

# The Futures and Fortunes of Drought Relief under Climate Change

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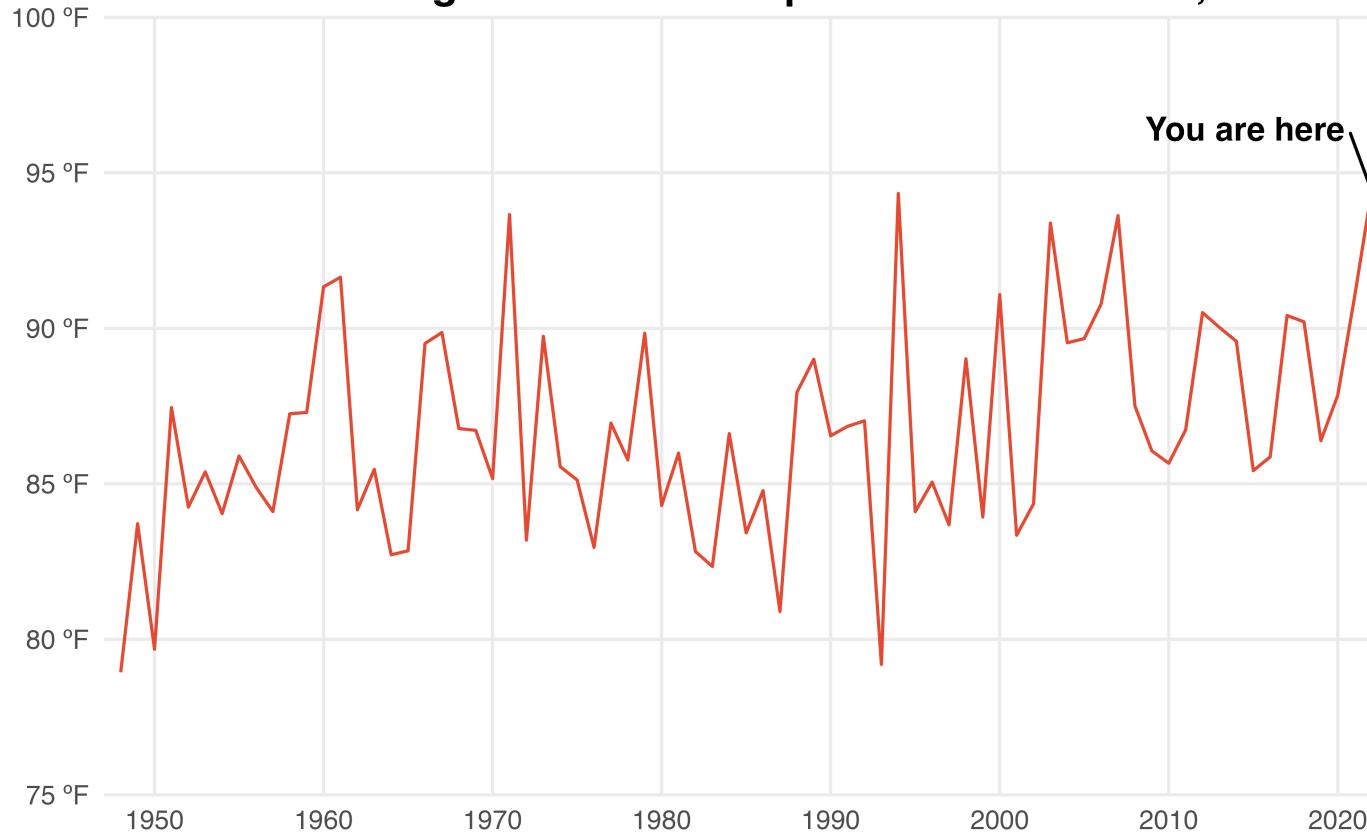
Patrick T. Fallon/Agence France-Presse — Getty Images



Montana  
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Office

July 15 to August 15

## Average Maximum Temperature in Missoula, MT



You are here

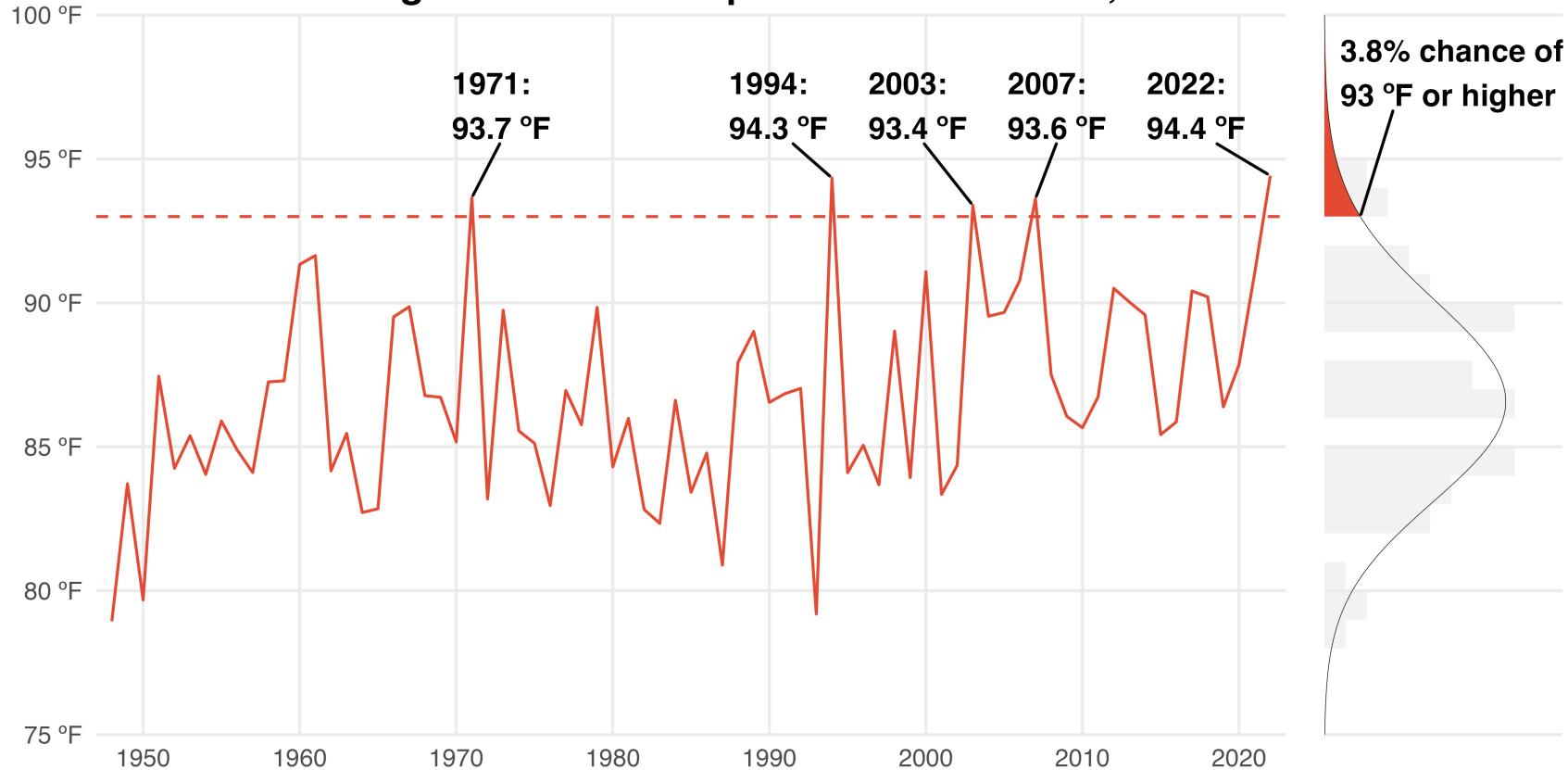
1.6% chance of  
94.4 °F or higher



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## Average Maximum Temperature in Missoula, MT

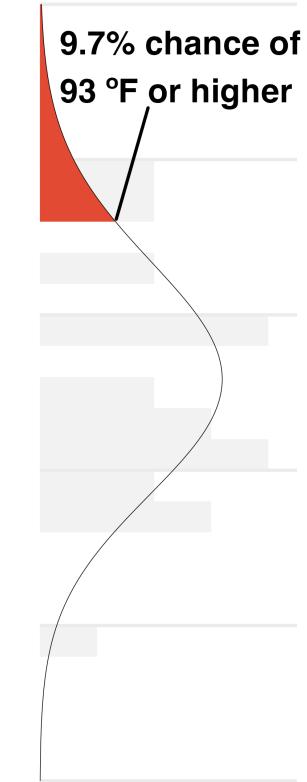
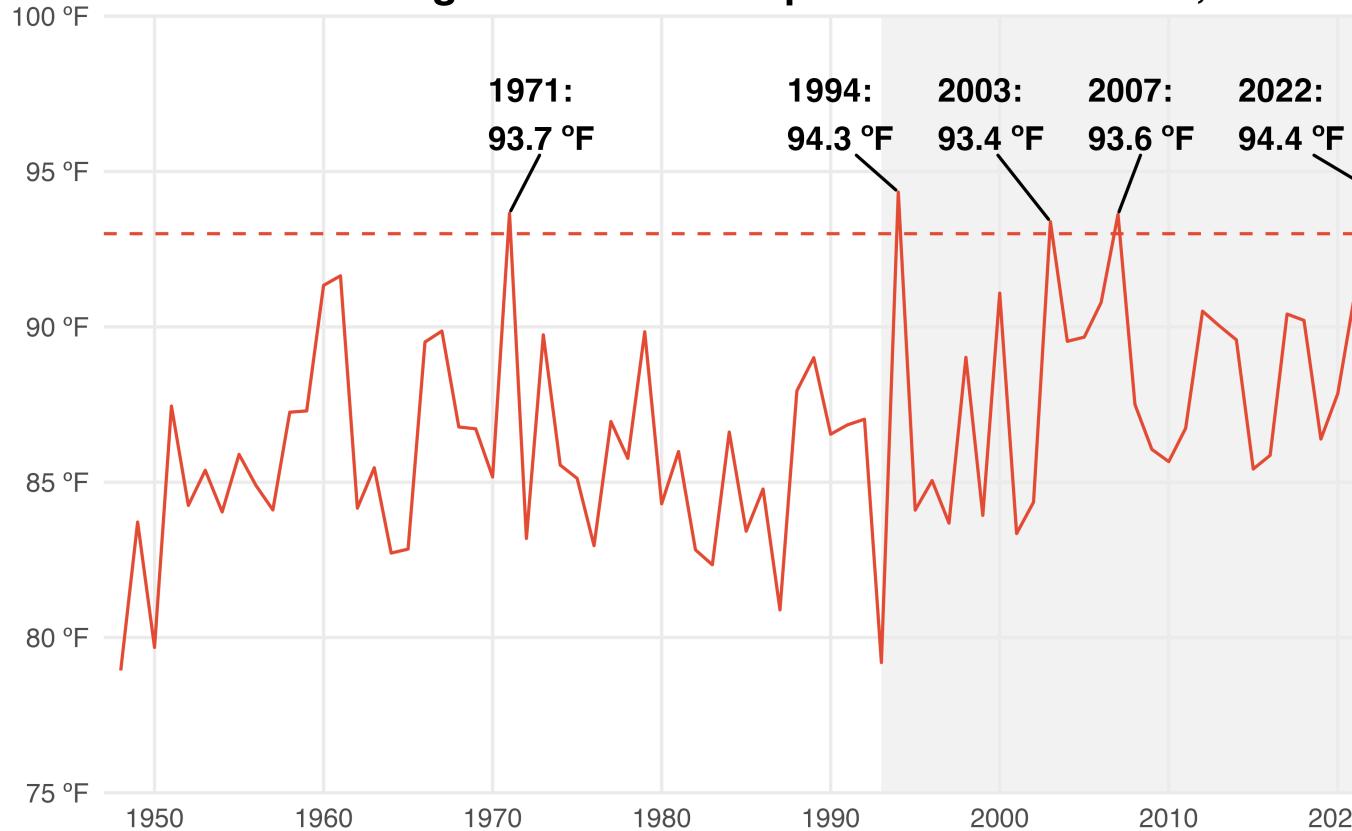




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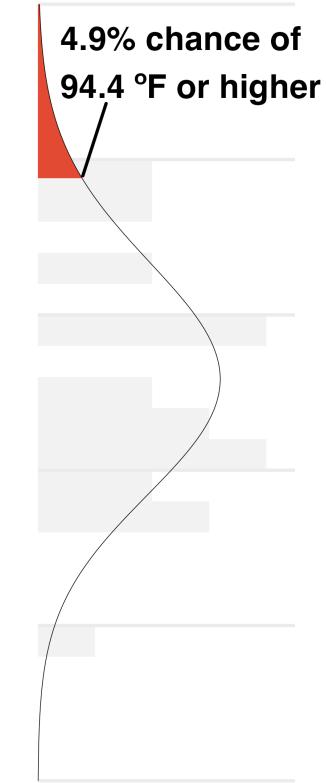
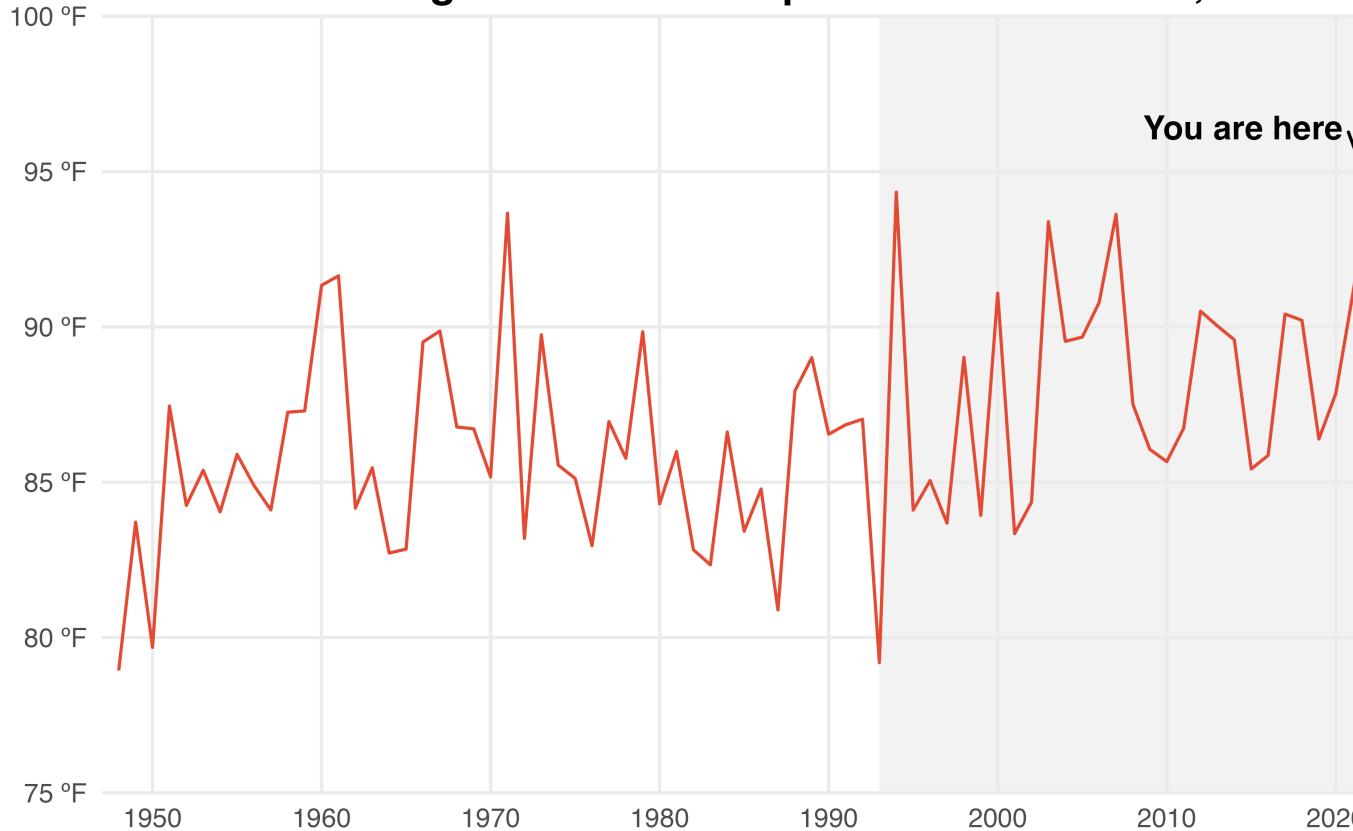


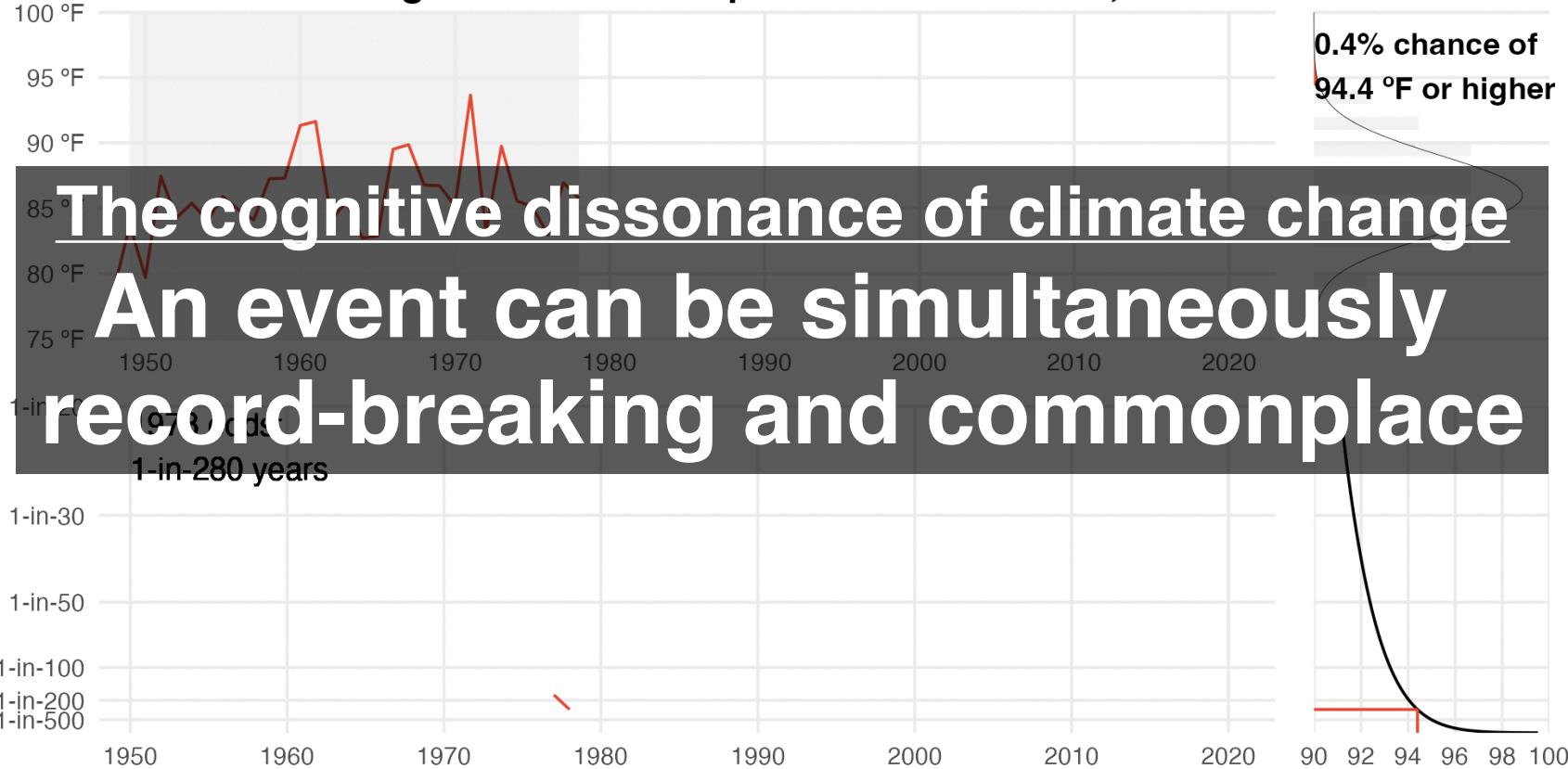


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## Average Maximum Temperature in Missoula, MT





ARTICLE

<https://doi.org/10.1038/s41467-022-30316-5>

OPEN



# Drought assessment has been outpaced by climate change: empirical arguments for a paradigm shift

Zachary H. Hoylman<sup>1,2</sup>, R. Kyle Bocinsky<sup>1,3</sup> & Kelsey G. Jencso<sup>1,2</sup>

Despite the acceleration of climate change, erroneous assumptions of climate stationarity are still inculcated in the management of water resources in the United States (US). The US system for drought detection, which triggers billions of dollars in emergency resources, adheres to this assumption with preference towards 60-year (or longer) record lengths for drought characterization. Using observed data from 1,934 Global Historical Climate Network (GHCN) sites across the US, we show that conclusions based on long climate records can substantially bias assessment of drought severity. Bias emerges by assuming that conditions from the early and mid 20th century are as likely to occur in today's climate. Numerical simulations reveal that drought assessment error is relatively low with limited climatology lengths (~30 year) and that error increases with longer record lengths where climate is changing rapidly. We assert that non-stationarity in climate must be accounted for in contemporary assessments to more accurately portray present drought risk.

**Under stationary assumptions, drought severity is exaggerated in locations that are experiencing aridification and underrepresented in locations that are getting wetter.**

This concept applies to other metrics commonly used in drought assessment.

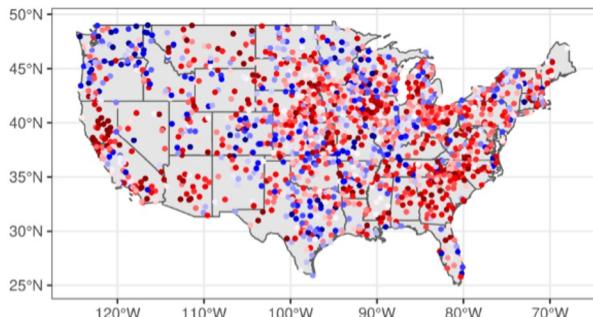
Shifting to 30-year drought climatologies achieves the following goals:

- Drought assessment better reflects present drought risk to affected communities;
- Greater standardization across datasets with differing periods of record;
- Better accounting for climate change into the future.

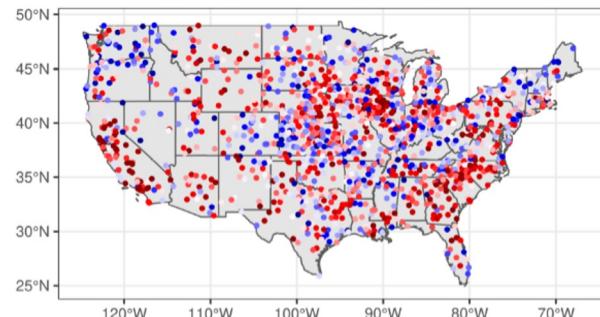
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# POR bias exceeds +/-1 class during severe drought

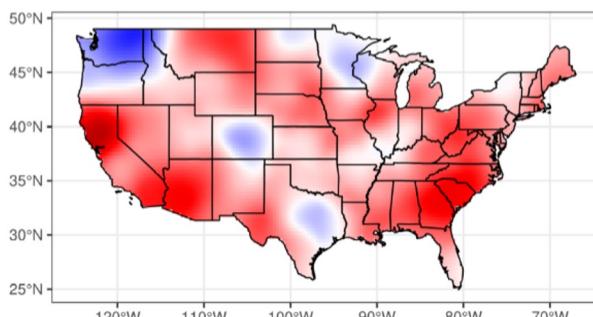
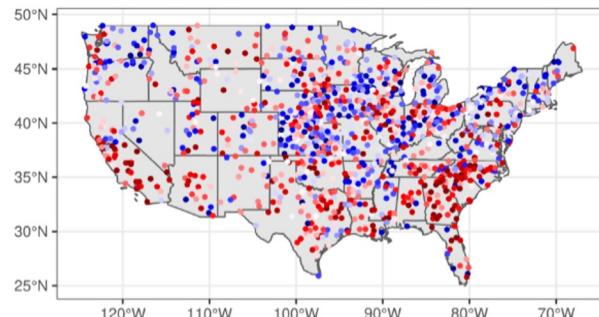
Daily Summer Bias (Very Dry Conditions, -2 > SPI)  
30 Day SPI (June 1 - August 31, 1991-2020)



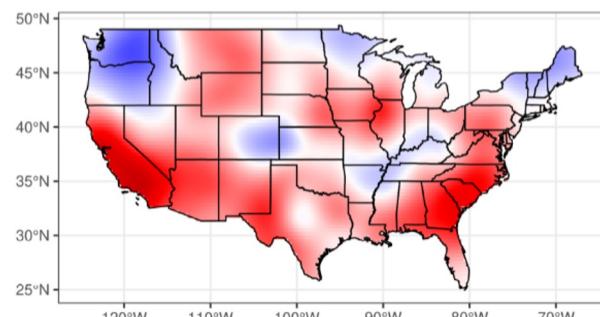
Daily Summer Bias (Very Dry Conditions, -2 > SPI)  
60 Day SPI (June 1 - August 31, 1991-2020)



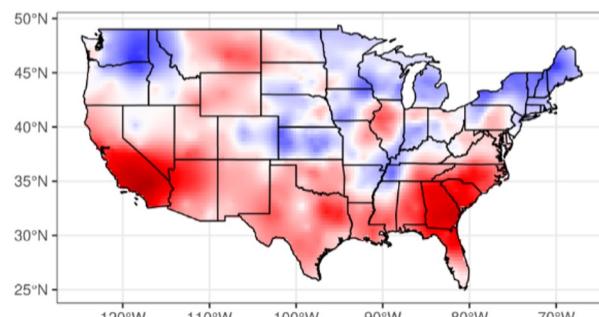
Daily Summer Bias (Very Dry Conditions, -2 > SPI)  
90 Day SPI (June 1 - August 31, 1991-2020)



-0.5 (Dry Bias) 0 (No Bias) 0.5 (Wet Bias)



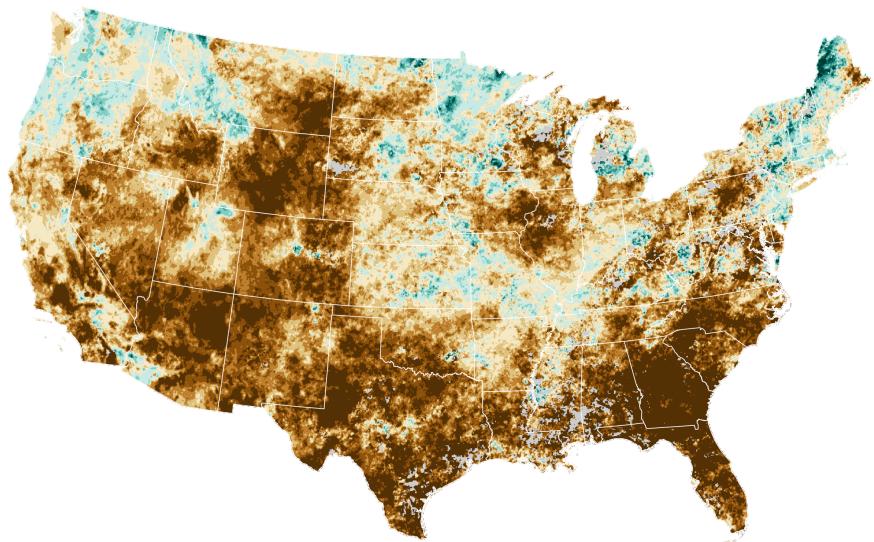
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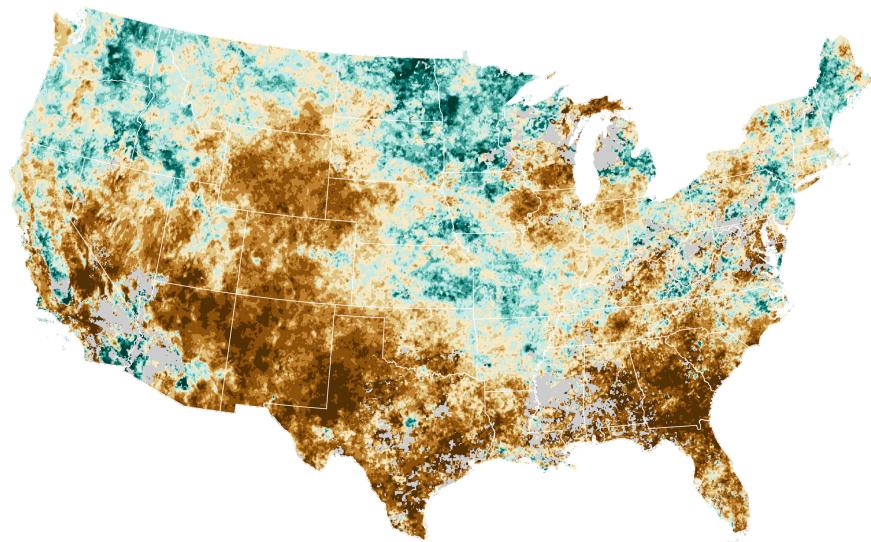
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# POR bias exceeds +/-1 class during severe drought

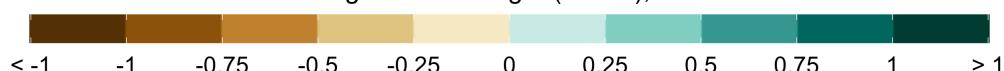
Precipitation only (SPI)



Precipitation and evaporation (SPEI)



Period-of-record bias during severe drought ( $\geq D2$ ), summer 2012–2021



- 1.** USDM declarations for severe drought ( $\geq$  D2) align with century-scale climatologies

Demonstrable bias against declaring drought in places that are getting wetter
- 2.** “Nearly automatic” disaster relief triggered by the USDM primarily benefits aridifying regions

Excess payments may be undermining adaptation
- 3.** Climate change scenarios suggest amplifying inequities in assistance

If the money is there to begin with...

# Summertime severe drought declarations

Period-of-record

USDM

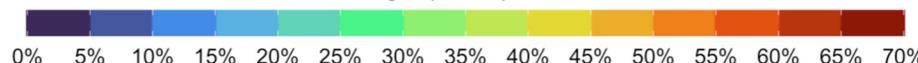
30-year

Precip. only (SPI)

Precip. and evap. (SPEI)

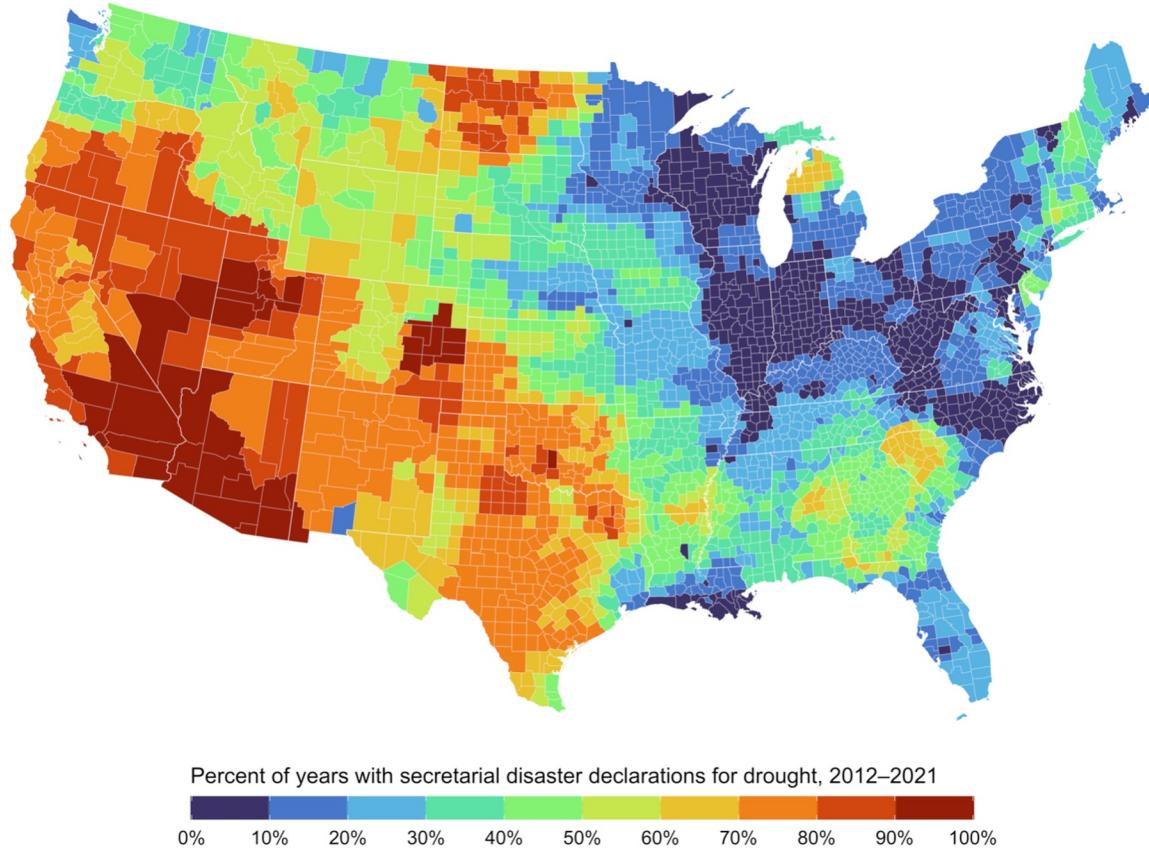
- USDM declares severe drought more often than either reference period
- Spatial patterns of POR (Southwest, southern Rockies) align with USDM
- 30-year reference period emphasizes drought conditions in Pacific NW

Percent of months in severe drought ( $\geq D2$ ), summer 2012–2021



Provider	Base Data	Reference Period	Documentation
West Wide Drought Tracker (SPI/SPEI)	PRISM	Full POR (1895-present)	<a href="https://wrcc.dri.edu/wwdt/about.php">https://wrcc.dri.edu/wwdt/about.php</a>
Climate Prediction Center (SPI)	CPC (Unified Precipitation Analysis)	Full POR (1950-present)	<a href="https://www.cpc.ncep.noaa.gov/products/Drought/Monitoring/spi.shtml">https://www.cpc.ncep.noaa.gov/products/Drought/Monitoring/spi.shtml</a>
NCEI/NOAA NADM (SPI)	?	Full POR (1951-Last Full Year)	<a href="https://www.ncei.noaa.gov/access/monitoring/nadm/indices/spi/div">https://www.ncei.noaa.gov/access/monitoring/nadm/indices/spi/div</a>
Western Regional Climate Center - WRCC (SPI)	NOAA/NWS/CPC NOAA/NESDIS/NCDC	Full POR (1895-present)	<a href="https://wrcc.dri.edu/Monitoring/spi_products.php">https://wrcc.dri.edu/Monitoring/spi_products.php</a> <a href="https://wrcc.dri.edu/cgi-bin/spiFmap.pl?spi01">https://wrcc.dri.edu/cgi-bin/spiFmap.pl?spi01</a>
SPEI Global Drought Monitor (SPEI)	NOAA NCEP CPC GHCN_CAMS / GPCC	1950 - 2010	<a href="https://spei.csic.es/map/maps.html#months=1#month=7#year=2022">https://spei.csic.es/map/maps.html#months=1#month=7#year=2022</a>
High Plains Regional Climate Center - HRPCC (SPI / SPEI)	Station data	POR of each station (truncated at 1900)  1980 - present (SPEI)	Email documentation
PSL - NOAA (EDDI)	NLDAS-2	1979-present	<a href="https://psl.noaa.gov/eddi/">https://psl.noaa.gov/eddi/</a>

# USDM triggers disaster declarations and relief

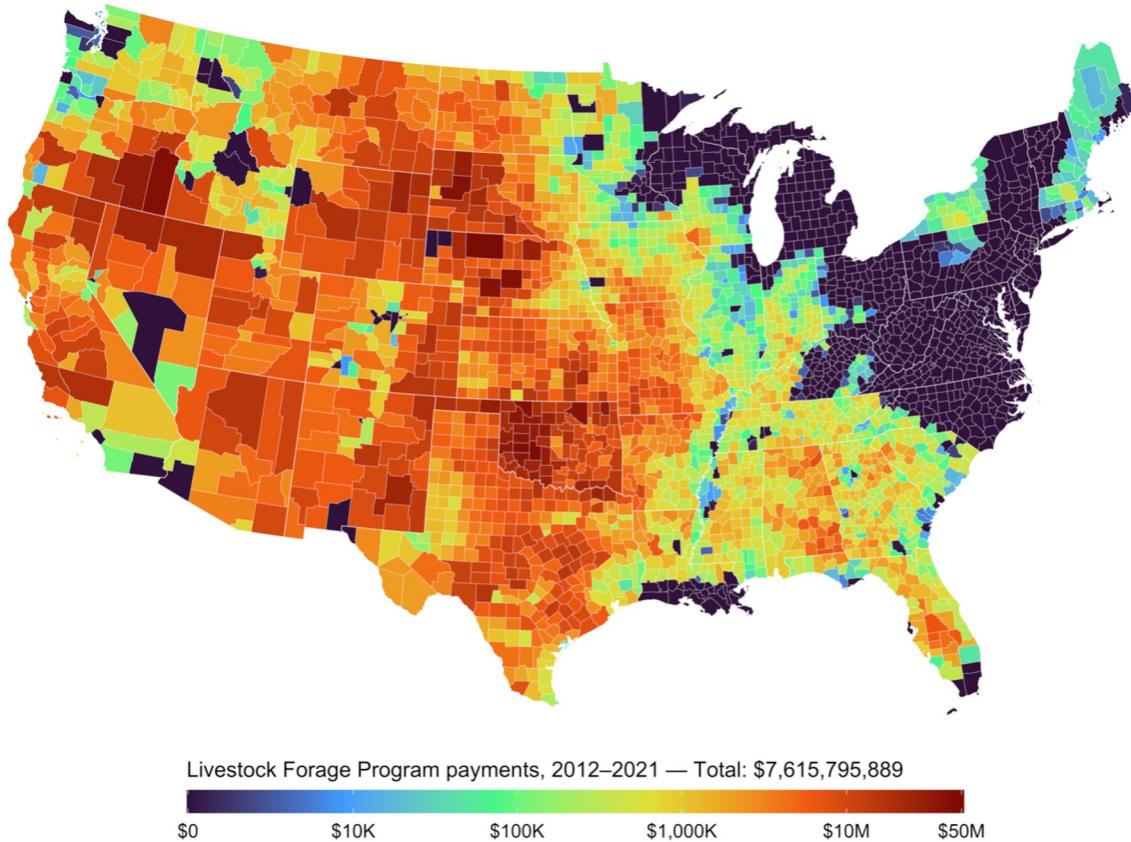


## USDA Secretarial Drought Disasters

“Fast Track” Secretarial disaster designations for severe drought provide for a **nearly automatic designation** when, during the growing season, any portion of a county meets the D2 (Severe Drought) drought intensity value for eight consecutive weeks or a higher drought intensity value for any length of time as reported in the U.S. Drought Monitor.

*7 CFR § 759.5 - Secretarial disaster area determination and notification process*

# USDM triggers disaster declarations and relief

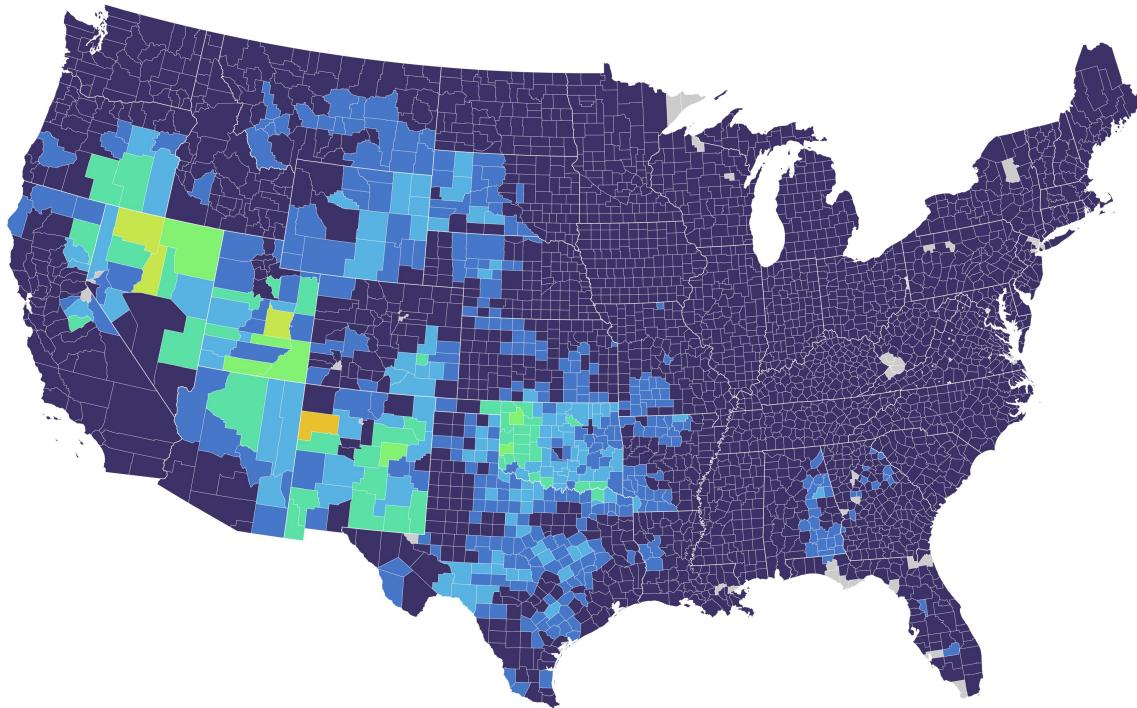


## Livestock Forage Program Eligibility Criteria

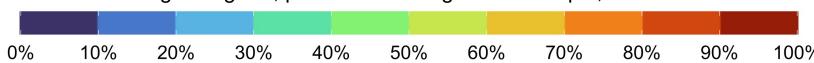
- 1 monthly payment:  
D2 (severe drought) for at least eight consecutive weeks
- 3 monthly payments:  
D3 (extreme drought) at any time
- 4 monthly payments:  
D3 (extreme drought) for at least four consecutive weeks or D4 (exceptional drought) intensity at any time
- 5 monthly payments:  
D4 (exceptional drought) for any four weeks

7 CFR § 1416.205 - *Eligible grazing losses*

# USDM triggers disaster declarations and relief



Livestock Forage Program, percent of average farm receipts, 2012–2021

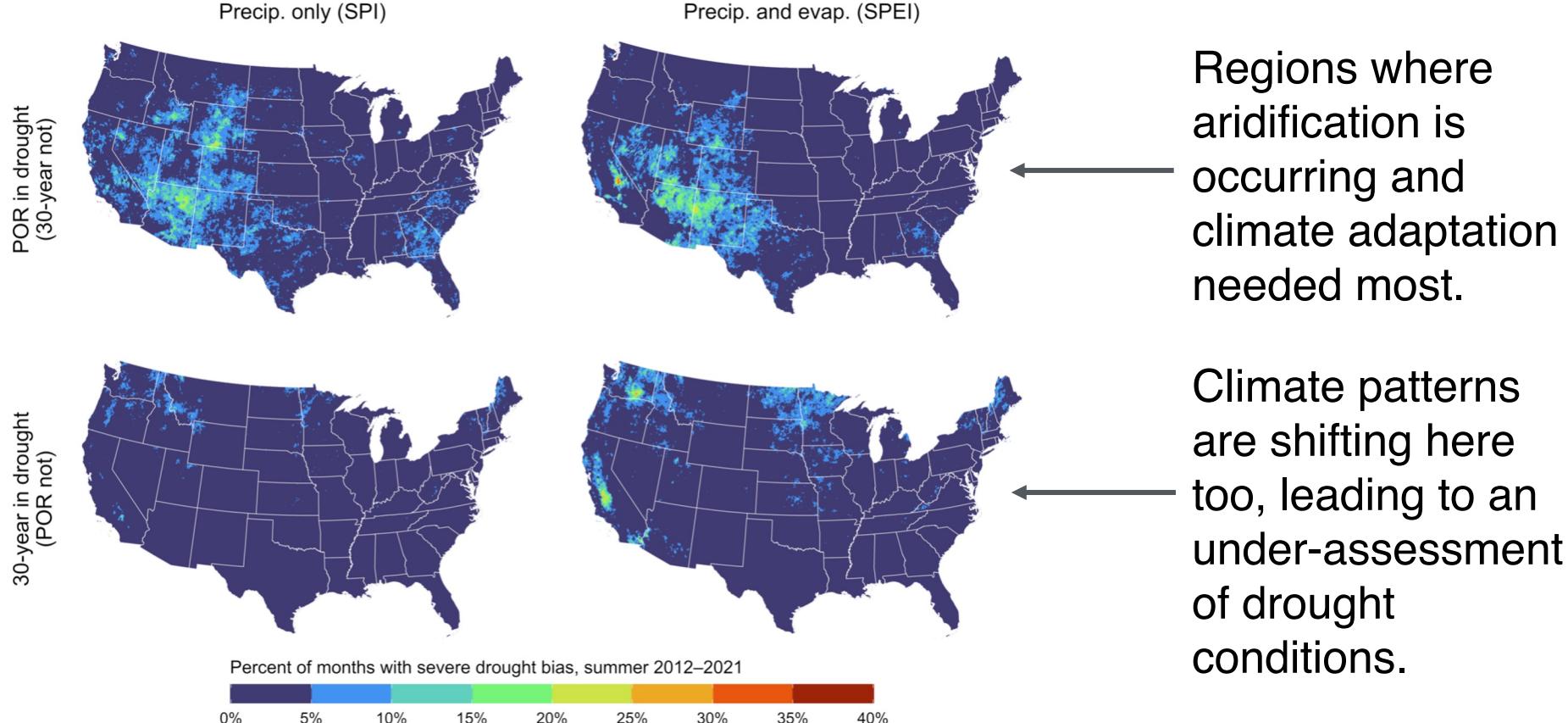


## Livestock Forage Program Eligibility Criteria

- 1 monthly payment:**  
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D4 (exceptional drought) for any four weeks

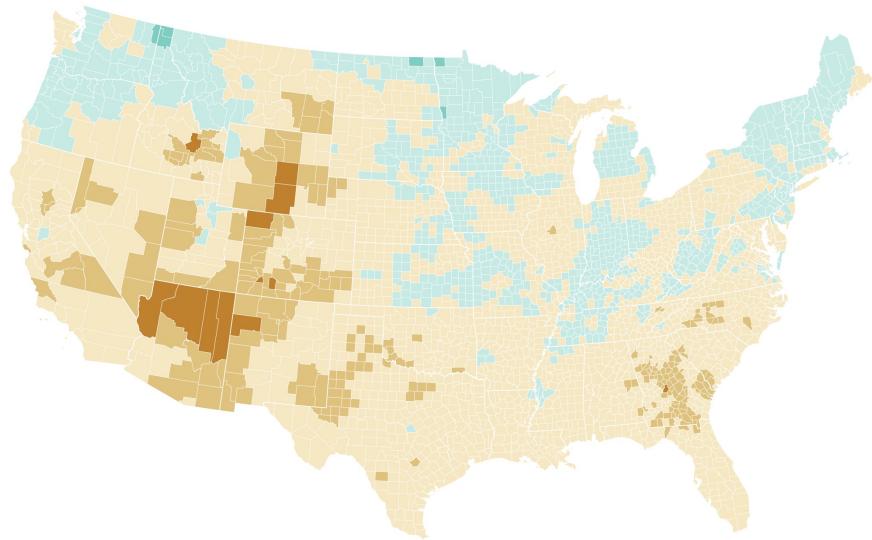
*7 CFR § 1416.205 - Eligible grazing losses*

# Drought bias affects disaster declarations and relief

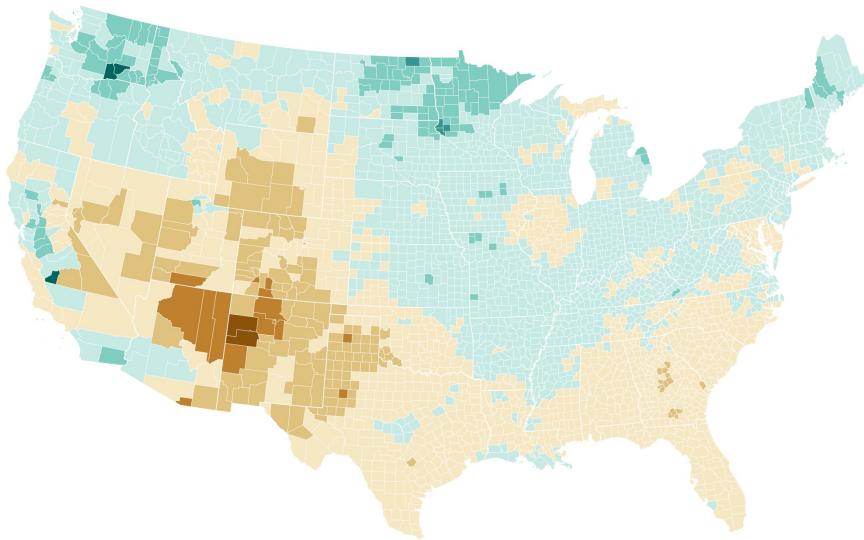


# Drought bias affects disaster declarations and relief

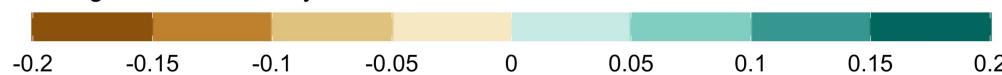
Precipitation only (SPI)



Precipitation and evaporation (SPEI)



Drought non-stationarity correction, summer 2012–2021



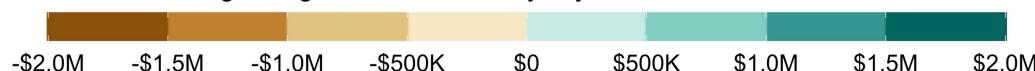
# Drought bias affects disaster declarations and relief

Precipitation only (SPI)

Precipitation and evaporation (SPEI)

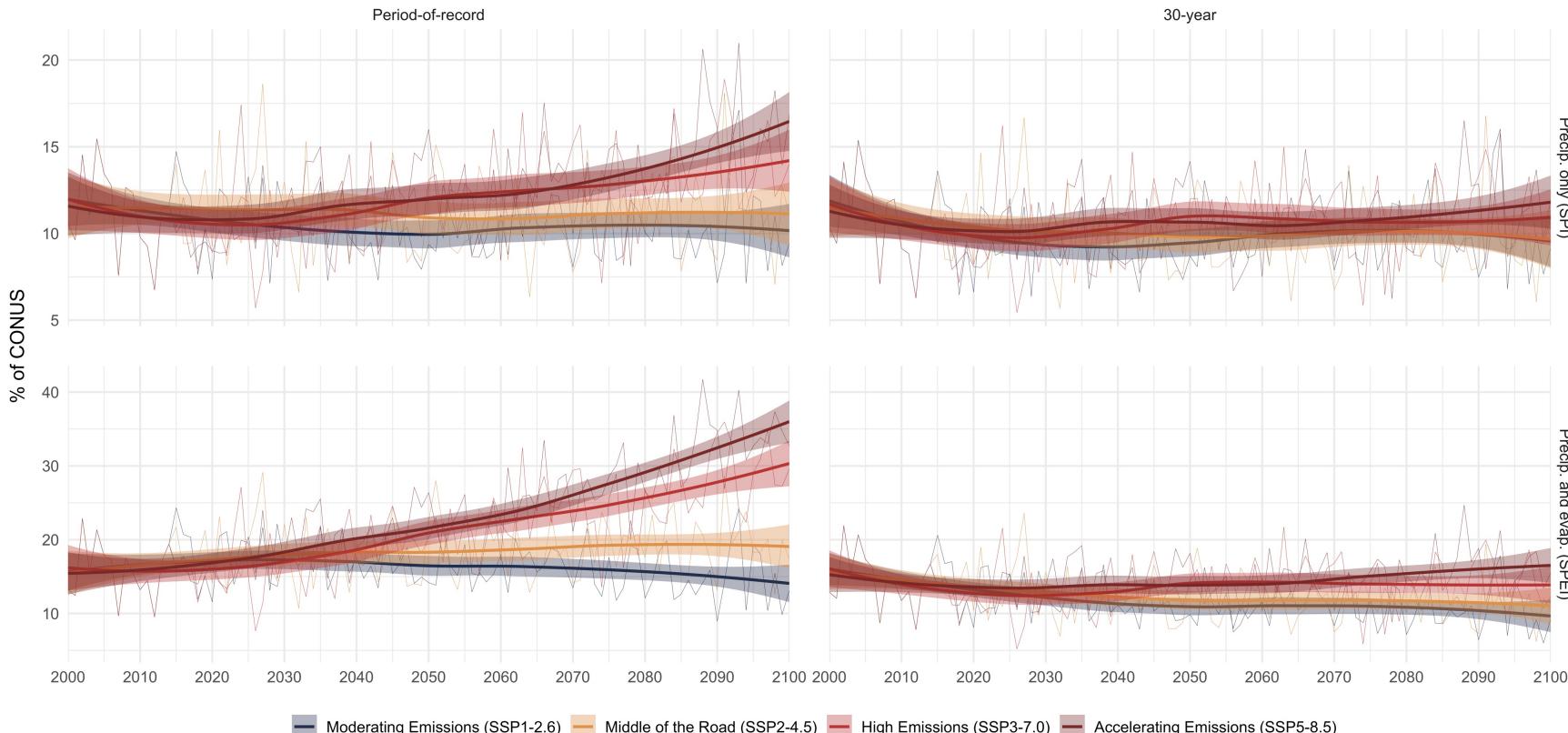
Under a 30-year reference period,  
drought relief would have been  
distributed differently, and would have  
been substantially less costly.

Livestock Forage Program nonstationarity adjustment, 2012–2021 — Total: -\$254,446,698



# POR-based drought relief is unsustainable

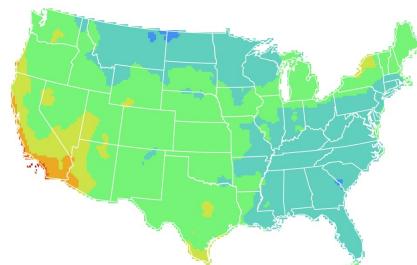
Percent of CONUS in severe drought ( $\geq D2$ ), summer 2000–2100



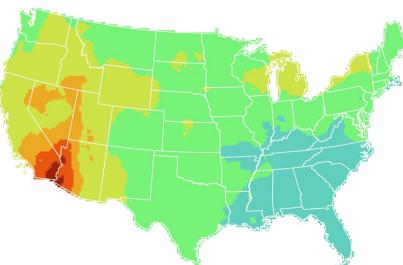
# POR-based drought relief is unsustainable

Period-of-record  
30-year

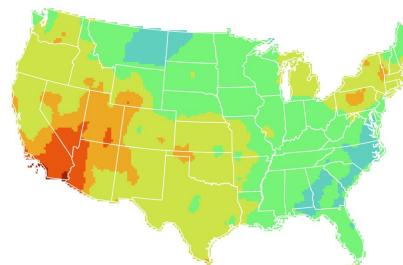
Moderating Emissions  
(SSP1-2.6)



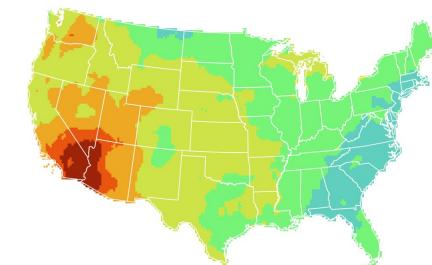
Middle of the Road  
(SSP2-4.5)



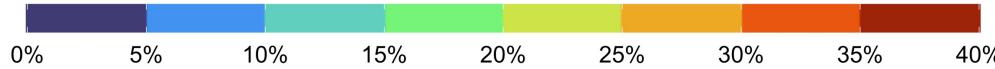
High Emissions  
(SSP3-7.0)



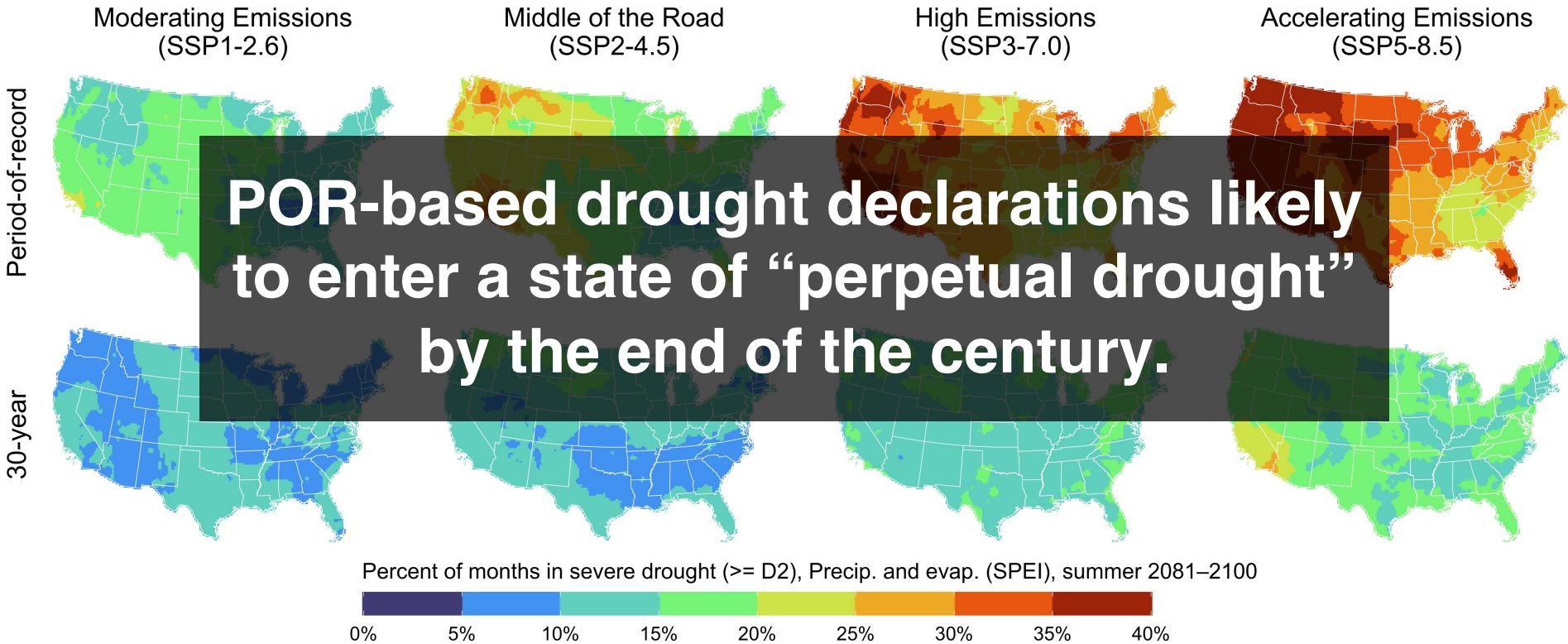
Accelerating Emissions  
(SSP5-8.5)



Percent of months in severe drought ( $\geq$  D2), Precip. and evap. (SPEI), summer 2041–2060



# POR-based drought relief is unsustainable

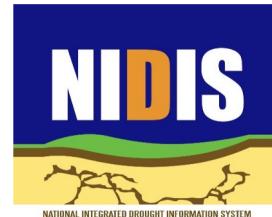


# Recommendations for drought monitoring

- 1. Begin the transition to standard, regularly updated reference periods (climatologies).**
- 2. Develop sector-specific drought assessments that align with adaptive capacity.**
- 3. Engage more fully with climate projections in order to inform drought adaptation efforts.**

# Recommendations for policymakers

- 1. Ensure that [drought] relief programs are responding to contemporary risk.**
- 2. Support drought monitoring as a tool for both risk assessment and climate adaptation.**
- 3. Target adaptation in those places and sectors that are experiencing the greatest change.**



# Montana Climate Office

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