

Catastrophe and Climate

# Actuarial Weather Extremes

## March 2021





# Actuarial Weather Extremes: March 2021

Record Temperatures, Precipitation, Snow  
Extreme Wind, Hail, Tornado and Flooding Events

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# Actuarial Weather Extremes: March 2021

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## Overview

This report examines monthly and daily extremes from the Global Historical Climatology Network (GHCN) monthly and daily records and associated flooding, as well as extreme wind events in the Northeast U.S. and tornado and flooding events in the Southeast U.S. These signal the changeover from extreme winter conditions to volatile spring storm conditions which have been found in the U.S.

**Record High Temperature, Precipitation, Flooding and Snow:** As illustrated in Figures 1, 2, 3 and 5, both monthly and daily records occurred at many GHCN stations. In many cases previous records, dating back to 1960, were exceeded by significant amounts.

**Extreme Wind, Hail and Tornado Storm Events:** As illustrated in Figures 4 and 6, Tennessee, Alabama and New Jersey saw extreme flood, tornado and wind events centered around March 17, 25 and 28.



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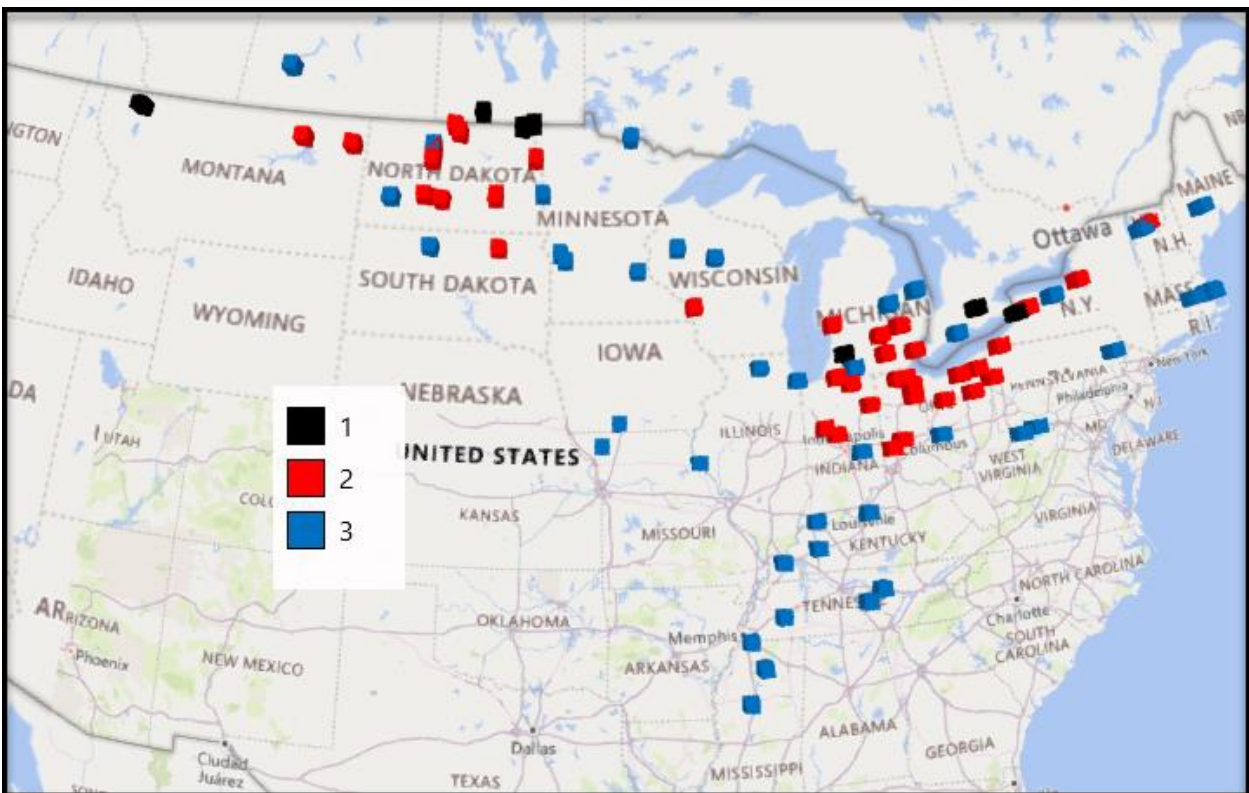
[Click here](#)



## Monthly and Daily Station Records for Temperature, Snow and Precipitation; Along with Associated Flooding

As shown in Figure 1, March 2021 was a record warm month for many stations on the U.S. / Canadian border area, and many stations just south of there had second or third highest record monthly warm temperature months of March in 2021, when compared to all March monthly averages from 1960-2021. Figure 2 shows similar monthly metrics for U.S. and Canadian stations for precipitation. Concentrations of record precipitation were found around Nebraska and Tennessee, which were impacted by two heavy days of precipitation. Figure 3 illustrates the extreme precipitation on March 14 in Nebraska and March 28 in Tennessee, illustrating stations with 3-5+ inches of single day precipitation in excess of daily records in March back to 1960. Figure 4 then associates the concurrent flooding; notably in Tennessee on March 28. Finally, Figure 5 illustrates the extreme snowfall that occurred in the Rocky Mountain states of Colorado and Wyoming showing stations that recorded 5-10+ inches of single day snowfall in excess of previous March daily records back to 1960.

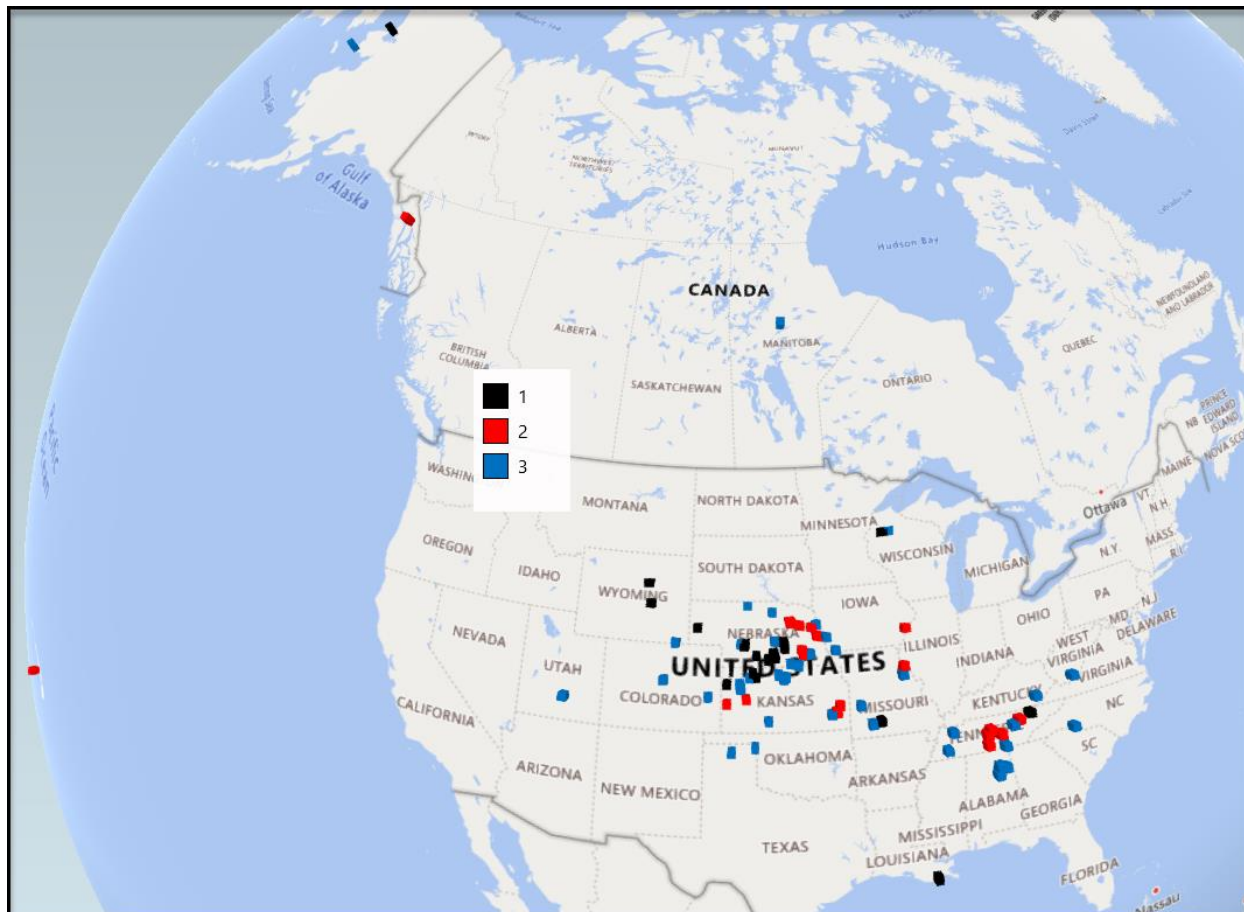
**Figure 1**  
 GLOBAL HISTORICAL CLIMATOLOGY NETWORK (GHCN) STATIONS IN U.S. AND CANADA WITH 1<sup>ST</sup>, 2<sup>ND</sup> OR 3<sup>RD</sup> HIGHEST DAILY HIGH TEMPERATURE (TMX) FOR MARCH 2021 VS MARCH AVERAGES IN 1960-2021.



Source: Global Historical Climatology Network (GHCN) station data (Accessed April 5, 2021).  
[ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd\\_all.tar.gz](ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz)

Figure 2 shows GHCN 2021 March monthly station records in black for precipitation in the US and Canada dating back to 1960, 2<sup>nd</sup> highest in red and 3<sup>rd</sup> highest in blue.

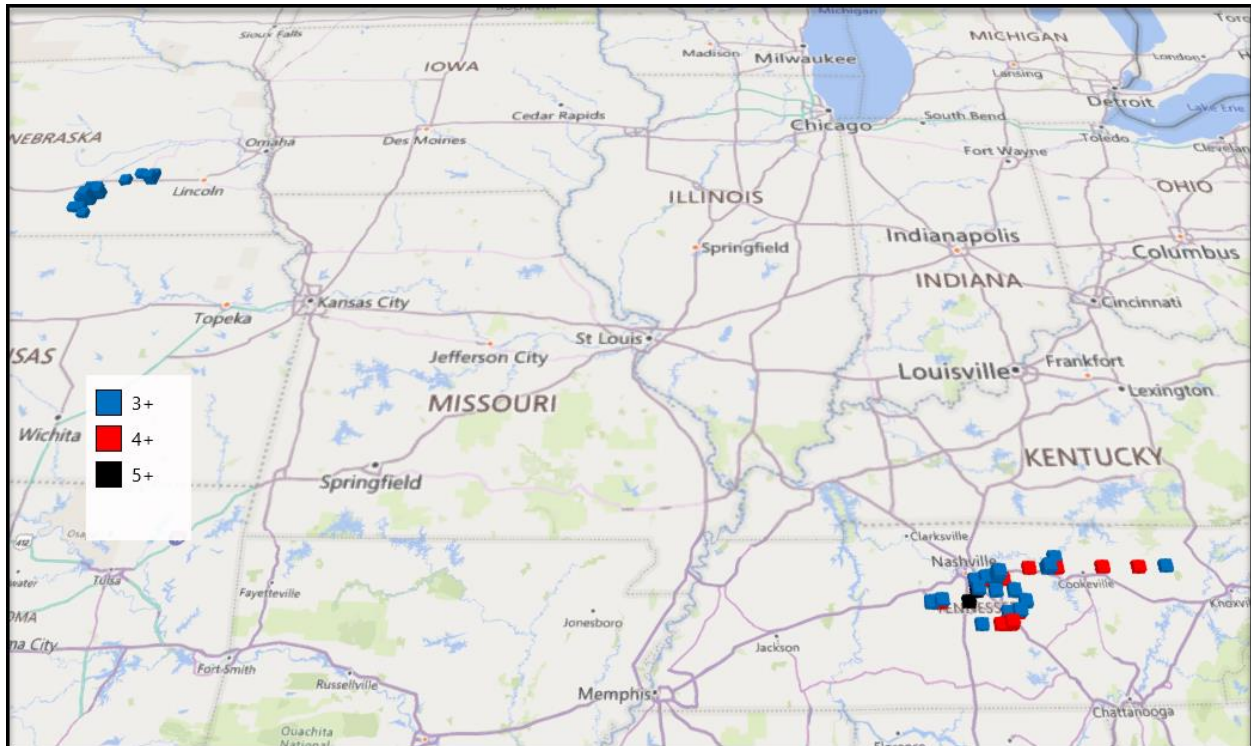
**Figure 2**  
 GHCN STATIONS IN U.S. AND CANADA WITH 1<sup>ST</sup>, 2<sup>ND</sup> OR 3<sup>RD</sup> HIGHEST DAILY PRECIPITATION (PRCP) FOR MARCH 2021 VS MARCH AVERAGES IN 1960-2021.



Source: Global Historical Climatology Network (GHCN) station data (Accessed April 5, 2021).  
[ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd\\_all.tar.gz](ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz)

Figure 3 shows daily precipitation records that exceeded the previous daily record by at least 3 and in some cases over 5 inches of daily rainfall. The most significant record-breaking daily rainfall was in the Nashville, TN areas, where significant flooding ensued.

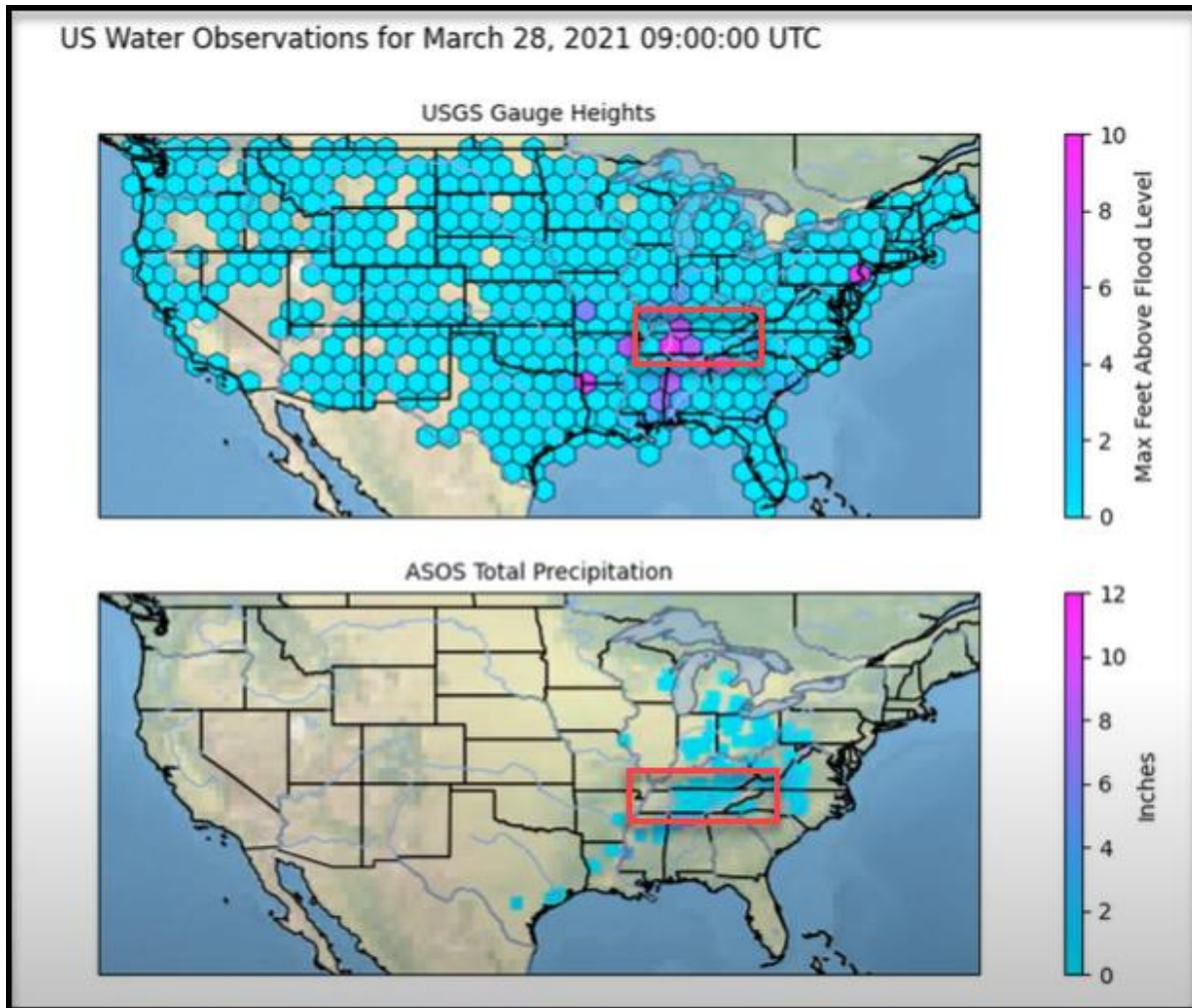
**Figure 3**  
**MARCH 14, 2021 (NEBRASKA) AND MARCH 28, 2021 (TENNESSEE) DAILY PRCP AMOUNTS 3+, 4+ AND 5+ INCHES GREATER THAN PREVIOUS MARCH 14 AND MARCH 28 DAILY RECORDS FROM 1960 – 2021.**



Source: GHCN station data (Accessed April 5, 2021). [ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd\\_all.tar.gz](ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz)

As shown in Figure 4, the Nashville, TN area had heavy rains and flooding on March 28. According to CNN<sup>1</sup> and NBC News, at least six deaths occurred, and 130 people had to be rescued from the flood. <sup>2</sup>

**Figure 4**  
MARCH 28, 2021 SNAPSHOT OF PRECIPITATION AND FLOODING CONDITIONS HIGHLIGHTING TENNESSEE.



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 April 8, 2021.

**The animation for the maps shown in Figure 4 can be viewed by clicking on this link:**

Sea, River, Buoy: [https://drive.google.com/file/d/1-HS2DkLtiOTOfOQ2Nze\\_sF60VMNrmtld/view?usp=sharing](https://drive.google.com/file/d/1-HS2DkLtiOTOfOQ2Nze_sF60VMNrmtld/view?usp=sharing)

Time Lapse animations created by Matthew Self, ASA using ASOS data and Python programming. Data accessed April 8, 2021.

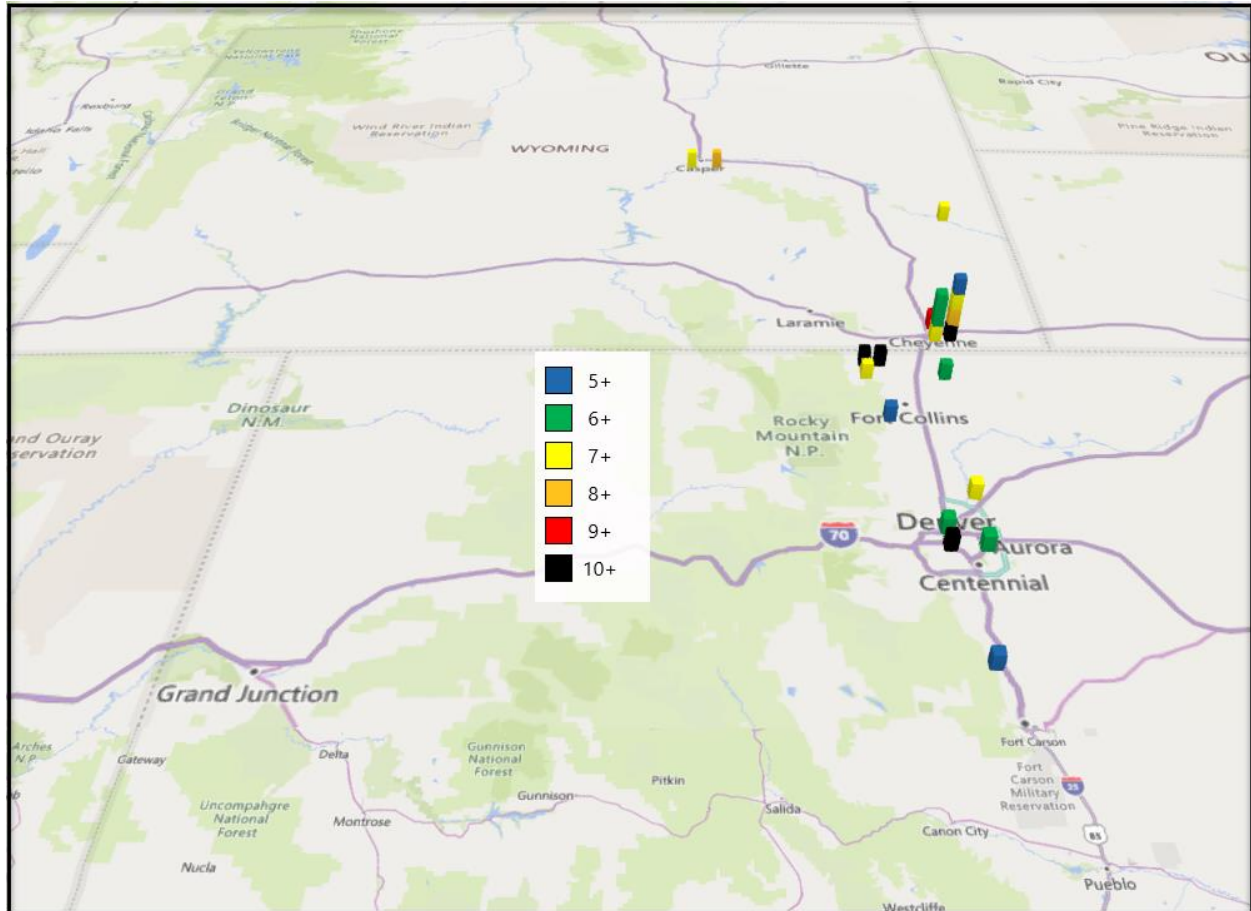
<sup>1</sup> CNN. March 29, 2021 [Nashville flash flood: Six dead and dozens of homes and businesses destroyed - CNN](#)

<sup>2</sup> NBC News. March 28, 2021. [At least four people dead, 130 rescued after Nashville floods \(nbcnews.com\)](#)



Figure 5 shows the significant mid-March 2021 snowfall that occurred in the Rocky Mountain areas primarily around Denver, CO and Cheyenne, WY. Daily high temperatures at these stations exceeded previous daily highs back to 1960 by 5-10+ inches.

**Figure 5**  
**MARCH 14 – 16, 2021 RECORD ONE-DAY SNOWFALL AMOUNTS IN COLORADO AND WYOMING FROM 5 – 10+ INCHES IN EXCESS OF PREVIOUS MARCH 14, 15, 16 DAILY RECORD AMOUNTS FROM 1960-2021**



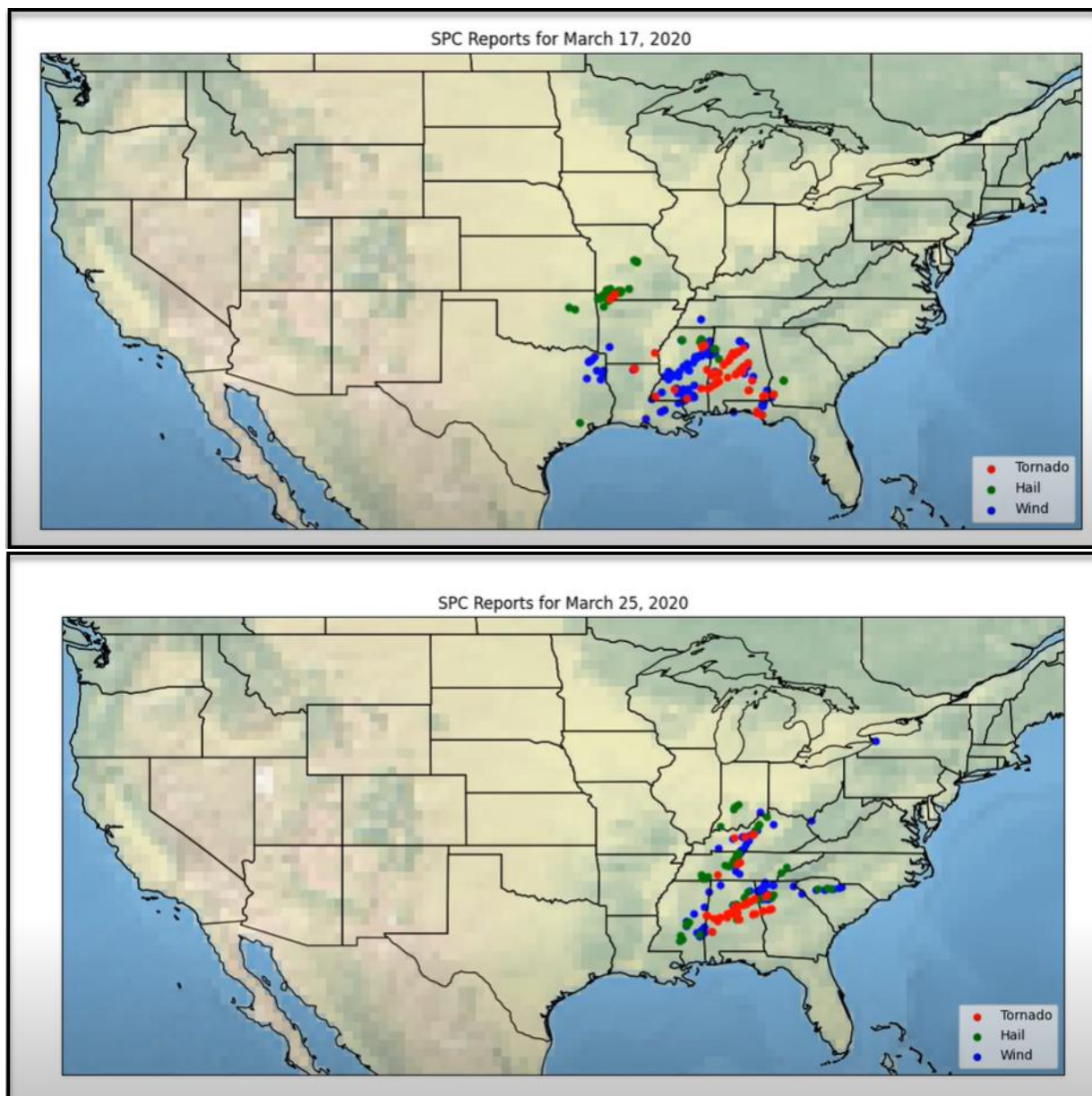
Source: GHCN station data (Accessed April 5, 2021). [ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd\\_all.tar.gz](ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz)

## Extreme Windstorm Events in the Northeast and Southeast U.S.

Figure 6 shows three significant dates of windstorm events during March 2021. March 17 and 25 there were many tornadoes in the Southeast U.S., particularly in Alabama. On March 28, there were significant concentrations of wind events, particularly in New Jersey and Alabama. According to CoreLogic, the March 25 Alabama storms caused 5 deaths and over 9,000 damaged properties.<sup>3</sup> On March 28, 2021 in New Jersey, 60-70 mile per hour winds knocked out power to tens of thousands and caused significant damage to a hotel.<sup>4</sup>

Figure 6

TORNADO, HAIL, AND WIND EVENTS MARCH 17, 25, AND 28, 2021 IN THE U.S.

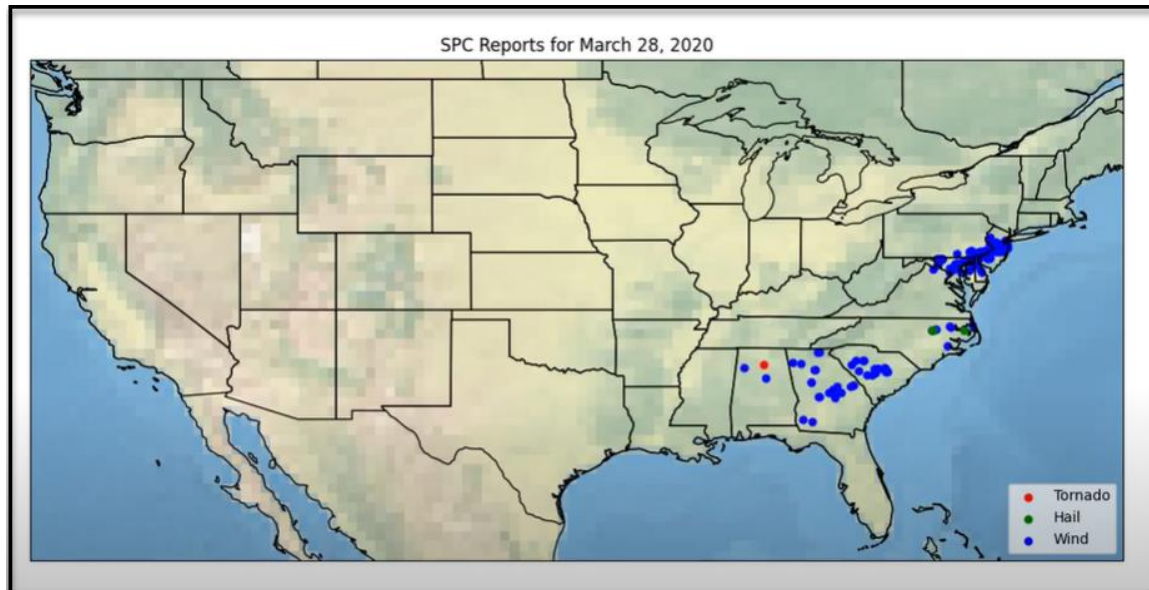


<sup>3</sup> CoreLogic. March 25, 2021. [Nearly 10,000 Homes Likely Impacted by Alabama, Georgia Tornado Outbreak \(corelogic.com\)](https://www.corelogic.com/newsroom/nearly-10000-homes-likely-impacted-by-alabama-georgia-tornado-outbreak)

<sup>4</sup> NJ.com. March 29, 2021. [Storms with 60 to 70 mph wind gusts rip across N.J. leaving trail of debris - nj.com](https://www.nj.com/news/weather/story/storms-with-60-to-70-mph-wind-gusts-rip-across-nj-leaving-trail-of-debris-2021-03-29/)

Figure 6 (continued)

TORNADO, HAIL, AND WIND EVENTS MARCH 17, 25, AND 28, 2021 IN THE U.S.




Source: National Weather Service Storm Prediction Center. Accessed April 8, 2021.

[https://www.spc.noaa.gov/climo/reports/210317\\_rpts.html](https://www.spc.noaa.gov/climo/reports/210317_rpts.html), [https://www.spc.noaa.gov/climo/reports/210325\\_rpts.html](https://www.spc.noaa.gov/climo/reports/210325_rpts.html), [https://www.spc.noaa.gov/climo/reports/210328\\_rpts.html](https://www.spc.noaa.gov/climo/reports/210328_rpts.html)

Animation Link for Daily Tornado, Hail, Wind Events March 2021, created by Matthew Self, ASA using ASOS data and Python programming. Data accessed April 8, 2021.


The animation can be viewed by clicking on the following link:

Daily SPC: [https://drive.google.com/file/d/1ns\\_KSYUmkw6WN4CCnRynrdSCUdnT\\_5w-/view?usp=sharing](https://drive.google.com/file/d/1ns_KSYUmkw6WN4CCnRynrdSCUdnT_5w-/view?usp=sharing)



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## 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.

### March 25, 2021 Storms Alabama

According to CoreLogic, the March 25, 2021 Alabama storms caused 5 deaths and over 9,000 damaged properties. <sup>5</sup>

### March 28, 2021 Flooding Tennessee

The Nashville, TN area had heavy rains and flooding on March 28. According to CNN<sup>6</sup> and NBC News, at least six deaths occurred, and 130 people had to be rescued from the flood. <sup>7</sup>

### March 28, 2021 Storms New Jersey

On March 28, 2021 in New Jersey 60-70 mile per hour winds knocked out power to tens of thousands and caused significant damage to a motel. <sup>8</sup>

## 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](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”
- 3) In the “Select From Available Data” section, choose the “Air Temperature [F]” and “1 hour Precipitation [inch]” options.

<sup>5</sup> CoreLogic. March 25, 2021. [Nearly 10,000 Homes Likely Impacted by Alabama, Georgia Tornado Outbreak \(corelogic.com\)](#)

<sup>6</sup> CNN. March 29, 2021 [Nashville flash flood: Six dead and dozens of homes and businesses destroyed - CNN](#)

<sup>7</sup> NBC News. March 28, 2021. [At least four people dead, 130 rescued after Nashville floods \(nbcnews.com\)](#)

<sup>8</sup> NJ.com. March 29, 2021. [Storms with 60 to 70 mph wind gusts rip across N.J. leaving trail of debris - nj.com](#)

- 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](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/210317\\_rpts.html](https://www.spc.noaa.gov/climo/reports/210317_rpts.html)

1. This page will show all Tornado, Wind, and Hail reports for 3/17/2021
2. Select the “210318 Reports” button at the top to move to the next day

## Acknowledgments

The authors wish to thank Matthew Self, ASA for his ongoing contributions to the monthly data available for analysis for this report.


## Feedback



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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.

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