Actuarial Weather Extremes: May 2021
Flooding, Severe Drought, Tornado, Wind and Hailstorms

AUTHOR

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

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

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

2) IA State (ASOS) Precipitation: https://mesonet.agron.iastate.edu/request/download.phtml

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://public.3.basecamp.com/p/M8bYeHUidgNWET8s7QoPQ5

Figure 4
MAY 2021 STREAMFLOW PERCENTILE FROM WITHIN THE MAY PERIODS IN 1991 TO 2021

**Figure 5**

**MAY 2021 DAILY FLOOD STAGE READINGS FOR EXAMPLE STATION IN TEXAS**

<table>
<thead>
<tr>
<th>station_nm</th>
<th>action_stage</th>
<th>flood_stage</th>
<th>moderate_flood</th>
<th>major_flood</th>
<th>Observation Date</th>
<th>Sum of daily_obs_dui</th>
<th>Flood_Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/1/2021</td>
<td>17.43</td>
<td>Action</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/2/2021</td>
<td>32.54</td>
<td>Major Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/3/2021</td>
<td>22.07</td>
<td>Major Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/4/2021</td>
<td>28.30</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/5/2021</td>
<td>25.73</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/6/2021</td>
<td>25.55</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/7/2021</td>
<td>21.34</td>
<td>Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/8/2021</td>
<td>18.27</td>
<td>Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/9/2021</td>
<td>13.03</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/10/2021</td>
<td>5.18</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/11/2021</td>
<td>7.02</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/12/2021</td>
<td>5.62</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/13/2021</td>
<td>4.79</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/14/2021</td>
<td>4.25</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/15/2021</td>
<td>5.89</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/16/2021</td>
<td>3.70</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/17/2021</td>
<td>4.80</td>
<td>None</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/18/2021</td>
<td>15.23</td>
<td>Action</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/19/2021</td>
<td>25.35</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/20/2021</td>
<td>26.65</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/21/2021</td>
<td>22.80</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/22/2021</td>
<td>23.08</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/23/2021</td>
<td>24.33</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/24/2021</td>
<td>23.93</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/25/2021</td>
<td>23.74</td>
<td>Moderate Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/26/2021</td>
<td>21.07</td>
<td>Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/27/2021</td>
<td>19.15</td>
<td>Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/28/2021</td>
<td>18.03</td>
<td>Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/29/2021</td>
<td>18.99</td>
<td>Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/30/2021</td>
<td>18.17</td>
<td>Flood</td>
</tr>
<tr>
<td>San Bernard Rv nr Boling, TX</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>5/31/2021</td>
<td>16.14</td>
<td>Action</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Week</th>
<th>None</th>
<th>D0-D4</th>
<th>D1-D4</th>
<th>D2-D4</th>
<th>D3-D4</th>
<th>D4</th>
<th>DSCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021-04-27</td>
<td>32.05</td>
<td>15.90</td>
<td>10.05</td>
<td>11.81</td>
<td>15.31</td>
<td>14.88</td>
<td>207</td>
</tr>
<tr>
<td>Change</td>
<td>-0.06</td>
<td>-2.50</td>
<td>-0.48</td>
<td>0.20</td>
<td>1.34</td>
<td>1.50</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Compare Two Weeks | U.S. Drought Monitor (unl.edu)
Permission | U.S. Drought Monitor (unl.edu)
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.

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.  

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


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

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

Figure 9
MAY 2021 HIGH WIND REPORTS SUMMARY

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

Figure 10
MAY 2021 TORNADO REPORTS SUMMARY

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