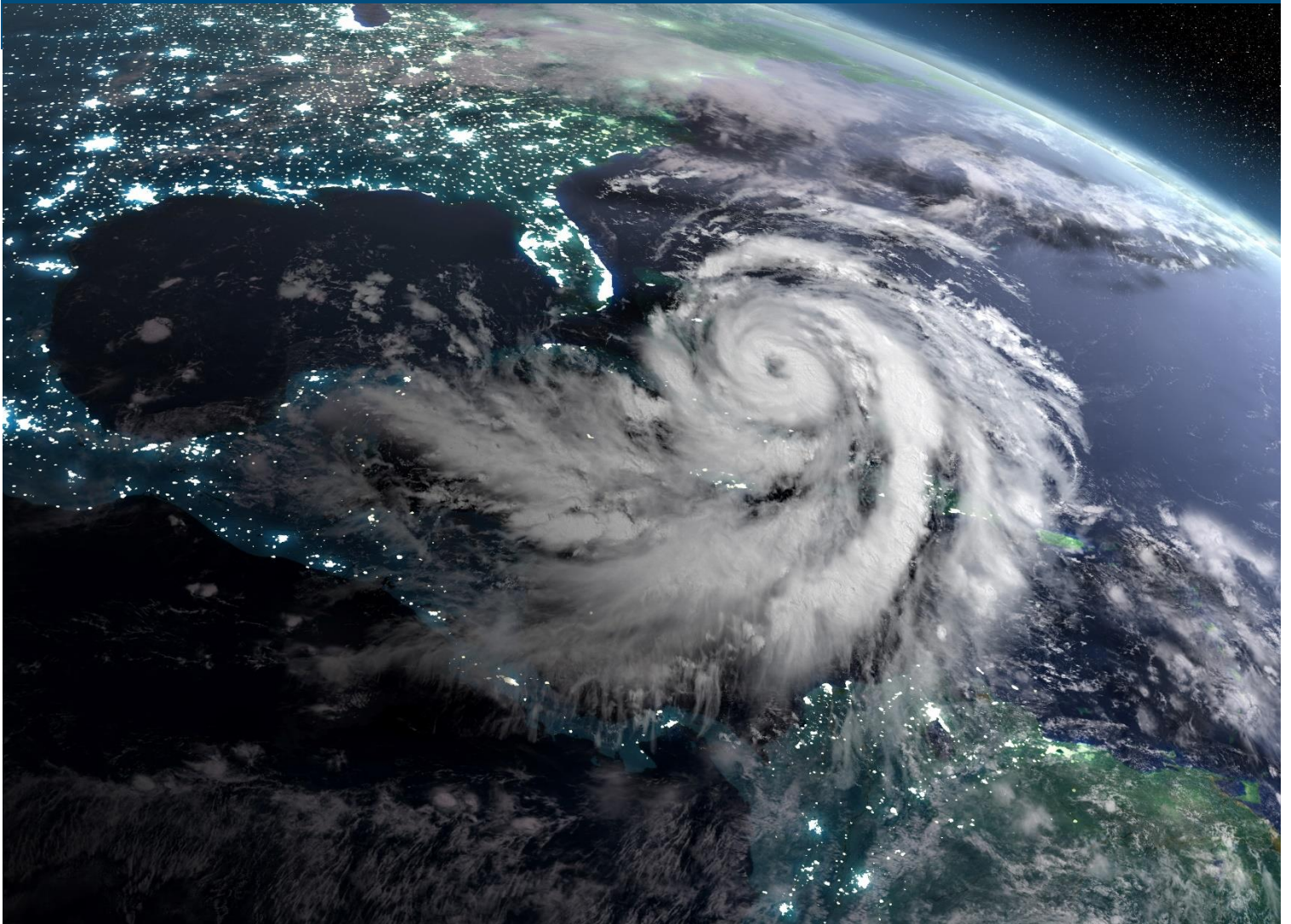




# Actuarial Weather Extremes

## April 2019



# Actuarial Weather Extremes: April 2019

## Spring Storms and a Trail of Rain, Snow and Temperature Extremes

### Overview

The Society of Actuaries (SOA) has developed a Weather Analysis Tool (“WAT”) that examines data from the Global Historical Climate Network (GHCN) to identify and summarize unusual or extreme single-day or multi-day weather events. Using results produced by WAT, the SOA intends to issue periodic reports that highlight extreme weather events occurring in North America. This report – the first produced using WAT – describes two major weather events that occurred in April 2019.

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. Of these, this report focuses on approximately 2,500 weather stations in North America that have consistently provided daily temperature, precipitation and snowfall data back to 1960. The lengthy data histories make it possible to rank daily observations against their corresponding historical distributions. Ranking, in turn, facilitates an assessment of whether an observation is at routine level or whether it is extreme.

Our analysis focuses on four weather variables provided by the GHCN data: TMAX, TMIN, PRCP and SNOW, which are, respectively, the daily maximum temperature, the daily minimum temperature, daily precipitation, and daily snowfall. Looking at these four metrics, this paper provides an analysis of certain weather events and patterns that occurred in April that were found to be extreme versus historical “norms”.

The data used in this analysis was downloaded on May 6th. Therefore, because most of the GHCN stations included in this analysis have a reporting lag of merely one or two days, the data for April is sufficiently complete.

This paper, as well as future WAT papers, will be brief, focusing solely on major weather events. To cater to those readers whose interest extends beyond these major events, we are developing an Excel tool that will contain records summarizing recent and historical weather for each of the 2,500 stations. We expect to have the Excel file ready for public distribution by August 2019. Each future paper will be released in tandem with an updated version of the Excel file.

### Methodology for Ranking Each Daily Weather Observation

To rank each daily observation, we use data back to 1960 that falls within a 10-day radius of the particular day of interest. For example, consider a TMAX observation of 51°F recorded on April 15, 2019 for a weather station in Chicago. To rank this observation, a TMAX distribution is compiled from the station’s 1960 to 2018 historical data, using observations from dates between April 5 and April 25. Against this empirical distribution, the April 2019 observation of 51°F falls at the 25th percentile, indicating that while this was a relatively cool day, it wasn’t “extreme”.

Using this ranking approach, WAT scans the GHCN data, searching for extremes. While there is no strict definition of “extreme”, WAT is typically used to flag observations that have a rank of 3% or less, or a rank of 97% or greater.

The scan of the April 2019 GHCN data revealed two major events in North America: (1) the “bomb cyclone” which hit the United States (U.S.) Midwest between April 10 and April 13, and (2) a storm that dropped heavy rain in the Southern and Eastern U.S. between April 17 and April 21. We examine these two events in the remainder of this paper.

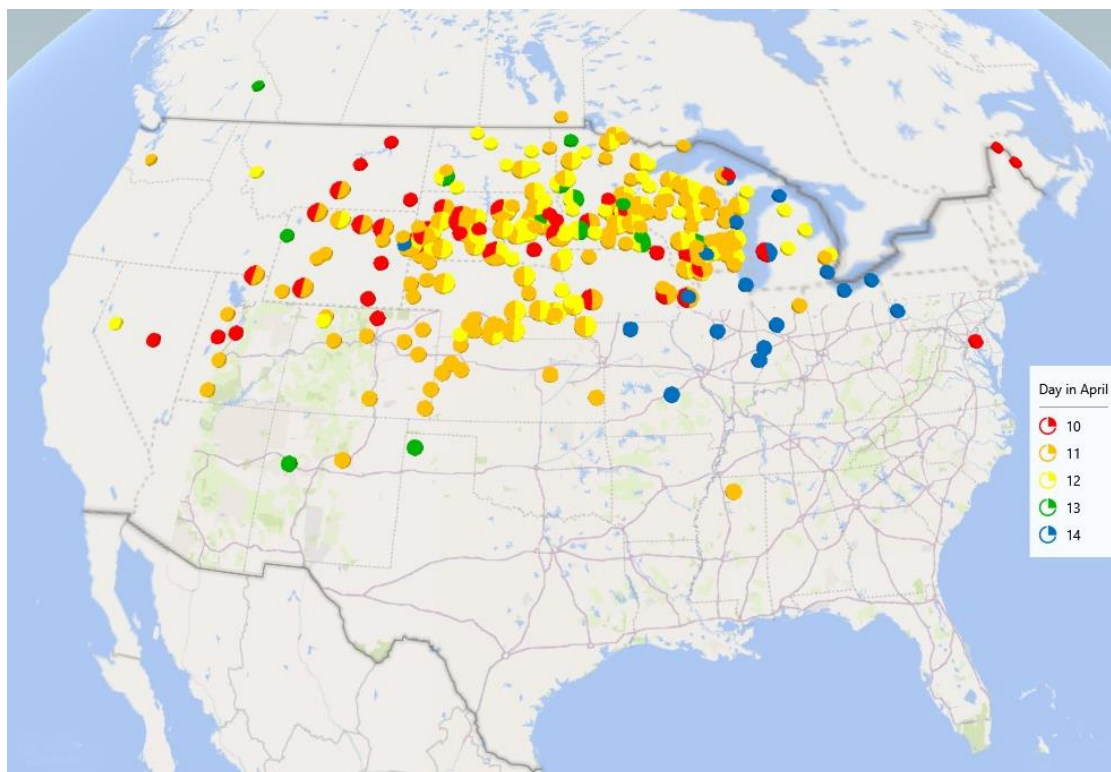
### “Bomb-Cyclone”: Extreme Temperature Swings, Snow in the U.S. Upper Midwest

Perhaps the most dramatic North American weather event in April 2019 was the “bomb cyclone” that swept across the Upper Midwest of the U.S. between April 10 and April 13. A bomb cyclone is a powerful, rapidly developing storm that brings with it an abrupt drop in barometric pressure, high winds, and heavy precipitation. In this case, the precipitation fell in the form of snow across a total of more than 20 U.S. states.

Among the 2,500 weather stations included in our analysis, 249 experienced 24-hour snow totals that exceeded the 97<sup>th</sup> percentile of their historical distributions (Figure 1). The average multi-day snowfall across these stations was 7.0 inches, but some stations received more than two feet of snow (Table 2).

In addition to significant snow accumulations, the storm brought with it a rapid change in temperatures. As the system passed through, temperatures abruptly shifted from spring-like to quite cold, followed by a return to spring-like weather.

**Figure 1**  
Stations that experienced a 24-hour snowfall above the 97<sup>th</sup> historical percentile



**Table 1**

Stations that received more than two feet of snow during the bomb cyclone

Station	State	Latitude North	Longitude West	Snow (inches)
RAINIER SUNSHINE POINT	WA	46.7	121.9	33.0
DEWEY	SD	43.5	104.0	26.5
COLOME	SD	43.3	99.7	26.3
MINNEAPOLIS NAS	MN	44.9	93.2	25.0

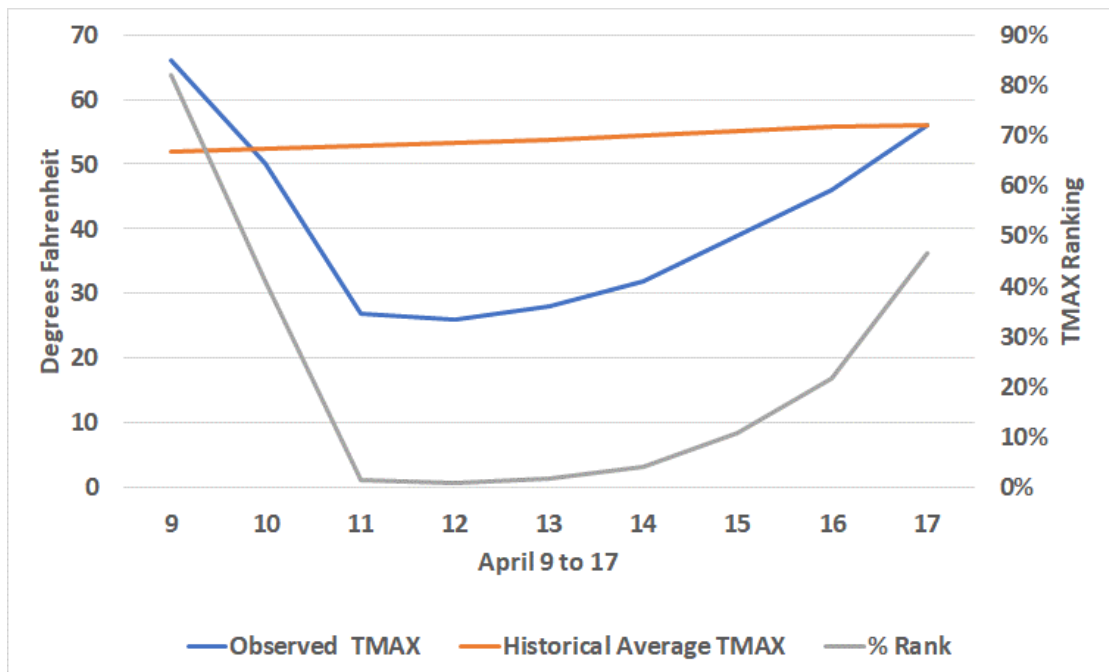
**Table 2**

Temperature change and snow fall around event period for Colome, South Dakota

Day of April	High Temperature (F)	High Temperature Rank %	Snow (Inches)
9	66.0	81.9%	0.0
10	50.0	41.0%	4.3
11	27.0	1.6%	13.5
12	26.1	1.1%	8.5
13	28.0	1.8%	0.0
14	32.0	4.0%	0.0
15	39.0	10.9%	0.0
16	46.0	21.8%	0.0
17	55.9	46.7%	0.0

**Figure 2**

Temperature change around event period for Colome, South Dakota



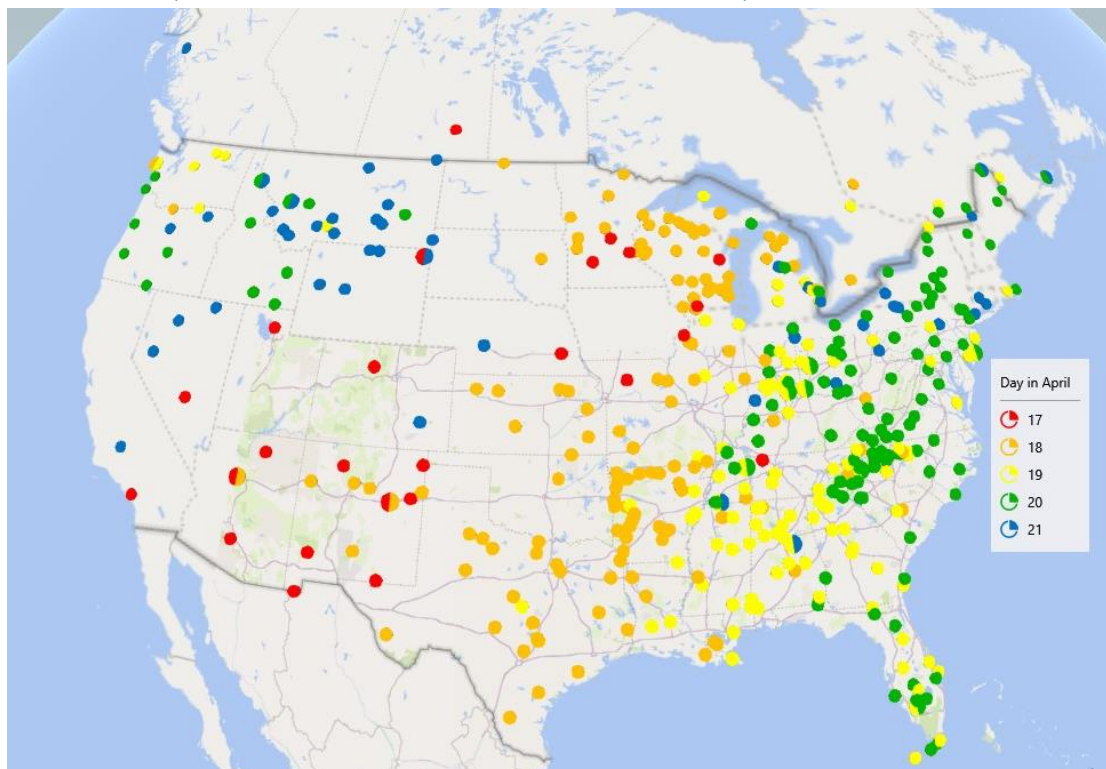
## Extreme Precipitation / Storms in Southern and Eastern U.S.: April 17-21

A large weather system moved across the U.S., from West to East, from April 17 through April 21. The system caused tornadoes in Texas, Oklahoma and Kansas on April 17, followed by tornadoes in Mississippi on April 18. On April 19, the system arrived on the east coast, where it triggered additional tornadoes in several states.

The system dropped a significant amount of rain. Nearly 450 of the 2,500 stations included in this analysis recorded 24-hour rainfall totals in excess of the 97<sup>th</sup> percentile of their historical precipitation distributions (Figure 3). Across these stations, the average total rainfall for the period analyzed was 1.7 inches. A number of stations received in excess of five inches of rain (Table 3).

**Figure 3**

Stations that experienced a 24-hour rainfall above the 97<sup>th</sup> historical percentile



**Table 3**

Stations receiving more than five inches of rain from April 17 to 21

Station	State	Latitude North	Longitude West	Rain (inches)
PISGAH FOREST 8 W	NC	35.3	82.8	7.30
BRIDGEWATER HYDRO	NC	35.7	81.8	6.90
WALTERBORO 1 SW	SC	32.9	80.7	6.22
FT SMITH RGNL AP	AR	35.3	94.4	5.44
MACON MIDDLE GA RGNL AP	GA	32.7	83.7	5.31
CHILDERSBURG	AL	33.3	86.4	5.11

## 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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