Monsoon 2023 – Weather & Climate Summary

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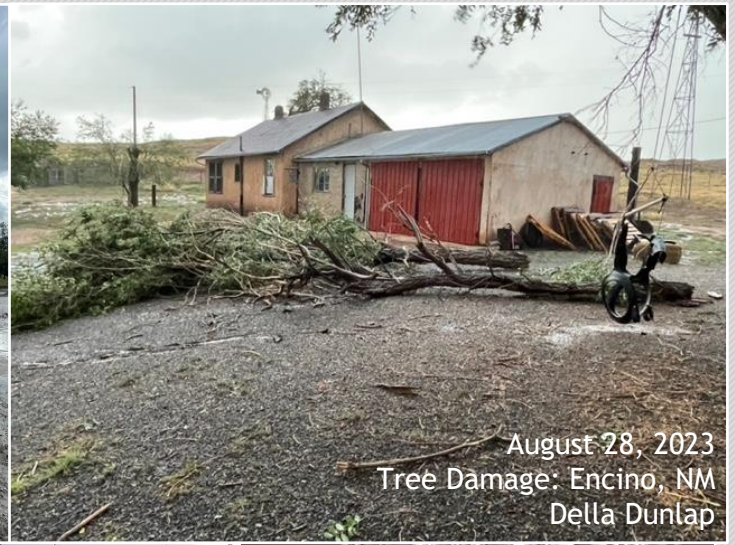
June 17, 2023
Hail: Des Moines, NM
Zach Osborn

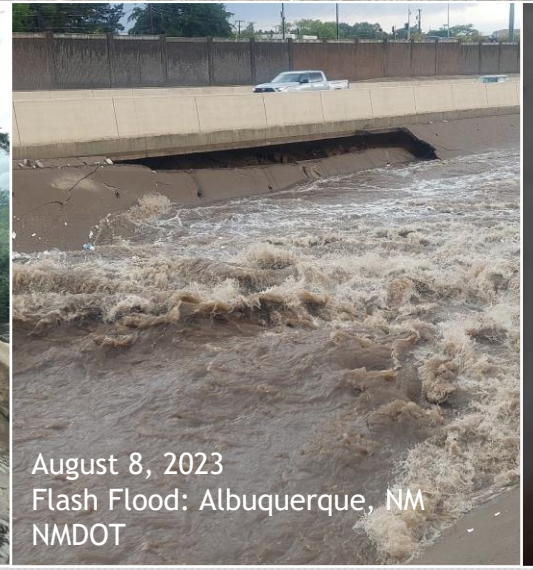

August 2, 2023
Tree Damage: Farmington, NM
Debra Mayeux


September 16, 2023
Flash Flood: Ruidoso, NM
Eric Queller


August 28, 2023
Tree Damage: Encino, NM
Della Dunlap


June 25, 2023
Tree Damage: Albuquerque, NM
Jacob Hollenbeck


August 15, 2023
Flash Flood: Ruidoso Canyon, NM
Eric Queller


August 8, 2023
Flash Flood: Albuquerque, NM
NMDOT


July 21, 2023
Flash Flood: San Ignacio, NM
Angelica Velasquez

[2023 ArcGIS Monsoon Season Story Map]

Climate Sites: June 15 – September 30, 2023

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The following 2023 monsoon summary provides a general review of the summer weather pattern, local and statewide temperature and precipitation records, severe weather, drought changes, and wildfires across the region. Data in this summary are considered preliminary until officially certified by the National Centers for Environmental Information (NCEI).

Albuquerque		Clayton		Roswell	
79.4°	1.92”	74.3°	5.52”	85.3°	2.41”
Warmest	10th Driest	6th Warmest	35th Driest	Warmest	9th Driest

The Albuquerque National Weather Service has three official climate sites; Albuquerque, Clayton, and Roswell. All three sites experienced well above normal temperatures and below normal precipitation. The Albuquerque International Sunport and the Roswell Industrial Air Center both recorded their hottest monsoon seasons on record!

We would like to thank all of our official cooperative observers, severe storm spotters, citizen weather observers, local and regional airport support staff, including NWS electronics technicians, and our local, county, state, and federal emergency management partners for providing weather support services throughout the summer of 2023.

Monsoon Conceptual Model

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Monsoon season officially starts June 15th and ends September 30th each year. The dry, westerly flow from the spring begins to relax and subtropical moisture begins making its way north into the desert southwest. The first several weeks are typically very hot as we await the arrival of deeper moisture from the south. On occasion, moisture surges from the Gulf of Mexico can interact with a more active jet stream early in the season to produce severe weather over eastern NM. As we progress into July the coverage of slow-moving showers and thunderstorms typically increases over the region. These storms often begin as the drier variety with gusty winds and blowing dust before transitioning to the wetter variety with locally heavy rainfall. As soil moisture increases across the region through July and August the potential for flash flooding also increases. In the ideal scenario, a feedback loop begins to take hold and higher soil moisture works with deeper atmospheric moisture to produce daily rounds of slow-moving showers and thunderstorms for several weeks. Remnant tropical waves moving into the region can result in monsoon burst patterns that produce widespread significant rainfall and flash flooding through September. Later in the season, periods of dry westerly flow begin to impact the region with an overall decrease in showers and thunderstorms. These dry air intrusions and even some cold fronts signal the forthcoming end to monsoon season and the arrival of fall. Of course, not every monsoon season is the same due to the effects of atmospheric variability from year to year. The impacts of climate change have complicated seasonal predictability, modified seasonal timing, varied precipitation intensity, and increased seasonal extremes*. The 2022 monsoon season was one of the wettest observed for NM since records began in the late 1800s followed by one of the hottest and driest monsoons observed in 2023.

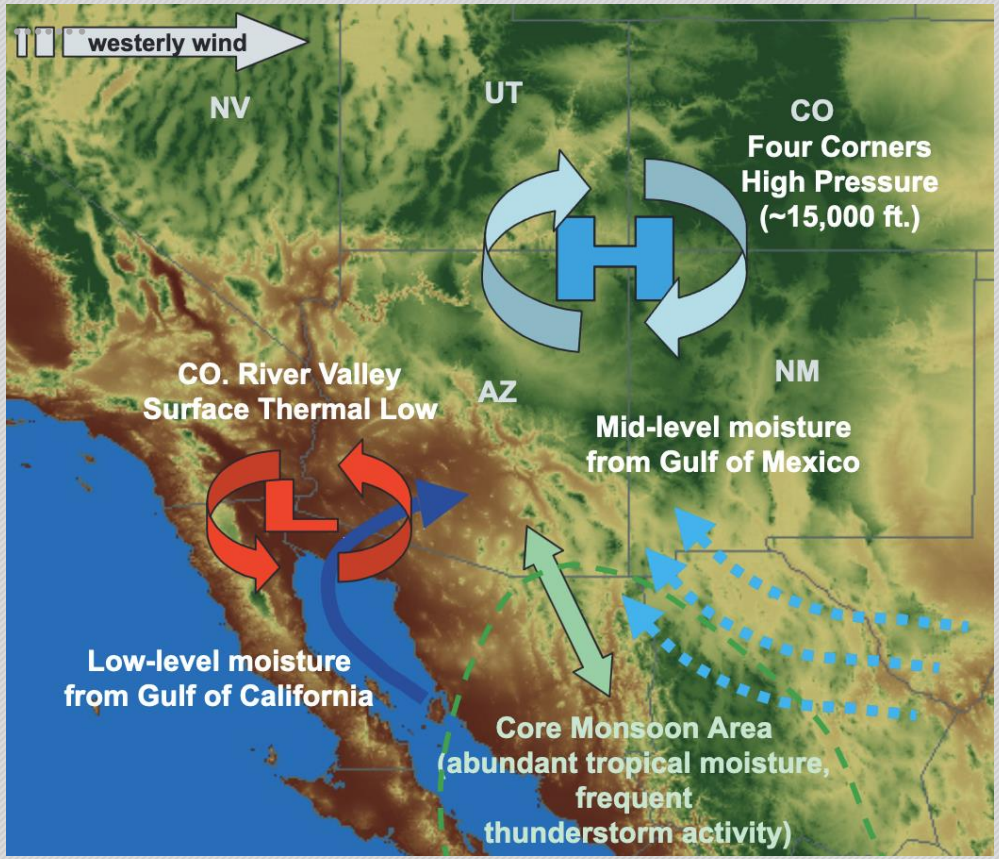

Image courtesy of University of AZ Cooperative Extension

*an abundance of research is available on the resources slide

ENSO Analysis – June to September 2023

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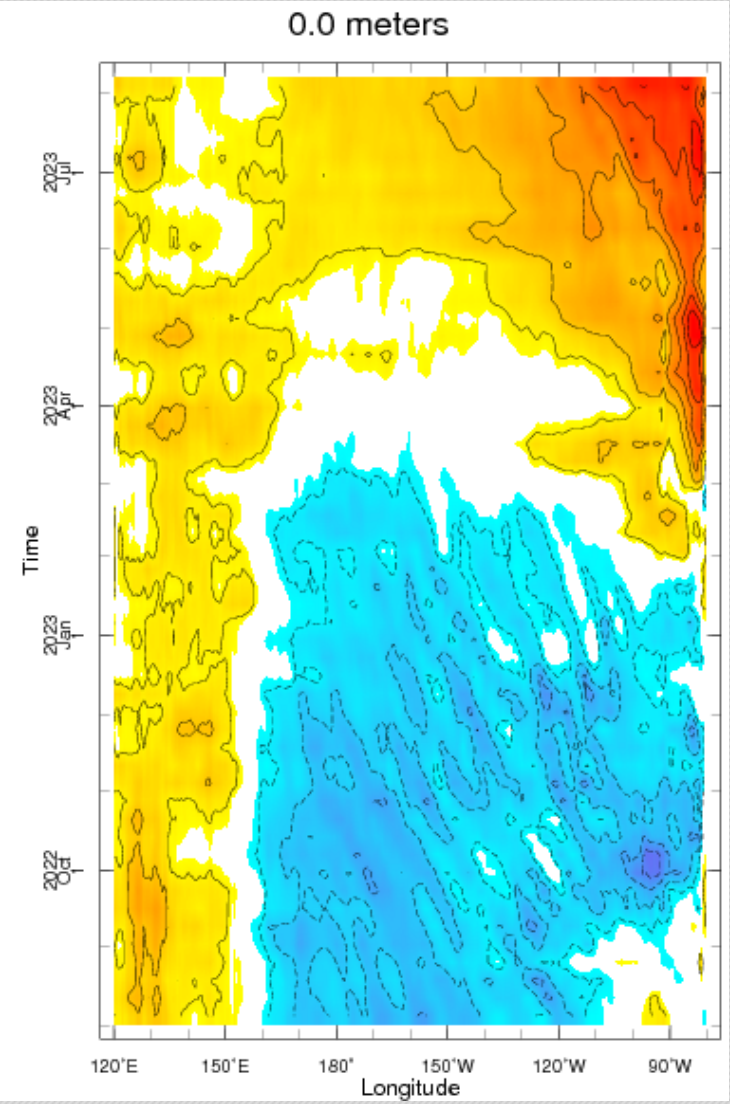
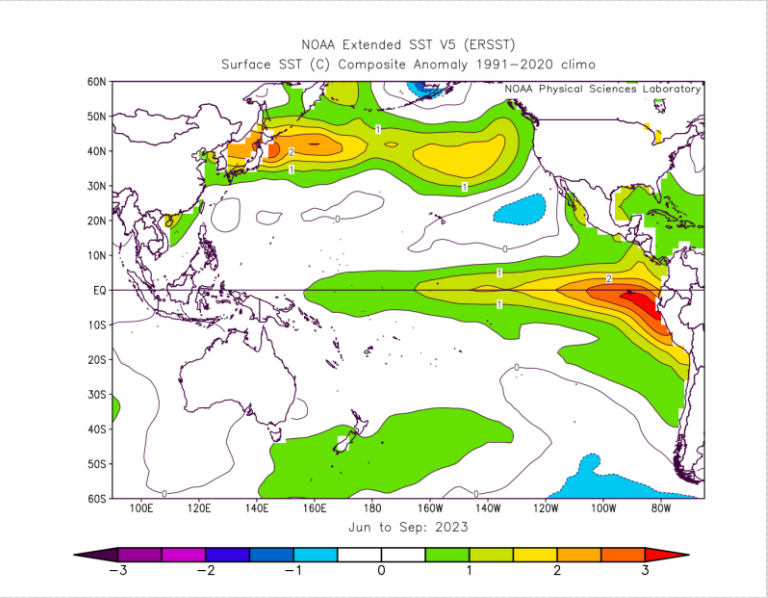


The past 12 months have seen a significant transition in the phase of ENSO (El Niño-Southern Oscillation) across the equatorial Pacific. This analysis is not intended to draw specific conclusions about how changes in ENSO through the summer of 2023 impacted the southwest monsoon. Rather, a summary of the ENSO evolution is provided with general conclusions about how this coupling of the ocean-atmosphere system may have led to changes in the idealized seasonal monsoon pattern over NM.

A persistent La Niña that dominated the equatorial Pacific for 3 years finally gave way to El Niño conditions by early summer 2023. The Hovmöller diagram on the left describes how sea surface temperature (SST) anomalies evolved through the past year (y-axis) along the equatorial Pacific (x-axis). The warm colors after April 2023 clearly indicate the presence of El Niño emerging in the eastern Pacific with above normal SSTs.

The image on the right shows the composite SST anomaly (1991-2020) for June to September 2023. The typical warm tongue of above normal SSTs is present from the west coast of South America westward into the central equatorial Pacific.



ENSO Analysis – June to September 2023

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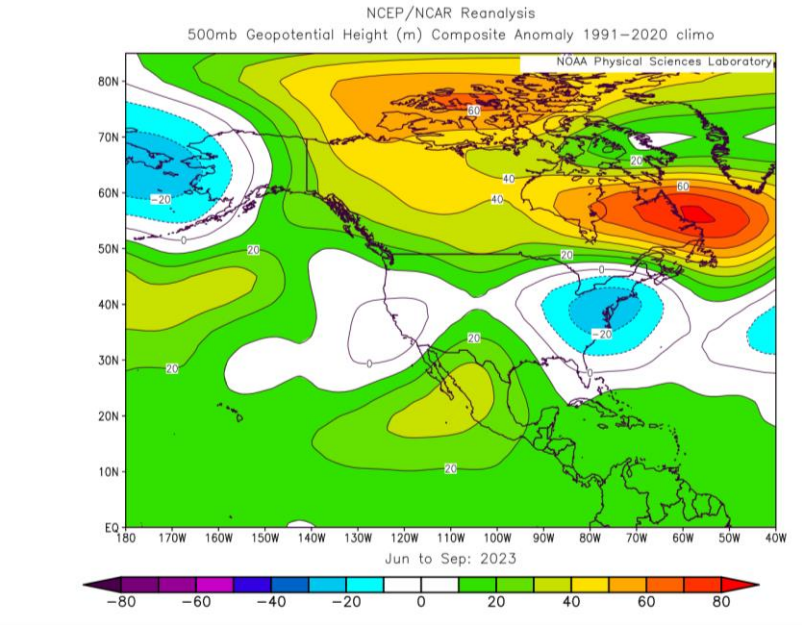
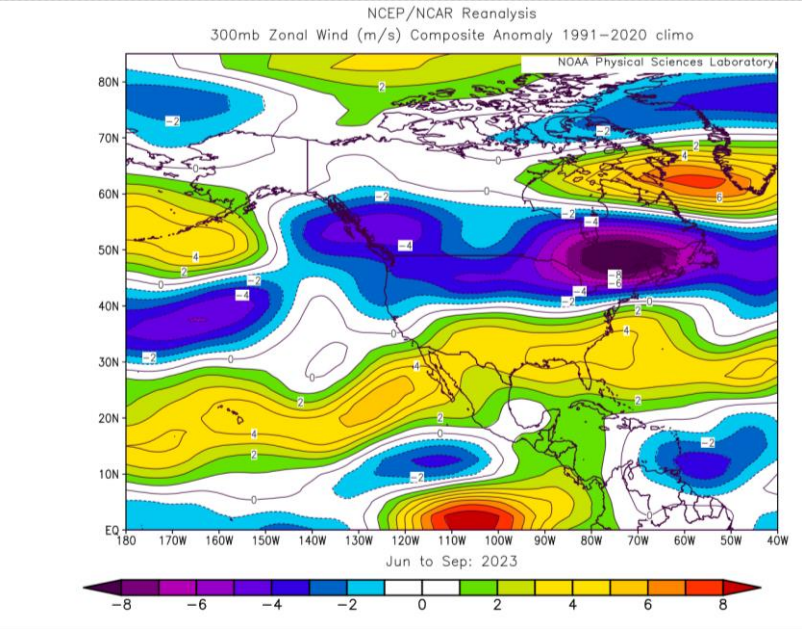


The image on the upper left is the 500mb geopotential height composite anomaly for June to September 2023 over North America. The 500mb geopotential height field is used by forecasters to describe the steering flow of weather systems around areas of high pressure (ridges) and low pressure (troughs) in the middle atmosphere. The warm colors on the image show where heights are higher than normal compared to the 30-year climatology (1991-2020) and cool colors are below normal. Regions that are located in the vicinity of higher 500mb heights during the summer months are associated with stronger high pressure, more sinking air, hotter temperatures, and less precipitation. The location of the 500mb height center is an important component to the idealized monsoon model. However, if the high is too strong the coverage of showers and thunderstorms will be limited and very hot temperatures will persist most days.



The image on the lower left is the 300-mb zonal wind composite anomaly for June to September 2023 over North America. The 300-mb zonal wind represents the westerly component of the jet stream. Monsoon season is associated with relaxed westerly flow across the southwest U.S. while the jet stream is situated well to the north. The warm colors on the image stretch across much of the southern U.S. indicating areas where westerly flow was stronger than normal over the 4-month period. For the summer of 2023, not only was the area of high pressure over the region stronger than normal on more occasions, there were more frequent westerly wind intrusions that disrupted regular influxes of moisture into the southwest U.S.

Analysis – Precipitable Water at Albuquerque

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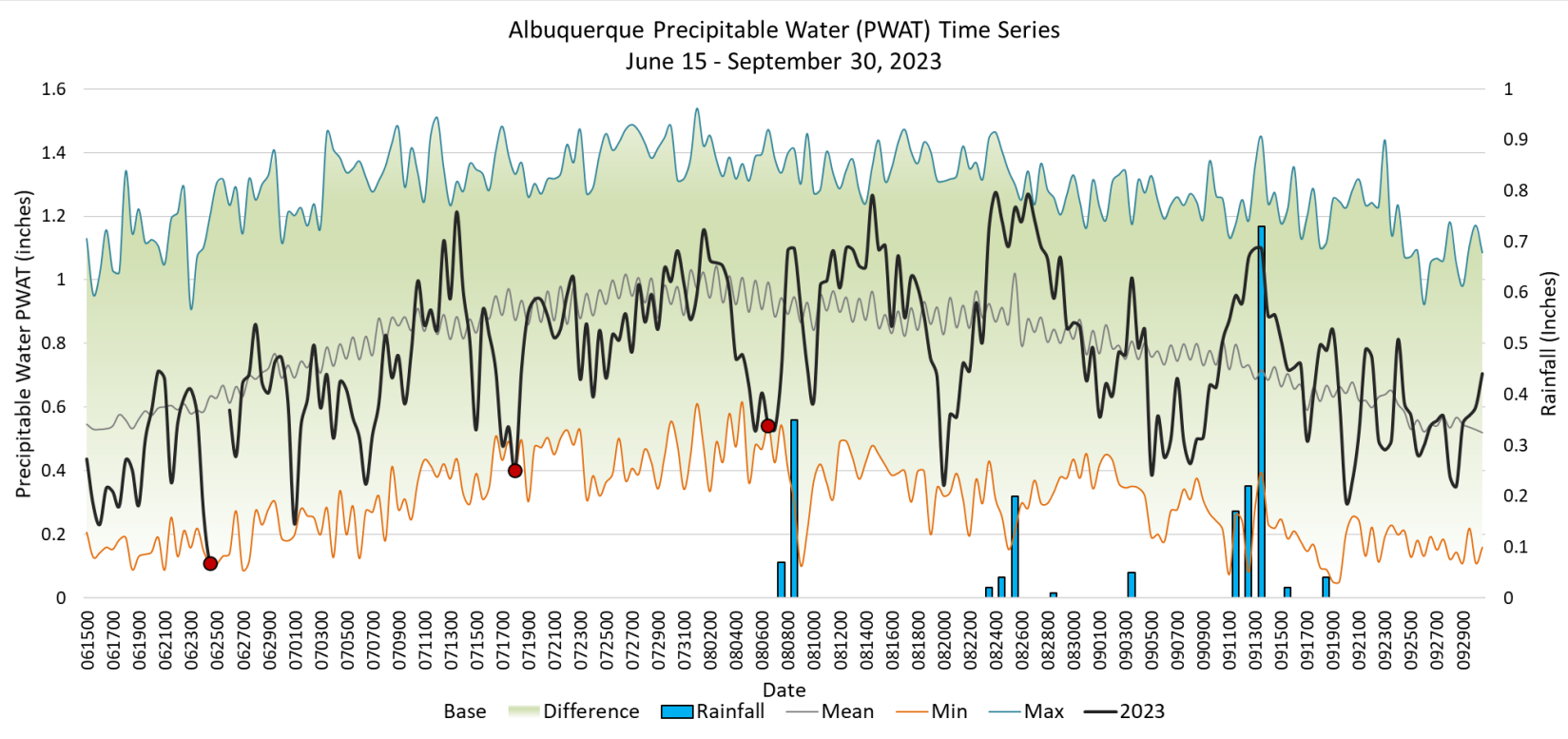

The precipitable water time series, or PWAT, shown by the black line above was created using data from the Albuquerque weather balloon for the period June 15 to September 30, 2023. PWAT can be used to describe the moisture content of an airmass that may become available to produce rainfall. Higher PWAT values have the potential to produce greater rainfall given sufficient lift and instability in the atmosphere. The green shaded area on the chart is bounded by the historical maximum (blue line) and historical minimum (orange line) PWAT from our weather balloon. The mean PWAT of all weather balloons released each day is shown by the thin gray line near the center of the green shaded area. The variability in the black line represents the various monsoon moisture surges and dry intrusions. There were three weather balloons that measured new record low PWAT values for the Albuquerque area this summer (red circles). The blue bars on the chart represent daily rainfall reported at the Albuquerque Sunport. Note the absence of rainfall during the first half of the 2023 monsoon season. In fact, the Albuquerque Sunport saw 77 days with no measurable rainfall ending August 6, 2023. This was the 13th longest stretch without rainfall for the Albuquerque area dating back to 1891. Most days when rain fell the PWAT was above the mean.

Analysis – June 2023

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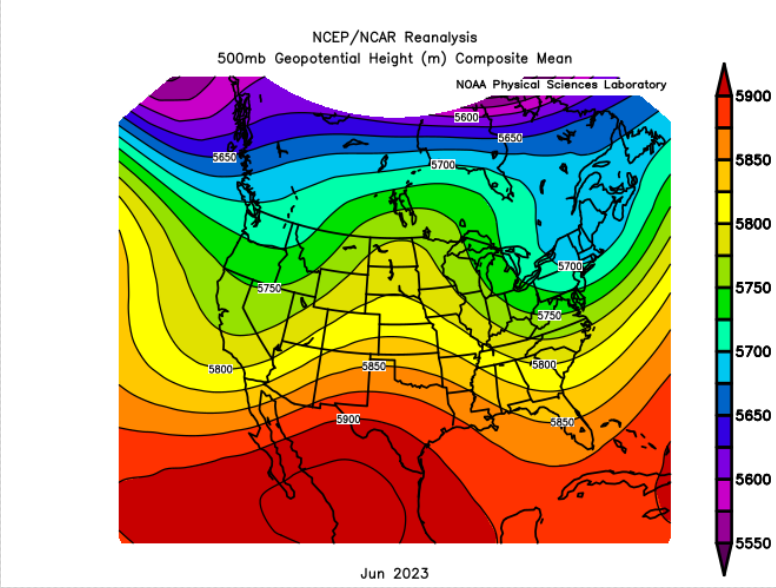
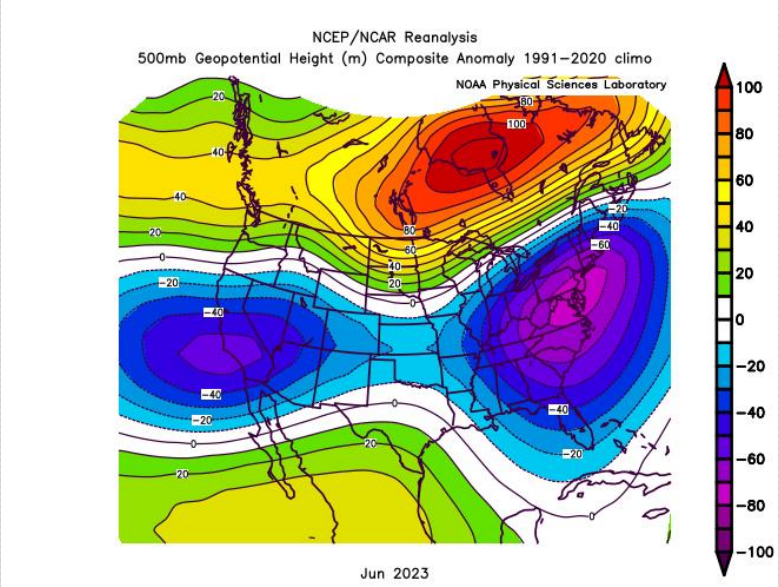
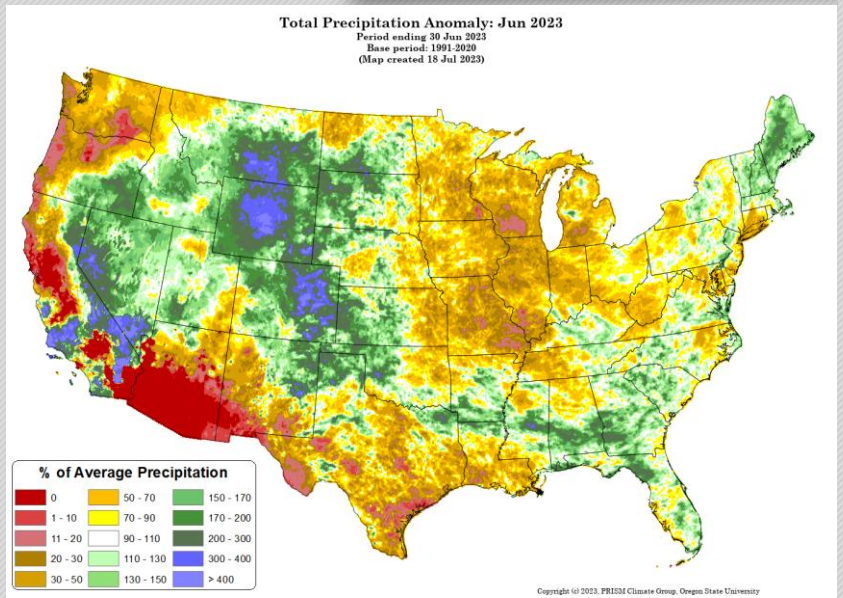
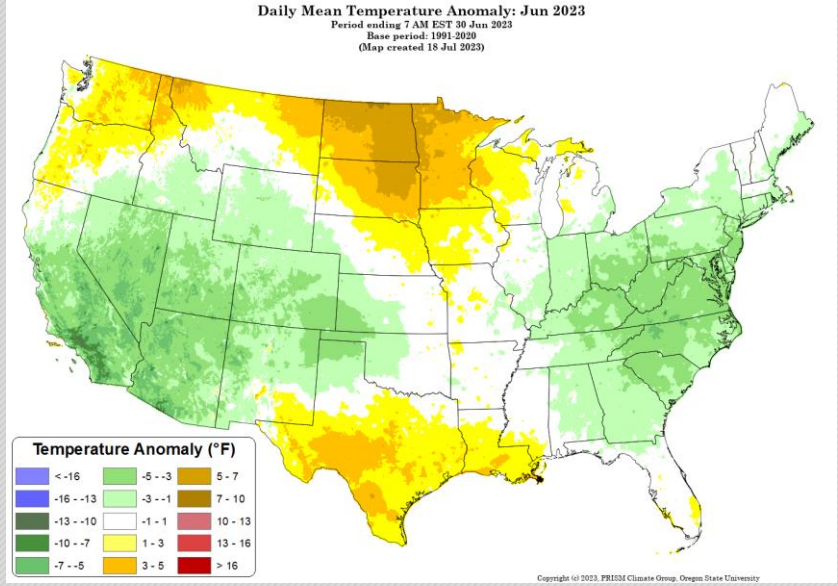




The image in the upper left is the 500mb geopotential height composite mean for the month of June and the lower left image is the composite anomaly. A large trough dominated the first half of June along the west coast. This trough was deeper than normal for June as noted by the below normal height anomaly (cool colors). The second half of June featured a strong high over Mexico building north toward NM. As such, the first half of June was relatively cool and wet for parts of NM before the official start to monsoon season on June 15th. The second half of June was much hotter and drier for most of the region except eastern NM. The upper right image highlights the above normal rainfall across northeast NM (cool colors). The lower right image shows below normal temperatures for much of the state which were mainly balanced around the first half of the month.





Analysis – June 2023

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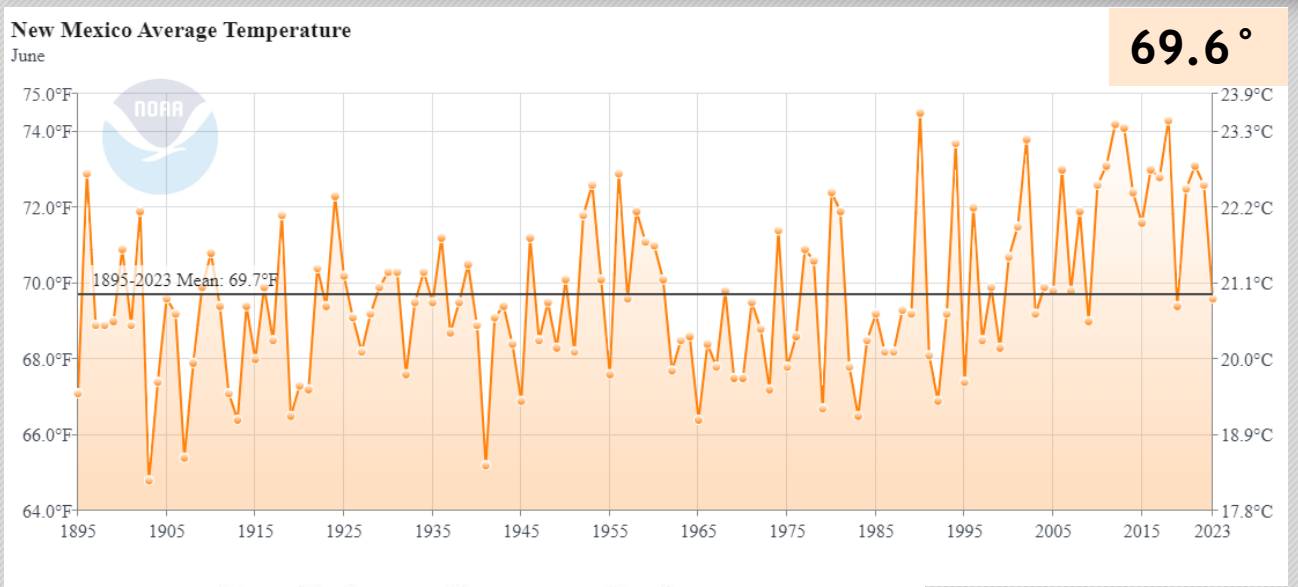
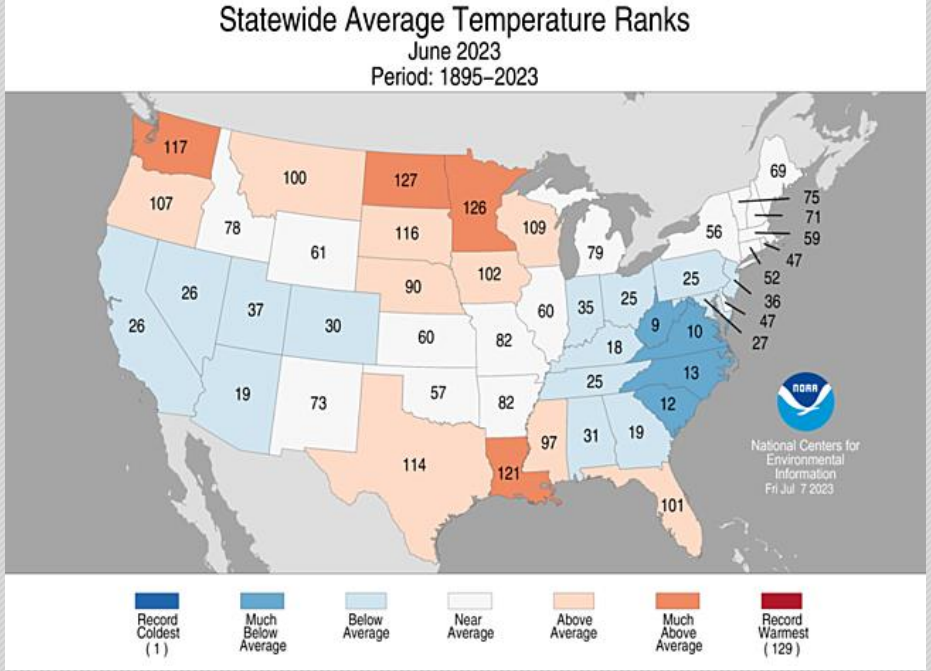
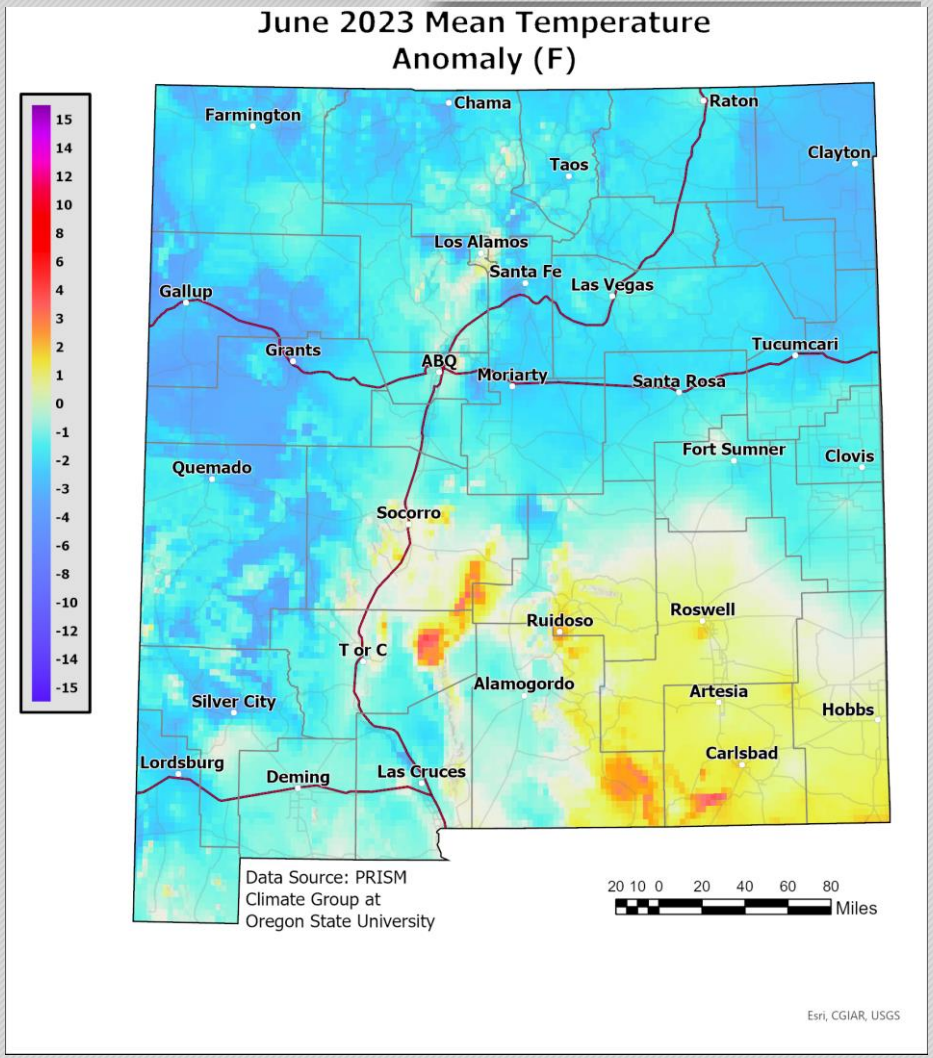




The upper left chart shows the trend in June average temperature for NM. June 2023 turned out to be right around normal given the cool start and warm finish. The lower left image from NCEI highlights NM right in the middle of the categorical range with average temperatures. The image on the right is a detailed gridded analysis of the mean temperature anomaly for June. Much of the state was below normal but also balanced out by the southeast where it was above normal.



Analysis – June 2023

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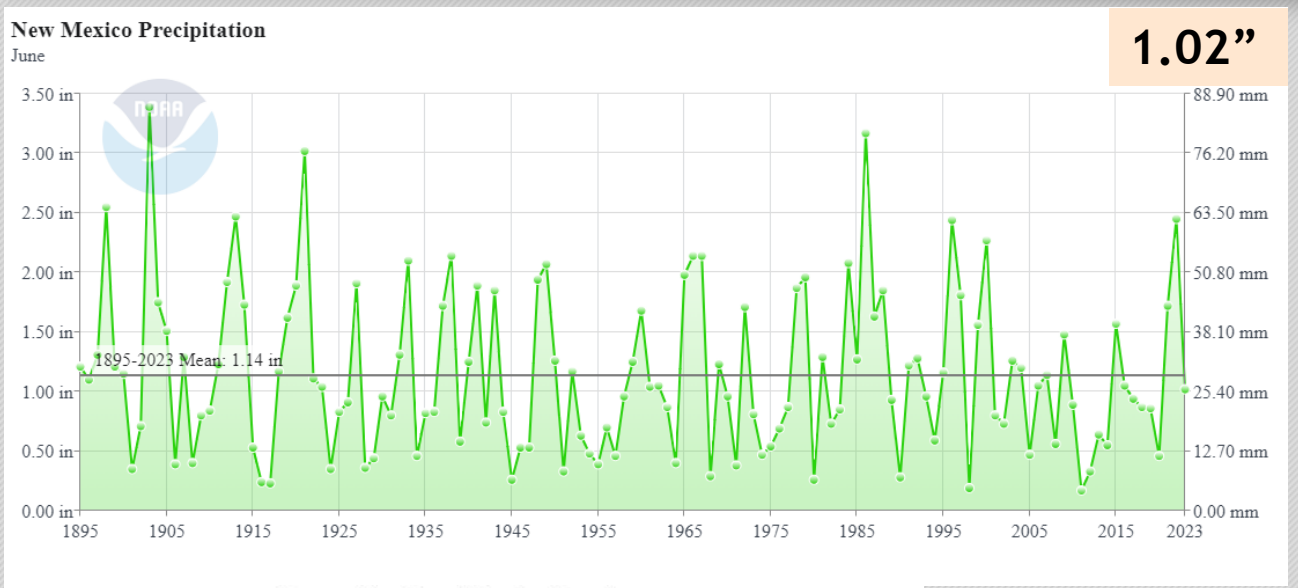
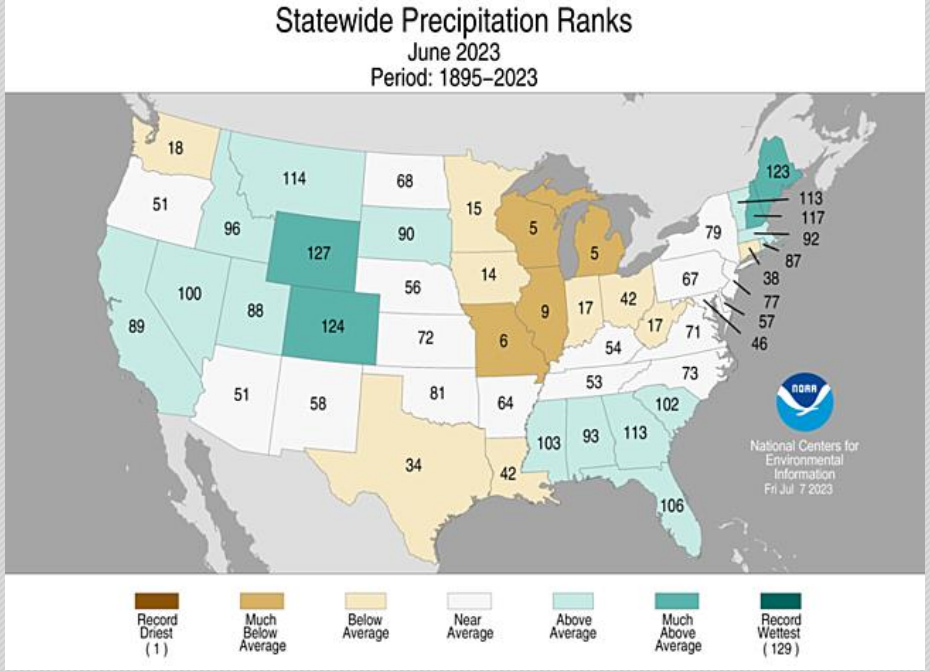
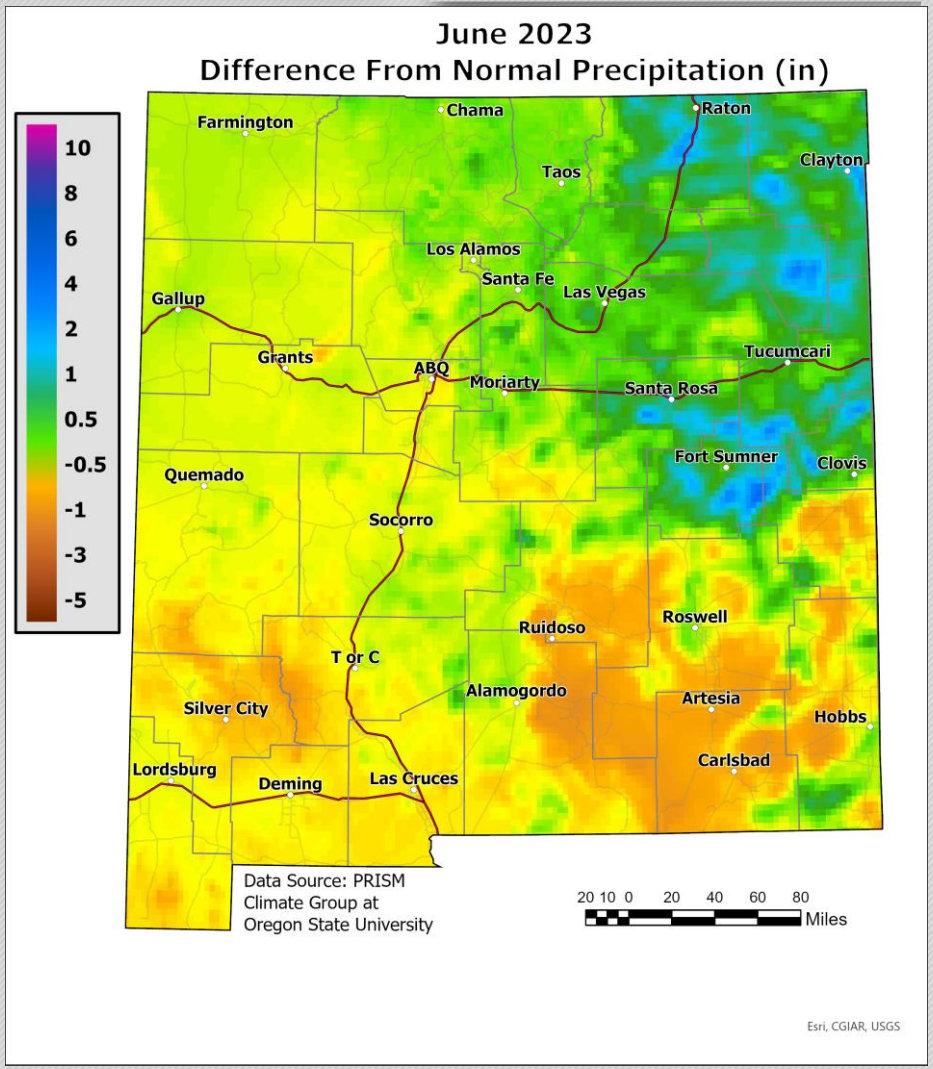




The upper left chart shows the trend in June average precipitation for NM. June 2023 turned out to be right around normal. The anomaly was 0.12” below normal. The lower left image from NCEI highlights NM right in the middle of the categorical range with average precipitation. The image on the right is a detailed gridded analysis of the mean precipitation anomaly for June. Much of the state was near to below normal except the east central and northeast plains which balanced out the rest of the state.



Analysis – July 2023

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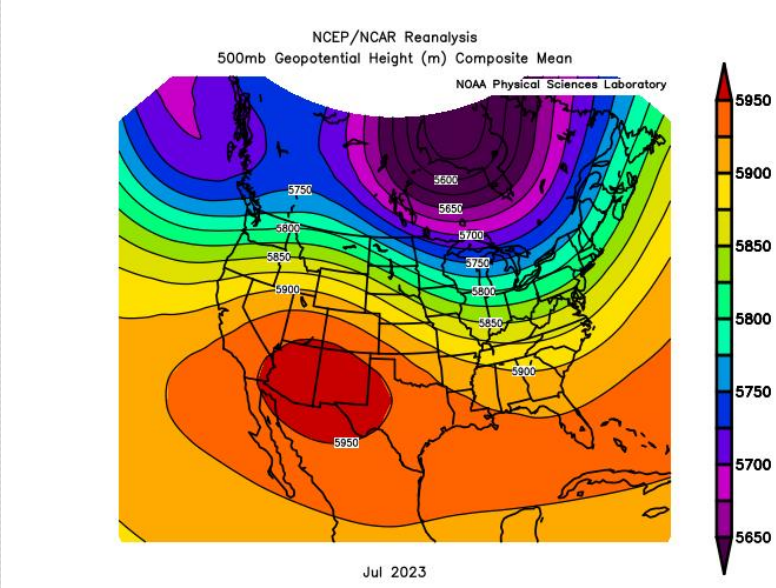
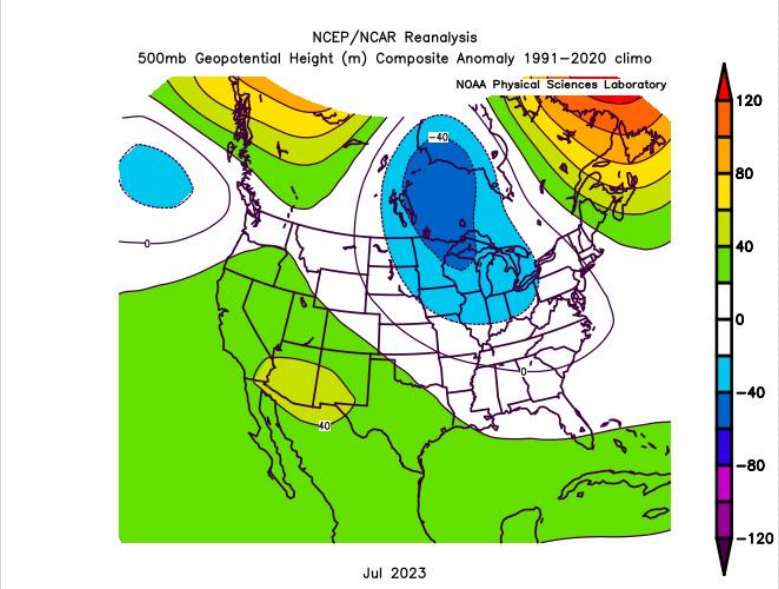
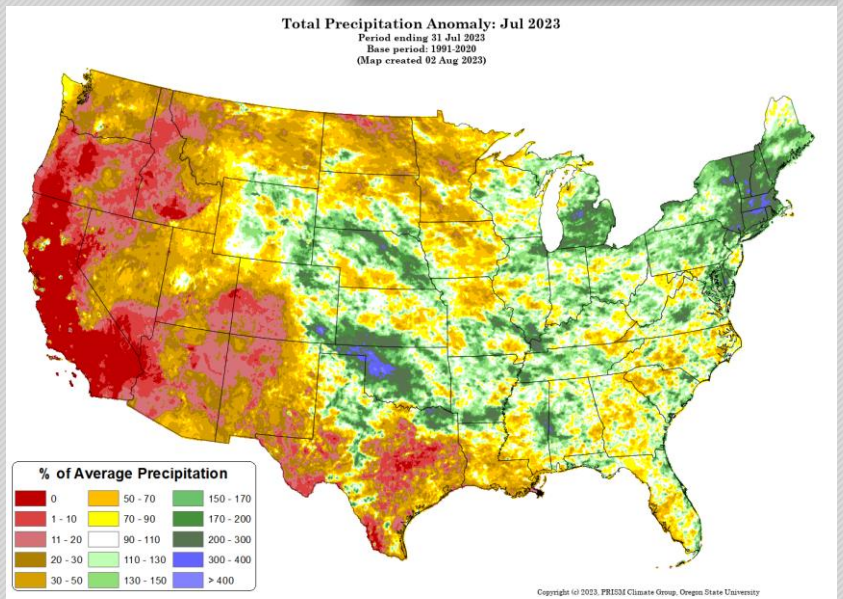
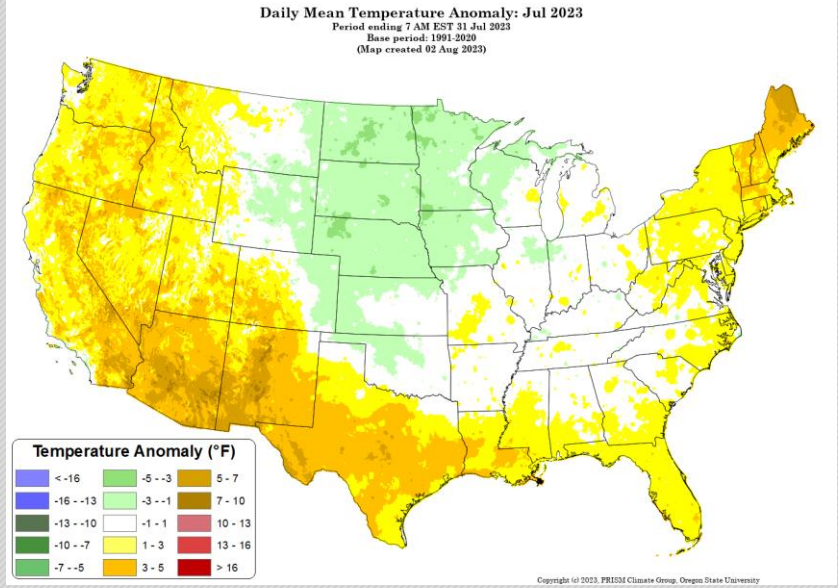




The 500mb geopotential height composite mean is shown in the upper left for the month of July and the lower left image shows the composite anomaly. A strong subtropical high shifted north into the desert southwest and dominated the region for the entire month. The coverage of showers and storms was very limited to extreme northeast NM and around the higher terrain. The upper right image shows below normal rainfall across much of NM with a sliver of above normal within Union County. It was brutally hot with widespread record temperatures on many days. The lower right image shows above normal temperatures for much of the state with some areas of the Rio Grande Valley nearly 10° above normal for the month of July.





Analysis – July 2023

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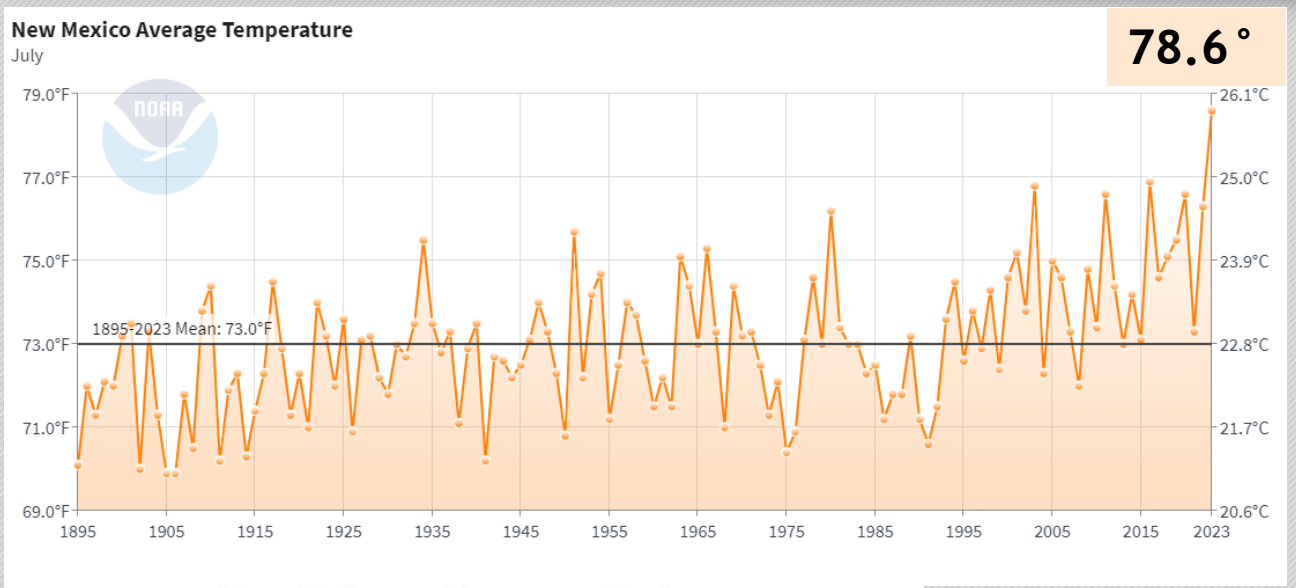
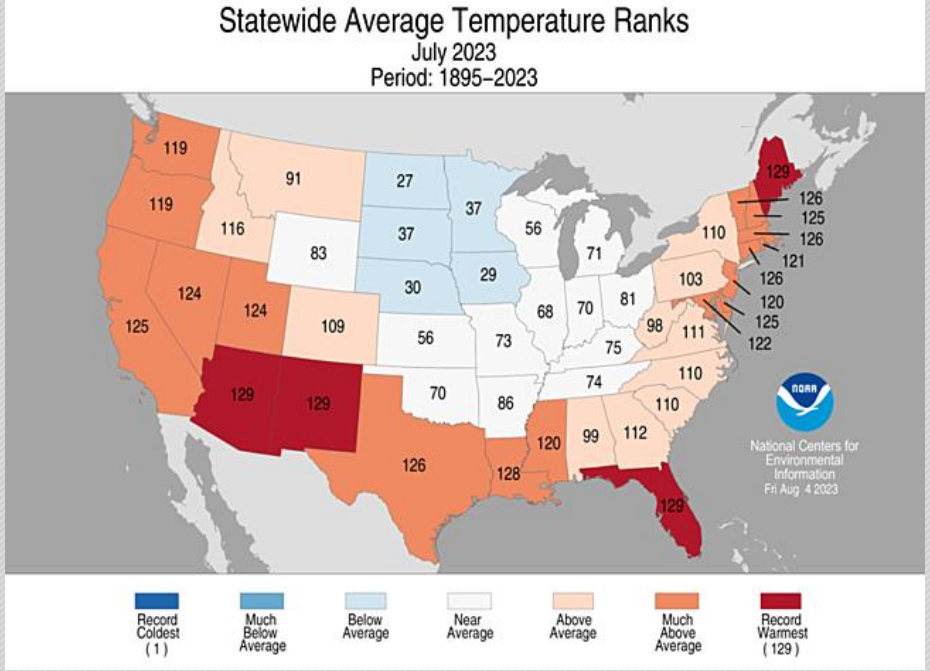
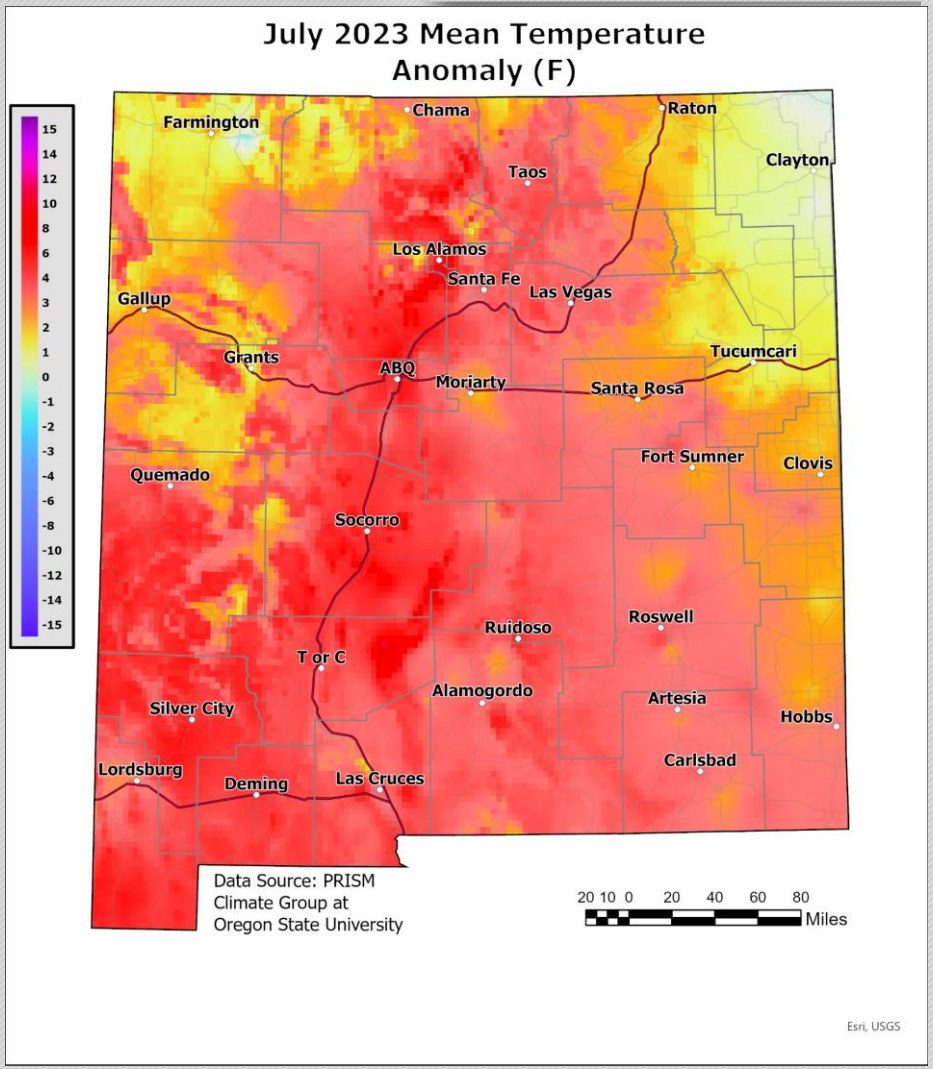




The upper left chart shows the trend in July average temperature for NM. July 2023 was a clear record breaker for hottest July dating back to 1895. The anomaly was 5.6° above normal. The lower left image from NCEI highlighted four states with a record hot July; NM, AZ, FL, and ME. The image on the right is a detailed gridded analysis of the mean temperature anomaly for July. Parts of the Rio Grande Valley and much of the bootheel region were nearly 10° above normal!



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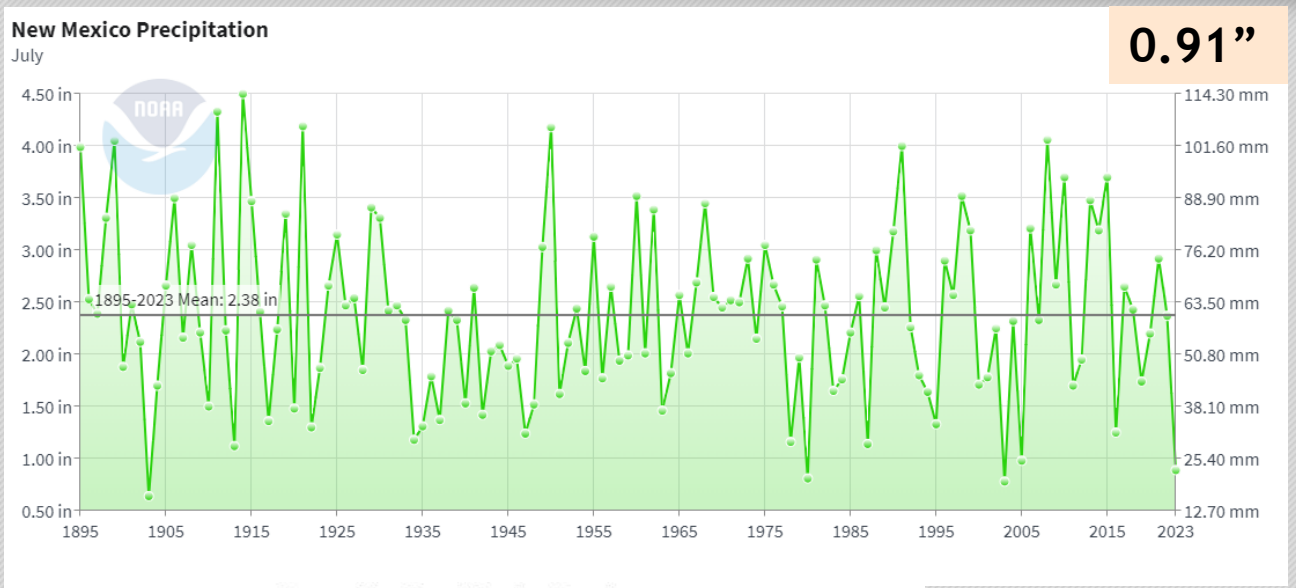
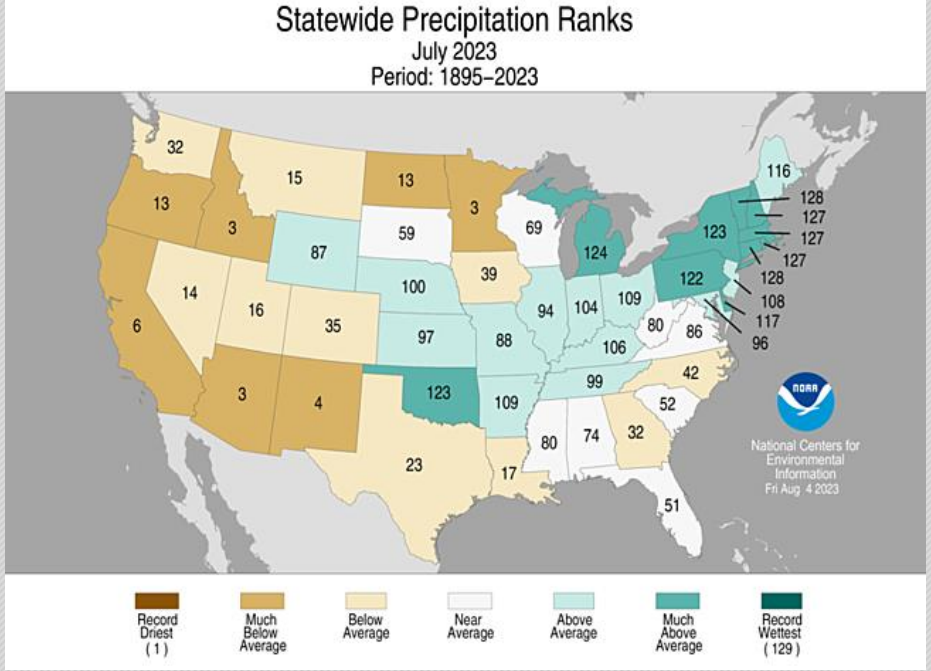
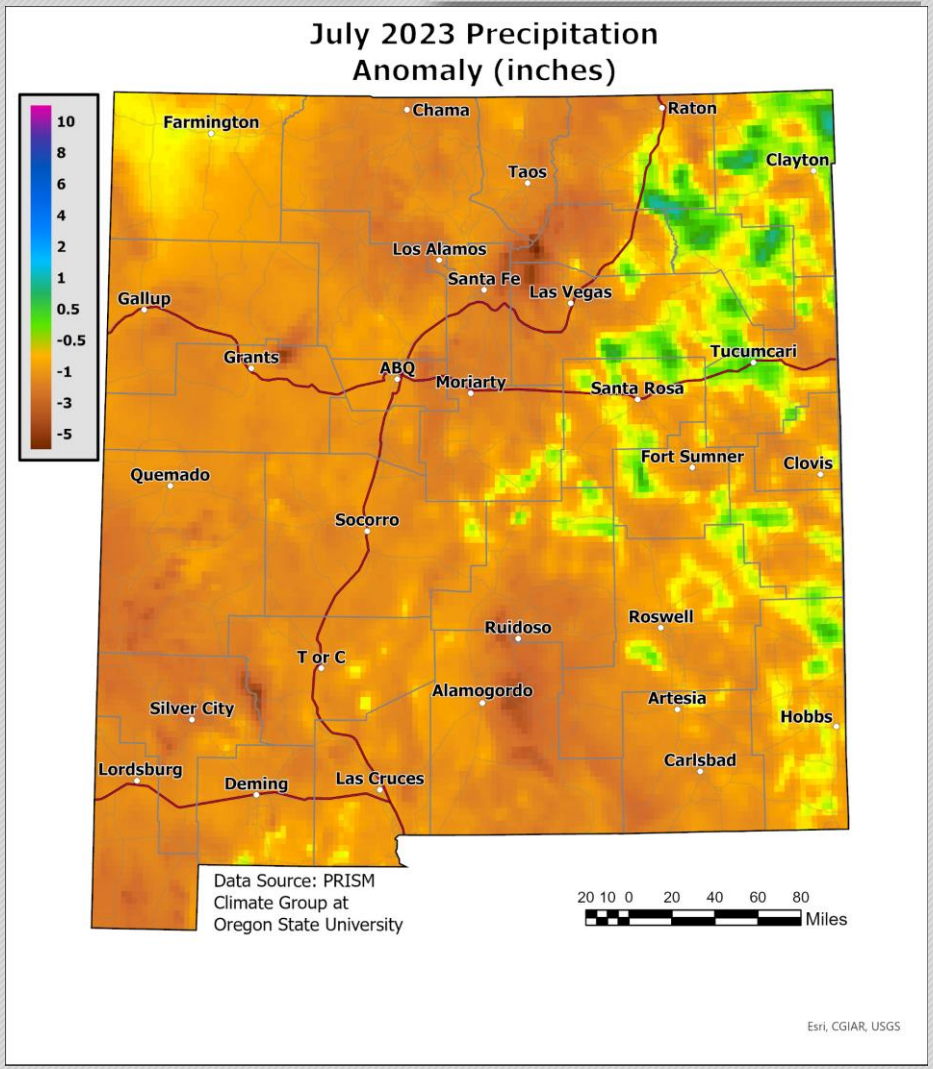




The upper left chart shows the trend in July average precipitation for NM. July is typically the wettest month of the year and it turned out to be extremely dry for most folks. The anomaly was 1.47” below normal. The lower left image from NCEI highlights NM at 4th driest on record. The image on the right is a detailed gridded analysis of the mean precipitation anomaly for July. Many places recorded no rainfall! A trace of rainfall at the Albuquerque Sunport was the first time in recorded history with no measurable rainfall in July.



Analysis – August 2023

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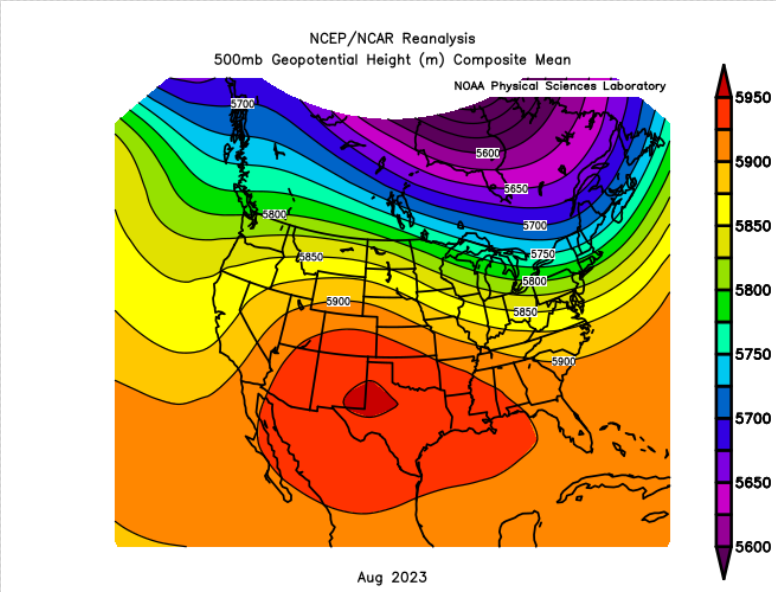
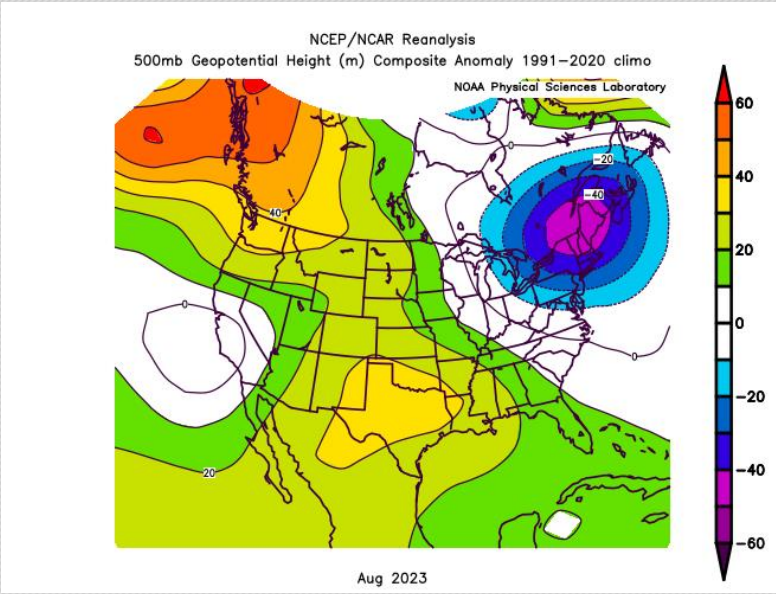
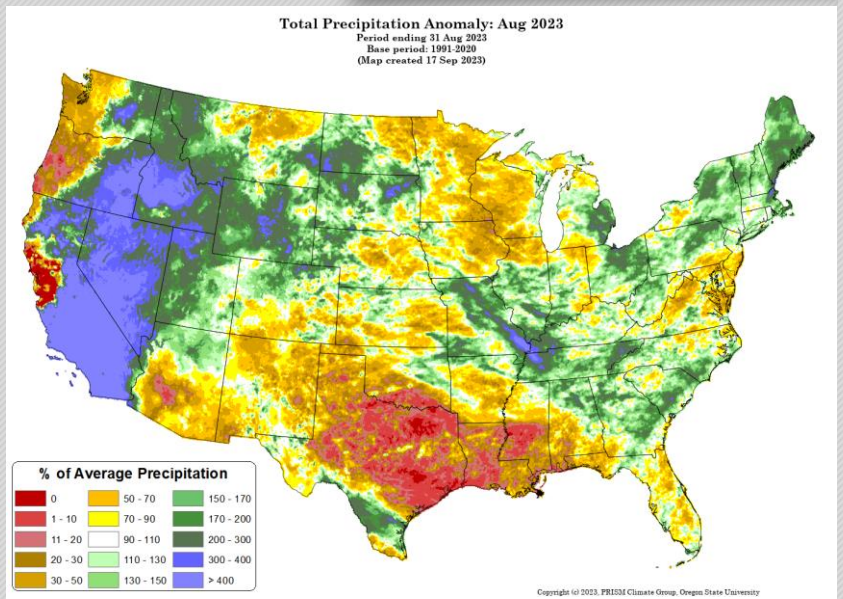
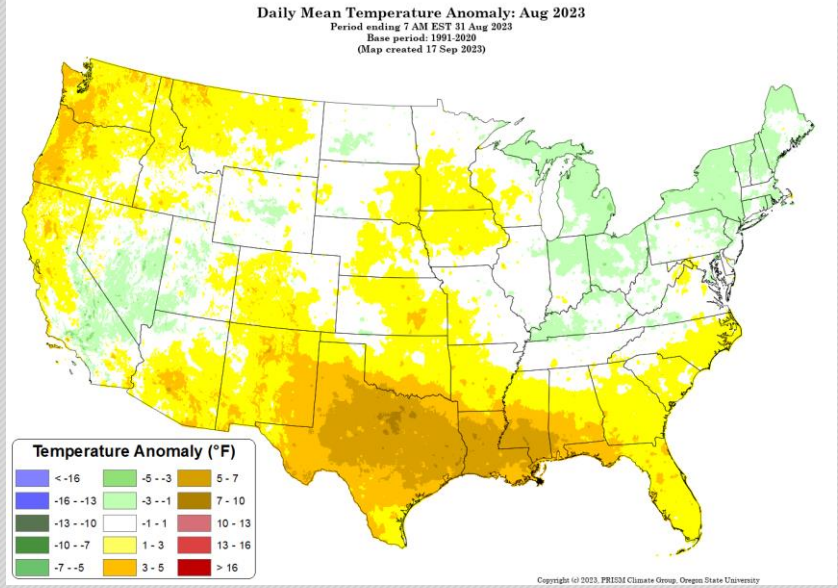




The upper left image shows the 500mb geopotential height composite mean for the month of August and the lower left image shows the composite anomaly. The very strong subtropical high shifted slightly east toward the Permian Basin but continued to dominate the entire southwest U.S. and TX through August. The trough signature along the west coast was associated with the remnants of Hurricane Hilary moving north from the west coast of Mexico into southern California. The coverage of showers and storms improved slightly over NM but was still mainly limited to high terrain areas as indicated by the upper right image. Brutal heat continued to envelop NM and TX. The lower right image indicates above normal temperatures continued over the entire region however relative to July the heat was not as excessive for NM.





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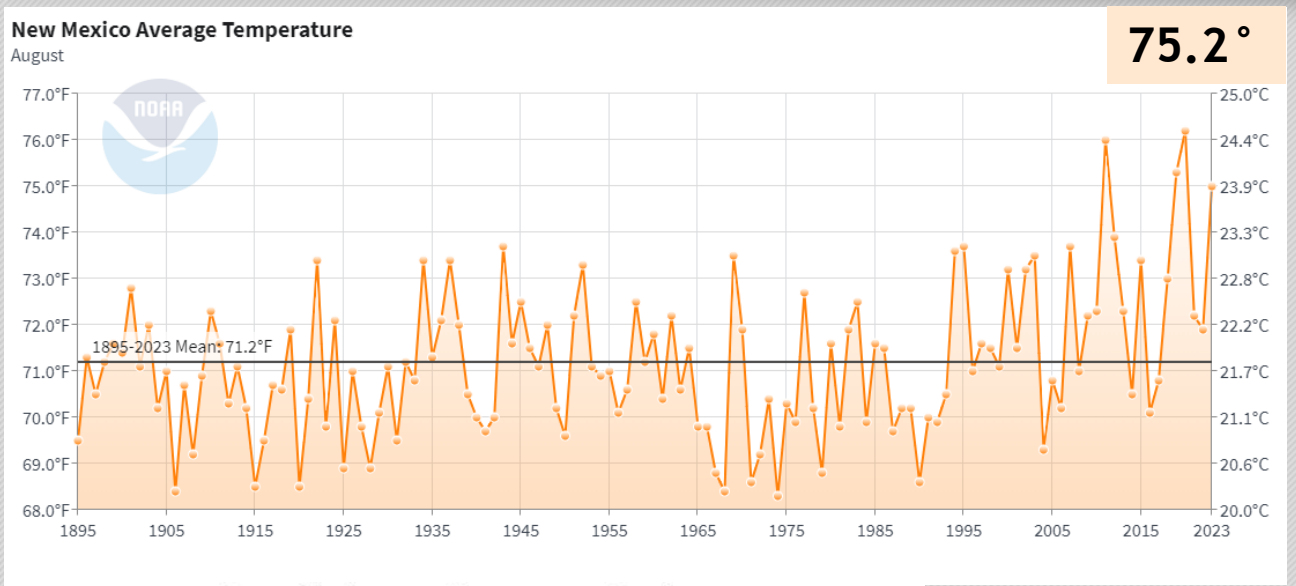
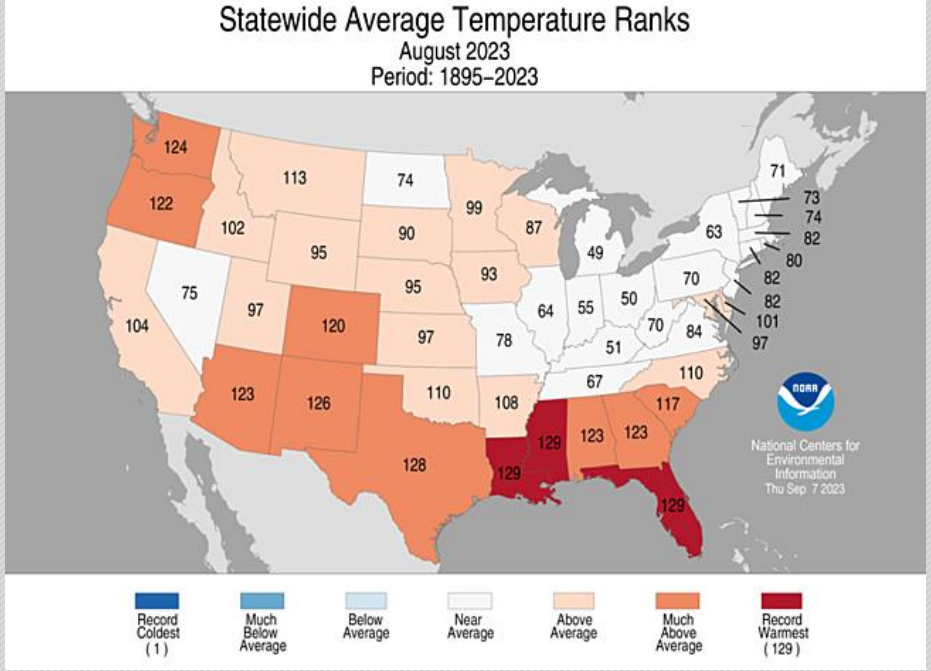
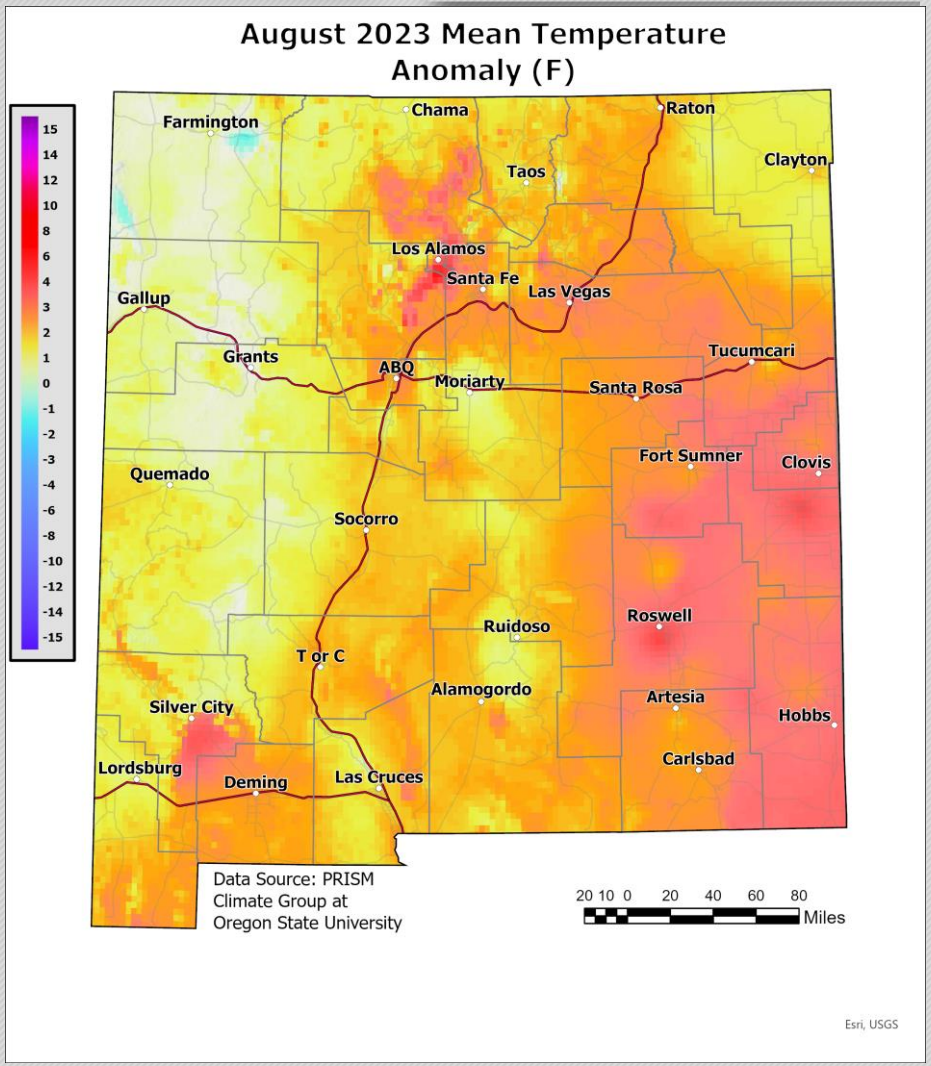




The upper left chart shows the trend in August average temperature for NM. August 2023 was the 4th warmest August on record dating back to 1895. The anomaly was 4.0° above normal. The lower left image from NCEI highlighted three states with a record hot August; FL, MS, and AL. The image on the right is a detailed gridded analysis of the mean temperature anomaly for August. The greatest above normal temperatures focused over central and eastern NM.



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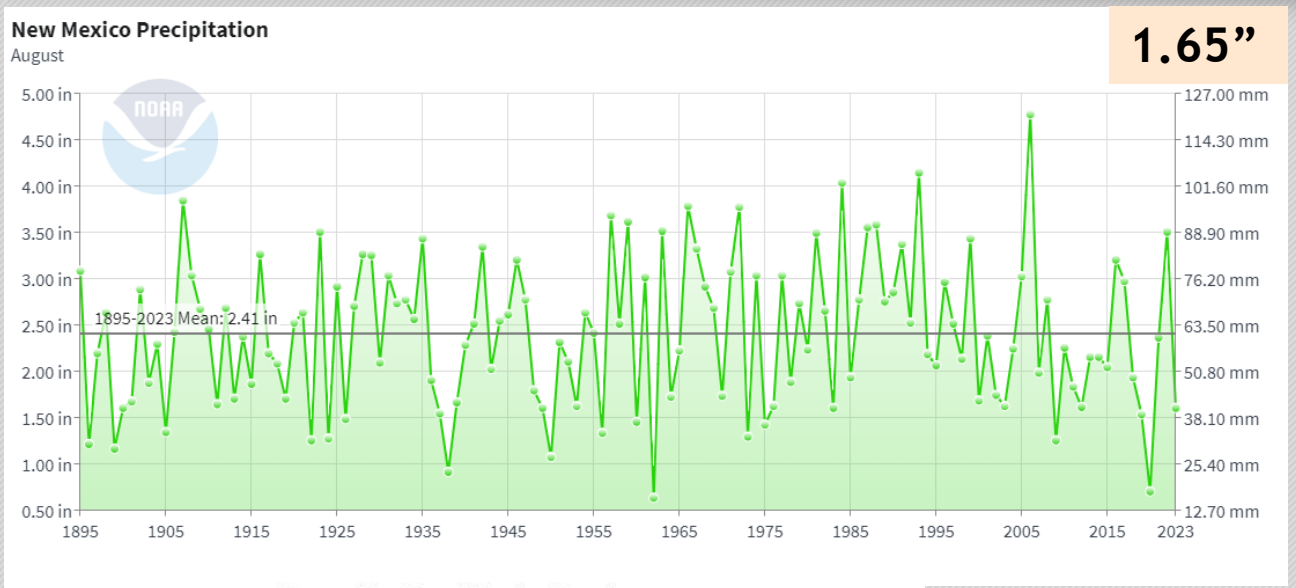
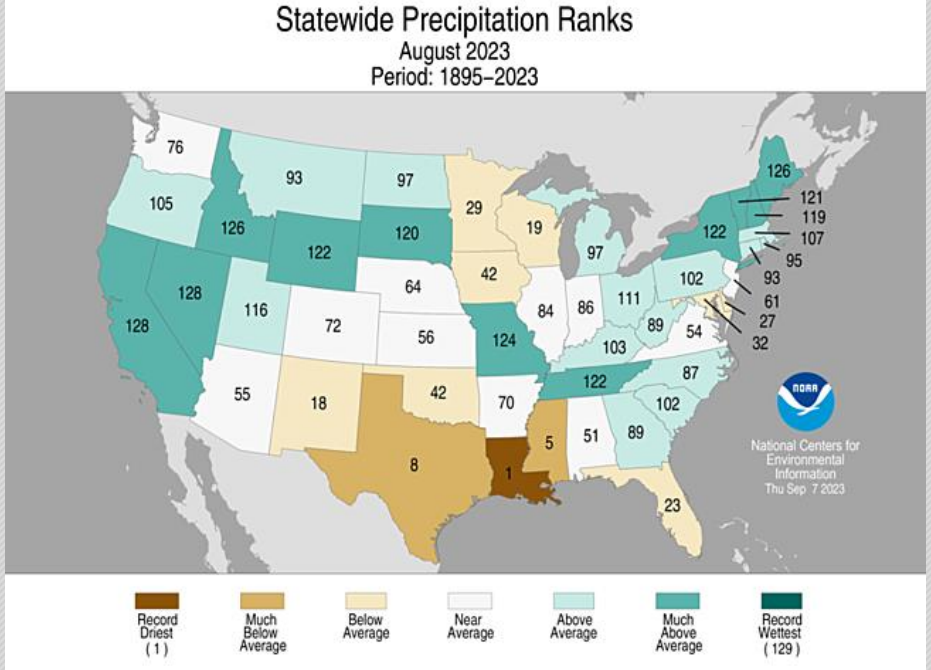
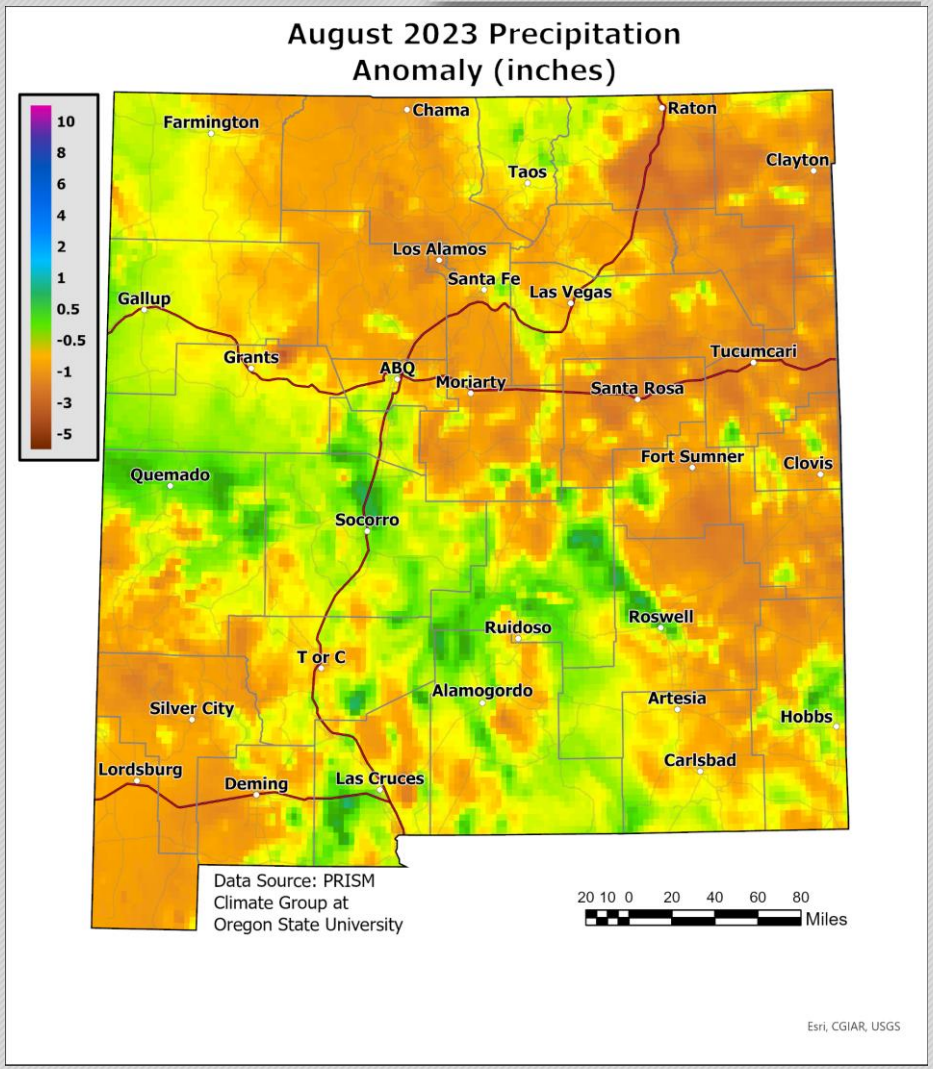




The upper left chart shows the trend in August average precipitation for NM. August is typically the 2nd wettest month of the year and it turned out to be dry again for most folks. The anomaly was 0.76” below normal. The lower left image from NCEI highlights NM at 18th driest on record. A detailed gridded analysis of the mean precipitation anomaly for August is shown on the right. Most places within central NM saw their first rainfall of the season by August while other areas still remained dry.



Analysis – September 2023

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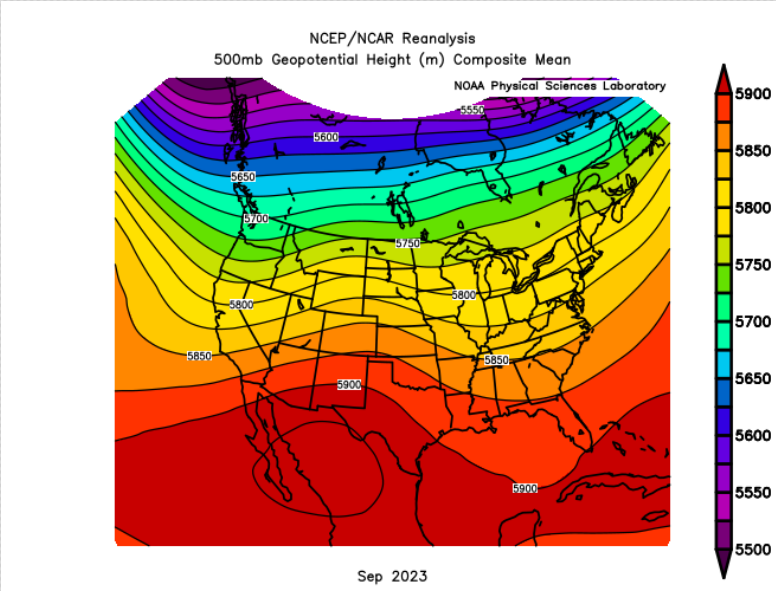
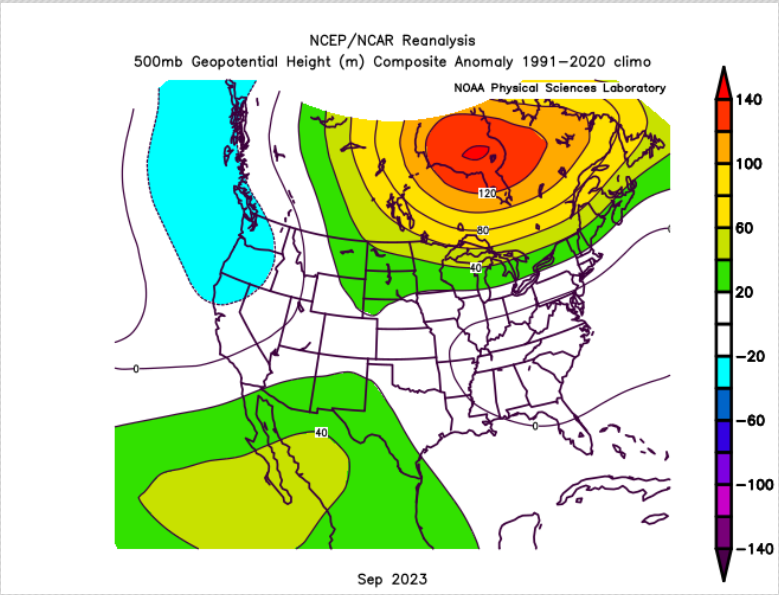
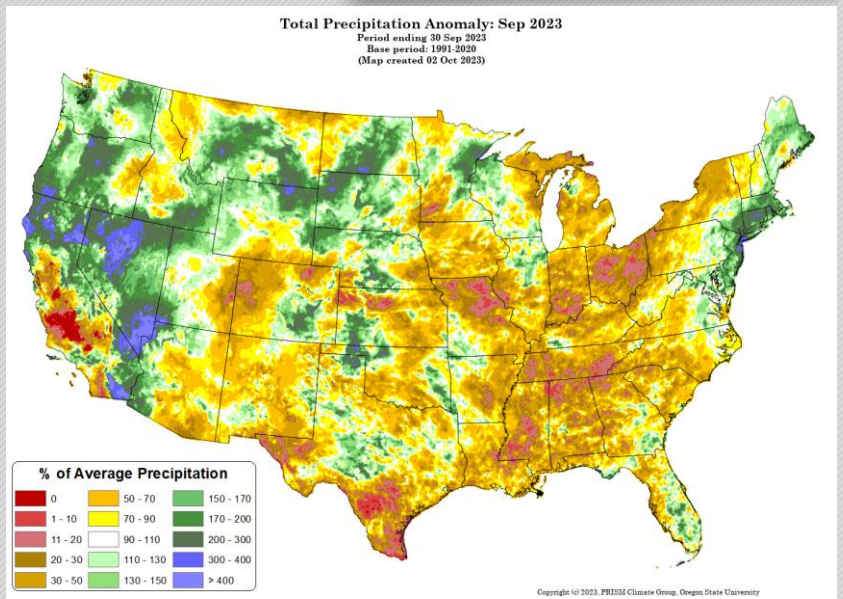
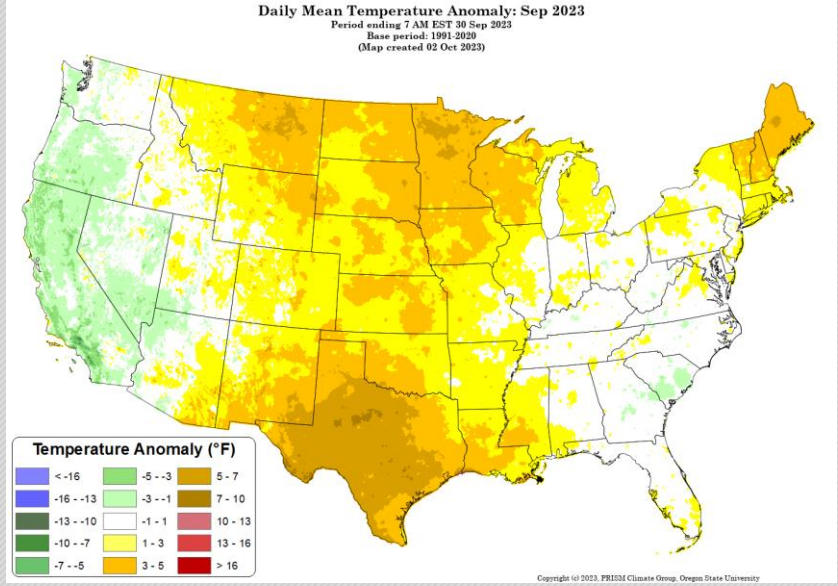




The 500mb geopotential height composite mean for the month of September is shown in the upper left and the composite anomaly in the lower left. The subtropical high shifted southwest into northern Mexico but remained strong through September. The coverage of showers and storms improved over eastern NM and the Gila region as shown on the upper right image. Record heat continued to impact NM with above normal temperatures statewide as indicated in the lower right image. By September, the extended period of hot and dry weather led to significant deterioration of drought across a large chunk of NM.





Analysis – September 2023

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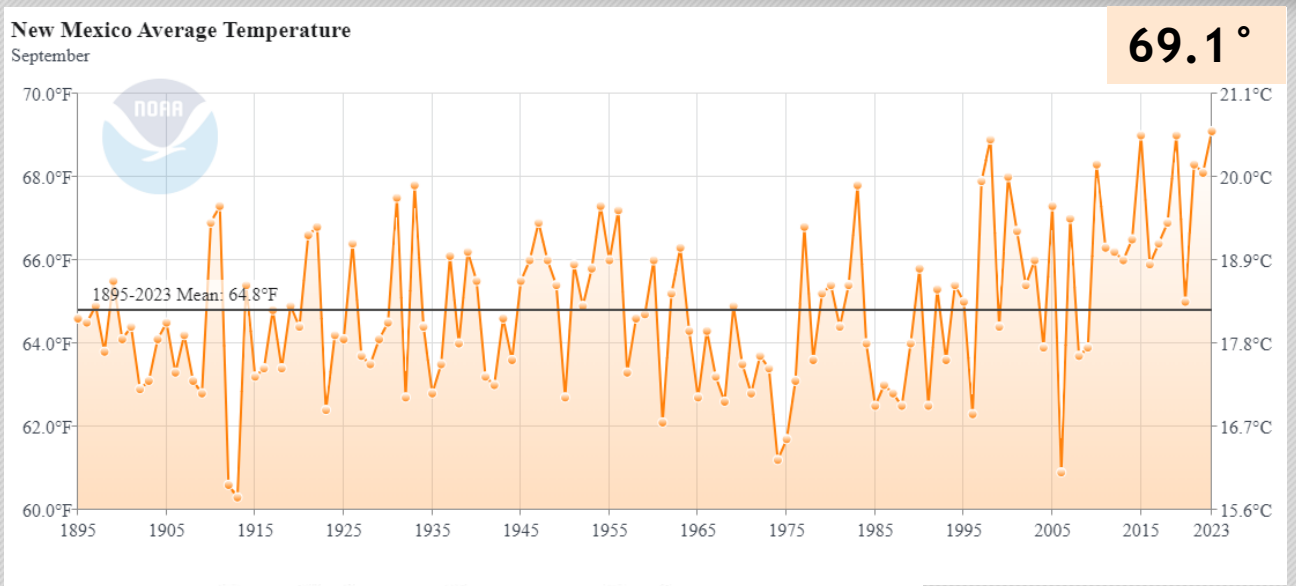
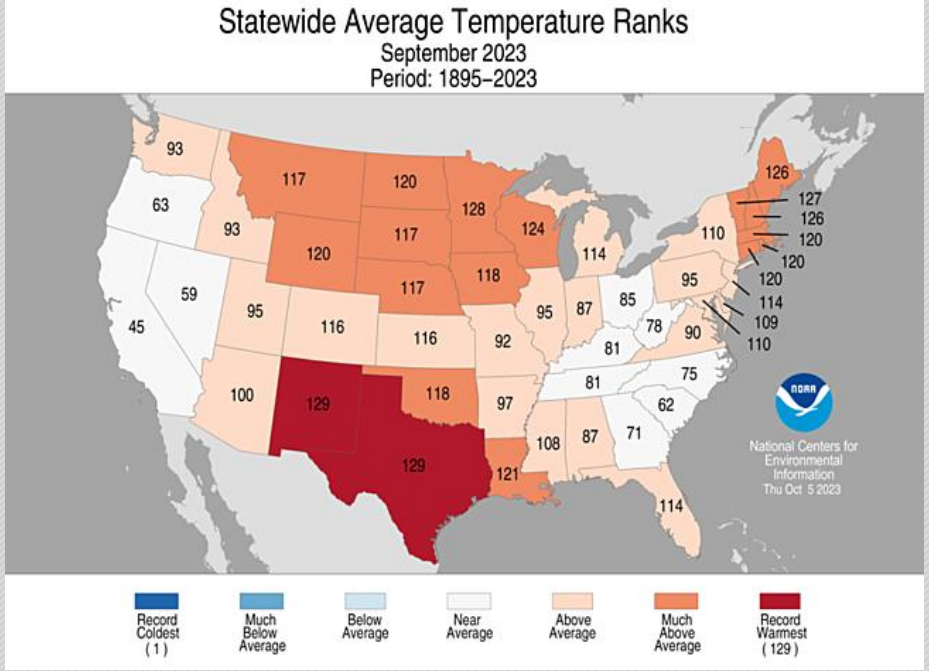
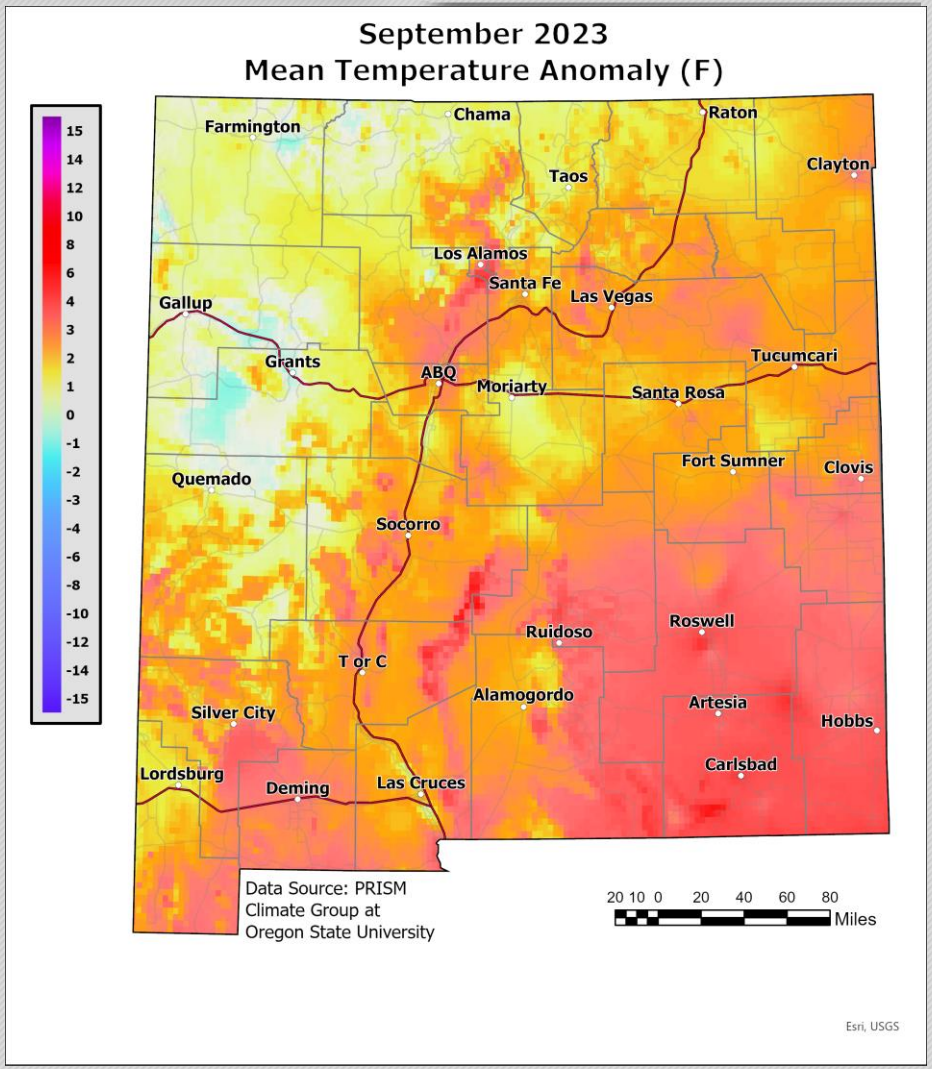




The upper left chart shows the trend in September average temperature for NM. September 2023 was the warmest September on record dating back to 1895. The anomaly was 4.3° above normal. The lower left image from NCEI highlighted two states with a record warm September; NM and TX. A detailed gridded analysis of the mean temperature anomaly for September is shown on the right. The greatest above normal temperatures focused over central and eastern NM once again.



Analysis – September 2023

ALBUQUERQUE
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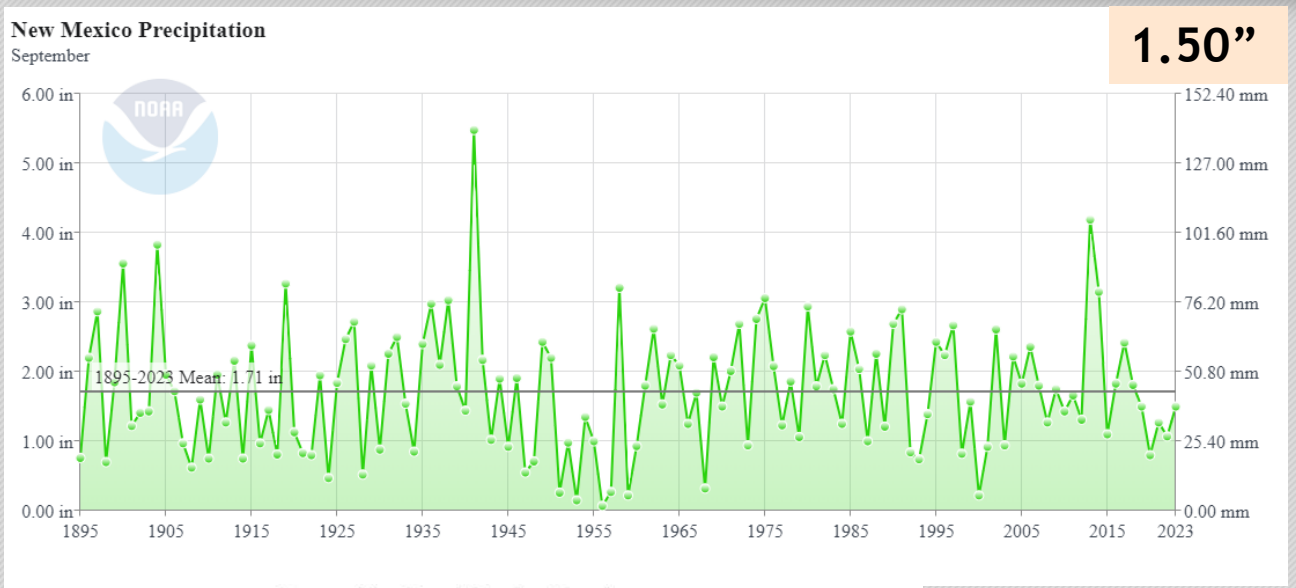
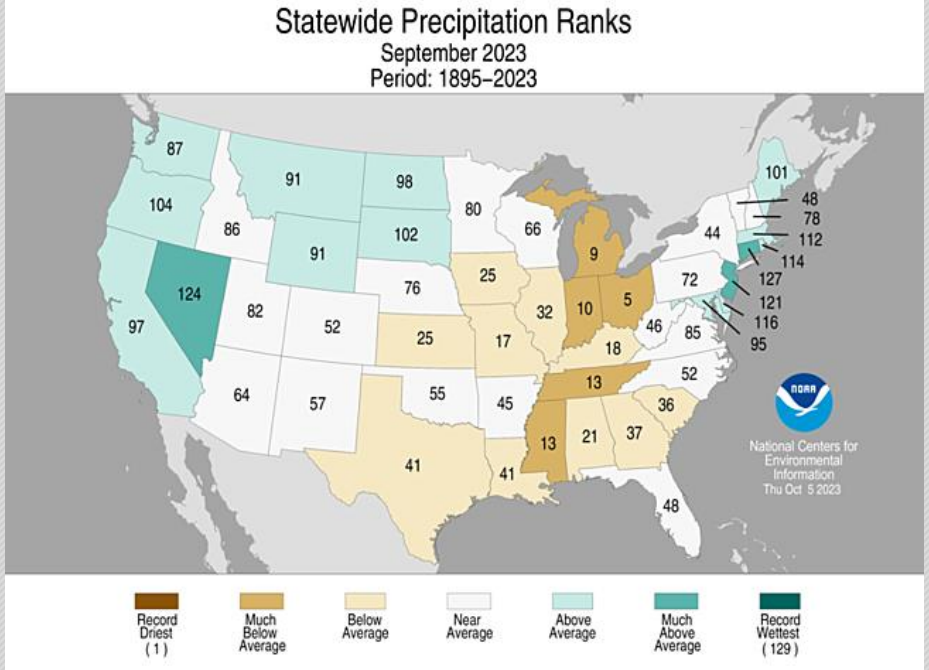
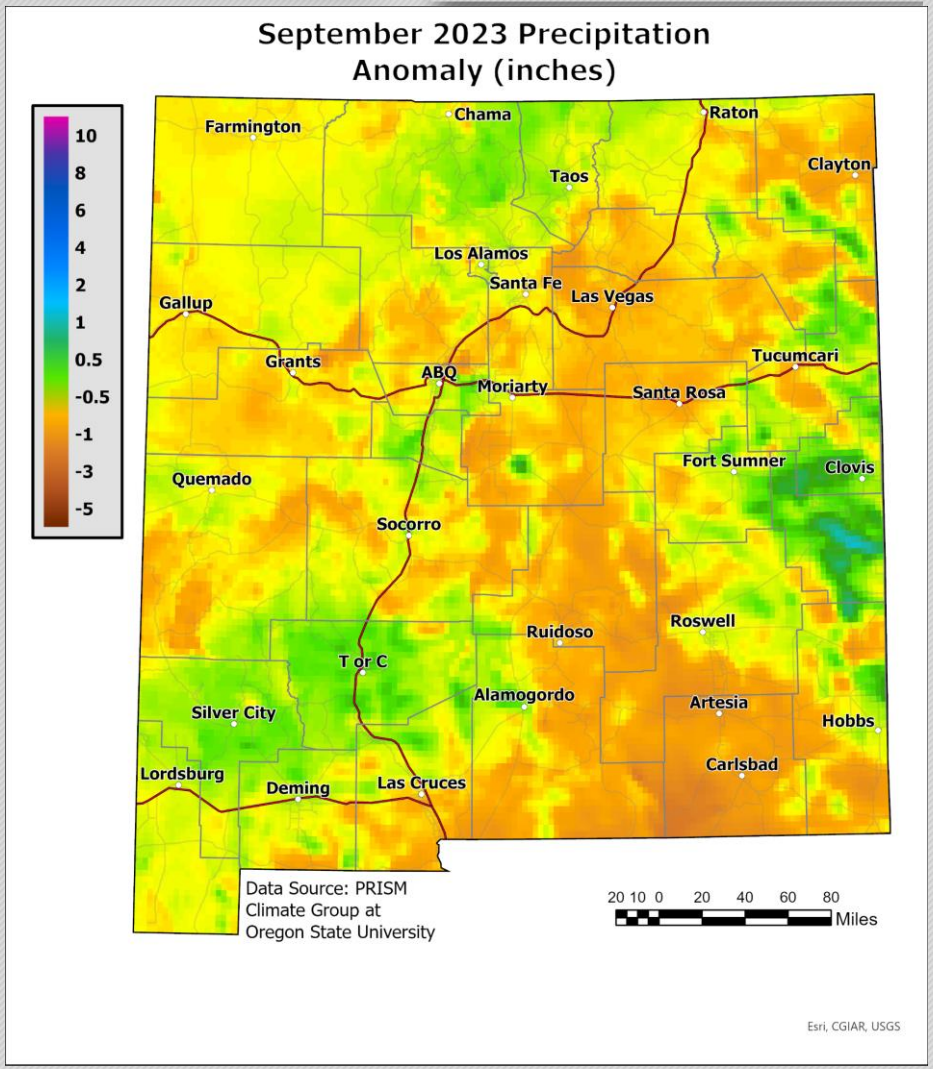


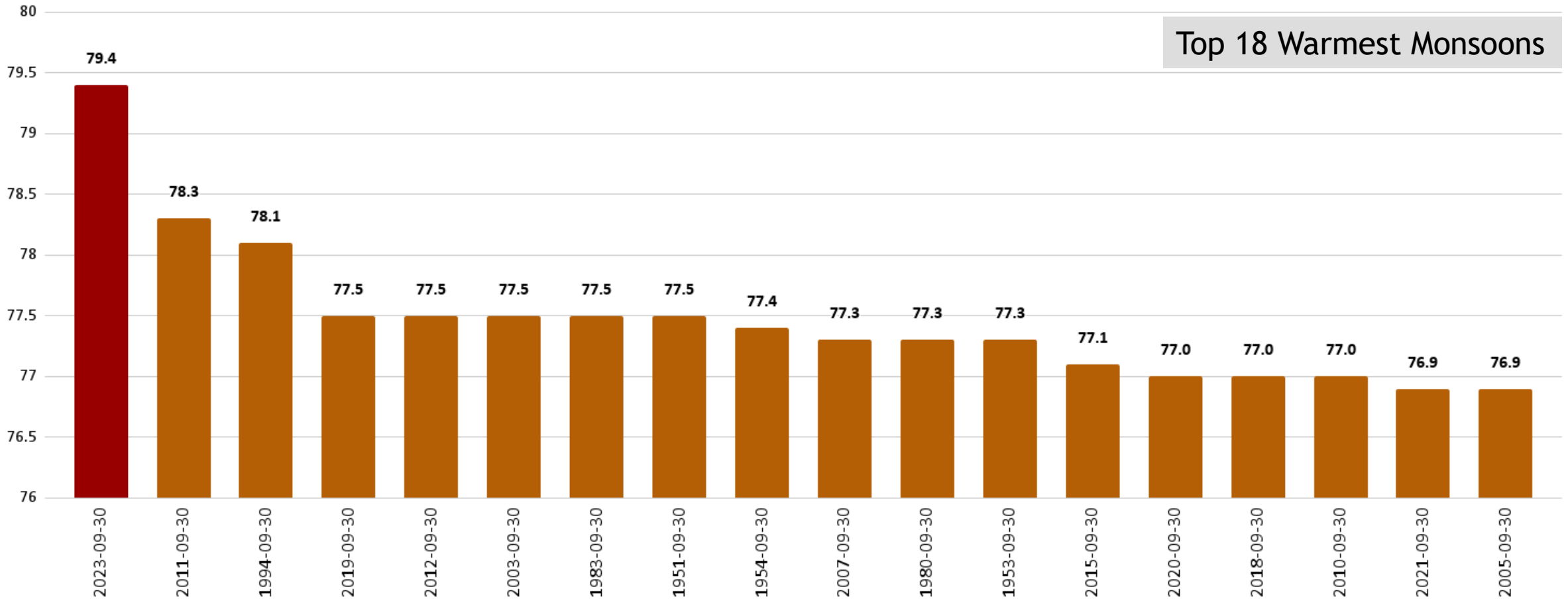


The upper left chart shows the trend in September average precipitation for NM. The coverage of showers and storms improved during September however many locations remained on the dry side. The anomaly was only 0.21” below normal. The lower left image from NCEI highlights NM at 57th driest on record so overall it was near normal. The image on the right is a detailed gridded analysis of the mean precipitation anomaly for August. Eastern NM was favored once again for better rainfall.



Albuquerque Monsoon Temperature Ranking

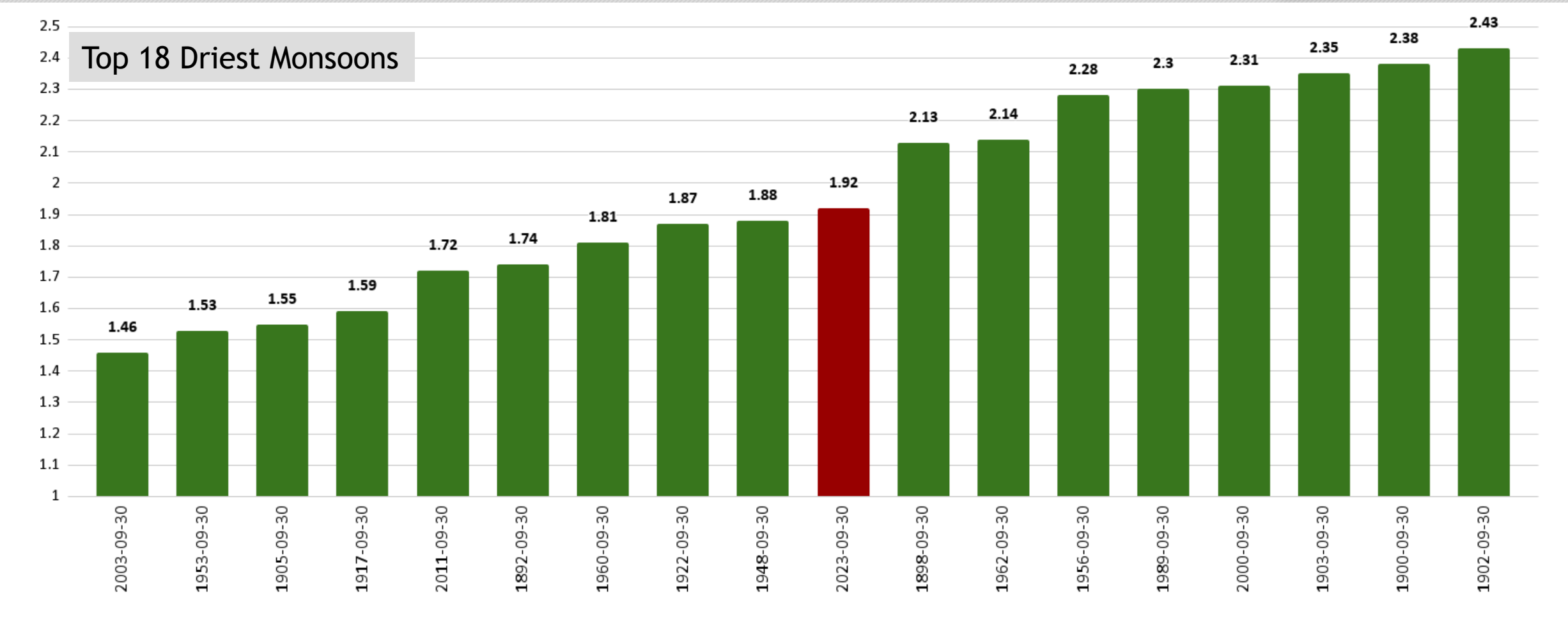
ALBUQUERQUE
Weather Forecast Office



The Albuquerque area recorded the warmest monsoon season on record at 79.4° (1891-2023). This broke the previous record of 78.3° set back in 2011. The new record shattered the previous record by 1.1° which is considerable given the average is measured over 107 days. The seasonal average temperature for 1980 was more than 2° cooler despite the record number of 100°+ days that year. There were 8 new record highs set and 14 new record high minimums during monsoon 2023.

Albuquerque Monsoon Rainfall Ranking

ALBUQUERQUE
Weather Forecast Office



The Albuquerque area reported the 10th driest monsoon season on record with 1.92” of rain (1891-2023). The 1991-2020 average between June 15th and September 30th is 4.70” so we picked up less than half of normal for the entire season. There was a 77 day stretch with no measurable rainfall that ended on August 6, 2023. This was the 13th longest stretch on record for the Albuquerque area. The longest dry stretch was 109 days ending on May 19, 1902.

Albuquerque Area 100°+ Days

ALBUQUERQUE
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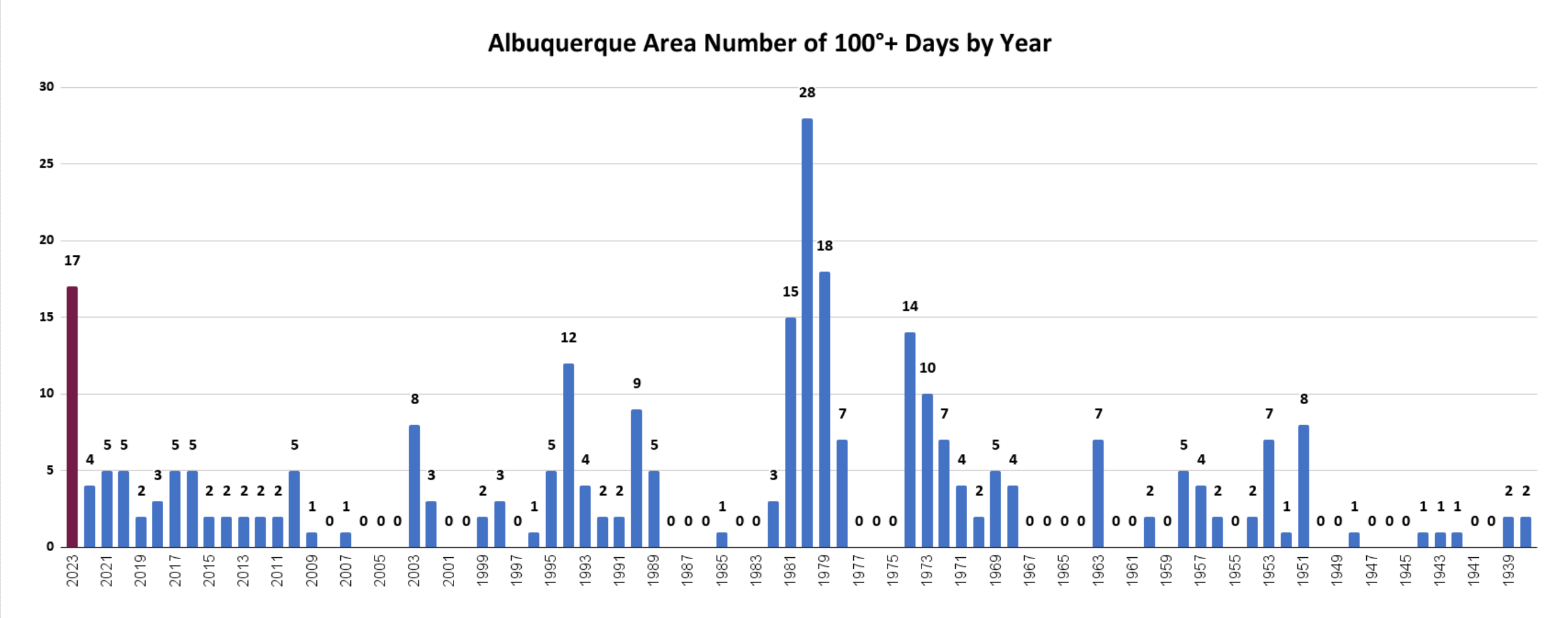

The chart above shows the total number of 100°+ days by year for the Albuquerque area. The 17 days in 2023 were the most 100° days in a single year since 1980. The 17 days in 2023 were also the 3rd greatest number of 100° days in any year since records began in 1891. The 18 days in 1979 are still a very close 2nd place. The record 28 days in 1980 will hopefully stay that way for many years to come.

Albuquerque Metro Rainfall: 2019 to 2023

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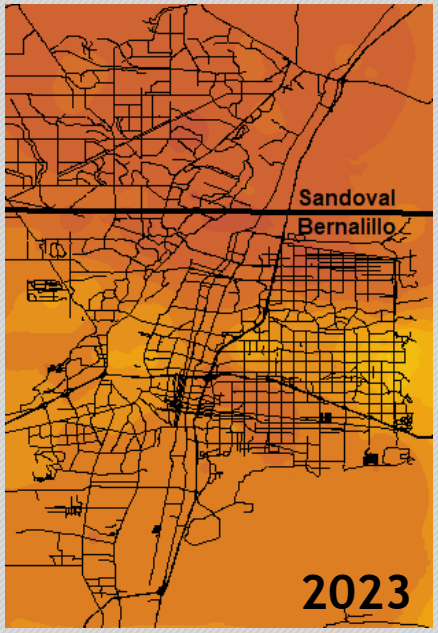
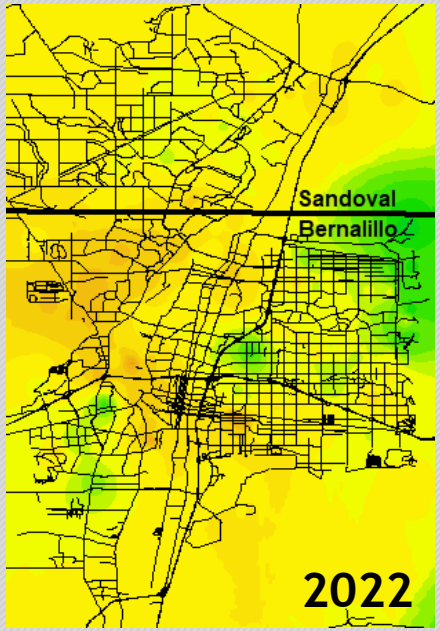
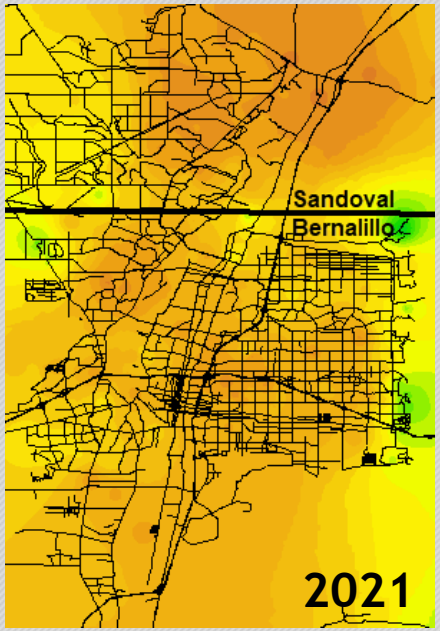
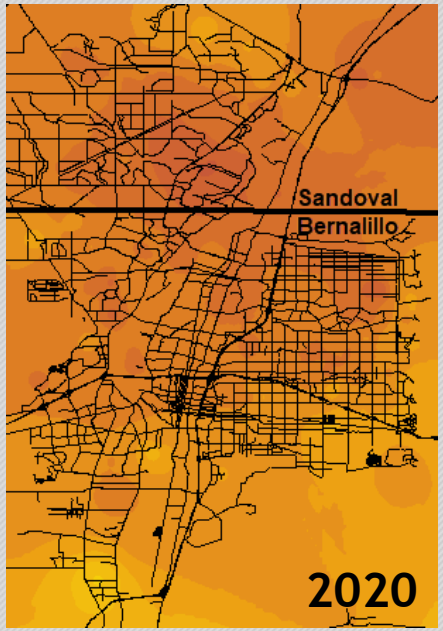
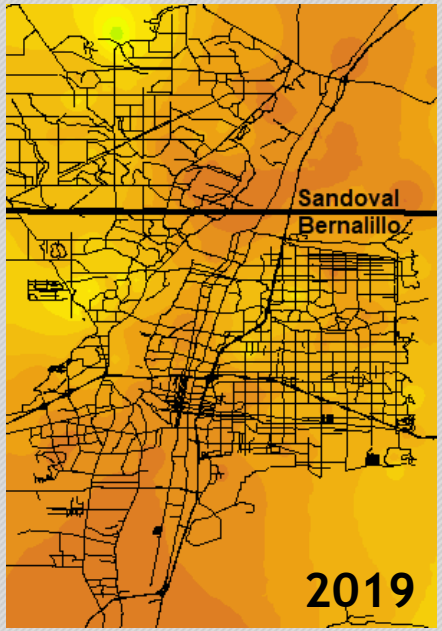


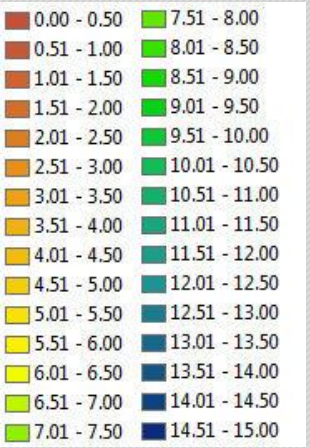








Rainfall across the metro area this monsoon was abysmal. Most areas picked up less than 2” of rainfall for the entire summer and some folks didn’t even break the 1” mark! One isolated thunderstorm over the northeast heights on August 8th dumped the bulk of their rainfall for the summer and produced major flash flooding within the I-40 arroyo channel system. Another storm that dumped 1 to 2” from the Petroglyphs southeast across the Rio Grande toward the Albuquerque Sunport on September 13th was the heaviest storm for that area all season. 2022 was significantly wetter for the metro area compared to 2023. Heavy rainfall was a bit more spotty in 2021 but most areas still did well. For a more detailed summary of metro area rainfall visit the link below.



Albuquerque Rainfall Maps: https://www.weather.gov/abq/northamericanmonsoon-abqmaps

Northern & Central NM 2023 Temperature Records

ALBUQUERQUE
Weather Forecast Office

Record Type	Number of Records Broken
Total Daily Max Temperature	395
Total Daily High Min Temperature	291
All-Time Max Temperature	8
All-Time High Min Temperature	4
All-Time Max Seasonal Average Temperature	12
June Max Temperature	0
June High Min Temperature	1
July Max Temperature	17
July High Min Temperature	8
August Max Temperature	9
August High Min Temperature	7
September Max Temperature	8
September High Min Temperature	2

The records table on the left was compiled using observing stations across the Albuquerque NWS forecast area. Stations in the analysis were required to be actively reporting as of 2023 and have a period of record of 50+ years. For the period from June 15th to September 30th, there were nearly 700 daily maximum and daily high minimum temperature records. Eight stations broke or tied a new all-time record high temperature. Twelve stations set a new record for the warmest monsoon season on record. The record heat reached a peak in July with several subsequent peaks throughout August and September.

Northern & Central NM 2023 Temperature Records

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Number of Days ≥ Max Temperature					Consecutive Days ≥ Max Temperature			
Location	**95°**	**100°**	**105°**	**110°**	**95°**	**100°**	**105°**	**110°**
Roswell	103	67*	29*	6*	66	15	10	2
Albuquerque	50	17	-	-	30*	7	-	-
Clayton	26	3	-	-	11	3	-	-
Farmington	43	14*	-	-	29*	8	-	-
Gallup	22	4*	-	-	16*	2	-	-
Santa Fe	23	1	-	-	8	1	-	-
Raton	6	-	-	-	1	-	-	-
Las Vegas	9*	1*	-	-	3*	1	-	-
Tucumcari	49	18	2	-	14	3	1	-

Not only was the record heat widespread on many days, the brutal summer heat during 2023 was relentless. The left-side of the table above details the number of days in 2023 with a high temperature at or above 95°, 100°, 105°, and 110°. The right-side of the table details the number of consecutive days in 2023 with a high temperature at or above 95°, 100°, 105°, and 110°. *Locations with an asterisk established a new record number of days for that category. Roswell was at the epicenter of the dangerous summer heat with 67 days at or above 100° and 29 days at or above 105°.

Northern & Central NM High Temperature Records

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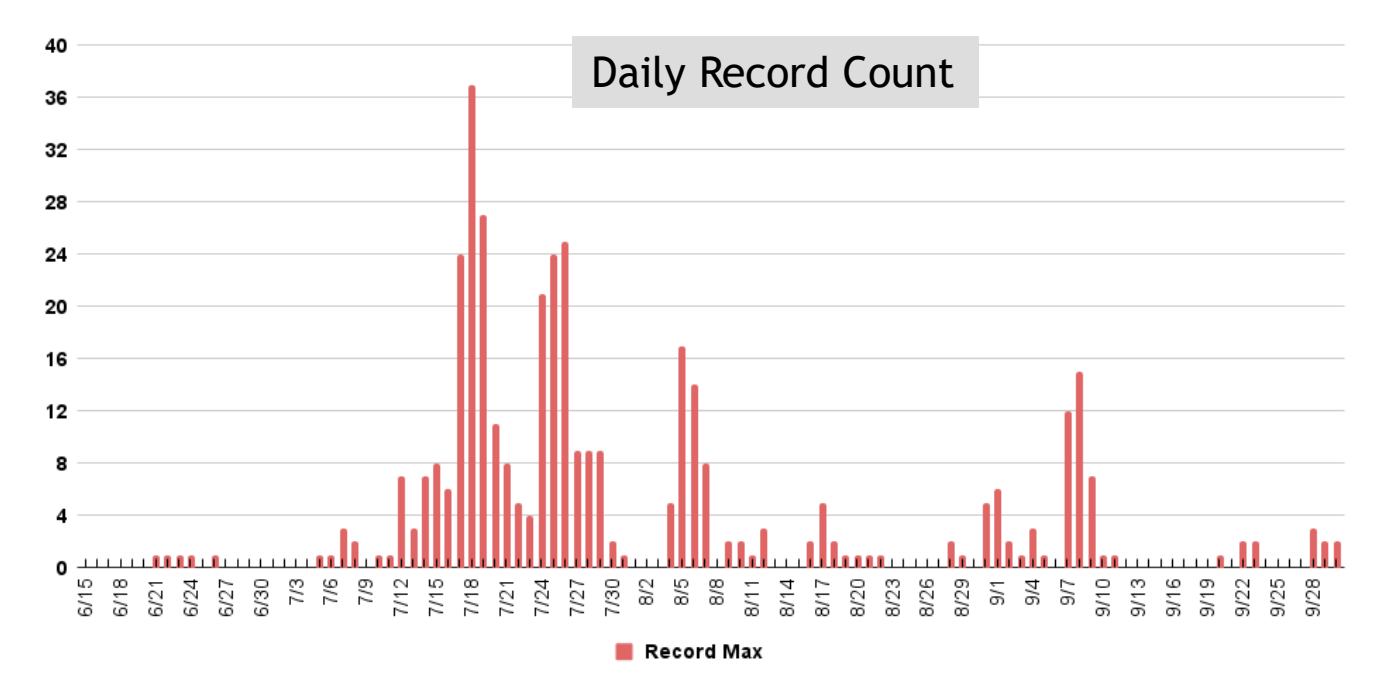
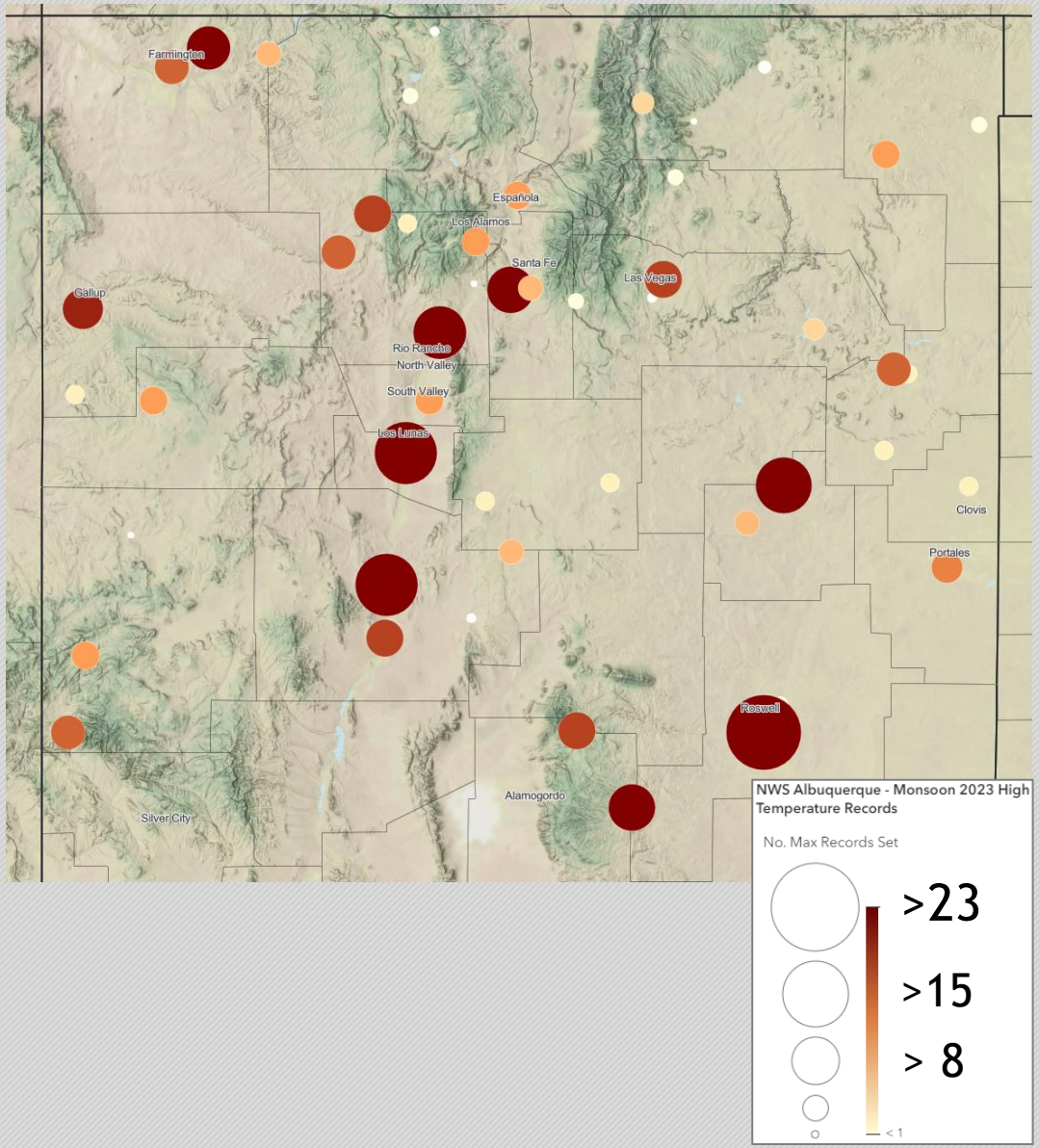
Weather Forecast Office

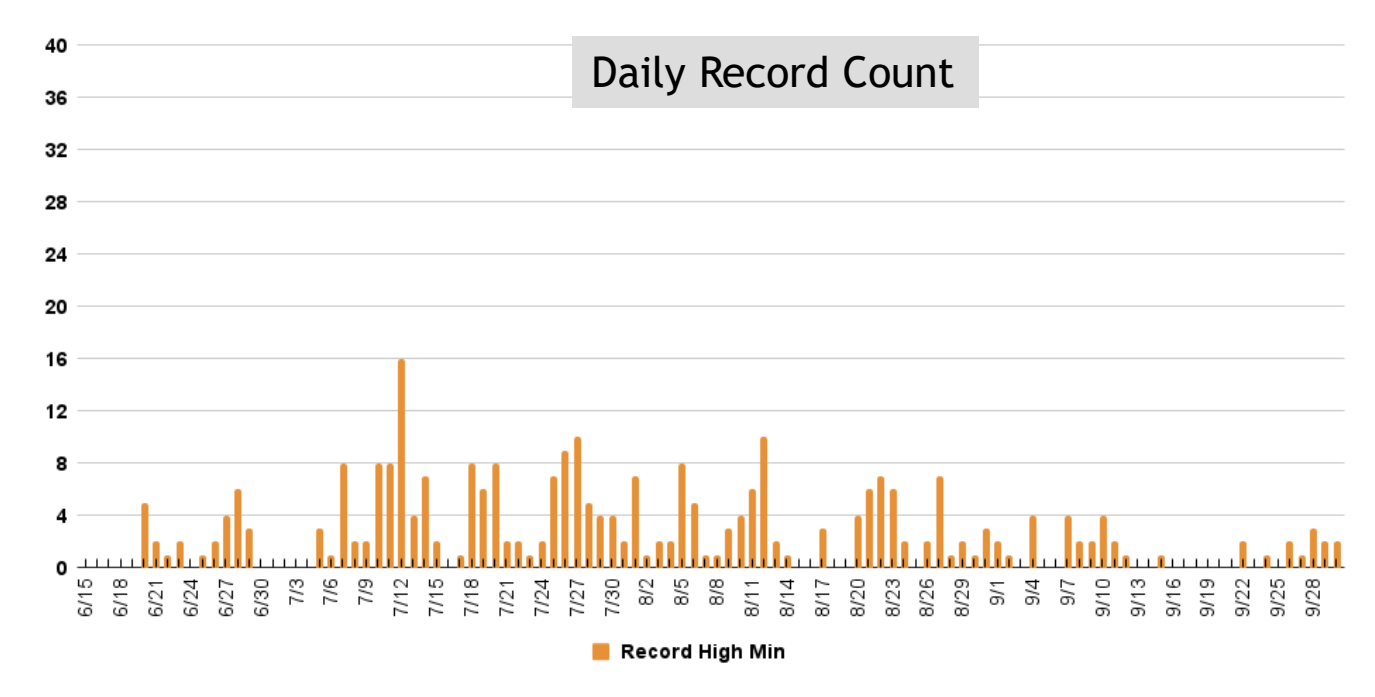


The chart above shows the number of sites by date with new record high temperatures from June 15th to September 30th, 2023. The most widespread record heat occurred on July 17th when 37 locations reported new record high temperatures. Several other peak dates were noted throughout the summer season. Record highs were still occurring at a couple locations right up to the end of September. The chart on the right is a "heat-map" which shows the number of records by location within the NWS Albuquerque forecast area. Larger circles indicate more records were broken over the course of the season.

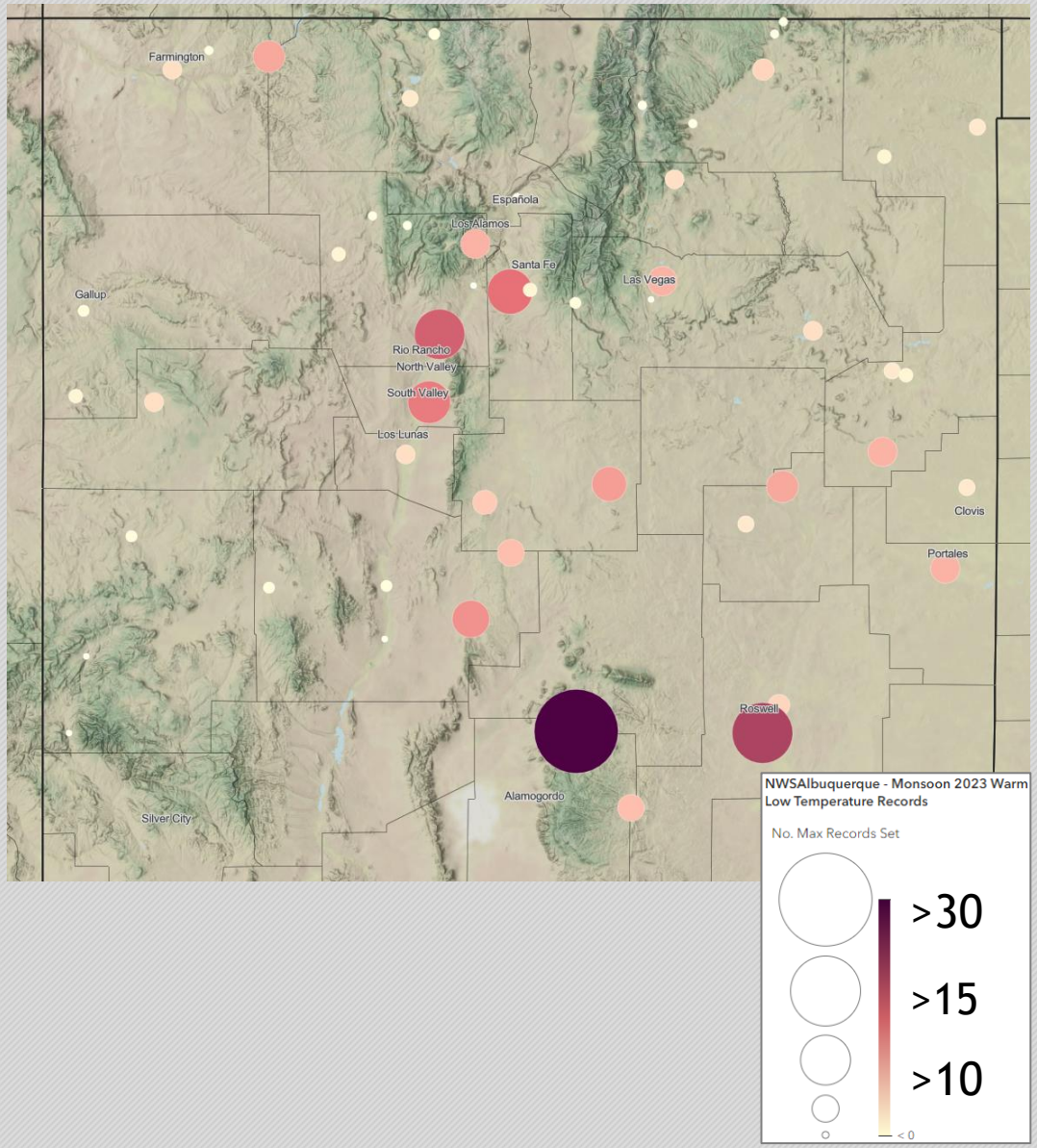


Northern & Central NM High Minimum Temperature Records

ALBUQUERQUE
Weather Forecast Office



The chart above shows the number of sites by date with new record high minimum temperatures from June 15th to September 30th, 2023. The most widespread record nighttime heat occurred on July 12th when 16 locations reported new record high minimum temperatures. Record overnight heat was rather persistent throughout the summer. The chart on the right is a “heat-map” which shows the number of records by location within the NWS Albuquerque forecast area. Larger circles indicate more records were broken. Ruidoso stands out at a whopping 30 nights with record high minimum temperatures!



New Mexico Drought

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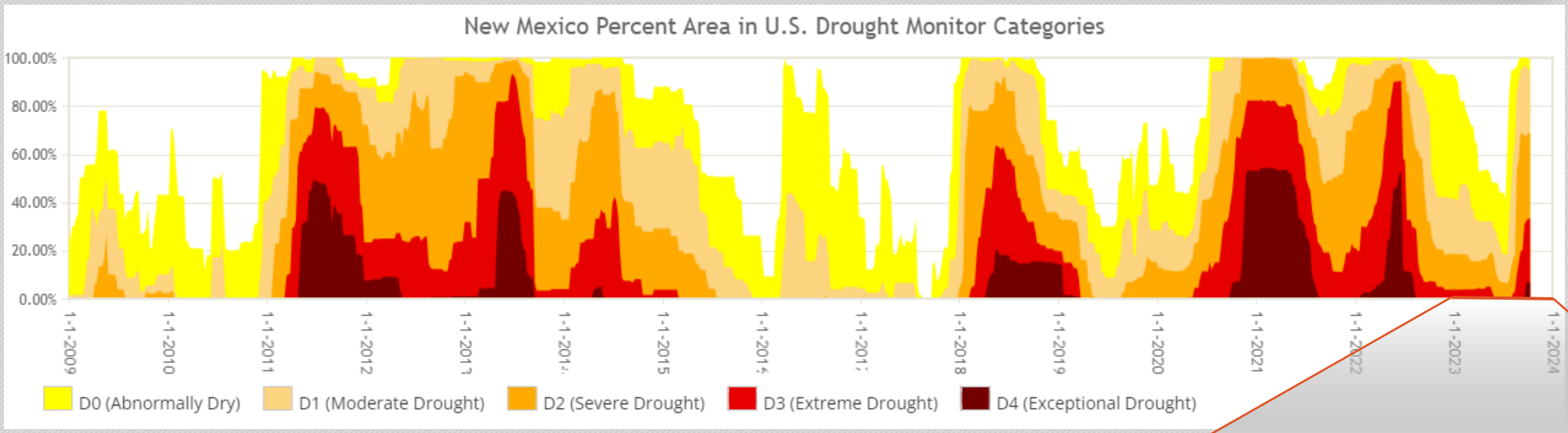
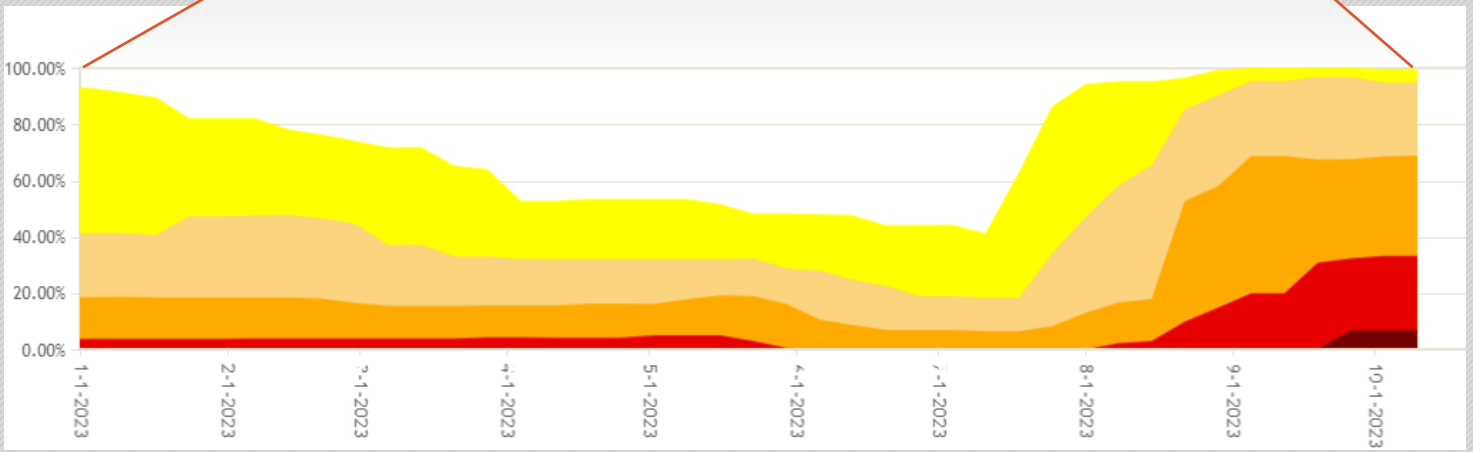


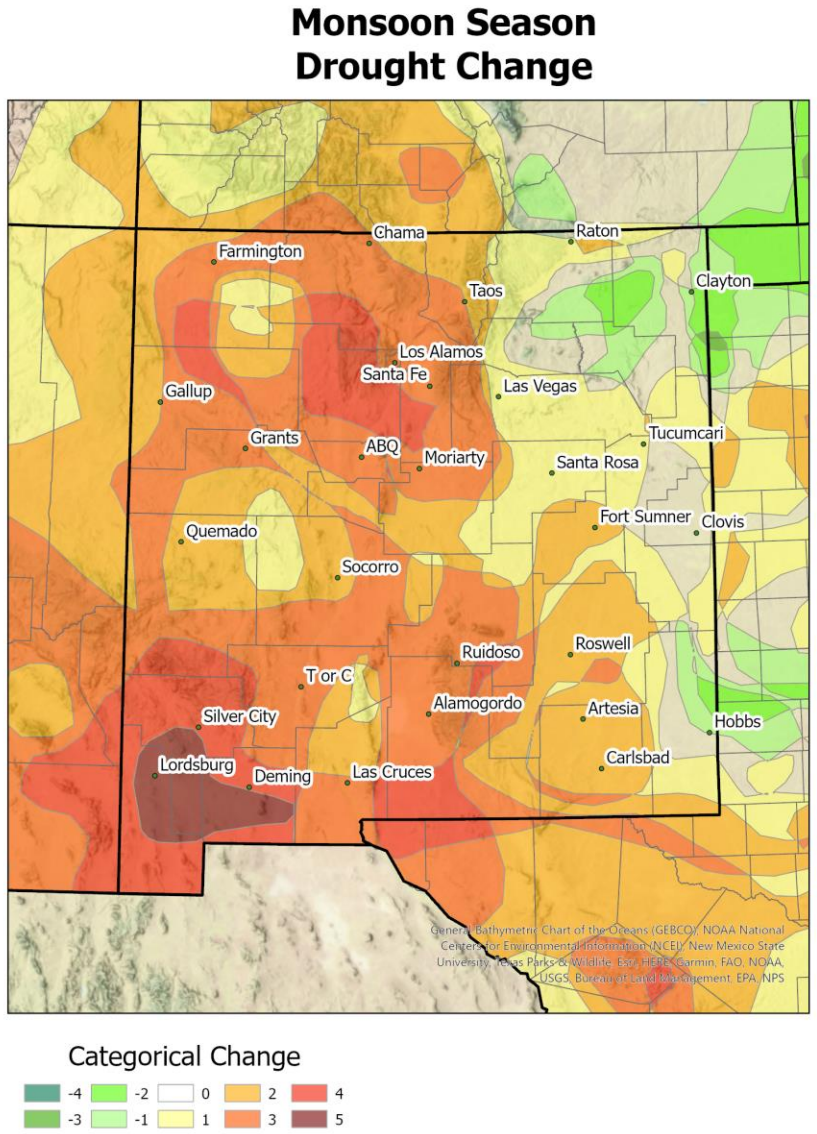
The image above shows the progression of the five drought categories from the U.S. Drought Monitor (USDM) from 2009 to 2023. The image on the right shows a more detailed progression of drought conditions in 2023. Drought deteriorated across NM during the summer of 2023. This is rare given the usual arrival of monsoon moisture. Since the inception of the USDM in 2000, drought conditions from the spring and early summer months have improved in all years except 2003 and 2020.

January 2023 through October 2023



New Mexico Drought

ALBUQUERQUE
Weather Forecast Office



The image on the left shows the categorical drought change from June 15th to September 30th for NM. The vast majority of NM saw degradation through the summer. The area between Lordsburg and Deming experienced a 5 category change from no drought to exceptional drought. The chart above shows western U.S. reservoir storage on October 1, 2023. NM reservoir storage is currently at 24% (2015 kaf) of median capacity which is below the 1991-2020 median of 30% (2499 kaf) for October 1st.

Northern & Central NM Wildfires 100+ Acres

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Weather Forecast Office

Incident information below was gathered for wildfires greater than 100 acres via nmfireinfo.com. This list is not a complete summary of all wildfires that were impacting the region between June 15th and September 30th, 2023. More detailed updates will become available in late 2023 and early 2024. Wildfire activity during 2023 was significantly reduced compared to 2022. Several limiting factors that may have contributed to a less active fire weather season included; above normal snowpack leading into the 2023 spring season, more springtime precipitation events, especially during May and early June 2023 across northern and eastern NM, as well as less frequent and less severe spring wind events.

Incident Name	Start/Detection Date	Location (County)	Acreage
Black Feather	August 5, 2023	Rio Arriba	2198
American Mesa	August 5, 2023	Rio Arriba	386
El Valle	September 8, 2023	Taos/Rio Arriba	525
Stout Canyon	September 5, 2023	Colfax	110
Rim	August 13, 2023	San Juan	150
West Mountain	August 3, 2023	Lincoln	598
Crosscut	July 27, 2023	Cibola	196
Hutchinson	July 23, 2023	Socorro	2816
West	August 1, 2023	Socorro	200
Mill	July 26, 2023	Socorro	600
Comanche	June 8, 2023	Rio Arriba	1974
Buford	September 19, 2023	Torrance/Lincoln	1500

Northern & Central NM Severe Weather

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Despite the dry conditions that impacted most of the region over the summer, there was actually a lot of severe weather that occurred over eastern NM. During the monsoon period from June 15th to July 31st there were 50 reports of large hail, 24 reports of severe thunderstorm winds, 2 funnel clouds spotted, and even one tornado. Many of these severe weather reports were focused over northeast NM. The pre-monsoon period from June 1st to June 15th was also very active across eastern NM when just over 50 reports of severe weather were received (not shown in table). The National Weather Service in Albuquerque issued the greatest number of Severe Thunderstorm Warnings for the month of June (181 warnings) dating back to 1986 and the 3rd most for the month of July (92 warnings). Tornado warnings were rare in 2023. Flash Flood Warning issuances were significantly reduced compared to 2022 when record monsoon rains fell over record wildfire acreage.

Storm Reports	Flash Flood	Large Hail	Severe Winds	Funnel Clouds	Tornado	Total
June 1-15	0	22	7	2	0	31
July 1-31	8	28	17	0	1	56
August 1-31	9	6	14	0	0	29
September 1-30	4	9	7	0	0	20

Resources

ALBUQUERQUE
Weather Forecast Office

2023 ArcGIS Monsoon Season Story Map

Questions/Comments – Email: sr-abq.webmaster@noaa.gov

- ABQ Monsoon Feature
- PRISM
- NCEI
- NOAA PSL Composites
- Climate Monsoon News
- ENSO Status
- IPCC Report
- CLIMAS
- NU SCI Magazine
- Syracuse University News