

Catastrophe and Climate

Actuarial Weather Extremes

May 2021





Actuarial Weather Extremes: May 2021

Flooding, Severe Drought, Tornado, Wind and Hailstorms

AUTHOR

Rob Montgomery, ASA, MAAA, FLMI
Patrick Wiese, ASA
Society of Actuaries



Give us your feedback!
Take a short survey on this report.

[Click here](#)

**Caveat and Disclaimer**

This study is published by the Society of Actuaries (SOA) and contains information from a variety of sources. It may or may not reflect the experience of any individual company. The study is for informational purposes only and should not be construed as professional or financial advice. The SOA does not recommend or endorse any particular use of the information provided in this study. The SOA makes no warranty, express or implied, or representation whatsoever and assumes no liability in connection with the use or misuse of this study.

Copyright © 2021 by the Society of Actuaries. All rights reserved.

CONTENTS

Overview	4
Flooding in Texas and Louisiana	5
Most-Severe Drought Areas Expanding in Western U.S. States	10
Extreme Wind and Hail Events	11
Rough Assessment of the Losses Caused by the Recent Extreme Weather	13
Data	13
Acknowledgments	14
Feedback	14
About The Society of Actuaries	15

Actuarial Weather Extremes: May 2021

Flooding, Severe Drought, Tornado, Wind and Hailstorms

Overview

This report examines weather extremes for flooding, drought, and severe storms. The flooding was the result of extreme daily rain amounts May 17-18, 2021 which lead to many streamflow stations registering May average streamflow amounts in the above the 95th percentile looking at months of May 1960-2021. Conversely, in the Western U.S., extreme drought conditions have worsened such that a greater portion of the geographic area is in the most extreme drought categories versus lesser or no-drought categories. In early May and in late May, widespread hail and windstorms impacted the Southeast U.S and Northeast U.S. respectively.

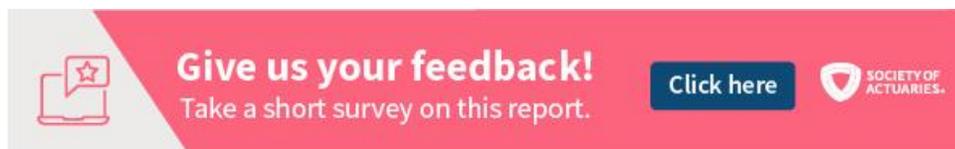
Flooding in Texas and Louisiana: As seen in Figures 1 through 5, heavy rains in Texas and Louisiana lead to extreme flooding conditions in an historical context when viewing May 2021 vs all May months in the period 1960-2021.

Most Severe Drought Expanding in the Western U.S.: The severe drought conditions in the Western U.S. have expanded such that a greater amount of the geographic area of the region now exists in the most severe drought categories, as shown in Figure 6. The State of California proposed a plan to invest \$2 Billion for emergency preparedness equipment and to restore California's wildfire susceptible landscape to be more resilient. ¹

Wind, Hail, Tornado Storms: As shown in Figures 7-10, a large wind, hail and tornado event impacted the Southern U.S. on May 2-4, and on May 26, a large wind event impacted Virginia through New York knocking out power with upward of 90,000 outages being reported, along with injuries from hail and building collapse.²

Other May 2021 Extreme Weather Notes:

- Tropical Storm Ana formed on May 22. This was the seventh year in a row that a named tropical cyclone formed before the June 1 official start to Hurricane Season.
- In 2020 there were 30 named storms in the Atlantic basin. This included 11 hurricanes, of which 7 were major hurricanes. ³ For 2021, the National Oceanic and Atmospheric Administration (NOAA) predicts there will be 13-20 named storms in the Atlantic basin, including 6-10 hurricanes, of which 3-5 will be major hurricanes. ⁴



¹ State of California. May 24, 2021. [At McClellan Air Force Base, Governor Newsom Highlights New Firefighting Aircraft, \\$2 Billion in Wildfire and Emergency Preparedness Investments | California Governor](#)

² Weather.com May 26, 2021. [Severe Weather Leaves Damage, Knocks Out Power to Thousands in Pennsylvania, New York and Virginia | The Weather Channel - Articles from The Weather Channel | weather.com](#)

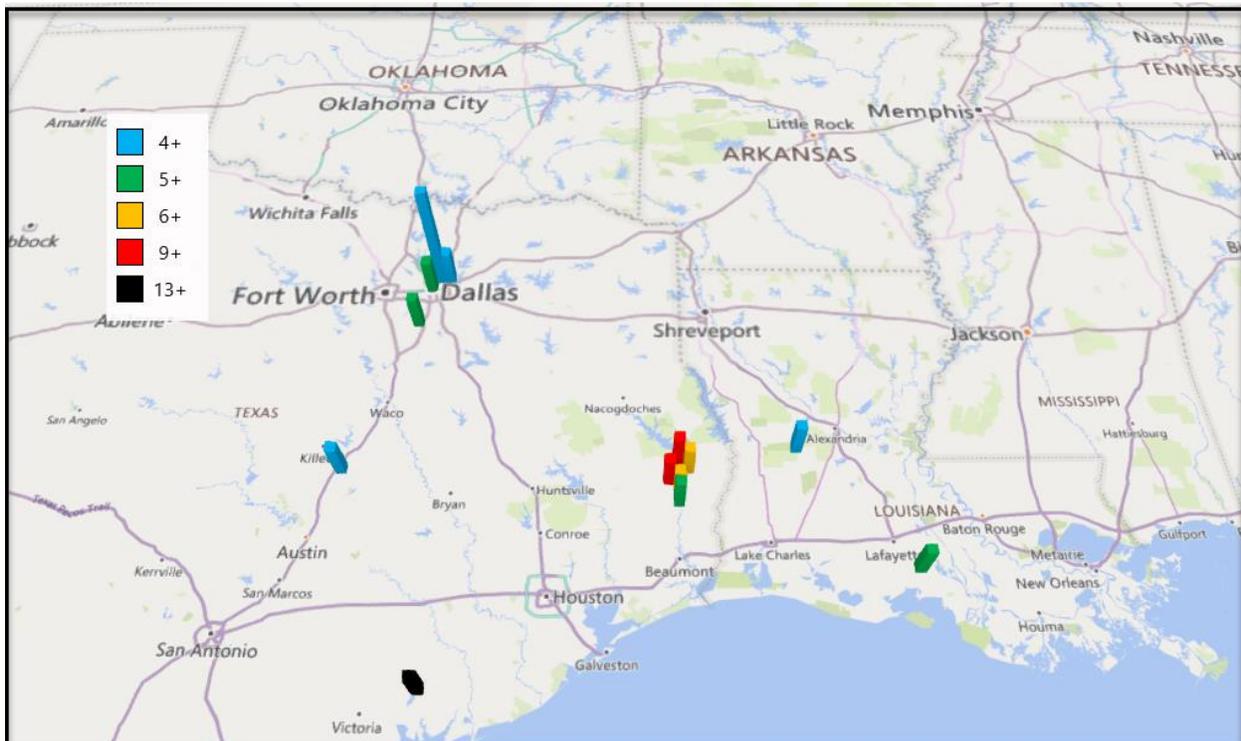
³ NOAA. Updated June 10, 2021. [Record-breaking Atlantic hurricane season draws to an end | National Oceanic and Atmospheric Administration \(noaa.gov\)](#)

⁴ NOAA. May 20, 2021. [NOAA predicts another active Atlantic hurricane season | National Oceanic and Atmospheric Administration](#)

Flooding in Texas and Louisiana

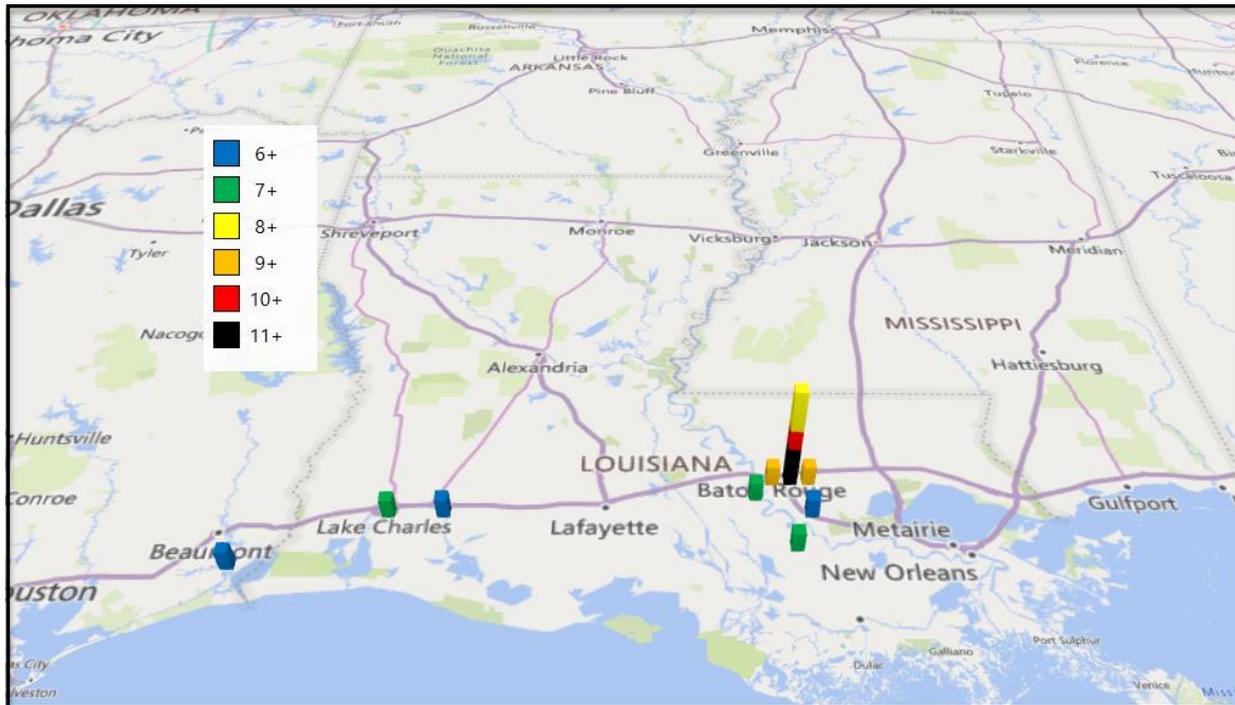
As seen in Figures 1 and 2, heavy daily precipitation amounts were recorded in Southern Texas and Louisiana on May 17 and 18. In some cases, daily totals were more than 10 inches. Figures 1 and 2 show Global Historical Climatology Network (GHCN) stations which recorded the highest May 17 or May 18 totals back to 1960, which were more than four inches (May 17) and six inches (May 18). Figure 3 shows a time-lapse animation of the month of May with simultaneous precipitation amounts and flood levels. These mid-May periods can be noted in the time-lapse. Figure 4 then has the May 2021 streamflow averages vs all May averages back to 1960. By the color indications, many stations in the Texas and Louisiana areas were between the 90th and 100th percentile. Finally, Figure 5 shows the daily build-up of flooding conditions for one station in Southern Texas, where moderate flooding occurred in mid-to late may, and for which Major flooding occurred earlier in the month. This is an example of one station’s data which contributes to the graphics that are contained in this report.

Figure 1
GLOBAL HISTORICAL CLIMATOLOGY NETWORK (GHCN) STATIONS IN TEXAS AND LOUISIANA WITH MAY 17 DAILY TOTAL PRECIPITATION RECORDS IN EXCESS OF 4 INCHES FOR MAY 17, 2021 VS THE MAY 17 AMOUNTS IN THE PERIOD 1960 – 2021.



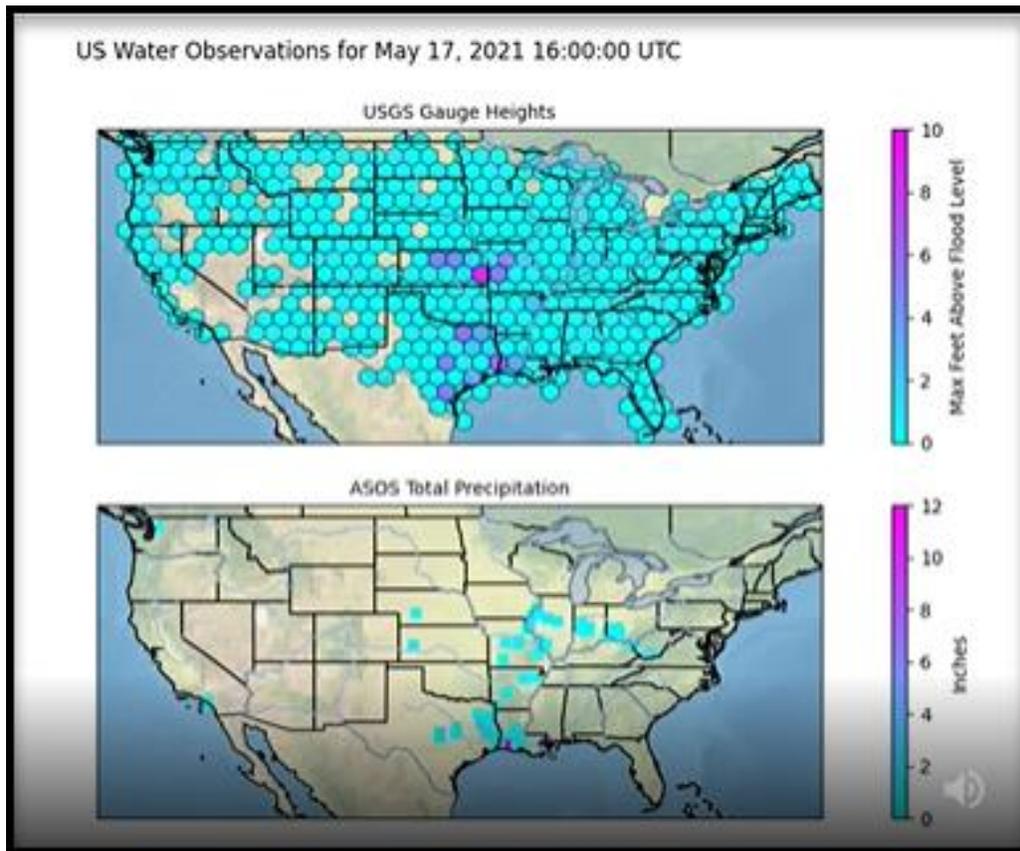
Source: Global Historical Climatology Network (GHCN) station data (Accessed June 4, 2021).
ftp://ftp.ncdc.noaa.gov/pub/data/gHCN/daily/gHCNd_all.tar.gz

Figure 2
GHCN STATIONS IN TEXAS AND LOUISIANA WITH MAY 18 DAILY TOTAL PRECIPITATION RECORDS IN EXCESS OF SIX INCHES FOR MAY 18, 2021 VS THE MAY 18 AMOUNTS IN THE PERIOD 1960 – 2021.



Source: Global Historical Climatology Network (GHCN) station data (Accessed June 4, 2021).
ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz

Figure 3
MAY 2021 PRECIPITATION AND FLOOD LEVELS TIME LAPSE



Source: 1) United States Geological Survey (USGS) Gauge Heights Real-Time Values:
<https://waterservices.usgs.gov/rest/IV-Test-Tool.html>

2) IA State (ASOS) Precipitation: <https://mesonet.agron.iastate.edu/request/download.phtml>
Accessed on June 5, 2021.

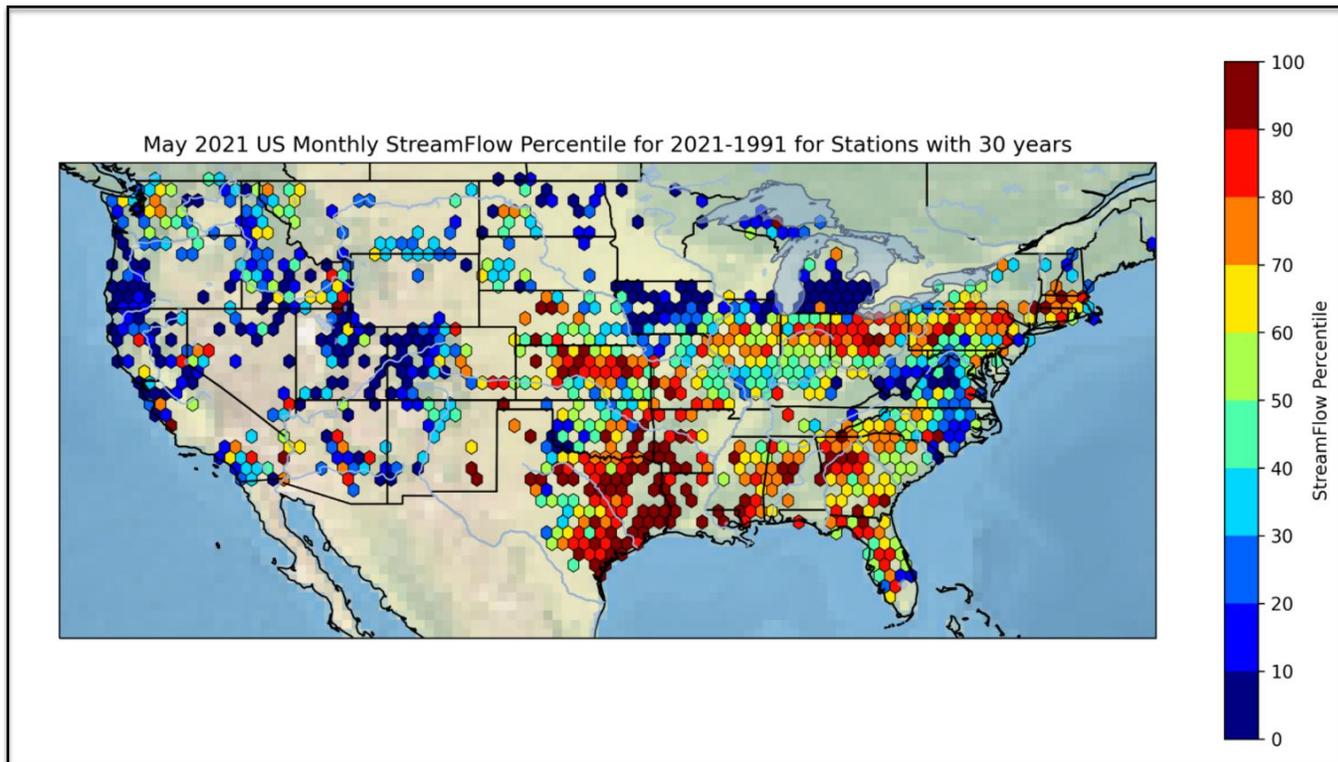
The animation for the maps shown in Figure 3 can be viewed by clicking on this link, and then clicking on the map that pops-up.

Sea, River, Buoy: <https://public3.basecamp.com/p/M8bYeHUdgNWEtRT8s7QbYYPQ5>

Time Lapse animations created by Matthew Self, ASA using ASOS data and Python programming. Data accessed June 5, 2021.

Figure 4

MAY 2021 STREAMFLOW PERCENTILE FROM WITHIN THE MAY PERIODS IN 1991 TO 2021



Source: Real-time Values (accessed June 5, 2021): <https://waterservices.usgs.gov/rest/IV-Test-Tool.html>

Figure 5
MAY 2021 DAILY FLOOD STAGE READINGS FOR EXAMPLE STATION IN TEXAS

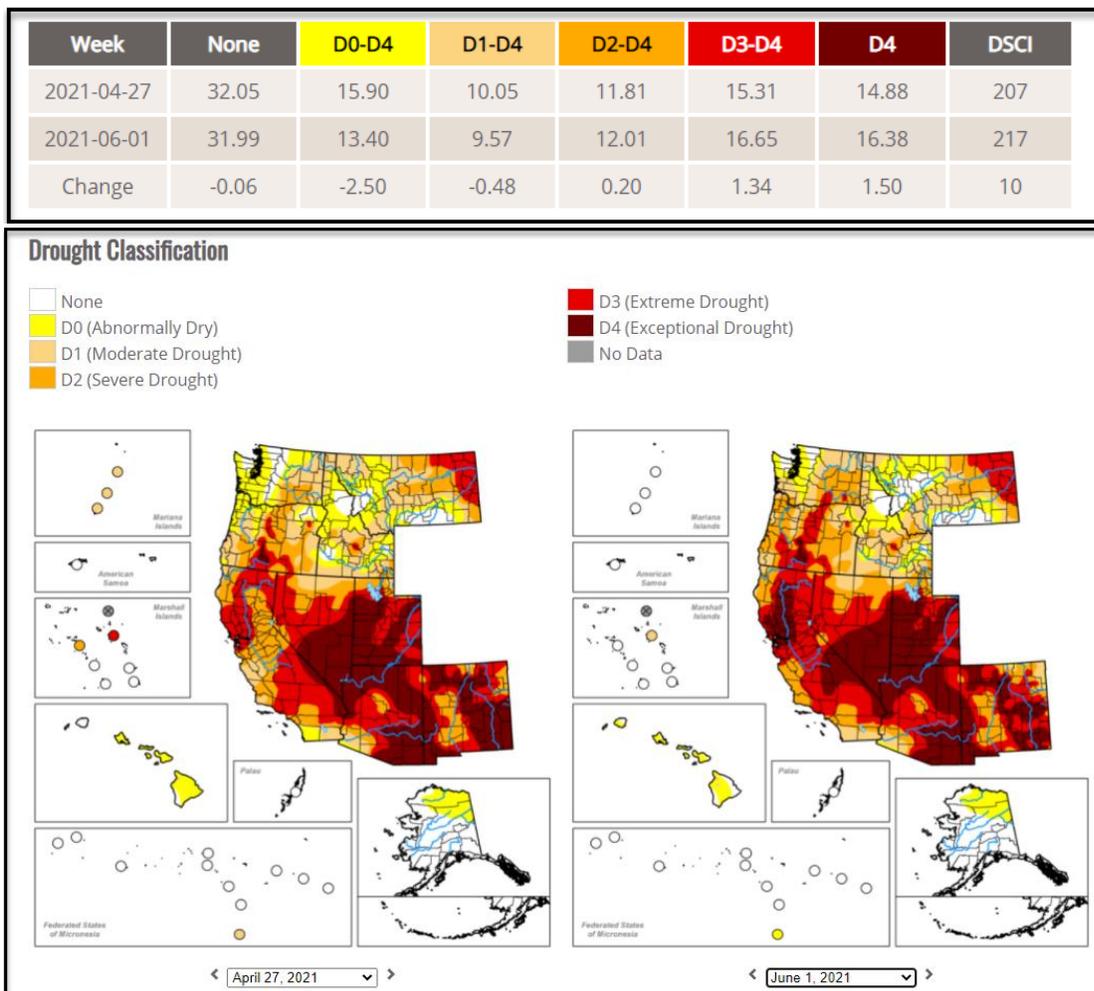
station_nm	action_stage	flood_stage	moderate_flood_ stage	major_flood_ stage	Observation_ Date	Sum of daily_obs_avg	Flood_Status
San Bernard Rv nr Boling, TX	14	18	22	32	5/1/2021	17.43	Action
San Bernard Rv nr Boling, TX	14	18	22	32	5/2/2021	32.54	Major Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/3/2021	32.07	Major Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/4/2021	28.30	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/5/2021	25.73	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/6/2021	23.55	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/7/2021	21.34	Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/8/2021	18.27	Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/9/2021	13.03	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/10/2021	9.18	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/11/2021	7.02	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/12/2021	5.62	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/13/2021	4.79	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/14/2021	4.26	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/15/2021	3.89	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/16/2021	3.70	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/17/2021	4.80	None
San Bernard Rv nr Boling, TX	14	18	22	32	5/18/2021	15.23	Action
San Bernard Rv nr Boling, TX	14	18	22	32	5/19/2021	23.35	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/20/2021	26.65	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/21/2021	22.80	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/22/2021	23.08	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/23/2021	24.33	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/24/2021	23.93	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/25/2021	23.74	Moderate Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/26/2021	21.07	Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/27/2021	19.15	Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/28/2021	18.03	Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/29/2021	18.99	Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/30/2021	18.17	Flood
San Bernard Rv nr Boling, TX	14	18	22	32	5/31/2021	16.14	Action
San Bernard Rv nr Boling, TX	14	18	22	32	6/1/2021	16.61	Action

Source: Real-time Values (accessed June 5, 2021): <https://waterservices.usgs.gov/rest/IV-Test-Tool.html>

Most-Severe Drought Areas Expanding in Western U.S. States

Figure 6 compares late April 2021 vs Late May 2021 (June 1) drought conditions in the Western U.S. As indicated in the table below, the areas of No-Drought, Abnormally Dry and Moderate Drought conditions have lessened, and the areas of Severe Drought, Extreme Drought and Exceptional Drought have increased. These severe conditions have persisted now for several months. As reported in the New York Times, much of the Western half of the U.S. is in a drought of historic proportions. This includes drought emergencies, water cutbacks, suffering agriculture, and wildfires burning earlier than usual.⁵

Figure 6
COMPARISON OF DROUGHT CONDITIONS IN THE WESTERN U.S. OVER MAY 2021



Source: [Compare Two Weeks | U.S. Drought Monitor \(unl.edu\)](https://www.unl.edu/drought-monitor/compare-two-weeks)

[Permission | U.S. Drought Monitor \(unl.edu\)](https://www.unl.edu/drought-monitor/compare-two-weeks)

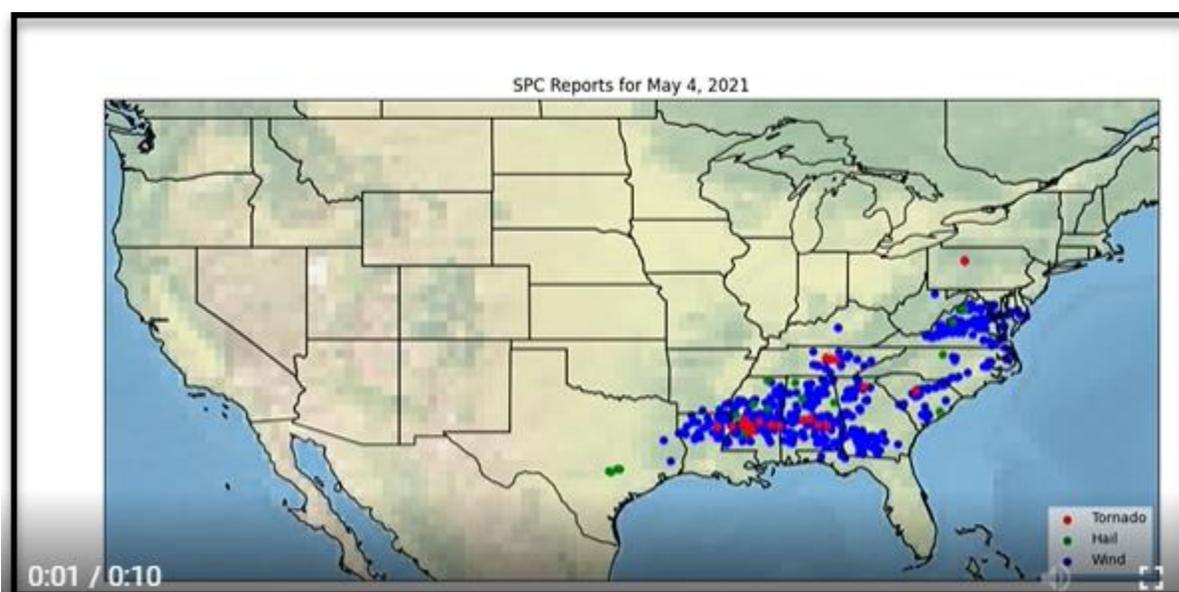
The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.

⁵ New York Times. June 17, 2021. [What To Know About The Drought in California and Western Half of US - The New York Times \(nytimes.com\)](https://www.nytimes.com/2021/06/17/us/drought-western-us.html)

Extreme Wind and Hail Events

As shown in Figures 7-10, there were a large number of wind, hail and tornado events in May 2021. In Texas, over 500 hail report were recorded during May 2021, including seven reports of hail size 4 inches or greater (Figure 8). Over 700 high wind reports were recorded on May 4, and over 400 on May 26 (Figure 9). In Mississippi, there were 52 tornadoes reported from May 2-4 (Figure 10). During the May 26 event, impacting Virginia through New York, upward of 90,000 power outages were being reported along with injuries from hail and building collapse.⁶

Figure 7
MAY 2021 TORNADO, WIND, & HAIL REPORTS TIME LAPSE



Source SPC: https://www.spc.noaa.gov/climo/reports/210501_rpts.html Date Accessed: 6/5/2021

The animation for the map shown in Figure 7 can be viewed by clicking on this link, and then clicking on the map that pops-up.

SPC Tornado, Wind, & Hail: <https://public.3.basecamp.com/p/M3k9mmjREx3pbRKgMDgw1ATv>

Time Lapse animations created by Matthew Self, ASA using ASOS data and Python programming. Data accessed June 5, 2021.

⁶ Weather.com May 26, 2021. [Severe Weather Leaves Damage, Knocks Out Power to Thousands in Pennsylvania, New York and Virginia | The Weather Channel - Articles from The Weather Channel | weather.com](#)

Figure 8
MAY 2021 HAIL REPORTS IN 1/100THS OF AN INCH (550 = 5.5 INCHES)

Count of Date	Column Labels	100	125	150	157	175	180	190	200	220	225	230	250	270	275	300	325	361	400	425	450	550	Grand Total
TX		197	67	66	1	81	-	-	46	1	-	-	25	-	19	8	-	-	2	2	1	2	518

Source SPC: https://www.spc.noaa.gov/climo/reports/210501_rpts.html Date Accessed: 6/5/2021

Figure 9
MAY 2021 HIGH WIND REPORTS SUMMARY

Row Labels	FL	GA	LA	MS	TX	SC	OK	AR	KY	TN	NH	KS	MO	AL	NC	VA	IA	IL	IN	NY	OH	MD	PA	NJ	WI	MI	WV	SD	VT	Grand Total
210503		28			26	29	15	53	15	41			14	7	6	3		4				9					11		261	
210504		3	108	44	158	2	44		4	2	23			125	19	157						10	1				1		707	
210506		6			17				3	3	40			32				1	1										103	
210509				5	29	17			7		6			13															82	
210511		3	4	11		33	6																						57	
210516						13		4				4						2											27	
210517				3		30		2																					37	
210518				3		27		2	6																				38	
210519				1		6																							14	
210523												2															38		57	
210525			1		9							1				6	1		1			7	40		33	19			71	
210526					11		6				22	39	1			38			65	7	40	116	50		6	17		464		
210527				12		16		17	4			3	35				1	16	1									107		
210528					34	10				9						13						2							85	
Grand Total		12	140	80	204	224	89	46	77	20	119	22	49	50	177	25	217	1	24	2	66	7	61	117	50	33	19	18	38	2,110

Source SPC: https://www.spc.noaa.gov/climo/reports/210501_rpts.html Date Accessed: 6/5/2021

Figure 10
MAY 2021 TORNADO REPORTS SUMMARY

Count of Injury/Fatality	Column Labels	210502	210503	210504	210505	210506	210509	210510	210511	210513	210514	210515	210516	210517	210518	210519	210520	210522	210523	210524	210526	210527	210528	210529	210530	210531	Grand Total	
AL		2		4																							6	
AR			2				1								1												4	
CO		1									2	2						10	10						1	4	1	31
GA			9	1																							10	
IA																											1	
IL			7			9																					18	
IN										1					1					24	19						45	
KS																											6	
KY			6																								17	
LA			3		2				1						10												3	
MD																											3	
MN																	10										11	
MO					1					1																	3	
MS			37		15			1							8												60	
NC																											1	
ND																											1	
NE			2		6																						22	
NM															9												16	
OK				1																							7	
PA				1	1																						2	
SC				11	1																						12	
SD													1								7	1					9	
TN			14	3			3																				22	
TX			8					1	2						8	9	5		3								52	
VA																											2	
WV																											1	
WY														1													1	
Grand Total		45	65	27	6	9	4	2	3	1	1	3	10	30	14	11	4	10	17	25	42	6	6	3	14	5	383	

Source SPC: https://www.spc.noaa.gov/climo/reports/210501_rpts.html Date Accessed: 6/5/2021



Give us your feedback!
Take a short survey on this report.

[Click here](#)



SOCIETY OF ACTUARIES.

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.

Texas and Louisiana heavy rains and flooding

There were five storm related deaths, mostly related to driving into high water, in Texas and Louisiana from the mid-May 2021 rain-storm event.⁷

Western U.S. Drought

The State of California proposed a plan to invest \$2 Billion for emergency preparedness equipment and to restore California's wildfire susceptible landscape to be more resilient. In April 2021, California implemented an early action wildfire package which included funding for "home hardening" in at-risk communities. Home Hardening measures include improvements to a home's roof, windows, walls, etc. to make it more able to withstand the effects of wildfire.⁸

Wind, Hail, and Tornado

As damages are tallied and claims come in, we can look to update the economic and insured impacts from the May 2-4 storms in the Southern U.S. and the May 26 windstorms in the Northeast U.S.

Data

Snow, Precipitation and temperature 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:

ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz

Filename: [ghcnd_all.tar.gz](#)

Automated Surface Observing System (ASOS) temperature and precipitation data

The steps below show how to get the hourly temperature and precipitation at the STL Airport, as an example, from the Iowa State University Automated Surface Observing System (ASOS):

IA State: <https://mesonet.agron.iastate.edu/request/download.phtml>

- 1) Select "Missouri ASOS" as the network and click "Switch to Network"
- 2) In the list of available stations, select the "[STL] ST. LOUIS" station, and click "Add Selected"

⁷ Reuters. May 21, 2021. [Heavy rain may bring more floods to Louisiana, Texas; 5 dead | Reuters](#)

⁸ State of California. May 24, 2021. [At McClellan Air Force Base, Governor Newsom Highlights New Firefighting Aircraft, \\$2 Billion in Wildfire and Emergency Preparedness Investments | California Governor](#)

- 3) In the “Select From Available Data” section, choose the “Air Temperature [F]” and “1 hour Precipitation [inch]” options.
- 4) Set the date range to 2020-October-1 and 2020-October-31 (or whatever range is desired)
- 5) Select “Yes” for “Include Latitude + Longitude”
- 6) Click “Get Data” at the bottom

These steps would give you the results from the URL below.

https://mesonet.agron.iastate.edu/cgi-bin/request/asos.py?station=STL&data=tmpf&data=p01i&year1=2020&month1=10&day1=1&year2=2020&month2=10&day2=31&tz=Etc%2FUTC&format=onlycomma&latlon=yes&elev=no&missing=M&trace=T&direct=no&report_type=1&report_type=2

USGS Gauge Heights

Real-Time Values: <https://waterservices.usgs.gov/rest/IV-Test-Tool.html>

1. Select “List of Sites” in the Major Filters section and enter the Site Number(s) of interest
2. In the Date Ranges section, select “Return all values within an absolute date range” and enter the Date Range of interest
3. For “Parameter Codes”, enter **00060** for Discharge, cubic feet per second or **00065** for Gage Height, feet.
4. At the bottom click “Generate the URL” then click “Run the Generated URL”

National Weather Service Storm Prediction Center Reports

SPC: https://www.spc.noaa.gov/climo/reports/210501_rpts.html

This page will show all Tornado, Wind, and Hail reports for 5/1/2021
Select the “210502 Reports” button at the top to move to the next day

Acknowledgments

The authors wish to thank Matthew Self, ASA for the monthly flood, hail, wind, tornado and precipitation data and analysis that were used for this report.

Feedback



Give us your feedback!

Take a short survey on this report.

Click here



SOCIETY OF
ACTUARIES.

About The Society of Actuaries

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.

The SOA supports actuaries and advances knowledge through research and education. As part of its work, the SOA seeks to inform public policy development and public understanding through research. The SOA aspires to be a trusted source of objective, data-driven research and analysis with an actuarial perspective for its members, industry, policymakers and the public. This distinct perspective comes from the SOA as an association of actuaries, who have a rigorous formal education and direct experience as practitioners as they perform applied research. The SOA also welcomes the opportunity to partner with other organizations in our work where appropriate.

The SOA has a history of working with public policymakers and regulators in developing historical experience studies and projection techniques as well as individual reports on health care, retirement and other topics. The SOA's research is intended to aid the work of policymakers and regulators and follow certain core principles:

Objectivity: The SOA's research informs and provides analysis that can be relied upon by other individuals or organizations involved in public policy discussions. The SOA does not take advocacy positions or lobby specific policy proposals.

Quality: The SOA aspires to the highest ethical and quality standards in all of its research and analysis. Our research process is overseen by experienced actuaries and nonactuaries from a range of industry sectors and organizations. A rigorous peer-review process ensures the quality and integrity of our work.

Relevance: The SOA provides timely research on public policy issues. Our research advances actuarial knowledge while providing critical insights on key policy issues, and thereby provides value to stakeholders and decision makers.

Quantification: The SOA leverages the diverse skill sets of actuaries to provide research and findings that are driven by the best available data and methods. Actuaries use detailed modeling to analyze financial risk and provide distinct insight and quantification. Further, actuarial standards require transparency and the disclosure of the assumptions and analytic approach underlying the work.

Society of Actuaries
475 N. Martingale Road, Suite 600
Schaumburg, Illinois 60173
www.SOA.org