SOCIETY OF ACTUARIES

Actuarial Weather Extremes
April 2020

Actuarial Weather Extremes: April 2020

Prolonged temperature and precipitation extremes, flooding and drought; along with severe storm activity.

Overview

This report examines weather extremes in temperature, precipitation, and event damage. For high or low precipitation we also look at extreme conditions for streamgage flow, flood conditions, and drought. We show year-to-date March vs April 2020 for Temperature and Precipitation to see how extremes conditions may persist in a longer-term context.

Precipitation: The NOAA 2020 Spring flood outlook is carried over from March for reference (Figure 1). Year-to-Date precipitation totals in Tennessee and Alabama are now more than any Jan-April back to 1960 and are an 8% increase above the previous record for each state. (Figures 2-5).

Streamgage and resulting flood areas can now be seen in Figures 6-9, and can be compared to the March Spring Flood Outlook in Figure 1, and the areas of historically high precipitation in January – April (Figures 2-5).

Drought maps are shown in Figures 10 and 11. These areas of drought show consistency with states for which the Jan-April YTD precipitation totals are ranked low for 2020 compared to the period 1960-2019, mostly in the lower 25%. (See Figures 5 and 10-13). As seen in Figure 13, many individual stations had record low precipitation amounts in April 2020 (vs Aprils 1960-2019).

Many states are having the hottest or one of the three hottest starts to the year since 1960, as shown in Figure 14 – Figure 17. As seen in Figure 15, Florida and Virginia average maximum daily temperature in the period January – April 2020 is higher than in the first four-month periods in 1960-2019. Many states are warmer than 95% or more than any of the previous 60 years' Jan-Apr. There are also correlations between high average year-to-date temperatures with areas of drought shown in Figures 10 and 11.

For extreme weather events we look at tornado activity in the context of historical tornado activity and expected losses.

In April there were 341 preliminary tornado reports. The average number of tornadoes for April in the period 1991-2010 was 155. April 12-13 there were 140 tornadoes preliminarily confirmed including 3 EF4 and 12 EF3. Thirty two fatalities were reported making this the most tornado-related deaths since April 27-30, 2014. Total damage costs reported likely to reach several billion dollars.[1]

EF refers to Enhanced Fujita Scale. In particular, EF3 includes wind gusts 136-165mph and EF4 includes wind gusts 166-200mph.[2]

As seen in Figure 18 and Figure 19, the April 2020 year-to-date tornado count, if the preliminary number of reported tornadoes holds up, will be the third most in the first four months of a year since 1950.

Figure 1 https://www.noaa.gov/media-release/us-spring-outlook-forecasts-another-year-of-widespread-river-flooding

[1] NOAA National Centers for Environmental Information, State of the Climate: Tornadoes for April 2020, published online May 2020, retrieved on May 11, 2020 from https://www.ncdc.noaa.gov/sotc/tornadoes/202004.
[2] https://www.spc.noaa.gov/efscale/ef-scale.html

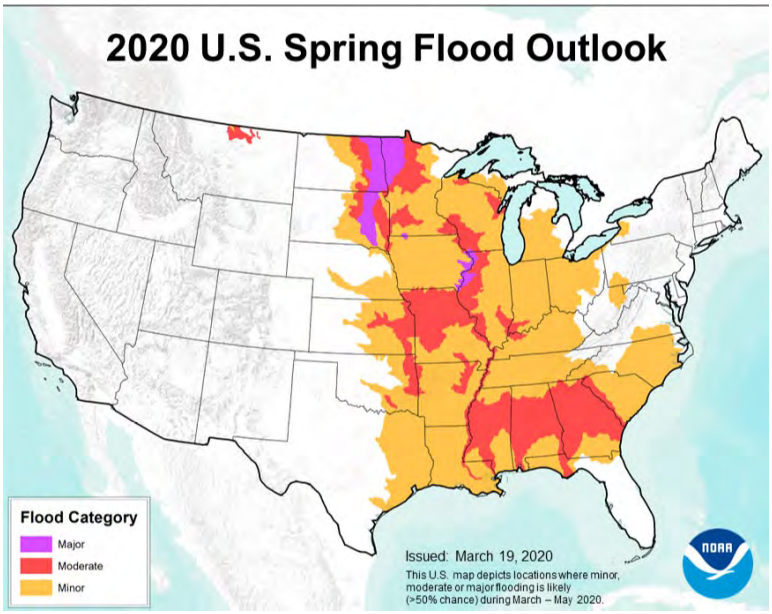


Figure 2

Average Station Precipitation inches by State in January through March 2020 (source: Global Historical Climatology Network (GHCN) station data)

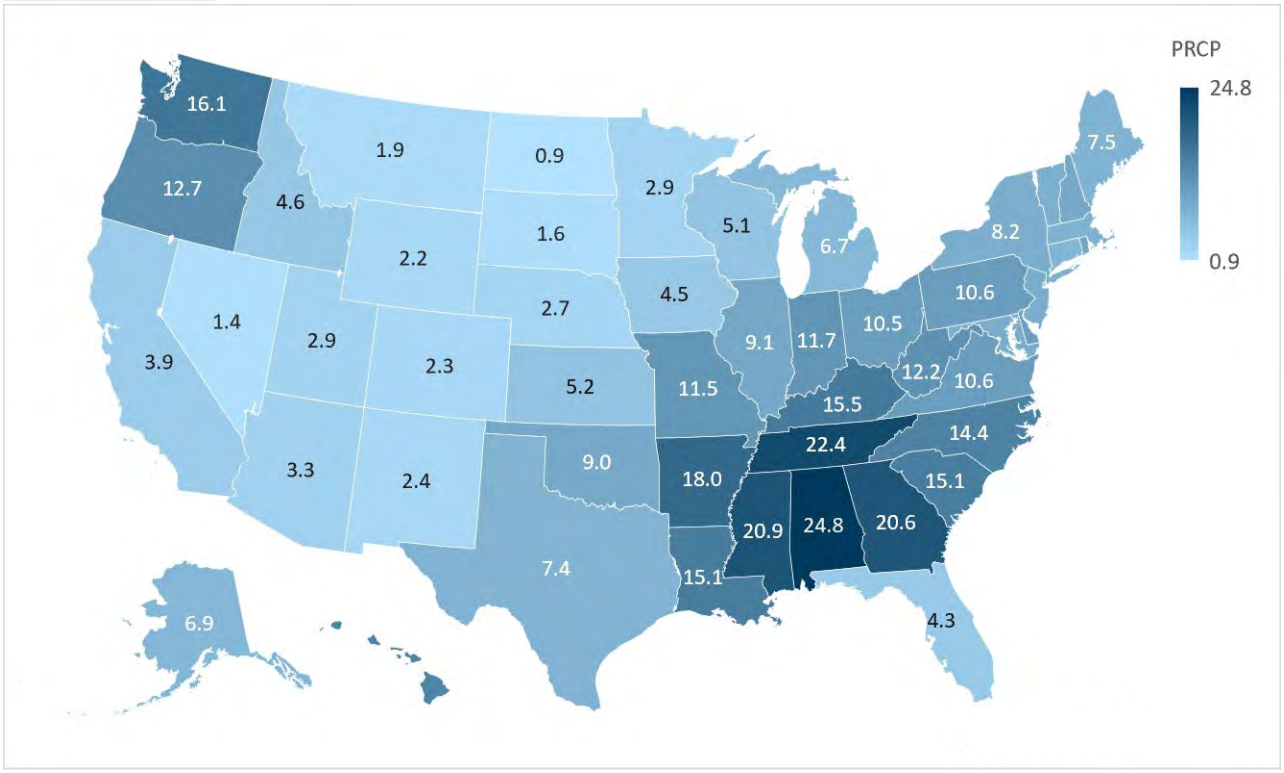


Figure 3

Average Station Precipitation inches by State in January through April 2020 (source: GHCN station data)

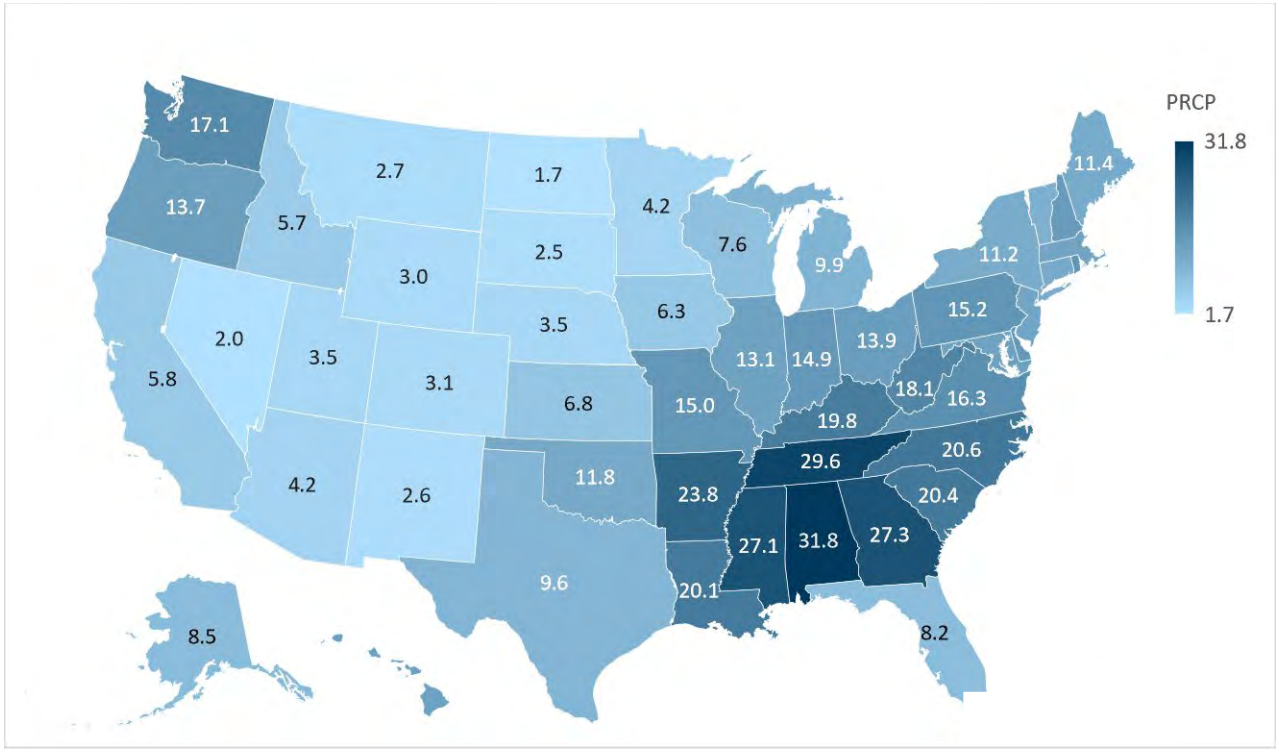


Figure 4
Percentile Ranking of January through March 2020 Precipitation Against Historical Data (1960-2019) (source: GHCN station data)

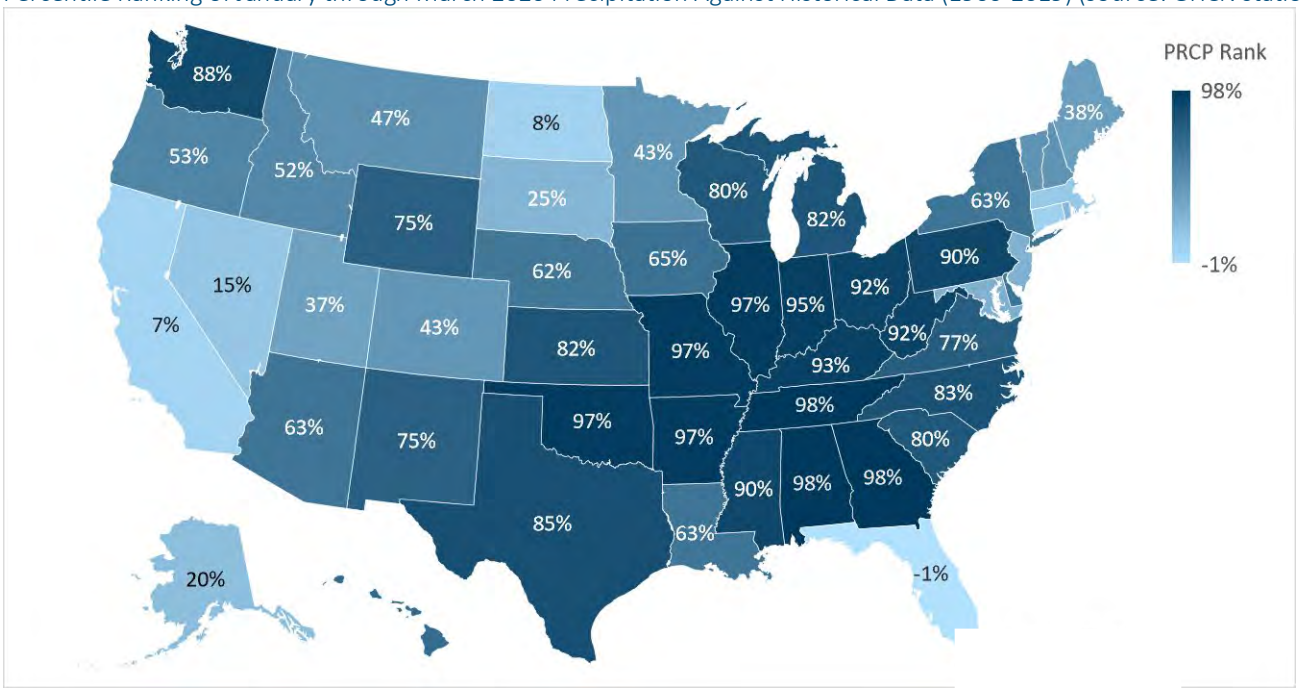


Figure 5
Percentile Ranking of January through April 2020 Precipitation Against Historical Data (1960-2019) (source: GHCN station data)

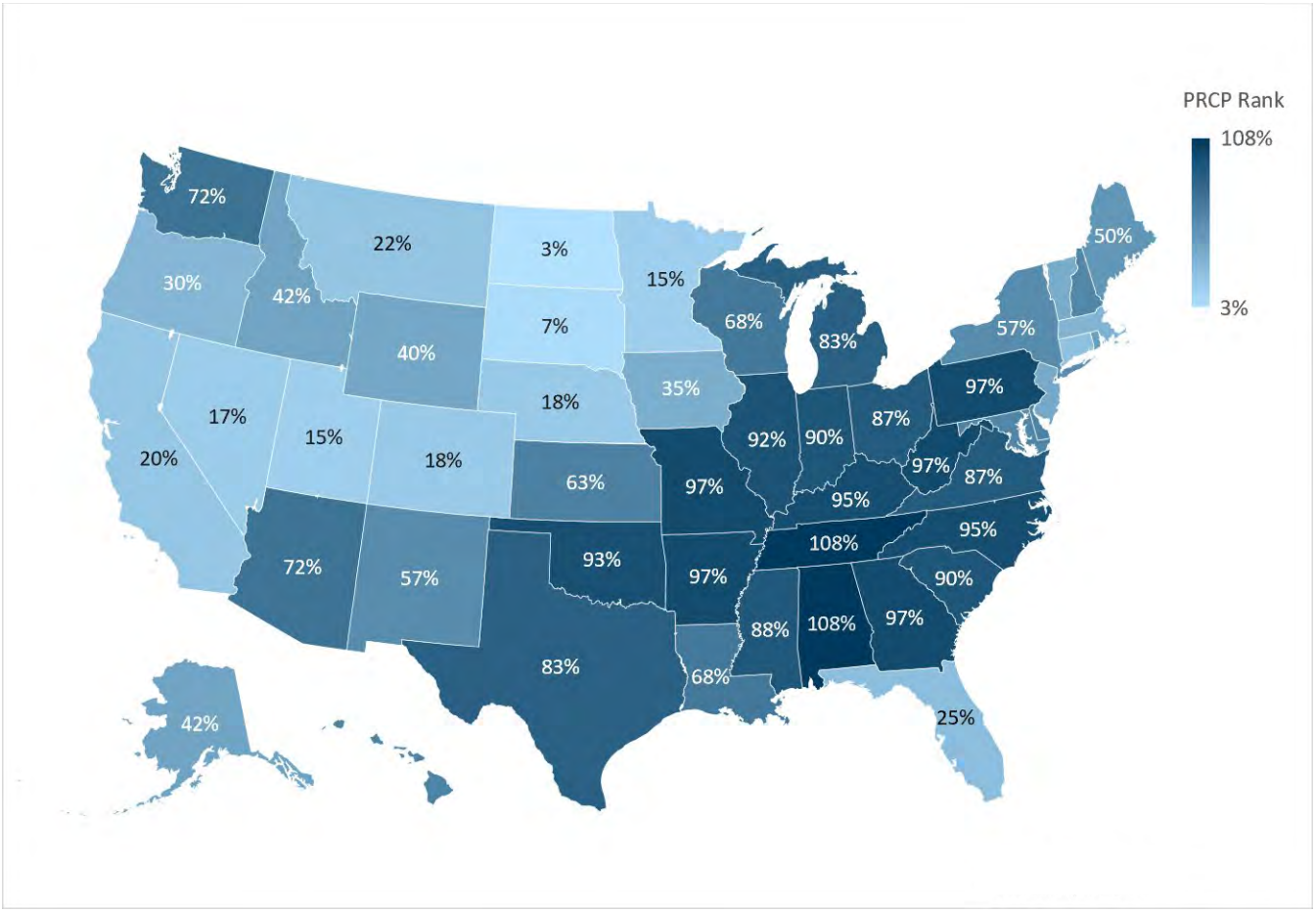
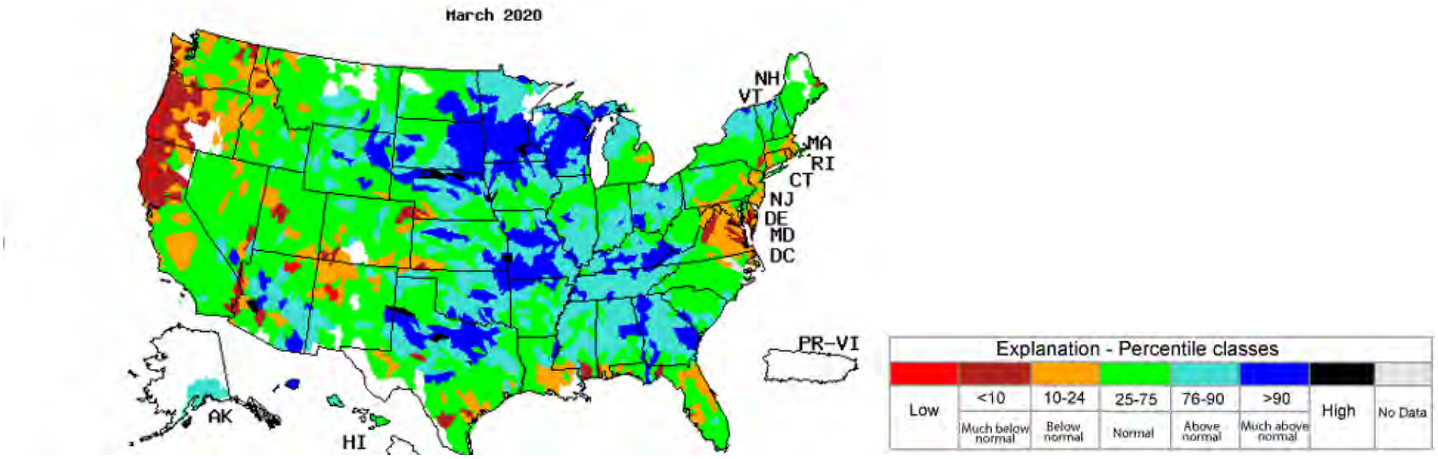


Figure 6

Heavy Rains in the Ohio river and Mississippi river / Missouri river valleys lead to high Stream flow (source: United States Geological Survey[3] (USGS))



The "monthly streamflow" map shows the average streamflow conditions for the past month. The map depicts monthly streamflow conditions as computed at USGS streamgages. The colors represent monthly streamflow compared to percentiles of historical

[3] This map was downloaded from the United States Geological Survey's website on April 7. It reflects streamflow conditions as of that date. URL: https://waterwatch.usgs.gov/index.php?id=mv01d&sid=w__map|m__mv01d_nwc

monthly streamflow for the month of the year. This map represents conditions adjusted for this time of the year. Only streamgages having at least 30 years of record are used.

Figure 7

Areas of high Stream flow in April 2020 (source: USGS)[4]

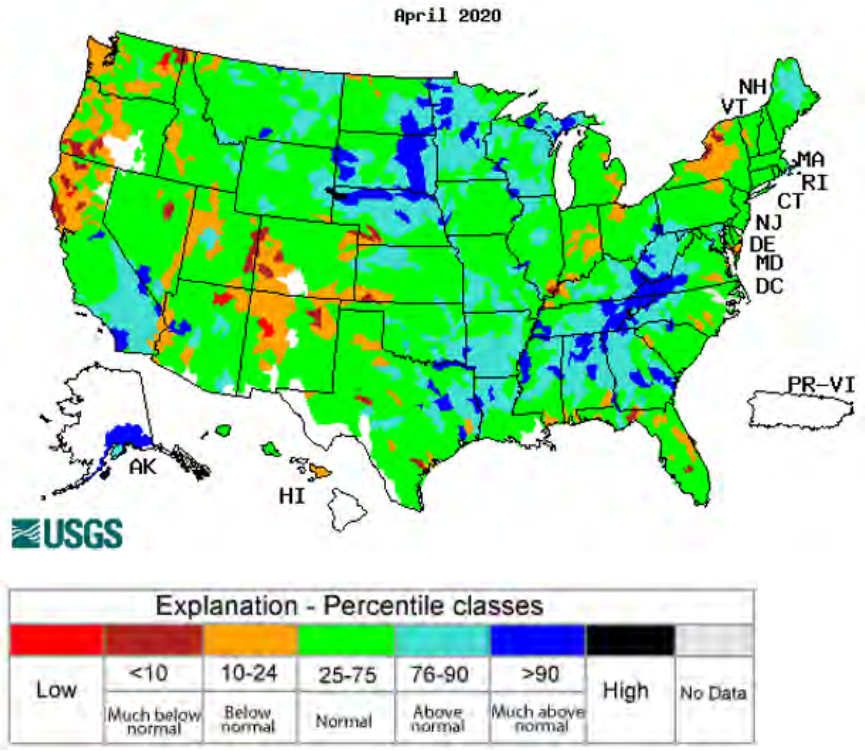
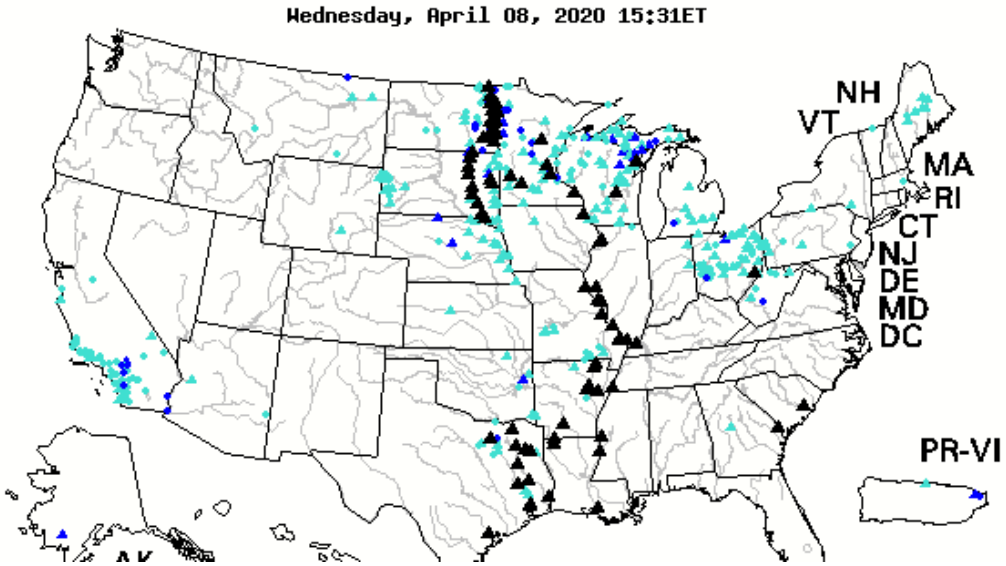


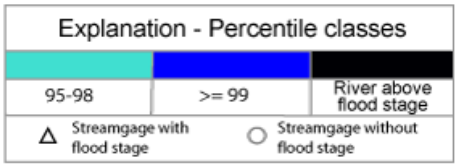
Figure 8

April 8, 2020 US Flood Conditions. [5]



[4] This map was downloaded from the United States Geological Survey's website on May 8. It reflects streamflow conditions as of that date. URL: https://waterwatch.usgs.gov/index.php?id=mv01d&sid=w__map|m__mv01d_nwc

[5] This map is from the USGS Waterwatch website. URL: https://waterwatch.usgs.gov/index.php?id=ww_flood



The "Flood and high flow" map shows the location of streamgages where the water level is currently at or above flood stage (depicted as a black triangle) or at high flow (depicted as blue circles) The high flow conditions are expressed as percentiles that compare the current (i.e., within the past several hours) instantaneous flow value to historical daily mean flow values for all days of the year.

Figure 9
May 8, 2020 US Flood Conditions. [6]

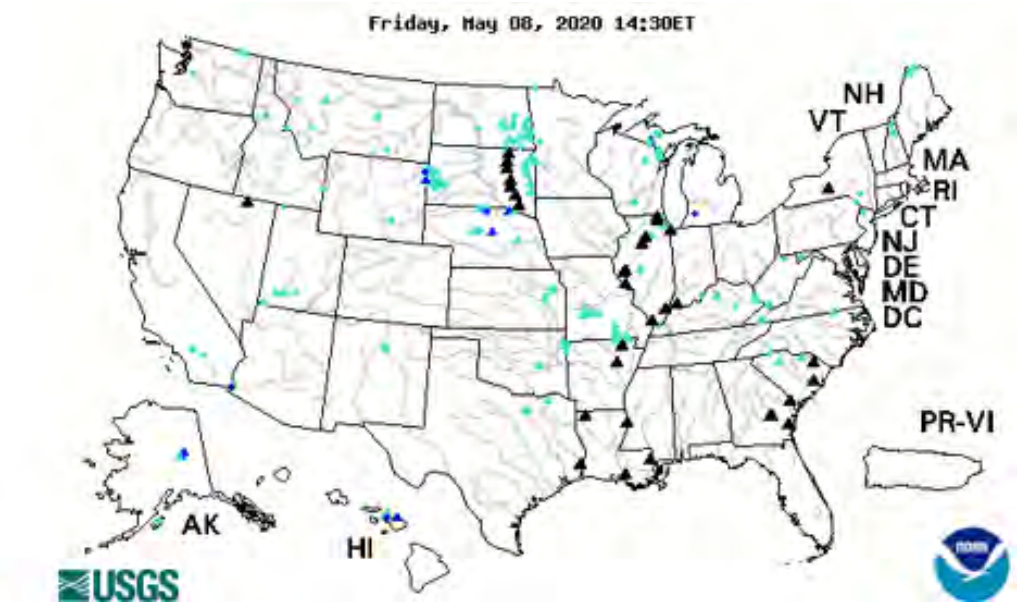


Figure 10
March 3, 2020 vs March 31, 2020 Drought Conditions. [7]

[6] This map is from the USGS Waterwatch website. URL: https://waterwatch.usgs.gov/index.php?id=ww_flood
[7] The U.S. Drought Monitor (USDM) is a map that is updated on a weekly basis, illustrating the areas of the U.S. that are experiencing drought. It is developed jointly by the National Drought Mitigation Center, the National Oceanic and Atmospheric Administration, and the U.S. Department of Agriculture: https://droughtmonitor.unl.edu/CurrentMap.aspx https://droughtmonitor.unl.edu/Maps/CompareTwoWeeks.aspx

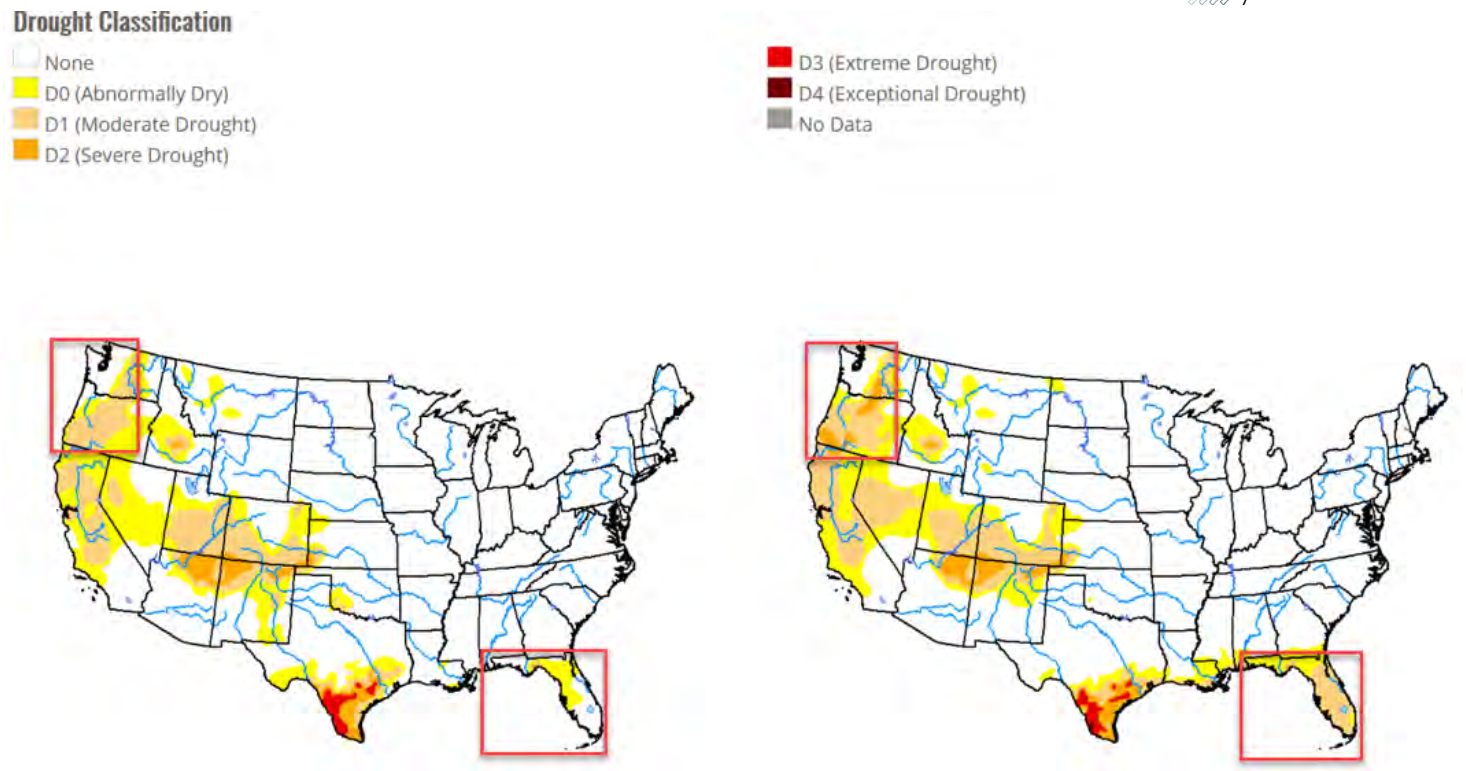


Figure 11
April 7, 2020, vs April 28, 2020 Drought Conditions (see footnote 6)

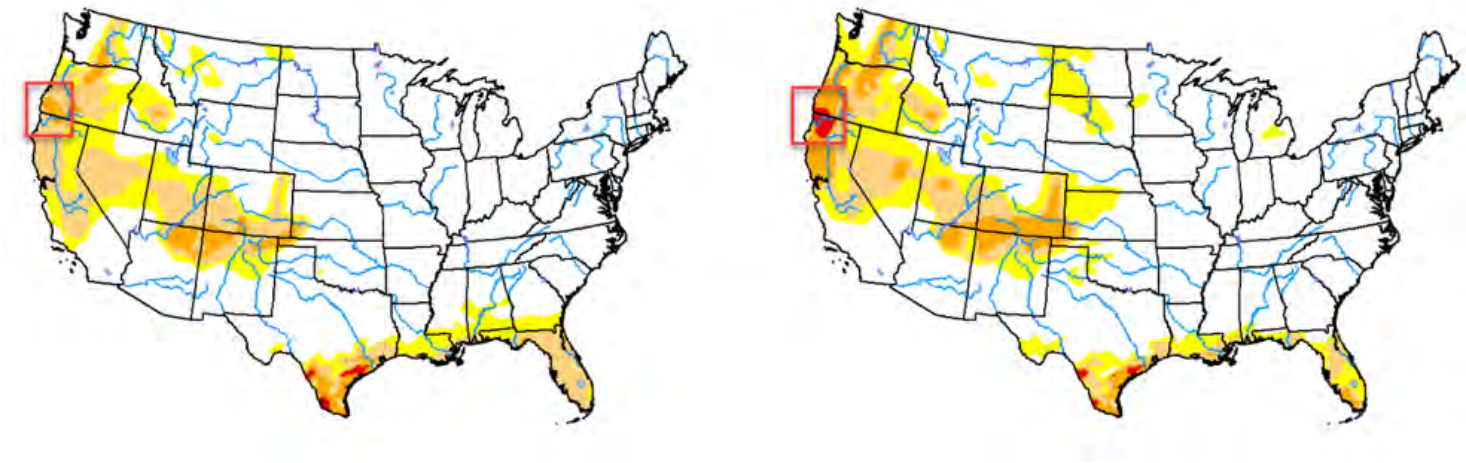


Figure 12

GHCN Station Data showing the stations which March 2020 was one of the wettest 5 Marches (Rank 1-5) and the driest 5 Marches (Rank 57-61) within the month of March in the 61-year period 1960-2020.

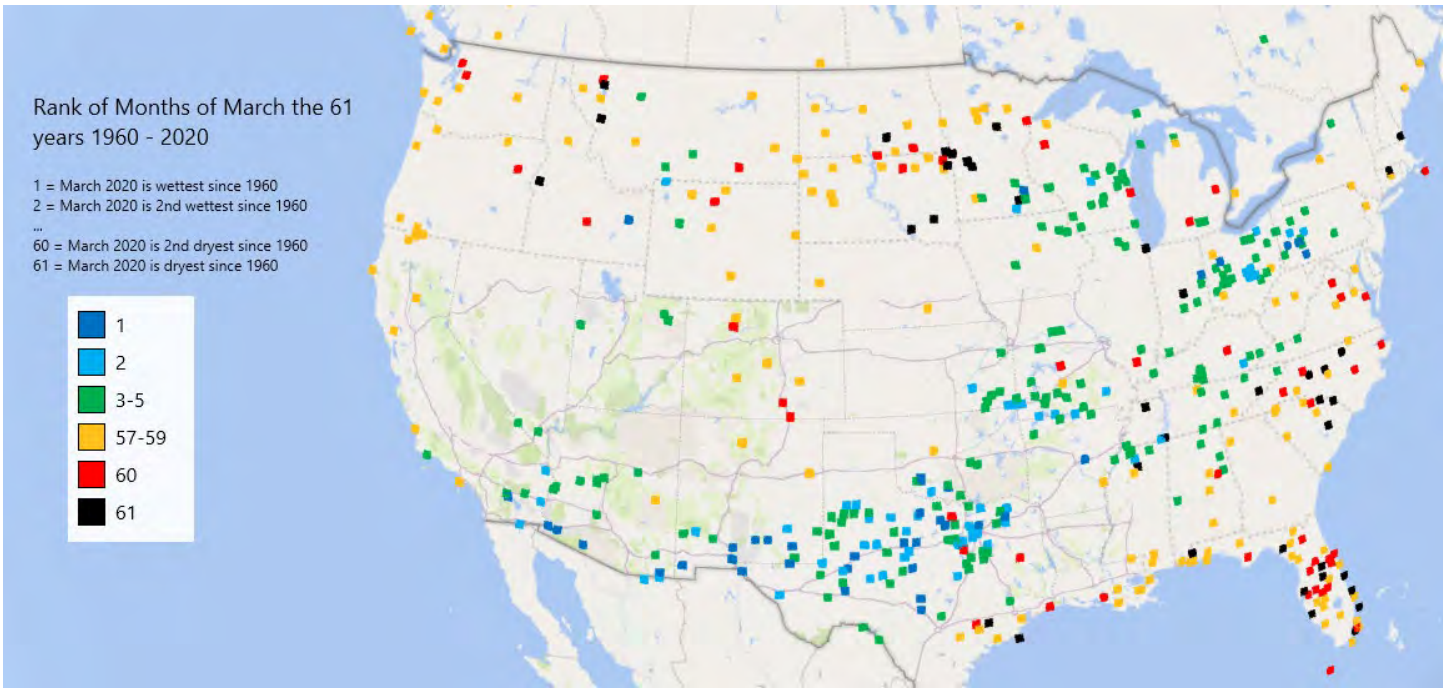


Figure 13

GHCN Station Data showing the stations which April 2020 was one of the wettest 5 Aprils (Rank 1-5) and the driest 5 Aprils (Rank 57-61) within the month of April in the 61-year period 1960-2020.

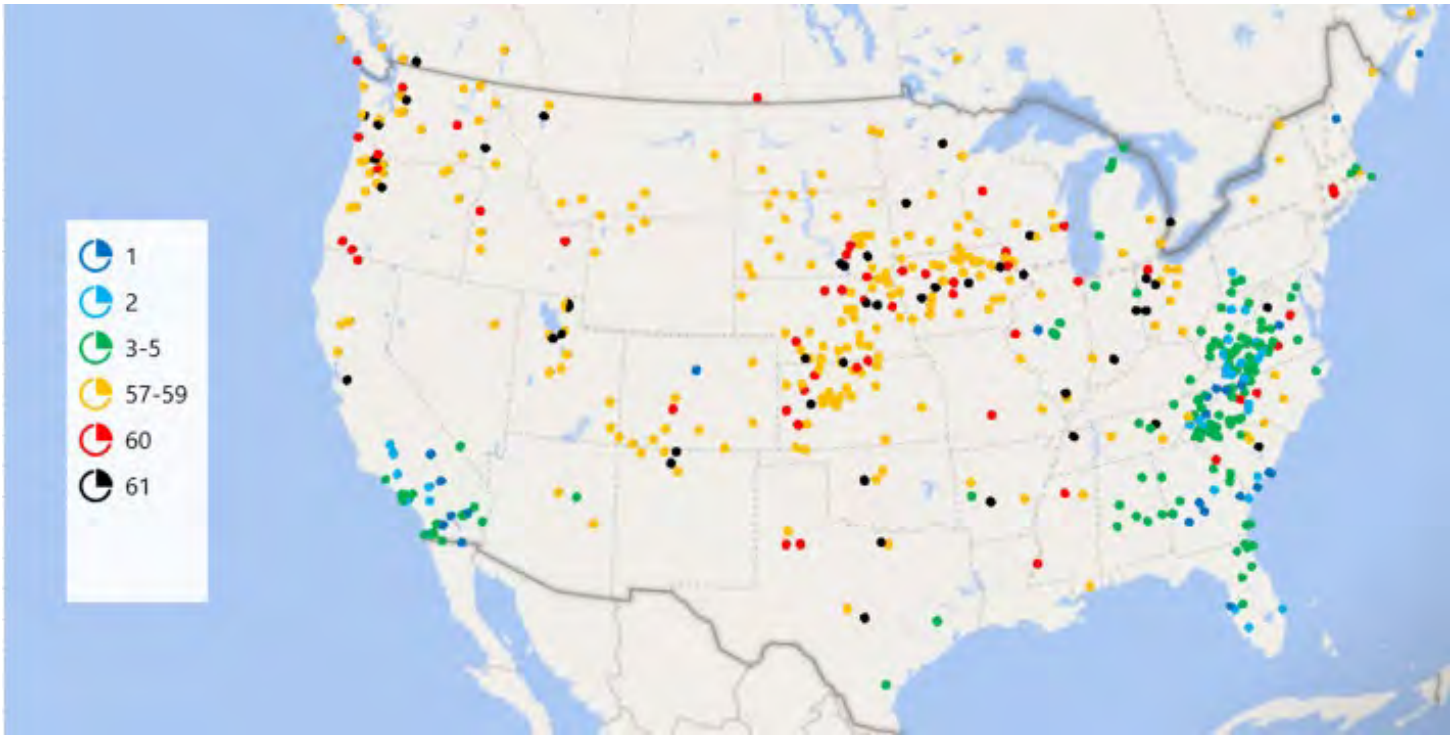


Figure 14

GHCN Daily Maximum Temperature (TMAX) data showing January through March 2020 ranked against the First Quarters from 1960-2019. A rank of 90% means that January through March 2020 was warmer than 90% of the First Quarters from 1960-2019. A rank above 100% indicates a new record in terms of percent of the previous record. (Florida is 102% for March YTD)

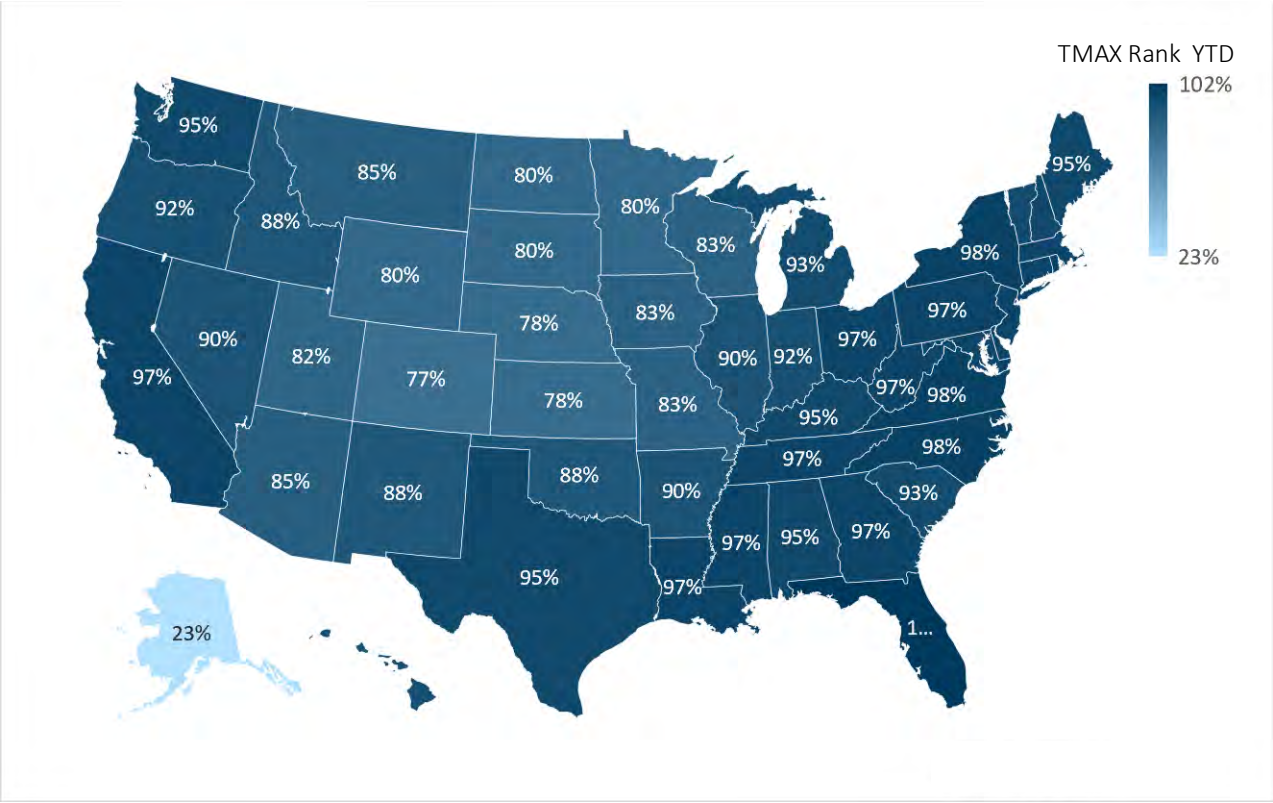


Figure 15
April YTD TMAX Rankings (Florida is 101% for April YTD, meaning 1% greater than any of the previous Jan-Apr periods in 1960-2019)

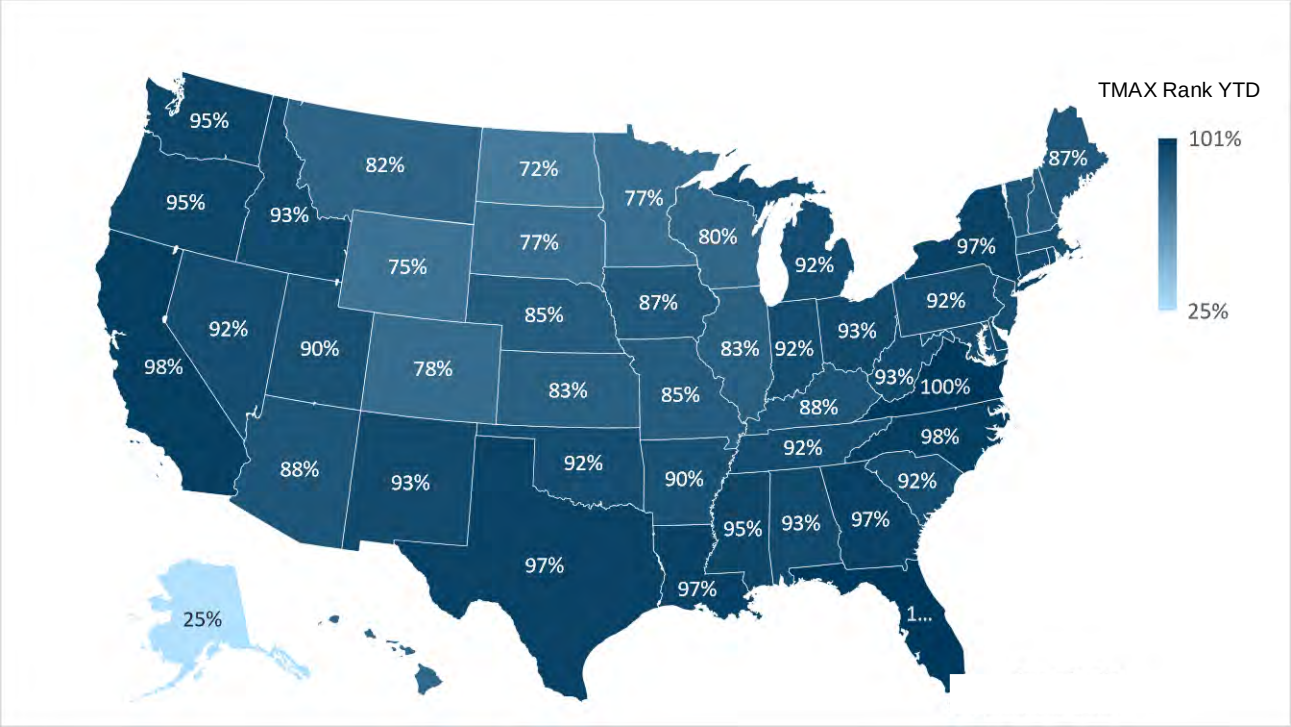


Figure 16
GHCN Station Data showing the stations which March 2020 was one of the hottest 5 Marches (Rank 1-5) and the coldest 5 Marches (Rank 57-61), in terms of average Daily Maximum Temperature (TMAX), in the 61-year period 1960-2020.

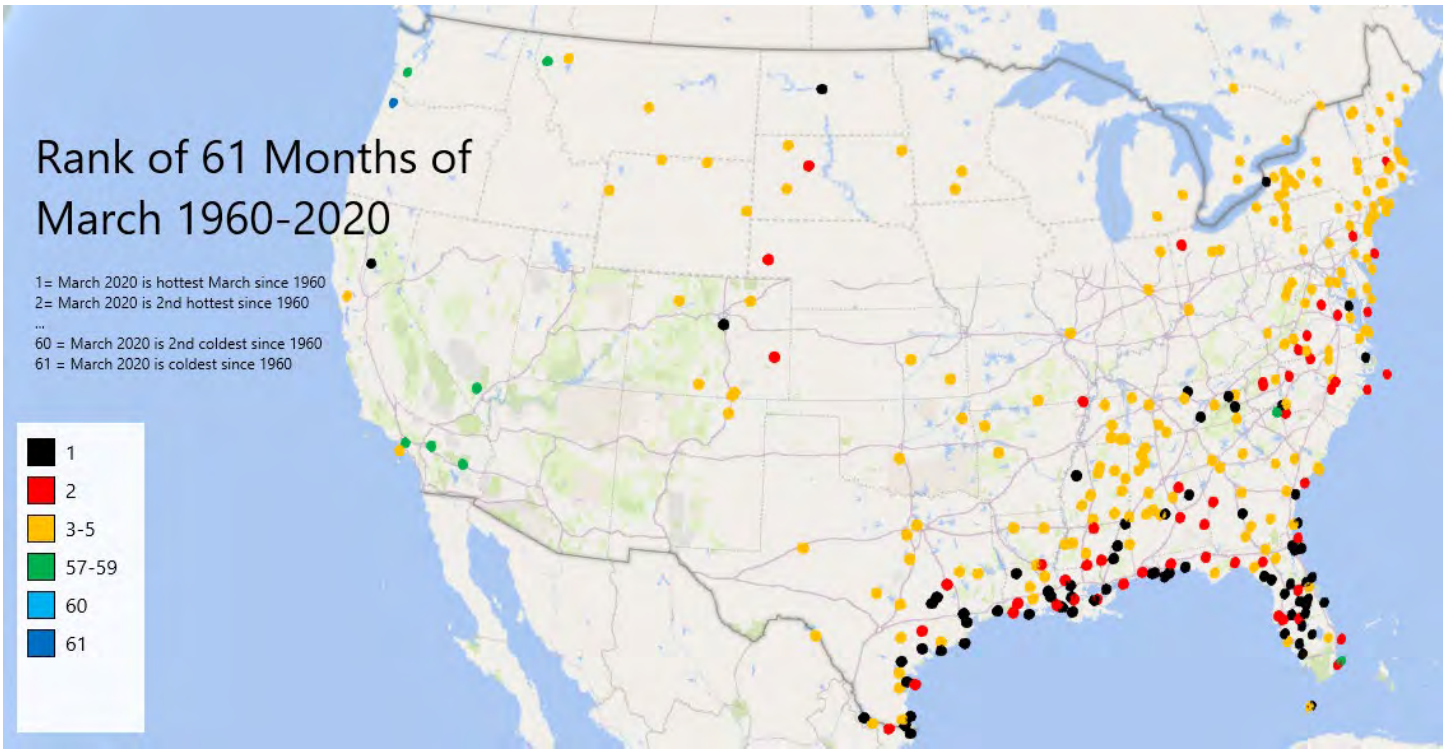


Figure 17

GHCN Station Data Showing the stations which April 2020 was one of the hottest 5 or coldest 5 Aprils, in terms of average Daily Maximum Temperature (TMAX), in the 61-year period 1960-2020.

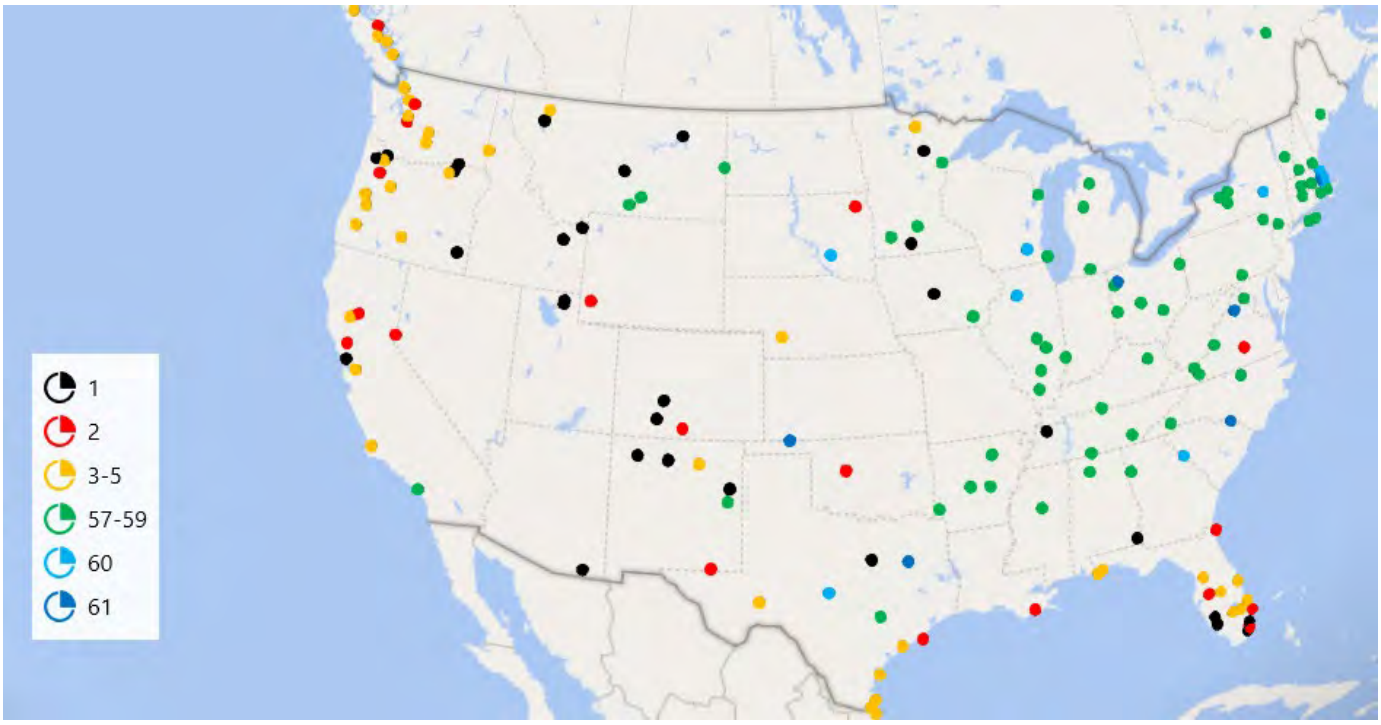


Figure 18

There were 341 preliminary tornado report in the US in April 2020 mostly in the Southeastern states. https://www.ncdc.noaa.gov/sotc/tornadoes/202004[8]

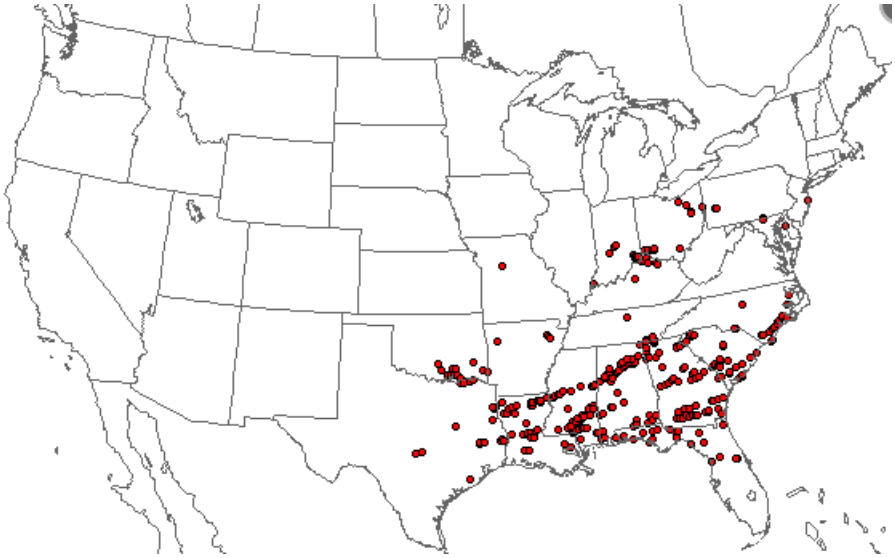
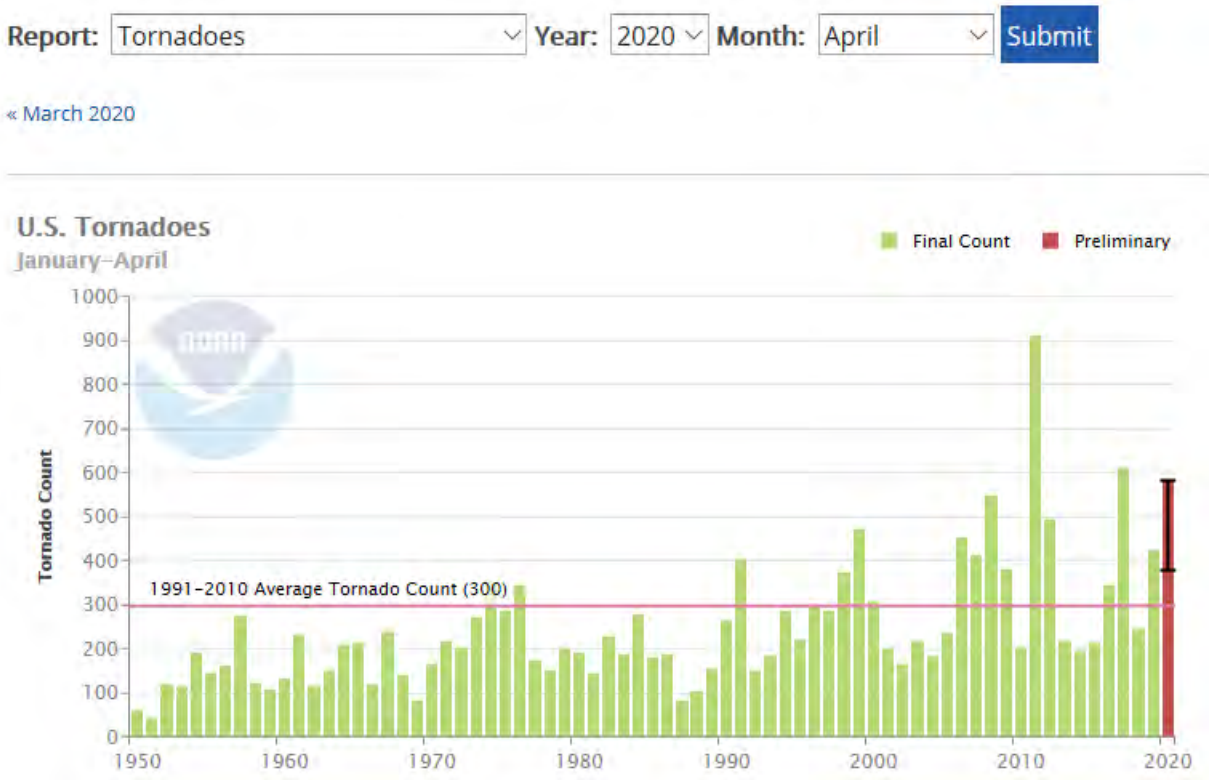


Figure 19

There were 583 tornadoes by preliminary count in Jan-Apr 2020. If all are included in the final count, 2020 will rank number 3 in the last 71 years Jan-Apr tornado count, back to 1950. https://www.ncdc.noaa.gov/sotc/tornadoes/202004[9]



Rough Assessment of the Losses Caused by Recent Extreme Weather

[8] NOAA National Centers for Environmental Information, State of the Climate: Tornadoes for April 2020, published online May 2020, retrieved on May 11, 2020 from https://www.ncdc.noaa.gov/sotc/tornadoes/202004.

[9] NOAA National Centers for Environmental Information, State of the Climate: Tornadoes for April 2020, published online May 2020, retrieved on May 11, 2020 from https://www.ncdc.noaa.gov/sotc/tornadoes/202004.

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. Below, we offer a rough assessment of the cost of some of the weather events covered in our reports over the last few months:

April 2020: Tornado Activity From Texas to Maryland

At least 140 tornadoes were confirmed from Texas to Maryland April 12-13. There were 32 fatalities related to the tornadoes. More than one million homes and businesses lost power. There was large damage with costs likely to reach several billion dollars.[10] We will look for developments of cost amounts for other April 2020 storm activity as it emerges.

March 2020: Heavy Rain, Flooding in Ohio and Indiana, Tornados in Tennessee

The AP News reported that five people were killed in Indiana after two vehicles were swept from roadway by floodwaters March 20.[11] The AP News also reported water rescues, power outages and road collapse in Central Ohio on March 20, 2020.[12]
AccuWeather reported that the March 3 Tornadoes in Tennessee had at least 24 deaths and losses estimated at $1.5 billion to $2.0 billion.[13]

February 2020: Heavy Rain in the Southeastern U.S.

The USA Today reported that about 1000 homes were flooded in Mississippi[14], with the city of Jackson particularly hard-hit. Flooding led to an evacuation[15] of some parts of Montgomery, Georgia. Evacuations also occurred in northwest Alabama[16], where highway 231 was closed indefinitely due to flood damage[17]. In Savannah, Georgia, many roads were temporarily closed due to flooding[18].

January 2020: Unseasonable Warmth Across Much of the Northern Hemisphere

One of the primary economic effects of the warm weather has been a reduction in the sales and consumption of fuel used for heating. According to an article in "Bloomberg Green", the loss in global oil demand due to warm weather is in the neighborhood of 800,000 barrels a day, which is, according to the article[19], roughly equivalent to the daily oil consumption across Turkey (the country). Ski resorts in France[20] and Japan[21] have had a difficult year due to a lack of snow. In a positive note, the warm weather may have boosted employment growth in the U.S.[22]

September – December 2019: Wildfires in Australia

On January 6, "Business Insider" reported[23] the following damage estimates related to recent and ongoing bushfires: 1600 destroyed homes, 5000 insurance claims totally $375 million, and 1% of GDP growth is estimated to be wiped-out. The article suggests that, after the damages are fully tallied, the cost will run into the billions of dollars. On January 7, "Time" reported that the fires have claimed the lives of at least 24 people[24]. On January 7, the Wall Street Journal reported[25] that, in New South Wales, over 600 head of livestock were killed. Researchers at the University of Sydney estimate that nearly half a billion mammals, birds and reptiles have been killed[26].

November: Flooding in Venice, Italy

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[10] NOAA National Centers for Environmental Information, State of the Climate: Tornadoes for April 2020, published online May 2020, retrieved on May 11, 2020 from https://www.ncdc.noaa.gov/sotc/tornadoes/202004.

[11] https://apnews.com/66c958d68ae35093b8b44c38d25dfeeb

[12] https://apnews.com/8d7fb96659bceaa1300b7bcd1d394dca

[13] https://www.accuweather.com/en/severe-weather/accuweather-estimates-the-total-damage-from-the-tennessee-tornadoes-will-approach-2-billion/697185

[14] https://www.usatoday.com/story/news/nation/2020/02/17/mississippi-flooding-swamps-southern-us/4784911002/

[15] https://www.wtoc.com/2020/02/13/flooding-causes-mandatory-evacuation-order-montgomery-co/

[16] https://www.al.com/news/2019/02/flooding-leading-to-home-evacuations-in-northwest-alabama.html

[17] https://www.waaytv.com/content/news/Highway-231-Closed-Indefinetely--567952871.html

[18] https://www.wtoc.com/2020/02/20/heavy-rain-flooding-affecting-roads-around-area/

[19] https://www.bloomberg.com/news/articles/2020-02-09/energy-markets-need-winter-and-climate-change-is-taking-it-away

[20] https://www.independent.co.uk/news/world/europe/france-ski-resort-closed-snow-mourtis-pyrenees-weather-winter-a9331926.html

[21] https://www.scmp.com/news/asia/east-asia/article/3046892/worst-winter-decades-japans-ski-resorts

[22] https://www.reuters.com/article/us-usa-economy/mild-weather-boosts-us-job-growth-jobless-rate-ticks-up-idUSKBN2010G3

[23] https://www.businessinsider.com.au/australian-bushfires-cost-economy-surplus-government-spending-2020-1

[24] https://time.com/5758186/australia-bushfire-size/

[25] https://www.wsj.com/articles/australia-fires-put-farmers-in-double-jeopardy-11578388736?mod=hp_lista_pos1

[26] https://sydney.edu.au/news-opinion/news/2020/01/03/a-statement-about-the-480-million-animals-killed-in-nsw-bushfire.html

According to a Wall Street Journal[27] published on November 25, the mayor of Venice has estimated the damage from the floods to be about $1.1 billion. However, the estimated "cost could rise, as further damage emerge".

November: A Series of Winter Storms Across the Northern U.S.

The most widely reported impacts of the winter storms were school closings, road closings, power outages and flight cancellations. Property damage appears to have been minimal, although it is too soon to offer a reliable cost estimate.

October: Typhoon Hagibis

According to AIR Worldwide, Typhoon Hagibis may generate between $8 billion and $16 billion in insured losses[28], with more with than half of the losses due to inland flooding. According to "The Mainichi", a Japanese newspaper, at least 83 people died[29] as a result of Typhoon Hagibis.

October: Cold Spell Across the U.S. and Canadian Great Plains

Some farms have reported agriculture losses due to the unexpected cold. For example, "Freight Waves" reports $45 million of estimated damage[30] to the potato crop in North Dakota and Minnesota.

September: Hurricane Dorian

While Dorian had an impact in the U.S. and Canada, losses are heavily concentrated in the Bahamas where the storm was at its greatest strength. According to AON's "Weather, Climate and Catastrophe Insight" annual report, the storm resulted in 83 deaths, economic losses of $10 billion, and insured losses of $3.5 billion.

September: Tropical Storm Imelda

According to the USA Today, the storm has been linked to five deaths[31], and, in its "Weather, Climate and Catastrophe Insight" annual report for 2019, AON estimates that economic losses are $5 billion, while insured losses are $1.2 billion.

September: Heat/Dry Spell in the U.S. Southeast

According to the Wall Street Journal[32], the unusual heat and dryness in the U.S. Southeast is having negative effects on agriculture. Potential effects include damage to grass used to feed livestock and damage to the cotton crop. In addition, the dry soil makes it more challenging to harvest peanuts. The Baltimore Sun (a newspaper) indicates that the drought is affecting soybean crops and could even affect next year's wheat crop which must be planted this fall[33].

August: Heavy Monsoon Rains in India

According to a Reuters' article published on August 14, heavy rains in the first half of August caused floods and landslides that displaced over one million persons in India and led to 270 deaths[34]. An article in Business Today[35] on August 16 indicates that coffee yields in the states of Karnataka, Kerala and Tamil Nadu are expected to decline by 30% to 40% due to August's rains and floods. Sugarcane, cotton and apple yields are also likely to be reduced[36].

Because India's monsoon season is volatile weather phenomenon with significant rainfall variation from year to year, month to month, and region to region, flood-induced fatalities and economic losses are not unusual in India. According to data from India's Central Water Commission, across the period from 1953 to 2017 an average of 1600 persons died each year due to heavy rains and floods, and across the 5-year period from 2013 to 2017, the average was 1953[37].

August: Heat Wave in Alaska

[27] https://www.wsj.com/articles/in-venice-a-struggle-to-rescue-damaged-art-and-architecture-11574703868

[28] https://www.air-worldwide.com/Press-Releases/AIR-Worldwide-Estimates-Insured-Losses-for-Typhoon-Hagibis-Will-be-Between-USD-8-Billion-and-USD-16-Billion/

[29] https://mainichi.jp/english/articles/20191022/p2g/00m/0dm/005000c

[30] https://www.freightwaves.com/news/mother-nature-turns-midwestern-spuds-to-duds

[31] https://www.usatoday.com/story/news/nation/2019/09/21/texas-flooding-tropical-storm-imelda-death-toll-increases-5/2402290001/

[32] https://www.wsj.com/articles/flash-drought-hits-south-as-record-heat-continues-into-fall-11570058348

[33] https://www.baltimoresun.com/weather/bs-md-drought-report-20190926-yooqxwbbuvcldise7a4oisugtm-story.html

[34] https://www.reuters.com/article/us-southasia-floods/india-floods-kill-more-than-270-displace-one-million-idUSKCN1V413K

[35] https://www.businesstoday.in/current/economy-politics/karnataka-floods-landslides-brew-fresh-troubles-coffee-second-year-straight/story/372972.html

[36] https://economictimes.indiatimes.com/news/economy/agriculture/sugarcane-cotton-apple-crops-hit-by-late-rainfall-pan-india/articleshow/70744401.cms

[37] https://www.business-standard.com/article/current-affairs/at-107-487-india-accounts-for-1-5th-of-global-deaths-from-floods-in-64-yrs-118071900052_1.html

During August, large numbers of dead salmon were found in several Alaskan rivers[38]. According to observers, the fish died prior to spawning, whereas salmon typically die only after spawning. Some researchers are attributing these premature deaths to unusually high river temperatures caused by a combination of high air temperatures and lack of rain[39].

July: Heat Waves in the U.S. and Europe

Fortunately, few human lives were lost in these heat waves. In regard to economic costs, an assessment is difficult. Some examples of the impact of the heat waves are as follows: (1) in both Germany and France, a number of nuclear power plants had to be taken offline, thus temporarily reducing total power generation[40]; (2) in the United Kingdom, railway service was disrupted because the unusually high temperatures caused train tracks to expand or kink[41]; (3) in the United Kingdom, thousands of chickens died in a farmhouse that lacked a cooling system[42]; and (4) on a farm in the Netherlands, over 2000 pigs suffocated[43] after a ventilation system failed during the heat wave.

July 13-16: Hurricane and Tropical Storm "Barry"

Over $600 million in economic losses and nearly $300 million in insured losses, according to industry experts.

[38] https://time.com/5661024/alaska-high-temperatures-salmon-deaths/

[39] https://observers.france24.com/en/20190821-salmon-die-alaska

[40] https://www.reuters.com/article/us-france-electricity-heatwave/hot-weather-cuts-french-german-nuclear-power-output-idUSKCN1UK0HR

[41] https://www.telegraph.co.uk/news/2019/07/25/uk-heatwave-britain-bracing-hottest-day-record-temperature-could/

[42] https://www.independent.co.uk/news/uk/home-news/chicken-uk-heatwave-farm-deaths-lincolnshire-tesco-sainsbury-a9025516.html

[43] https://veganuary.com/blog/over-2000-pigs-suffocate-on-factory-farm-as-ventilation-system-fails/

June 21-22: Derecho in Central and Eastern U.S.
An extreme wind event known as a "derecho" caused damage across a 1000-mile path from Nebraska to South Carolina. Thousands of structures affected, with economic losses estimated to be over $100 million by industry experts.

May: Severe Weather in U.S. Plains, Midwest and Southeast
Tornadoes, straight-line winds, hail, flooding: close to $3 billion of economic losses and $2 billion of insured losses, according to industry experts.

May to June: Flooding in U.S. Breadbasket
Flooding has had a significant impact on farmers' ability to plant crops this year. Economic and insured losses are estimated to be in excess of $4 billion by industry experts.

Data

The 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:

ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/

Filename = ghcnd_all.tar.gz

The online documentation for the GHCN dataset does not indicate whether the precipitation field contains, in addition to rainfall, the liquid-equivalent for other forms of precipitation such as snow and sleet. Therefore, for a random sample of several hundred stations, we compared daily precipitation data against daily snowfall data. We found that, without any exceptions, the precipitation data field captures both rainfall and the liquid-equivalent amount of snowfall.

SOA Research Team for This Report

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About the Society of Actuaries

With roots dating back to 1889, the Society of Actuaries (SOA) is the world's largest actuarial professional organization with more than 30,000 actuaries as members. Through education and research, the SOA advances actuaries as leaders in measuring and managing risk to improve financial outcomes for individuals, organizations, and the public.

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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