SOCIETY OF ACTUARIES

Actuarial Weather Extremes
June 2019

Actuarial Weather Extremes: June 2019

Extreme Weather on Both Sides of the Atlantic

Overview

In April 2019, the Society of Actuaries (SOA) released its first monthly report focusing on weather extremes. This report is the third in the monthly series, focusing on extreme weather events that occurred in June 2019. Each future report will cover weather events that occurred during the most recently completed month. While the emphasis of the reports is on weather events in North America, we intend to periodically cover extreme weather events that occur in other locations.

This report highlights three major weather stories that unfolded across the month of June:

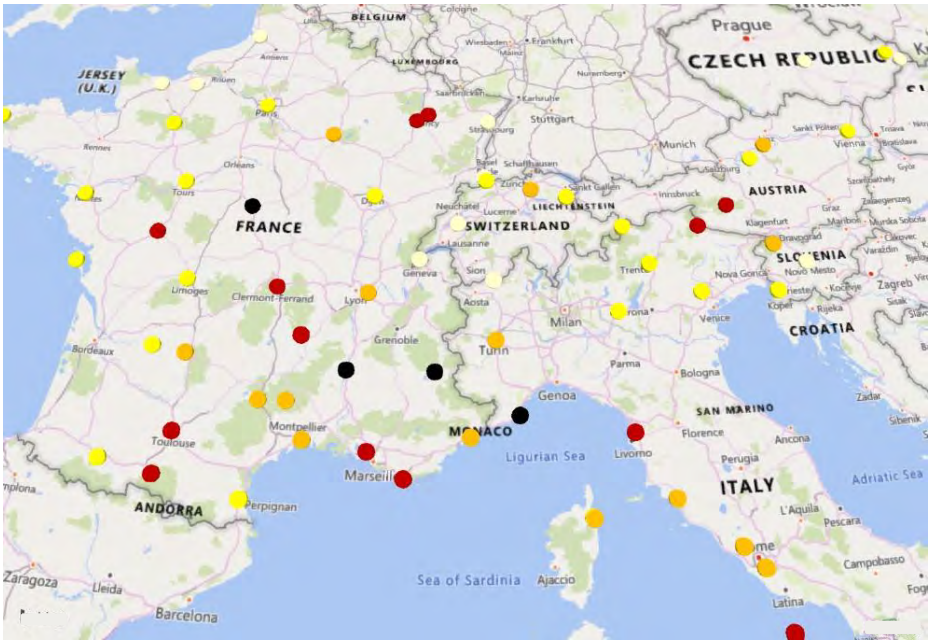
- A heat wave gripped much of Europe in the last week of June
- An extreme wind event known as a "derecho" swept across a 1000-mile path in the United States (U.S.) on June 21, beginning in Nebraska and culminating in South Carolina
- Widespread flooding continues throughout the Central U.S, with a significant impact on farming

Heat Wave in Europe

Beginning on June 26, and still continuing as of June 30, much of Western and Central Europe experienced a significant heat wave. The hardest hit country was France, where many GHCN[1] weather stations reported multiple consecutive days of record or near-record temperatures, as shown in Figure 1, Table 1 and Table 2.

Figure 1

Number of Days Between June 26 and 30 Where the Daily High Temperature Exceeded the 99th Historical Percentile



Each dot in Figure 1 represents a weather station that reported at least one daily high temperature between June 26 and June 30 that exceeded the corresponding historical 99th percentile. The colors indicate the total number of days above the 99th percentile:

Light Yellow = 1 day
Yellow = 2 days
Orange = 3 days
Red = 4 days
Black = 5 days

Note that June 2019 data for Germany and Spain was not yet available at the time of this report's publication.

[1] Data for Figure 1, Table 1 and Table 2 was obtained from the Global Historical Climatology Network ("GHCN") weather database, which is publicly available through the National Oceanic and Atmospheric Administration (NOAA). The appendix provides more information about this dataset, and, in addition, explains our approach for ranking current temperature observations against historical data.

Table 1

Top Ten Temperature Records June 26 to 30, Ranked by Degrees Above Historical Average Daily High Temperature

Country	City or Name of Weather Station	Latitude North	Longitude East	Day	High Temp (F)	Degrees (F) Above Average
France	Montpellier	43.6	4.0	June 28	110.3	28.5
France	Bourges	47.1	2.4	June 27	103.1	27.7
Poland	Lawica	52.4	16.8	June 26	100.4	27.6
France	Mediterranee	43.6	4.0	June 28	110.3	27.4
France	Bourges	47.1	2.4	June 29	102.9	27.3
France	Brest-Guipavas	48.4	-4.4	June 27	93.7	27.0
France	Bourges	47.1	2.4	June 28	102.0	26.5
France	Clermont-Ferrand	45.8	3.2	June 27	102.7	26.4
France	Perpignan	42.7	2.9	June 28	108.3	26.3
France	Mont-Aigoual	44.1	3.6	June 28	85.8	26.3

This table does not reflect data from Germany and Spain because it was not yet available at the time of this report's publication.

Table 2

An Example of a Location that Experienced a Multi-Day Period of Unusually High Heat

Country	City	Latitude North	Longitude East	Day	High Temp (F)	Degrees (F) Above Average	Percent Rank[2]
France	Bourges	47.1	2.4	June 24	93.2	17.8	97.5%
France	Bourges	47.1	2.4	June 25	91.4	16.0	96.0%
France	Bourges	47.1	2.4	June 26	100.2	24.9	99.9%
France	Bourges	47.1	2.4	June 27	103.1	27.7	Record
France	Bourges	47.1	2.4	June 28	102.0	26.5	Record
France	Bourges	47.1	2.4	June 29	102.9	27.3	Record
France	Bourges	47.1	2.4	June 30	99.5	23.9	99.9%

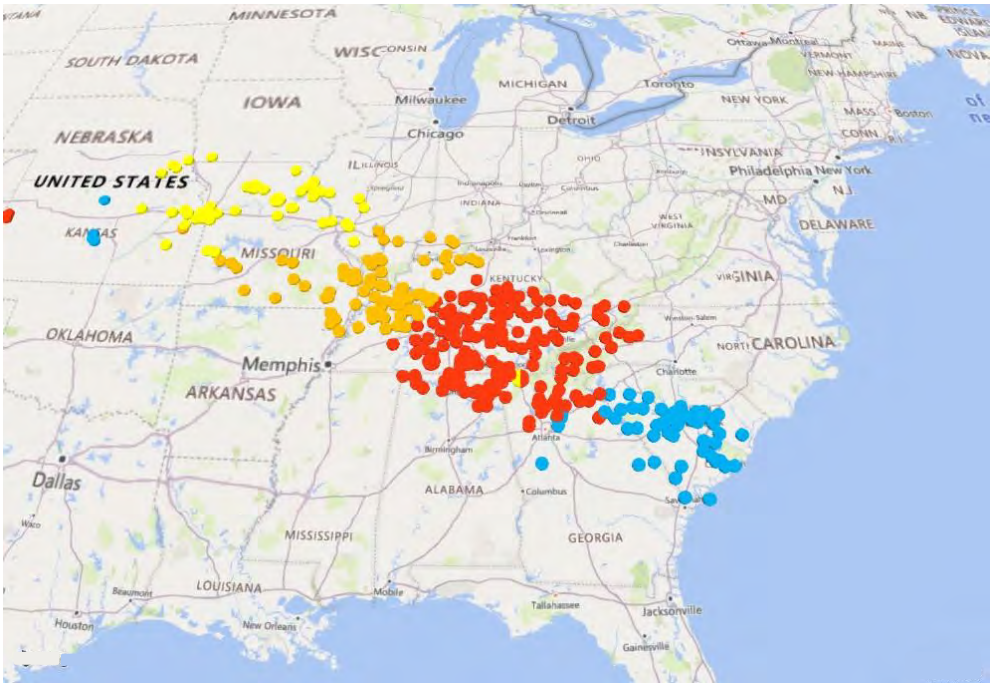
A Derecho Caused Damage Stretching from Nebraska to South Carolina

On June 21, a line of powerful storms known as a "derecho" traveled across a 1000-mile path, beginning its destructive journey in the Midwest, and concluding in South Carolina about 24 hours later (Figure 2 and Table 3). Derechos are characterized by strong straight-lined winds that are often accompanied by heavy rain. According to experts that we consulted, derechos are rare, occuring perhaps only a couple times a year, on average, in the U.S.

[2] "Percent Rank" compares the daily high temperature (TMAX) against the corresponding historical TMAX distribution. A rank of 99%, for example, means that the TMAX observation exceeded 99% of historical observations falling within a 10-day radius of the specified date. A "record" is an observation that exceeded the previous maximum historical observation, again using a 10-day radius. A more detailed explanation of the ranking approach can be found in the Methods section at the end of this report.

Figure 2

Path Taken by Derecho Across a 24-Hour Period on June 21



Each dot in Figure 2 represents a high-speed wind event recorded by NOAA's Storm Prediction Center on June 21.

The colors indicate the number of hours elapsed since the Derecho's inception:

Yellow = 0 to 6 hours
Orange = 6 to 12 hours
Red = 12 to 18 hours
Blue = 18 to 24 hours

Table 3

Top Ten Reported Wind Speeds During the Derecho

State	County	Latitude North	Longitude West	Wind Speed in MPH
Kansas	Wallace	38.9	101.8	94
Tennessee	Roberston	36.5	86.9	80
Illinois	Williamson	37.7	88.9	75
Kentucky	Calloway	36.7	88.5	75
Missouri	Jackson	39.0	94.4	74
Missouri	Scott	37.2	89.6	72
Kansas	Rice	38.3	98.2	72
Missouri	Linn	39.8	93.3	70
Missouri	Cedar	37.9	94.0	70
Kentucky	Marshall	36.9	88.4	70

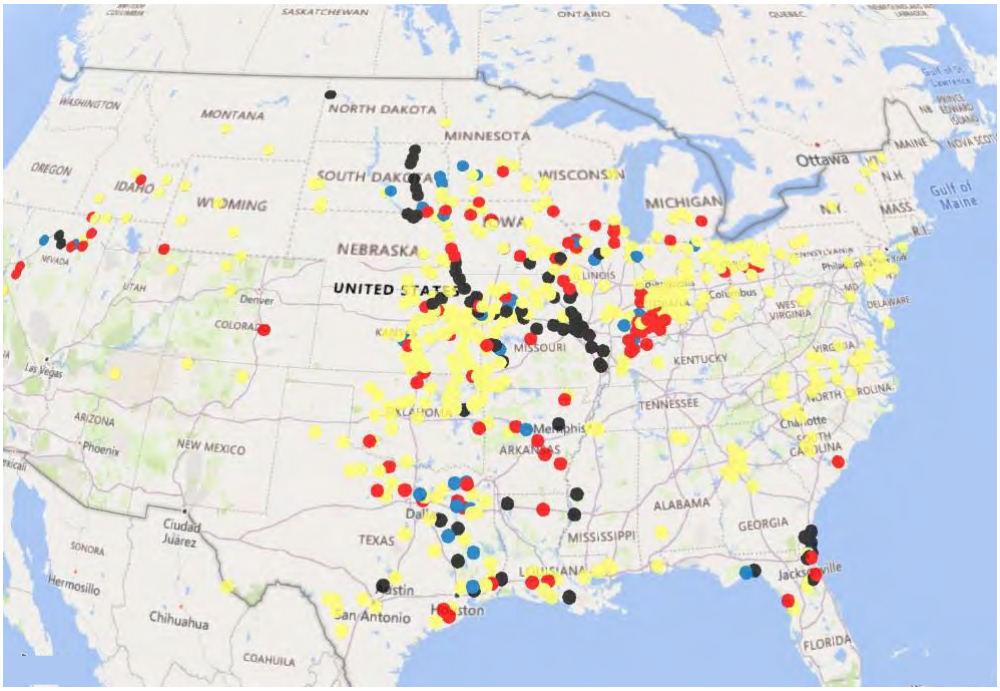
Data source: Severe Weather Report on June 21 from NOAA's Storm Prediction Center

Widespread Flooding in Central and Southcentral U.S.

Widespread flooding continues to affect a significant portion of the U.S, as shown in Figure 3. The flooding is a consequence of a number of factors, including a winter and spring characterized by snowfall and rainfall accumulations that significantly exceeded historic norms across much of the U.S. breadbasket, as shown in Figures 4 and 5.

Figure 3

United States Geological Survey Streamgages that Reported Flooding in June 2019

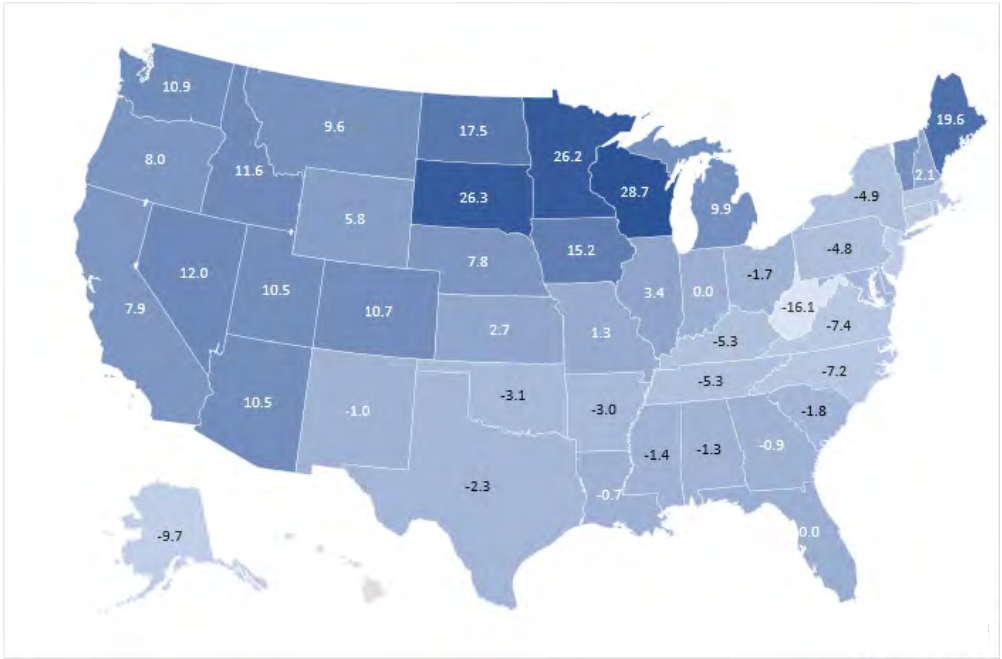


The streamgage locations are color-coded to indicate the total number of days of flooding in June 2019, as follows:

Yellow = 1 to 7 days
Red = 8 to 15 days
Blue = 16 to 23 days
Black = 24 to 30 days

Figure 4

Total January-to-April Snowfall in 2019 Minus the Corresponding Historical Average (inches)

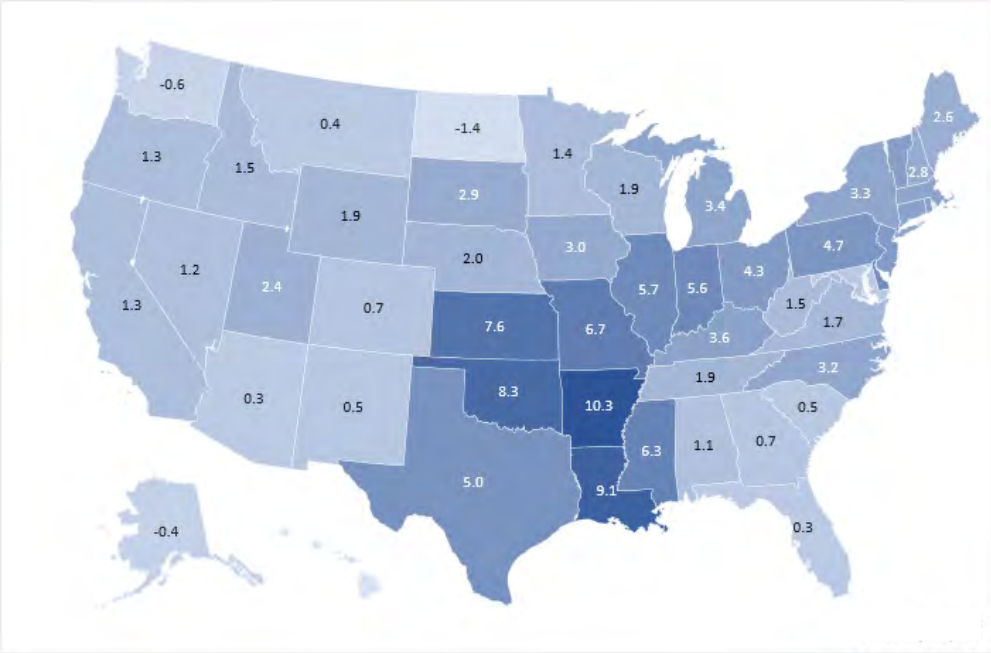


Using GHCN data from 1960 through 2018, the average total snowfall from January through April was computed separately by state (by averaging across each state's weather stations). These results were then compared to each state's January-to-April snowfall in 2019.

For Minnesota, for example, total January-to-April snowfall in 2019 was 26.2 inches above the historical average.

Figure 5

Total April-to-June Rainfall in 2019 Minus the Corresponding Historical Average (inches)



Using GHCN data from 1960 through 2018, the average total rainfall from April through June was computed separately by state (by averaging across each state's weather stations). These results were then compared to each state's April-to-June rainfall in 2019.

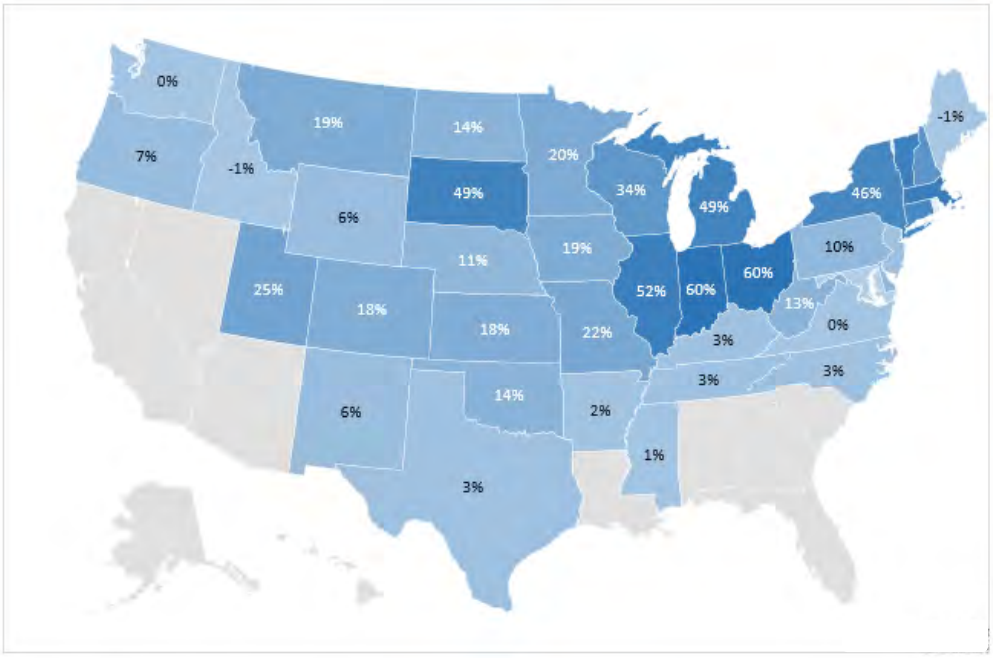
For Arkansas, for example, total rainfall from April to June in 2019 was 10.3 inches above the historical average.

Impact of Floods on Crop Planting Progress

Flooding has been a persistent problem throughout much of the U.S. breadbasket since late March, causing many farmers to either delay planting their crops or to abandon the goal of producing a crop this season. Consequently, as of early June, corn and soybean planting progress was significantly behind historical norms (Figures 6 and 7):

Figure 6

Corn: Historical Median Percent Planted on June 2nd Minus Percent Planted on June 2nd, 2019



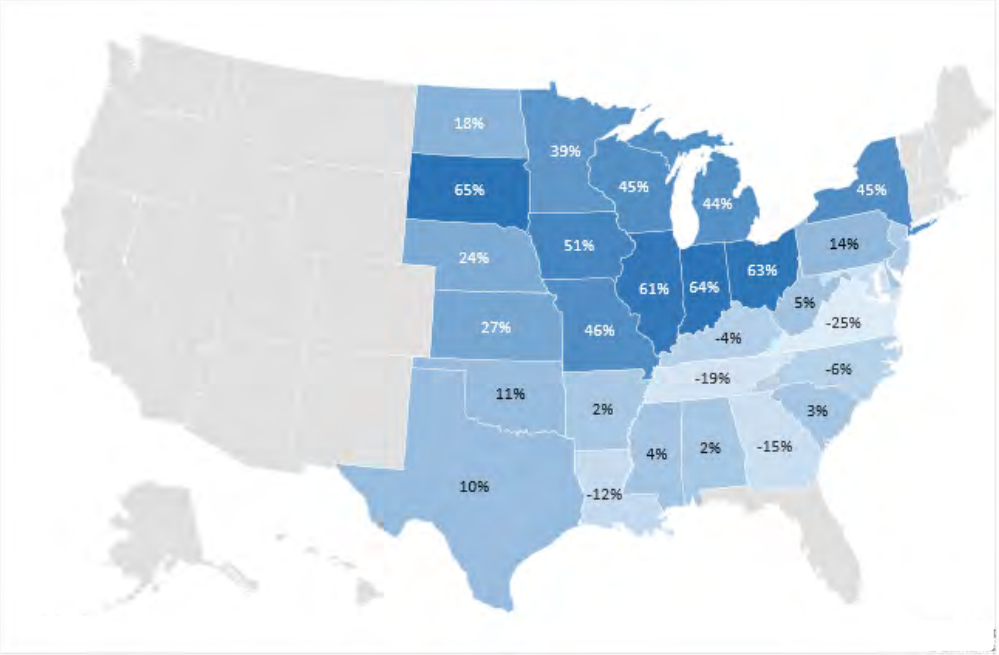
Using 1980-2018 data from the U.S. Department of Agriculture's "Quick Stats" database, the median historical corn planting progress percentage was computed for June 2 and compared against progress made as of June 2, 2019.

In Ohio, for example, the median historical progress for June 2nd is 93%, but progress on June 2, 2019 was only 33% -- a gap of 60%.

Those states that are blank produce either no corn or an insignificant share of total national output.

Figure 7

Soybeans: Historical Median Percent Planted on June 2nd Minus Percent Planted on June 2nd, 2019



Using 1980-2018 data from the U.S. Department of Agriculture's "Quick Stats" database, the median historical soybean planting progress percentage was computed for June 2 and compared against progress made as of June 2, 2019.

In Ohio, for example, the median historical progress for June 2nd is 81%, but progress on June 2, 2019 was only 18% -- a gap of 63%.

Those states that are blank produce either no soybeans or an insignificant share of total national output.

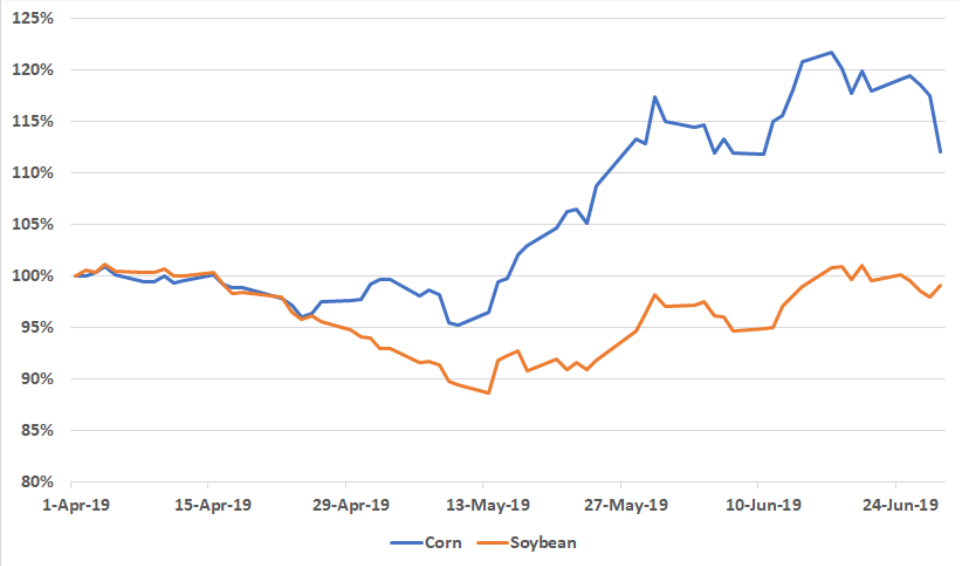
Rough Assessment of the Economic Impact of Recent Extreme Weather

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.

With respect to the impact of the recent and ongoing floods on farming, insufficient time has elapsed to offer a solid loss estimate, but our consultations with industry experts lead us to believe that lost crop yields could be material. Indeed, corn and soybean futures have surged over the last two months, suggesting that the floods will have a significant impact on crop yields:

Figure 8

September Futures Prices for Corn and Soybeans, Relative to Prices on April 1st, 2019



These September future prices are expressed relative to the closing price on April 1st. The underlying data is from the Chicago Board of Trade. The ticker symbols are as follows: zcu19 for corn, and zsu19 for soybeans.

We are working to include commentary in this series of reports which trends from more general and estimated losses to more specific and confirmed amounts. At this time, we offer the following loss impact notes related to weather extremes illustrated in previous monthly reports:

April 2019

Bomb Cyclone April 10-12 (noted in April 2019 Report): Economic losses expected to exceed $100M. The number of structures affected and claims are expected to be in the thousands.

May 2019

US Tornadoes, Straight Line Winds, Hail, Flooding: Multiple $Billions of Insured and Total Economic Losses expected.

Methods

To rank each daily TMAX observation used in the European heat wave exhibits, we used GHCN data back to 1960 that falls within a 10-day radius of a particular day of interest. For example, consider a TMAX observation of 85.5°F recorded on June 18, 2019 by a weather station in Paris, France. To rank this observation, a TMAX distribution was compiled from the station's 1960 to 2018 historical data, using observations from dates falling between June 8 and June 28. Against this empirical distribution, the TMAX observation from June 18th, 2019 falls at the 94th percentile, which means that 6% of historical observations exceeded 85.5°F. Note that the GHCN database is hosted by the National Oceanic and Atmospheric Administration (NOAA) and is available for download from NOAA's website. The data provides daily weather observations from over 100,000 weather stations worldwide, covering more than 180 countries.

Data

The data used in this analysis is publicly available and can be downloaded from the internet via the sites listed below.

GHCN daily station data used to produce the European heat wave exhibits:

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

Filename = ghcnd_all.tar.gz

NOAA's Severe Weather Report for June 21, used to produce the Derecho exhibit:

https://www.spc.noaa.gov/climo/reports/190621_rpts.html

USGS streamgage data for June 2019 used to produce the flood exhibit:

https://waterwatch.usgs.gov/index.php?id=wwdp2_2

USDA "Quick Stats" database, used to produce the crop planting progress exhibits:

https://quickstats.nass.usda.gov/

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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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