SOA Research Institute

Catastrophe and Climate

Actuarial Weather Extremes: July 2021

Globally Record Heat, Midwest U.S. Storms, Extreme Precipitation in Southwest U.S.

August 2021

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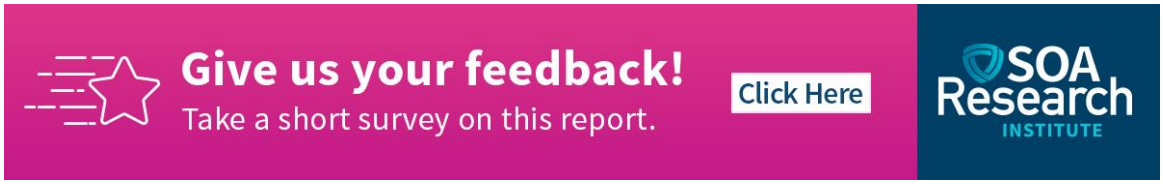

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Overview

This report examines weather conditions for daily maximum temperature (TMAX), inland storm activity from wind, hail and tornadoes, and record precipitation in the very dry extreme drought area of the Southwestern United States.

Globally, July 2021 was the Hottest Month on Record: According to the National Oceanic and Atmospheric Administration (NOAA), July 2021 was Earth's hottest July and month ever recorded since records began 142 years ago. It was 0.02 degrees F higher than the previous record set in July 2016, which was also tied in 2019 and 2020. [1] As seen in Figures 1 and 2, the record setting global monthly temperature was driven by records set in the Western U.S. and Canada and in Asia.

Active Storm Activity in the Midwestern U.S.: As seen in Figures 3–5, July 2021 wind, hail and tornado activity was high in Midwestern U.S. states, particularly in Nebraska and Iowa in the middle part of the month. During July 14, there were 26 tornadoes in Iowa, which was the 3rd highest single day occurrence since records began in 1980.[2]

Southwestern U.S. Precipitation: As seen in Figures 6–8, record precipitation was recorded at many stations across Arizona, New Mexico, Nevada and Utah in the U.S. There were a significant number of daily records in these states, in particular in Arizona which also had a statewide record for the month of July, looking back to 1960. These precipitation amounts alleviated some severe drought conditions in these states, particularly in Arizona, during July 2021, but also caused flash floods.[3]

Global Hottest Month

According to the NOAA, July 2021 was Earth's hottest month globally since records began 142 years ago. It was 0.02 of a degree F (0.01 of a degree C) higher than the previous record which occurred in July 2016, which was then tied in 2019 and 2020.[1] As seen in Figures 1 and 2, the record setting global monthly temperature was driven by record daily temperatures records set in the Western U.S. states and Canadian provinces and in Asia as seen in Figure 1. Figure 2 shows that many Western U.S. states and Canadian provinces had record or near record monthly

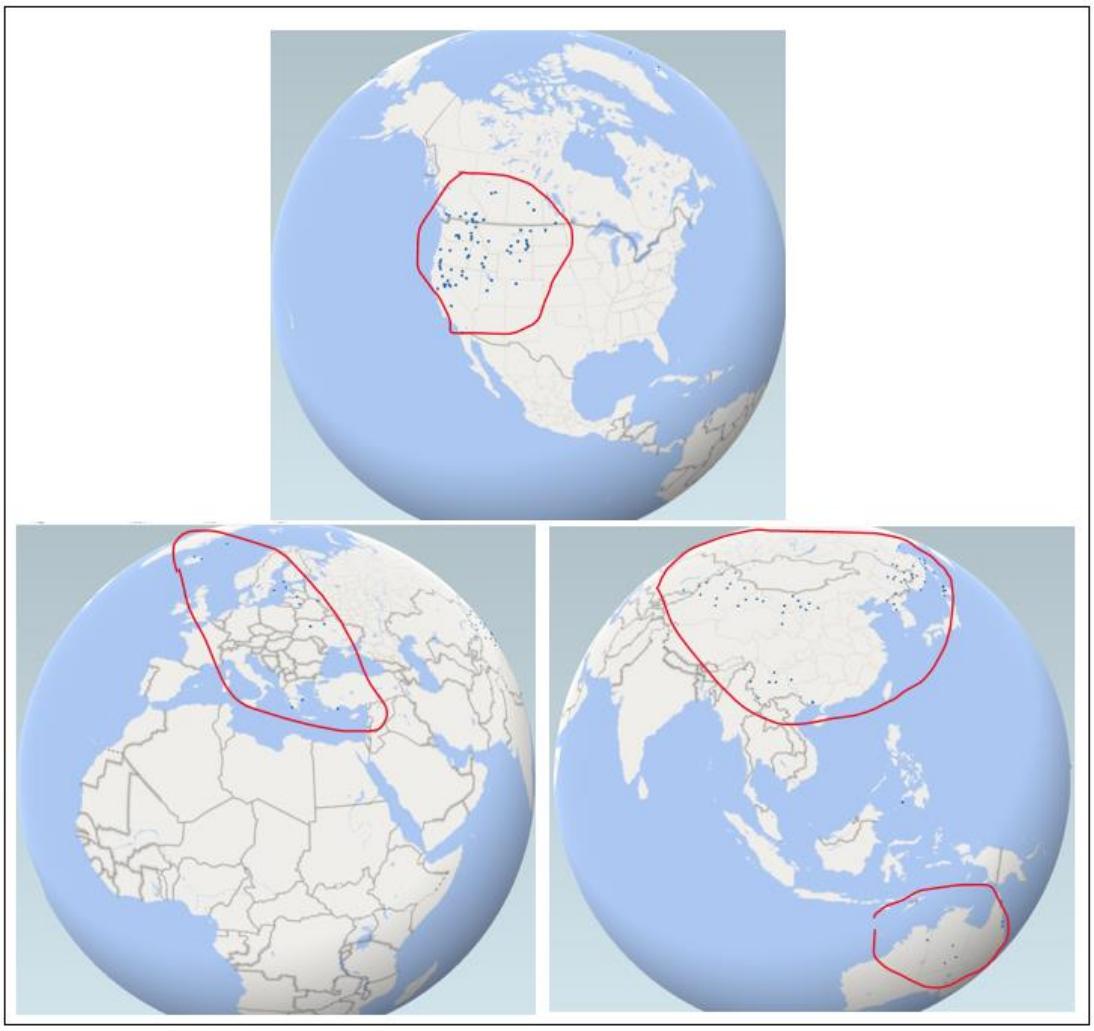
[1] National Oceanic and Atmospheric Administration. August 13, 2021. "It's official: July was Earth's hottest month on record." https://www.noaa.gov/news/its-official-july-2021-was-earths-hottest-month-on-record
[2] National Weather Service. July 25, 2021. "July 14, 2021 Iowa Tornado Outbreak." https://www.weather.gov/dmx/TornadoOutbreak_July14_2021
[3] Floodlist.com News. July 28, 2021. "USA—State of Emergency After Flash Floods in Utah, Nevada; 3 People Missing in New Mexico and Arizona." https://floodlist.com/america/usa/floods-utah-newmexico-nevada-july-2021

temperatures in July 2021 vs July 1960 –2020. For example, the province of Saskatchewan had a record TMAX for the month which was 101% of the previous monthly record in the period 1960-2020.

As reported by NOAA, with the July data, it appears likely that 2021 will be among the 10 warmest years on record. Also, NOAA Administrator Rick Spinrad gave a statement referring to the Intergovernmental Panel on Climate Change (IPCC)'s 6th Assessment Report recently released that: "Today, scientists from across the globe delivered the most up-to-date assessment of the ways in which the climate is changing. It is a sobering IPCC report that finds that human influence is, unequivocally, causing climate change, and it confirms the impacts are widespread and rapidly intensifying."[4]

Figure 1

GLOBAL HISTORICAL CLIMATOLOGY NETWORK (GHCN) STATION RECORDS FOR TMAX JULY 2021 VS JULY 1960 – 2020.

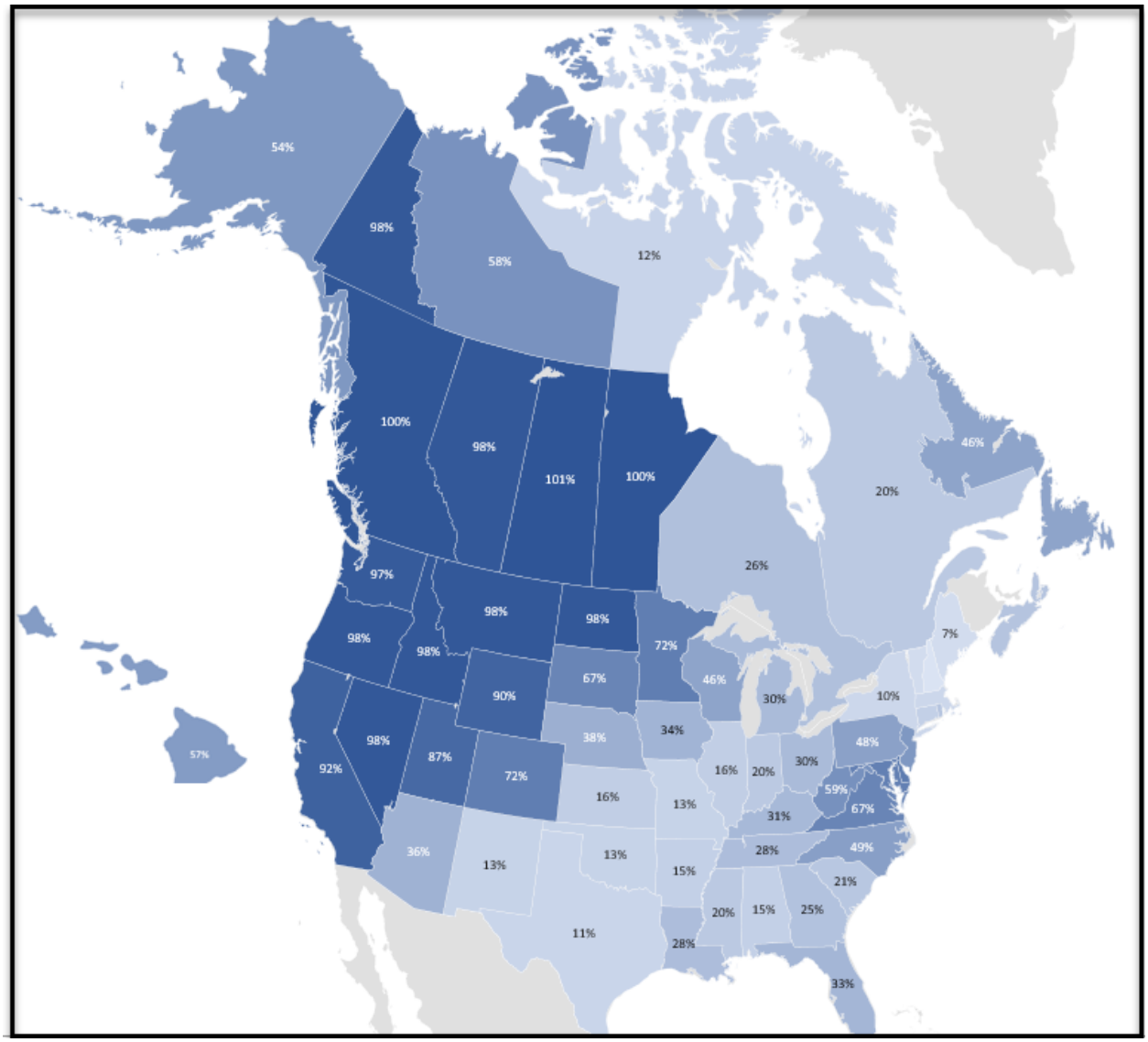


Source: Global Historical Climatology Network (GHCN) station data (Accessed August 5, 2021). https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz

[4] National Oceanic and Atmospheric Administration. August 9, 2021. https://www.noaa.gov/news-release/statement-from-noaa-administrator-rick-spinrad-on-new-ipcc-report

Figure 2

PERCENTILE RANKING OF MONTHLY TMAX BY STATE/PROVINCE IN U.S. AND CANADA JULY 2021 VERSUS HISTORICAL DATA 1960 –2020



Source: Global Historical Climatology Network (GHCN) station data (Accessed August 5, 2021). https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz

Active Storm Activity in Midwestern U.S.

As seen in Figures 3–5, July 2021 Wind, Hail and Tornado activity was high in Midwestern U.S. states, particularly in Nebraska and Iowa in the middle part of the month. During July 14, there were 26 tornadoes in Iowa, which was the 3rd highest single day occurrence since records began in 1980.[5] Particularly high daily activity occurred in Nebraska on July 9 with 186 reported storm incidents of high wind as shown in Figure 3, high hailstorm counts in Iowa on July

[5] National Weather Service. July 25, 2021. "July 14, 2021 Iowa Tornado Outbreak. https://www.weather.gov/dmx/TornadoOutbreak_July14_2021

9 (Figure 4), and high tornado report counts in Iowa on July 14 (Figure 5). Other impactful day/state combinations can be found in these figures. During the July 9 storms in Nebraska, approximately 200,000 homes lost power across the state.[6]

Figure 3

U.S. STATES WHICH HAD A DAY WITH AT LEAST 40 HIGH WIND REPORTS IN JULY 2021

	Count of Injury/Fatality																	
	Row Labels	KS	MO	VA	IL	NY	OH	MD	PA	DE	NJ	NE	MN	WI	MA	AZ	RI	Grand Total
222	210701	#	-	62	-	-	1	58	19	17	13	-	#	-	1	-	#	222
22	210702	#	-	-	-	2	-	-	5	#	5	-	#	-	-	4	#	22
16	210703	#	-	-	-	-	-	-	-	#	-	-	#	-	-	1	#	16
37	210704	5	-	-	-	-	-	-	-	#	-	-	#	-	-	-	#	37
30	210705	#	-	-	-	3	-	-	-	#	-	-	#	1	-	-	#	30
281	210706	3	-	-	-	107	-	-	34	#	43	1	3	13	25	-	#	281
365	210707	#	-	9	-	67	46	10	118	#	-	-	#	-	21	2	#	365
144	210708	#	2	3	1	19	7	-	28	#	26	-	#	-	-	1	#	144
432	210709	42	70	-	14	8	-	6	17	1	2	186	#	-	-	13	#	432
155	210710	9	10	7	8	-	1	-	-	#	-	1	#	-	-	42	#	155
116	210711	#	-	1	-	-	-	3	35	#	-	-	#	-	-	4	#	116
123	210712	#	-	1	1	-	-	9	28	2	29	-	#	-	-	5	#	123
179	210713	2	-	8	-	60	3	4	65	#	-	-	#	1	-	4	#	179
138	210714	#	-	34	7	3	-	27	-	#	6	-	#	11	11	1	#	138
54	210715	#	-	2	1	2	7	-	4	#	-	-	#	-	-	9	#	54
106	210716	1	-	-	1	-	26	-	18	#	2	4	#	-	6	1	#	106
233	210717	#	2	37	-	22	-	28	45	#	24	1	#	-	6	-	#	233
36	210718	6	-	3	-	-	-	-	-	#	-	-	#	-	-	1	#	36
39	210719	#	-	-	-	-	-	-	1	#	-	-	3	-	-	-	#	39
170	210720	#	-	-	-	105	2	-	9	#	-	-	#	-	1	3	#	170
54	210721	#	-	6	-	-	-	13	13	#	10	-	#	-	2	4	#	54
71	210722	#	-	-	-	-	-	-	-	#	-	-	#	-	-	5	#	71
99	210723	#	-	-	-	-	-	-	-	#	-	-	48	1	1	-	#	99
69	210724	2	-	6	10	-	1	-	-	#	-	1	#	-	-	1	#	69
65	210725	6	-	2	-	1	-	-	-	#	-	-	#	-	-	4	#	65
186	210726	4	-	58	-	-	-	20	-	#	-	-	15	40	-	-	#	186
202	210727	#	-	18	2	35	-	-	24	#	3	-	3	4	64	-	4	202
277	210728	#	-	24	61	-	-	4	10	#	-	-	1	86	-	-	#	277
194	210729	#	2	37	-	8	33	18	42	1	17	-	#	-	2	1	#	194
31	210730	#	1	-	-	-	-	-	-	#	-	1	#	-	-	3	#	31
78	210731	#	13	-	-	-	-	-	-	#	-	-	#	2	-	-	#	78
	Grand Total	80	100	318	106	442	127	200	515	21	180	195	73	159	140	109	4	4,224

Source: NOAA Storm Prediction Center (SPC) https://www.spc.noaa.gov/climo/reports/210701_rpts.html Date Accessed 8/7/2021.

[6] New Channel Nebraska. July 10, 2021. https://www.newschannelnebraska.com/story/44278117/power-outages-fallen-trees-among-the-damage-in-overnight-storm

Figure 4

U.S. STATES WHICH HAD A DAY WITH AT LEAST 10 HAILSTORM REPORTS IN JULY 2021

	Count of Location	Column Labels																
	Row Labels	IL	KS	MO	MN	IA	NE	WI	SD	PA	MD	NM	ND	ME	MT	NJ	NY	Grand Total
14	210701	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	14
11	210702	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	11
19	210703	-	-	-	-	-	3	-	7	-	-	-	5	-	-	-	-	19
21	210704	-	8	-	-	-	4	-	-	-	-	-	-	-	-	-	-	21
5	210705	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	1	5
39	210706	-	-	-	-	-	-	-	2	11	-	1	-	-	18	2	-	39
15	210707	-	-	-	-	-	-	-	-	4	-	1	-	-	1	-	2	15
77	210708	-	-	-	-	7	3	-	30	1	-	-	9	-	15	12	-	77
118	210709	11	-	17	-	53	22	-	2	-	-	-	-	-	-	-	-	118
16	210710	-	5	-	-	-	-	-	-	-	-	2	-	-	-	-	-	16
29	210711	-	-	-	-	-	-	-	-	-	-	18	-	-	1	-	-	29
4	210712	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	4
15	210713	-	1	-	2	1	1	1	-	3	-	-	-	-	-	-	-	15
14	210714	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	14
8	210715	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	8
21	210716	-	-	-	-	-	1	-	14	-	-	-	6	-	-	-	-	21
24	210717	-	-	-	-	-	-	-	4	2	1	-	1	-	-	2	5	24
23	210718	-	19	-	-	-	1	-	-	-	-	-	-	-	-	-	-	23
17	210719	-	-	-	2	-	-	-	-	-	-	-	14	-	-	-	1	17
24	210720	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	15	24
28	210721	-	-	-	-	-	-	-	-	9	-	-	-	-	8	10	-	28
2	210722	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2
36	210723	-	-	-	14	-	-	-	4	-	-	2	-	1	-	-	-	36
2	210724	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
39	210725	-	-	-	8	-	-	-	18	-	-	-	8	-	-	-	-	39
44	210726	-	-	-	26	-	-	11	1	-	1	-	1	-	-	-	-	44
14	210727	-	-	-	5	-	-	6	-	-	-	-	1	-	-	-	-	14
29	210728	-	-	-	12	-	-	3	-	-	9	-	-	-	-	-	-	29
21	210729	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	21
5	210730	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	5
3	210731	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Grand Total	13	35	19	69	64	35	23	86	31	21	26	45	1	45	33	26	737

Source: SPC https://www.spc.noaa.gov/climo/reports/210701_rpts.html Date Accessed: 8/7/2021

Figure 5

DAYS IN JULY 2021 WHICH HAD AT LEAST 10 TORNADOES IN AN INDIVIDUAL U.S. STATE

Count of Remarks				
Row Labels	210714	210728	210729	Grand Total
AZ	-	-	-	2
CO	-	-	-	3
CT	-	-	-	1
DC	-	-	-	2
DE	-	-	-	3
FL	-	-	-	3
GA	-	-	-	4
IA	57	-	-	57
IL	-	-	2	8
IN	-	-	2	2
KS	-	-	-	1
MD	-	-	1	1
MI	-	-	-	5
MN	-	-	-	4
MO	-	-	-	2
MT	-	-	-	1
NC	-	-	-	3
NE	-	-	-	2
NJ	-	-	2	5
NM	-	-	-	2
NV	-	-	-	1
NY	-	-	-	1
OH	-	-	12	13
PA	-	-	13	13
SC	-	-	-	5
TX	-	-	-	4
UT	1	1	-	3
VA	-	-	-	4
WI	-	18	-	18
WY	-	-	-	1
Grand Total	58	19	32	174

Source: SPC https://www.spc.noaa.gov/climo/reports/210701_rpts.html Date Accessed: 8/7/2021

Southwestern U.S. Precipitation

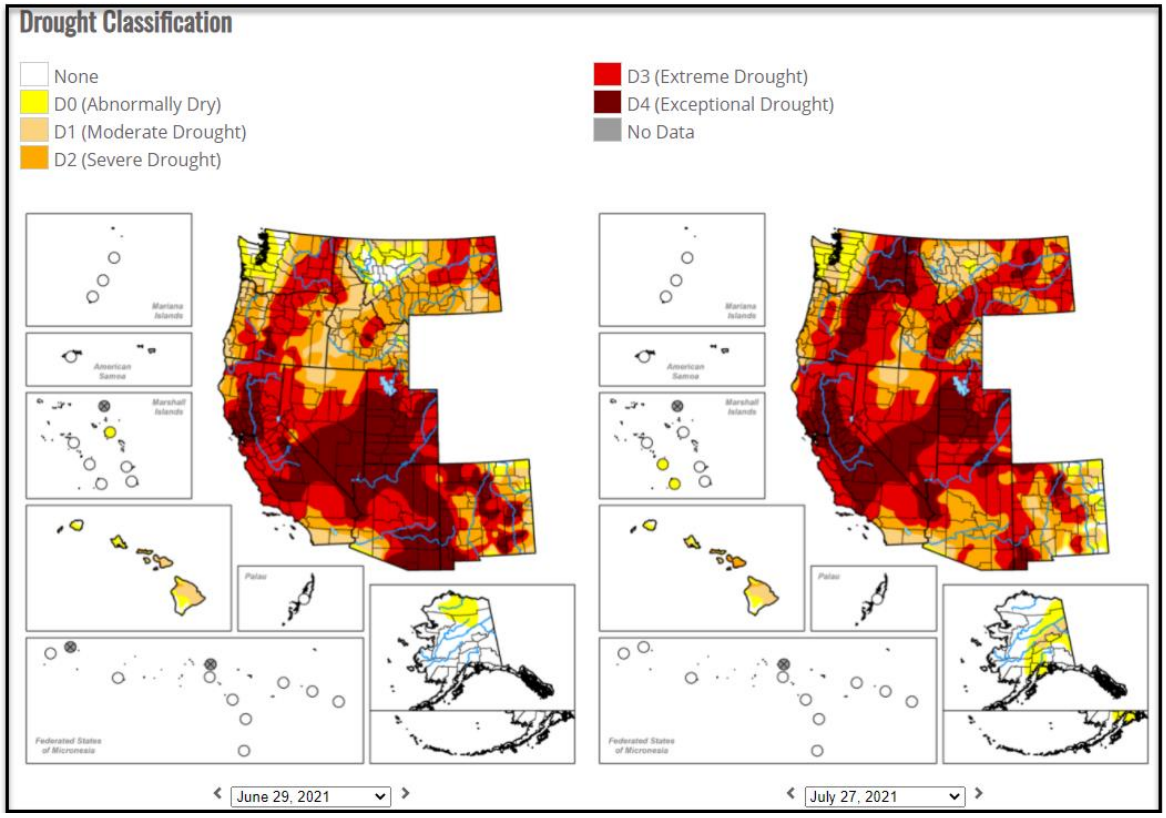
Figure 6 compares beginning and end of July 2021 drought conditions in the Western U.S. states. As shown in the figure, the most severe condition of Exceptional Drought decreased in area, and in the states of Arizona, New Mexico, Nevada and Utah, the conditions improved for the drought. The high precipitation that relieved the drought, also caused flash flooding in these states. Cedar City, Utah declared a state of emergency after July 26 flash

flooding. The rain overwhelmed flood control structures and left residential housing units un-inhabitable.[7] Figure 7 shows areas of precipitation that represent daily station records in Arizona, New Mexico, Nevada and Utah. Several stations recorded multiple record days in July 2021. Arizona had a large number of such daily records, and as shown in Figure 8, Arizona also had the highest precipitation during the month of July in 2021 when looking as far back as 1960, with an amount 112% of the previous monthly record.

Figure 6

COMPARISON OF DROUGHT CONDITIONS IN THE WESTERN U.S. DURING JULY 2021

Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4	DSCI
2021-06-29	33.01	66.99	58.52	51.26	37.26	16.60	231
2021-07-27	27.32	72.68	62.17	54.00	40.42	15.41	245
Change	-5.69	5.69	3.65	2.74	3.16	-1.19	14

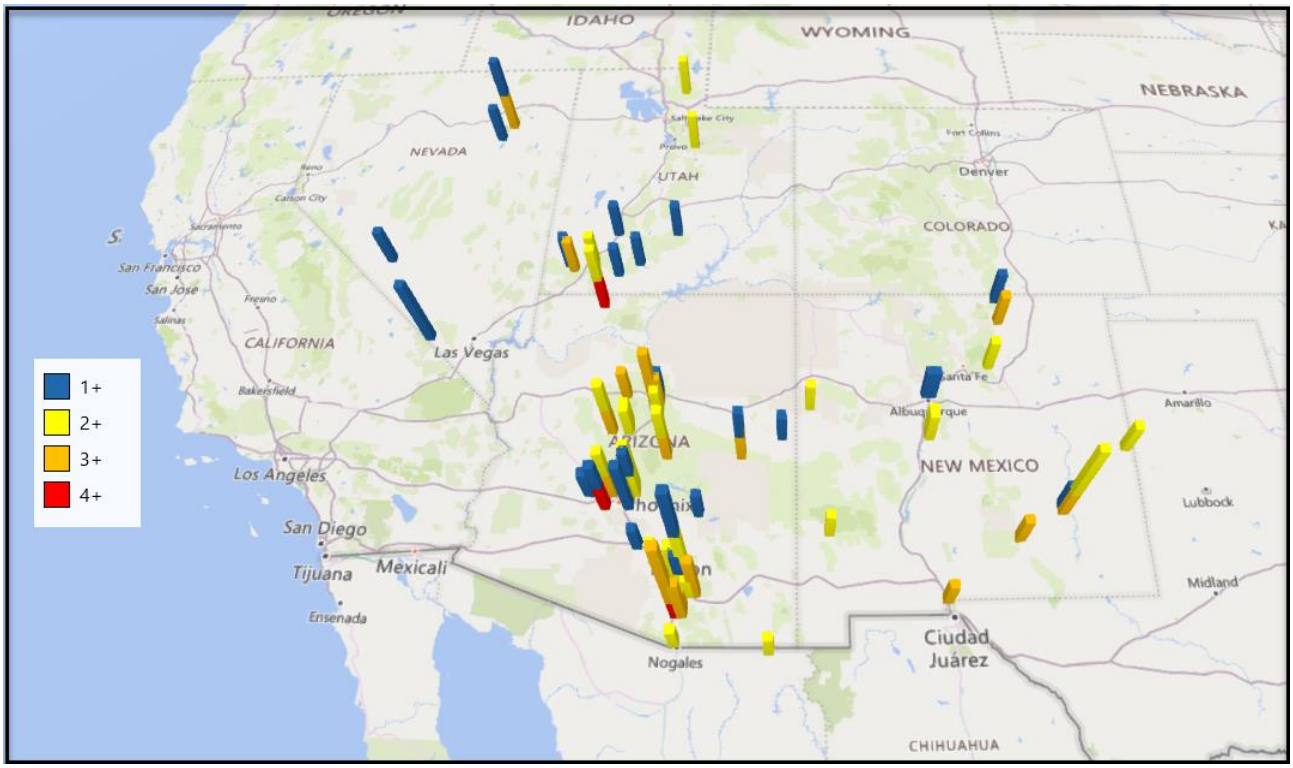


Source: https://droughtmonitor.unl.edu/Maps/CompareTwoWeeks.aspx The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.

[7] Floodlist.com News. July 28, 2021. https://floodlist.com/america/usa/floods-utah-newmexico-nevada-july-2021

Figure 7

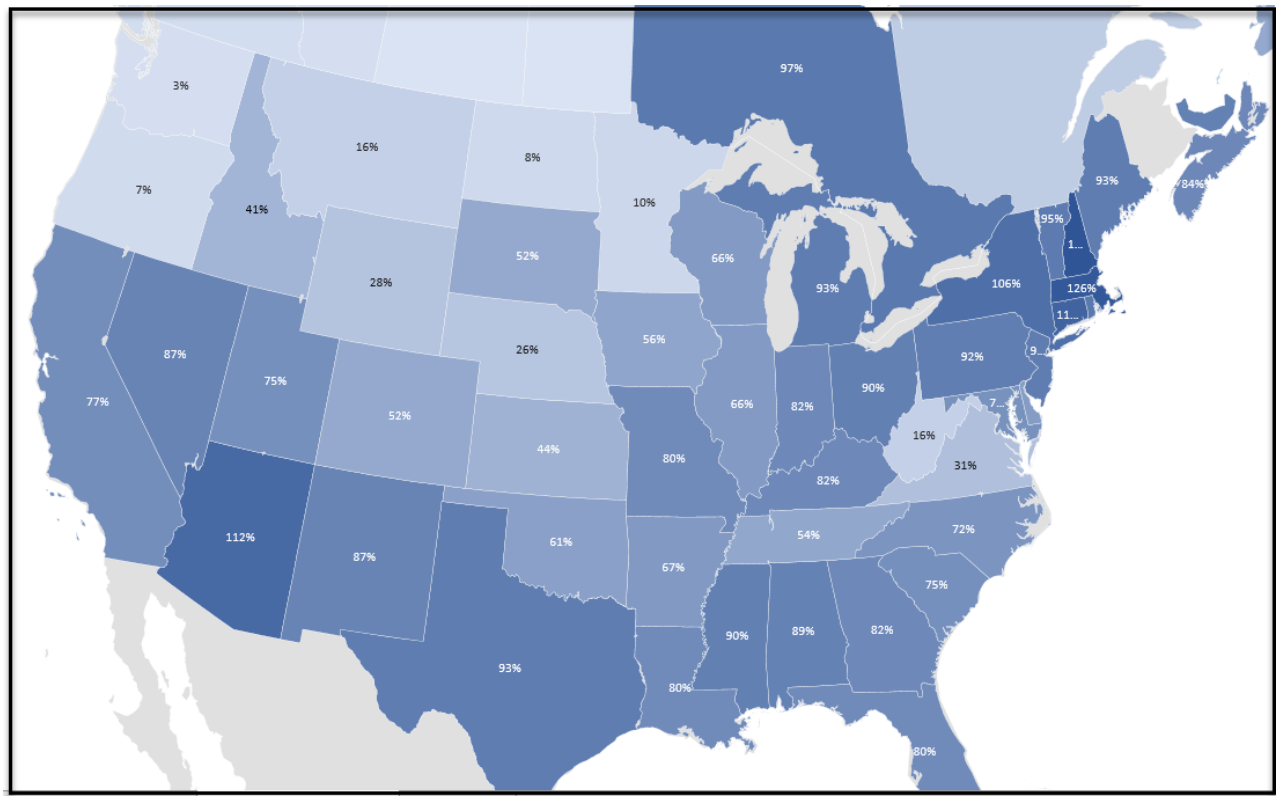
DAILY PRECIPITATION RECORDS FOR JULY DAYS 1960 –2021 OCCURRING IN JULY 2021 IN ARIZONA, NEW MEXICO, NEVADA AND UTAH AT STATIONS WITH ONE INCH OR MORE DAILY PRECIPITATION. STACKED BAR INDICATES MULTIPLE DAY OCCURANCES MEETING CRITERIA AT THAT STATION.



Source: Global Historical Climatology Network (GHCN) station data (Accessed August 5, 2021).
https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz

Figure 8

MONTHLY PRECIPITATION RANKING OF JULY 2021 AMONG JULY MONTHLY AMOUNTS IN 1960 –2021.



Source: Global Historical Climatology Network (GHCN) station data (Accessed August 5, 2021).
https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz

Rough Assessment of the Losses Caused by the Recent Extreme Weather

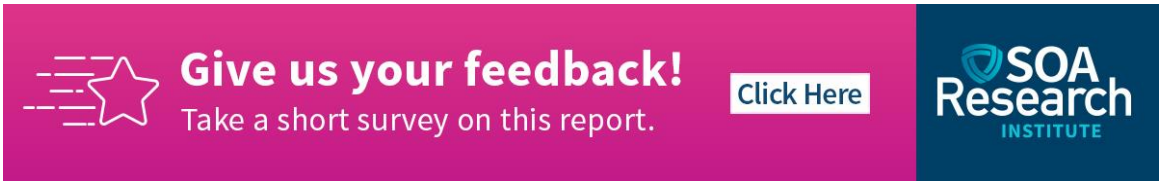
Economic and insured losses are often difficult to estimate in the immediate aftermath of an extreme weather event. With the passage of time, the extent of the losses gradually becomes clearer.

Storms in Midwest US

During the July 9 storms in Nebraska, approximately 200,000 homes lost power across the state.[8]

[8] New Channel Nebraska. July 10, 2021. https://www.newschannelnebraska.com/story/44278117/power-outages-fallen-trees-among-the-damage-in-overnight-storm

Feedback



Data

Temperature data and **Precipitation data** used in this report was obtained from the **Global Historical Climatology Network** ("GHCN") weather database, which provides daily weather observations from over 100,000 weather stations worldwide, covering over 180 countries. The database is publicly available through the National Oceanic and Atmospheric Administration (NOAA) via the following FTP site:

Source: https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/

Filename: ghcnd_all.tar.gz

National Weather Service Storm Prediction Center Reports
SPC: https://www.spc.noaa.gov/climo/reports/210701_rpts.html
This page will show all Tornado, Wind, and Hail reports for 7/1/2021
Select the "210702 Reports" button at the top to move to the next day

Acknowledgments

The authors wish to thank Matthew Self, ASA for supplying the SPC storm data used for this report.

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With roots dating back to 1889, the Society of Actuaries (SOA) is the world's largest actuarial professional organizations with more than 31,000 members. Through research and education, the SOA's mission is to advance actuarial knowledge and to enhance the ability of actuaries to provide expert advice and relevant solutions for financial, business and societal challenges. The SOA's vision is for actuaries to be the leading professionals in the measurement and management of risk.

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