STATE CLIMATE EXTREMES COMMITTEE MEMORANDUM

FROM: State Climate Extremes Committee
(Horne, Stachelski, Schmitz, Griffin, Mizzell, Arndt)
DATE: 5 April 2019
SUBJ: South Carolina State Record – Annual Rainfall Total 2018

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Date: 2019.04.30 10:35:04 -04'00'

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Summary

The combination of tropical cyclones and an overall unsettled weather pattern during 2018 led to one of the wettest years on record for South Carolina since 1895. The following observation was examined by the State Climate Extremes Committee (SCEC) to determine its validity and potential status of the highest annual precipitation total directly observed at a weather station in South Carolina:

- Location: **Jocassee 8 WNW (Mountain Rest, SC)**
- Date: **1 January – 31 December 2018**
- Value: **123.45 inches**

After considering the observation and various surrounding factors, the ***SCEC determined the Jocassee 8 WNW observation to be valid, and it now stands as the record annual rainfall total for South Carolina.*** This value supersedes the accepted previous record of 119.16 inches occurring in 1979 observed at Hogback Mountain.

About the SCEC

This State Climate Extremes Committee (SCEC) was composed of members representing five bodies: the National Weather Service (NWS) Weather Forecast Office in Greer, South Carolina (WFO Greenville-Spartanburg; GSP), the NWS Eastern Region's Cooperative Observer Program leadership, the South Carolina State Climatology Office, the Southeast Regional Climate Center, and the National Centers for Environmental Information. It is convened to adjudicate potential records for validity. If validated, the observation is considered the state record for that record type. More details about the SCEC are available online at https://www.ncdc.noaa.gov/extremes/scec/details.

About the Station and Observation

The Jocassee 8 WNW (Cooperative Observer ID 38-4581; GHCN-Daily ID USC00384581) is a traditional daily observing station located in Oconee County, in the Upstate of South Carolina. It has been in service since October 1940, per NWS GSP Station Information System form. The station is operated by the South Carolina Department of Natural Resources (SCDNR) Walhalla Fish Hatchery and attended by the SCDNR staff members.

The site reports its official 24-hour precipitation totals from a Standard 8-inch Rain Gauge (SRG), the inner is made of brass and the outer tube is made from copper (Figure 1). There is a rebuilt Fischer-Porter (FPR-D) automated rain gauge co-located on the property, roughly 100 yards from the location of the SRG (Figure 2). The Jocassee 8 WNW COOP site is on a biannual visitation and inspection cycle (typically completed during the Spring and Fall) and was last inspected on 30 October 2018. During this visit, the observer was presented with their 75-year length of service award, and the visit did not yield any issues as the equipment tested well within performance standards. The FPR-D was also winterized during the scheduled inspection.

The siting of the gauge is in an open area, surrounded by a heavily wooded area as the property is located within Sumter National Forest. Trees are located between 30 and 70 feet from the gauge, and a standard flagpole is situated 8 feet and 4 inches from the center of the funnel of the SRG (Figure 3).

Meteorological Plausibility of the Observation

According to the Climate at a Glance Tool from the National Centers for Environmental Information, the statewide average annual precipitation for 2018 was 57.29 inches, 9.57 inches above the 1895-2018 base period average of 47.72 inches. For the region where the Jocassee 8 WNW station is located (Climate Division 1: Mountain), the 2018 average annual precipitation total was 85.38 inches. During 2018, the station recorded monthly rainfall totals over ten inches during January, February, May, July, August, November, and December (Table 1). The passage of Tropical Storm Alberto over the region influenced the total of 17.74 inches measured in May 2018. Notably, the station did not receive significant rainfall from Tropical Storm Florence (0.56 inches). Hurricane Michael contributed 5.64 inches of the 8.52-inch total for October 2018. The station elevation is 2,500 feet; based on the mountainous terrain, upslope enhanced rainfall is likely to occur in the area.

	Jan	Feb	Mar	Apr	May	Jun
2018	10.16	11.71	5.05	9.63	17.74	3.72

	Jul	Aug	Sep	Oct	Nov	Dec
2018	12.12	12.87	4.52	8.52	10.15	17.25

Table 1. Monthly Rainfall totals from the Jocassee 8 WNW. (pulled from xmACIS)

Based on data collected from the area, the meteorological conditions were optimal for precipitation recorded at the Jocassee 8 WNW station during 2018 and is supported by widespread observations of annual precipitation from nearby stations from the CoCoRaHS and USGS rain gauge networks (see Table 2). Additional documentation of the locations of the COOP, CoCoRaHS, and USGS rain gauge can be found on maps provided in Appendix A (Figures 4, 5 and 6).

Station Name	Network	2018 Annual Precipitation Total
Slicking Rock Mountain	USGS	118.21”
Caesar Head	COOP	117.29”
Sunfish Mountain	USGS	112.98”
Table Rock	COOP	100.37”
Slater-Marietta 6.4 NW	CoCoRaHS	101.11” (350 reports)
Sunset 0.5 NW	CoCoRaHS	97.45”
Westminster 6.0 WNW	CoCoRaHS	92.07” (364 reports)
Walhalla	COOP	84.27”
Cleveland 3S	COOP	82.43”

Table 2. Select annual rainfall totals from stations surrounding the area of Jocassee 8 WNW.

Previous Record and Other Notable Observations

The previous official record was 119.16 inches set in 1979 at Hogback Mountain (Cooperative Observer ID 38-4177; GHCN-Daily ID USC00384177), located in Greenville County, South Carolina. According to the *Climatological Data Annual Summary – South Carolina 1979*, the annual precipitation total for Hogback Mountain is listed as ‘E120.12’. A review of the Cooperative Observation Forms (NWS FORM E-15) found through the Climate Database Modernization Program Tool, and an xmACIS query both yielded totals of 119.16 inches. The monthly total listed on two of the forms were calculated incorrectly:

- the total on the August 1979 form is 11.46 inches. However, the totals of the daily precipitation value equal 10.46 inches
- the total on the October 1979 form is listed as 9.85 inches. However, the totals from the daily precipitation values equal 10.85 inches

A review of data in the archives of the Southeast Regional Climate Center and the National Centers for Environmental Information revealed a potential “hidden” candidate for the historical record. A previous observation of 120.75 inches reported in 2013 from the same station, Jocassee 8 WNW, appeared in the record. The 2013 value underwent discussion amongst the SCEC and was not considered valid, due to concerns with the observation practices (missing data and accumulated totals) conducted by the main observer before the current observer took over the duties at the location.

Before the April 3 meeting of the SCEC, a member of Greenville Water contacted NWS GSP Observing Program Lead, Chris Horne, and presented rainfall data they collected via an SRG on their property at Table Rock Reservoir, which was higher (125.62 inches) than the total recorded at the Jocassee 8 WNW station. After a review of the data, it was decided by the committee, to not consider the observation of 125.62 inches observed by the Greenville Water rain gauge as the SCEC has always drawn from established networks, and partly due to concerns of accessibility of the observations, their exclusion from the NCEI meteorological records and unknown observing practices and metadata records. The committee decided to make use of the 'note' feature on the SCEC website to include the value as an unofficial amount, as has been done with other values deemed plausible by other committees.

Anecdotal Information from the Observer

The following narrative comes from the observer at Jocassee 8 WNW about the impacts the above normal rainfall had on the operations of the SCDNR Fish Hatchery:

> "What we observe during a heavy rain event, and certainly observed on numerous occasions during 2018, was an increase in sediment loads (Figure 7; red circle) entering the hatchery. In a typical year, remnants of tropical systems, or heavy rain events in general, would create increased sediments loads in the streams that feed the hatchery. The East Fork of the Chattooga River and Indian Camp Creek have little to no human disturbance upstream of the hatchery. However, those rain events almost always cause the streams to become discolored or dingy as if runoff and erosion were occurring from land disturbance. With both streams serving as gravity fed water sources for the hatchery without any filtration, sediment settles in the tanks and raceways.
>
> As a result of increased sediment loads, staff must manually remove the sediment by shovel and backhoe. Additionally, we observe an increase in parasites affecting the fish after heavy rain events. Higher sediment amounts and parasite loads can adversely affect fish health. Staff routinely worked to mitigate those stressors during 2018.
>
> A positive to the 2018 rainfall amounts was the high stream flow that fed into the hatchery. Under normal conditions, the hatchery observes approximately 2,800-3,000 gallons per minute (gpm) pass through the hatchery. That equates to roughly 4.03-4.32 million gallons per day (mgpd). During 2018, the hatchery experienced normal flows or above normal flows throughout the year. In the past, hatchery staff have observed flows approach 1,300 gpm (1.87 mgpd) in some years as drought conditions have substantially reduced streamflow. Maintaining a cold-water trout facility is extremely difficult during low volume, high-temperature drought events.
>
> Although 2018 offered its own set of challenges, abundant rainfall was much more beneficial than had we experienced a drought. Consistent flows lead to improved fish health and those same flow reduce many of the effects of fish diseases that we have encountered during low flow conditions."

Finding of committee

After considering the observation, the state, and condition of the observing equipment, and the meteorological environment in which the observation was recorded, **the SCEC has determined, unanimously, that the 123.45 inches observed at the Jocassee 8 WNW station is indeed valid and constitutes a new record annual precipitation total for South Carolina**. The SCEC made this final determination on 3 April 2019.

Committee Members:

- Chris Horne, Observations Program Leader (OPL), NWS WFO Greenville-Spartanburg
- Chris Stachelski, NWS Eastern Region Cooperative Observer Program Lead
- William Schmitz, Service Climatologist, Southeast Regional Climate Center
- Melissa Griffin, South Carolina State Climatology Office, South Carolina Department of Natural Resources
- Hope Mizzell, South Carolina State Climatology Office, South Carolina Department of Natural Resources
- Deke Arndt, Chief, Monitoring Section, National Centers for Environmental Information

Additional Participant:

- Bryant Korzeniewski, National Centers for Environmental Information

Acknowledgments

The SCEC thanks the observers referred to in this document for their dedication to quality observations, and to Melissa Griffin, SCDNR, for serving as the primary author of this document.

References

Climatological Data Annual Summary – South Carolina 1979, Vol 82, Number 13, National Climatic Data Center, 1980, Asheville, NC, Table 2, Page 3.

Abbreviations

ACIS: Applied Climate Information System, a data system used by the NWS and state climate offices
CoCoRaHS: Community Collaborative Rain, Hail & Snow Network, a system of volunteer observers
COOP: Cooperative Observer Program, of the National Weather Service
FPR-D: Fischer-Porter rain gauge
GHCN: Global Historical Climatology Network, a global collection of daily weather data
NCEI: National Centers for Environmental Information
NWS WFO GSP: National Weather Service Weather Forecast Office, Greenville-Spartanburg
OPL: Observations Program Leader, a role within a WFO
SCDNR: South Carolina Department of Natural Resources
SCEC: State Climate Extremes Committee
SRG: Standard Rain Gauge
USGS: United States Geological Survey
WNW: west-northwest

Appendix One – Additional Documentation

Figure 1. NWS Greenville-Spartanburg OPL Chris Horne inspecting the Jocassee SRG. Courtesy of M.Griffin.

Figure 2. NWS Greenville-Spartanburg OPL Chris Horne inspecting the Jocassee FPR-D. Google Earth Map annotated with the locations of both rain gauges on the property. Courtesy of M.Griffin.

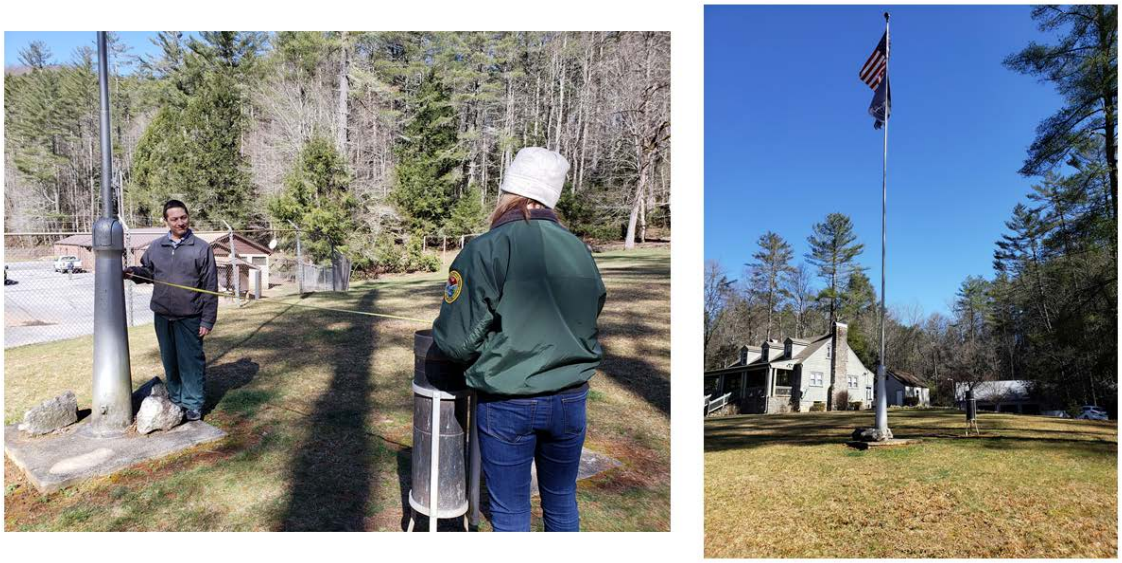
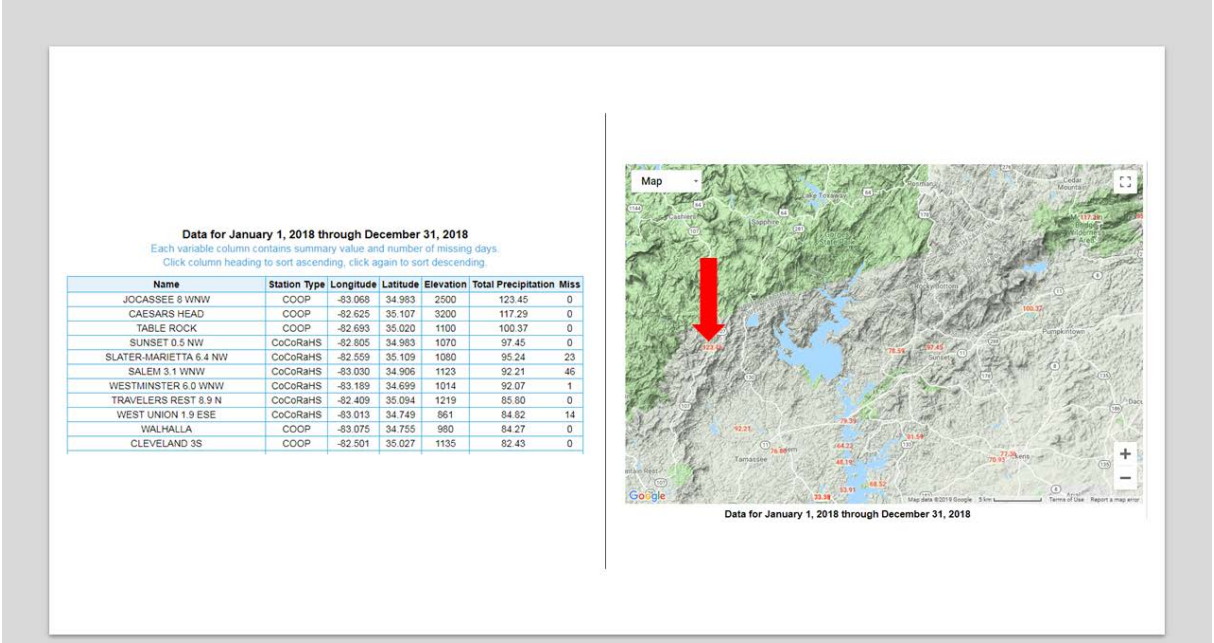


Figure 3. NWS Greenville-Spartanburg OPL Chris Horne and South Carolina State Climatologist Hope Mizzell measuring the distance from the rain gauge to the nearby flagpole on the property. Courtesy of M.Griffin.



Data for January 1, 2018 through December 31, 2018

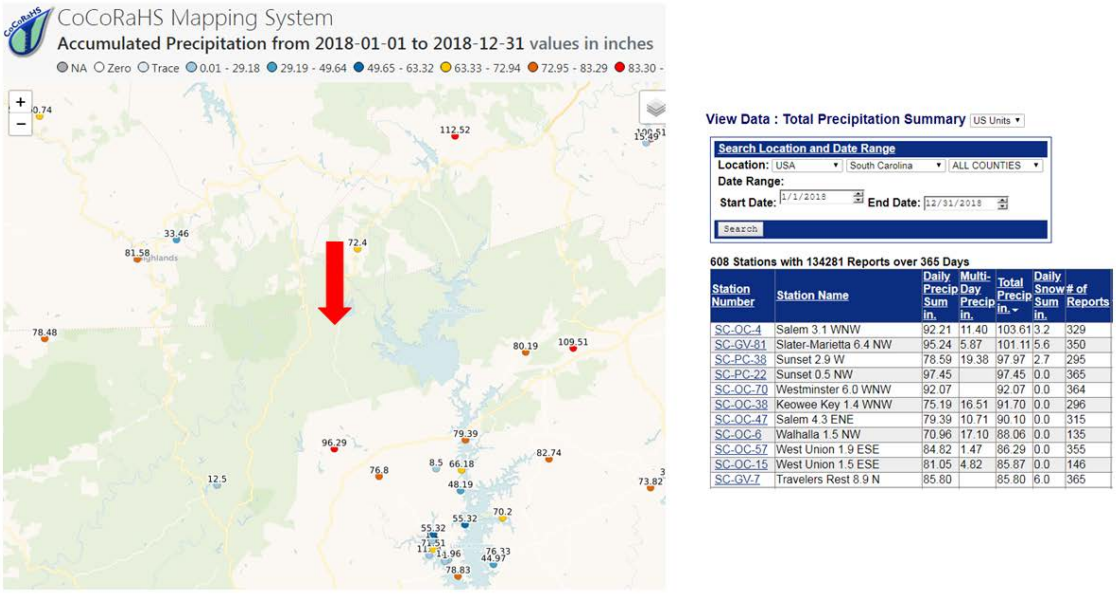
Each variable column contains summary value and number of missing days.

Click column heading to sort ascending, click again to sort descending.

Name	Station Type	Longitude	Latitude	Elevation	Total Precipitation	Miss
JOCASSEE 8 WNW	COOP	-83.068	34.983	2500	123.45	0
CAESARS HEAD	COOP	-82.625	35.107	3200	117.29	0
TABLE ROCK	COOP	-82.693	35.020	1100	100.37	0
SUNSET 0.5 NW	CoCoRaHS	-82.805	34.983	1070	97.45	0
SLATER-MARIETTA 6.4 NW	CoCoRaHS	-82.559	35.109	1080	95.24	23
SALEM 3.1 WNW	CoCoRaHS	-83.030	34.906	1123	92.21	46
WESTMINSTER 6.0 WNW	CoCoRaHS	-83.189	34.699	1014	92.07	1
TRAVELERS REST 8.9 N	CoCoRaHS	-82.409	35.094	1219	85.80	0
WEST UNION 1.9 ESE	CoCoRaHS	-83.013	34.749	861	84.82	14
WALHALLA	COOP	-83.075	34.755	960	84.27	0
CLEVELAND 3S	COOP	-82.501	35.027	1135	82.43	0

Data for January 1, 2018 through December 31, 2018

Figure 4. List and map of annual (1 January – 31 December 2018) precipitation totals from NWS COOP and South Carolina CoCoRaHS observers. Courtesy of xmACIS



Station Number	Station Name	Daily Precip Sum in.	Multi-Day Precip in.	Total Precip in.	Daily Snow Sum in.	# of Reports
SC-OC-4	Salem 3.1 WNW	92.21	11.40	103.61	3.2	329
SC-GV-81	Slater-Marietta 6.4 NW	95.24	5.87	101.11	5.6	350
SC-PC-38	Sunset 2.9 W	78.59	19.38	97.97	2.7	295
SC-PC-22	Sunset 0.5 NW	97.45		97.45	0.0	365
SC-OC-70	Westminster 6.0 WNW	92.07		92.07	0.0	364
SC-OC-38	Keowee Key 1.4 WNW	75.19	16.51	91.70	0.0	296
SC-OC-47	Salem 4.3 ENE	79.39	10.71	90.10	0.0	315
SC-OC-6	Walhalla 1.5 NW	70.96	17.10	88.06	0.0	135
SC-OC-57	West Union 1.9 ESE	84.82	1.47	86.29	0.0	355
SC-OC-15	West Union 1.5 ESE	81.05	4.82	85.87	0.0	146
SC-GV-7	Travelers Rest 8.9 N	85.80		85.80	6.0	365

Figure 5. List and map of annual (1 January – 31 December 2018) precipitation totals from South Carolina CoCoRaHS observers. Courtesy of CoCoRaHS.

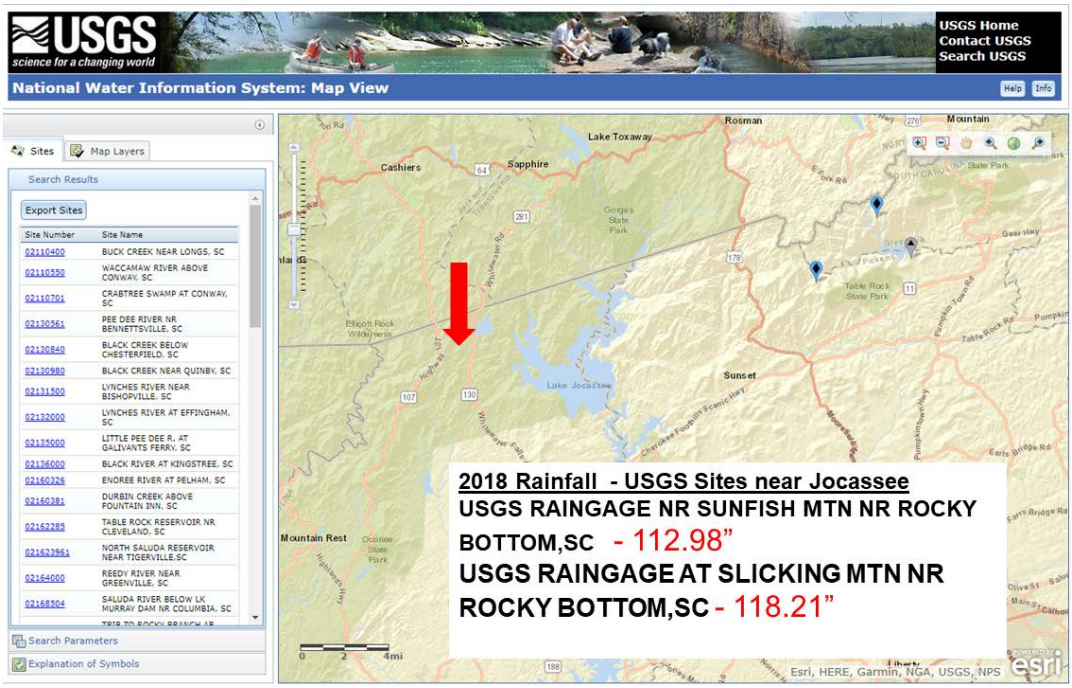


Figure 6. List and map of annual (1 January – 31 December 2018) precipitation totals from automated rain gauges. Courtesy of USGS.

Figure 7. Photo of sediment loads in the hatchery tanks at the SCDNR Walhalla Fish Hatchery co-located at the Jocassee 8 WNW station. Courtesy of M.Griffin.