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# Climate Context of 2018-2019 Mississippi River and Tributaries Floods

■ **JANUARY 14, 2020** .....

**Presenters: Jim Noel, OHRFC | Steve Buan, NCRFC**



# Mississippi River System 2019 Floods

- Weather/climate patterns driving the Mississippi flooding in 2019
- Response in the soils and precipitation – a climate perspective
- Historic years similar to 2019 in Mississippi drainage
- Mississippi River Basin 2019 Record Crests
- Mississippi River Basin Flows in 2019

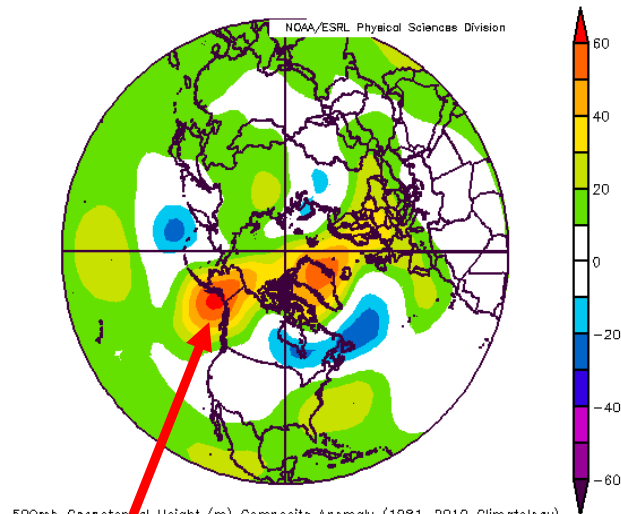


# Important Highlights

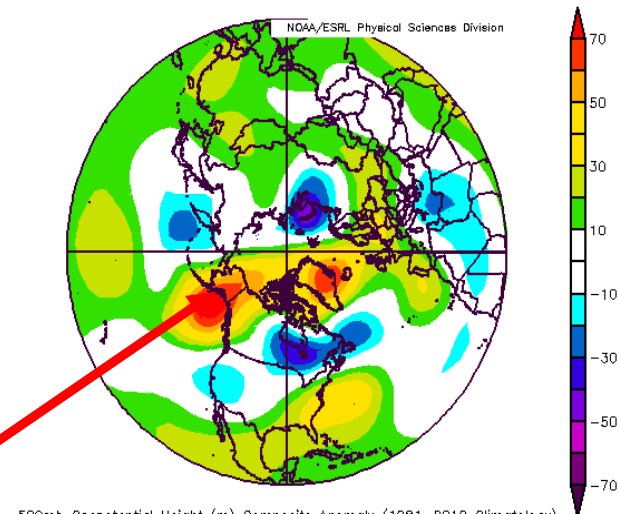
- Upper level 500 hPa flow anomaly was persistent for much of the water year especially first half of 2019 when flooding peaked
- Blocking and anomalous pattern in Alaska and northern Canada was a key ingredient
- Enhanced westerlies and zonal to southwest flow under Alaska anomaly into United States and southern Canada



# N.H. 500 hPa Anomaly



Oct 1 2018 – Sep 30 2019



Jan 1 2019 – Jun 30 2019

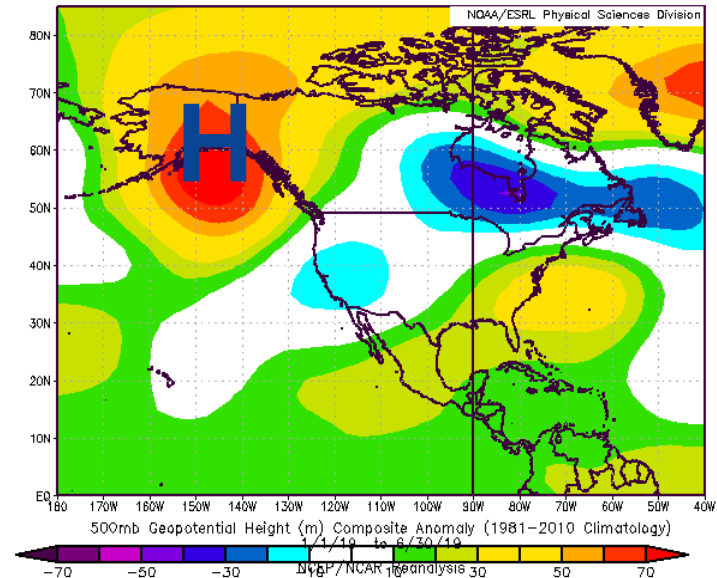
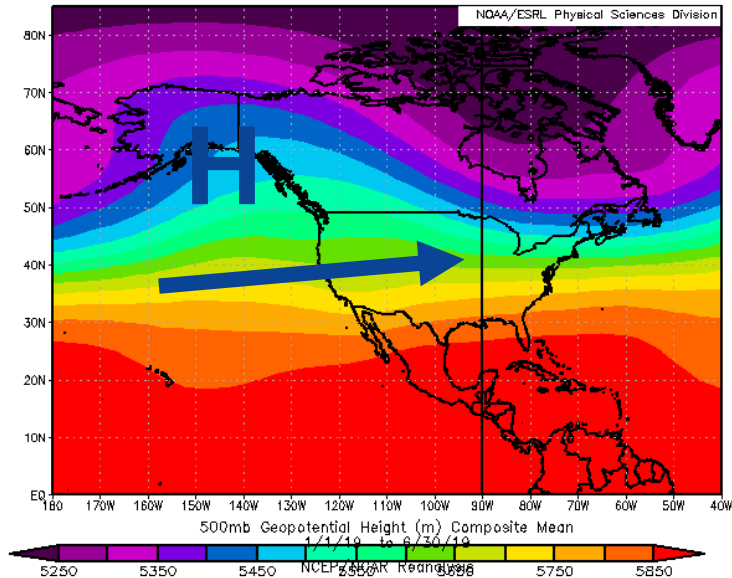
Broad positive anomaly over Alaska to northwest Canada with negative anomaly from western U.S. to southeast Canada throughout much of year



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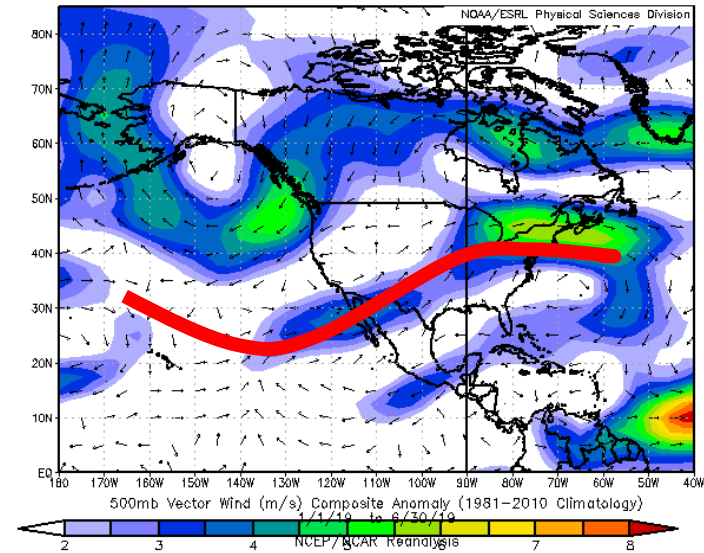
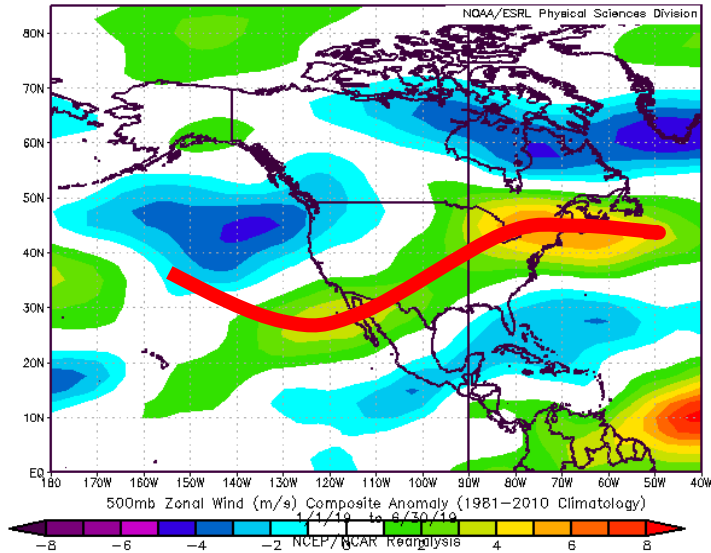
# North America 500 hPa Anomaly



Jan 1 2019 – Jun 30 2019 500 hPa Heights (left image), Anomalies (right image)

Persistent zonal flow yielded enhanced number of moderate storm systems moving across much of United States repeatedly

# 500 hPa Zonal and Vector Wind Anomaly



Jan 1 2019 – Jun 30 2019 500 hPa Zonal Wind Anomaly (left), Vector Wind (right)

Jet Stream enhanced and flowing from a west/southwest direction not uncommon but the duration was uncommon



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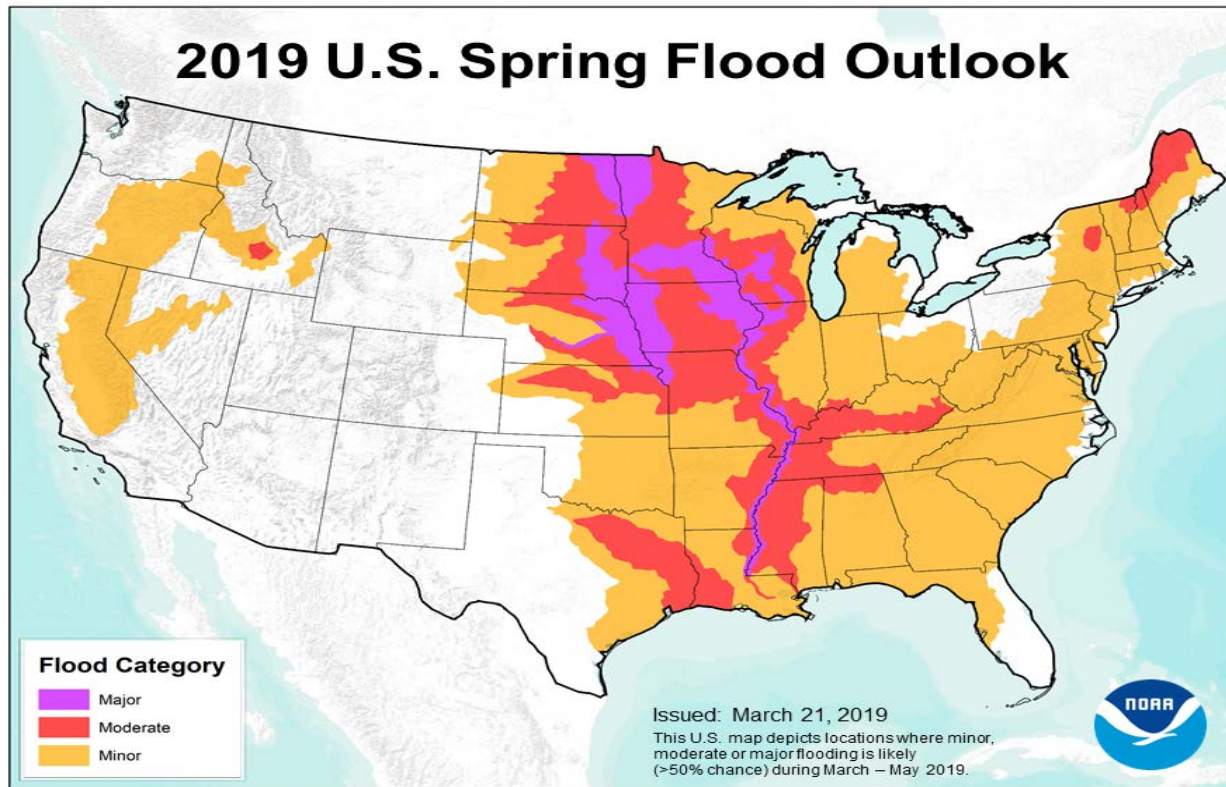
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# Communicating Flood Risk

The highlighting of enhanced risk began in February 2019 webinars to partners

The risk was communicated through the NOAA/NWS Spring Flood Outlook in March

Updates continued through spring by the national, regional and local NOAA/NWS centers



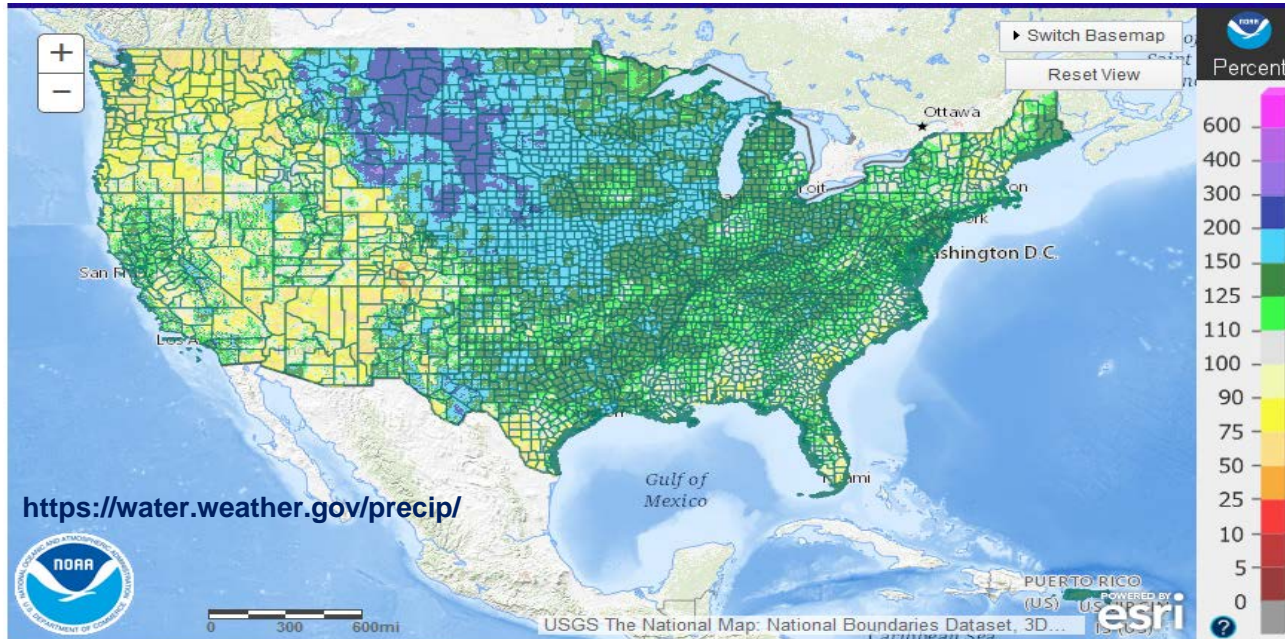
**2019 NOAA Spring Flood Outlook issued March 21, 2019**



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# Precipitation Anomaly for 2019 Water Year



**Oct. 1 2018 – Sep 30 2019 NOAA/NWS Precipitation Anomaly**

Result was a +125-200% of normal precipitation over much of U.S. except Pacific Northwest. Mississippi drainage much above normal. Missouri basin hit hardest 150-400%+ above normal.



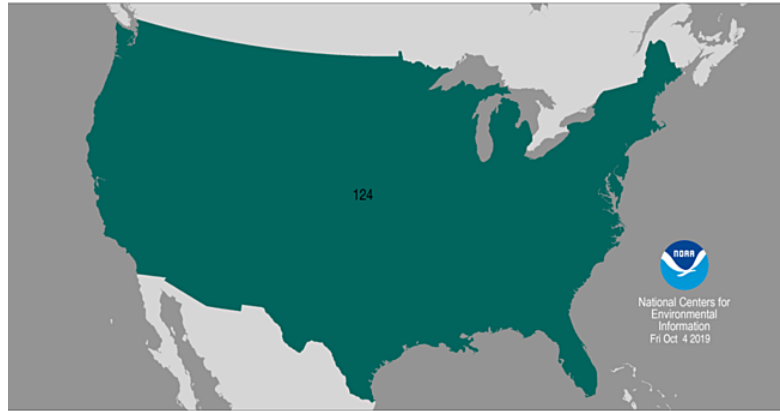
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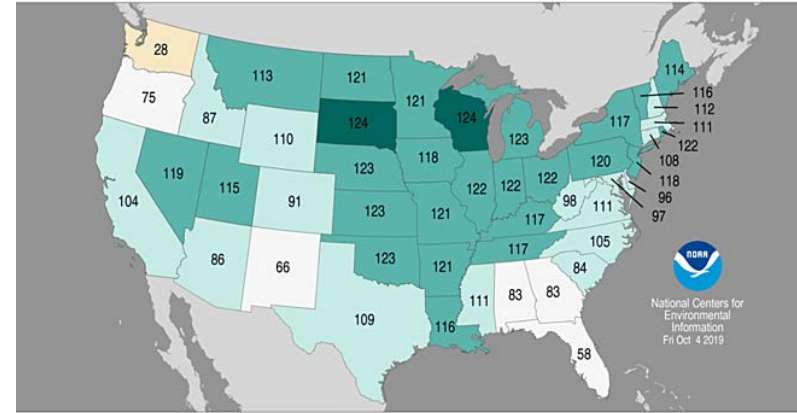


# Precipitation Ranks for 2019 Water Year

National Precipitation Rank  
October 2018–September 2019  
Period: 1895–2019



Statewide Precipitation Ranks  
October 2018–September 2019  
Period: 1895–2019



<https://www.ncdc.noaa.gov/temp-and-precip/us-maps>

**Oct. 1 2018 – Sep 30 2019 NOAA/NCEI Precipitation Ranks**

The U.S. ranks #1 in precipitation for wettest water year. In the Mississippi drainage system most states ranked in top 3 wettest. South Dakota and Wisconsin ranked #1.

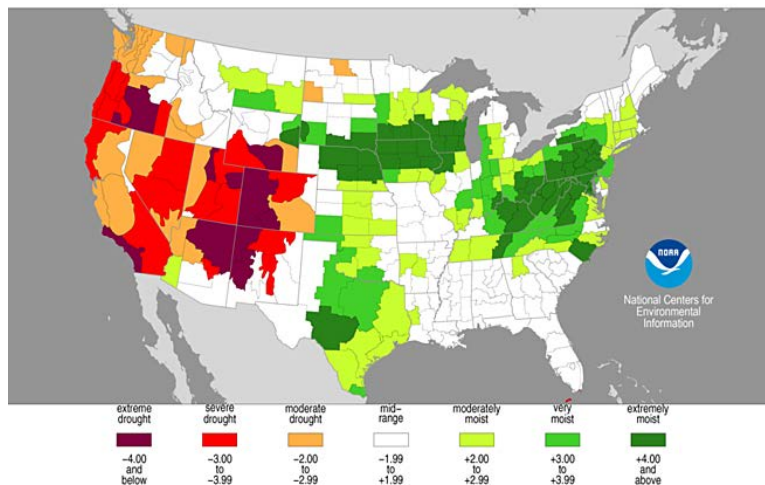


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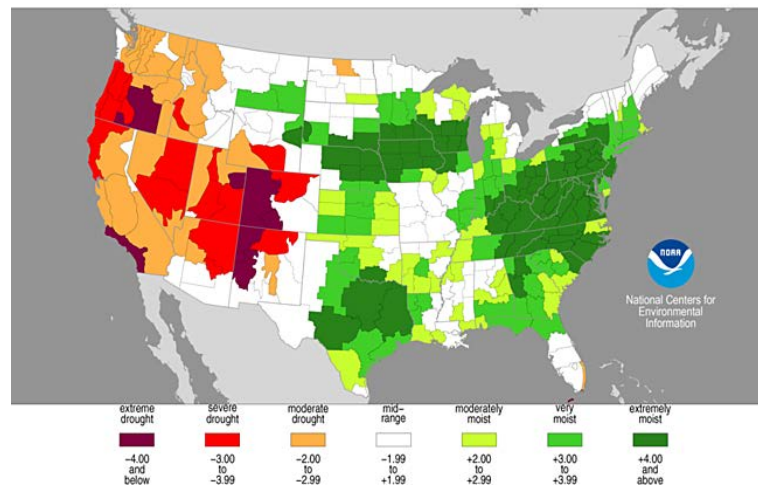
# Soil Conditions for 2019 Water Year

Palmer Drought Severity Index  
October, 2018



**Oct. 2018 Palmer Drought Index**

Palmer Drought Severity Index  
December, 2018



**Dec. 2018 Palmer Drought Index**

<https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers>

The start of 2019 water year was wet in Ohio River Basin and Upper Mississippi River Basin. The wet conditions slowly expanded at the start of meteorological winter in December 2018 leading to significant frozen water in ground in upper Mississippi and parts of Missouri/Ohio River systems.



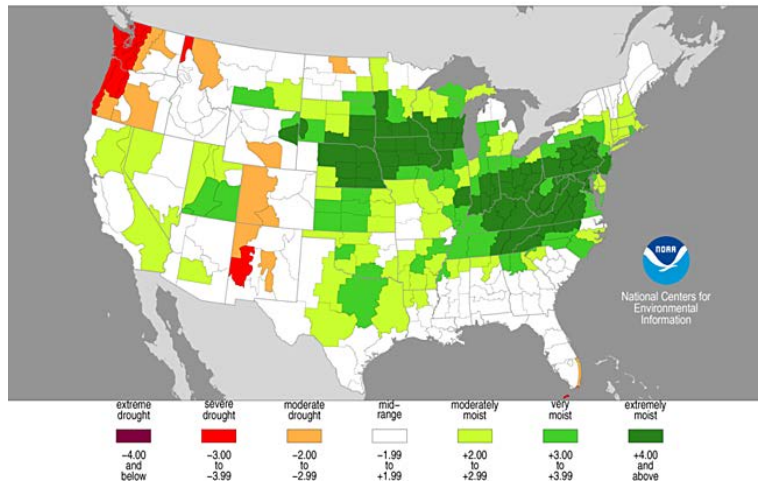
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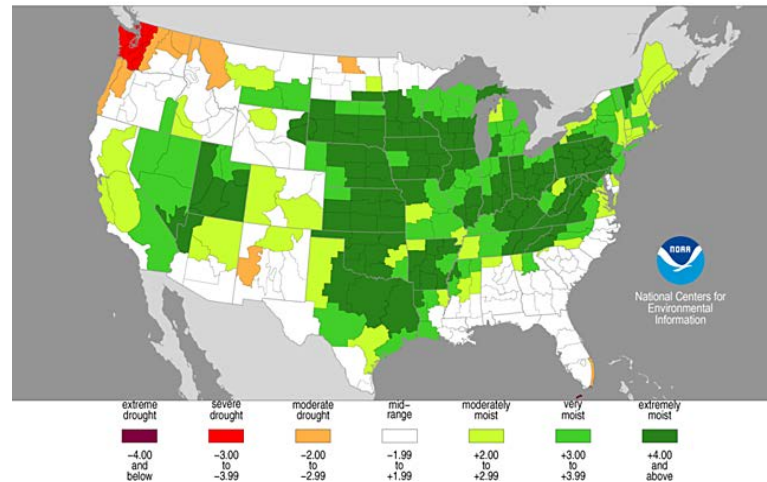
# Soil Conditions for 2019 Water Year

Palmer Drought Severity Index  
March, 2019



**Mar. 2019 Palmer Drought Index**

Palmer Drought Severity Index  
June, 2019



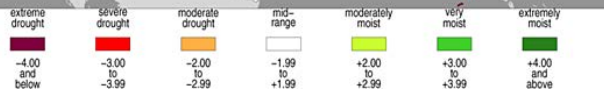
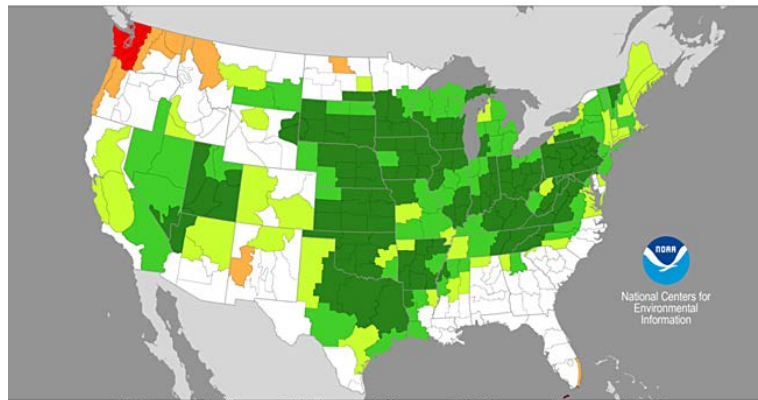
**Jun. 2019 Palmer Drought Index**

<https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers>

Wet conditions locked into place during the winter season and was similar between December to March. Conditions became wetter and peaked in May and June 2019. This greatly impacted the economy especially agriculture.

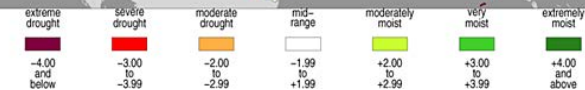
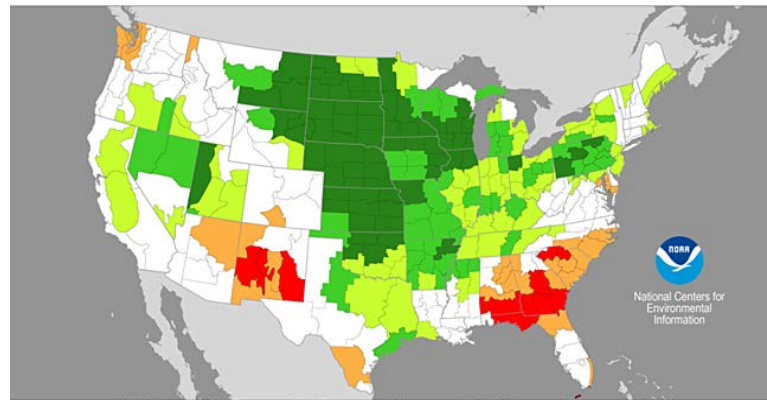
# Soil Conditions for 2019 Water Year

Palmer Drought Severity Index  
June, 2019



**Jun. 2019 Palmer Drought Index**

Palmer Drought Severity Index  
September, 2019



**Sep. 2019 Palmer Drought Index**

<https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers>

Wet conditions weakened in the eastern section of the Mississippi River system including the Ohio Valley during summer and early fall 2019.

Excessive wet conditions continued in much of the rest of the system

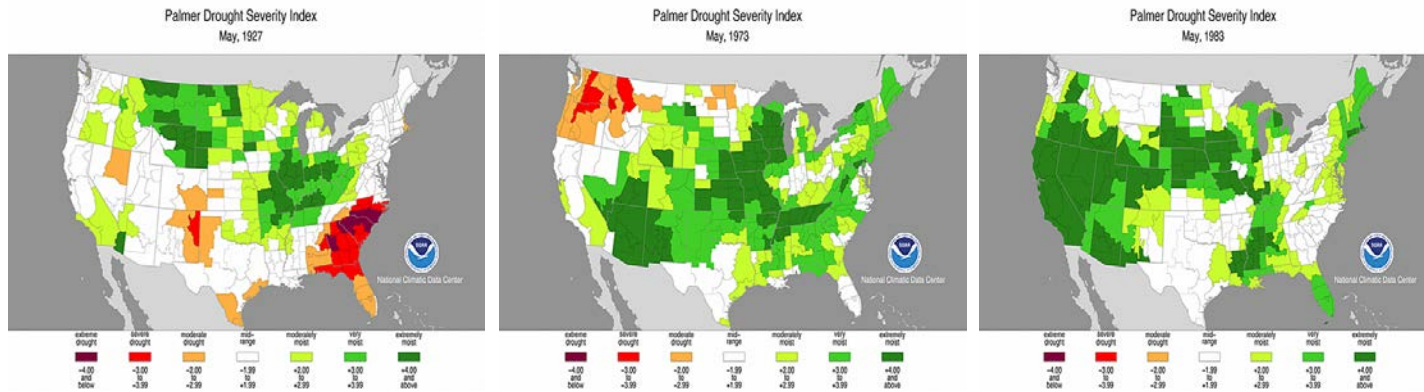


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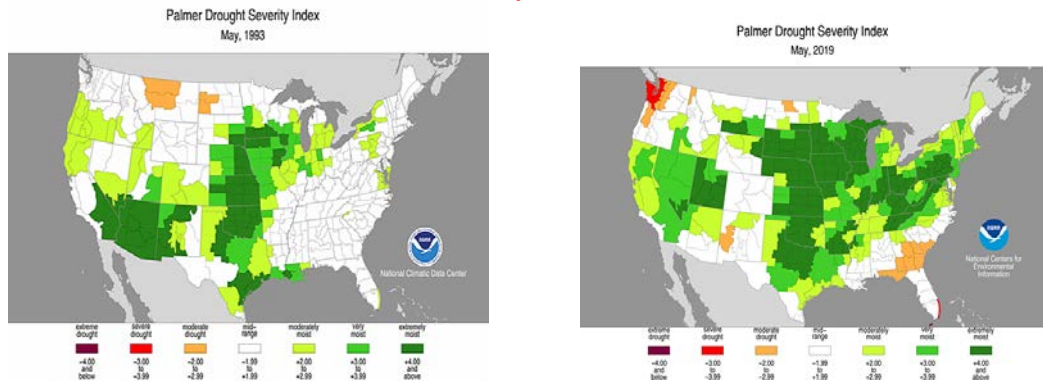
# Historic Years Most Similar to 2018/2019



1926/27

1972/73

1982/83



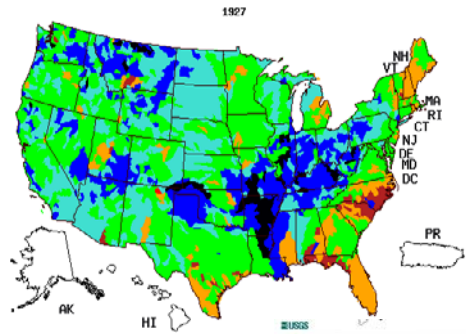
1992/93

2018/19

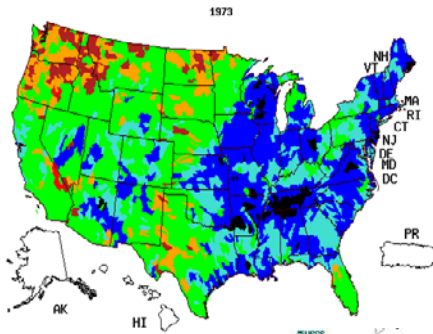


# Runoff from Historic Similar Years

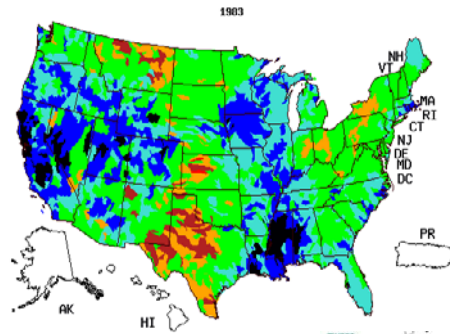
[https://waterwatch.usgs.gov/index.php?dt=wy01d&plot\\_tp=nwc&st=xus&yr=2018&map\\_dt=2018&m=romap3&w=map](https://waterwatch.usgs.gov/index.php?dt=wy01d&plot_tp=nwc&st=xus&yr=2018&map_dt=2018&m=romap3&w=map)



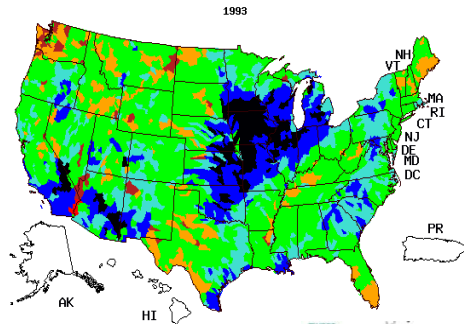
1926/27



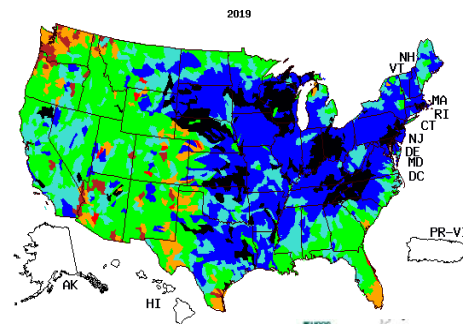
1972/73



1982/83



1992/93



2018/19



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# 2019 Mississippi Basin Record Crests

River Forecast Center

# Record Floods

Consecutive Days

Missouri Basin

50

Seven sites  
267-272 consecutive  
days above flood

Upper Mississippi Basin

11

Three sites  
108 consecutive days  
above flood  
One site – 62 days  
above major

Arkansas/Red Basin

11

Mid/Lower Mississippi Basin

3

Ohio River Basin

2



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# 2019 Mississippi Basin Record Crests

## Take Away Message

- The record crests and peak events were focused in the Missouri basin.
- 2019 did not take out most of the high levels from historic years like 1927, 1993 or 1937 outside of the Missouri basin.
- Peak events are driven by short-term meteorological events (even in Missouri in 2019) but 2019 was more of a climatological event.



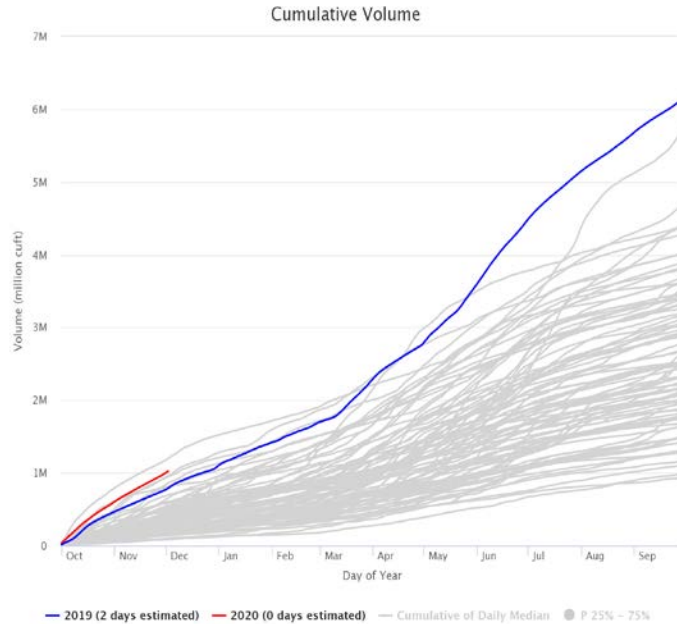
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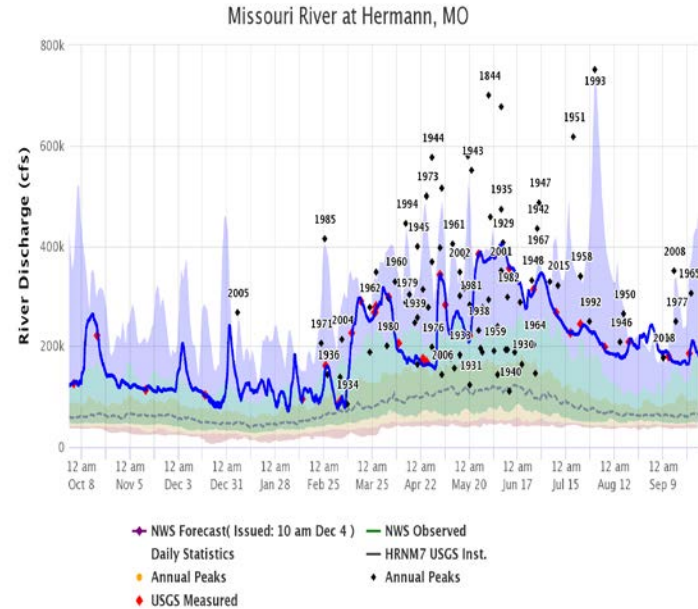


# Missouri River Basin Cumulative Volume



**Cumulative Volume Lower Missouri River at Herman since 1929**

New cumulative volume peak for 2019 water year. 1993 was previous record. However, the record crest of 1993 was about 3 feet higher than 2019.



**1993 remains peak of record Flow above normal entire year**

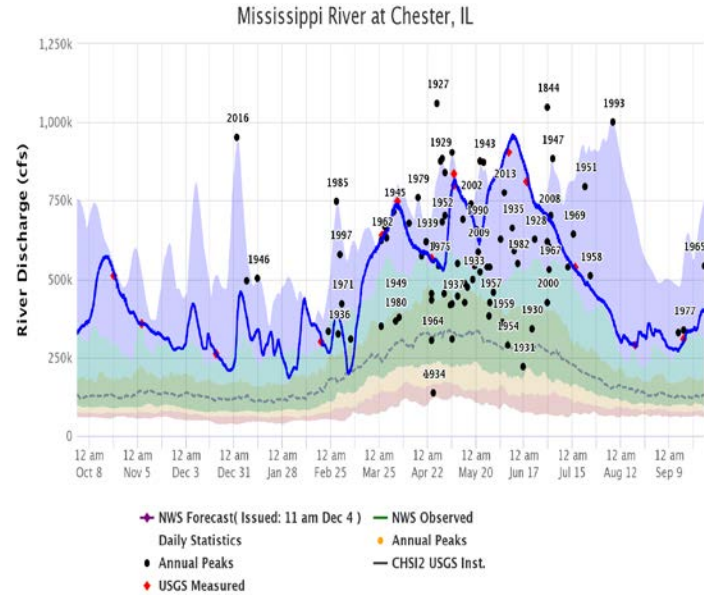
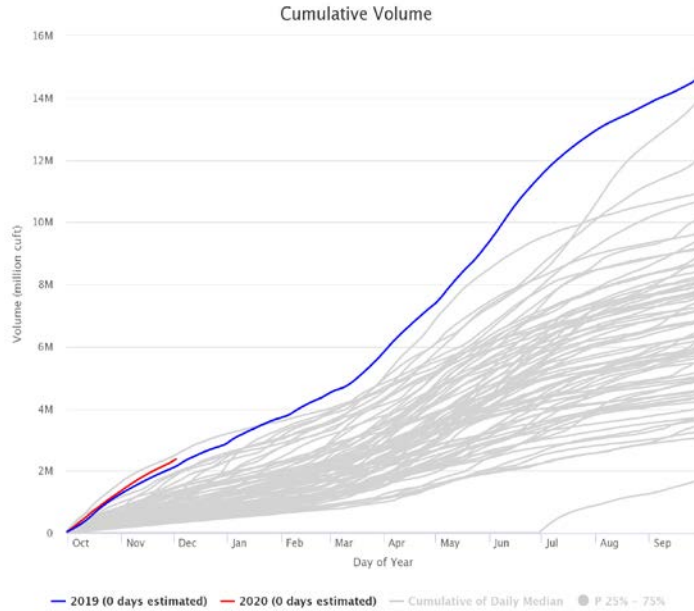


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# Upper Mississippi River Basin Cumulative Volume

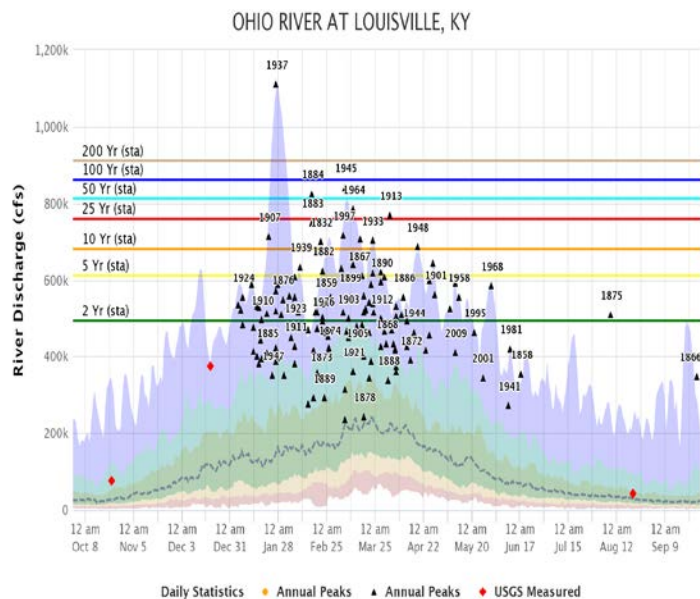
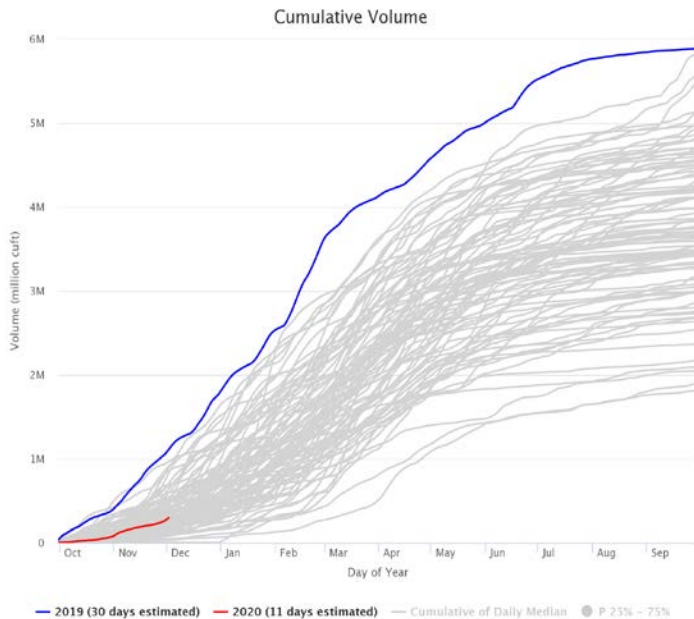


**Cumulative Volume Upper Mississippi River at Chester since 1942**

**1993/1927/1844 remain peaks of record. Flow above normal entire year**

New cumulative volume peak for 2019 water year. 1927/1844/1993 were previous records. 1993 stage was about 3 feet higher than 2019.

# Ohio River Basin Cumulative Volume



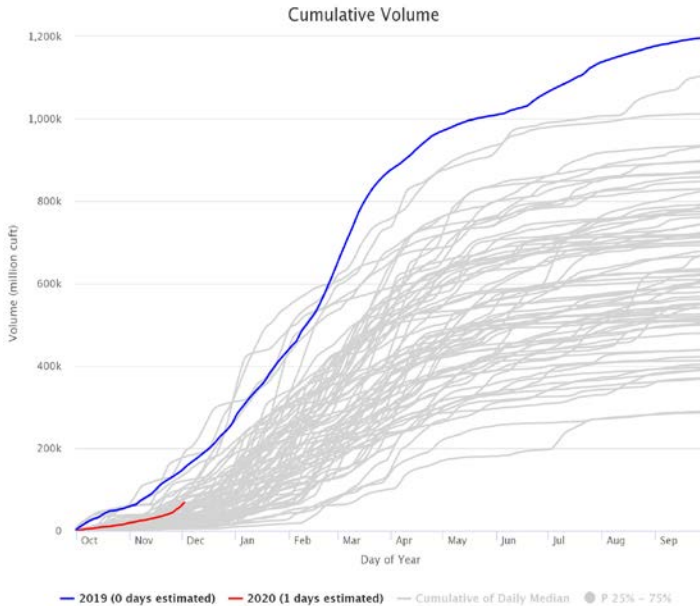
## Cumulative Volume Ohio River At Louisville since 1928

## 1937 remains peaks of record. Flow above normal until summer 2019

New cumulative volume peak for 2019 water year. 1937 record peak stage adjusted for reservoirs about 15 feet higher than 2019.

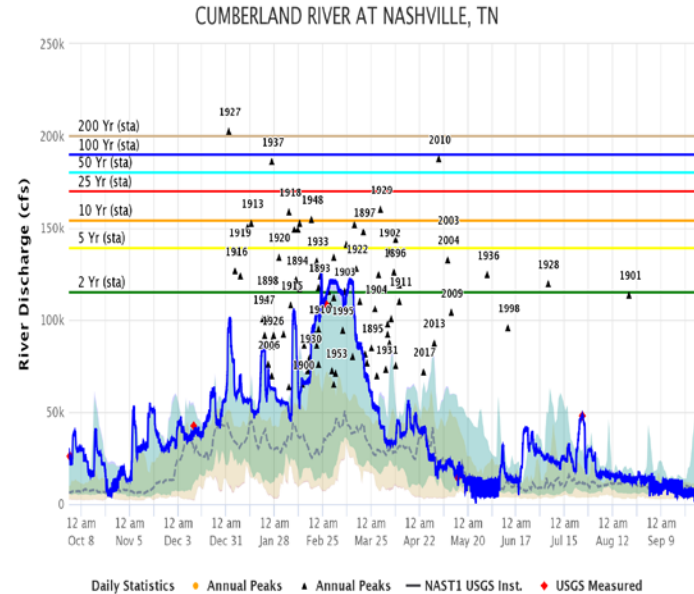


# Cumberland River Basin Cumulative Volume



**Cumulative Volume Cumberland  
At Nashville since 1893**

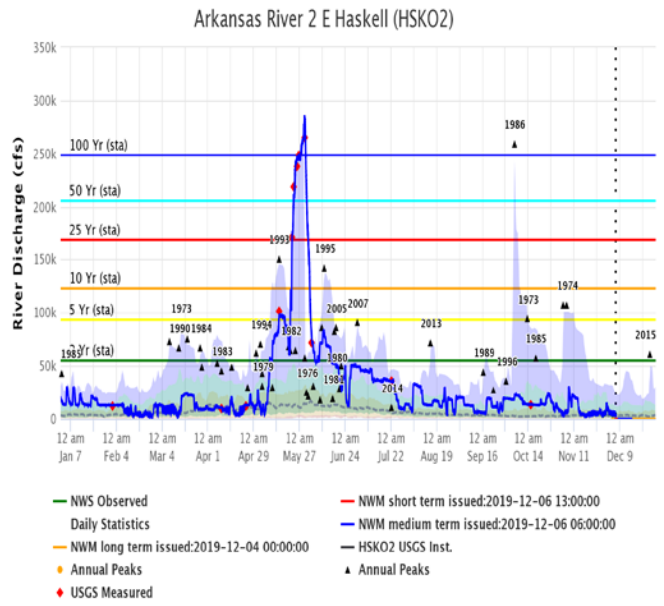
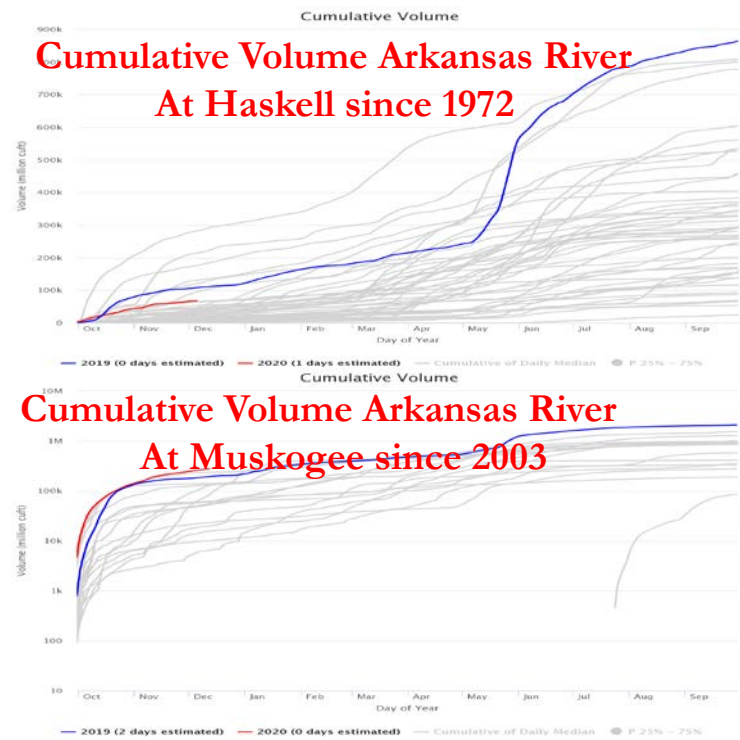
New cumulative volume peak for 2019 water year. 1937 record peak stage adjusted for reservoirs about 15 feet higher than 2019.



**1927 remains peak of record. Flow  
above normal until summer 2019**



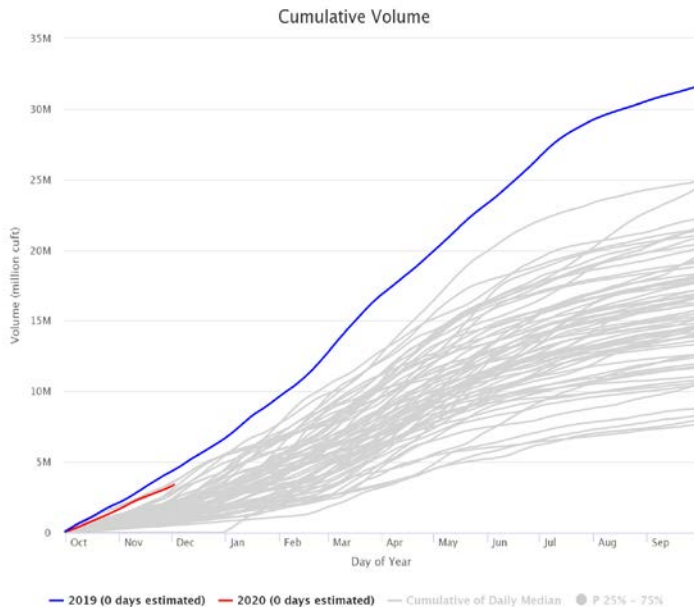
# Arkansas River Basin Cumulative Volume



**2<sup>nd</sup> highest crest of 24+ feet. About 2 feet below the 1980 record.**

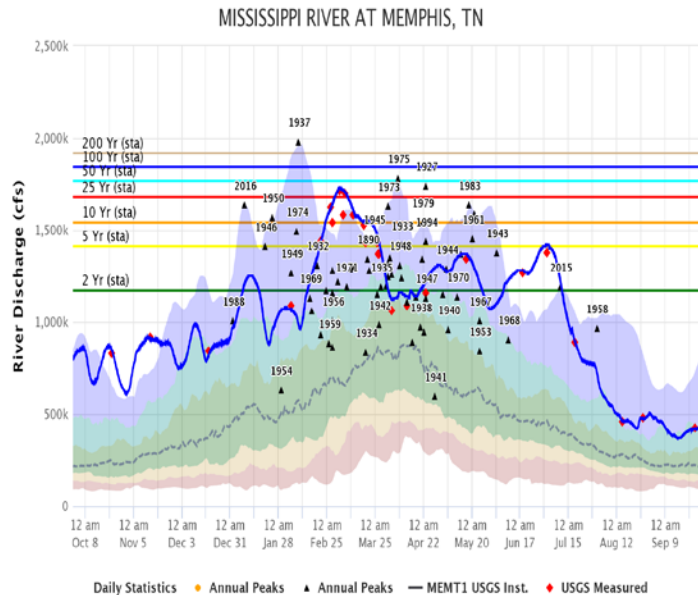
New cumulative volume peak for 2019 water year beating 1999. The cumulative volume lagged behind until May to July time frame.

# Lower Mississippi River Basin Cumulative Volume



## Cumulative Volume Mississippi At Memphis since 1933

New cumulative volume peak for 2019 water year, twice 1937. 1937 record peak stage. Top volume years were 2019, 1973, 1993. Peak stage years: 1937, 1975, 1927.



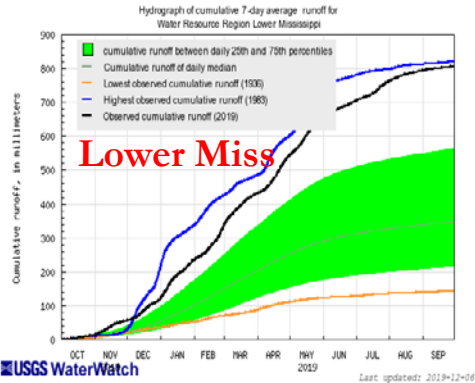
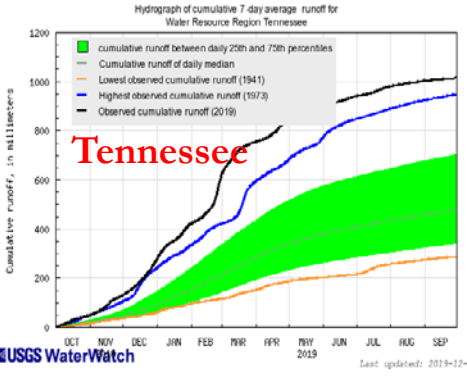
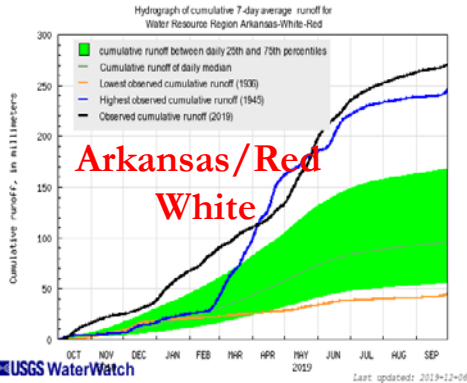
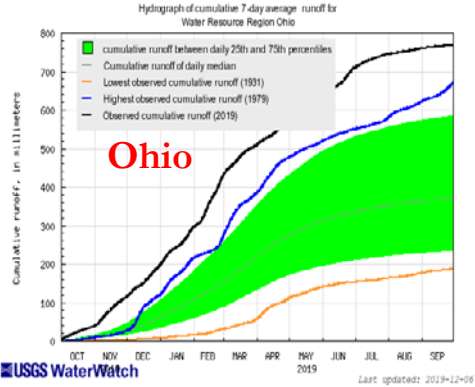
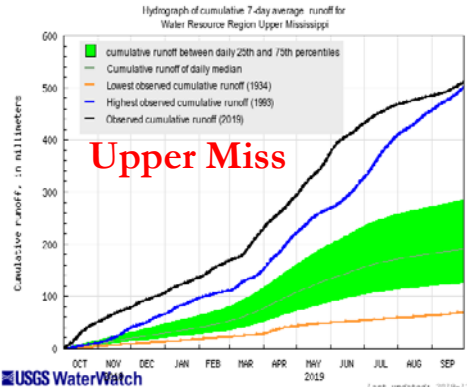
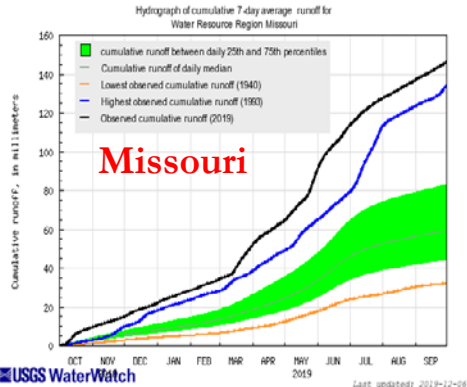
## 1937 remains peak of record. Flow above normal for all of 2019.



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# USGS Cumulative Runoff Volume for 2019



Above or at new records across Mississippi drainage system in 2019 for runoff





# Summary

- Except for the Missouri basin, 2019 **did not** create a significant amount of new record flood levels in the Mississippi River system.
- A persistent storm track through the Mississippi River system for a large part of 2019 water year yielded persistent high flows.
- This led to the longest **DURATION** event with the highest cumulative volume flows throughout most of the Mississippi River system in about 100 years or more and stressed the system including agriculture.

