

Emergent Trends Complicate the Interpretation of the United States Drought Monitor (USDM)

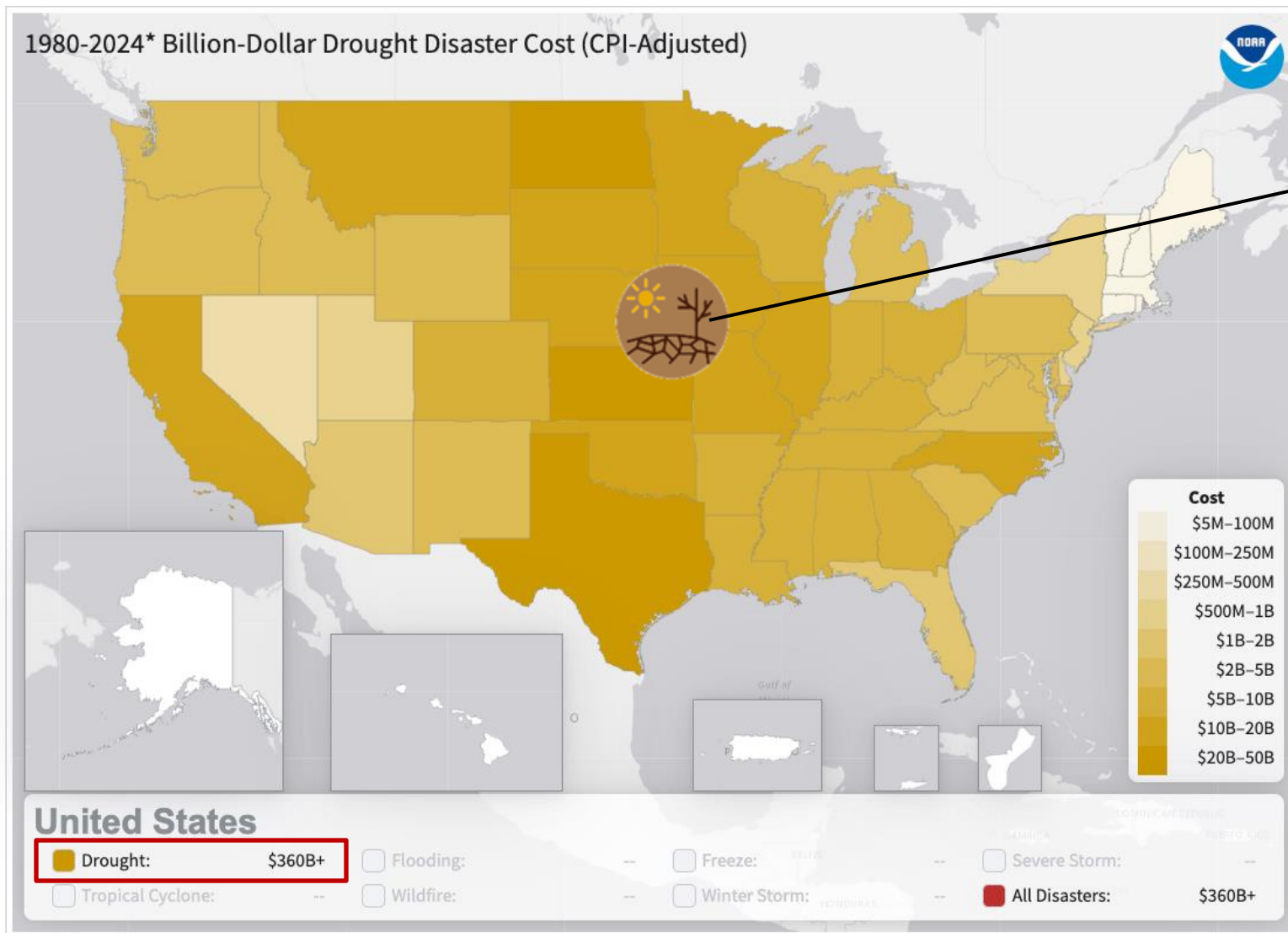
Zhiying Li, Indiana University Bloomington

with Jason Smerdon (Columbia), Richard Seager (Columbia),
Noel Siegert (Columbia), and Justin Mankin (Dartmouth and Columbia)

August 20, 2024

Midwest Drought Early Warning System Partners Meeting

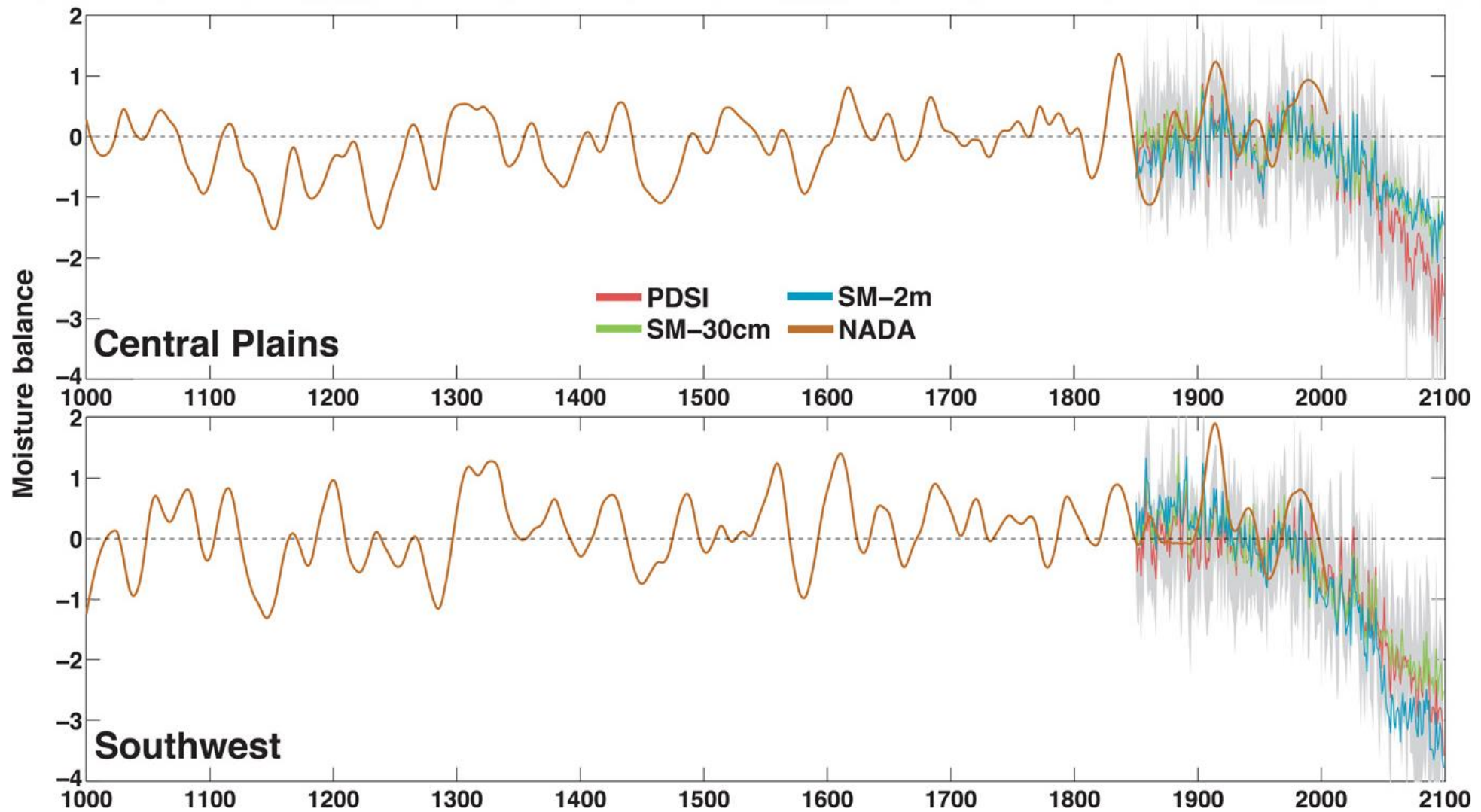
Drought is a costly anomaly



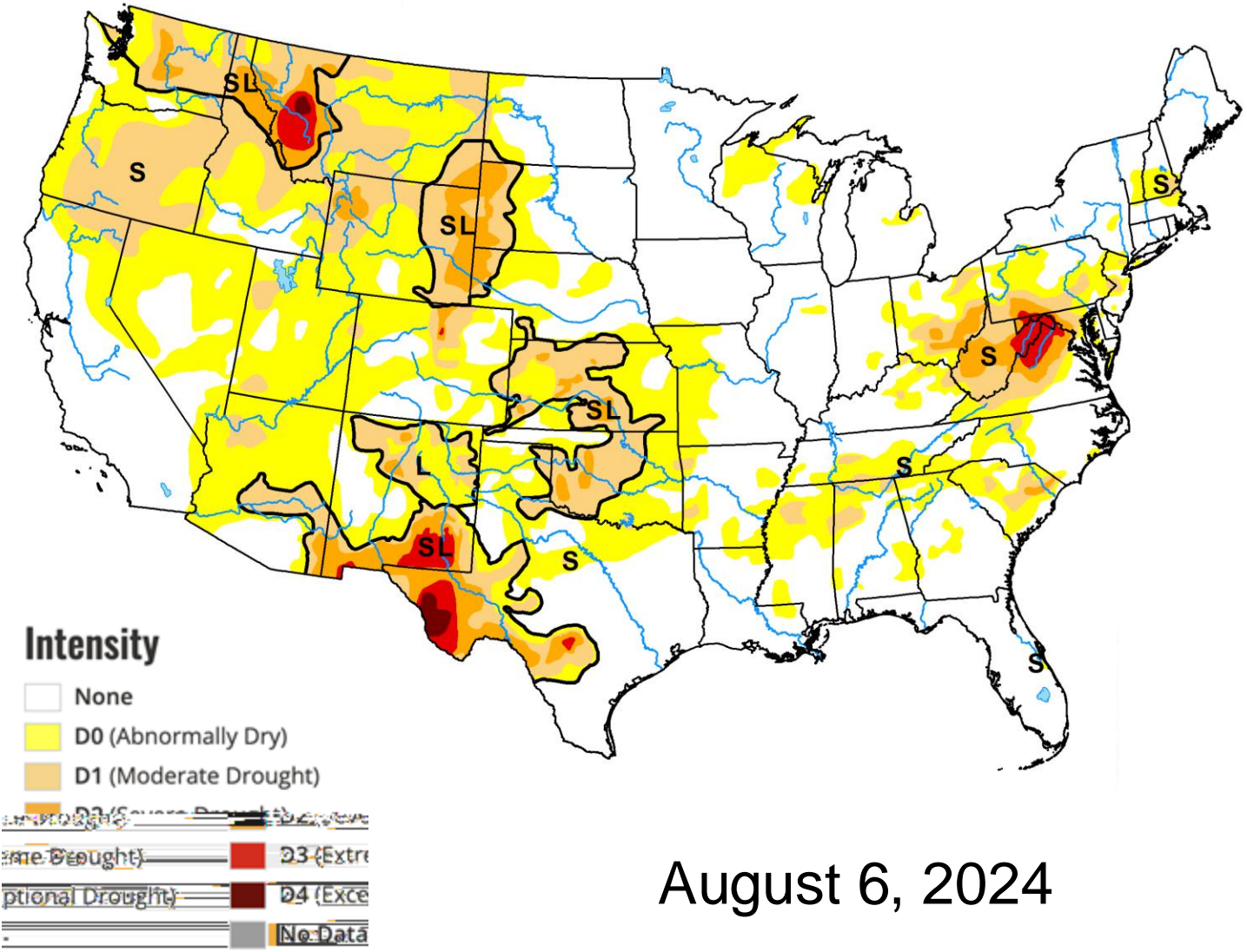
U.S. Drought/Heat Wave 2022

- The most extensive drought in the U.S. since the 1930s.
- Cost: \$41.7 billions
- Deaths: 123

Climate is nonstationary



Does current drought monitoring reflect nonstationary climate?



OUTLINE

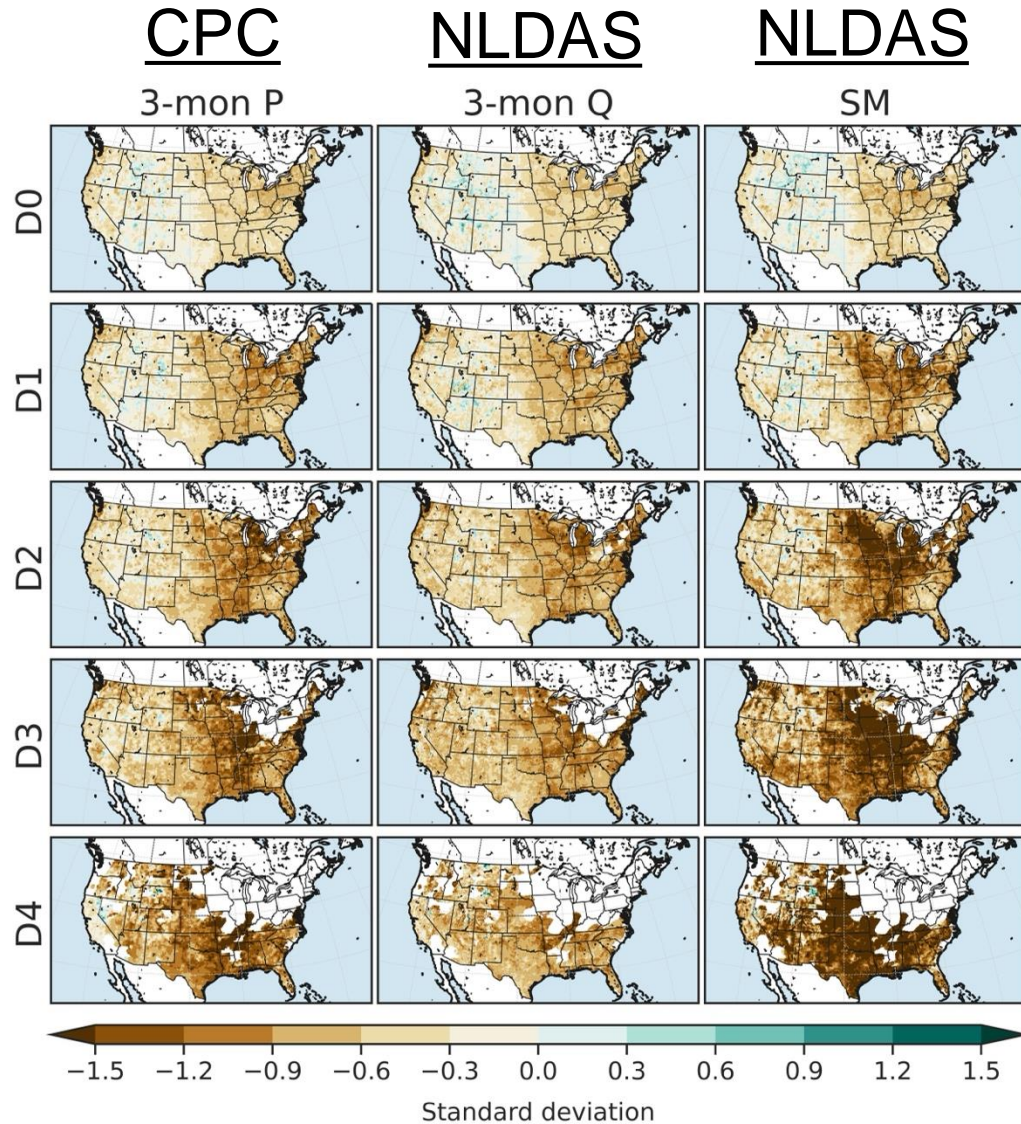
1. USDM is reflecting nonstationary climate, as measured by residence time.
2. The nonstationarity is also reflected in percentile-based thresholds in variables, like soil moisture and vapor pressure deficit.

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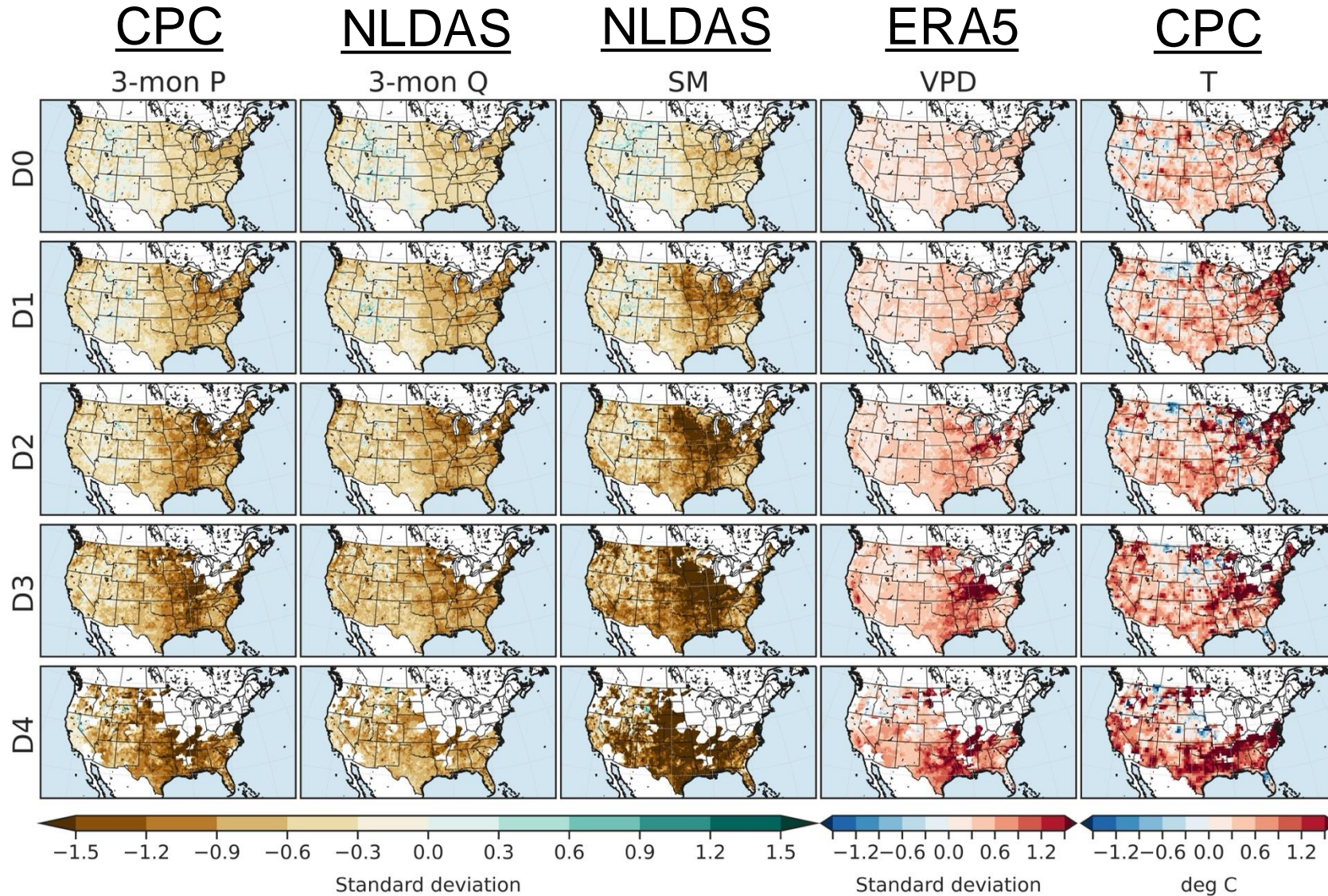
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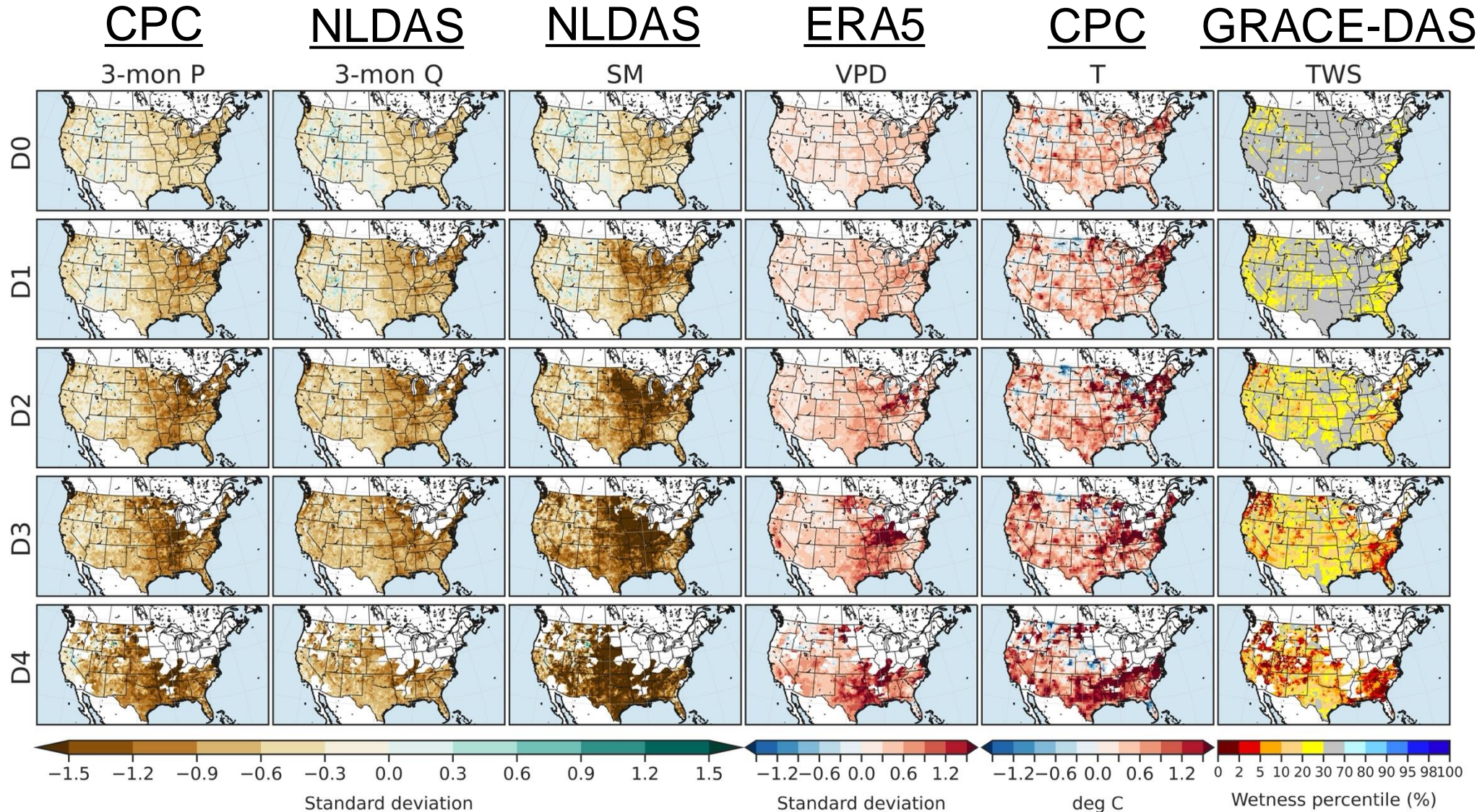
The USDM drought classes are associated with hydroclimatic conditions that are drier or warmer than normal.



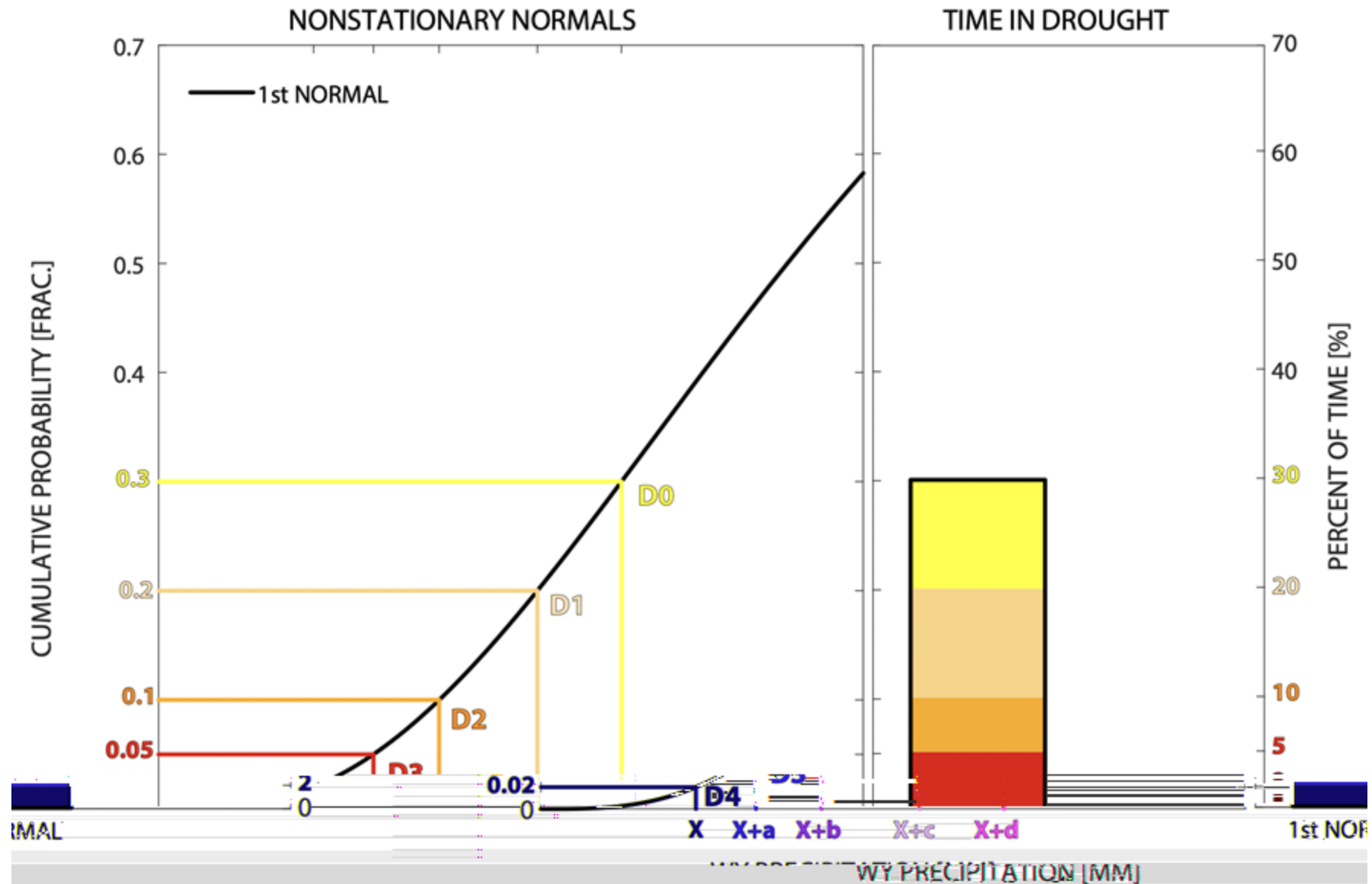
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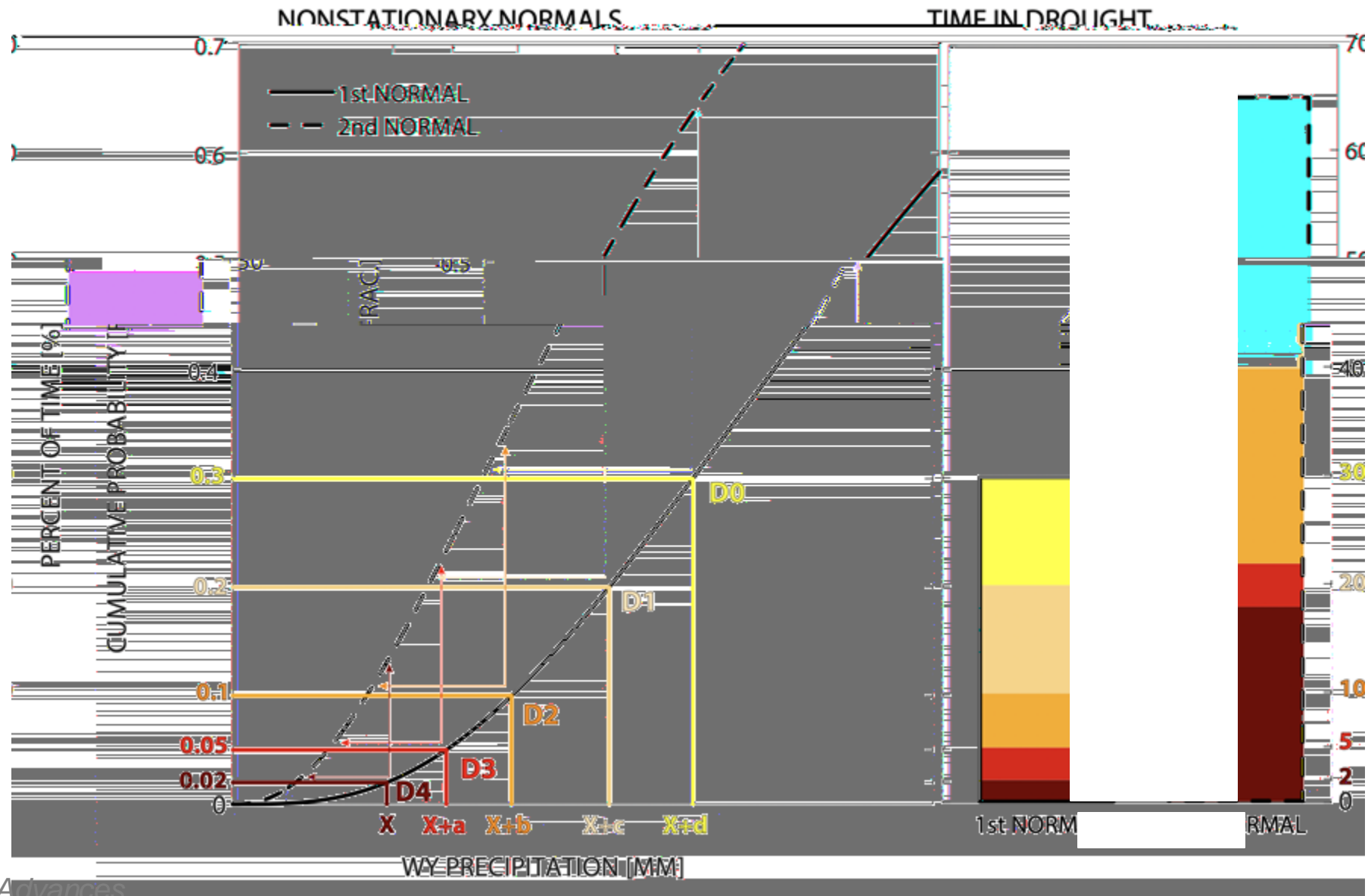
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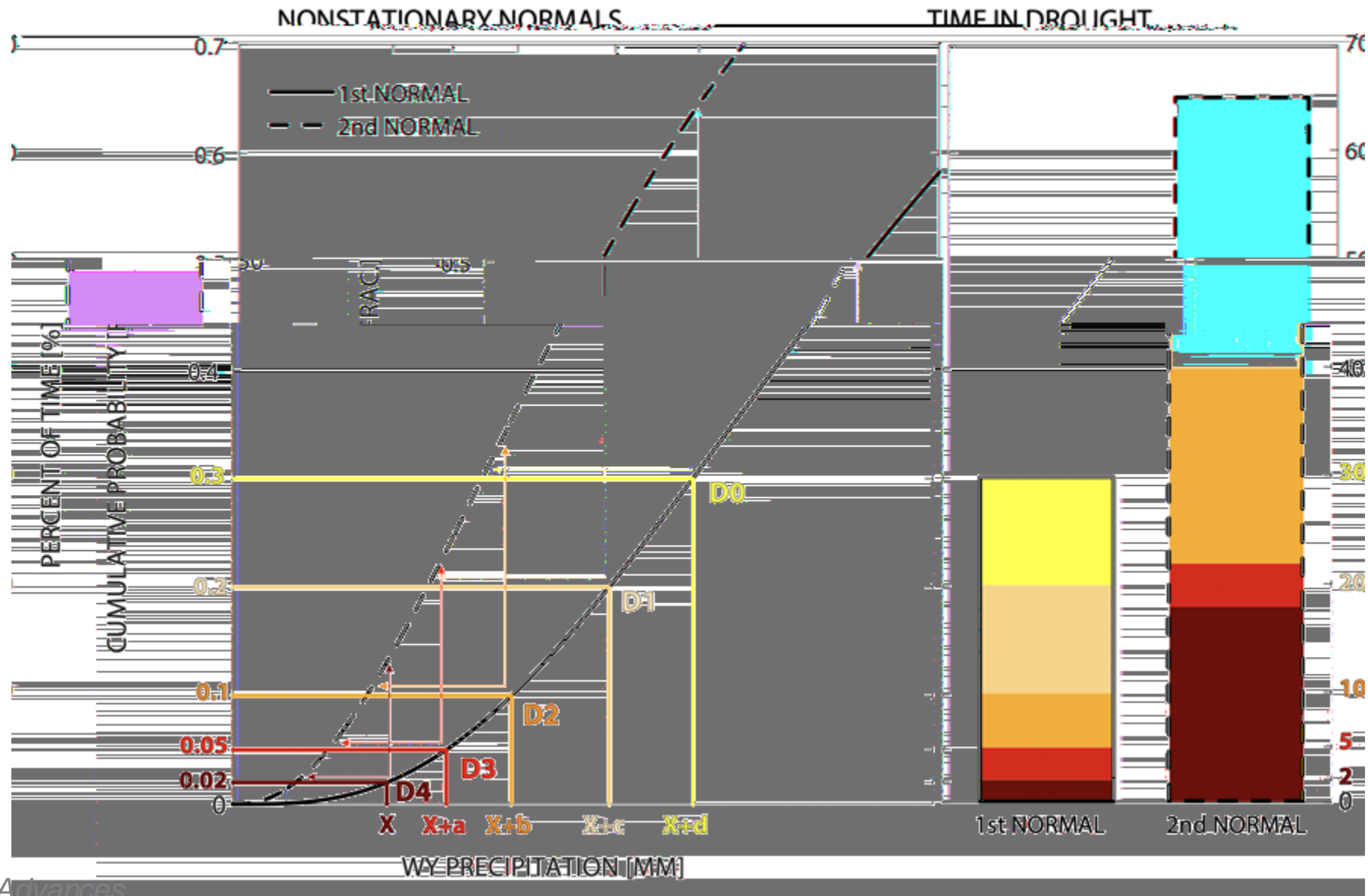
Residence time: percent of time in drought



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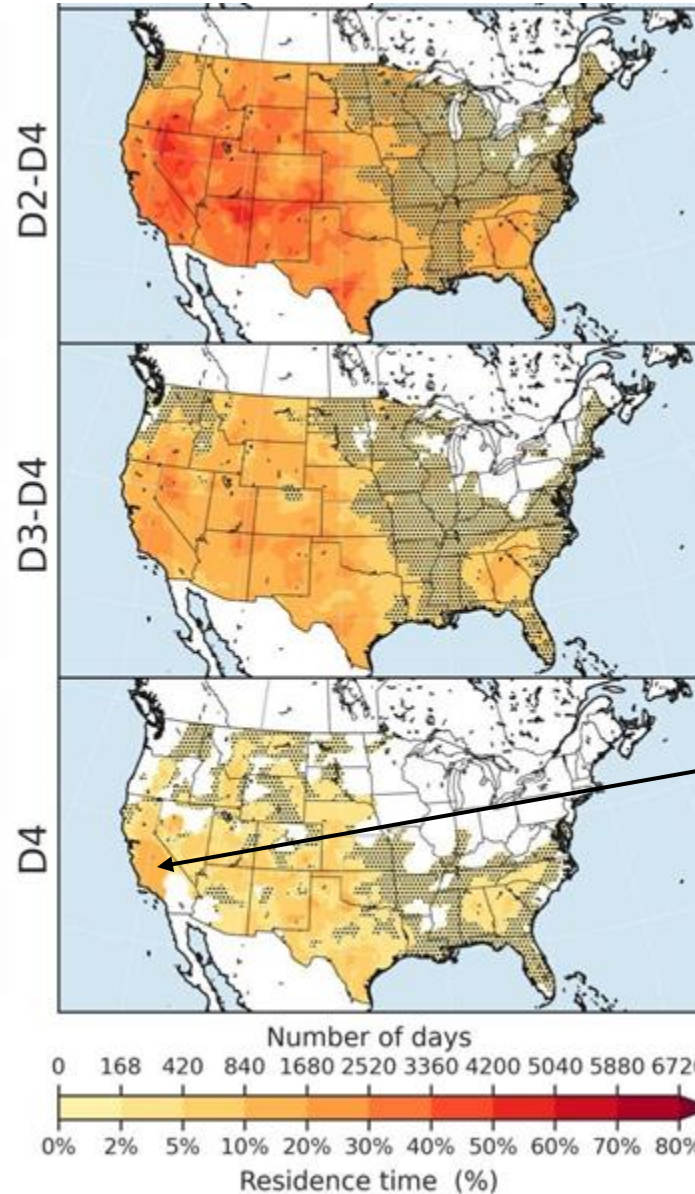
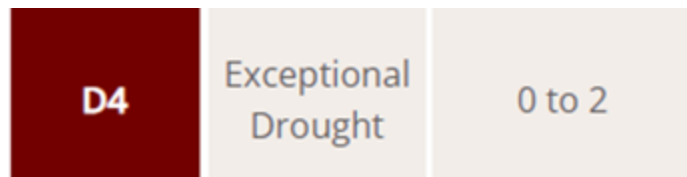
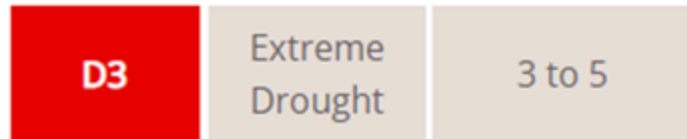


Residence time: percent of time in drought



USDM is reflecting climate nonstationarity.

USDM percentile guideline

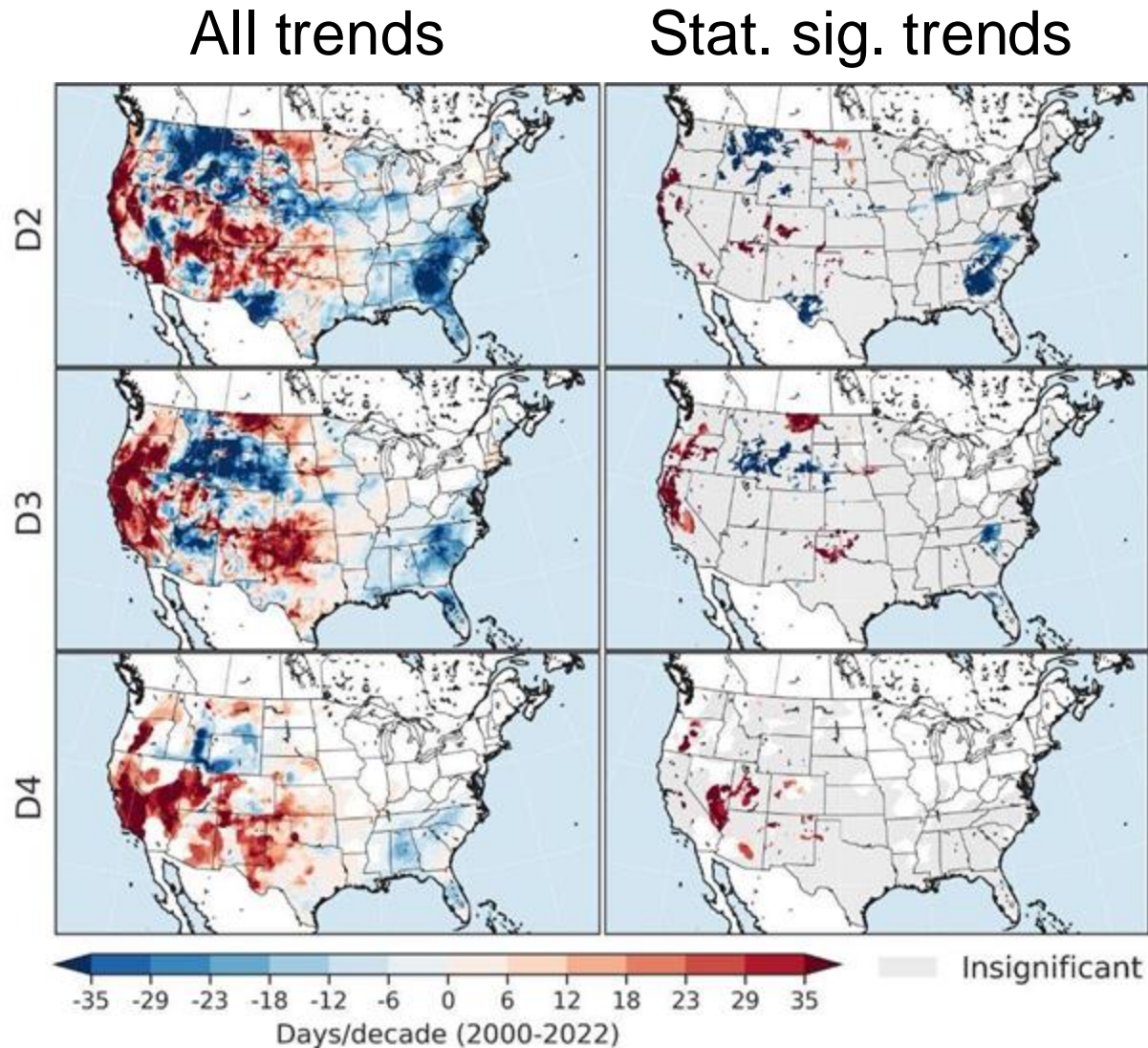


- **Spatial variation:**
Time length: western > eastern

- **Compared with guideline:**
Residence time in >50% D4: > 2%

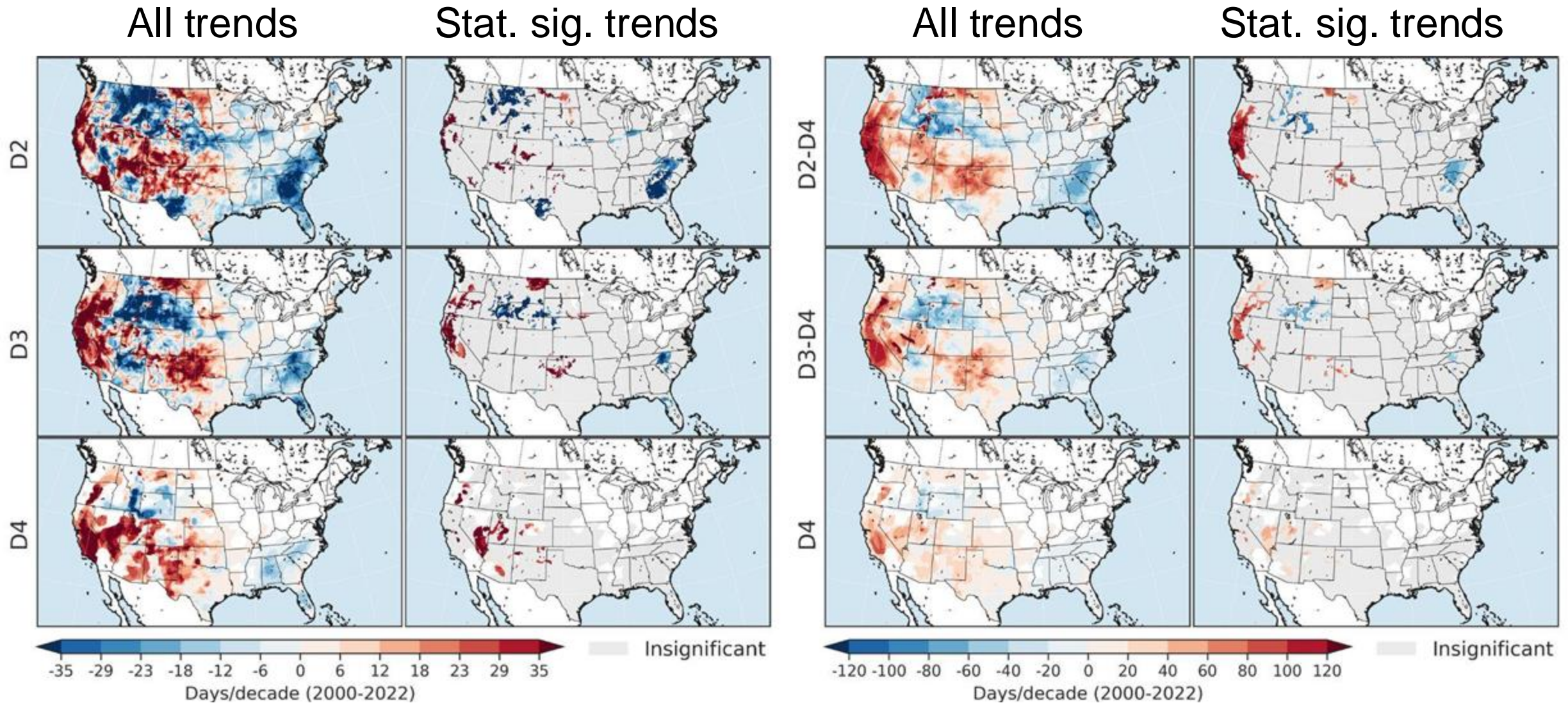
>18% residence time:
One out of every six years is
“exceptional”?

Historical trends in the USDM



- **D2/D3:** sig. decreasing in Idaho, Wyoming, western Montana, Georgia, and the Carolinas.
- **D4:** sig. increasing in Nevada, Utah, Arizona, Colorado, and New Mexico

Historical trends in the USDM



OUTLINE

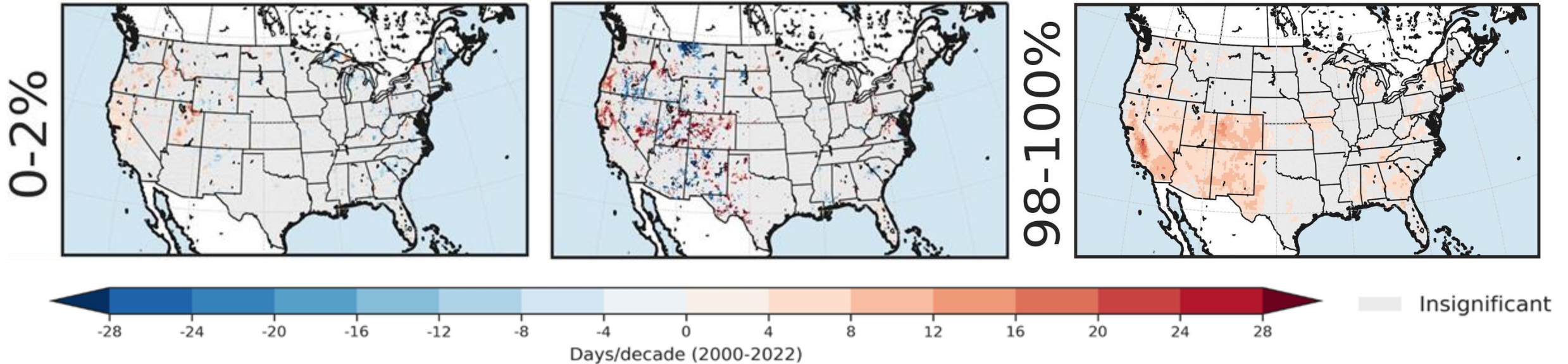
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Trends in residence time of associated geophysical conditions

Precipitation

Soil moisture

Vapor pressure deficit

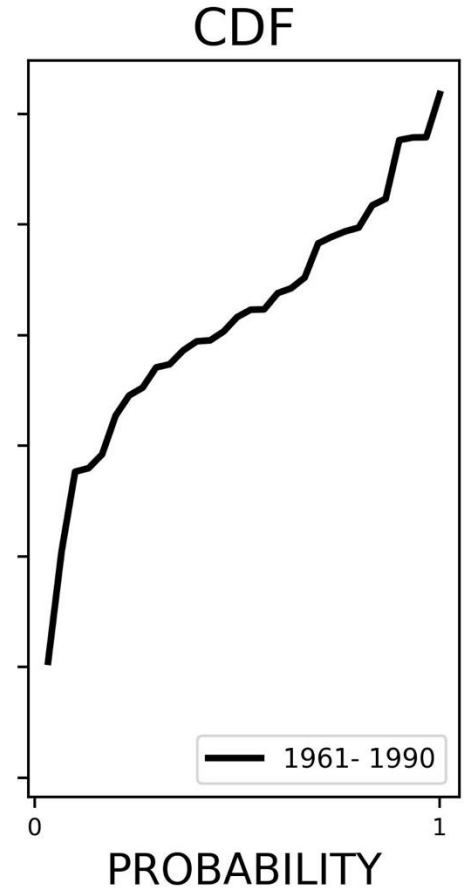
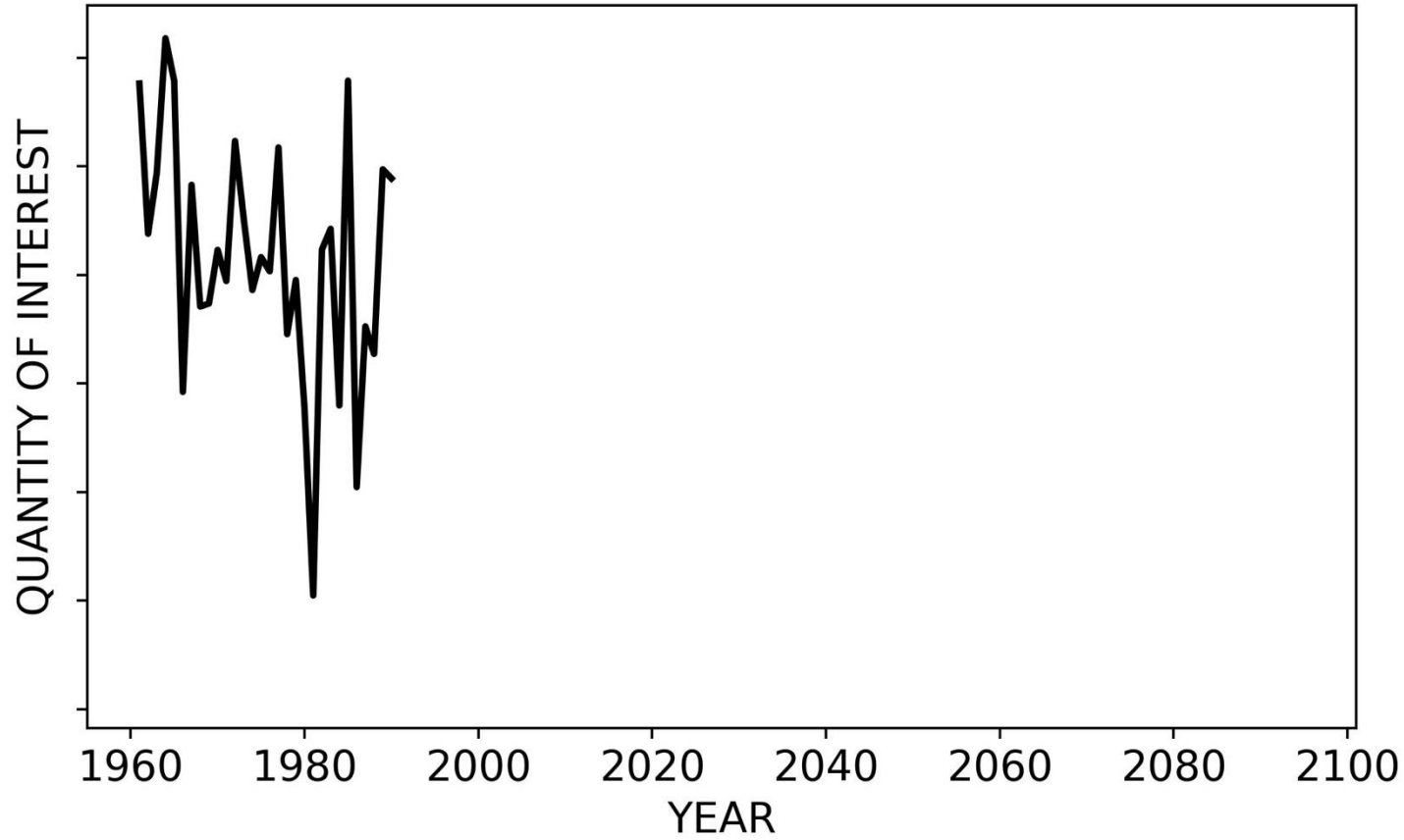


- Trends in the majority of the areas is statistically significantly **increasing**.
- Trends exhibit in the highest percentiles of **temperature-driven** variables.

Will climate cause a shift in U.S. drought classification?

Time of Emergence (ToE): the year when the magnitude associated with a wetter percentile is permanently below the magnitude associated with a drier percentile in the baseline period (1961-1990).

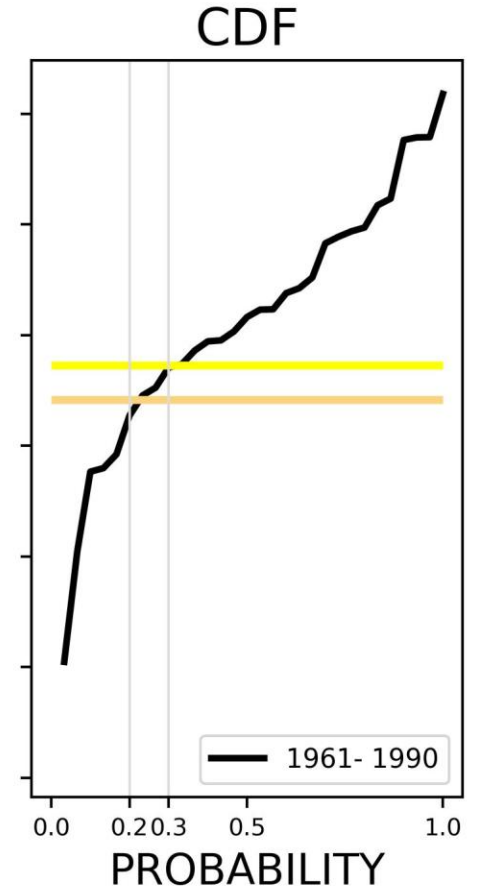
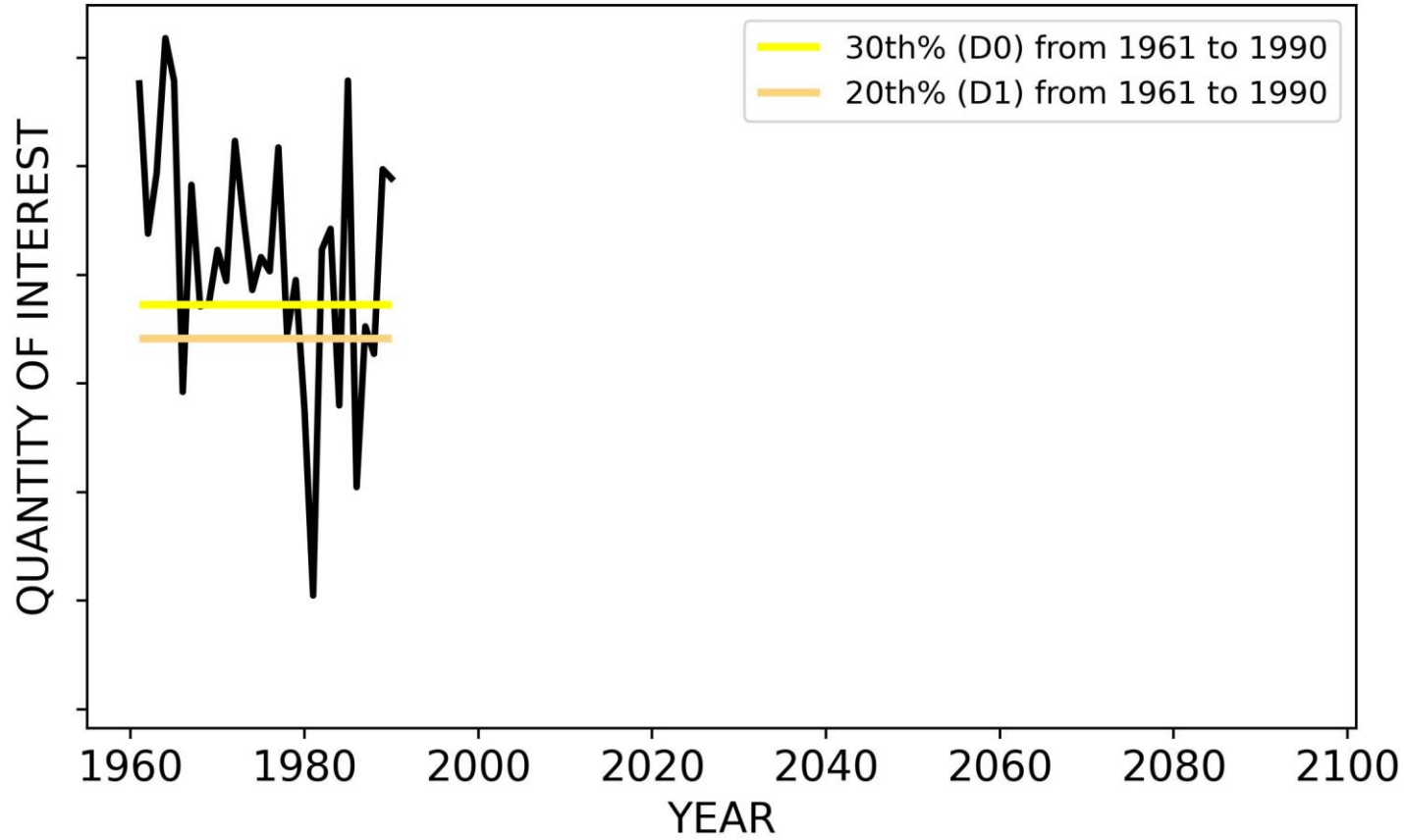
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D0	21 to 30
D1	11 to 20
D2	6 to 10
D3	3 to 5
D4	0 to 2



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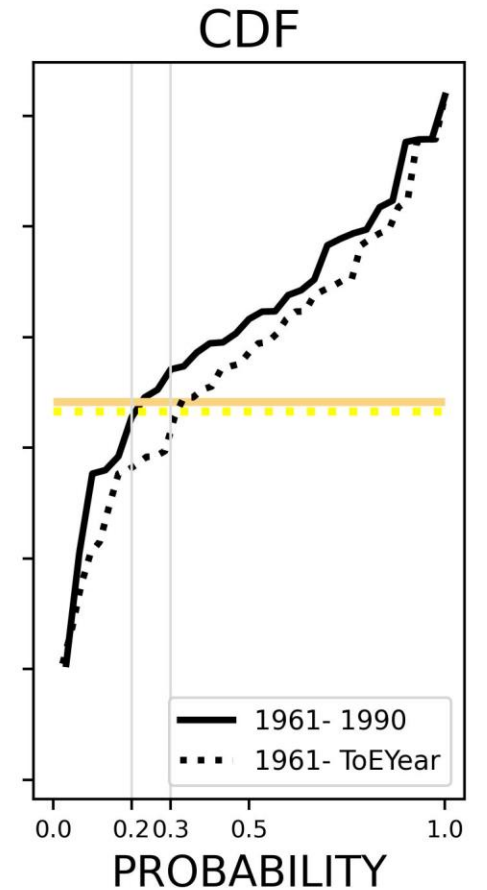
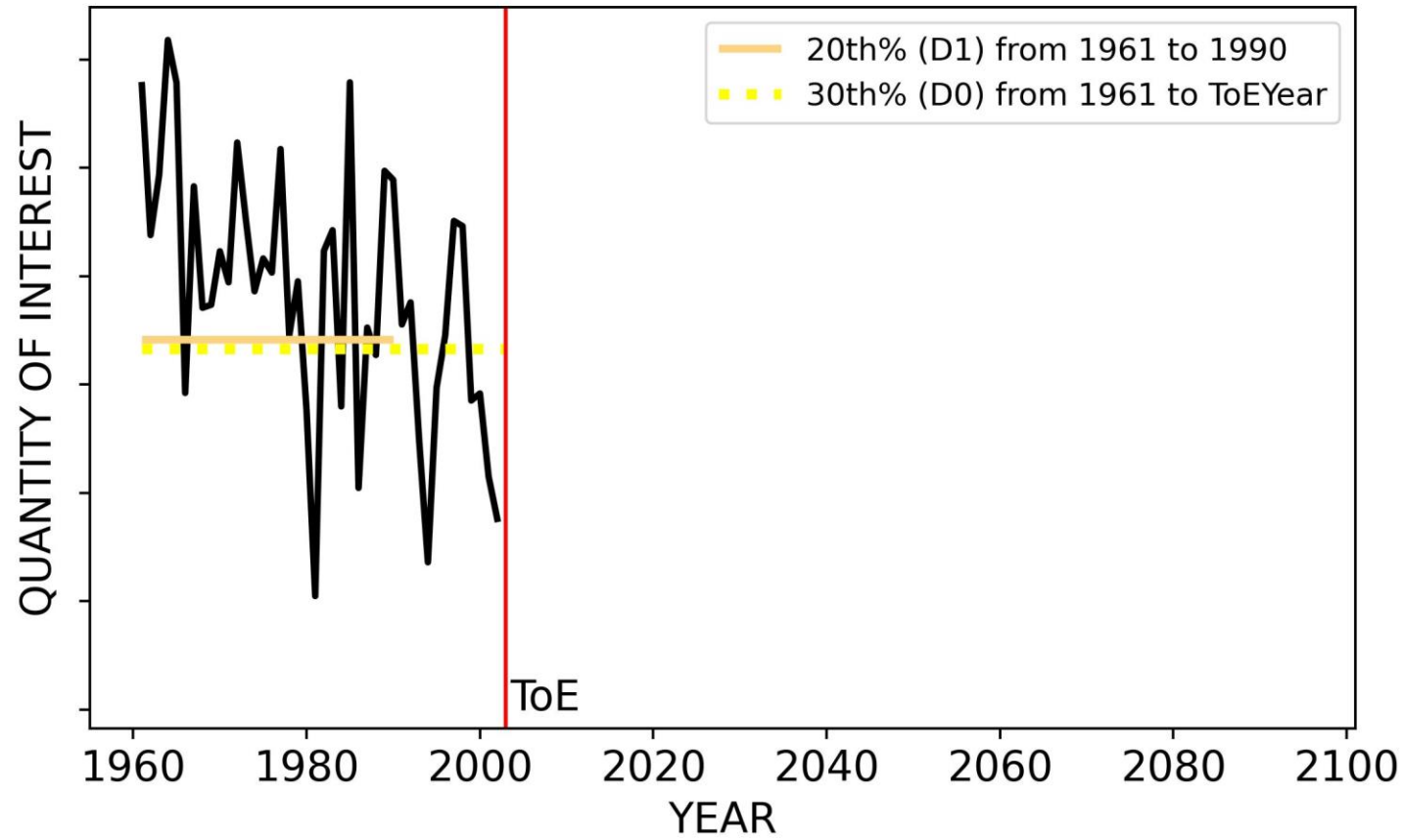
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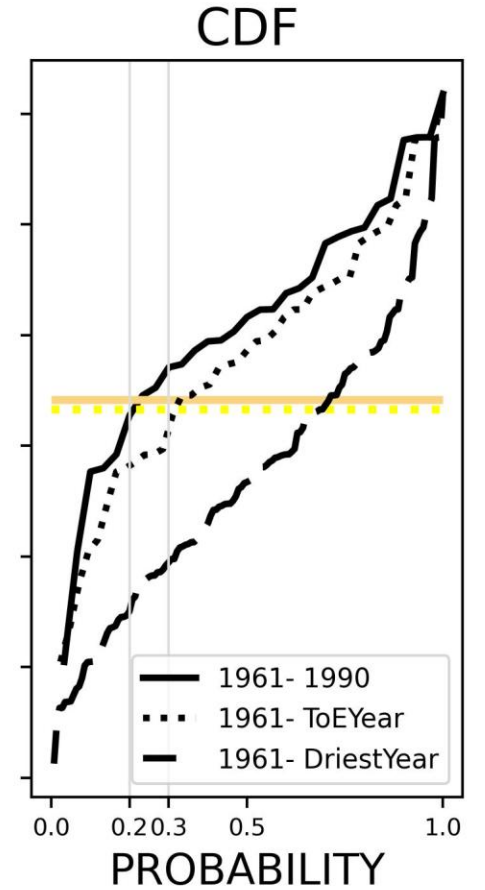
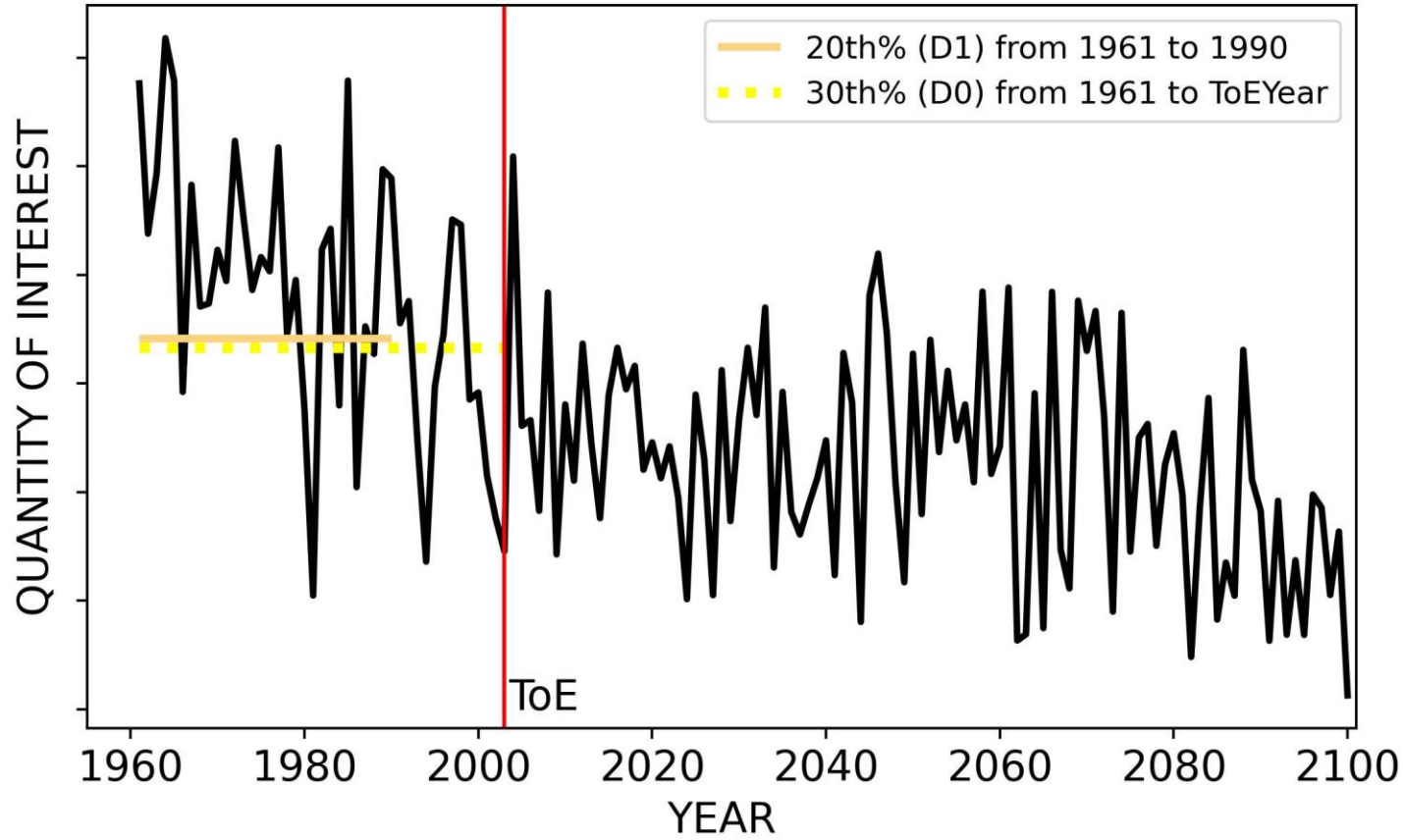
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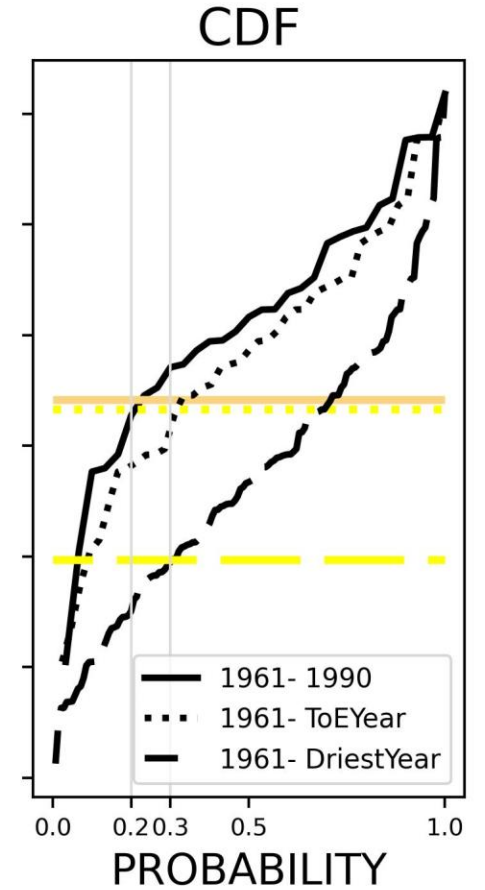
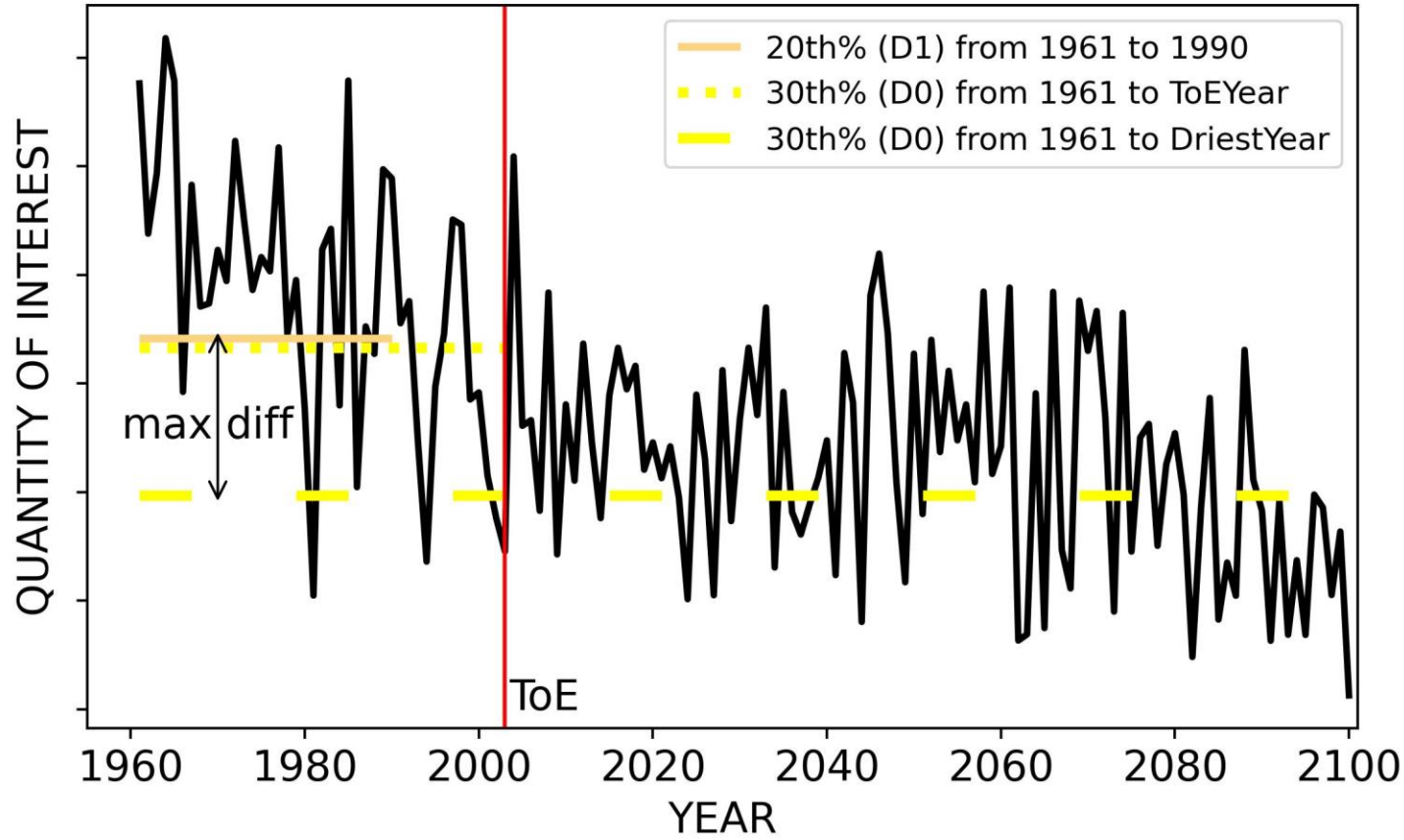
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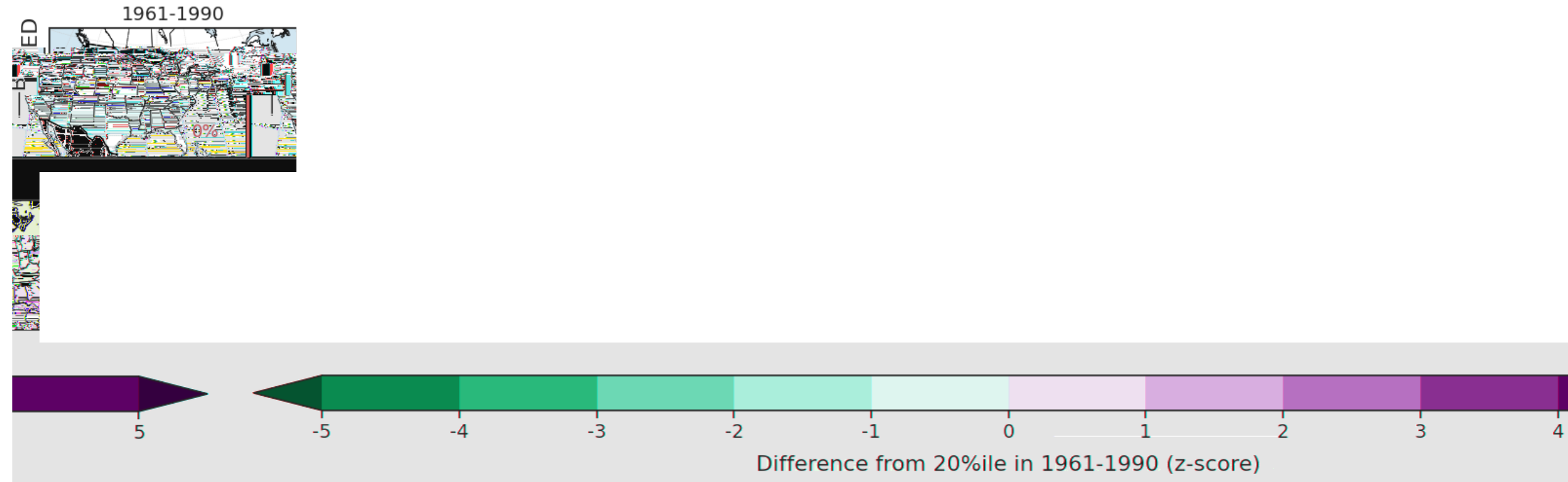
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Climate Trends Force Step Changes in U.S. Drought Classifications

Data source: Multi-model ensemble mean from 21 CMIP6 models

30% DRY DIFFERENCE IN 1-METER SOIL MOISTURE COMPARED TO 20% DRY FROM 1961-1990

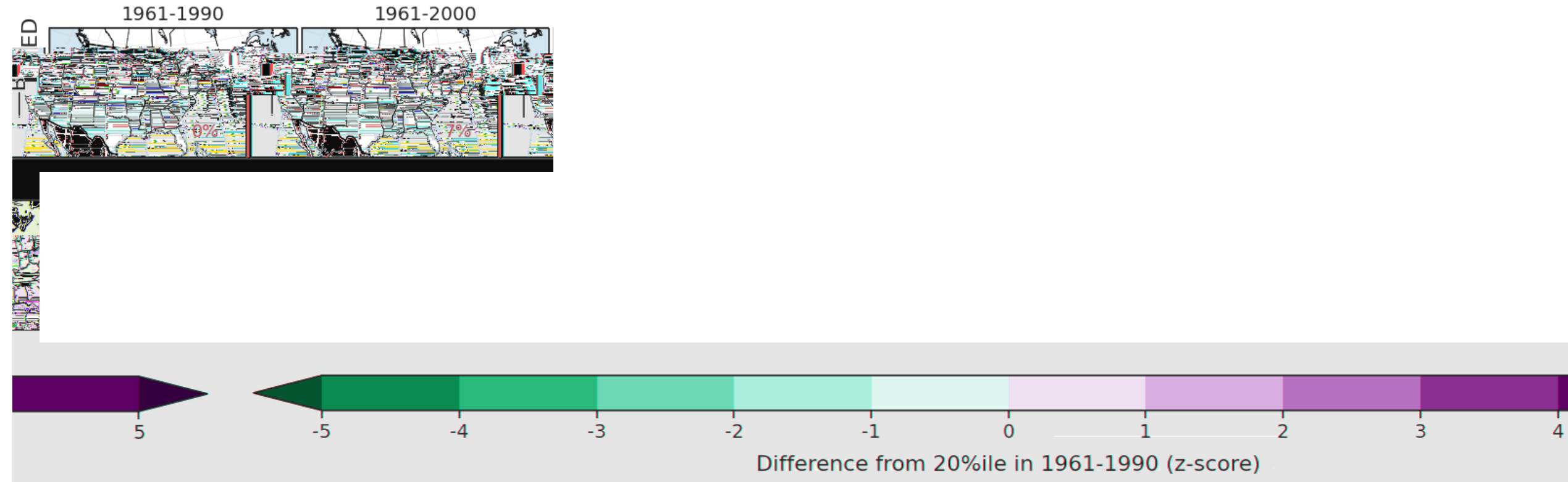


The red numbers in the lower right are the percentage of dry difference in CONUS.

Climate Trends Force Step Changes in U.S. Drought Classifications

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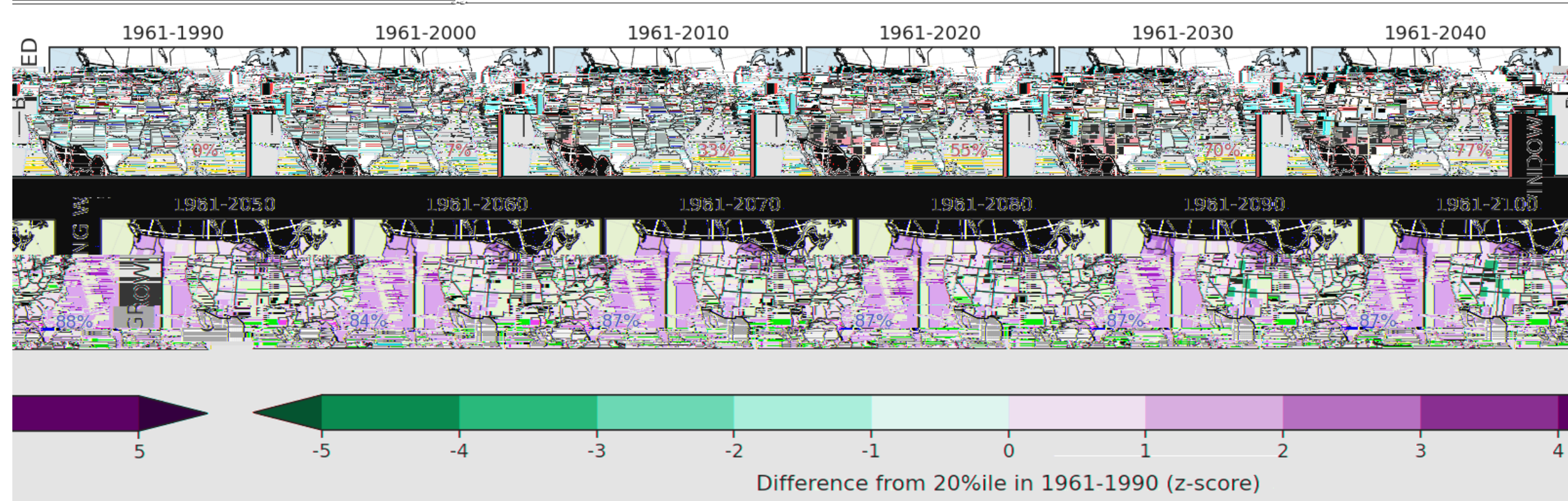


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Lower soil moisture magnitude associated with a wetter percentile.

30%ILE IIA 1-METER SOIL MOISTURE COMPARED TO 20%ILE FROM 1961-1990



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Conclusions

- USDM is reflecting nonstationary climate, as measured by residence time.
- The nonstationarity is also reflected in percentile-based thresholds in variables, like soil moisture and VPD.
- We raise critical questions about whether and how drought diagnosis, classification, and monitoring should address long-term intervals of wet and dry periods or trends.

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Thank you for your attention!

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