Catastrophe and Climate
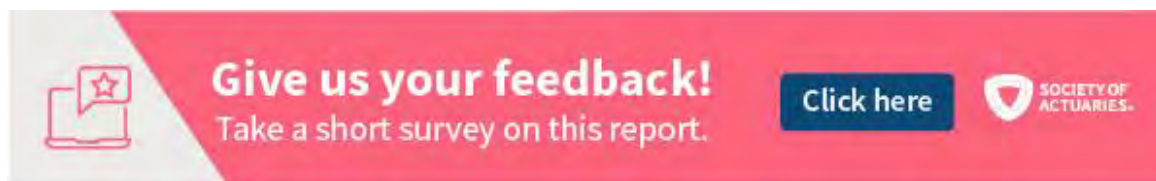
Actuarial Weather Extremes
December 2020

Actuarial Weather Extremes: December 2020

U.S. Western Drought, Eastern Flood, 2nd Warmest Year Globally

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Caveat and Disclaimer

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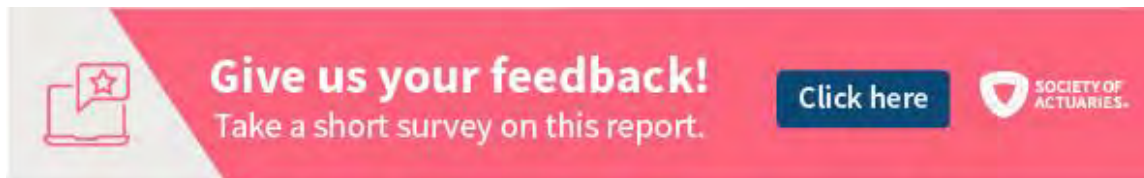## Overview

This report examines three extreme weather phenomena in December 2020: Continuing drought in the Western United States, heavy precipitation, snowfall, and flood in the Eastern U.S., and ranking 2020 global land and ocean temperature vs previous annual averages of the last 141 years.

Drought: In the Southwest U.S., many areas saw moderate or greater drought conditions for all 52 weeks of 2020. Additionally, 2020 was a year of drought condition degradation, with some areas degrading several classes over the year. For the year, drought losses in the U.S. were in the range of $4.5 Billion (See Figures 1 and 2).[1][2]

Precipitation, Snow and Flood: On December 24/25, mainly from Ohio east through Pennsylvania, New York, Massachusetts and into Virginia, record amounts of precipitation and snow fell which were followed by flooding mainly in Pennsylvania, New York and Virginia (See Figures 3, 4, 5).

Historically Warm Global Temperature: As shown in Figure 6, 2020 was the second warmest year dating back to 1880 when ranking average global land and ocean temperature, second only by 0.02 degrees Celsius to 2016. 2020 was 0.98 degrees Celsius above the 20th Century average land and ocean temperature and 2016 was 1.00 degree above.

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[1] National Integrated Drought Information System. January 7, 2021. 2020 in Review: A Look Back at Drought Across the United States in 12 Maps | Drought.gov

[2] January 8, 2021. Billion-Dollar Weather and Climate Disasters: Overview | National Centers for Environmental Information (NCEI) (noaa.gov)

Drought

Figure 1 shows that December 2020 drought conditions continue to be widespread and significant, especially in much of the western U.S., including in those areas that had been impacted by wildfires. Compared to late December 2019, the drought conditions degraded several classes across the six class classifications of: No Drought, Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought and Exceptional Drought. Some areas in the Southwest U.S. degraded a full five classes over the year.

Figure 1

DROUGHT CONDITIONS IN THE CONTINENTAL U.S. DECEMBER 2019 AND DECEMBER 2020

Source: NOAA Climate.gov Drought Monitor (Accessed January 19, 2021).

https://www.climate.gov/maps-data/data-snapshots/usdroughtmonitor-weekly-ndmc-2019-12-31?theme=Drought

https://www.climate.gov/maps-data/data-snapshots/usdroughtmonitor-weekly-ndmc-2020-12-29?theme=Drought

According to the NOAA National Centers for Environmental Information (NCEI) Billion-Dollar Weather and Climate Disasters Overview, 2020 set the new record of 22 billion-dollar loss events far exceeding the previous annual record of 16 events in 2011 and 2017. Figure 2 shows that for the year 2020, drought (1 of the 22 events) losses were in the range of $4.5 Billion.[3]

Figure 2
DROUGHT COSTS IN THE U.S. SINCE 1980

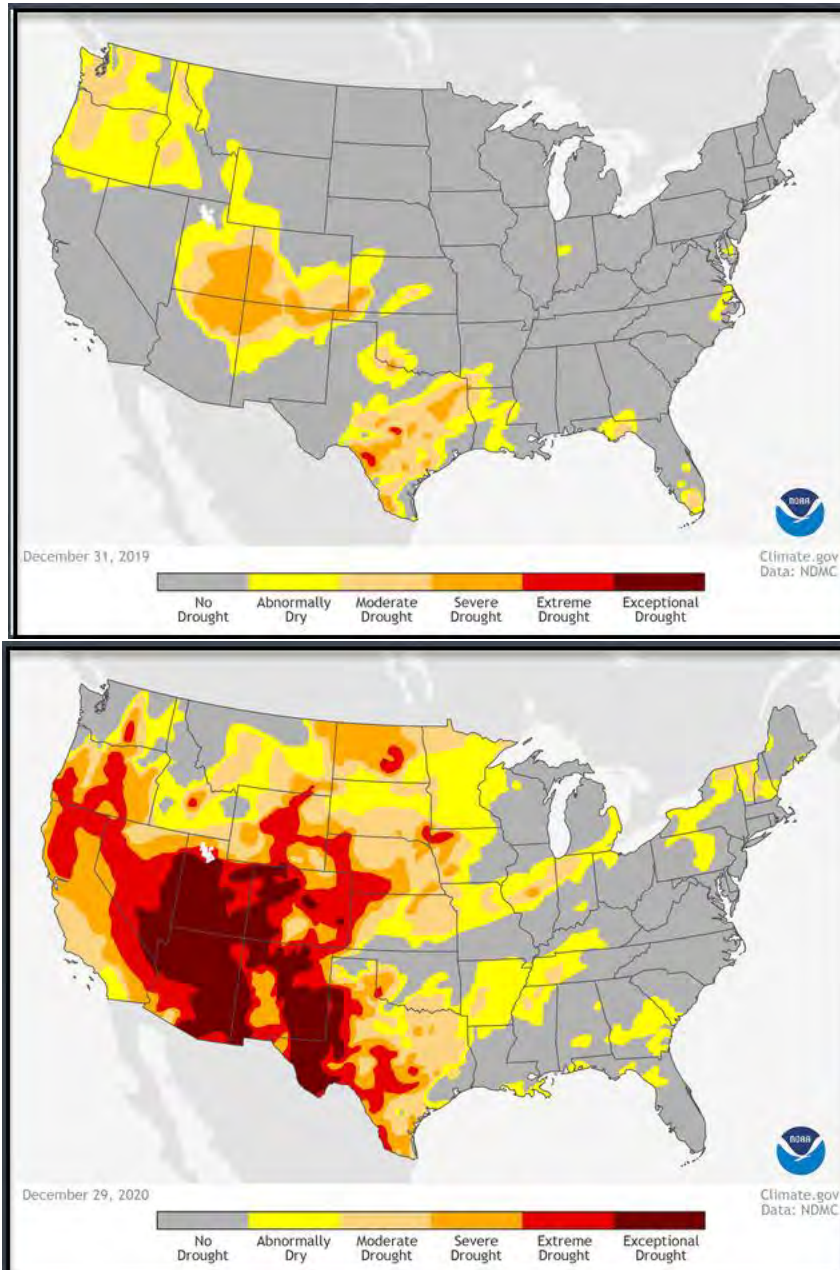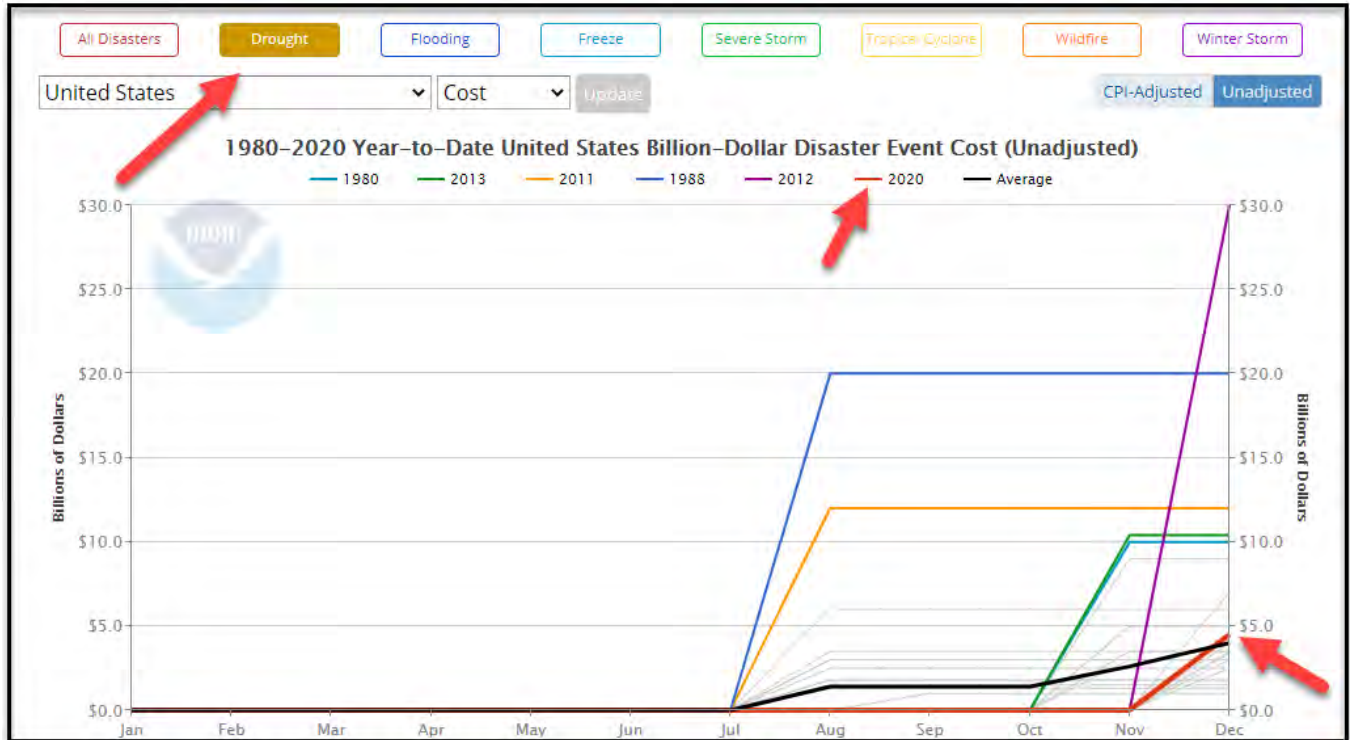[3] January 8, 2021. Billion-Dollar Weather and Climate Disasters: Overview | National Centers for Environmental Information (NCEI) (noaa.gov)

Late December Precipitation, Snow and Flooding

PRECIPITATION

A system moved through the Midwest and Northeast U.S. on December 25 setting record amounts for rain and snowfall.   (See Figure 3).   Across the Northeast U.S., from Pennsylvania through Maine, power outages affected some 300,000 people. Some areas in the Interior Northeast U.S. had 3 inches of rain fall in areas that had recently had snowfall.[4]

Figure 3
GLOBAL HISTORICAL CLIMATOLOGY NETWORK (GHCN) STATIONS WITH U.S. DAILY PRECIPTATION RECORDS IN EXCESS OF 3 INCHES AND SNOW RECORDS IN EXCESS OF 6 INCHES SET ON DECEMBER 25, 2020 FOR DECEMBER DAILY PRECIPITATION AND SNOW BACK TO 1960. THE CHART INDICATES INCHES OF DAILY RAINFALL OR SNOWFALL.
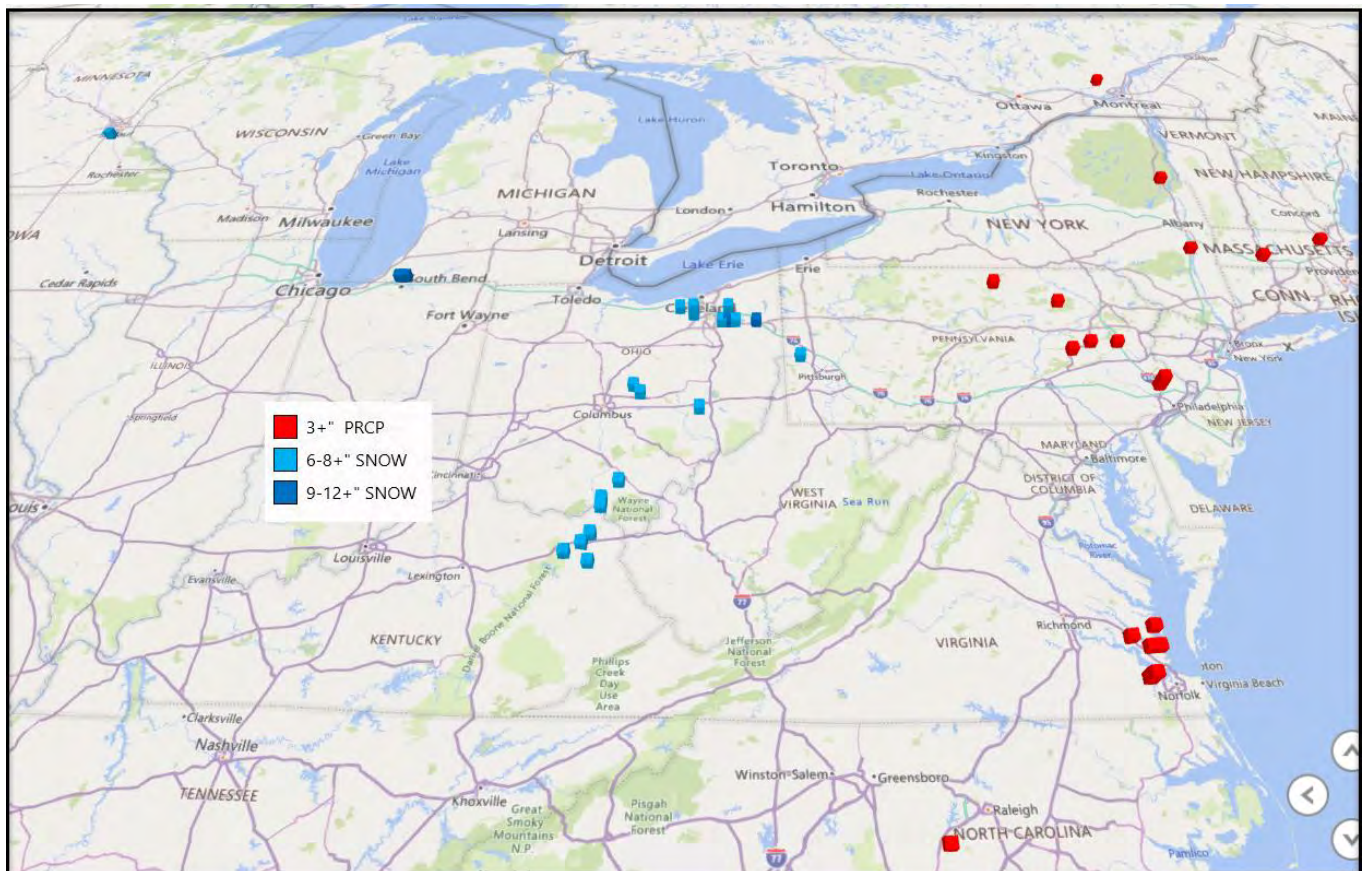
Source: GHCN station data (Accessed January 4, 2021). ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/ghcnd_all.tar.gz

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[4] December 27, 2020.   Storm Produces White Christmas, Power Outages in East | AccuWeather

FLOODING

**Time Lapse of Flooding and Precipitation**: By clicking on the link below Figure 4, you can see the December 2020 hourly time lapse of precipitation and subsequent flooding. The heavy precipitation seen December 24/25 is followed by flood conditions primarily in New York, Pennsylvania, and Virginia. The precipitation shown here is consistent with the record setting station readings shown in Figure 3 above.

Figure 4

FLOOD AND PRECIPITATION DECEMBER 2020 TIME LAPSE ANIMATION USING DATA FROM UNITED STATES GEOLOGICAL SURVEY (USGS) STREAMGAGE DATA AND THE IOWA STATE UNIVERSITY AUTOMATED SURFACE OBSERVING SYSTEM (ASOS)
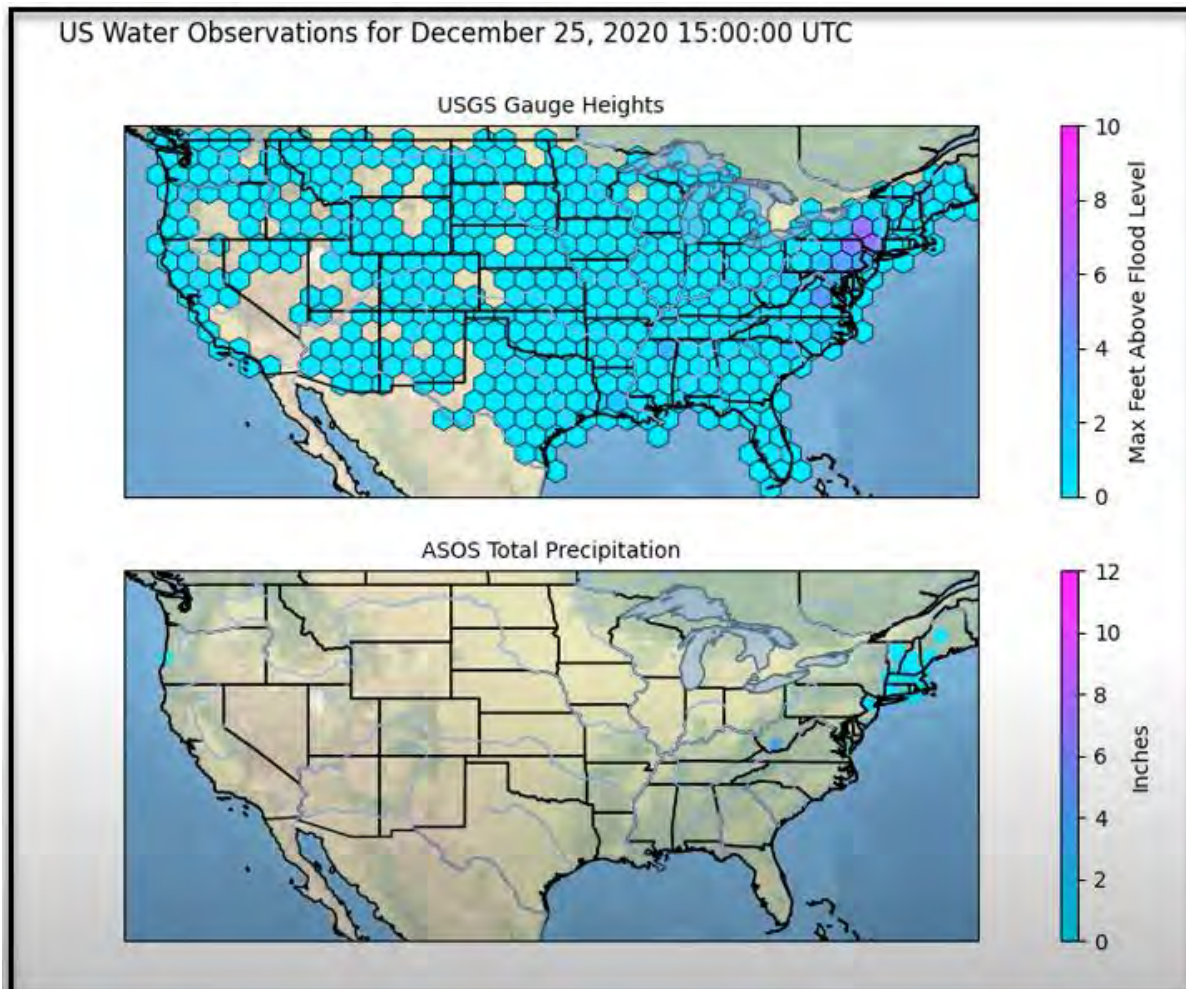
Time Lapse created by Matthew Self, ASA using USGS data, ASOS data and Python programming. Data accessed January 1, 2021.

Click this Link for Time-Lapse Animation

https://drive.google.com/file/d/1VHdwukp49Q78zvnNHFVdcYzf6sCaW-F8/view?usp=sharing

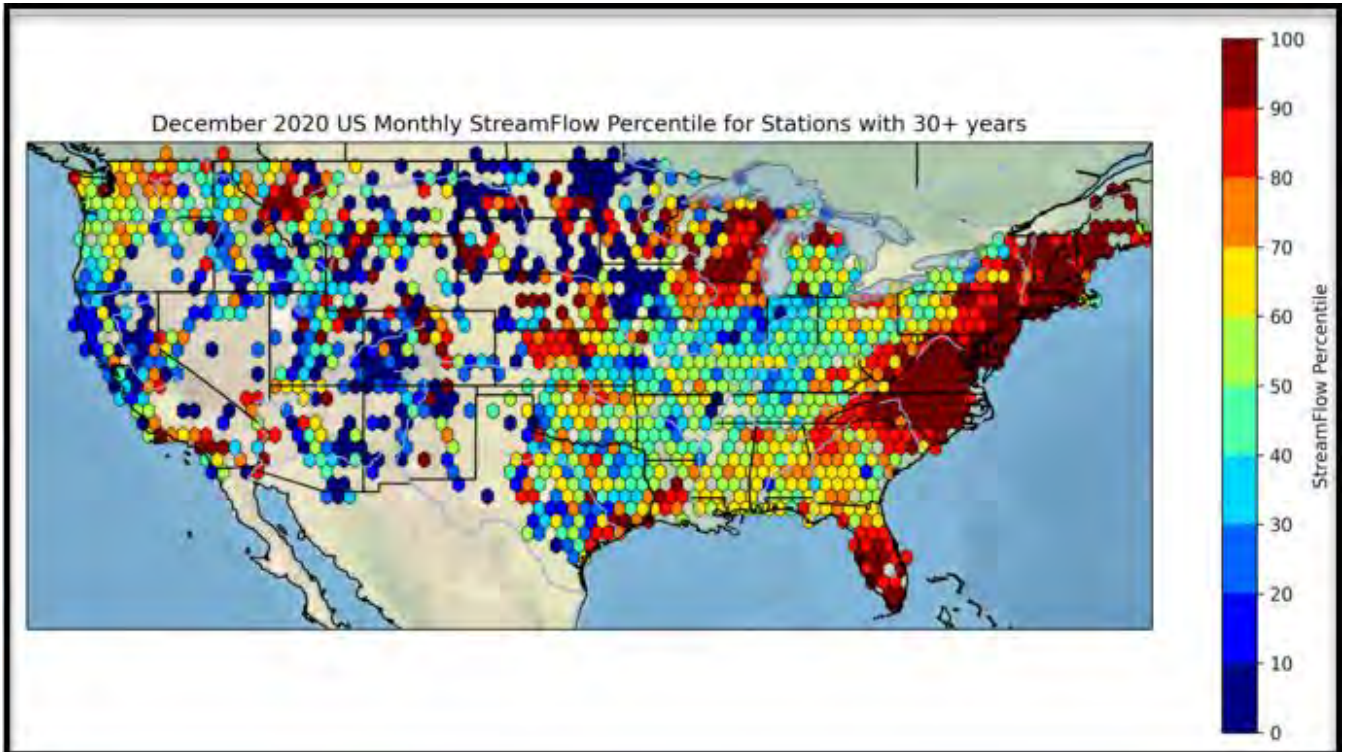Source: United States Geological Survey (USGS) Daily Values, retrieved 1/1/2021: https://waterservices.usgs.gov/rest/DV-Test-Tool.html
Source: IA State University ASOS, retrieved 1/1/2021: https://mesonet.agron.iastate.edu/request/download.phtml

Ranking December 2020 streamflow versus past years, 2020 had the heaviest stream flows in the MidAtlantic states and in the Northeast U.S., as seen in Figure 5. Many areas in the Western U.S. had particularly low stream flows in December 2020 vs past years, but the percentiles in the North Carolina through Maine states were high and consistent with areas shown to have flooding in late December in Figure 4.

Figure 5
STREAMFLOW DATA TAKEN FROM USGS DATA AND SHOWING AVERAGE DECEMBER FLOODING IN 2020 VS PAST DECEMBERS FOR STATIONS THAT HAVE AT LEAST 30 YEARS OF HISTORICAL DATA.


Source: United States Geological Survey (USGS) Daily Values, retrieved on 1/1/2021: https://waterservices.usgs.gov/rest/DV-Test-Tool.html
Historical Means: https://waterservices.usgs.gov/rest/Statistics-Service-Test-Tool.html

Global Land and Ocean Temperature in 2020 vs 20th Century Average

Looking at the full year 2020, the global average temperature for the year was second only to 2016 as the highest anomaly above the 20th Century average global temperature. 2020 was the 2nd warmest on record for this global measure, at 0.98 degrees Celsius above the 20th century average, second only to 2016 which was 1.00 degree Celsius above the 20th Century average.

Figure 6

GLOBAL LAND AND OCEAN AVERAGE ANNUAL TEMPERATURE DEPARTURE FROM 20TH CENTURY AVERAGE IN DEGREES CELSIUS
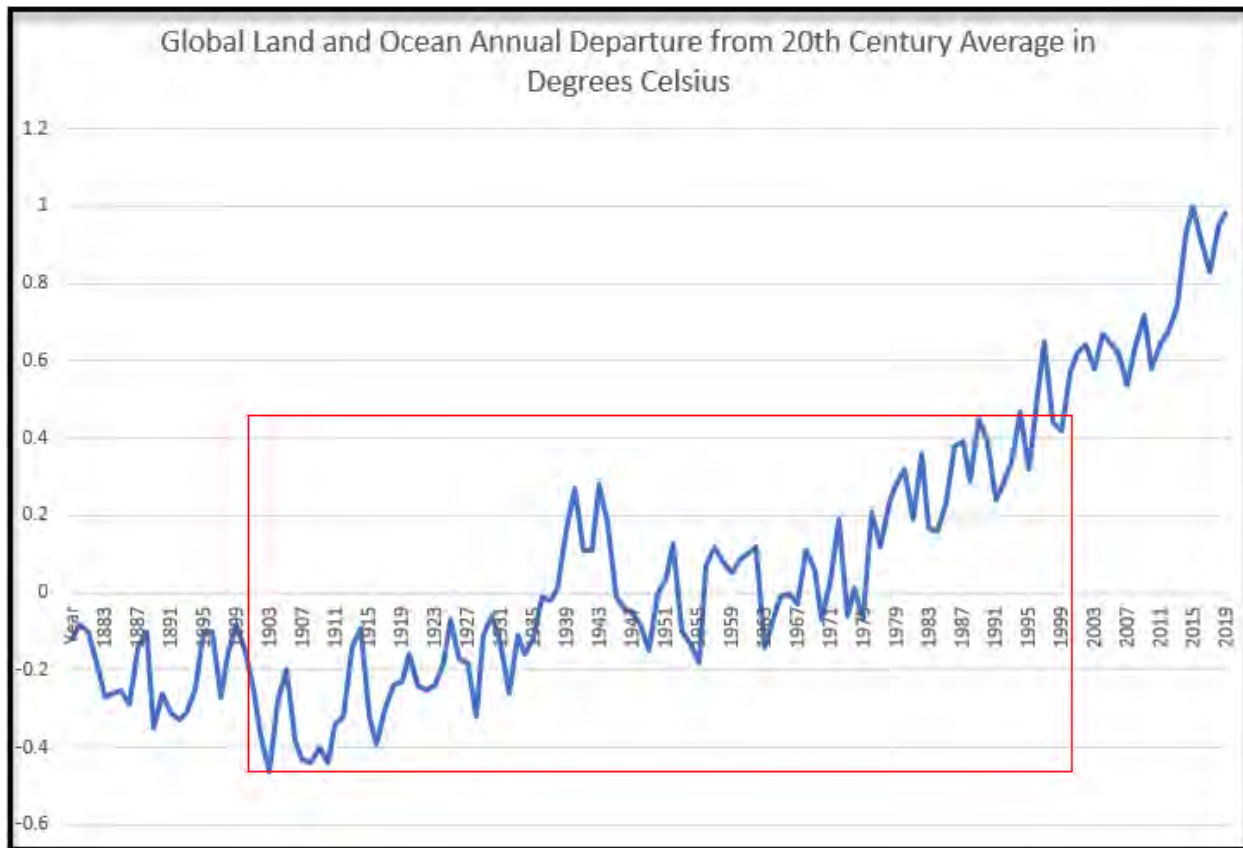
Source: NOAA National Centers for Environmental information (NCEI), Climate at a Glance: Global Haywood Plots, published January 2021, retrieved on January 15, 2021 from https://www.ncdc.noaa.gov/cag/global/haywood/globe/land_ocean

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.

2020 Drought Losses

In the Southwest United States, many areas saw moderate or worse drought conditions for all 52 weeks of 2020. Additionally, 2020 was a year of drought condition degradation, with some areas degrading several classes over the year. For the year, drought losses in the U.S. were in the range of $4.5 Billion (See Figures 1 and 2).[56]

Data

Snow 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:

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.

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

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[5] National Integrated Drought Information System. January 7, 2021. 2020 in Review: A Look Back at Drought Across the United States in 12 Maps | Drought.gov
[6] January 8, 2021. Billion-Dollar Weather and Climate Disasters: Overview | National Centers for Environmental Information (NCEI) (noaa.gov)

=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 Flood Data
Source: United States Geological Survey (USGS) Daily Values:
Daily Values: https://waterservices.usgs.gov/rest/DV-Test-Tool.html
   a) Select "List of Sites" in the Major Filters section and enter the Site Number(s) of interest
   b) In the Date Ranges section, select "Return all values within an absolute date range" and enter the Date Range of interest
   c) Enter "00003" for the Statistics Code; 00003 is the Mean Observation
   d) For "Sites serving parameter codes", enter **00060** for Discharge, cubic feet per second or **00065** for Gage Height, feet.
   e) At the bottom click "Generate the URL" then click "Run the Generated URL"

Historical Means: https://waterservices.usgs.gov/rest/Statistics-Service-Test-Tool.html
   a) Enter the Site Number(s) of interest
   b) Select "Monthly statistics" and the "Mean (average)" Statistic Type
   c) Enter 00060 in the box for "Sites serving parameter codes"
   d) At the bottom click "Generate the URL" then click "Run the Generated URL"
   e) The output will be the Mean Discharge for each month in the historical record

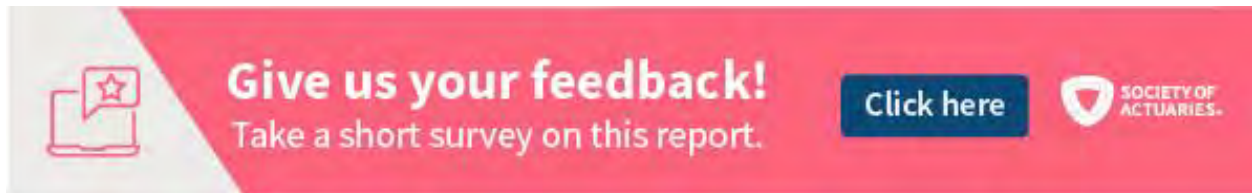**NOAA National Centers for Environmental Information Data**
Source: Global Land and Ocean Year to Date Temperature Anomalies. December Year to Date totals for each year 1880 to 2020. https://www.ncdc.noaa.gov/cag/global/haywood/globe/land_ocean

Acknowledgments

Feedback

About The Society of Actuaries

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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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