Tools for Monitoring Agricultural Drought in Missouri

2025 Missouri Crop Management Conference
December 9, 2025

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UNIVERSITY OF MISSOURI Extension

Missouri Climate Center

Hydroclimate Extremes

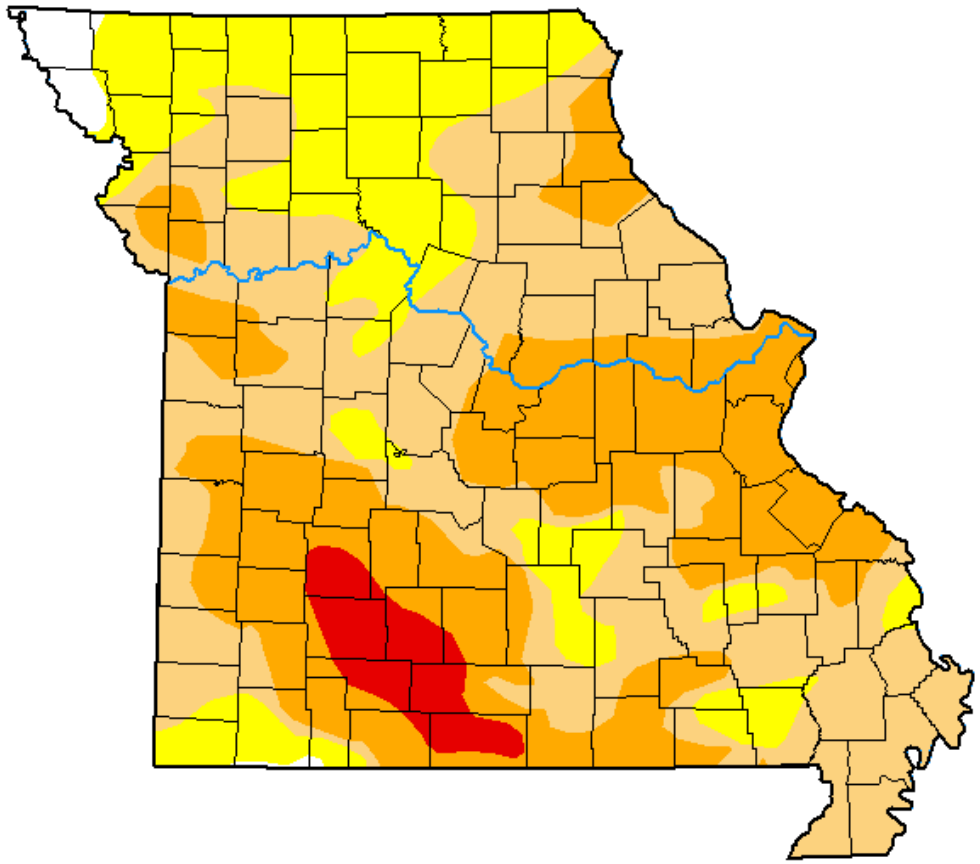
Billion-dollar events to affect Missouri from 1980 to 2024 (CPI-Adjusted)

Disaster Type	Events	Events/Year	Percent Frequency	Total Costs	Percent of Total Costs
Drought	16	0.4	13.3%	$10.0B-$20.0B	20.9%
Flooding	9	0.2	7.5%	$10.0B-$20.0B	26.9%
Freeze	2	0.0	1.7%	$500M-$1.0B	1.1%
Severe Storm	82	1.8	68.3%	$20.0B-$50.0B	48.6%
Tropical Cyclone	2	0.0	1.7%	$500M-$1.0B	0.9%
Wildfire	--	--	--	--	--
Winter Storm	9	0.2	7.5%	$500M-$1.0B	1.5%
All Disasters	**120**	**2.7**	**100.0%**	**$50.0B-$100.0B**	**100.0%**

https://www.ncei.noaa.gov/access/billions/state-summary/MO

U.S. Drought Monitor

Missouri



October 14, 2025

(Released Thursday, Oct. 16, 2025)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.52	98.48	76.94	35.85	3.94	0.00
Last Week *10-07-2025*	2.50	97.50	70.93	26.76	0.00	0.00
3 Months Ago *07-15-2025*	90.65	9.35	0.00	0.00	0.00	0.00
Start of Calendar Year *01-07-2025*	69.71	30.29	11.75	0.00	0.00	0.00
Start of Water Year *10-01-2024*	39.30	60.70	23.73	7.95	0.00	0.00
One Year Ago *10-15-2024*	22.95	77.05	39.37	18.07	4.50	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Richard Tinker

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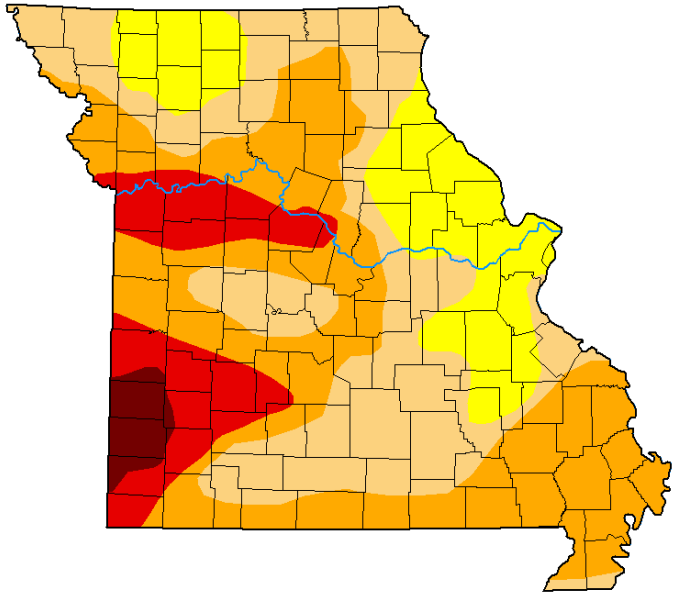
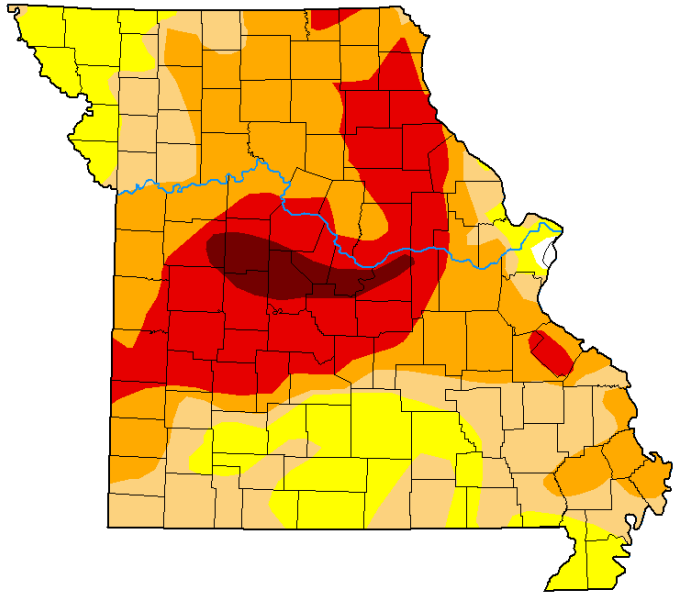
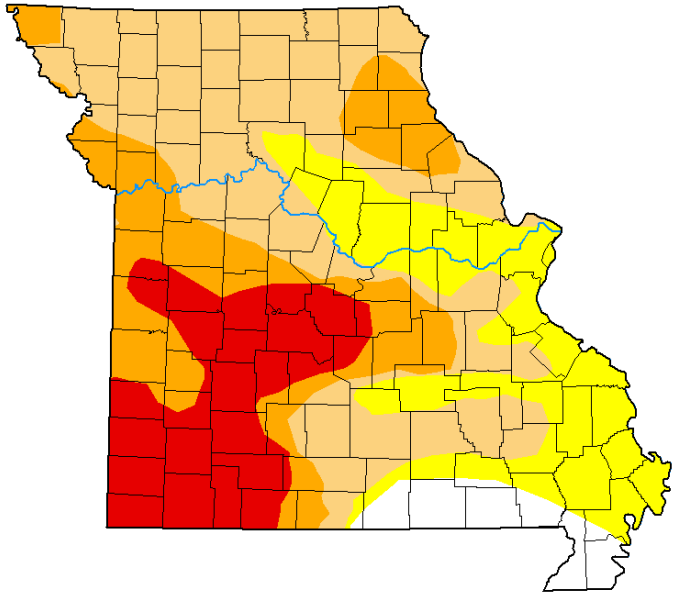
October 18, 2022



July 11, 2023



October 29, 2024



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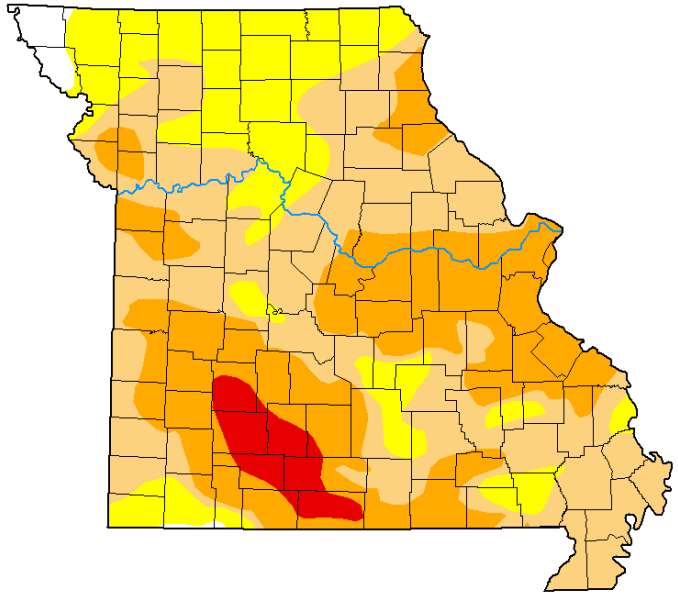

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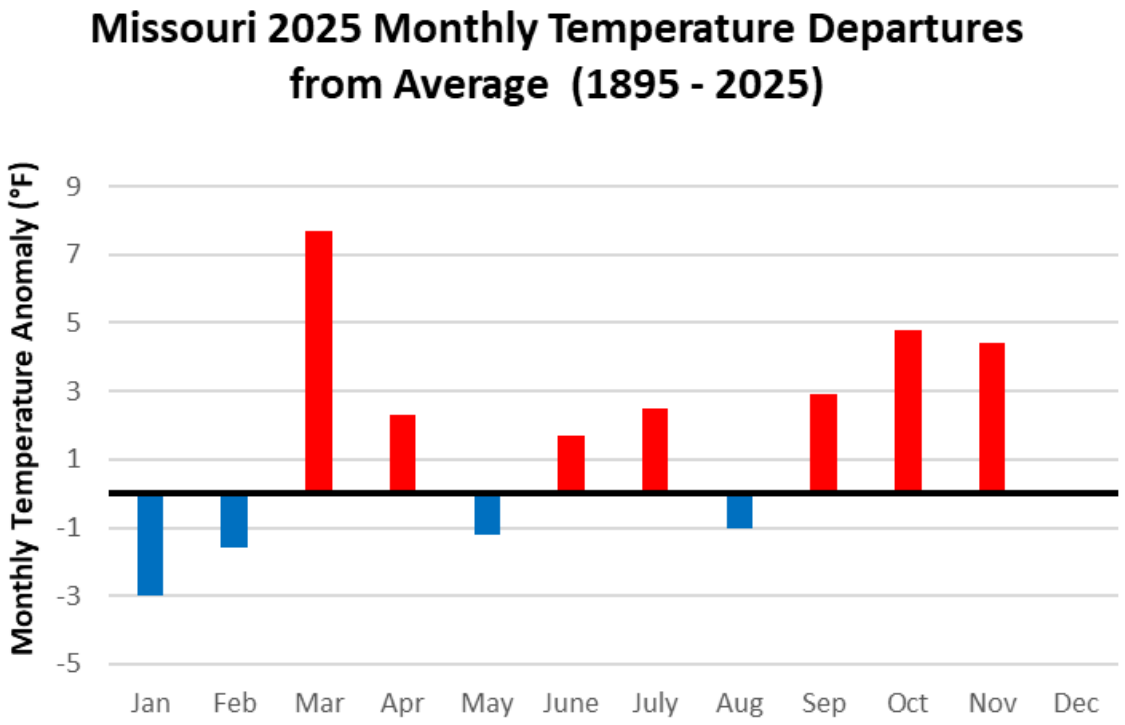
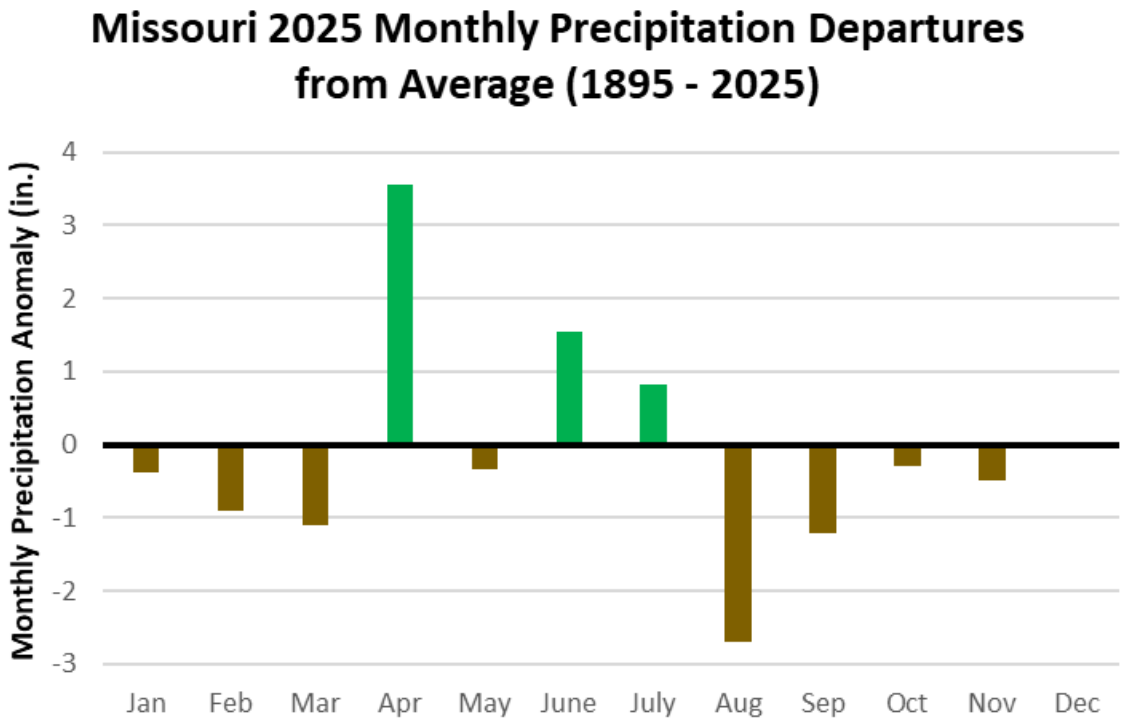
2025 Statewide Climate Summary



YTD: + 1.8 °F



YTD: - 0.54”

https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide

January & February 2025 Summary: Snowy and Cold

Monthly Data for January 2025 for Missouri

Each variable column contains summary value, date of occurrence (if applicable).
Click column heading to sort ascending, click again to sort descending.

Name	County	Lowest Min Temperature	Date
ALBANY	Gentry	-18	22
SMITHVILLE LAKE	Clay	-17	21
CONCEPTION	Nodaway	-16	21
MARSHALL	Saline	-12	22
CLARKSVILLE L&D 24	Pike	-12	22
ST JOSEPH ROSECRANS MEMORIAL AP	Buchanan	-12	07
CHILLICOTHE MISSOURI	Livingston	-12	21
PRINCETON	Mercer	-12	21
MARYVILLE 2E	Nodaway	-12	22
COSBY 2W	Andrew	-11	21
CHILLICOTHE AGRI-SCIENCE CENTER	Livingston	-11	07
CAMERON	DeKalb	-11	22
KIRKSVILLE REGIONAL AP	Adair	-11	21
KIRKSVILLE	Adair	-11	22
SPICKARD 7 W	Grundy	-11	22

- Missouri's statewide average temperature during January 2025 was 29.4°F (- 2.5°F)
- Missouri's statewide average precipitation (liquid equivalent) in January was 1.94" (- 0.15")
- Missouri's statewide average temperature during February 2025 was 31.5°F (- 2.3°F)
- Missouri's statewide average precipitation (liquid equivalent) in February was 1.35" (- 0.67")

Ranks based on data from 1895 to 2024 (130 years) https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/

January & February 2025 Summary: Snowy and Cold

Monthly Data for February 2025 for Missouri

Each variable column contains summary value, date of occurrence (if applicable).
Click column heading to sort ascending, click again to sort descending.

Name	County	Lowest Min Temperature	Date
SMITHVILLE LAKE	Clay	-22	20
CONCEPTION	Nodaway	-16	20
COLE CAMP 3NW	Benton	-16	20
SEDALIA WATER PLANT	Pettis	-16	21
MARSHALL	Saline	-15	20
SALEM 10 W	Dent	-15	21
PRINCETON	Mercer	-15	21
ALBANY	Gentry	-14	23
BILLINGS 1SW	Christian	-14	20
MARSHFIELD 4 WSW	Webster	-14	21
BUTLER 4W	Bates	-14	20
LOCKWOOD	Dade	-13	21
BOLIVAR 1 NE	Polk	-13	21
COSBY 2W	Andrew	-13	22
ST JOSEPH ROSECRANS MEMORIAL AP	Buchanan	-13	20

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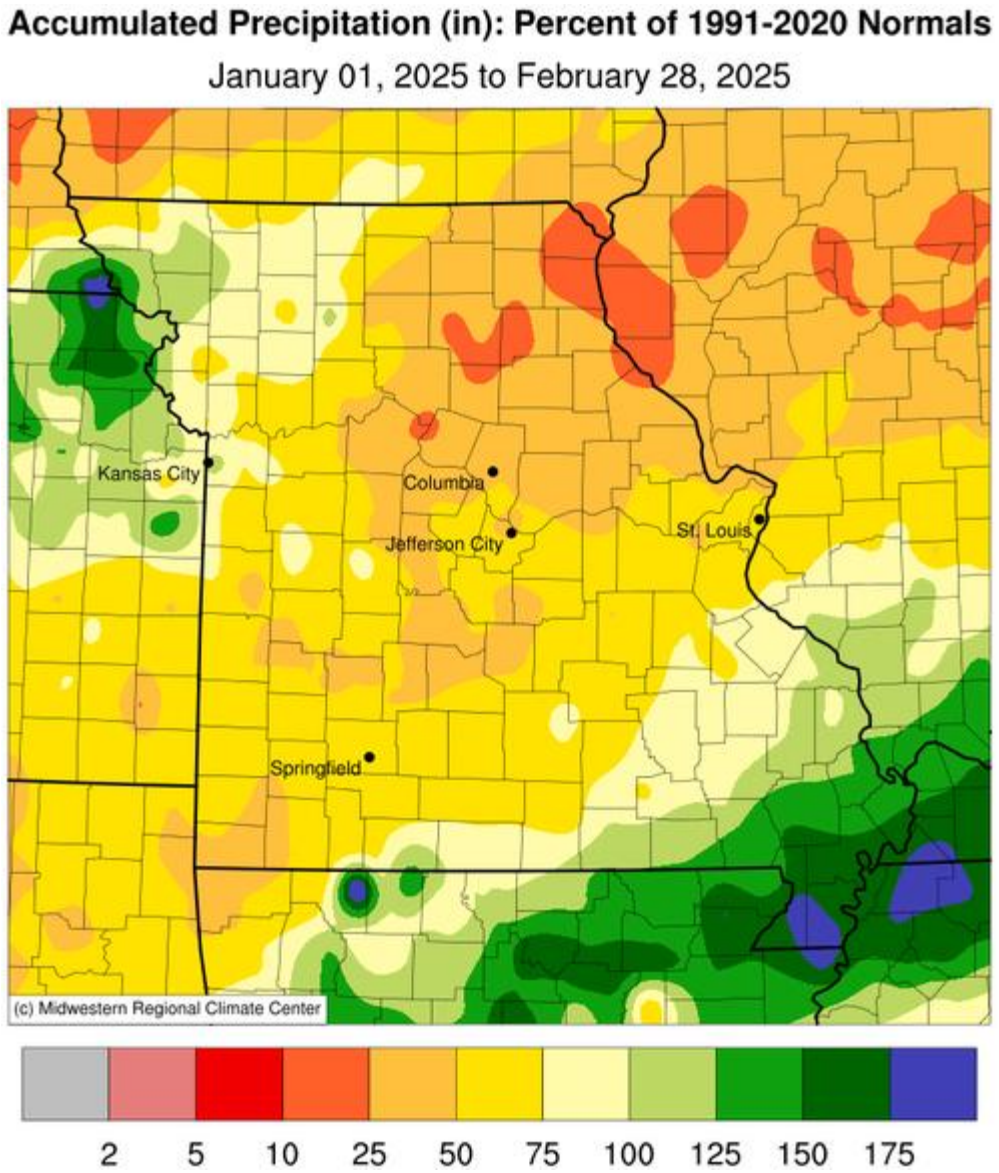
February 2025



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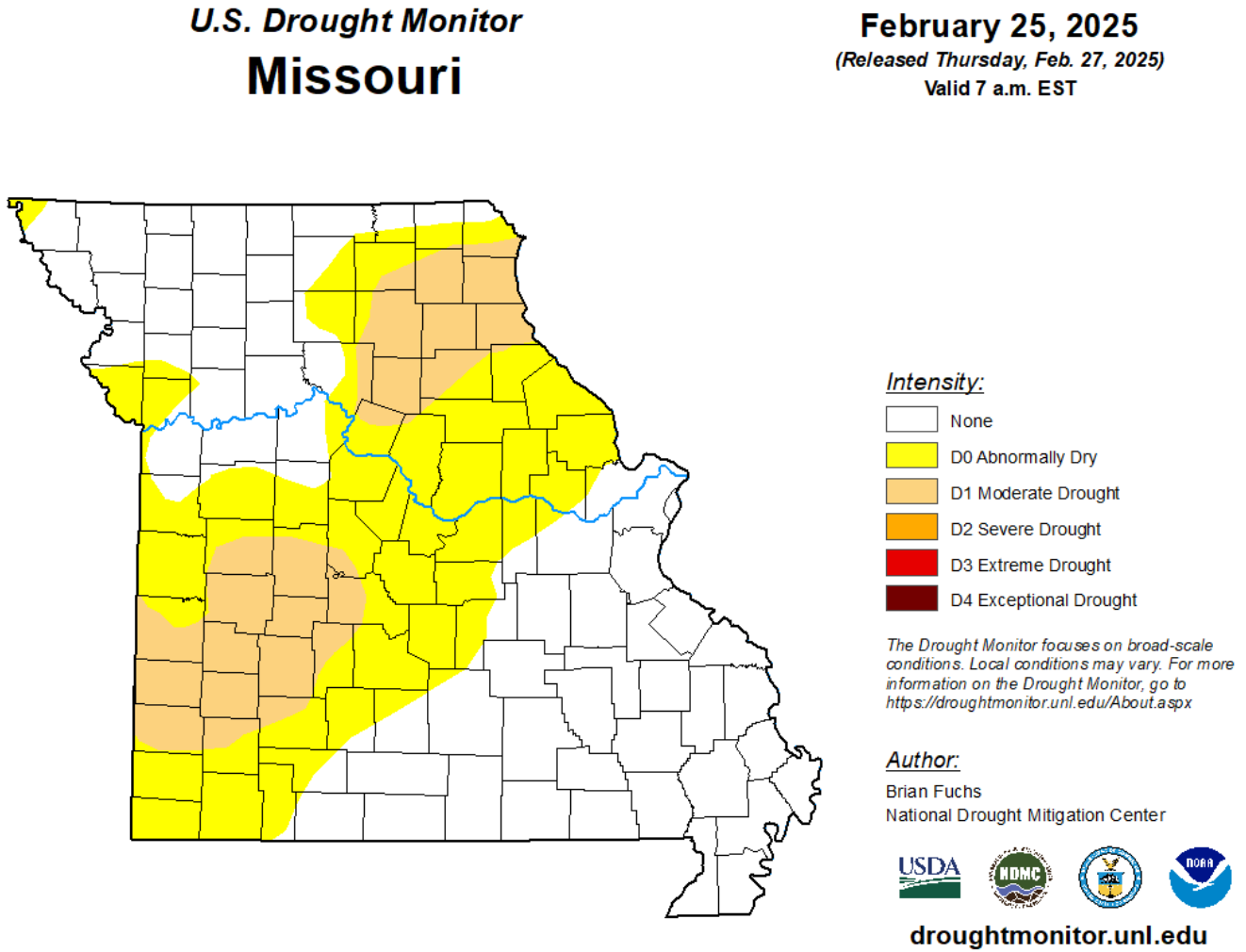
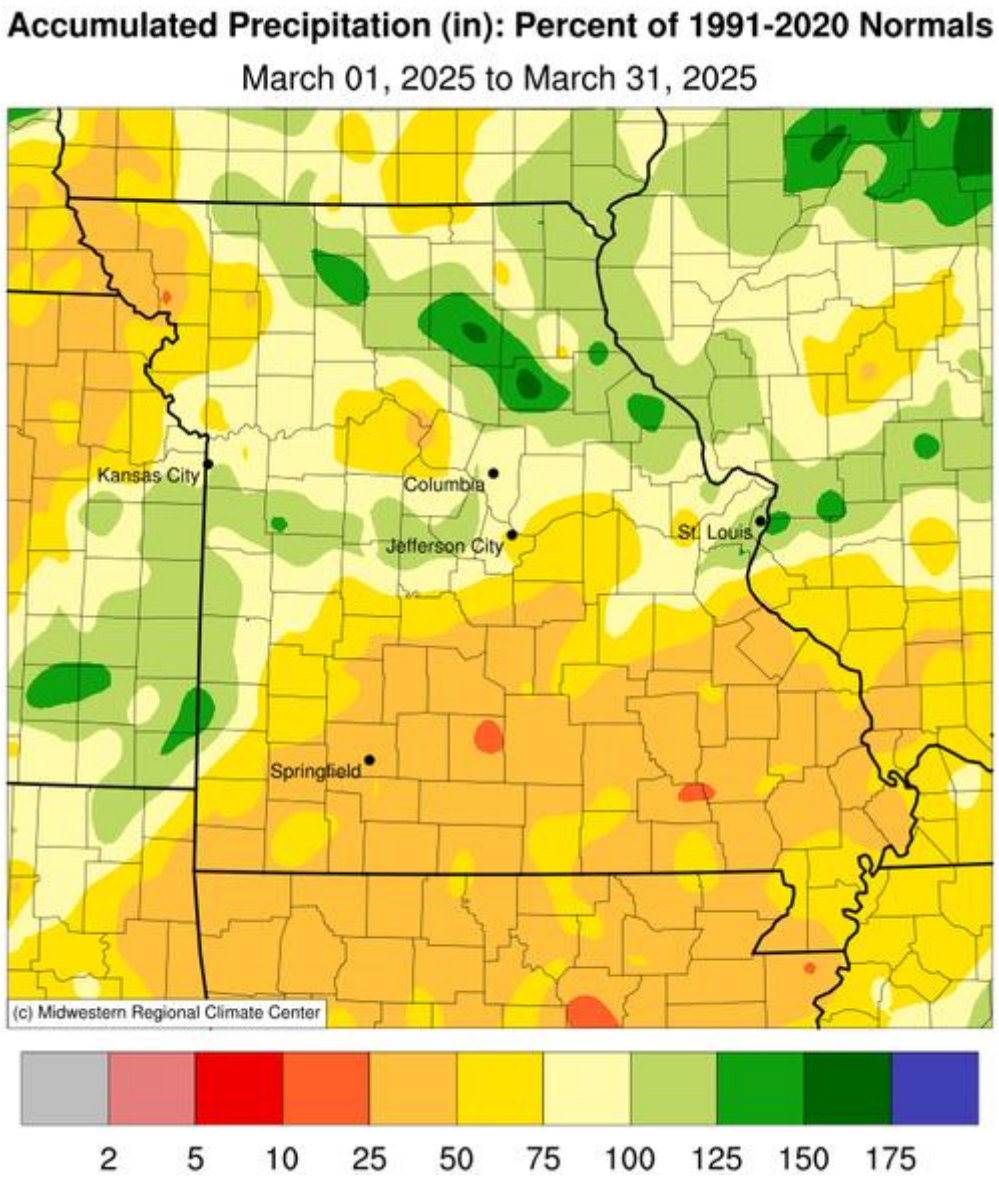


March 2025



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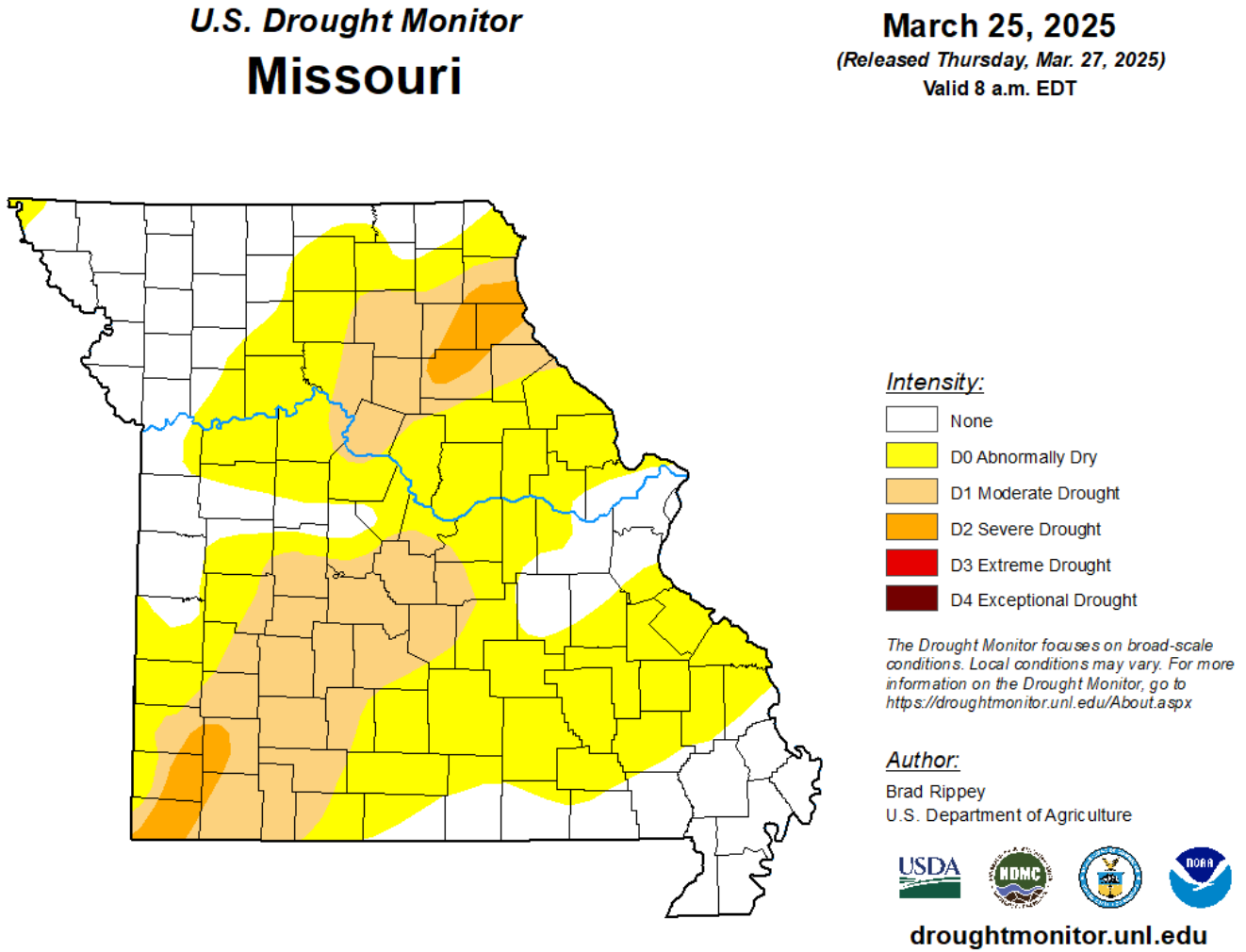
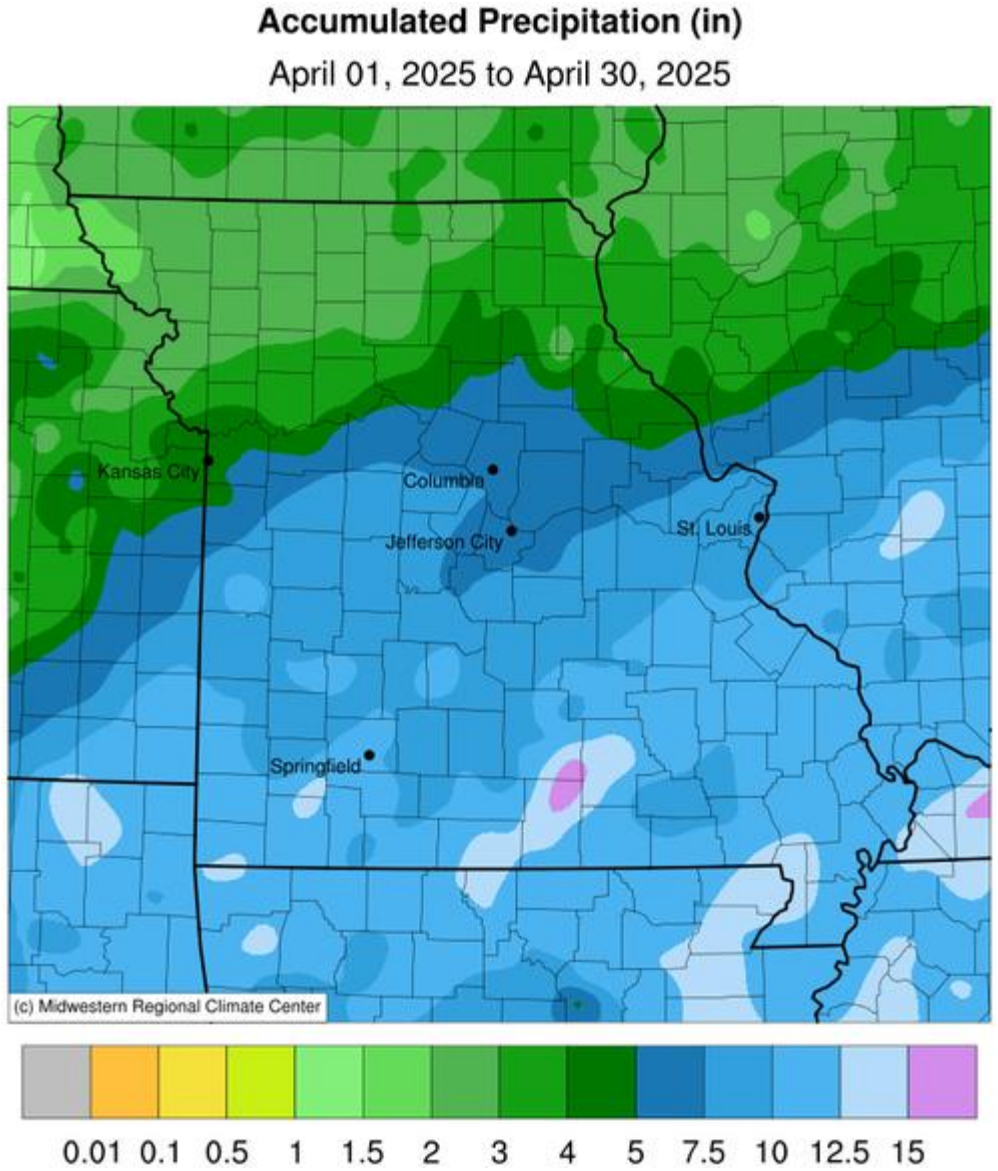


April Rainfall



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Rainfall Rankings (Missouri's 4th wettest April)

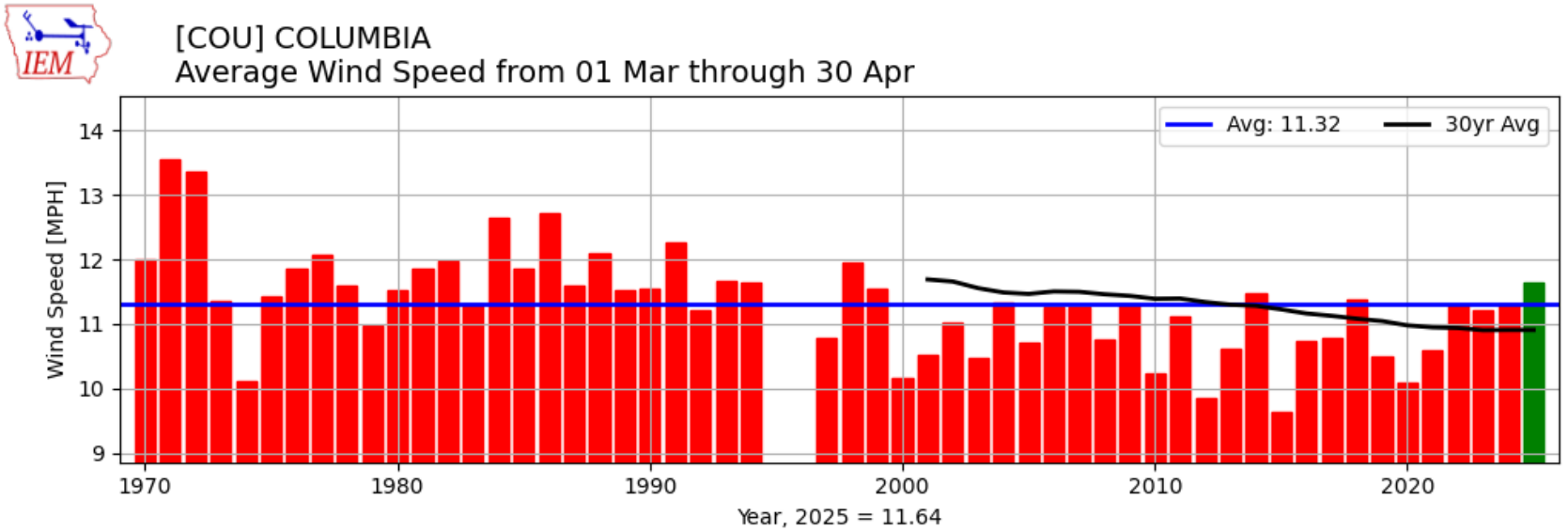
- St. Louis (10.85"): Wettest April on record *1874 - present*
- Springfield (13.29"): Wettest April on record *1887 - present*

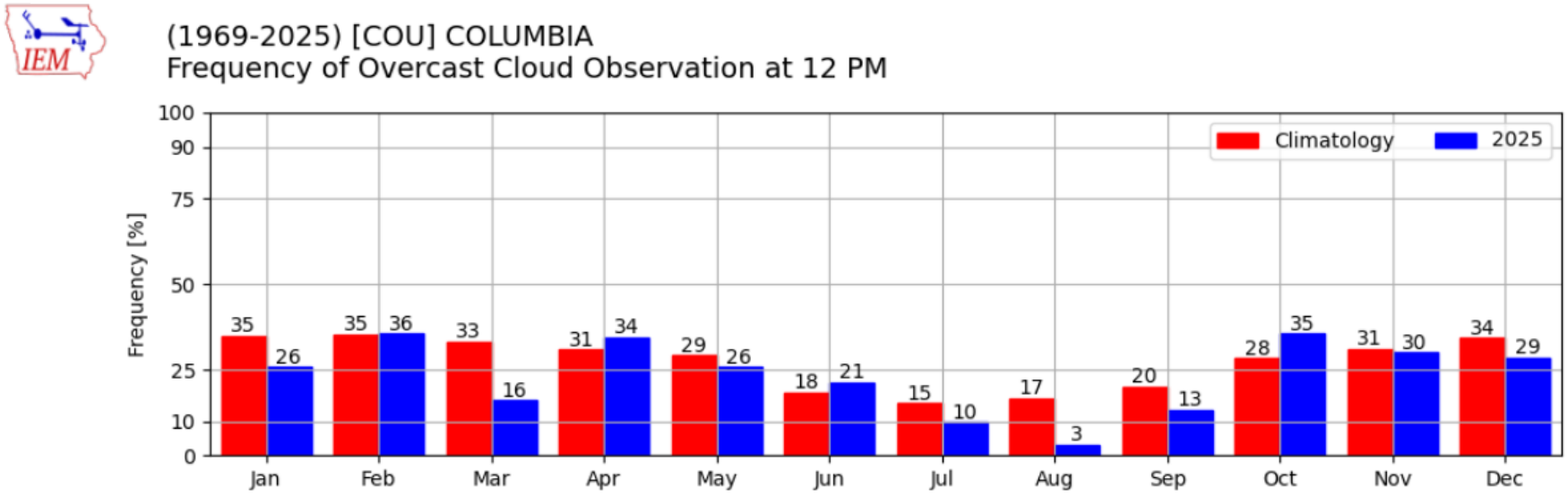
Monthly Data for April 2025 for Missouri

Click column heading to sort ascending, click again to sort descending.

Name	County	Total Precipitation
SUMMERSVILLE 3.6 S	Texas	18.02
WEST PLAINS 10.6 S	Howell	15.57
WEST PLAINS 2.2 NNW	Howell	15.53
TECUMSEH 2.2 SE	Ozark	15.51
MOUNTAIN VIEW 7.0 NE	Shannon	15.05
AURORA 2.7 S	Lawrence	14.96
TECUMSEH 1W	Ozark	14.92
WEST PLAINS MUNICIPAL AP	Howell	14.63
GAINESVILLE 6.2 ENE	Ozark	14.20
REPUBLIC 0.8 ESE	Greene	13.95
NEW MADRID 0.2 SE	New Madrid	13.83
KENNETT 0.8 N	Dunklin	13.79
EMINENCE 4.7 ESE	Shannon	13.71
MALDEN MUNICIPAL AP	Dunklin	13.67
MARIONVILLE 4.7 N	Lawrence	13.62
NEOSHO 2.0 NNW	Newton	13.41
WEST PLAINS 1.5 NW	Howell	13.33

Windy and Cloudy April





https://mesonet.agron.iastate.edu/

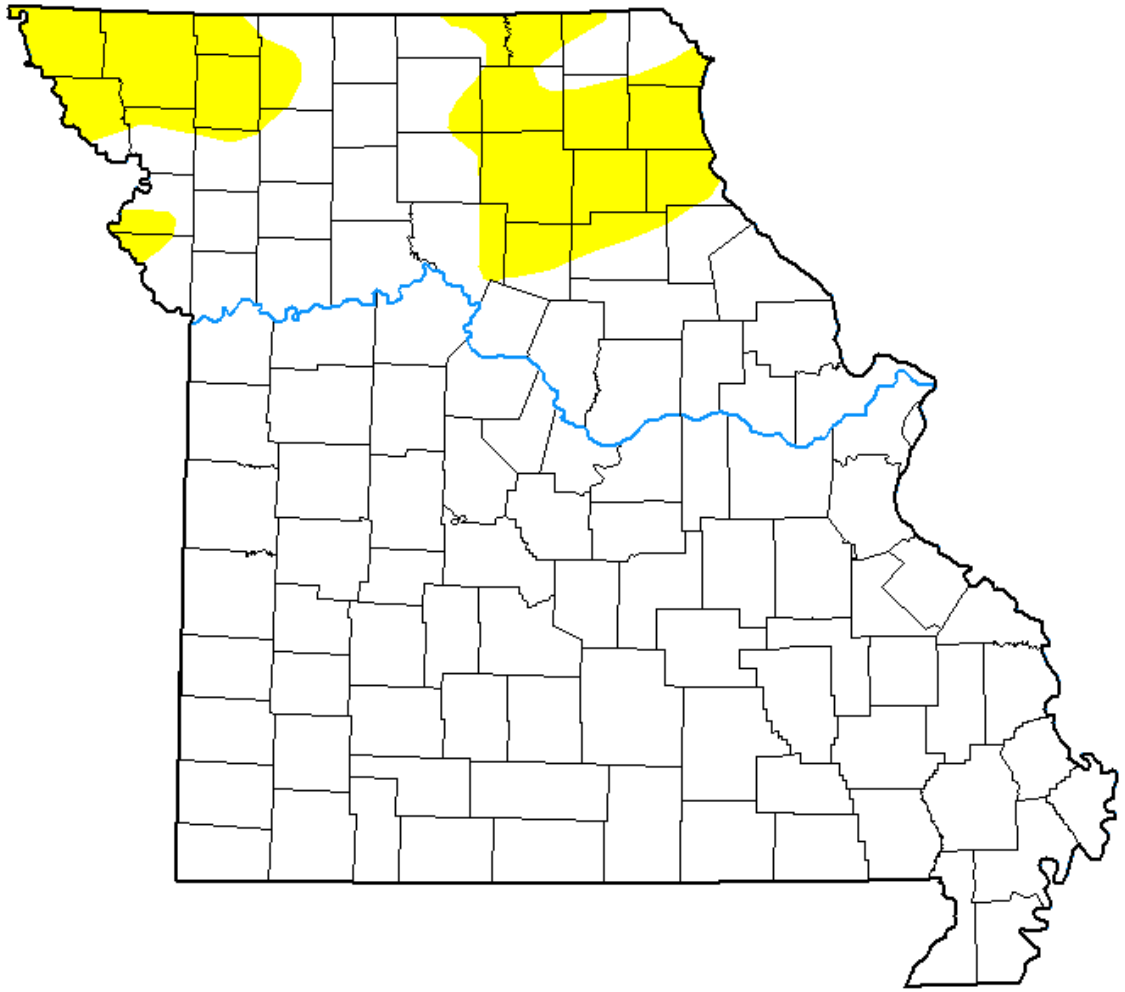
U.S. Drought Monitor

Missouri

April 29, 2025

(Released Thursday, May. 1, 2025)

Valid 8 a.m. EDT



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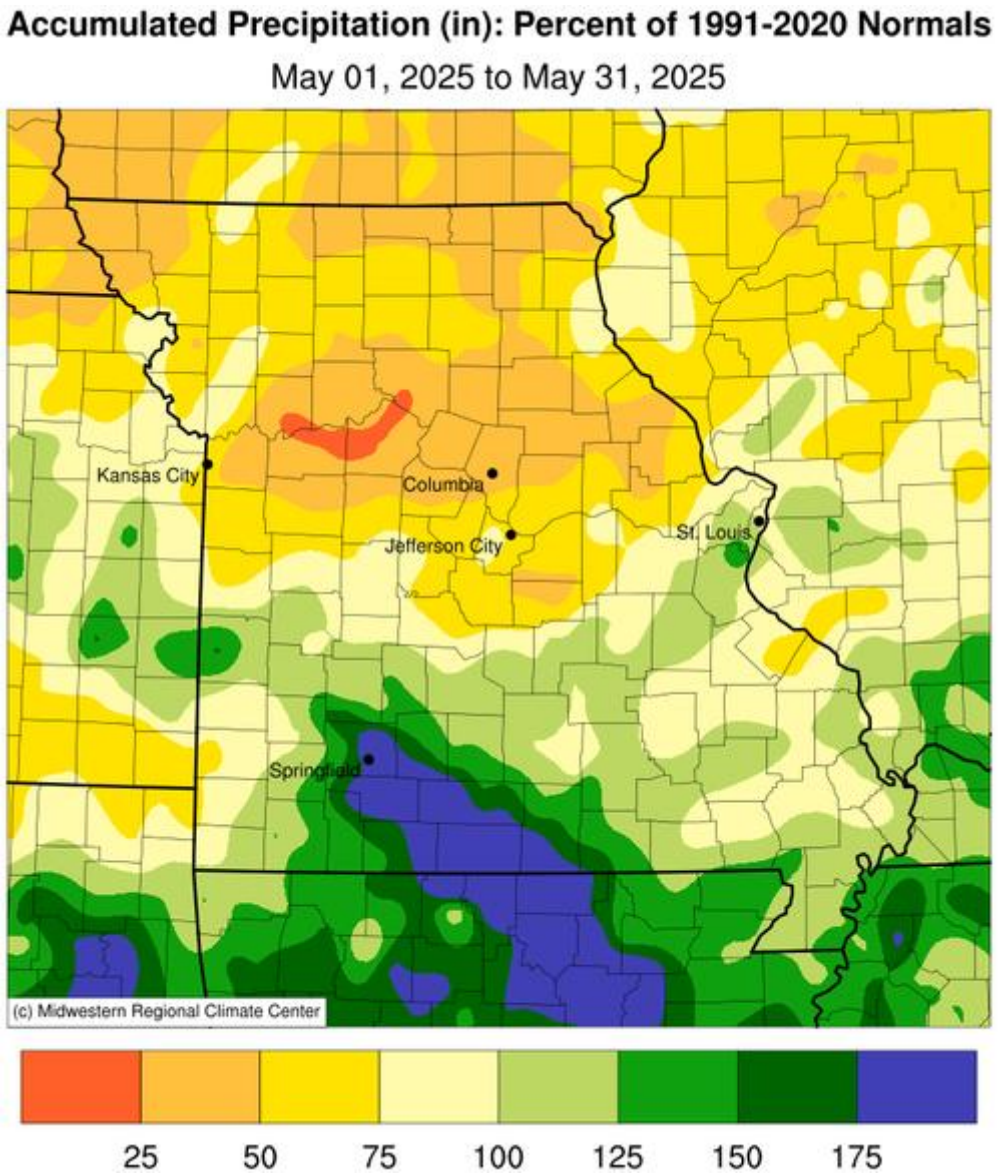
May 2025



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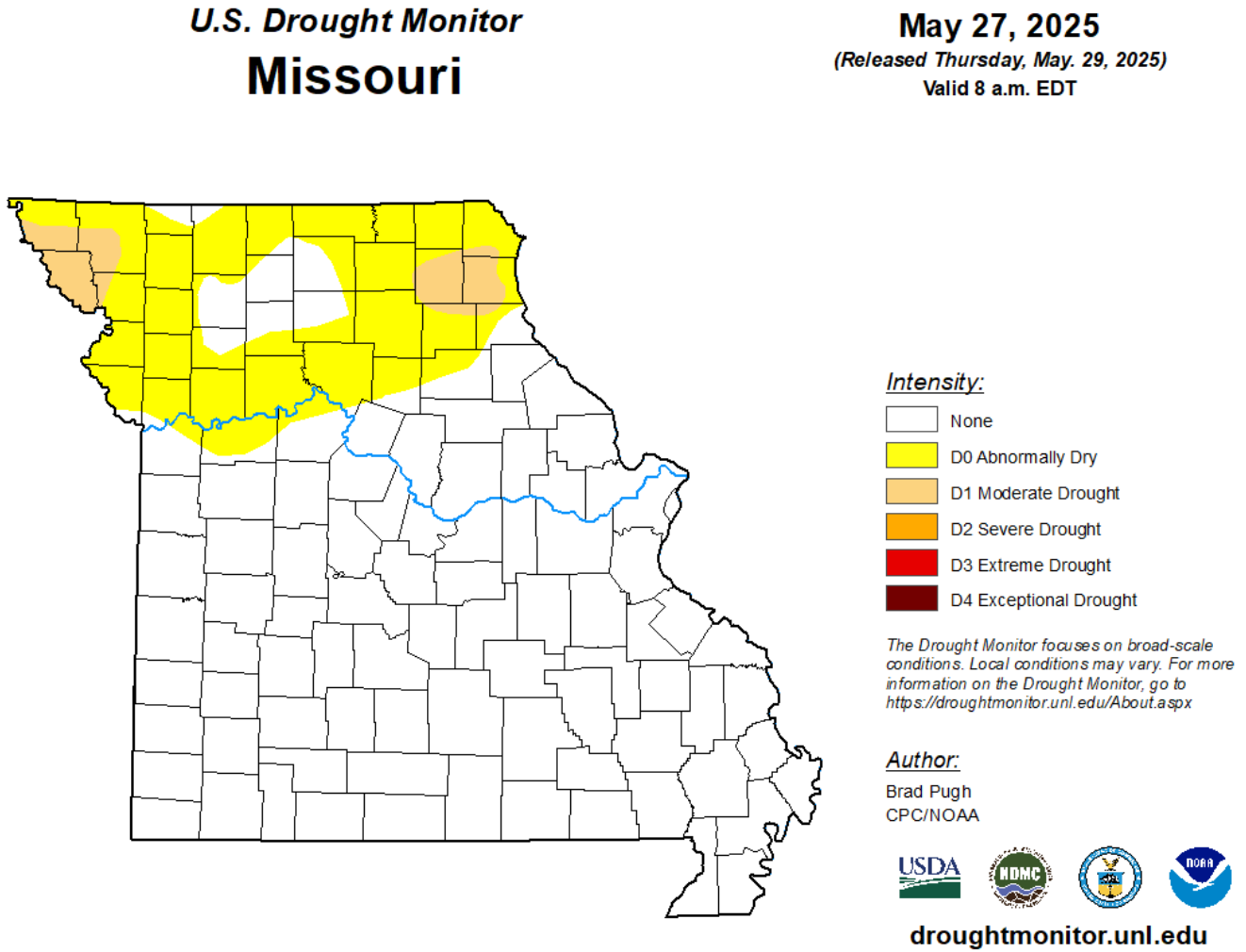
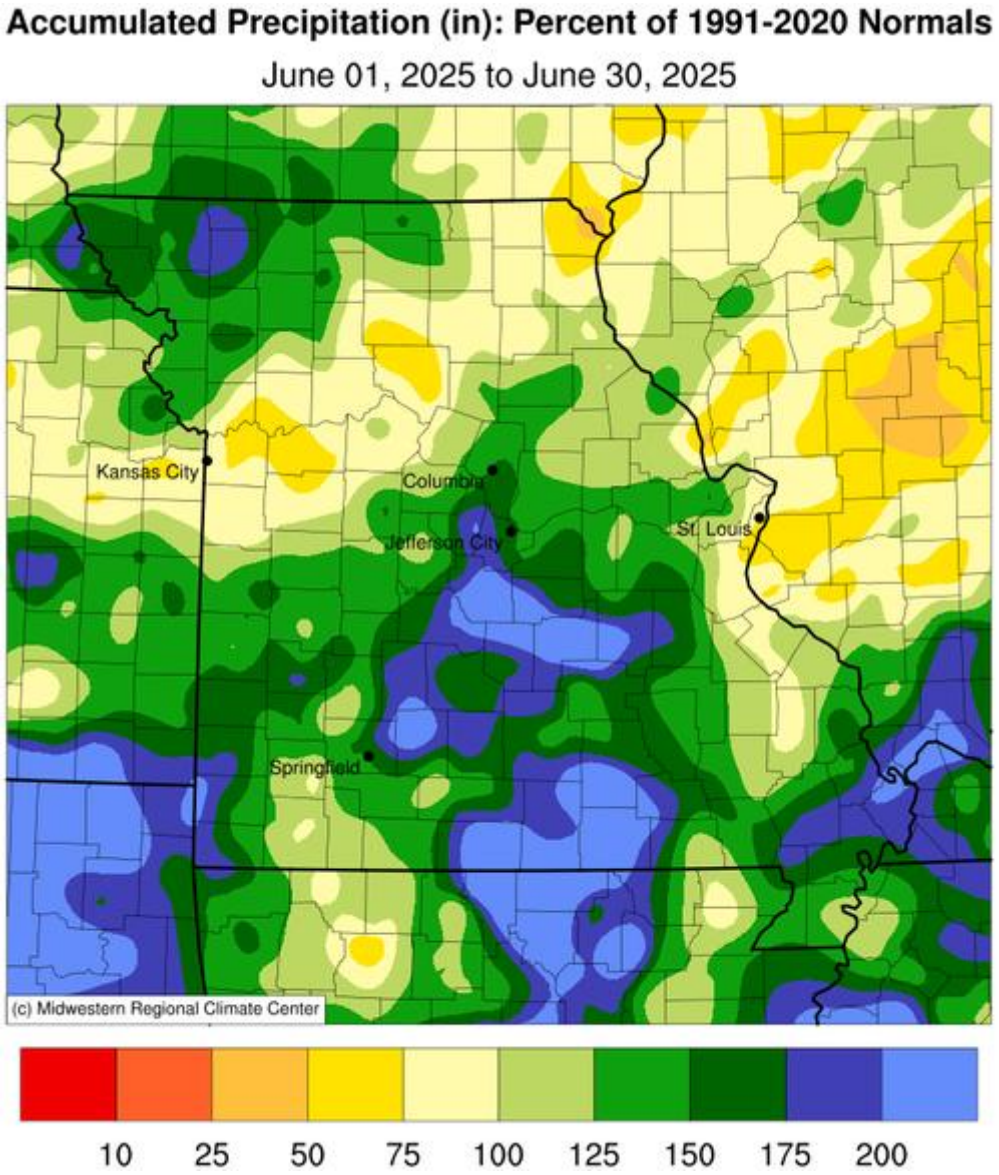


June 2025



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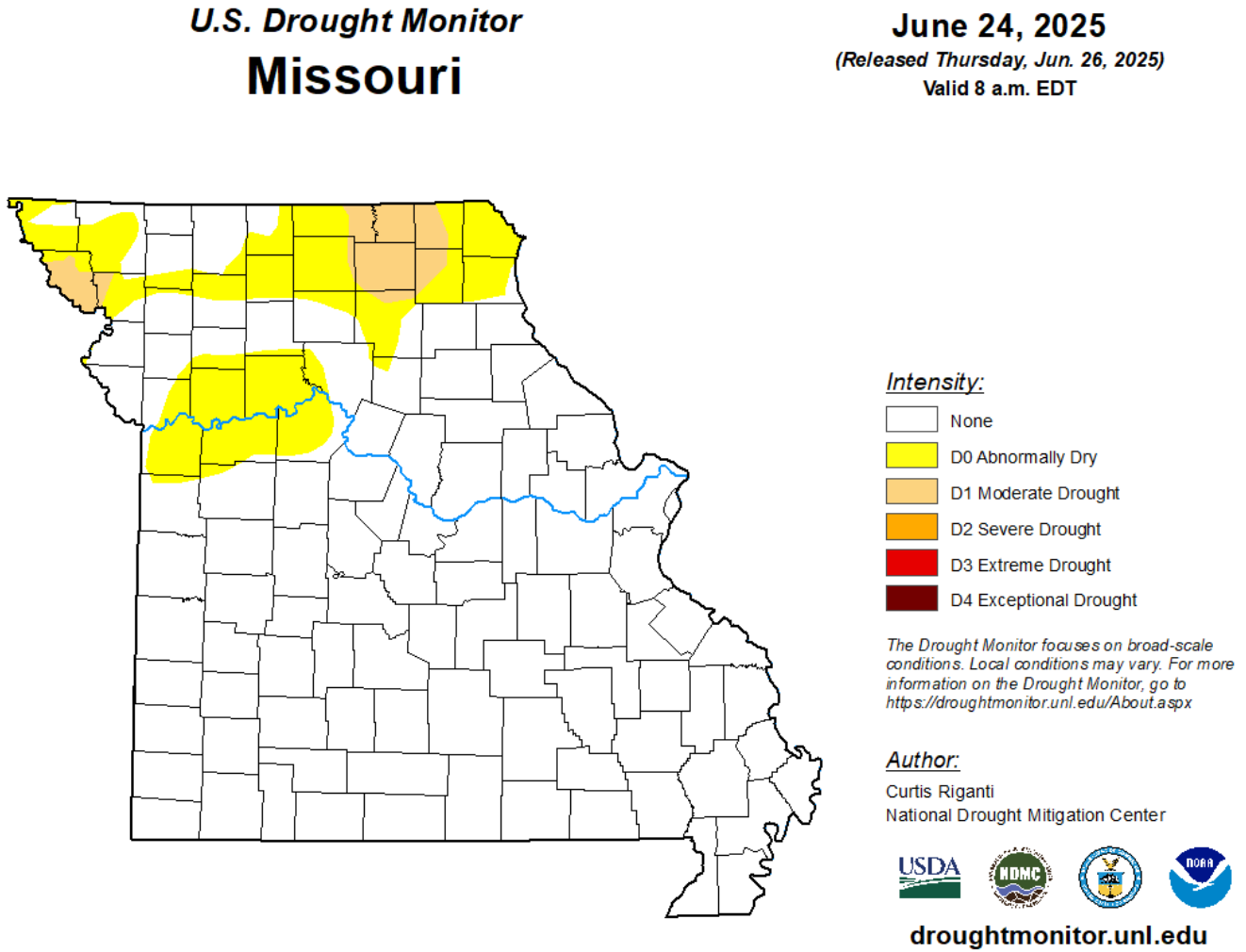
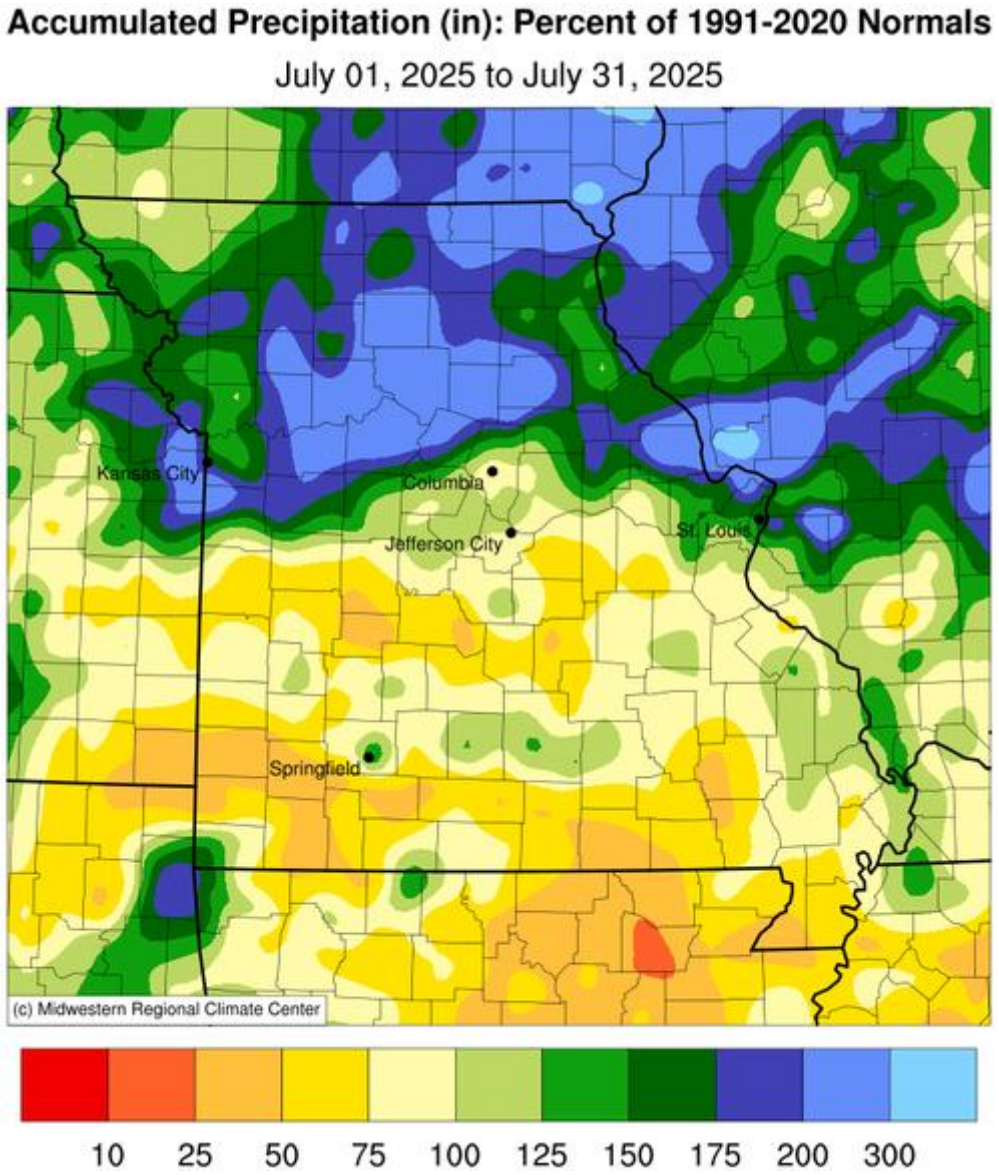


July 2025



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U.S. Drought Monitor
Missouri

July 22, 2025
(Released Thursday, Jul. 24, 2025)
Valid 8 a.m. EDT

Intensity:
None
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The Drought Monitor focuses on broad-scale

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Missouri

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(Released Thursday, Jul. 31, 2025)
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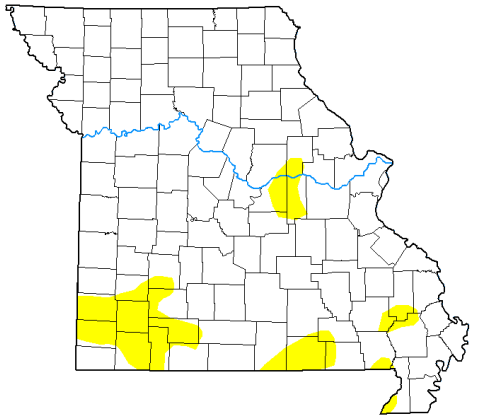

August 5, 2025
(Released Thursday, Aug. 7, 2025)
Valid 8 a.m. EDT

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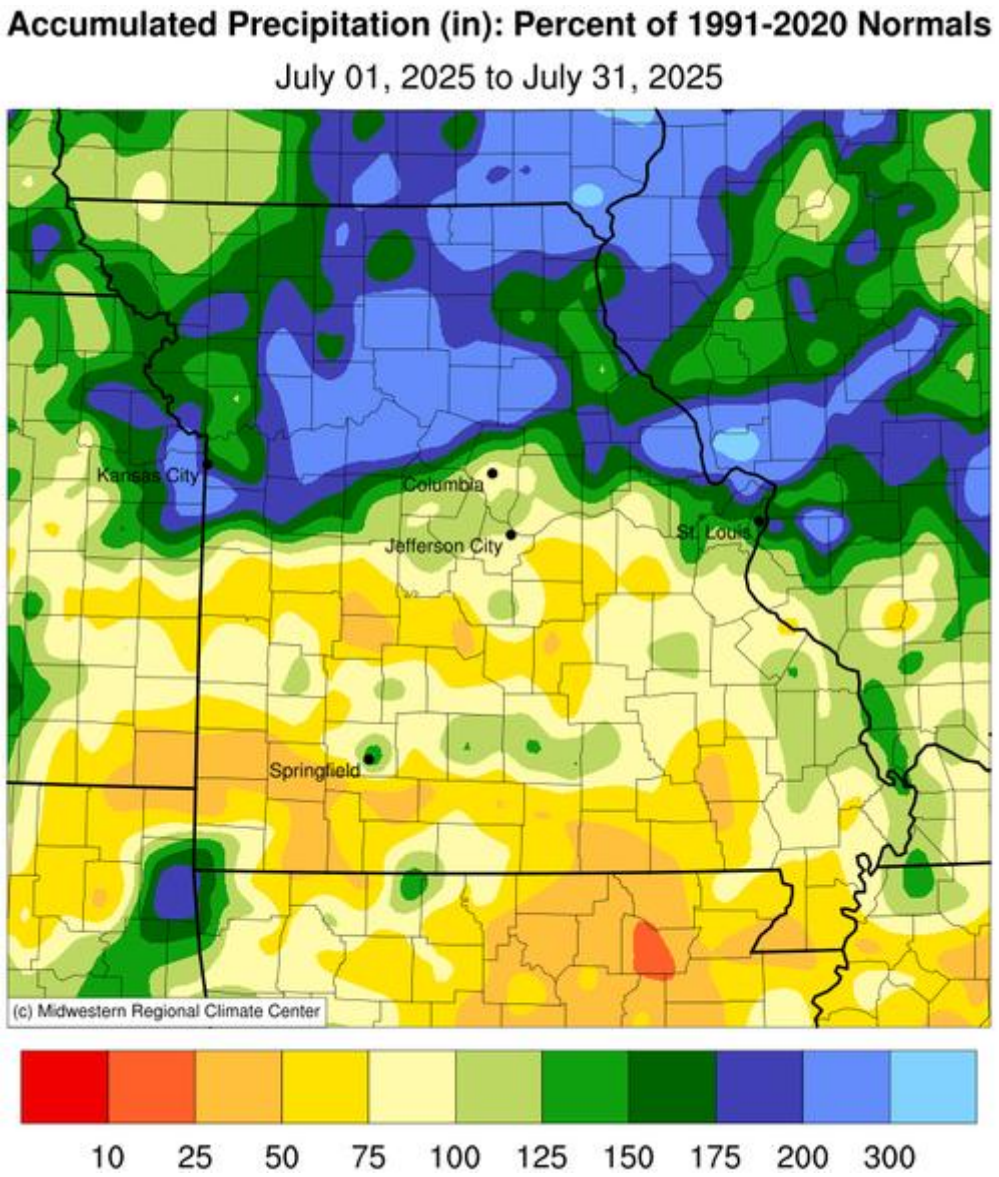

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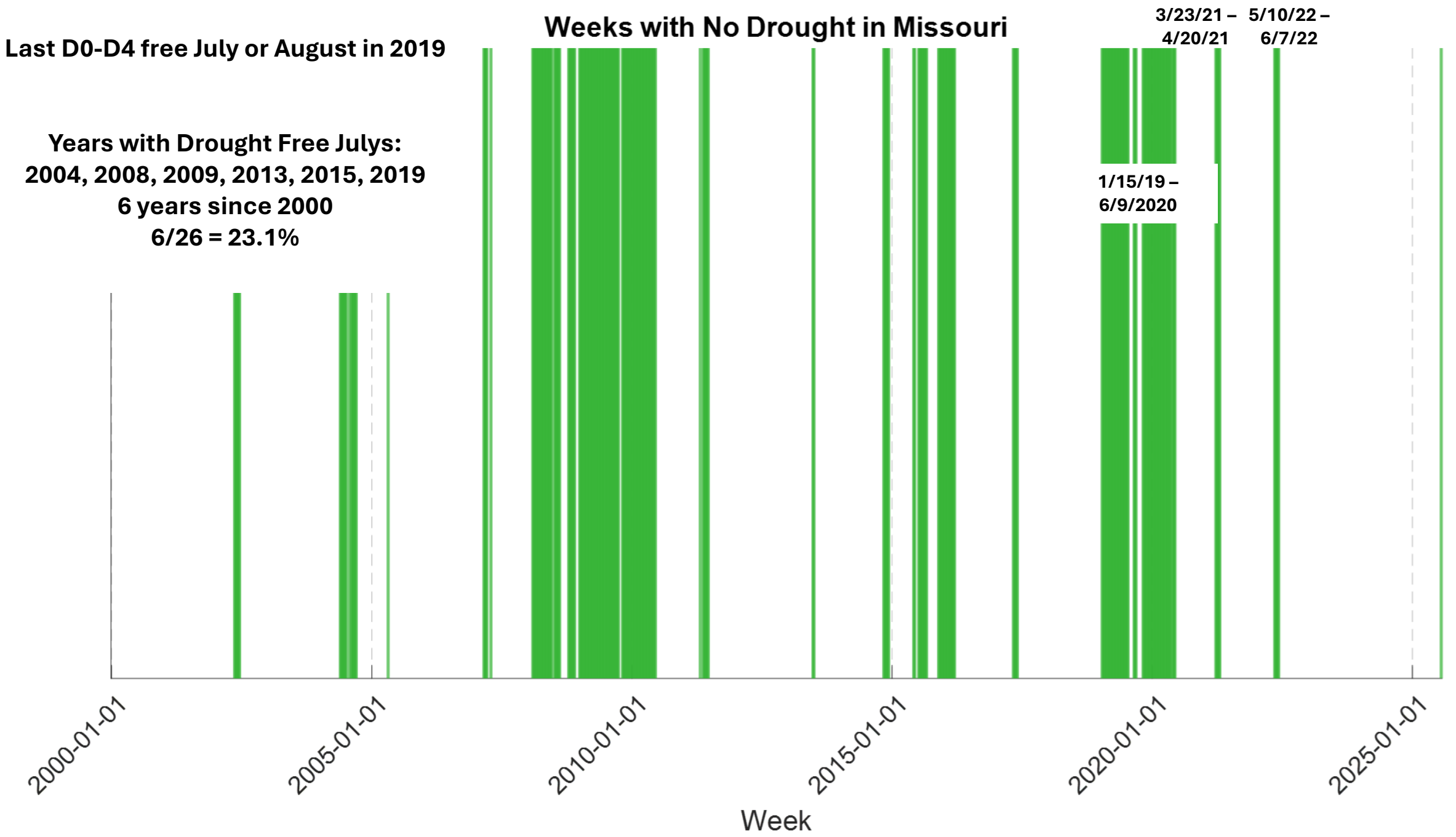
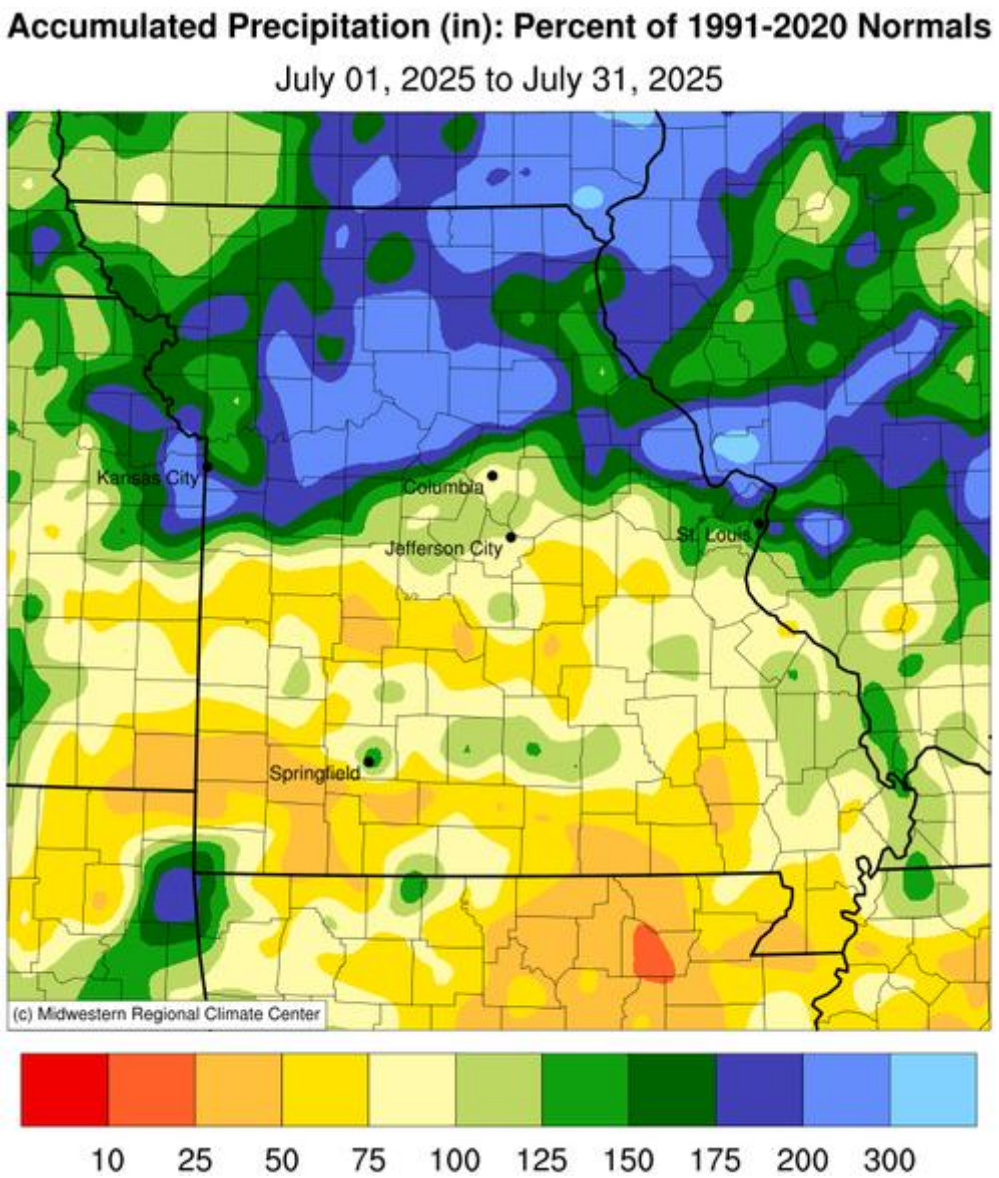
First "clear" map since June 7, 2022!


Last D0-D4 free July or August in 2019
Years with Drought Free Julys:
2004, 2008, 2009, 2013, 2015, 2019
6 years since 2000
6/26 = 23.1%
Weeks with No Drought in Missouri
3/23/21 – 4/20/21
5/10/22 – 6/7/22
1/15/19 – 6/9/2020
2000-01-01
2005-01-01
2010-01-01
2015-01-01
2020-01-01
2025-01-01
Week

July 2025



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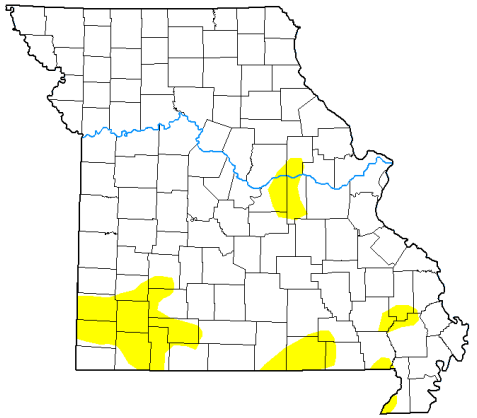

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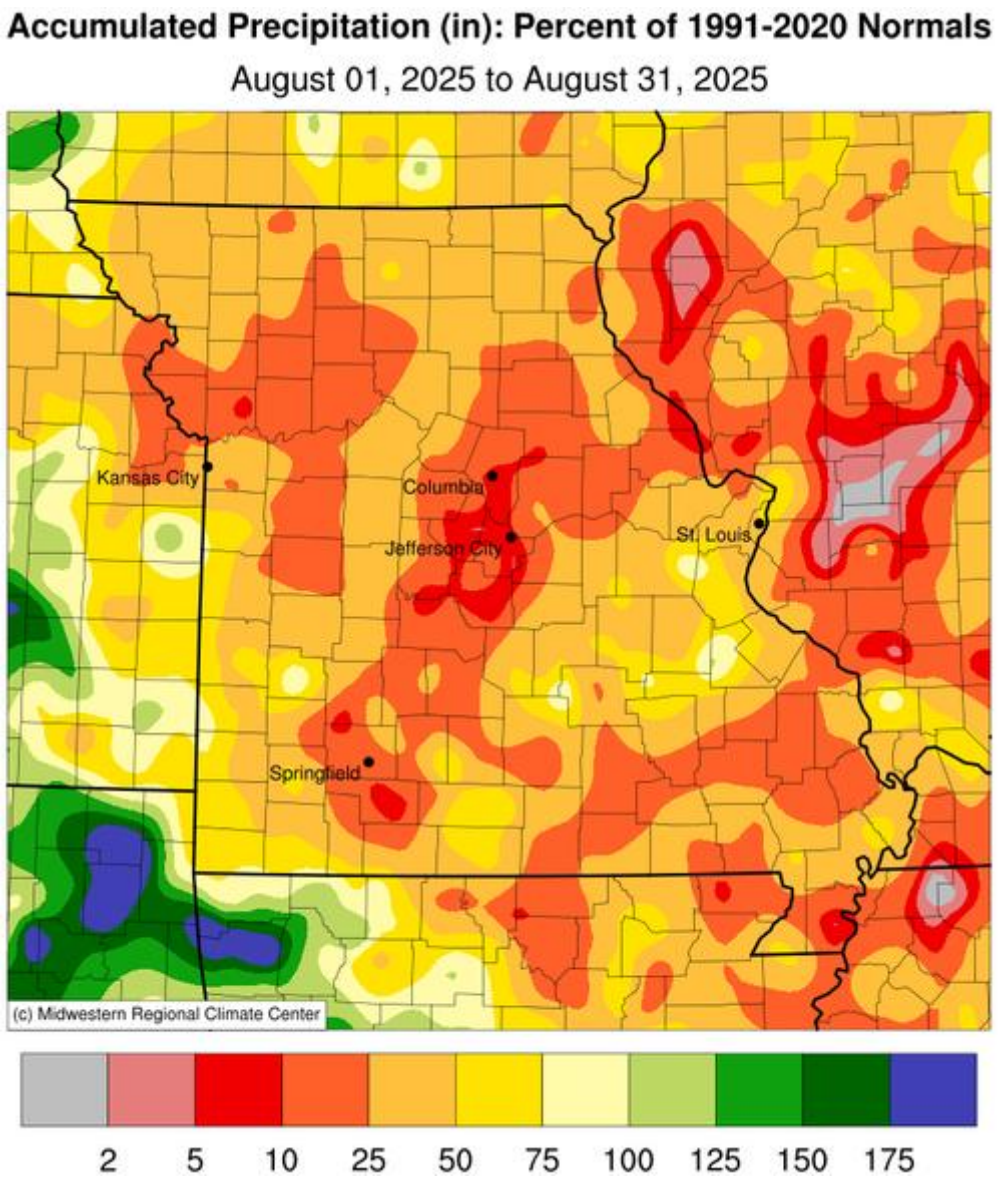
August 2025: Flash Drought



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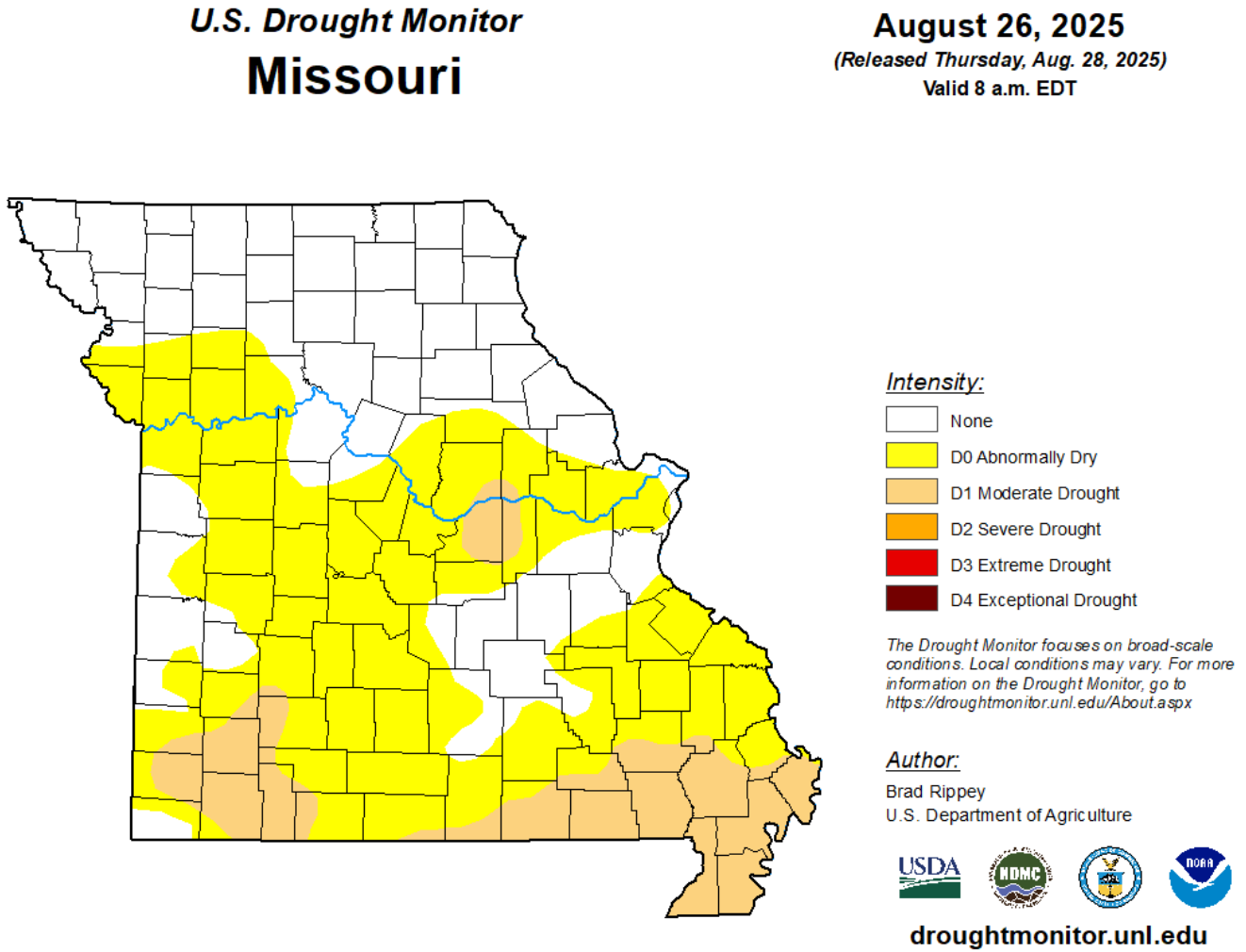

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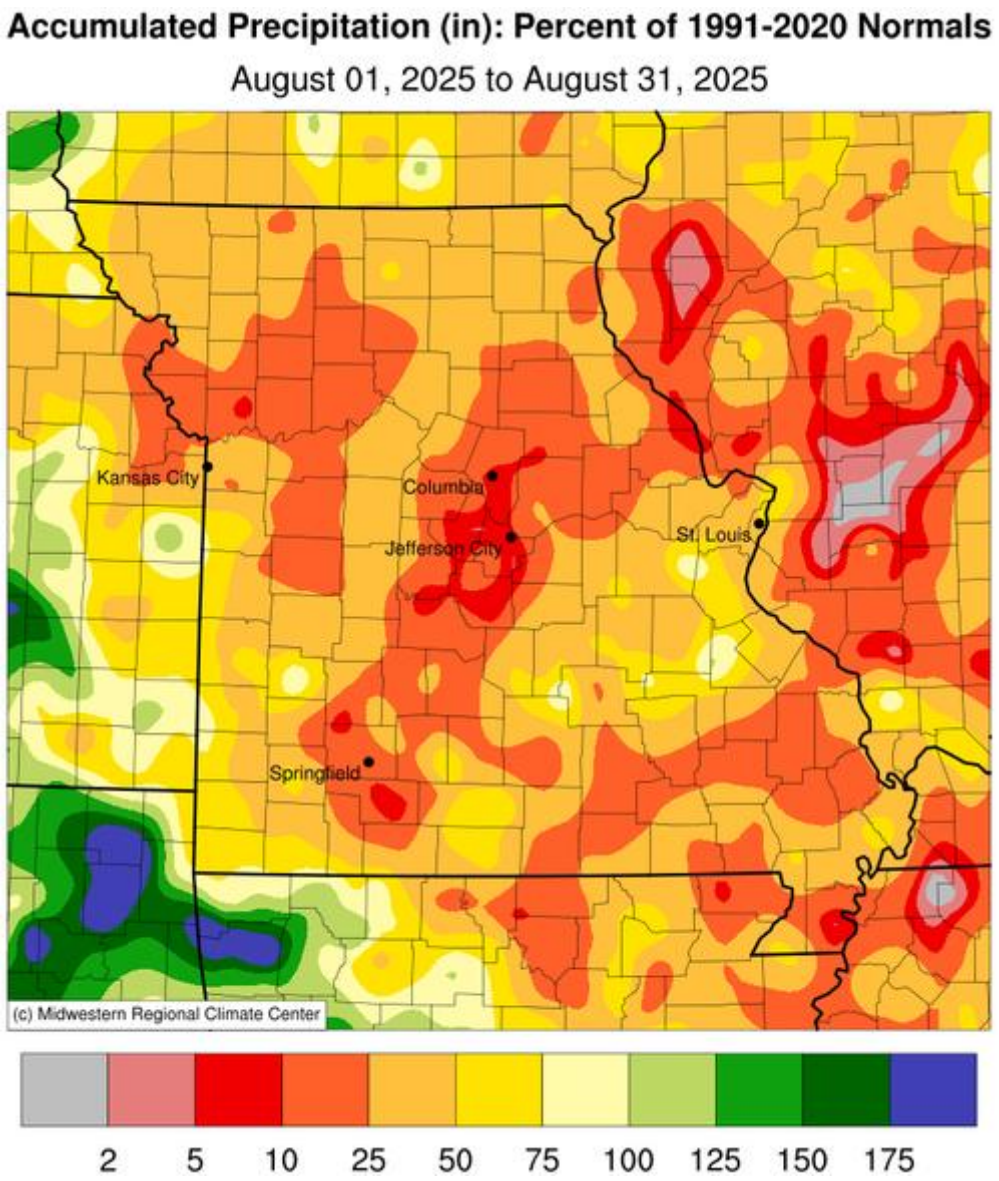
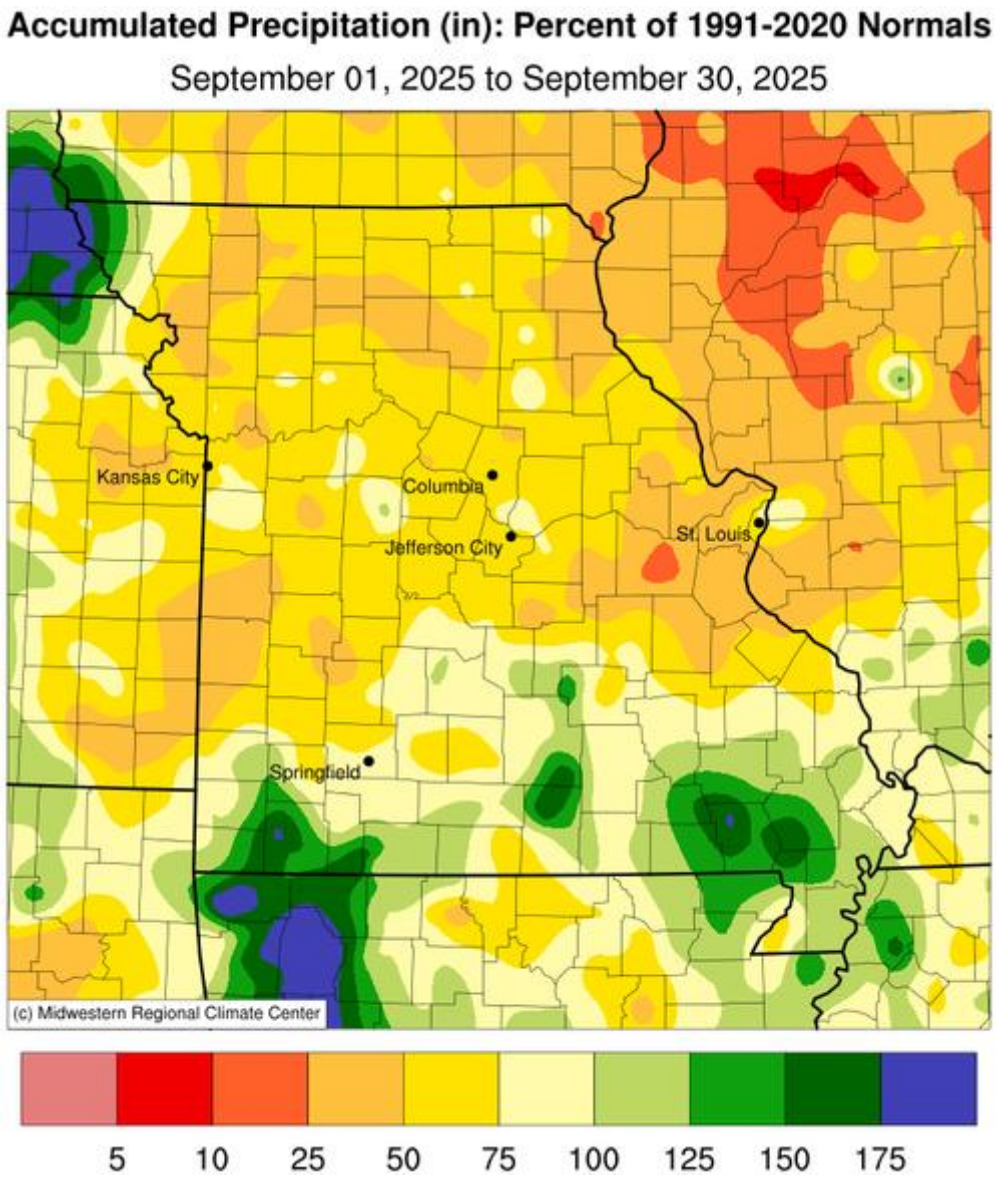


https://mrcc.purdue.edu/CLIMATE/

- Missouri's statewide average precipitation during August (0.97") was *drier than average* (- 2.98")
  - 2nd driest August on record (1909)
  - Springfield: Driest August ever (0.19")
  - Columbia: 2nd driest August (0.11")

September 2025



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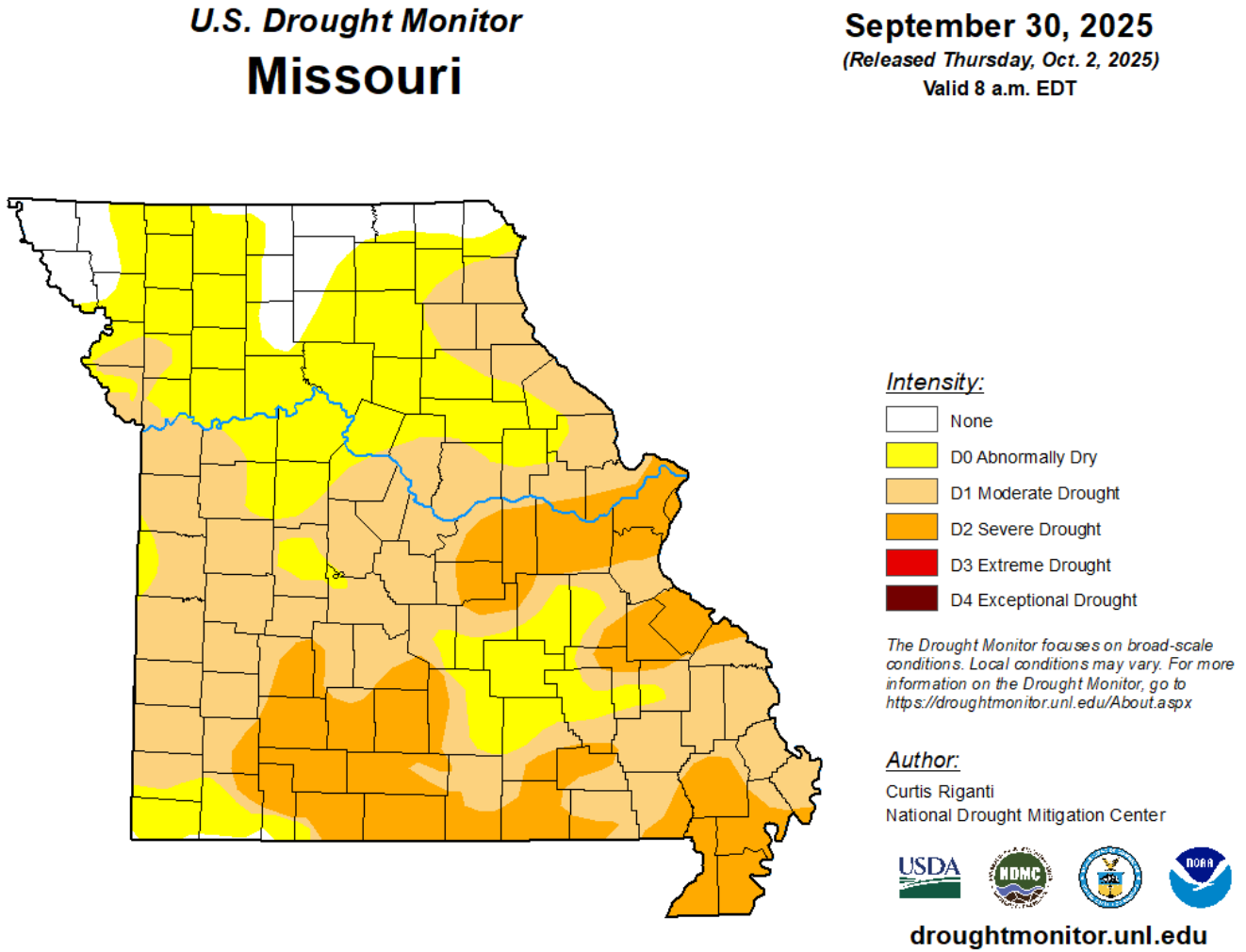
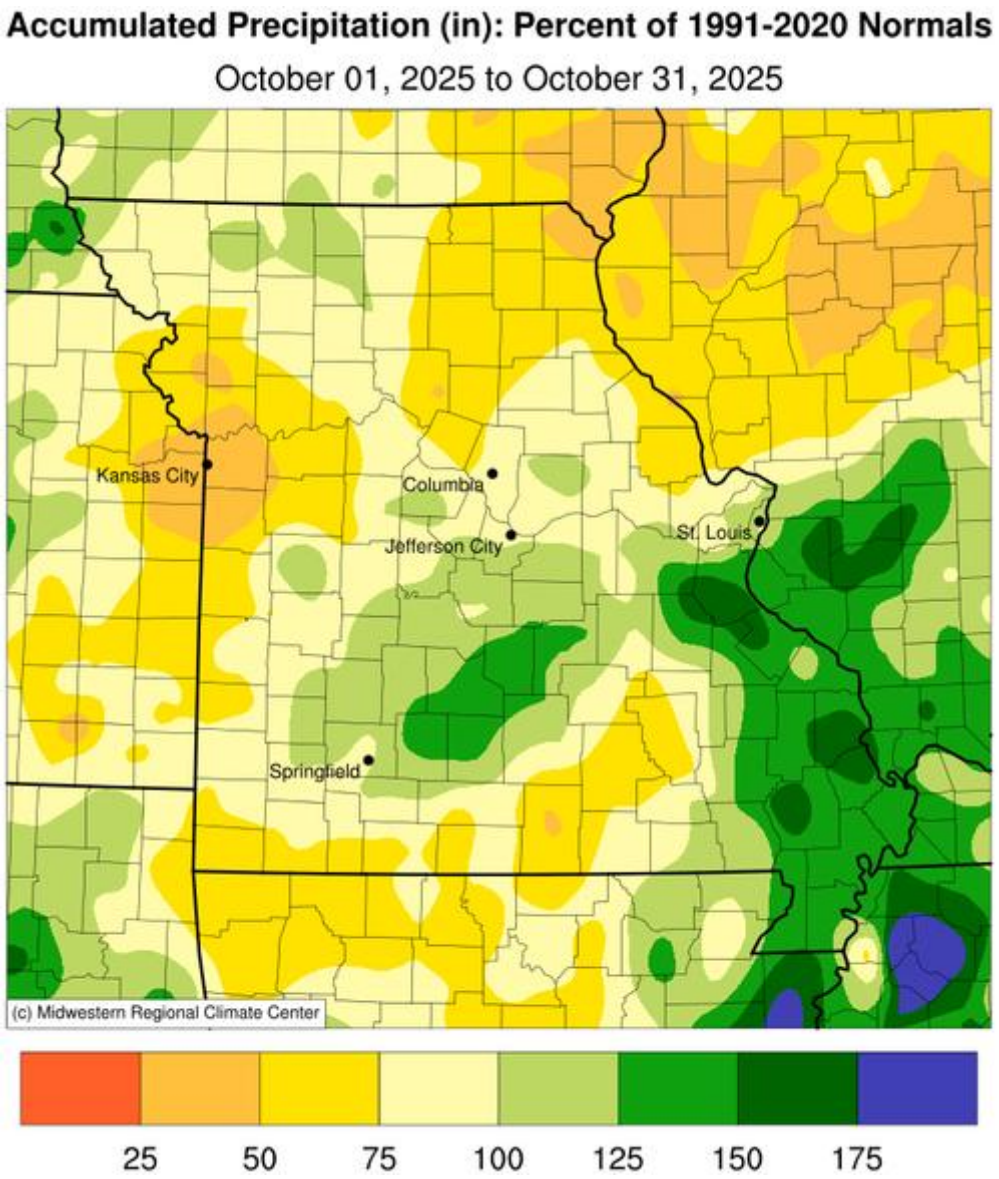


October 2025



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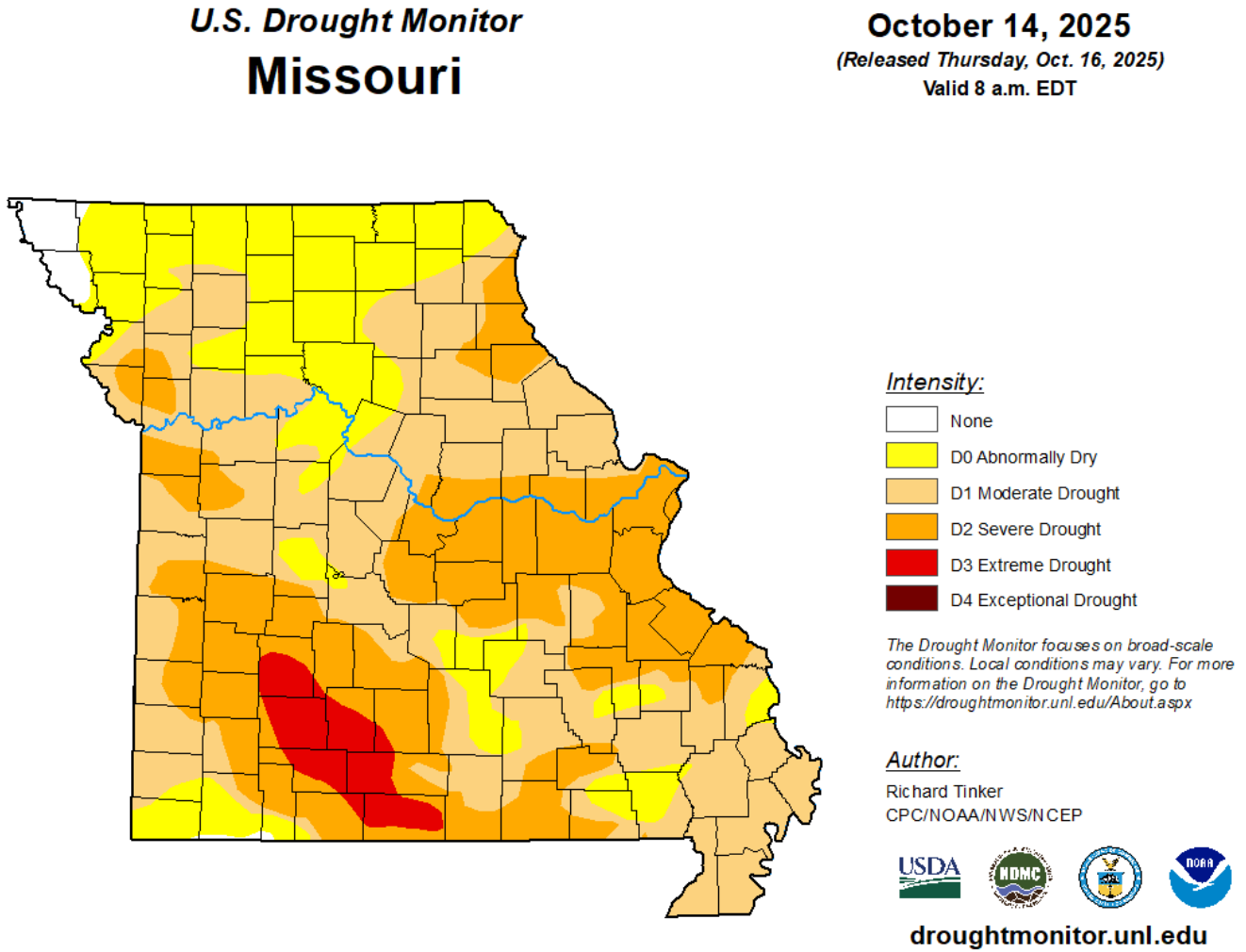


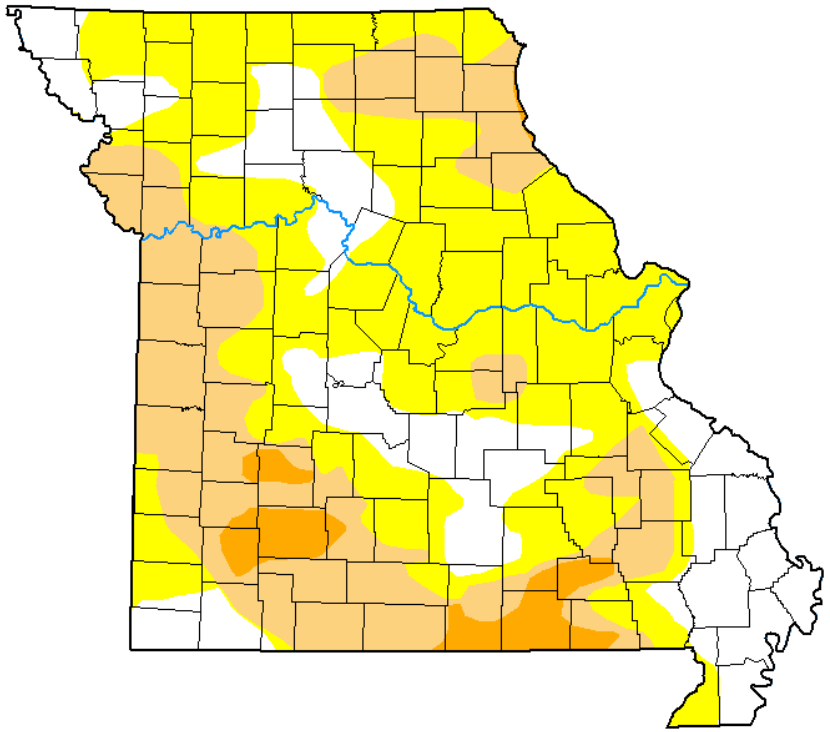
U.S. Drought Monitor

Missouri

December 2, 2025

(Released Thursday, Dec. 4, 2025)

Valid 7 a.m. EST



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

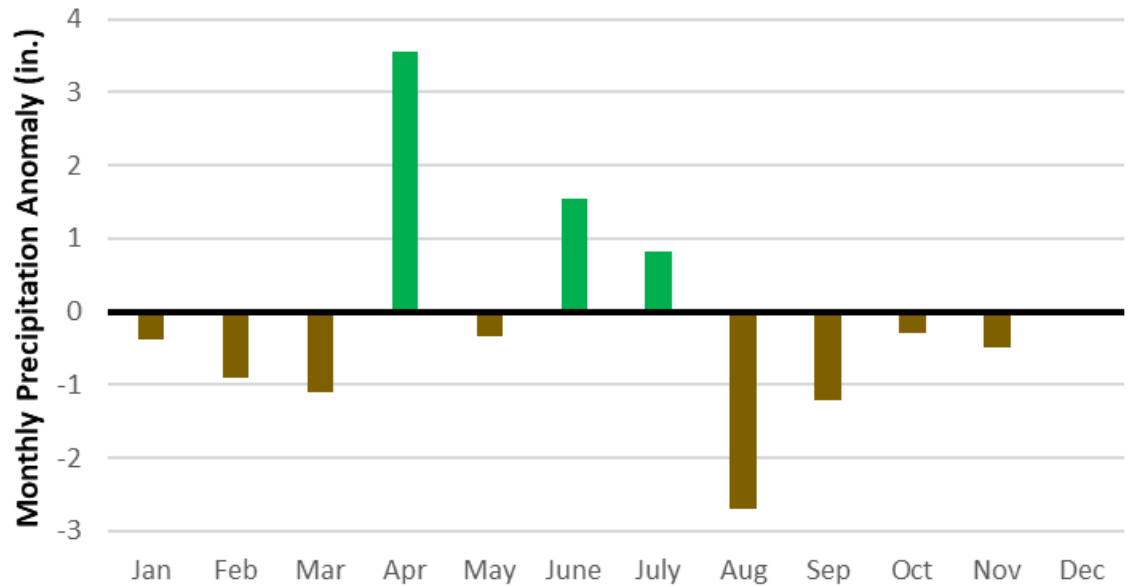
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

David Simeral
Western Regional Climate Center

droughtmonitor.unl.edu

Missouri 2025 Monthly Precipitation Departures from Average (1895 - 2025)



Texas County – Sep. 2, 2025

Webster County – Sep. 30, 2025

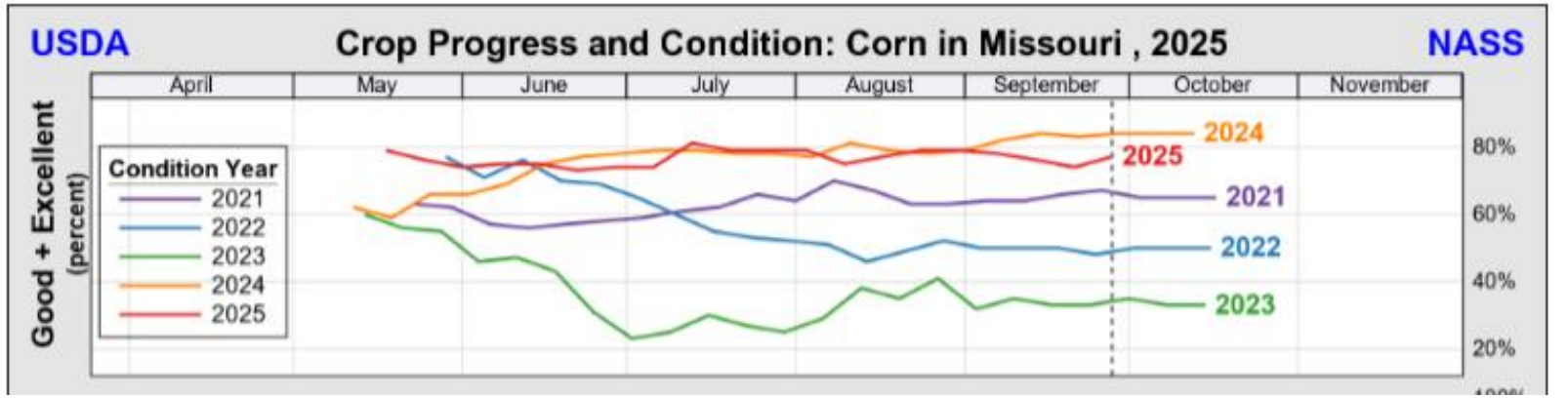
https://droughtimpacts.unl.edu/Tools/ConditionMonitoringObservations.aspx

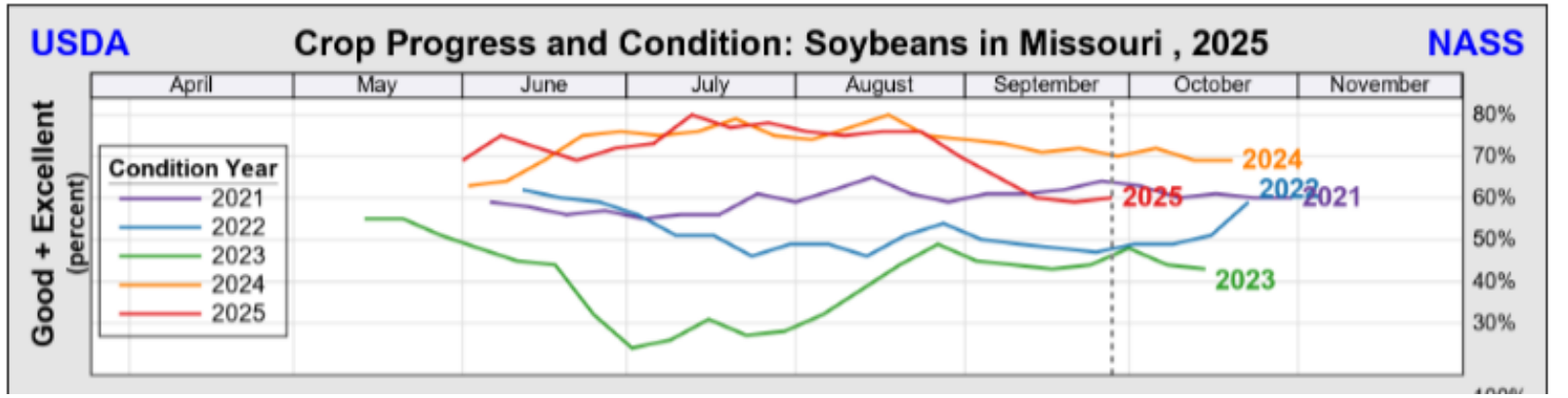
Texas County – Sep. 17, 2025

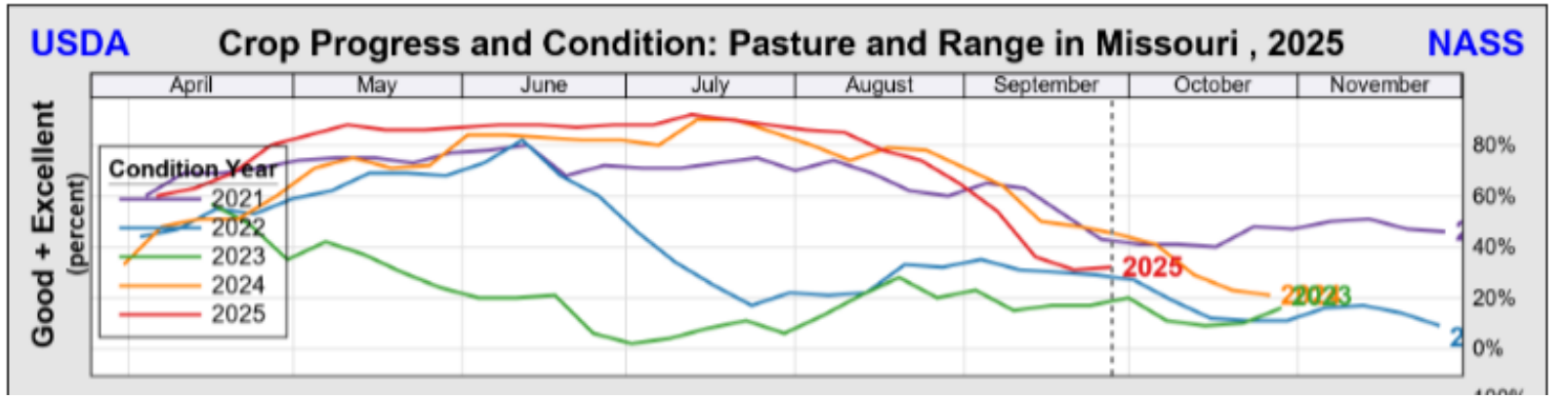
Douglas County – Sep. 16, 2025

Wright County – Sep. 18, 2025

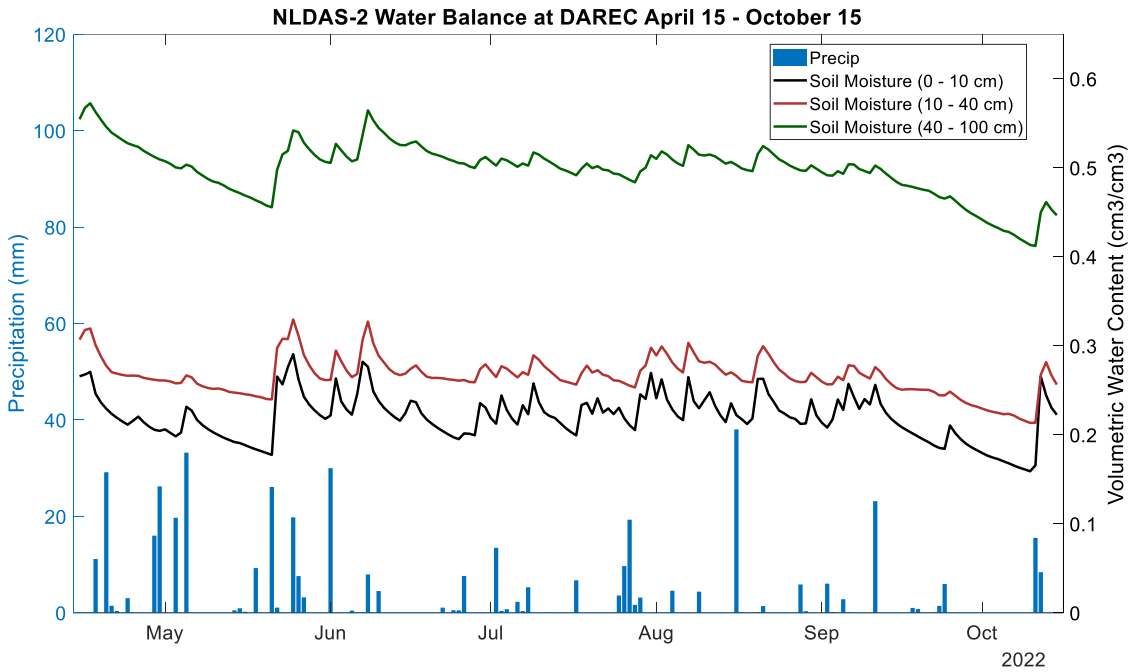
https://droughtimpacts.unl.edu/Tools/ConditionMonitoringObservations.aspx

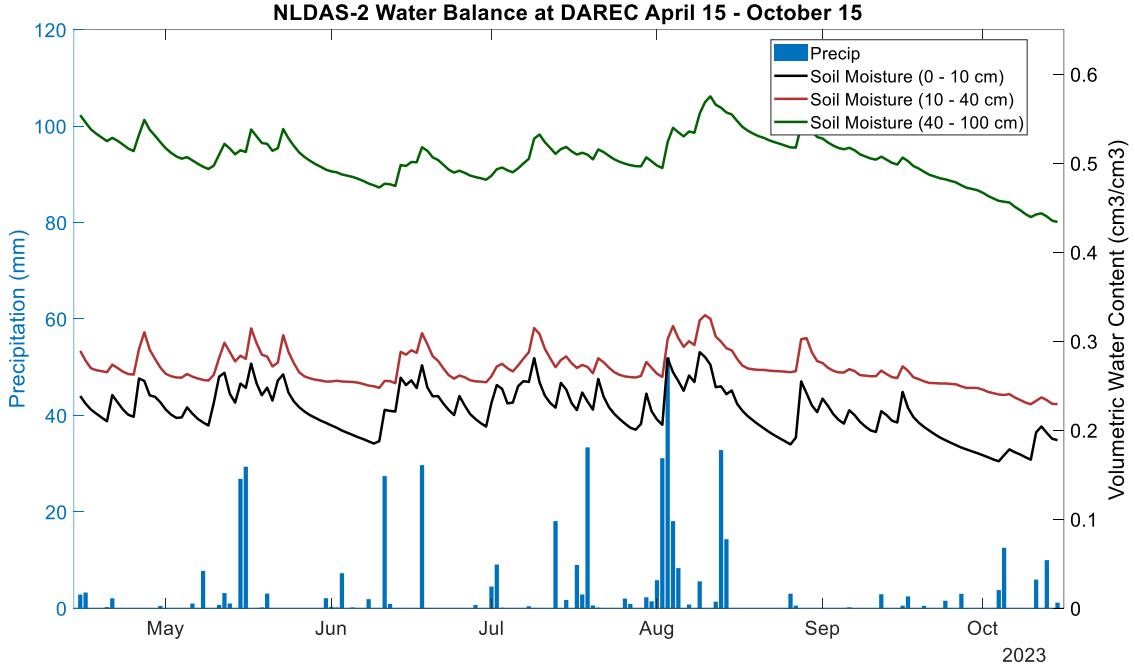






https://www.nass.usda.gov/Charts_and_Maps/Crop_Progress_&_Condition/index.php


NLDAS-2 Water Balance at DAREC April 15 - October 15
Precip
Soil Moisture (0 - 10 cm)
Soil Moisture (10 - 40 cm)
Soil Moisture (40 - 100 cm)
Precipitation (mm)
Volumetric Water Content (cm3/cm3)
May
Jun
Jul
Aug
Sep
Oct
2022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Precipitation (mm)
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Jul
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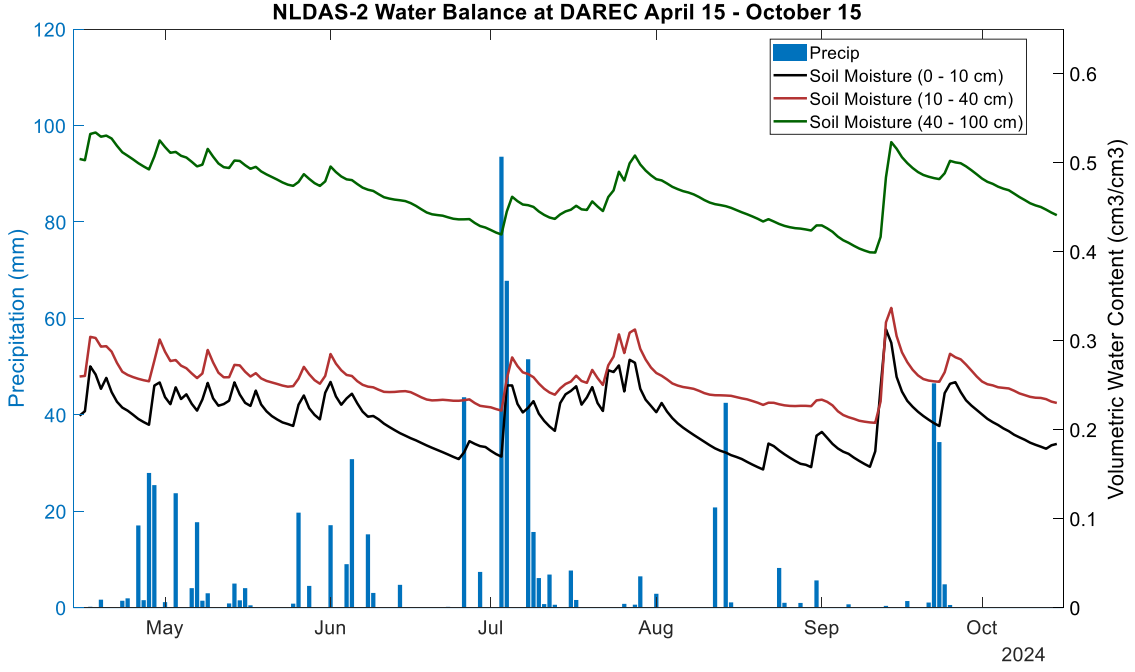
2023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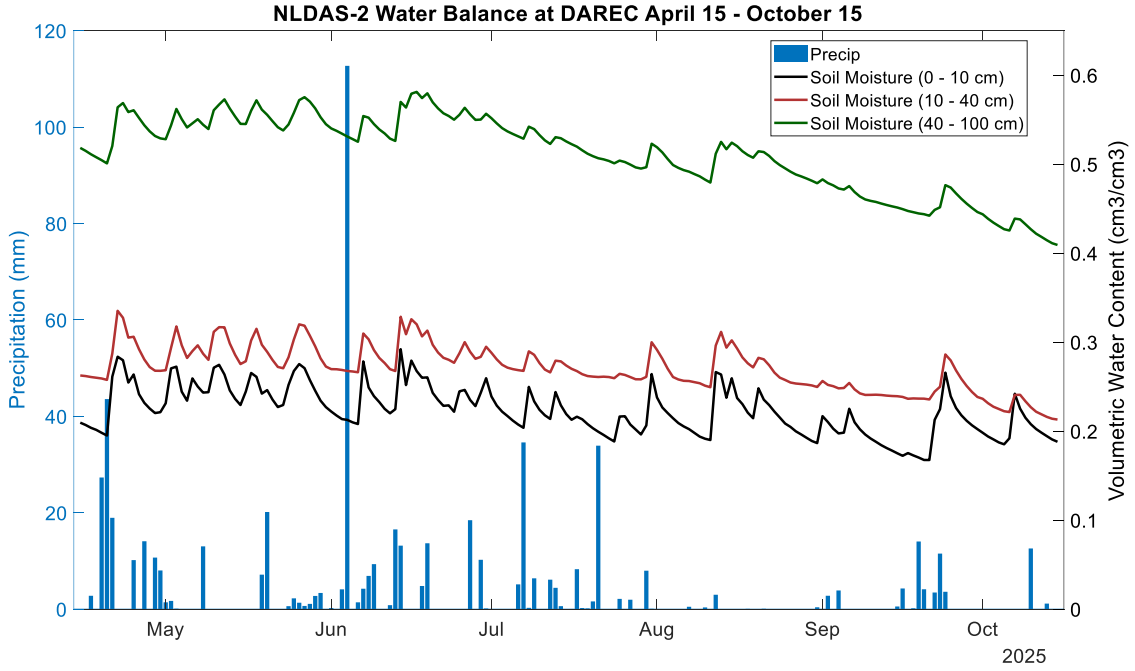
Soil Moisture (40 - 100 cm)
Precipitation (mm)
Volumetric Water Content (cm3/cm3)
May
Jun
Jul
Aug
Sep
Oct
2024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Precipitation (mm)
Volumetric Water Content (cm3/cm3)
May
Jun
Jul
Aug
Sep
Oct
2025

Courtesy: Amanda Wolfgeher, Missouri Department of Natural Resources

Missouri Hydrology Information Center (MoHIC)

MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

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Missouri Hydrology Information Center (MoHIC)

MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

Soil and Atmospheric Monitoring Plan

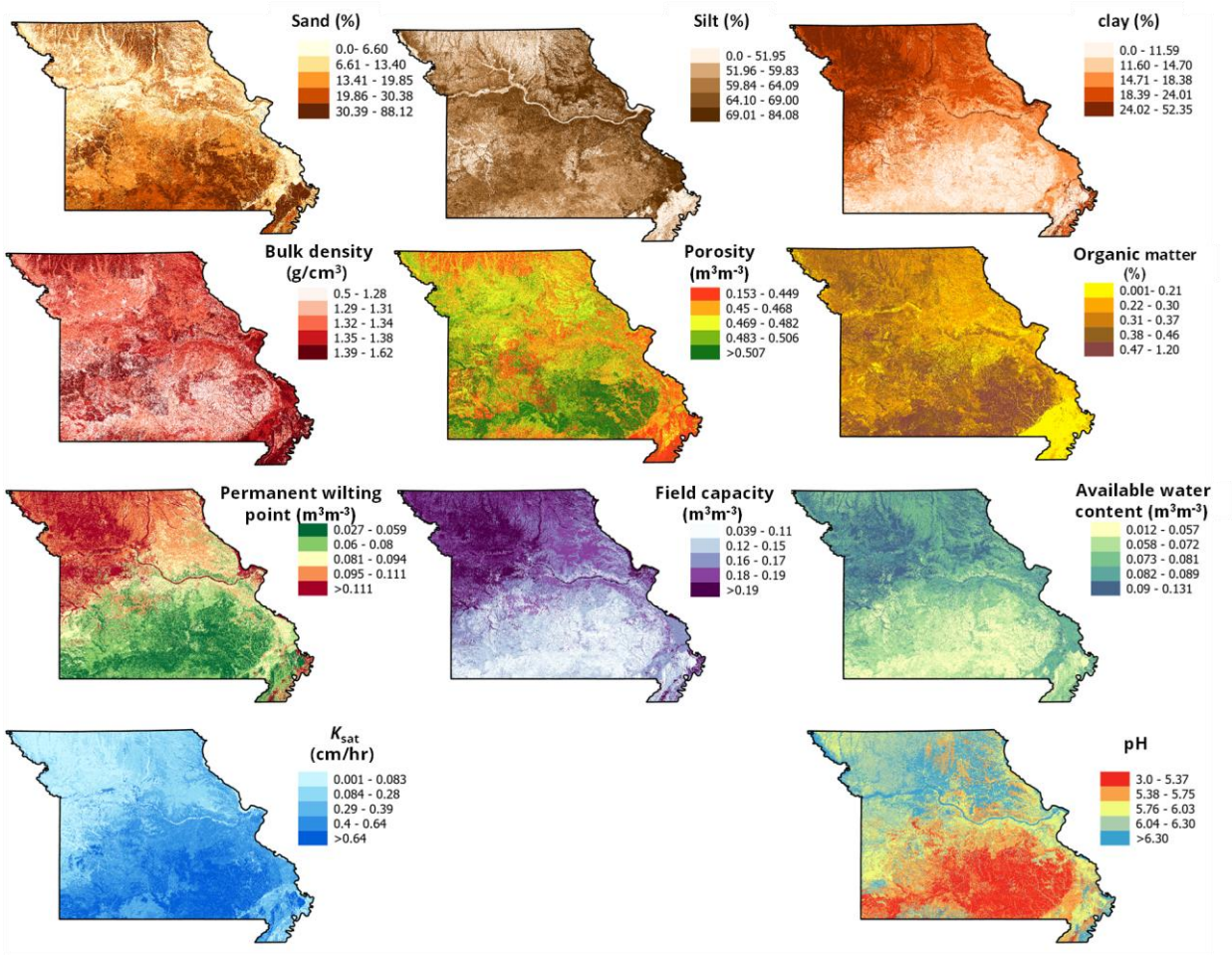
The plan will provide statewide recommendations for:

4) Site Selection

- Spatial Coverage
- Spatial Representativeness

Assessment Parameters:

- Proximity to Existing Stations
- Soil Physical Properties
- Land Use



Missouri Hydrology Information Center (MoHIC)

MISSOURI DEPARTMENT OF NATURAL RESOURCES

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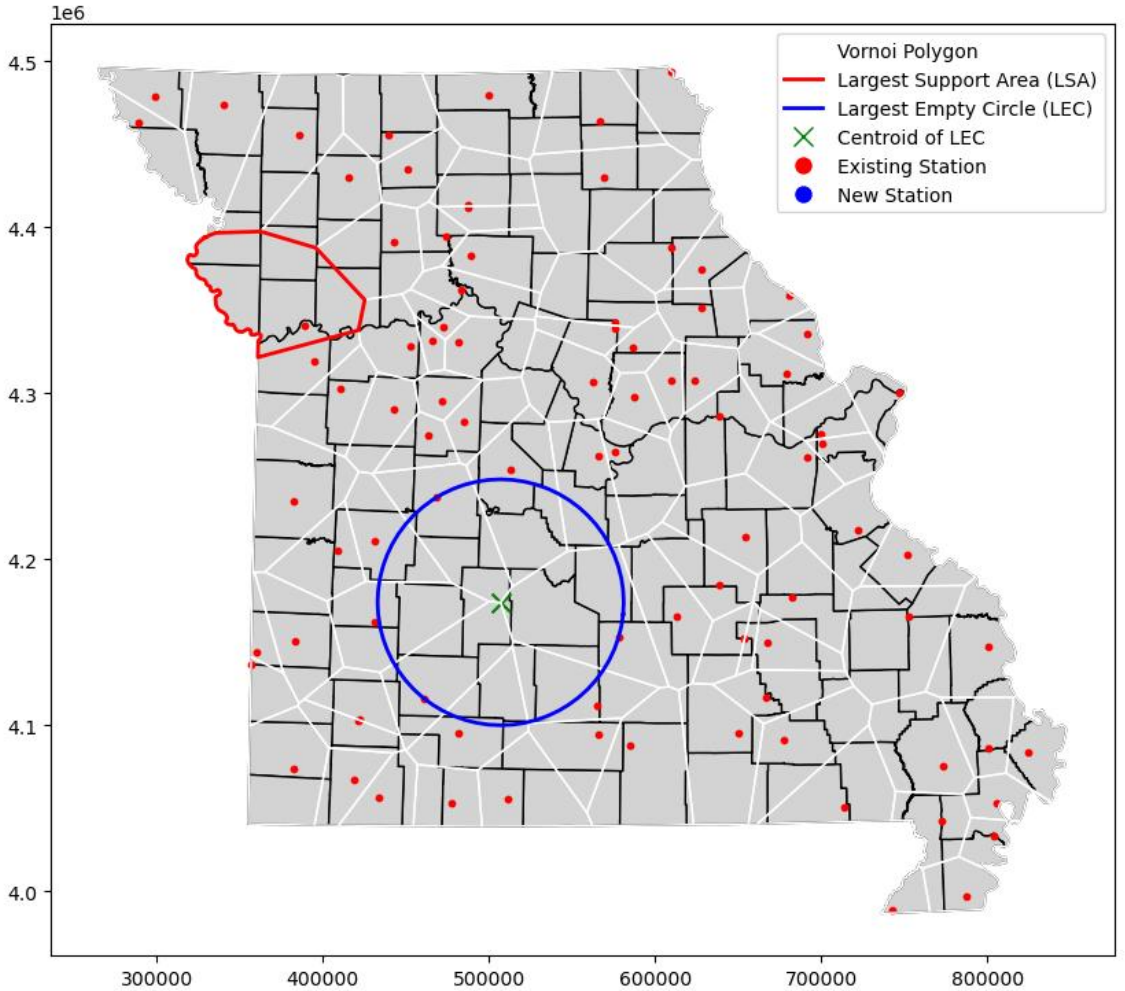


Courtesy: Varshini Kumanan, University of Missouri

Missouri Hydrology Information Center (MoHIC)

MISSOURI DEPARTMENT OF NATURAL RESOURCES

Soil Moisture Mapping

- Utilize modeling and interpolation methodologies to develop gridded statewide soil moisture maps in near real-time
- Maps of soil moisture content at five depths (5, 10, 20, 50, and 100 cm)
- Consider remote sensing and modeled datasets as well as other geophysical variables that improve estimations of soil moisture

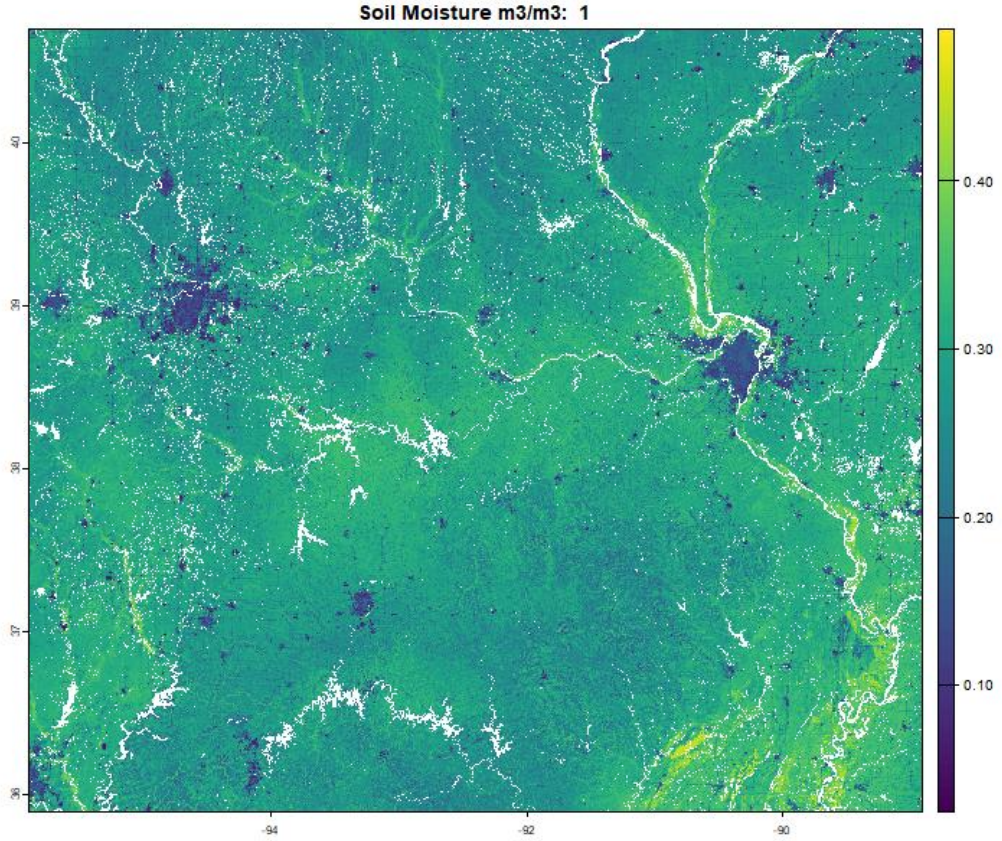
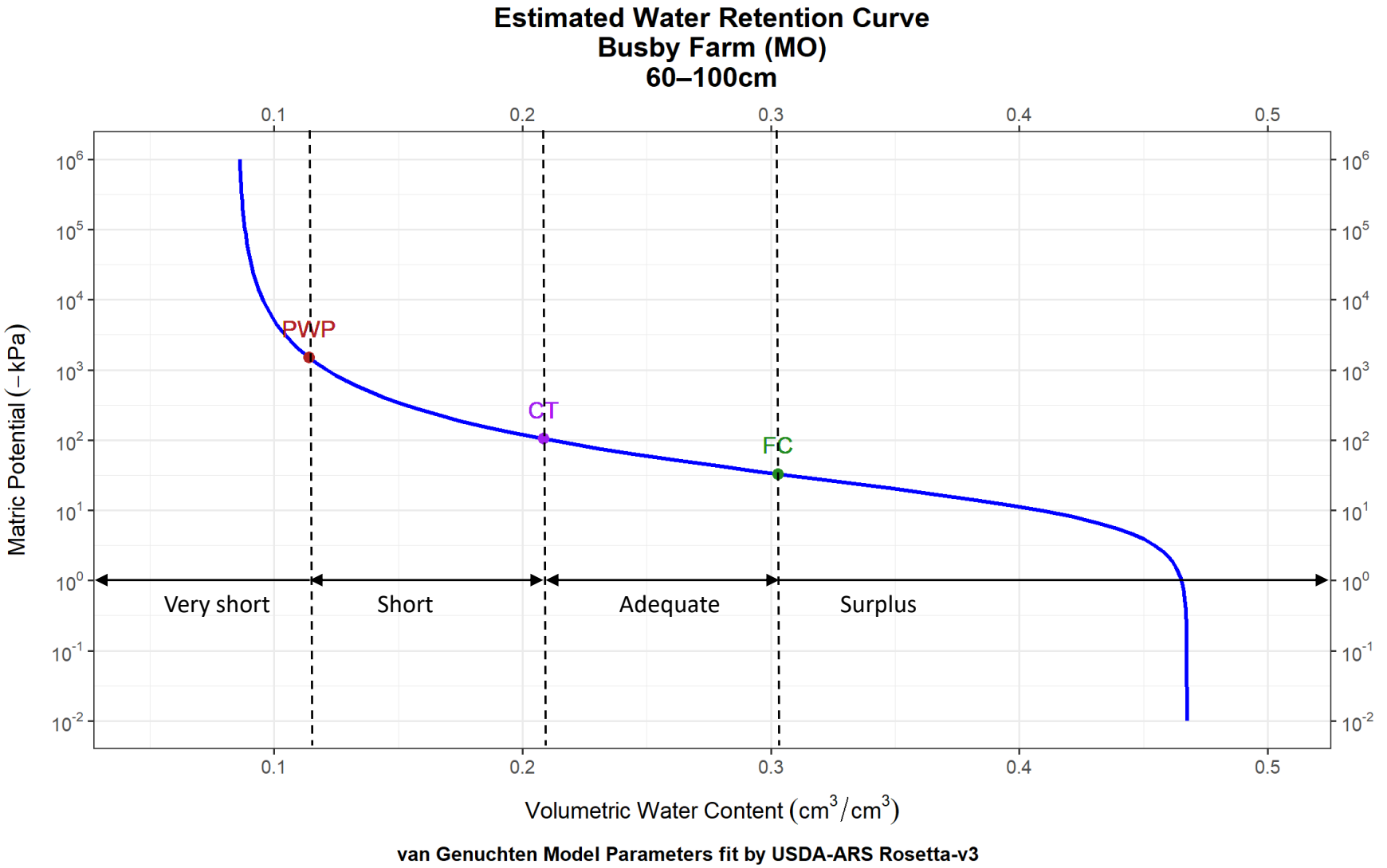


Figure. Depiction of Statewide Spatially Distributed Soil Moisture Product (SMAP-HB), Produced Used Similar Modeling Approach

Missouri Hydrology Information Center (MoHIC)

MISSOURI DEPARTMENT OF NATURAL RESOURCES



SM – Current day soil moisture observation
PWP – Permanent Wilting Point
FC- Field Capacity
CT – Critical Threshold
FAW – Fractional Available Water
PAW – Plant Available Water

Fractional Available Water

Amount of moisture in soil available to plants

FAW = (SM - PWP)/(FC - PWP)

Expressed as a fraction

0% (limited available water)

100% (plenty of available water)

Critical Threshold

The condition at which further drying reduces vegetation transpiration

CT = (FC + PWP)/2

Plant Available Water

Plant available water in inches at each depth

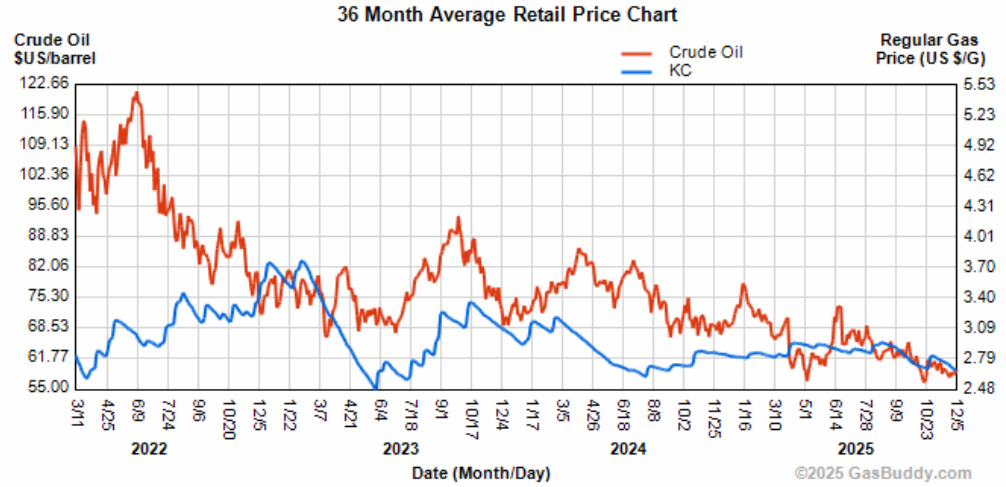
PAW = (SM - PWP) × soil layer thickness

Soil properties obtained from USDA gSURRGO database (percentages of sand, silt, and clay)
Water retention curves, FC and PWP values derived from USDA-ARS Rosetta v3 and VG model
Fractional Available Water and Soil Moisture Categorization adapted from UMRB dashboard

USDA's Soil Moisture Categorization

Surplus: soil moisture greater than FC
Adequate: soil moisture between CT and FC
Short: soil moisture between PWP and CT
Very Short: representing soil moisture below the PWP

Looking Ahead: Climate Outlooks



Types of Weather/Climate Forecasts

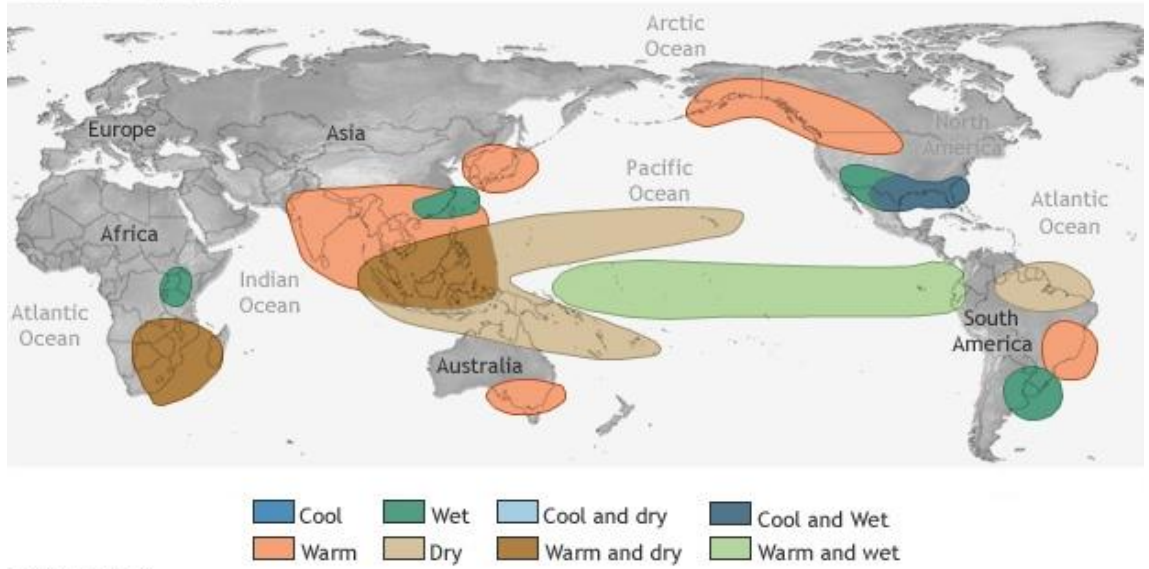
- **Climatology:** Average January gas price in KC (2021-2025): $2.74/gal
- **Persistence:** Current gas price (KC): $2.70/gal
- **Trend:** Kansas City gas prices have been declining since 2023. The only notable spike in prices this year occurred in June/July
- **Analog:** Today's crude oil price: ~ $58/barrel (recent declines are lowest since February, 2021). Gas price (KC) in February, 2021: ~ $2.90/gal ↑
- **Teleconnections:** What else can we use to predict gas prices?

Teleconnections – linkages between weather changes occurring in widely separated regions of the globe (American Meteorological Society, https://glossary.ametsoc.org)

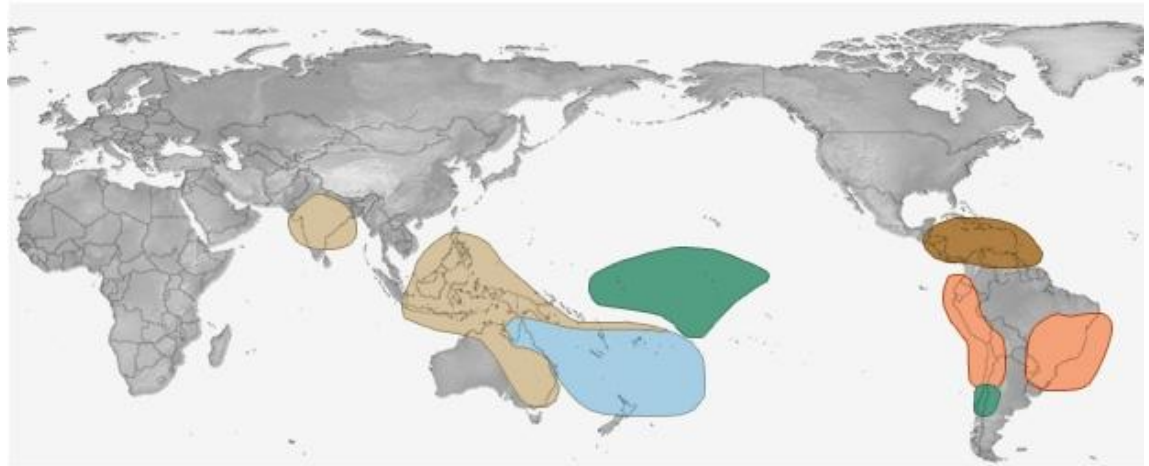
Teleconnections

EL NIÑO CLIMATE IMPACTS

December-February

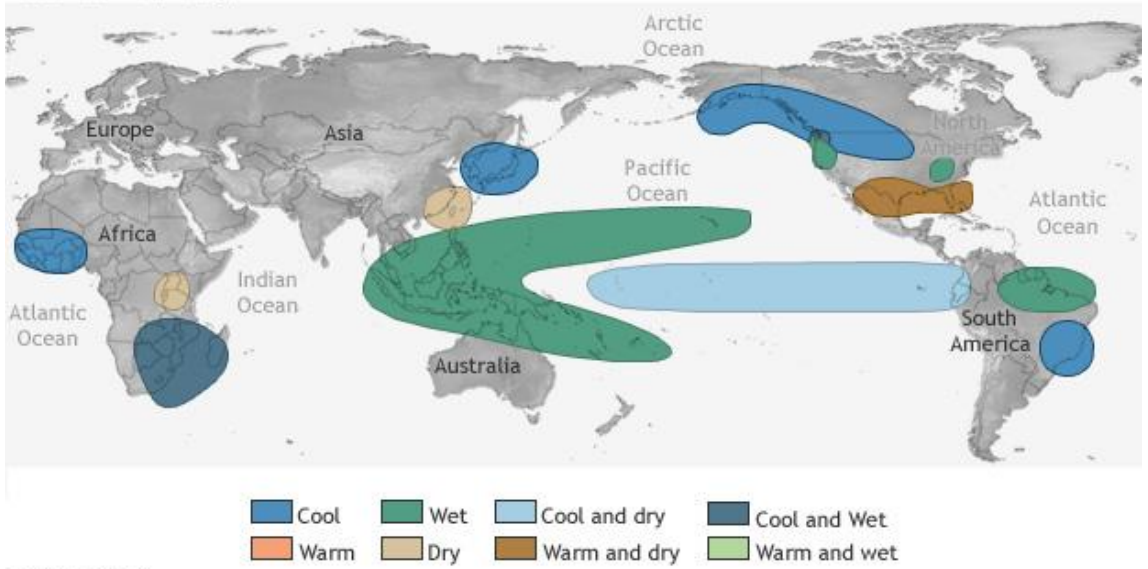


June-August



LA NIÑA CLIMATE IMPACTS

December-February



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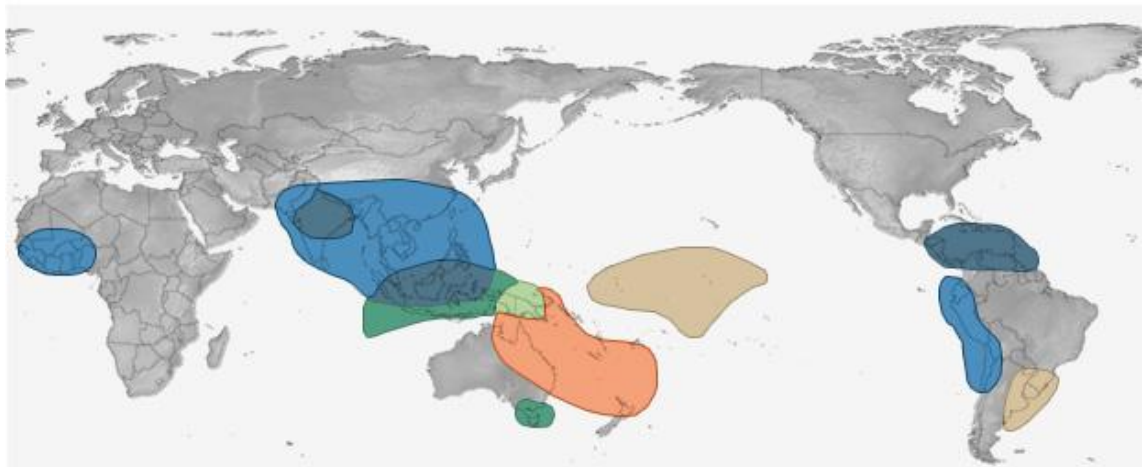


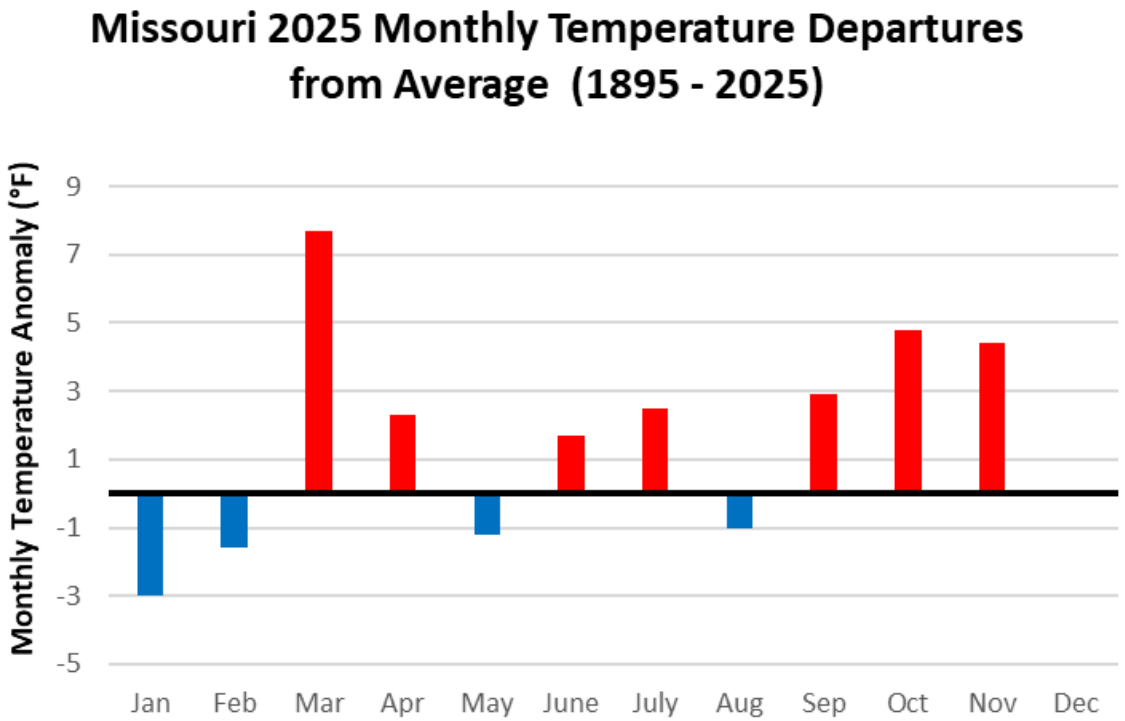
Types of Weather Forecasts

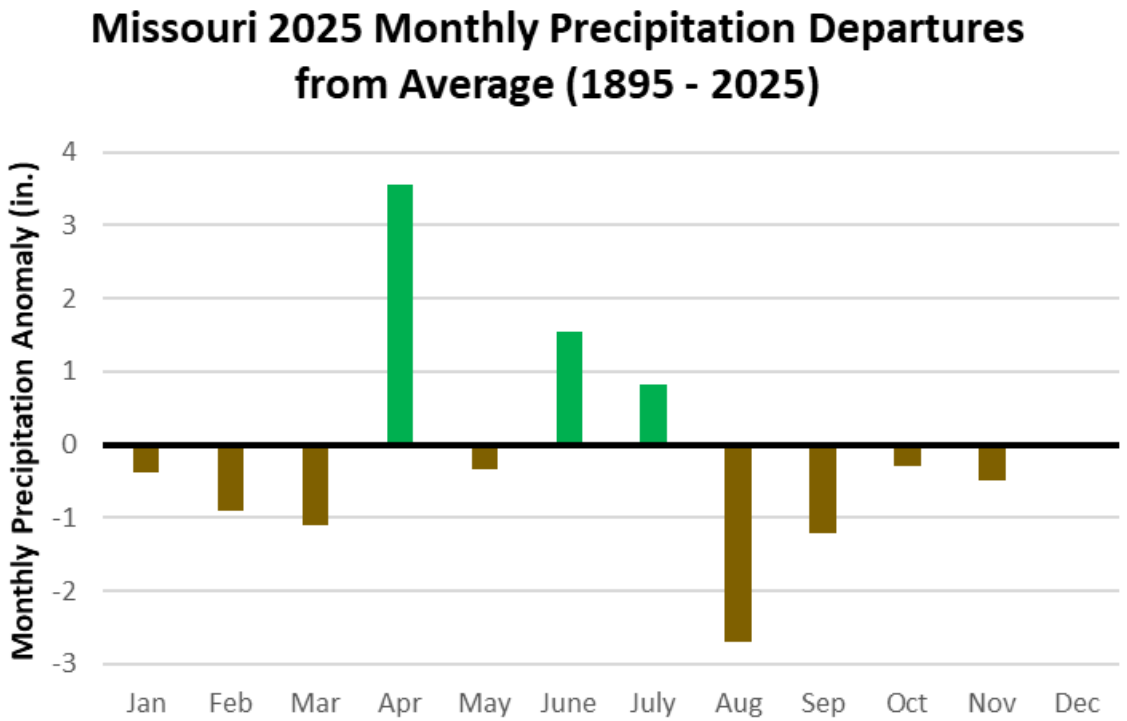
- Despite the method used to construct a forecast, the results must be communicated
  - Forecast value vs. forecast accuracy
- 3 types of forecasts – depends on end user or variable
  - Quantitative
  - Probabilistic
  - Qualitative

Types of Weather Forecasts

- 3 types of forecasts – depends on end user or variable
- Tomorrow's gas price in Kansas City:
  - Quantitative: $2.65/gal
  - Probabilistic: 95% chance gas price less$2.80/gal
  - Qualitative: Slightly less than average and very cheap

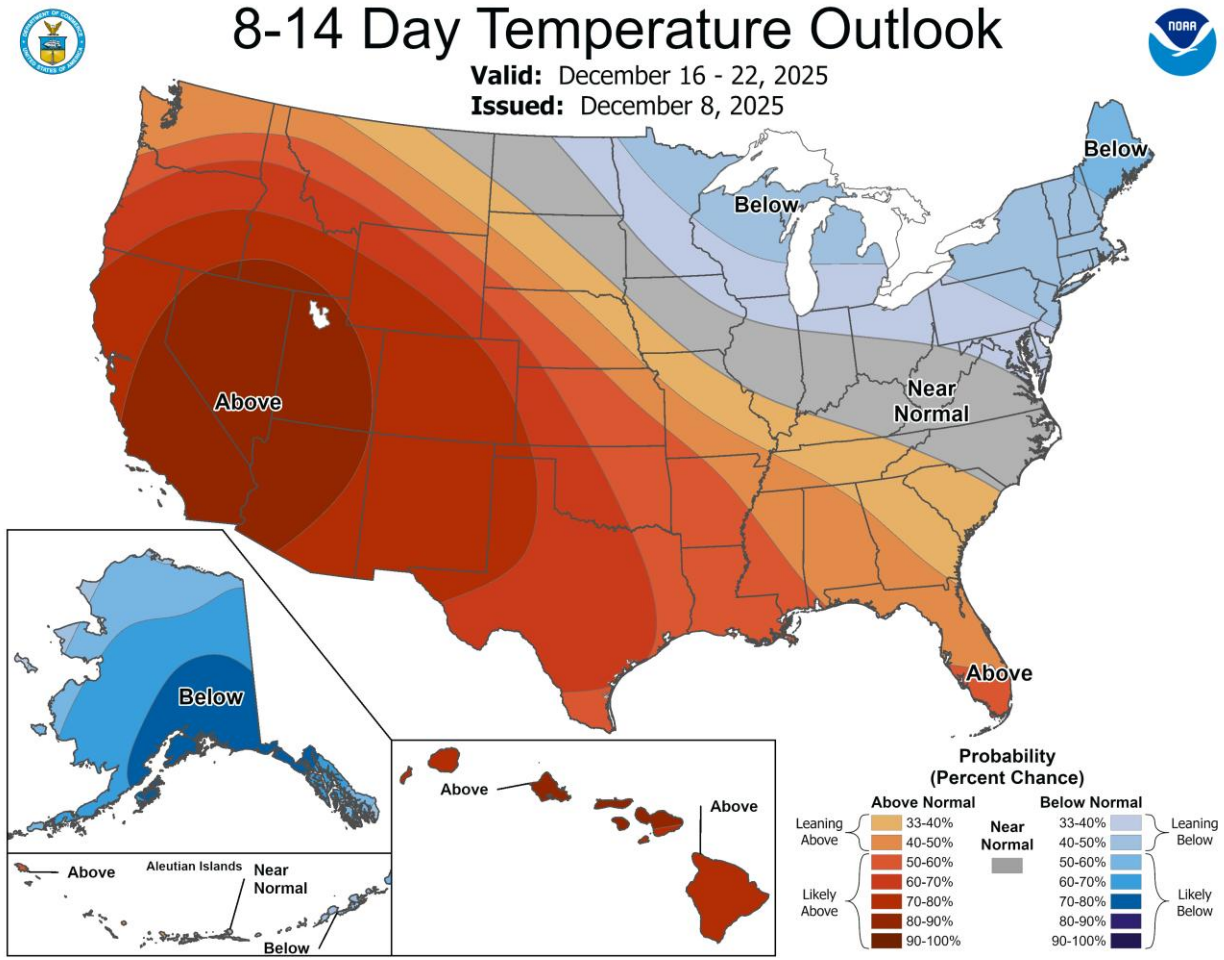
2025 Statewide Climate Summary

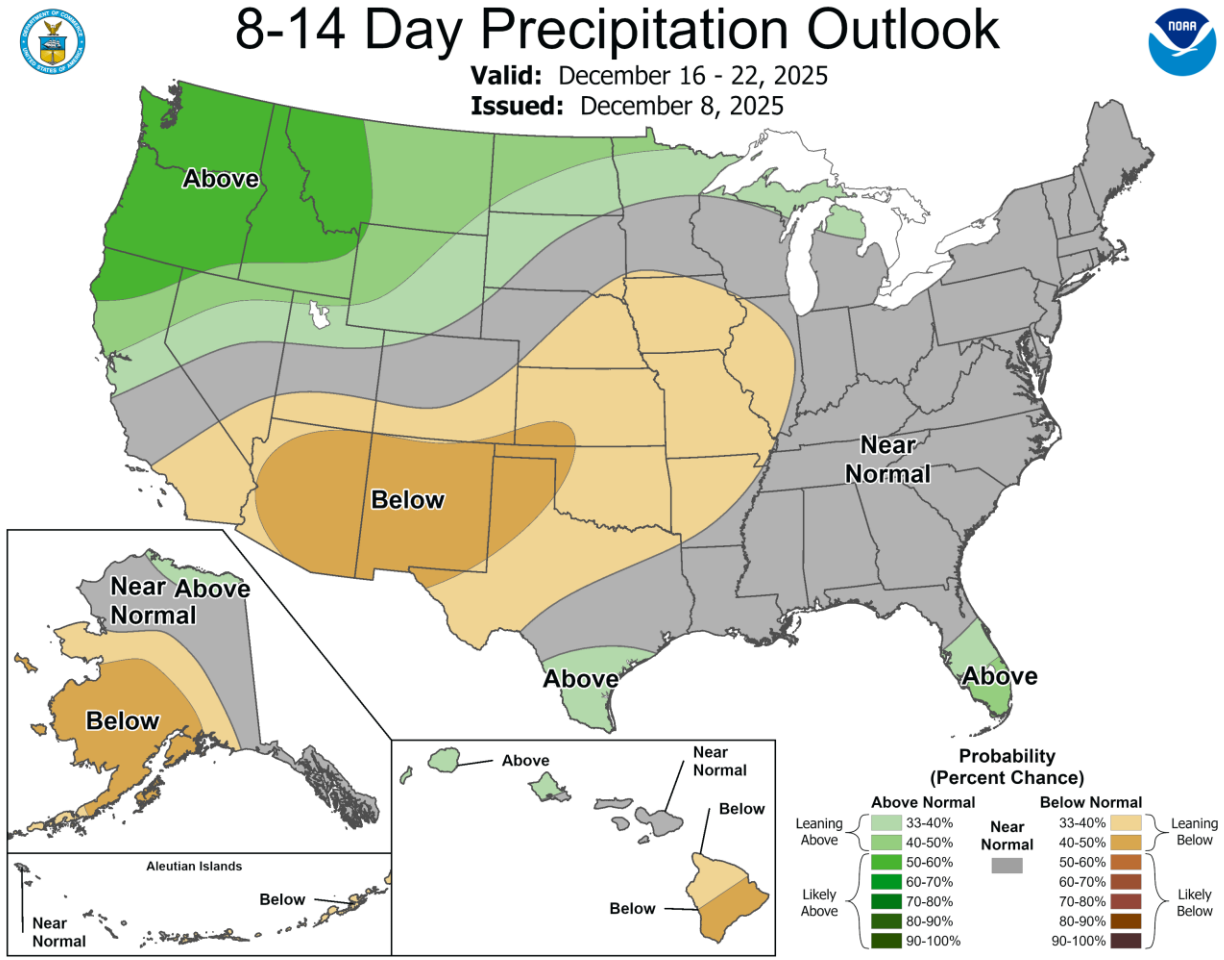




https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide

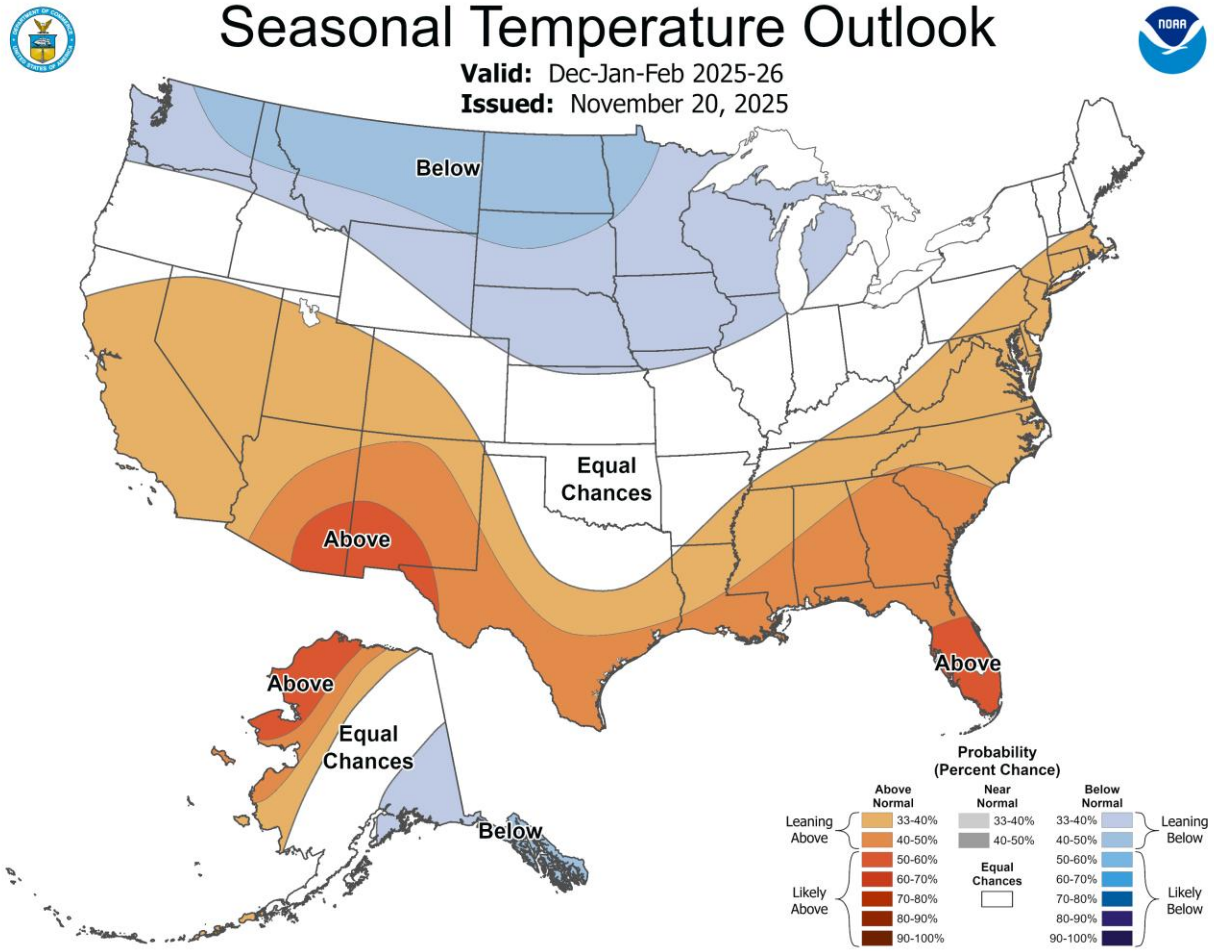
Looking Ahead

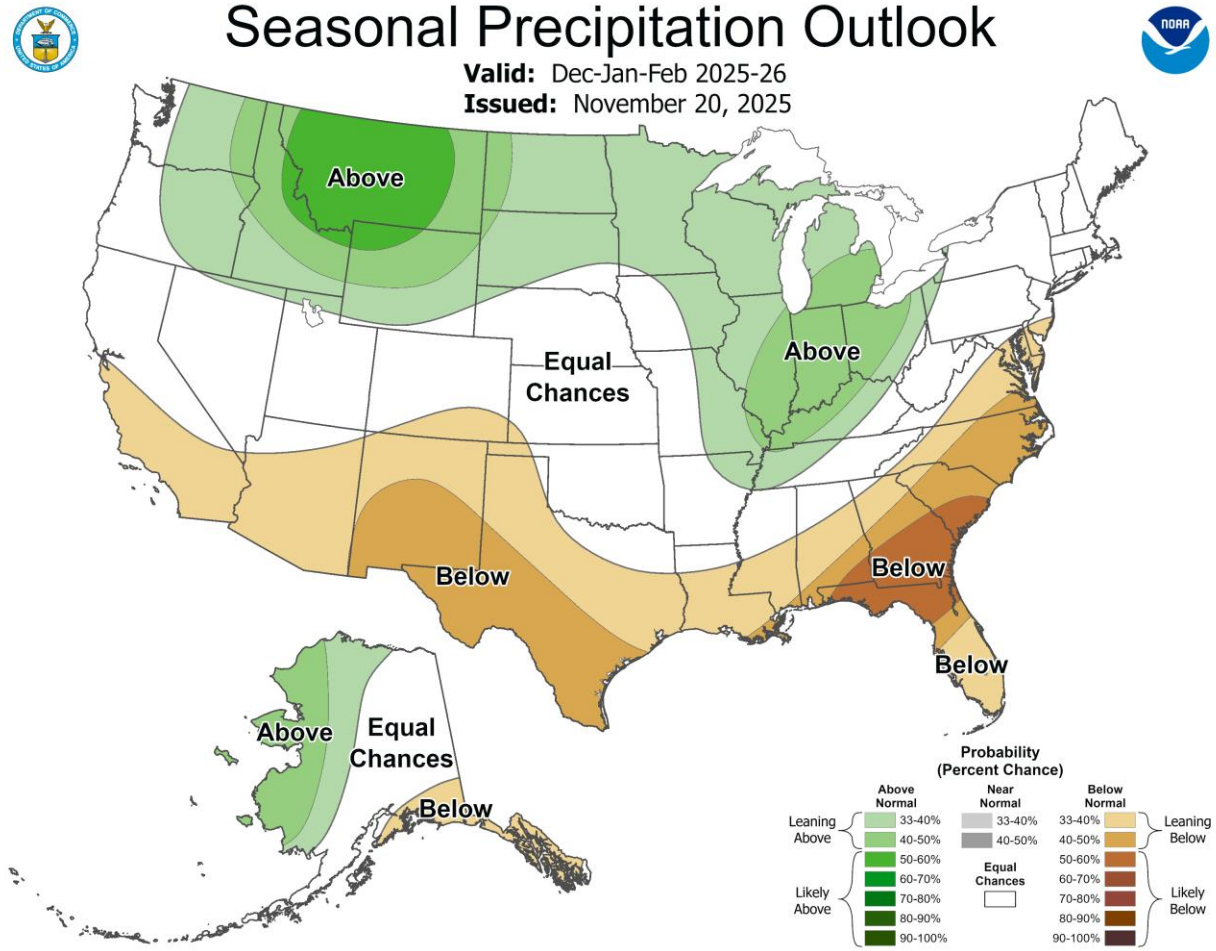




https://www.cpc.ncep.noaa.gov/

Looking Ahead





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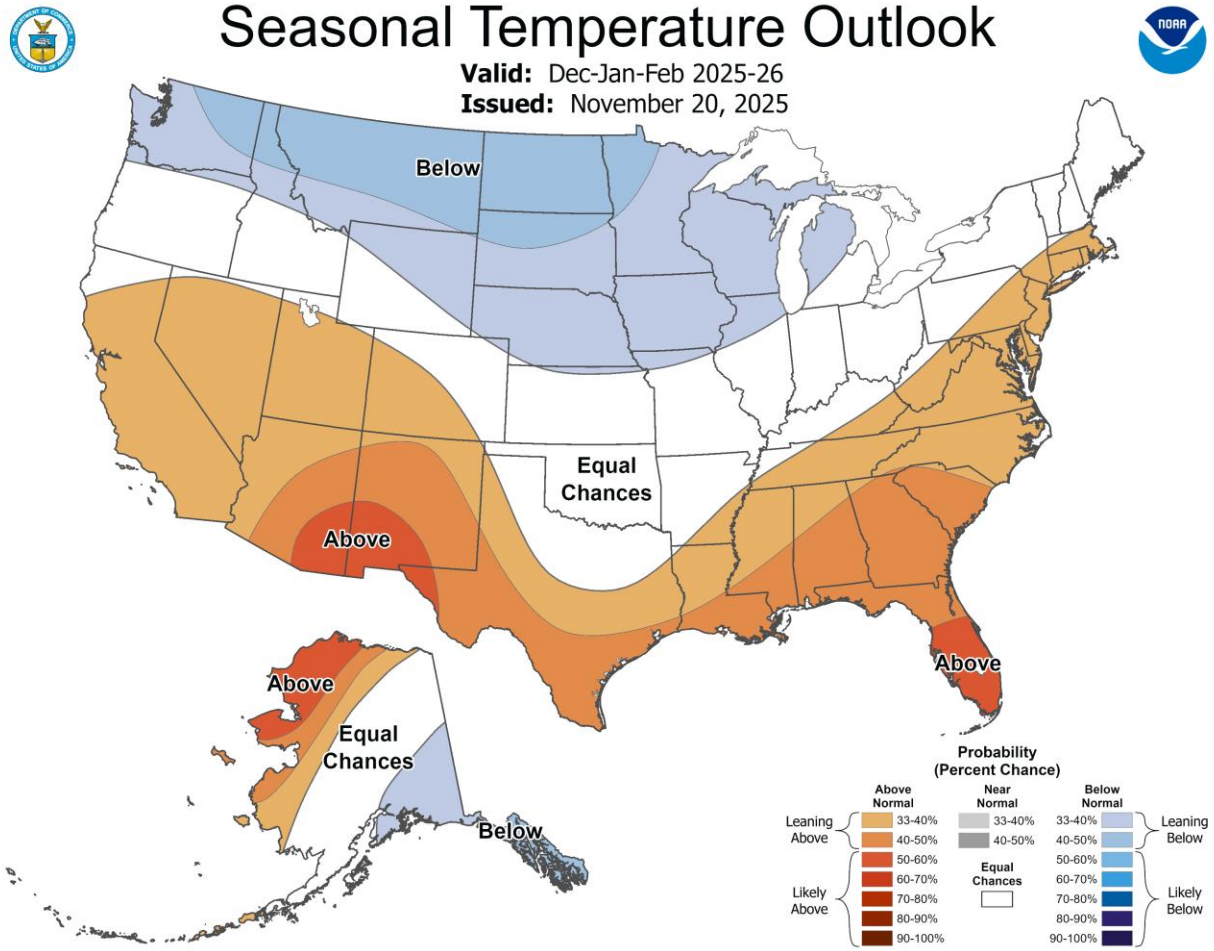
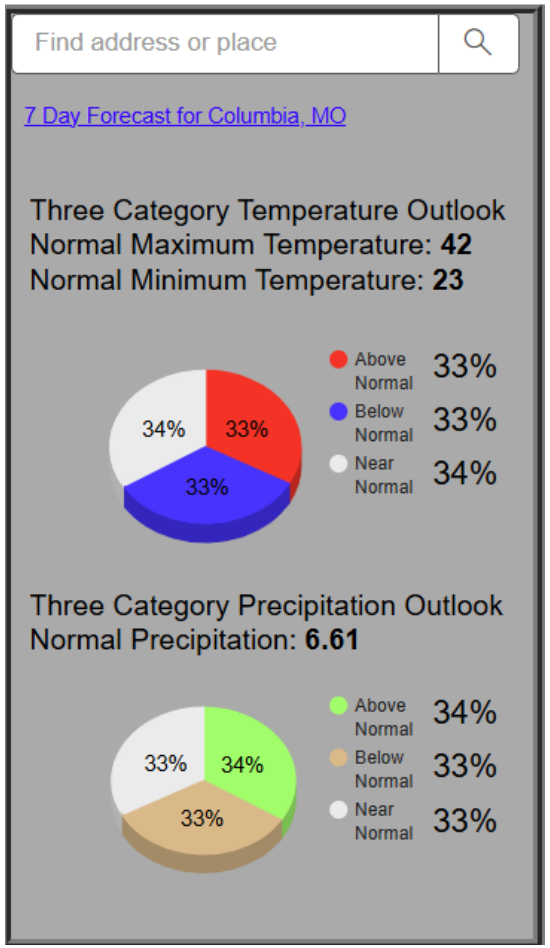
Looking Ahead



How to Interpret Climate Prediction Center Outlooks:

https://www.weather.gov/afc/GuideToInterpretCPCProducts



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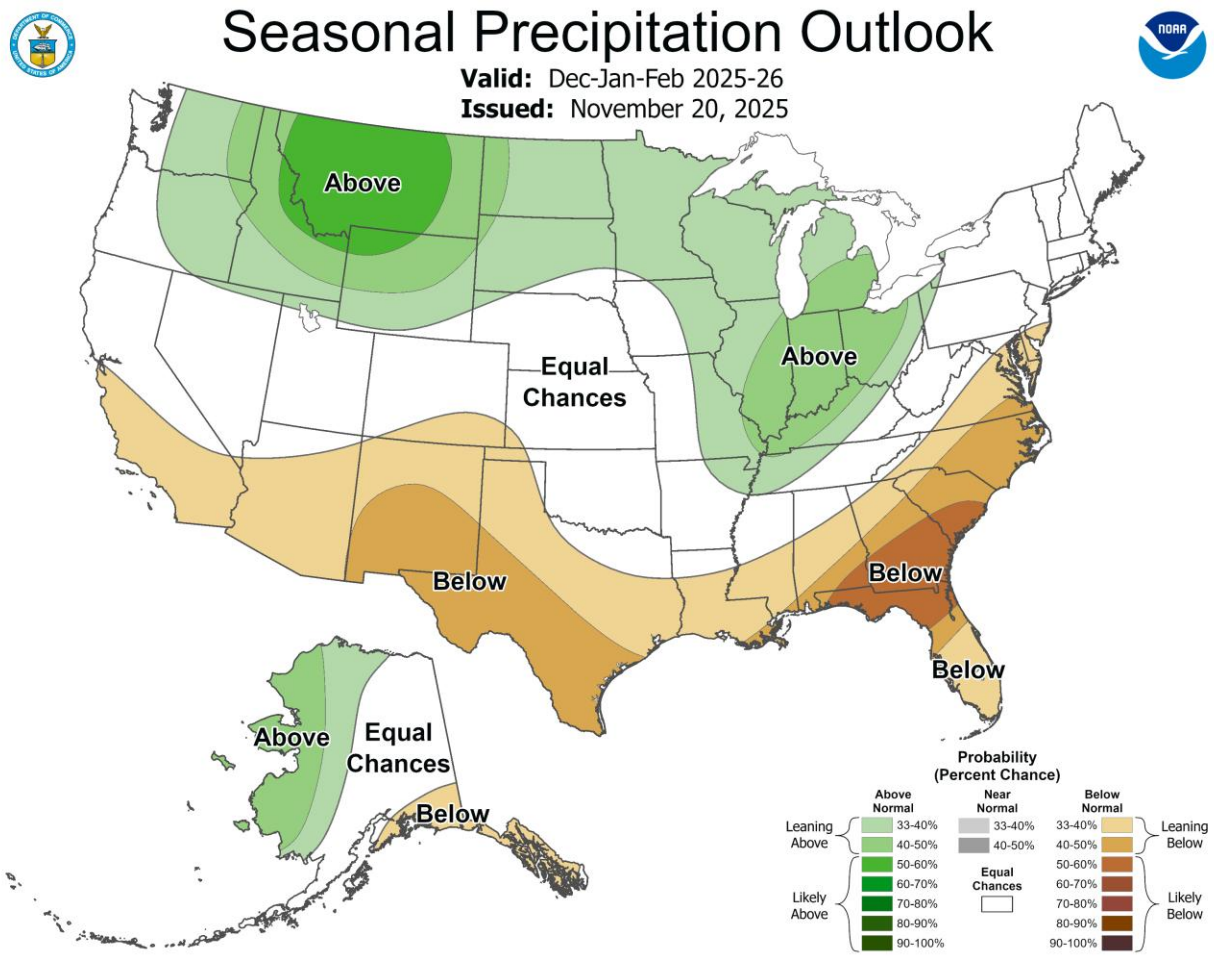

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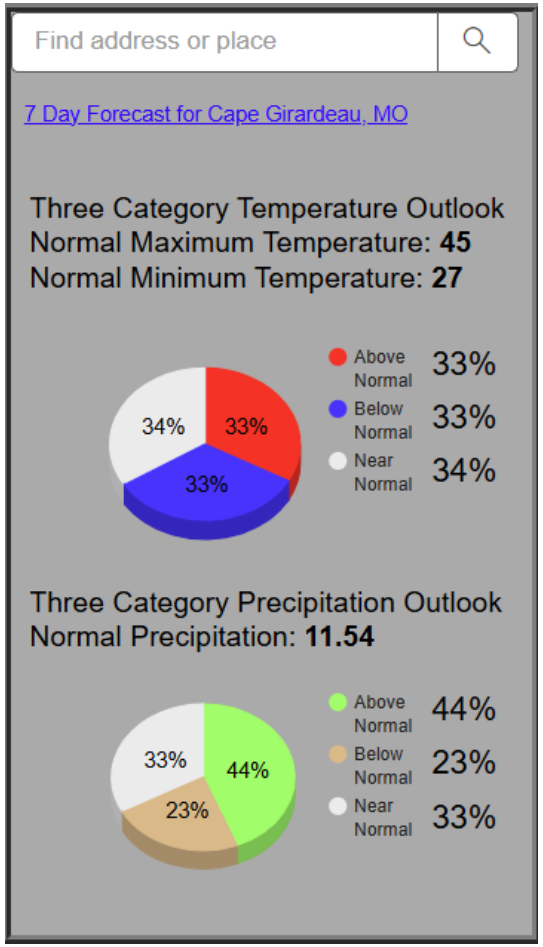

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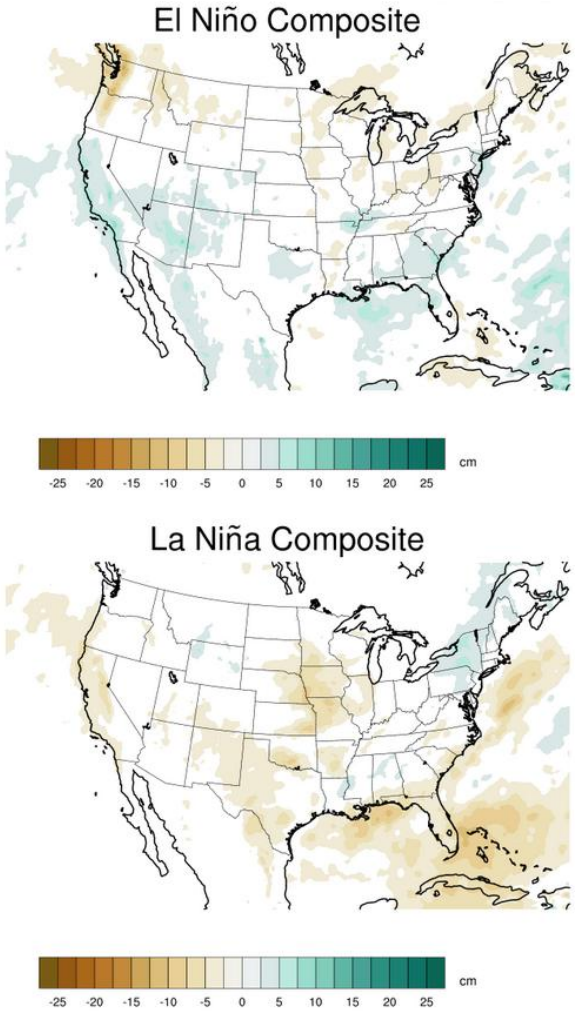
Looking Ahead

Mar-May Precipitation/day Anomalies from ERA5
1991-2020 climo



ENSO Alert System Status: La Niña Advisory

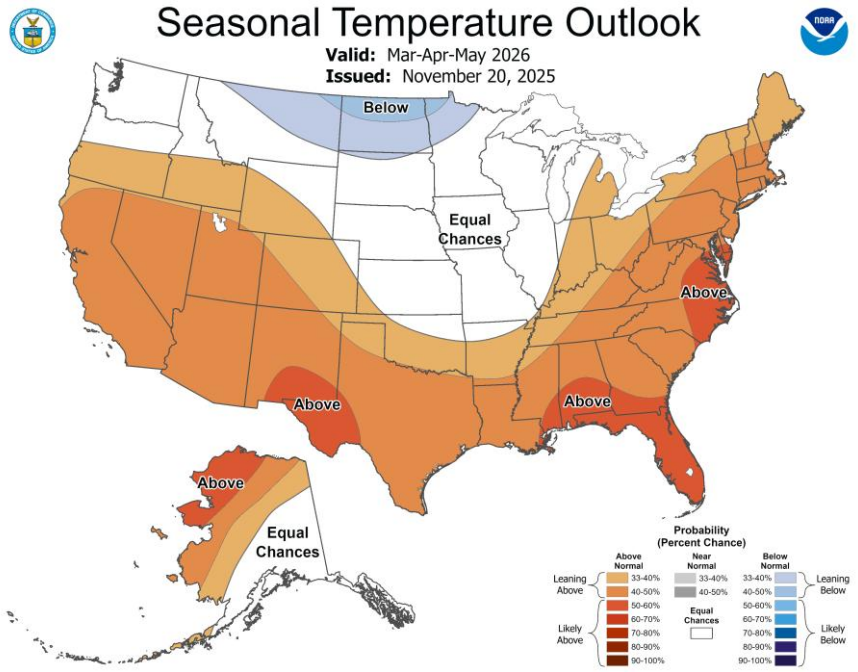
La Niña is present.*

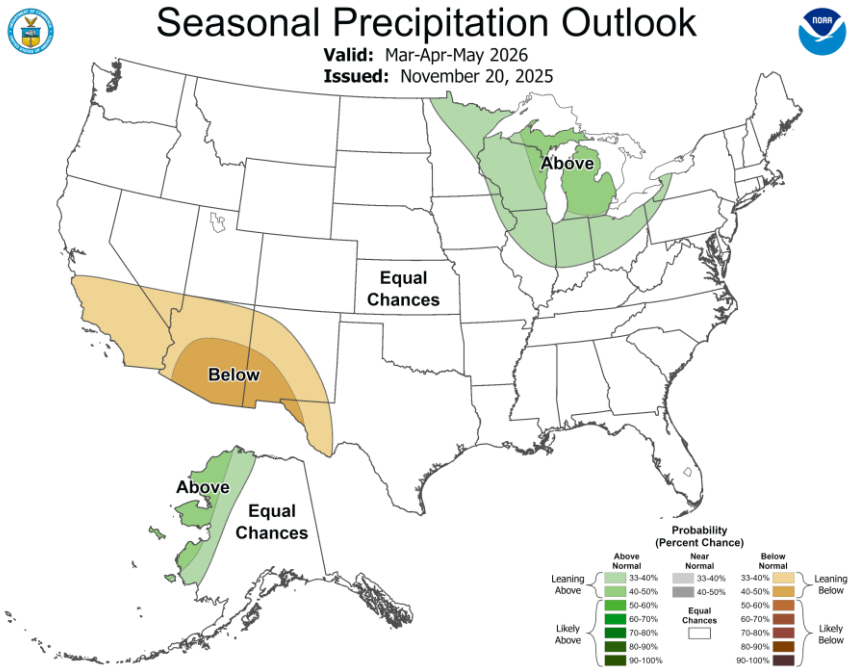
Equatorial sea surface temperatures (SSTs) are below average across the central and east-central Pacific Ocean.

Atmospheric anomalies over the tropical Pacific Ocean are consistent with La Niña.

La Niña is favored to continue into the Northern Hemisphere winter, with a transition to ENSO-neutral most likely in January-March 2026 (61% chance).*

Update prepared by:
Climate Prediction Center / NCEP
1 December 2025

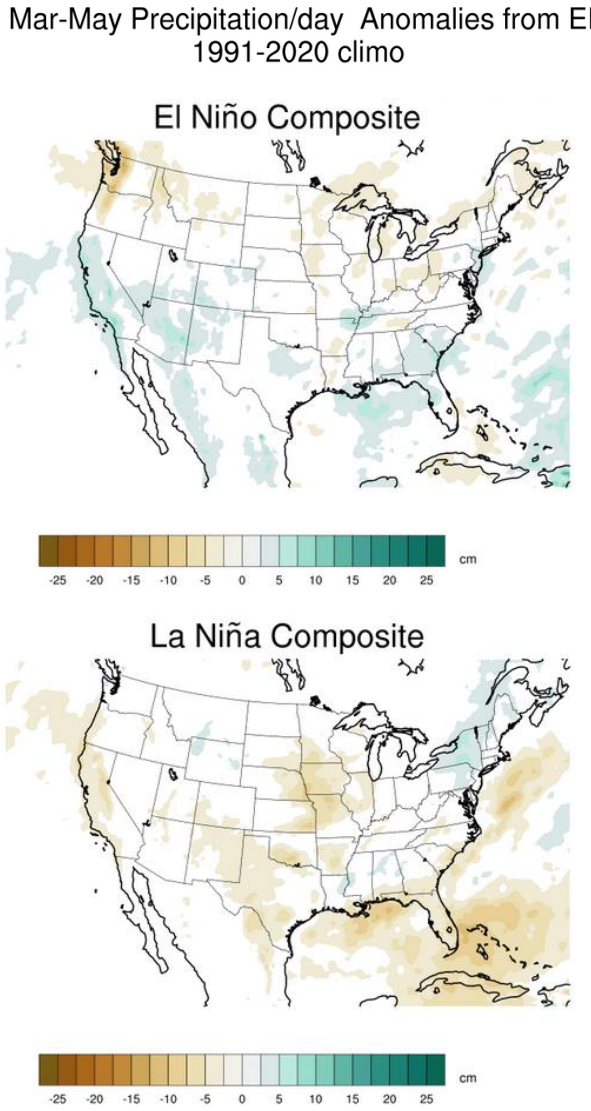




https://www.psl.noaa.gov/enso/difference

https://www.cpc.ncep.noaa.gov/

Looking Ahead



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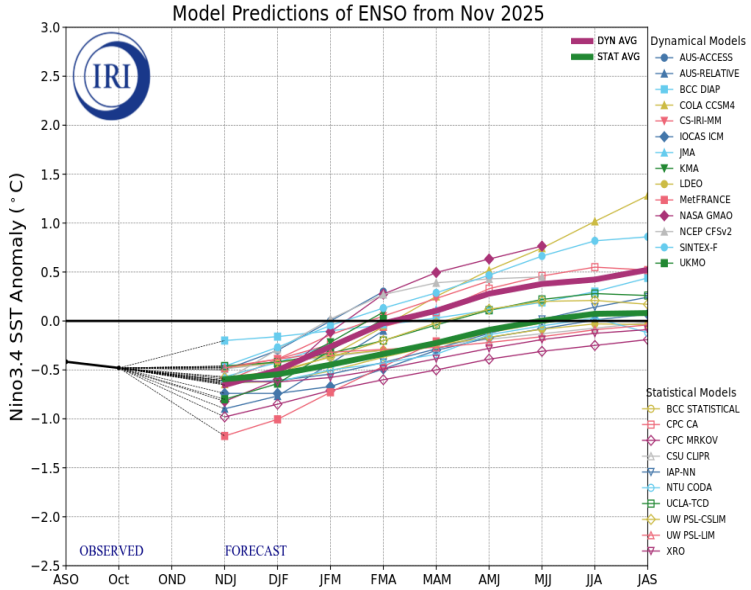
Update prepared by:
Climate Prediction Center / NCEP
1 December 2025

Figure provided by the International Research Institute (IRI) for Climate and Society (updated 19 November 2025).



https://www.cpc.ncep.noaa.gov/

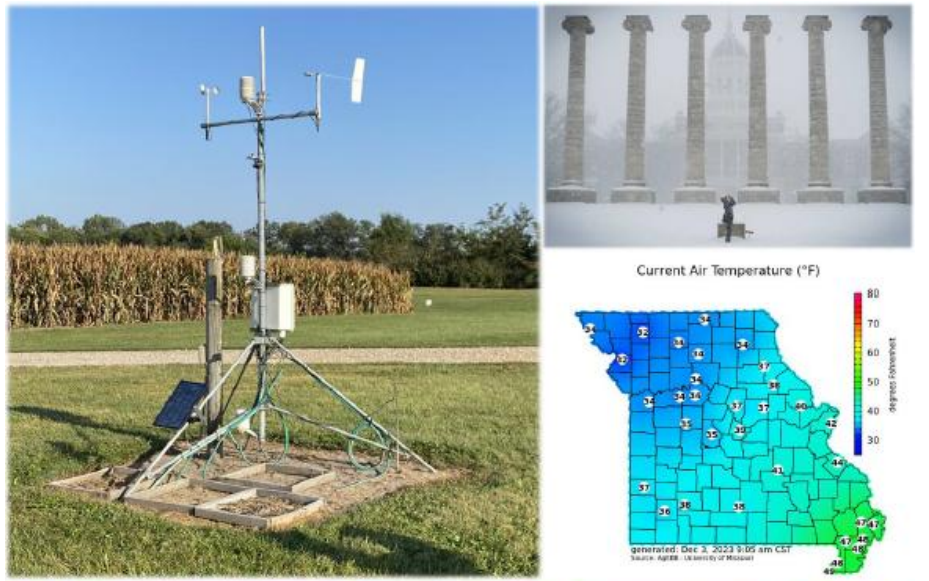
Thank you!

Zack Leasor, PhD
Assistant Professor | Missouri State Climatologist
School of Natural Resources | University of Missouri
320 Anheuser-Busch Natural Resources Building | Columbia MO 65211
O: 573-882-5908 | **E:** leasorz@missouri.edu
W: http://climate.missouri.edu

Missouri Mesonet:
http://agebb.missouri.edu/weather/stations/

UNIVERSITY OF MISSOURI Extension

Missouri Climate Center



MISSOURI CLIMATE CENTER

http://climate.missouri.edu/

The Missouri Climate Center was established in 1995 and is an integrated unit for atmospheric and climate science research and extension in the University of Missouri's College of Agriculture, Food and Natural Resources, the School of Natural Resources, and the School's Atmospheric Science Program. The Center's primary mission is to monitor and document Missouri's climate and to produce value-added products and tools from available weather data. These climate tools provide needed information for effective planning and management of state agriculture, industry, and natural resources. The Missouri Climate Center is an institutional associate member of the American Association of State Climatologists (AASC) with an AASC recognized state climate office designation.