climate data services and specialized climate products.

For More Information Online

High Plains Regional Climate Center: http://hprcc.unl.edu

High Plains Regional Climate Services: http://hprcc.unl.edu/services

CLIMOD: http://climod.unl.edu

Regional Climate Centers and ACIS: http://www.rcc-acis.org

National Weather Service: http://www.weather.gov

National Climatic Data Center: http://ncdc.noaa.gov

University of Nebraska - Lincoln: http://www.unl.edu

National Drought Mitigation Center: http://drought.unl.edu

Climate Prediction Center: http://www.cpc.noaa.gov

NOAA Storm Prediction Center: http://www.spc.noaa.gov

Photo of the Nebraska Sandhills by Bill Sorensen - Senior Programmer - HPRCC

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