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

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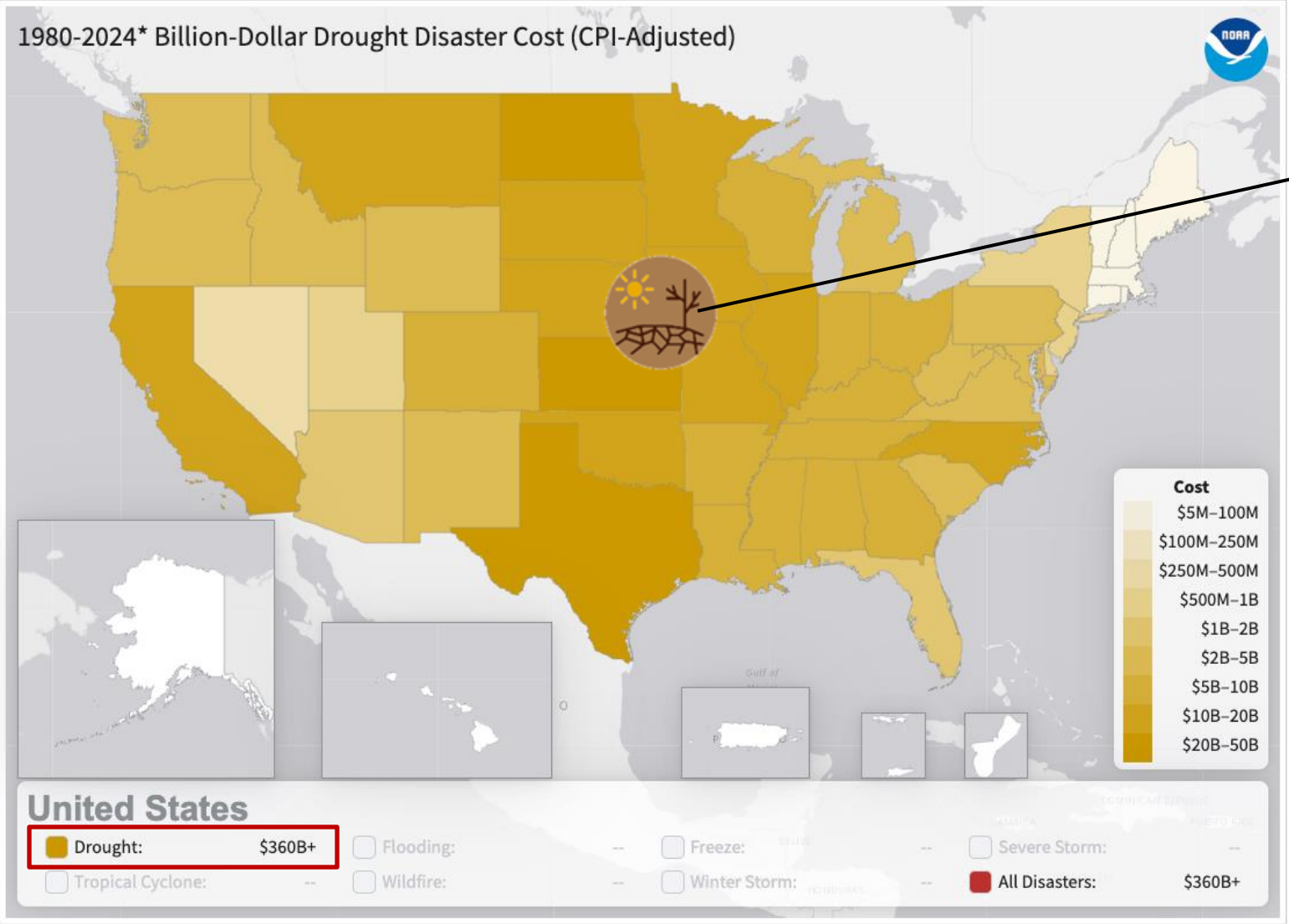
Noel Siegert (Columbia), and Justin Mankin (Dartmouth and Columbia)

August 20, 2024

Midwest Drought Early Warning System Partners Meeting

Drought is a costly anomaly



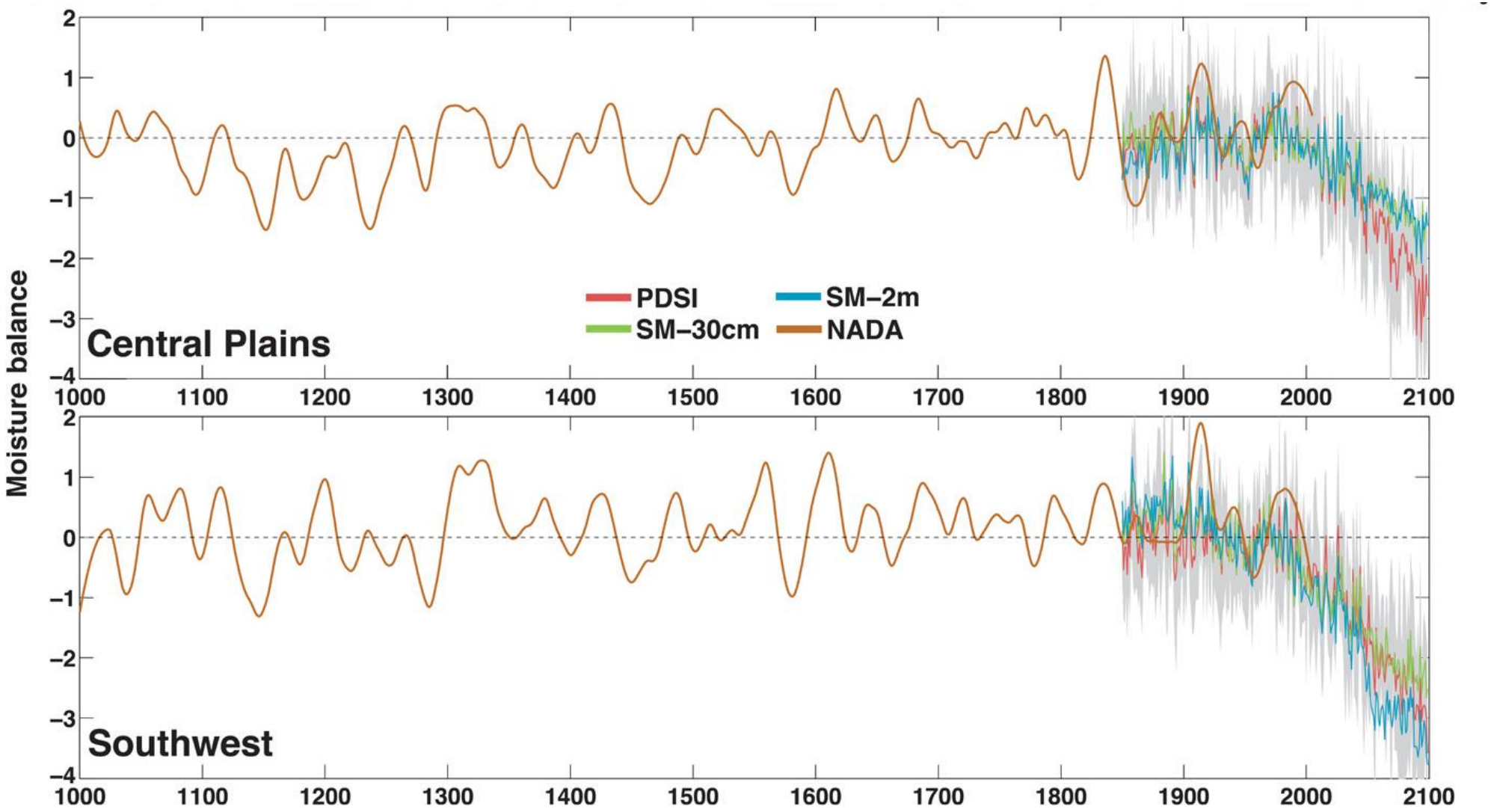
U.S. Drought/Heat Wave 2012

- The most extensive drought in the U.S. since the 1930s.

- Cost: $41.7 billions
- Deaths: 123

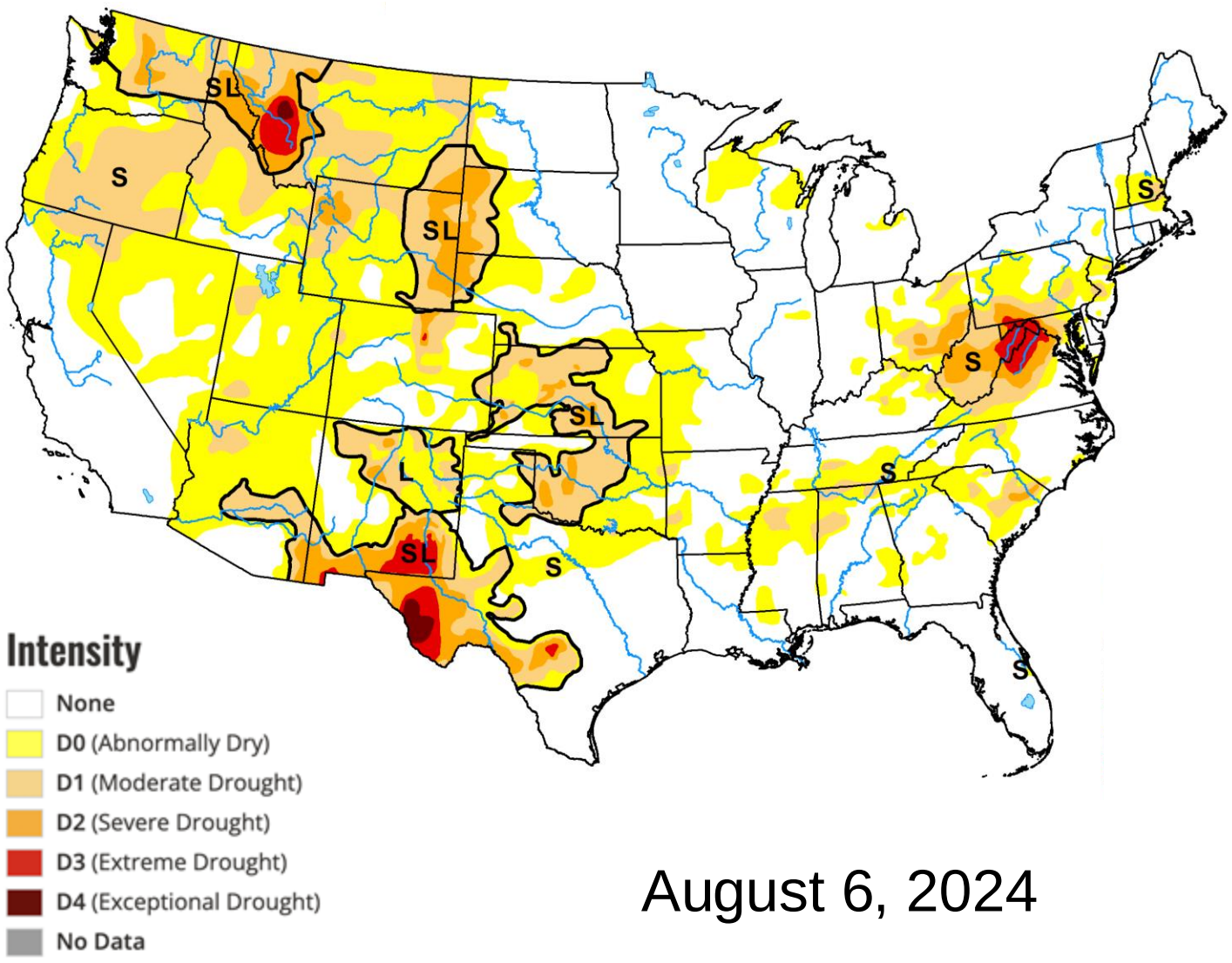
Source: NOAA NCEI U.S. Billion-Dollar Weather and Climate Disasters

Climate is nonstationary



Cook et al. (2015)

Does current drought monitoring reflect nonstationary climate?



August 6, 2024

https://droughtmonitor.unl.edu/

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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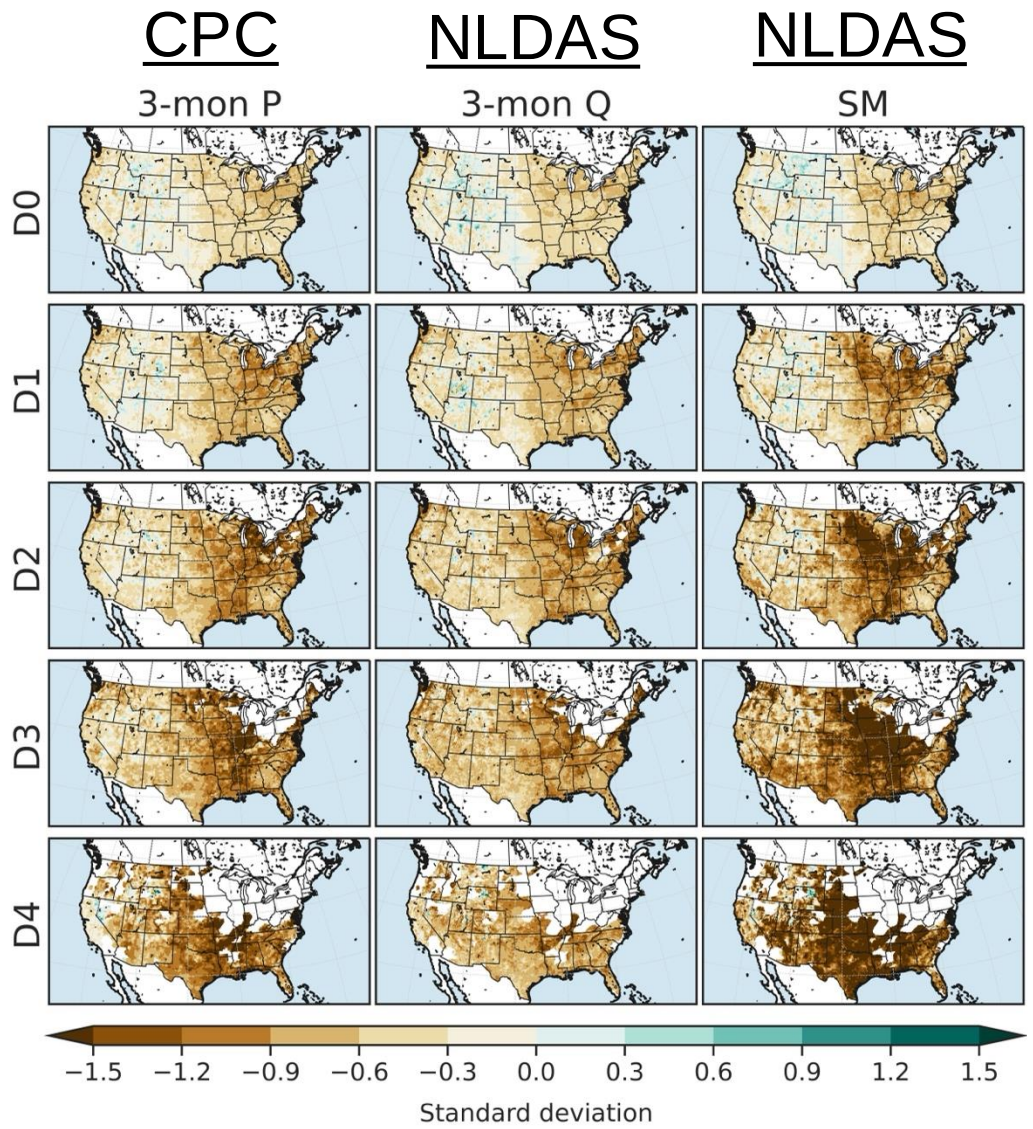

Li et al., 2024, *AGU Advances*

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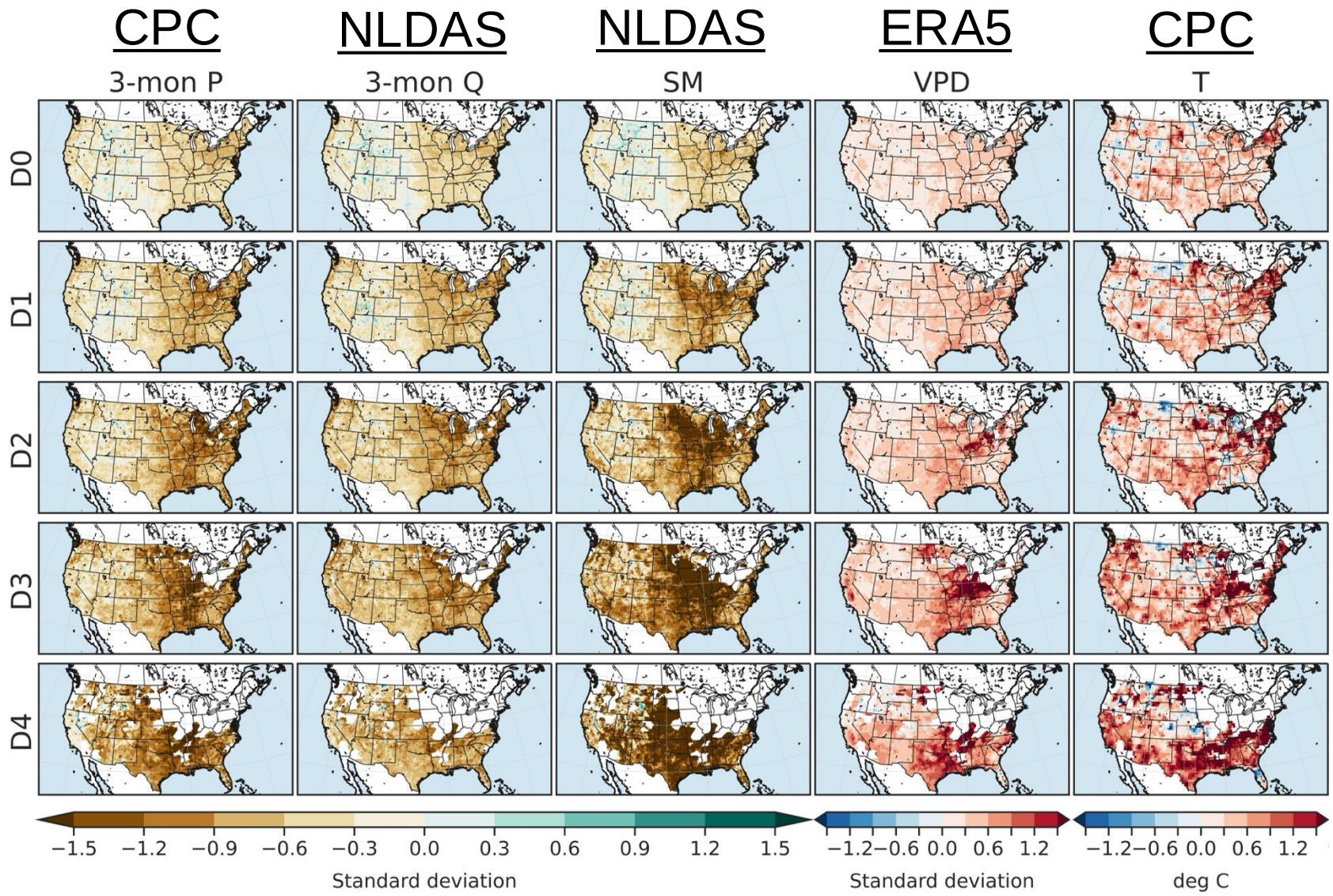

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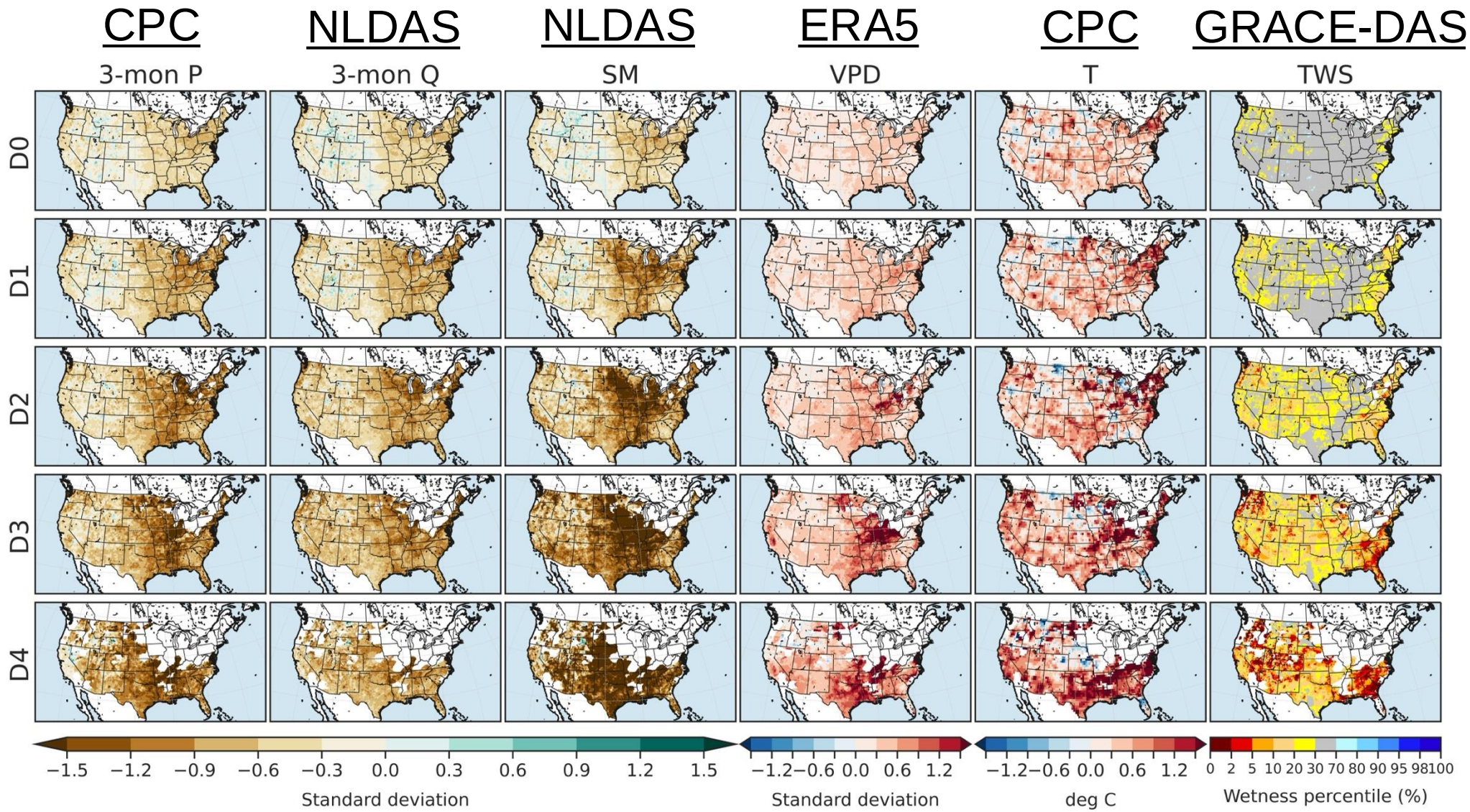
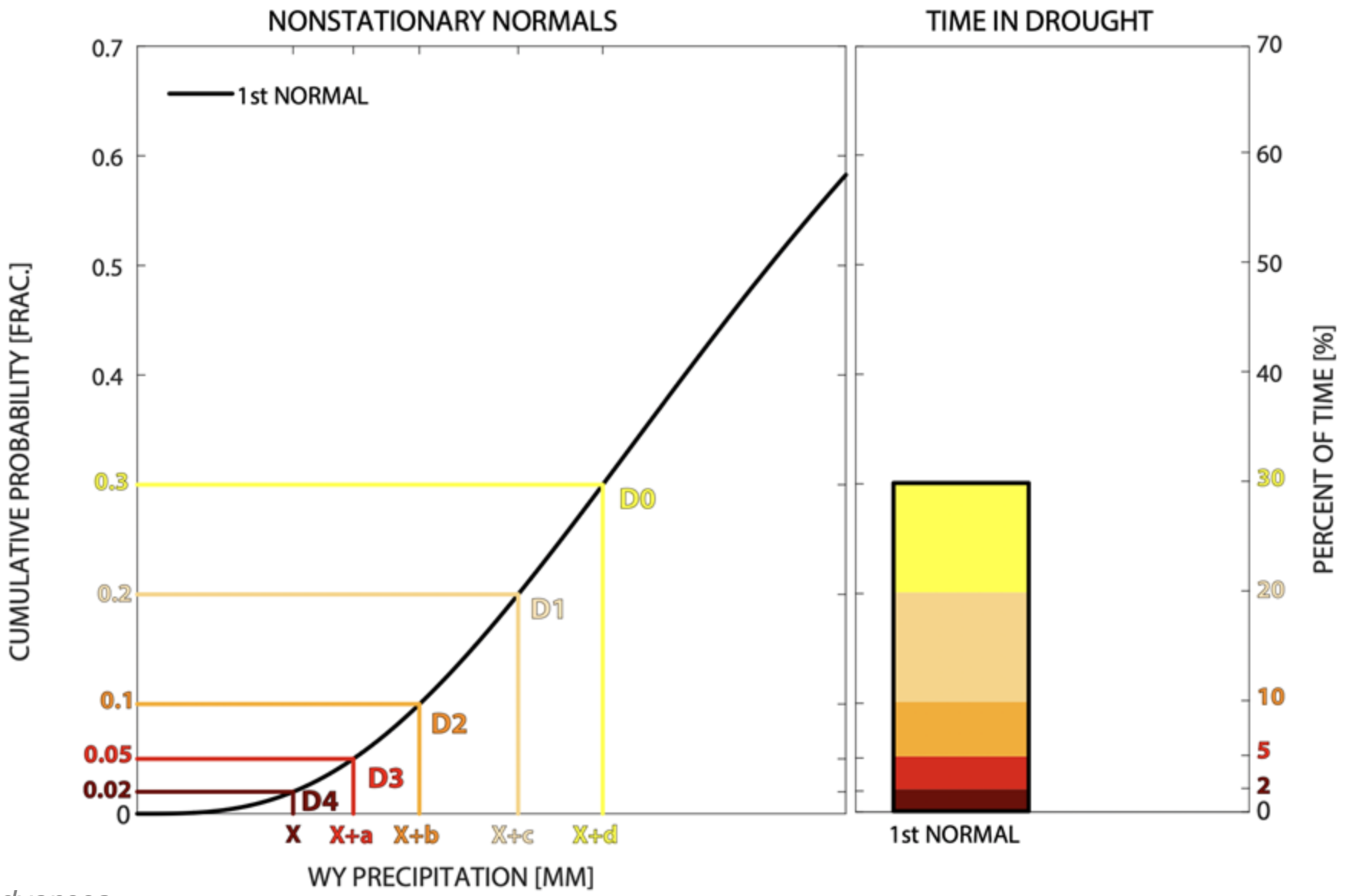


Li et al., 2024, *AGU Advances*

Residence time: percent of time in drought



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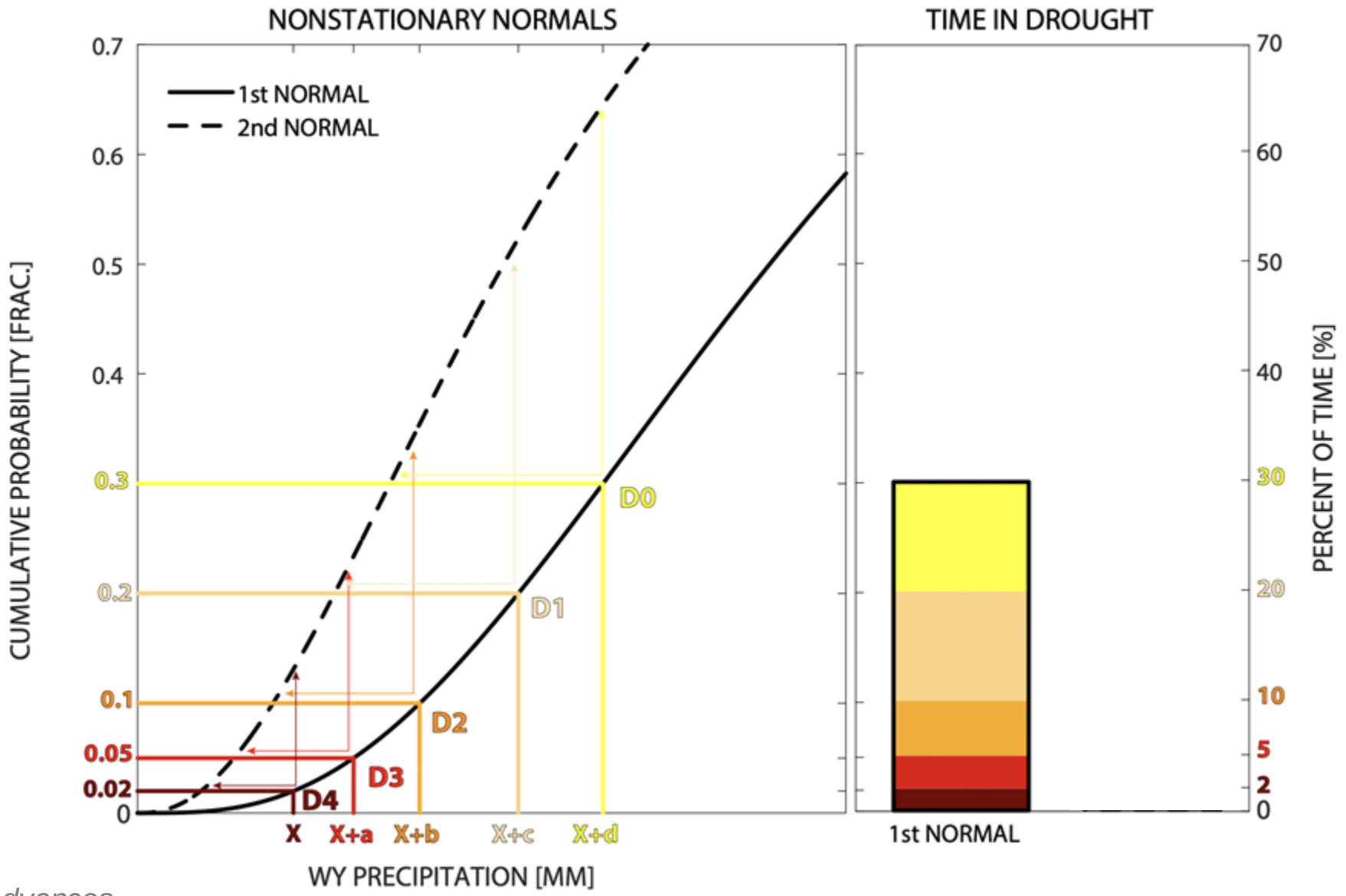

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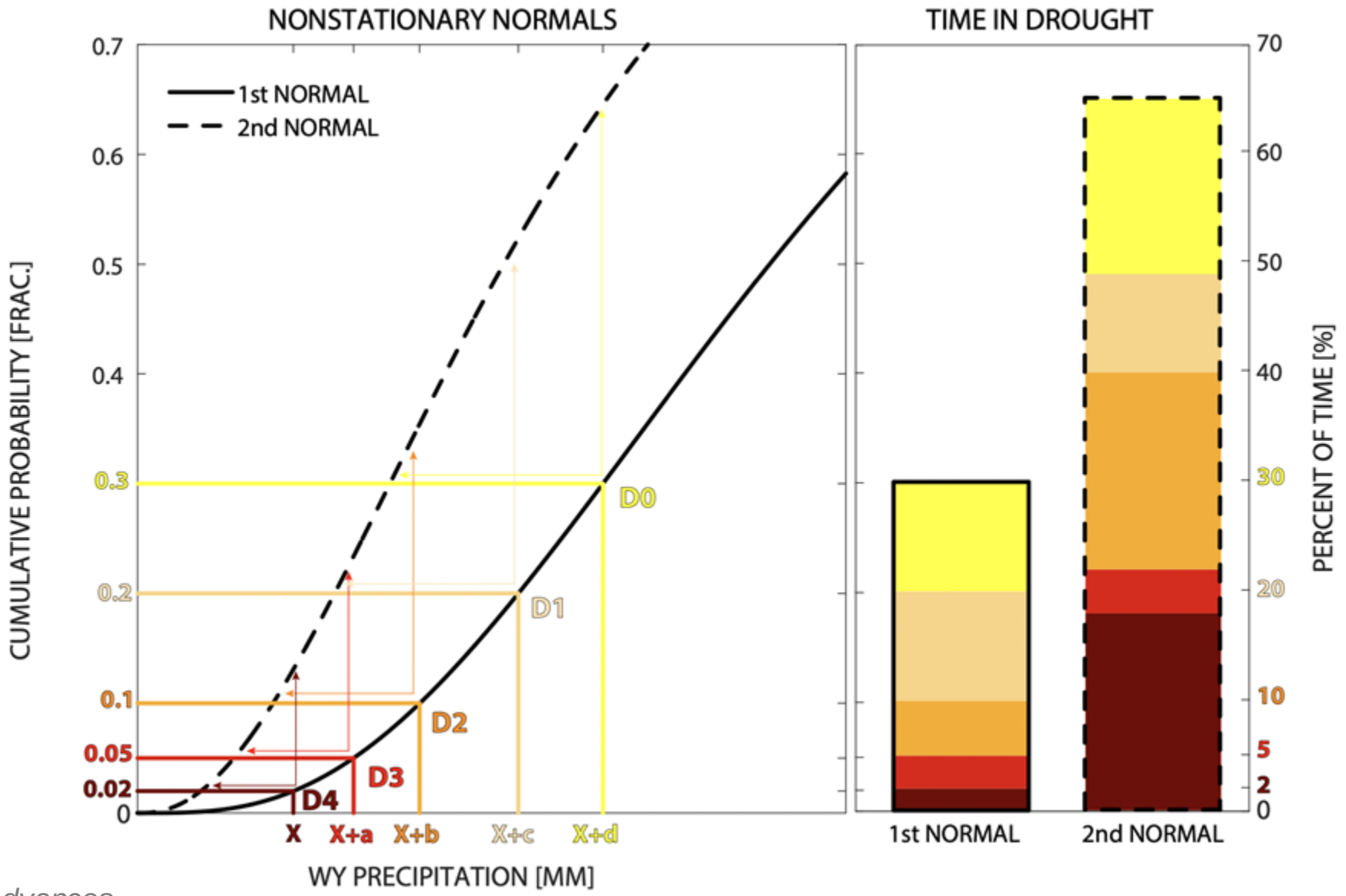
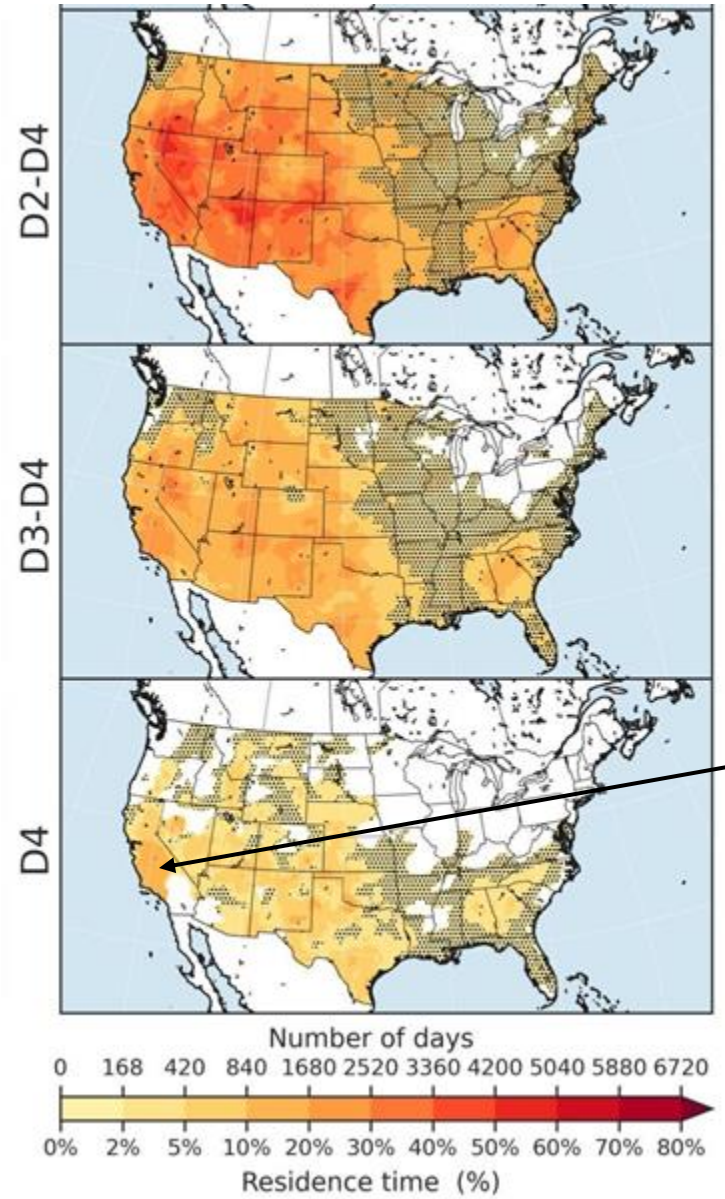


Li et al., 2024, *AGU Advances*

USDM is reflecting climate nonstationarity.

USDM
percentile guideline

D2	Severe Drought	6 to 10
D3	Extreme Drought	3 to 5
D4	Exceptional Drought	0 to 2



- **Spatial variation:**

Time length: western > eastern

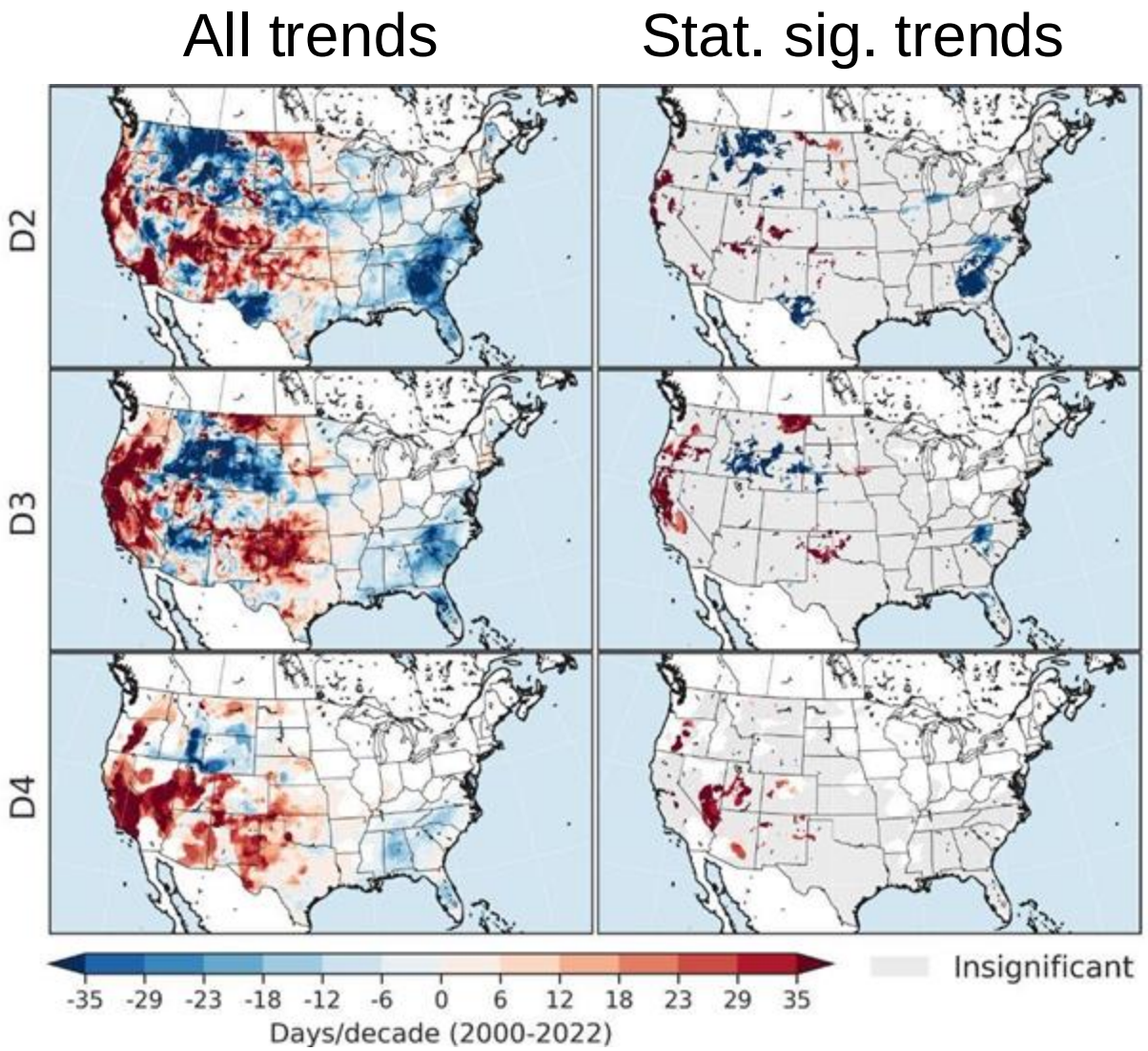
- **Compared with guideline:**

Residence time in >50% D4: > 2%

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

Li et al., 2024, *AGU Advances*

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

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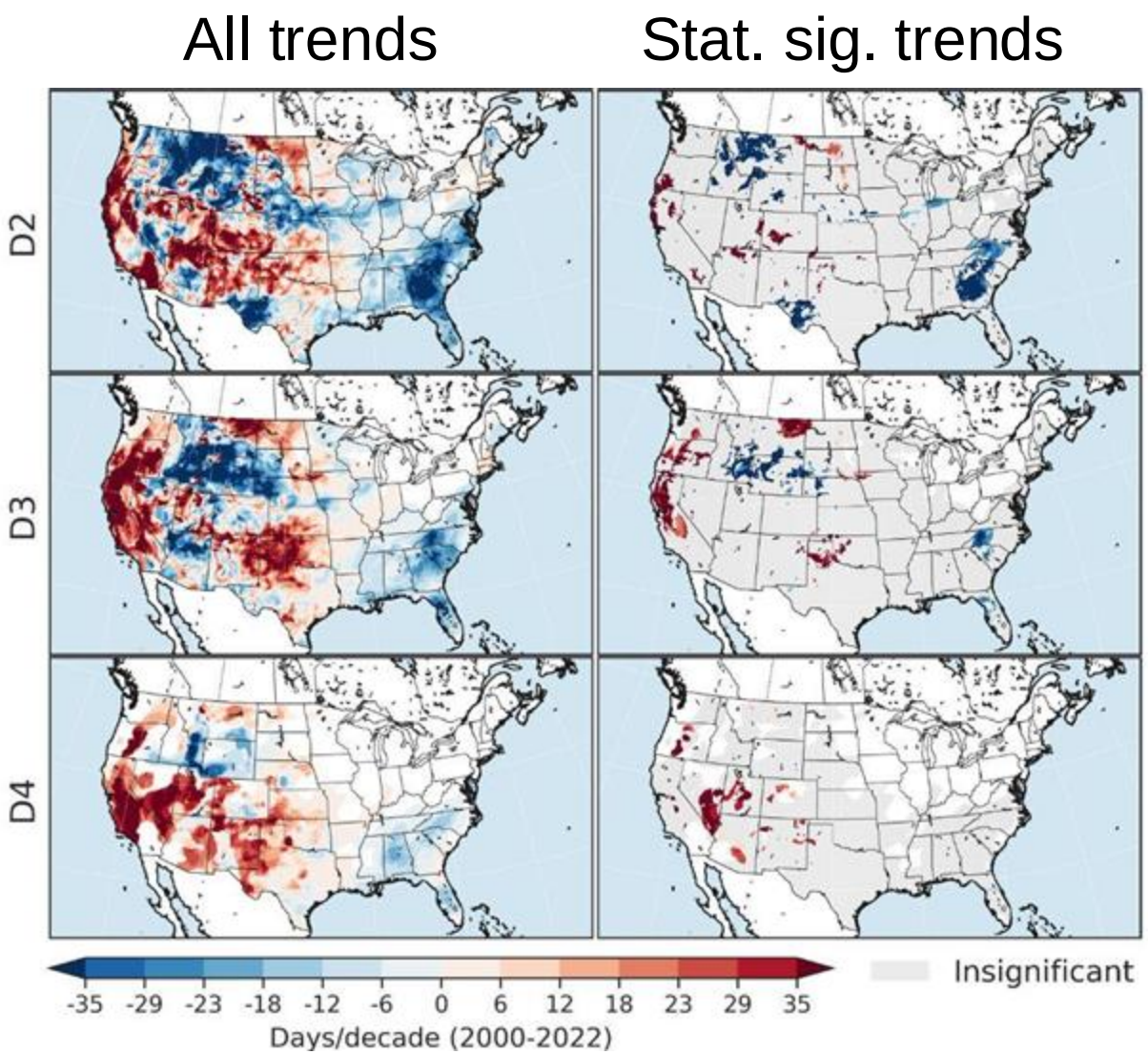

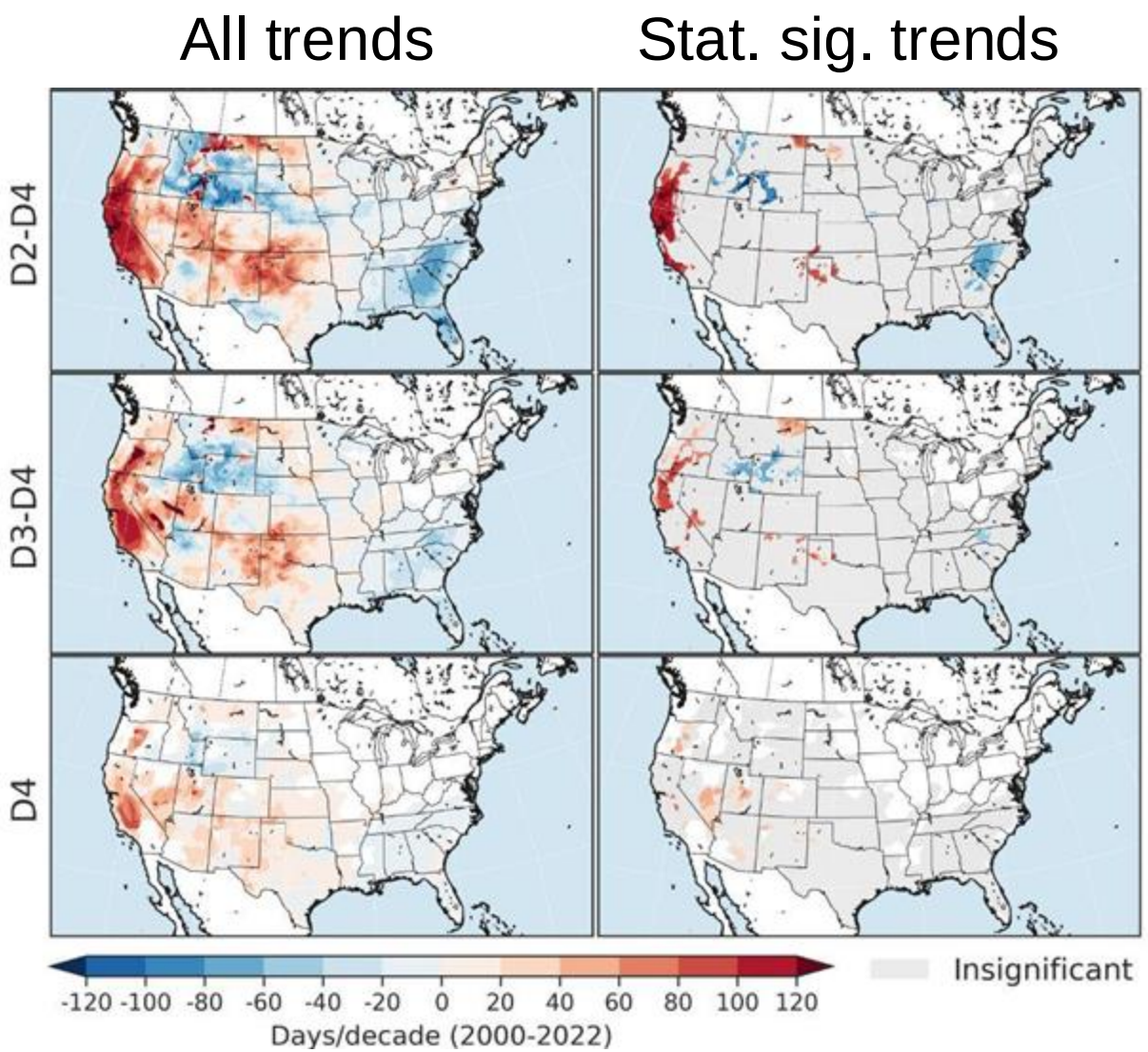

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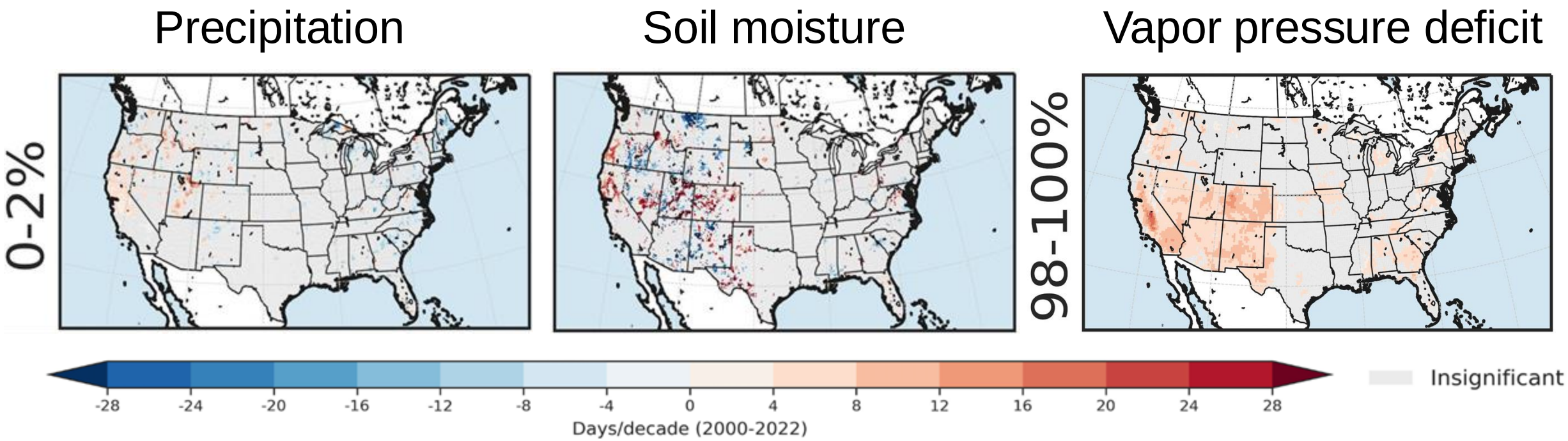
Trends in residence time of associated geophysical conditions



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

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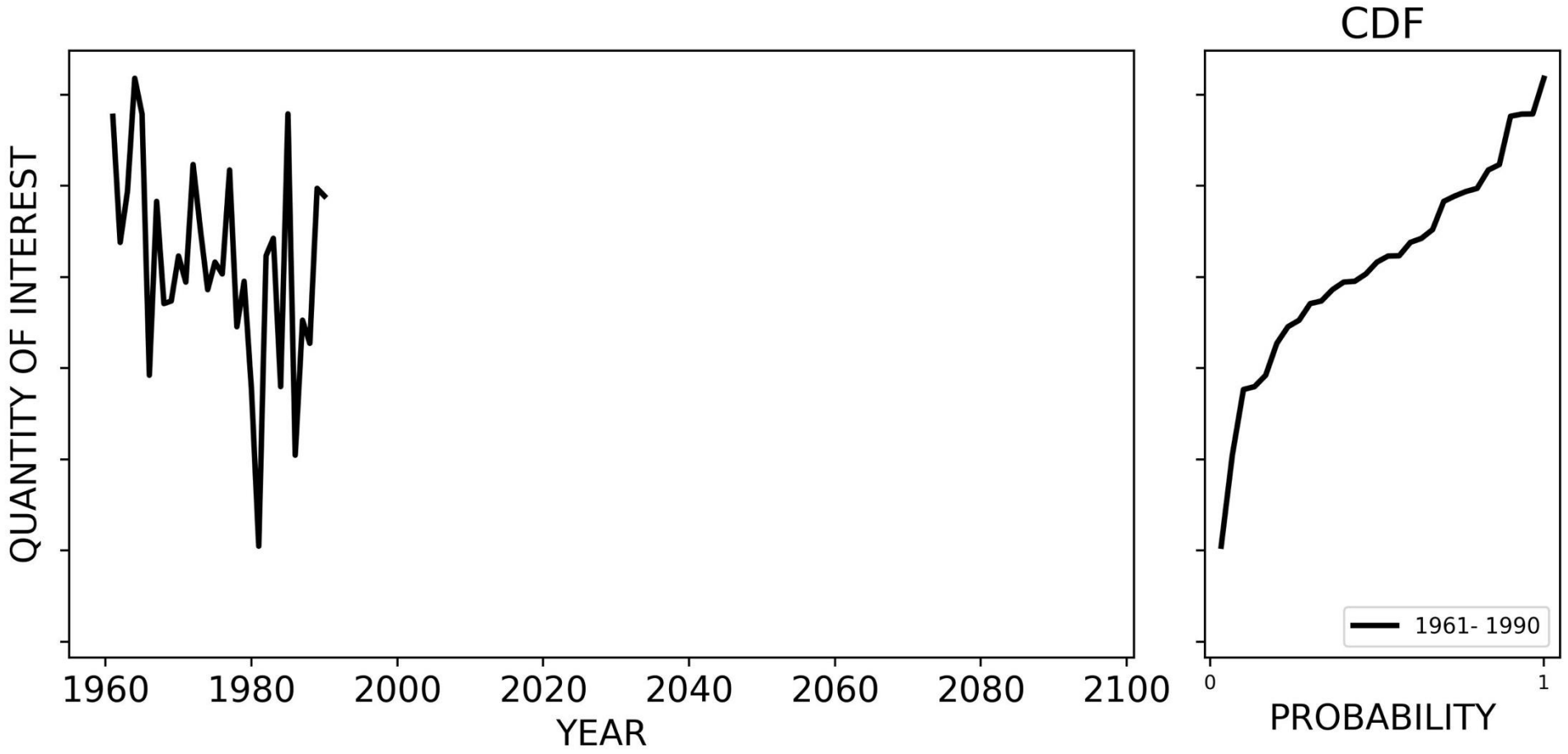
Will climate cause a shift in U.S. drought classification?

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).

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



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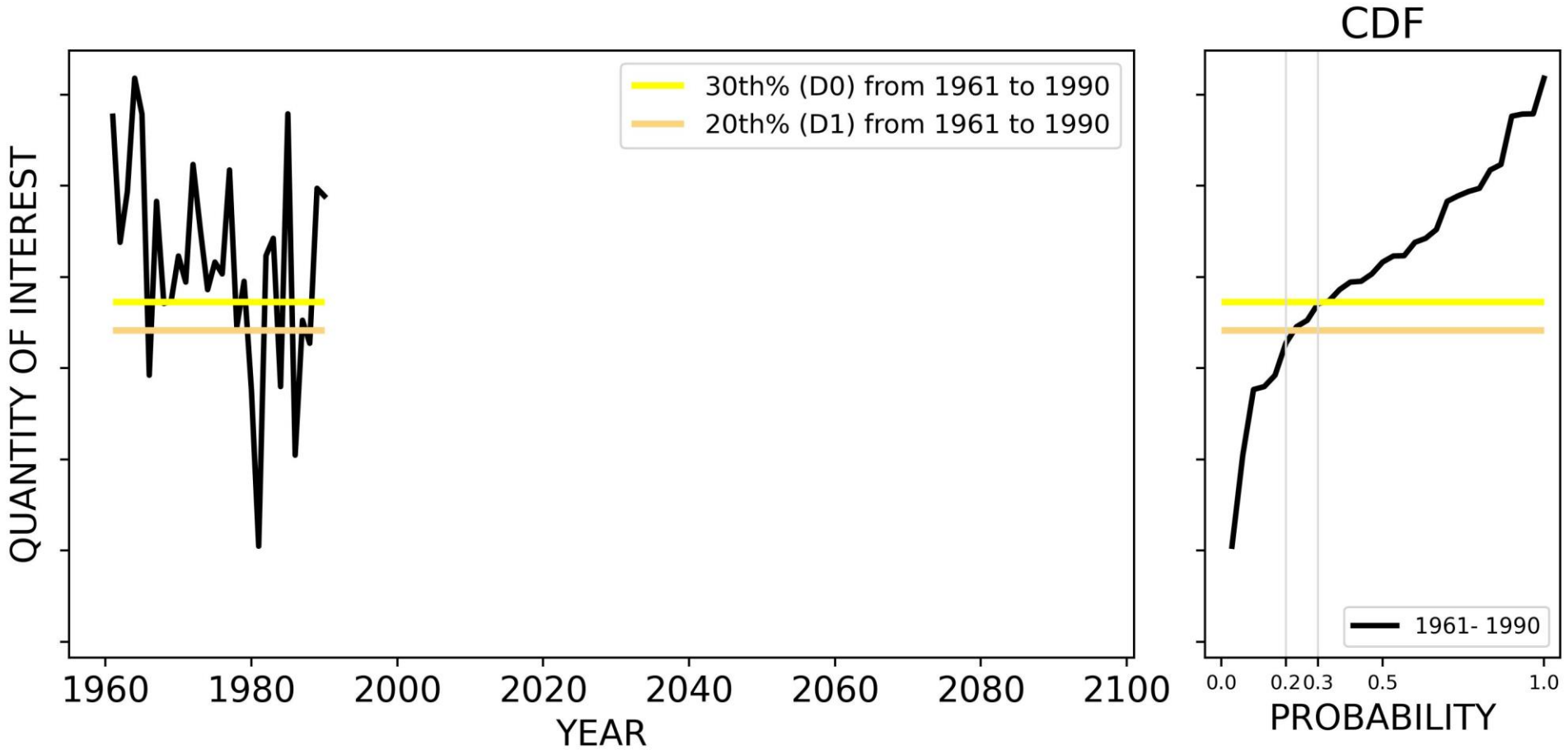

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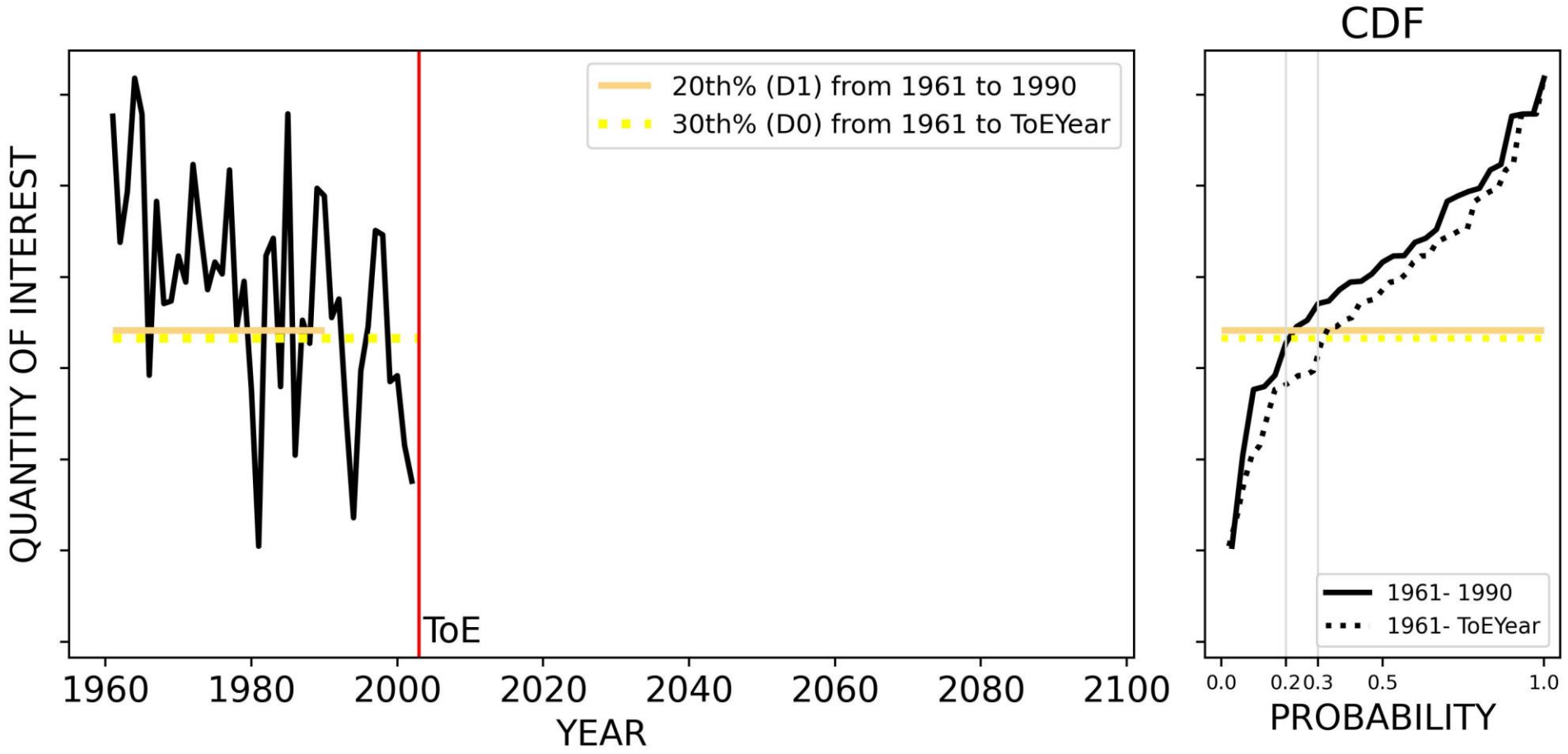

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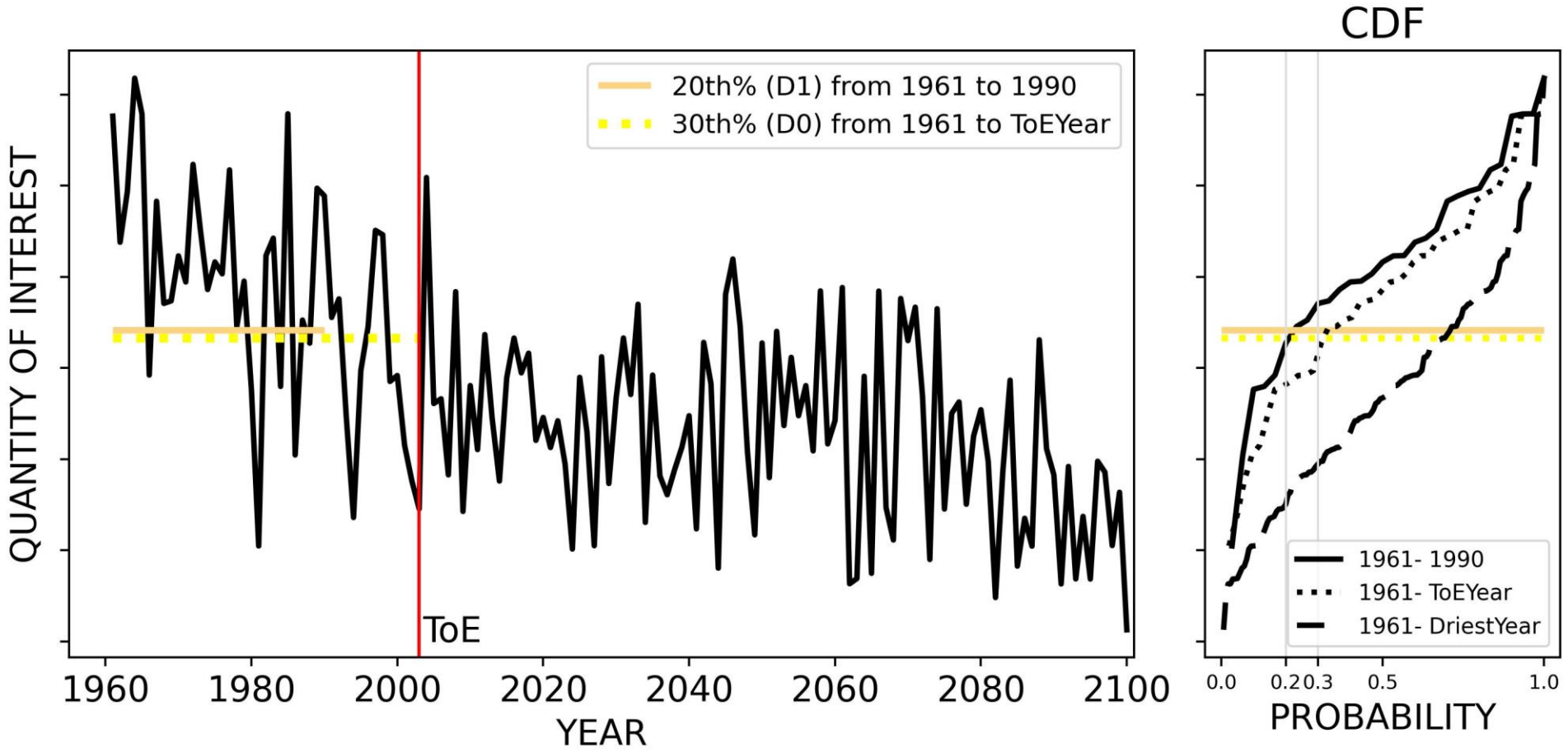

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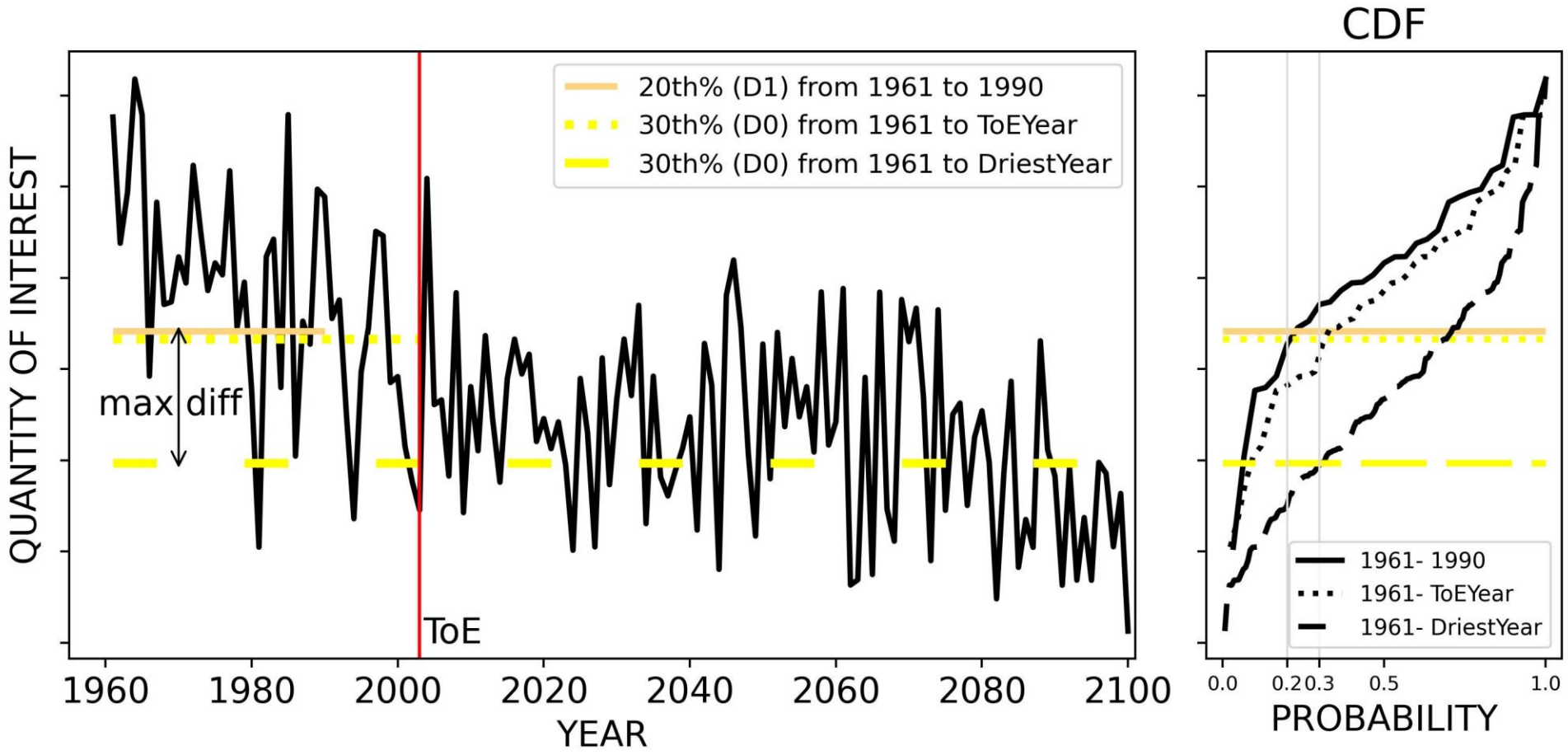
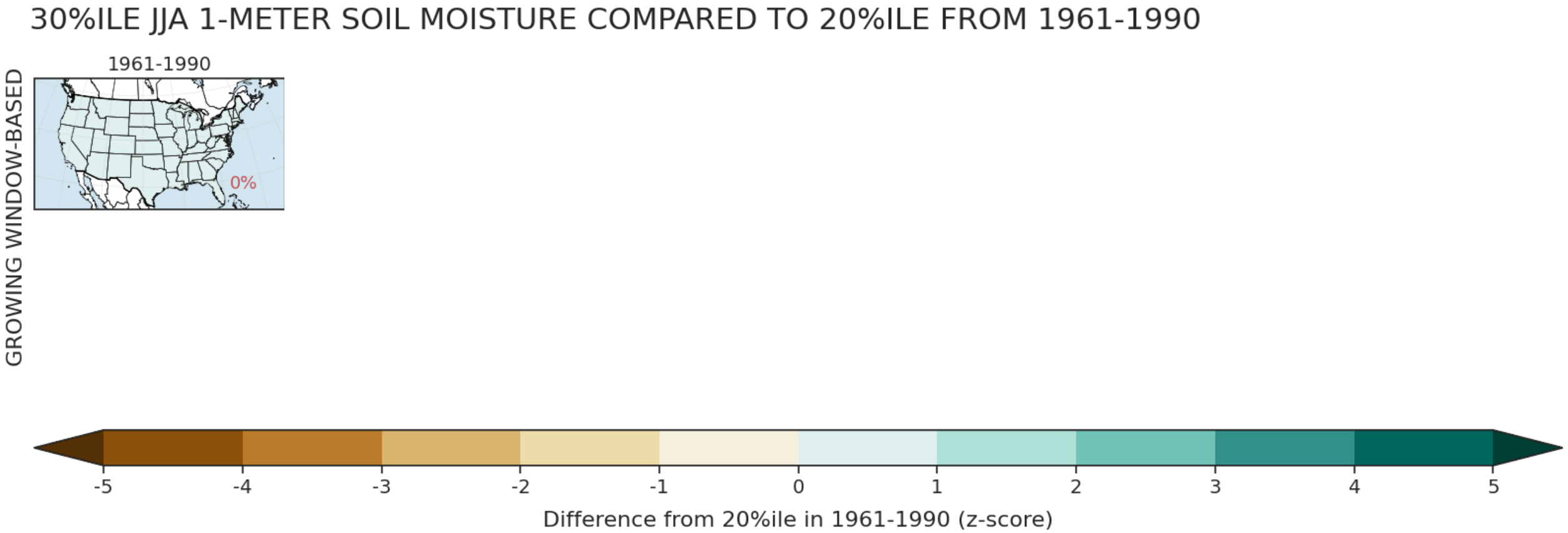


Climate Trends Force Step Changes in U.S. Drought Classifications

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



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

Li et al., in prep.

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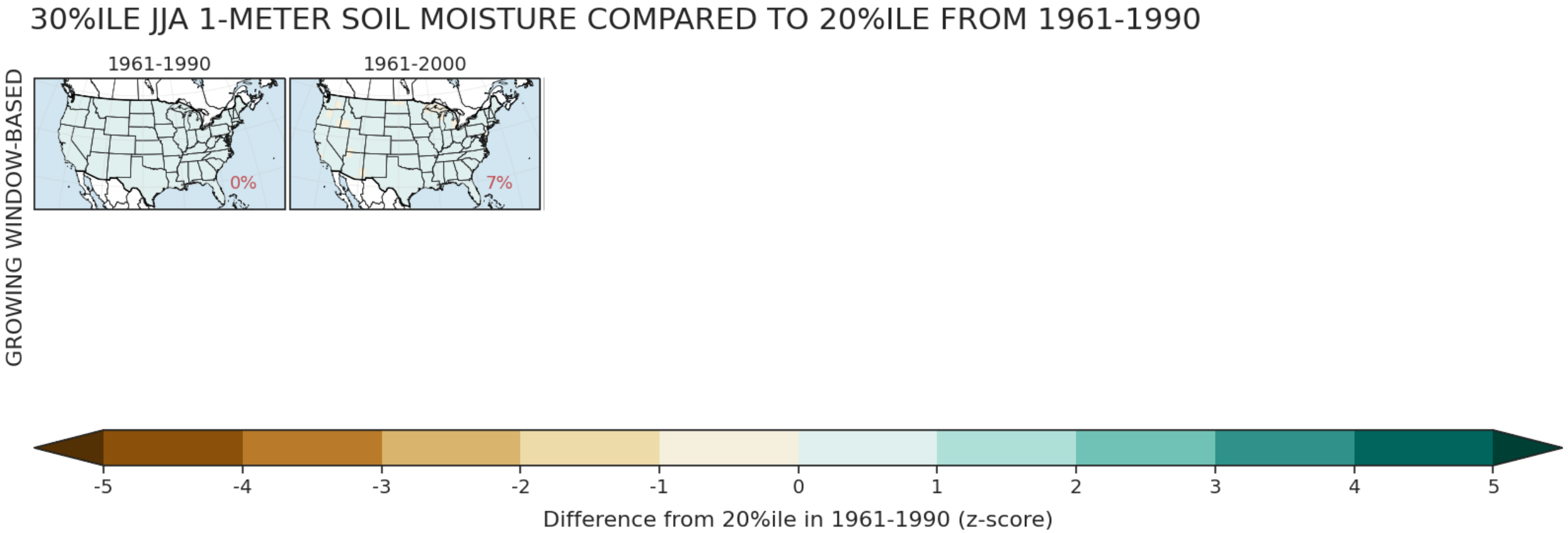

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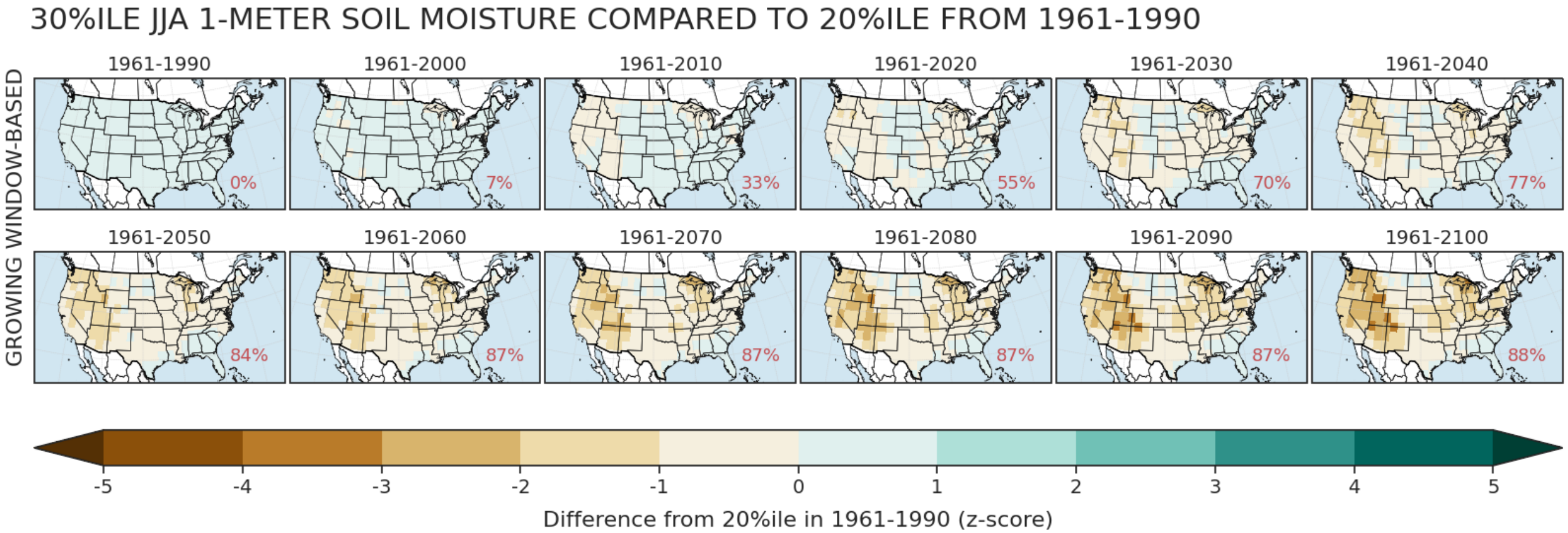
Lower soil moisture magnitude associated with a wetter percentile.



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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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