# Improving Resiliency to Rainfall Extremes in Oklahoma

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Southern Climate Impacts Planning Program

*Oklahoma Clean Lakes and Watersheds Association*
*27th Annual Conference*
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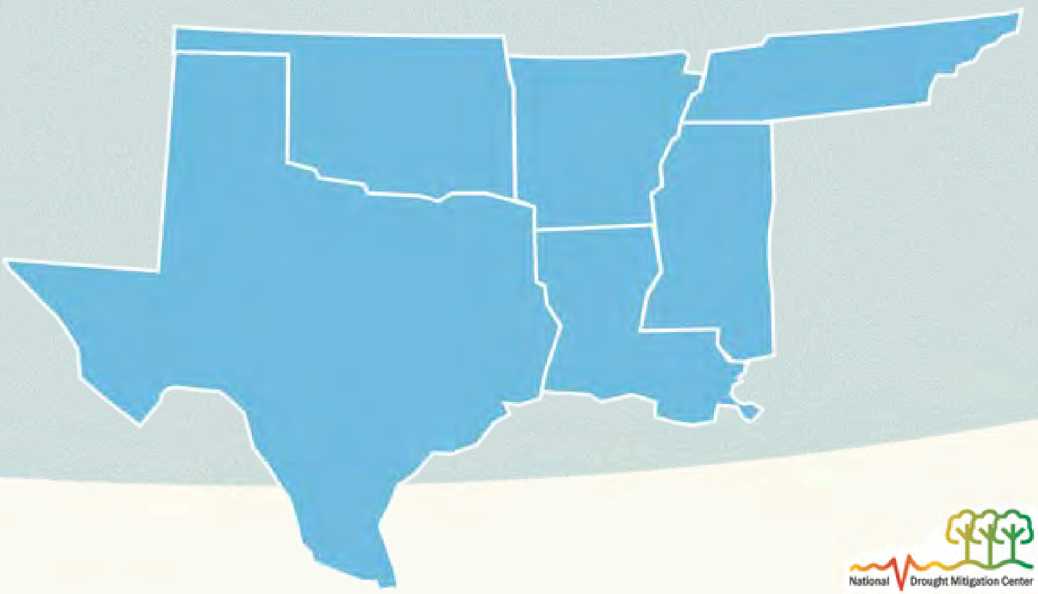
# About the Southern Climate Impacts Planning Program (SCIPP)

- Established in 2008
- 1 of 11 NOAA Regional Integrated Sciences and Assessments teams
- Collaboration between OU, Louisiana State University, Texas A&M University, and National Drought Mitigation Center
- Mission: Increase the region’s resiliency and preparedness for weather and climate extremes.



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# Oklahoma Extremes

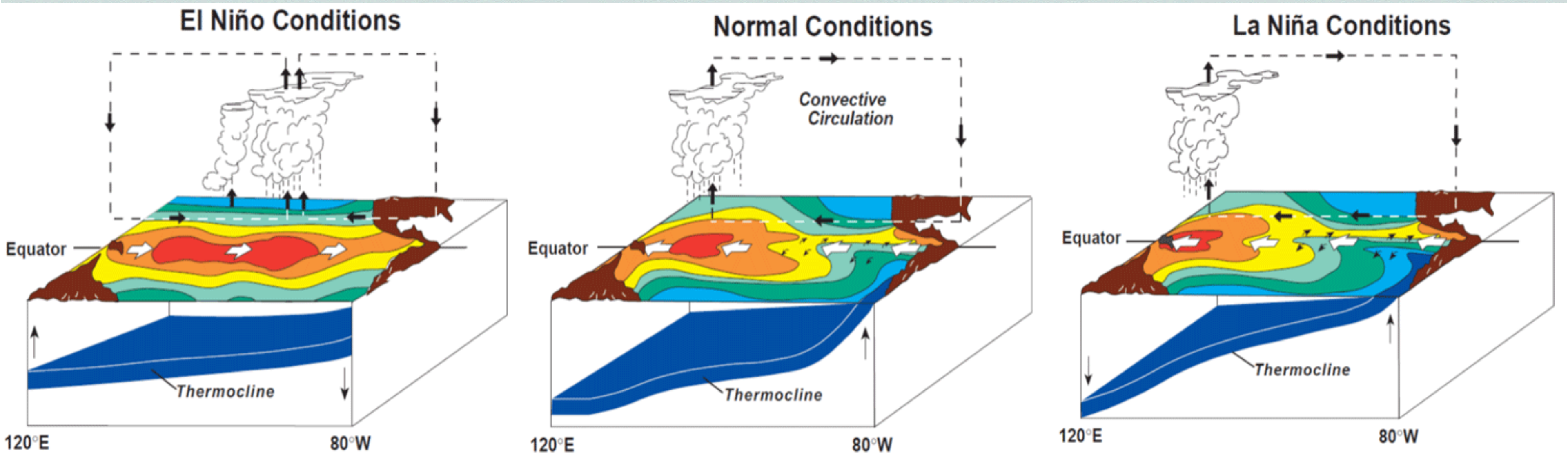
# Ocean Circulations

Large factor in climate variability

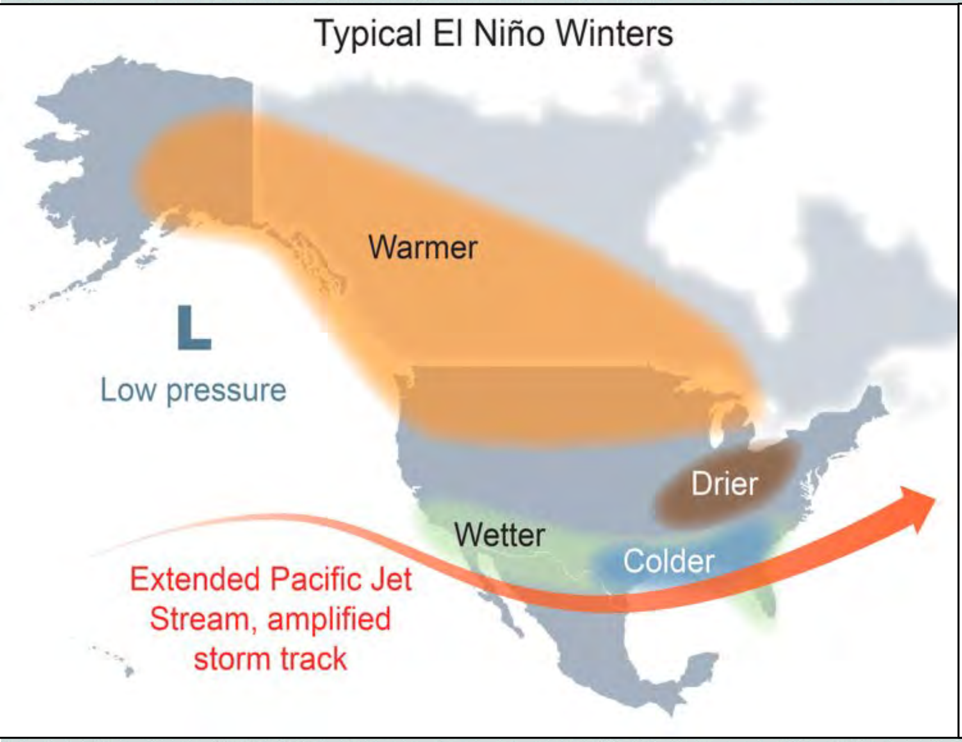
- Oscillations occur across ocean basins
- Sea surface temperatures flip between warm and cold phases
- Impacts location of the jet streams

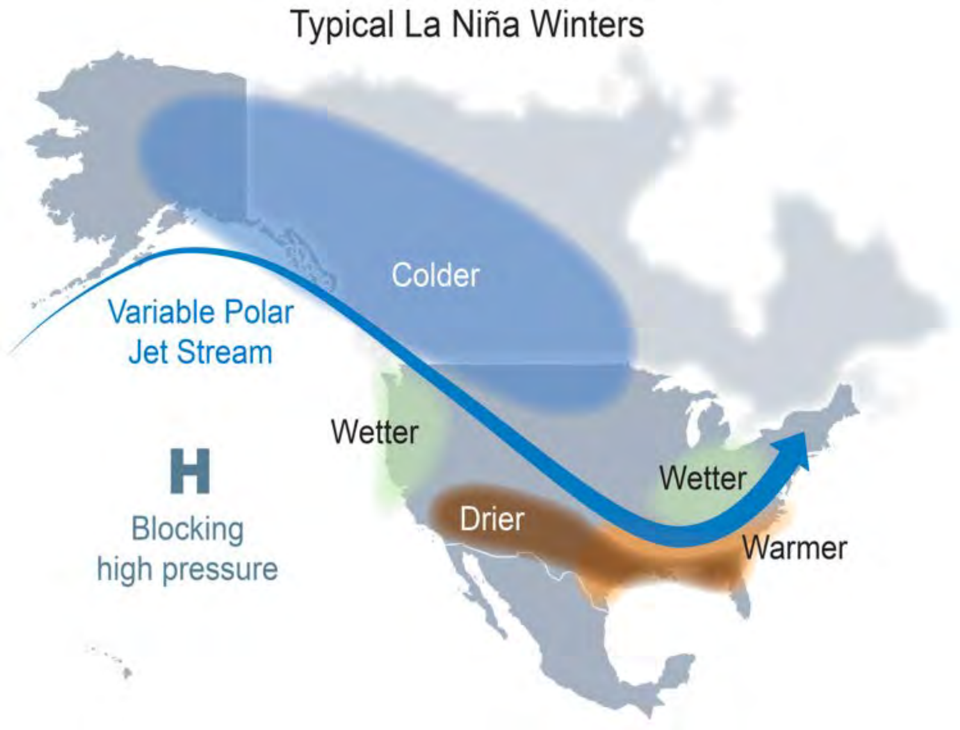
El Niño-Southern Oscillation (ENSO):

- El Niño/La Niña/Neutral
- Tropical Pacific
- Interannual: 2 to 7 year timescale



# El Niño-Southern Oscillation (ENSO)




**El Niño (warm phase)**
strengthens jet stream south
trends cool and wet in South

**La Niña (cold phase)**
shifts jet stream north
trends dry and warm in South

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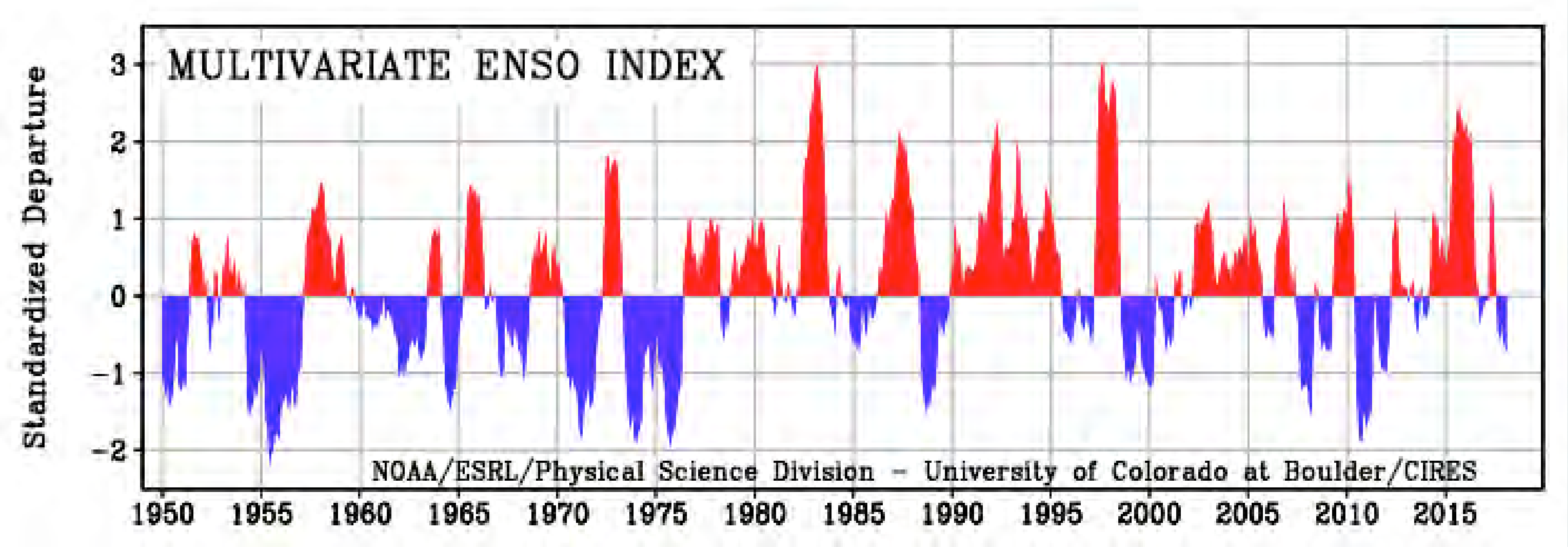
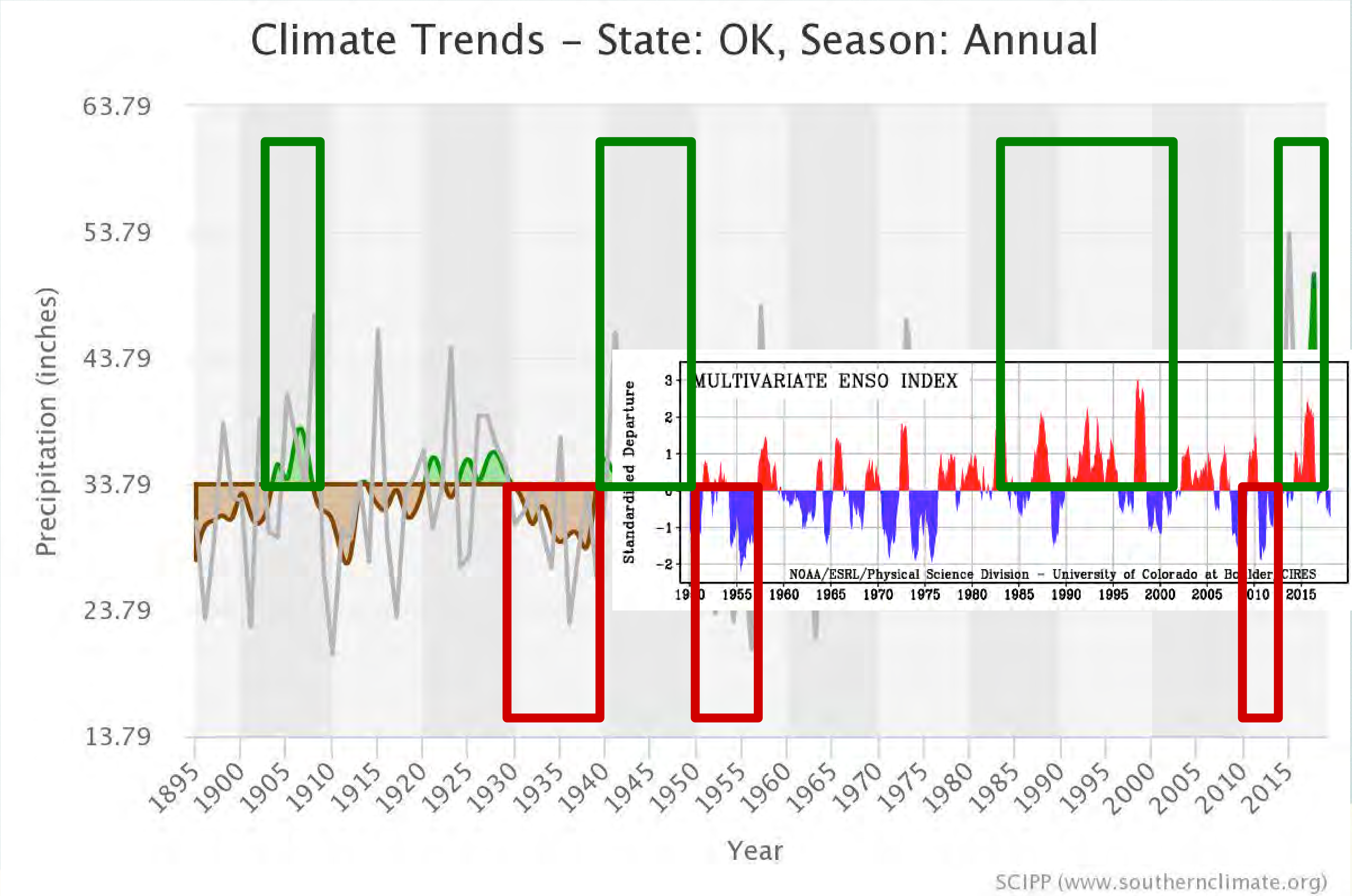
# “Phases” of ENSO

**Preference for El Niños**




**Preference for La Niñas**

*Source: NCA*



Climate Trends – State: OK, Season: Annual
Precipitation (inches)
63.79
53.79
43.79
33.79
23.79
13.79
Year
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
MULTIVARIATE ENSO INDEX
Standardized Departure
NOAA/ESRL/Physical Science Division – University of Colorado at Boulder CIRES
SCIPP (www.southernclimate.org)

# What is a Dipole?

A pair of equal and opposite electric charges or magnetic poles of opposite sign separated especially by a small distance.

An abrupt year-to-year transition from drought to flood (pluvial).

Able to erase multi-year droughts in a matter of months.

Based on the work of Jordan Christian, Katy Christian & Jeff Basara, University of Oklahoma.

Christian, J., K. Christian, and J. Basara (2015). Drought and Pluvial Dipole Events within the Great Plains of the United States. *Journal of Applied Meteorology and Climatology,* **54**, 1886-1898.

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# Defining Dipole Events

Years were categorized as:

- Drought: 90% of normal or less
- Pluvial (wet): 110% of normal or greater
- Normal: 90-110%

Year-to-Year changes from drought to pluvial were identified.

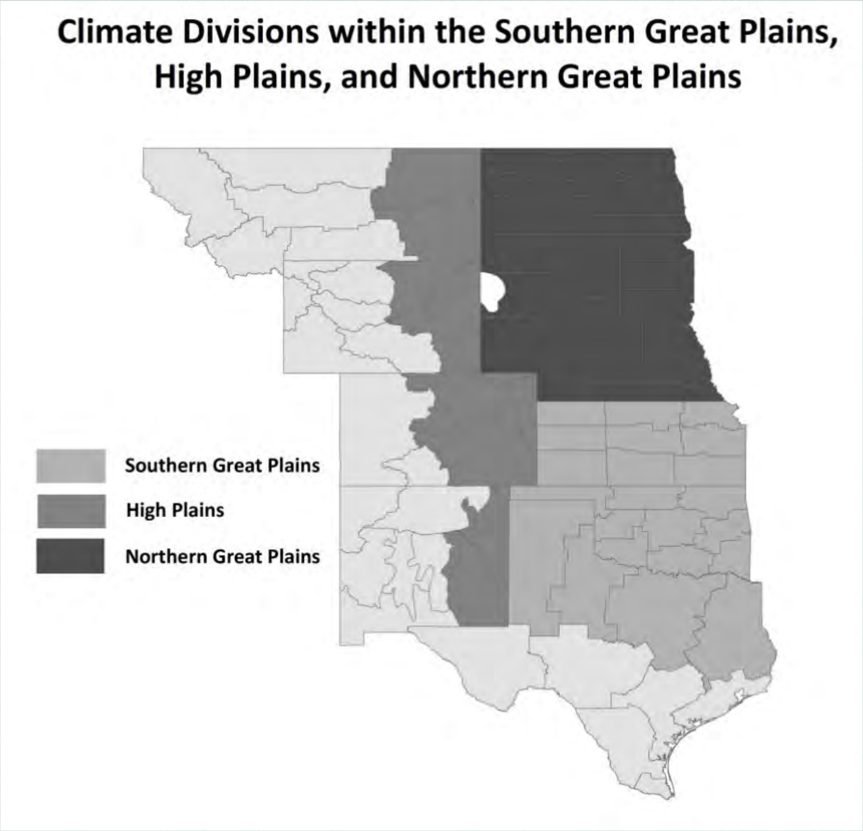
Also looked at large inter-annual changes, regardless of phase:

- From very dry to less dry
- From near-normal to very wet

# Study Area

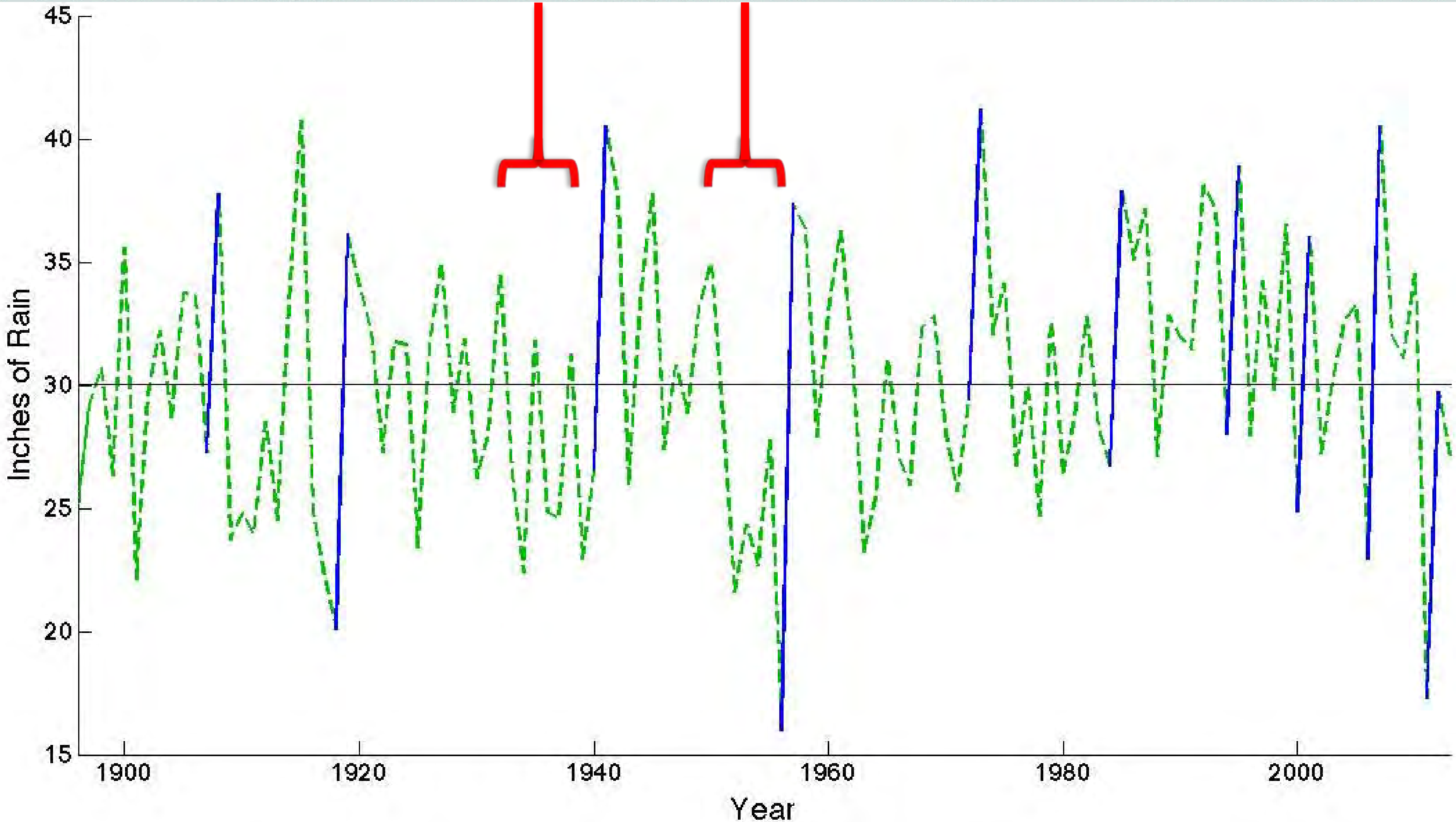
3 regions with different climate characteristics:
-Southern Great Plains (SGP)
-Northern Great Plains (NGP)
-High Plains (HP)

Probability of a significant drought year followed by a pluvial year:
-SGP: 25%
-NGP: 25%
-HP: 16%



# Notable Occurrences in Southern Great Plains

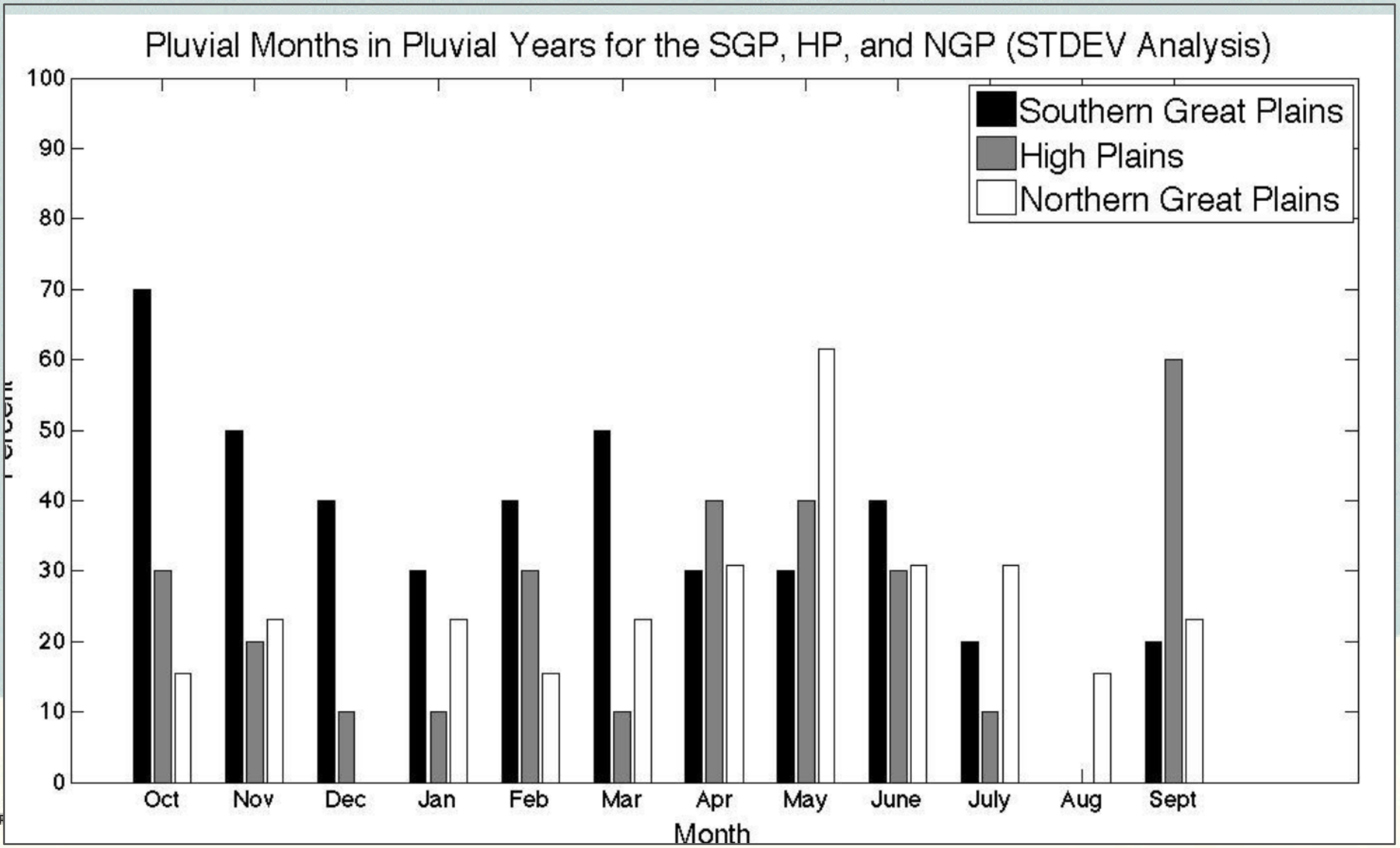
Droughts of Record



# When Does It Happen?

Wettest months of pluvial year varies by region.
-Months with 40% or more above normal precipitation.

SGP transition most likely fall / late winter.

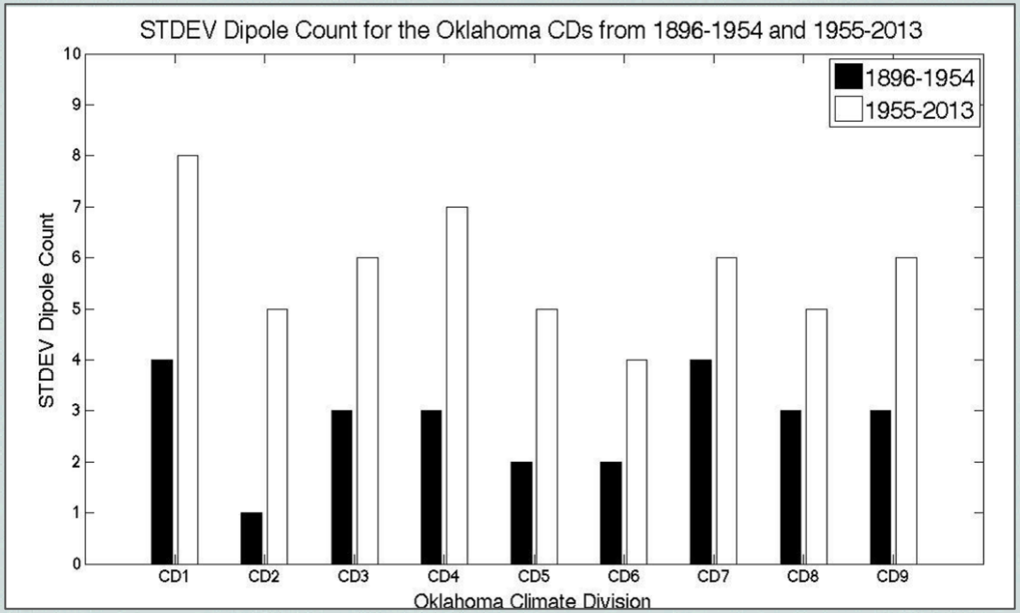


# Becoming More Frequent?

In SGP, more common in second half of climate record than first half.

Only 3 events 1896-1945:
- Average spacing 17 years

7 events 1955-2013:
-Average spacing 9 years
-3 in last 12 years (includes 2015)




No such trends in NGP or HP.

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# Increasing Precipitation **Variability** in U.S. Great Plains (GP)

Ruiz-Barradas and Nigam (2005) showed that the GP is an area of high precipitation variability in the U.S.

Flanagan et al. (2017) noted that the variability of the “asynchronicity” between the annual temperature and precipitation maxima in the SGP is increasing.

Weaver et al. (2016) noted a change in the April/May/June precipitation variability over the NGP and SGP.

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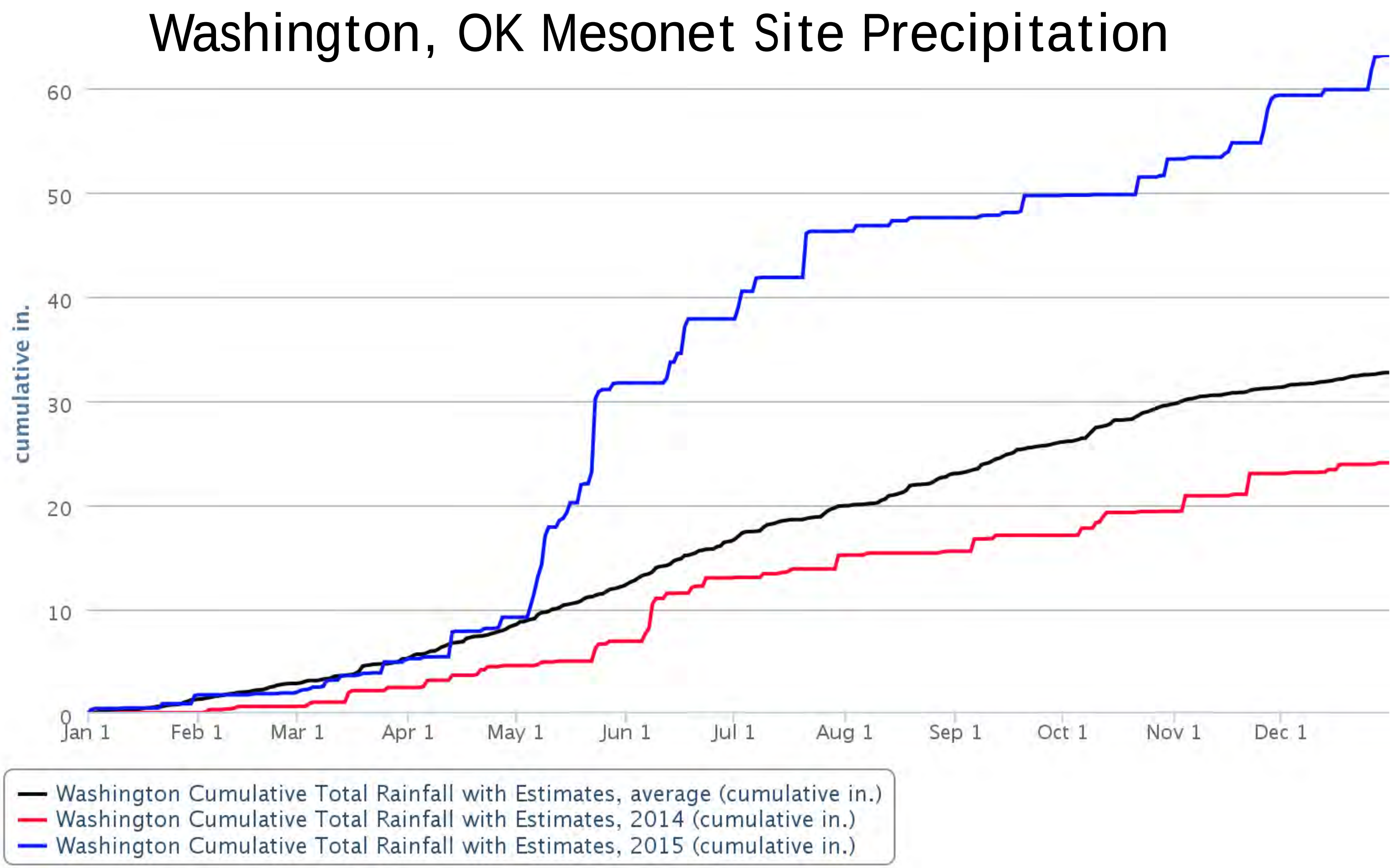
# Impacts of Dipole Precipitation




Average (Black) 2014 (Red) 2015 (Blue)

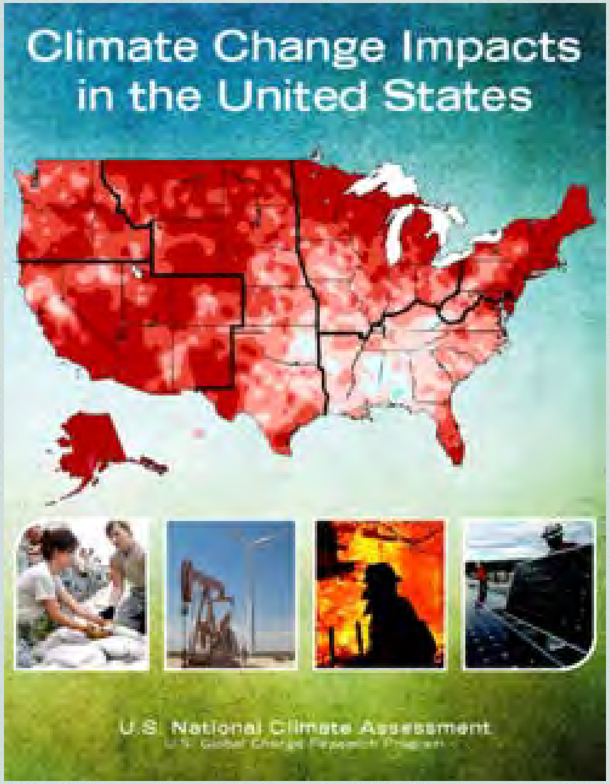

October 2014


May 2015

# Takeaway Messages for Oklahoma (Dipole Events)

- Droughts in the Plains often end abruptly.
- In Southern Plains, the transition is most likely to occur in Fall or Winter.
- In the Southern Plains, the flip between dry and wet years appears to be increasingly common (i.e. precipitation extremes have always existed in natural cycles but the variability is increasing).
- Dr. Basara and others are currently conducting research on the cause of the observed patterns. Early findings indicate large scale atmospheric patterns (i.e. Rossby waves) are a cause on a seasonal to inter-annual scale.

# Oklahoma's Observed & Future Changes to Climate




https://nca2014.globalchange.gov/


https://science2017.globalchange.gov/

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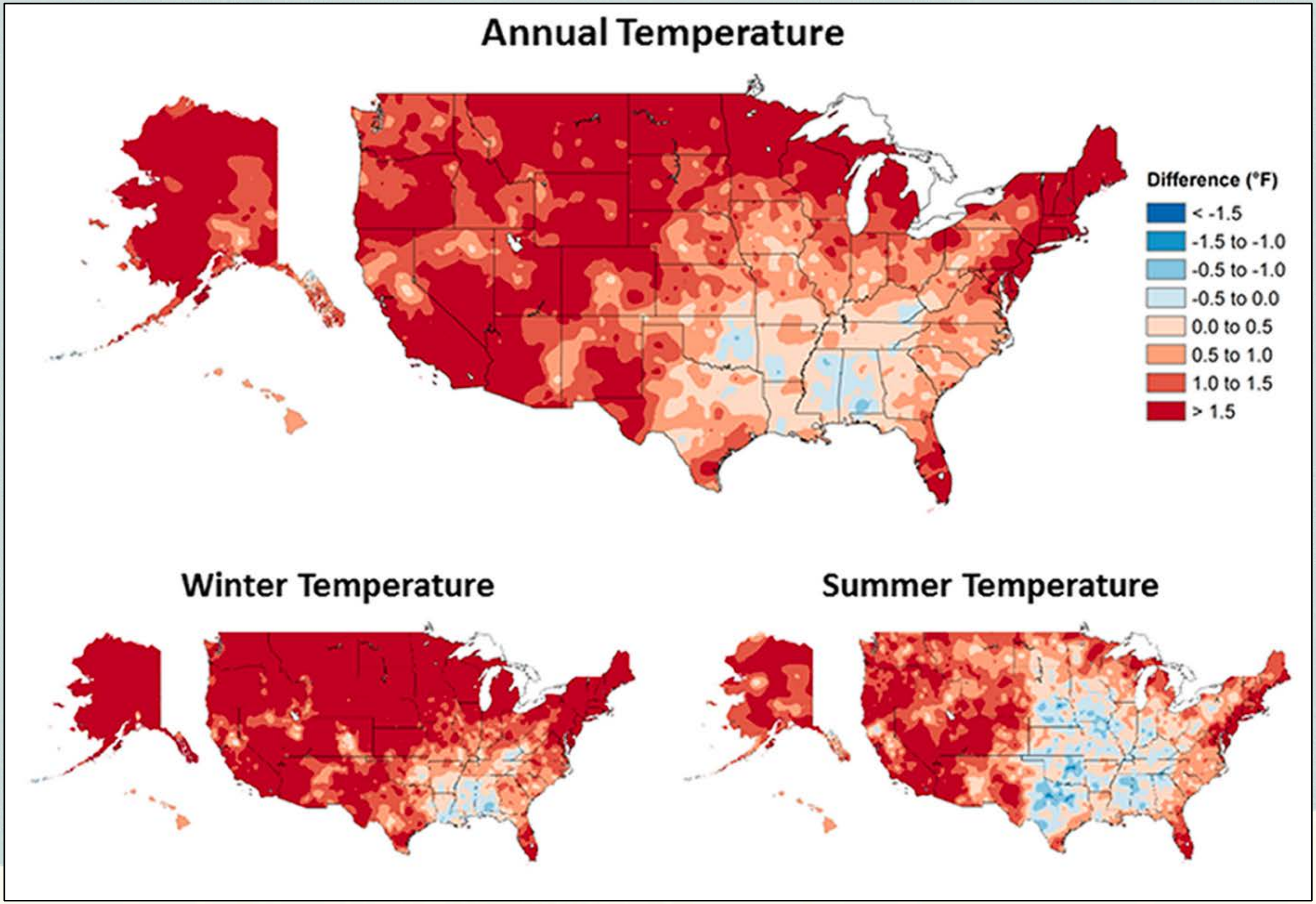
# Observed Temperature Changes

(1986-2016) average relative to the (1901-1960) average

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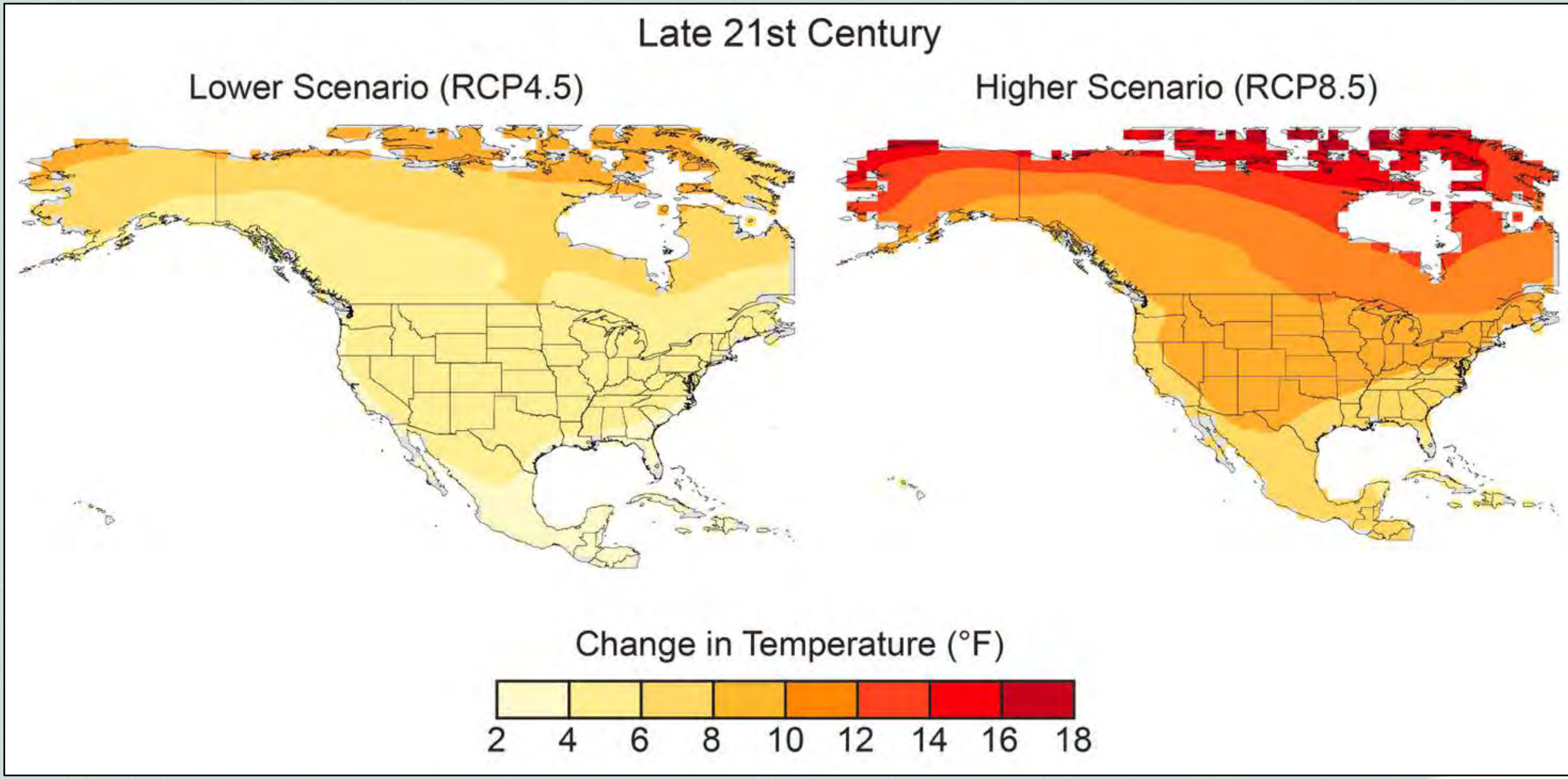
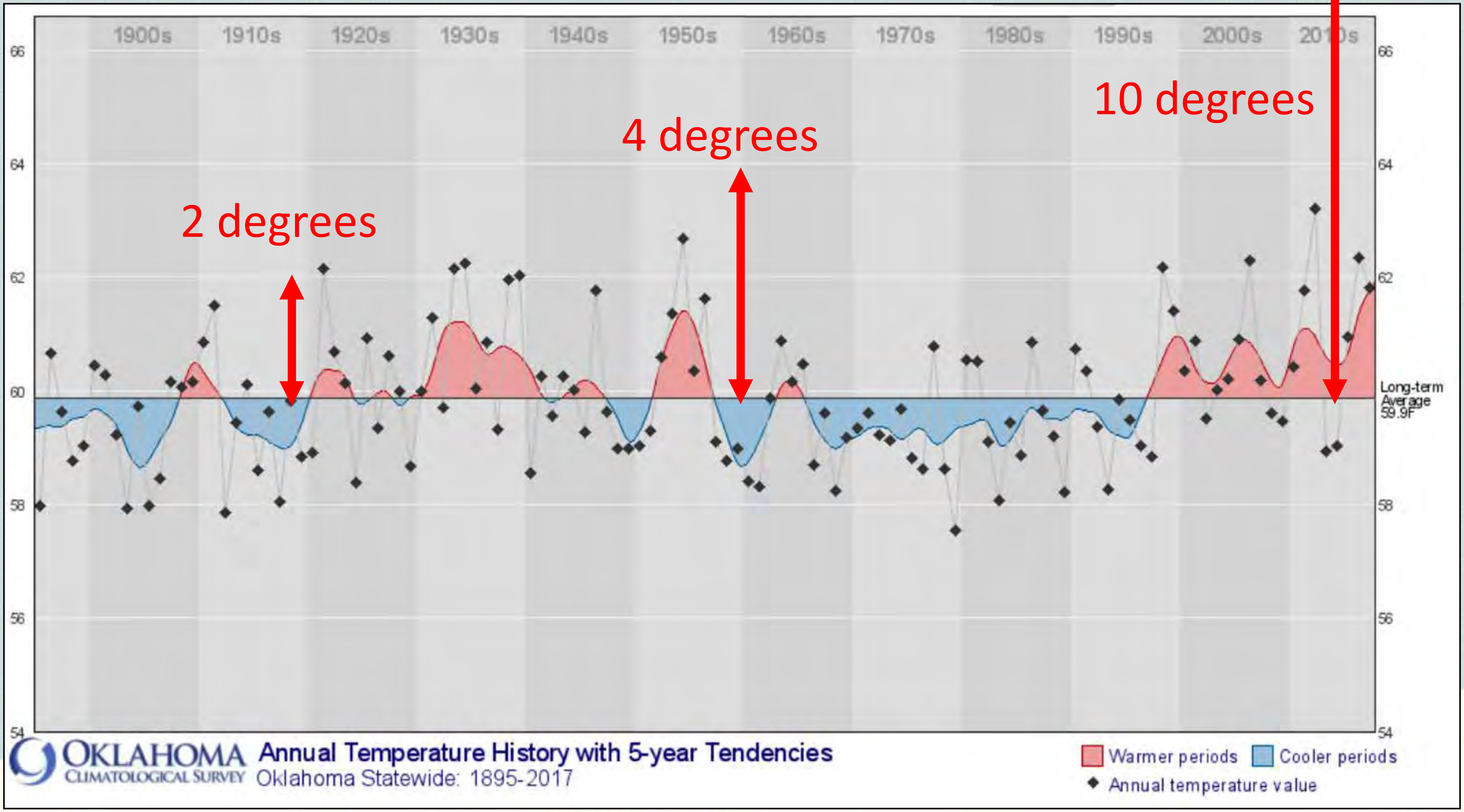
# Projected Changes in Annual Average Temperature

## (2070-2099) relative to (1976-2005)



# Temperature Changes in the Southern Plains

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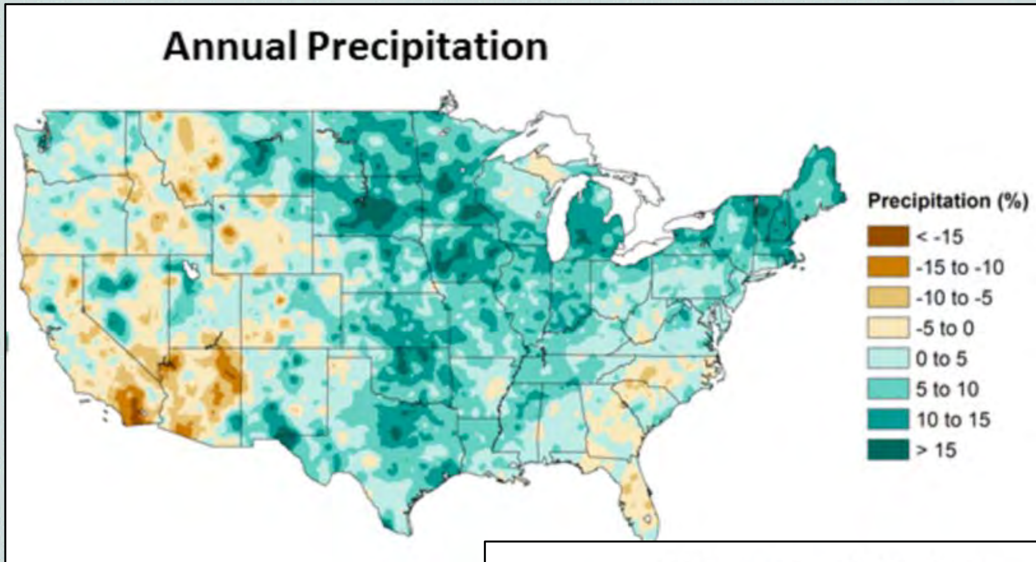
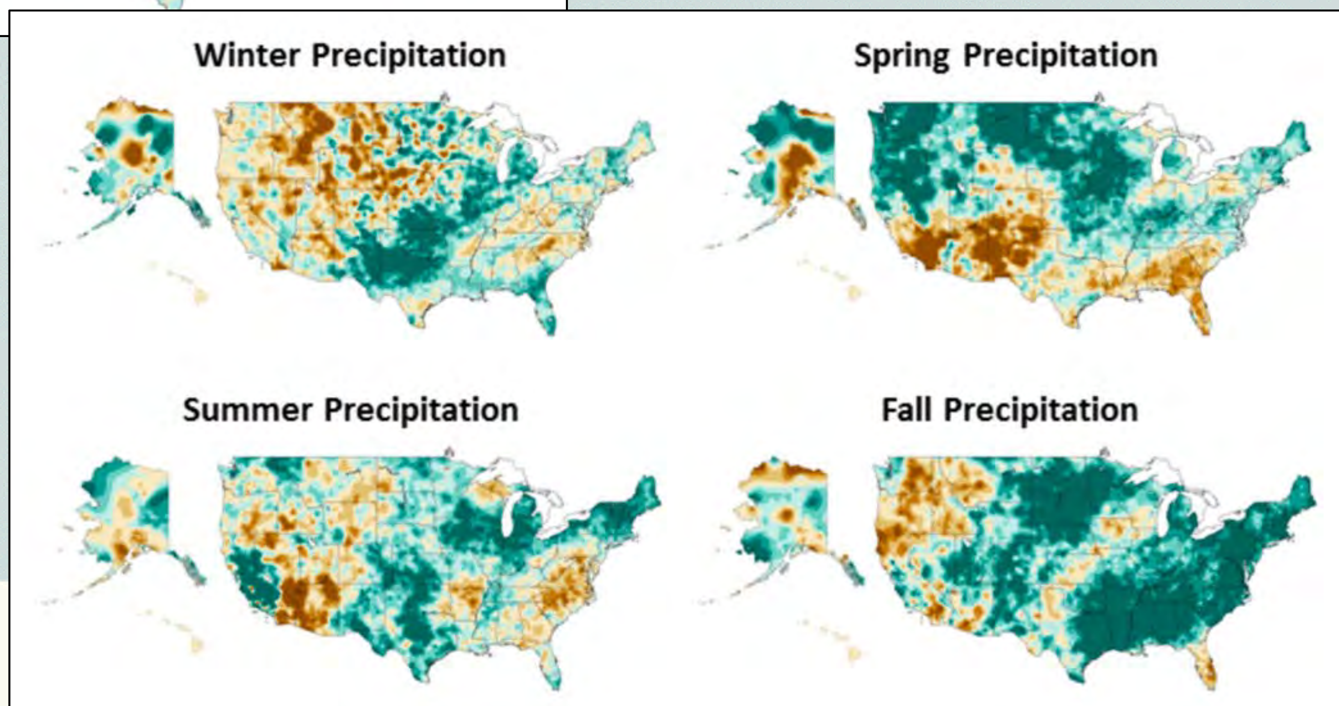
# Observed Precipitation Change

(1986-2015) average relative to the (1901-1960) average

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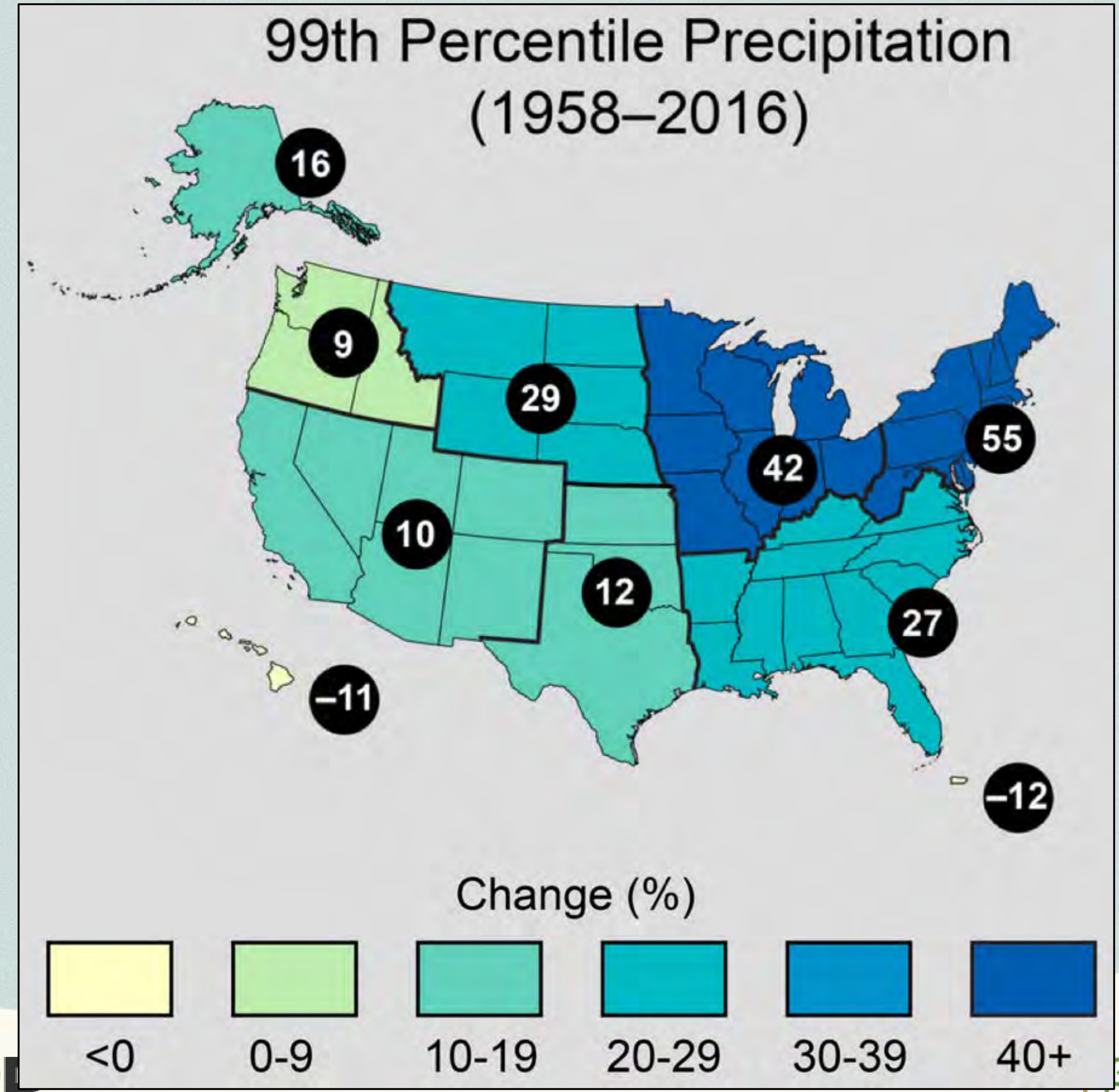
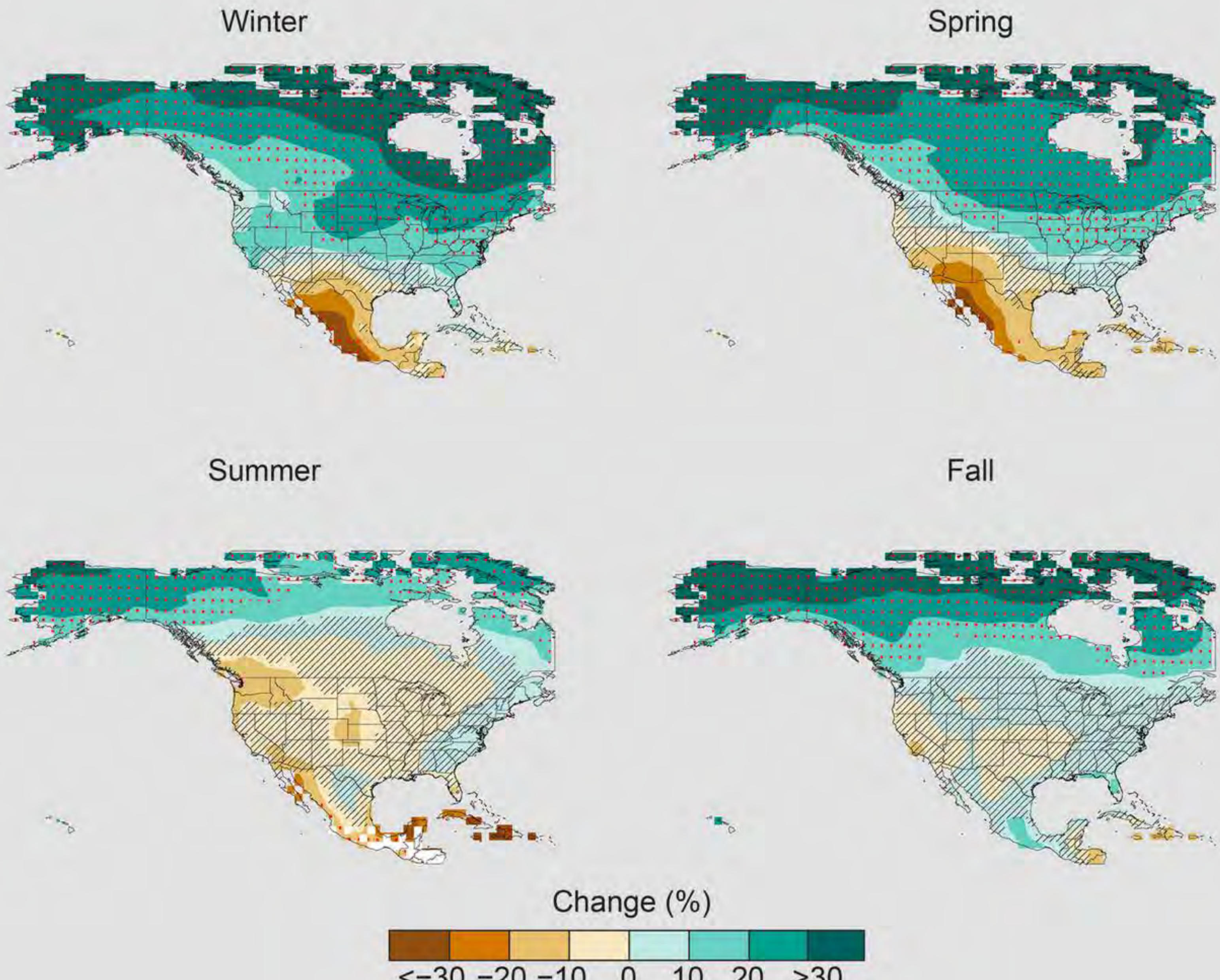
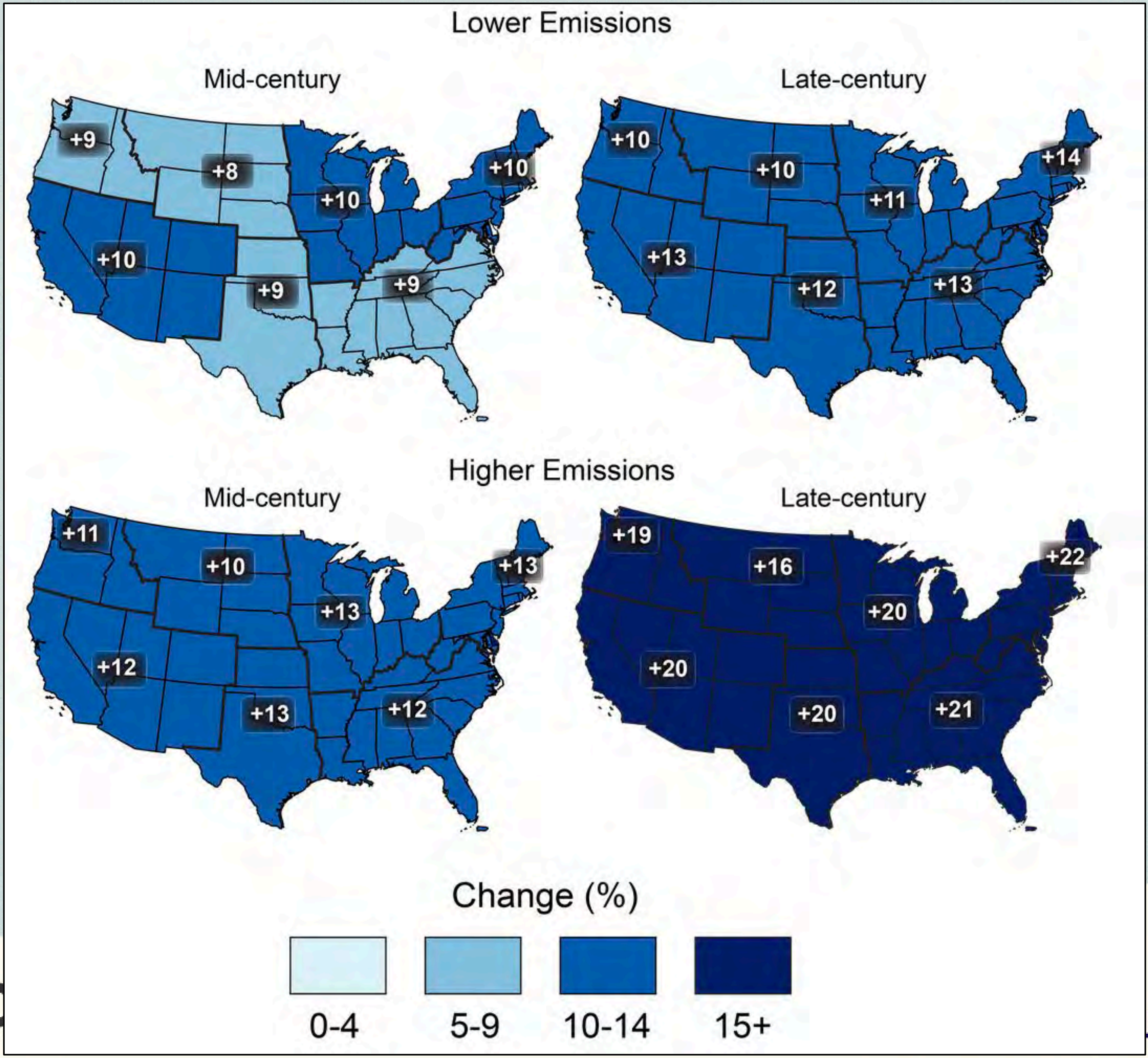
# Observed Changes in Heavy Precipitation

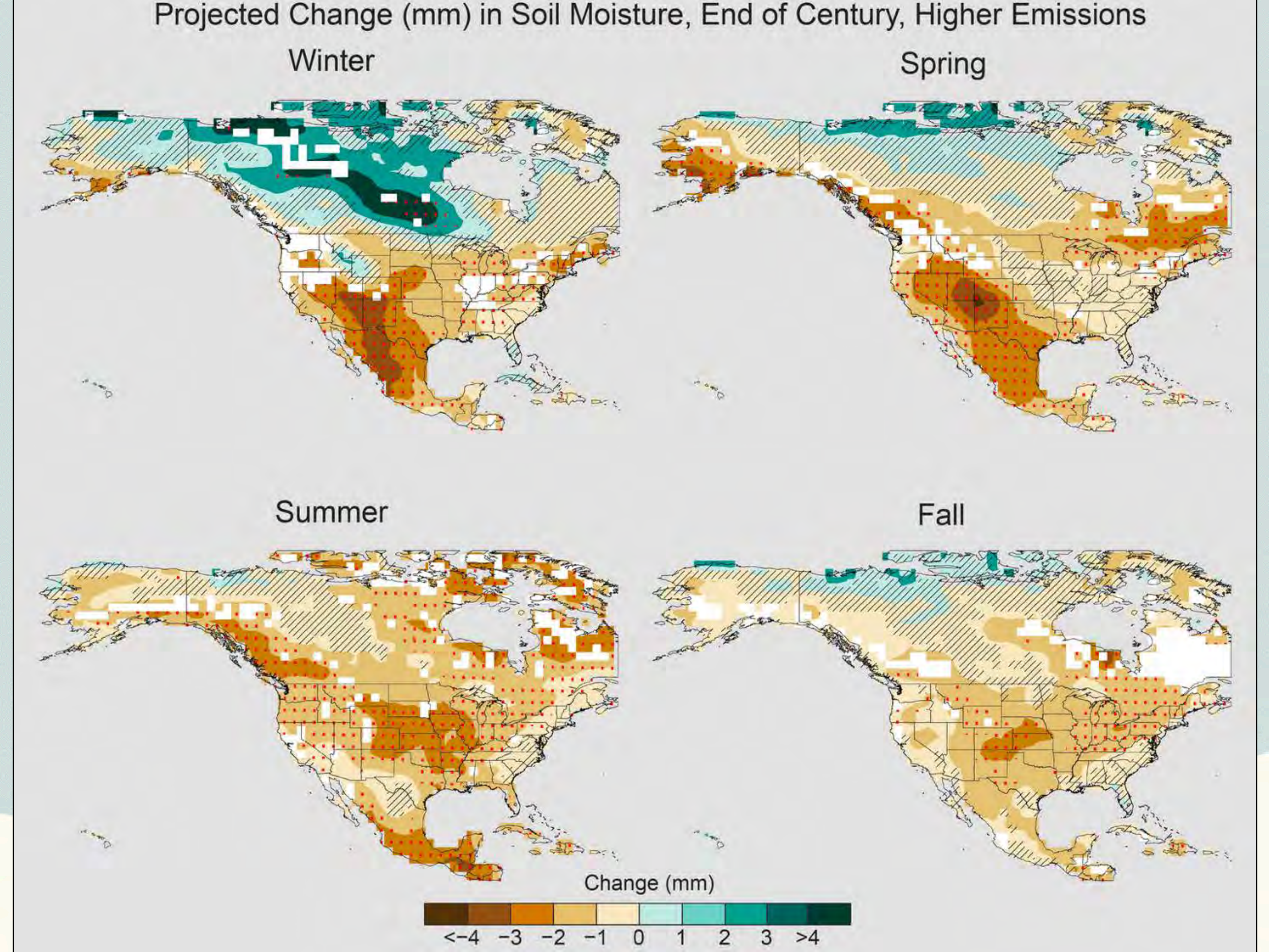


# Projected Change (%) in Seasonal Precipitation by end of century (2070-2099)



# Projected Change in Daily, 20-year Extreme Precipitation




Projected Change (mm) in Soil Moisture, End of Century, Higher Emissions
Winter
Spring
Summer
Fall
Change (mm)
<−4
−3
−2
−1
0
1
2
3
>4

# Takeaway Messages for Oklahoma
## (ENSO and Climate Variability and Change)

- Climate signal still dominated by natural variability
- ENSO effects are most prominent in winter
  - El Niño = cooler, wetter conditions
  - La Niña= drier conditions, more conducive for drought to form
- Warmer, wetter winters
- Increase in extreme precipitation frequency
- Higher temperatures will likely lead to the increase of droughts
- High precipitation variability creates lake and watershed management challenges.

# Thank You!

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