Assessing the 2023 Hot Droughts in Southwestern North America

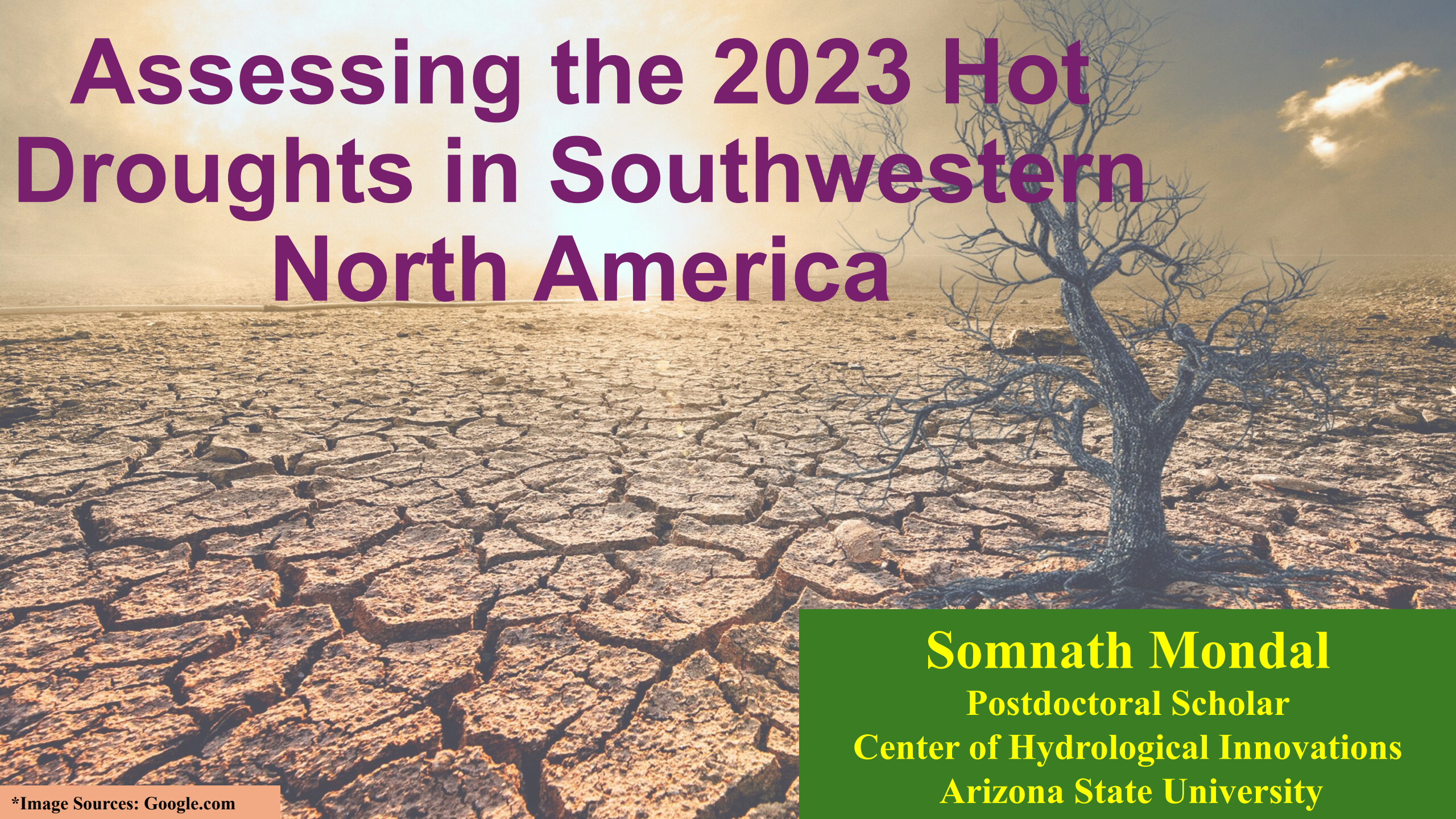

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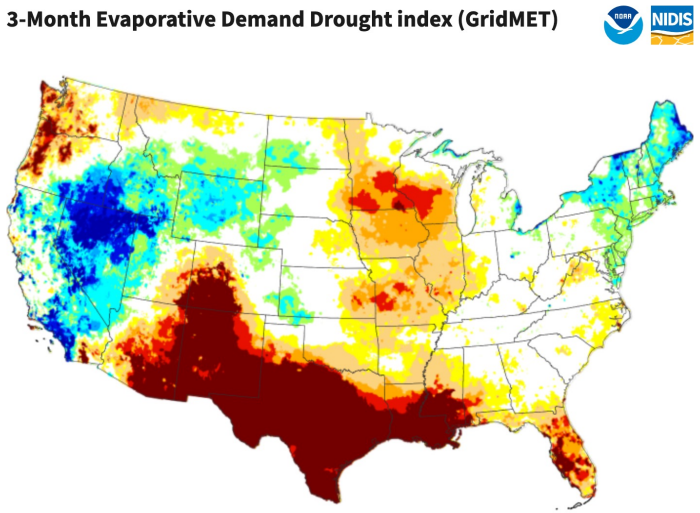
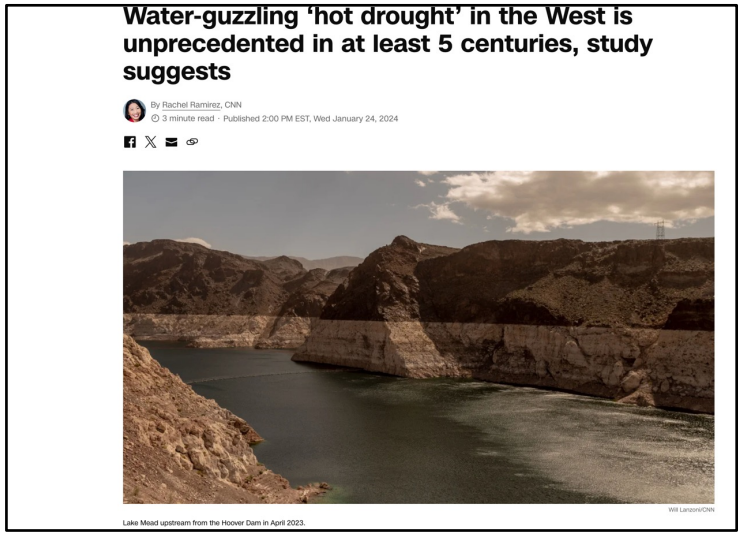
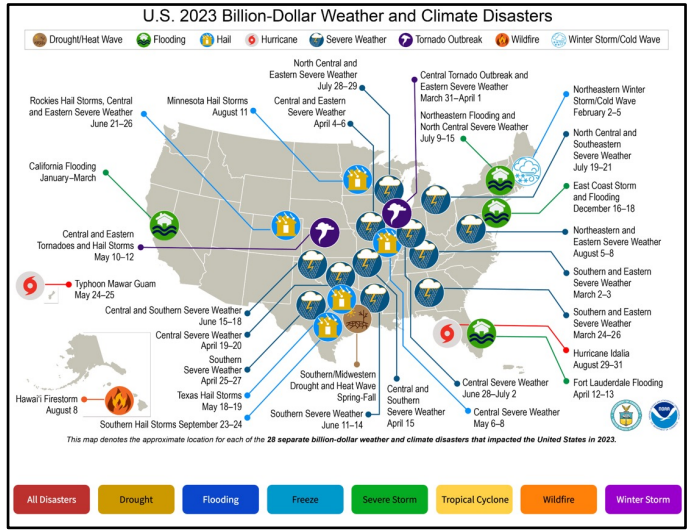
*Image Sources: Google.com

Introduction & Objectives



September 16th, 2023





- Spatiotemporal Characteristics of Droughts, Heatwaves and Hot Drought (CDHW)
- Changes in Spatiotemporal Characteristics (Frequency, Duration, Severity)
- Statistical Model Selection & Quantification of Unusuality (Block Maxima)

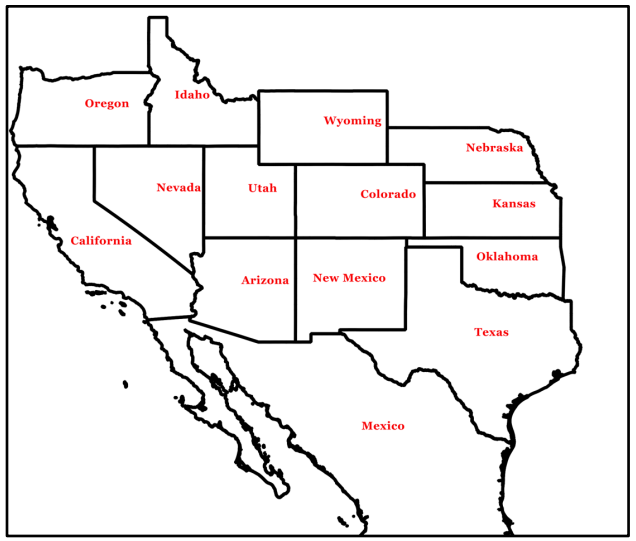
***Image Sources:**

https://www.ncei.noaa.gov/access/billions/

https://www.drought.gov/news/summer-2023-review-look-back-drought-across-us-10-maps-2023-09-21

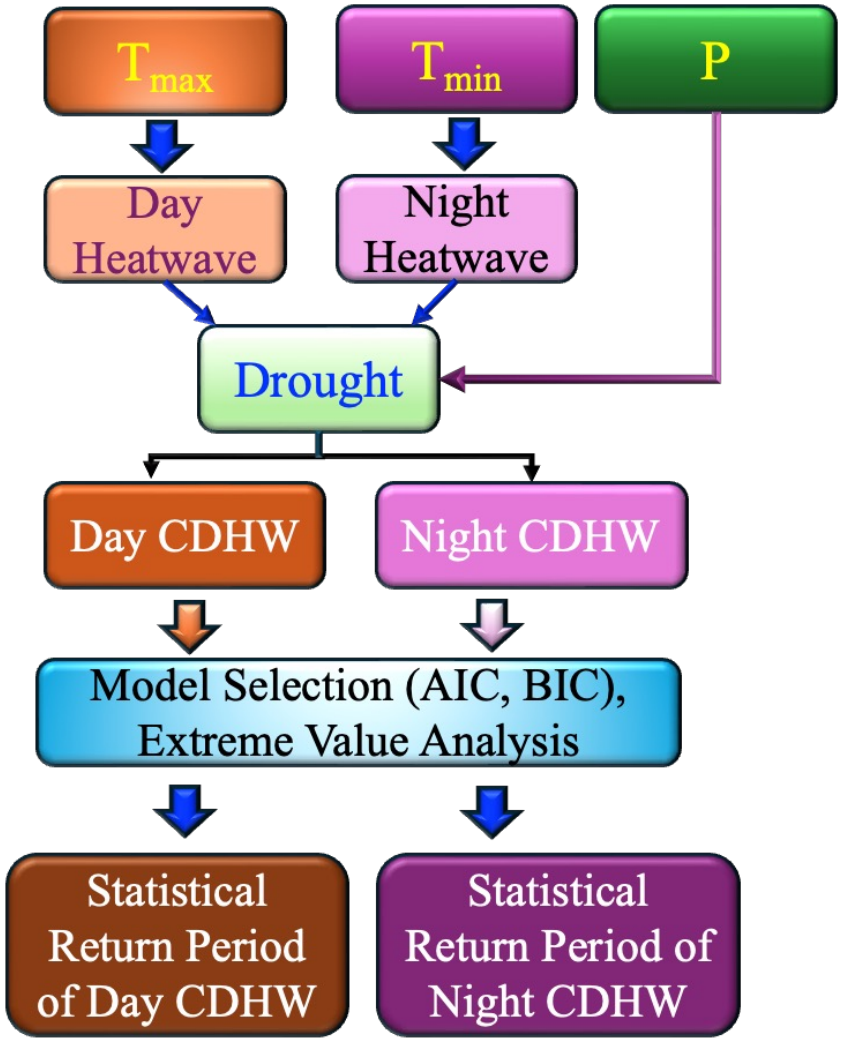
https://www.cnn.com/2024/01/24/climate/hot-drought-west-climate/index.html

Data & Methodology



Temperature & Precipitation Data

- Climatic Prediction Center (CPC) Global
- Spatial Resolution 0.5°× 0.5°
- Temporal Length (1979-Present)



Methodology

Heatwaves

$HW_j = 1$ if $T > 0.90p$ (For at least 3 days)

Droughts

$Dr_j = 1$ if $SPI < -1.0$ (for atleast 2 weeks)

CDHWs

$CDHW_j = 1$ if $HW_j = 1$ & $Dr_j = 1$

CDHW Severity

$$CDHW_{severity/day} = (-1 * SPI)\left(\frac{T_d - T_{25}}{T_{75} - T_{25}}\right)$$

Extreme Value Analysis

$$f(\upsilon) = \left(\frac{k}{c}\right)\left(\frac{\upsilon^{k-1}}{c}\right)\exp\left[-\left(\frac{\upsilon}{c}\right)^k\right]$$

$$F(\upsilon) = 1 - \exp\left[-\left(\frac{v}{c}\right)^k\right]$$

$$p = \frac{1}{RP} = 1 - F(\upsilon)$$

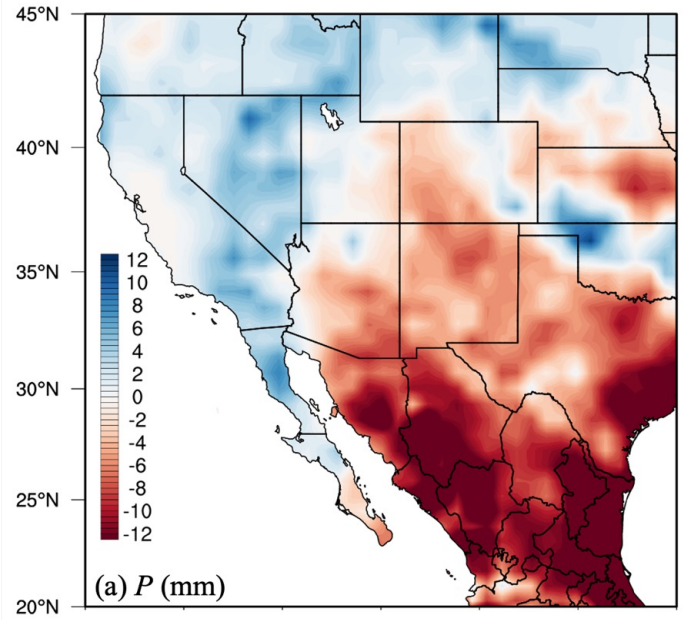
Model Selection

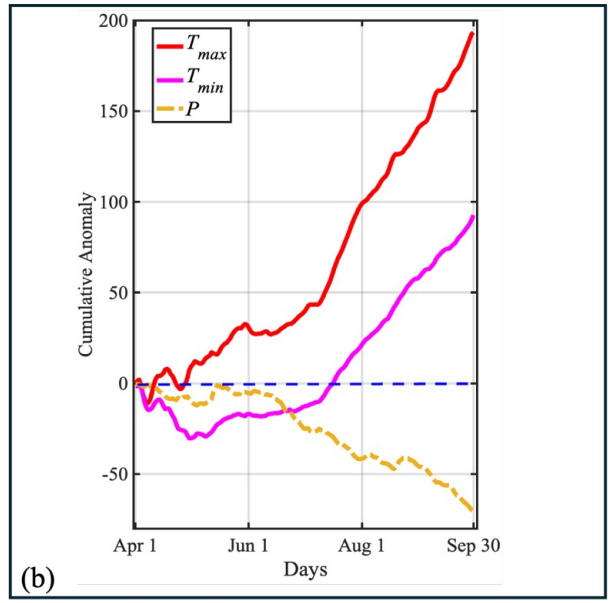
$$AIC = 2(k) - 2\ln(L)$$

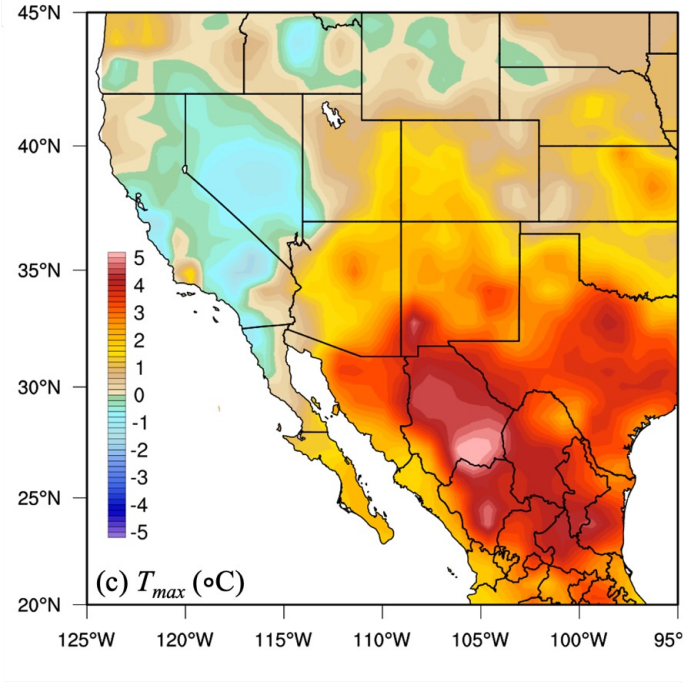
$$BIC = -2\ln(L) + d\ln(N)$$

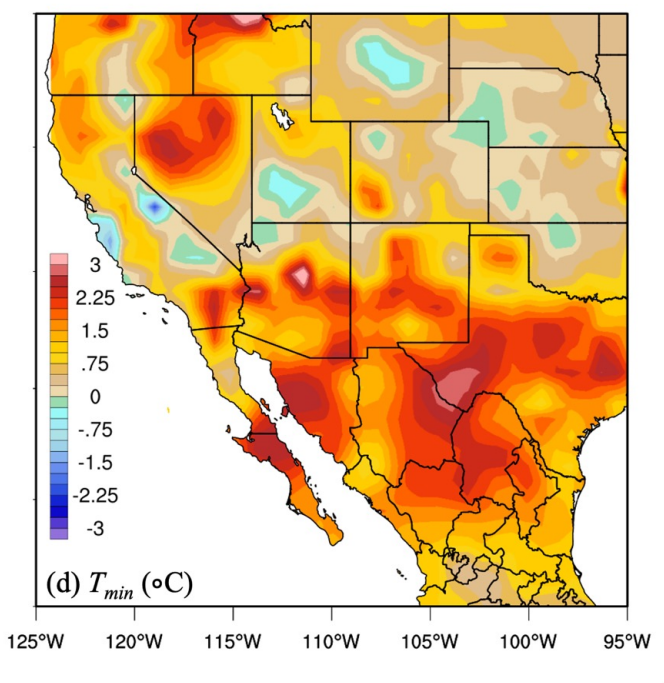
Results

Hydroclimatic Anomalies



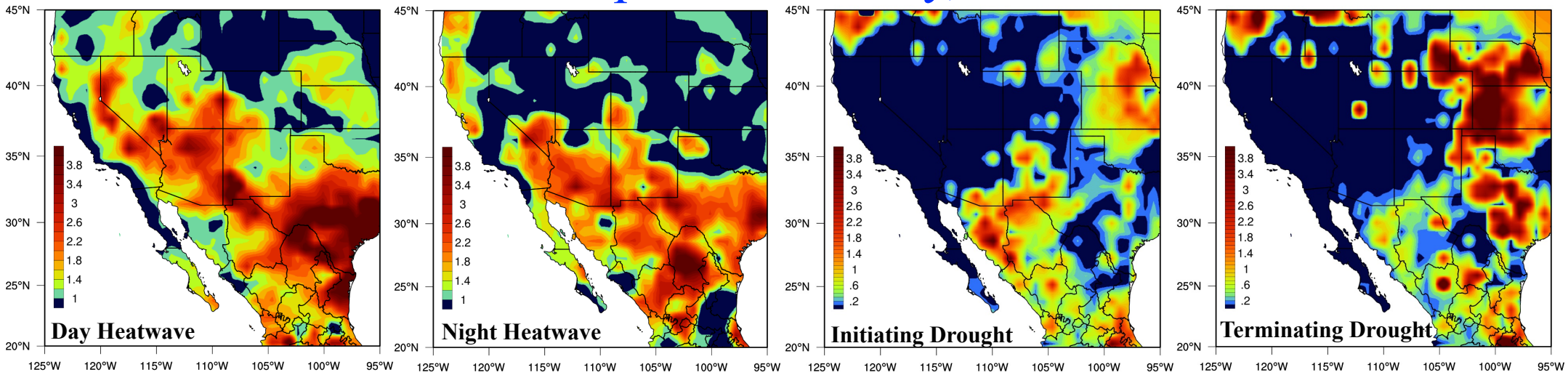




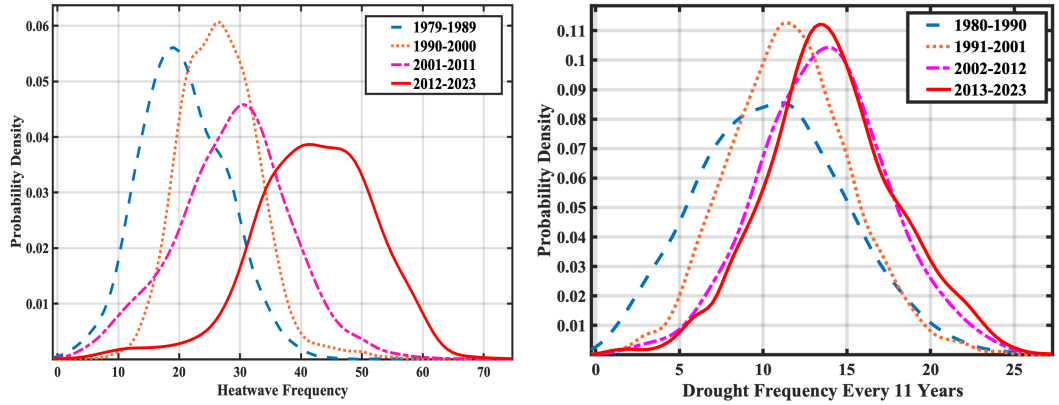


Droughts & Heatwaves

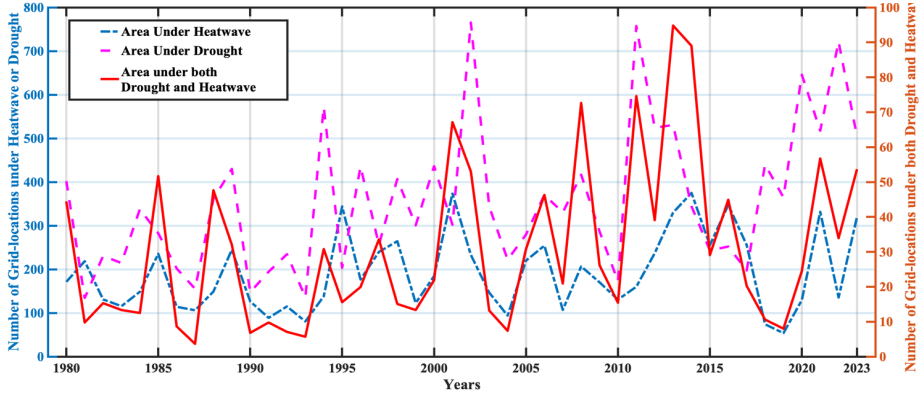
Amplified Severity, 2023



Decadal Change in Frequency

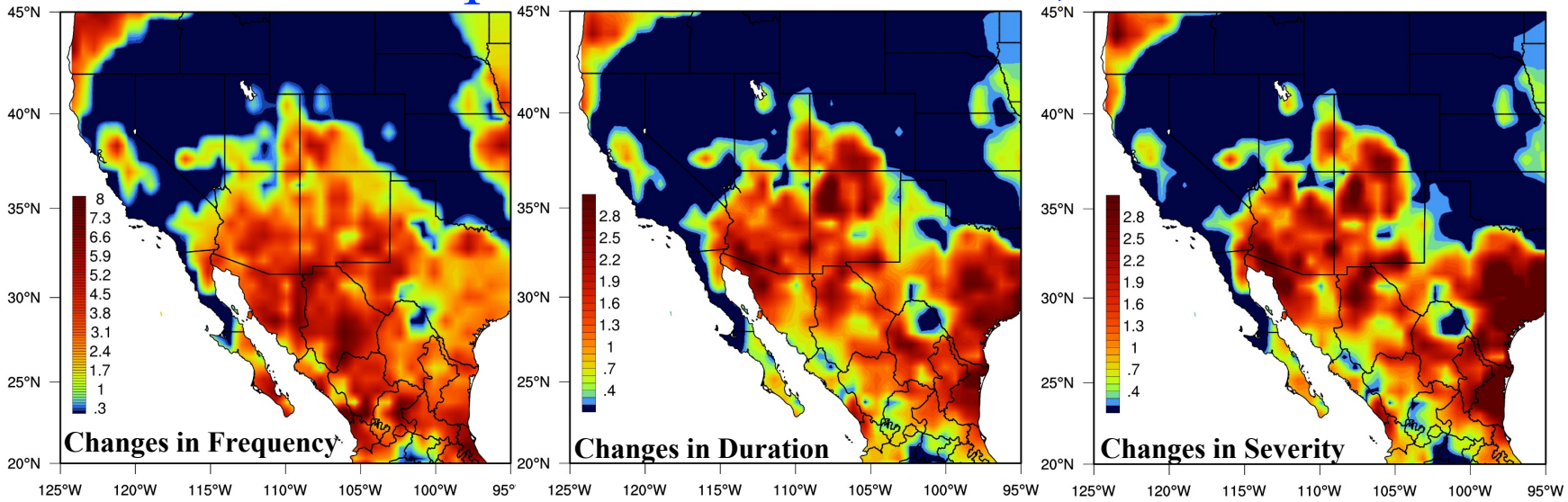


Increase in Concurrence

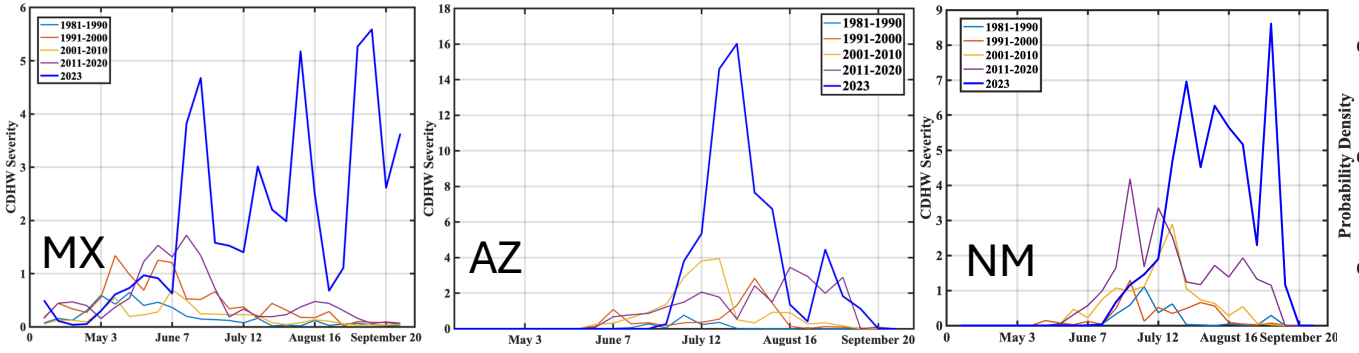


Compound Drought & Heatwave (CDHW)

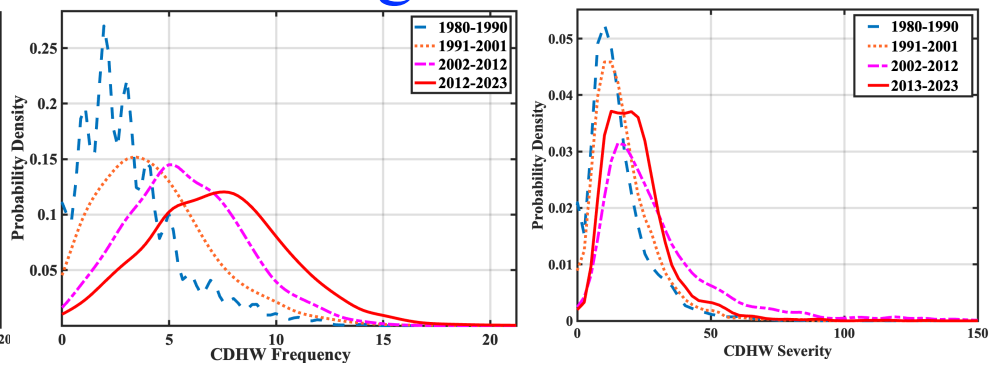
Amplified Characteristics, 2023



Spatially Averaged Severity

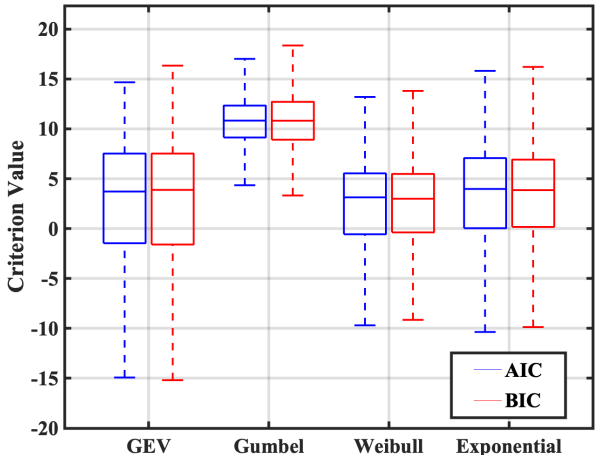


Changes in CDHW

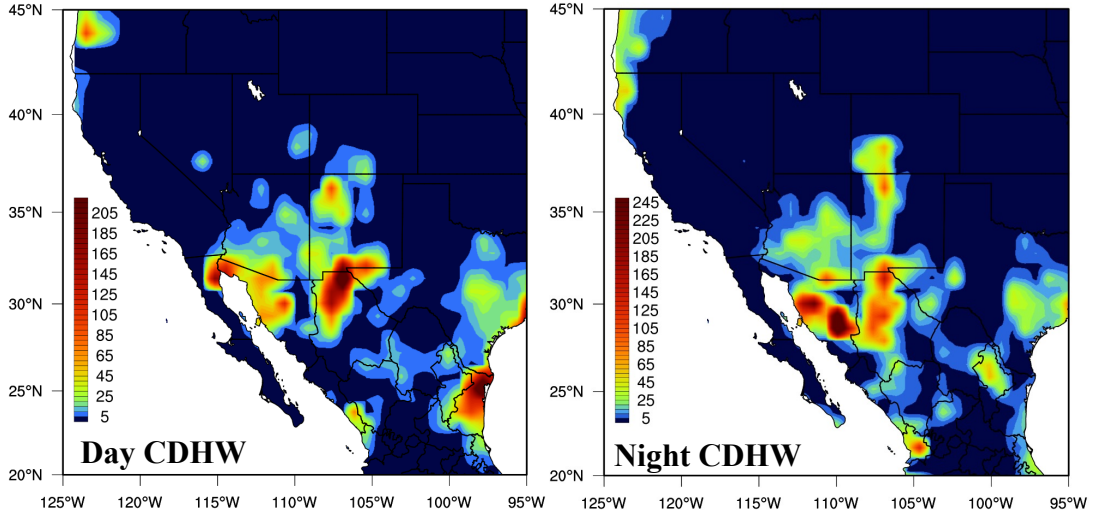


Unusuality of CDHW

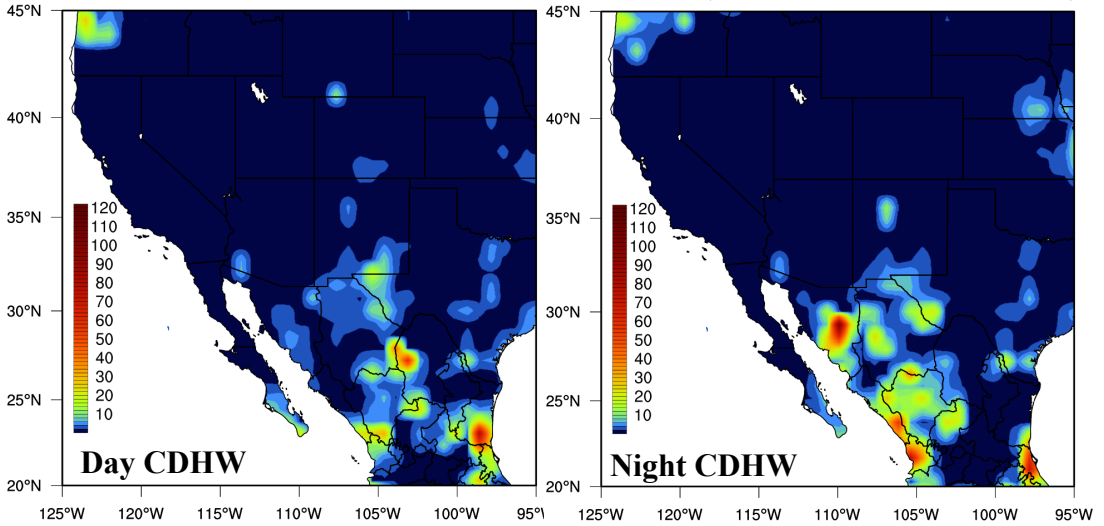
Model Selection



SPI 3 + Moderate HW (Return Period)



SPI 12 + Moderate HW (Return Period)



Conclusion

- Over 2023, Heatwaves, Droughts and CDHWs show amplified severity
- On Decadal scale, changes in characteristics of heatwaves, Droughts and CDHWs are prominent
- Nighttime and short-term CDHWs are more unusual than their daytime and long-term counterpart
- The study advocates incorporation of nighttime CDHWs as drying transcends beyond diurnal cycle