The Impact of the 2017-2018 Precipitation Whiplash Event Across the Southern Great Plains

Bryony L. Puxley*[1] | Elinor R. Martin[1,2]

[1]*School of Meteorology, University of Oklahoma, Norman, 73019;*

[2]*South Central Climate Adaptation Science Center, Norman, OK, United States of America*

Background and Motivation

- Rapid transitions in precipitations extremes, also known as precipitation whiplash events, can have direct critical impacts to agriculture, infrastructure, water quality, and water quantity.
- The green-up of vegetation during periods of excessive rainfall can pose a ***considerable fire risk*** after a transition into drought as desiccation of the land surface can yield fuel available for wildfires [Scasta et al. 2016].
- This relationship between precipitation variability and wildfires has been studied extensively across regions such as California [Dudney et al., 2017; Hernández Ayala et al., 2021]; ***however, the influence across the SGP is less well known.***
- This study examined the role of preceding precipitation anomalies in providing fuel for wildfires across the SGP. In particular, a critical precipitation whiplash event that occurred during 2017 and 2018 across parts of the SGP, which preceded a mega-fire event in the Spring of 2018 was examined.

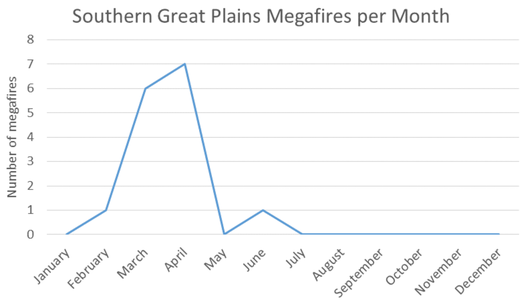


Fig 1: Southern Great Plains megafires per month 2006–2018. (Lindley et al. 2019)

Data

- Daily precipitation from the Parameter-Elevation Regressions on Independent Slopes Model (PRISM) [1981-2020] dataset.
  - Spatial resolution: 4 km.
- Regional 2 m temperature data [1981-2020] was obtained from the ERA5 reanalysis dataset.
  - Spatial Resolution: 0.25 degrees.
- Normalized Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI) from the Moderate Resolution Imaging Spectroradiometer (MODIS) [2002-2020]
  - Spatial Resolution: 5 km.
- Fractional Water Index (FWI) calculated using the calibrated change in temperature of the soil over time after a heat pulse is introduced from the Oklahoma Mesonet [1997-2020].
  - 4 Sites: Cheyenne, El Reno, Shawnee, & Webbers Falls.
- Number of Wildfires and Number of Acres burned [1984-2020] was acquired from the Monitoring Trends in Burn Severity (MTBS) program.

Wildfires and Antecedent Conditions

- Lag correlation analysis of historical data implies that an active April wildfire season are linked to elevated spring vegetation conditions, an anomalously wet summer, and a subsequent dry and warm winter coinciding with reduced vegetation conditions.

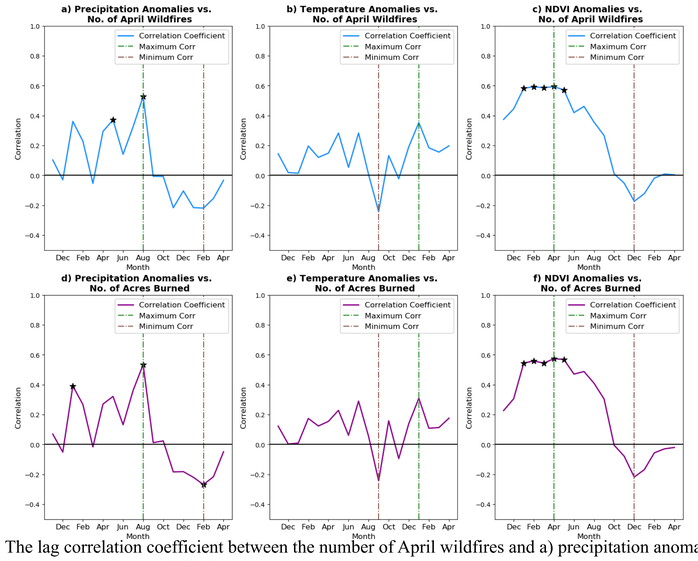
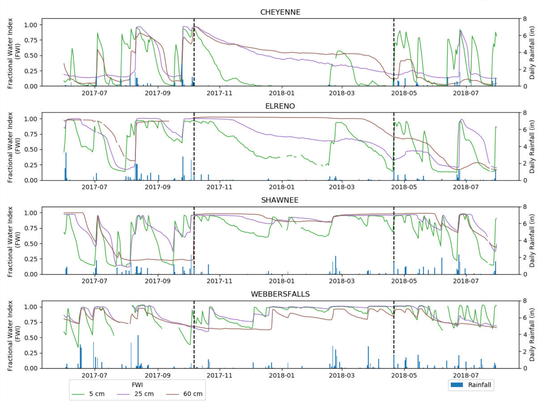


Fig 2: The lag correlation coefficient between the number of April wildfires and a) precipitation anomalies, b) temperature anomalies, c) NDVI anomalies and the number of acres burned by April wildfires and d) precipitation anomalies, e) temperature anomalies, f) NDVI anomalies. All values are domain-averaged across the primary study domain, as shown in Figs 5 & 6. The green and brown dashed lines show the maximum and minimum correlation coefficients, respectively, and the black stars show values that are significant to the 95% level, calculated using Monte Carlo.

Soil Moisture Conditions during 2017 and 2018



Overall, the transect created using Oklahoma Mesonet stations highlighting soil moisture conditions across the drought gradient, confirms that soils became desiccated through the root zone within the drought-affected areas (Cheyenne & El Reno)

Fig 3: Daily rainfall totals (blue) and Fractional Water Index (FWI) for three levels; 5cm (green), 25cm (purple), and 60 cm (brown), for 4 Oklahoma Mesonet sites throughout 2017 and 2018. The black dashed lines signify the different periods for analysis: Period 1 (Jun 1st – Oct 7th) and Period 2 (Oct 8th – April 24th)

Precipitation and Vegetation during 2017 and 2018

- Precipitation anomalies that were **137% of normal** during the growing season of 2017 rapidly cascaded into drought conditions with precipitation anomalies **21% of normal** throughout the cool winter season.
- The excessive precipitation supported vigorous vegetation recovery and growth with vegetation indices peaking at approximately **1 standard deviation** above average during August 2017, before the subsequent drought period rapidly desiccated the terrestrial surface.

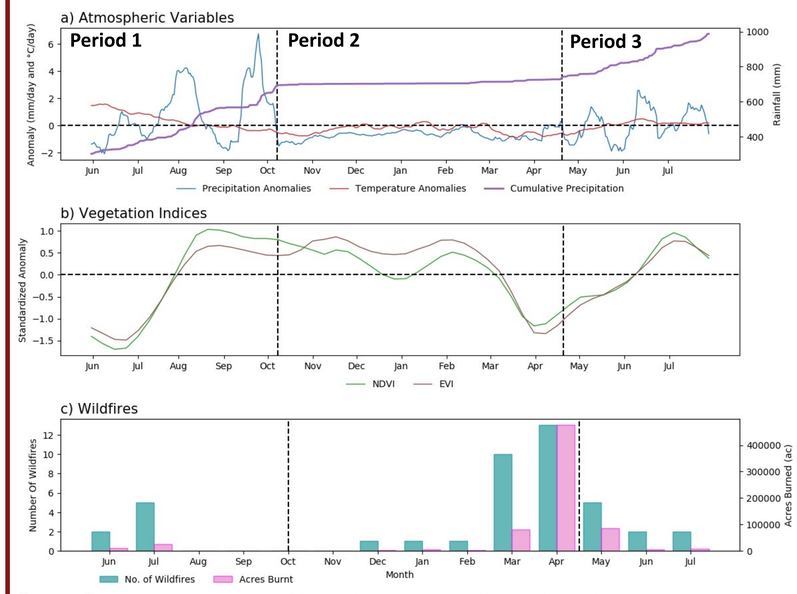
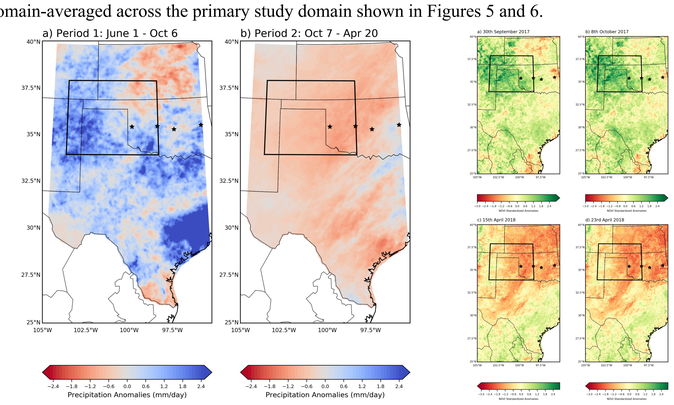


Fig 4: a) Time series of precipitation (blue) and temperature (red) anomalies and cumulative precipitation totals (purple); b) NDVI (green) and EVI (brown) standardized anomalies; and c) the number of wildfires (blue) plus the number of acres burned by wildfires (pink) per month for the primary domain. All values are domain-averaged across the primary study domain shown in Figures 5 and 6.



Figs 5 & 6: Precipitation anomalies (left) and standardized NDVI anomalies (right) across the Southern Great Plains. Black box outlines area averaged to create the timeseries above (Fig 4). Black stars represent the location of the four Oklahoma Mesonet sites from west to east; Cheyenne, El Reno, Shawnee, and Webbers Falls.

Conclusions

- Excessive precipitation 9 months prior followed by reduced precipitation 2 months prior can significantly impact the severity of the wildfire season.
- The relationship between precipitation, temperature, vegetation, and spring wildfires illustrates that antecedent conditions could be a useful for predicting the severity of the fire season across this region.
- Recognition of antecedent conditions that are conducive to an active fire season has already influenced strategic preparations and decision-making during the 2011 Texas wildfires (Lindley et al. 2014)

NSF EPSCoR Research Infrastructure Improvement Award No. OIA-1946093

Contact: Bryony Puxley | bryony.puxley@ou.edu