TEXAS CoCoRaHS OBSERVER

Fall 2017

"Because every drop counts, as do all Zeros."

The Training Issue

Welcome to the Texas CoCoRaHS Observer newsletter.

The purpose of this newsletter is to keep observers informed of the latest news, events and happenings related to the CoCoRaHS program here in Texas, as well as news about the latest weather patterns affecting each region of Texas.

If you have questions, comments or suggestions, feel free to contact us via the emails listed on the back page.

Special Training Issue: This edition of the Texas CoCoRaHS Observer will focus on training material for observers to learn and apply the proper observing standards so all of CoCoRaHS data will be suitable for users to ingest this data into scientific computer models and research programs which will give an accurate picture of Texas precipitation. Many times an observer will have to be aware of current weather conditions and how changes in conditions during a 24 hour period will affect what is or isn't in their gauge. For example, sometimes an observer will find water in their gauge when it didn't rain. By an observer knowing that heavy dew formed overnight, a correct observation and report will be made entering zero rainfall and adding comments mentioning that condensation was observed. This is just one example of how important training material is to educate all observers of different types of conditions and how to properly report what they observe and measure. Training items begin on page 22.

Inside this issue:

La Niña expected for the winter

By NOAA Climate Prediction Center

Forecasters at NOAA's Climate Prediction Center released the U.S. Winter Outlook today, with La Nina potentially emerging for the second year in a row as the biggest wildcard in how this year's winter will shape up. La Nina has a 55% to 65% chance of developing before winter sets in.

"If La Nina conditions develop, we predict it will be weak and potentially short-lived, but it could still shape the character of the upcoming winter," said Mike Halpert, deputy director of NOAA's

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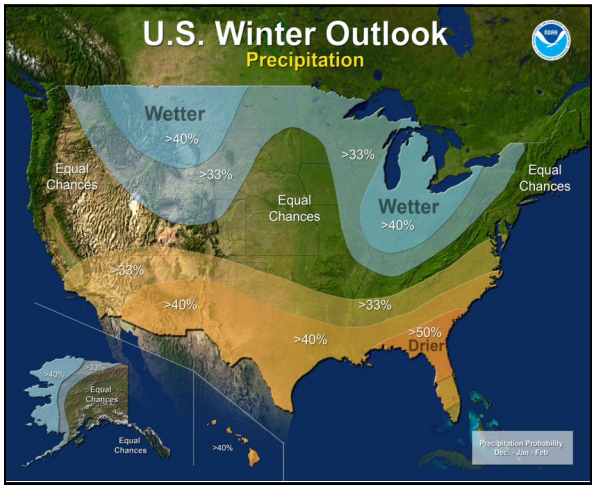


La Niña expected to highlight winter weather

La Nina

Continued from Page 1

Climate Prediction Center. "Typical La Nina patterns during winter include above average precipitation and colder than average temperatures along the Northern Tier of the U.S. and below normal precipitation and drier conditions across the South."

Other factors that influence winter weather include the Arctic Oscillation, which influences the number of arctic air masses that penetrate into the South and is difficult to predict more than one to two weeks in advance, and the Madden-Julian Oscillation, which can affect the number of heavy rain events along the West Coast.

The 2017 U.S. Winter Outlook (December through February):

Precipitation

- Wetter-than-average conditions are favored across most of the northern United States, extending from the northern Rockies, to the eastern Great Lakes, the Ohio Valley, in Hawaii and in western and northern Alaska.
- Drier-than-normal conditions are most likely across the entire southern U.S.

Temperature

- Warmer-than-normal conditions are most likely across the southern two-thirds of the continental U.S., along the East Coast, across Hawaii and in western and northern Alaska.
- Below-average temperatures are favored along the Northern Tier of the country from Minnesota to the Pacific Northwest and in southeastern Alaska.
- The rest of the country falls into the *equal chance* category, which means they have an equal chance for above-, near-, or below-normal temperatures and/or precipitation because there is not a strong enough climate signal in these areas to shift the odds.

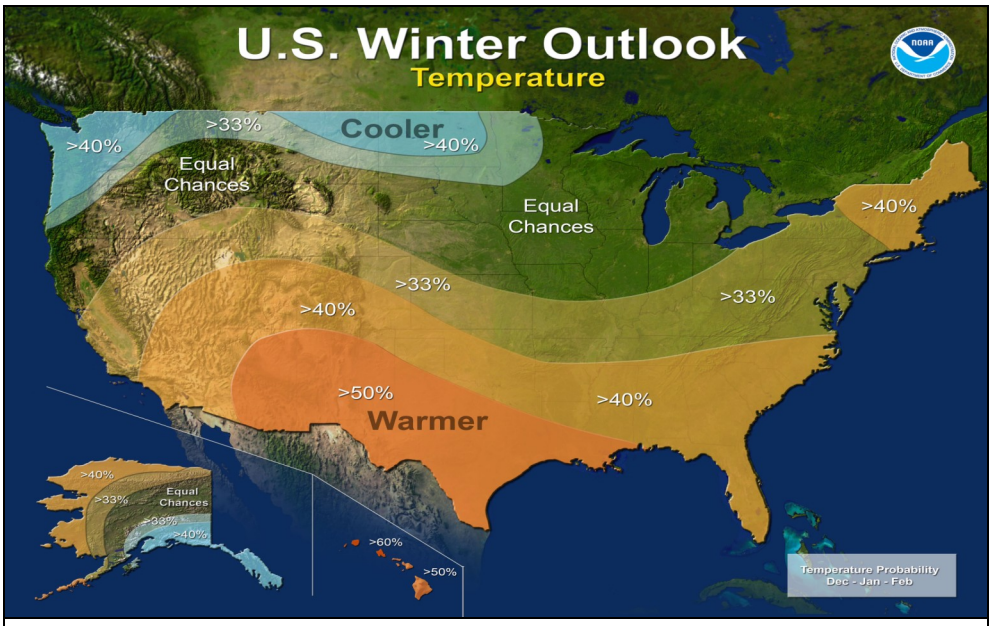
Drought

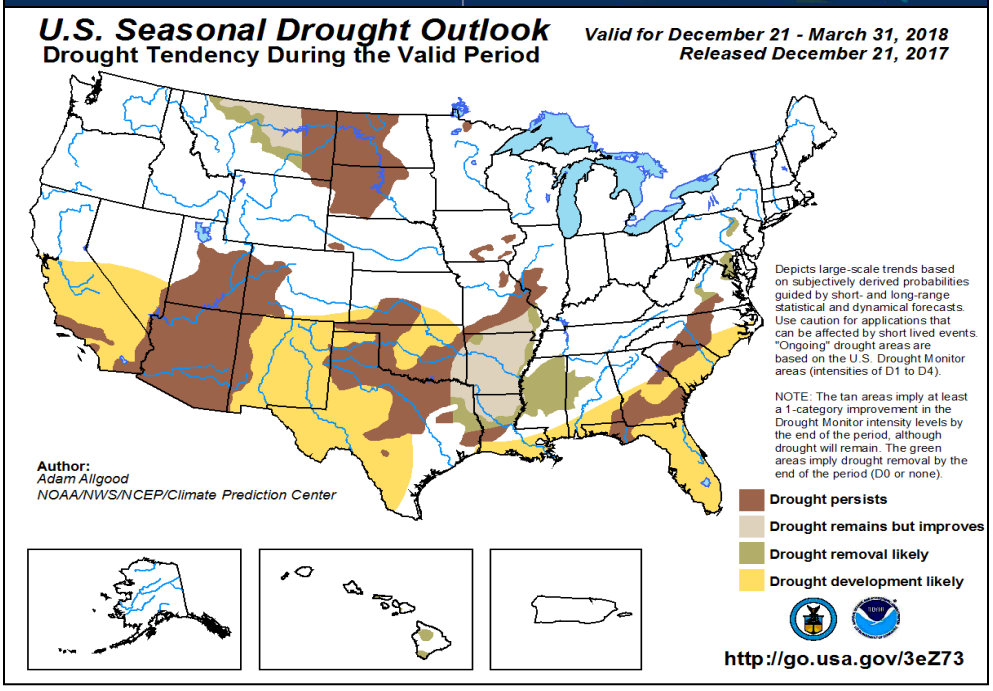
Despite the outlook favoring above-average precipitation this winter, drought is likely to persis in parts of the northern Plains, although improvement is anticipated farther West.

- Elsewhere, drought could develop across scattered areas of the South, mainly in regions that missed the rainfall associated with the active 2017 hurricane season.

2017-2018 winter weather outlook

- A fairly mild winter expected. There will be some occasional outbreaks of cold. A colder winter, compared to last winter.
- Temperatures averaging around 1 degrees above normal December through February
- Most cold periods will be short-lived
- Slightly below normal rainfall expected this winter
- Driest across western Texas. Wettest east





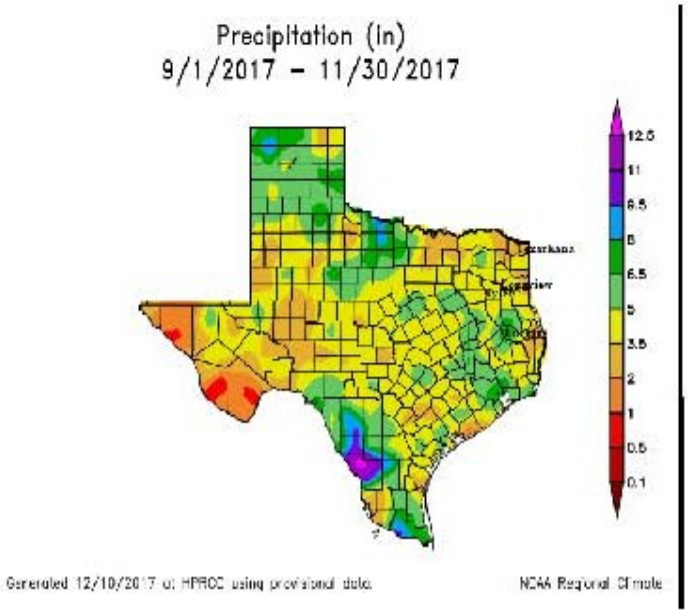
East Texas Regional Climate Summary

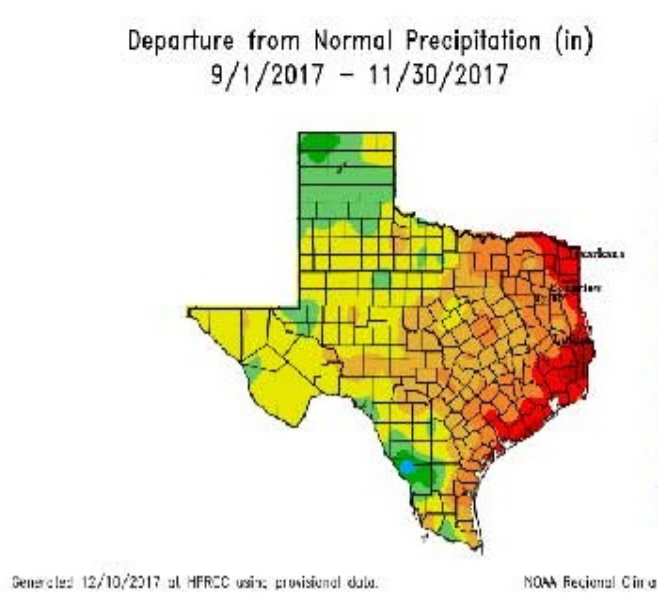
East Texas Regional Summary (Fall 2017)

By: Davyon Hill (Meteorologist) & Jason Hansford (Senior Meteorologist) - National Weather Service-Shreveport

Autumn 2017 (September/October/November) was very dry across East Texas. Nearly all of the Climate and CoCoRaHS stations reported less than 5 inches of rain total between the months of September, October, and November. During the month of September many locations saw less than an inch of rainfall, with Longview Regional Airport only seeing 0.02 tenths of rain for the entire month. These dry conditions resulted in Severe Drought conditions across most of East Texas, with locations along the Red River in Extreme Drought.

CITY:	FALL RAINFALL/ (DEP. FROM NORMAL)	PERCENTAGE OF NORMAL	DRIEST FALL RANK
TEXARKANA AR (RECORDS SINCE 1892)	4.29 (-8.89)	33%	8TH
MT. PLEASANT TX (RECORDS SINCE 1905)	3.70 (-8.61)	30%	3RD
TYLER TX (AIRPORT)	3.21 (-9.08)	26%	N/A
TYLER TX (COOPERATIVE OBSERVING STATION)	4.09 (-8.25)	33%	N/A
LONGVIEW TX (RECORDS SINCE 1902)	3.97 (-8.44)	32%	6TH
MARSHALL TX (RECORDS SINCE 1893)	3.49 (-9.34)	27%	5TH
LUFKIN TX (RECORDS SINCE 1907)	6.91 (-7.01)	50%	---





North Texas Fall Weather Summary

By Greg Story
National Weather Service-Fort Worth

We really have been on a rainfall roller coaster in north Texas this year. Just to review, our region had one of the driest springs of record, then we ended up with one of the wettest summers of record. After the fourth driest month of May of record, parts of north Texas received over 8" in June. Additionally, June 24 became the wettest of any June day ever. July was also a wet month. We had the 10th wettest summer of record since 1899, and that was before August had even started! And… as it turned out August was also wet. August ended the month a little over 2" above normal. DFW airport ended up having its 6th wettest summer of record with 16.80", which is nearly 9" above normal. The roller coaster took a downturn this fall. September ended as the driest month of 2017 so far with only 0.47" of precipitation. This was less than the 0.70" in May, leaving May as the second driest month of 2017. This was the 13th driest September on record. The DFW airport had 30 consecutive days without measurable rain, but that ended September 27 when 0.17" was recorded. This tied for the 27th longest rain-free period with nothing more than a trace. Normal rainfall in September is 2.55", so this month was 2.08" below normal.

October was dry as well, which was not good news considering it is usually one of our wetter months in north Texas. In October we received 2.12" of precipitation. Normally in October we get 4.22", so this month was 2.10" below normal.

And, as it turns out, November was warm and dry as well. The autumn season ended with the lowest total precipitation in five years with 3.40" at DFW, and that ranked number 13 among the driest on record. From September 1 through November 30 the 3.40" we received is about 6" lower than the 9.48" we normally receive. The fall season September through November is climatologically wetter than the summer and winter seasons in north Texas, so the bad news was that the autumn of 2017

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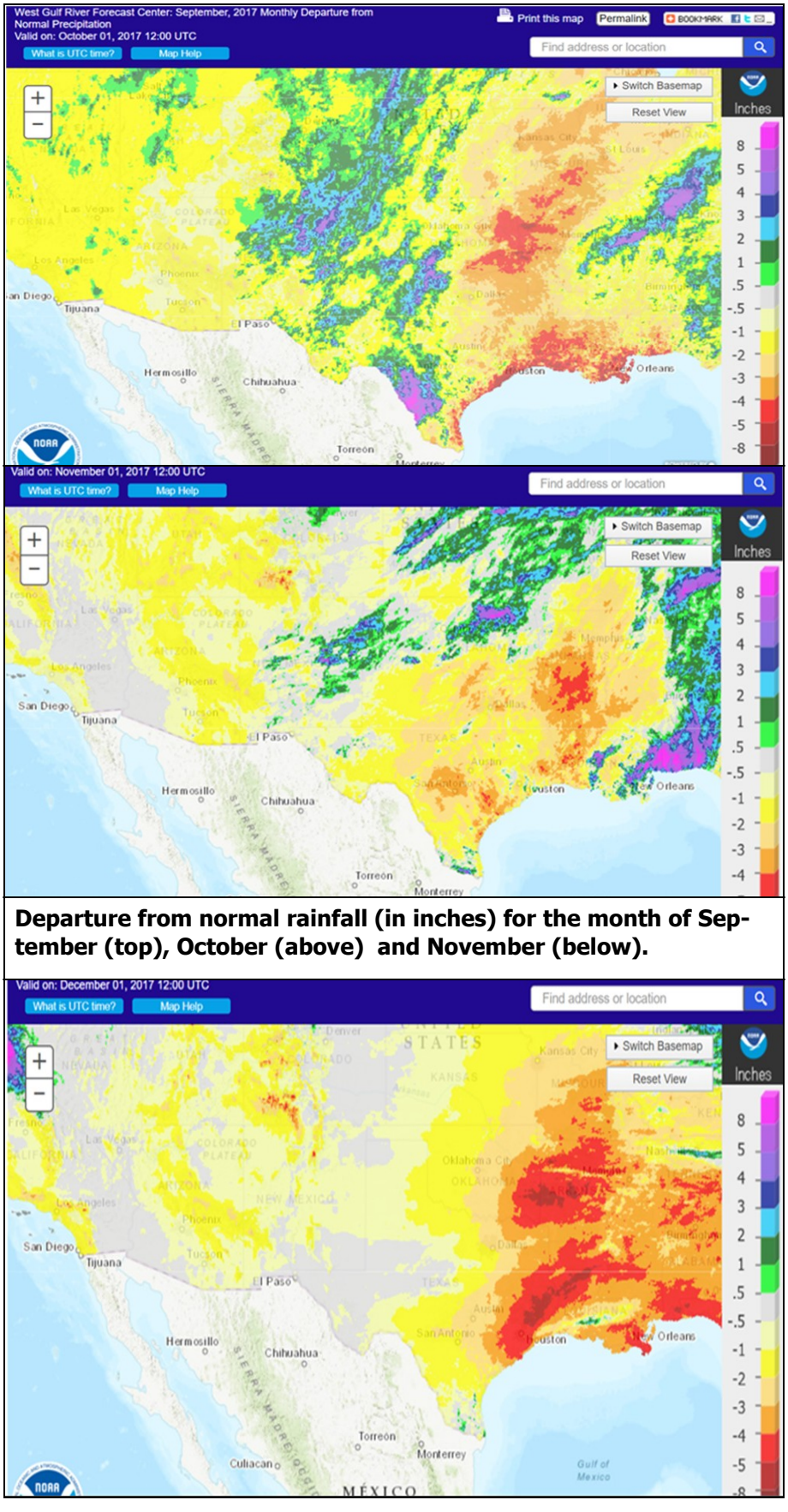


Departure from normal rainfall (in inches) for the month of September (top), October (above) and November (below).

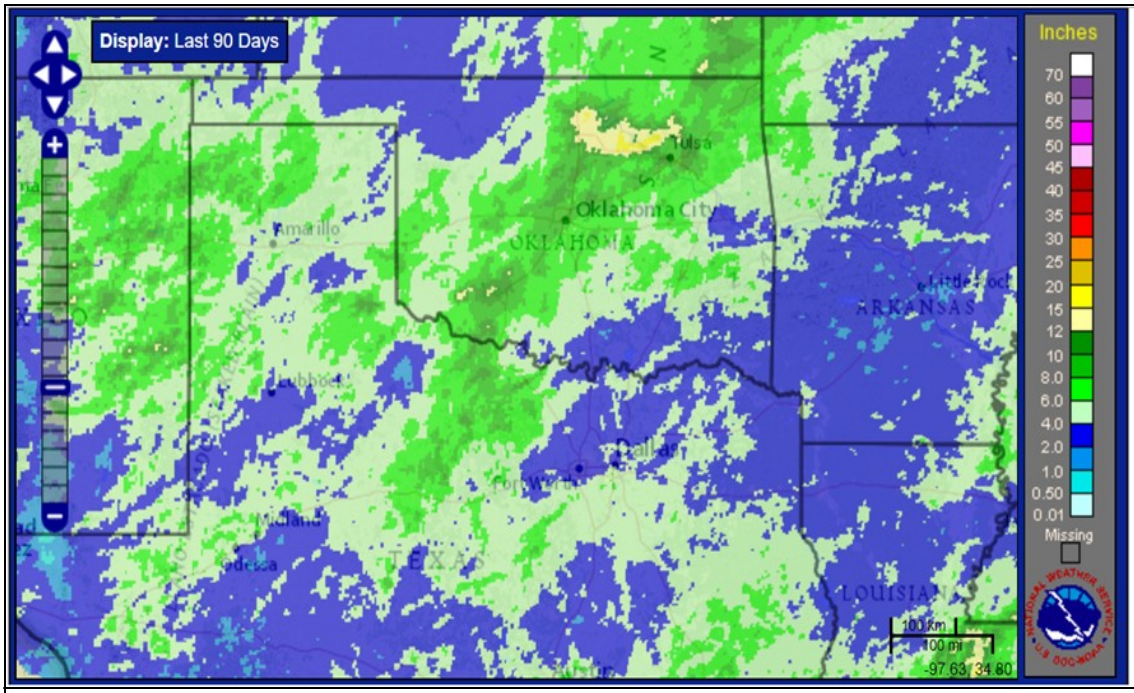
North Texas Fall Weather Summary

CONTINUED from Page 4

was among the driest on record for much of North and Central Texas. In November we received 0.81" of precipitation. Normally in November we get 2.71", so this month was 1.90" below normal. For 2017, the DFW airport has received 32.06". The normal amount is 33.59" so officially the precipitation for this year is below normal by -1.53". Other north Texas locations have similar reports.

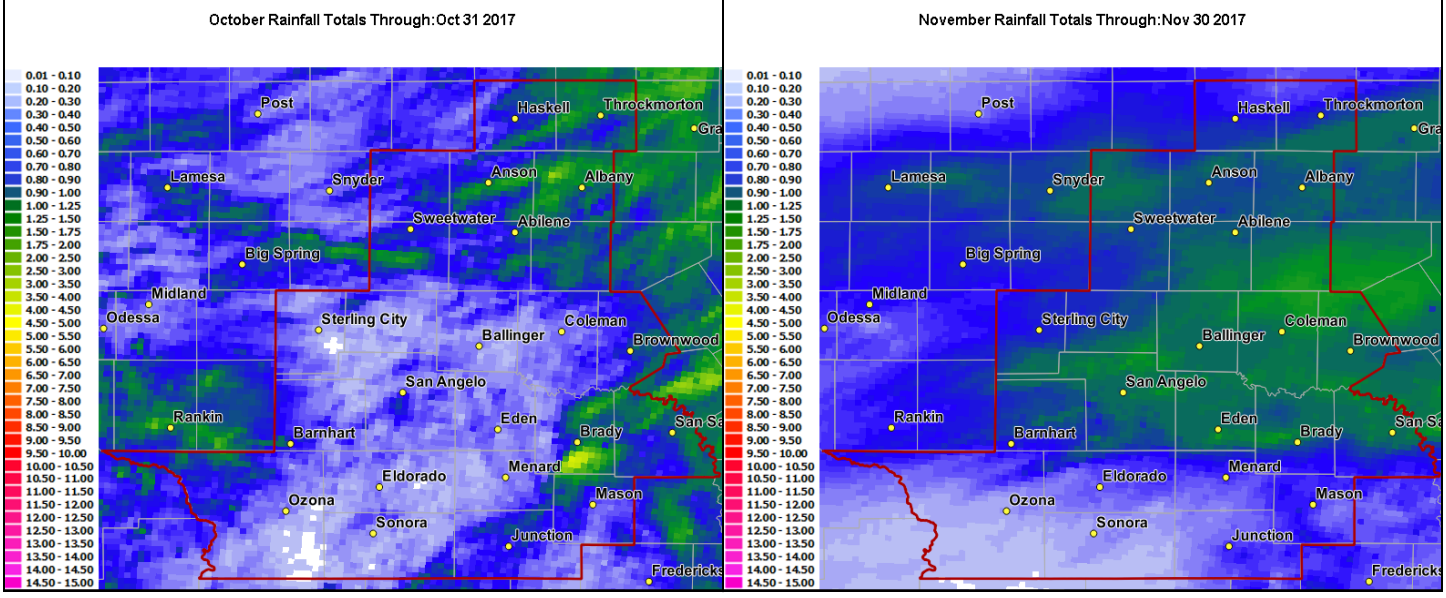
So in conclusion, I want each of you to know how valuable your rainfall reading are to us. Since I work for the National Weather Service, I can assure you that your rainfall readings have become increasingly important. Even in a dry weather pattern, your rainfall readings contribute greatly to our mission of saving lives and property from not only floods, but drought here in Texas. Even when you report a zero rainfall reading for a day, you

And please spread the word to your friends and neighbors...we need more observers. The more observers that report, the better the chances of us catching the magnitude of floods and drought. Our final precipitation estimates that we compute from your CoCoRaHS observations go into the making of the state and national drought monitor each week. Thank YOU so much for your efforts. Have a great holiday season!



Radar estimated precipitation for northern Texas and surrounding states for the fall season (September-October-November).

Rainfall across San Angelo Region



Wichita Falls Regional Fall Climate Summary

By Charles Kuster
CIMMS/NSSL

The Wichita Falls region experienced a warm and dry fall for the most part this year. Most areas saw below normal rainfall especially in Hardeman, Foard, and Knox County where rainfall deficits exceeded 3" in some areas (Fig. 1). In total, there were 70 dry days (no CoCoRaHS observers reporting 0.05" or higher) and 22 wet days (one or more CoCoRaHS observers reporting at least 0.05"). November was especially dry as 0.09" was the maximum 24-hour rainfall total reported by any CoCoRaHS observer, and the month ended with a 13-day streak of all CoCoRaHS observers reporting 0.00" of rain. Wichita Falls also experienced its 14th driest November on record and set an all-time record high

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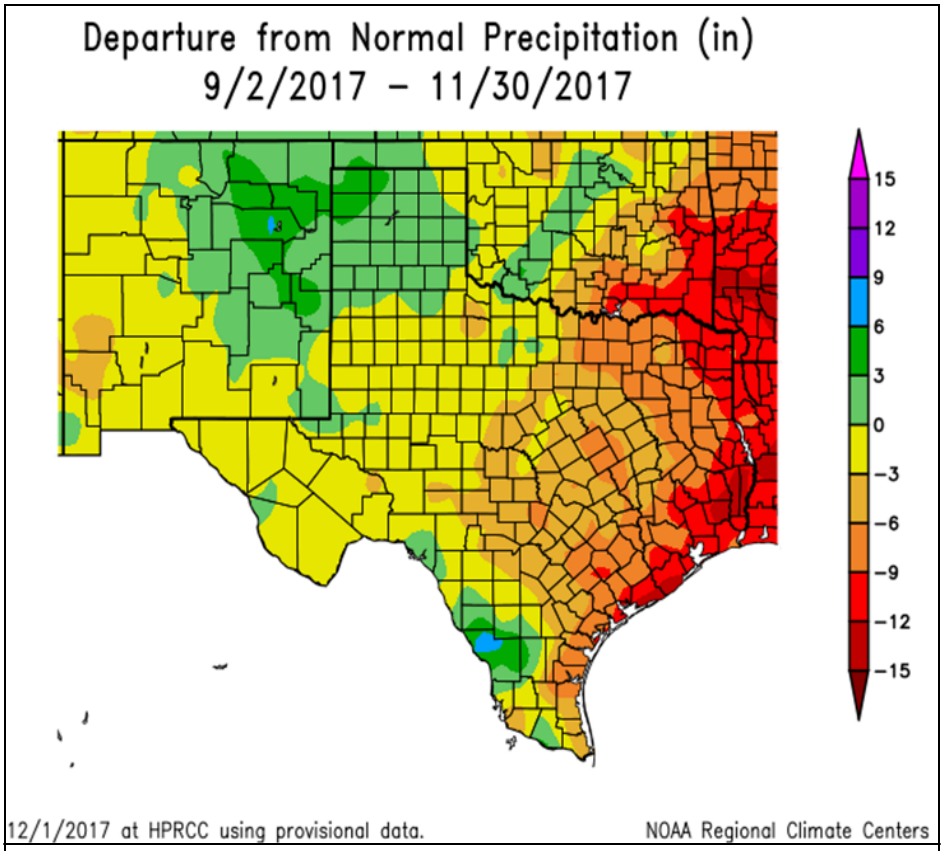


Figure 1: Departure from normal precipitation for September 2017 through November 2017. Warm colors indicate below normal precipitation and cool colors indicate above normal precipitation.

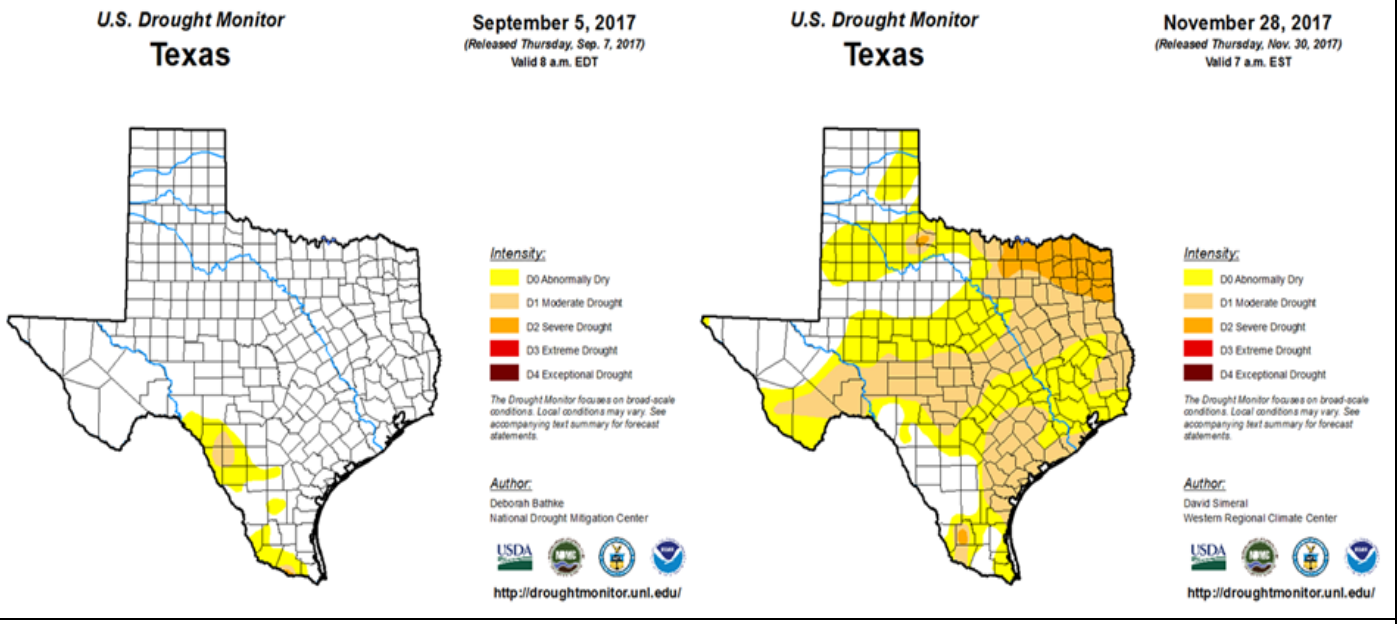


Figure 2: Change in the U.S. Drought Monitor for Texas from September 5, 2017 (left) to November 28, 2017 (right).

Wichita Falls Regional Fall Climate Summary

CONTINUED from page 6

temperature for the month of November (90° Fahrenheit on November 2nd and 4th). With this warm and dry weather, it is not surprising that drought has developed in the area since the beginning of September (Fig. 2 —Page 6). The worst drought (D2: "severe drought") according to the U.S. Drought Monitor was located across Foard County.

Most of the rain that did fall this season came during the final 10 days of September when there were three separate rain events where at least one CoCoRaHS observer reported more than 1.0" in a 24-hour period. The most substantial event occurred on September 26–27 when multiple rounds of heavy rain produced widespread rainfall totals of 3–6" especially across Archer, Hardeman, Wichita and Wilbarger County (Fig. 3).

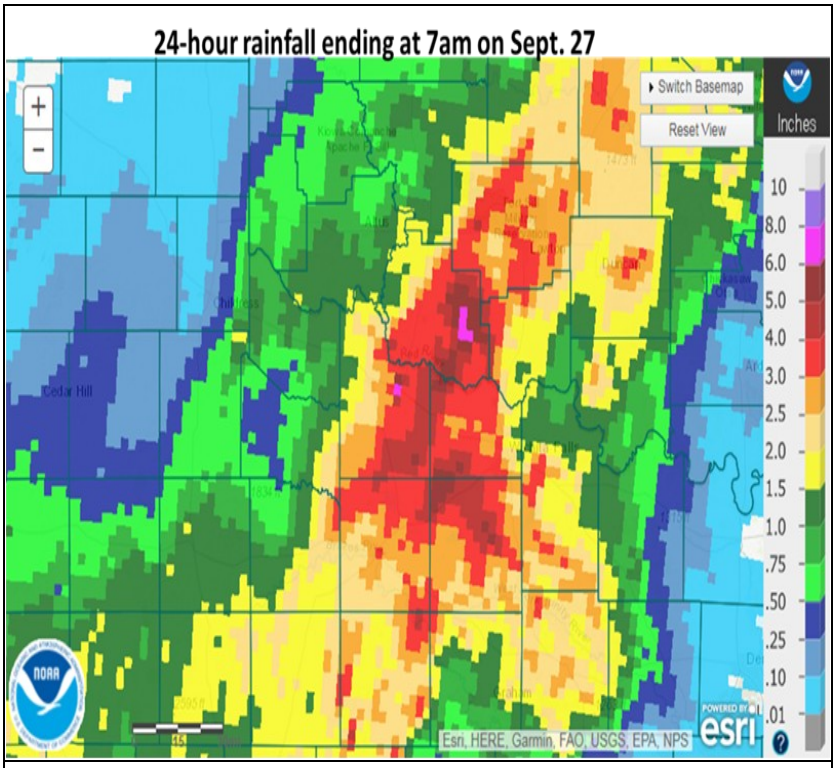
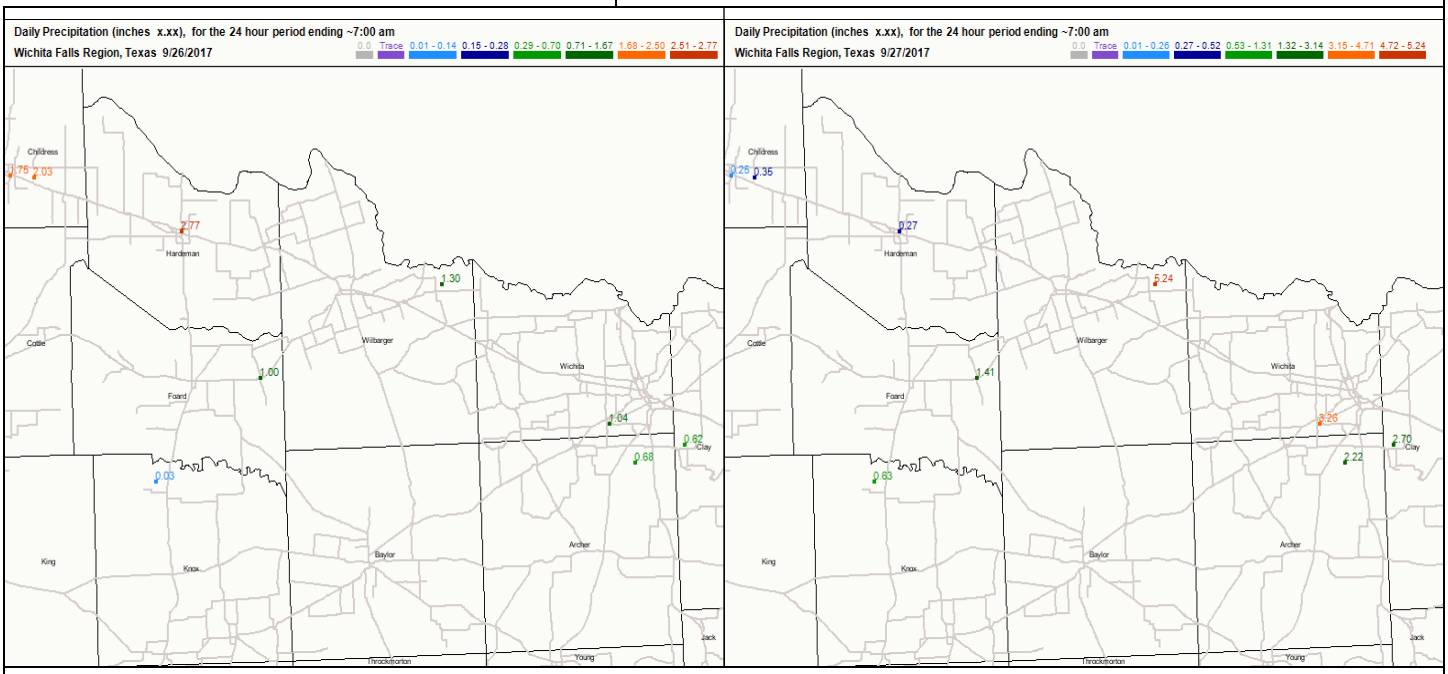


Figure 3. Radar estimated 24-hour rainfall totals for the period ending at 7 am on September 27, 2017.



Rainfall totals as reported by CoCoRaHS Observers for the rain event of September 26-27th across the Wichita Falls region. On the 26th (left), the heaviest rains were reported in Childress and Harderman Counties then in Wilbarger, Wichita and Archer Counties on the 27th (right).

Heavy Rains flood parts of southern Panhandle

By National Weather Service
WFO Lubbock

Wednesday night (October 4th) into early Thursday morning, a small complex of thunderstorms that moved slowly from eastern Briscoe County, through much of Hall County, and into western Childress County produced heavy rain across much of the watershed of the Prairie Dog Town Fork of the Red River. Radar estimates of rainfall along the path of the storms ranged from about 3 to 6" (see map below). As all the rain water surged into the tributaries of the Red River, it produced a large water rise that moved downstream and produced flooding along the river banks.

Here is a map of radar estimated rainfall from the thunderstorms (the legend may be difficult to see, red and purple colors indicate about 3 to 7").

The heavy rain resulted in rapid runoff that generated localized flash flooding including in and around Memphis and Estelline. This prompted the closure of a portion of Highway 287. The flooding also washed out portions of FM 1619 just east of Highway 287. were reported.

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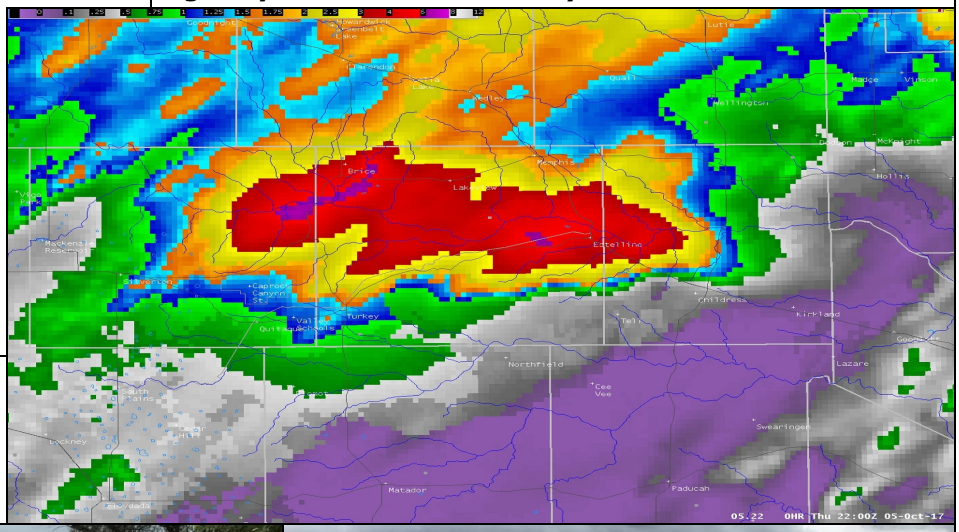
Photograph of high water running under the bridge along highway 83 in Childress County.



Right: Radar estimated rainfall from Oct 4-5, 2017 across Lubbock and South Plains Region

<u>Left:</u> The flood waters washed out parts of FM 1619 just east of Highway 287 near Newlin. The significant runoff pushed the Prairie Dog Town Fork of the Red River over flood stage. <u>Right:</u> Flood water flowing under Highway 287 between Newlin and Estelline. The images are courtesy of Bruce Haynie.

Heavy Rains cause flooding in southern Panhandle

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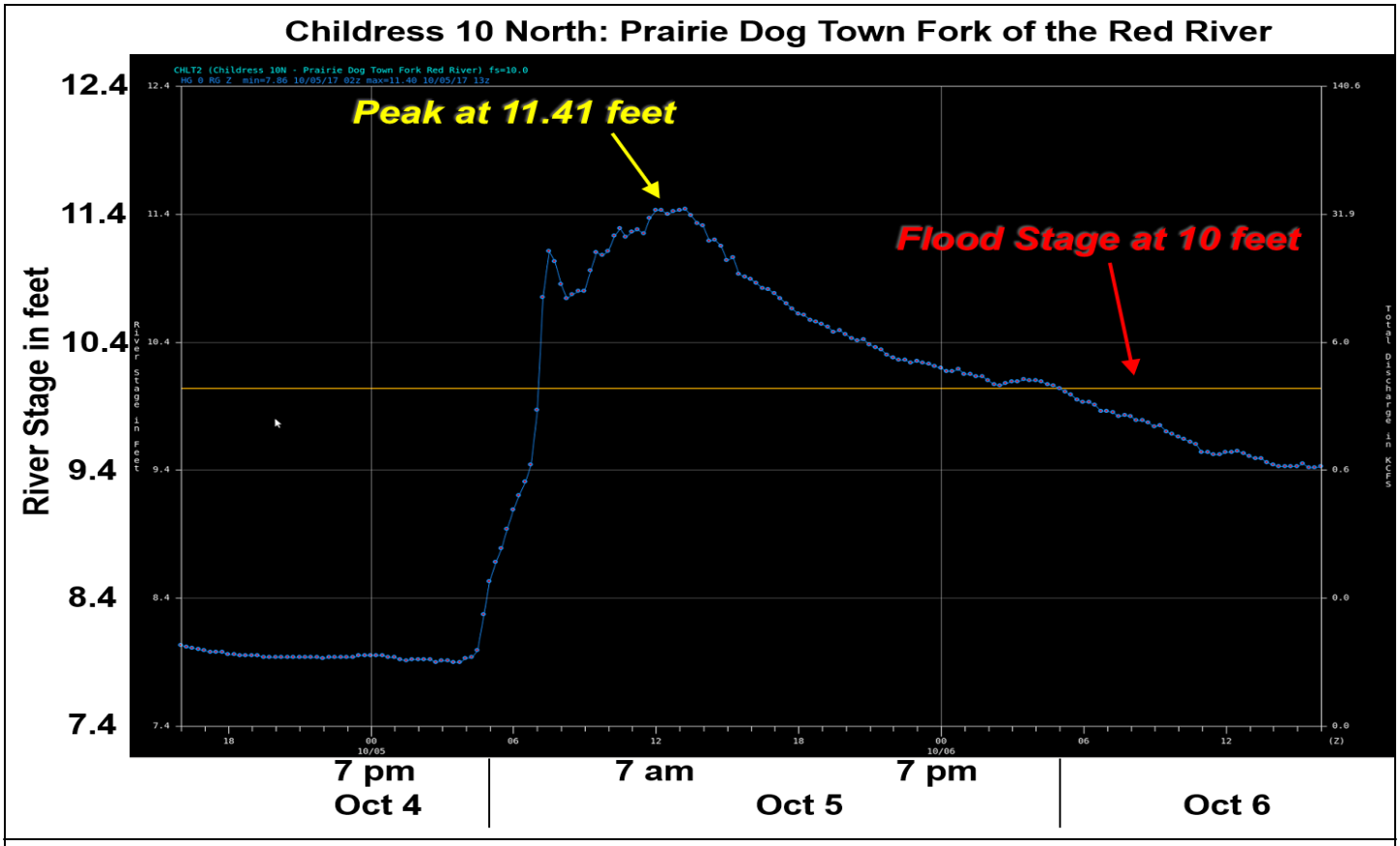
The flash flooding did trap a couple of vehicles near Newlin, though thankfully no injuries were reported. Flooding was reported along the river from near Brice to northwest of Childress. A river gauge along Highway 83 north of Childress measured the water rise moving across Childress County. It is shown in the graph below:



Graph of water rise along the Prairie Dog Town Fork of the Red River north of Childress .

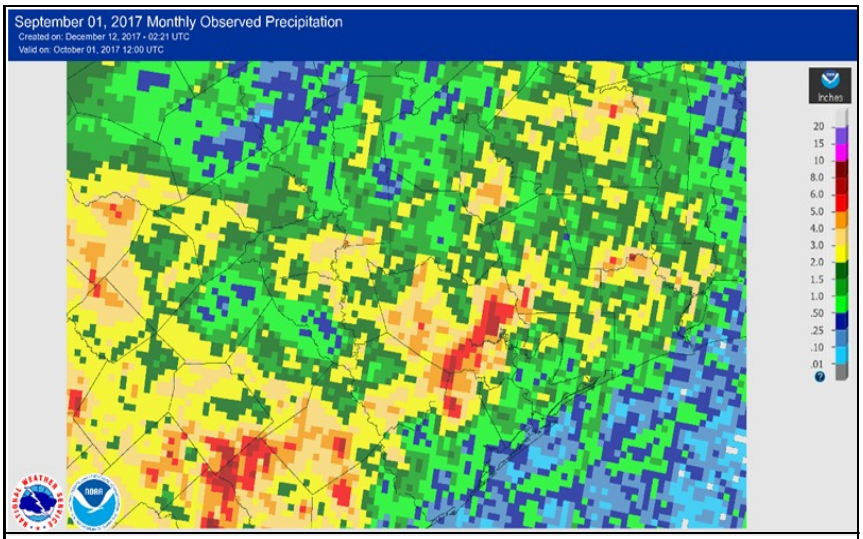
Rank	Feet	Date
1	16.90	06/01/1957
2	13.94	05/21/1977
3	13.47	01/01/1978
4	12.10	10/03/1986
5	12.00	06/26/1965
6	11.60	06/04/1995
7	11.41	10/5/2017
8	11.20	08/31/1986
9	11.10	08/29/1968
10	11.06	10/31/1998

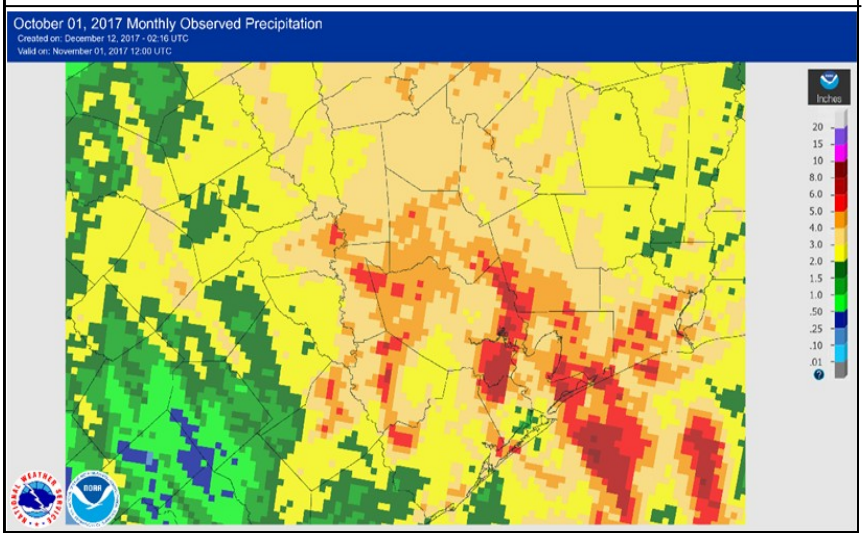
Since the channel for the Red River in this area is so wide, and the slope is shallow, flooding impacts at this location are not severe. At 11.41 feet, minor flooding of farm and ranch land will occur. Cattle in the flood plain are threatened. The water flowing in the river will be over 1/2 mile wide.

The table at left shows the historical high water rises at the gauge along highway 83 north of Childress. This event was the 7th highest crest in the database.

Southeast Texas Fall Climate Summary

By Ron Havran
Houston/Galveston CoCoRaHS Regional Coordinator





Radar estimated precipitation across Southeastern Texas for September (above) and October (below)

September climate highlights

Temperatures near average across all of SE Texas for the month.

Dryness returned to SE Texas after Harvey departed the region.

All areas except SE and eastern Harris County had below normal rainfall.

Western, southwestern, and northeastern counties had below normal rainfall.

Galveston recorded rain on only two days for the month.

Heaviest rain fell on the 18th, 20th, and 28th across the region.

CoCoRaHS observer county region wide rainfall averaged 1.54".

Highest CoCoRaHS county rainfall average was Harris with 2.73".

Lowest CoCoRaHS county rainfall average was Galveston with 0.77".

October climate highlights

Temperatures averaged near normal for the month.

High temperatures near mid 90's on the 9th and low 90"s from the 12th to 15th.

Low temperatures in the low to mid 30's on the 28th and 29th.

Rainfall was slightly above average in SE portions of the region.

Central counties had near average rainfall while below average rainfall occurred in western and SW counties.

Significant rains on the 3rd, 20th, and 22nd across the region.

CoCoRaHS observer county region wide rainfall averaged 3.18".

Highest CoCoRaHS county rainfall average was Harris with 4.16".

Lowest CoCoRaHS county rainfall average was Colorado with 1.60".

November climate highlights

Average monthly temperatures were approximately five degrees above normal.

High temperatures reached into the upper 80s to low 90s on the warmest days of the month.

All four primary climate stations ranked in the top ten warmest November on record.

Most of the total rainfall that occurred throughout November occurred on the first of the month.

Little measurable rainfall occurred with any of the weak cold fronts that pushed through the region.

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Southeast Texas Fall Climate Summary

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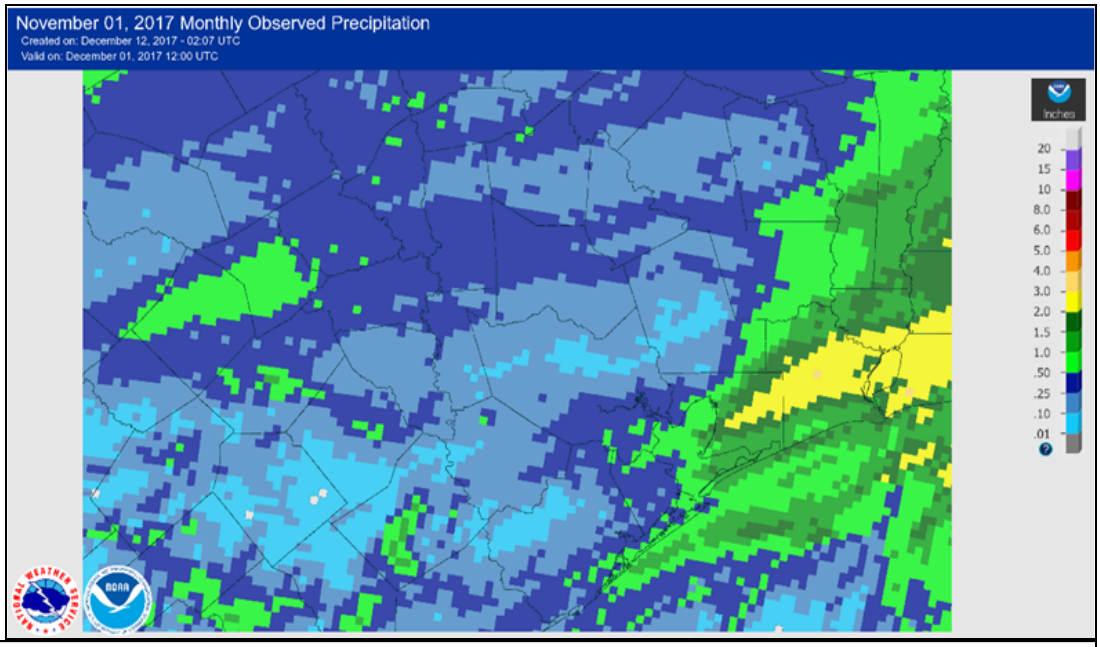
Little measurable rainfall occurred with any of the weak cold fronts that pushed through the region.
SE Texas weather was dominated by a subtropical ridge through the month, keeping conditions dry.
CoCoRaHS observer county region wide rainfall averaged 0.23".
Highest CoCoRaHS county rainfall average was Galveston with 0.47".
Lowest CoCoRaHS county rainfall average was Waller with 0.13".



Autumn highlights

Three month fall CoCoRaHS observer county rainfall average was 4.96".

Harris County had the highest 3-month CoCoRaHS rainfall average with 7.10".

Warm and dry conditions prevailed most of the sea-

Fall 2017 CoCoRaHS Houston/Galveston Region Rainfall

County Rainfall Average and County Station Rainfall Maximum Total in inches per month

County	September		October		November		Fall Total
	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	3-Month Rain Total
Austin	0.81	2.31	2.27	3.85	0.15	0.20	3.23
Brazoria	2.06	4.31	3.05	5.10	0.24	0.37	5.35
Chambers	N/A	3.05	N/A	4.45	N/A	0.90	N/A
Colorado	1.00	1.74	1.60	2.07	0.17	0.25	2.77
Fort Bend	1.48	2.22	3.15	4.37	0.18	0.24	4.81
Galveston	0.77	1.57	3.79	7.33	0.47	1.18	5.03
Harris	2.73	5.13	4.16	7.42	0.21	0.46	7.10
Jackson	N/A	2.77	N/A	1.28	N/A	0.36	N/A
Liberty	2.36	3.31	2.97	3.77	0.24	0.42	5.57
Matagorda	N/A	1.81	N/A	1.89	N/A	0.30	N/A
Montgomery	1.18	2.24	4.08	5.19	0.27	0.48	5.53
Polk	1.53	2.46	3.46	4.11	0.17	0.21	5.16
San Jacinto	0.83	1.03	3.48	3.93	0.25	0.42	4.56
Waller	N/A	1.00	N/A	2.65	N/A	0.13	N/A
Wharton	2.21	3.33	2.96	3.65	0.23	0.46	5.40
Region Totals	1.54	5.13	3.18	7.42	0.23	1.18	4.96

Brazos Valley Region Fall Climate Summary

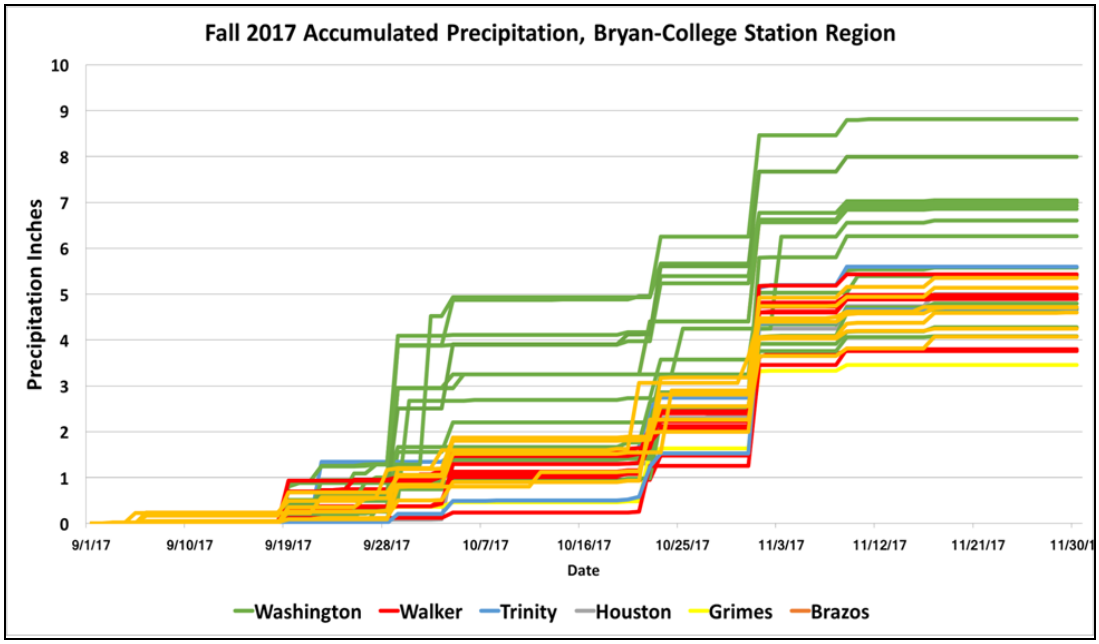
By: Jeramy Dedrick, Graduate Assistant for the Office of the State Climatologist, Brooke Barker, Graduate Assistant for the Office of the State Climatologist, John Nielsen-Gammon, Texas A&M University, Texas State Climatologist, Regional Co-CoRaHs Coordinator

Summary:

The fall season was a period of recovery post-Hurricane Harvey. Temperatures were consistently warmer than average, while precipitation was relatively lower than average. At the beginning of the season, observers recorded low amounts of precipitation in the region. Measurable rain began to be recorded during mid-October and early November, but a dry spell in the latter part of November kept accumulated precipitation totals consistent for the remainder of the season. Average rainfall for the fall season is around 11 inches, though the majority of observers recorded lower than this amount.

Observer Statistics:

There were 44 active CoCoRaHS observers during the fall period. This was a decrease of two observers from the summer season. 9 observers during this season reported for the full 91 days, while 24 other observers reported for at least 80% of the period, providing 33 active observers with reliable measurements across 6 counties.



`The accumulated precipitation graph (above) shows that September was the driest month during the season, while October was the relative wettest. Observers across the region recorded minimal amounts of rain during November as represented by the consistent lines at the end of the season.

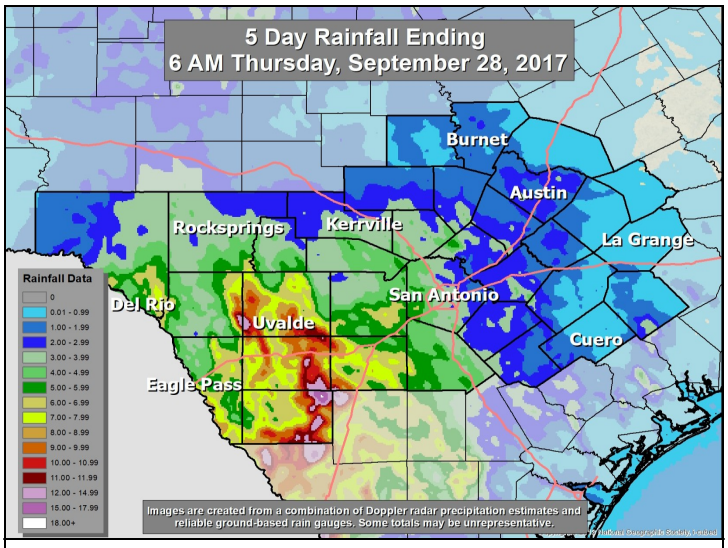
Season Statistics:

Wettest Day: 3.24", October 2 (Washington County)
Wettest seasonal total: 8.82", (Washington County)
Longest spell of days with measurable rain: 4 (Walker & Trinity Counties)
Longest spell of days with measurable rain: 21 (Walker, Washington, & Brazos Counties)

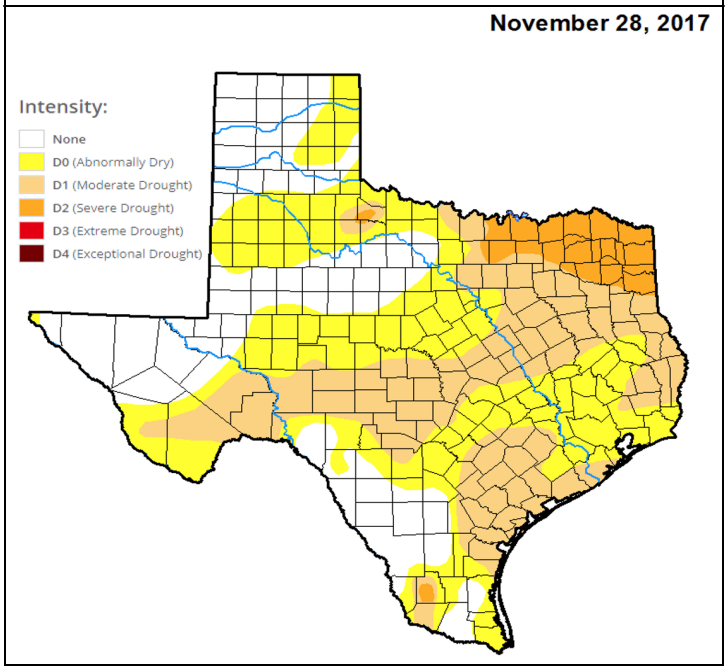
Quiet Fall season across South Central Texas

By: Brett Williams and Larry Hopper
National Weather Service WFO Austin/San Antonio

Fall 2017 was relatively quiet across South Central Texas as we only had one flash flood event in the Rio Grande Plains in late September and two severe weather reports for thunderstorm wind damage in early September. Otherwise, fall was generally drier and warmer than normal with the South Central Texas Climate Division having their 11th driest (4.45", or 5.02" below normal) and 17th warmest (2.0° F above normal) fall since 1895. Although all four of our climate sites recorded above normal temperatures during fall, only our three sites along the Interstate 35 corridor were drier than normal as Del Rio experienced their 41st wettest fall on record. This was primarily due to a rainy period in late September that caused the South Texas Climate Division (that includes the Rio Grande Plains) to only be 0.74" below normal for the fall season.



Above: Radar estimated rainfall for 5-day rain event ending at 6 A.M. on 28 September 2017.
Below: Due to fairly dry fall season, many areas of Texas in drought.



The first half of September was quite pleasant as drier air and a couple of frontal passages helped keep high temperatures in the 80s and lower 90s and low temperatures in the upper 50s and 60s in the wake of Hurricane Harvey. A strong front also moved through South Central Texas early on September 6th, nearly three weeks earlier than normal (September 25th) and the earliest since 2011. However, the heat returned by the middle of September to keep the region's temperatures near normal for the month ahead of a brief wet period that occurred during the last week of September as deep moisture associated with Tropical Storm Pilar in the Pacific interacted with a slow-moving cold front. Measurable rainfall occurred for seven consecutive days at Del Rio (5.88"), six days at San Antonio (2.80"), five days at Austin-Bergstrom (3.81"), and four days at Austin-Camp Mabry (2.01") from September 24-30th. The heaviest rainfall occurred during a four day period from September 25-28th when portions of the Rio Grande Plains in Uvalde, Zavala, and Dimmit Counties received over 10" of rain with a peak rainfall total of around 18" in northeastern Dimmit County. Aside from this period, no other single daily rainfall event met or exceeded one inch at the four official climate sites for the rest of the fall season.

October and November were both very dry across all of South Central Texas, but temperatures were slightly below normal during October and much above normal during November. San Antonio (0.46") and Del Rio (0.43") were much drier than normal during October, experiencing their 20th and 26th driest Octobers on record, respectively, whereas the Austin area received closer to 2" as over half an inch of rain fell in two rain events on October 3rd and 22nd. An early freeze also occurred on October 28th and 29th over much of the Hill Country and southern Edwards Plateau, with even Austin Bergstrom dropping down to 32° F on the 29th. Dry weather continued into November as the region remained under high pressure or northwest flow aloft, with temperatures ranking fourth warmest (2.0° F above normal) since 1895 across South Central Texas. All of our climate sites had one of their thirty driest and ten warmest Novembers on record with Austin Camp Mabry experiencing their 2nd warmest. Record high temperatures were set on the warmest day of the month, November 5th, at both Austin Camp Mabry (88° F) and San Antonio (91° F). These warm and dry conditions common during La Niña over South Central Texas caused most of the region to be in abnormally dry or moderate drought (D1) conditions by the end of November with drought expected to expand and intensify this winter.

Permian Basin Fall Weather Summary

By Jim DeBerry
National Weather Service-Midland/Odessa

West Texas and Southeast New Mexico saw a fairly dry fall, as the synoptic pattern was not conducive to precipitation rain events.

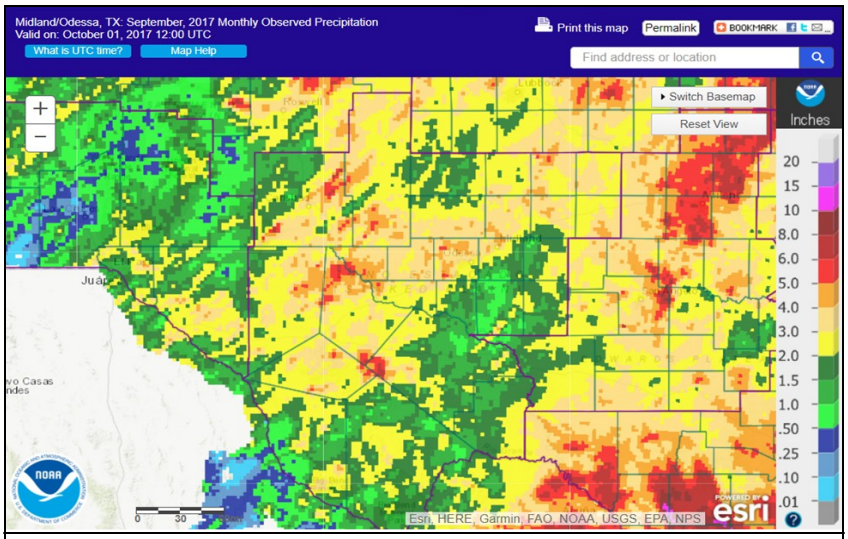
The summertime ridge weakened significantly in September as a series of upper-level troughs dug into the western CONUS and went to work on it. A significant trough developed late in the month, bringing significant rainfall to the area. The only flood reports were urban flooding in Midland in Midland County and Odessa in Ector County, as well as roadways in the vicinity. These occurred mainly on September 25th and 26th. Monthly radar rainfall estimates ranged from 0.25" near Candelaria and Presidio along the Rio Grande to 8.00" near Alpine and in stretches of the Pecos River Valley. Highest observed rainfalls were in the neighborhood of 4", and the average observed rainfall was just over 2.25".

The Rio Grande and Pecos Rivers also saw elevated activity in September. The Rio Grande was in minor flood much of the month due mainly to extended releases from Luis Leon Reservoir in Mexico.

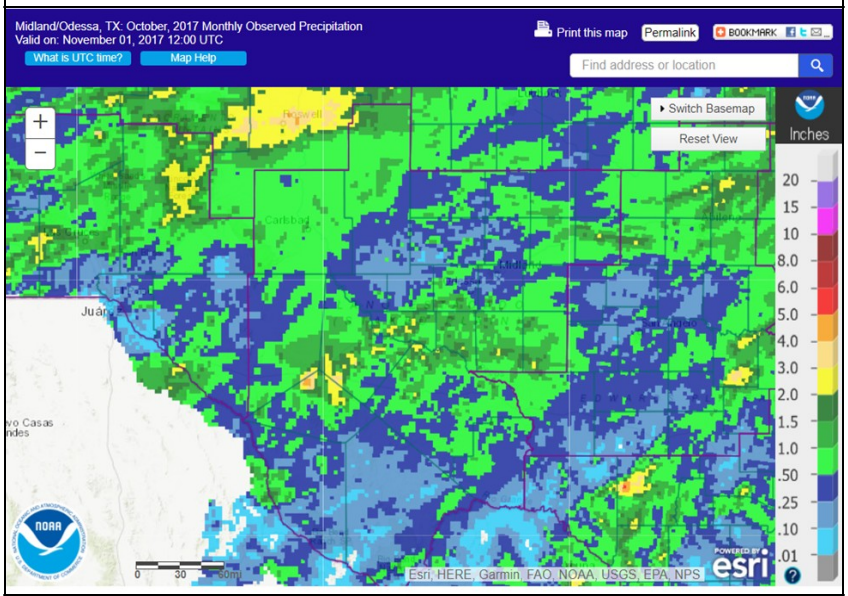
October was quite uneventful, hydrologically, and rainfall dropped off considerably. The first few cold fronts of fall began encroaching into the area, but with little moisture to work with, no flash flooding events were noted. Monthly radar rainfall estimates ranged from nothing along the Rio Grande near Lajitas to up to 5" in the Davis Mountains. Highest observed rainfalls were 1.5-1.75", and the average observed rainfall was a measly 0.45".

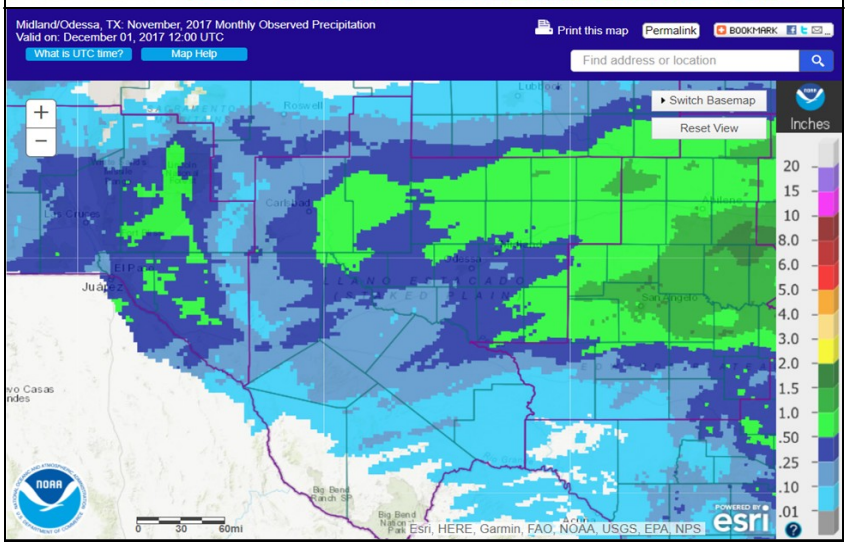
The Rio Grande was in minor flood above Presidio for the first part of the month, but had returned to near base flow by the end of October.

November was quite uneventful for West Texas and Southeast New Mexico, as the synoptic pattern afforded little chance for rain. Monthly radar rainfall estimates ranged from nothing along the U.S. border to 2" or less in the upper Colorado River Valley. Highest observed rainfall was near 1.25", and the average observed rainfall was only 0.30". Despite meager rainfall this fall, all of Southeast New Mexico remains out of drought. However, moderate drought has now developed over the lower Trans Pecos region, and spread west into portions of Brewster and Presidio Counties. Reservoir levels across the HSA averaged 52.6% of conservation capacity as of December 1st:



Radar estimated precipitation across West Texas and the Permain Basin region for September (top), October (center) and November (below).





Hurricane Harvey

Harvey...The Storm that Wouldn't Leave

Nikki Hathaway, Katie Magee, Katie Landy-Guyton; National Weather Service Houston/Galveston

The Lifecycle of Harvey

Harvey was the longest lasting storm on record after making landfall in Texas with a total lifespan of 117 hours, breaking the previous record of 54 hours during Hurricane Fern in 1971. The National Hurricane Center (NHC) began issuing public advisories for tropical cyclone Harvey on the morning of August 17th, and did not issue the final advisory until the evening of August 30th. This system began as a disorganized area of low pressure which formed west of Africa in the southeast corner of the Atlantic basin. On August 17th, this system became better organized while just east of the Lesser Antilles and was later upgraded to Tropical Storm Harvey. It continued to move through the Windward Islands, and into the Caribbean Sea where it weakened to a tropical wave. After tracking through the western Caribbean Sea on August 22nd, Harvey crossed over the Yucatan Peninsula and reemerged in the southern Gulf of Mexico on August 23rd. Shortly after reorganizing over the warm tropical waters, Harvey underwent a serious structural reorganization process, which in the meteorological community is referred to as rapid intensification. Rapid intensification is defined as an increase in the tropical system's maximum sustained wind speeds of at least 30 kts over a 24 hour period. While undergoing rapid intensification, Harvey transformed from a tropical depression into a category 4 hurricane in approximately 40 hours.

Harvey made its first landfall in the U.S. along the middle Texas coast near Port Aransas around 10:00PM on August 25th, with wind speeds exceeding 130 mph. Hurricane Harvey was the first category 4 hurricane to make landfall in the United States since Hurricane Charley, which made landfall near Punta Gorda, Florida, in 2004. Additionally, Hurricane Harvey was the first hurricane to hit the Texas coast since 2008 when Hurricane Ike made landfall in Galveston, Texas, and was the first major hurricane (category 3 or stronger) to make landfall in Texas since Hurricane Bret in 1999. Harvey is also the first named storm on record to make two Gulf Coast landfalls greater than 60 hours apart.

Following Harvey's first landfall in the state of Texas, the overall forward motion slowed to near 5 mph just north of Victoria, Texas. This was partially due to the middle to upper level pattern in the atmosphere over the region, which at the time had two areas of high pressure on both sides of the system. As a result, Harvey stalled over Southeast Texas for multiple days, producing catastrophic riverine and flash flooding. On August 28th, Harvey shifted south and southeastward back over the northern Gulf of Mexico and continued to slowly move to the northeast, dumping additional rainfall on August 29th and 30th. Harvey maintained tropical storm intensity even after moving offshore and meandering along the Texas coastal bend. Finally, on the morning of August 30th, Harvey made its second landfall in the U.S. (third landfall throughout lifecycle) just west of Cameron, Louisiana. This allowed most of the remaining rainfall associated with the system to shift to the east toward Louisiana; however, prolific flooding continued over Southeast Texas.

The preliminary best track of tropical cyclone Harvey can be seen in Figure 1a, and a closer look around the Southeast Texas coastline in Figure 1b (NHC/ESRI).

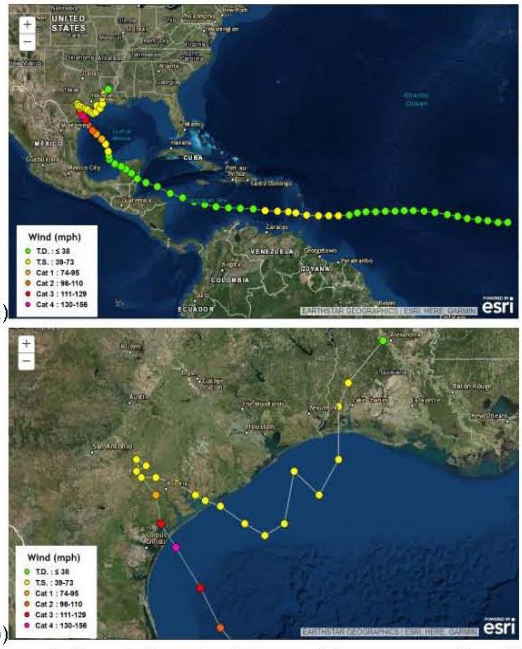


Figure 1: Overall lifecycle of Harvey (a) and zoomed in path specific to Southeast Texas (b) provided by NHC Preliminary Best Track of Harvey, powered by ESRI.

Harvey's Record-Shattering Precipitation

In short, the rainfall from Harvey was both devastating and unprecedented. Over 10,000 square miles of area in Texas and Louisiana saw greater than 30 inches of rain in just five days, as seen in Figure 2 (Nielsen-Gammon 2017).

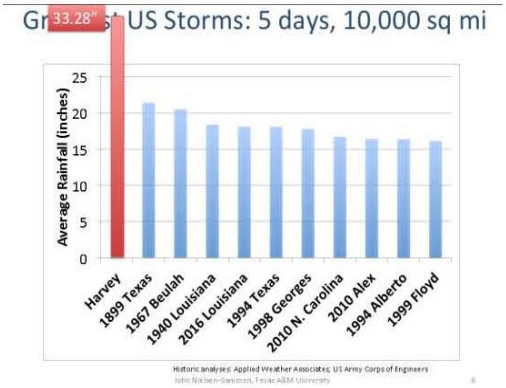


Figure 2: Greatest US Storm-Total rainfall for 5 continuous days over 10,000 square miles, provided by Dr. John Nielsen-Gammon of Texas A&M University. Hurricane Harvey (2017) set a new record with 33.28 inches of recorded rainfall widespread over 10,000 square miles in five days.

This is over 10 inches greater than the next-largest amount of rainfall from the 1899 Texas hurricane. For perspective, Figures 3a and 3b show the total rainfall from Harvey over Texas and over New England, respectively. The wide swath of 20+ inches of total rainfall that swallowed much of Southeast Texas takes up almost the entirety of Massachusetts, Rhode Island, and Connecticut.

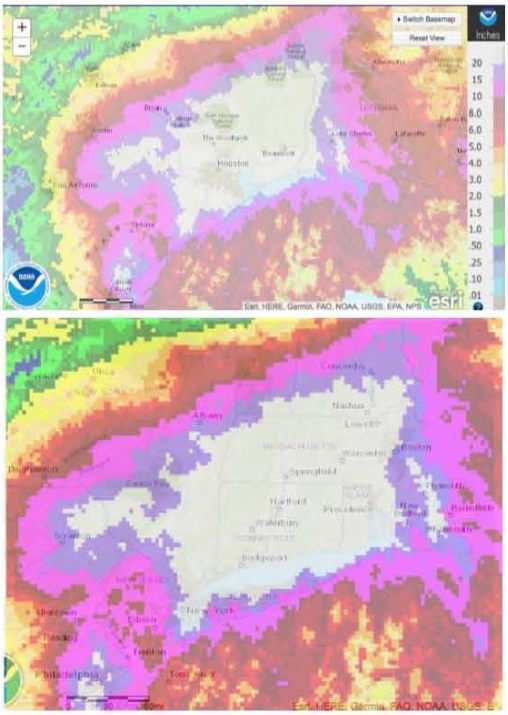


Figure 3: Total rainfall from Hurricane Harvey (2017) over Southeast Texas and Southwest Louisiana with old color bar (a), as well as same rainfall amounts centered over New England (b).

The overall total rainfall with a corrected color bar can be seen in Figure 4, which highlights the relatively tight spatial gradient separating 20 inches of rainfall from an even more impressive 40 inches total.

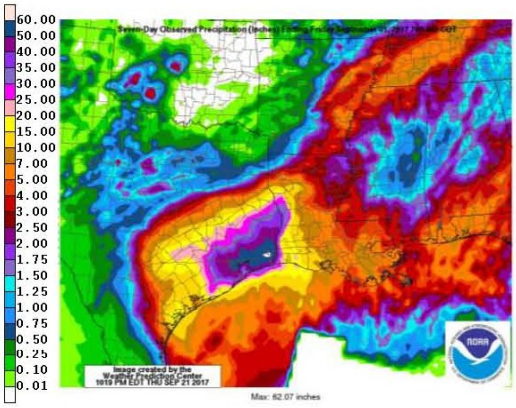


Figure 4: Hurricane Harvey (2017) total rainfall with an adjusted color bar.

The largest amount of rainfall recorded at a single station during Harvey was 60.58 inches in Nederland, Texas. For the Houston National Weather Service (NWS) Weather Forecast Office (WFO) area, the highest rainfall was 56.00 inches in Friendswood, Texas. The highest report from CoCoRaHS observers was Station Number TX-LR-14 in Dayton, Texas, with a precipitation total of 49.31 inches from 8/25/17-8/31/17. All three of these rainfall totals beat the previous record for most rain in the Continental U.S. (CONUS) from a landfalling tropical system, which was previously 48.00 inches in Medina, Texas from Tropical Storm Amelia in 1978. However, the rainfall totals for Nederland and Friendswood, Texas, not only beat the CONUS record, but they also beat the record overall for the United States. In 1950, Hurricane Hiki struck Hawaii and produced 52.00 inches of rain at the Kanalohuluhulu Ranger Station in Hawaii.

These impressive rainfall totals become even more staggering when compared to recent heavy precipitation events. In 1979, Tropical Storm Claudette made landfall near the Texas-Louisiana border on July 23, 1979. Alvin, Texas, recorded a total of 45 inches with this storm and still holds the Continental U.S. record for highest rainfall in a 24-hour period (43 inches). This rainfall is compared with the rainfall during Hurricane Harvey (2017) in Figure 5. While Tropical Storm Claudette shows a small area of 40+ inches of total rainfall (as indicated by the yellow area), the Hurricane Harvey rainfall map illustrates the widespread extent of its devastating rainfall.

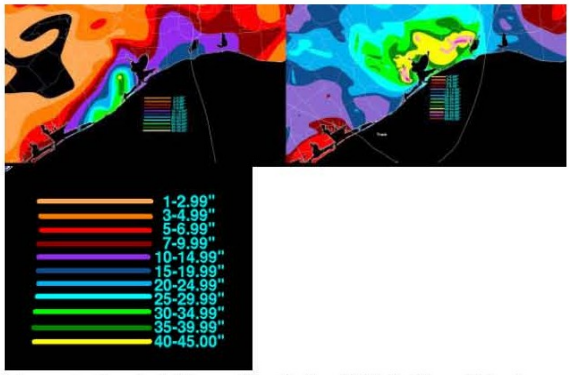


Figure 5: Tropical Storm Claudette, 1979 (left) and Hurricane Harvey, 2017 (right) rainfall totals with the same color bar (bottom), provided by David Roth from the Weather Prediction Center (WPC).

Additionally, Tropical Storm Allison in 2001 made landfall near Morgan City, Louisiana, and caused a maximum rainfall just over 40 inches. Figure 6 portrays how this rainfall compares to Hurricane Harvey (2017). As with Tropical Storm Claudette (1979), the pinprick of 40+ inches of total rainfall pales in comparison to the harrowing total rainfall seen with Harvey.

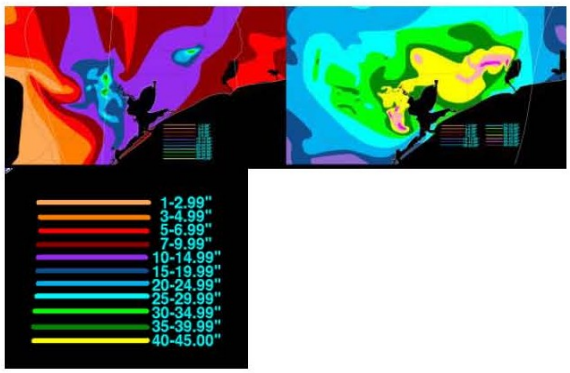


Figure 6: Tropical Storm Allison, 2001 (left) and Hurricane Harvey, 2017 (right) rainfall totals with the same color bar, provided by David Roth from the Weather Prediction Center (WPC)

Additional notable heavy rainfall events for the Houston area include what is now known as the "Memorial Day 2015" flood, which had a maximum rainfall accumulation of 11.0 inches at Brays Bayou and Beltway 8 on May 25, 2015 through May 27, 2015. The highest CoCoRaHS observation during the Memorial Day 2015 flood was 10.02 inches of rainfall 6.2 miles west of Downtown Houston (Harris County Flood Control District (HCFCD), June 11 2015). In the subsequent year, the "Tax Day" flood struck on April 17-18, 2016. The Houston area had a maximum rainfall total of 23.50 inches in Pattison, Texas, with an average rainfall of 7.75 inches across Harris County (HCFCD, June 27, 2016). Unfortunately, this was not the end of the devastating flooding of 2016. During the "Memorial Day 2016" flood on May 26-27, 2016, a maximum rainfall amount of 20+ inches fell over Brenham, Texas.

While significant flooding is not a rare event in Southeast Texas, or the entire Gulf Coast for that matter, Harvey is unique in its *extent* of devastating flooding. Although peak rainfall totals over 40 inches have been previously recorded in the Texas area, the great extent to which this catastrophic rainfall occurred will set this event apart for decades to come.

Harvey's Flooding and Impacts

Nearly 6.5 million people were impacted by 30 inches or more of rainfall over a 6-day time period: August 25th through August 30th. Of the 6.5 million people, 6 million were in the Houston area alone (Figure 7).

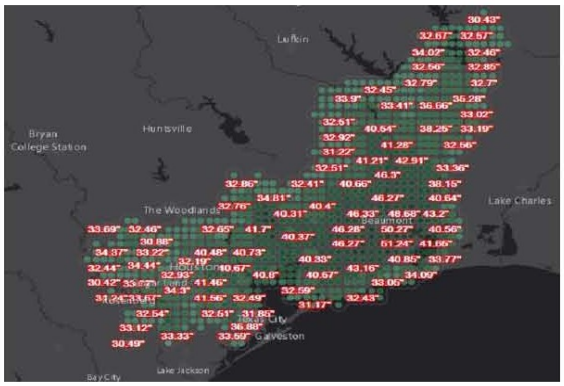


Figure 7: Image illustrates the extent of 30+ inch rainfall reports during Harvey.

The widespread nature of record rainfall led to the catastrophic impacts across Southeast Texas both from riverine and flash flooding. Widespread river flooding occurred with 60 of the 67 official NWS river forecast locations reaching flood stage. Of the 67 forecast points, 46 reached *major* flood status and 31 sites reached *record* flood. Several of these record crests broke their previous record by a large margin (Figure 8).

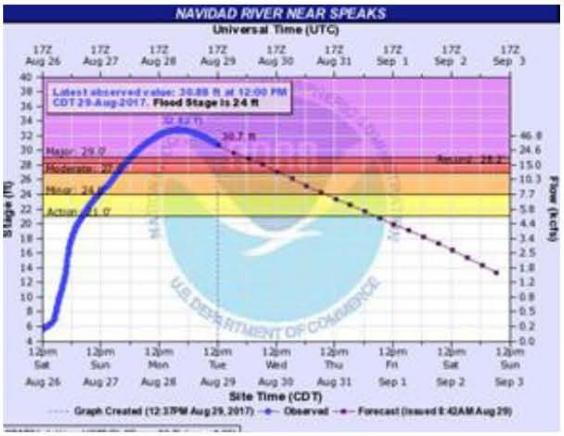


Figure 8: Hydrograph shows the crest from Harvey's rainfall at the Navidad River near Speaks, Texas. This location broke its previous record by nearly 4.5 feet.

Record flooding occurred along portions of the Trinity, San Jacinto, Brazos, San Bernard, and Navidad Rivers, as well as many of the Harris County bayous and

creeks. Reservoirs in Southeast Texas were also affected by Harvey's wrath. Record releases were set at both Addicks and Barker Reservoirs on Buffalo Bayou, as well as Lake Conroe and Lake Houston along the San Jacinto River.

In addition to major and record riverine flooding, flash flooding also took a toll on Southeast Texas. Harvey became Houston's 4th flash flood emergency event in a 2 ¼ year period and was by far the most devastating. Over the course of four days, 62 flash flood warnings were issued by the National Weather Service Houston/Galveston office. Both the riverine and flash flooding caused the inundation of homes, businesses, and vehicles, causing Harvey to be one of the most devastating floods on record (Figure 9).

Figure 9: Residents evacuate flooded home in a Houstonian neighborhood during Harvey. Photo provided by Mark Mulligan, Houston Chronicle.

Based on Disaster Summary Outline (DSO) reports from counties impacted by Harvey, over 300,000 structures flooded across Southeast Texas; and, according to the Texas Attorney General, nearly one million vehicles flooded. Many primary and secondary roads, including I-10, I-45, and I-69, across Southeast Texas were inundated and closed due to flooding.

Over 75 fatalities, both direct and indirect, occurred from Harvey; nearly 50 of these fatalities were in the Houston area alone. In addition to the fatalities, the economic losses prove Harvey to be one of the most costly hurricanes on record. According to Michael Hicks of Ball State University and Mark Burton of University of Tennessee, there are at least $198 billion in damages in Texas due to Harvey (Hicks and Burton 2017, Hurricane Harvey: Preliminary Estimates of Commercial and Public Sector Damages on the Houston Metropolitan Area). An additional $15 billion in economic losses were estimated from port closures in Houston, Galveston and Freeport alone. According to Texas A&M AgriLife Extension Service, there were approximately $200 million in agricultural losses from Harvey: $93 million from livestock (Figure 10), $100 million from cotton and $8 million from rice and soybeans. FEMA director Brock Long called Harvey the worst disaster in Texas history.

Figure 10: Rangers working tirelessly to evacuate cattle out of flood waters. Photo provided by Rod Aydelotte, Waco Tribune Herald.

Importance of Rainfall Reports

Before Harvey made landfall, many reports compared Harvey to past extreme rainfall producing tropical cyclones such as Allison and Claudette, but why is that? The

comparisons were used to convey the magnitude and severity of Harvey's potential. These comparisons would not have been possible if scientists and reporters had not collected rainfall reports and impacts from previous storms.

Not only were these comparisons useful, but the daily rainfall reports prove even more critical to the NWS forecast and warning process. First, rainfall reports were used to validate weather model output and the NWS rainfall forecasts. Second, the rainfall reports were incorporated into the river forecasts and flood warnings to alert communities of imminent and occurring flooding. Lastly, rainfall reports have been gathered to analyze the magnitude and severity of Harvey as a whole. All of these uses are vital to the NWS mission of saving lives and property.

Rainfall reports can come from both automated and manual gauge readings. Both are needed to achieve the NWS mission; however, Harvey can be used to show just how important manual reports truly are. During the post storm analysis of Harvey, a report of 51.88 inches was recording at Cedar Bayou, making it the highest rainfall report in the Houston/Galveston area. After some detailed analysis, it was determined the gauge flooded during the event and the report was no longer valid. This is just one limitation of the automated rain gauge. Other limitations include gauge malfunctions and limits to rainfall rate capacity. All of these caveats prove just how important manual reports are to data collection.

A true testament to manual rainfall observations can be heard through the stories of CoCoRaHS observers during Harvey. One CoCoRaHS observer, Bill Read, shares his story below.

"I am located in Westover Park, a subdivision on the far west side of League City, Galveston County, Texas. The incredible rain rates and totals sent the stream our neighborhood drains into (Clear Creek) into record flood shortly after 1 am on the 27th. The level was so high that our drainage ditch could no longer discharge the runoff and was backing up. Water levels rode to the slabs in much of Westover Park. I recorded 45.34" for a storm total due to Harvey. I had to empty the gage twice during the extreme rainfall event the night of the 26th/27th. While emptying the gage I obviously missed recording rain that fell during the short time interval I was measuring, so the actual rainfall was a little higher than reported.

Harvey was by far the most extreme rain event I have witnessed. During my 40 year NWS career I worked four events that produced locally more than 40" of rain...Each one was catastrophic for the areas impacted and set record flood levels on area streams, but none matched Harvey for destruction and area impacted."

Harvey demonstrates just how critical it is to collect data both during and after a storm. Now, more than ever, we need to grow our CoCoRaHS program to promote adequate, reliable reports for forecasting, warning, and post storm analysis. The NWS and the community rely on the CoCoRaHS network and its dedication to collecting real-time rainfall reports.

Conclusion

As evidenced by the prolific rainfall and flooding, Harvey was an unprecedented event that wreaked havoc across southeast Texas. However, with the help of precise rainfall reports, we are able to provide more

accurate, timely forecasts and warnings, as well as analyze Harvey's impacts to help us become more prepared for the next storm.

Dan Reilly, the Warning Coordination Meteorologist for NWS Houston/Galveston would like to issue the following thank you to the brave and vigilant CoCoRaHS observers:

"We appreciate our CoCoRaHS observers who tirelessly took observations during Harvey. The rainfall with Harvey was so intense, especially Saturday night when many observers had to empty their gauges in the middle of the night during driving rains as they would otherwise have overflowed! These observations were critical for documenting this historic event and for modelling river and bayou flooding during the event. We can't thank you enough."

Nikki Hathaway, Katie Magee, Katie Landry-Guyton - NWS Houston/Galveston

CoCoRaHS Reporting Tips and Training

In this edition we are dedicating many pages to training material for our observers. We consulted our Texas QC team lead H. L. Lovell for some tips and advice for our observers to follow in their daily observations. We listed below some of the most common errors our QC team sees monthly. The purpose of these tips and in depth training pages is to educate the observer on the proper observing techniques and proper reporting types for the kinds of weather they observe daily. One of the most important things an observer can do once he or she signs up is to purchase official 4-inch diameter rain gauge recommended by CoCoRaHS. By all observers using this gauge we have a scientific benchmark of recording equipment that makes precipitation comparable across the country. Please do not enter precipitation amounts from any automatic recoding instruments into the CoCoRaHS database.

Observing Tips & Training Reminders

- Profile page: Keep all personal information you have in the CoCoRaHS system up to date. This includes your physical address, e-mail address, contact phone numbers, observation times, and any other information that may have changed in the last month. You can send an e-mail with updated contact information to the following address at texas.cocorahs@austin.rr.com.
- Multi-Day Reports: The number one error our QC team sees that observers make in their observations is entering an amount that fell over more than 24 hours. As an example, a gauge reads 0.65" of water, but the last daily report was two days ago. In this instance, a multi-day report should be entered for the time period since the last daily report was entered. In depth training material is listed in this edition which covers how to do this very important report so that your data is complete and that a multi-day amount is not reported on a daily report.
- Decimals Matter: Placing the decimal in the wrong place on a rainfall amount is the next biggest error our QC team sees. Please make sure before you hit submit on your reports to check that the amount you typed into the precipitation box matches the reading you took off of your gauge. An example is you physically read 0.57" of rain. Make sure that you did not enter 5.70" or 57.00" of rain. Yes we have seen very high rainfall totals doing QC of data. In depth training material in this edition shows how an observer can check their report entered on a map or on a county listing of stations. By checking these data sets an observer can see how their precipitation amount compares to nearby CoCoRaHS stations in their county. When using the CoCoRaHS App on your cell phone be extra careful of the values you enter. Try to check on-line the value you just entered to verify it is correct.
- Zeros Count: Please report even if you did not receive any precipitation. An entry of 0.00" is just as valuable as a report of a day with rainfall. This data is used in many ways to produce an accurate picture in mapping of total monthly rainfall across your county. These zero reports data is used to produce the Drought Monitor maps across the US each week. CoCoRaHS observer reports are the largest source of data for these maps.

CoCoRaHS Reporting Tips and Training

- Daily Gauge Checks: It is so important to check your gauge every day, as mentioned above about the importance of reporting zero rainfall. It is not uncommon to find a collection of water in your gauge on clear nights from the formation of dew on the gauge and then draining inside the inner funnel and giving the appearance of rainfall. Please do not report condensation from dew, frost, or fog as precipitation. Please make a note in the "Observation Notes" section of your Daily Precipitation Report Form that you received water from dew, frost, or fog in your gauge but don't enter a number value in the precipitation box and leave as 0.00".
- Advanced CoCoRaHS Observer Techniques: Being a good precipitation observer requires staying up to date about the weather you are having now, the conditions over the past 24 hours, and what may happen during the next 24 hours. By watching the sky daily and at night as well you will know that the water in your gauge was condensation from dew and not rainfall since you saw clear skies for over the last 24 hours. This keeps you ready for anything to measure including flooding rains that might top your gauge (be ready to make extra observations to empty that gauge before it overflows during a flood overnight), snowfall – be ready to remove the funnels so your gauge is ready to measure snowfall, thunderstorms that might produce hail, and other types of conditions and severe weather that might affect your area.
- Standard Reporting Time: Try to make and submit your observation as close to the standard observing time of 7am as possible, but try not to be later than 9am. This is important for the continuity of mapping precipitation amounts.
- Less than 24 hour Reporting Problem: One pattern of errors noted by our QC team is the reporting of rainfall in the afternoon of the day that is after the 7am report. Sometimes observers get excited about a big gully washer from an afternoon thunderstorm that produces a large amount of rainfall. Please do not submit this amount as a Daily Report until the next daily reporting time, which is typically 7am. If a serious rain event occurs between reporting times, please submit a **Significant Weather Report**. This report goes straight to the local National Weather Service office so forecasters can see the 4.25" of rainfall you just had the last hour in your back yard. This report is a real time report and does not replace the daily report. The next morning at 7am please submit your daily report including the 4.25" from yesterday afternoon and any other rainfall that occurred up to 7am that following morning.
- Additional Information about Daily Reports: Make sure your daily report of rainfall or zero rainfall is for the previous 24 hours. Do not try to go back and guess which day it rained on or didn't rain on. The QC team has seen some large amounts of rainfall being reported on a 24 hour day time frame that did not have a cloud in the sky. Also zero reports of rainfall have been reported on days that had flooding rains throughout a county. The best rule of thumb is to follow proper reporting guidelines discussed in this document and this will not happen.
- Basic Observation Technique: Please remember to read your gage correctly - an example would be to always remember to read the bottom of the meniscus in the inner tube when making an observation of rainfall. Additional training material can be found in previous editions of the newsletter and on-line at cocorahs.org.
- Questions: If you have questions about how to make a report or something in the training material isn't easily understandable then please send an e-mail to texas.cocorahs@austin.rr.com. Your e-mail will be answered in a timely fashion to get you up to speed on being a great CoCoRaHS observer.

Sleet and Snow Reporting Procedures

My Data Entry : Daily Precipitation Report Form

Reporting Snow and Sleet

Precipitation Report Form Submit Data Reset

Station Number : IL-CP-1

Station Name : Homer 2.0 N

* Denotes Required Field

12/1/2015 *Observation Date

7:00 AM *Observation Time

0.23 in. *Rain and Melted Snow to th... gauge during the past 24 hours, or T for trace, or NA for unknown.

vation Notes: (This will be available to the public)

Very little wind - good gauge catch.

Melt the frozen precip in the gauge and report it here. If you cannot melt or do not have a measurement, change to NA. Do not leave it as zero.

The depth of snow and/or sleet measured on your snow board or flat, level surface is entered here.

Comments are always helpful.

New Snowfall

2.6 in. Accumulation of new snow in inches to the nearest tenth

0.25 in. Melted value from core to the nearest hundredth

Total Snow and Ice on Ground at Observation Time

2.5 in. Depth of total snow and ice (new and old) in inches to the nearest half inch

NA in. Melted value from core to the nearest hundredth

This is the water measured from a core of snow taken from your snow board. If you do not take a separate core leave this NA. Do not copy your precip into this field.

This the depth of snow and ice on the ground each day, whether or not any snow has fallen.

This is for the SWE of total on the ground, old plus new snow and ice.

uration Information

a time is unknown or the storm has not ended leav...

Precipitation Began

Precipitation Ended ○AM ○PM

Heaviest Precipitation Began ○AM ○PM

Heaviest Precipitation Lasted minutes

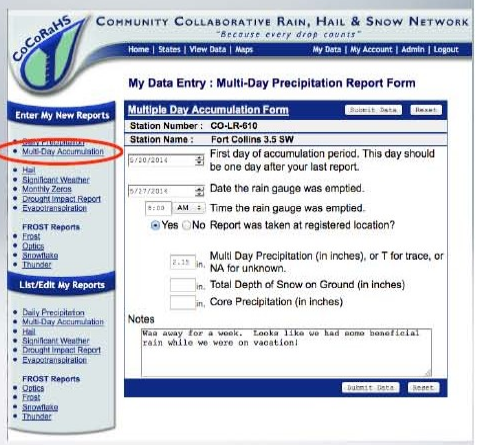
These times are: Select Time Accuracy

Multi-Day Precipitation Form

If you are away on vacation or out of town this is the form for you.

Just put in the dates that you were gone and record what you found in the gauge.

There is no need to file an additional daily report.



Is Your Rainfall Report for One Day, or is it for Multiple Days?

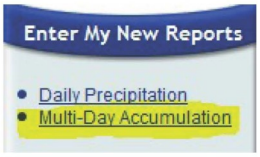
It is important not only to read your rain gauge correctly, but to report correctly as well. If you have an amount that has accumulated in the gauge over a period of two or more days (like over a weekend), you must report this using the Multi-Day Accumulation report, NOT the Daily report.

For many observers reporting precipitation for multiple days is an infrequent occurrence, and we forget that these amounts are entered differently than the daily report. The Daily Report form (the one that appears after you log in) is ONLY for an amount collected for a one-day period. If you are reporting an amount collected for a period of two or more days, then use the Multi-Day Precipitation form on the web site. This form is for reporting an accumulation of precipitation over two or more days where you did not take daily observations. In other words, for any given date, you should report precipitation using either the Daily Precipitation Report or the Multi-Day Precipitation Report form.

Here are two examples which will clarify how to report precipitation for multiple days.

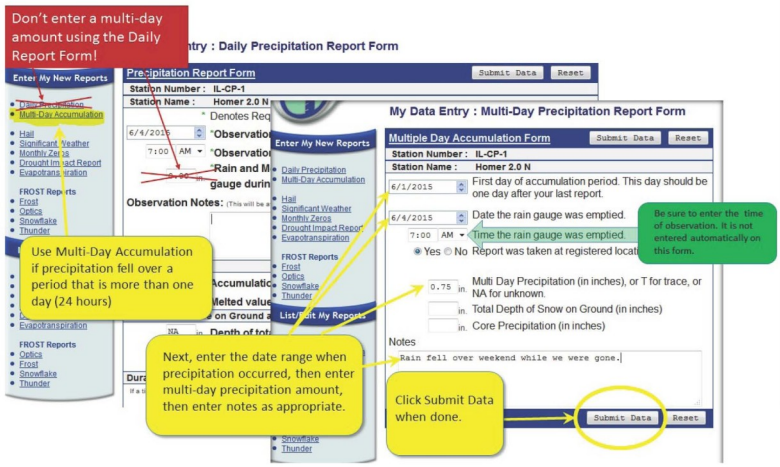
Example 1

After your observation on May 31, you head out for a long weekend. You return late on June 3. On the morning of June 4 you check your rain gauge and find 0.75 inches of rain in the tube. How do you report this?



Log on to the CoCoRaHS web site as usual. IGNORE the Daily Report screen that pops up. Instead select Multi-Day Accumulation in the menu

On the form, enter the first day of accumulation. In this case it is 6/1, the day after your last report (May 31). You emptied the rain gauge on 6/4. Enter the time you emptied the rain gauge, then enter the amount that you measured in the field labeled "Multi Day Precipitation (in inches)". In this case, you would enter 0.75. Click on Submit Data and you are done.



Example 2

One weekend you take your daily observations but for a variety of reasons are not able to get access to the computer to enter your observations into the CoCoRaHS web site. You have the following observations:

6/1 0.01"
6/2 0.00"
6/3 0.50"
6/4 0.25"

You are able to enter your data on June 4. How do you report this?

DO NOT use the Multi-Day Precipitation form. That is only used for entering one measurement that represents an accumulation over a period of two or more days, not for multiple daily reports.

DO use the Daily Precipitation report form. When the form appears on the screen, change the date to 6/1, enter the observation, and click the Submit Data button. Then, click on Daily Precipitation under Enter My New Reports, change the date to 6/2 and enter that observation and click the Submit Data button. Repeat for the last two observations.

CoCoRaHS Reporting Tips

Understanding the Difference between Precipitation and Condensation

Question: ***Which one does CoCoRaHS measure and what is the difference?***

Answer:
Dew, fog, fog mist, and frost are a process of condensation of water vapor changing from a vapor phase to a liquid phase which is deposited on surfaces such as a rain gauge.

Precipitation is a process of a liquid or solid phase aqueous particles that originate in the atmosphere such as a cloud and fall to the earth's surface as rain, hail, sleet, and snow. CoCoRaHS measures rain, hail, sleet, and snow.

Note: CoCoRaHS also does measure evapotranspiration which requires a separate gauge to measure. This can be viewed as the opposite of condensation in a way but also takes rainfall into the gauge measuring process.

Hopefully this brief the description will help observer's understanding of how to correctly take their measurements. If you do observe condensation in your gauge please don't enter the amount in the precipitation box. Instead mention the amount you observed in the daily comments as being dew, fog deposit, or frost. Enter zero for your observation on that day. Make sure you empty this amount so it doesn't get recorded as extra rainfall if it happens to rain before the next day's observation. Usually condensation amounts will be 0.03" or lower in your gauge.

Reporting "Traces" of Precipitation

By Steve Smart, Observation Program Leader
National Weather Service- WFO Austin/San Antonio

What's more than nothing, but less than a measurable amount? That depends on what we're talking about. If a cooking recipe calls for a dab of butter, or a dollop of whip cream how much is that exactly? If we're talking about a trace amount in a CoCoRaHS rain gauge, that's something else.

How much is a trace amount of liquid in your official, four-inch, plastic CoCoRaHS rain gauge? To answer we first must ask, "what is the smallest measurable amount of liquid in your gauge that can be observed?" If you answered 0.01 (one hundredth) of an inch, you are correct! Therefore, if the amount is not zero, but you cannot determine there's sufficient liquid in the rain gauge to be one hundredth of an inch, then the proper amount to record and report is a trace. Done. You've completed your duty and now you're on to something else.

Hold on, don't go anywhere just yet. We're talking about weather and we're talking about rain gauges and precipitation when it comes to measuring and reporting amounts of liquid found in those gauges. There are some key words here to examine: weather, rain, precipitation, measuring, reporting and liquid.

Weather is the state of the atmosphere at any given time and rain, a type of precipitation, may be falling. Precipitation may be in liquid or frozen form, such as drizzle or heavy snow. Measuring and reporting amounts from your gauge is always done using a liquid total, regardless of the precipitation type (liquid or frozen). Note: Please see the CoCoRaHS Training Slide Show for Measuring Snow, entitled: "In Depth, Snow Measuring."

The mantra for CoCoRaHS is "Because Every Drop Counts." Let's look at that for a moment. Drop, in this case, implies a small or tiny, yet individual volume of unfrozen liquid that falls from a cloud. Herein lies a great clue to solving the mystery of the trace.

You see, in order to be classified as precipitation, liquid drops or frozen crystals must "fall" from a cloud structure and they must reach the surface. Here's where it can get interesting, or confusing when it comes to reporting a trace of precipitation.

For example. It's 3 p.m. one hot summer afternoon and a passing shower only produces a few drops that reach your gauge. What do you report the next morning even though it appears there is absolutely nothing in your gauge? A zero? No, that's incorrect. You would report a trace because something fell from a cloud, even if it was a few drops and your gauge appears to be bone dry.

Another example. It has been clear and cool for a few days, then one morning you awake to find it's foggy outside and there's moisture in your gauge. What do you report? A trace? Maybe it's a trace amount, but maybe it really should be zero. In a case like this, there are some key things to consider before you submit your report. Was there any fog the day before?

Can you rule out the measurement of at least one hundredth (0.01)? How confident are you that precipitation actually "fell" sometime in the past 24 hour period (especially overnight when you may have been sleeping)? Are other CoCoRaHS stations near you, in your county, or area reporting trace amounts or more? Do weather reports confirm the existence of fog? It's your call, but sometimes the line between reporting a trace or zero can be razor thin. (Something to remember: It is important to the CoCoRaHS program and the National Weather Service to discern where precipitation did or did not occur, and sometimes it comes down to a trace amount.)

Unless you were able to observe the conditions at your station for the entire 24 hour period, then you will not know for sure if some precipitation occurred along with the formation of fog. Usually, light to heavy drizzle occurs with dense, persistent fog events. This is true if the visibility is reduced to less than one quarter mile. However, if it was truly fog or mist and no precipitation occurred, then this should sway your decision to submit 0.00 for your daily report (remarks of fog are definitely helpful and appreciated!).

Why all the fuss? Because fog or mist is a result of a condensation process and it is not a precipitation process. In other words, nothing "fell" or "dropped" into your gauge when fog or mist occurred. Very small water droplets formed from the water vapor in the air and were suspended in the atmosphere as a result of the condensation process (to create the fog). Your gauge too got some moisture in it from the same condensation process (much like removing a cold, canned beverage from the fridge and setting it on the coffee table…better have it on a coaster!).

There is a huge difference between condensation and precipitation! Sure, condensation can lead to precipitation, but that's not always the case. Dew (also condensation) or melted frost on your gauge may also trick you into reporting a trace amount of precipitation, but you won't be fooled now, will you?

So let's recap: A trace is more than zero (in a 24 hour period), but less than a discernable amount that would lead you to report one hundredth (0.01). A trace amount (liquid or frozen precipitation) must be from precipitation, not solely from condensation. It's a lot to digest! Yes, these may be morsels of wisdom and nuggests of truth, peppered with bits and pieces all just to talk about a trace of something in a rain gauge. Oh for cryin' out loud! Please just cut me a Texas-size, hunk of pumpkin pie and yes, I'll have a heapin' gob o' whip cream on top!

Reporting Significant Weather Events

CoCoRaHS Training for Correct Reporting of Heavy Rain and Flooding During Storms and Events – How to Submit **Significant Weather Reports of Heavy Rain**

Reason and Purpose: During flood events which include Hurricanes, Tropical Storms, Severe thunderstorms, and heavy rain from various weather systems observers need to know how to submit the proper reports of their observations and how often they should report and for how large of amounts of rainfall. This primer will educate the observer of correct procedures to follow on reading their gage and the best times to read their gage when very heavy and extreme rainfall is occurring. Many times in these type of events gages will overflow their capacity. Tips and guidelines to help observers read rain rainfall totals that exceed the capacity of the gage are discussed. By following these guidelines observers are adding value to their observations which are used by professionals in making critical decisions on flooding and potential impacts of the weather conditions which are being observed.

CoCoRaHS rain gage capacity: The rain collector is 4.25" wide and 14" tall graduated to the nearest inch with .01" intervals for the inner cylinder tube. The inner tube measures 1" of rain and then will overflow into the outer cylinder which will hold an additional 10". The total amount the gage can hold when completely full will be around 11.30" of rain – the 11.00" of the two cylinders plus about 0.30" of rain in the top collection funnel before overflowing. All rain must be read by measuring out in the inner funnel.

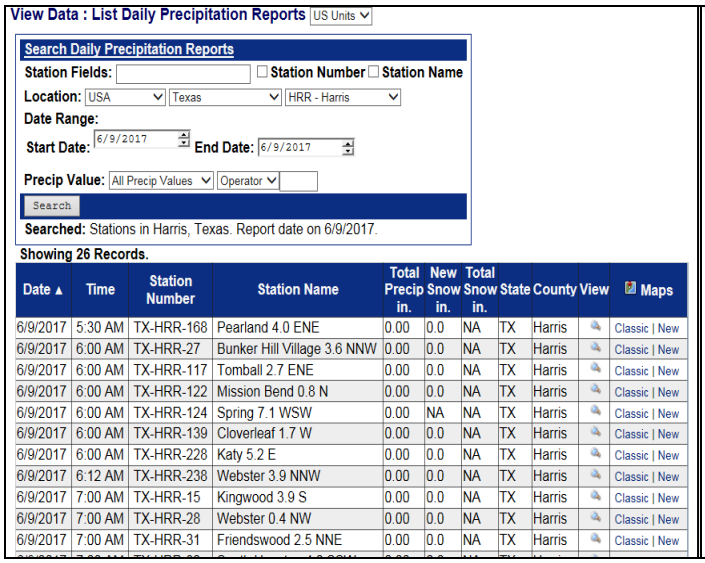
Thresholds for Significant Weather Reports (SWR) of very heavy rain events: Typical heavy rain events and storms will exceed the capacity of the CoCoRaHS gage during a 24 hour period before the observer's next observation. **A threshold for reading the rain gage when possible will be at the 6.00" level or just after the gage looks half full.** If the observer is at the location of the gage when this is occurring the observer should try to read and empty the gage at the first possible break in the heavy rain even if just for a few minutes. Make note of the time that this is done and then submit a SWR. Most observers may not be able to do this until later in day or evening. **All observers should read and empty their gages before turning in for the night during very heavy rainfall storms and events to allow for maximum collection of rain in the gage overnight while it may be impossible to read the gage at night**. Make note of all times of reading the gage and please keep a running total of the storm event and submit this each time a SWR is made. Also note that a SWR is not a replacement for a daily report. The two reports serve to different purposes. A daily report is a once a day for a 24 hour period total of rain from the last report made. A SWR report is for the time period entered for the report and how much rain has fallen in that time frame. The SWR is a real time update to forecasters as to the current state of rainfall and flooding at your location. Forecasters use this data on the fly in updating models and forecasting new rainfall effects on a region.

Verifying your rainfall data

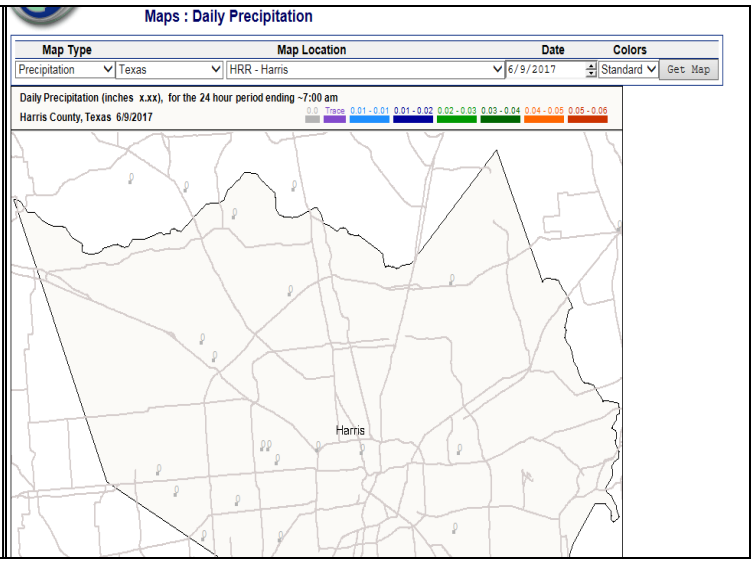
How to verify your observation was entered correctly on the website?

By Ron Havran, CoCoRaHS Houston/Galveston Regional Coordinator

There are two simple ways to verify each day that the measurement you made of your CoCoRaHS gage has been entered into the database on the website correctly. The first way is to go to search "Daily Precipitation Reports" and enter the county you are in and the days date for start date and end date. Hit the search box and wait a few seconds for all observations in that county to fill in the page. Locate your stations number and then find the view icon and click on that to view the report you just made. This is quick check to verify that you didn't mistype the rainfall amount or enter an incorrect total for the day's precipitation amount. Also take a look at all rainfall amounts entered for a county on that morning. If something seems odd about the amount you entered compared to all the other stations in the county then check some of these observations from these stations for any comments about rainfall or storm information. Compare this information to your observation and weather you have observed in the last 24 hours. The second way to verify your information entered for your observation is correct and to see how it compares to other stations is to click on "Maps" and go to "Precipitation Maps". From here you can go to "Classic" or "New" map selection. Enter your county name and the date then hit the "Get Map" box. A map of your county will appear with all observations made that morning. Check to see how your amount entered compares to the closet stations in your county. These two methods will help you in making sure your data entered into the database is error free and will be a valuable asset to users of CoCoRaHS data.



Date ▲	Time	Station Number	Station Name	Total Precip in.	New Snow in.	Total Snow in.	State	County	View	Maps
6/9/2017	5:30 AM	TX-HRR-168	Pearland 4.0 ENE	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	6:00 AM	TX-HRR-27	Bunker Hill Village 3.6 NNW	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	6:00 AM	TX-HRR-117	Tomball 2.7 ENE	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	6:00 AM	TX-HRR-122	Mission Bend 0.8 N	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	6:00 AM	TX-HRR-124	Spring 7.1 WSW	0.00	NA	NA	TX	Harris		Classic | New
6/9/2017	6:00 AM	TX-HRR-139	Cloverleaf 1.7 W	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	6:00 AM	TX-HRR-228	Katy 5.2 E	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	6:12 AM	TX-HRR-238	Webster 3.9 NNW	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	7:00 AM	TX-HRR-15	Kingwood 3.9 S	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	7:00 AM	TX-HRR-28	Webster 0.4 NW	0.00	0.0	NA	TX	Harris		Classic | New
6/9/2017	7:00 AM	TX-HRR-31	Friendswood 2.5 NNE	0.00	0.0	NA	TX	Harris		Classic | New



Daily zeros are just as important as a daily rainfall amount!

Please remember to report days with no rainfall as a complete precipitation record of your station is critical data for many different users and researchers of CoCoRaHS data. The National Drought Mitigation Center uses CoCoRaHS daily zeros data as top source of data in the United States in making Drought Monitor Maps across the country. So each day that you report that your station had zero rainfall that data is being used every week in the making of a new drought monitor map for the United States. So please keep up the good job of reporting daily zeros for this valuable database to have accurate data across the country.

CoCoRaHS Webinar Series

In December 2011 CoCoRaHS kicked off a new and exciting monthly Webinar series called **CoCoRaHS WxTalk** (wx is shorthand for weather). CoCoRaHS WxTalk consists of a series of monthly one-hour interactive Webinars featuring engaging experts in the fields of atmospheric science, climatology and other pertinent disciplines. These easy to follow presentations are live and approximately sixty minutes long. The audience is given the chance to submit questions which the experts answer live on the air.

Topics have included: Snow, Satellites, Hurricanes, Lightning, Clouds, Tornadoes, Flash Floods, Fire Weather, Weather History, Radar and How to become a Meteorologist, just to name a few.

There are many exciting Webinars on the agenda in the months ahead, so please tell your friends to join us. All WxTalk Webinars are free and most are recorded for later viewing.

**Although headphones are a good way of listening to the Webinars, only a set of speakers is required to hear the Webinar. The audience will be muted so there is no need for a microphone. All incoming correspondence during the Webinar should be in typed form.*

Upcoming WxTalk Webinars:

Thursday, January 25, 2018 - 1:00PM EDT

Storm Surge, Run From the Water, Hide from the Wind

Jamie Rhome
Storm Surge Specialist, Team Lead
National Hurricane Center
Miami, Florida

"Jamie Rhome is the Team-Lead of the National Hurricane Center Storm Surge Unit in Miami, Florida, a group that specializes in predicting storm surge inundation heights accompanying land-falling tropical cyclones using the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) computer model. The SLOSH model aids the unit in forecasting potential inundation values, posting watches and warnings of possible and expected life threatening surges, conducting post-storm model verification along, and creating the basis for Hurricane Evacuation Studies (HES) conducted by the Federal Emergency Management Agency (FEMA).

Jamie will discuss how hurricane storm surge threatens coastal communities in the United States and abroad, as well as how the NHC Storm Surge Unit forecasts surges from hurricanes using the SLOSH model. Along with real-time products and surge forecasting discussions, he will present the various risk analysis products available to emergency managers and the public before a storm even forms, and talk about what work has been done to assess and mitigate individual communities' flood risk from storm surges.

Texas CoCoRaHS Observer
The official newsletter of Texas CoCoRaHS

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