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## NWS Houston, Texas September 2019 <br> Regional Climate Summary

## Produced by Jimmy Fowler \& Nikki Hathaway

. . . Abnormally warm temperatures continued with extreme rainfall brought on by Tropical Storm Imelda. . .
September continued the abnormally warm temperatures with twenty three daily temperature records broken across the primary climate sites. Initially drought conditions expanded across the entire area for the start of the month, but then extreme rainfall from Tropical Storm Imelda helped to reverse the dry conditions across the eastern and southern portions of the region. Imelda's extreme rainfall brought flash flooding to portions of Chambers, Liberty, Montgomery, Harris, Galveston, Matagorda, and Brazoria counties. After Imelda, the abnormally dry and hot conditions continued for the rest of the month.


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## September 2019 by the Numbers

Location
(records started)

City of Houston, TX (1888)

Houston Hobby, TX (1930)

City of Galveston, TX (1871)

City of College Station, TX (1882)

Conroe, TX (1997)

Huntsville, TX (1997)

Sugar Land, TX (2000)

Palacios, TX (1943)

Clover Field (Pearland), TX (1997)

David Wayne Hooks
(Tomball), TX (1998)
Angleton, TX (1998)

League City, TX (1990)

Average
Temp
$83.9^{\circ} \mathrm{F}$
$84.4^{\circ} \mathrm{F}$
$86.0^{\circ} \mathrm{F}$
$81.9^{\circ} \mathrm{F}$
$84.1^{\circ} \mathrm{F}$
$83.8^{\circ} \mathrm{F}$
$85.9^{\circ} \mathrm{F}$
$83.9^{\circ} \mathrm{F}$
$82.6^{\circ} \mathrm{F}$
$82.0^{\circ} \mathrm{F}$
$84.3^{\circ} \mathrm{F}$

Ranking

WARMEST ON RECORD (1st)
$2^{\text {nd }}$ Warmest

WARMEST ON
RECORD (1st)
$2^{\text {nd }}$ Warmest
$2^{\text {nd }}$ Warmest

WARMEST ON
RECORD ( $1^{\text {st }}$ )
WARMEST ON
RECORD (1st)
WARMEST ON RECORD (1st)
$2^{\text {nd }}$ Warmest
$2^{\text {nd }}$ Warmest
$5^{\text {th }}$ Warmest

WARMEST ON RECORD ( $1^{\text {st }}$ )

Total
Rainfall

Ranking

WETTEST ON RECORD ( $1^{\text {st }}$ )

3rd Wettest
18.06"
$2.54^{\prime \prime}$
17.73"
$1.26^{\prime \prime}$
9.30"
$3.12^{\prime \prime}$
10.93"
$4.79 "$
15.76"
14.44 "

WETTEST ON RECORD (1st)
$7^{\text {th }}$ Driest

WETTEST ON RECORD (1st)
$32^{\text {nd }}$ Driest

WETTEST ON
RECORD (1s)
$8^{\text {th }}$ Wettest
$2^{\text {nd }}$ Wettest
$3^{\text {rd }}$ Wettest

## Precipitation

Overall the month of September saw above normal precipitation, but this was mainly due to the extreme rainfall brought on by Tropical Storm Imelda. Galveston, Houston-Hobby, and the city of Houston all saw above normal precipitation totals, while College Station received slightly below normal monthly totals. This was mainly due to Imelda impacting the coastal and eastern portions of the region and not reaching into the Brazos Valley as much. Imelda brought daily record rainfall amounts that occurred on the $17^{\text {th }} \& 18^{\text {th }}$ at Houston-Hobby, on the $18^{\text {th }}$ and $19^{\text {th }}$ at Galveston, and on the $19^{\text {th }}$ for the city of Houston.

| Site | Total <br> Precipitation (in.) | Departure from <br> Normal (in.) | Number of <br> Thunder Days | Maximum Daily <br> Precipitation (in./date) |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Galveston <br> (GLS) | 18.06 | +12.03 | 11 | 6.81 | September <br> 19 th |
| Houston <br> Hobby <br> (HOU) | 11.48 | +6.27 | 7 | 4.67 | September <br> 17 th |
| City of <br> Houston <br> (IAH) | 14.95 | +10.83 | 8 | 9.21 | September <br> $19 t h$ |
| College <br> Station <br> (CLL) | 2.54 | -0.64 | 6 | 1.08 | September |

## Precipitation (Continued)

Total Monthly Precipitation - September 2019

## Inches




## Precipitation (Continued)

Total Monthly Precipitation Departure From Normal - September 2019

## Inches

| $\square$ |
| :--- |
| $\square$ |
| $\square$ |
| -3 |
| -2 |
| -1 |
| -0 |
| -0 |
| $\square+0$ |
| $\square$ |$+$

$<-4.00$
$-3.99--3.00$
$-2.99--2.00$
$-1.99-1.00$
$-0.99--0.50$
$-0.49-0.00$
$+0.01-+0.49$
$+0.50-+0.99$
$+1.00-+1.99$
$+2.00-+3.99$
$+4.00-+5.99$
$+6.00-+7.99$
$+8.00-+9.99$
$+10.00-+14.99$
$>+15.00$

Created by the NWS Forecast Office Houston/Galveston, TX


## Temperatures

All of the primary climate sites experienced above normal temperatures during the month of September. The cities of Houston and Galveston experienced their warmest Septembers on record while College Station and Houston-Hobby ranked at number two. This September in Galveston was so warm it would actually rank as the $9^{\text {th }}$ warmest August on record. The city of Houston started out the month with its last $100^{\circ} \mathrm{F}$ on the year, while College station reached the threshold twice: Sept. $4^{\text {th }}$ and $6^{\text {th }}$.

| Site | Average <br> Temp <br> (F) | Average <br> High <br> Temp (F) | Average <br> Low <br> Temp (F) | Normal <br> Average <br> Temp (F) | Departure <br> From <br> Normal (F) | Maximum <br> Temperature <br> (F) | Minimum <br> Temperature <br> (F) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Galveston <br> (GLS) | 86.0 | 91.2 | 80.8 | 81.6 | +4.4 | 96 on Sept. <br> $14^{\text {th }}$ | 73 on Sept. <br> $19^{\text {th }}$ |
| Houston <br> Hobby <br> (HOU) | 84.4 | 92.1 | 76.7 | 80.1 | +4.3 | 98 on Sept. <br> $14^{\text {th }}$ | 74 on Sept. |
| $25^{\text {th }}$ \& $26^{\text {th }}$ |  |  |  |  |  |  |  |
| City of |  |  |  |  |  |  |  |
| Houston <br> (IAH) | 83.9 | 93.1 | 74.6 | 79.9 | +4.0 | 100 on <br> Sept. st $^{\text {st }}$ | 71 on Sept. <br> $8^{\text {th }} \& 26^{\text {th }}$ |
| College <br> Station <br> (CLL) | 84.9 | 94.9 | 74.8 | 80.0 | +4.9 | 100 on <br> Sept. $4^{\text {th }} \&$ <br> $6^{\text {th }}$ | 72 on Sept. |
| $25^{\text {th }}$ |  |  |  |  |  |  |  |

## Monthly Temperature Charts

## Daily Temperature Data - College Station Area, TX (ThreadEx)

Period of Record - Max temperature: 1888-10-01 to 2019-09-30; Min temperature: 1882-05-15 to 2019-09-30. Normals period: 1981-2010. Click and drag to zoom chart.


Daily Temperature Data - Galveston Area, TX (ThreadEx)
Period of Record - 1874-05-10 to 2019-09-30. Normals period: 1981-2010. Click and drag to zoom chart.


## Monthly Temperature Charts (continued)

Daily Temperature Data - Houston Area, TX (ThreadEx)
Period of Record - 1889-05-01 to 2019-09-30. Normals period: 1981-2010. Click and drag to zoom chart.


Period of Record - 1930-08-01 to 2019-09-30. Normals period: 1981-2010. Click and drag to zoom chart.


## Drought Conditions

By the end of the month, D2 severe drought conditions expanded across portions of Madison, Brazos, Grimes, Burleson, and Washington counties. Additionally, improvements were made across the southeastern zones of the forecast area due to the heavy rainfall associated with Tropical Storm Imelda.
Most Recent Drought Map
Posted: September 26

| None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 49.70 | 50.30 | 29.22 | 5.01 | 0.00 | 0.00 |

Drought Conditions (Percent Area)

Source: http://droughtmonitor.unl.edu

Intensity:
None
D0 (Abnormally Dry)
D1 (Moderate Drought)
D2 (Severe Drought)
D3 (Extreme Drought)
D4 (Exceptional Drought)

## September Daily Record Reports

A total of 28 daily records were set across the primary climate sites.

| Site | Date | Record Type | New Record | Previous Record |
| :---: | :---: | :---: | :---: | :---: |
| Houston Hobby | $\begin{aligned} & \text { September } \\ & 2^{\text {nd }} \end{aligned}$ | High Min Temperature | $79^{\circ}$ | $79^{\circ}$ in 2014 |
| Houston Hobby | September $4^{\text {th }}$ | High Min Temperature | $82^{\circ}$ | $80^{\circ}$ in 1989 |
| City of Galveston | September $4^{\text {th }}$ | High Min Temperature | $85^{\circ}$ | $84^{\circ}$ in 1989 |
| City of Galveston | September $6^{\text {th }}$ | High Max Temperature | $95^{\circ}$ | $94^{\circ}$ in 1912 |
| Houston Hobby | September $6^{\text {th }}$ | High Max <br> Temperature | $97^{\circ}$ | $97^{\circ}$ in 1963 |
| City of Houston | September $6^{\text {th }}$ | High Max <br> Temperature | $99^{\circ}$ | $99^{\circ}$ in 1909 |
| City of Houston | September $7^{\text {th }}$ | High Max Temperature | $99^{\circ}$ | $98^{\circ}$ in 1963 |
| City of Galveston | September $10^{\text {th }}$ | High Min Temperature | $83^{\circ}$ | $83^{\circ}$ in 2014 |
| Houston Hobby | September $10^{\text {th }}$ | High Min Temperature | $79^{\circ}$ | $79^{\circ}$ in 1961 |
| City of Galveston | September $12^{\text {th }}$ | High Min Temperature | $84^{\circ}$ | $83^{\circ}$ in 1909 |
| City of Galveston | September $13^{\text {th }}$ | High Max Temperature | $95^{\circ}$ | $93^{\circ}$ in 2002 |
| City of Galveston | September $14^{\text {th }}$ | High Max Temperature | $96^{\circ}$ | $93^{\circ}$ in 1900 |
|  |  | 11 |  |  |

## September Daily Record Reports Continued

| Site | Date | Record Type | New Record | Previous Record |
| :---: | :---: | :---: | :---: | :---: |
| Houston Hobby | $\begin{aligned} & \text { September } \\ & 14^{\text {th }} \end{aligned}$ | High Max Temperature | $98^{\circ}$ | $98^{\circ}$ in 2011 |
| City of Galveston | September $15^{\text {th }}$ | High Max <br> Temperature | $94^{\circ}$ | $94^{\circ}$ in 1900 |
| Houston Hobby | September $17^{\text {th }}$ | Max Rainfall | 4.67" | 2.59 " in 1958 |
| Houston Hobby | September $18^{\text {th }}$ | Max Rainfall | 2.68 " | $2.32^{\prime \prime}$ in 1979 |
| City of Galveston | September $18^{\text {th }}$ | Max Rainfall | 6.20" | 2.47 " in 1979 |
| City of Houston | $\begin{aligned} & \text { September } \\ & 19^{\text {th }} \end{aligned}$ | Max Rainfall | 9.21" | 6.92 " in 1979 |
| City of Galveston | $\begin{gathered} \text { September } \\ 19^{\text {th }} \end{gathered}$ | Max Rainfall | 6.81" | $5.11^{\prime \prime}$ in 1979 |
| City of Galveston | $\begin{aligned} & \text { September } \\ & 21^{\text {st }} \end{aligned}$ | High Min Temperature | $83^{\circ}$ | $83^{\circ}$ in 1992 |
| City of Galveston | $\begin{aligned} & \text { September } \\ & 23^{\text {rd }} \end{aligned}$ | High Min Temperature | $82^{\circ}$ | $82^{\circ}$ in 2000 |
| City of College Station | $\begin{aligned} & \text { September } \\ & 24^{\text {th }} \end{aligned}$ | High Min Temperature | $76^{\circ}$ | $76^{\circ}$ in 1984 |
| City of Galveston | $\begin{aligned} & \text { September } \\ & 28^{\text {th }} \end{aligned}$ | High Min Temperature | $83^{\circ}$ | $82^{\circ}$ in 2005 |
| City of Galveston | $\begin{aligned} & \text { September } \\ & 29^{\text {th }} \end{aligned}$ | High Min Temperature | $82^{\circ}$ | $82^{\circ}$ in 1986 |
| Houston Hobby | $\begin{aligned} & \text { September } \\ & 29^{\text {th }} \end{aligned}$ | High Min Temperature | $78^{\circ}$ | $77^{\circ}$ in 2013 |

## September Daily Record Reports Continued

| Site | Date | Record Type | New Record | Previous Record |
| :---: | :---: | :---: | :---: | :---: |
| City of Galveston | September <br> $30^{\text {th }}$ | High Min <br> Temperature | $83^{\circ}$ | $82^{\circ}$ in 1986 |
| City of College <br> Station | September <br> $30^{\text {th }}$ | High Min <br> Temperature | $76^{\circ}$ | $75^{\circ}$ in 1986 |
| Houston Hobby | September <br> $30^{\text {th }}$ | High Min <br> Temperature | $79^{\circ}$ | $77^{\circ}$ in 1986 |

## October Outlook

For October, the latest outlook from the Climate Prediction Center (CPC) calls for a $55 \%$ chance of above normal temperatures, $33 \%$ near normal temperatures, and a $12 \%$ chance for below normal temperatures across the area. The precipitation outlook calls for equal chances for above, below, or normal precipitation, across much of Southeast Texas. Across portions of the southeast zones such as Galveston, $31 \%$ chance of above normal precipitation, $33 \%$ near normal precipitation, and a $36 \%$ chance for below normal precipitation.

| Site | Average <br> Temp( ${ }^{\circ} \mathrm{F}$ ) | Normal High ( ${ }^{\circ}$ F) | Norma Low ( ${ }^{\circ}$ F | Site | Normal Monthly Precipitation (in.) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Galveston | 74.3 | 80.6 | 68.1 | Galveston (GLS) | 5.52 |
| Houston Hobby | 72.1 | 81.2 | 63.1 | Houston Hobby (HOU) | 5.99 |
| City of Houston | 71.5 | 82.0 | 60.9 | City of Houston (IAH) | 5.70 |
|  |  |  |  | College Station (CLL) | 4.91 |
| College Station | 70.8 | 81.4 | 60.3 |  |  |
| Temperature Outlook |  |  |  | Precipitation Outlook |  |
|  |  |  |  |  |  |

## ENSO Observations

Sea Surface Temperature Anomalies across the Tropical Pacific Ocean during the month of September

## Current ENSO Phase: Neutral

Sea Surface Temperature Anomalies ( ${ }^{\circ} \mathrm{C}$ ) in the Tropical Pacific

-1

[^0]Mar '17
Jun '17
Sept ' 17
Dec '17
Mar '18
Jun '18
Sep '18
Dec ' 18
Mar '19
Jun '19
Sep'19

## ENSO Forecast

## The Climate Prediction Center's ENSO Forecast: ENSO-Neutral Continues

- There is a $85 \%$ chance of ENSO-Neutral conditions continuing through the fall
- There is a 55-60\% chance of ENSO-Neutral conditions continuing through the spring

Inactive


El Niño or La Niña Watch: Issued when conditions are favorable for the development of El Nifío or La Niña conditions within the next six months.

El Nifio or La Nifia Advisory: Issued when El Niño or La Niña conditions are observed and expected to continue.

## Tropical Storm Imelda

## 17 Sep 2019 18:01Z NOAA/NESDIS/STAR GOES-East ABI GEOCOLOR



On September $17^{\text {th }}$, an area of low pressure over the northwestern Gulf of Mexico organized becoming Tropical Depression Eleven around 12 PM CDT. By 12:45 PM CDT, the National Hurricane Center issued an update to strengthen the system into Tropical Storm Imelda. At approximately 1:30 PM CDT that afternoon, Imelda made landfall near Freeport, Texas with a minimum central pressure of 1005 millibars (29.68 inches of mercury). This system was not long lasting and quickly weakened after landfall, becoming a tropical depression by 7 PM that evening.

## Tropical Storm Imelda

## Imelda Storm Total Rainfall

## Tuesday 7 AM to Thursday 7 PM QPE

This is a 60 hour precipitation estimate (surface observations, radar, satellite) of Imelda's total rainfall which lead to catastrophic flooding across our southeastern forecast area.

Many Harris County rain gauges reported greater than 15 inch totals (locally 25 inches) from Conroe in Montgomery County southeastward into eastern Harris County (north and east Houston metro), Liberty and Chambers Counties. Most of the highest 24 hour rain totals fell today at between 10 to 15 inches when a near west-to-east storm feeder band very slowly sagged southward through this area. Many common hourly rainfall rates were on the order of 4 to 6 inches.

At 4 PM, Bush-Intercontinental Airport (which was shut down) recorded an all-time September daily rainfall record of 9.20 inches (City of Houston).

Many of the hardest hit areas during Harvey were impacted during this event; generally those communities from eastern Houston east on 1-10 into Liberty, Chambers and Jefferson Counties.

An extreme rain amount of 43.15 inches (unofficial) occurred near Fannett, Texas in Jefferson County near the Chambers County line.


> A tornado also occurred associated with a band of thunderstorms within Tropical Storm Imelda. An EF-1 tornado with maximum sustained winds of 90 MPH was on the ground for about 3 miles near Highlands, TX. It brought down large tree branches, snapped tree trunks, and damaged a few structures.

## Tropical Storm Imelda

Highest Storm Total Rainfall Amounts

| City/Town | County | Rainfal <br> (inches |
| :--- | :---: | :--- |
| NW Winnie | Chambers | 40.79 |
| WNW Devers | Liberty | 36.26 |
| E Hankamer | Chambers | 33.15 |
| SE Roman Forest | Harris | 29.72 |
| Splendora | Montgomery | 27.04 |
| Sargent | Matagorda | 23.06 |
| SE Cut And Shoot | Montgomery | 22.84 |
| N Huffman | Harris | 22.52 |

## Lowest Sea Level Pressure Observations

| City | Min Pressure <br> $(\mathrm{MB})$ |
| :--- | :--- |
| High Island | 997.97 |
| Brazos 451 Oil Platform | 1005.08 |
| Angleton | 1007.11 |


| City/Town | County | Rainfall <br> (inches) |
| :--- | :---: | :--- |
| SW Porter | Harris | 21.35 |
| NE Crosby | Harris | 20.76 |
| NNW Dayton | Harris | 19.99 |
| N Daisetta | Liberty | 18.86 |
| SE Galveston <br> Scholes Field | Galveston | 17.72 |
| SSW <br> Kingwood | Harris | 17.68 |
| SSE Anahuac | Chambers | 17.08 |
| SW Porter <br> Heights | Harris | 16.60 |


| Date/ Time <br> (UTC) | Max <br> Sustained (KT) | Date/ Time <br> (UTC) |
| :--- | :--- | :--- |
| $17 / 1115$ | $135 / 028$ | $17 / 2035$ |
| $17 / 1315$ | $180 / 020$ | $17 / 1335$ |
| $17 / 1930$ | $200 / 018$ | $17 / 2230$ |

Maximum Observed Water Level

| City | County | Water Level <br> (FT) | Datum | Date/Time <br> (UTC) |
| :--- | :--- | :--- | :--- | :--- |
| Manchester | Harris | 3.50 | MHHW | $19 / 1948$ |
| Eagle Point | Galveston | 2.22 | MHHW | $17 / 0312$ |
| Galveston Pier | Galveston | 2.08 | MHHW | $16 / 2324$ |

## Climate Primary Site History

## Galveston (GLS)

Records for Galveston are from observations at the following locations: 67-69 Strand (April 1, 1871 - Aug 31, 1874); 23rd and the Strand (Sep 1, 1874 - July 29, 1878), 1.75 miles WSW of the previous location; the Custom House at Bath Street and the Strand (July 30, 1878 - May 8, 1882); Colorado and Santa Fe Railroad Building at 25th and the Strand (May 9, 1882 - March 14, 1883); back to the Custom House which later became the Cotton Exchange Building (March 15, 1883 June 24, 1898), about a 1/3 of a mile E of the previous Custom House location; The Levy Building at 2223 Market Street (June 25, 1898 - Nov 26, 1900); the Trust Building at Tremont and Post Office Streets (Nov 27, 1900 - June 24, 1946), onequarter mile south of the Levy Building; the U.S. Post Office Building at 601 Rosenberg (June 25, 1946-1994); Scholes Field (January 1995 to present).

## Houston Hobby (HOU)

Records are based upon observations beginning in August 1931.

## City of Houston (IAH)

Records for the City of Houston are from observations at the following locations: Cotton Station from July 1881 through September 1909, Stewart Building at Preston and Fannin from September 1909 through February 1926, Shell Building at Texas and Fannin from March 1926 through August 1938, Federal Building at Franklin and Fannin from August 1938 through May 1969, Intercontinental Airport from June 1969 to the present.

## College Station (CLL)

Records from 1893 through July 1951 are based on observations taken at the Texas Agriculture Experiment COOP Station main farm located 6 miles southwest of College Station. Records from August 1951 through the present are based on observations taken at Easterwood Field. Normal temperatures are calculated from


[^0]:    Sep '16
    Dec '16

