

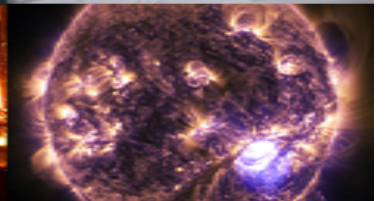
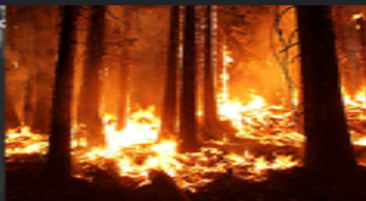
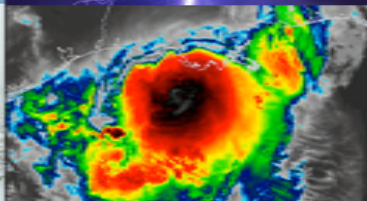
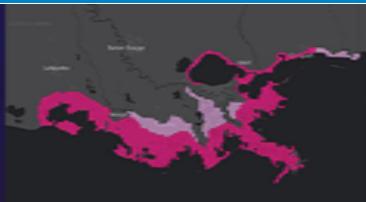
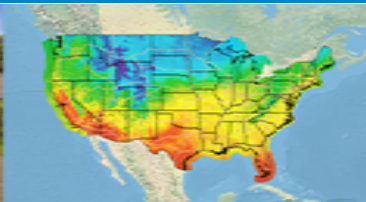


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The Historical Context of the 2018–19 Mississippi River Flood Event

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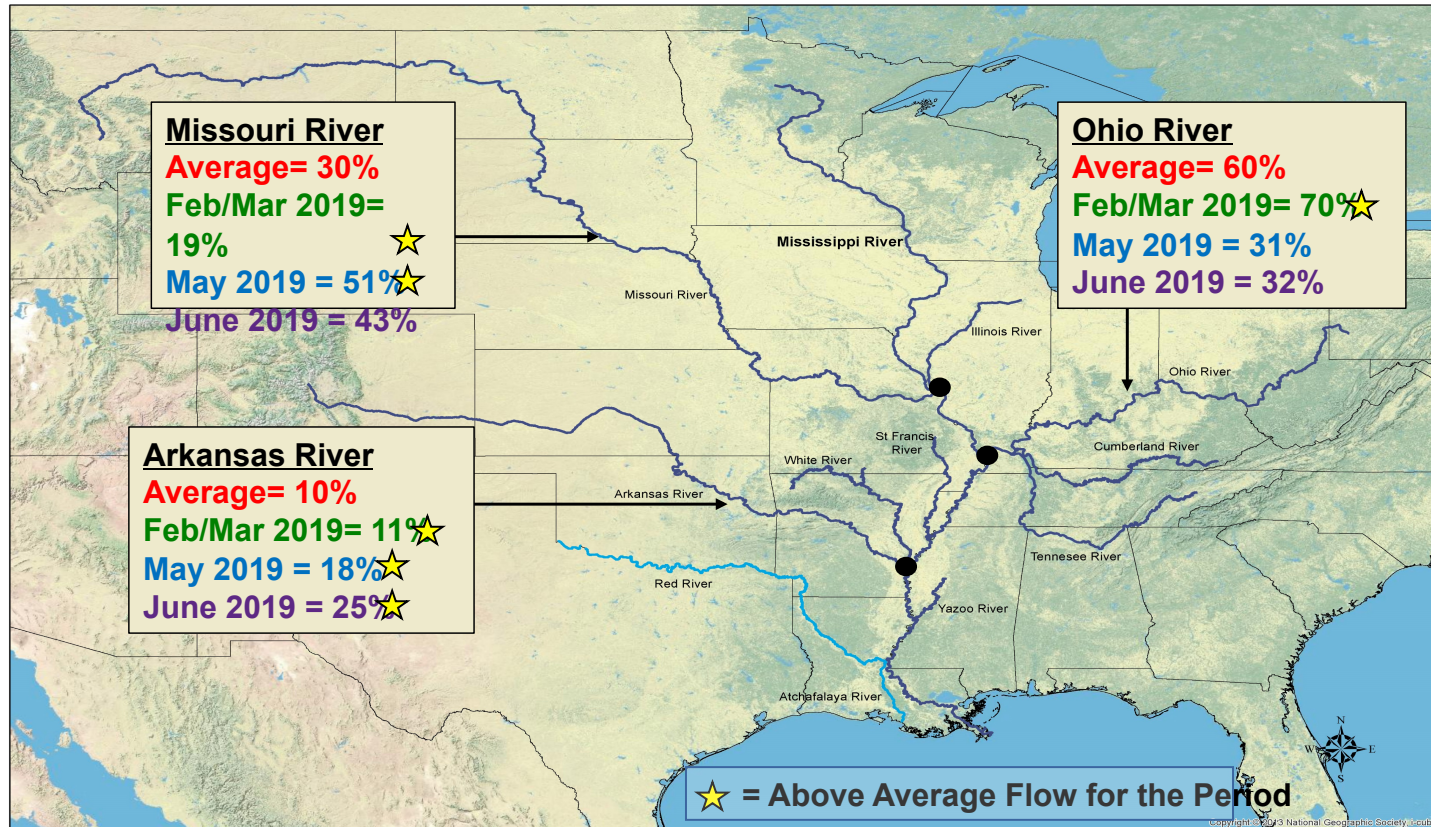


Historical Comparison For 2019 Flows On The Missouri, Ohio, And Arkansas Rivers

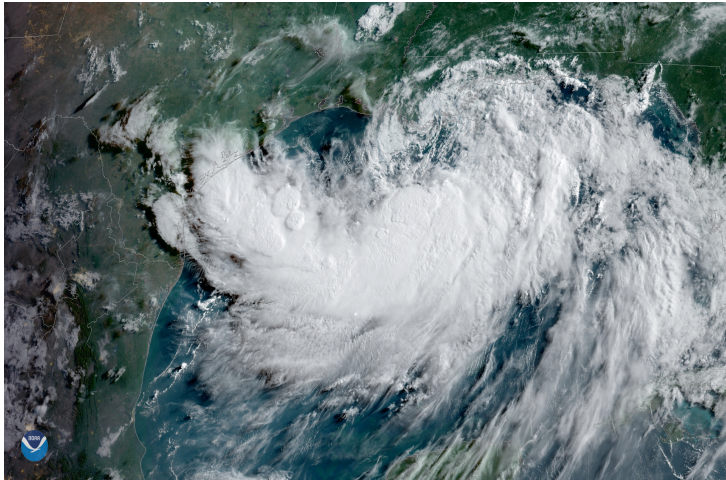
A Tale Of Three Flood Waves



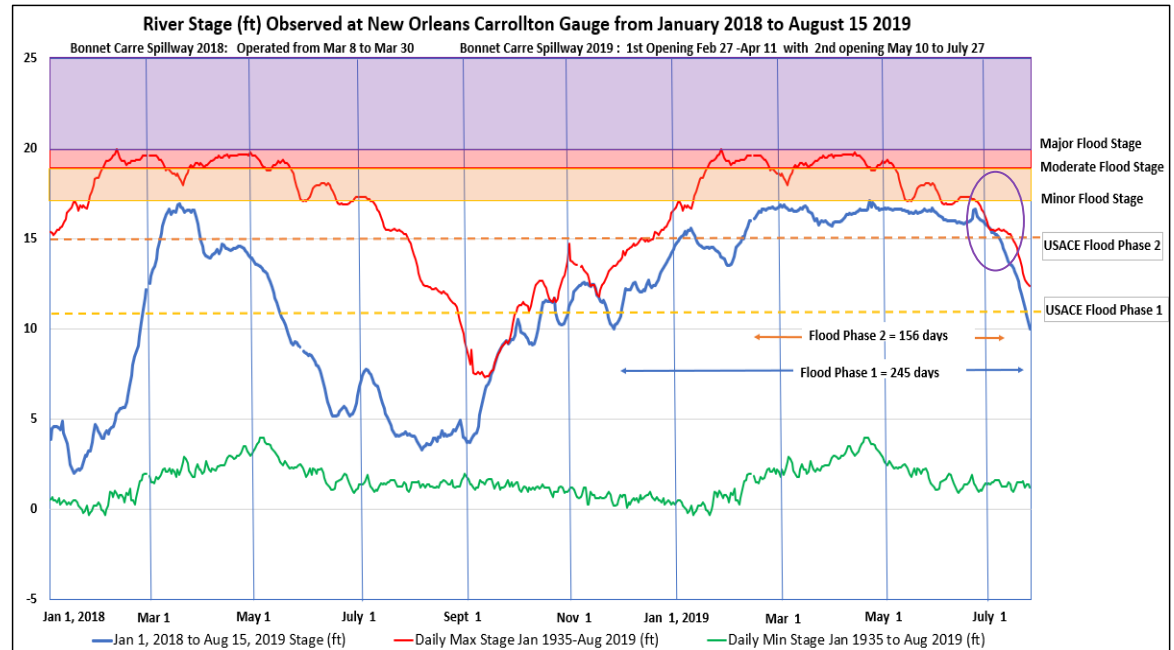
Lower
Mississippi



Respective River Systems Contribution To The Overall Flow Of The Lower Mississippi River (USACE MVD)



NOAA GOES East Image the morning of July 12, 2019



First time the possibility occurred where storm surge would impact the lower Mississippi River in high flow conditions with the Bonnet Carre Spillway open

New Records for Number of Days Above Flood Stage Set in Multiple Locations



Lower
Mississippi

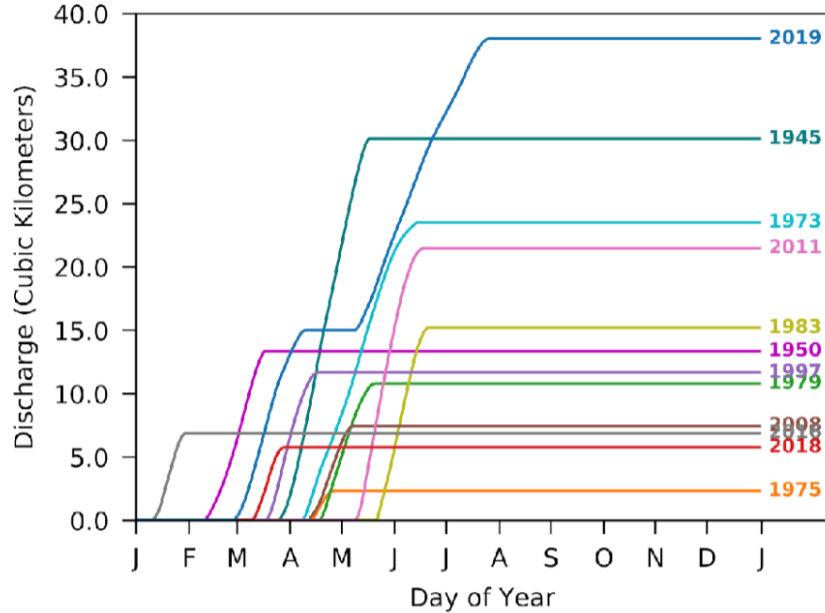
Location	Days Above Flood Stage				
	Record	2019 (Late December 2018- Early August)	2011 (Late March-Mid June)	1973 (Late March- Early June)	1927 (Mid March-Late June)
Cairo, IL	156 days in 2019	156 days (February 8 –July 13)	59	97	76
Memphis, TN	65 days in 1927	39 days (February 19-March 29)	35	64	65
Arkansas City, AR	197 days in 1927	94 days (April 16-July 19)	44	72	197
Greenville, MS	155 days in 2019	155 days (February 17- July 21)	46	71	115
Vicksburg, MS	185 days in 1927	162 days (February 17-July 28)	48	83	185
Natchez, MS	215 days in 2019	215 days (January 4- August 6)	53	90	77
Red River Landing, LA	224 days in 2019	224 days (December 27-August 7)	59	95	152
Baton Rouge, LA	211 days in 2019	211 days (January 6-August 4)	79	99	135

- Yellow: Records set for flood duration in the 2018-2019 flood for the respective location.
- Light Orange: Records from 1927 that remain in place for Memphis, Arkansas City, and Vicksburg.



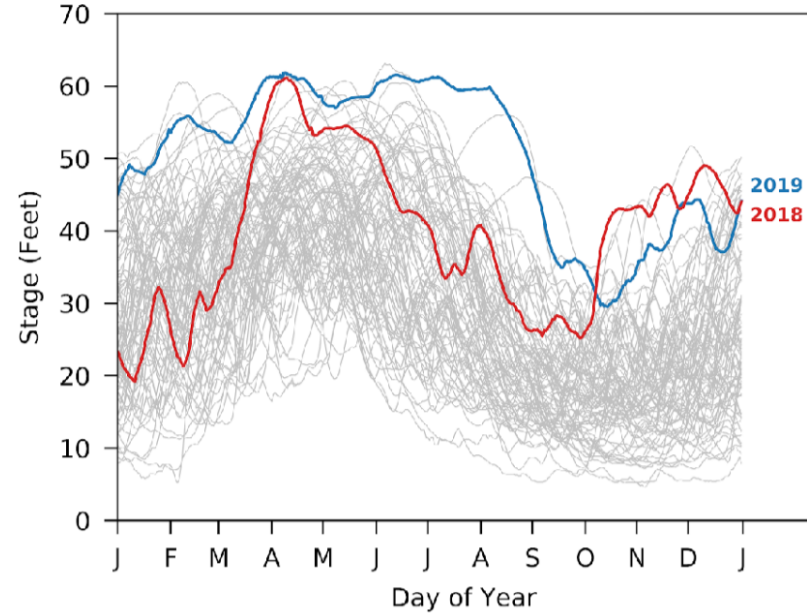
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review (a) Bonnet Carre Spillway Cumulative Discharge



Cumulative Bonnet Carre spillway discharge for calendar years in which it was open since 1945.

(b) Mississippi River at Red River Landing Stage



Red River Landing, LA stage for calendar years since 1935.

The river began climbing in Oct. 2018

2019 is the first time there were two openings of the Bonnet Carre Spillway.

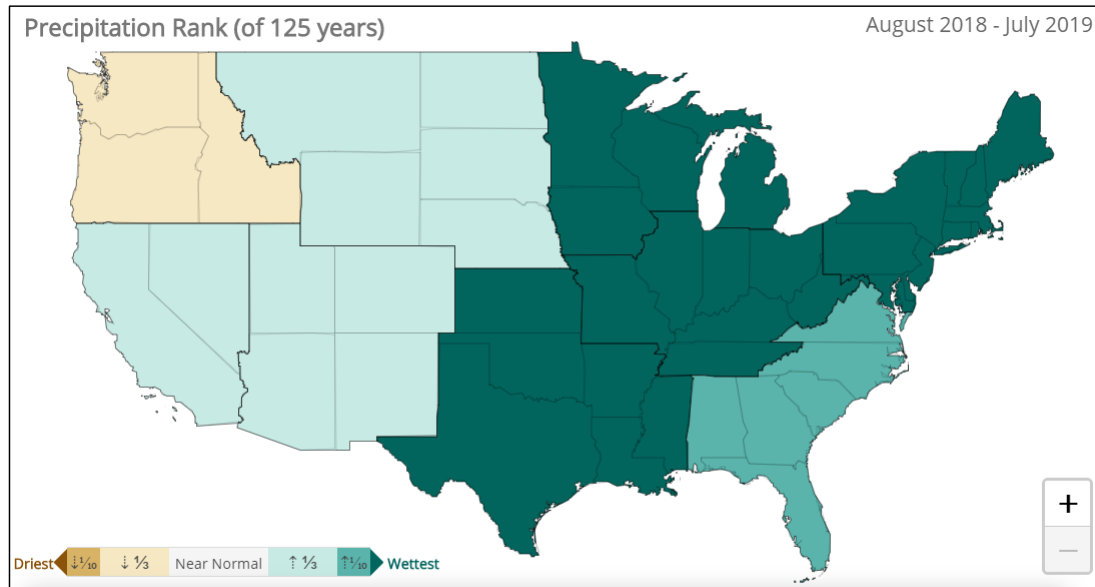
- The first was Feb 27-April 11 for 44 days
- The second was May 10-July 27 for 79 days

This was the longest combined opening of the spillway (123 days) well exceeding the previous record of 75 days in 1973.

Rainfall Rankings for the 12 month period (Aug-July) in the Mississippi and Ohio Valleys since 1895



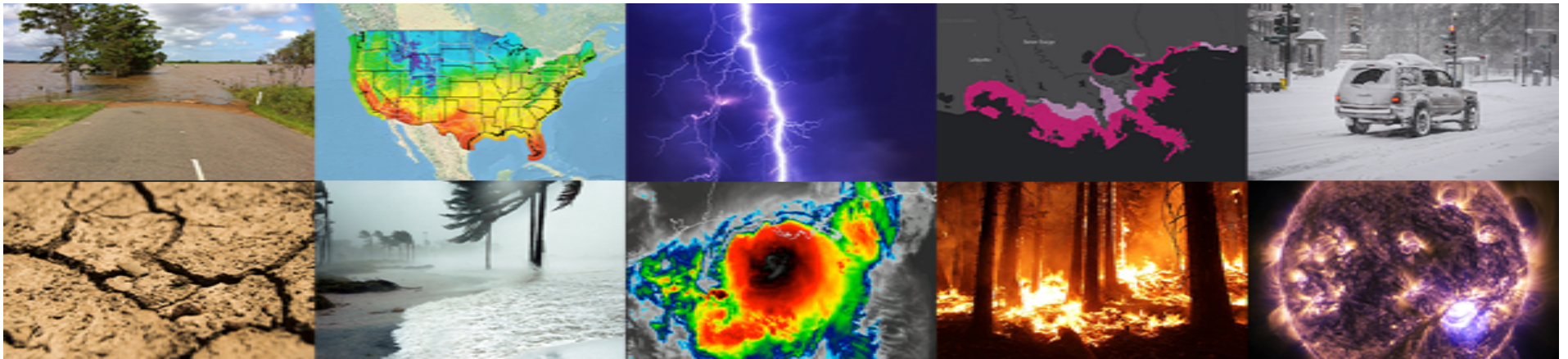
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Mississippi



Region	Value	Rank (125 years)	Anomaly	1901-2000 Mean
Northeast	56.40"	125 (wettest)	14.36"	42.04"
Upper Midwest	40.19"	125 (wettest)	10.46"	29.73"
Ohio Valley	58.63"	125 (wettest)	16.39"	42.24"
South	49.61"	125 (wettest)	14.72"	34.89"
Southeast	58.99"	120 (5 th wettest)	8.64"	50.35"

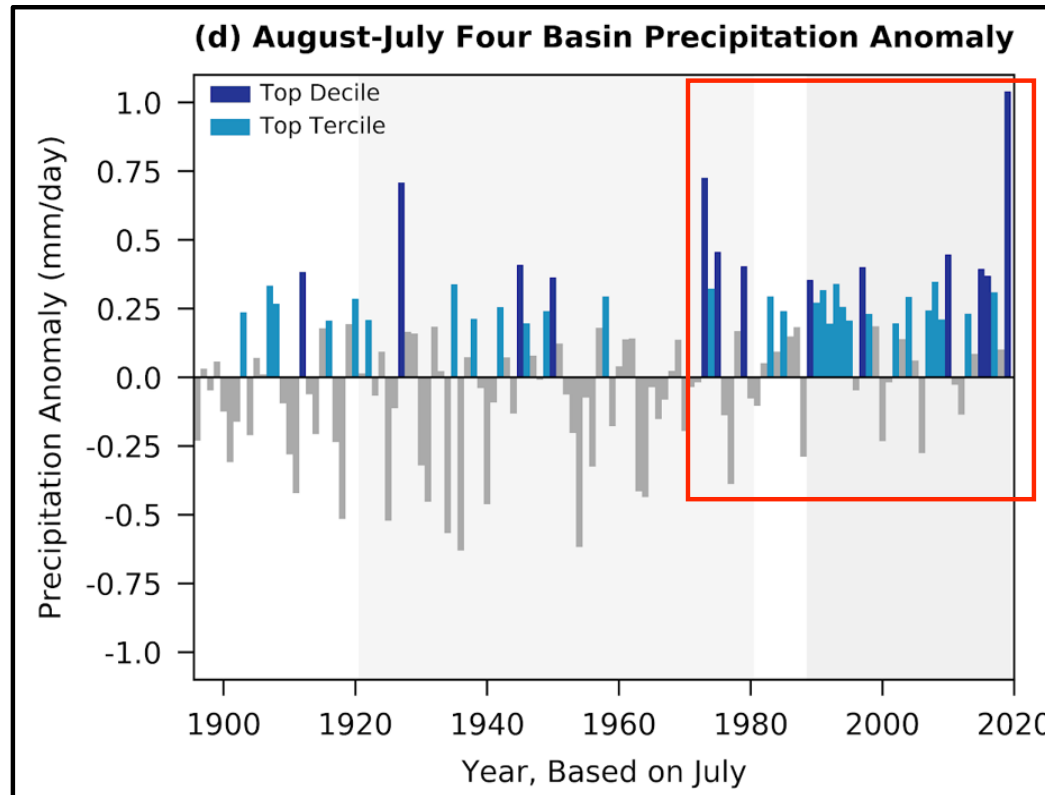
NOAA National Centers for Environmental information, Climate at a Glance: Regional Mapping, published October 2020, retrieved on November 5, 2020 from <https://www.ncdc.noaa.gov/cag/>

Trends in the Magnitude of Heavy Rainfall Events in the Mississippi River Watershed





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Area weighted average **August-July (12 month period)** precipitation anomaly in mm/day in the Upper Mississippi, the Arkansas-White-Red, the Ohio, and the Lower Mississippi catchments based on conditions since 1896.

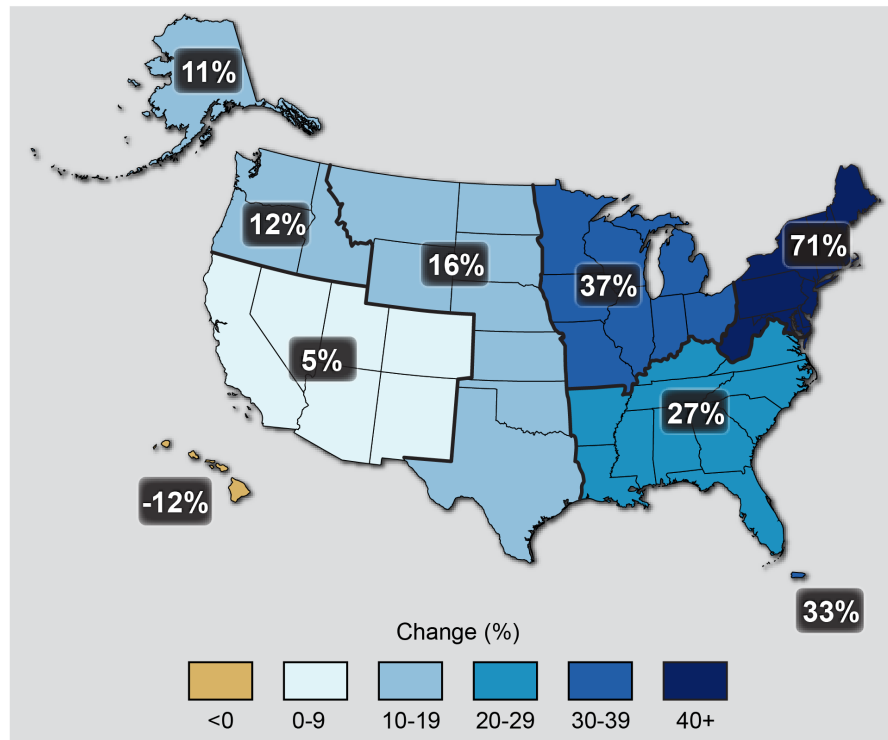
Percent of change in precipitation amount produced in very heavy precipitation events

Calculated using 1% rainfall events for each region from 1958 to 2012



Lower
Mississippi

Observed Change in Very Heavy Precipitation



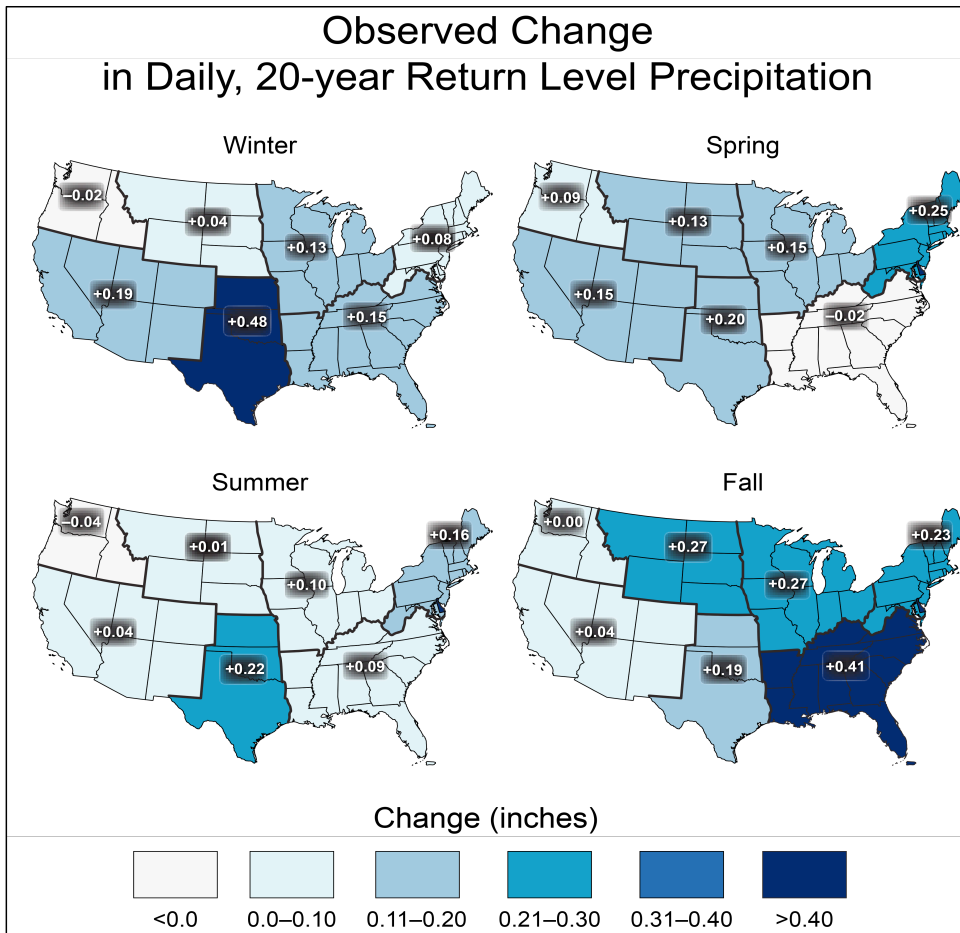
These trends are larger than natural variations for the Northeast, Midwest, Puerto Rico, Southeast, Great Plains, and Alaska (National Climate Assessment 2014)

Changes in rainfall amounts by season - National Climate Assessment 4

In any given year, 5% chance that an event of this magnitude will happen

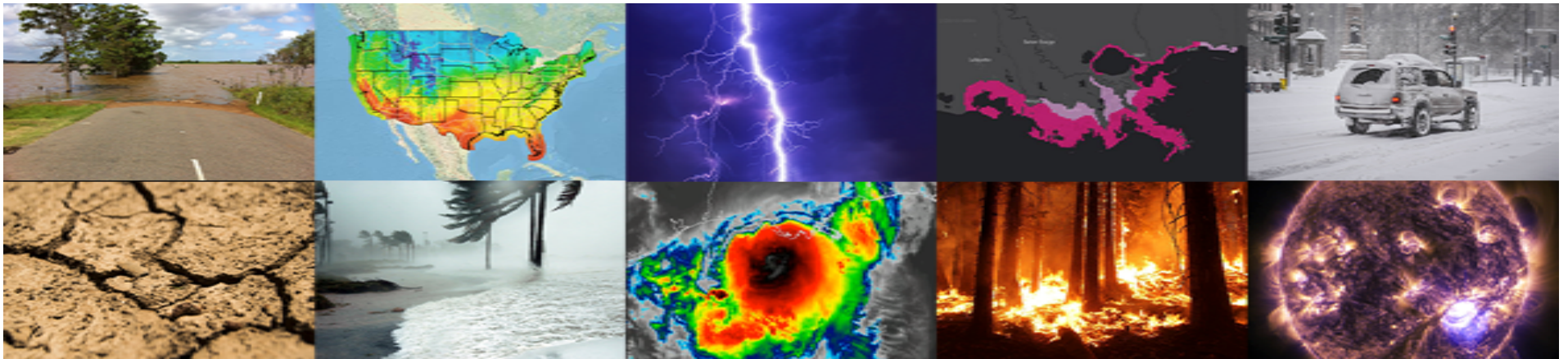


Lower
Mississippi



- Varies geographically by season
- Rainfall amounts from these events have **increased** more than 0.4 inch in places
 - 0.48 inch increase across southern plains in winter
 - In the southeast U.S. the seasonality of daily heavy rain events and the amount of precipitation is noteworthy
 - Fall Average : 0.41 inch increase
 - Spring Average: 0.02 inch decrease
- In the middle and upper Mississippi and Missouri basin there are precipitation increases for all seasons

Trends in the Frequency of Heavy Rainfall Events in the Mississippi River Watershed

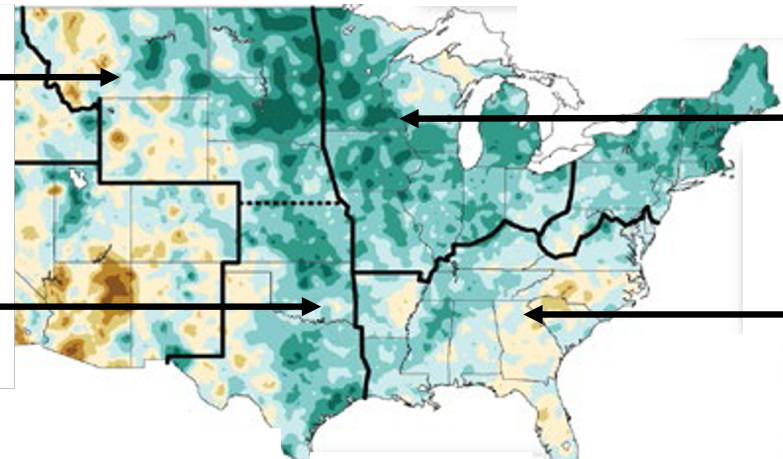
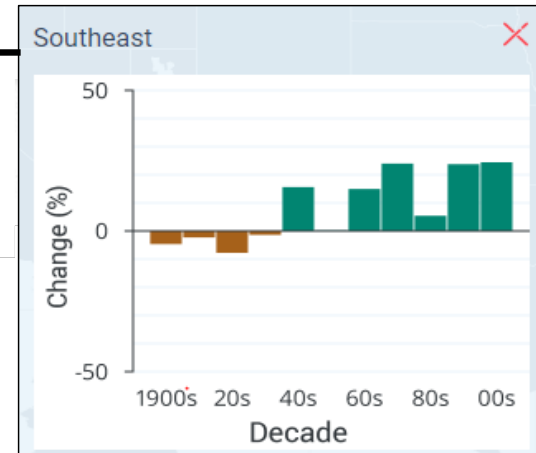
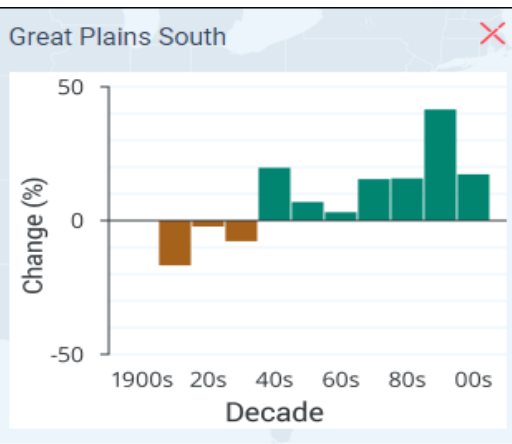
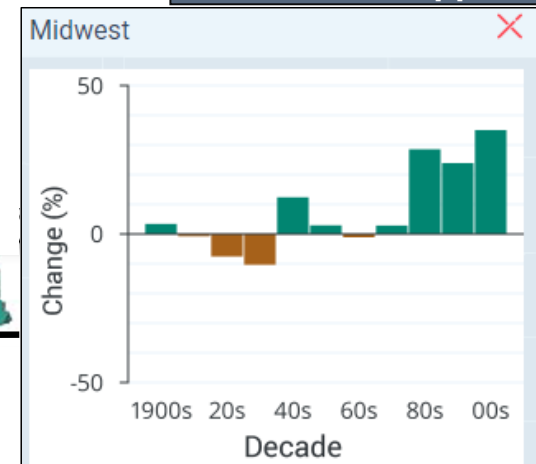
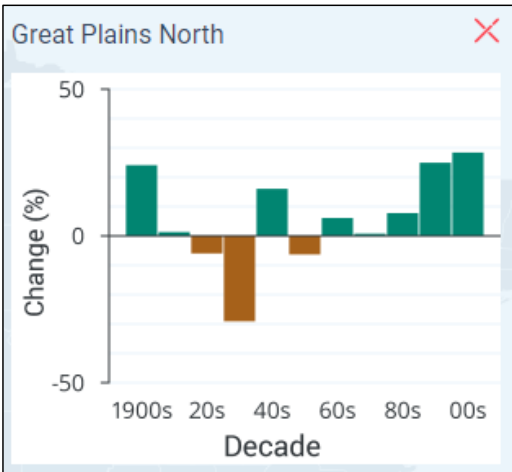


Frequency of 1% of all daily events from 1901 to 2012 for each region

Percent change by decade from 1901 to 2012 for the Mississippi River watershed



Lower Mississippi



Frequency of excessive rainfall events has increased in each of the regions within the Mississippi River watershed.



2-Day Precipitation Events Exceeding 5-Year Recurrence Interval

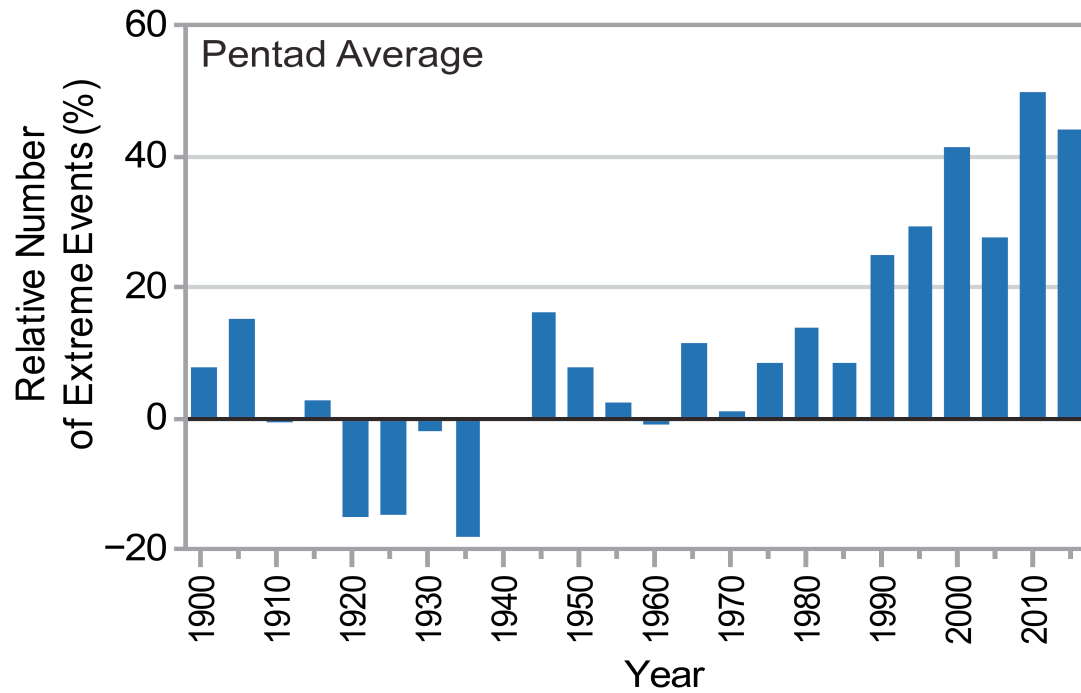


Figure source: Figure 7.3 in *Climate Science Special Report, Fourth National Climate Assessment Volume 1*, USGCRP 2017.



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