



# TEXAS CoCoRaHS OBSERVER

## Autumn 2021

Vol. 7 - 3



### Welcome to

### The

### Texas CoCoRaHS

### Observer Newsletter

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

### Inside this issue

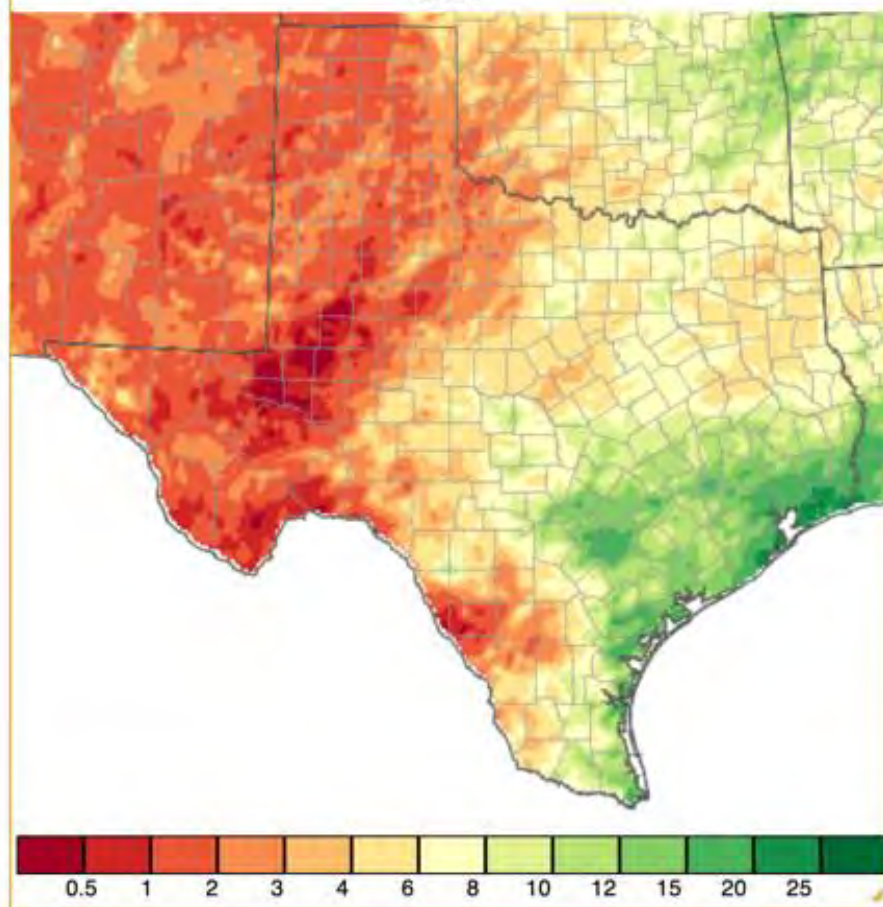
<i>Far West Texas</i>	<b>3</b>
<i>Weather Summary</i>	
<i>Austin/San Antonio</i>	<b>5</b>
<i>Weather Summary</i>	
<i>North Texas Regional</i>	<b>8</b>
<i>Summary</i>	
<i>Southeast Texas</i>	<b>15</b>
<i>Regional Summary</i>	
<i>West Central Texas</i>	<b>23</b>
<i>Regional Summary</i>	
<i>Brazos Valley</i>	<b>26</b>
<i>Regional Summary</i>	
<i>Corpus Christi</i>	<b>27</b>
<i>Regional Summary</i>	
<i>West TX/SE New Mex.</i>	<b>30</b>
<i>Regional Summary</i>	
<i>Rio Grande Valley</i>	<b>32</b>
<i>Regional Summary</i>	
<i>Wichita Falls</i>	<b>40</b>
<i>Regional Summary</i>	
<i>East Texas</i>	<b>42</b>
<i>Regional Summary</i>	
<i>Winter Weather</i>	<b>44</b>
<i>Outlook/Forecast</i>	
<i>Precipitation vs.</i>	<b>46</b>
<i>Condensation</i>	
<i>Reporting Snowfall</i>	<b>47</b>
<i>Correctly</i>	
<i>Measuring Snowfall</i>	<b>48</b>
<i>Process Steps</i>	
<i>Scheduled CoCoRaHS</i>	<b>49</b>
<i>Webinars</i>	

## Texas Autumn Weather Summary

*John Nielsen-Gammon, Texas State Climatologist*

Figure from the PRISM group, Oregon State University, generated using SC-ACIS

### Total Precipitation - September 1, 2021 through November 30, 2021



Late summer in Texas is a race. Will temperatures cool off before the rain tapers off? If they do, then we get plenty of rain that stays in the soil all winter. This would make cool-season forage grasses and winter wheat very happy, if only cool-season forage grasses and winter wheat had emotions.

Continued on page 2→

***“Because Every Drop Counts, As Do All Zeros”***

## Texas Autumn Weather Summary (continued)

This year, the rain won the race. Across much of the state, it pretty much ended in August. Various parts of western and southern Texas received less than half an inch over the entire three-month period. Most of that rain fell in September and early October, allowing stations such as Midland to have sixty consecutive days (and counting) without measurable precipitation. The Permian Basin, it seems, has more oil than water.

Speaking of energy, I've seen a lot of chatter about the upcoming winter and whether the power grid will be able to make it through the winter without a major blackout or even a near-catastrophe like we had last February. I don't have any intelligent comments to contribute about the power generation or reliability measures that have been put into place over the past several months. I can, however, say something intelligent-sounding about the upcoming winter season. And it may not be what you think.

The standard story is this: there is a La Niña, and La Niña means warmer than normal temperatures for Texas, so we should be able to make it through the season unscathed.

Let's take these one at a time.

First, there is indeed a La Niña. The average value of the standard index for El Niño during the past three months was -0.8, meaning the central tropical Pacific was running about 0.8 °C below normal. If it stays below -0.8 for another couple of months, it will be an official La Niña event. And the odds favor that: indeed, the official outlook from the Climate Prediction Center says that the index value will probably be below -1.0 for the winter.

In standard terminology, a La Niña that bottoms out below -1.0 would be a moderate La Niña; one that stays milder would be a weak La Niña. There's also the strong La Niña category; the last time we saw that was in 2011.

Typically, La Niña winters are mild winters for Texas. The jet stream stays farther north than usual, storms tend to miss us, and the cold air stays bottled up in the Arctic. The whole of the southern United States tends to be warmer than normal, while the northern United States and Canada tends to be cooler than normal.

So far, so good. But there's a catch. All that cold air sitting up north is just waiting for an opportunity to plunge southward and enter Texas. Last winter was a moderate La Niña winter too, and y'all know how that turned out.

But maybe that was just a fluke. To check, I estimated the coldest temperatures of the winter across Texas for every year since 1950. With global warming, recent winters have been much milder on average than past winters, so I've broken them up into two chunks. In the first chunk, 1951-2000, out of the seven winters when temperatures got the coldest, three were La Niña winters and four were neutral. Since 2001, five of the seven coldest were La Niña winters. Looked at another way, there's a one in three chance of extreme cold during a La Niña winter and only a one in eight chance of extreme cold during any other winter.

If you're feeling optimistic, you'd note that we'll still probably make it through the season unscathed. A one in three chance of extreme cold, after all, means a two in three chance of no extreme cold. If you're feeling pessimistic, you'd say that we'll probably have unusually dry weather, a power outage, or both. Finally, if you're feeling conscientious, keep making those rainfall measurements!

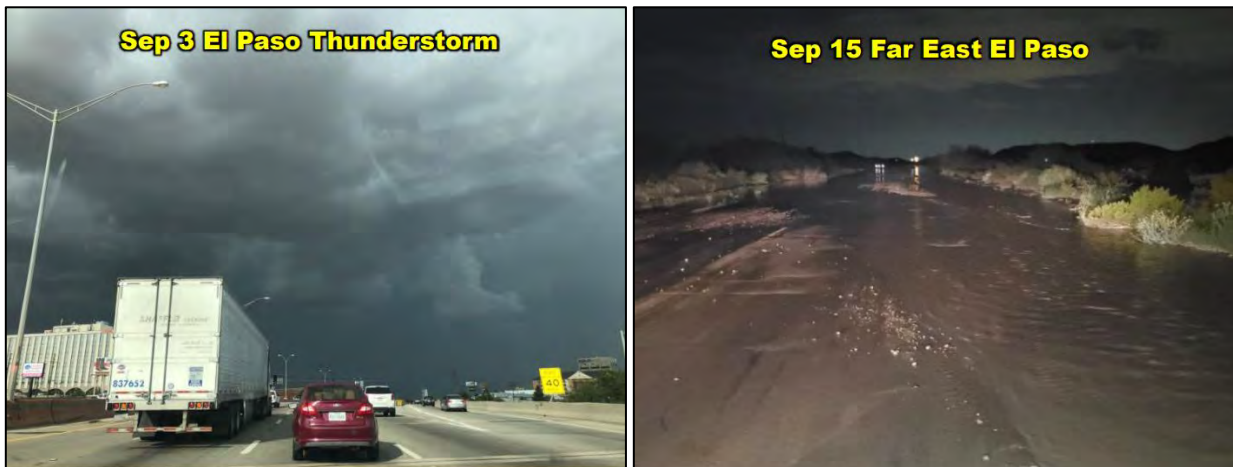
## Far West Texas Regional Summary

### 53 Consecutive Days of 0.00" Marks Dry Fall Season in El Paso

By: Connor Dennhardt, Meteorologist - National Weather Service El Paso

Drier weather was welcomed to far west Texas the past few months, following a very active summer monsoon and the improvement of drought conditions. The return of La Nina in the Northern Hemisphere mirrored historical patterns by keeping the U.S. Southwest drier than normal. Strong high pressure systems aloft and persistent polar jet flow well to our north caused a lengthened period of dry weather and above normal temperatures. Many cold fronts that arrived helped bring temperatures down to near normal, but failed to maintain cool temperatures for longer than a few days.

The fall season is typically a drier period for southern New Mexico and far west Texas as monsoonal moisture becomes more limited and synoptic lows to our north favor westerly surface flow. The fall season may also bring a secondary severe weather season with more favorable wind shear, something that did not occur in 2021. In Texas, El Paso and Hudspeth counties typically report 2"-3" of liquid precipitation during the September-November timeframe with the climatological average at El Paso International Airport (KELP) being **2.54"**. This makes up only 29% of the average annual rainfall. The majority of precipitation in this region falls during the summer monsoon, where autumn is typically a transition period where moisture exits and cooler continental air arrives from the north.



**Figure 1: Thunderstorms and rainfall in El Paso County, Texas during September 2021. A few roadways were flooded in the middle of the month.**

September brought a couple of light rain events to El Paso County, in particular the first and last weeks of the month. Many CoCoRaHS observers reported monthly totals of **1.00"- 1.50"**. October was particularly dry, beginning a period of 53 consecutive days with no measureable CoCoRaHS reports in El Paso and Hudspeth Counties. This dry spell didn't end until the week of Thanksgiving, when a light rain event brought **0.25"- 0.50"** in measureable precipitation to the region.



## Far West Texas Regional Summary (continued)

Season rain totals of **2.00"** - **3.00"** were fairly near normal for this time of year. Precipitation events fell in batches, with long periods of dry weather in between. The most memorable event of this year's fall season occurred early in the month of September as the remnants of Tropical Cyclone Nora funneled moisture northward into the region. No snow fell across the area this year, a change from the rare October snow event in 2020. Drought conditions worsened slightly following a very wet summer, with the U.S. Drought Monitor upgrading most of the area to Abnormally Dry status.



**Figure 2: CoCoRaHS Monthly Precipitation Summaries for the 2021 fall season for El Paso County, Texas.**

The fall season featured 34 active observers in El Paso County, and 2 in Hudspeth County. A total of 1,688 daily reports were submitted, along with 31 multiple-day reports. Only 277 daily reports had measureable precipitation, which means 84% of total reports were 0.00". No Significant Weather or Condition Monitoring reports were submitted this season. Thanks again to all our local observers who participated in the 2021 autumn season!

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*CoCoRaHS Texas would like to remind everyone that a 4 inch diameter rain gauge makes a great Christmas present for that special someone on your list this Christmas.*



## Austin/San Antonio Regional Summary

### Another Warm Fall with Wet Conditions East and Drier West

By Keith White, with contributions from Aaron Treadway – WFO Austin/San Antonio

September was a warm, dry month for the most part, with well above normal daytime highs for the majority of the first three weeks of the month. San Antonio saw it's only three 100 degree days this year come in September, while Austin Camp Mabry reached the century mark 7 of its 12 times for 2021 in September. Del Rio reached 100 on fully half (15) of the days in September.

Aside from some scattered showers and storms on the 6<sup>th</sup>, mainly north of the I-10 and US-90 corridor, and another round west of US-281 on the 18<sup>th</sup>, only light, isolated rainfall impacted the region prior to September 28<sup>th</sup>. The event on the 6<sup>th</sup> did produce some locally heavy rainfall prompting a Flash Flood Warning for portions of Blanco County, and several Flood Advisories were also issued across portions of the Hill Country and I-35 corridor.

Towards the end of the month, showers and thunderstorms brought widespread heavy rain to mainly the eastern half of the region Tuesday night into Wednesday the 28<sup>th</sup>-29<sup>th</sup>. As much as 6.47" of rain was reported in north-central Comal County, but amounts in excess of 2+ inches fell across a significant portion of the area with 19 of our 33 counties having at least one report >2". Four Flash Flood Warnings were issued during this event.

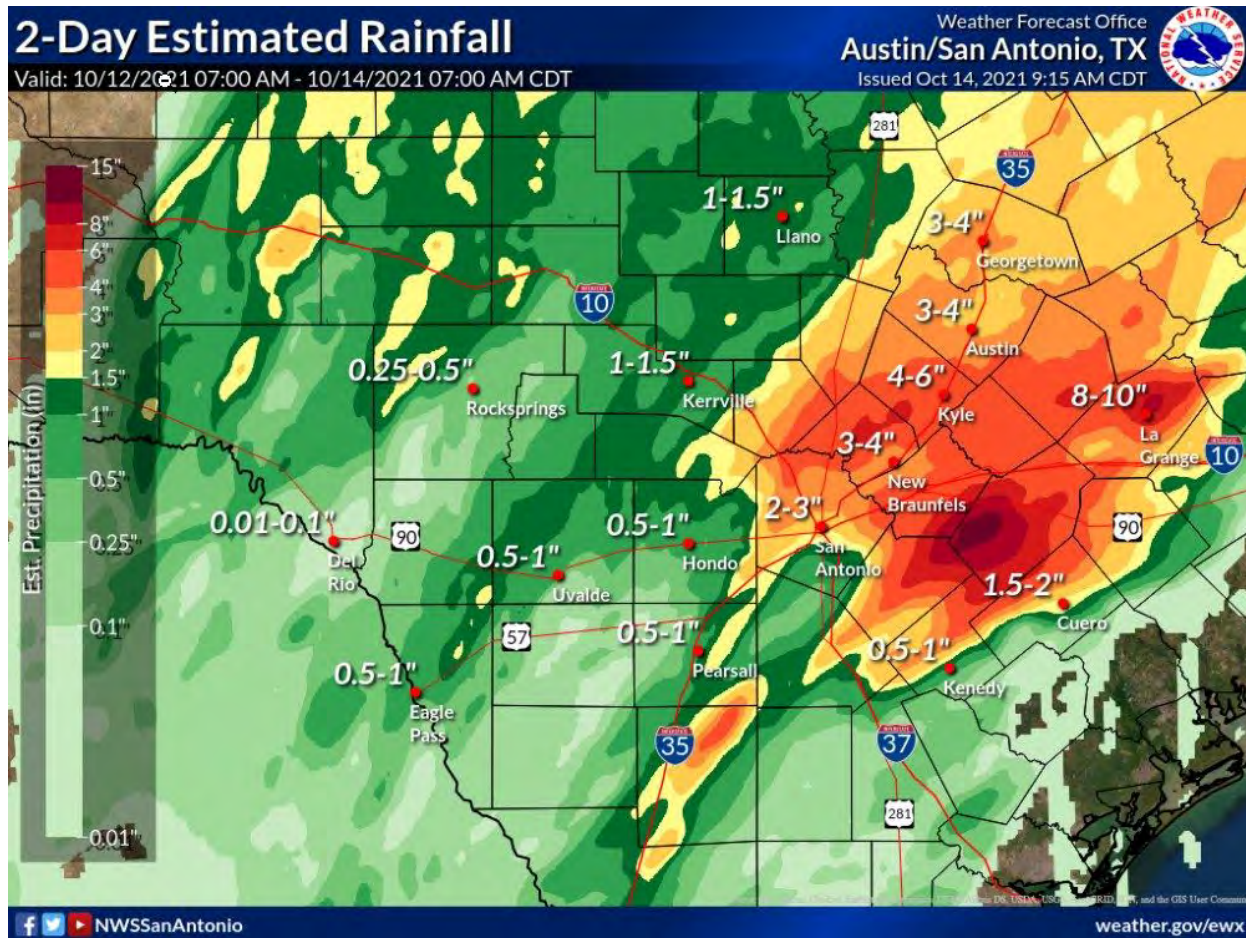
October continued the warm trend South Central Texas has been seeing this fall, but with the arrival of a trio of cold fronts the month was very wet across the area. Austin, San Antonio, and Del Rio continued to experience highs in the low 90s for the first third of the month, a good 5 to 7 degrees above average. Del Rio hit 99 degrees on October 10th, which was the site's 10th warmest October temperature ever. The three I-35 climate sites finished with above average precipitation, while Del Rio was a tenth of an inch below their October average.

The month began with pockets of heavy rainfall thanks to a boundary and lift associated with a large upper low across the Western U.S on the first of the month. While the Hill Country, Edwards Plateau, and Rio Grande Plains saw widespread 1.5" to 3" of rainfall, a few pockets in SE Travis County, Wilson County, and west of Uvalde saw upwards of 4" prompting 10 Flood Advisories to be issued across these areas.

Significant Flash Flooding and River Flooding took place as a result of heavy rainfall during the morning hours of October 14th. A slow moving boundary combined with Gulf and Pacific moisture from Hurricane Pamela resulted in strong thunderstorms that produced multiple pockets of 5"- 10" rainfall accumulations (Figure 1). The first was widespread 5" to 8" totals across much of Comal County below Canyon Dam and across Hays County between Wimberley and San Marcos. This heavy rain led to rises to moderate flood stage along the Guadalupe River through New Braunfels and moderate to major flood along the San Marcos River from San Marcos to Luling. This water moved downstream and combined with 8" to 10" of rain that fell across Gonzales County to continue the moderate flooding along the Guadalupe from Gonzales to Cuero. One note is that Sandies Creek at Westhoff crested in major flood stage at its 3rd highest crest ever, above its crest during Hurricane Harvey, and just below the crest of the 1998 flood.



Ten Flash Flood Warnings were issued in addition to the numerous River Flood Warnings, and in all, more than three dozen CoCoRaHS observers reported rainfall amounts in excess of 5" during this event. Real-time rainfall reports from the Significant Event Reporting page contributed to higher confidence in radar estimated rainfall amounts and assisted forecasters while issuing flood products.



**Figure 1: Estimated rainfall accumulations from the October 14th, 2021 flooding event.**

The last rain event for October was due to a Pacific front that moved through on the morning of October 27th. The fast moving line of storms produced damaging winds and a quick 0.5" - 1" of rainfall across much of the area. A week or so later, the final notable rain event of the fall arrived along with an arctic cold front on November 3rd. Isolated patches of 1-2+" of rain fell over our western counties, while larger areas of 1" - 2.5" amounts fell across the greater Austin Metro area as well as southeast of San Antonio. South-central Texas became more entrenched in a drier, warmer La Niña pattern after that, with only light, isolated rains until the last week of the month. A few days of scattered showers and a few thunderstorms returned from the 24th through the 27th, bringing at least 0.25" to all of south-central Texas except the areas that needed it most across Val Verde, Dimmit, and southern Maverick counties.

## Austin/San Antonio Summary (continued)

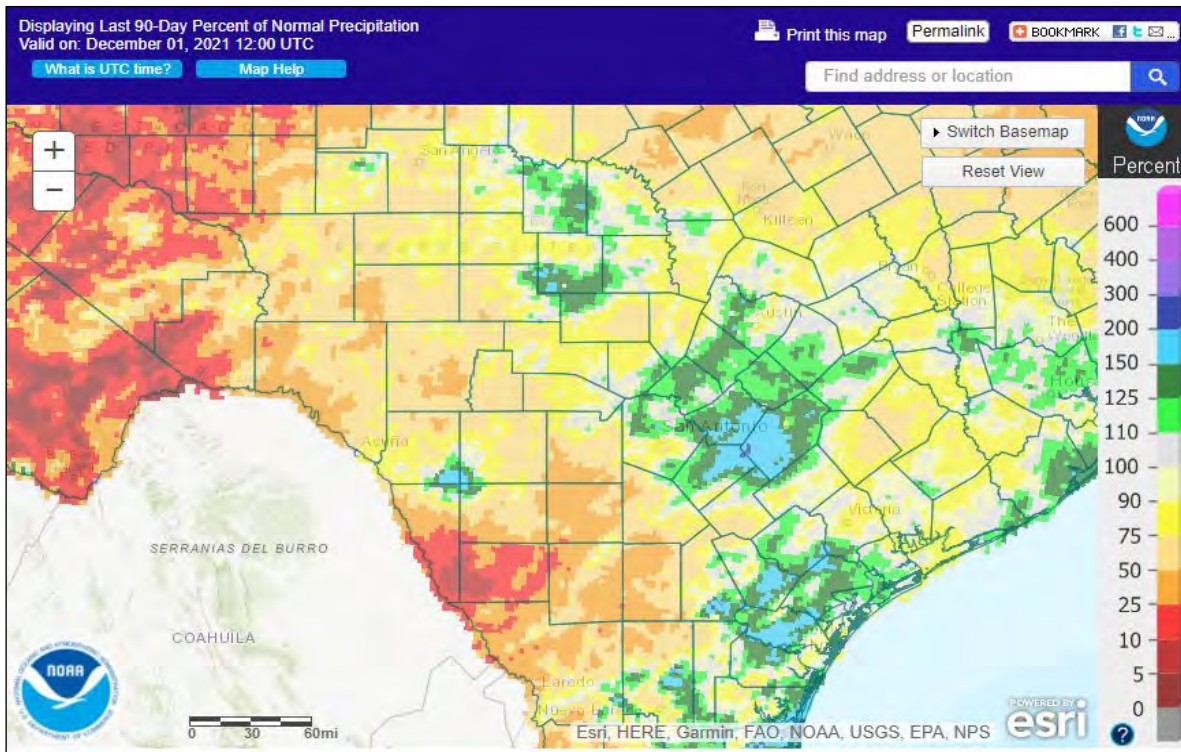


Figure 2: Ninety day percent of normal rainfall valid ending 6am CST Dec 1st, 2021.

On the whole, the entirety of south-central Texas experienced a warmer than normal fall, with the largest anomalies near the Rio Grande. In addition, much of the area along and east of I-35 finished meteorological fall with a surplus of rainfall (Figure 2), largely due to the mid-October event. Small patches of above-normal rainfall also existed east of Del Rio and west-southwest of Llano. The rest of the region experienced a dry fall, particularly along the Rio Grande near and south of Eagle Pass. As a result, drought has gradually expanded in these regions over the past several weeks to months (Figure 3). This trend may continue into winter.

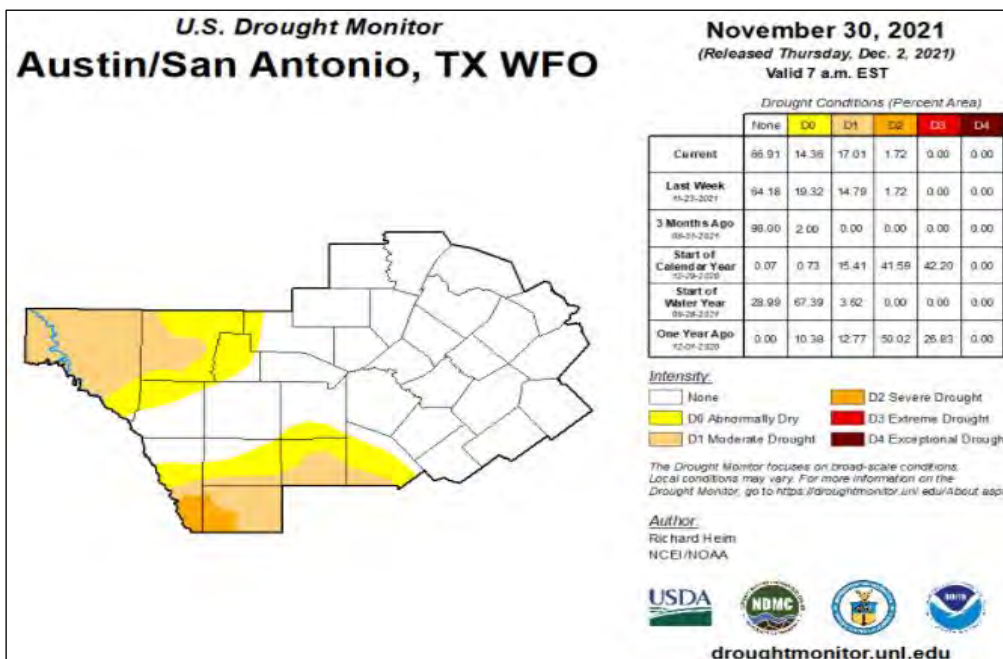


Figure 3: U.S. Drought Monitor for Central Texas valid 7am CST November 30, 2021.



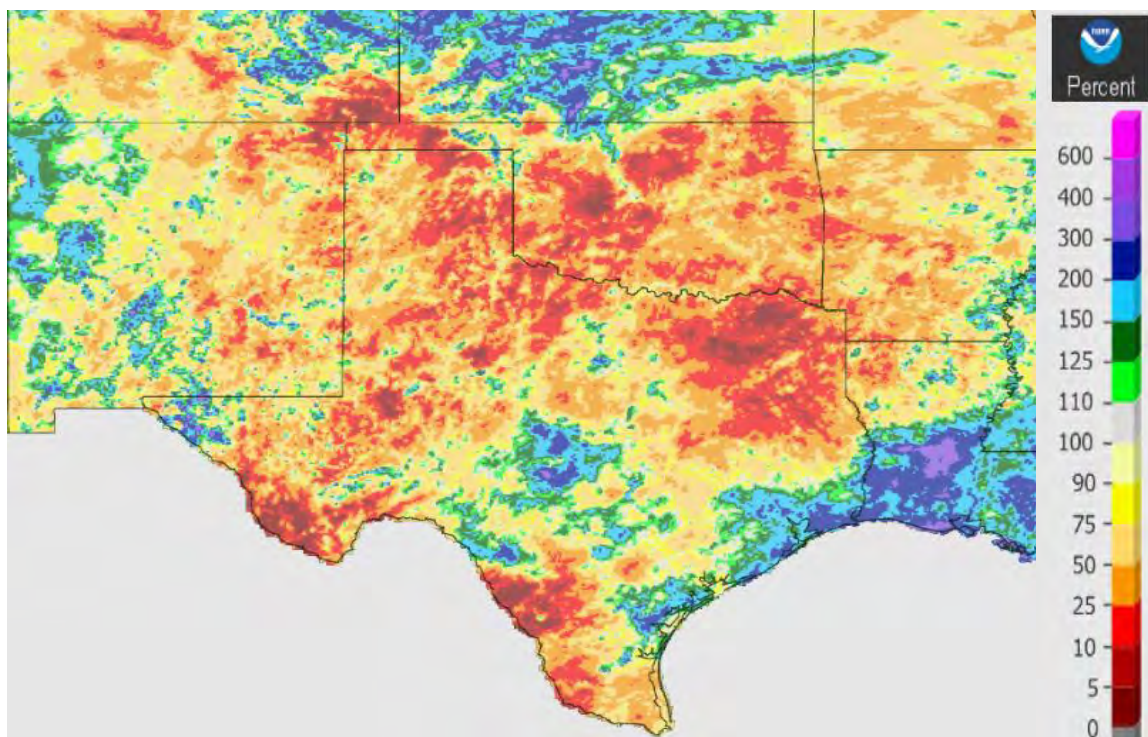
## North Texas Regional Summary

### Tame Autumn Weather across North Texas

By: Greg Story, Retired NWS Meteorologist

Season's greetings from North Texas! After an eventful summer weather-wise, the fall weather was pretty tame in North Texas. In fact, a good part of North Texas is observing abnormally dry soil moisture conditions or even some moderate drought conditions as of November 30. It reminds me that your rainfall reports are as valuable as ever in determining areas of drought as well as floods. I am thankful to each and every one of you for reporting your rainfall via CoCoRaHS! Your reports continue to be invaluable to the National Weather Service (and other entities, such as the Texas State Climatologist and the National Drought Mitigation Center).

Over the past several months, in June it turned dry over most of the state. The Gulf coast, parts of Deep South Texas, and West Texas saw above normal rainfall. But a lot of Southwest, Central and Northeast Texas saw below normal precipitation. In July the wet cycle from earlier in the year returned. Only North Central, Northeast and far Southwest Texas had below normal rainfall while much of Central and South Texas had above normal rains. In August, rainfall was above normal across much of northern Texas, as well as the Concho valley. But, a good part of East Texas and the Texas panhandle had drier than normal conditions. By September it turned drier again across a good part of Texas. Rainfall was below normal especially over Northeast Texas and over West Texas. The only above normal rainfall was noted over the Texas Hill Country and along the immediate Texas Gulf coast. October continued to be quite dry. Below normal rainfall was again noted over much of Northeast Texas, but Southwest Texas had much below normal precipitation. Only the area east and southeast of San Antonio and along the lower Texas Gulf coast saw above normal rainfall. In November it was quite dry over the majority of the state, especially the northwest half of Texas where below normal precipitation occurred. Meanwhile, it was very wet with above normal precipitation over Deep South Texas.



**Figure 1: Percent of normal precipitation map for September 2021:** The dark green, blue and purple colors indicate above normal precipitation; the beige, dark yellow and light green colors indicate near normal, while the orange and dark red colors indicate below normal precipitation. September was drier compared to previous months across a good part of Texas. Rainfall was below normal especially over Northeast Texas and over West Texas. The only above normal rainfall was noted over the Texas Hill Country and along the immediate Texas Gulf coast.



## North Texas Regional Summary (continued)

At DFW Airport in September 2021 they only received 0.25". The normal amount of rainfall in September is 2.72" so DFW was -2.47" below normal for the month.

In Waco during September 2021, they picked up 0.94". The normal amount of rainfall in September is 2.87" so Waco was -1.93" below normal for the month.

For each month, I will highlight the more significant weather events. I know there is a lot of information given, and it is intended for you to pick your "favorite" storm or a particular day to see what happened. Which days did you report your heaviest precipitation amounts? You can read about them here and compare what you observed against the maximum amounts. There were about six storm systems which affected our weather in September. Here are the highlights of the weather for the month.

September 5 - 6:

A weak cold front moved from northern into Central Texas on the 5th. Showers and thunderstorms occurred, with the heaviest rain over Central Texas. They got 1.33" near Gatesville on the Leon River, and 0.76" fell east of Lorena. And further west Woodson received 1.03". Lingering rain occurred along the nearly stationary front over central Texas on the 6th. Near San Saba they picked up 2.86", while near Richland Springs they received 1.17". Further south, Johnson City got nearly 3".

September 8:

A weak cold front moved across North Texas during the morning of the 8<sup>th</sup>, and into Central and Southwest Texas in the afternoon and evening. Rainfall amounts were generally 1" or less, with the area west northwest of Saginaw receiving 0.80" and the Fort Worth Botanical Gardens getting 0.65".

September 13 - 15:

Tropical system Nicholas moved along the lower Texas Gulf coast early on the 13th, and made landfall as a hurricane early on the 14th near Sargent, TX. The rainfall was low over the North Texas region. But over the middle Texas Gulf coast they received 8.22" in Freeport and 7.93" near Sargent. Nicholas moved very slowly northeast near Houston on the 14th and produced large rain amounts over Southeast Texas into southern Louisiana. They picked up 4.48" south southeast of Dayton and 3.09" south southeast of Kirbyville. Nicholas weakened to a tropical depression early on the 15th, and the most significant rain pushed out of Texas into Louisiana. Residual rainfall amounts were 0.25" or less.

September 21:

A strong cold front moved across Texas which brought true fall temperatures, but not much rainfall. The rainfall amounts were mostly under a 0.50", but parts of Deep South Texas got 2.50" to almost 5".

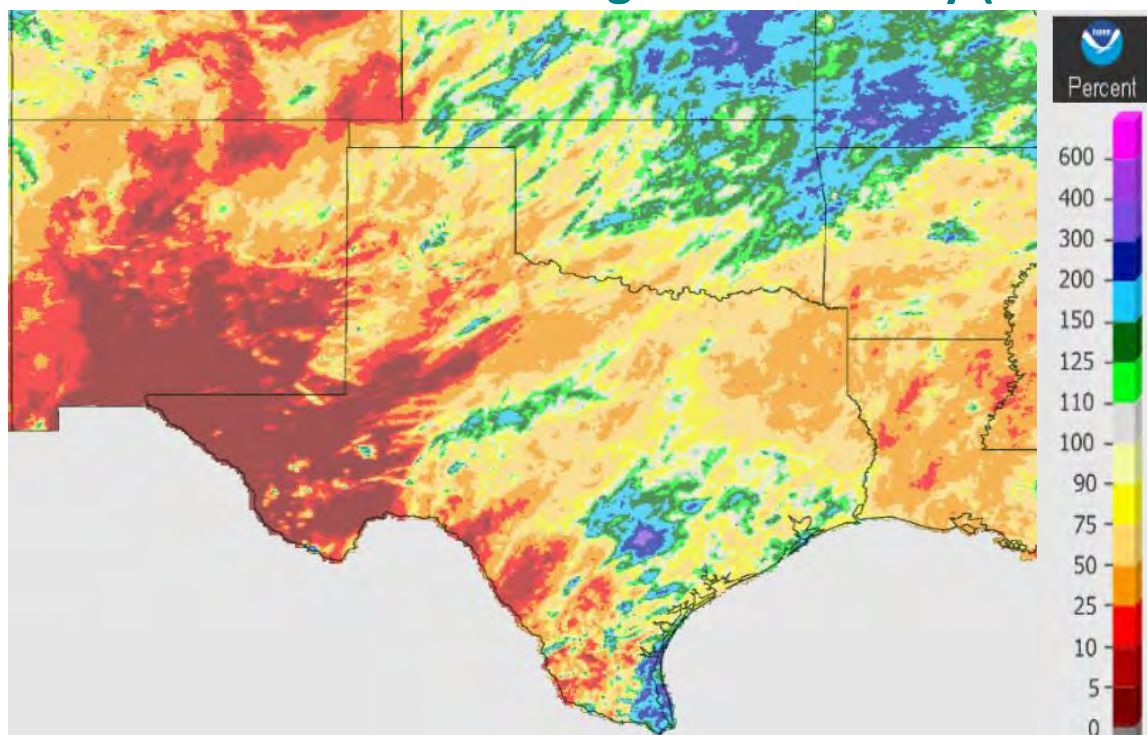
September 28 - 29:

An upper level low pressure system developed near the four corners region. Showers and thunderstorms developed over western and central Texas, as well as over extreme Southeast Texas. Heaviest rain in North Texas was from Lampasas to Killeen with 2.50" to a little over 3". Further south, the area near Canyon Lake received nearly 6.50". The rain pushed south and east to the Gulf coast as the first short wave trough lifted out. Then new thunderstorms developed along the dryline and produced a few thunderstorms over the western parts of North Texas. Near South Bend on the Brazos River they picked up 1.85". Further south 3.19" fell southeast of Corpus Christi.

September 30 into October 1:

A new upper level storm system replaced the old one near the four corners region. New thunderstorms developed over the western parts of North Texas on the 30th that shifted into the central and south parts of the state. In North Texas, Benbrook received 4.83" while northeast of Morgan they got 4.42". Further south near Corpus Christi, 7.55" was reported east northeast of Robstown.

## North Texas Regional Summary (continued)



**Figure 2: Percent of normal precipitation map for October 2021:** The dark green, blue and purple colors indicate above normal precipitation; the light yellow and light green colors indicate near normal, while the orange and dark red colors indicate below normal precipitation. October continued to be quite dry. Below normal rainfall was again noted over much of Northeast Texas, but southwest Texas had much below normal precipitation. Only the area east and southeast of San Antonio and along the lower Texas Gulf coast saw above normal rainfall.

At DFW Airport in October 2021 they received 2.96". The normal amount of rainfall in October is 4.37" so DFW was -1.41" below normal for the month.

In Waco during October 2021, they picked up 3.83". The normal amount of rainfall in October is 4.41" so Waco was -0.58" below normal for the month.

There were about five storm systems which affected our weather in October. Here are the highlights of the weather for the month.

### October 1 - 3:

The storm which moved near the four corners region on September 30 continued to advance eastward. Showers and thunderstorms continued on the 1st over a good part of the state. Locally heavy rain was noted over North Texas, with the area north northeast of Rockwall reporting 3.90". Much further south, the Brownsville TX area received 8" to nearly 10.75". Rain continued on the 2nd as a cold front crossed Texas. In North Texas the maximum amounts were northeast of Hasse at the Leon River with 1.81" and north northeast of Comanche with 1.43". Further south around Houston they received slightly over 3". The last of the rain moved out of Texas as the upper low weakened, passed off to our north and moved east. Most remaining rainfall amounts on the 3rd were less than 1".

### October 10 - 11:

A strong short wave trough moved from the four corners region across the Texas panhandle and Oklahoma to Southeast Kansas. A long line of thunderstorms developed on the 10th, and these moved out of Texas the morning of the 11th. Severe thunderstorms with high winds occurred. On the 10th the heaviest rain in North Texas was near Burkburnett with 1.92", and the area northwest of Greenville received 1.55". Further southeast, Liberty TX got 1.95". Residual rainfall of slightly over 2" was noted over extreme Southeast Texas on the 11th.



## North Texas Regional Summary (continued)

October 12 - 14:

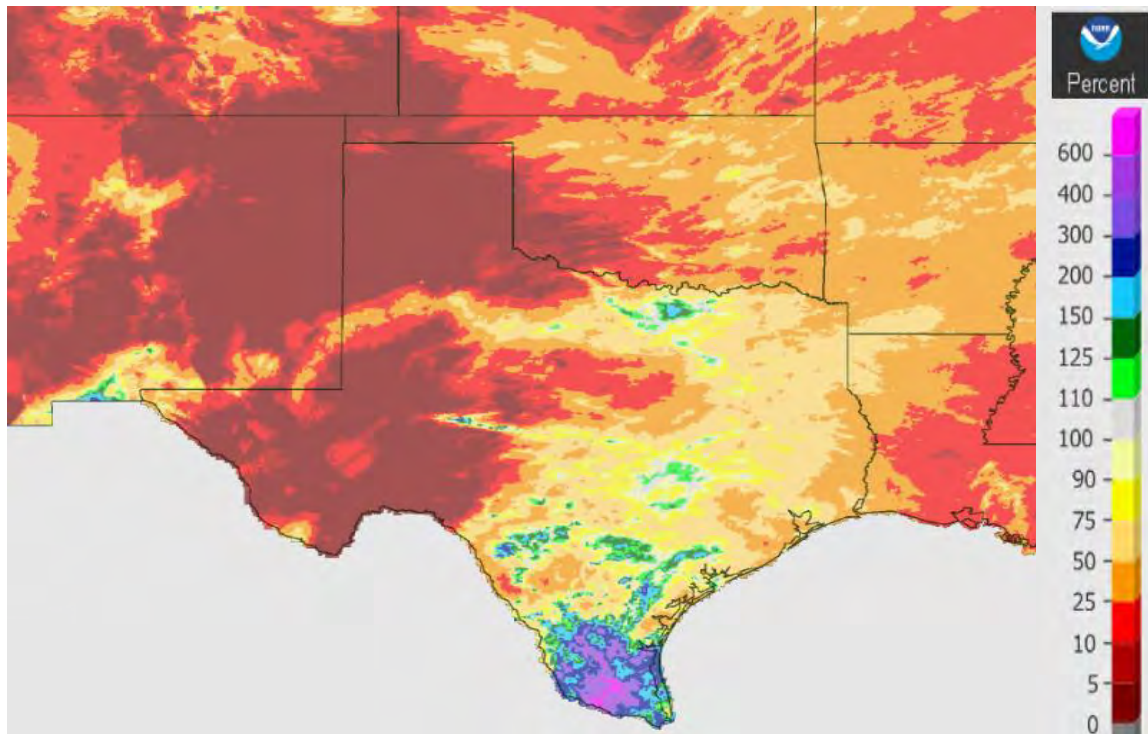
A large upper atmospheric closed low formed over Arizona on the 12th, and rainfall began over parts of Texas. As the upper low moved northeastward, it picked up moisture from the remnants of eastern Pacific tropical system Pamela. The end result was widespread rainfall. On the 12th, most of the rainfall was initially less than 1", with the heaviest around Vernon over West Texas and near Center in East Texas. A large area of rain continued on the 13th and grew in areal coverage and intensity later on the 13th. The heaviest rain in North Texas was north of Mesquite with 3.90" and east southeast of Troy with 3.70". The rainfall was much heavier over Central Texas where 10.39" fell northeast of Leesville, and 8" to 10" rainfall was noted from LaGrange and Luling to Gonzales. The initial storm system moved out of Texas on the 14th and the rains came to an end. Residual rainfall of 4" to 6" occurred on the 14th from Yoakum and Tivoli to Goliad. Then a strong cold front moved across Texas on the 15th. A few showers and thunderstorms developed along and ahead of the cold front from Central to Northeast Texas. The heaviest rain was actually near South Padre Island where 3.88" occurred northwest of Port Isabel.

October 24:

A weak cold front passed through North Texas. Some thunderstorms developed over extreme North Texas, but rainfall amounts were less than 1".

October 26 - 27:

A dryline and a strong cold front created showers and thunderstorms late on the 26th and into the 27th. The heaviest rain on the 26th was over Central Texas from the Austin/San Antonio area to Leesville where 1.43" fell. In North Texas the maximum rainfall was east southeast of Wichita Falls with 1.37" and they also got 1.23" to the west southwest of Richardson. On the 27th the rain moved out of the state, but not before severe weather hit from near Houston, Deweyville and Orange to Lake Charles. The maximum rainfall was over Southeast Texas where 3.42" fell northwest of Mauriceville.



**Figure 3: Percent of normal precipitation map for November 2021:** The dark green, blue and purple colors indicate above normal precipitation; the light yellow and light green colors indicate near normal, while the orange and dark red colors indicate below normal precipitation. In November it was quite dry over the majority of the state, especially the northwest half of Texas, where below or much below normal precipitation occurred. Meanwhile, it was very wet with above normal precipitation over Deep South Texas.

At DFW Airport in November 2021 they got 3.11". The normal amount of precipitation in November is 2.53" so DFW was +0.58" above normal for the month.

In Waco during November 2021, they picked up 0.96". The normal amount of precipitation is 2.71" so they were -1.75" below normal for the month.

## North Texas Regional Summary (continued)

There were about six significant storm systems which affected our weather in November. Here are the highlights of the weather for the month.

### November 2 – 3:

A strong cold front and an upper level disturbance brought rain to much of Texas. Initially on the 2nd the heaviest rain was over North Texas. The heaviest rain was 3.51" at Van Alstyne, followed by 3.19" east northeast of Van Alstyne and 2.90" south southwest of Anna. On the 3rd the heaviest rain shifted southward where 3.99" fell over Deep South Texas northwest of Hebbronville, 3.86" fell east northeast of Hebbronville and 3.80" occurred at Falcon Reservoir near Falcon Heights. Over North Texas the heaviest rain fell west of Rockwall with 1.58".

### November 10 - 11:

A strong short wave trough pushed a cold front across Texas. Showers and thunderstorms developed later in the day on the 10th. Rainfall amounts varied widely, with the maximum rainfall amounts being almost 2.50". At Rosser they received 2.44" and northeast of Cottonwood they picked up 2.42". The showers and thunderstorms moved out of Southeast Texas the morning of the 11th. Residual maximum rainfall amounts on the 11th were around 1" to 1.50" in and around Houston.

### November 17 - 18:

A strong cold front moved through Texas on the 17th into the morning of the 18th. For north Texas, the front passed without rainfall. Showers and a few thunderstorms developed over east and Deep South Texas late on the 17th into the 18th. Around 1" of rain fell near Brownsville. On the 18th, residual rainfall of 2" to 2.75" fell again around Brownsville and Harlingen.

### November 21:

A secondary cold front moved across Texas on the 21st and produced some locally heavy rain once again over Deep South Texas. The heaviest rain was 2.89" at Alice, followed by 2.22" at north northeast of Edinburg and 2.08" at McAllen.

### November 24 – 25:

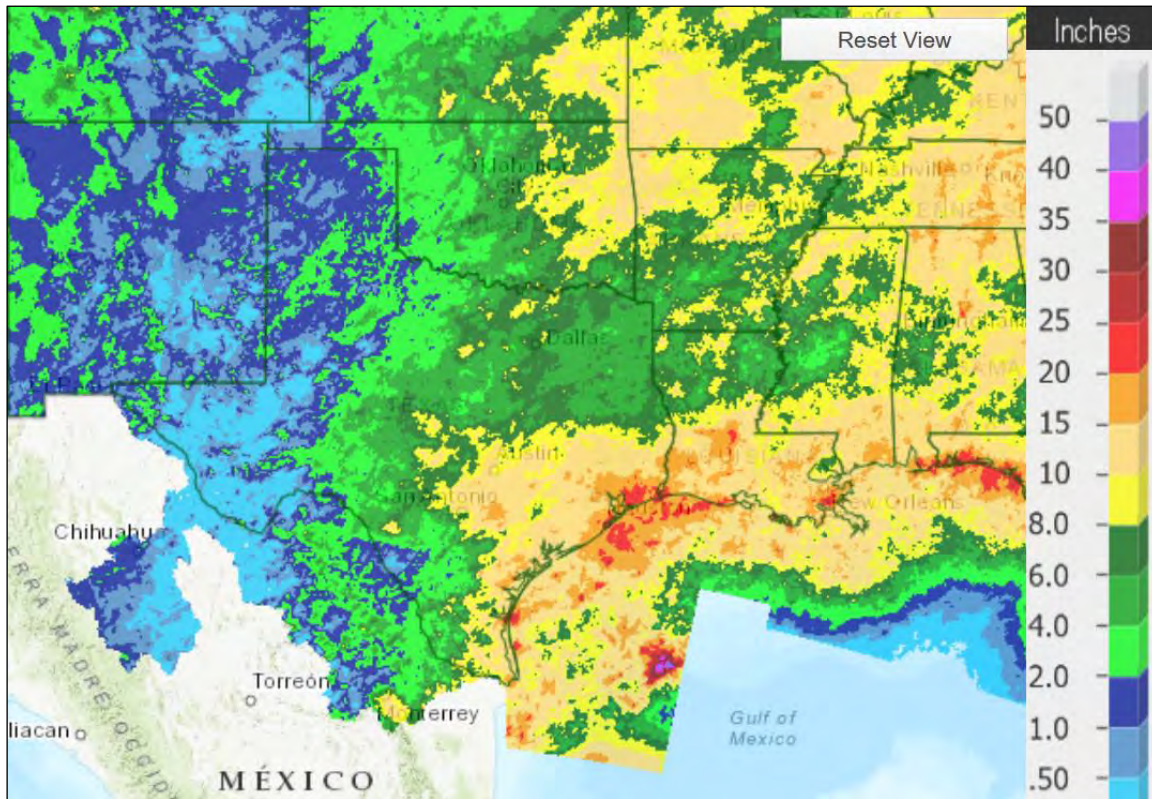
A cold front moved through Texas late on the 24th into the 25th. Most of the rain was over eastern and southern Texas. In North Texas the heaviest rain was northeast of Easterly with 1.93", north of Bullard with 1.56" and near Ennis with 1.17". Residual rainfall of 2" to 2.50" occurred over parts of South and Southeast Texas on the 25th.

### November 26 - 28:

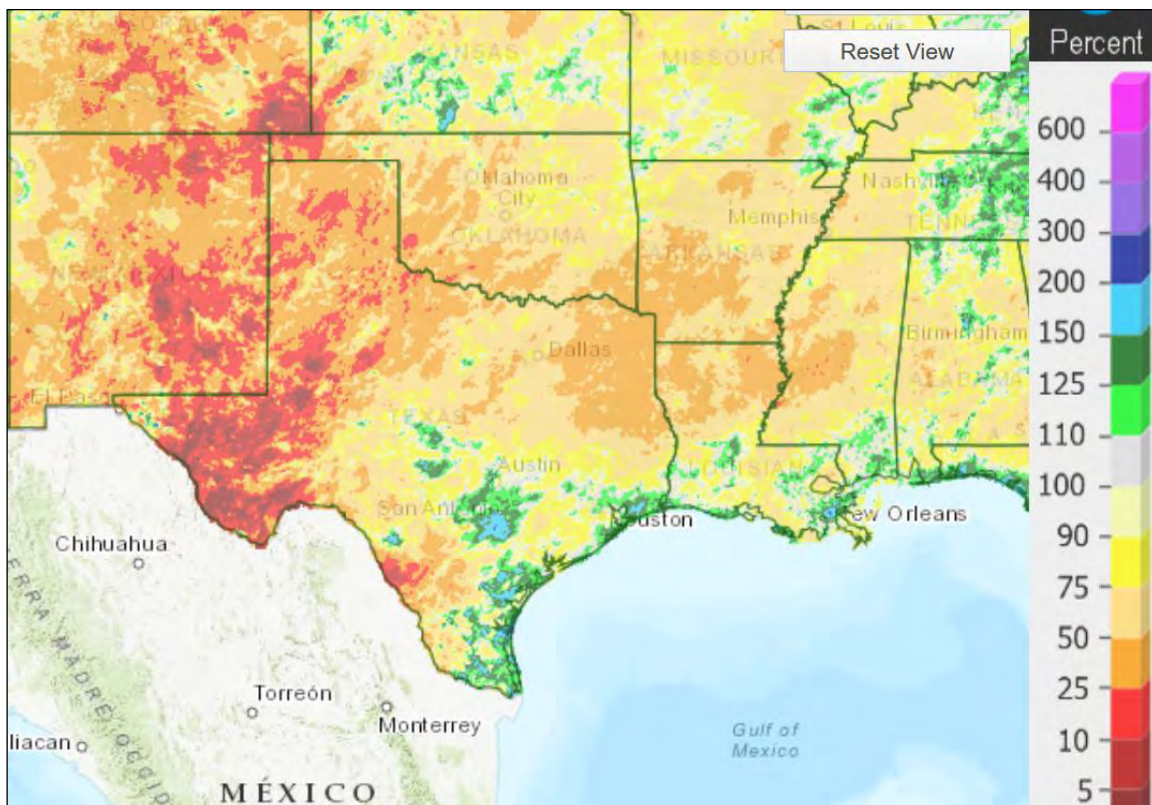
An upper level low pressure system formed over northwest Mexico and moved east. It opened up and moved across Texas as a short wave trough. Rain out ahead of the low began to spread into Texas late on the 26th and became widespread on the 27th. Initial rainfall amounts late on the 26th into the morning of the 27th were all 1" or less across much of South Texas. On the 27th the maximum rainfall was over North Texas where 2.70" fell south of Sanger and 1.64" occurred northwest of Springtown. Then, the residual rainfall into the 28th was very light.



## North Texas Summary (continued)



**Figure 4: Autumn season precipitation for 2021:** The brown, bright red, and purple colors indicate the largest precipitation totals, while the light green and blue colors show the lightest amounts.



**Figure 5: Percent of Normal Precipitation for autumn 2021:** The dark blue and green colors indicate above normal precipitation. The brown, bright yellow and red colors indicate below normal amounts. Note there was some prolonged dryness over northeast Texas and much of west Texas. But also of note was the isolated spots along the Texas Gulf coast into Deep South Texas that received much above normal amounts. Overall, near to below normal precipitation occurred over Texas.

## North Texas Summary (continued)

At DFW airport for the fall season they received 6.32". The normal amount of precipitation for autumn is 9.62" so they were -3.30" for the season.

In Waco for the fall season, they received 5.73". The normal amount of precipitation for autumn is 9.99" so they were -4.26" below normal for the season.

For 2021, DFW airport has received 33.16". The normal amount of precipitation from January through November is 34.17" so they were -1.01" below normal.

For 2021, Waco has received 32.63". The normal amount of precipitation from January through November is 33.53" so they were -0.90" below normal.

We just had the season of Thanksgiving. One thing I am thankful for is all of you! Thanks again for your dedication for taking all your weather observations! The amount of the rainfall which fell at your station is extremely important and valuable information to the National Weather Service, especially to the West Gulf River Forecast Center. You may wonder if anyone looks at your weather reports day in and day out. Rest assured; they are! Remember, on days you are not home or unable to report your 24-hour rainfall for any reason, you can make a multi-day accumulation report upon your return. This is important information as well.

For those of you just beginning in CoCoRaHS, welcome! Everyone, please consider inviting your neighbors, relatives and friends to join CoCoRaHS! The more rainfall observers we have, the better our chances are of determining the highest rainfall totals during rainfall events. If we can help you with your observations or submitting your reports in any way, please let us know!

Have a great holiday season, stay well, and happy observing!

Greg Story

---

*CoCoRaHS Texas would like to remind everyone that a 4 inch diameter rain gauge makes a great Christmas present for that special someone on your list this Christmas.*





## SE Texas Regional Summary

September storms to begin autumn then much drier conditions through November

### Houston/Galveston Section of SE Texas

By: Ron Havran - CoCoRaHS Regional Coordinator SE Texas Region, HCFCF

#### September

Temperatures across the Houston-Galveston section of SE Texas ended up near normal in most climate station sites this month. There was a large span in rainfall totals for the month that was determined by the track of Hurricane Nicholas. More information about *Hurricane Nicholas* will follow in a storm summary at the end of this regions autumn weather summary. Looking at Figure 1 below the counties of Galveston, Chambers, Brazoria, Liberty, and Harris counties had the highest rainfall totals for the month. The bulk of the monthly rainfall total for those counties was a result of Hurricane Nicholas shown in Figure 2. CoCoRaHS observers were very busy reading their gauges and reporting their observations during this time. A big thanks to all CoCoRaHS observers for their daily reporting of rainfall totals. Figure 3 shows CoCoRaHS observer rainfall totals for September. The western and northern sections of the region had much lower rainfall for the month and finished below normal by 1" to 2". Overall the entire region finished above normal for the month. See Table 1.

September 01, 2021 Monthly Observed Precipitation

Created on: November 03, 2021 - 01:27 UTC

Valid on: October 01, 2021 12:00 UTC

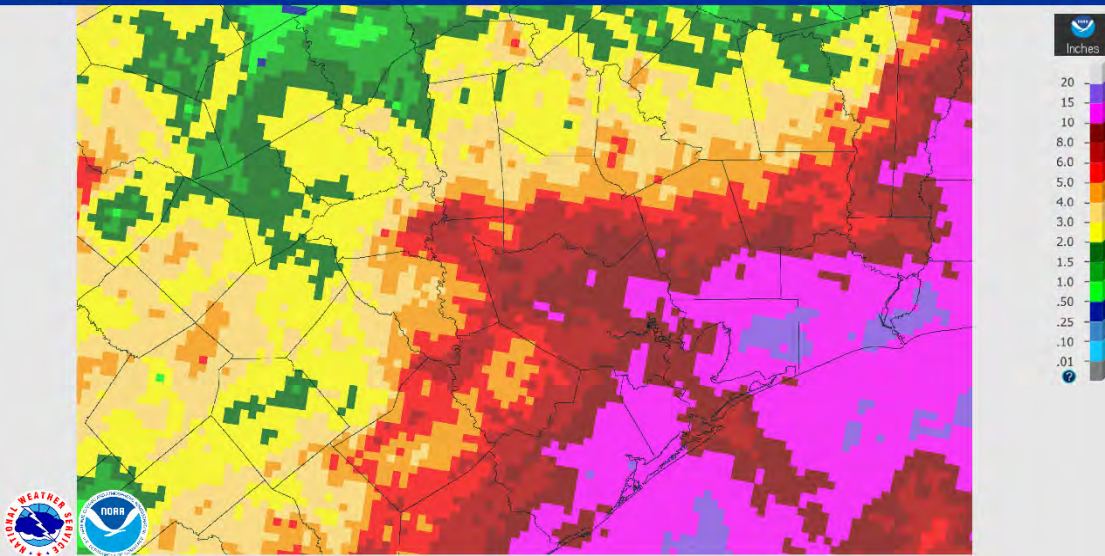


Figure 1: September 2021 Rainfall for SE Texas.

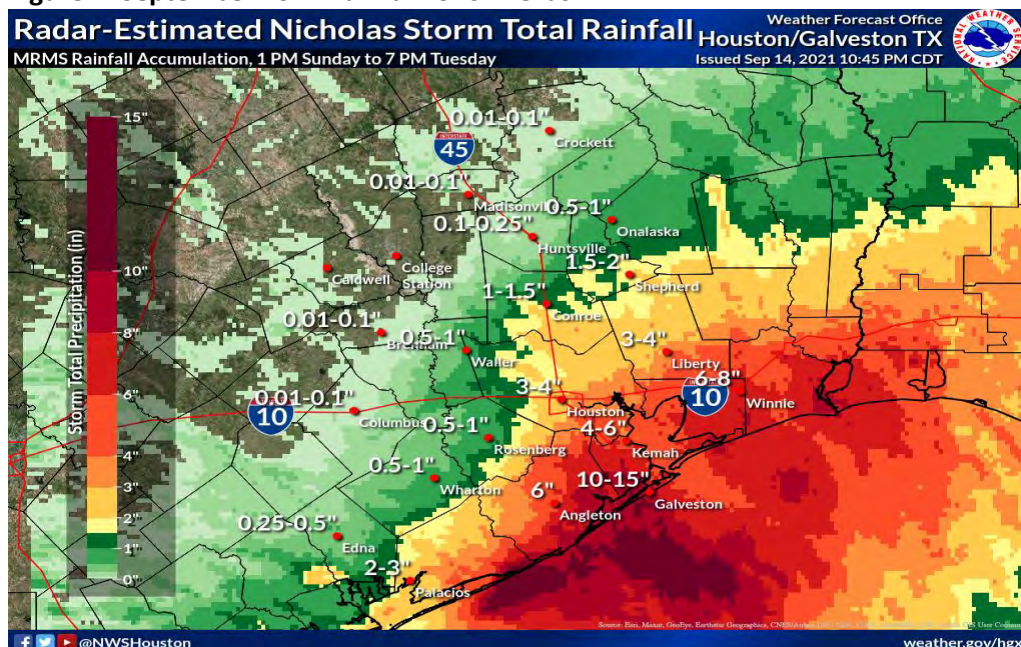


Figure 2: Radar Estimated Storm Total Rainfall for Hurricane Nicholas.



## SE Texas Regional Summary (continued)

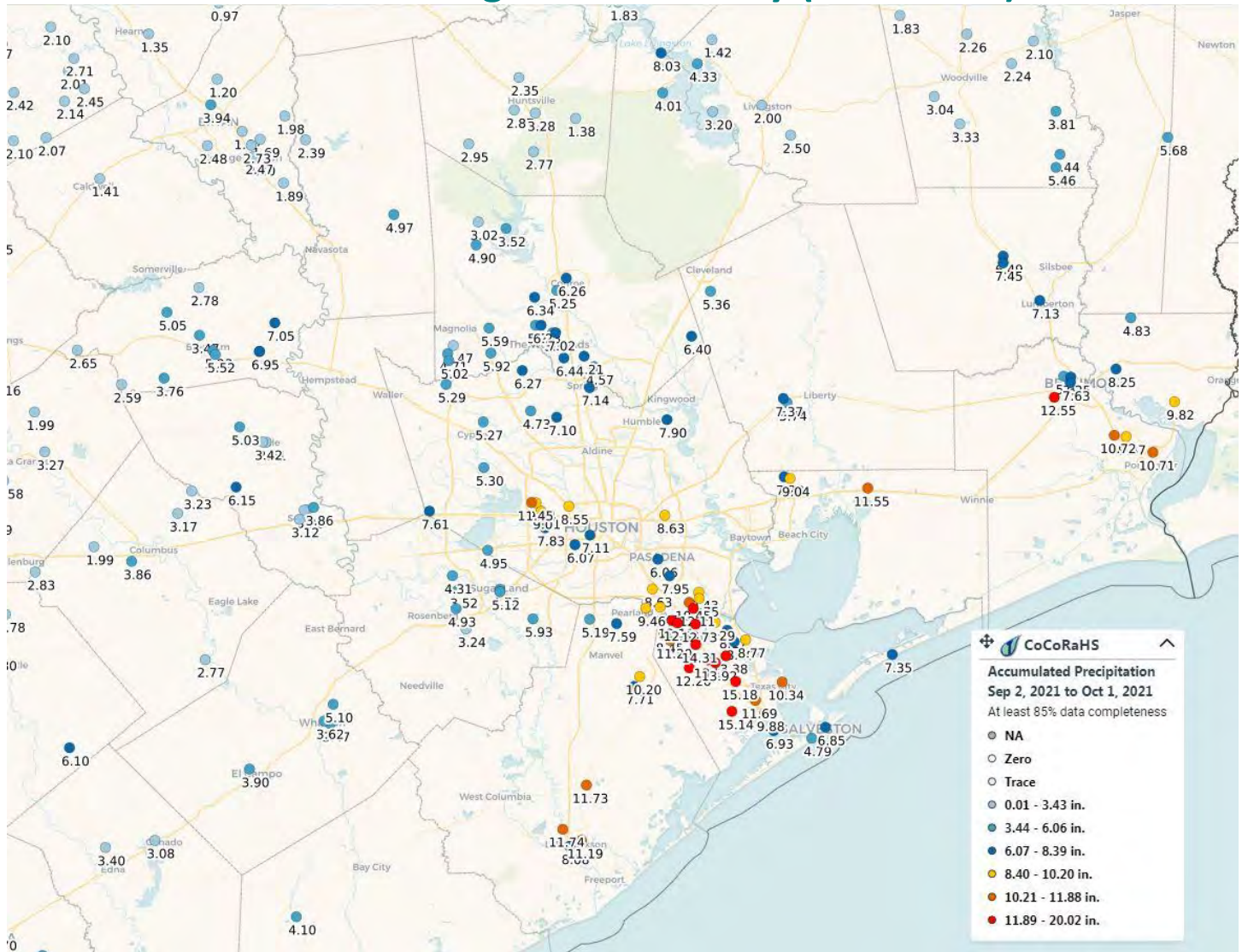


Figure 3: CoCoRaHS observer rainfall totals for the month of September in SE Texas.

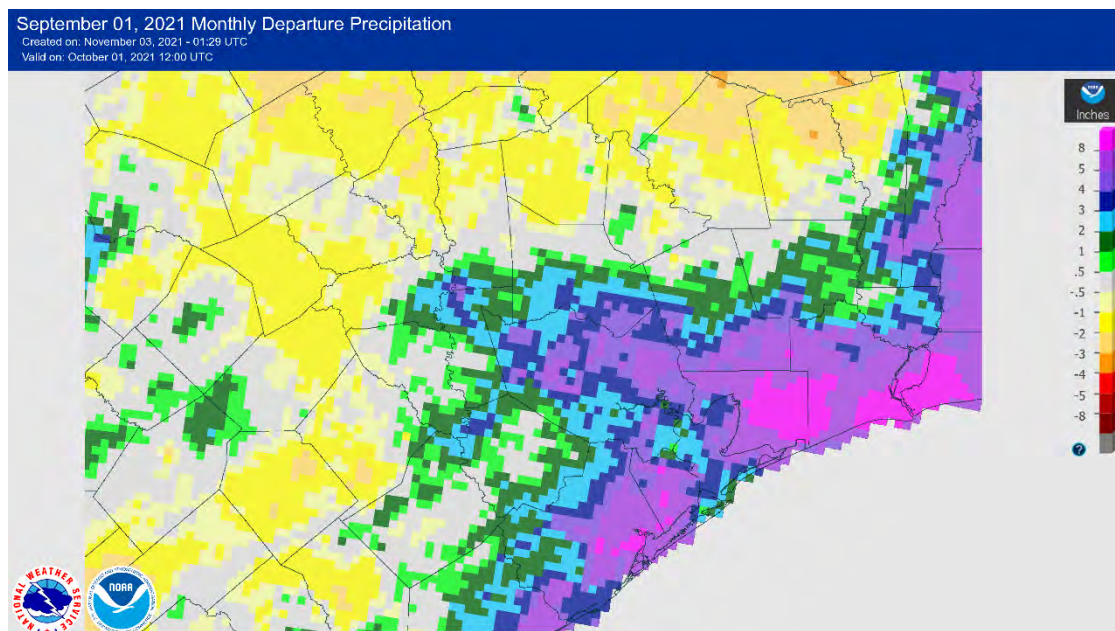


Figure 4: September 2021 Departure from Normal Rainfall for SE Texas.



## SE Texas Regional Summary (continued)

### October

Weather conditions across the region in October had temperatures that averaged 3-4 degrees above normal. Most areas had between 5 to 11 days over 90°F. Foggy morning became more common with clear longer nights after sunny warm days. Precipitation totals finished up the month below normal from 1" to 3" in most areas. There were exceptions in isolated areas that experienced heavy thunderstorms occurring during the month such as southcentral Harris County, coastal counties of Galveston and Brazoria counties, and southwest portions of Jackson County. Most counties had very similar rainfall totals. Many days this month had clear skies or very few clouds. Most stations only recorded about 4 to 6 days of significant rainfall. See Figure 6 for CoCoRaHS observer rainfall totals for the month. Thanks for reporting zero amount days. This will give you a complete data set for all 31 days of the month. Also this data is important information for determining drought conditions.

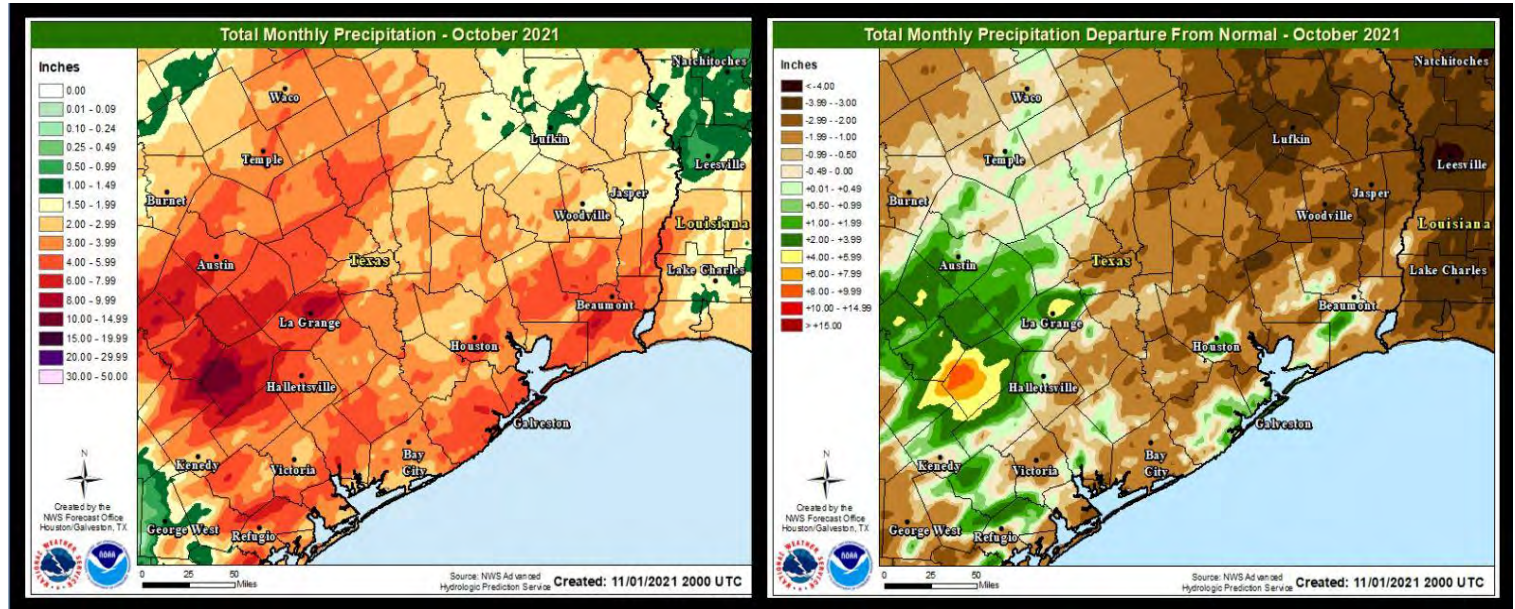


Figure 5: October 2021 Rainfall and Monthly Departure from Normal for SE Texas.

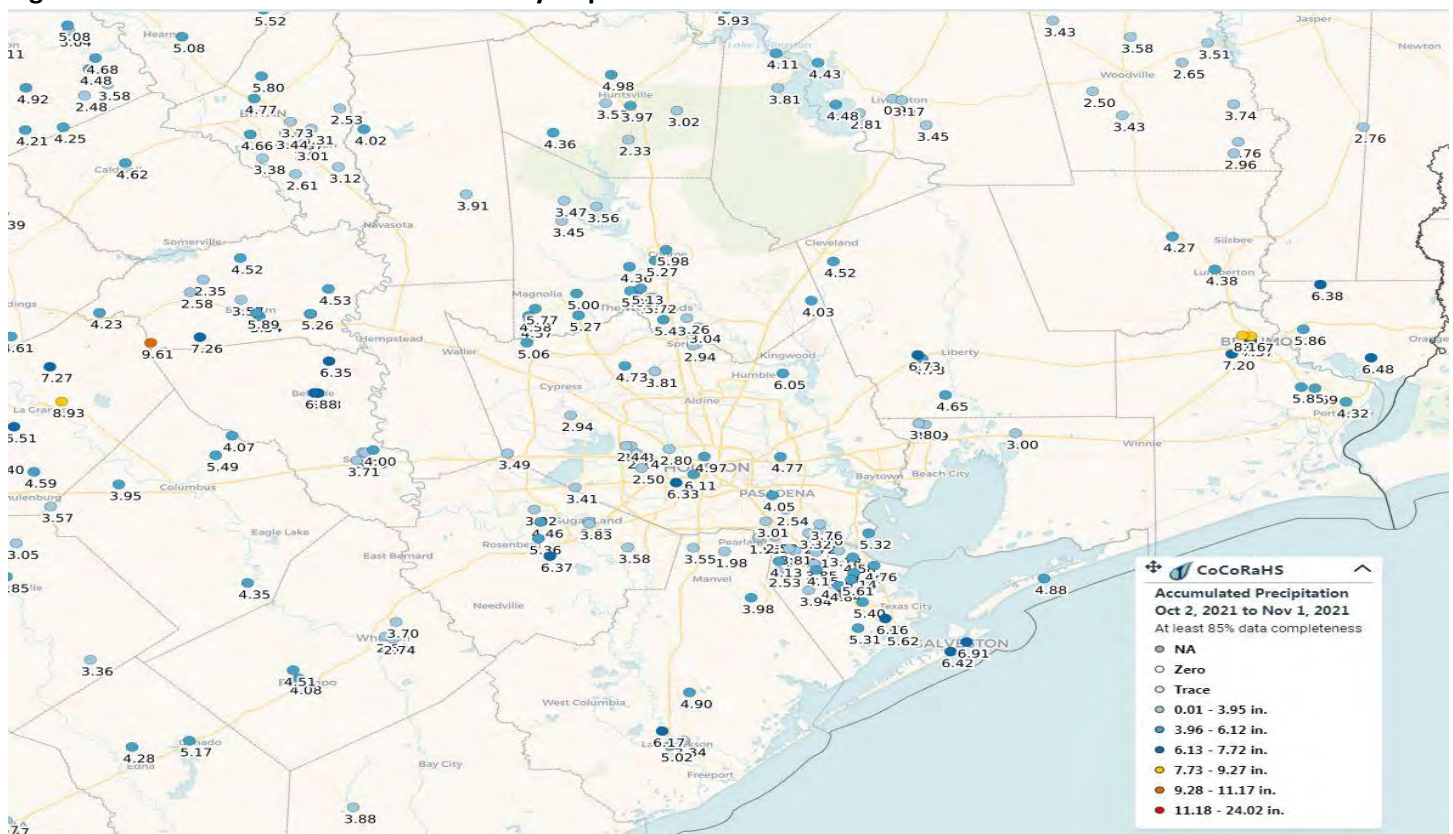


Figure 6: CoCoRaHS observer rainfall totals for the month of October in SE Texas.



## SE Texas Regional Summary (continued)

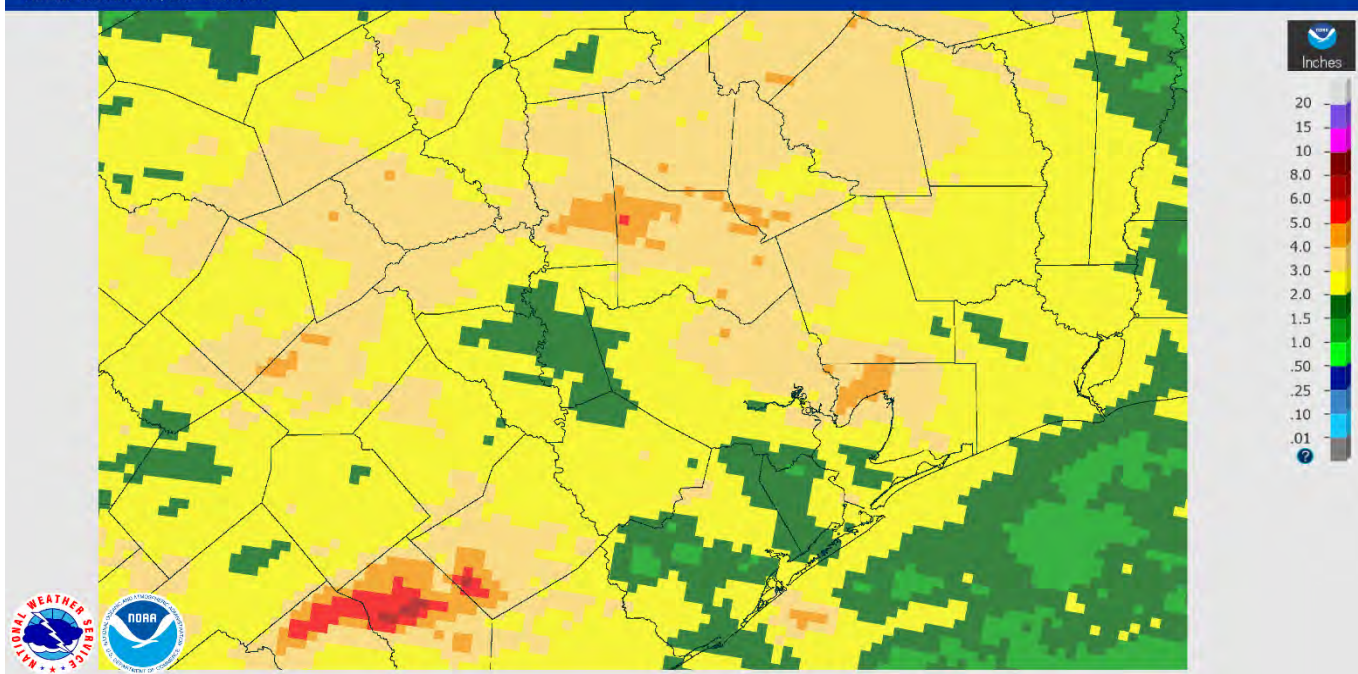
### November

Not much to talk about in November as for as rainfall and storms go. Temperatures for the month averaged out to near normal values in most locations. Mostly sunny days prevailed through the month that were mild to warm at times. With mostly clear skies and very long nights at this time of the year radiational cooling resulted in many morning lows in the 40's with dense fog. The entire region had below normal precipitation except for southwestern portions near Jackson County. The highest CoCoRaHS observer recorded county rainfall average for the month was Jackson County with 4.93". Several counties ended up with less than 2.00" of rain for the month. See figures 7 and 8 below.

#### November 01, 2021 Monthly Observed Precipitation

Created on: December 07, 2021 - 00:10 UTC

Valid on: December 01, 2021 12:00 UTC

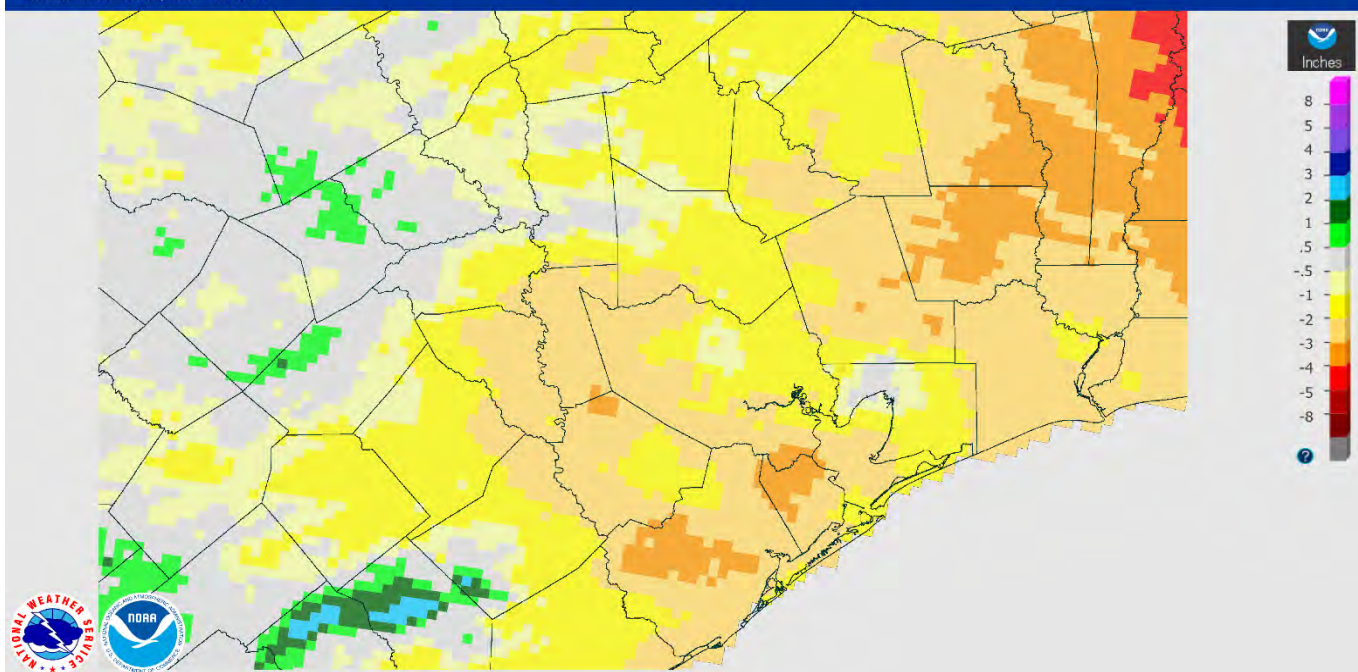


**Figure 7: November 2021 Rainfall for SE Texas.**

#### November 01, 2021 Monthly Departure Precipitation

Created on: December 07, 2021 - 00:13 UTC

Valid on: December 01, 2021 12:00 UTC



**Figure 8: November 2021 Departure from Normal Rainfall for SE Texas.**



## SE Texas Regional Summary (continued)

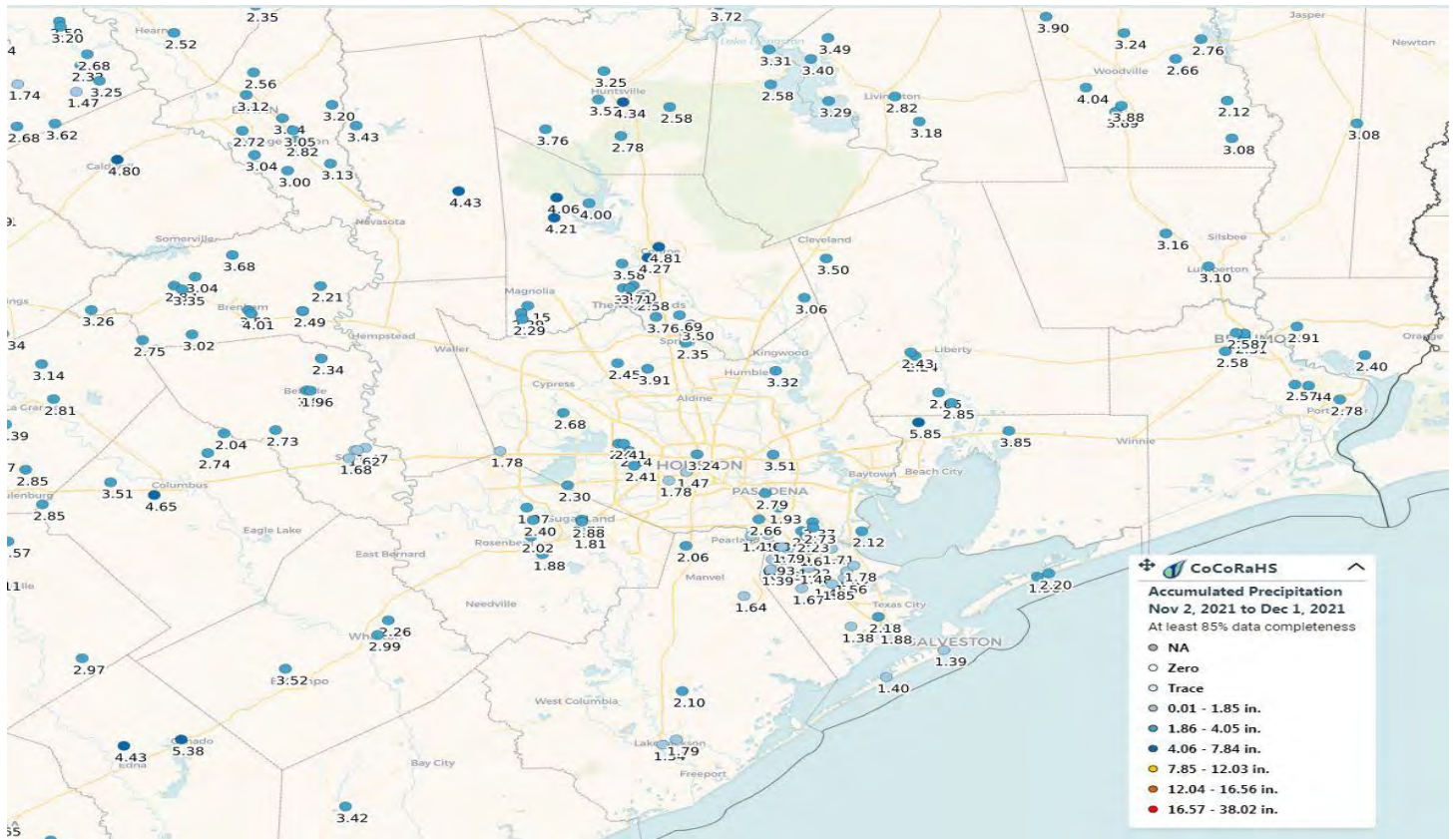


Figure 9: CoCoRaHS observer rainfall totals for the month of November in SE Texas.

### Autumn 2021 CoCoRaHS SE Texas Stations Houston/Galveston Section Rainfall

Actual Station Measured County Rainfall Averages in inches per month

County	September	October	November	Autumn Total
	AVG.	AVG.	AVG.	Sep.- Nov.
Austin	3.65	4.58	1.92	10.15
Brazoria	9.17	4.13	1.84	15.14
Chambers	9.28	3.34	3.63	16.25
Colorado	2.99	4.61	2.97	10.57
Fort Bend	4.86	4.78	1.98	11.62
Galveston	10.37	4.85	1.55	16.77
Harris	7.92	3.63	2.29	13.84
Jackson	3.24	4.62	4.93	12.79
Liberty	9.42	4.49	2.73	16.64
Montgomery	5.25	4.43	3.26	12.94
Polk	3.12	3.42	2.92	9.46
San Jacinto	6.02	3.91	2.96	12.89
Wharton	4.11	3.40	2.88	10.39
Region Totals	6.11	4.17	2.76	13.03

Highlights highest rain total for a county in a month

Highlights lowest rain total for a county in a month

Note: All data taken from the CoCoRaHS website in Total Precipitation Summary Report

Note: Only counties with 2 or more active observers reporting are displayed in this chart

Table 1: SE Texas Houston/Galveston Section CoCoRaHS Observer Rainfall County Averages.



## SE Texas Regional Summary (continued)

**Very Wet September then much drier the rest of the season**  
**Golden Triangle Section of SE Texas**

### September

Temperatures across the Golden Triangle averaged about 1.5°F below normal for September. Rainfall for the month was above normal. A large amount of the monthly rain fell on the first 4 days of the month. Jefferson County had the highest CoCoRaHS observer county average rainfall for the month with 8.89". Orange County was close behind with 8.01" of rain for September. A big thanks to all CoCoRaHS observers for their daily reporting of rainfall totals. See figures 1 through 4 at the beginning of this article for CoCoRaHS observer monthly rainfall totals, Hurricane Nicholas totals, and radar estimated amounts and departure from normal values.

### October

For October temperature averages for the month were below normal about 1.5°F to 2.0°F. Precipitation totals averaged slightly below normal in Jasper and Tyler counties while Jefferson and Orange counties averaged slightly above normal. There was an area of higher rainfall totals for the month SW of Beaumont. See figure 5 and 6 previous pages for CoCoRaHS observer rainfall totals and radar estimated rainfall totals for the month.

### November

Lots of sunny, mild, and dry days for most of the month of November. Radiational cooling at night resulted in fog on many days of the month but cleared out nicely the following morning. With all the sunny days temperatures were slightly above normal while rainfall was below normal this month. Tyler County had the highest CoCoRaHS observer county rainfall average at only 3.32". Dry just about everywhere in this section for November. See figures 7 through 9 on previous page for CoCoRaHS observer rainfall totals and radar estimated rain totals.

**Autumn 2021 CoCoRaHS SE Texas Stations Golden Triangle Section Rainfall**

Actual Station Measured County Rainfall Averages in inches per month

County	September	October	November	Autumn Total
	AVG.	AVG.	AVG.	Sep.- Nov.
Hardin	6.99	5.15	2.74	14.88
Jasper	5.68	2.76	3.08	11.52
Jefferson	8.89	6.68	2.56	18.13
Newton	No data	No data	No data	No data
Orange	8.01	6.61	2.38	17.00
Tyler	2.95	3.04	3.32	9.31
Region Totals	6.50	4.85	2.82	14.17



Highlights highest average rain total for a county in a month

Highlights lowest average rain total for a county in a month

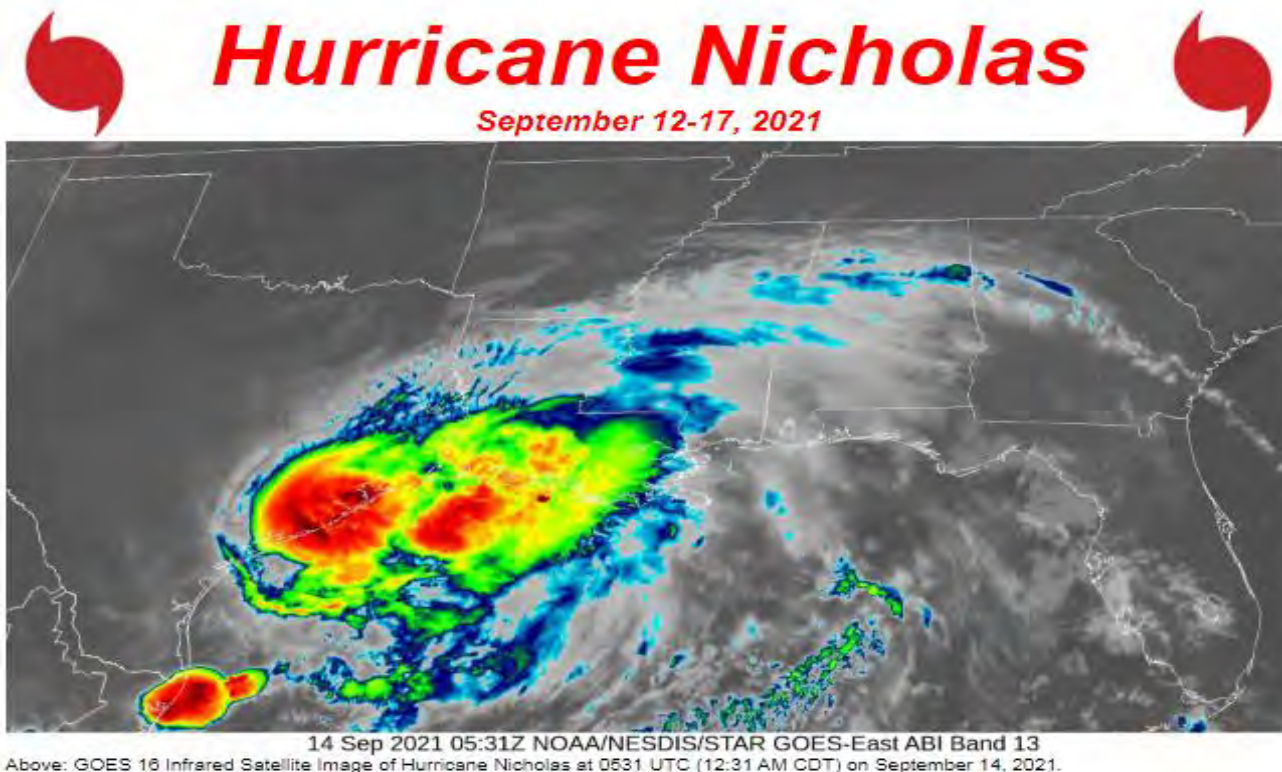
Note: All data taken from the CoCoRaHS website in Total Precipitation Summary Report

Note: Only counties with 2 or more active observers reporting are displayed in this chart.

**Table 2: SE Texas Golden Triangle Section CoCoRaHS Observer Rainfall County Averages.**

## SE Texas Regional Summary (continued)

Hurricane Nicholas summary from the NWS Forecast Office in Lake Charles, LA



Above: GOES 16 Infrared Satellite Image of Hurricane Nicholas at 0531 UTC (12:31 AM CDT) on September 14, 2021.

On September 9th, the National Hurricane Center began monitoring a tropical wave over the western Caribbean Sea for potential development. By September 12th, the system became better organized over the Bay of Campeche. Air Force reconnaissance aircraft investigated the system after daybreak, and found minimal tropical storm force winds, thus being upgraded to Tropical Storm Nicholas at 10 A.M. CDT.

Nicholas had trouble remaining organized as it moved north-northwest towards the Texas coast due to persistent west to southwesterly wind shear. On the evening of September 12th, the center of Nicholas re-formed about 170 miles to the north-northwest of the previous center, confirmed by aircraft reconnaissance and Brownsville radar, placing it around 95 miles southeast of the Mouth of the Rio Grande River.

Despite the warm Gulf waters in the mid to upper 80s, continued wind shear kept Nicholas from rapid strengthening the rest of night through most of the day on September 13th. Later that evening, an intense burst of convection over Nicholas's center was enough to bring the intensity up to 75 mph (65 knots) and a minimal central pressure of 988mb (29.18inHg) and was upgraded to a hurricane by 10 P.M. CDT.

Hurricane Nicholas made landfall at 75 mph (65 knots) and a minimal central pressure of 991mb (29.26inHg) near 12:30 A.M. September 14th on the eastern part of the Matagorda Peninsula, about 10 miles west-southwest of Sargent Beach, Texas. Nicholas moved further inland and weakened back to a tropical storm by 4 A.M. CDT. Nicholas continued weakening as it turned more east-northeast, traveling coastal Southeast Texas for the remainder of the day, weakening to a tropical depression by 10 P.M. CDT near Beaumont, Texas.

From September 15-16th, Tropical Depression Nicholas continued slowly eastward across Southern Louisiana, making an anticyclonic loop on the 16th. Nicholas was designated post tropical due to the lack of convection early on the 17th while it headed northward across Central Louisiana, dissipating later that evening across North Louisiana.

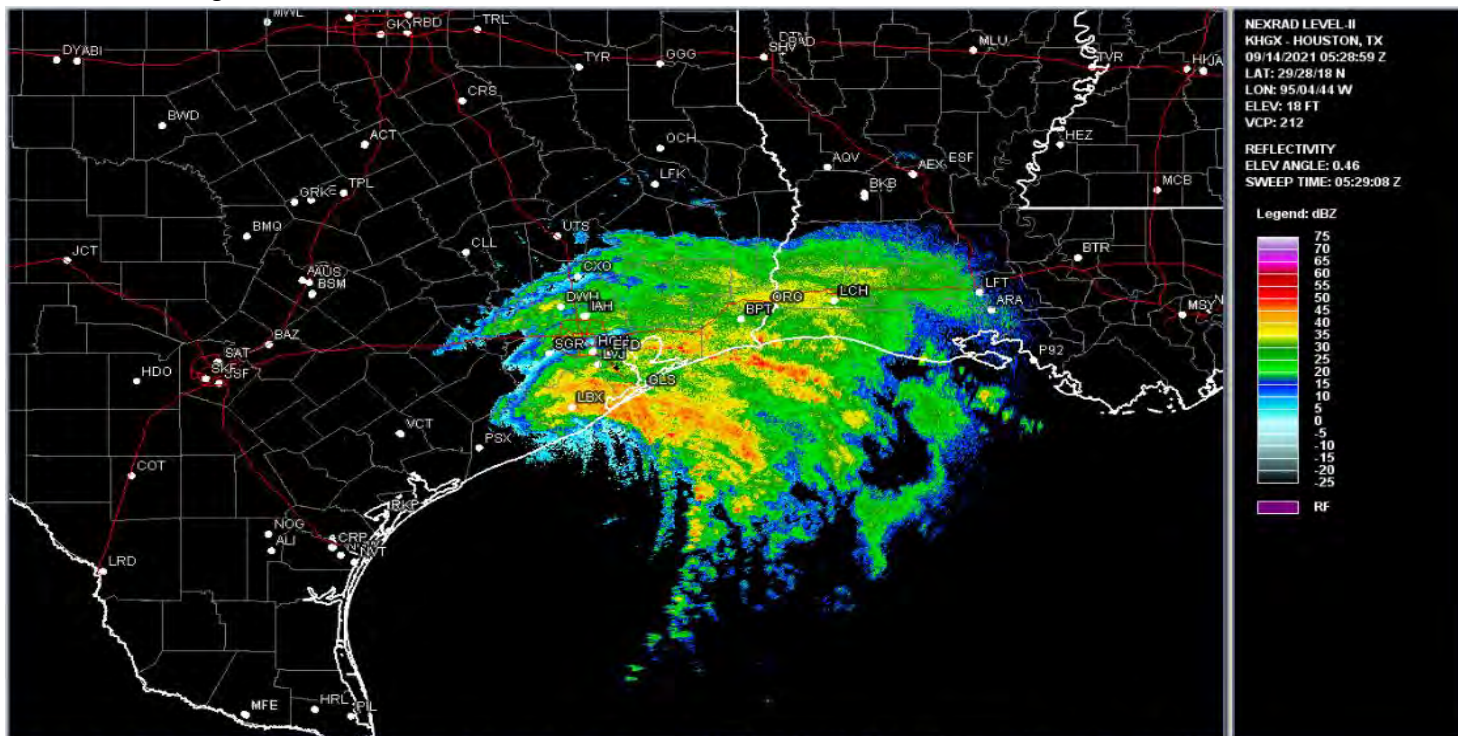
The strongest winds with Nicholas occurred across Jefferson County in Southeast Texas and the adjacent coastal waters. Along the coast, the Sabine Pass, TX NOS site recorded maximum sustained winds of 47 mph (41 knots) with a peak gust of 62 mph (54 knots) around 4 AM CDT on September 14th. Further inland at the Beaumont & Port Arthur Southeast Regional Airport, maximum sustained winds of 36 mph (31 knots) with a peak gust of 52 mph (45 knots) was recorded around 7:45 A.M. CDT on September 14th. Across Cameron Parish Louisiana, the Cameron, LA NOS site recorded maximum sustained winds of 43 mph (37 knots) with a peak gust of 49 mph (43 knots) around 10:18 A.M. CDT on September 14th. Further east along the coast and north into Calcasieu Parish, maximum gusts near 40-45 mph were recorded during the day.



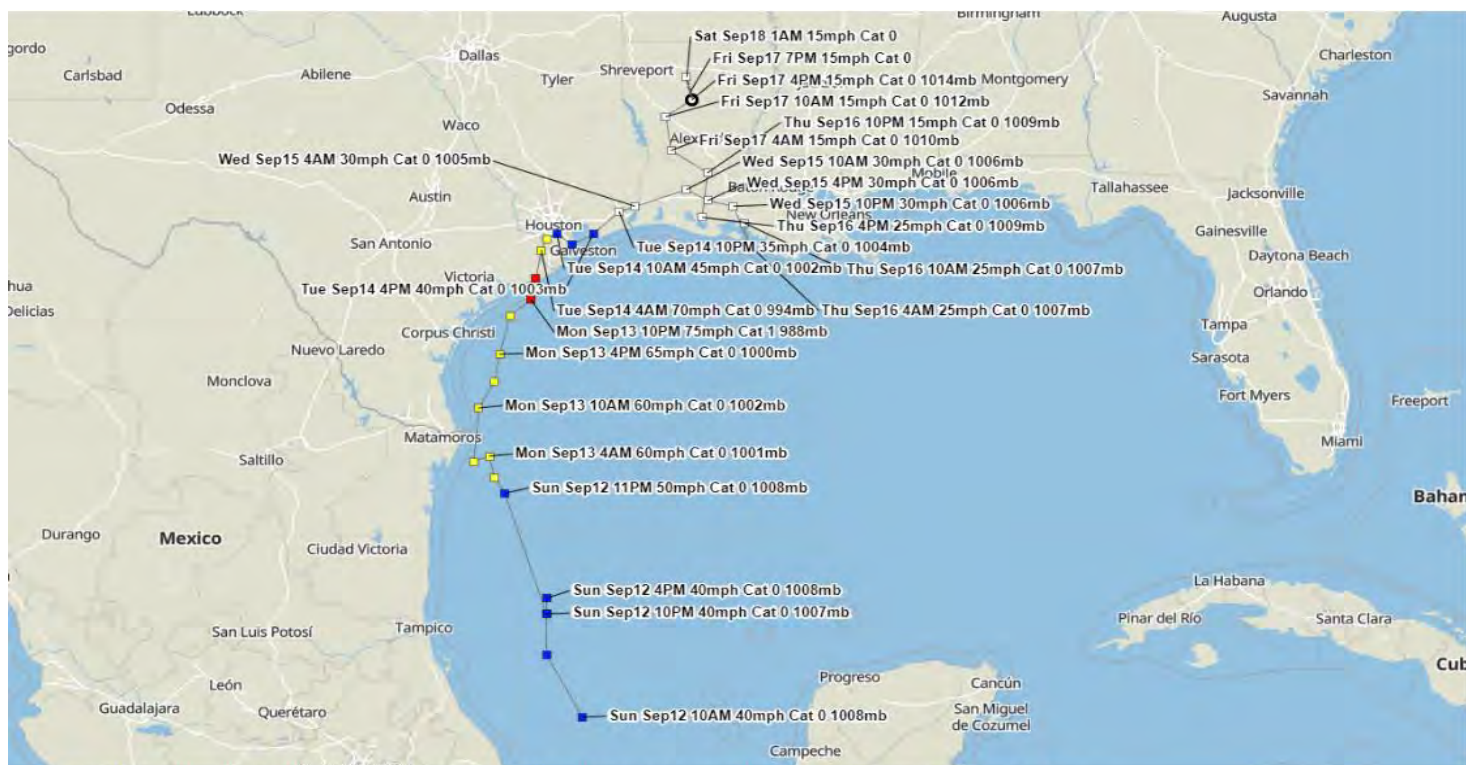
## SE Texas Regional Summary (continued)

The highest storm surge values between 2.0 and 2.5 feet Mean Higher High Water (MHHW) were recorded along coastal Southeast Texas from High Island eastward to the Atchafalaya River September 14th into early on September 15th.

Due to the slow movement after landfall, rainfall of 4" to 8" were common across Southeast Texas and Southern Louisiana. Higher rainfall amounts of 8" to 14" were recorded across Rapides, Avoyelles, St. Landry and Evangeline parishes, most of this falling the evening and early morning hours September 14-15th. The highest storm total rainfall of 14.06" was recorded at the cooperative observing site of Bunkie, LA. Several roads were underwater across Rapides, Avoyelles, St. Landry and Evangeline parishes in Central Louisiana, as well as Jefferson and Orange counties in Southeast Texas.



Above: Houston, TX WSR-88D radar image of Hurricane Nicholas at 0529 UTC (12:29 AM CDT) on September 14, 2021.



Above: Hurricane track of Hurricane Nicholas from operational National Hurricane Center public advisories.



## Abilene/San Angelo Regional Summary

### Warm and Dry Autumn across West Central Texas

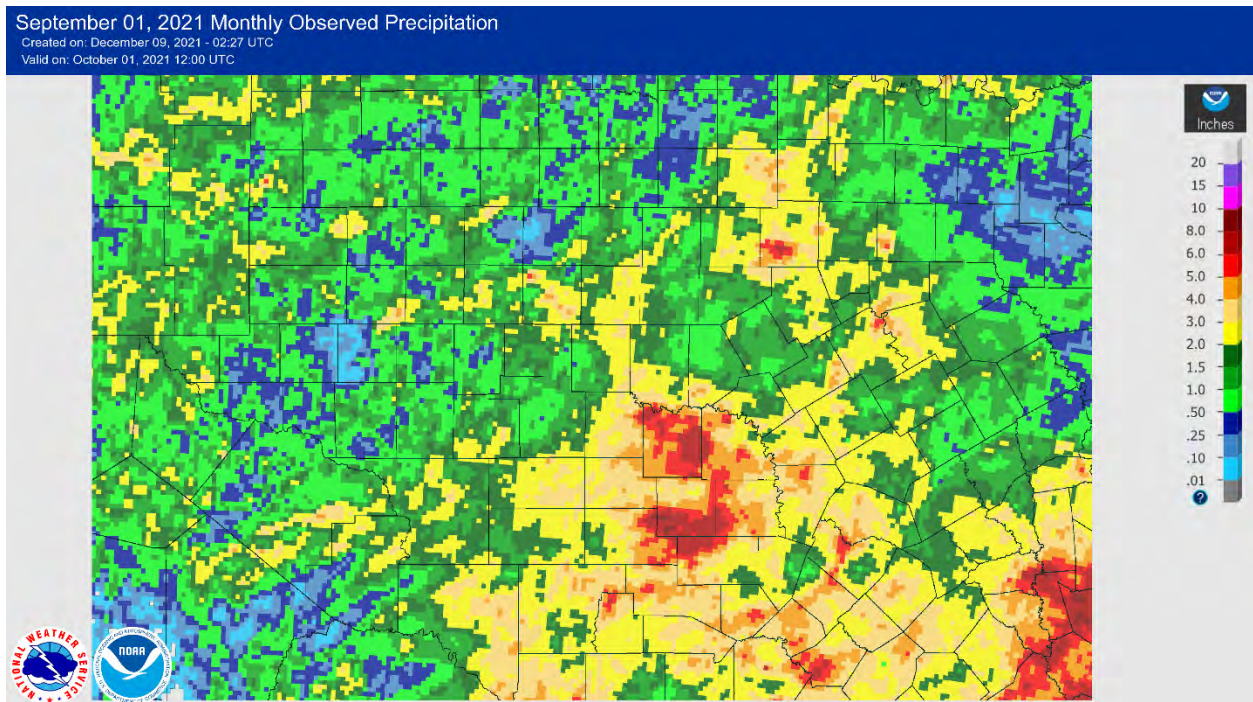
By: Joel Dunn, Observation Program Leader- San Angelo NWS WFO

The autumn of 2021 across West Central Texas trended warmer and drier, with highs in the 90s persisting into late September and a few in October. What's more, September ended one of the driest months of the year for most of the area, and while October fared a little better, still came in drier than normal.

#### September 2021

The month of September began and remained mostly hot and dry, with above normal temperatures and below normal rainfall dominating the overall weather pattern. In fact, Abilene broke a 67 year record when they recorded a high temperature 104°F on the 20<sup>th</sup> of the month, while San Angelo tied the high temperature of 102°F on the same day, set in 1953. Some hope of relief was pinned on the passage of Tropical Storm Nicholas. Though the coastal area saw activity as the Tropical storm passed through, West Central Texas saw only a few hundredths.

The month seemed like it would end as it had begun, hot and dry. However, an upper level disturbance over the Baja California was forecast to migrate northeast toward the Colorado Rockies, at which time another upper level low would deepen across the desert southwest. This resulted in much needed lift across West Central Texas, bringing showers and thunderstorms to the area for several days. As can be seen in image 1, the rainfall totals still ended quite variable for the month with most of the rainfall occurring across the northwest Hill Country. Despite the last minute storms most of the area still came in below normal for the month.



**Image 1: Observed September Rainfall**

City	Precipitation (in)	Departure from Normal (in)
Abilene	2.58	-0.09
San Angelo	0.39	-2.12
Junction	1.68	-0.73

**Table 1 - September's Observed Rainfall & Departure from Normal**

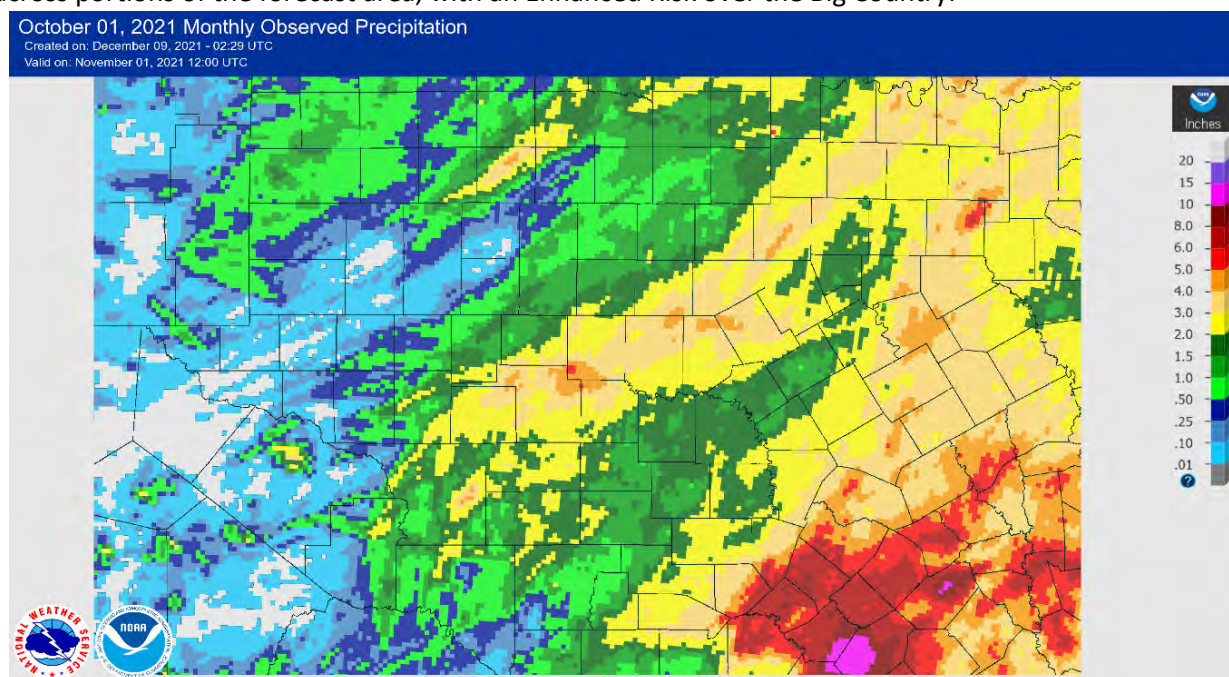
## Abilene/San Angelo Regional Summary (continued)

October 2021

October began as September ended, wet, with residual showers and thunderstorms developing mainly across the Concho Valley and portions of the Heartland. These storms persisted for a couple of days producing generous rainfall totals for this time of year.

Though October isn't known for being cold it is often expected that a cooling trend would set up and begin the autumn temperatures, however this year would be different. A hot and dry pattern would develop across the area and usher in what some Texans refer to as Second Summer, a short period of time in the fall when temperatures should be cooler but instead jump into the 80s and 90s as high pressure returns to the area. This pattern was broken twice during the month of October by upper level low pressure systems, bringing welcome rainfall and cooler temperatures. The first such low moved into the area on the 10<sup>th</sup> and 11<sup>th</sup> of October, which brought rainfall generally in excess of half an inch.

Once the low pressure moved off, high pressure again settled over the area and temperatures warmed into the 80s and 90s. Both Abilene and San Angelo set new record high temperatures on October 25<sup>th</sup>. Abilene's new record high temperature of 92 degrees broke the old record of 91 degrees set in 1950. San Angelo's new record high temperature of 95 degrees broke the old record of 91 degrees set in 1933. This trend might have persisted were it not for the strong pacific system that moved into West Central Texas. This system was strong enough for the Storm Prediction Center to issue a Slight Risk of severe weather across portions of the forecast area, with an Enhanced Risk over the Big Country.



**Image 2: Observed October Rainfall**

The pacific air mass brought with it not only healthy rainfall totals but cooler weather, resulting in near normal temperatures for what remained of the month.

City	Precipitation (in)	Departure from Normal (in)
Abilene	1.48	-1.35
San Angelo	2.64	0.22
Junction	1.61	-0.54

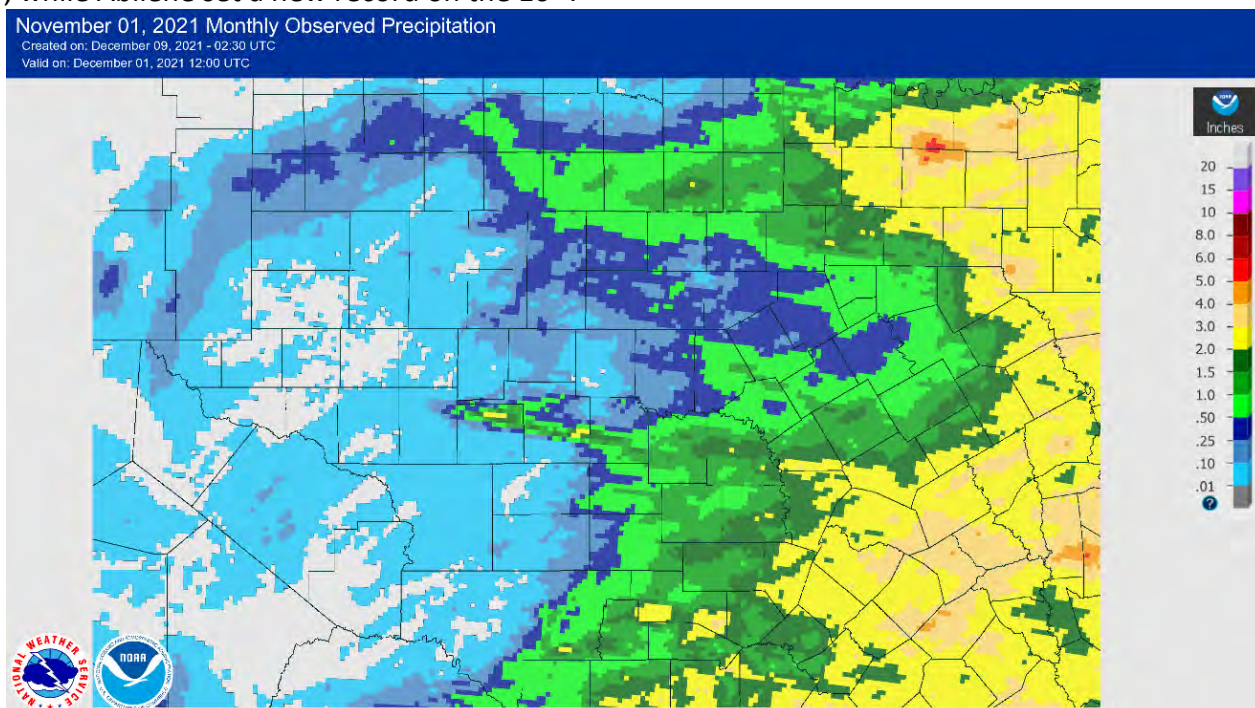
**Table 2 - October's Observed Rainfall & Departure from Normal**



## Abilene/San Angelo Regional Summary (continued)

November 2021

The month of November begins the dry season for West Central Texas and though there have been past years that have ended rather wet, that was not to be the case. A few areas such as the Northwest Hill Country, the northern Big Country, and a small portion of the Concho Valley recorded totals between 1"-2", the rest of the area received less than 0.5". Dominated by upper level high pressure akin to a summer time pattern, temperatures remained unseasonably warm and rainfall was scarce. In fact San Angelo set two new record high temperatures on the 15<sup>th</sup> and 16<sup>th</sup>, while Abilene set a new record on the 16<sup>th</sup>.



As can be seen in the image above, a narrow swath of precipitation fell across the Concho Valley, keeping San Angelo just above normal for the month. However, Abilene experienced their 28<sup>th</sup> driest November on record, while Junction experienced their 22<sup>nd</sup> driest on record.

City	Precipitation (in)	Departure from Normal (in)
Abilene	0.24	-1.16
San Angelo	1.04	0.12
Junction	0.63	-0.89

*Table 3 - November Observed Rainfall & Departure from Normal*

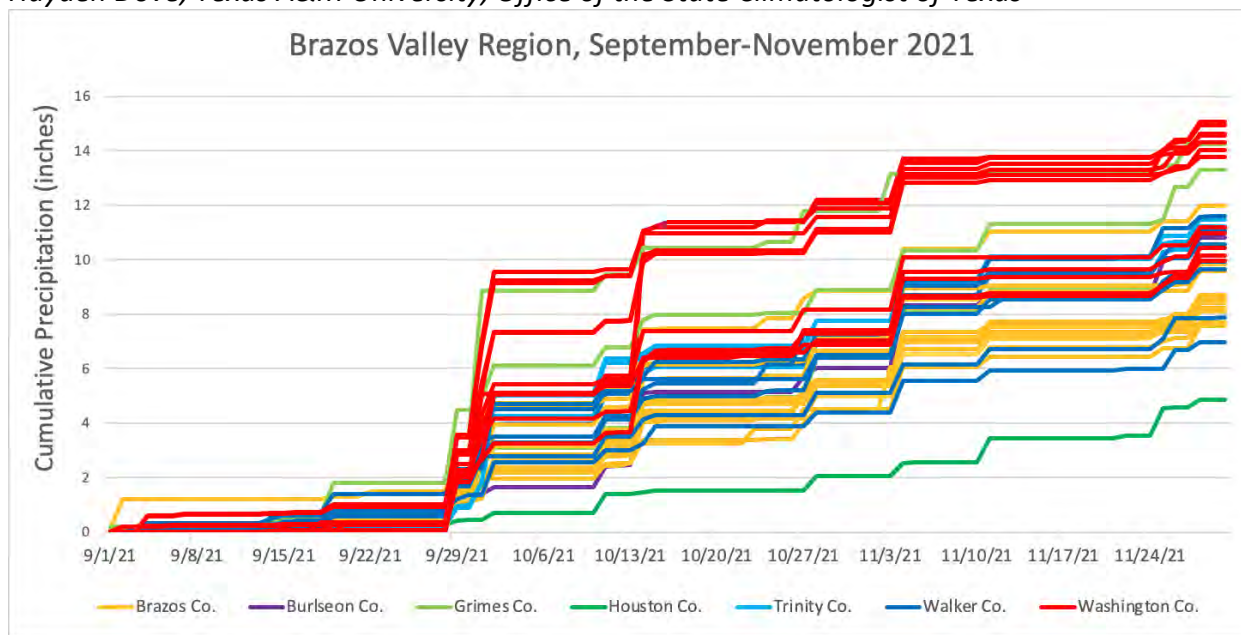


## Brazos Valley Regional Summary

### Fall 2021 Precipitation Summary

#### Bryan-College Station/Brazos Valley Region, Texas

Hayden Dove, Texas A&M University, Office of the State Climatologist of Texas



### Summary:

Following the very dry end to last season, the Brazos Valley continued to look like a desert throughout the start of the fall season. The first 3 weeks of September saw less than 1" of precipitation across most of the region. The script flipped following the end of September and beginning of October with most of the region receiving another 2" to 4". Washington and Grimes Counties in particular saw even more rain with most areas of these counties receiving 4" to 7" of precipitation. Drier conditions resumed with the remainder of October and November witnessing a steady increase in precipitation. Throughout the remainder of the season an additional 5" to 7" of precipitation were recorded across the region. While the counties farther east typically receive more precipitation, similar to last season, Washington and Grimes Counties outperformed the likes of Houston and Trinity Counties in the rainfall department.

### Observer Statistics:

We were thrilled to see 50 active observers across the fall season. What makes it better is that 31 of these observers had no more than 10 days of missing observations! In total, we were able to pull usable precipitation data from 42 observers across this period.

### Season Statistics:

*Wettest Day:* 7.69", October 14th, Washington County

*Wettest Seasonal Total:* 15.07", Washington County

*Driest Seasonal Total:* 4.86", Houston County

*Soggy Socks Award (longest spell of daily reports with measurable rain):* Brazos County experienced six consecutive days of measurable precipitation from October 11th through October 16th.

*Dusty Soles Award (longest spell of daily reports without measurable rain):* Washington County experienced twenty consecutive days without measurable precipitation from November 5th through November 24th.

## Corpus Christi Regional Summary

### Series of Fronts Contributing to Mostly Seasonal Rainfall

By: Juan Pena Jr., Meteorologist, National Weather Service - Corpus Christi

September was a tale of two anomalies with the eastern half checking in with above average rainfall while areas out west came in below normal (figure 1). A few observers across the Coastal Bend reported rainfall amounts over 10" for the month while most observers checked in with amounts between 5" to 7". Rainfall totals gradually diminished across the Coastal Plains with rainfall reports between 2"- 4" with a sharper drop off across the Brush Country. Across the Brush Country and the Rio Grande Palins, observations varied from .14 to near 2" for month. The majority of all rainfall across coastal locations can be attributed to Tropical Storm Nicholas and an MCS that swept across the area, with the MCS being the more significant event of the two when it came to rainfall. For observers further west, all the rainfall reported was attributed the passage of a cold front towards the end of the month.

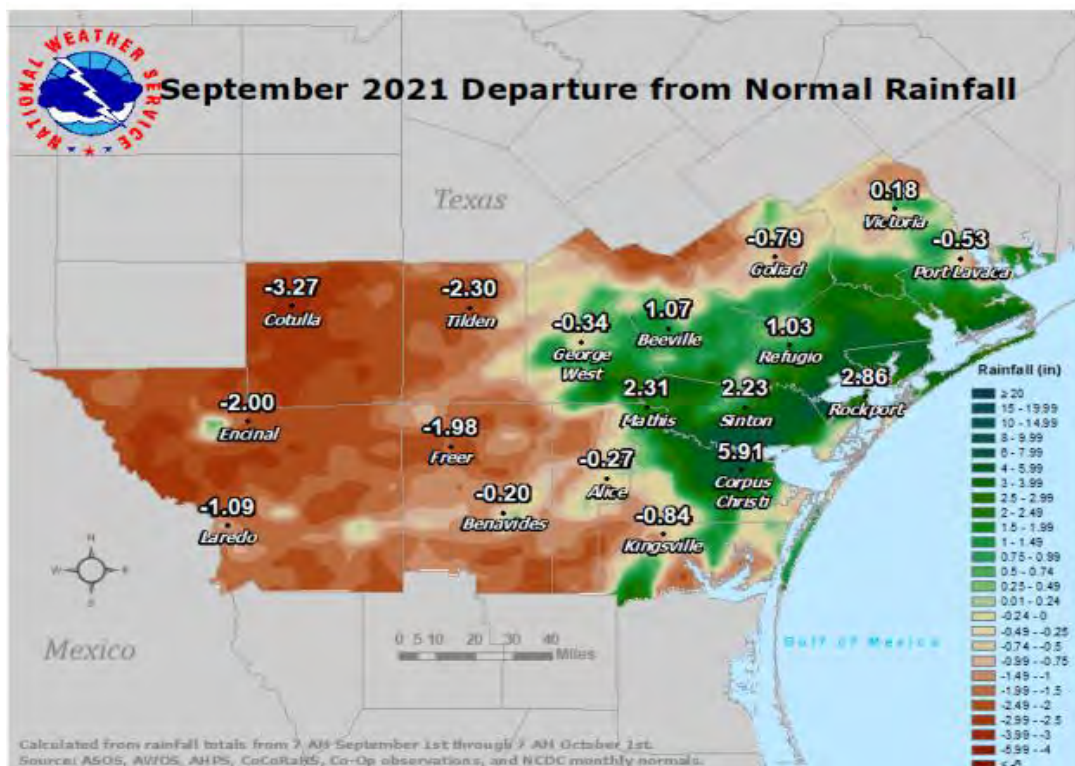


Figure 1: September 2021 Estimated Departure from Normal Rainfall

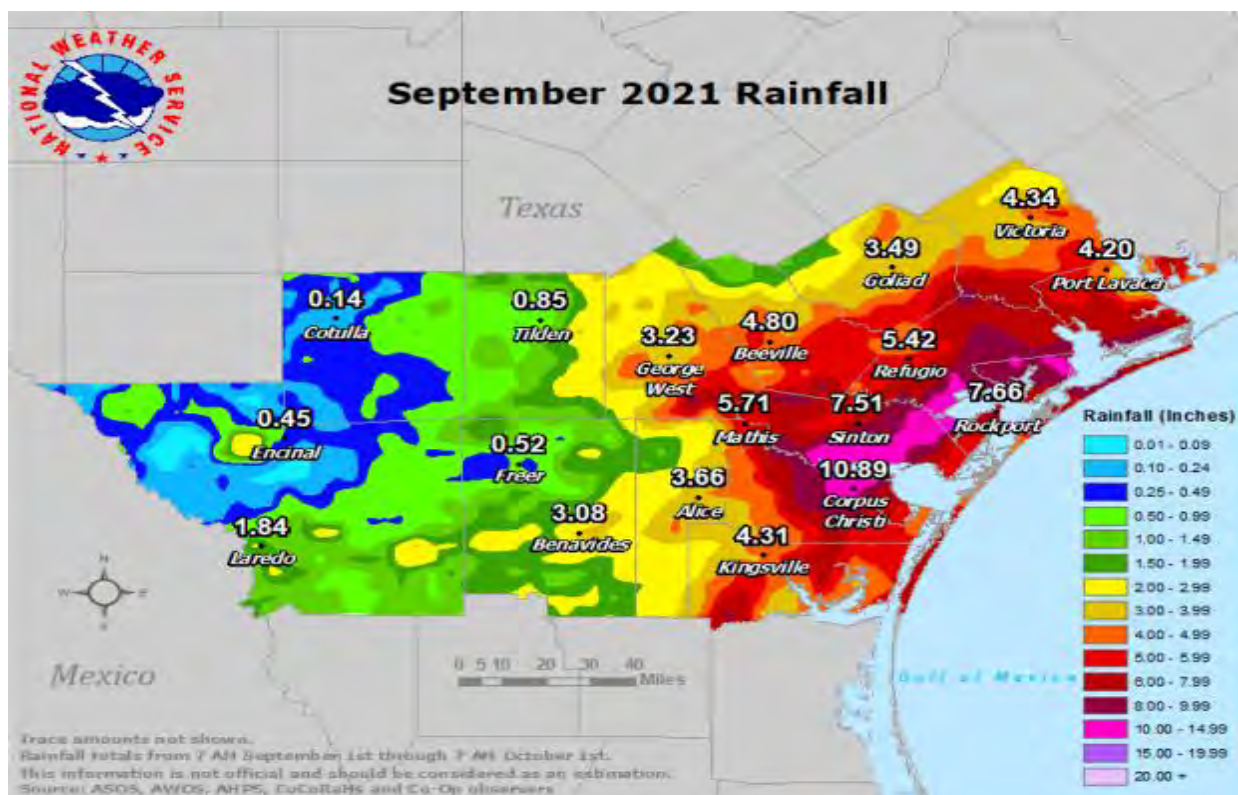


Figure 2: September 2021 Estimated Rainfall Totals



## Corpus Christi Regional Summary (continued)

A fairly seasonal rainfall pattern was observed for the month of October with observers reporting accumulations between 1" - 5" across the County Warning Area (CWA). The month was mostly dry with only scattered showers except for a couple of rainfall events, one at the beginning of the month and another in the middle of the month. The majority of the rainfall reported across the Coastal Plains and Coastal Bend came on the first day of the month as another MCS came across the area due to an abundance of moisture and upper level low that moved across the area towards the end of September and beginning of October. The majority of observer reported rainfall totals between 2" - 4" while only a couple of isolated observers reported accumulations near 8" - 9". During the middle of the month, the remnants of Tropical Storm Pamela from the Pacific Basin traversed across the area providing much needed rain. During the couple of days that the remnants tracked across the area, observers across the Rio Grande Plains and Brush Country reported totals 1.5" - 5". However, the winners of this rain event as the Coastal Bend and Victoria Crossroads where observers reported between 1.5" - 8", with the largest accumulations across the Victoria Crossroads.

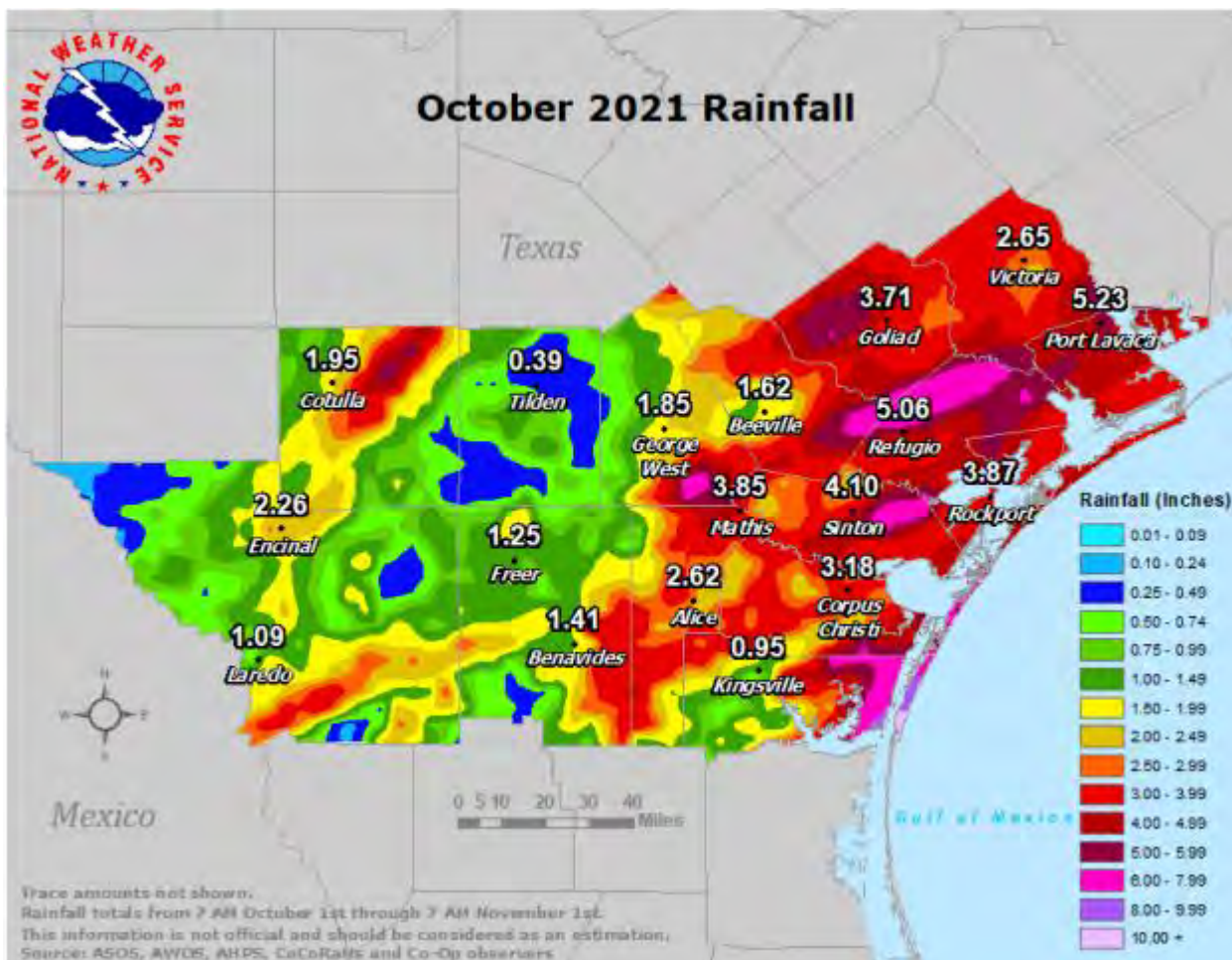


Figure 3: October 2021 Estimated Rainfall Totals

## Corpus Christi Regional Summary (continued)

November's rainfall totals were pretty seasonable, except for Southern Brush Country where some areas saw as much as 3" above normal. Several cold fronts moved across the area during the month resulting in scattered to numerous showers. Early in the month when the first front moved across the area, observers in the Southern Brush Country reported accumulations between 1" - 3" of rain with isolated amounts up to 5". During the middle of the month, weak fronts swept across the area resulting in weak showers. The next significant event for the month occurred over the Thanksgiving holiday as another cold front moved across South Texas. Observers across the Coastal Bend and Victoria Crossroads reported accumulations between 1" - 3" with isolated reports of 4". Meanwhile, observers across the rest of the CWA reported amounts of 1" or less. Summing the reports from all the cold fronts, observers reported accumulations between 1" - 6" for the month of November.

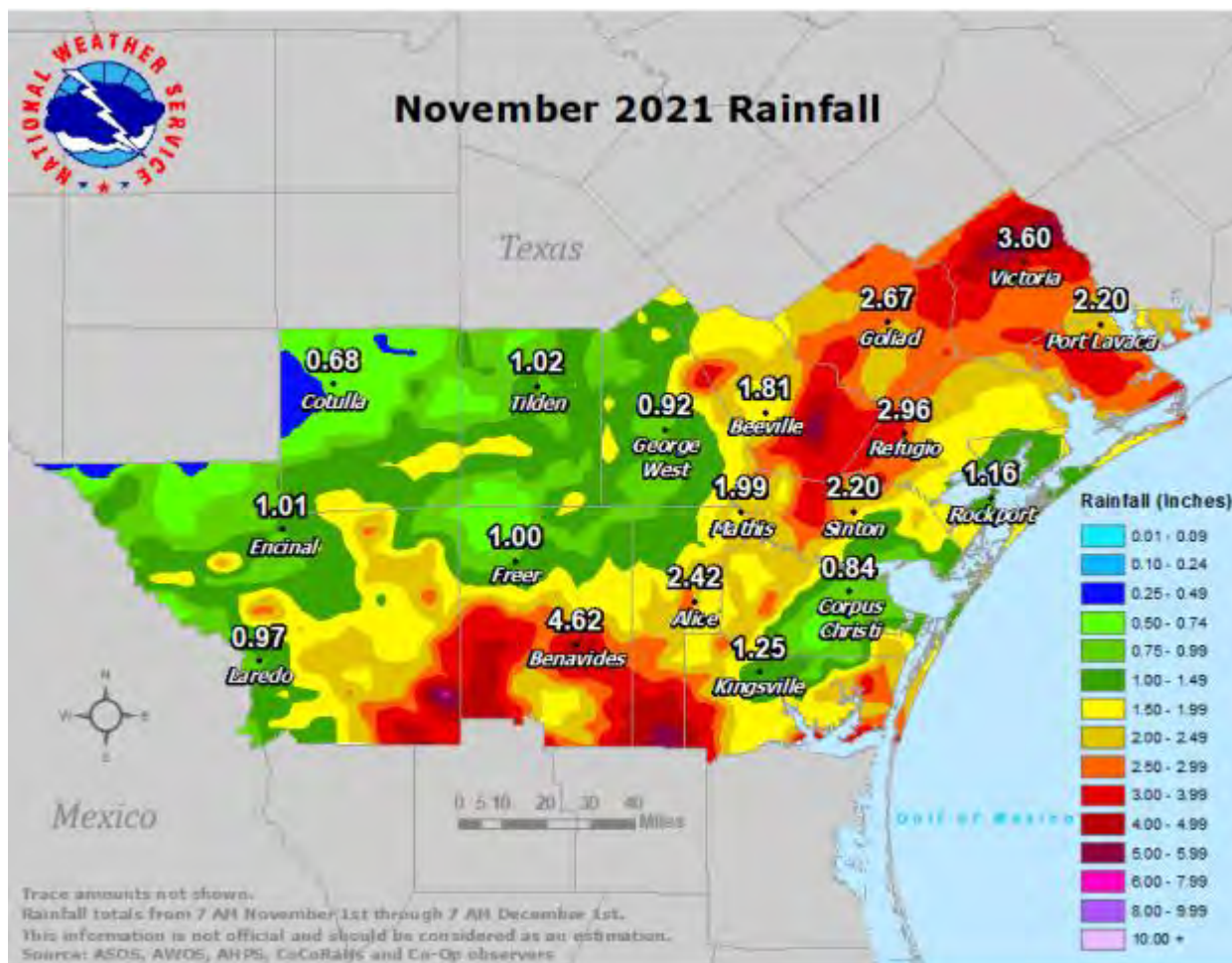


Figure 4: November 2021 Estimated Rainfall Totals



## West Texas/ SE New Mexico Regional Summary

West Texas and Southeast New Mexico saw a dry, warm fall, courtesy of a strengthening La Nina.

By: James DeBerry,  
Meteorologist/Hydrology  
Program Manager, NWS Midland

### September

September was a dry month, with little notable hydrologic activity, even as the synoptic pattern transitioned from summer to fall. No flooding was reported.

Monthly radar rainfall estimates ranged from nothing in parts of the Presidio Valley to 4-5" in isolated areas throughout the domain. However, the highest observed rainfall was only 2.40" at Dog Canyon in Culberson County. The average of rainfall reported across West Texas and Southeast New Mexico was 0.71". Reservoir levels averaged 64.0% of conservation capacity as of October 1<sup>st</sup>:

### October

October was a fairly dry month, and little hydrologic activity was reported. The one event of note occurred on October 21, when thunderstorms developed in the vicinity of Rio Grande Village in Brewster County. Debris and mud flows rendered several roads impassable. Intense rainfall on both sides of the river brought the Rio Grande into flood at Boquillas.

Monthly radar rainfall estimates ranged from nothing over much of west of the Pecos to up to 4" in southwest Brewster County. The highest observed rainfall was 2.45" at the Cope Ranch in Reagan County. The average of rainfall reported across West Texas and Southeast New Mexico was just 0.37".

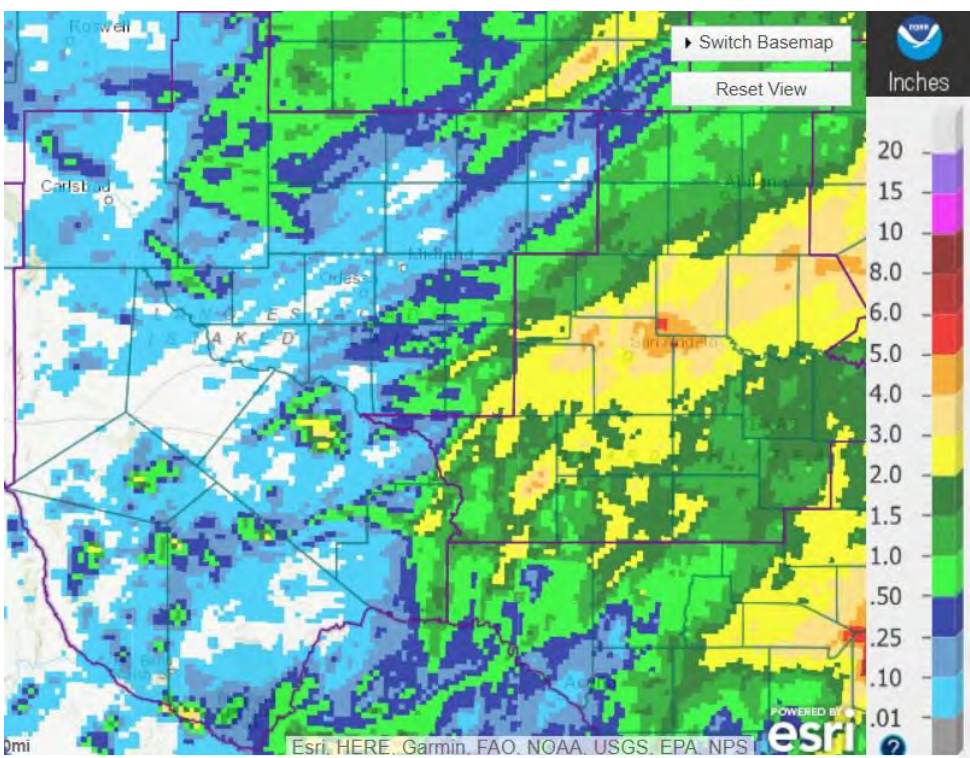
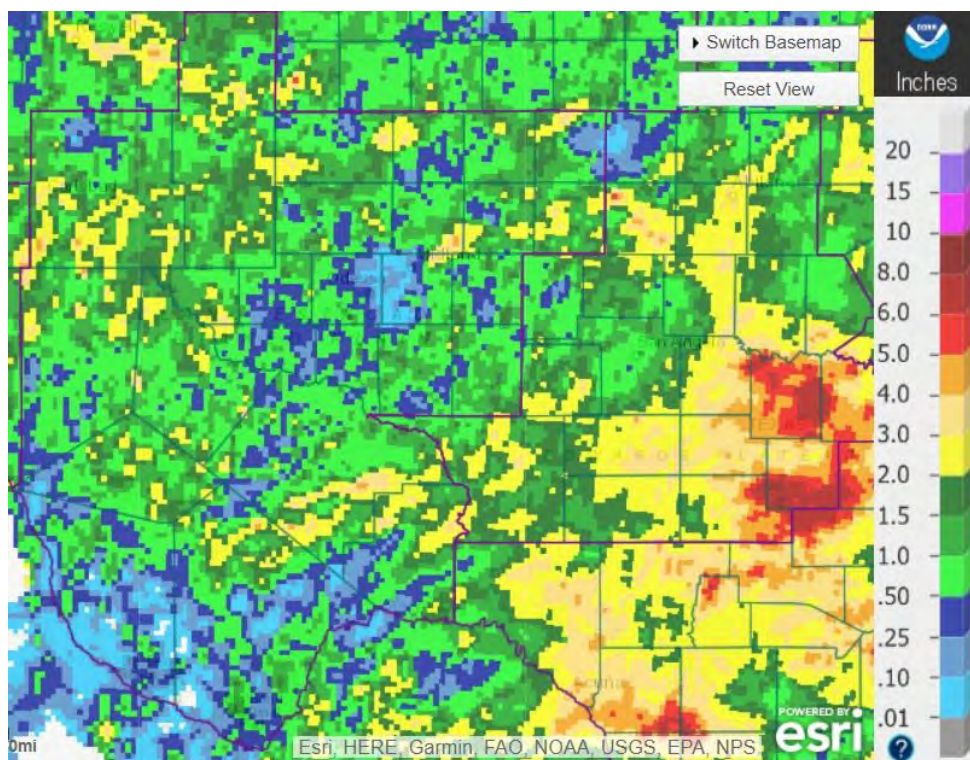


Figure 2: October Precipitation



## West Texas/ SE New Mexico Regional Summary (continued)

### November

The drought continued in November under La Nina, with meager rainfall and no notable hydrologic activity. As of 1 December, Midland International Air and Space Port has gone 61 days without measurable rainfall.

Monthly radar rainfall estimates were the lowest in some time, and ranged from nothing over much of West Texas and Southeast New Mexico to 1" in eastern Reagan County. The highest observed rainfall was 0.42" at Brantley Dam in Eddy County. The average of precipitation reported across West Texas and Southeast New Mexico was just 0.07".

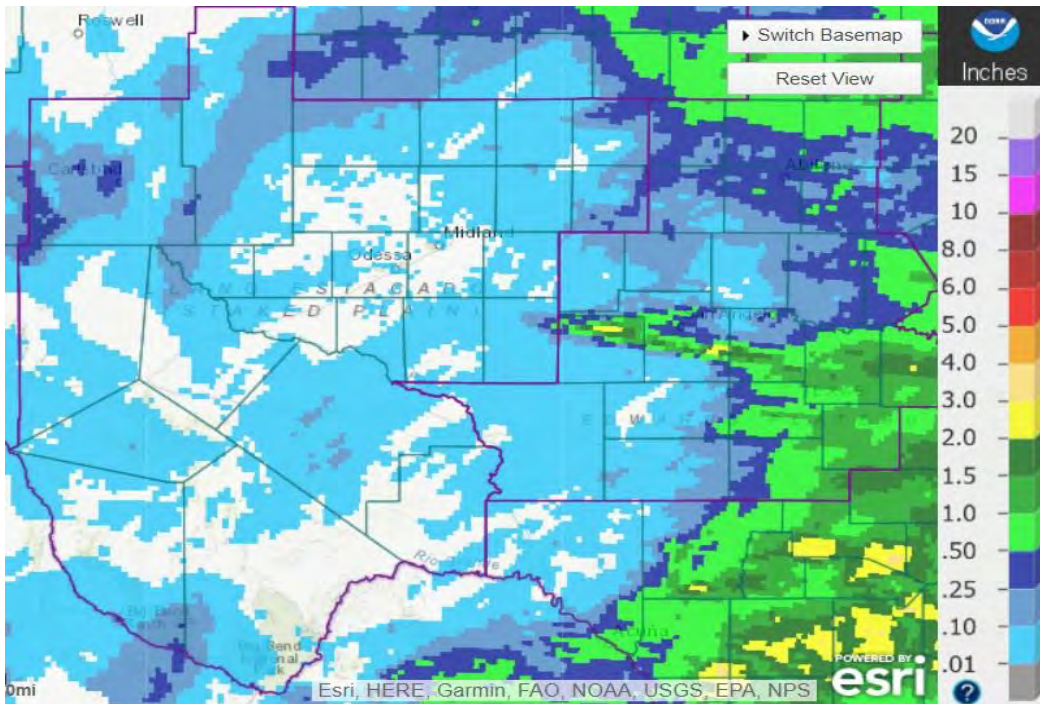


Figure 3: November Precipitation

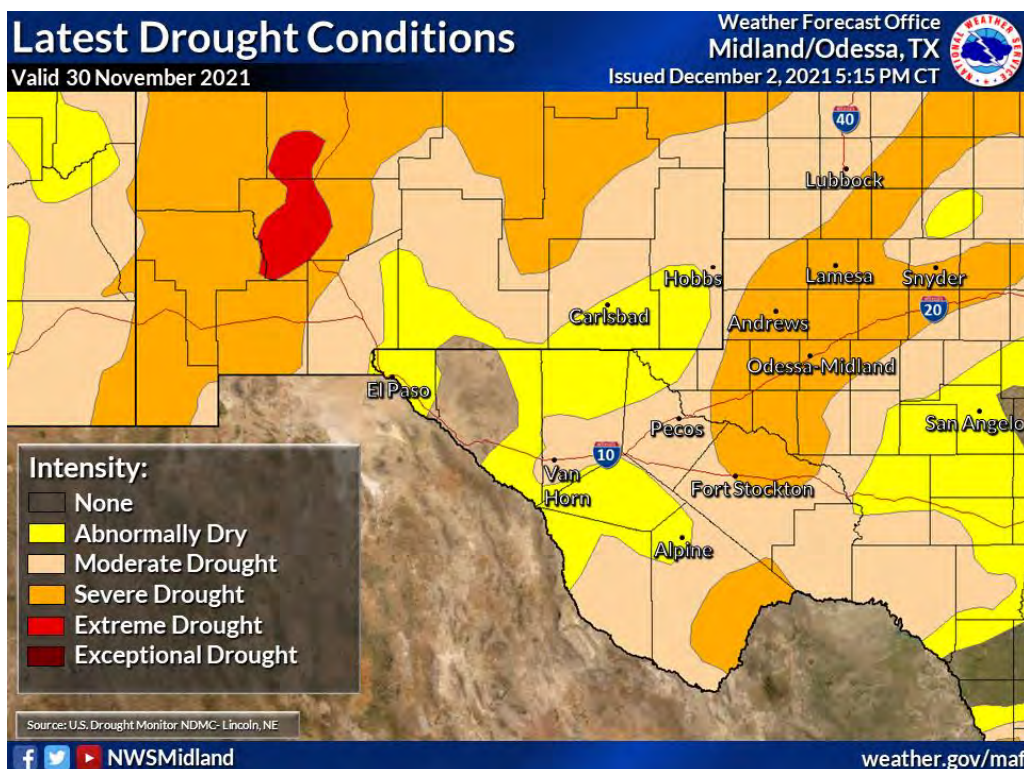


Figure 4: Drought conditions at the end of autumn across Western Texas



## Rio Grande Valley Regional Summary

### Autumn 2021 in the Lower Rio Grande Valley: Warm, Wet...and Dry

*October, November Rains Make Up September Deficits for Many*

By: Barry Goldsmith, Warning Coordination Meteorologist, NWS Brownsville/Rio Grande Valley

*Season ranks among top ten warmest, all-time*

### Autumn 2021 Temperature and Rainfall Across the Rio Grande Valley

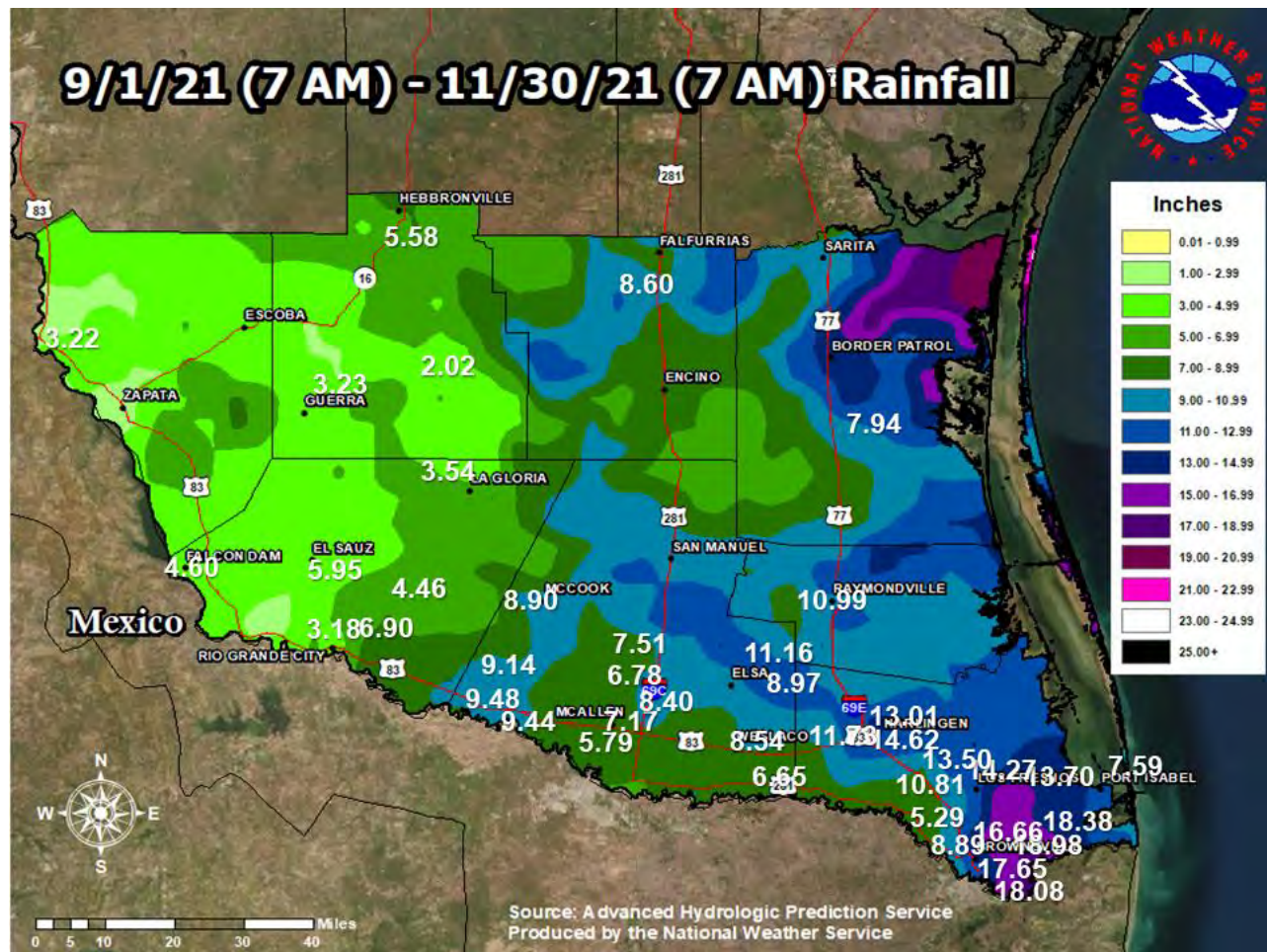
Location	Avg. Temp	Rank (since)	Record (year)	Total Rainfall	Rank (since)	Record (year)
Brownsville	78.5	2 (1878)	79.6 (2016)	17.65	14 (1878)	31.60 (1886)
Harlingen	77.3	8 (1912)	79.6 (2016)	14.62	17 (1912)	24.55 (1933)
McAllen	78.4	9 (1941)	82.4 (2016)	5.79	45 (1941)	18.82 (2003)
Edinburg	77.4	2 (2000)	78.1 (2012)	6.97	11 (2000)	18.52 (2003)
McCook	76.7	8 (1942)	78.5 (2016)	8.90	16 (1942)	24.90 (1967)
Rio Grande City	77.6	6 (1897*)	80.7 (1901)	3.18	20 <sup>th</sup> driest	0.47 (1938)

Top Ten Warmest
Top Twenty Driest
Comparison to Wet Record
Top Twenty Wettest
Comparison to Dry Record

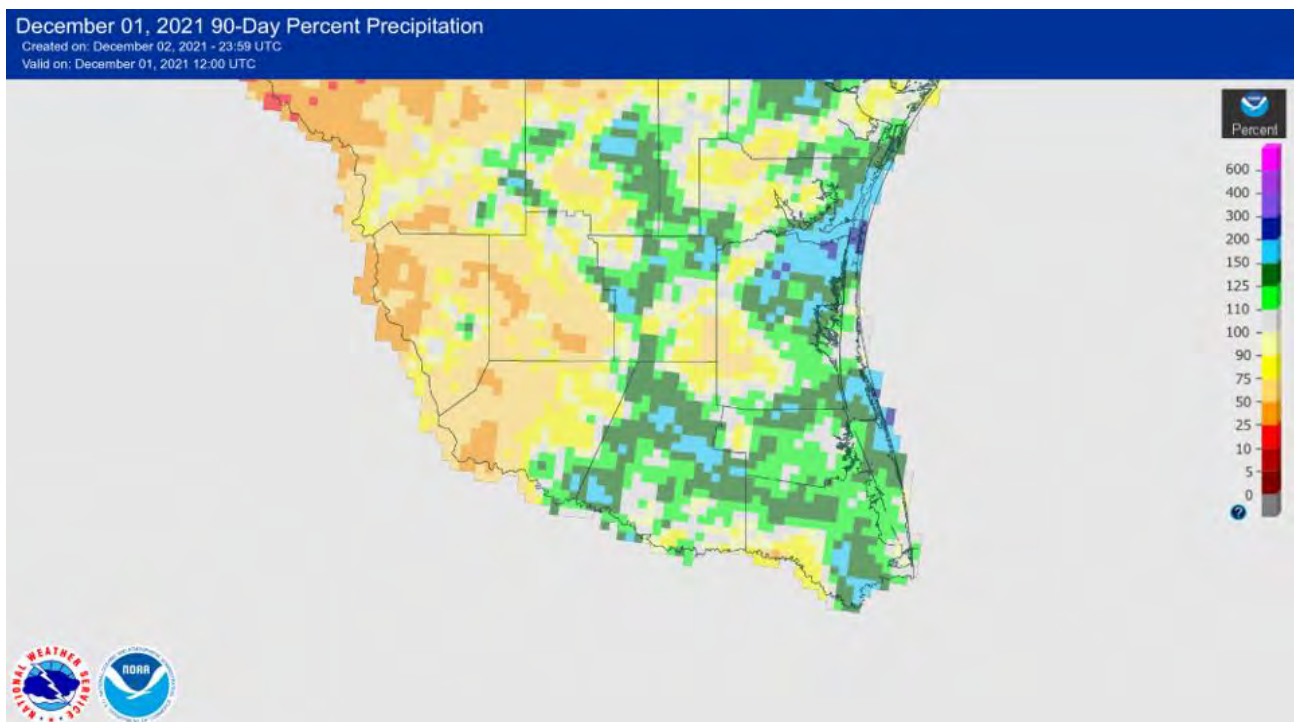
Autumn 2021 continued a trend that has dominated much of the 21<sup>st</sup> Century: Much warmer than long-term average temperatures – and a continuation of summer-like temperatures well into the 10<sup>th</sup> and even parts of the 11<sup>th</sup> month of the calendar year. Most primary locations across the Lower Rio Grande Valley reached top ten warmest status; for Brownsville and McAllen, this was the sixth time in the past decade that autumn temperatures ranked in the top ten. A near-record warm start to December will likely ensure that 2021 ranks in the higher tier of all-time temperatures; as of December 8<sup>th</sup>, Brownsville sat at 18<sup>th</sup> warmest (144 years on record); Harlingen sat at 23<sup>rd</sup> warmest (110 years), and McAllen sat at 29<sup>th</sup> warmest (81 years).

Rainfall varied across the region. In general, higher rainfall occurred along and east of Interstate 69-C (IH-69C)/US 281, from McAllen to Falfurrias to the Lower Texas coast. The lack of rainfall (with few exceptions) during the climatologically wettest month of the year (September) carried through October across the Deep South Texas Brush Country and Rio Grande Plains before November rains improved severe drought to just abnormally dry conditions. Toward the coast, a dry to very dry September was eliminated by more widespread heavy rain events in October and November. The following are brief summaries of each month in autumn 2021.

## Rio Grande Valley Regional Summary (continued)



**Figure 1. Annotated autumn 2021 rainfall map for the Lower Rio Grande Valley/Deep S. Texas region. Observations are a combination of CoCoRaHS, Automated Surface Observation Stations (ASOS), Automated Weather Observation Stations (AWOS), and Texas Mesonet stations.**



**Figure 2. The "west", not the best: Starr, Jim Hogg, and Zapata County were generally dry, while Hidalgo and Brooks County to the Lower Texas Coast were generally wet in autumn 2021.**



## Rio Grande Valley Regional Summary (continued)

### September

The month began with little fanfare, other than searing heat and no rainfall relief for the first week of the month. The month is traditionally known for several tropical-type events, from tropical waves to full blown hurricanes. 2021 met the criteria, but only briefly, as a sheared-out Tropical Storm Nicholas with a very tight center “waved” to the Lower Texas coast early on September 13<sup>th</sup>. Nicholas’ very small center passed a mere 30 miles east of South Padre Island; outer rain bands dropped a welcome 1 to 2.5” along and east of IH-69C but only sprinkles across most of Jim Hogg and Starr County. Additional rains of 0.5 to 1” fell along IH-69C that afternoon, ending the threat for an early start of drought by mid-month. Relief was short-lived, as little to no rain fell for the rest of the month, with two local exceptions: Brownsville during the morning of September 30<sup>th</sup> (2.33”) and Brooks County that afternoon (radar estimated 3 to 5” on the Brush Country region).

#### September 13, 2021 1-Day Observed Precipitation

Created on: December 10, 2021 - 01:25 UTC  
Valid on: September 13, 2021 12:00 UTC

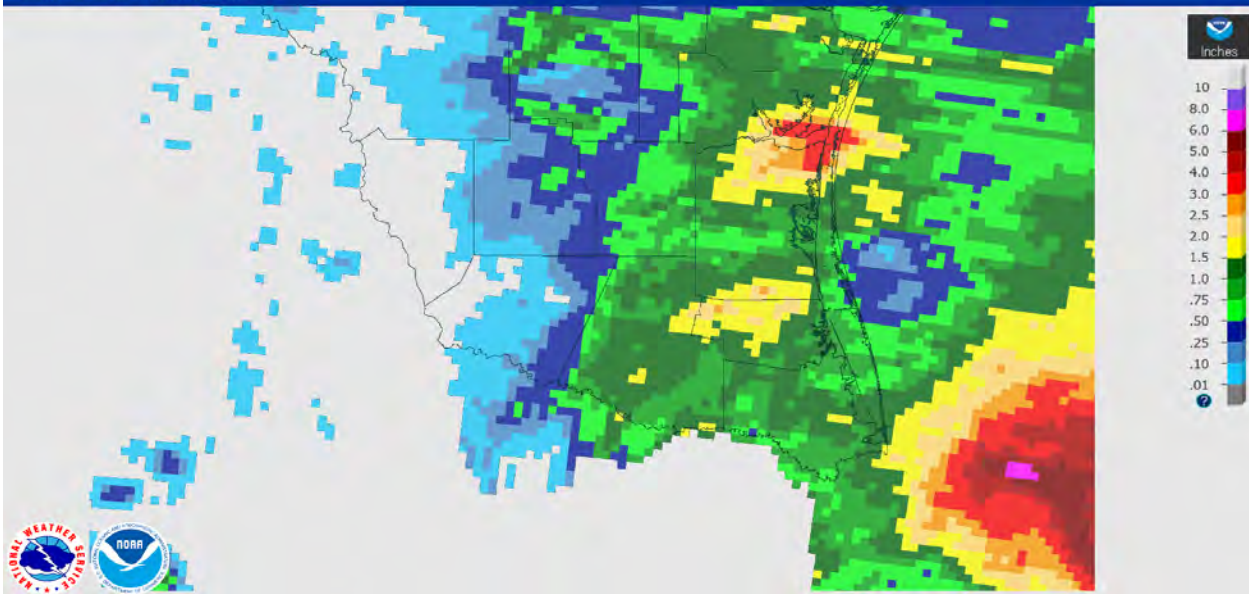


Figure 3. Rainfall associated with Tropical Storm Nicholas and the associated shear axis. Note the core of heavy rainfall, estimated at 8" or more, with the core of Nicholas 30 miles east of South Padre Island.

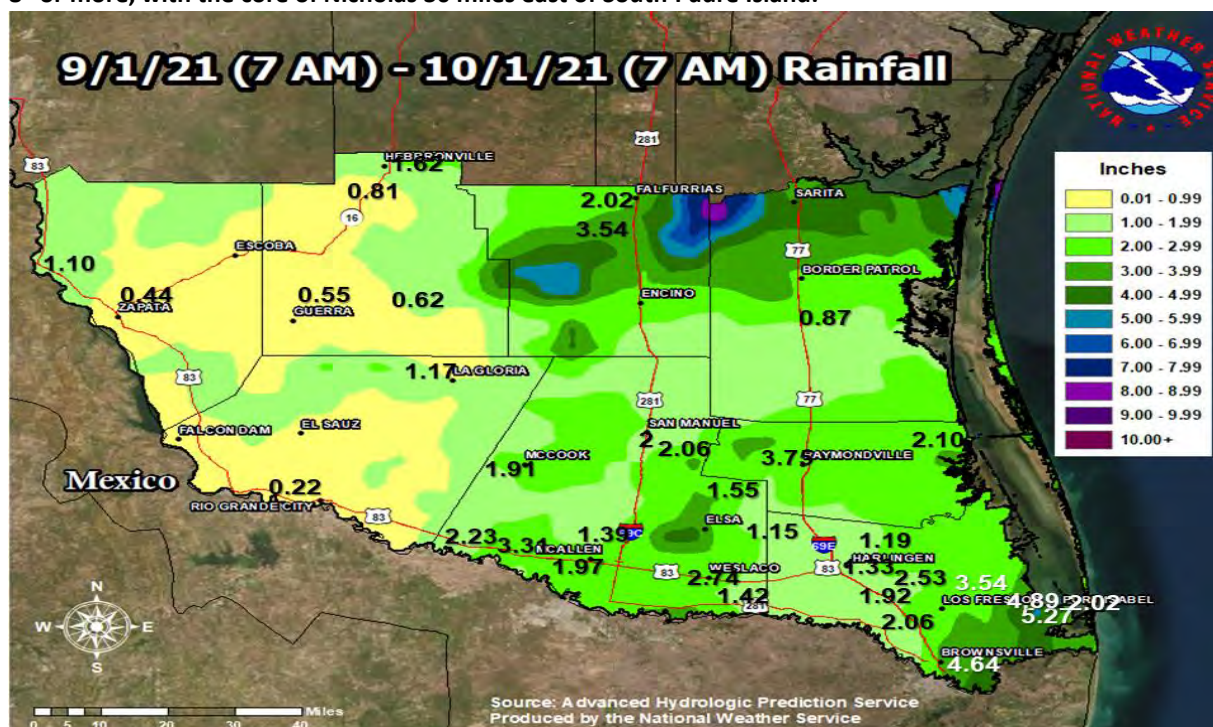


Figure 4. Annotated September 2021 rainfall map for the Lower Rio Grande Valley/Deep S. Texas region. Observations are a combination of CoCoRaHS, Automated Surface Observation Stations (ASOS), Automated Weather Observation Stations (AWOS), and Texas Mesonet stations

## Rio Grande Valley Regional Summary (continued)

### October



Figure 5. Photo of resaca/retention area over spilling banks onto Vermillion Ave. in east Brownsville, closing the road, on October 1-2, 2021. Location was very close to peak rainfall from CoCoRaHS observer for the event (10.72 daily total).

In a single day, the lack of “typical” monthly rainfall expected in September was made up for many times over on the 1<sup>st</sup>. Deep tropical moisture, multiple convective boundaries, and sufficient upper-level energy moving between a trough of low pressure across the U.S. Four Corners region and a subtropical ridge over the western Gulf combined to create record torrential rain and widespread flooding, generally along and east of IH-69E/US 77 from Cameron through Kenedy County. Six to more than 10” fell in multiple rain bands, culminating in a deluge estimated at 4” per hour for two hours across the east side of Brownsville during the peak of the Friday afternoon/evening commute. A CoCoRaHS observer just north of the NWS Office in east Brownsville reported 10.72” on the 1<sup>st</sup>, and a two-day total of 13.53” that included the aforementioned morning downpour on September 30<sup>th</sup>. Brownsville and Harlingen each shattered their all-time official NWS October 1<sup>st</sup> rainfall record by more than 5”, and Harlingen’s 7.97” was the second highest calendar day rainfall on record (since 1911), only surpassed by 9.79 inches on April 5, 1991.



## Rio Grande Valley Regional Summary (continued)

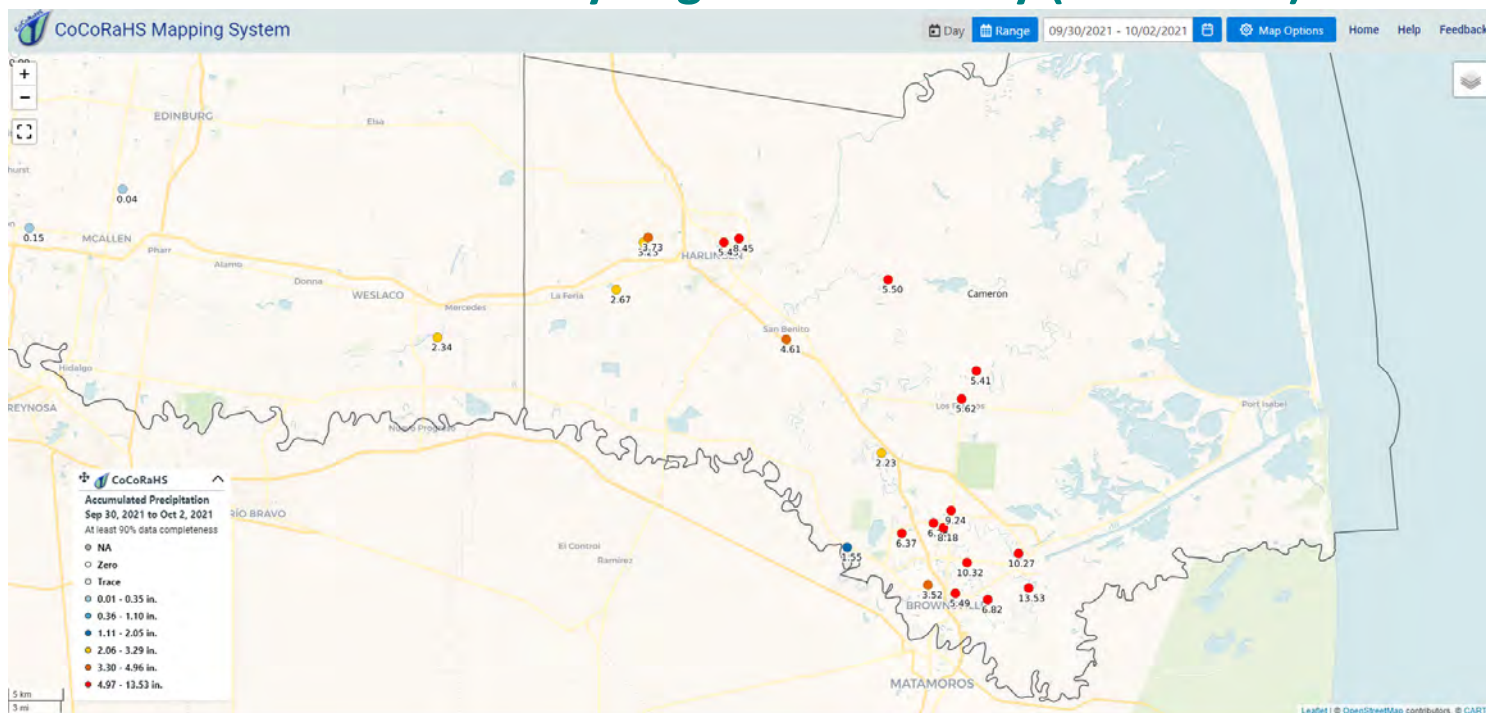


Figure 6. CoCoRaHS mapping system map of rainfall from October 1, 2021, in Cameron County.

Following the inundation (and disaster declaration) in Cameron County on the 1<sup>st</sup>, October settled in as a hot month, with the lack of rainfall from Brooks and Hidalgo County west to Zapata County pushing the month into or near the top ten driest October in McAllen (12<sup>th</sup> driest) and Edinburg (9<sup>th</sup> driest, but only 21 years of record). Brownsville and Harlingen, buoyed by the record-shattering daily rainfall on the 1<sup>st</sup>, ended up among the top ten wettest (Brownsville, 10<sup>th</sup>; Harlingen, 5<sup>th</sup>). Additional rains in Harlingen and Brownsville around the 15<sup>th</sup>/16<sup>th</sup> and again on the 22<sup>nd</sup> combined with the earlier rainfall was enough to keep drought conditions from returning. Such was not the case across Jim Hogg, Starr, and Zapata County, where the lack of first-half-of-autumn rainfall and the aforementioned heat worsened conditions to severe (Drought level D2) to begin November.

### October 2021 Across the Rio Grande Valley: Hot, Dry...and Wet

Location	Avg. Temp	Rank (since)	Record (year)	Total Rainfall	Rank (since)	Record (year)
Brownsville	80.1	4 (1878)	80.4 (2004)	9.17	10 (1878)	17.12 (1958)
Harlingen	78.6	8 (1912)	80.9 (2004)	9.35	5 (1912)	11.09 (2003)
McAllen	80.5	4 (1941)	82.9 (2016)	0.29	67 (12 <sup>th</sup> driest) (1941)	12.04 (1958)
Edinburg	79.5	3 (2000)	80.7 (2016)	1.04	16 (9 <sup>th</sup> driest)	6.35 (2002)
McCook	78.4	6 (1942)	81.1 (2004)	3.36	21 (1942)	10.00 (2003)
Rio Grande City	79.5	5 (1897*)	82.3 (1901)	Incomplete	N/A	9.20 (2003)



Top Ten Warmest



Top Twenty Wettest



Top Twenty Driest

## Rio Grande Valley Regional Summary (continued)

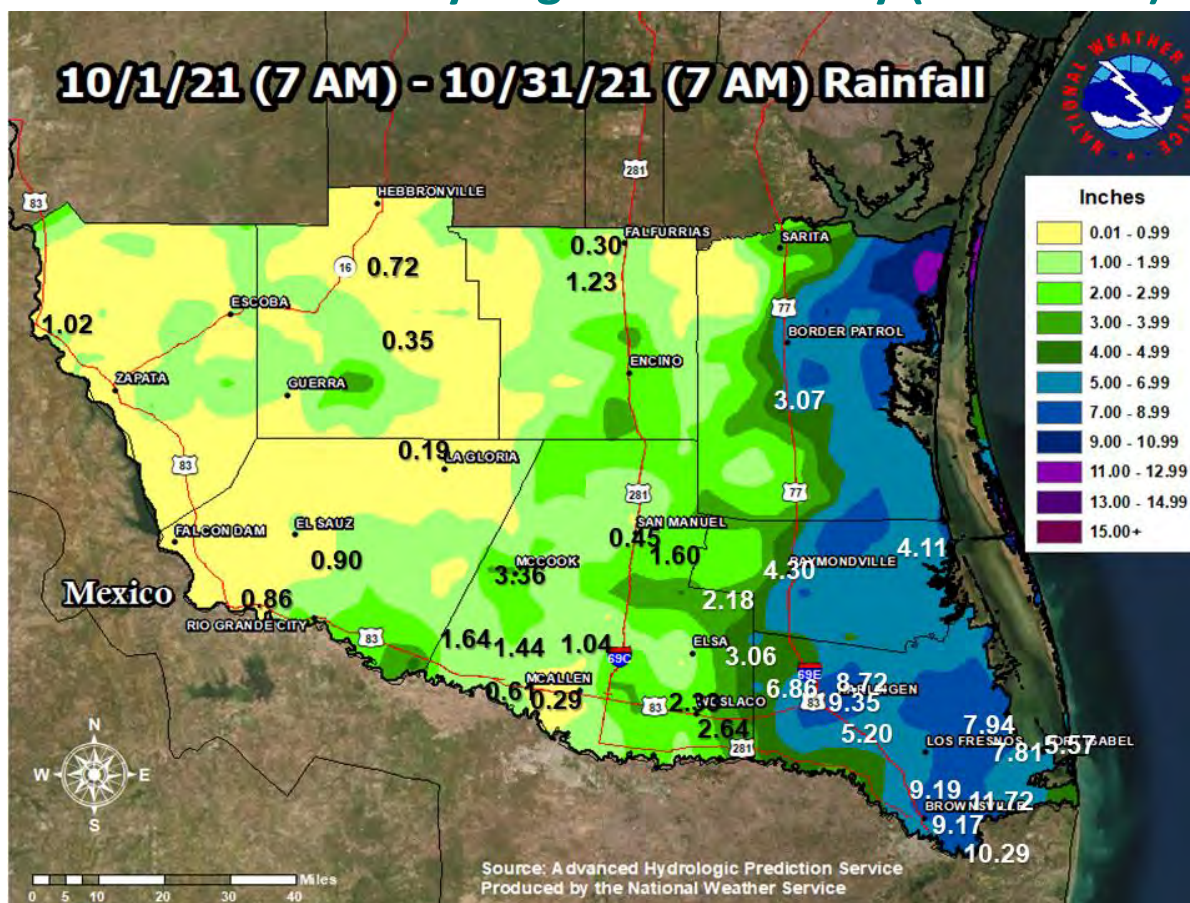


Figure 7. Annotated October 2021 rainfall map for the Lower Rio Grande Valley/Deep S. Texas region. Observations are a combination of CoCoRaHS, Automated Surface Observation Stations (ASOS), Automated Weather Observation Stations (AWOS), and Texas Mesonet stations.

### October 01, 2021 Monthly Percent Precipitation

Created on: December 03, 2021 - 19:27 UTC

Valid on: November 01, 2021 12:00 UTC

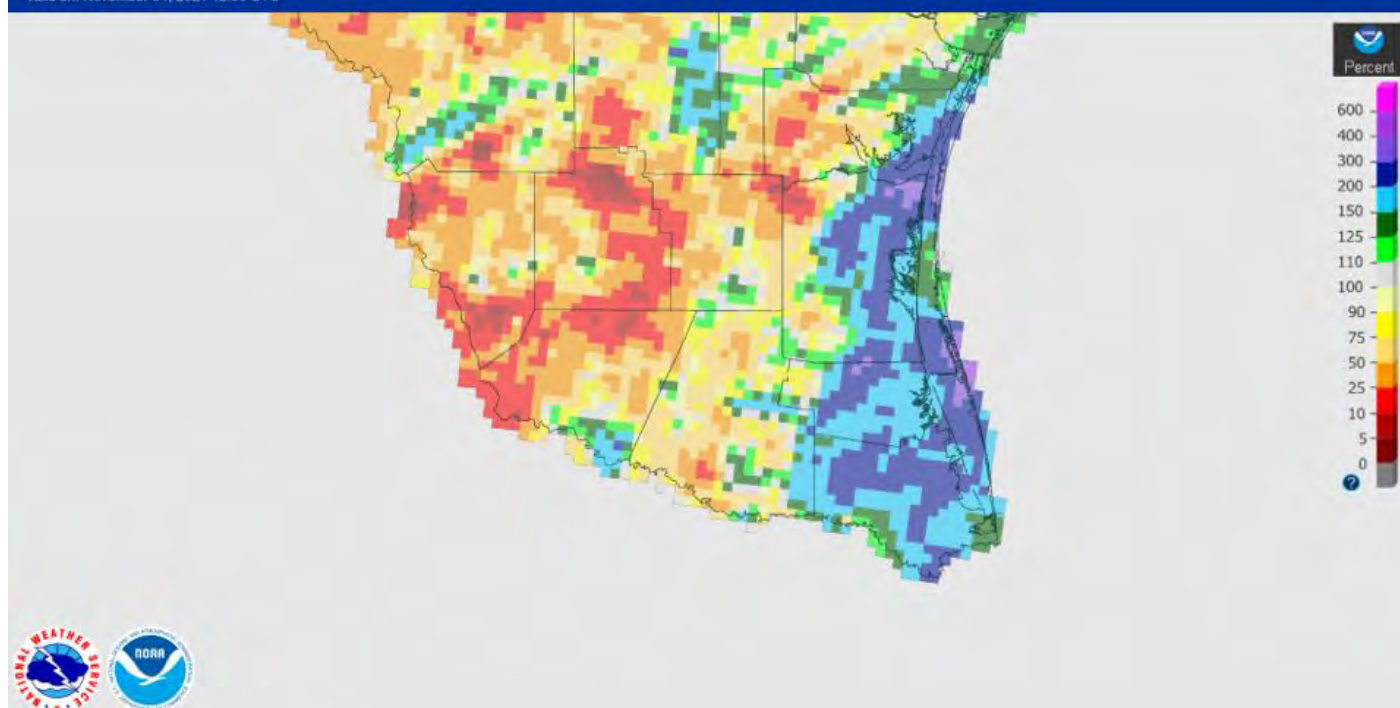


Figure 8. Percent of monthly rainfall, October 2021.



## Rio Grande Valley Regional Summary (continued)

### November

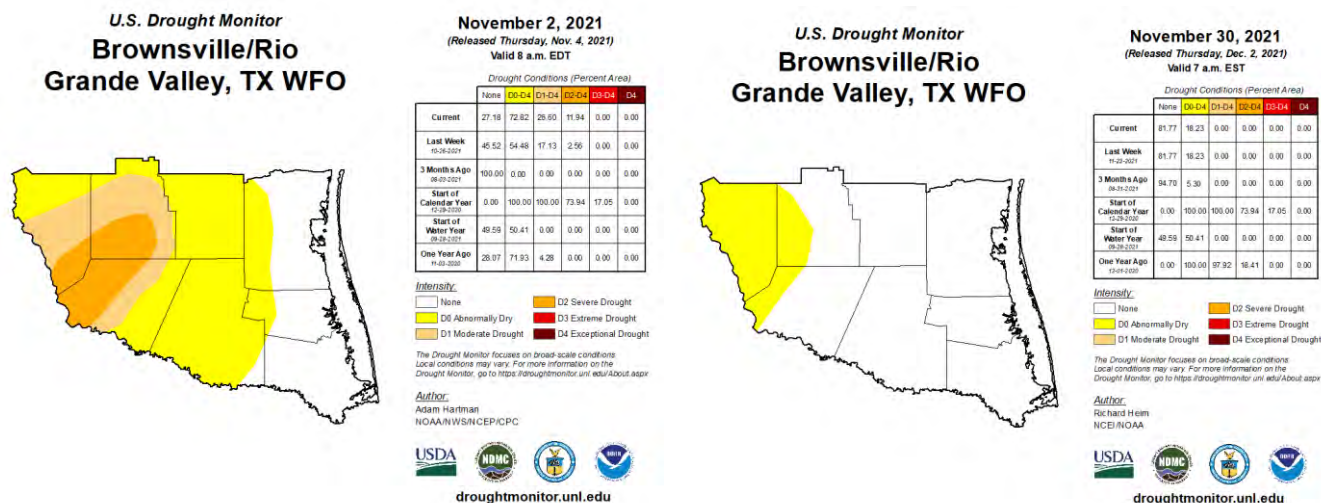


Figure 9. Drought conditions on November 2 (left) and November 30 (right).

Autumn's first significant cold front rolled across the Lower Rio Grande Valley on November 4<sup>th</sup>, accompanied by fairly widespread clusters of showers and thunderstorms including northern Jim Hogg, much of Zapata, and a large swath of northern Hidalgo County. Pockets of 3" to 4" of rain in areas that desperately needed it would begin to improve drought conditions across these areas, as temperatures fell into the 50s and lower 60s behind the front. Temperatures quickly rebounded by the 7<sup>th</sup>, with a stretch of above average temperatures until the next "wet" front on November 18<sup>th</sup>, when rainfall of 1.5" to 3" fell in stripes from the Rio Grande east of Brownsville through central Hidalgo County/eastern Starr, northward through Brooks County, with heaviest rains (3.49") falling just east of Brownsville.

The month's final cold front would bring the chilliest air of the season on Black Friday, preceded by more helpful, drought-repelling rains mainly from Brooks and Hidalgo County toward the coast on Thanksgiving Day. The multiple rain events that covered nearly all of the Lower Rio Grande Valley/Deep South Texas region in November relegated dryness to the Rio Grande Plains/Brush Country by month's end. In a month that typically known to be one of the driest on the calendar, November overachieved – by 150 to 600 percent of the 1991-2020 averages (Figure 11).

## Rio Grande Valley Regional Summary (continued)

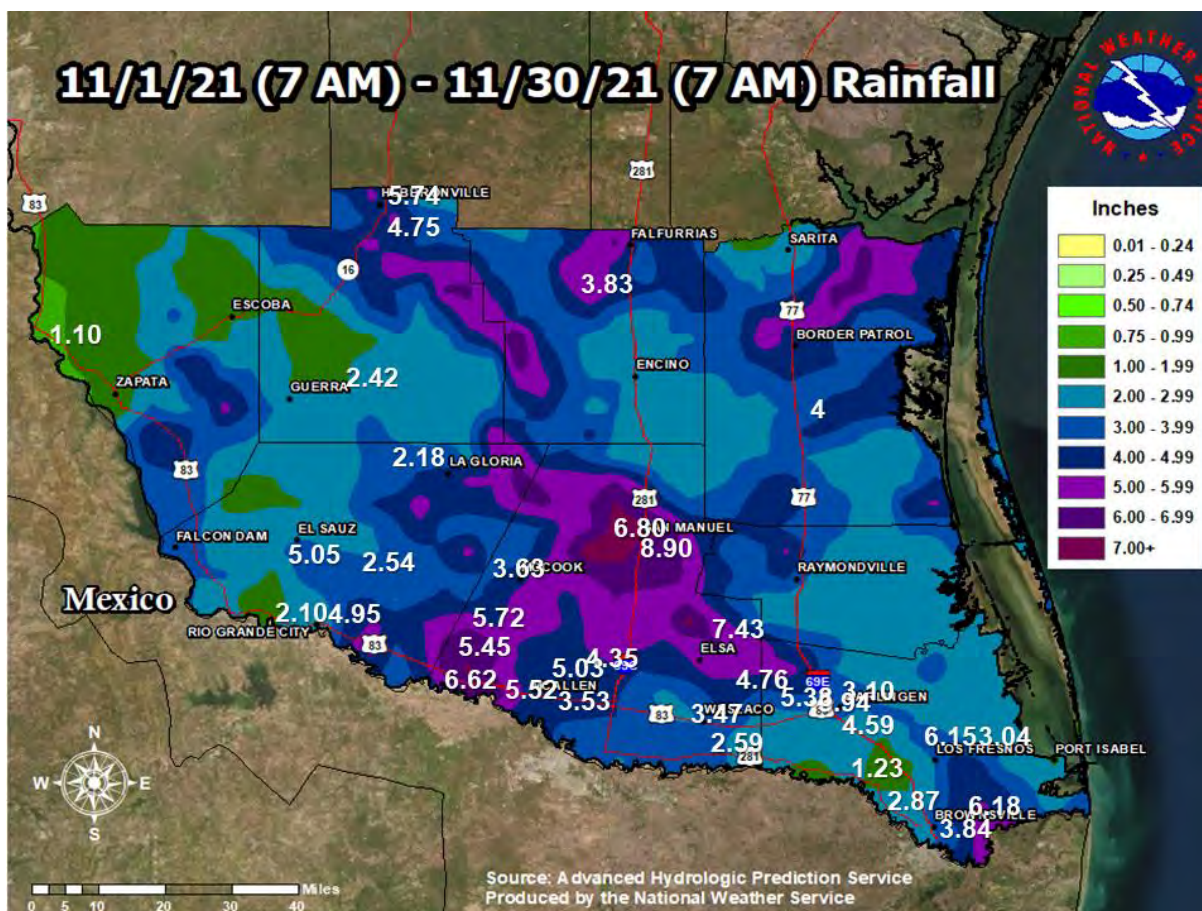


Figure 10. Annotated November 2021 rainfall map for the Lower Rio Grande Valley/Deep S. Texas region. Observations are a combination of CoCoRaHS, Automated Surface Observation Stations (ASOS), Automated Weather Observation Stations (AWOS), and Texas Mesonet stations.

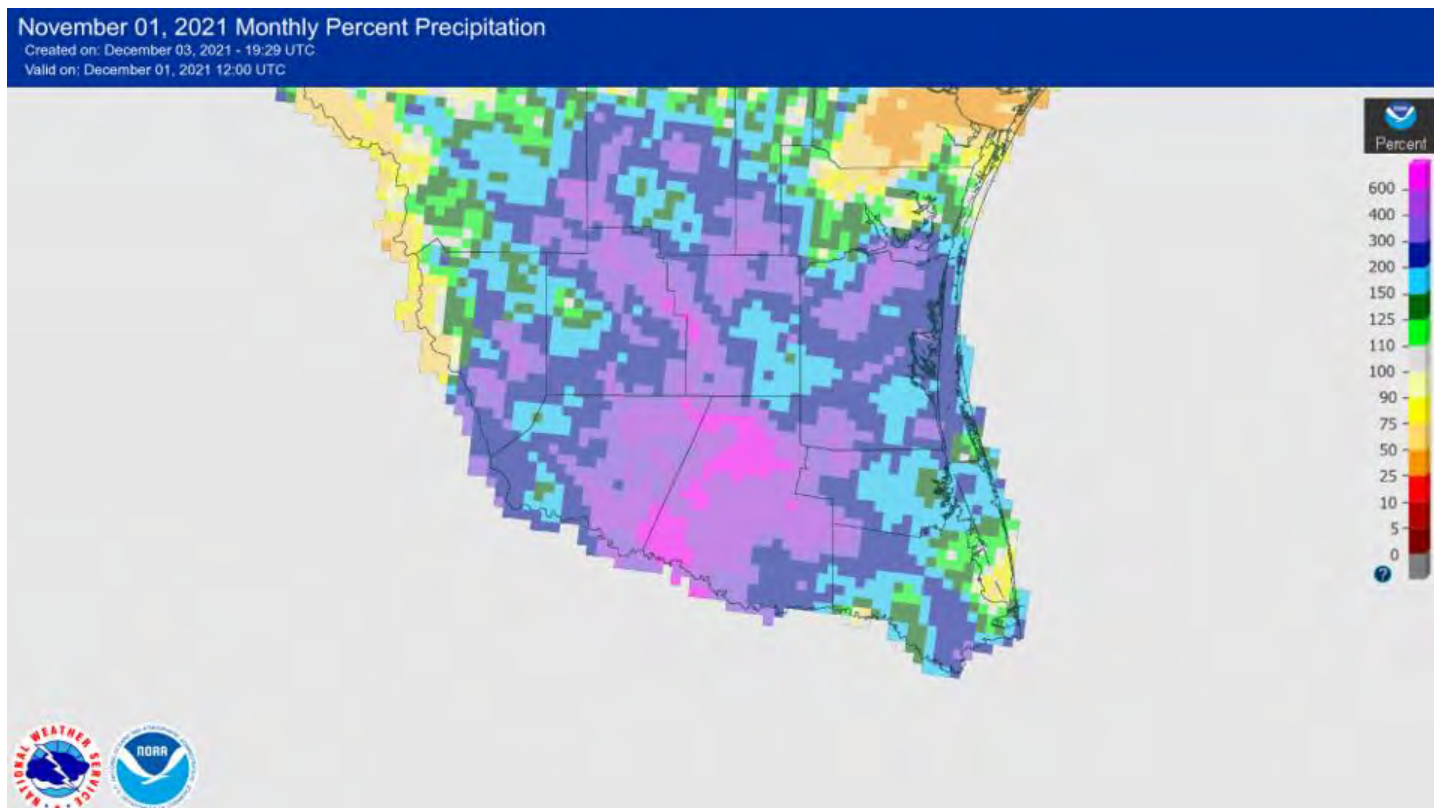


Figure 11. Percentage of average rainfall, November 2021.



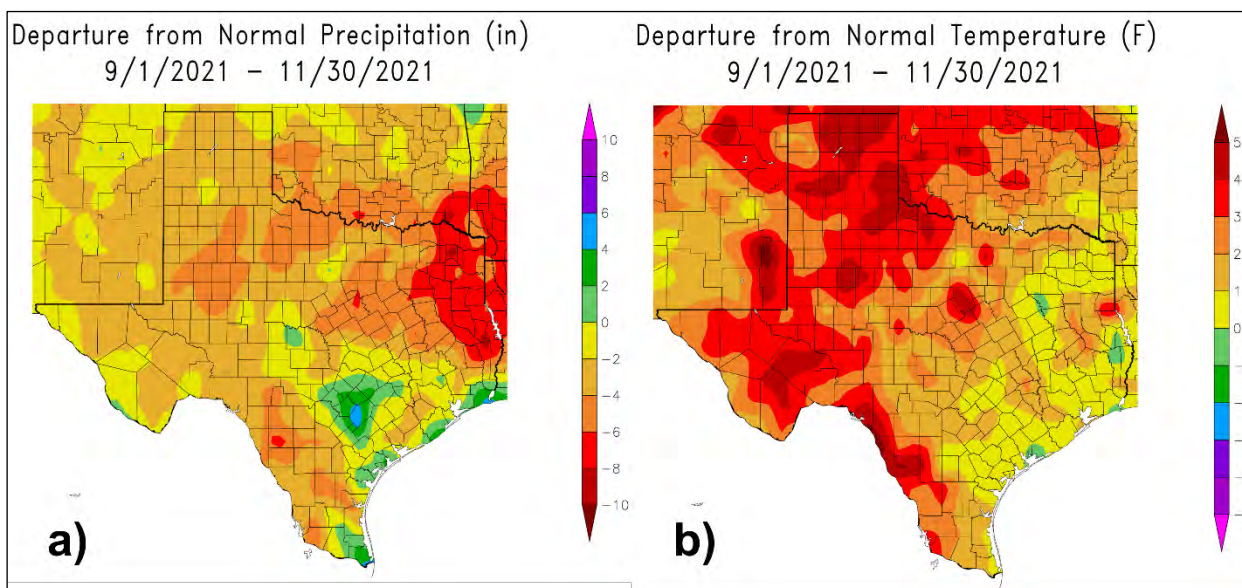
## Wichita Falls Regional Summary

### Drought Returns with Warm and Dry Fall

By Charles Kuster

CIWRO/NSSL

It was a very warm and dry fall in the Wichita Falls area. Rainfall was generally 4" to 6" below normal (Fig. 1a) and temperatures were generally 3 to 4 degrees Fahrenheit above normal (Fig. 1b). In total, we experienced 77 dry days (all CoCoRaHS stations reported less than 0.05") and 14 wet days (at least one CoCoRaHS station reported 0.05" or more) this fall. Interestingly, last fall was also quite dry, and we actually experienced exactly the same number of dry and wet days as this fall. November ended with 19 straight dry days and only had 3 wet days in total. As a result of the warm and dry weather, drought conditions have returned to our region. At the end of the summer, none of our area was under a drought designation according to the U.S. Drought Monitor (Fig. 2a). By the end of the fall, nearly our entire region was under moderate or severe drought (Fig. 2b).



**Figure 1. Departure from normal a) precipitation and b) temperature for the beginning of September through the end of November. Warm colors indicate below normal precipitation (a) and above normal temperatures (b), while cool colors indicate above normal precipitation (a) and below normal temperatures (b).**

With all of the dry weather lately, thanks to all CoCoRaHS observers reporting 0.00" every day! Reports of zero are also really important and help meteorologists better track and define drought. Another important way CoCoRaHS observers can help scientists track drought conditions is through the Condition Monitoring reports.

## Wichita Falls Regional Summary (continued)

These reports allow us to share what the landscape looks like in our area and how either wet or dry conditions might be affecting us and are used in the creation of the Drought Monitor maps (Fig. 2). Submitting such a report once a week can be a great addition to our normal CoCoRaHS daily reports.

For those interested, more info about these reports can be found here:

[https://media.cocorahs.org/docs/ConditionReportingGuide\\_1.4A/assets/player/KeynoteDHTMLPlayer.html#1](https://media.cocorahs.org/docs/ConditionReportingGuide_1.4A/assets/player/KeynoteDHTMLPlayer.html#1)

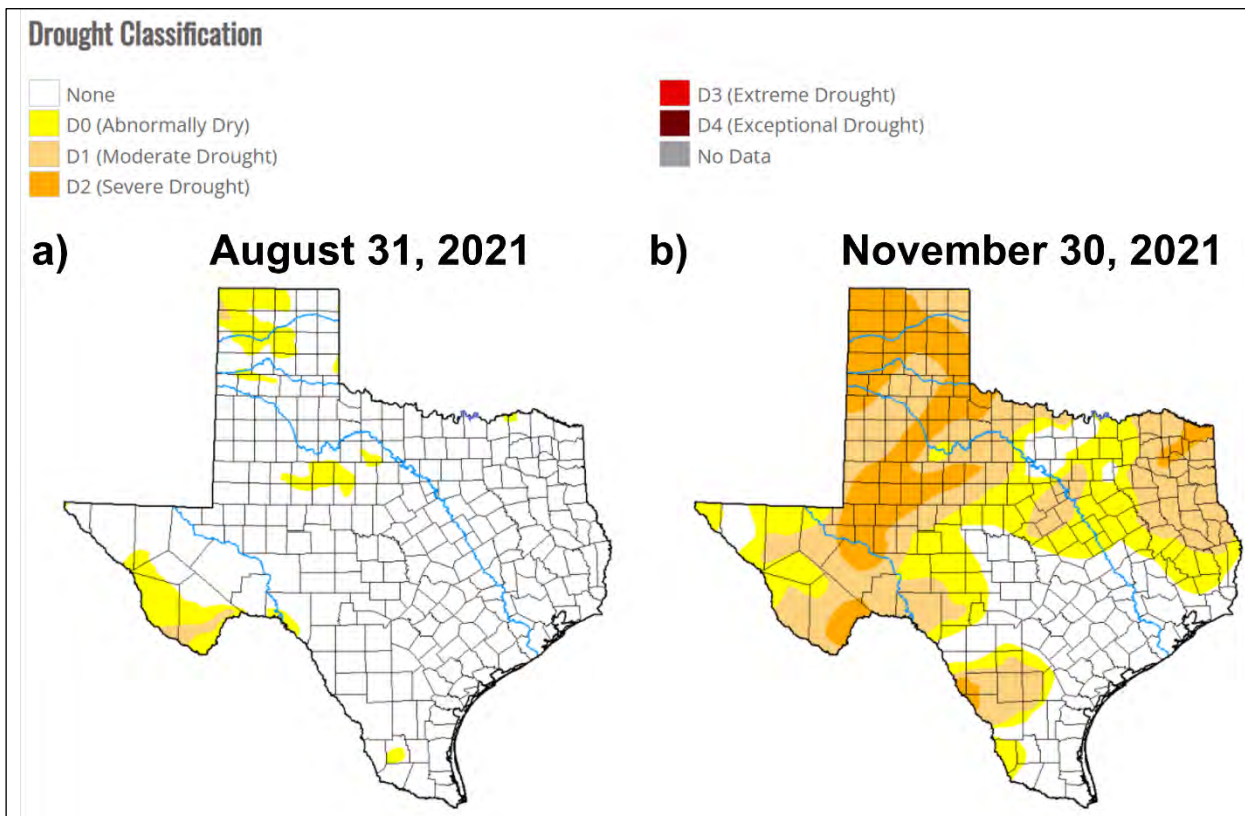


Figure 2. Change in drought conditions as defined by the U.S. Drought Monitor between a) August 31, 2021, and b) November 30, 2021.

*CoCoRaHS Texas would like to remind everyone that a 4 inch diameter rain gauge makes a great Christmas present for that special someone on your list this Christmas.*





## East Texas Regional Summary

### Drought Conditions Return to East Texas

**By: Davyon Hill, Meteorologist (National Weather Service-Shreveport, LA)**

Quite a contrast in seasons as the region went from above normal precipitation during the summer months, to well below normal rainfall by the start of the meteorological Fall. Generally speaking, the month of September was the driest month of 2021. The overwhelming majority of the CoCoRaHS sites reported less than 2" of rainfall for the month, with many of those sites reporting less than 1" of rain.

East Texas saw an increase in rainfall for the month of October, as all of our CoCoRaHS sites reported above 1" of total precipitation. However, amounts remained below the climatological normal of 4" to 5", as most CoCoRaHS locations reported monthly totals near 2". Despite the lack of precipitation, the region still managed to receive reports of severe weather during the month, as storms along cold fronts on the 10<sup>th</sup> and 27<sup>th</sup> produced sporadic wind damage.

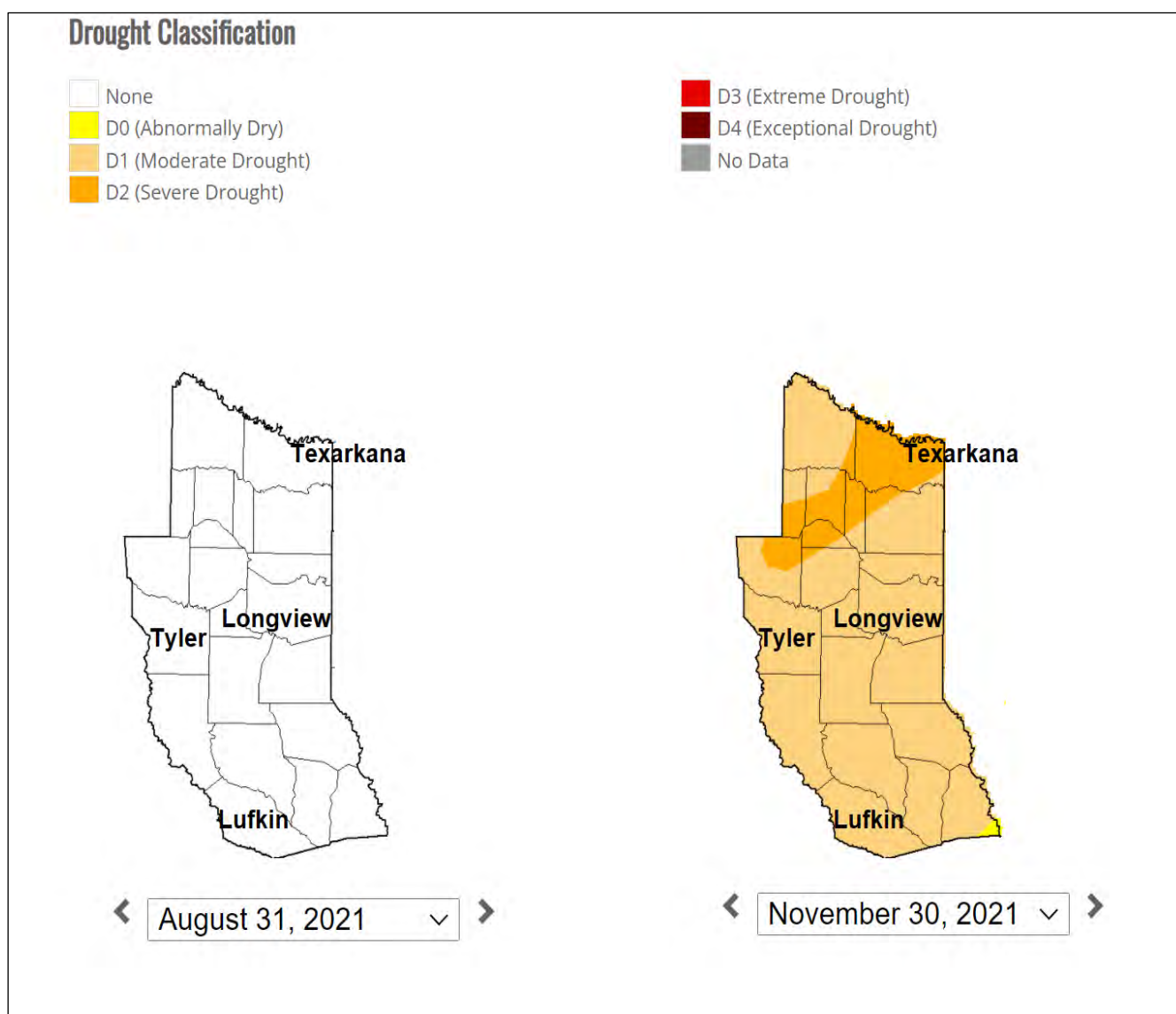


**Figure 1: A large billboard blown down – October 27, 2021  
Near downtown Lufkin, TX (Angelina County)  
Photo Credit: Lufkin Police Department**

## East Texas Regional Summary (continued)

Although precipitation amounts continued to increase as we moved through the month of November, monthly totals remained below the 4" to 5" climatological normal, as the majority of CoCoRaHS sites reported between 2" to 3" of rainfall. Like the previous 2021 autumn months, most of the rainfall occurred with the passage of cold fronts throughout the month. The frontal passage on the 11<sup>th</sup> (Veteran's Day) stood out the most, as it brought much needed widespread rainfall along with severe weather as two tornadoes, rated EF-0 and EF-1 respectively, were reported in Harrison County. Fortunately, damage was confined to some snapped tree limbs and a few uprooted trees.

In summary, below normal rainfall over the past few months has resulted in Fall 2021 being the driest season of the year. This has also allowed drought conditions to return to all of East Texas, with Severe Drought classification settling in some locations.



**Figure 2: Drought Monitor East Texas**  
**Image Courtesy of NDMC/USDA/NOAA**



## Texas Winter Weather Outlook for 2022

By: Bob Rose, Meteorologist, Lower Colorado River Authority

The winter season is here and most of us still have very vivid memories from last February's extremely cold and wintry weather. Texas climate records show this was a unique event, with just a handful of cold outbreaks as widespread and of similar cold magnitude in recorded history. Many factors in the atmosphere had to line up just right to deliver that kind of persistent, cold weather deep into the heart of Texas. While there's always some chance a similar cold outbreak could develop in every winter, the probability for it to happen is very low. In other words, while a repeat of last winter's extreme cold is within the realm of possibilities, the chance for a repeat this winter appears unlikely.

Winter 2021-2022 is actually shaping up to be a fairly mild dry winter across Texas. Although many factors go into predicting the winter pattern, the primary driver this winter is expected to be a weak to moderate La Niña. The La Niña developed back in September and quickly began to have a strong influence on the jet stream pattern across North America. Much of the western and southwestern U.S., including a good part Texas, saw below-normal rainfall over the fall months. At the same time, the position of the jet stream kept the coldest air up in Canada, enabling temperatures across most of the U.S. to average well above-normal.

Forecasts call for the weak to moderate La Niña to remain in place through early spring of 2022. Through much of the upcoming winter, La Niña is expected to direct the jet stream into the Pacific Northwest and western Canada, the central Plains states, and the Ohio Valley. This jet stream configuration will likely continue to keep much of the coldest air to the north of Texas and at the same time limit the number of storm systems that could potentially move into Texas.

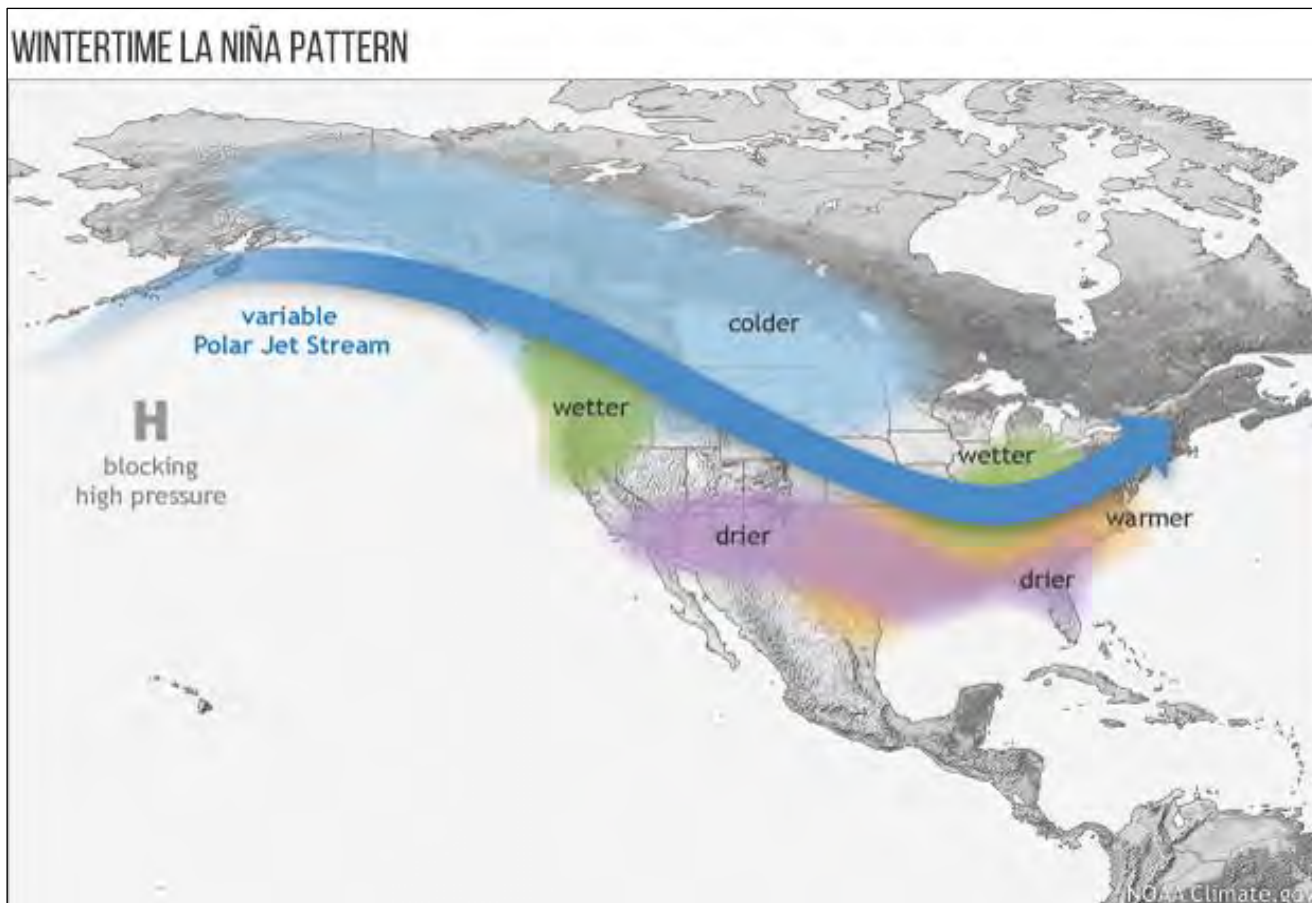


Figure 1: Typical wintertime upper level wind pattern during La Niña.

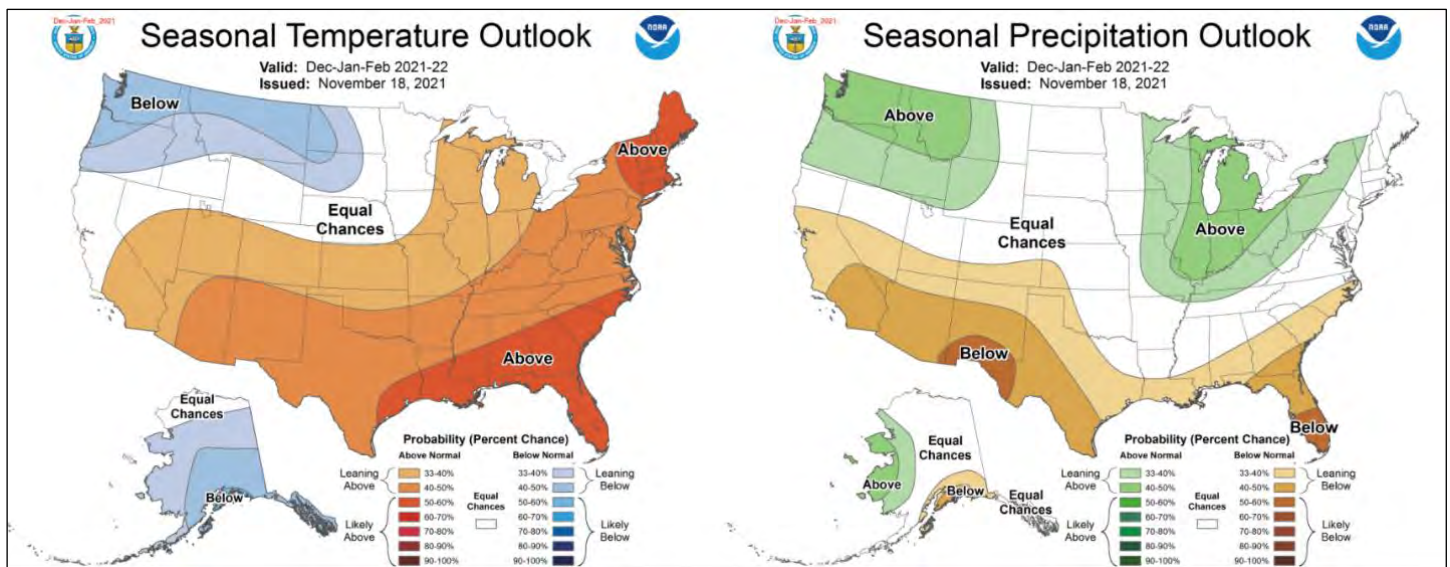
Surface weather patterns shown for mostly likely precipitation/temperature departure from normal.

## Texas Winter Weather Outlook for 2022 (continued)

Of course, La Niña will not be the only feature in the atmosphere or the oceans to have an influence on this winter's weather. However, La Niña is expected to be the strongest driver. But at times, other oscillations and features in the atmosphere may temporarily overwhelm the dry and mild influence from La Nina, allowing for intrusions of cold air and periods of rain. In fact, parts of the state may even see a few shots of wintry precipitation. However, these occurrences of cold, wet, or wintry weather are expected to be fairly short-lived.

Below-normal rainfall over the winter period is expected to cause the expansion of drought conditions across much of the state. For the western third of the state, where drought conditions developed in early fall, little drought improvement is expected.

The National Weather Service's winter weather outlook shows high odds temperatures will average above-normal and precipitation will average below-normal across the majority of Texas:



**Figure 2: Winter Seasonal Temperature and Precipitation Outlook for 2022**

It's shaping up to be a fairly mild and dry winter across Texas. Sustained periods of cold temperatures are not expected. However, drought expansion and drought deterioration are forecast. Let's hope conditions turn around in the spring when La Niña is predicted to dissipate, allowing the jet stream to return to a more normal configuration.



## Observer Tips, Information & Training Material

### Understanding the Difference between Precipitation and Condensation

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

**Answer:** CoCoRaHS measures rain, hail, sleet, and snow. These are all forms of precipitation.

Precipitation is a process of a liquid or solid aqueous particles in the atmosphere such as a cloud and fall to the earth's surface as rain, hail, sleet, and snow. Only precipitation values *should* be reported on a daily report form.

Condensation is the process of water vapor changing from a vapor phase to a liquid phase which is deposited on surfaces such as a rain gauge. Dew, fog, fog mist, and frost are all the result of condensation. CoCoRaHS does not measure or report any values of condensation. CoCoRaHS observers *shouldn't* report condensation collection in the 4-inch diameter gauge as precipitation on the daily report form. Only make a note in comments of condensation from dew.

Do I report morning dew that has collected in my rain gauge?



**Answer:** *No. Dew is not precipitation, but you may note the dew in the comments*

During the autumn and the winter season when sunny warm days occur and are followed by long clear nights that cool down to near the dew point, condensation will form on surfaces that cool below the dew point from radiational cooling. Condensation is a process where water vapor, that is already present around a gauge, condenses onto the surface of that gauge and collects in the inner tube. CoCoRaHS daily reports are set-up to have the precipitation box the place that you enter anything that falls from much higher elevations in the sky such as rain, snow, freezing rain, and sleet. Please only reports these values of precipitation in this box. Do not report condensation values in this box. Only list in comments that dew and fog occurred and you did measure some in the gauge. You must check your gauge every day to remove any condensation that did form in it so it doesn't get counted when rainfall does occur. Also remember to completely sling all water and moisture out of the inner tube so it doesn't get counted again the next morning. It only takes a small amount moisture to measure 0.01" of inch in the inner tube. A very precise instrument.

Hopefully these tips and the understanding of how condensation forms will help an observer know proper reporting in these situations. There is a huge difference between condensation and precipitation. CoCoRaHS does have a report that measures condensation and evaporation processes which is called an **Evapotranspiration Report**. To measure these processes requires a much different type of measuring device that has a much higher cost than the 4 inch standard precipitation gauge. Information is available on the website that lists equipment requirements, siting, and reporting procedures. For those who are willing to take on the task and cost of measuring and reporting these hydrological processes there is help material online on the CoCoRaHS website in a detailed pdf at the web address below.

<https://www.cocorahs.org/Content.aspx?page=et>

## Observer Tips, Information & Training Material (continued)

Important information to help CoCoRaHS observers in Texas measure and report snowfall and frozen precipitation

An in depth snow training webinar has a ton of great information for anyone to become trained on all aspects of measuring snowfall. A link is listed here to this training material for all to use: <https://media.cocorahs.org/docs/MeasuringSnow2.1.pdf>

**My Data Entry : Daily Precipitation Report Form**

**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 the gauge during the past 24 hours

Observation Notes : (This will be available to the public)  
Very little wind - good gauge catch.

**Reporting Snow and Sleet**

The depth of snow and/or sleet that fell in the past 24 hours measured on your snow board or flat, level surface is entered here.

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. Do not enter your snowfall 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

**Duration Information**

Precipitation Began  
Precipitation Ended  
Heaviest Precipitation Began  
Heaviest Precipitation Lasted

These times are: Select Time Accuracy

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.





# Observer Tips, Information & Training Material (continued)



www.weather.gov

## Measuring Snow



www.cocorahs.org

### Step 1: Observe

- ♦ **Water Equivalent of New Snow:** Melt the amount of *new* snow that fell in your gauge during the last 24 hours. Measure the amount of liquid to the nearest hundredth of an inch (such as 0.38").
- ♦ **New Snowfall:** Measure the depth of *new* snow to the nearest tenth of an inch (such as 4.7") on your snow board.
- ♦ **Melted new snowfall snow core (use if it is windy):**
  - ⇒ Place your gauge upside down on your snow board, firmly push down and "cut a biscuit".
  - ⇒ Carefully turn the gauge right side up trying not to let any snow spill.
  - ⇒ Be sure to clear the snow off your snow board and place it back on the ground.
  - ⇒ Take the gauge inside and allow the snow to melt. Measure the amount of liquid to the nearest hundredth of an inch (such as 0.38").
- ♦ **Total Snow and Ice on the Ground (Snow Depth):** Measure the depth of *total* snow to the nearest half an inch (such as 5.5") on the ground. You may need to take several measurements and average them to get your total depth of snow.
- ♦ **Snow Water Equivalent of Total Snow and Ice on the Ground (Mondays):**
  - ⇒ Place your gauge upside down on the ground, firmly push down and "cut a biscuit".
  - ⇒ Carefully turn the gauge right side up trying not to let any snow spill.
  - ⇒ Take the gauge inside and allow the snow to melt. Measure the amount of liquid to the nearest hundredth of an inch (such as 0.38").

### Step 2: Report

- ♦ Log into the CoCoRaHS website (<http://www.cocorahs.org/Login.aspx>)
- ♦ Enter your data in the appropriate cells and click "Submit Data".

Precipitation Report Form		Submit Data	Reset
Station Number :			
Station Name :			
* Denotes Required Field			
12/19/2011	Observation Date		
7:00 AM	Observation Time		
Rain and Melted Snow to the nearest hundredth inch that has fallen in the gauge during the past 24 hours			
<input type="radio"/> Yes <input type="radio"/> No Report was taken at registered location?			
Observation Notes: (This will be available to the public)			
<div> <div>New Snowfall</div> <div> <div>Accumulation of new snow in inches to the nearest tenth</div> <div>Melted value from core to the nearest hundredth</div> </div> </div>			
<div> <div>Total Snow and Ice on Ground at Observation Time</div> <div> <div>Depth of total snow and ice (new and old) in inches to the nearest half inch</div> <div>Melted value from core to the nearest hundredth</div> </div> </div>			

## Scheduled CoCoRaHS Webinars

### Upcoming WxTalk Webinars:

**Special Webinar** - January 13, 2022 -1PM EST  
**"A Review of Significant Weather Events Occurring in 2021"**

Greg Carbin  
 NOAA/Weather Prediction Center  
 College Park, MD



*"Greg will present an overview of hazardous weather episodes impacting life and property within the United States during 2021. Selected events will be presented in quasi-chronological order and described with photos, maps, and loops of satellite and radar data. While many of the events selected for this talk captured the attention of the media and public, some of these "meteorological memories" may have been forgotten as more substantial weather events occurred throughout the year. This review will highlight some of the "big stories", as well as smaller short-term events. The presentation will include descriptions of significant and deadly weather events of the past year including winter storms, tornadoes and floods. Along with the meteorological set-up for each event, an impact summary will also be provided.*

**Webinar #80** - March 3, 2022 -1PM EST

**Maritime Weather, Oceanography and Safe Navigation**

Tom Cuff, Director  
 NOAA/NWS Office of Observations  
 Silver Spring, MD



	<p><b><i>Texas CoCoRaHS Observer</i></b></p> <p>The official newsletter of Texas CoCoRaHS</p>		
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