

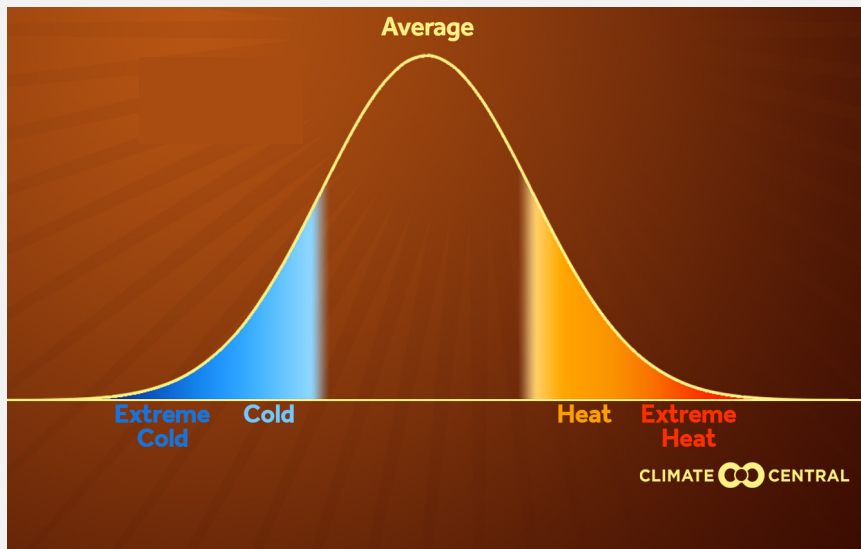
Climate Change and Extreme Weather Trends in the South Central US



Jason C. Furtado, School of Meteorology, University of Oklahoma
SC-CASC Fall Meeting 2022
10 November 2022

WHAT IS “EXTREME WEATHER?”

The *Mathematical* Definition



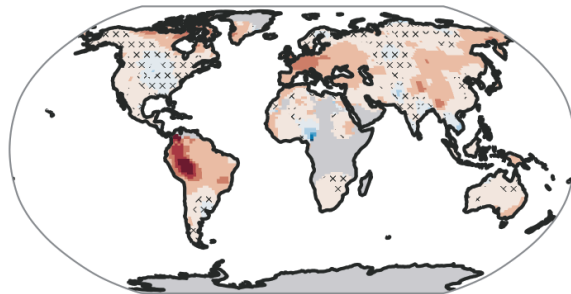
Impacts-Based Definition



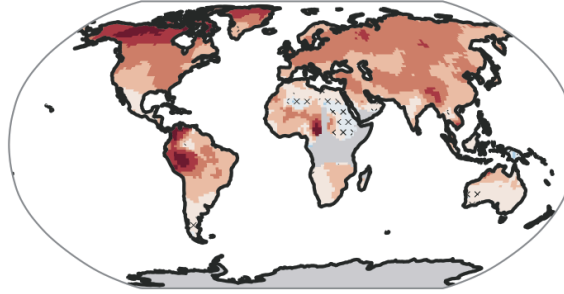
TRENDS IN EXTREME WEATHER EVENTS (TEMPERATURE)

Observed linear trends over 1960–2018

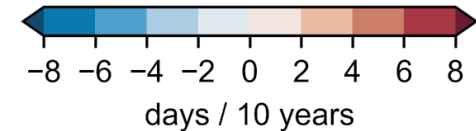
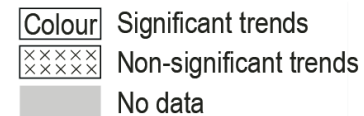
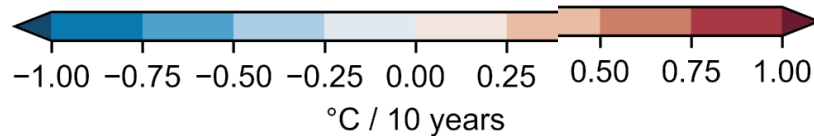
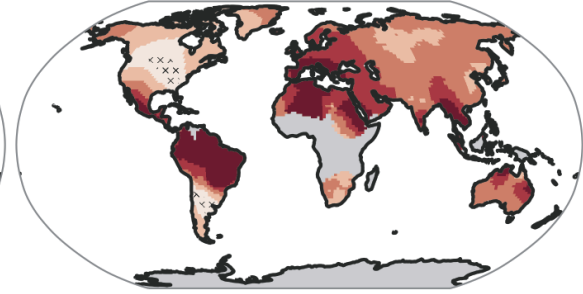
(a) Annual hottest temperature (TXx)



(b) Annual coldest temperature (TNn)



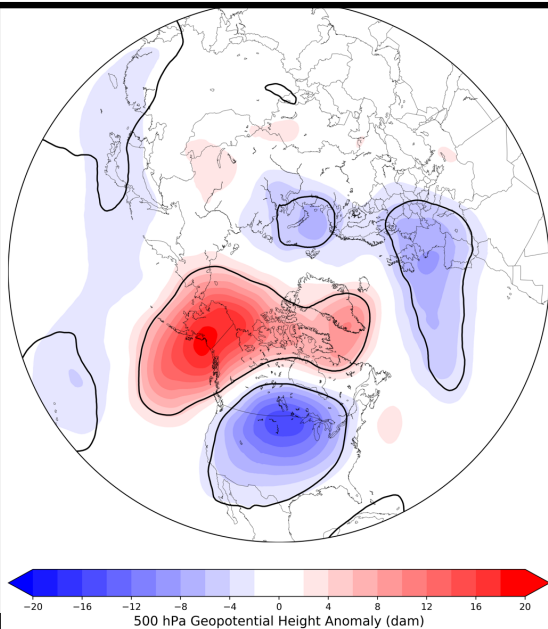
(c) Number of days exceeding 90th percentile (TX90p)



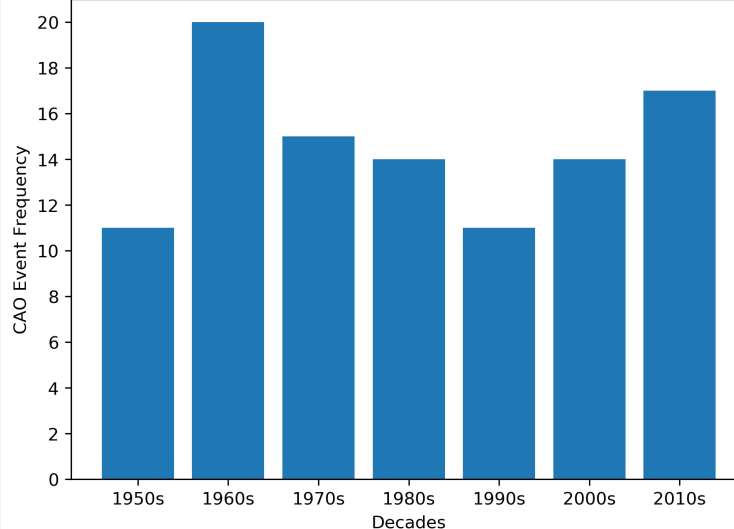
Source: IPCC AR6

COLD AIR OUTBREAKS (CAOs) ARE ON THE INCREASE TOO!

**Favorable 500 hPa GPH Anomalies
During Central Plains CAOs (1950-
2021)**

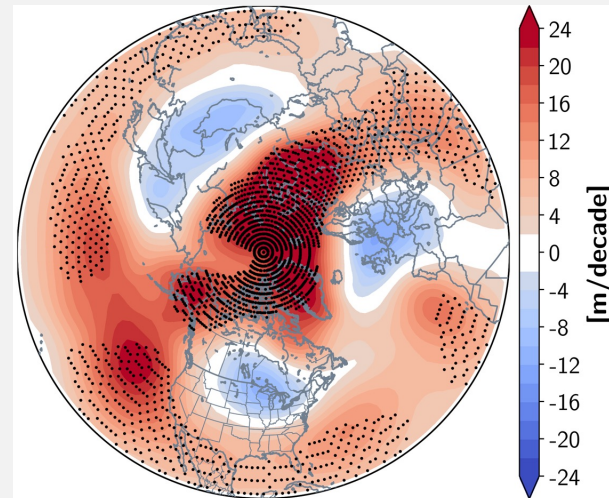


Central US CAO Frequency by Decade



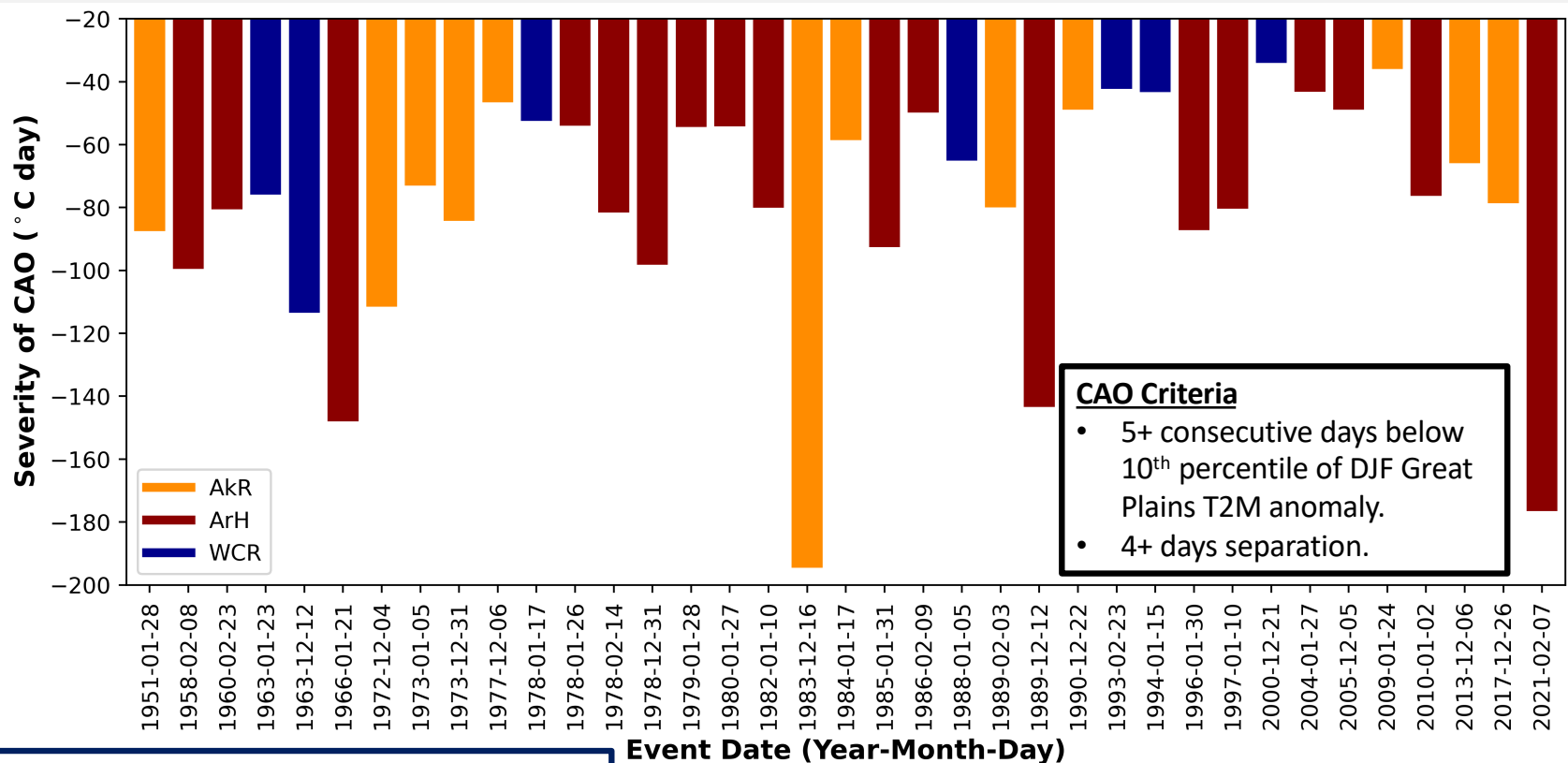
Grant #OIA-1946093

Trend- 500 hPa Heights



*Data: ERA-5/ERA-Interim
Contour: Significant @ 90%
Millin et al. [2022]*

HISTORIC CENTRAL US COLD AIR OUTBREAKS



Severity = Avg Daily T2M anomaly x Duration



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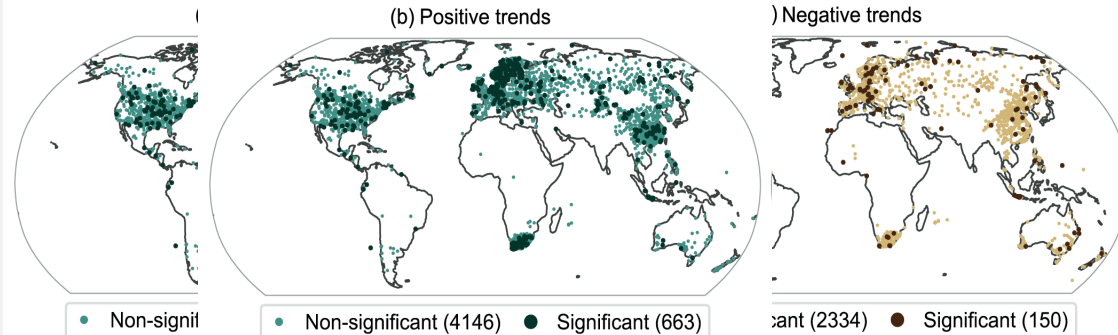
Data: ERA-5 Reanalysis
Millin et al. [2022] J. Climate

TRENDS IN EXTREME WEATHER EVENTS (PRECIPITATION)

Observed trends in annual maximum daily precipitation (Rx1day)

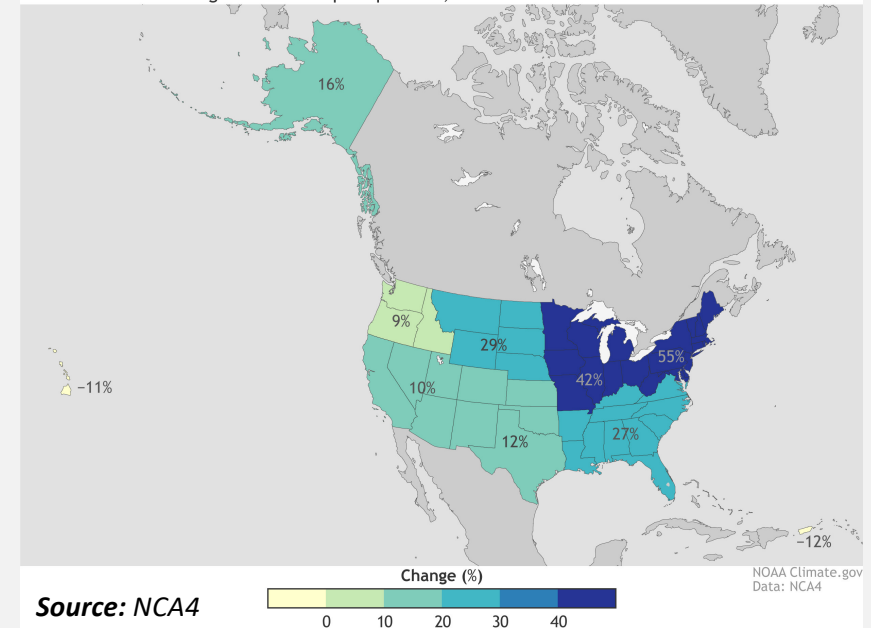
(b) Positive trends

(c) Negative trends

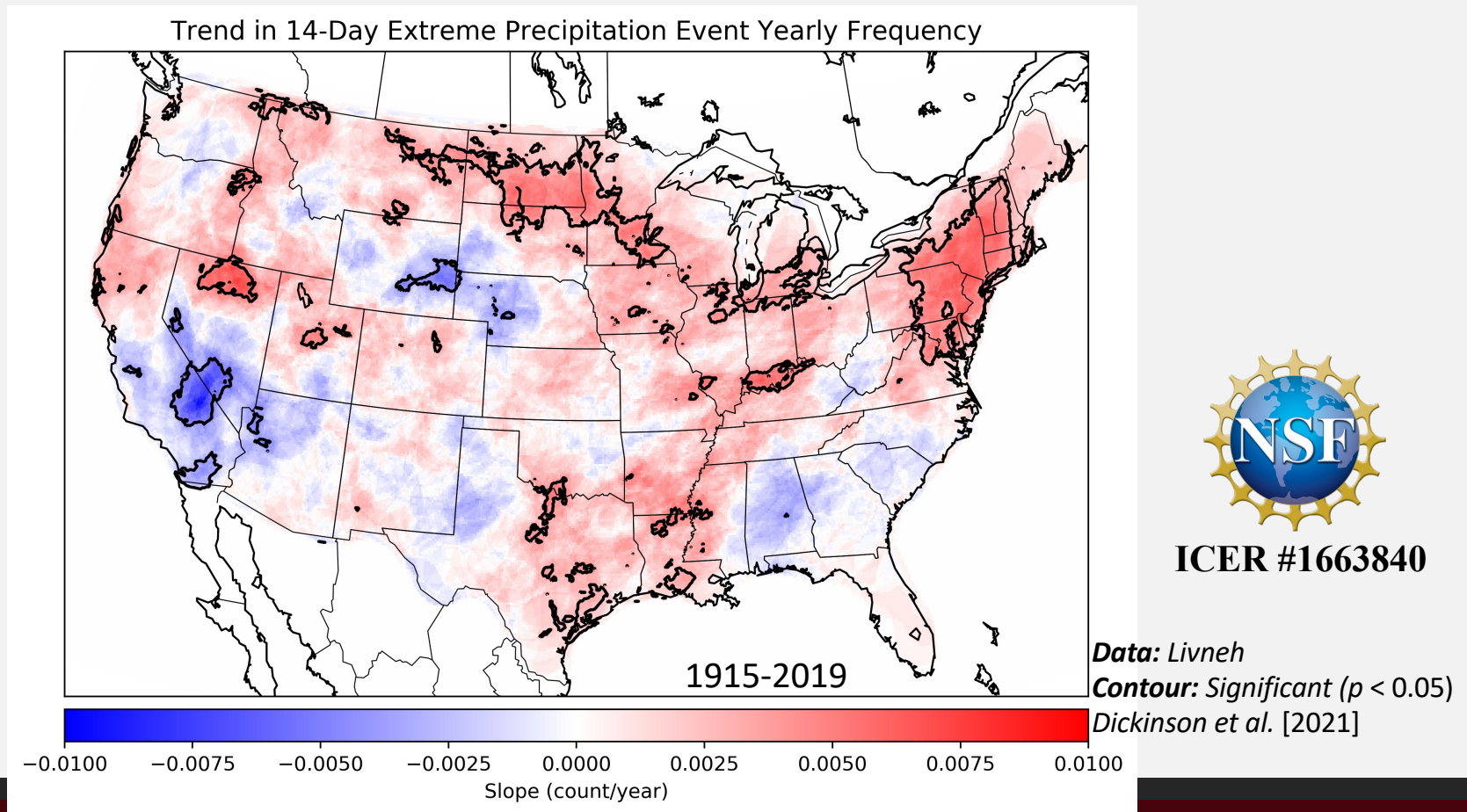


Source: IPCC AR6

Observed recent change in extreme precipitation, 1958–2016

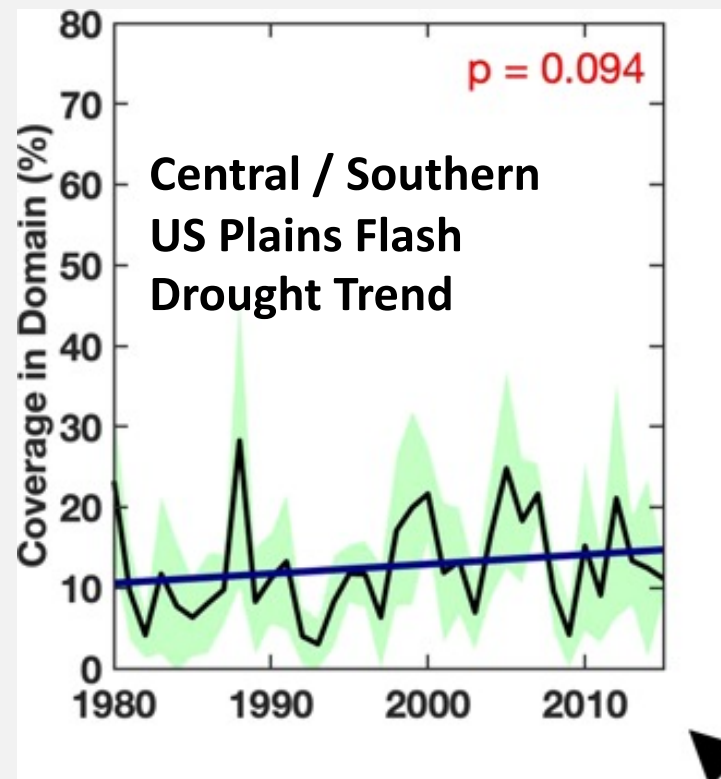
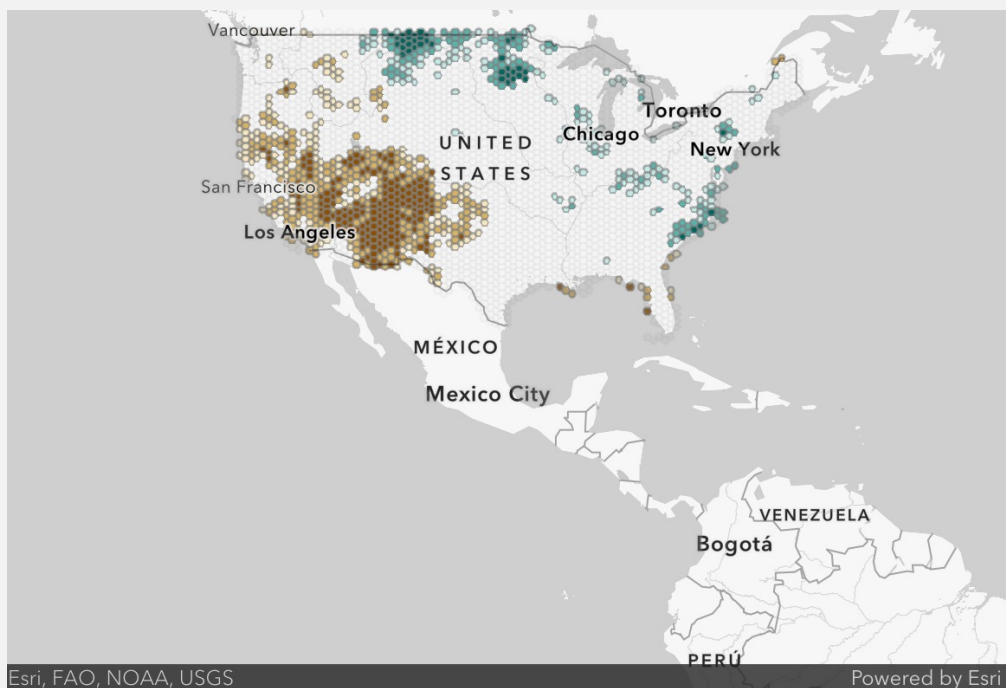


TRENDS IN "RAINY PERIODS" (14-DAY EXTREME RAINFALL)



TRENDS IN EXTREME WEATHER EVENTS (DROUGHT)

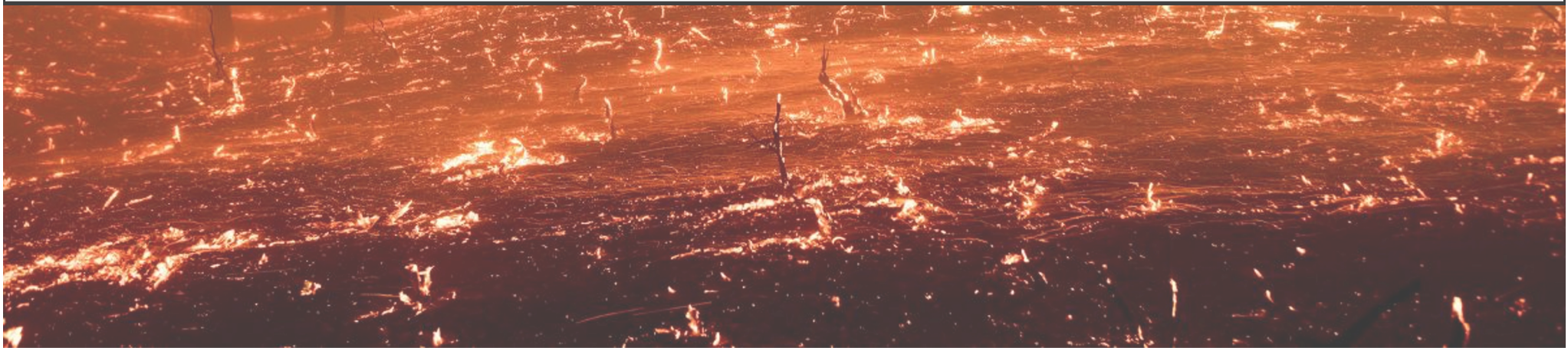
Trend in Drought and Moisture Surplus (1980-2019)



Christian et al. [2021]



HOW DOES CLIMATE CHANGE PLAY INTO EXTREME WEATHER FREQUENCY AND INTENSITY?



PHYSICAL MECHANISMS FOR CLIMATE CHANGE → EXTREME EVENTS

(#1) *The Clausius-Clapeyron Effect*

- For every 1°C of warming, the atmosphere can hold 7% more water vapor.
- Can result in **excess rainfall** and/or exacerbate **drought**

(#2) **More instability = More extreme weather**

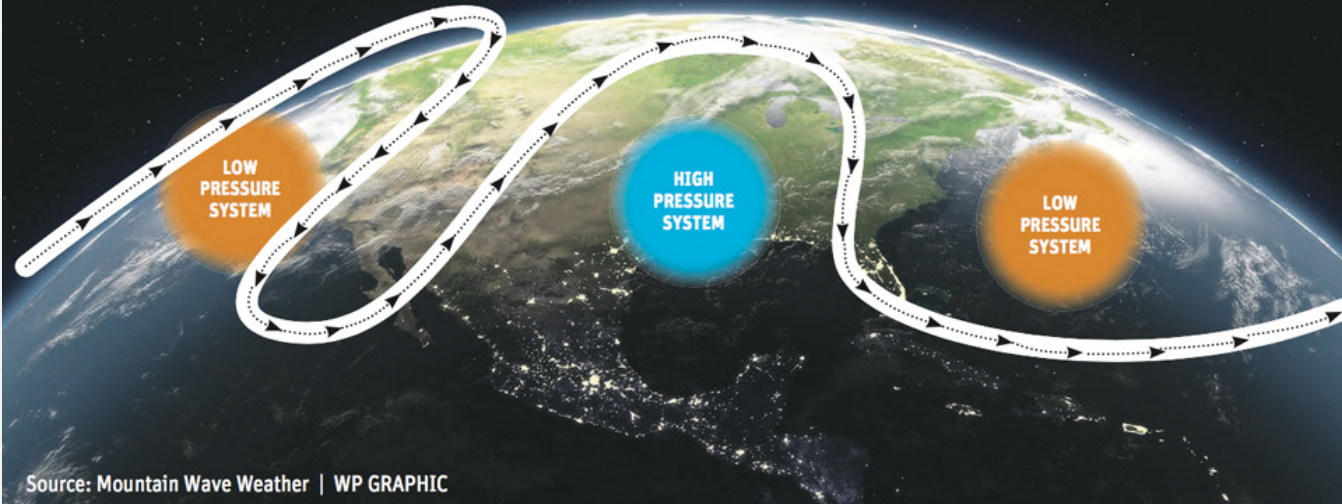
- *If* surface warming > warming at upper levels, then convection can become more vigorous → strengthen tropical & extratropical storms

(#3) **Wavier Jet Stream = More extremes**

- As the Arctic warms faster than lower latitudes, the polar jet stream weakens.

WHEN WEATHER STICKS AROUND

Atmospheric blocking has been linked to periods of persistent weather in which drought, freezing temperatures or heat sticks around for weeks. Here you can see a persistent pattern where a high pressure system is blocked between two low pressure systems.



Source: Mountain Wave Weather | WP GRAPHIC

A “wavier” jet is slower and promotes persistent weather patterns with multiple effects
(BLOCKING)



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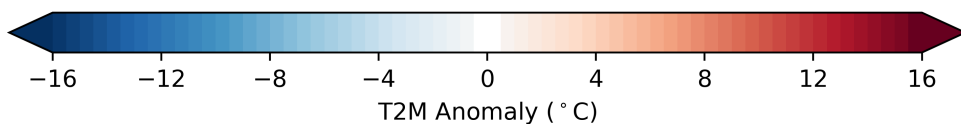
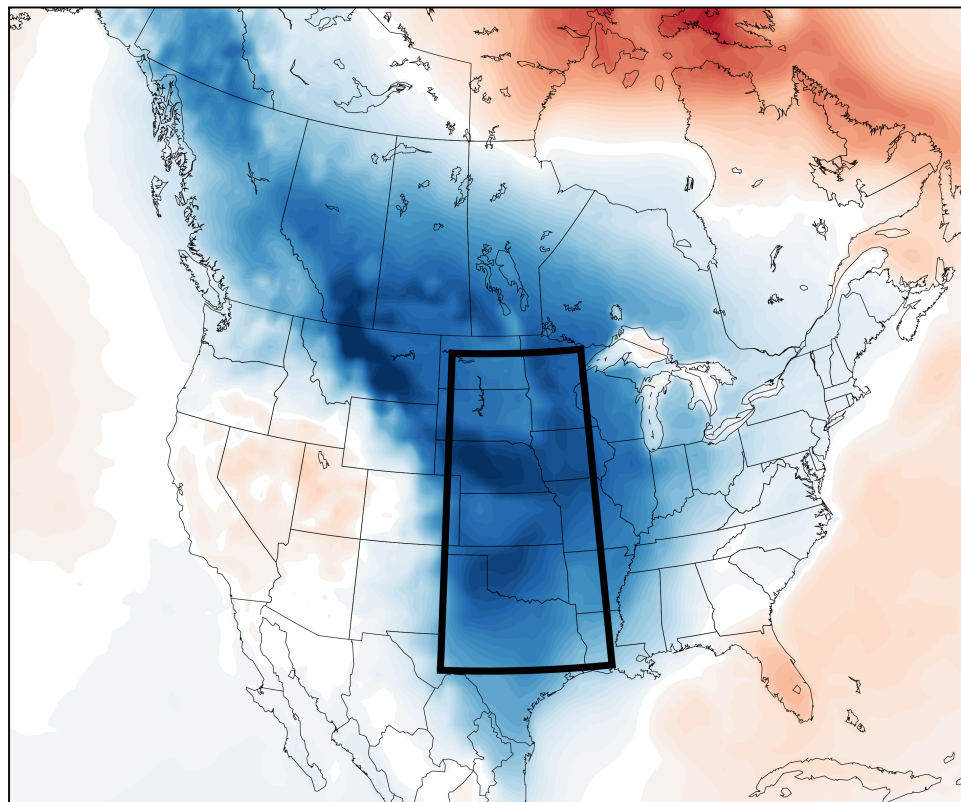
THANK YOU!

E-mail: jfurtado@ou.edu

Web: <http://ifurtado.org>

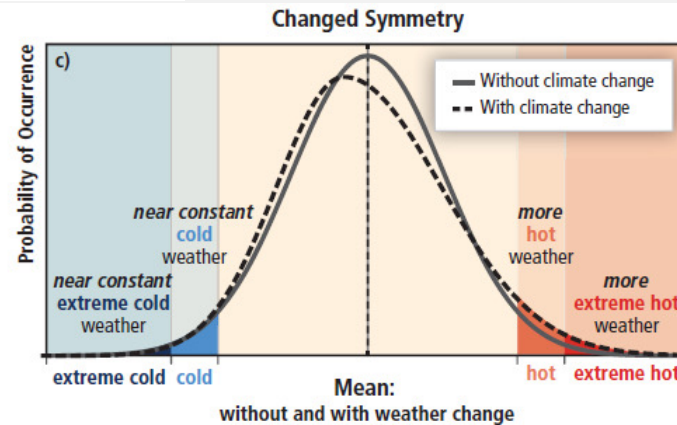
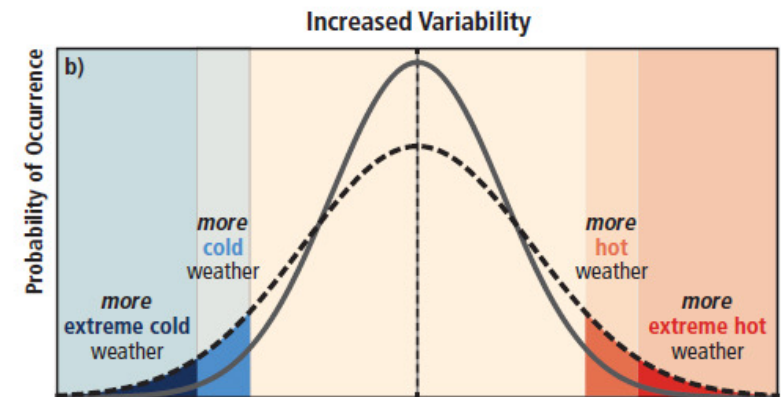
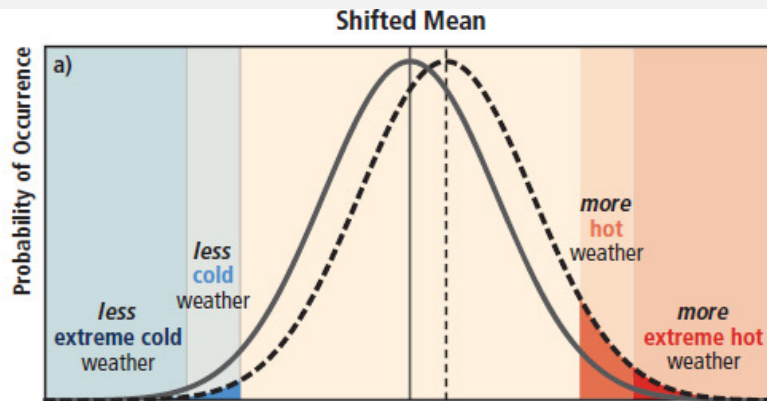
LinkedIn: <https://www.linkedin.com/in/jason-c-furtado/>

7 Feb 2021 to 20 Feb 2021



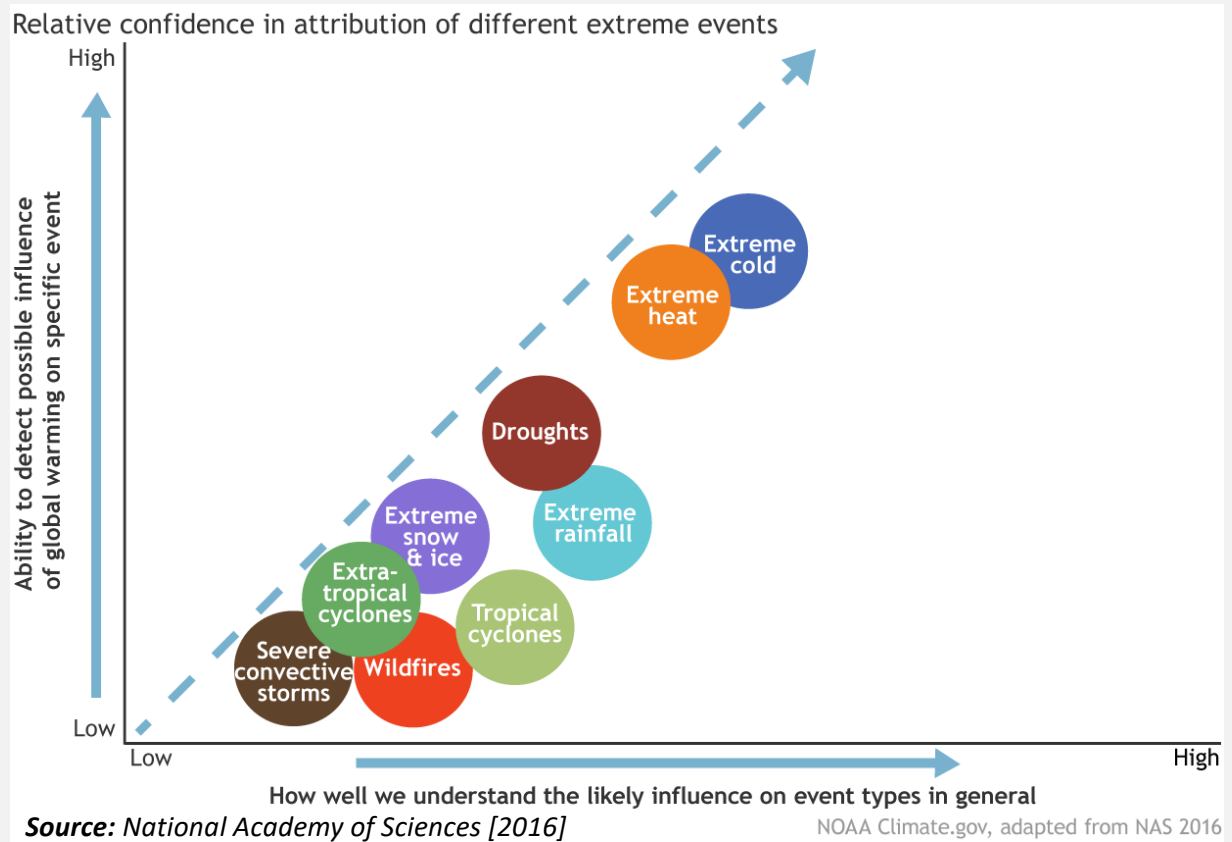
**SURFACE
TEMPERATURE
DEPARTURES
DURING THE FEB
2021 CAO (EVENT
AVERAGE)**

CLIMATE CHANGE “LOADS THE DICE” FOR EXTREMES

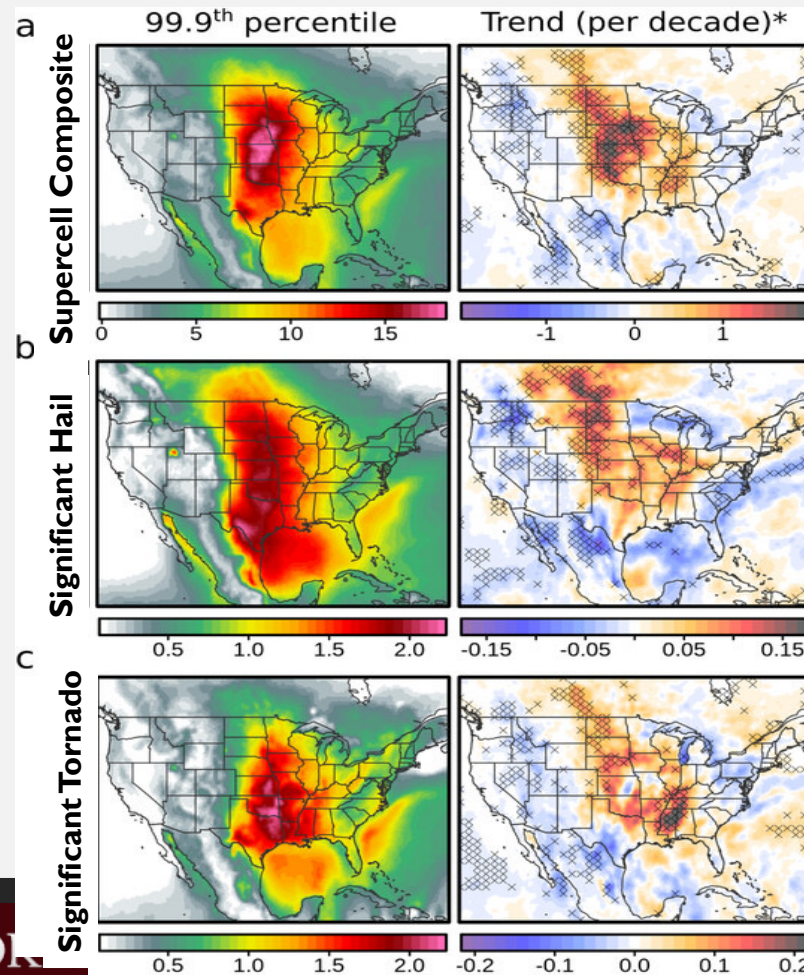


Source: National Academy of Sciences [2016]

ATTRIBUTION OF CLIMATE CHANGE TO EXTREME WEATHER EVENTS

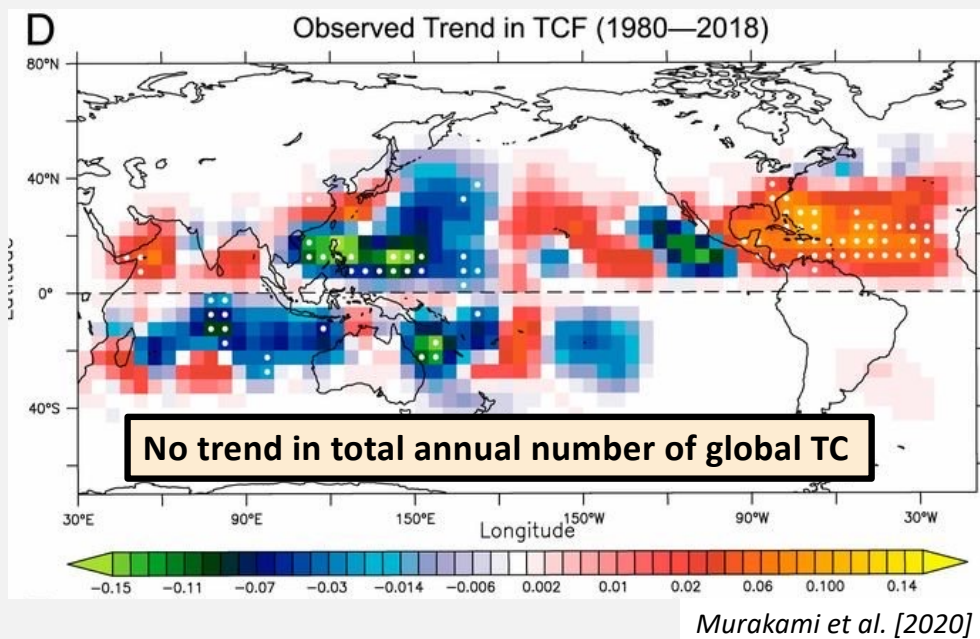


TRENDS IN EXTREME WEATHER EVENTS (SEVERE WEATHER)



Tazsarek et al. [2021]

TRENDS IN EXTREME WEATHER EVENTS (TCs)



BUT

**MORE INTENSE
HURRICANES**

