The Changing Hydroclimate of the Great Plains

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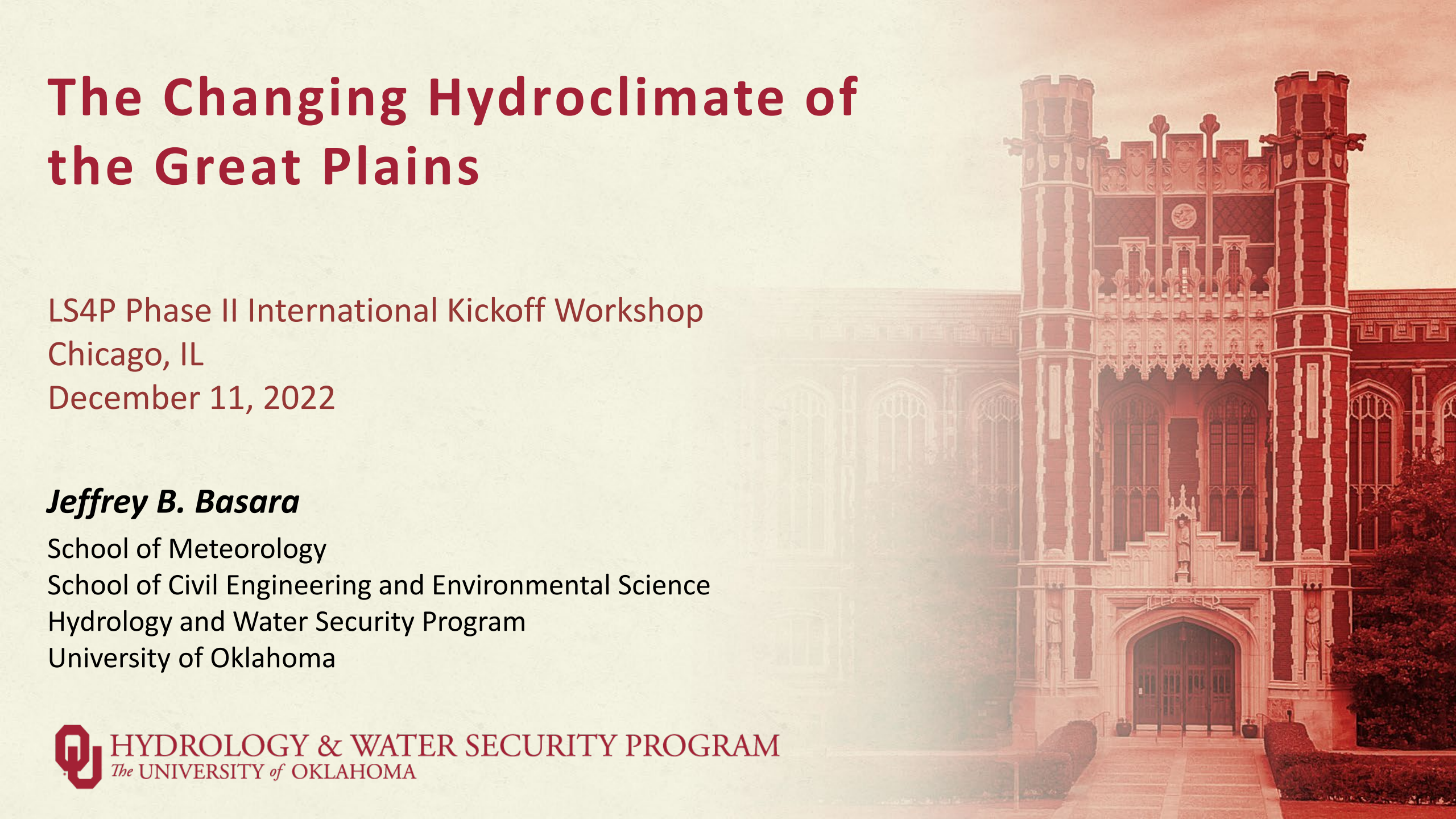

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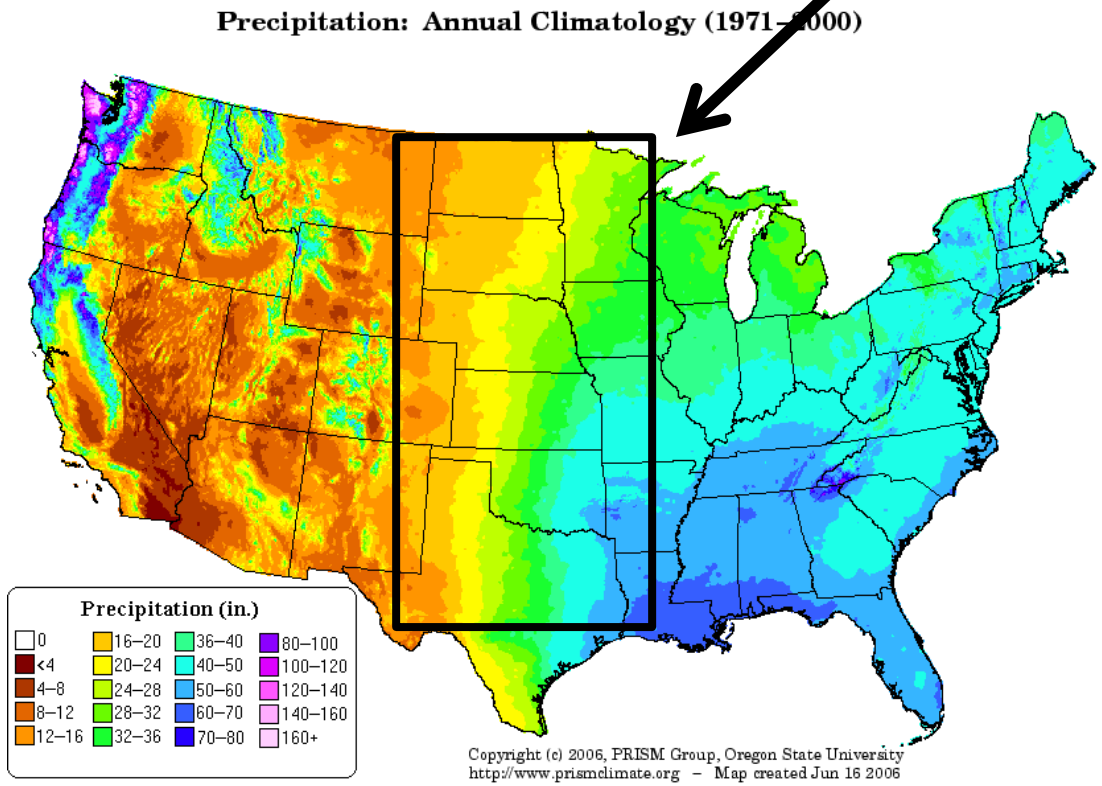
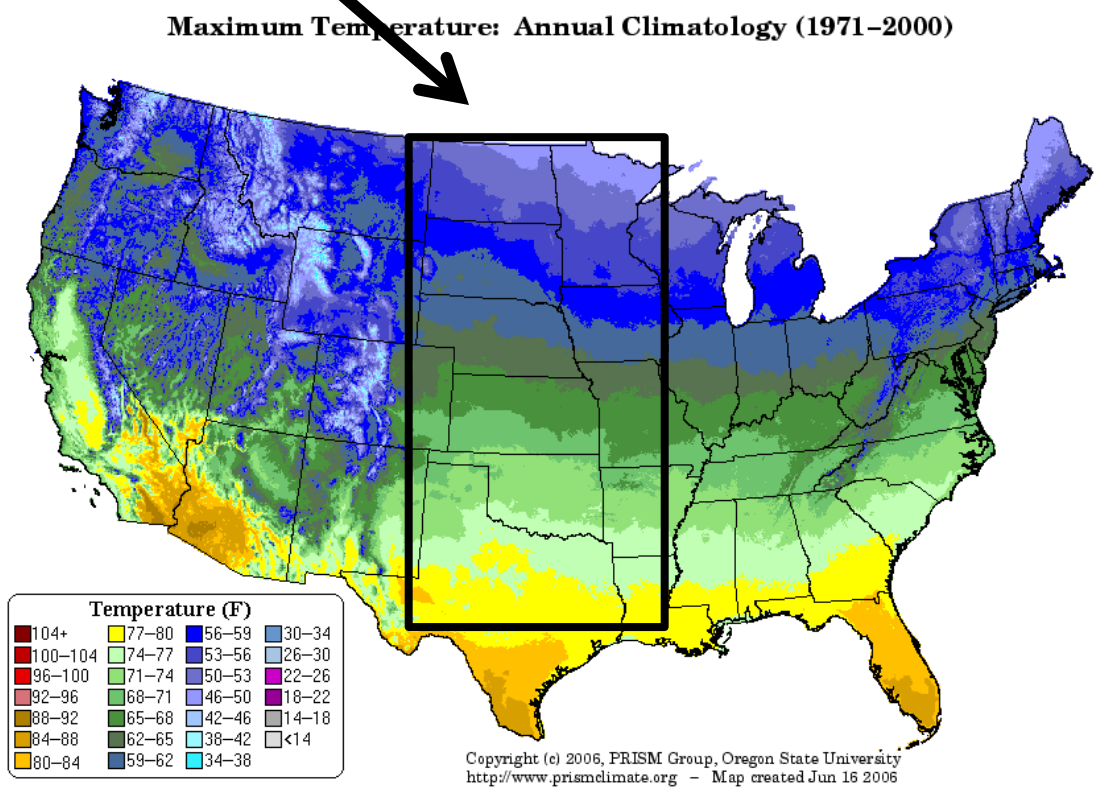
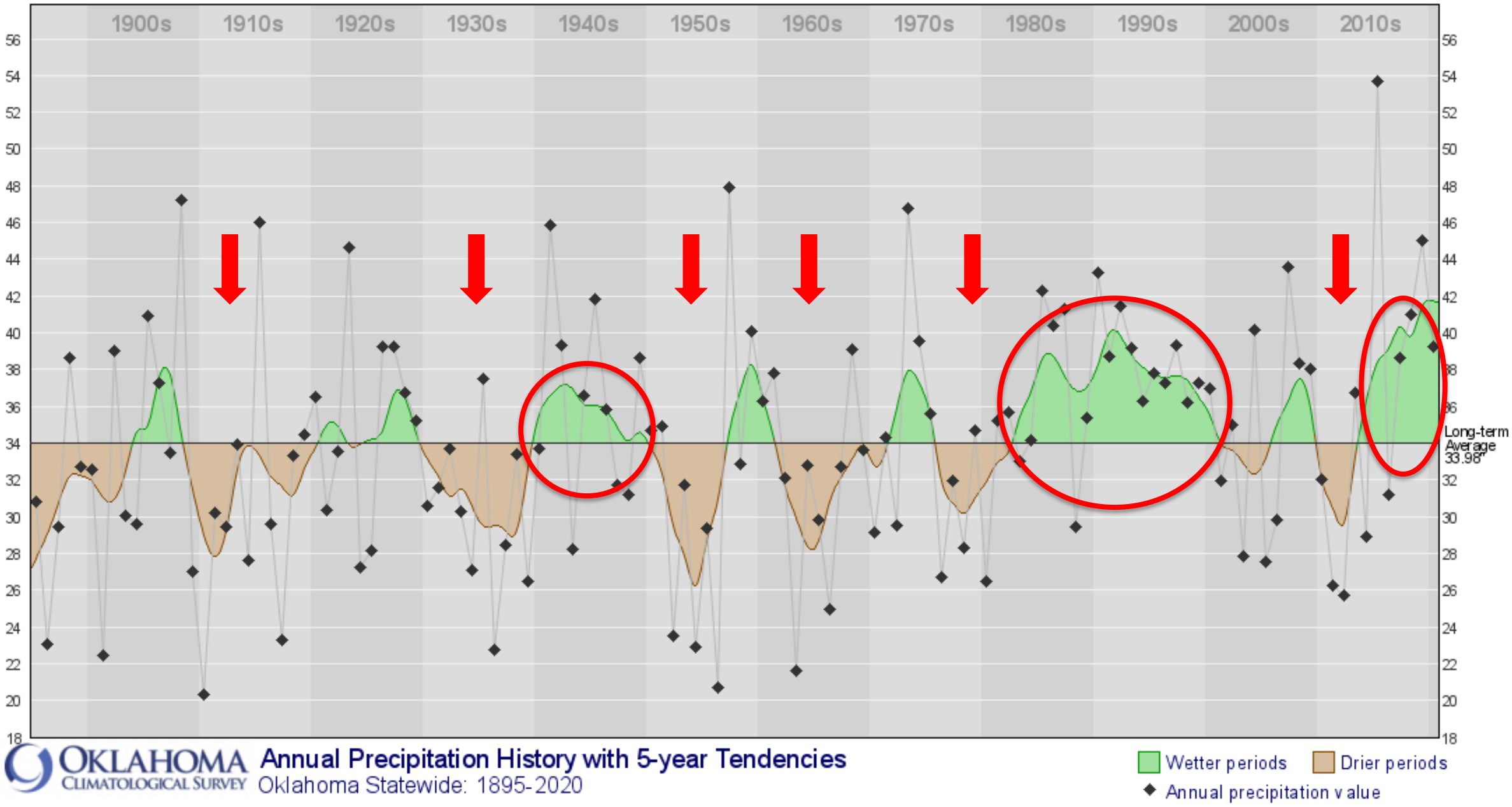
Climate Characteristics of the Great Plains

Orthogonal Gradients of Precipitation and Temperature

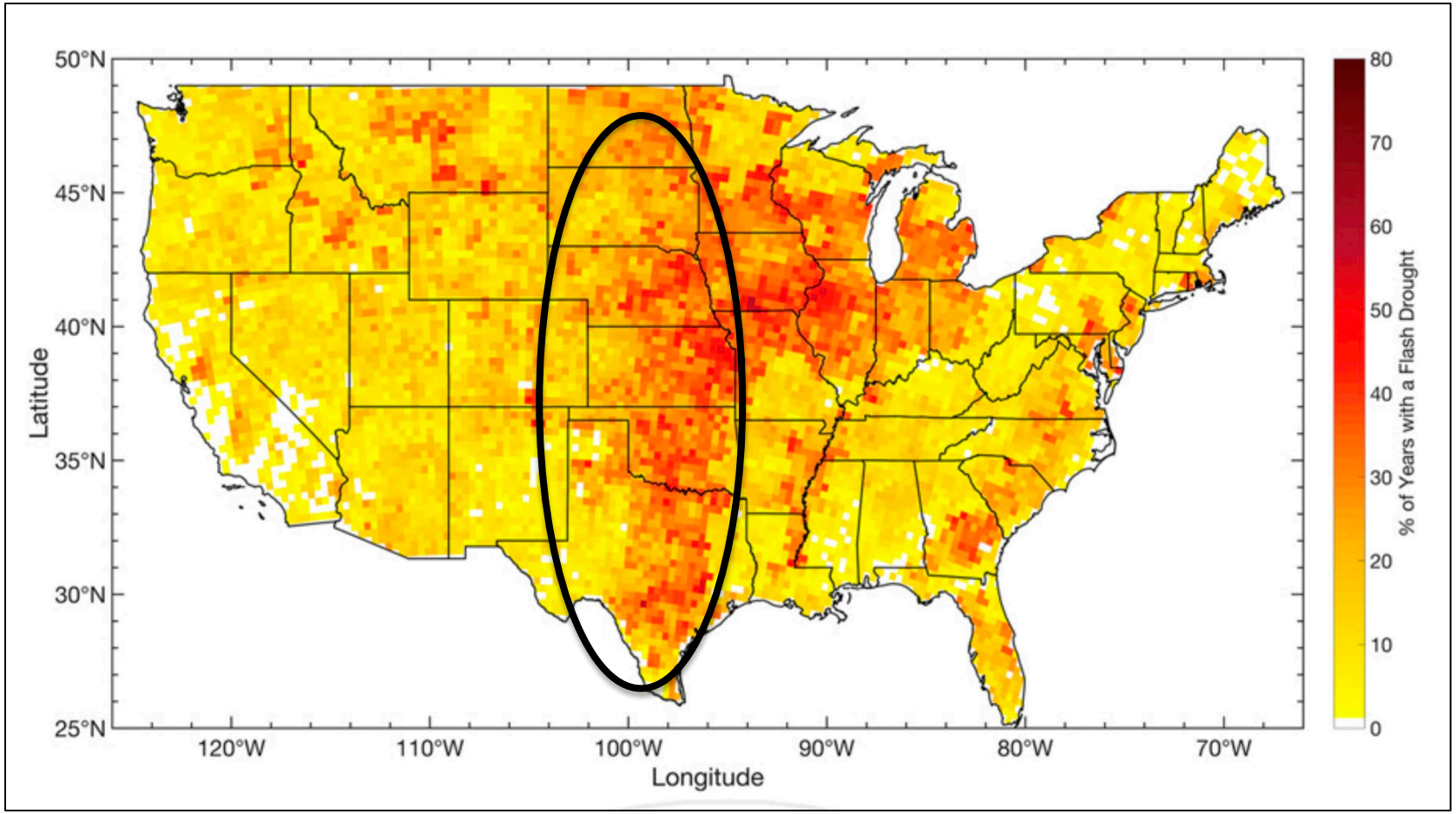




Example: Historical Droughts (and Pluvials) in Oklahoma



Flash Drought Occurrence – Identification and Spatial Climatology



The Standardized Evaporative Stress Ratio (SESR) was used for flash drought analysis (Christian et al. 2019a).

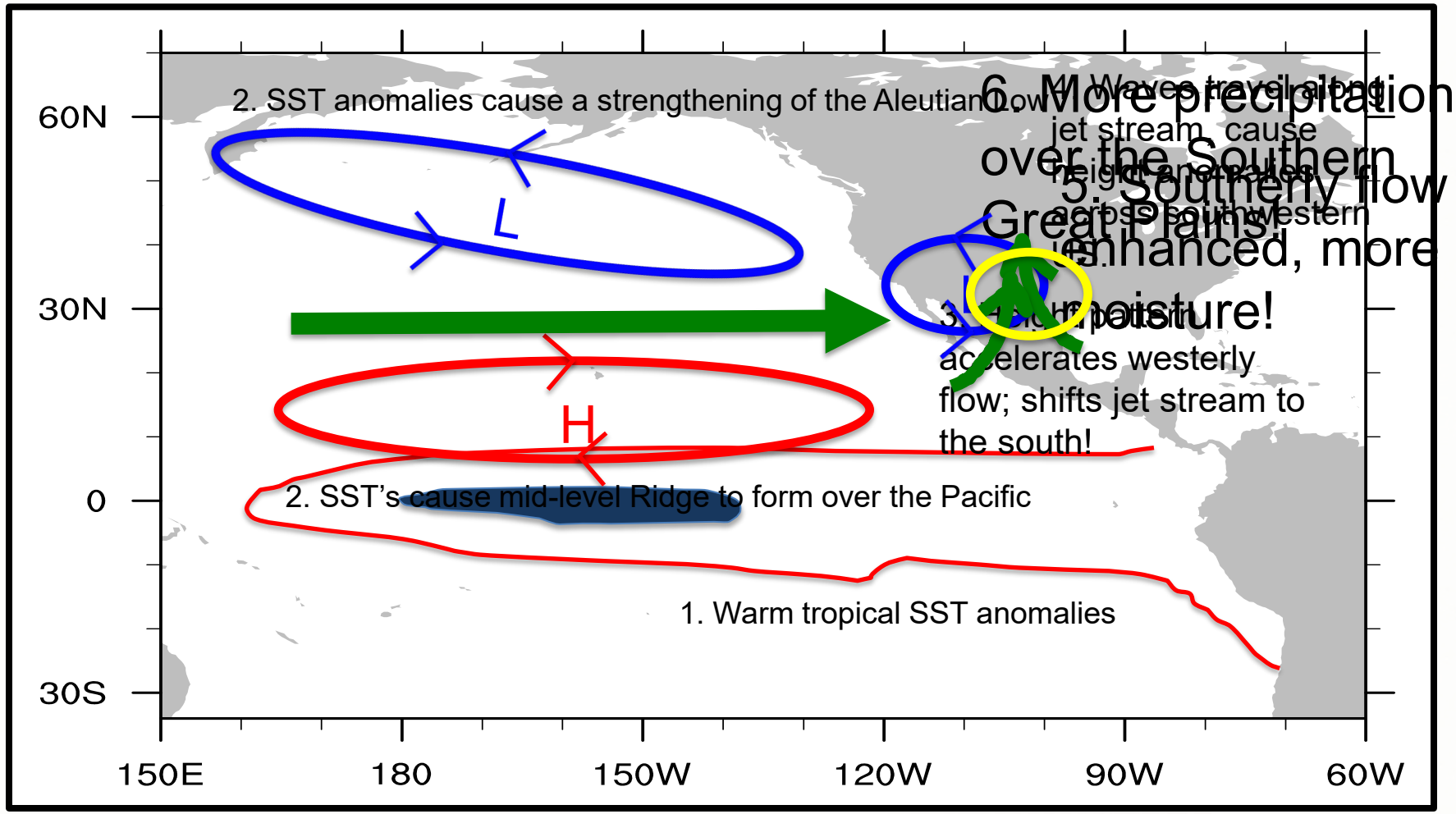
- ESR is the ratio of evapotranspiration (ET) to potential evapotranspiration (PET)

$$ESR = \frac{ET}{PET}$$

- ET incorporates evaporation, vegetation conditions, and soil moisture.
- PET incorporates temperature, humidity, wind speed, etc.
- Provides a measure of overall moisture stress on the environment
- ESR values are standardized (ESR → SESR)

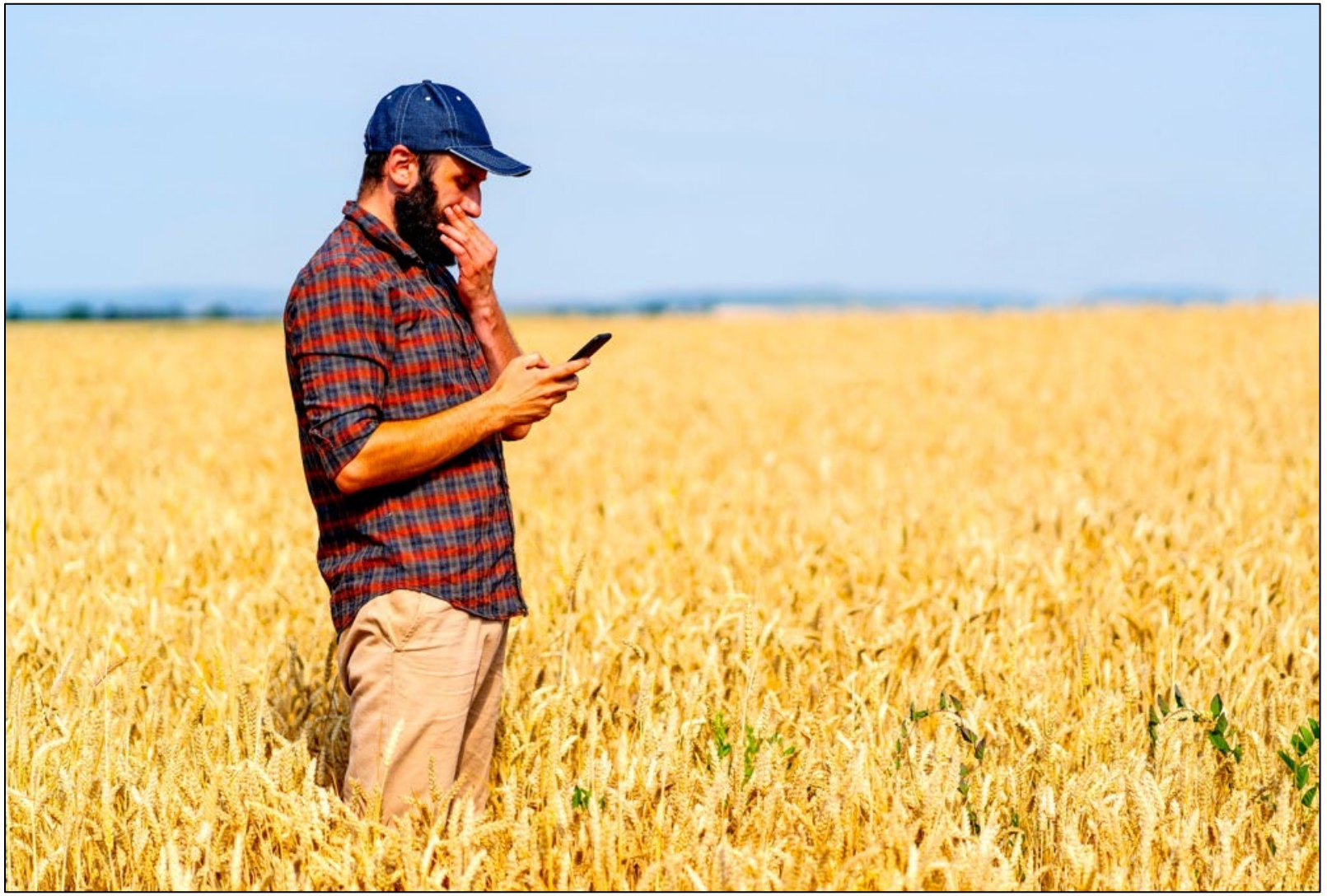
Christian, J.I., J.B. Basara, J.A. Otkin, E.D. Hunt, R.A. Wakefield, P.X. Flanagan, and X. Xiao, 2019: A Methodology for Flash Drought Identification: Application of Flash Drought Frequency Across the United States. *J. Hydrometeor.*, https://doi.org/10.1175/JHM-D-18-0198.1

Example – Drivers of Excessive Precipitation



Flanagan, P.X., **J.B. Basara**, J.C. Furtado, E.R. Martin, and X. Xiao, 2019: Role of Sea Surface Temperatures in Forcing Circulation Anomalies Driving United States Great Plains Pluvial Years. *J. Climate*, **32**, 7081–7100.

The Question?



Is the Hydroclimate of the Great Plains changing?

Variability of Precipitation

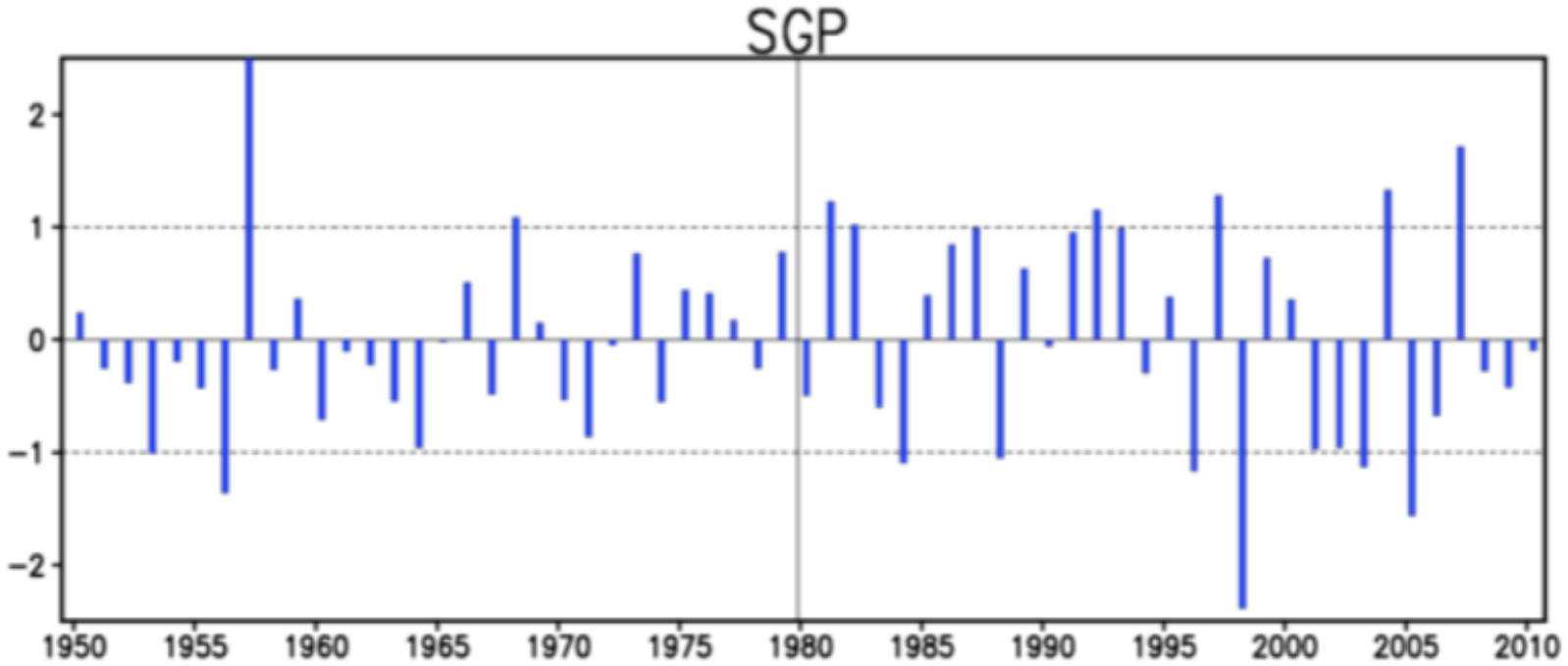
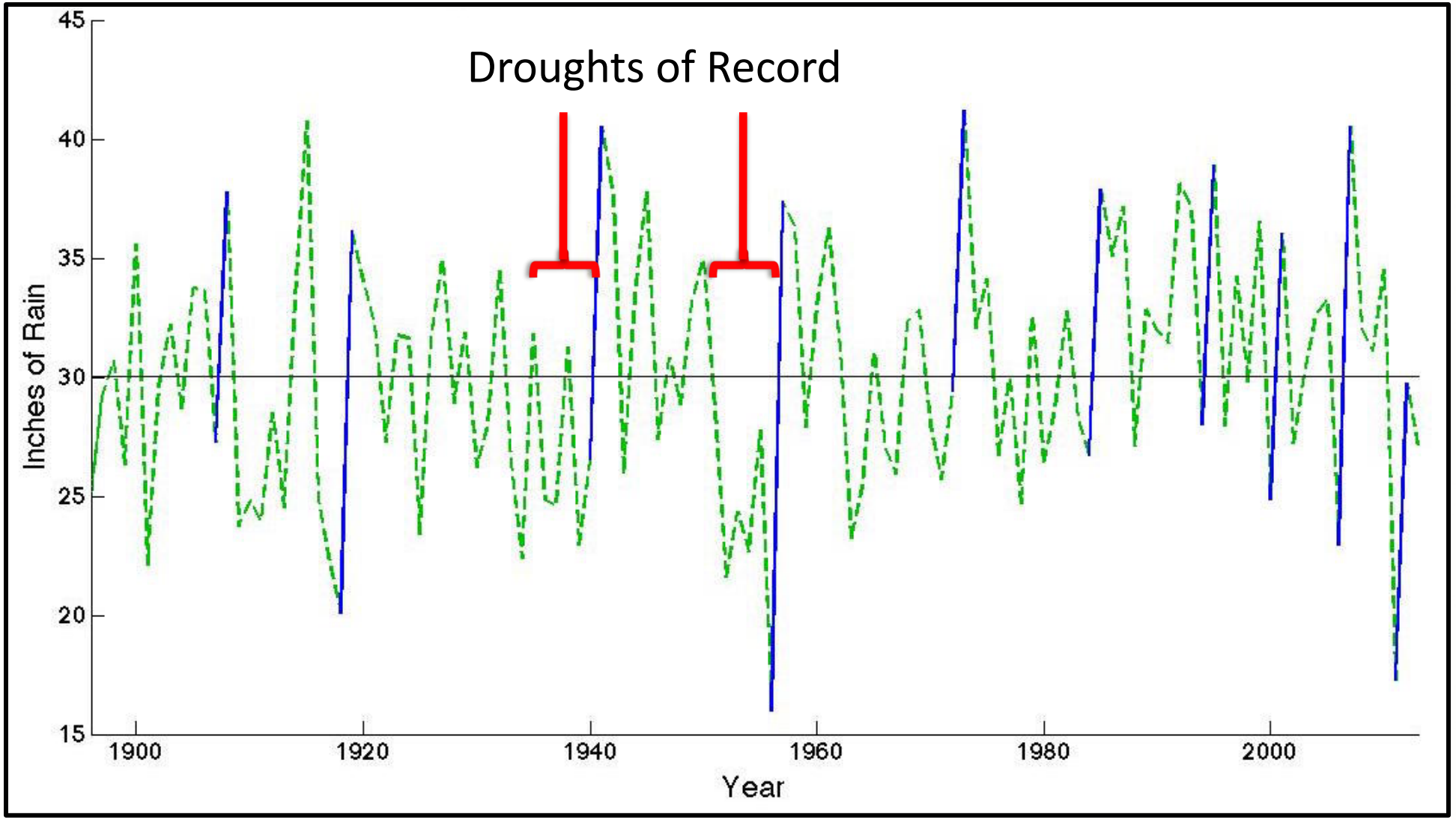


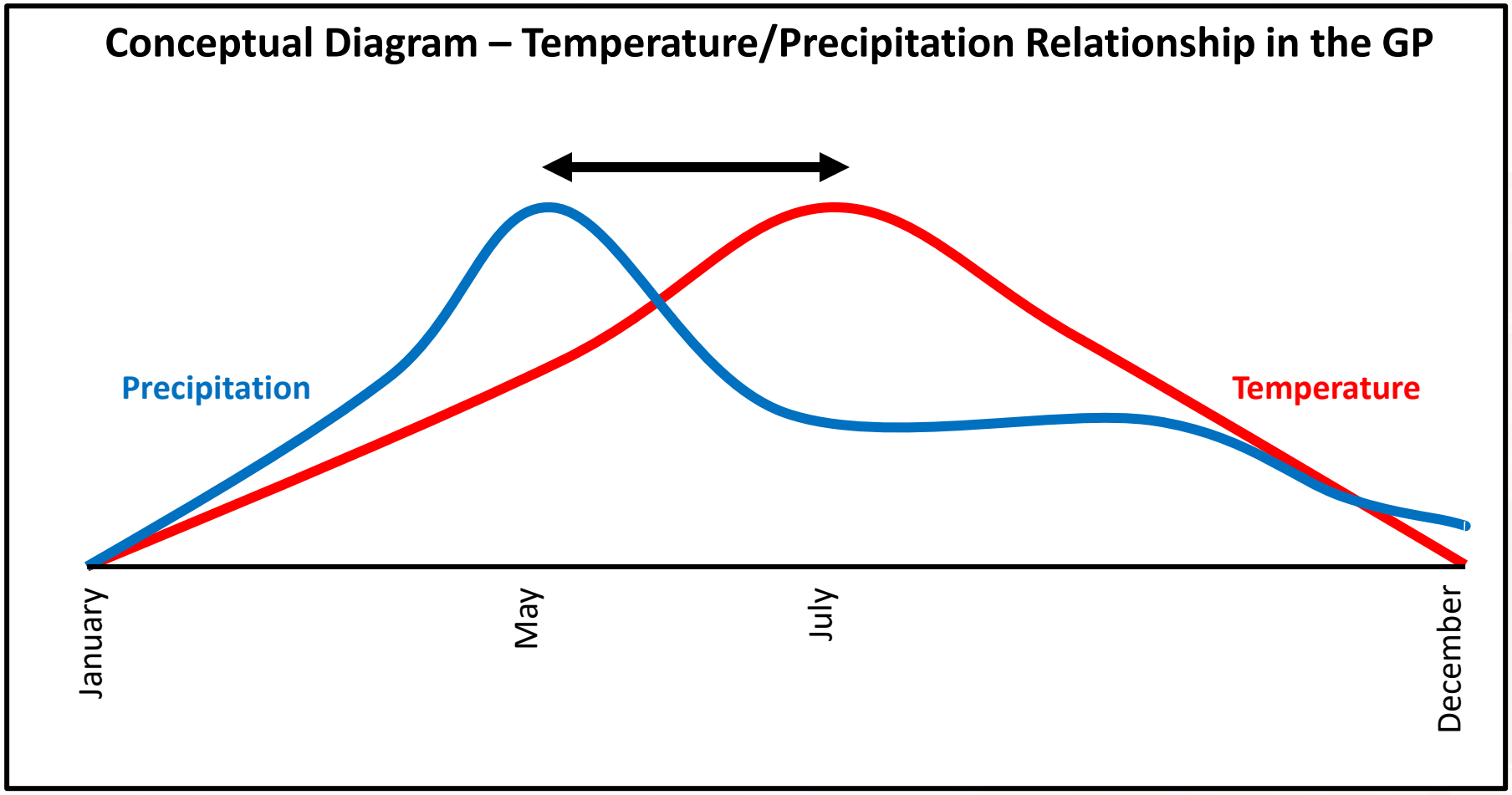
Figure 2. Normalized time series of AMJ precipitation anomaly indices for 1950-2010 for the NGP (upper), SE (middle), and SGP (lower) regions. Area averaging is conducted within the latitude and longitude regions shown in Figure 1 and values are expressed in units of standard deviation.

Weaver, S., S. Baxter, and K. Harnos, 2016: Regional Changes in the Interannual Variability of U.S. Warm Season Precipitation. J. Climate. doi:10.1175/JCLI-D-14-00803.1.

Transitions from Drought to Pluvial Events



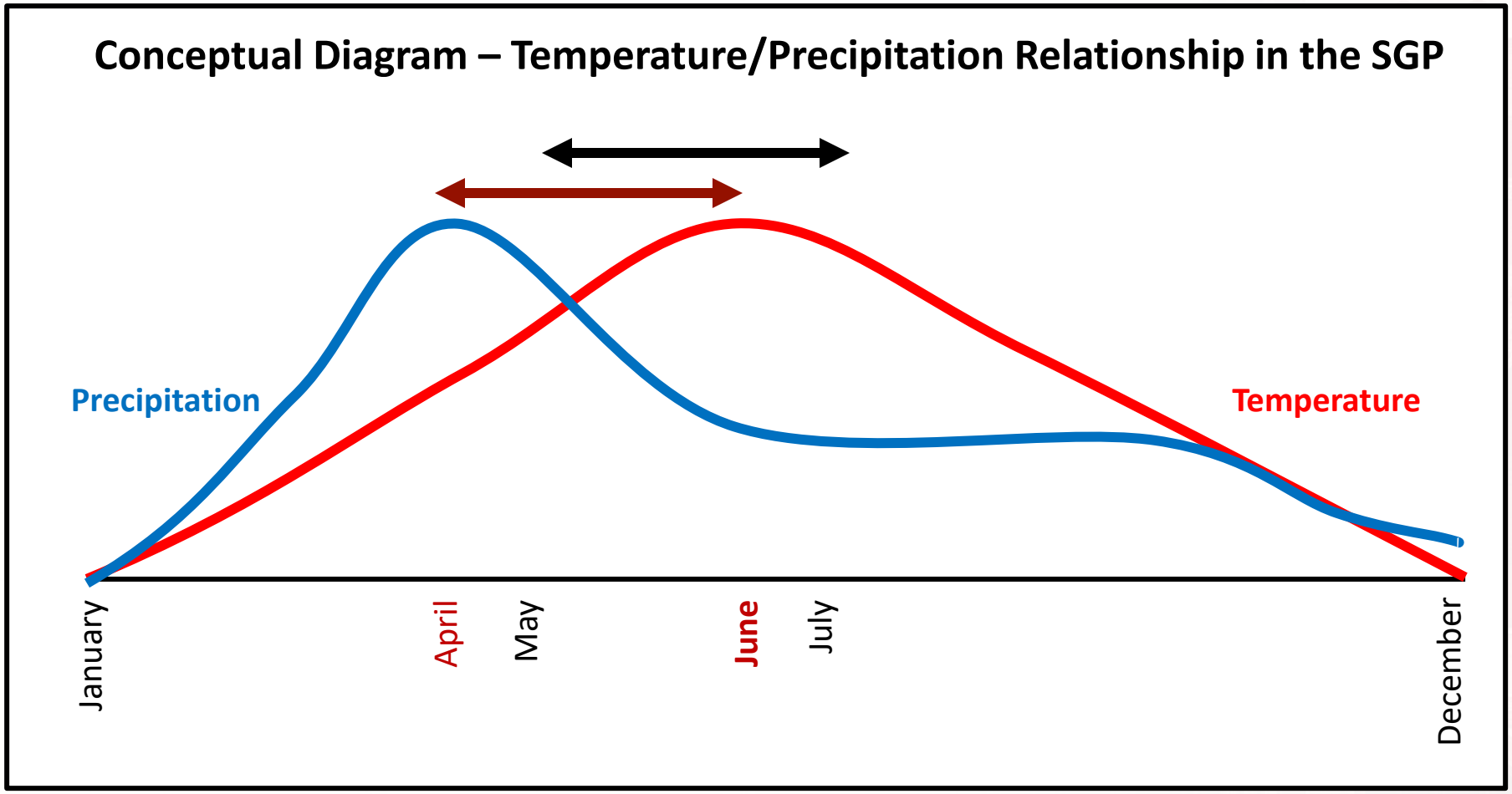
Christian, J., K. Christian, and J. B. Basara, 2015: Drought and Pluvial Dipole Events within the Great Plains of the United States. *J. Appl. Meteor. Climatol.*, **54**, 1886–1898.



Question: Is the annual timing between the *peak* of precipitation versus the *peak* of temperature changing?

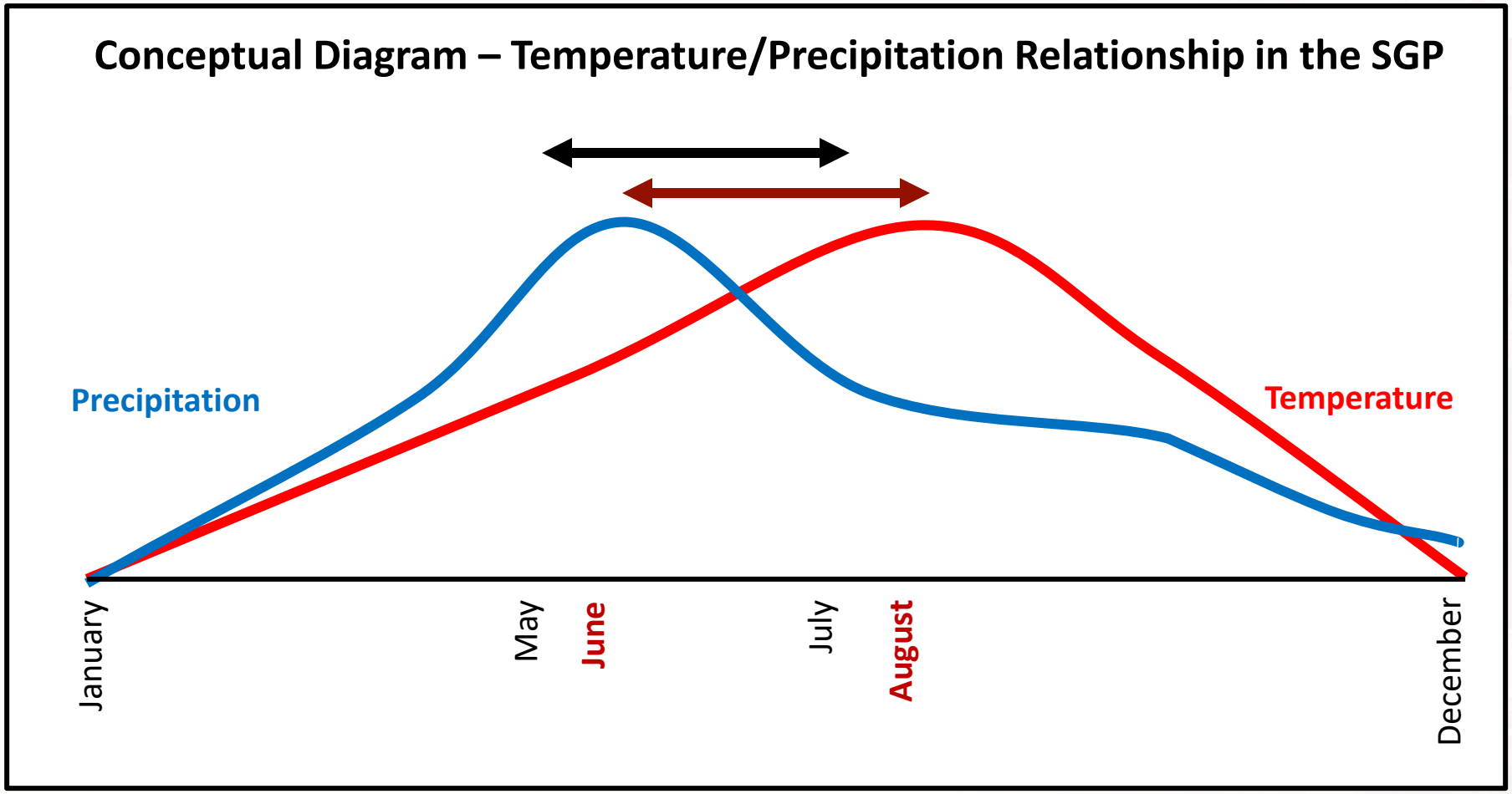
Flanagan, P. X., J. B. Basara, and X. Xiao, 2017: Long-term analysis of the asynchronicity between temperature and precipitation maxima in the United States Great Plains. *International Journal of Climatology*, **37,** 3919-3933. dos:10.1002/joc.4966.

Was there a consistent shift to earlier in the year?



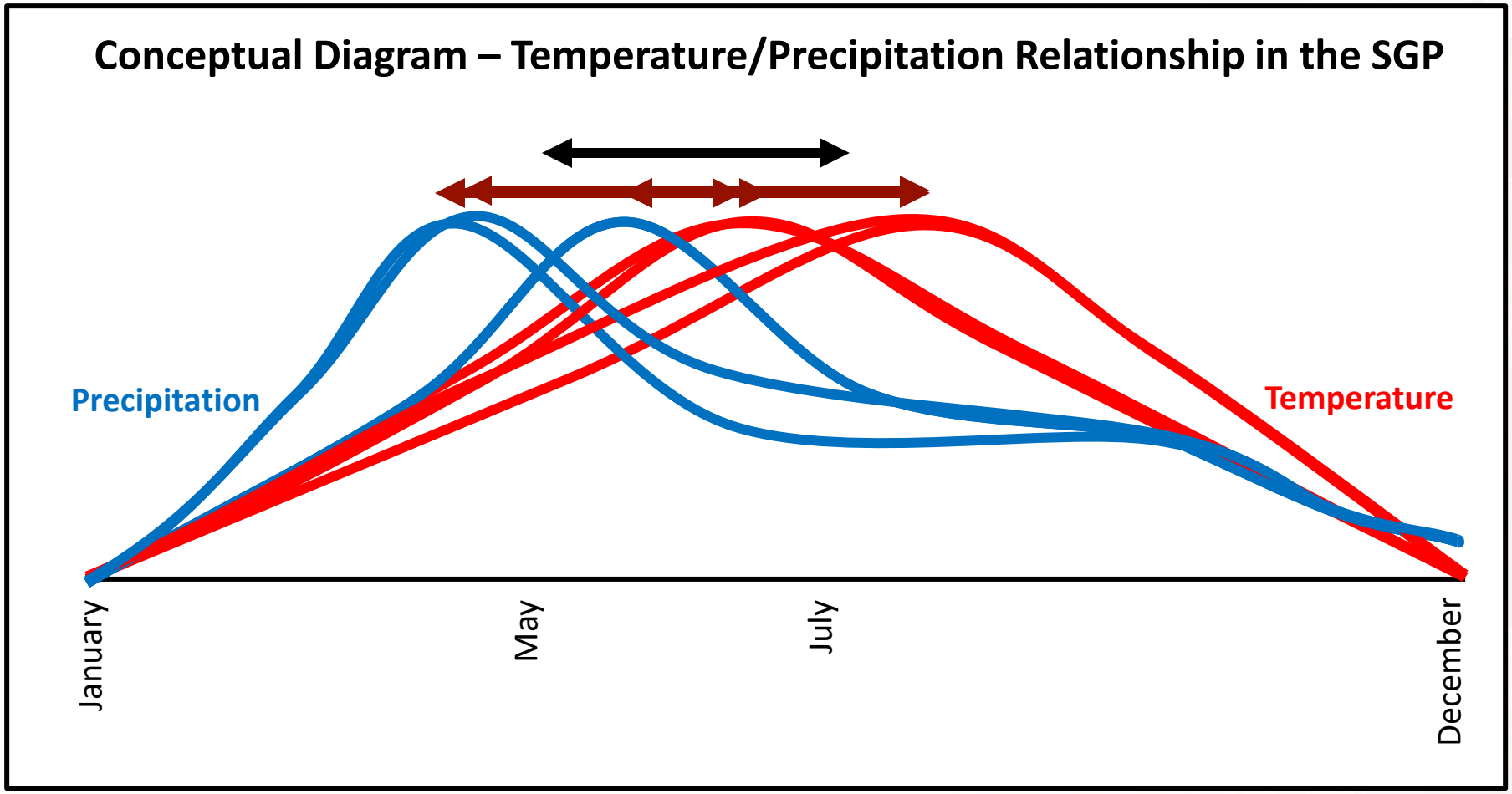
Answer: NO!

Was there a consistent shift to later in the year?

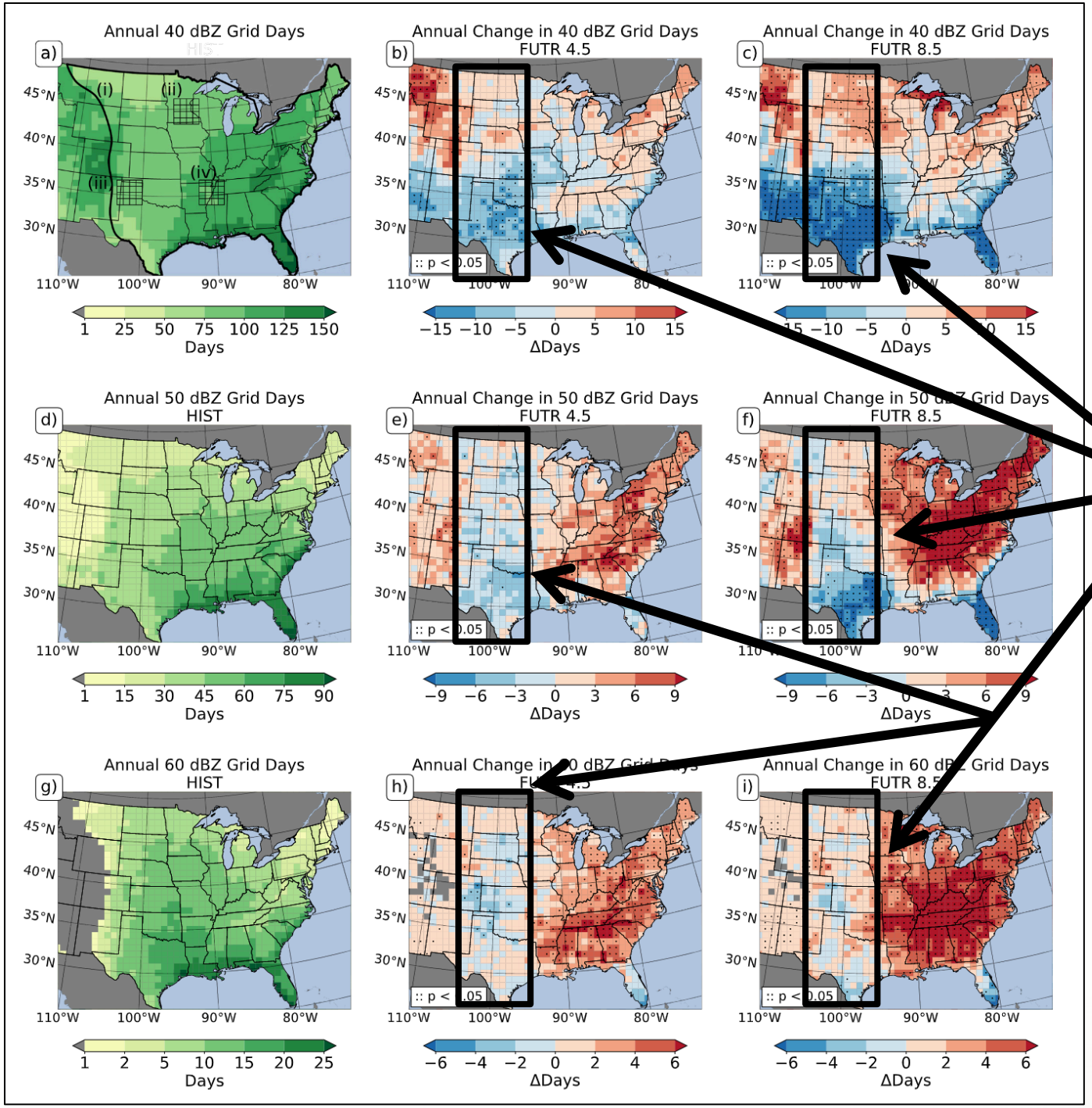


Answer: NO!

What was the result of the analysis?



Answer: The overall variability is increasing.

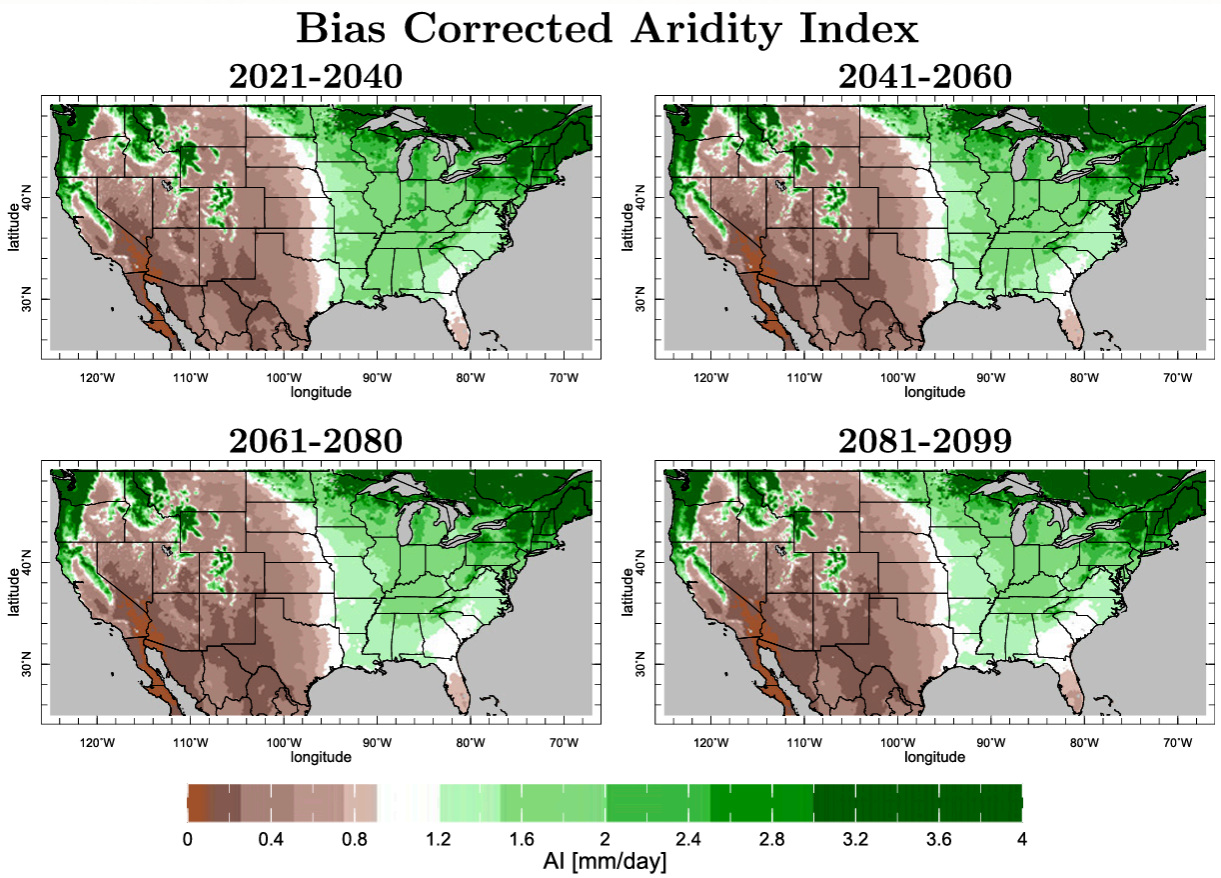


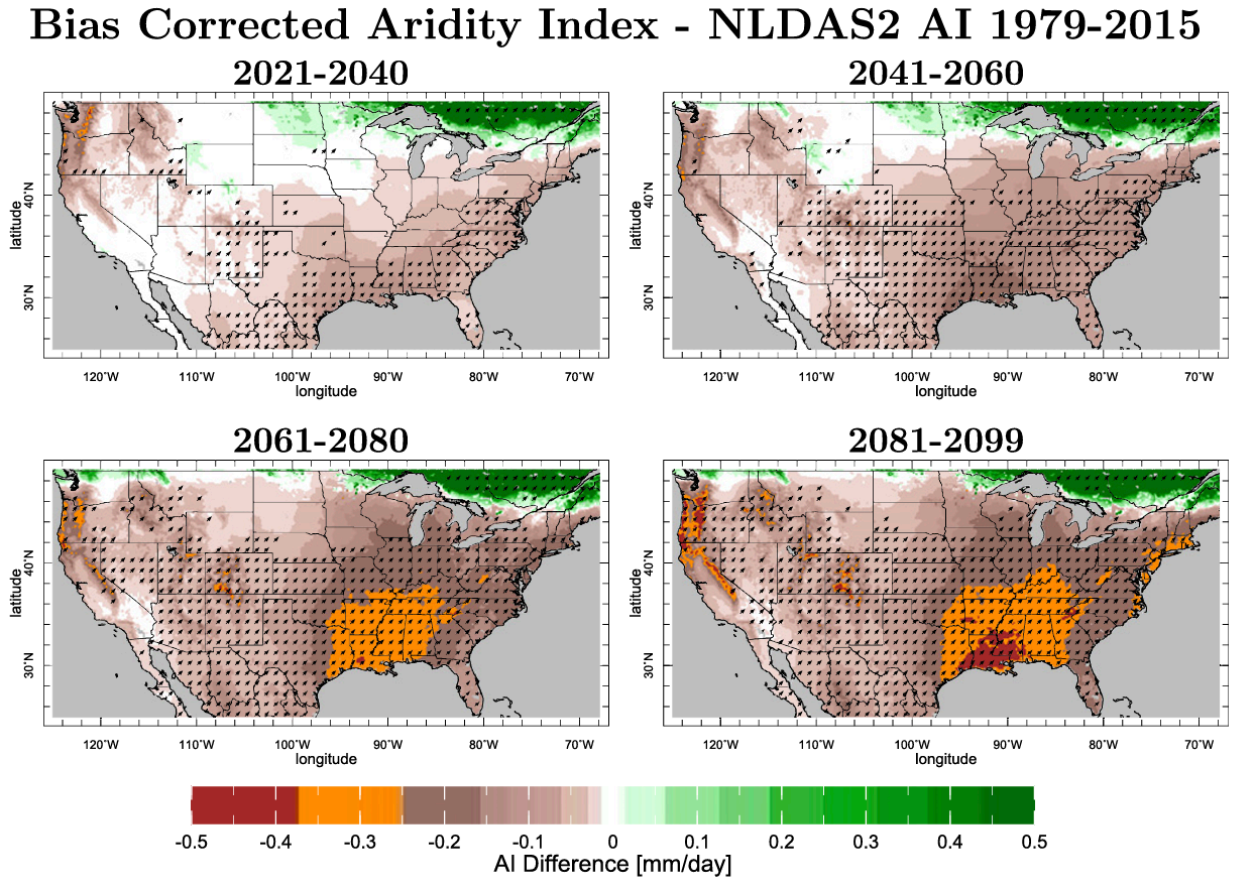
Changes to Convective Storms in the GP

Notable decreases is convective storms in future climate scenarios

Haberlie, A. M., Ashley, W. S., Battisto, C. M., & Gensini, V. A. (2022). Thunderstorm activity under intermediate and extreme climate change scenarios. *Geophysical Research Letters*, 49, e2022GL098779.

The Changing Precipitation Gradient of the GP





Takeaway – Aridity is <u>increasing</u> and the "gradient" is <u>shifting east</u>

Seager, R., Feldman, J., Lis, N., Ting, M., Williams, A. P., Nakamura, J., Liu, H., & Henderson, N. (2018). Whither the 100th Meridian? The Once and Future Physical and Human Geography of America's Arid–Humid Divide. Part II: The Meridian Moves East, *Earth Interactions*, *22*(5), 1-24.

Summary – The Hydroclimate of the Great Plains

The Challenge

- **The region is marked by sharp gradients – defines the hydroclimate**
- **Highly variable**
- **Extremes occur at the full range of spatial/temporal scales (Weather/S2S/Climate)**
- **Linkages are local to global**

The Hydroclimate is Changing

- **Processes and Dynamics**
- **Characteristics of the Region**
- **Frequency of Extremes**
- **Overall Variability is Accelerating**

The trends/results are supported by many studies/teams/projects (i.e., more than shown)

More work to be done – Local versus Remote – Opportunities within LS4P Phase II?

An opportunity moving forward …

A Special Collection proposal for the American Meteorological Society

The Changing Climate of the Great Plains

- Serve as an organizer
- Suggest contributors
- Submit a manuscript

Interested? Contact → jbasara@ou.edu

Acknowledgments

Co-authors and Collaborators:

Paul Flanagan*, Jordan Christian*, Ryann Wakefield*, Hayden Mahan, Jean Liu**, Bryony Puxley, Jason Furtado, Elinor Martin, Cameron Homeyer, Xiangming Xiao, Rajen Bajgain, Yuting Zhou, Jason Otkin, Eric Hunt, Jean Steiner, Amber Campbell, Daniel Devlin, Chuck Rice, David Brown**

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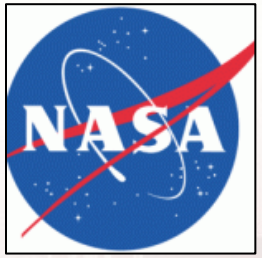

Questions?

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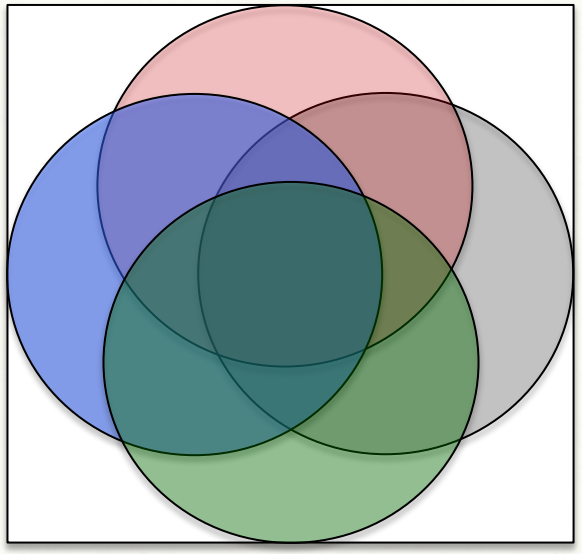
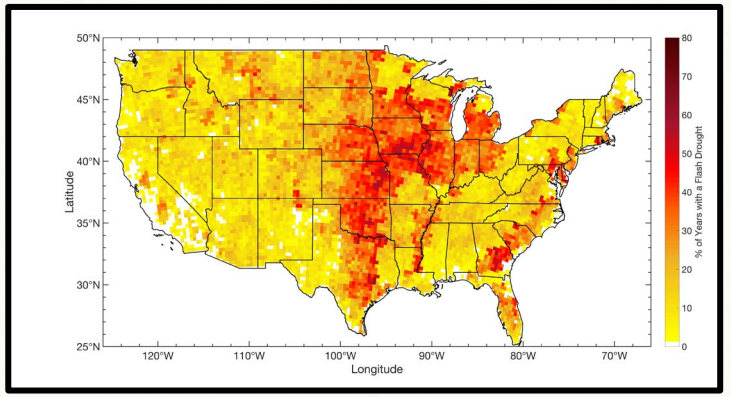
http://hydrometeorology.oucreate.com





CHEWe Research Group - Interdisciplinary Research Focus