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A Day in the Life of the CoCoRaHS Network

by Henry Reges and Nolan Doesken



CoCoRaHS (the Community Collaborative Rain, Hail and Snow Network) was first described in *Weatherwise* in 2010. Since that time, this network of rain gauge “tenders” has expanded to all of the provinces of Canada, Puerto Rico, the U.S. Virgin Islands, and the Bahamas. With more than 22,000 active participants, it continues to be the largest single source of daily precipitation observations. This April the network recorded its 50 millionth observation submitted by an observer. It shines as a sterling example of how the larger nonprofessional community of citizen scientists can play a vital role in providing critical meteorological information that many professionals use on a daily basis.

Let’s follow along in this semi-fictional *Saturday Evening Post*-like narrative in the life of a day of CoCoRaHS, highlighting what is new (but in some aspects still the same) over the past decade.

We begin in the early hours of a Monday morning in a small rural town in the low country of South Carolina. Already this morning several observers in the area have submitted their rainfall amounts, and some have even submitted an auxiliary *condition* report, which provides a weekly snapshot of what an observer’s surrounding landscape looks like (extremely wet, normal, dry, very dry, etc.). This anecdotal information, in combination with accurate rainfall reports, is used by the authors of the U.S. Drought Monitor as they prepare their weekly updates. Reports from rural parts of the country are especially helpful where there is often little other information.

On this particular day, CoCo Joe’s alarm clock rings at 7 a.m. In his 15 years as a CoCoRaHS weather observer, CoCo Joe has recorded nearly 4,800 CoCoRaHS observations. He gets out of bed, puts on a pot of coffee, and takes the short walk outside to retrieve the morning newspaper. On his way back inside, CoCo Joe stops by his calibrated, four-inch-diameter high-capacity rain gauge. It rained overnight, and he has come to realize that what has fallen in his gauge at his home will most likely be quite different from what the newspaper reports tomorrow from his local airport 12 miles away. Joe has learned, as do many observers with CoCoRaHS, that precipitation can vary greatly over distances. CoCo Joe pulls out his cell phone and brings up the CoCoRaHS app (something now used by 40% of observers since it debuted in the mid-teens) and types in 0.67 inch, the amount he reads from his gauge. Joe’s is an important observation, as he is the only observer northwest of town for 15 miles. There is an NWS COOP observer 10 miles south of him.

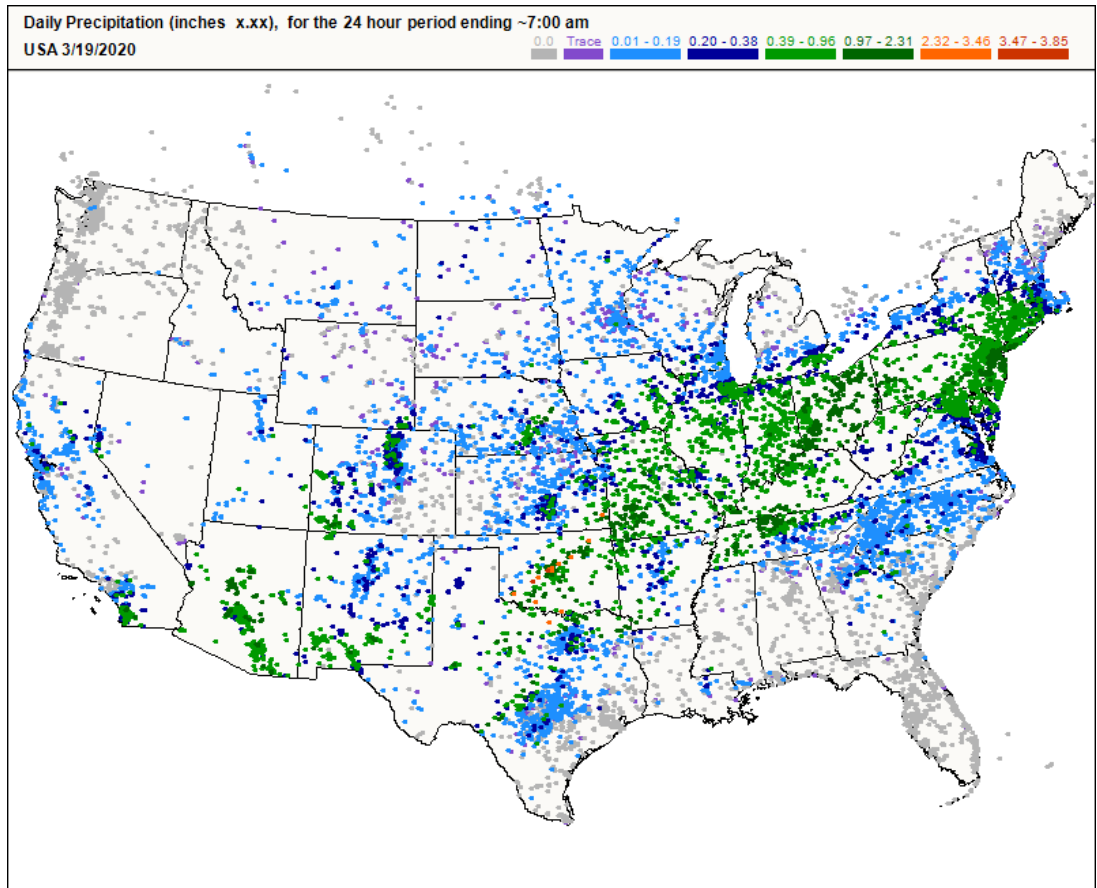
Joe could be any one of the 22,000 men, women, and children who participate in

CoCoRaHS. They’re citizens of all ages, from school-aged children to those in their 90s, all going outside to read a rain gauge and then share their data. In fact, Joe’s sister Maggie will be waking up soon in the suburbs of Chicago and reading her gauge. Maggie is a retiree in her late 60s and very active on social media. In the past 10 years CoCoRaHS has established a presence on Facebook and Twitter and more recently on Instagram, so many followers can view weather events in their communities. Social media has also provided an avenue for recruiting new volunteers and has been a step for CoCoRaHS to reach new, younger audiences as well. Today, Maggie will be posting a photo of the 15 inches of snow that fell in her backyard,



CoCoRaHS observer on Grand Bahama Island.

HENRY REGES



A CoCoRaHS observation map on a day with very widespread precipitation.

and many will witness the weather of Illinois that day just by seeing her post. She also posts a screen shot of a map of the snowfall totals in her community.

CoCo Joe loves looking at the CoCoRaHS maps on the computer as well. As he sips his coffee, he can pull up and zoom in on his brother Charlie's community on Florida's Gulf Coast. It's now 8:00 a.m. local time, and Charlie's observation has appeared on the map. Charlie became an observer in 2017 during CoCoRaHS' annual recruiting drive held every March (he saw an interesting article in the *Tampa Bay Times* looking for citizens to measure precipitation in their backyards). It's called CoCoRaHS March Madness, and all 50 states compete against each other during the month to see which can recruit the greatest number of new observers. The winner gets the CoCoRaHS Cup for a year (much like the NHL's Stanley Cup!). A good portion of CoCoRaHS' new observers join this way, and a surprising number stick with the program for many years. There is always the challenge of replenishing the network's corps. Some begin and realize that this is not for them. Others move, some pass away, and a few decide to take a break. It's like water flowing in and out of a

pipe. We have several observers who have been with the program for more than 20 years, and many have been with the program for 10. This year, those who have been providing observations for 10 years or more will become part of the 1991–2020 set of 30-year normals for the country. Each station, after 100 observations, becomes part of the U.S. permanent record and is incorporated into the NOAA/National Centers for Environmental Information (NCEI) Daily Global Historical Climate Network



ALLEN JUNAS & ALLISON JACOBS

A rain gauge atop a high-rise building in Chicago, Illinois.



A Reference Evapotranspiration gauge measures the water evaporated from the ground back to the atmosphere both as transpiration from the leaves of plants and also as direct evaporation from open water and soil. This is an optional measurement adopted by the network back in 2012. A handful of volunteer observers take these very helpful supplemental measurements.

(GHCN). Many observers do not realize how important their observations are or that they play a role in U.S. history.


Back to Charlie: Charlie did not have any precipitation during the past 24 hours. He types in a zero. Because Charlie does not have a cell phone, he is able to input his data via his computer. Zeros are just as important as higher numbers in precipitation measurements, and CoCoRaHS observers are very diligent in recording them. A zero can make a world of difference (especially during the convective season), showing where it did and did not rain. Charlie is dedicated to becoming more weather savvy, and enjoys participating in CoCoRaHS' WxTalk Webinars. There's one this afternoon that he is very interested in on Storm Surge during tropical systems, as he lives on the bay. These informative, hour-long educational pieces are given by guest speakers in the field of weather and climate, with topics ranging from lightning, to regional climate, to what it takes to become a meteorologist. Each webinar is free, recorded, and available on YouTube. Seventy have been cataloged to date.

Charlie's son Michael is also a CoCoRaHS observer. Michael lives in South-Central New Mexico. He has a large pistachio orchard, so for him, what falls from the sky is very important to his livelihood. He records his precipitation or lack thereof every day, and also participates by recording an extra observation as part of his daily repertoire. He has an ET gauge placed near his rain gauge and measures reference evapotranspiration (the water evaporated from the ground back to the atmosphere both as transpiration from the leaves of plants and also as direct evaporation from open water and soil). This is an optional measurement adopted by the network back in 2012. A handful of volunteer observers take these measurements, reporting the other half of the water cycle—the water that goes back into the atmosphere. Michael loves seeing both his precipitation and evaporation charted on a CoCoRaHS water balance graph. The chart colors show whether there is a surplus of moisture or a deficit and whether he needs to irrigate his orchard. Many of Michael's farmhands take turns reading the gauge, and some have even started putting a rain gauge out at home to see how their locations compare with Michael's orchard. Michael has shared some of the CoCoRaHS education materials translated into Spanish by the local NWS office with his workers.

As the day progresses, we zoom out west to visit Joe's 10-year-old granddaughter Lisa in Northern California. She is in the fourth grade



Hoar frost on a rain gauge.


COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK
"Because every drop counts"

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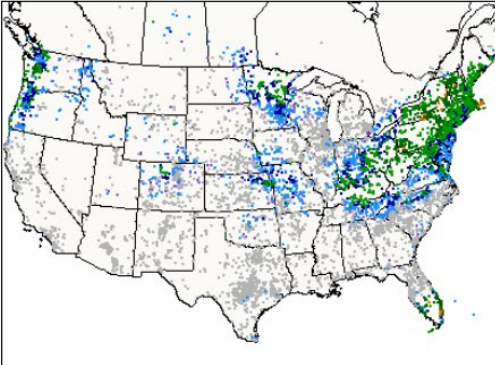
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Welcome to CoCoRaHS! "Volunteers working together to measure precipitation across the nations."

OVER 50 MILLION OBSERVATIONS
... submitted by CoCo observers! WOW!
50M

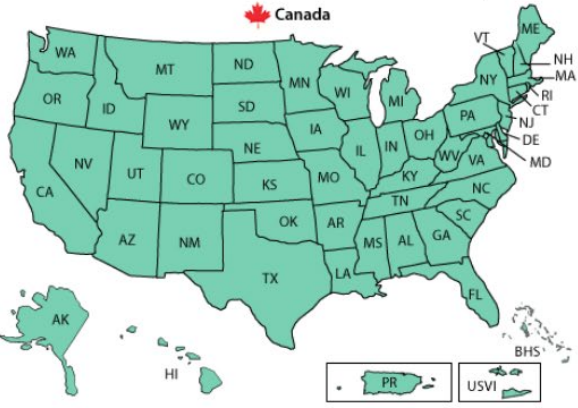
Reports received today 4/27/2020 as of 3:25 PM EDT

Daily	Multi-day	SigWx	Hail	Condition	ET
10,078	213	1	0	41	56



Daily Precipitation (inches x.xx) USA 4/27/2020

- Trace
- 0.00 - 0.12
- 0.13 - 0.24
- 0.25 - 0.61
- 0.62 - 1.46
- 1.47 - 2.19
- 2.20 - 2.44



Canada



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- Soil Moisture
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WEATHERYOURSELF

A sample of what the CoCoRaHS homepage looks like for volunteers.

and is getting ready to head to school. Lisa's school has a CoCoRaHS rain gauge donated by a local benefactor who is interested in seeing that the students of his community become climate literate. Each morning her teacher assigns a different pair of students in her homeroom to go out and measure what has fallen in the gauge. The students take the observation, record it on the Web and then during morning announcements over the PA system read it out to the school. This morning, Lisa and her classmate Wendy have recorded 1.55 inches of precipitation from a long, rainy night. In the past 10 years, CoCoRaHS has put a lot of emphasis on education, especially K-12. There are teacher resources, educational

animations (a full set not only for children, but for adults alike on the water cycle, measuring snow, etc.), and lesson examples available on the CoCoRaHS website. Lisa's teacher will be using the data collected over the past six months as part of a science lesson for her students later today. This particular week is also very important not only in California, but also across the country. During the last 10 years, CoCoRaHS has promoted "Rain Gauge Week," in which it encourages each of the hundreds of participating schools across the country to take a reading each day. It can be a challenge when you do not have a science champion on the faculty, but progress is being made.



A nearly full rain gauge from an observer in Beecher, Illinois.

That afternoon after school, Lisa's mom is taking Lisa and her brother to the local library. In the past several years, CoCoRaHS has begun to focus on libraries as a place to recruit and educate citizens about rainfall, its importance, and its variability. In many parts of the country, especially rural areas, the local library might be the only place residents come across information on how to help monitor the climate.

A few hours later, the sun is overhead on the Big Island of Hawaii. CoCoRaHS plays an important part in measuring precipitation on the island archipelago. Back in April 2018, 36.49 inches of rain fell during 24 hours in an observer's backyard on the north shore of Kauai. Another observer recorded 13.67 inches of rain from a pyrocumulus thunderstorm over Leilani Estates on the Big Island during the July 2018 volcanic eruption on the Big Island. Today, Jim, a CoCoRaHS observer in Hawaii in his late 20s who lives in downtown Honolulu, rechecks his daily observation. After receiving a brief friendly email from his local coordinator, he realizes that he has made a decimal error on his report, which is easy to do. A few quick clicks of the mouse and all is well again. CoCoRaHS prides itself in high quality data while also encouraging children and others who are brand new to data collection. Errors will be made. But through various quality control mechanisms, and with many eyes looking, errors are often easily recognized on the maps. Our quality control team at CoCoRaHS headquarters meticulously reviews the data each day.

Jim is one of several observers across the network who is located in a downtown urban setting. In Chicago, one observer has her gauge on the roof of a 70-story highrise on the lakefront. The condo superintendent and security guard escorts her daily to the roof to make her observation. The American Meteorological Society has a

CoCoRaHS gauge at its headquarters on Beacon Street in the heart of downtown Boston, providing important precipitation information from the office's urban setting. There is even a gauge on a houseboat on a Potomac River inlet in Washington D.C. Because it may be difficult to find suitable locations for a rain gauge in densely developed urban areas, observers are highly sought after in and near urban centers.

On the international front, the day is ending over CoCoRaHS Bahamas. More than 20 observers have recorded their rainfall amounts earlier in the day, ranging from a "spry" (that's what they call a sprinkle there) to over two inches on the Island of San Salvador. Through a small grant by the World Meteorological Organization in conjunction with the Bahamas Department of Meteorology, CoCoRaHS was able to expand to the islands in 2016. The data there have helped tremendously, especially on islands where little data were available beforehand. The network has struggled after being battered by numerous devastating hurricanes in 2017 and 2019, with many stations being wiped out—yet several keep observing. The National Hurricane Center continues to tout CoCoRaHS as a great resource for poststorm analysis, not only over the Caribbean, but also wherever tropical systems affect an area. Puerto Rico's CoCoRaHS network system, which began in 2015, has taken major hits from hurricanes, too, halving the number of observers



COCORAHHS

An observer with a record rainfall on the island of Kauai in Hawaii.



CoCoRaHS uses a series of animated videos to teach both children and adults about measuring precipitation and the water cycle.

remaining. Yet the network remains resilient and rebounds after each hit, too. It is now after dark there, as a National Weather Service CoCoRaHS coordinator team contacts several observers and thanks them for their service. Throughout the CoCoRaHS network, more than 250 state and regional coordinators engage, recruit, train, and encourage their volunteer observers, working tirelessly to make the network a success in their region.

And let's not forget Canada. CoCoRaHS Canada started in Manitoba in 2011 during a year with horrendous snowmelt flooding. Hundreds of volunteers have joined since then, with daily observations streaming in from the Maritimes to the Yukon each day. The network plays an important part in measuring snowfall, supplementing Environment Canada's precipitation data. Earlier on this particular day, Richard in Saskatchewan waded out in a raging snowstorm to take a snowfall measurement. He measured 27 centimeters with a heavy water content. His and many other measurements play an important role in crop production forecasts as he awaits the spring planting of wheat across the Western Canadian Prairies. The network continues to grow steadily across the country.

As darkness falls across most of the observing regions, CoCo Joe is getting ready for bed. It is raining once again across the low country of South Carolina, and he will have something to look forward to in his gauge tomorrow morning. His sister, Maggie, is watching a recorded CoCoRaHS

Webinar on Space Weather as she winds down her day. In Northern California, Lisa is showing her dad a book she checked out of their local library on gardening, pointing out to him how precipitation accounts for what flowers and vegetables can be grown in certain areas of the country. She will share this with her class tomorrow. And Jim in Hawaii is getting his surfboard ready for a late afternoon ride as the wind kicks up some awesome waves.

Throughout the day, all of the data gathered by CoCoRaHS is being pulled or pushed from the database to myriad users—some for instantaneous applications such as weather forecasting and others for future research and tracking long-term climate fluctuations. The data literally flow like water through the CoCoRaHS cyber-infrastructure to assist data users by providing them a valuable means of ground truthing their algorithms and improving their data products. Data flows into the system via volunteer observers (just like CoCo Joe, Charlie, Maggie, and others) who report their observations via the CoCoRaHS website or mobile apps. Data from other manual gauge networks, such as Nebraska's NeRain (yes, Joe has a cousin participating in that program), are imported into the CoCoRaHS dataset to make it readily available to downstream users. This pool of data is distributed to data users in a variety of ways. Large data aggregators such as NCEI's GHCN and the National Centers for Environmental Prediction Meteorological Assimilation Data Ingest System

Gauge-Filling Rains

The rain gauge used by CoCoRaHS volunteers holds over 11 inches (280 millimeters) of rain. That is a whole lot of rain, especially when it falls in a short amount of time! Most areas of the country have never seen that much rain in a day. But since CoCoRaHS became a nationwide network in 2010, every year there have been gauge-filling rains somewhere in the country. Not surprisingly, these huge rains cause incredible flooding and are most common near the Gulf of Mexico and along the southeast U.S. Atlantic Coast during late summer and fall (often, but not always, associated with tropical storms), and in the rain belts of Hawaii on the Big Island and on Kauai. But such torrential rainfalls have occurred in many locations, and are often associated with highly localized extreme thunderstorms. Examples are Dane County (Madison), Wisconsin, in 2018; Nashville, Tennessee, in 2010; and Islip, New York in 2014. In fact, it was a highly localized storm that occurred in Fort Collins, Colorado, on July 28, 1997, that was the impetus to launch CoCoRaHS!

One of the truly monumental storms in modern history was Hurricane Harvey, which made landfall on the Texas Gulf Coast on August 25, 2017, and then lingered over southeast Texas and adjacent portions of Louisiana for nearly a week. Despite widespread extreme flooding, hundreds of CoCoRaHS volunteers continued to report daily. More than 10 inches of rain fell over portions of this area on six consecutive days, and rainfall totals for the storm approached and locally exceeded 50 inches. Thanks to a combination of excellent radar coverage, along with large numbers of accurate rain gauge measurements, this epic storm was exceptionally well documented, providing invaluable information to engineers, hydrologists, and meteorologists whose research will benefit the country for decades to come.

ingest the data on a scheduled basis to aggregate it with who need access to the broadest possible data set with uniform formatting. Other CoCoRaHS data users pull the data directly from the source using CoCoRaHS' data export system that allows them to filter down to specific subset of data that is relevant to their needs. These data users include NWS Weather Forecast Offices for forecasts, poststorm analysis, and radar calibration; River Forecast Offices and other hydrologists for the prediction of stream flows and river levels; municipal water managers to assess available water supplies; farmers and ranchers for crop development and soil moisture assessment; and the insurance industry to verify if storms were present. Even recreationists like golfers, fishermen, and picnickers use the data, which they can view online. Time-sensitive data, such as significant weather and hail observations, are pushed to the NWS in near real time to provide forecast officers credible reports from trained volunteers to complement their radar products and help them issue weather warnings and alerts sooner. So while Jim is getting his surfboard ready in the afternoon, a lot is going on behind the scenes that most observers are unaware of. The amazing thing about CoCoRaHS is that each observer's precipitation reports are being used in one way or another.

As you can see, a lot happens over the CoCoRaHS community during a typical day. The observations taken of rain, hail and snow play a bigger role than first meets the eye. Furthermore, COVID-19 has not slowed us down. In fact, participation rates reached an all-time high for March – May 2020 with so many folks across the country staying at home. Citizen science has become an important part of our nation's fabric, and CoCoRaHS is proud of being a small part of it.

Perhaps you are reading this article today and are saying to yourself, "Hey I can do that! ... This might be fun. Just five minutes a day? Yes sign me up!" We'd love to have you. Please consider becoming part of this diverse network of weather enthusiasts. Report when you can, and join the thousands who are "Cuckoo for CoCoRaHS" across our international community (www.cocorahs.org).

Good night, CoCo Joe. It looks like your gauge is filling to the brim. **W**

NOLAN DOESKEN is the founder of CoCoRaHS and HENRY REGES is the CoCoRaHS U.S. National Coordinator and Meteorologist.

They would like to express appreciation for the help and support of the whole staff at CoCoRaHS headquarters at Colorado State University in Fort Collins, Colorado.